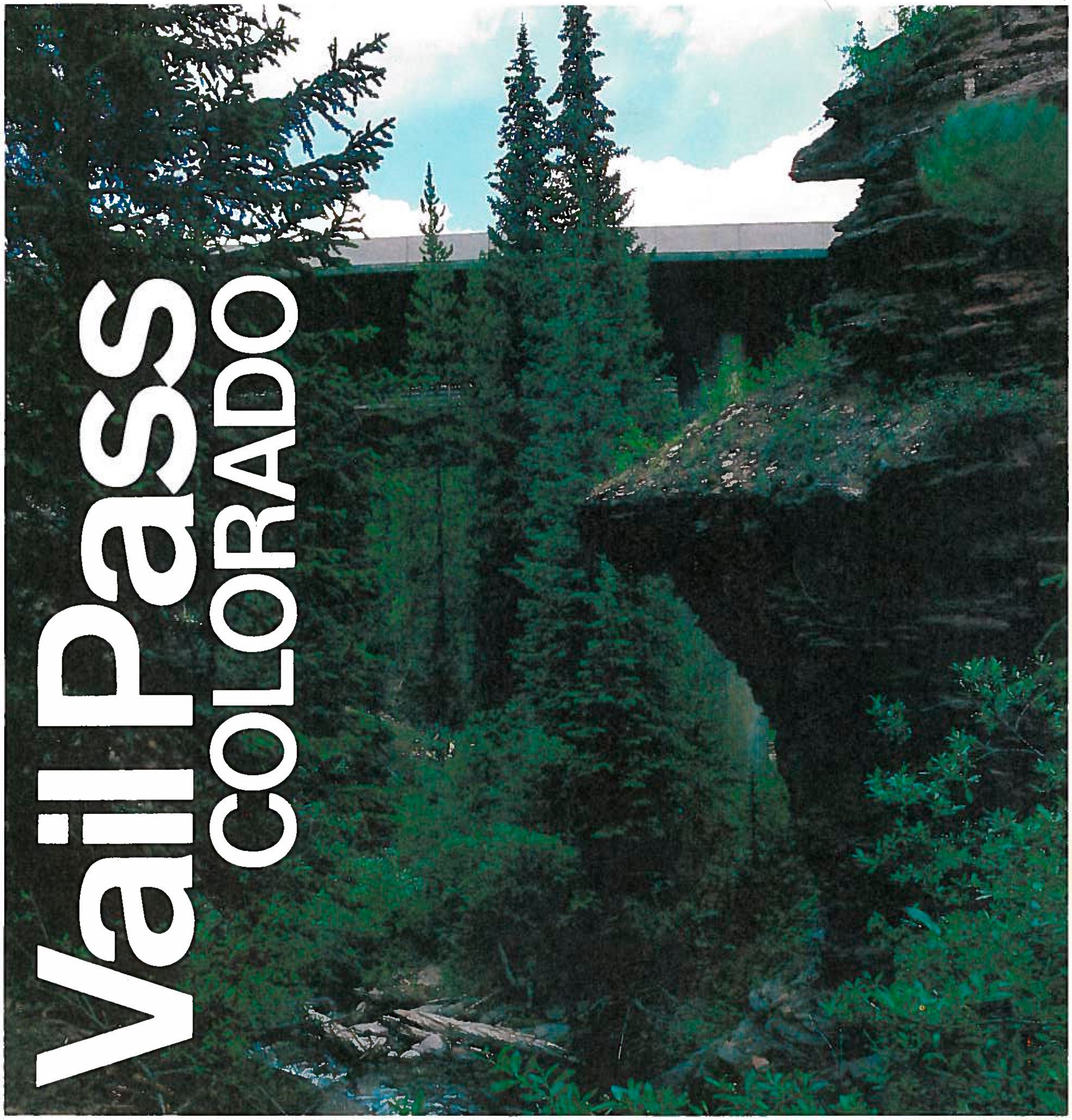
I-70 IN A MOUNTAIN ENVIRONMENT

Vail Pass COLORADO



FHWA-TS-78-208

I-70
IN A MOUNTAIN ENVIRONMENT
Vail Pass
COLORADO

PREPARED BY THE COLORADO DEPARTMENT OF HIGHWAYS
FOR THE UNITED STATES DEPARTMENT OF TRANSPORTATION,
FEDERAL HIGHWAY ADMINISTRATION OFFICE OF DEVELOPMENT,
IN COOPERATION WITH THE UNITED STATES FOREST SERVICE,
UNITED STATES DEPARTMENT OF AGRICULTURE.

THIS DOCUMENT IS DISSEMINATED UNDER THE SPONSORSHIP OF THE UNITED STATES DEPARTMENT OF TRANSPORTATION IN THE INTEREST OF INFORMATION EXCHANGE. THIS REPORT DOES NOT CONSTITUTE A STANDARD, SPECIFICATION, OR REGULATION.

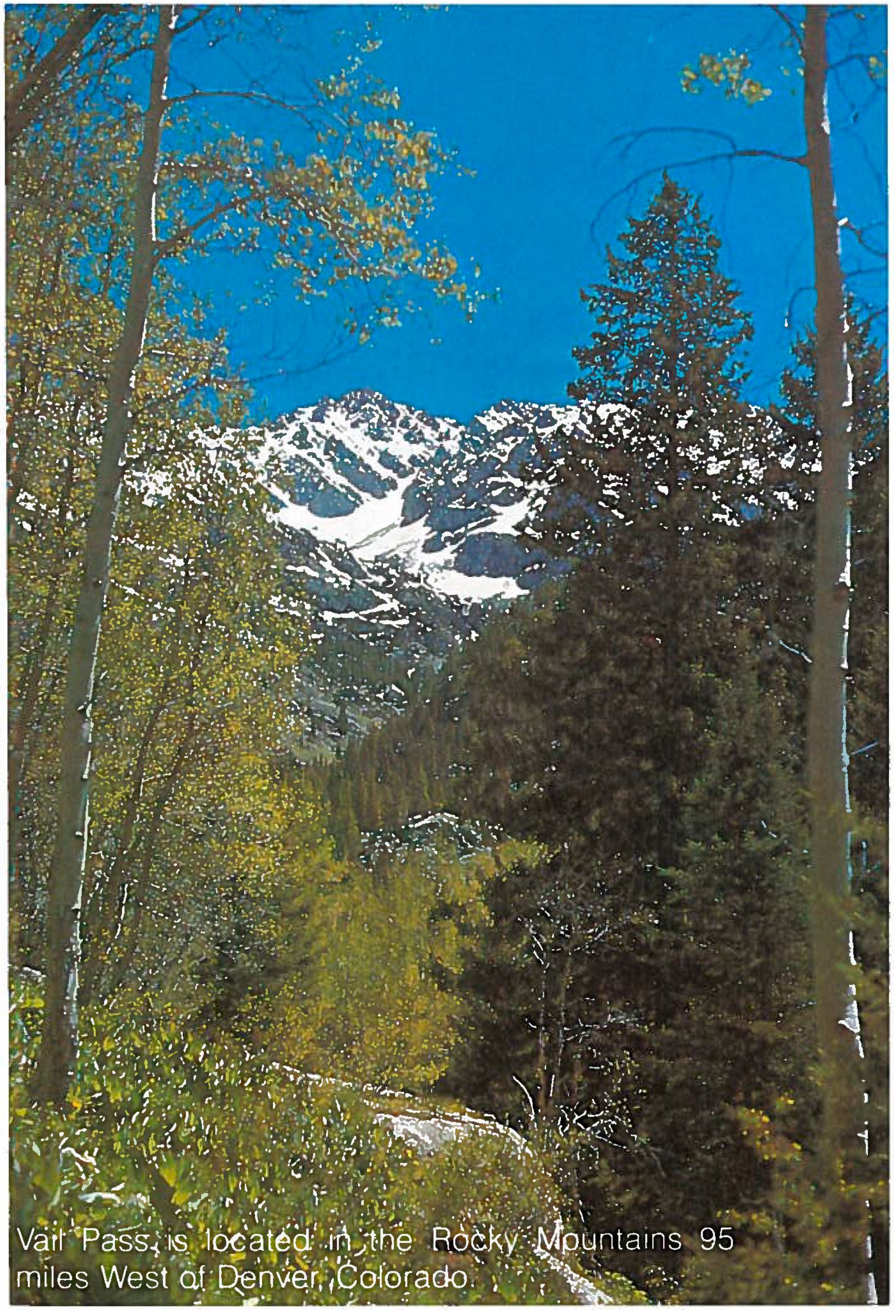
FHWA-TS-78-208

This booklet, 'I 70 In A Mountain Environment, Vail Pass, Colorado,' illustrates a successful environmental protection effort through interagency cooperation. Importantly this effort was accomplished at early project development stages and continued through to project completion. Professional expertise provided by the various agencies presented a truly interdisciplinary effort to which all were receptive. Interstate construction through a mountain environment often destroys or severely impacts many delicate environmental systems but it has been found that with intelligent actions by all concerned parties minimal adverse impact will result.

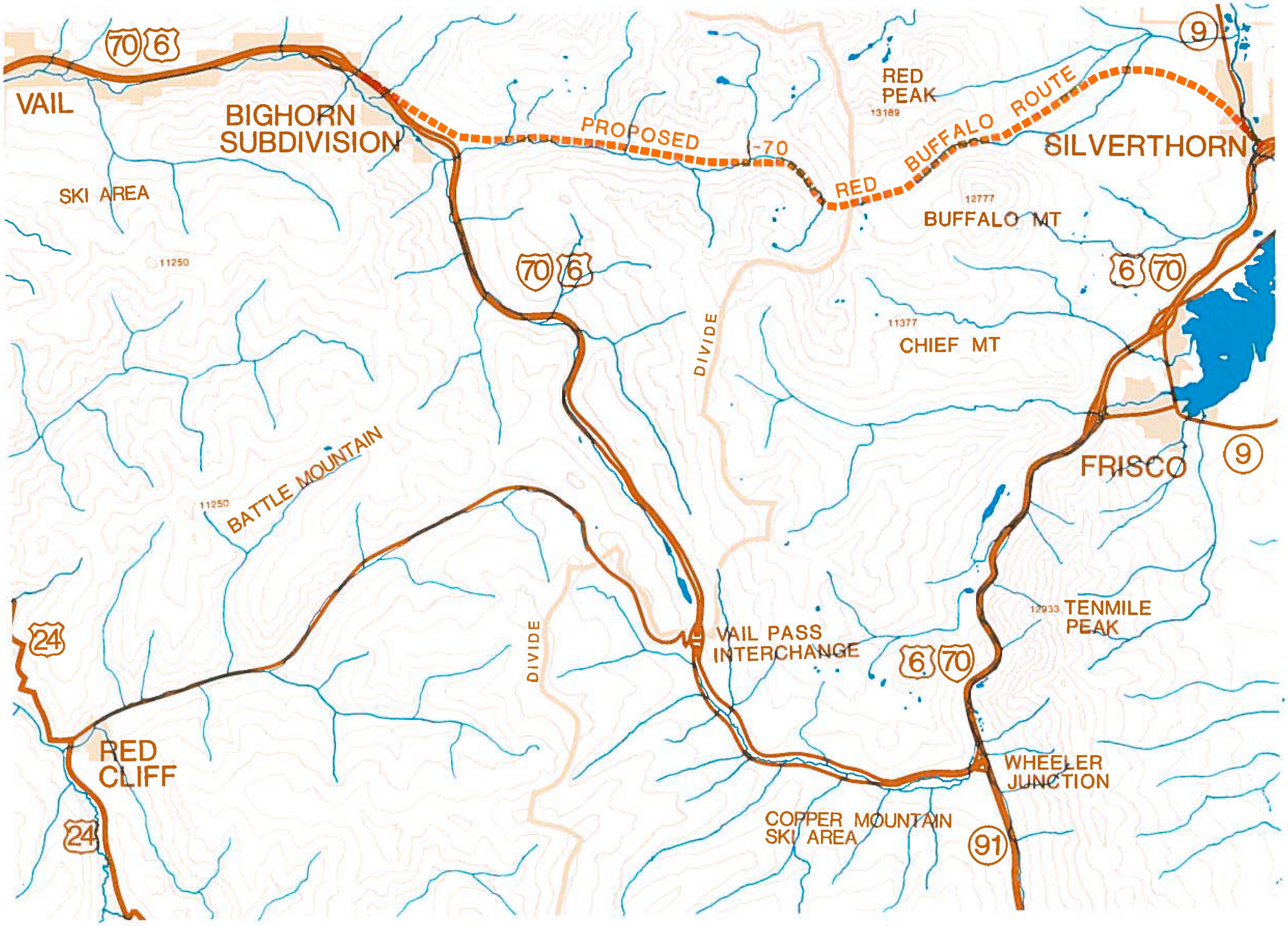
Jack Kinstlinger
Executive Director
Department of Highways

Craig W. Rupp
Regional Forester, Region II
USDA Forest Service

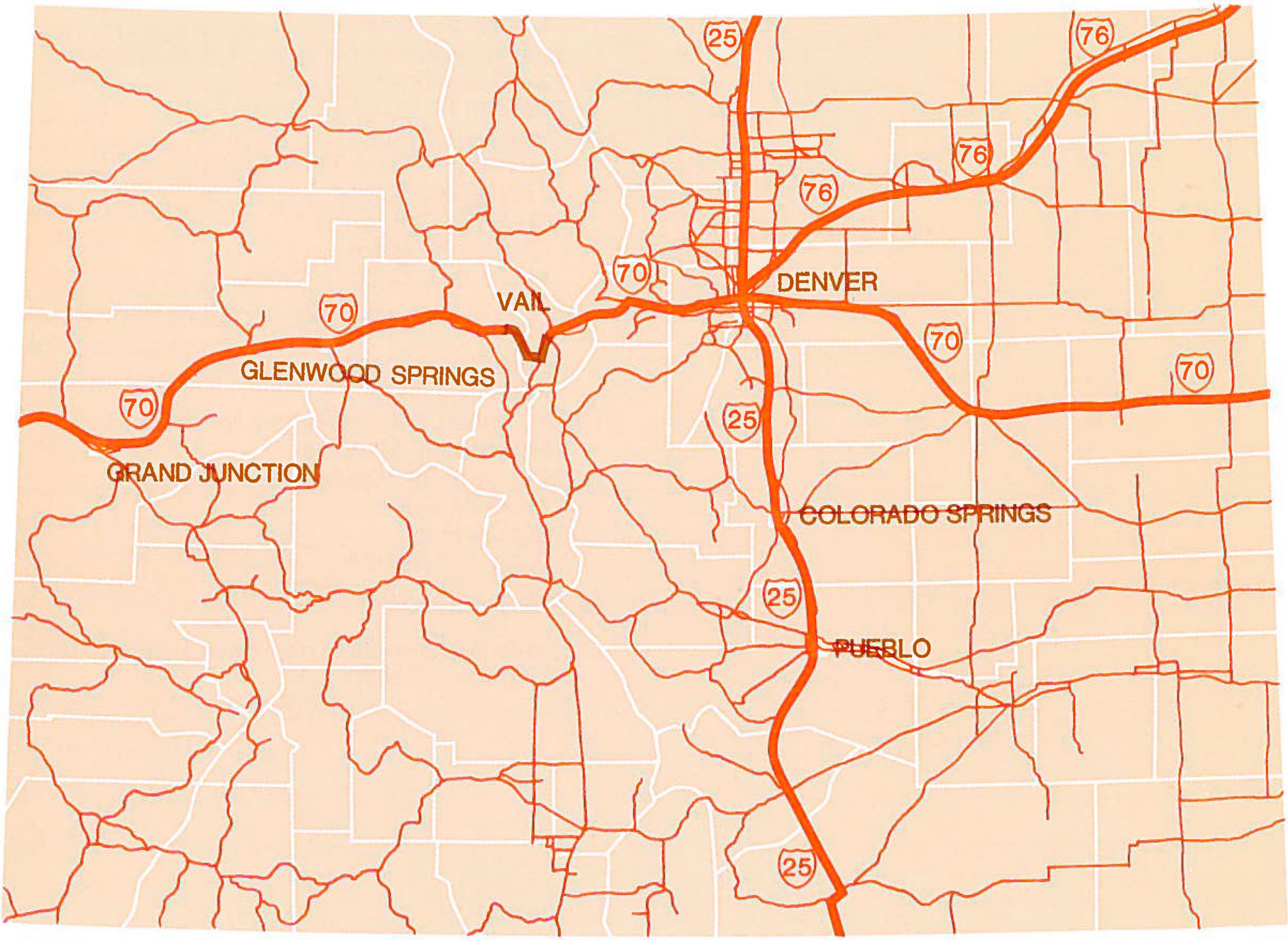
A. J. Siccardi
Division Administrator
Colorado Division
Federal Highway Administration



Vail Pass, is located in the Rocky Mountains 95 miles West of Denver, Colorado.



VAIL
BIGHORN SUBDIVISION
PROPOSED I-70
RED BUFFALO ROUTE
RED PEAK
13189
SILVERTHORN
SKI AREA
12777
BUFFALO MT
11250
11377
CHIEF MT
DIVIDE
BATTLE MOUNTAIN
FRISCO
12933 TENMILE PEAK
VAIL PASS INTERCHANGE
RED CLIFF
WHEELER JUNCTION
COPPER MOUNTAIN SKI AREA
70
6
9
24
91



25
76
76
76
70
DENVER
VAIL
70
70
70
GLENWOOD SPRINGS
70
25
GRAND JUNCTION
COLORADO SPRINGS
25
PUEBLO
25

V

ACKNOWLEDGEMENTS

State Highway District Engineers
Richard A. Prosence
Robert E. Heathcote

Federal Highway Administration Area Engineers
C. Phillip Smith
William R. Dixon

USDA Forest Service
Supervisor—White River National Forest
Thomas C. Evans

I 70 Liason Officer
Charles H. Miller
Maurice D. Barz

PUBLICATION STEERING COMMITTEE

Colorado Department of Highways
Michael J. Tupa

USDA, Forest Service, Rocky Mountain Region
Hubertus J. Mittmann

USDOT, Federal Highway Administration
Larry W. Smith
James Hunt
John J. Hamernik

DESIGN AND LAYOUT

Colorado Department of Highways, Graphics Unit
Dennis J. Masel

TABLE OF CONTENTS

INTRODUCTION

This book documents the many innovative ideas, designs and construction techniques used in the planning, design and construction of Interstate Highway 70 over Vail Pass. At an elevation of 10,603 feet, Vail Pass is one of the highest locations of an Interstate Highway in the United States. Due to the high elevation, the growing season is short, which makes for a sensitive vegetative environment. Soils are very erodible with great potential for mass movement. With this sensitive landbase and the spectacular scenery which attracts thousands of people from all over the United States and from other countries, the task of fitting an Interstate Highway into this mountain environment became a major challenge. Successful solutions for many of the sensitive environmental problems of this highway development were found and applied through the cooperation of many different agencies and professionals.

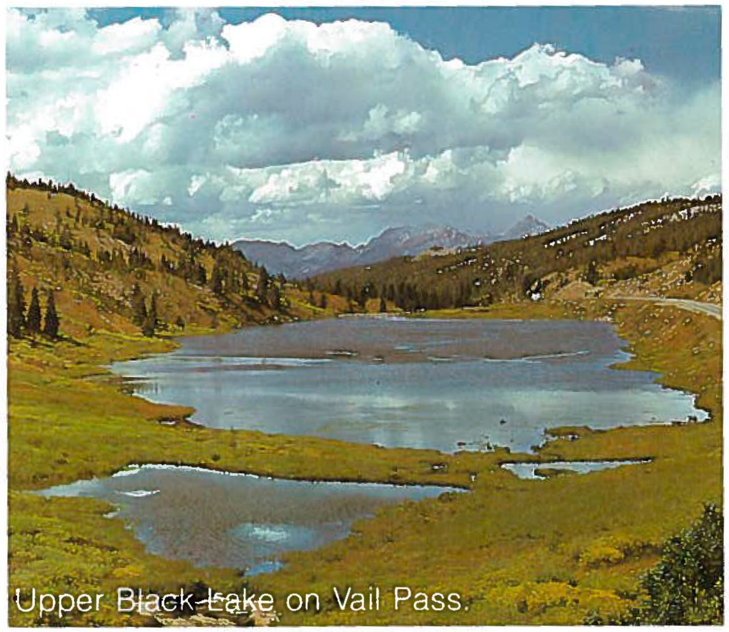
INTERSTATE PURPOSE

The Interstate Highway system, as it is commonly called under the Highway Act of 1956, is actually entitled "The National System of Interstate and Defense Highways." Standards implementing this act include criteria relating to heavy oversized vehicles to accommodate a variety of military vehicles. Although conceived primarily as a high-speed, multilane, divided highway for use by civilian traffic, in the event of a national emergency the roadway and structures will accommodate selected civilian and emergency vehicles in conjunction with military convoys.

The Vail Pass Section is designed to the same standards as its adjoining sections and the rest of I-70 in Colorado. Thus it will fulfill military requirements as originally intended.

PLANNING

In 1957, mileage was added to the interstate system which extended Interstate 70 westerly from Denver, Colorado into Utah. This plan involved crossing the Rocky Mountains in Colorado with an interstate of high design standards. In order to resolve controversies that developed as to the route to be selected, a thorough study of alternative routes was conducted. The "Pavlo Report," compiled in 1959, recommended a route generally following U.S.



Upper Black Lake on Vail Pass.

6 using the Straight Creek Tunnel location and extending westerly over Vail Pass. The Vail Pass segment crosses the Gore Range at 10,603 feet elevation and remains one of the last segments of interstate across Colorado to be completed. In 1966 two corridors were proposed for Interstate 70 near Vail. These were the Red Buffalo and Vail Pass routes. In May 1968, pursuant to Sec. 3b of the Wilderness Act, the Secretary of Agriculture determined that the Red Buffalo route across the southern tip of the Gore Range-Eagles Nest Primitive Area was not in the public interest.

Corridor selection was thus limited to the Vail Pass proposal. The route remained controversial, however, and with the advent of the National Environmental Policy Act (NEPA) in 1969, a series of environmental impact statements were written, reviewed and revised. Construction began on a 1.5 mile section of Interstate 70 east of Vail in September, 1973, but environmental studies, reports and clearances on the full proposal continued through 1975.

Some 23 individual projects will be involved in the total Vail Pass construction schedule before its final completion in 1978.

INTERAGENCY COOPERATION

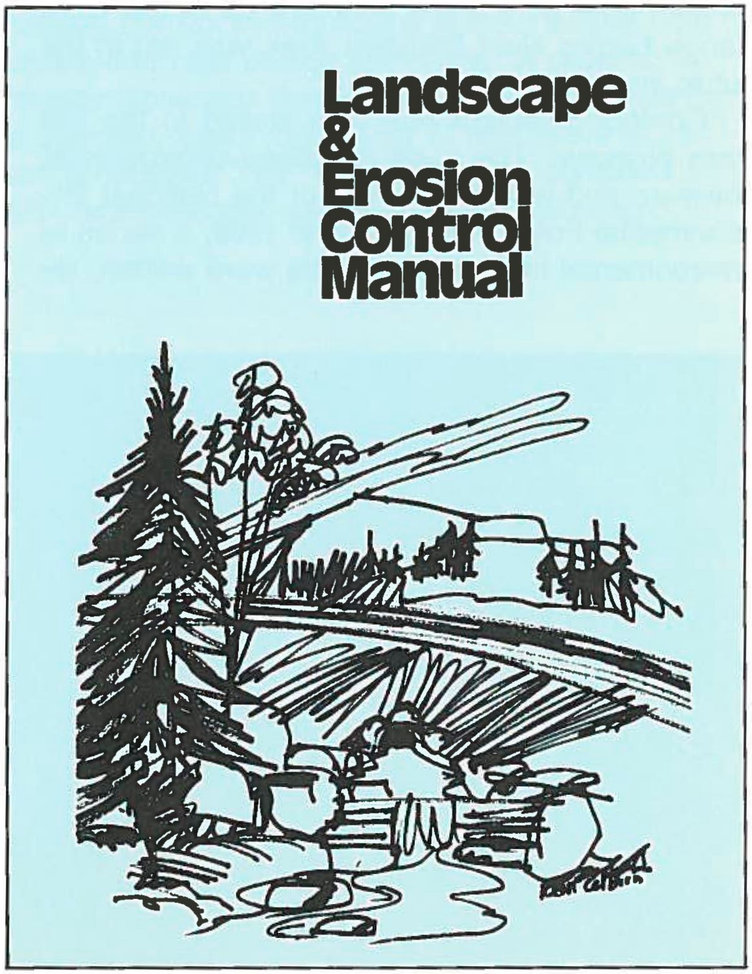
In the early 1970's, communication with other Federal and State agencies yielded substantial data to the design studies. The U.S. Forest Service as the land managing agency played a very active role in the development of the Vail Pass project through the White River National Forest. From the very beginning every effort was made to minimize or eliminate adverse environmental impacts. In 1975 the White River National Forest was the third highest recreationally used National Forest in the United States and the majority of visitors who use the area enter via automobile on Interstate 70. Because of this, scenic quality was considered a key value within the project area.

Subsequent memorandums of understanding were prepared between the Dillon and Holy Cross Ranger Districts of the Forest Service and the Colorado Division of Highways outlining construction techniques and contractor requirements to be followed on Vail Pass. These early design meetings and cooperation set the stage for a smooth running, environmentally sound and aesthetically pleasing project. The Colorado Division of Wildlife aided with game crossing locations, habitat criteria and channel change configuration information. Many local agencies offered assistance with information about water quality and revegetation techniques. The study team's purpose was to prepare design criteria for highway alignment and structure design.

ALIGNMENT AND DESIGN CONCEPTS

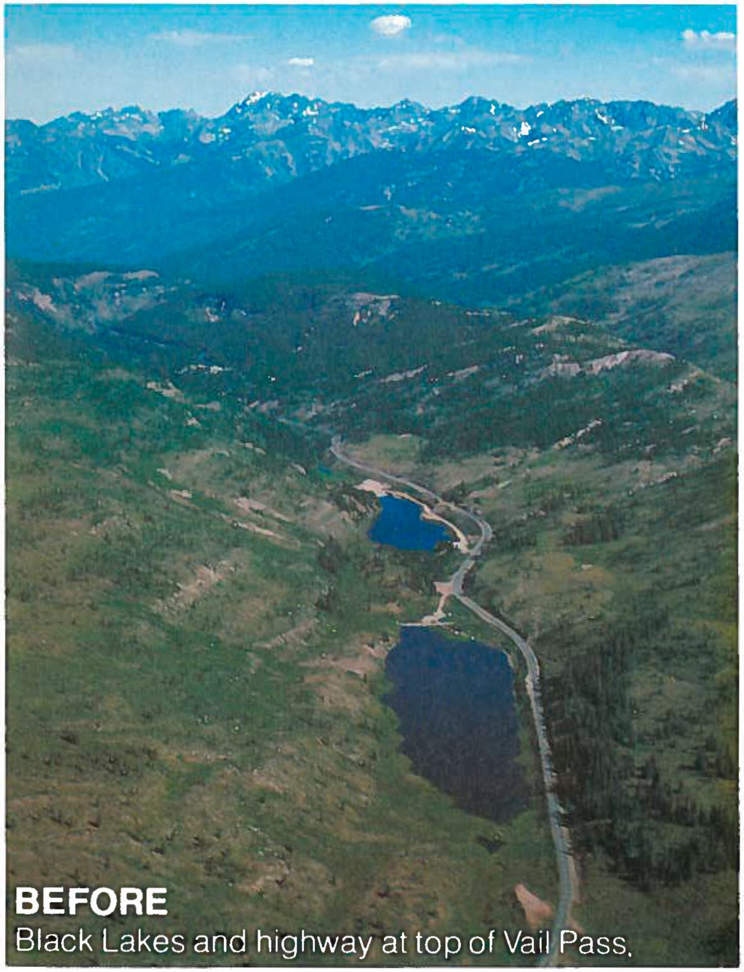
Once the corridor location was selected and approved, detailed alignment studies were initiated. "Intermediate Geologic Investigations" by Robinson and Lord, and the "Vail Pass Environmental Study" by Barton, Stoddard, Milhollin and Higgins as well as other studies listed in the appendix were used as a base for the formulation of alternative alignment proposals. Determination of the final alignment was not an easy task because of the many constraints from geologic, soils, ecologic, social, cultural and scenic quality considerations.

A number of land slide areas had to be crossed and most of the soils along the route are very erodible and subject to slumping. From the ecological standpoint two aspects were of major importance: (1) The fragile environment, with its high elevation and short growing season, and (2) The location of this highway, taking into consideration the deep snowpack and snow removal as well as rapid spring runoff. Wildlife crossings were a major consideration and had to be carefully planned. It was also imperative to protect all fishing streams from siltation and other pollution and to protect the drinking water supplies on both sides of the pass. Stream relocation and alteration therefore had to be held to a minimum. Since Vail Pass is known for its scenery, landscape alterations had to be visually acceptable. Vegetative patterns had to be analyzed, landform and soils studied and waterflows and intermittent drainage ways had to be inventoried in detail. All of these considerations were tempered with engineering requirements. Only after the final alignment was decided could the design portion of the highway and landscape treatment take place. But landscape design was an integral part of the highway design and not an afterthought to hide construction scars with cosmetic treatment. The alignment and design con-



cept stage was used to fit the highway to the land with the least possible disturbance from the ecological as well as the visual standpoint. Significantly, during many design meetings construction techniques learned on other projects were found to be applicable to the Vail Pass endeavor.

During early design phases the study team felt that predictable environmental impacts could be mitigated by using standard contract documents such as plans, specifications and bid schedules. But as studies progressed it became clear that unforeseen circumstances would occur during construction calling for readjustments. Consequently


BEFORE
Black Lakes and highway at top of Vail Pass.


AFTER
Black Lakes and highway at top of Vail Pass

special accounts were set up to finance unforeseen environmental protection expenses. Provision was also made for on-site monitoring during construction: personnel were assigned to help solve erosion control, landscape and revegetation problems as work progressed. In January 1975 the Colorado Division of Highways assigned a full time Erosion Control/Water Quality Specialist to Vail Pass. Although general landscape and erosion control guidelines were developed to the satisfaction of all, new and effective techniques were used with end results far superior to those previously expected. Consequently, as construction progressed, the new techniques were incorporated into standard contract documents thereby improving cost effectiveness and design.

LANDSCAPE TREATMENT

Many landscape techniques were used on Vail Pass to stabilize highway slopes and to achieve visual compatibility with the surrounding forested mountain sides. Although slope "beautification" was an initial objective, successful landscape treatments were soon found to be those that imitated existing landscape elements. Methods of erosion control, slope stabilization, and revegetation eventually merged into a format which has proven successful in the consideration of scenic quality. Hence construction techniques listed below overlap in results they actually accomplished.

Stable highway slopes were always the basic consideration in any treatment. At no time could landscape treatments undermine the engineered stability factors necessary for an interstate highway.

Highway safety was also an important consider-

After the needed borrow was removed the areas were immediately rehabilitated according to the grading and landscaping plan.

ation. Treatments were designed to assure the safety of the motorist. Median landscaping with large boulders and trees at the ditch line were used sparingly and only in areas deemed safe for the motoring public. Shoulder landform treatments were kept to the engineered requirement. Snow removal operations also limited the extent of shoulder treatments to modified berms and minor plantings. Larger trees were only planted near the top of cut slopes and the toe of fill slopes to minimize snowplow damage and allow ample snow storage. A landscape plan was developed for this project and was integrated into the construction plans. The intensity of the treatments

Landscape treatment showing grading into natural topography, seeded grasses, tree planting and incorporation of rocks to achieve blending between the disturbed and natural area.

varied according to the amount of landscape manipulation and area visibility. The most visible areas received the greatest attention. On these sites plantings, slope molding and other treatments were used to their fullest. Slope molding and rock cut sculpturing treatments were worked into construction operations before clearing began by modifying slope stake placement.

To achieve the necessary blending, landscape work was generally concentrated near the base of fills and the top of cut slopes. This standard was employed over most of the pass to satisfy safety, snow removal, and visual quality requirements.

The techniques used on Vail Pass developed from a design approach established early in the project's construction history. It was recognized that a motorist traveling 50 miles per hour would not be able to see detailed landscape patterns. This gross pattern recognition played heavily on landscape forms and linear qualities. Changes in colors and textures were minimal and often only seasonal. In pedestrian areas or areas of slower traffic movement, treatments concentrated on details to properly relate landscape features to the motorist.

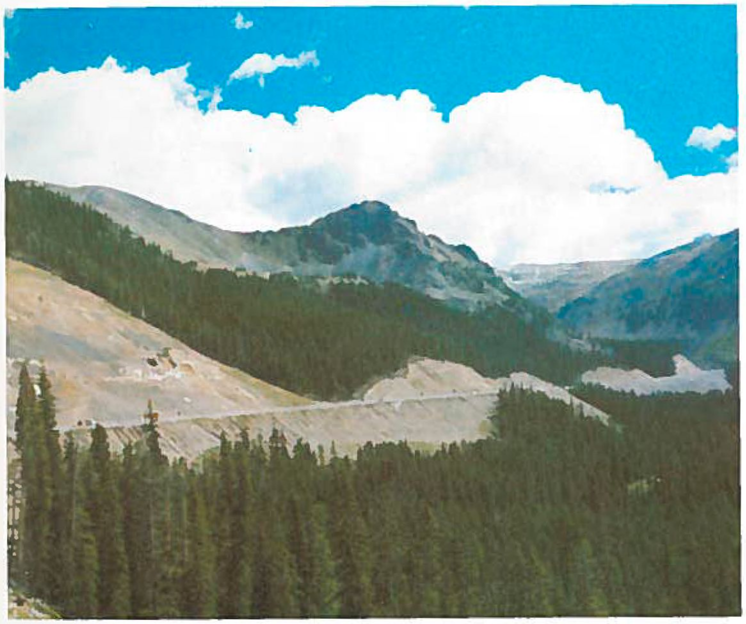
In areas of high traffic flow, landscape treatment reflected and extended existing landforms, vegetation patterns and landscape features. Because of the lack of detail required, plant material groupings often lacked species diversity typical of urban plantings. Plant groupings of one or two tree species were used without attention to understory shrubs and forbs.

The Vail landscape approach was intended to completely eliminate visible change points by modifying vegetation clearing lines, cut slope lines and even modulating median ditch location. All treatments were adjusted to blend with existing or planted features, simulating natural forms.

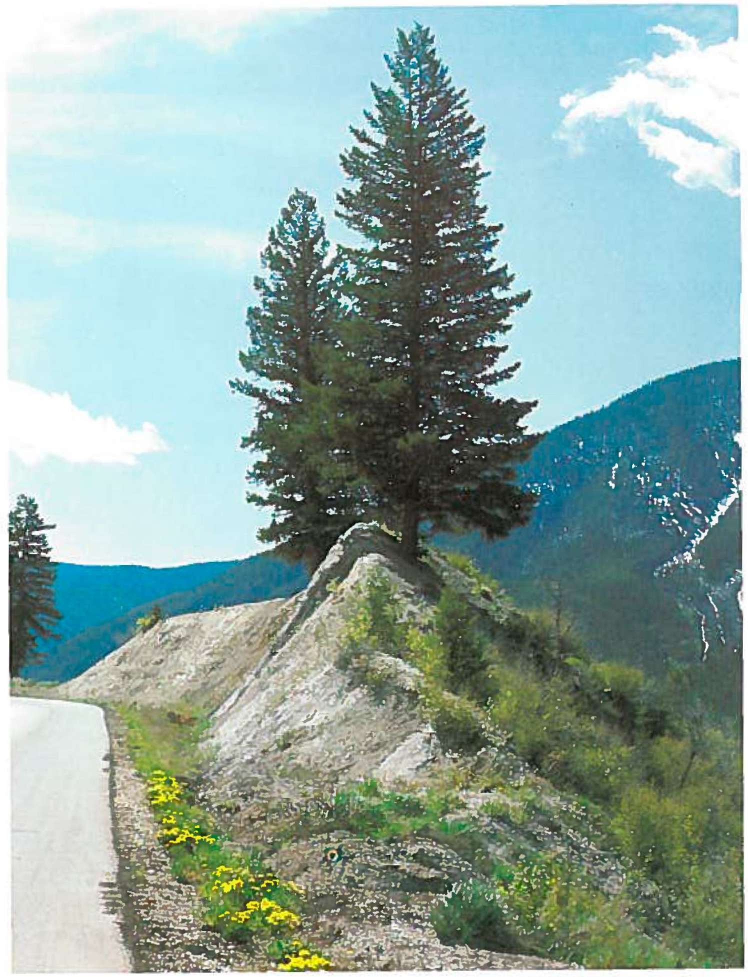
EARTHWORK

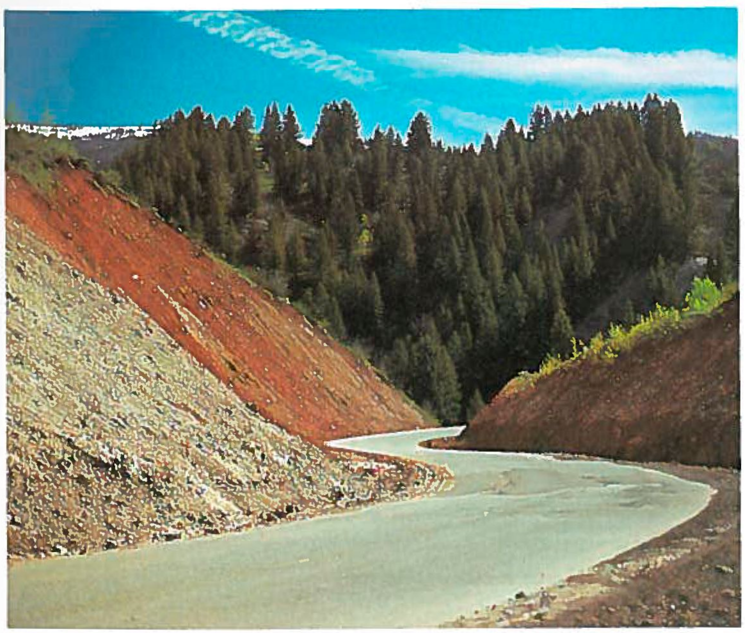
In the past, cut and fill slopes were designed only to satisfy slope stability and balance material quantities. As a greater awareness for aesthetics and the appearance of the final project took shape, it was realized that these maximum slopes were imposed on the landscape, limiting motorist appreciation for the lay of the land. Although slopes were designed with profile and cross sections, little attempt was made to modify these typical sections in the field.

On Vail Pass, slope molding techniques were incorporated into contract documents. Provisions were also added to test new techniques. Standard slopes were established as a minimum slope treatment. In areas where minimum cut slope treatments could be modified, additional materials generated were used to mold and flatten fill slopes. Cross sections were studied to suggest areas of possible slope molding. Slope stakes were then adjusted by the project landscape architect and survey squad to inexpensively accomplish slope treatment objectives.



All of these slopes look artificial, no attempt was made to blend them into the natural topography. Slopes shown are too steep for revegetation and will continue to erode, creating major maintenance problems.

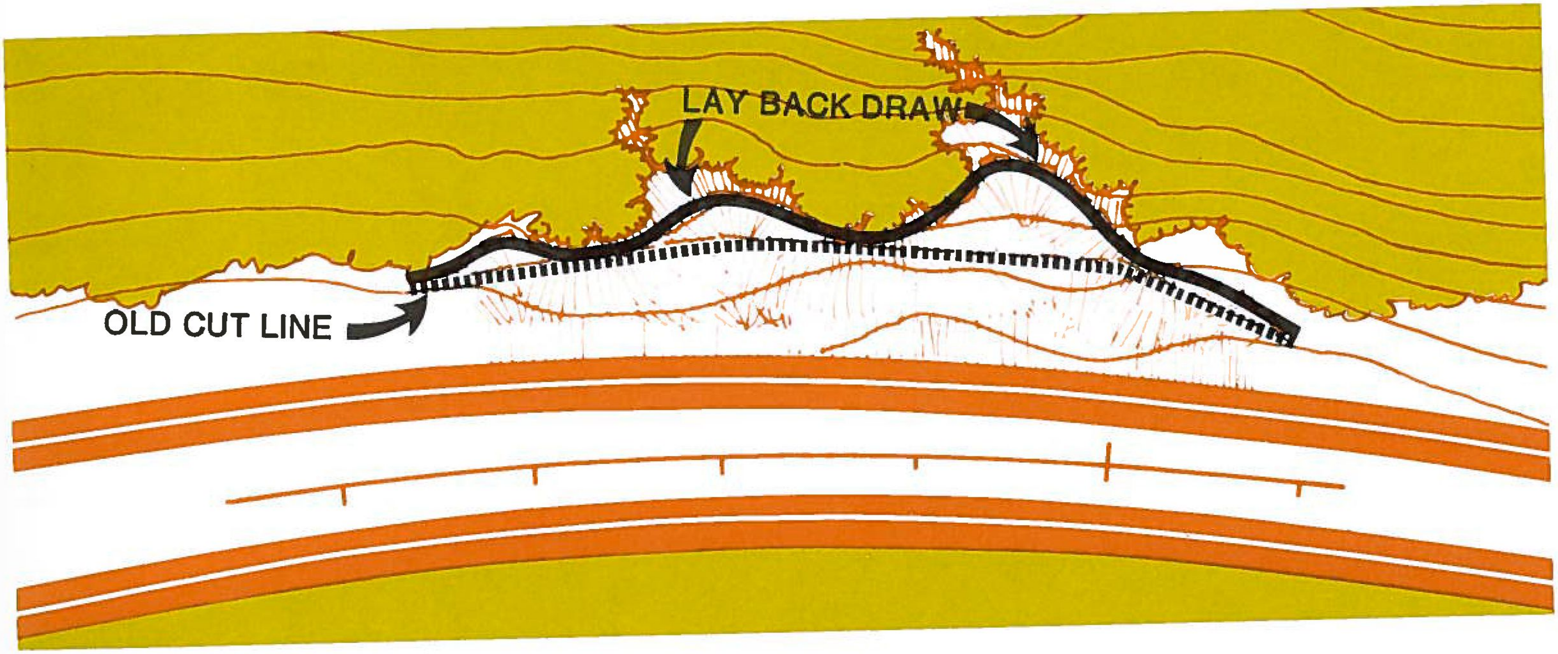


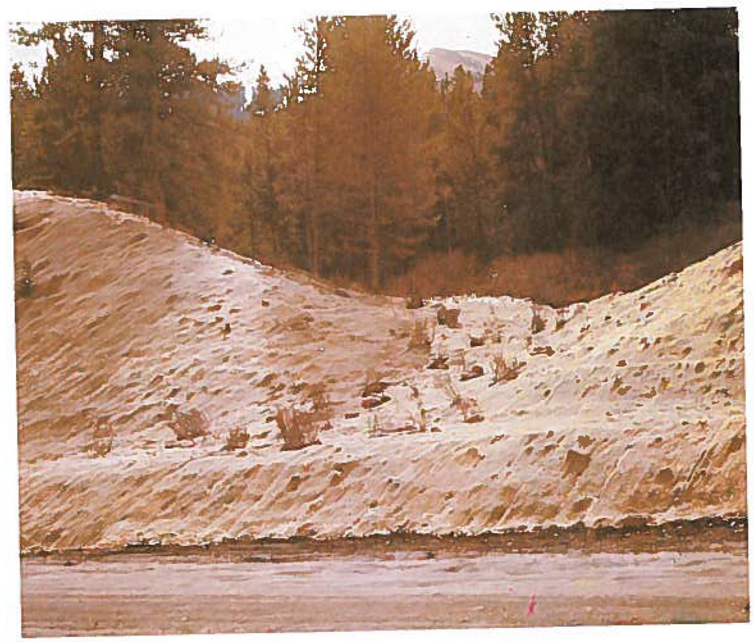


1. Lay Back Draws

In areas where natural draws were encountered the cutslope was laid back or flattened to match that of the draw. This treatment resulted in natural appearing cutslopes and added greatly to the overall project success.

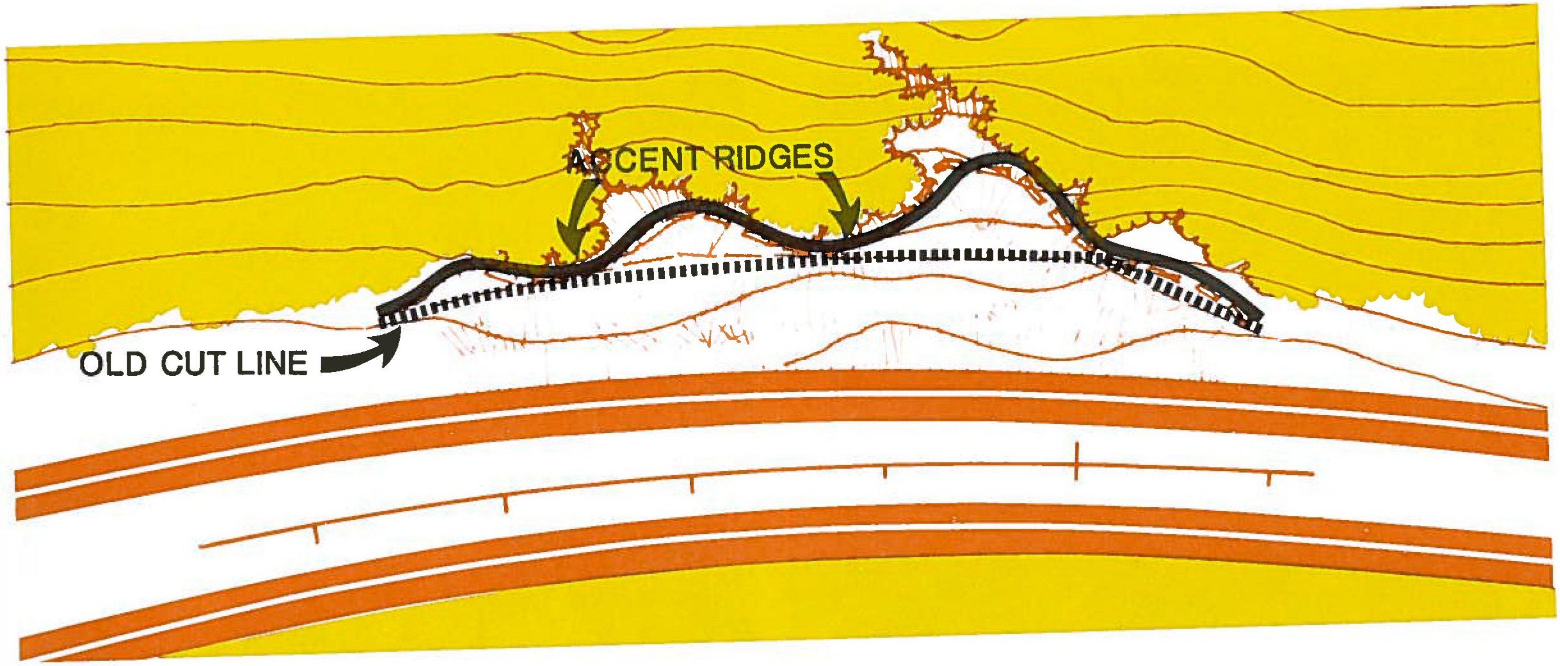
Draws are laid back to a natural angle, to visually continue existing drainages.

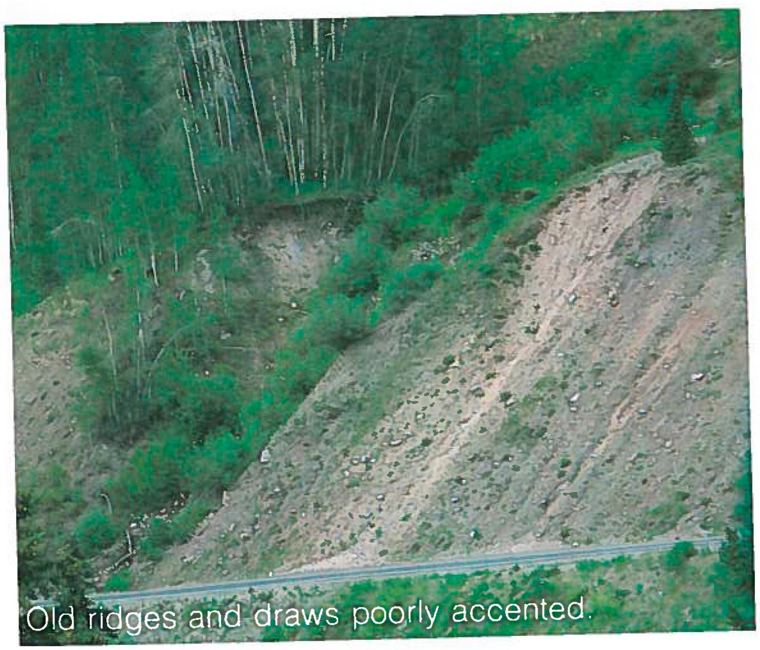

LAY BACK DRAW
OLD CUT LINE

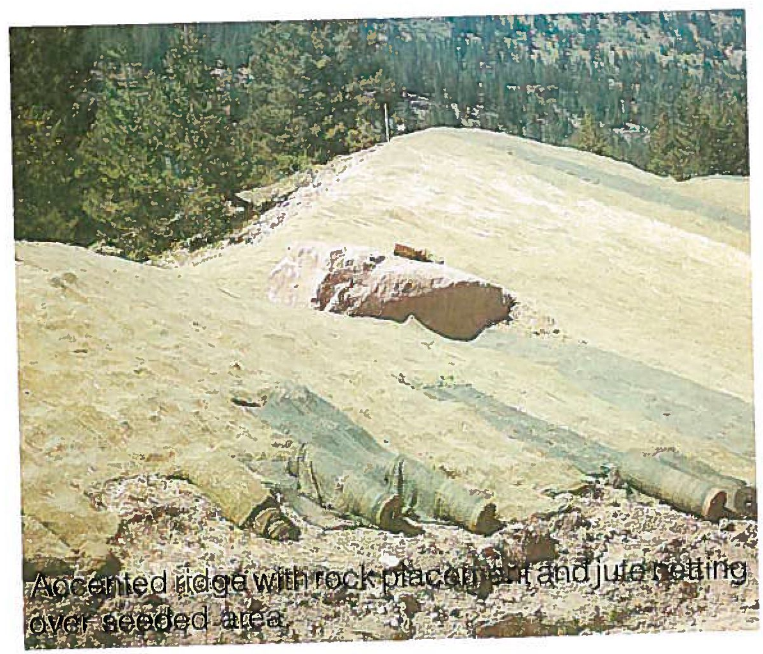


2. Accent Ridges

Where natural ridges were encountered they were accented by steepening (to stable limits) and rounding to a convex form. This is only successful along short runs. Where long ridge cuts were encountered, additional slope treatments were necessary. Although this treatment proved only moderately successful, it did smooth the natural to standard transition edge along the roadway.

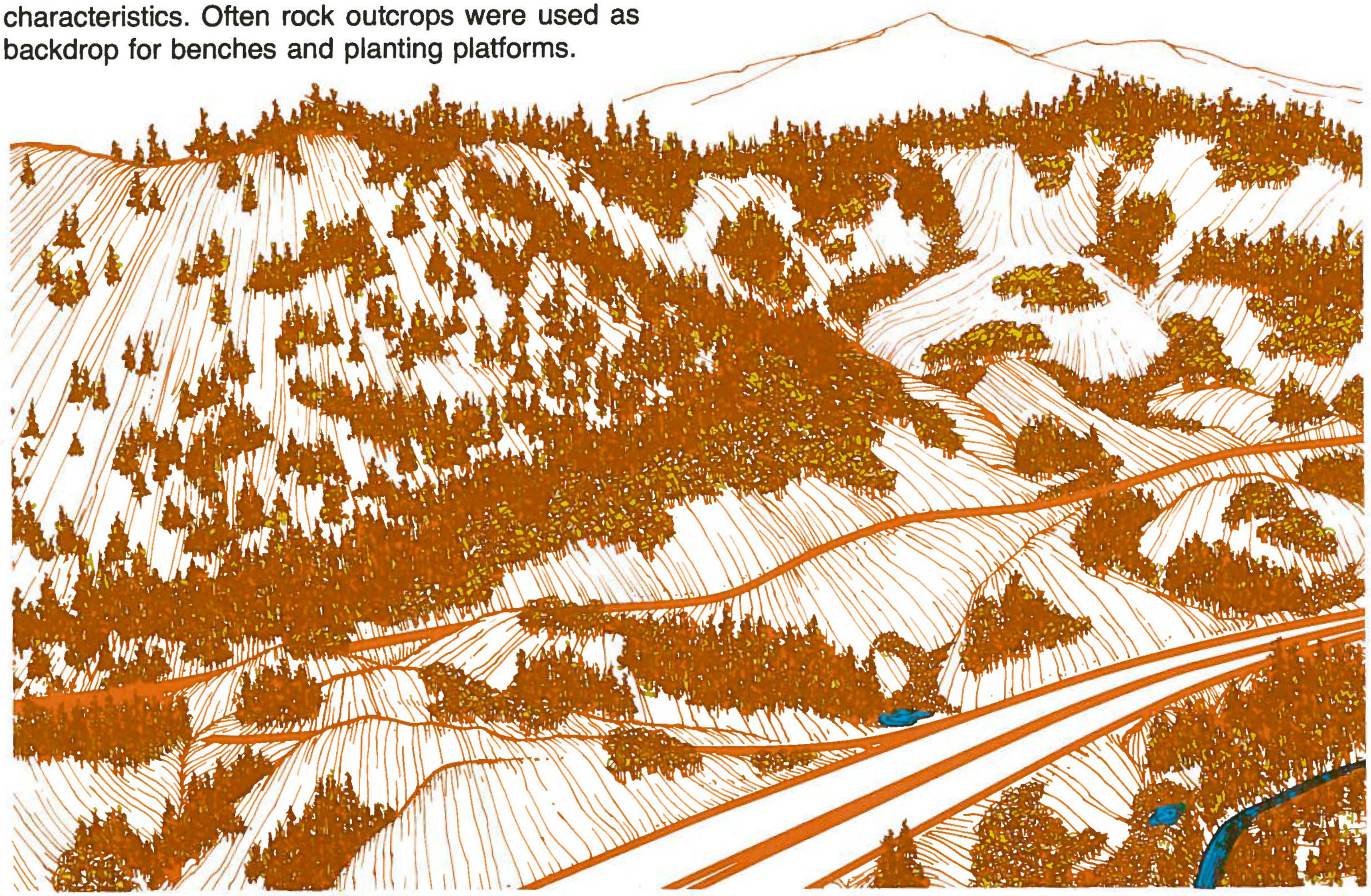


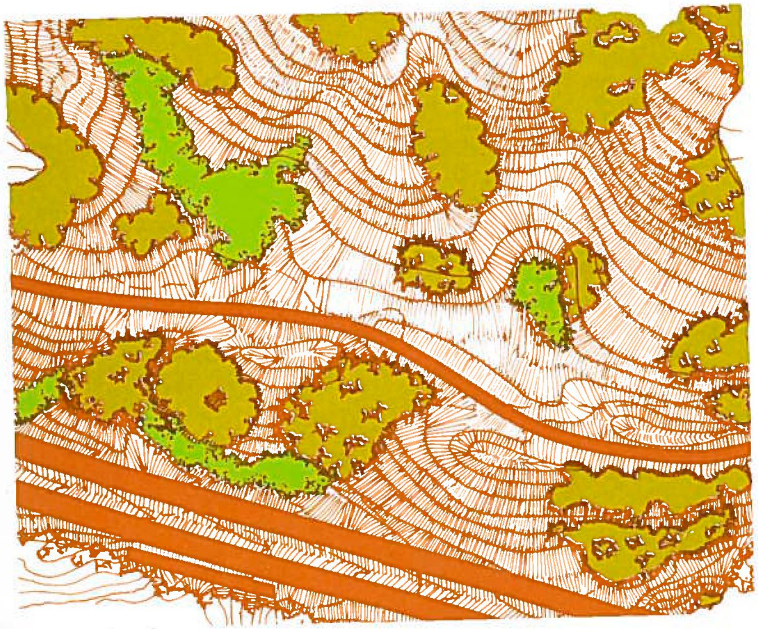

Old ridges and draws poorly accented.


Accented ridge with rock placement and jute netting over seeded area.

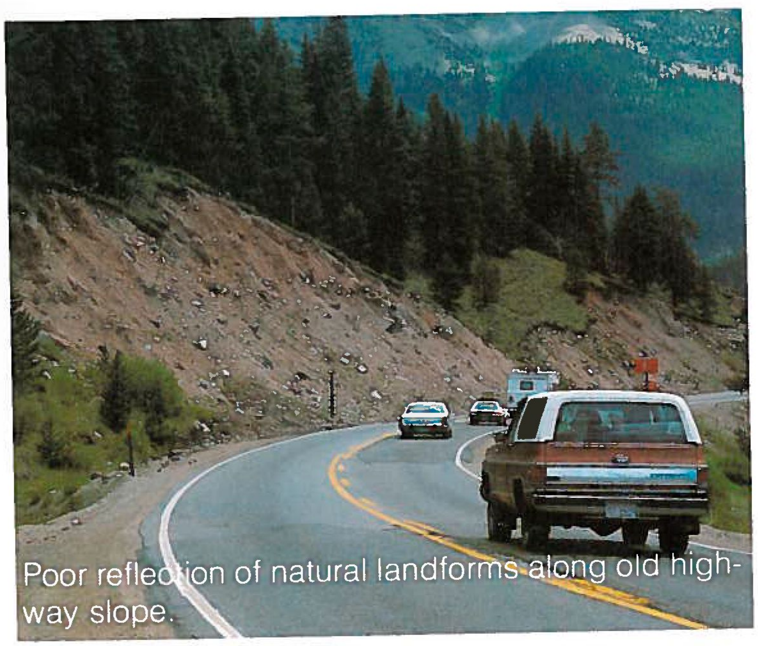
3. Created Landform Diversity

On some large slopes it was impossible to modify slope characteristics by just laying back draws and accenting ridges. On these slopes, diversity was created by modifying slope ratios and developing false draws and ridges along the slope. Large slopes were rarely left at their 2:1 ratio but often flattened and rolled to reflect existing landscape characteristics. Often rock outcrops were used as backdrop for benches and planting platforms.





Landform diversity, vegetative edge treatment and use of on-site rocks create the needed diversity for a natural appearing highway slope.

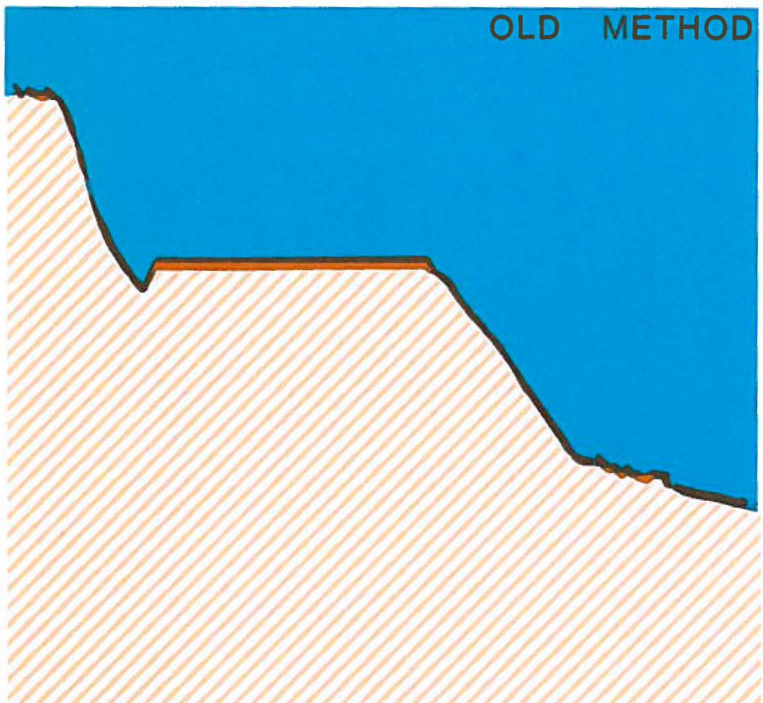


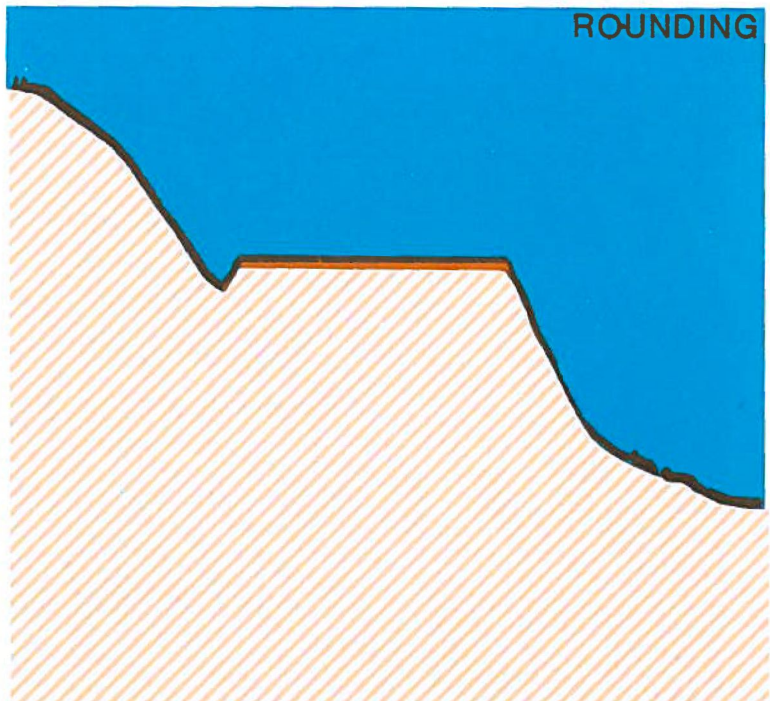
Poor reflection of natural landforms along old highway slope.

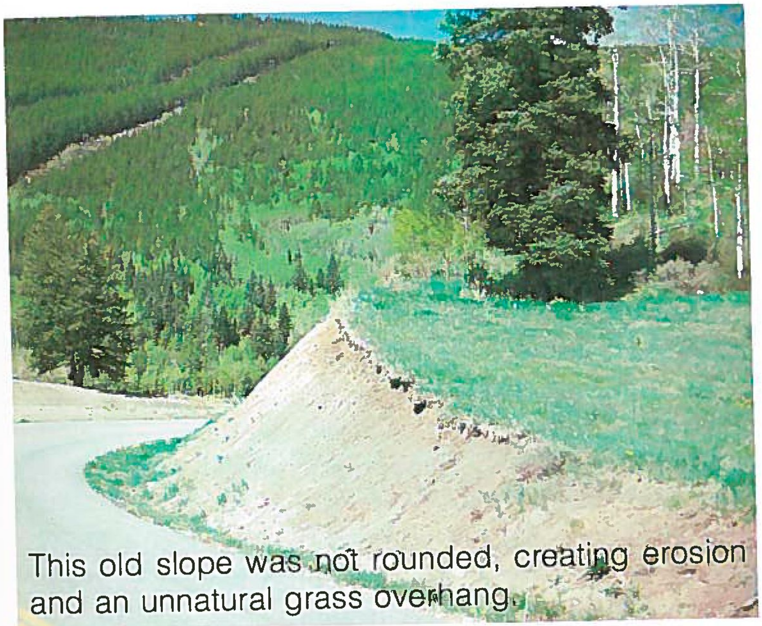
4. Rounding

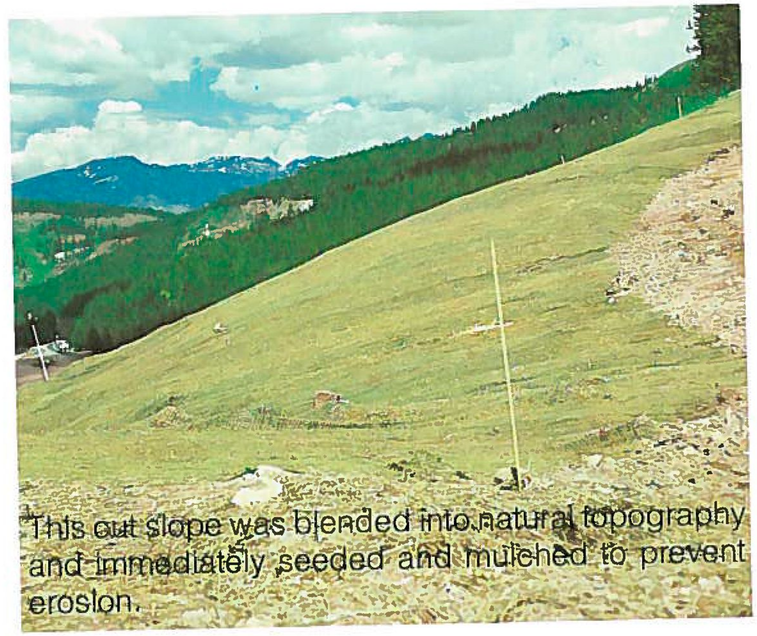
All cut slopes were rounded at the top to present a softer transition line between constructed and existing slopes. This treatment was relatively easy and results were significant. Where rounding occurred above the slope, additional right-of-way was needed and more vegetation was often disturbed. But the recovery time of the slope was considerably shorter, and visual scars healed faster.

Rounding was also effective at the toe of the fill slopes. Again, this treatment was intended to blend the fill slope with existing terrain.

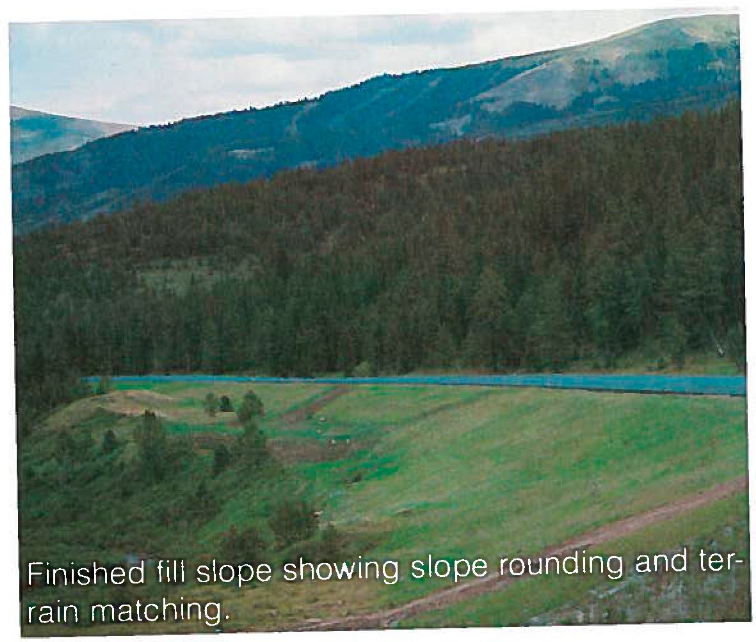





This old slope was not rounded, creating erosion and an unnatural grass overhang.


This cut slope was blended into natural topography and immediately seeded and mulched to prevent erosion.


Old fill slope treatment


Finished fill slope showing slope rounding and terrain matching.

ROCK CUT SCULPTURING

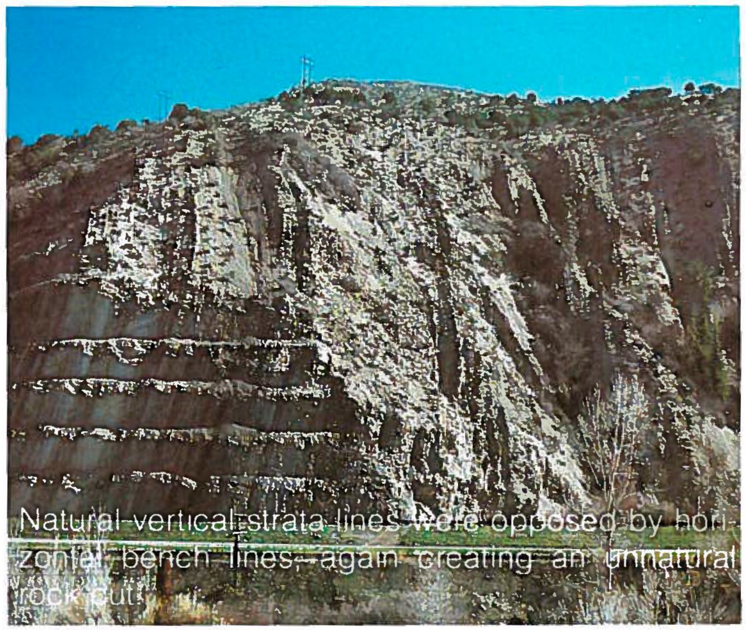
In the past typical rock cuts were presplit along one face or along a number of benched faces to a typical section which satisfied only slope stability and balanced material quantity parameters. These cuts presented the motorist with little more than fine geological cross sections to view. Typically, these rock cuts did not contain the diverse fracture lines characterizing natural rock faces. Pre-splitting methods left vertical drill scars every two feet, and uniform bench section left few natural rock faces for the motorist to view.

Vail Pass has an abundance of natural rock outcrops. The red sandstone was found easily erodible and often only required ripping with a dozer to expose rock cut faces. Many rock cuts encountered were of an unstable nature requiring structural geologists to monitor and design stable rock cut sections and construction techniques. The project team worked with geologists to design sculptured rock cuts which would be visually compatible with existing rock outcrops.

Plan and perspective concepts were drawn from typical sections to provide the contractor and project personnel with an idea of what was to be accomplished. It was always understood that this concept would change with on-site conditions. On highly visible rock cuts the project landscape architect often helped stake bench placement, insuring that the best rock faces would be preserved.

Rock cuts were designed to produce a staggered bench effect which would reflect natural terrain and accent natural fracture lines in the rock.

These vertical drill marks create an unnatural appearing rock face.

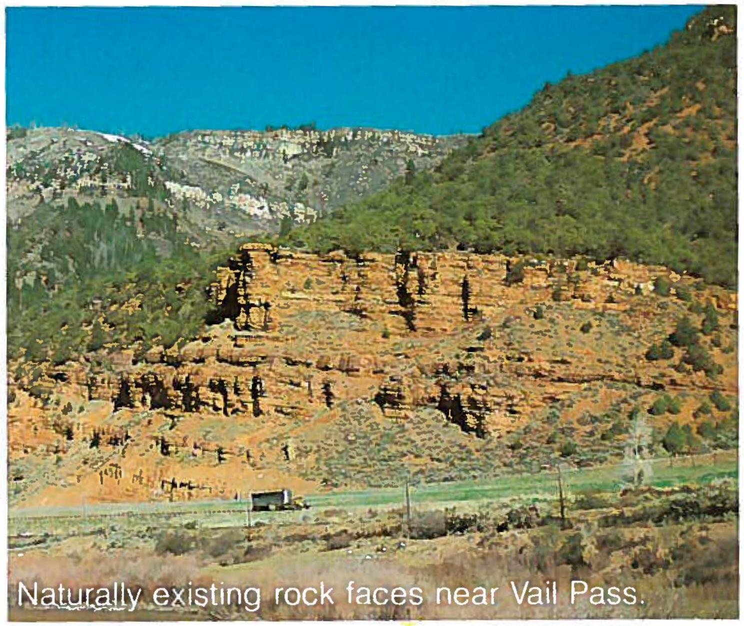


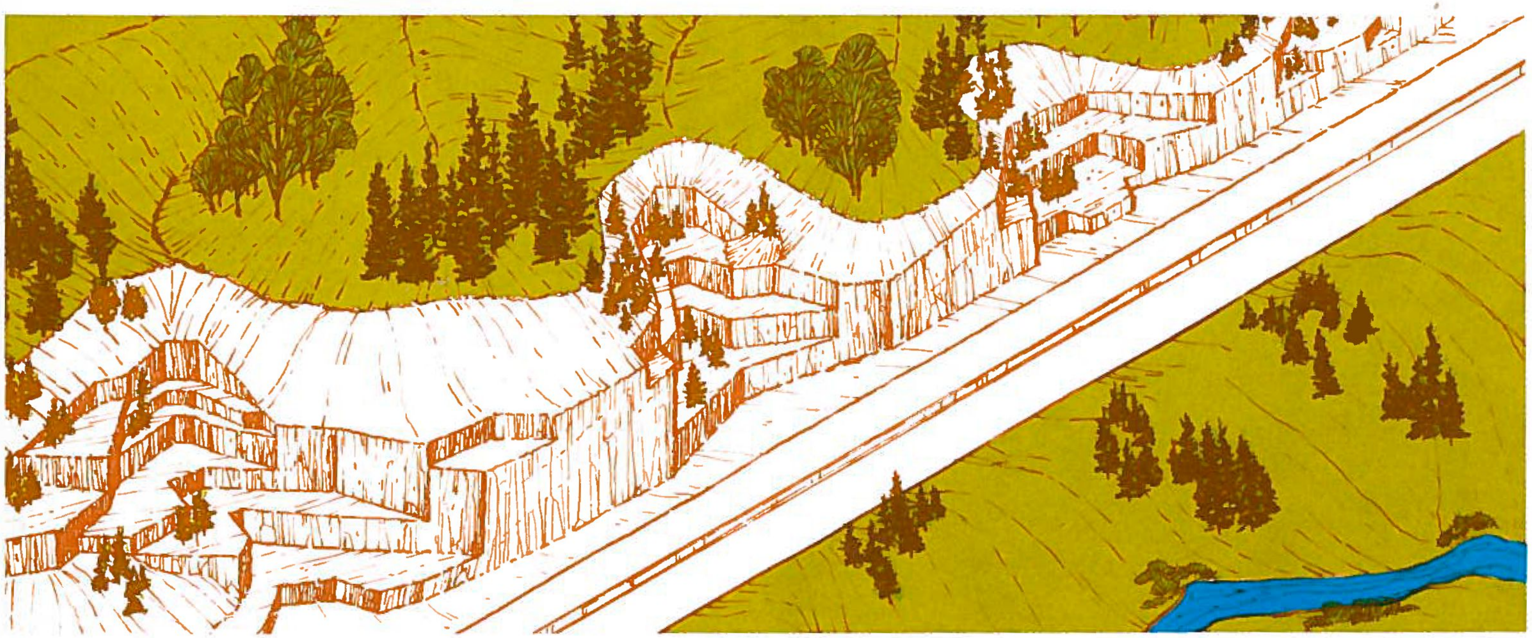
Natural vertical strata lines were opposed by horizontal bench lines—again creating an unnatural rock cut.

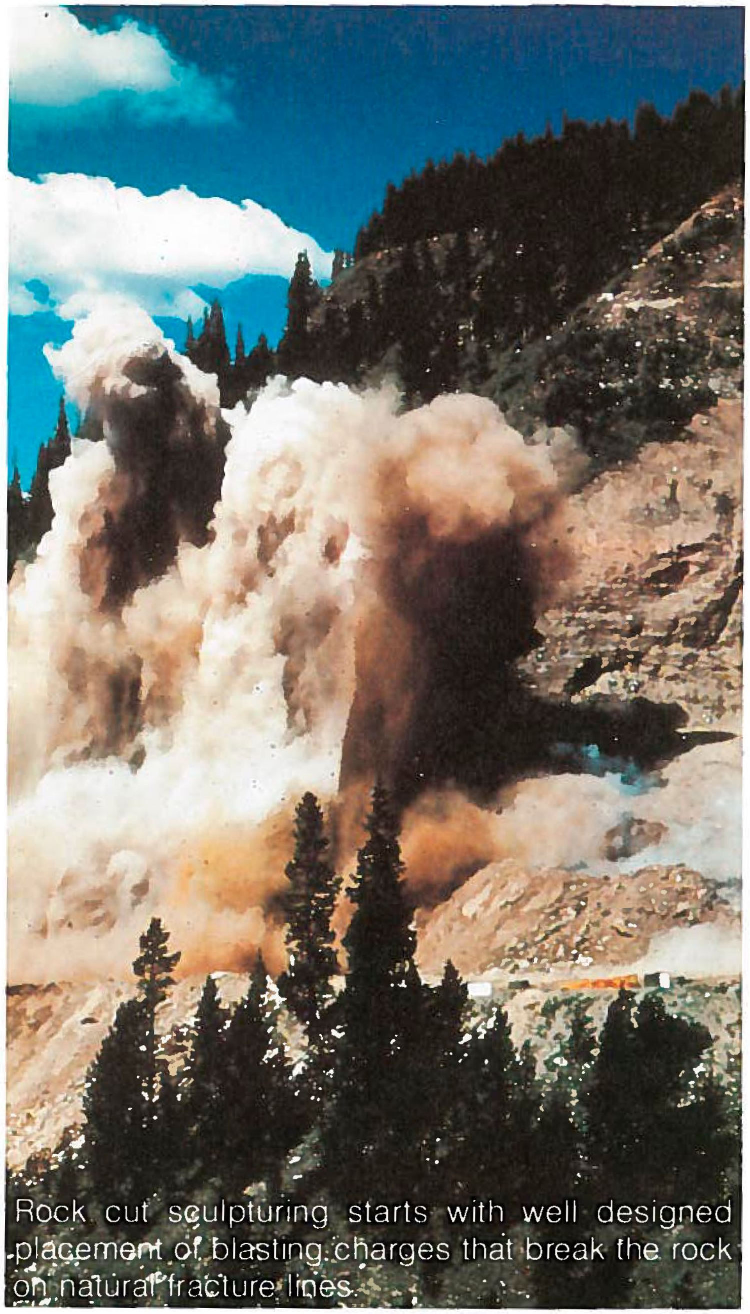
Where pre-splitting was necessary staggered benches were encouraged. Where slope stability was not a factor, "wild cat" blasting techniques allowed natural rock fractures to be exposed and produced some of the most pleasing results.

Where drainage ways were encountered, water features were accented and designed into a rock cut concept plan and constructed into the final rock cut.

On all rock cuts, planting pockets were left on benches for later introduction of plant material. The planting of trees and shrubs helped to reduce the size and scale of the rock cuts. Topsoil was spread on all rock benches to encourage grass growth and minimize the visual scar through revegetation.

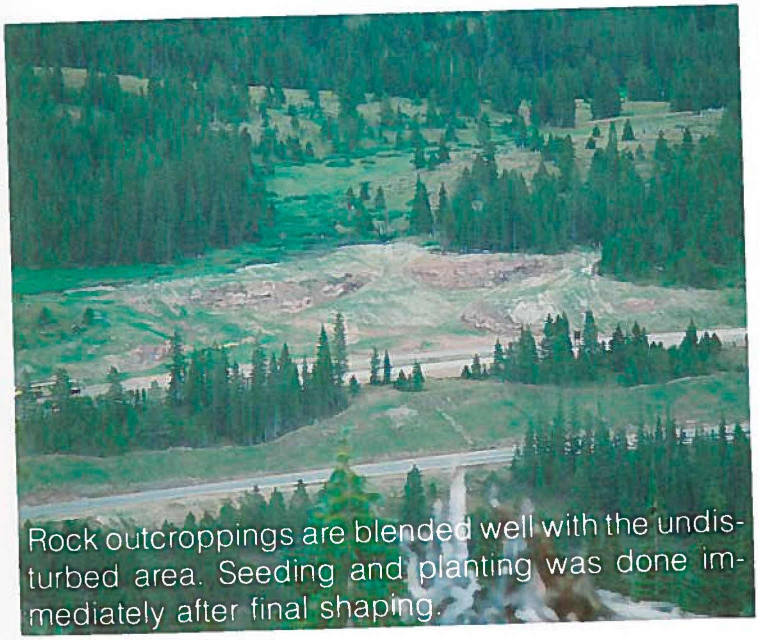

Naturally existing rock faces near Vail Pass.

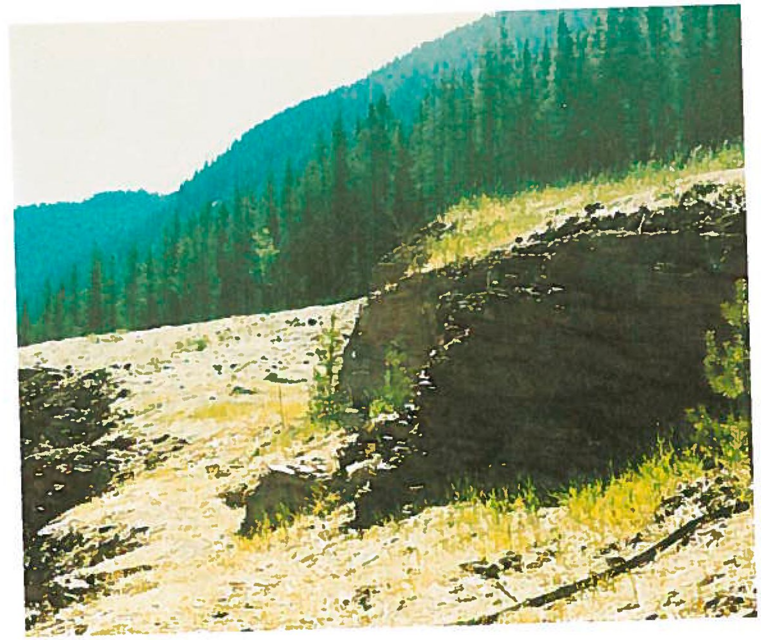


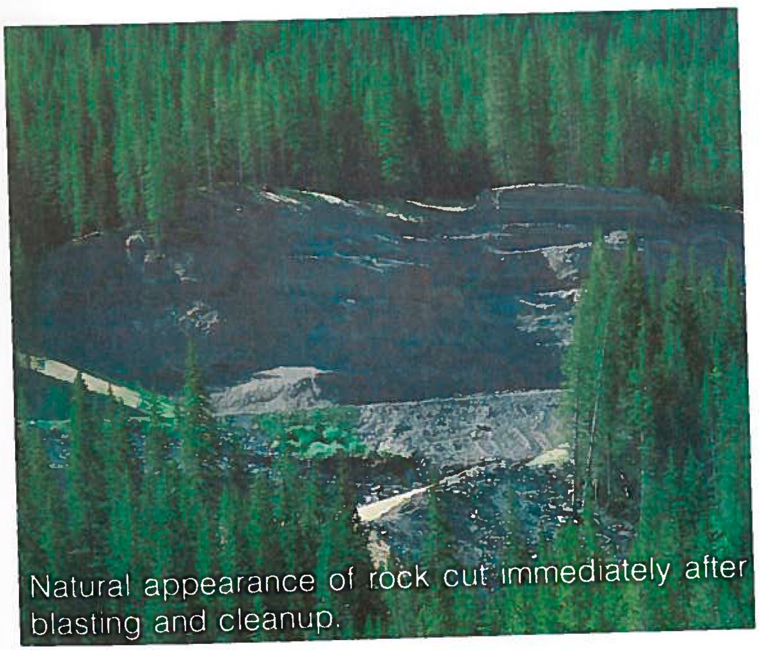


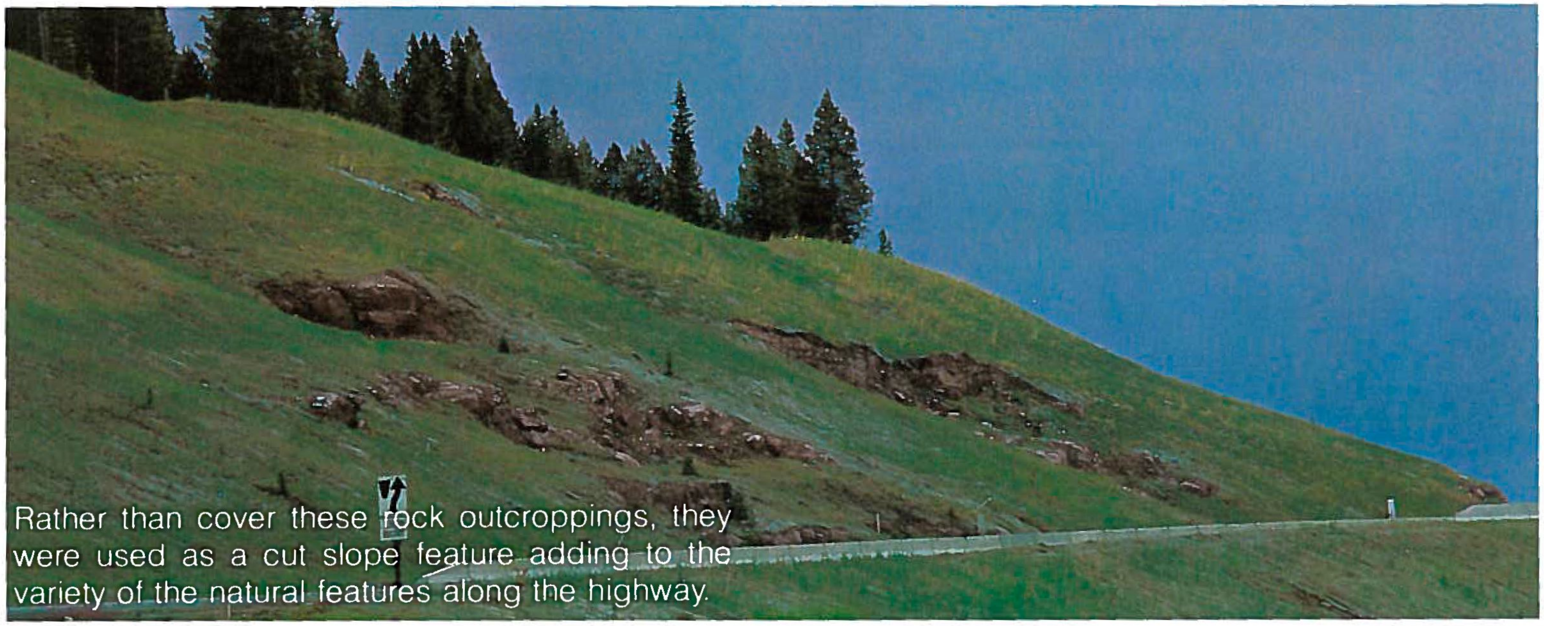
Rock cut sculpturing starts with well designed placement of blasting charges that break the rock on natural fracture lines.

Loose rock is removed revealing the rock face.

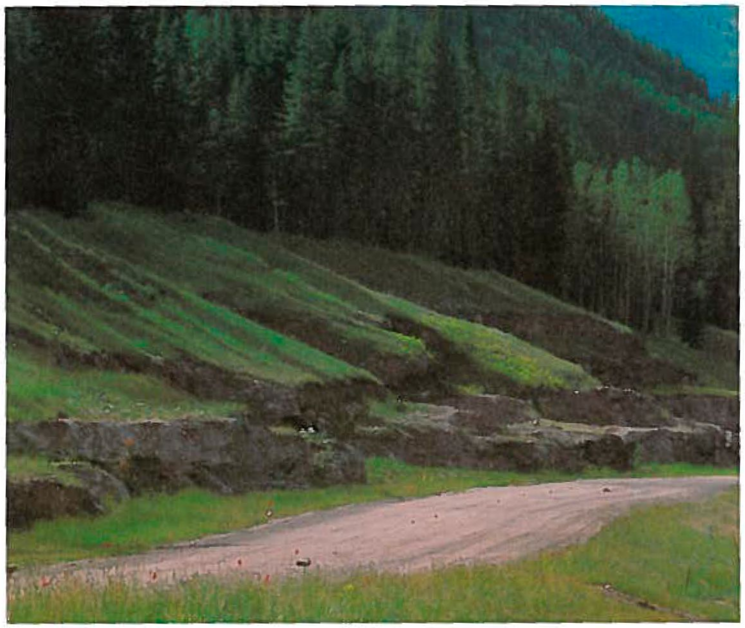

Rock outcroppings are blended well with the undisturbed area. Seeding and planting was done immediately after final shaping.

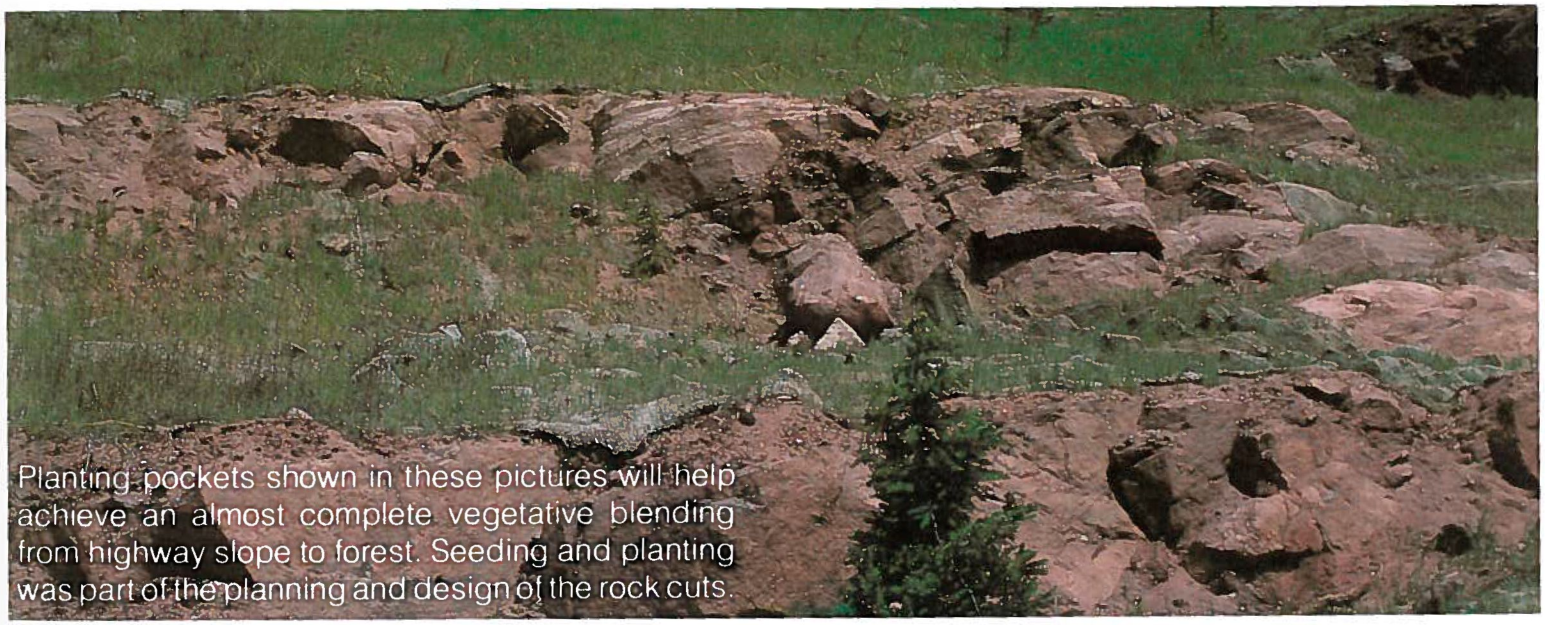



Natural appearance of rock cut immediately after blasting and cleanup.

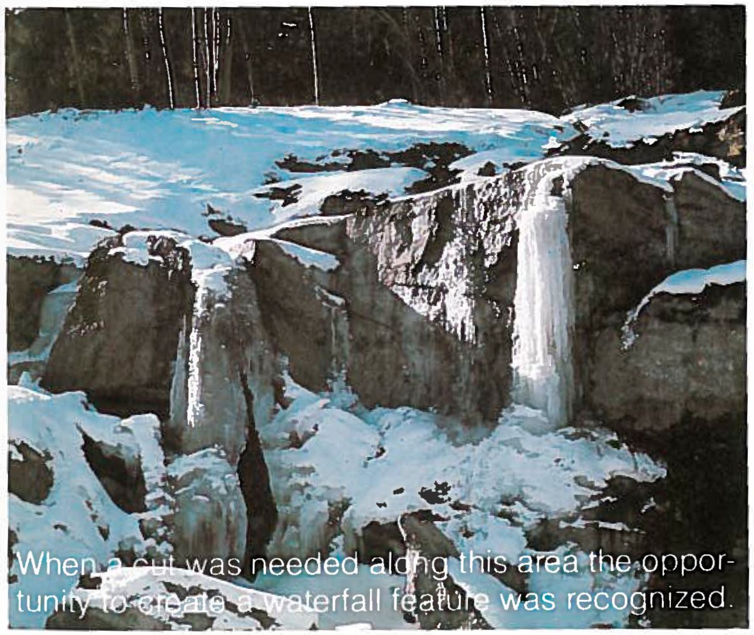


Rather than cover these rock outcroppings, they were used as a cut slope feature adding to the variety of the natural features along the highway.





Planting pockets shown in these pictures will help achieve an almost complete vegetative blending from highway slope to forest. Seeding and planting was part of the planning and design of the rock cuts.



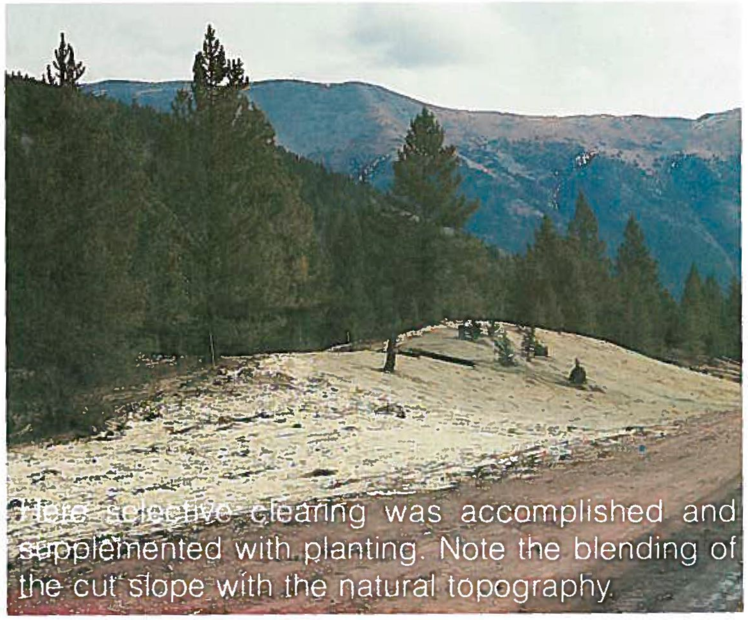
When a cut was needed along this area the opportunity to create a waterfall feature was recognized.

An old waterfall feature not developed to its potential along an older highway.

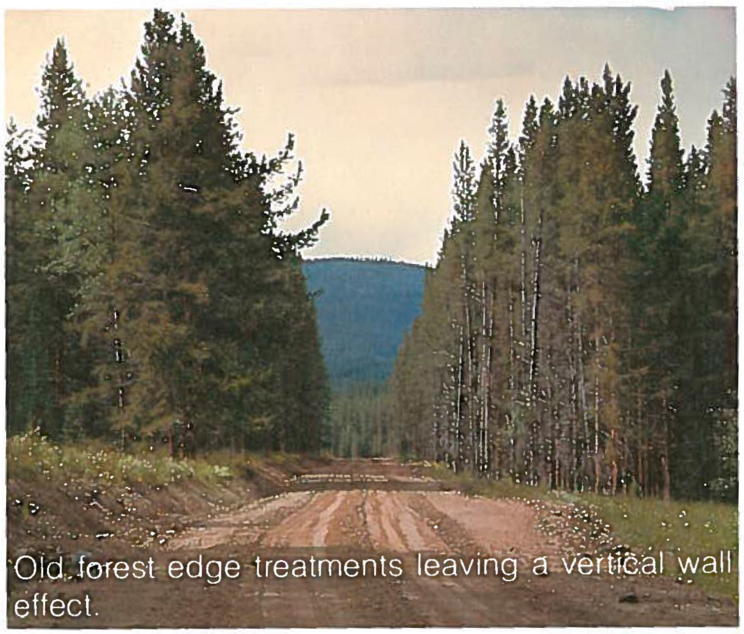
CLEARING TECHNIQUES

Vail Pass lies within an Aspen, Lodgepole Pine/Spruce-Fir forested area. Prior to construction it was feared that standard clearing techniques would leave vertical vegetation walls at the top of the cut and the bottom of fill slopes. As other landscape treatments were incorporated into the projects, methods of selective thinning and clearing were developed, emphasizing vegetation patterns above and below the highway slope.

Forest Service methods of selective thinning were used to produce a softer edge by cutting out taller older trees in favor of younger ones. This method produced a natural forest edge effect which was easy to blend with other plantings. This thinning process also minimized the number of possible wind

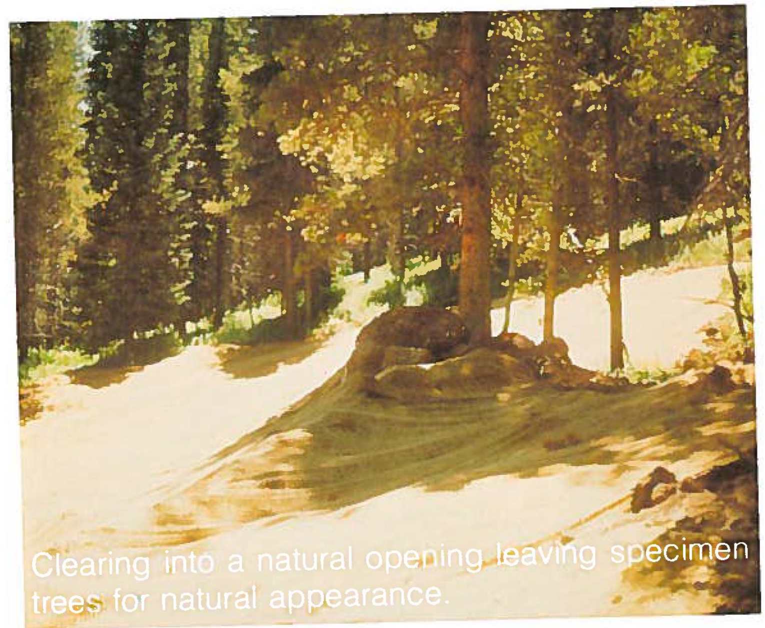


Here selective clearing was accomplished and supplemented with planting. Note the blending of the cut slope with the natural topography.



Old forest edge treatments leaving a vertical wall effect.


Trees were selectively marked. Based on size, age and overall pattern in the area.


Clearing into a natural opening leaving specimen trees for natural appearance.


The far slope demonstrates the resulting effects during and after construction.

Free firewood was stacked along the highway for easy public pickup.

fall trees along the slopes.

Selective clearing techniques were used to clear natural openings and match open areas on the highway slope. Where possible, existing vegetation was cleared to promote and frame scenic overlooks.

It was realized that additional clearing or thinning would further remove the forest from the highway, hence, on-site decisions of what critical areas required treatment were important. Cooperation with Forest Service and Highway personnel helped eliminate unnecessary clearing while encouraging necessary work.

Slash from clearing operations was either sold, given away or burned at the direction of the Forest Service.

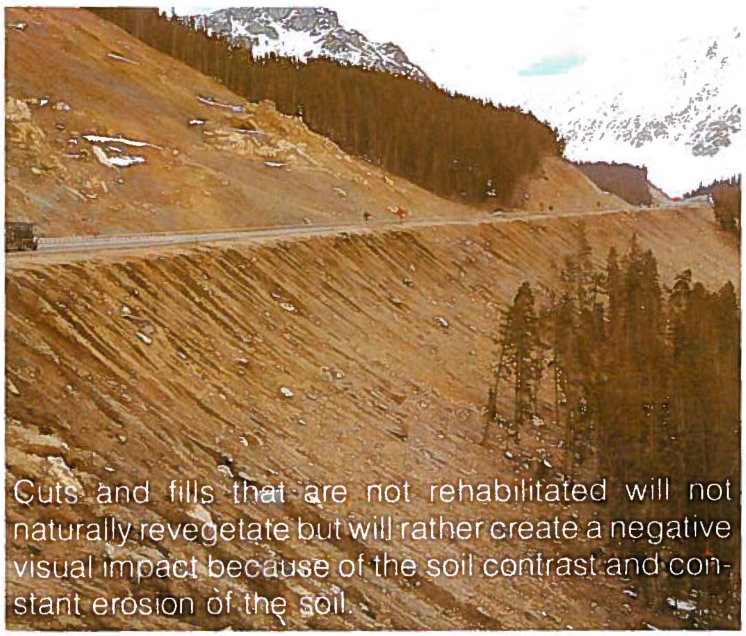

Larger logs were sold to lumber companies.


Slash and other material that could not be sold or given away was burned.

REVEGETATION

At one time revegetating highway slopes was considered unnecessary. Exposed slopes were left for natural processes to heal the wounds. Highway slopes exposed and left in this manner have taken 30 or more years to establish a stabilizing vegetative cover. These eroding slopes require constant maintenance attention to clean ditches and to safeguard the water quality in nearby streams.

It is now recognized that although vegetated slopes are pleasing to view they also represent stabilized slopes which require little return maintenance. Reestablished vegetation is also important as cover and food for wildlife. Revegetation techniques are recognized as an important feature of any reclamation effort and Vail Pass has shown their benefits.


Cuts and fills that are not rehabilitated will not naturally revegetate but will rather create a negative visual impact because of the soil contrast and constant erosion of the soil.

Several types of vegetative material were used on Vail Pass. Grasses were seeded on all disturbed areas. Wildflower seeding was attempted in highly visible areas. Shrubs and trees were transplanted to continue the forest edge onto the highway slopes.

Grass mixtures used were of native and adaptable species. Those chosen were evaluated for their stabilizing root mat which would limit soil erosion and foster natural seed encroachment.

Seed mixtures were chosen to satisfy project elevation and slope exposure changes. Checks on stand diversity were made and those areas with poor grass stands were reseeded until a satisfactory stand was achieved. Soil mulches and nettings were also used to stabilize and protect the ground until the grass was established. These mulch and netting types are covered in the Erosion Control section.

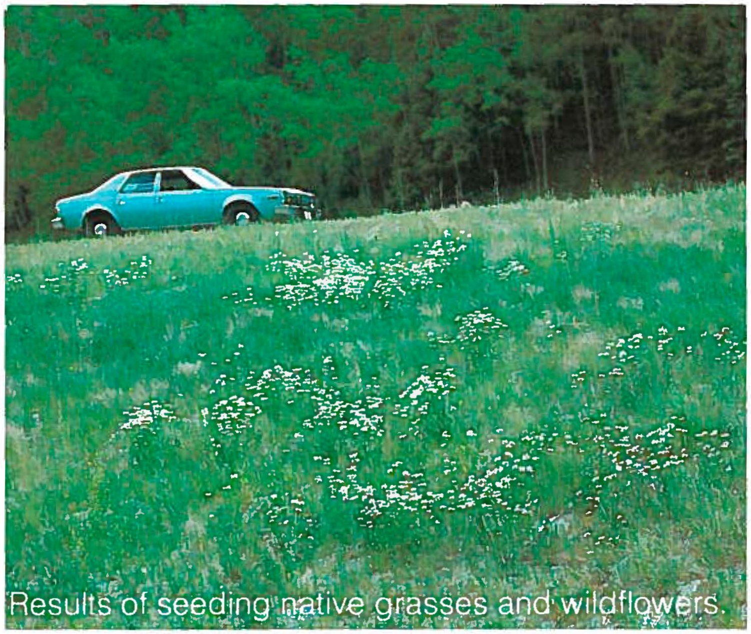
Wildflower species were seeded throughout the Vail Pass projects. Penstemone, primrose, fringed gentian, wild iris, columbine, aspen daisy and composite species were hand broadcast in areas of high visual sensitivity and in areas where similar species were visible on mountain slopes above the highway slopes.

The Division is monitoring areas seeded with wildflowers to determine whether the cost and effort was warranted. It has already been found that some native wildflower species quickly (within 2-3 years) spread from the forest onto the highway slopes almost as fast as the seeded varieties grew.

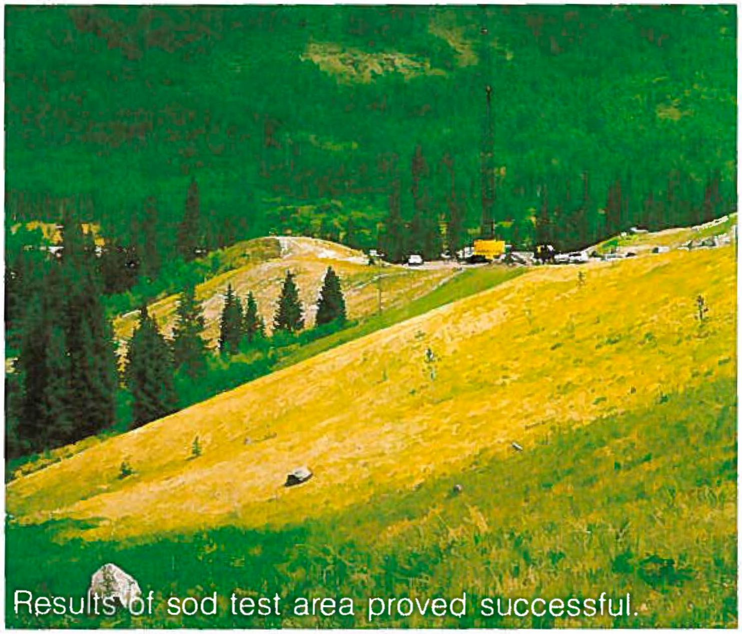
Trees and shrubs were planted on the Vail Pass projects to primarily beautify the disturbed roadside and blend it with undisturbed areas. Some shrub groupings (willow and bog birch) were located to absorb excess soil moisture and provide added root mat stability to the area. Plant groupings were located in areas most visible to the motorist to make best use of limited plant material quantities. All groupings were designed so that they would visually extend to the highway slope plant groupings above the slope. Most of the tree and shrub plant material was transplanted from designated forest areas.

The Forest Service helped locate nearby stands of young aspen, spruce, fir and lodgepole. These young (under 5′) trees were transferred from the forest to the highway slopes in one operation. Trees growing in future disturbed areas were dug and stored in nurseries established in the project area.

These trees were then transferred to the highway slope as construction progressed past them. Some large trees were purchased to give height and stand diversity to particularly sensitive slopes.

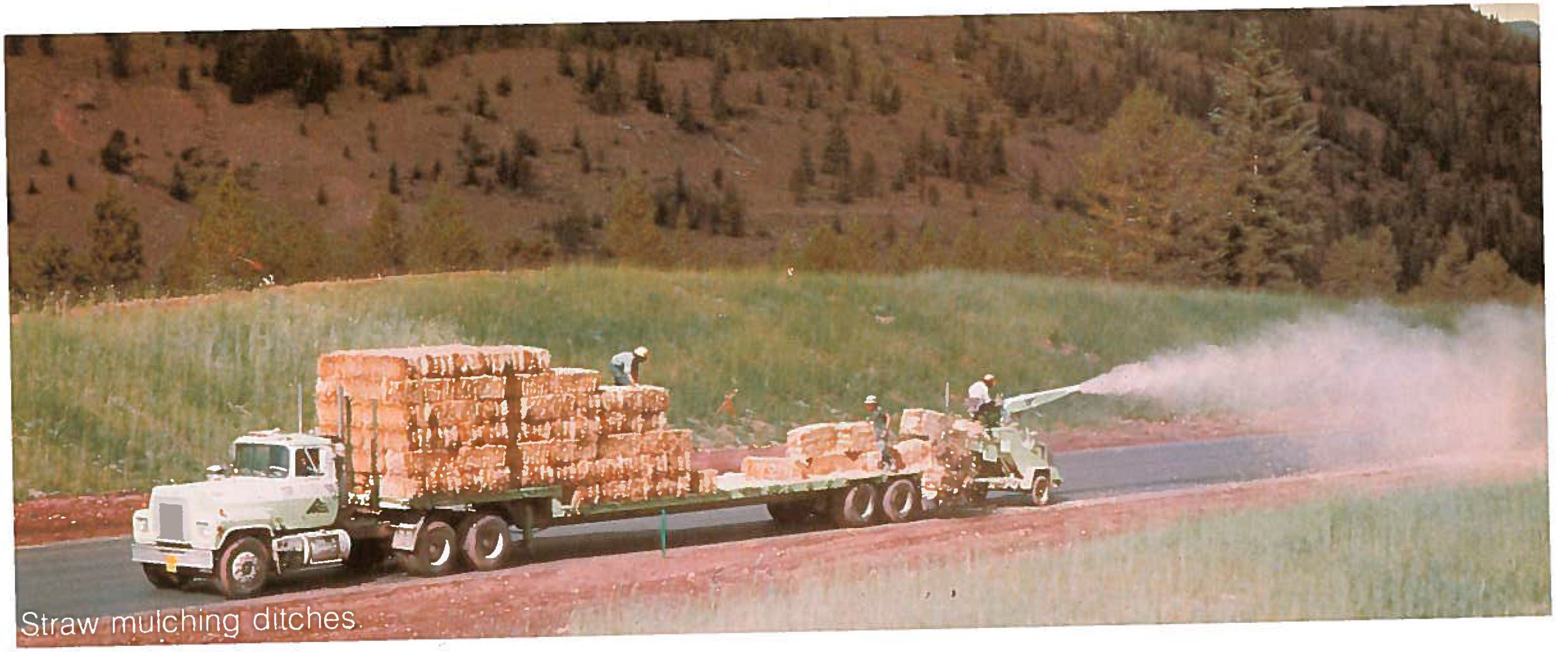


Results of seeding native grasses and wildflowers.



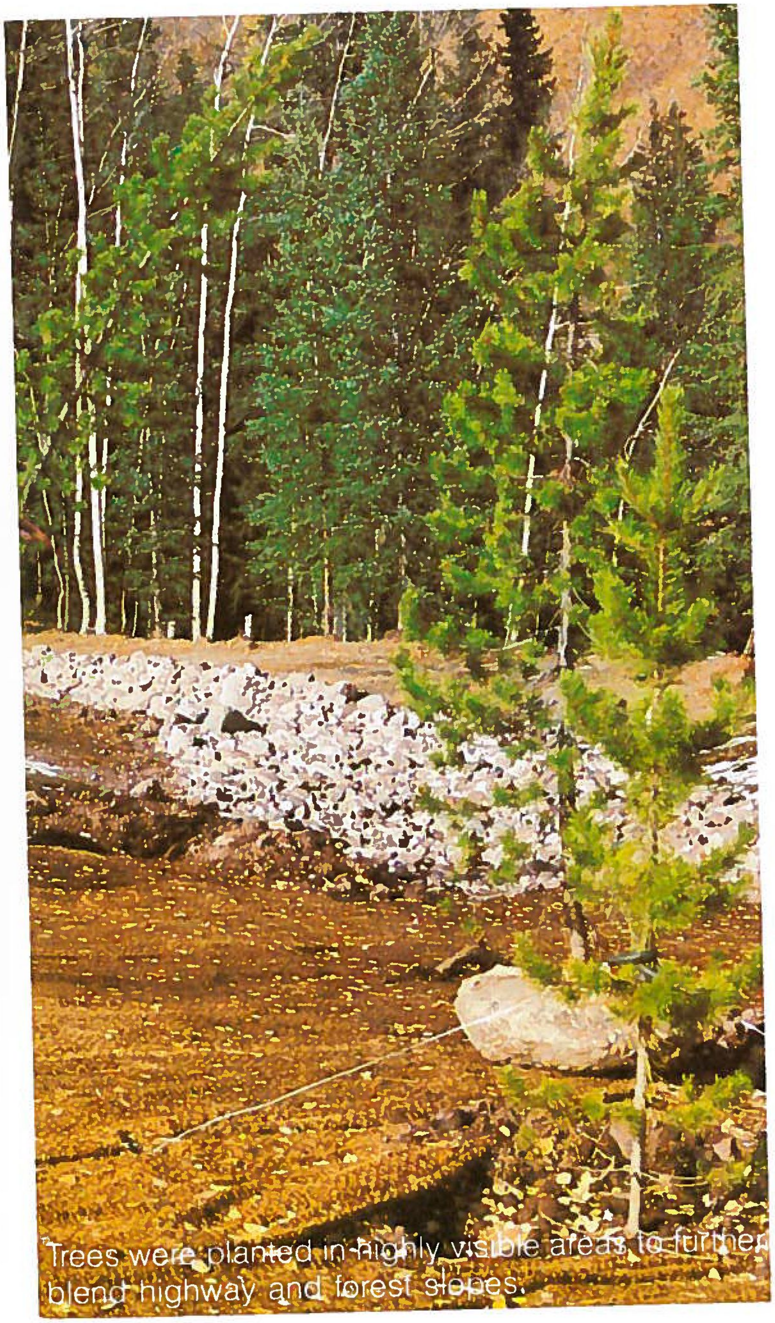
Results of sod test area proved successful.

As slopes were finalized topsoil, seed, fertilizer, mulch and jute netting were applied.



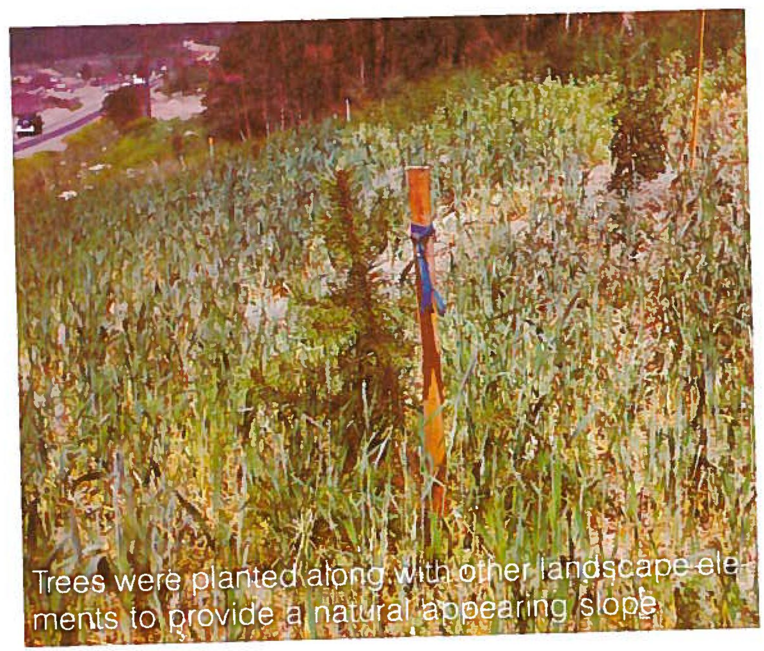
Straw mulching ditches.

If a healthy grass stand was not achieved the slope was reseeded.

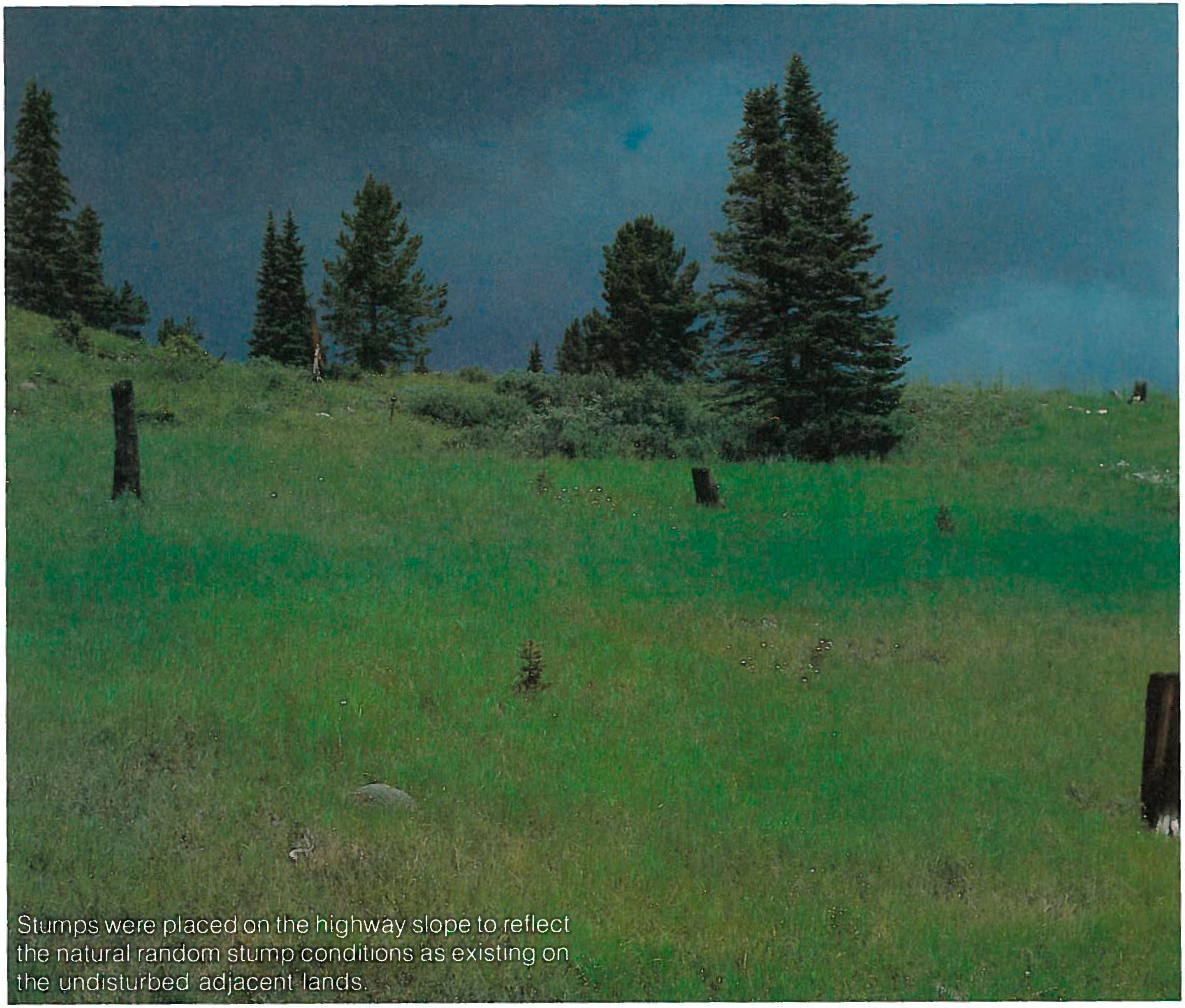


Trees were planted in highly visible areas to further blend highway and forest slopes.

Plant material taken from highway ROW was potted and stored until construction was completed.



Trees were planted along with other landscape elements to provide a natural appearing slope.



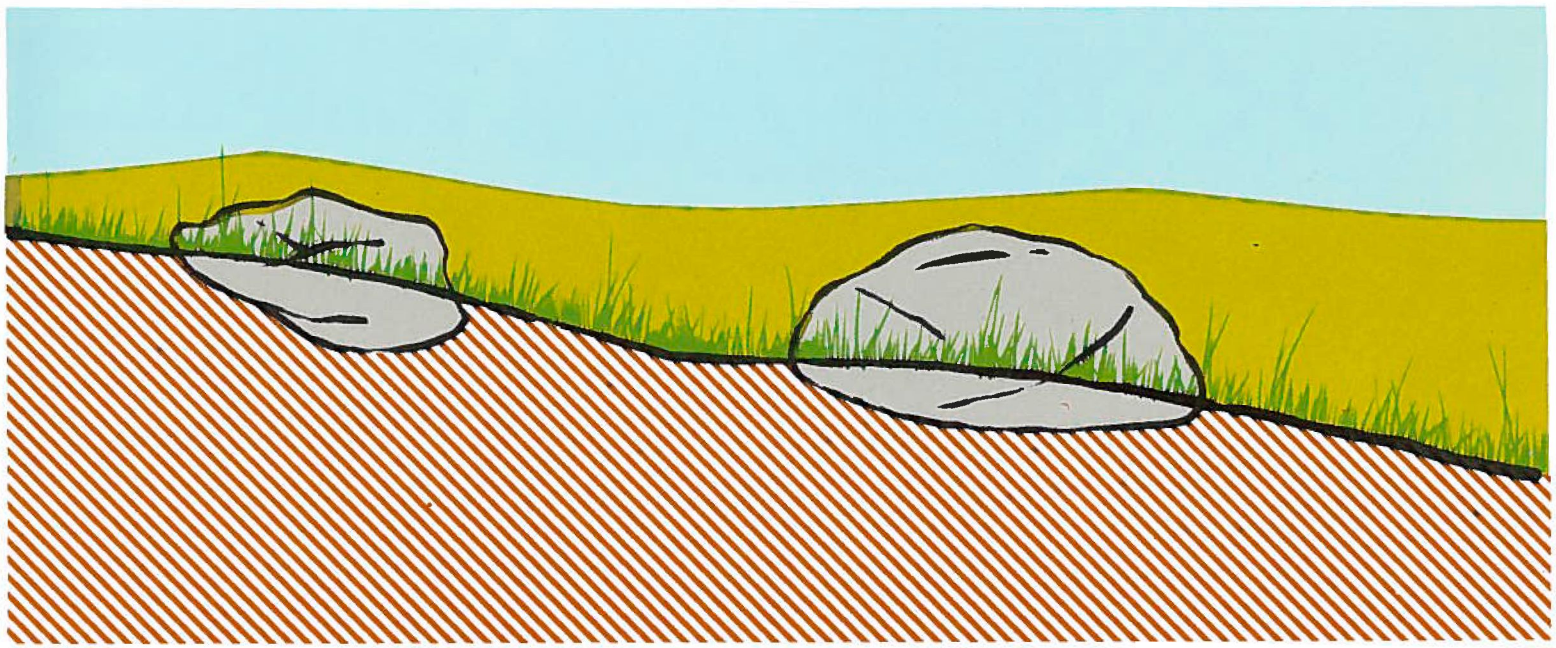
Stumps were placed on the highway slope to reflect the natural random stump conditions as existing on the undisturbed adjacent lands.

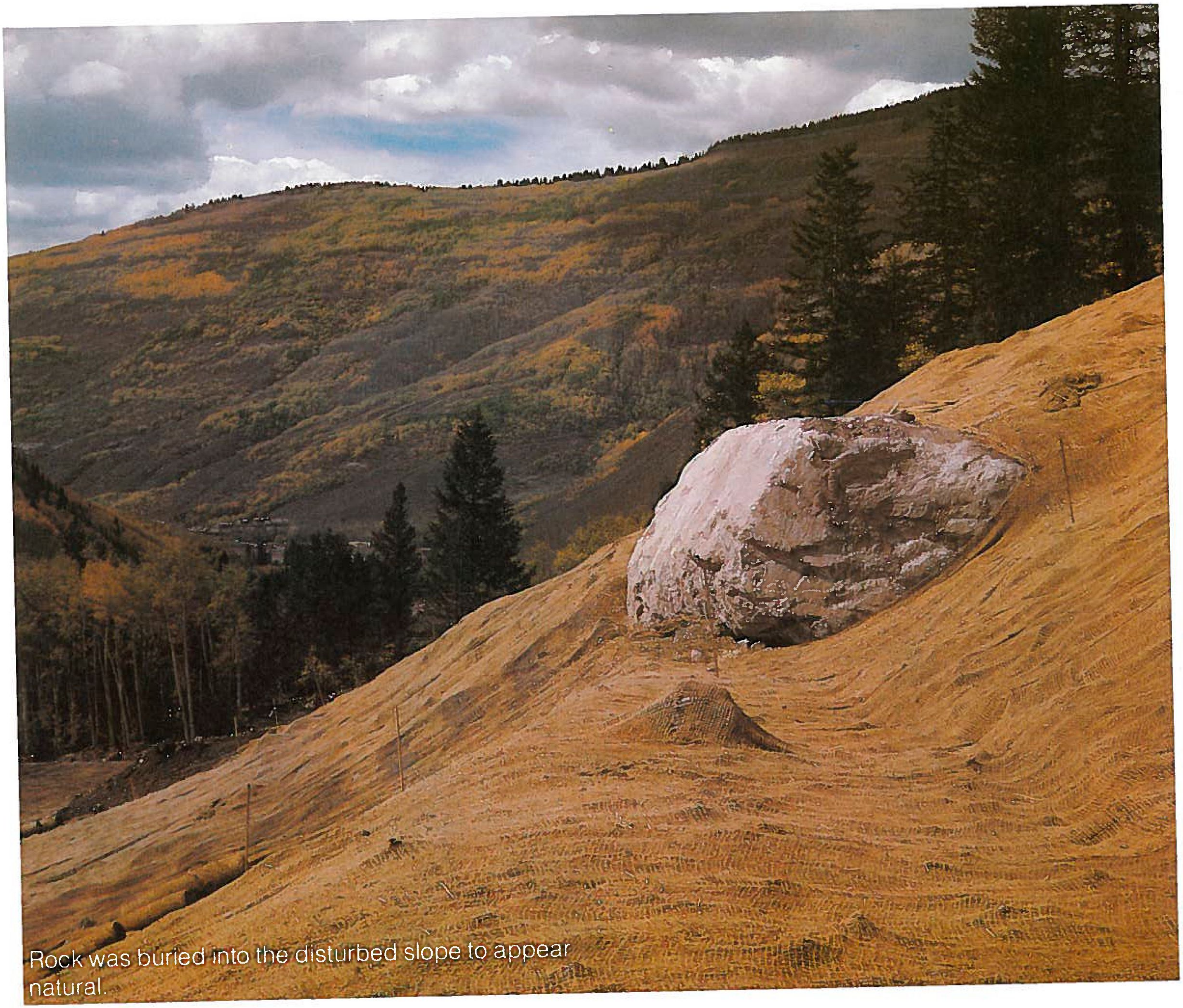
ON-SITE RESOURCES

As with plantings and land form grading, selective placement of boulders, stumps and old logs on the highway slope reflects existing conditions above the slope. The top of Vail Pass now is scattered with old stumps, exposed boulders and in some areas old logs.

These landscape features were easily available outside the disturbed area or within the project limits before clearing began. Once the finished slope was seeded the stumps and logs were randomly staked on the slope to approximate a natural scattering which occurred in the adjacent area. Boulders were usually worked into the slope to appear as natural outcroppings.

After the material was placed, tree plantings were arranged within the groupings again to reflect natural conditions.





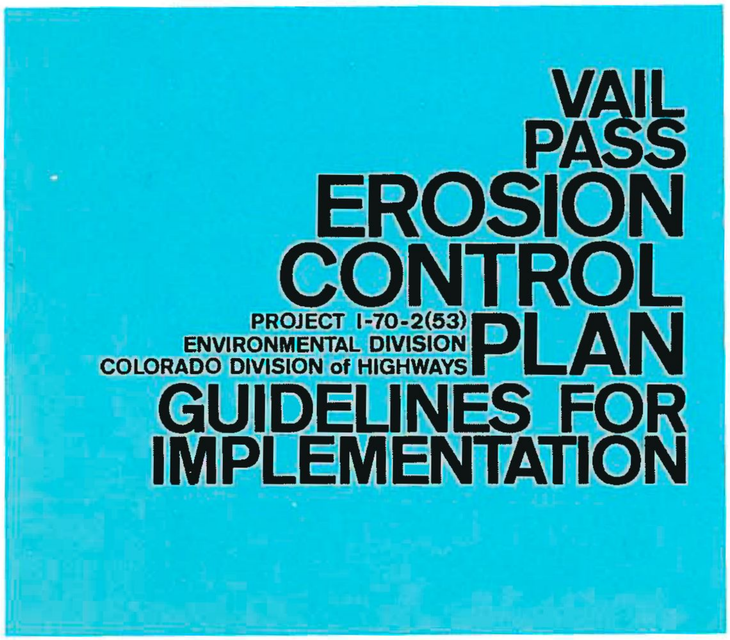
Rock was buried into the disturbed slope to appear natural.


Rock, trees, shrubs and grasses were all used in combination to create a completely landscaped highway corridor.

EROSION CONTROL

Erosion control planning was initiated on Vail Pass for a number of reasons. Roadway construction exposed a red colloidal clay which remained in suspension weeks after entering nearby streams.

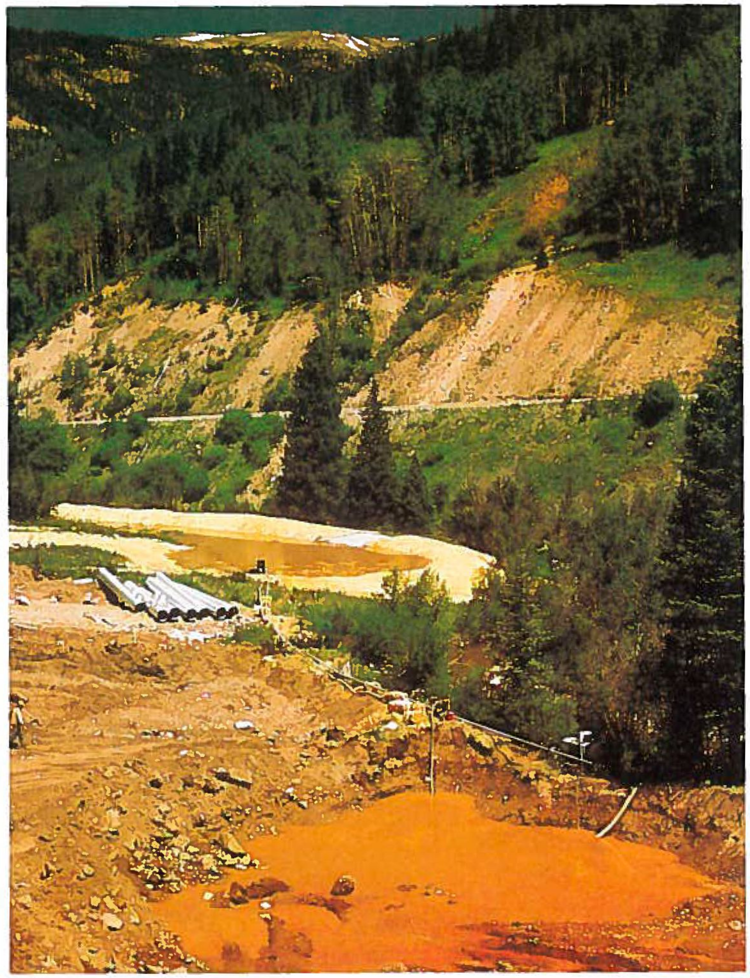
Local communities of Vail and Copper Mountain receive their drinking water from the streams affected and it became apparent an increased sediment load would quickly clog their water filtration systems. Wildlife dependent upon the stream would also have suffered from an increased sediment load. It was feared that heavy sedimentation during fish spawning time would severely impact riparian populations. The Wildlife Division, local communities, FHWA, Forest Service, Colorado Department of Health and seemingly a score of other agencies supported the need for innovative and effective methods to control runoff erosion from the project sites.


VAIL PASS EROSION CONTROL PLAN

PROJECT I-70-2(53)
ENVIRONMENTAL DIVISION
COLORADO DIVISION of HIGHWAYS

GUIDELINES FOR IMPLEMENTATION

Early projects provided testing and proving grounds for later full scale erosion control attempts on succeeding projects. New products were continually being tested to find those best suited to the subalpine conditions on Vail Pass.



TEMPORARY EROSION CONTROL MEASURES

Erosion control measures were designed into the Vail projects to provide a complete system coverage. It was found that certain erosion causing conditions existed only during construction and would not be present after the construction operation ended. These conditions were treated with temporary erosion control measures, often in place for only a few hours until the potential erosion problem was solved. Erosion problems which were seen to last beyond the construction project were treated with permanent erosion control measures, features which stablized the disturbed area and minimized soil movement through natural means.

Temporary erosion control measures always started with an erosion control system plan designed to minimally affect local water quality and clean sediment-laden water encountered within the disturbed area. To accomplish this objective, clean water drainages and streams were intercepted above and channelized through the construction area without contaminating the water with sediment from the disturbed ground. Once this clean water diversion was accomplished, all sediment-laden water generated within the disturbed area was channelized and directed to sediment ponds for treatment before discharge into the stream. At all times the success of the erosion control system was measured by the amount of sediment in the stream below the project. When the amount of suspended solids below the project was the same as the sample tested above the project then the erosion control

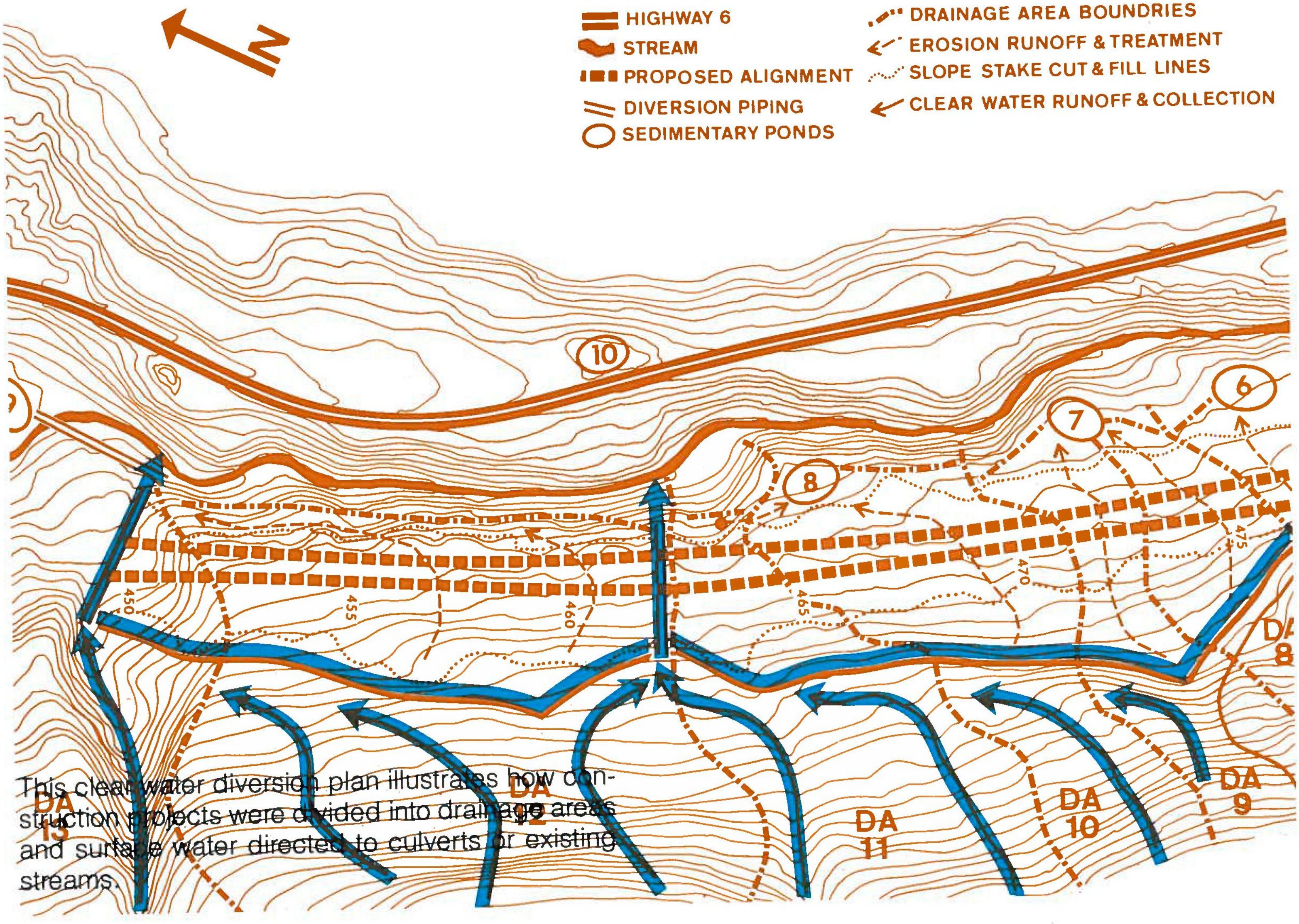
Without a comprehensive erosion control program, soil erosion from disturbed land into the stream would result. This drawing shows how clear water is diverted from the project area and how dirty water is treated before discharge into the stream.

Piping was stored on site for possible emergency use.

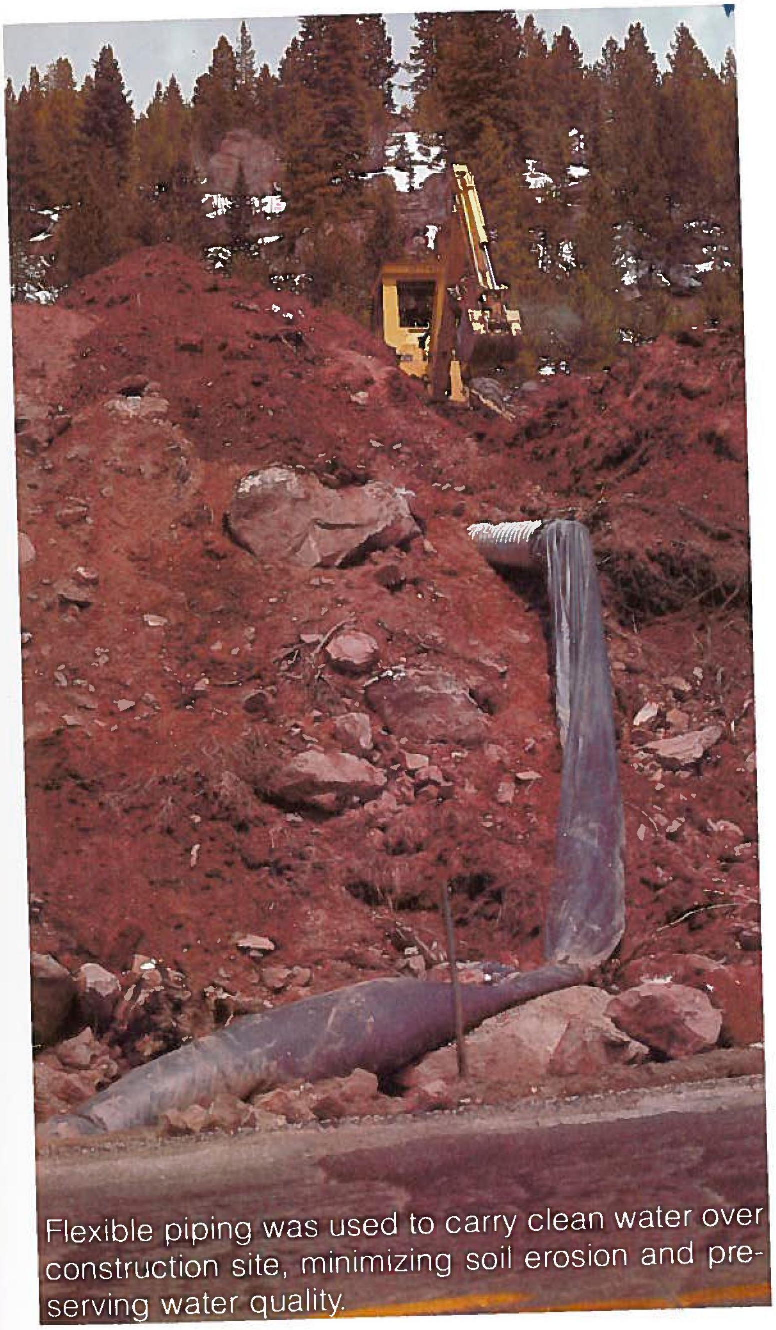
EROSION CONTROL SYSTEM

PROJECT I 70-2 (53)

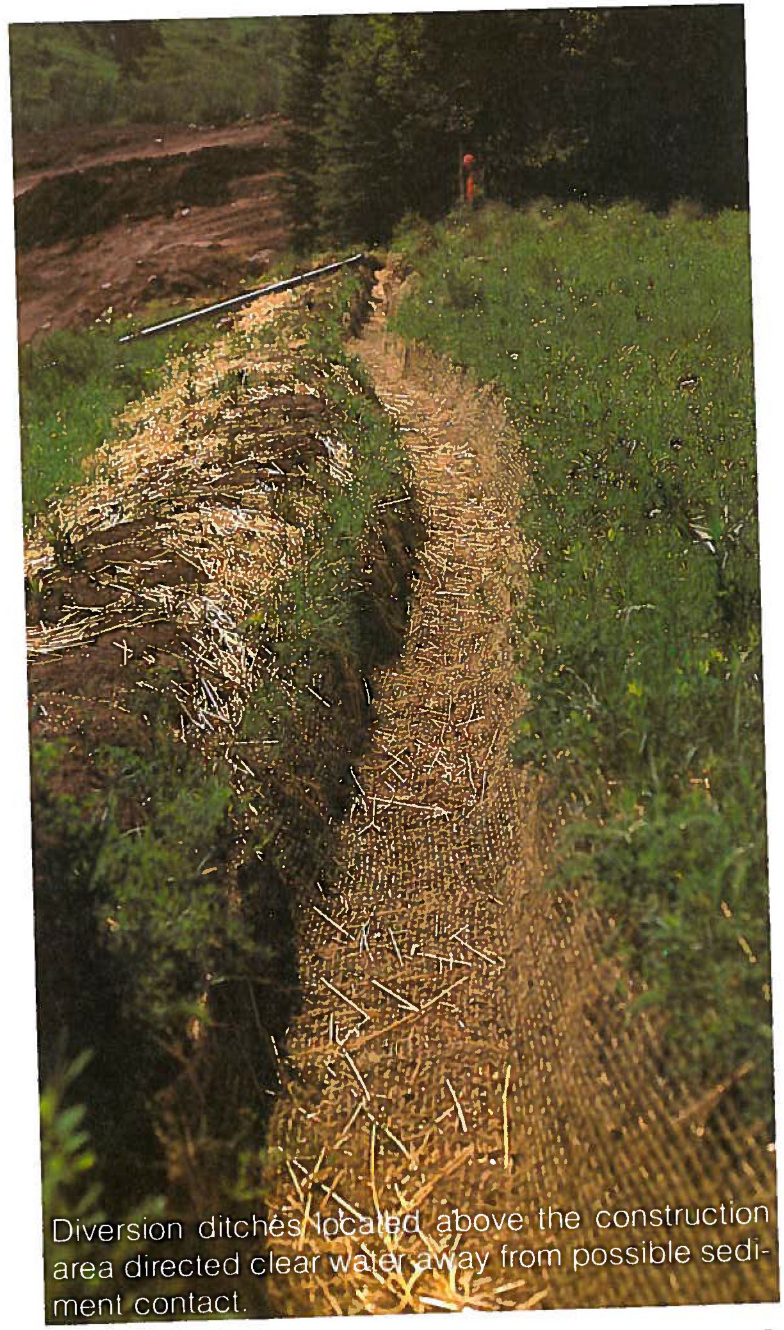
CLEAR WATER DIVERSION



This clear water diversion plan illustrates how construction projects were divided into drainage areas and surface water directed to culverts or existing streams.

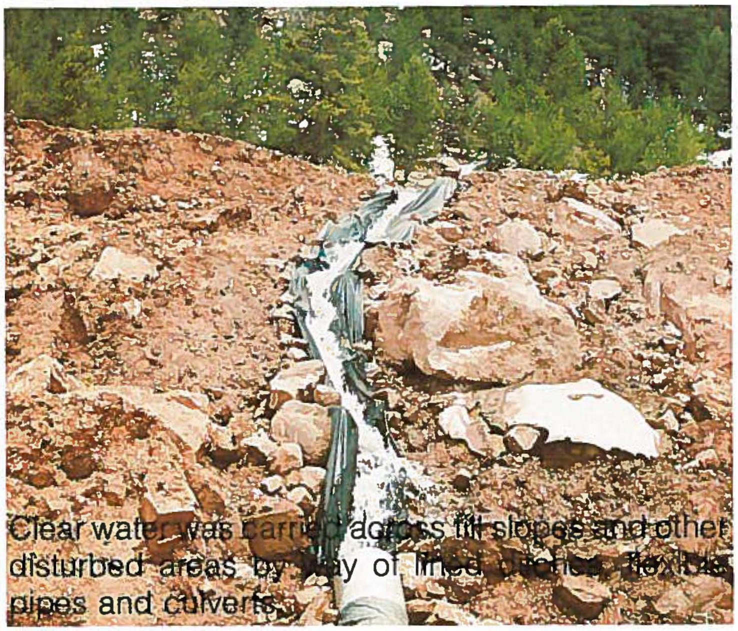


Flexible piping was used to carry clean water over construction site, minimizing soil erosion and preserving water quality.



Diversion ditches located above the construction area directed clear water away from possible sediment contact.

Here a temporary diversion structure was lined with plastic.

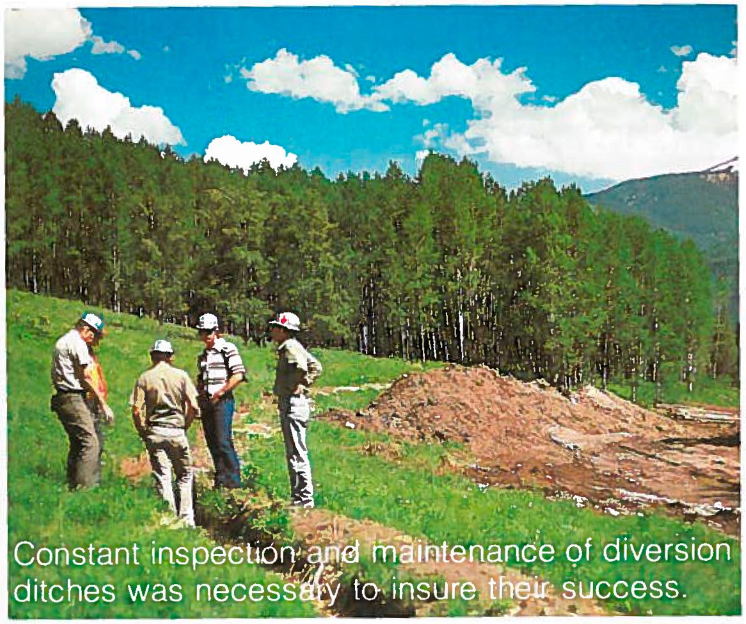


Clear water was carried across fill slopes and other disturbed areas by way of lined ditches, flexible pipes and culverts.

measures were considered successful.

The Forest Service assisted the Division of Highways in developing a water quality plan which stipulated that the contractor provide men, equipment and materials to maintain existing water quality. This plan also required the contractor to provide an erosion control plan which would integrate construction operations with proposed temporary and permanent erosion control measures.

Clear water diversion techniques varied depending on available materials and the size of the cross stream. Typically a ditch was dug above the project area and lined with plastic or jute netting. This ditch intercepted any minor drainages and cross surface runoff, channelizing it to existing larger streams at the end of the project segments or to other more temporary features.

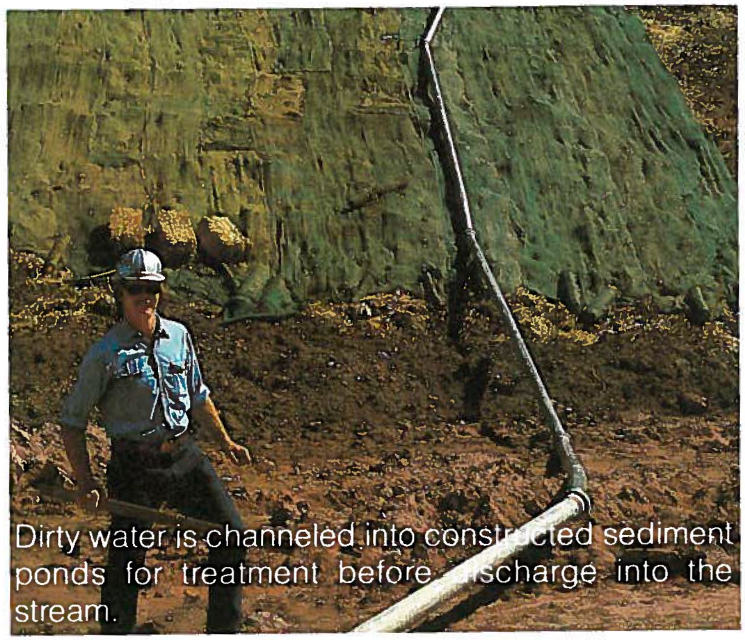


Constant inspection and maintenance of diversion ditches was necessary to insure their success.

Piping of all sizes was used to transport clear water across the construction area.

Typical of these features was flexible piping. The flexible piping originated from a clean water collecting basin and carried the stream down an exposed fill slope or across the construction area. This piping was removed once the permanent culvert was in place. Often one section of flexible piping was used a number of times within the duration of one project.

Ditch liners were also used for the same purposes as the flexible pipe but only for very short duration periods. The use of these clear water diversion measures increased the efficiency of sediment ponds and made the overall erosion control program more manageable.

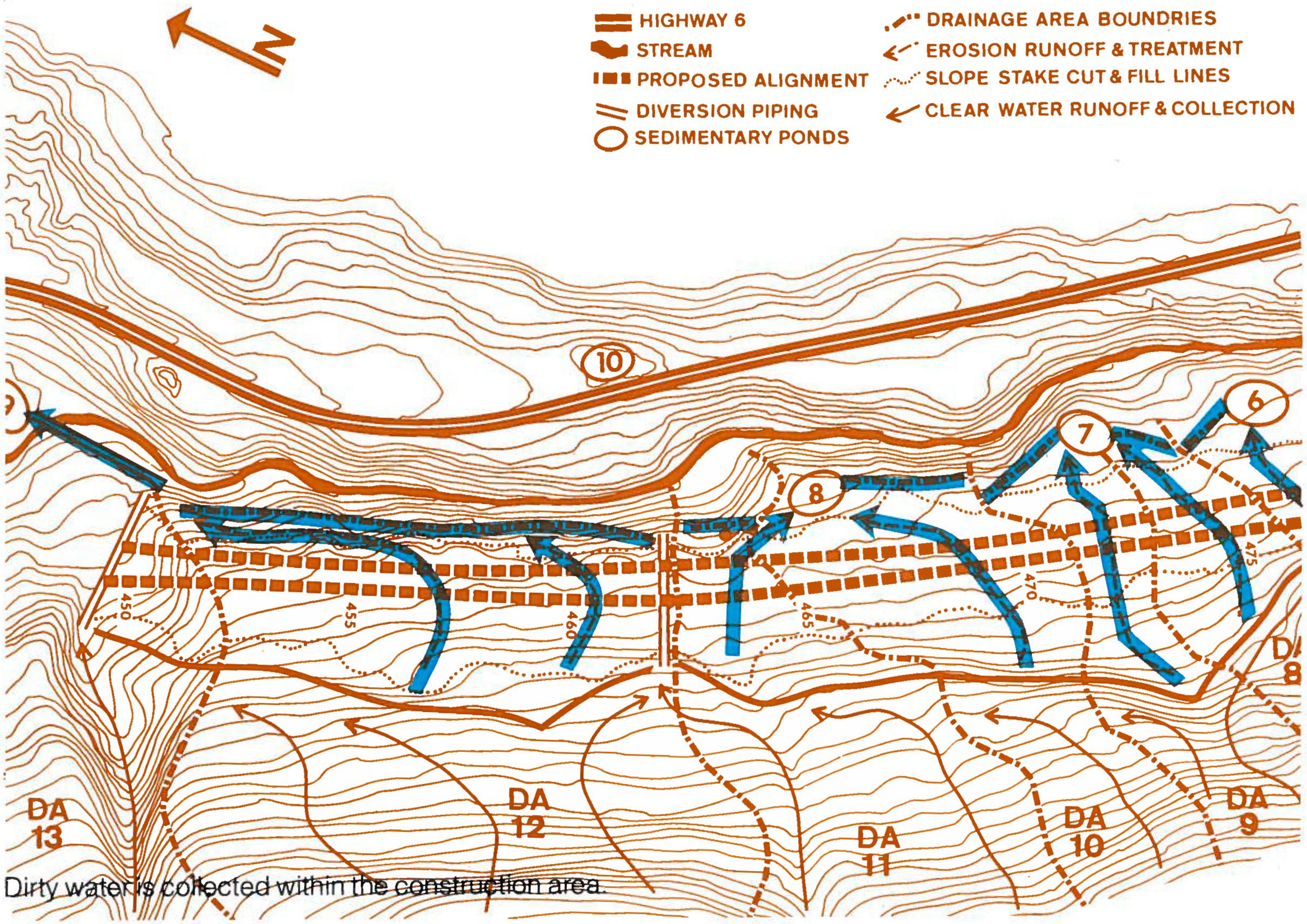


Dirty water is channeled into constructed sediment ponds for treatment before discharge into the stream.

EROSION CONTROL SYSTEM

PROJECT I 70-2 (53)

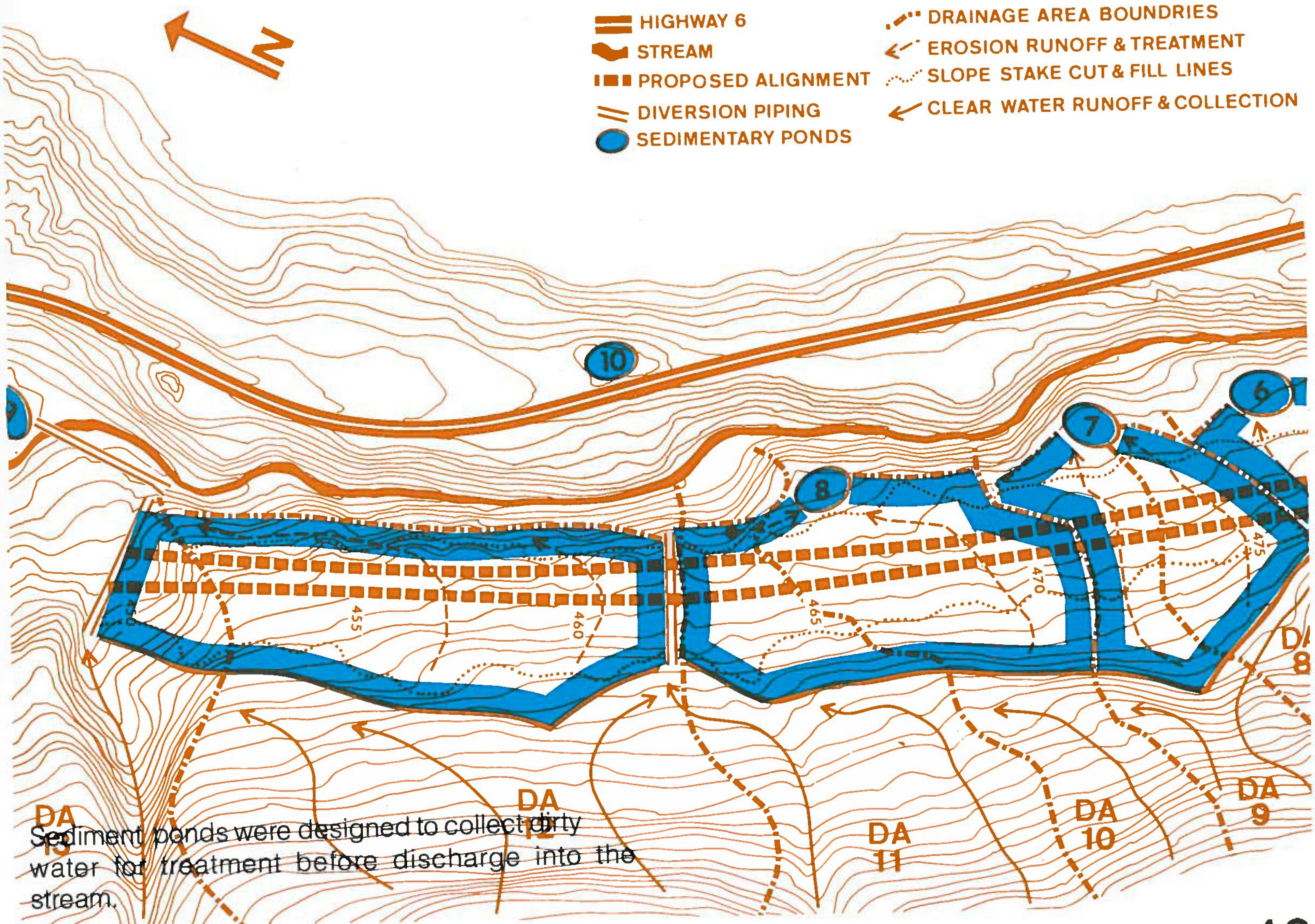
EROSION RUNOFF COLLECTION



Dirty water is collected within the construction area.

EROSION CONTROL SYSTEM
PROJECT I 70-2 (53)

SEDIMENT POND DESIGN



Sediment ponds were designed to collect dirty water for treatment before discharge into the stream.

DIRTY WATER TREATMENTS

With the clear water directed from the construction area only rain and ground water flowing on the disturbed ground needed to be treated. All sediment laden water was diverted into sediment ponds for treatment prior to discharge into the stream. Sediment ponds were designed and constructed to handle water collected from a specific drainage area within the disturbed area. This division of the project lead to more efficient use of smaller sediment ponds.

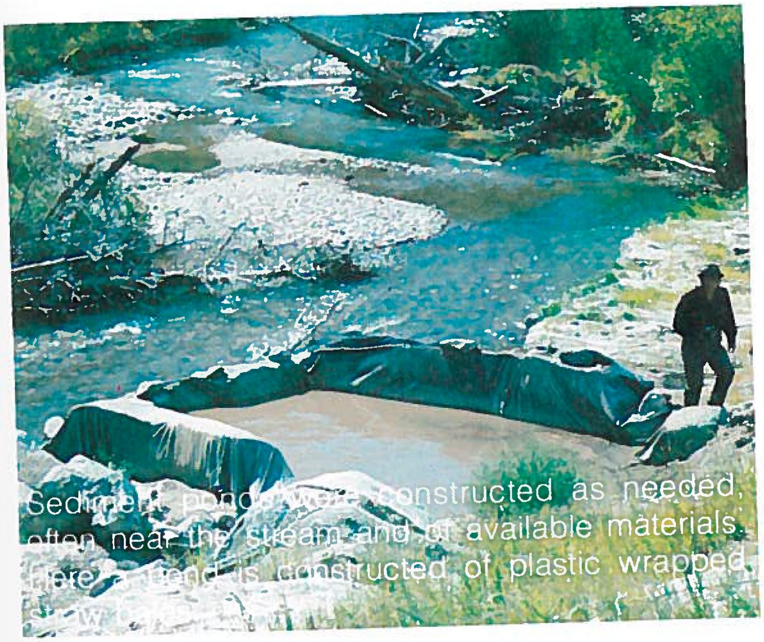
In principle, sediment ponds are intended to hold water until the sediment has time to settle out. Then the clean water is skimmed from the top of the pond for discharge into the stream. On Vail Pass, soil encountered was often colloidal clay requiring lengthy settling times and therefore, limiting the turnover time of the ponds. Chemical settling agents were added to the ponds to speed settling time. These chemicals were tested for potential environmental impacts and none were found. The turnover rate of settling ponds was increased considerably and settling agents were eventually used on all ponds.

Other erosion control techniques were used to control small erosion problems on a temporary basis. Hay or straw bales were used to control erosion at the base of fill slopes or in areas where the dirty water diversion system failed. The erosion bales were placed within an eroded drainage to slow water and act as a mini sediment pond. These erosion bales also proved effective at culvert inlet and outlets slowing water velocity and allowing time for the water to deposit suspended sediments.

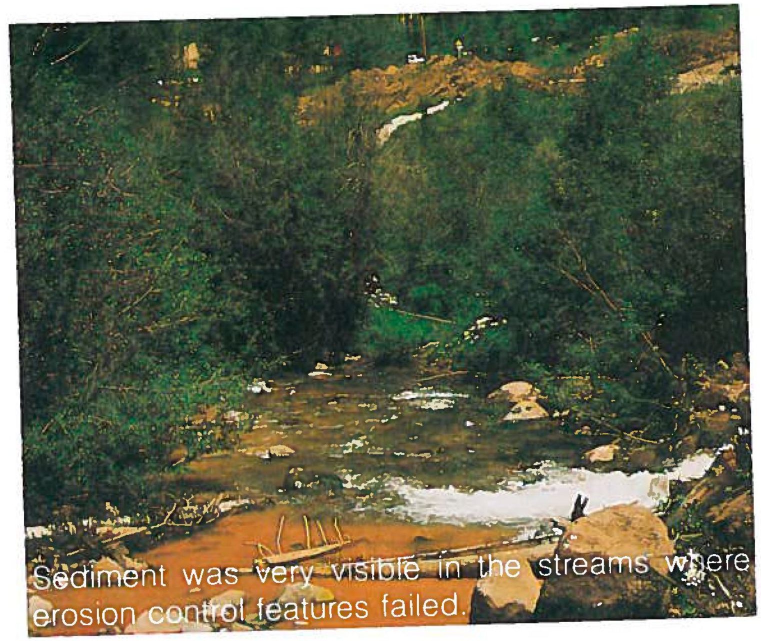
Erosion bales were used extensively along fill slopes and in especially sensitive drainage areas.

A constructed sediment pond near the stream.

Old highway ditches were sometimes used as sediment ponds. Stand pipes were attached to existing culverts to increase the ponds capacity.



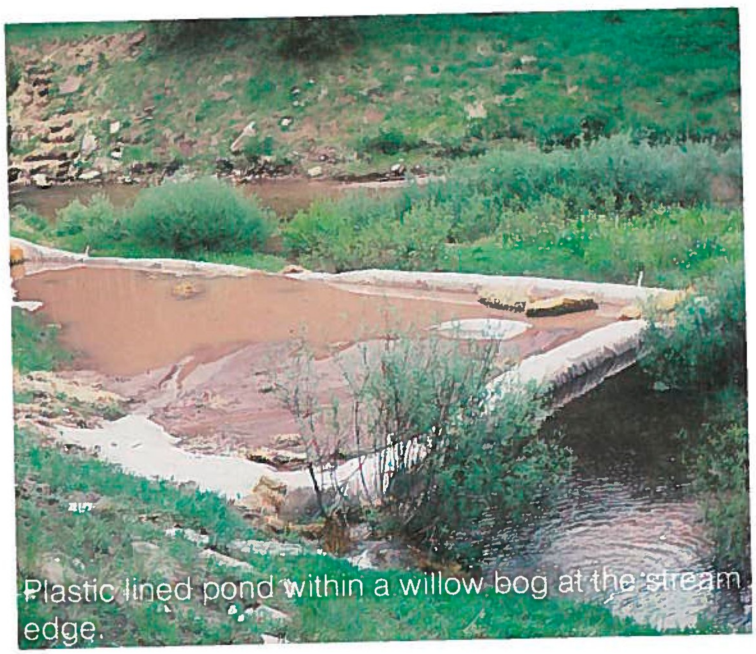
Sediment ponds were constructed as needed, often near the stream and of available materials. Here a pond is constructed of plastic wrapped straw bales.



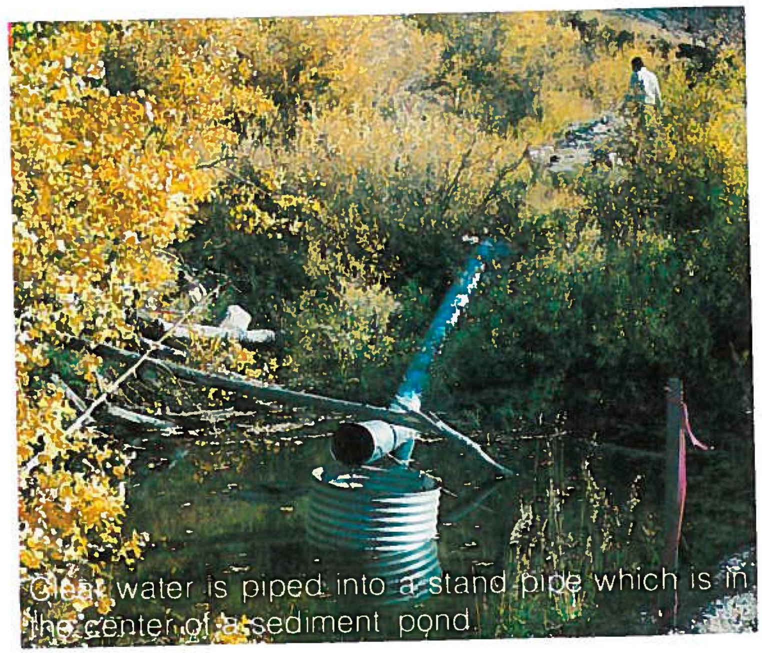
Sediment was very visible in the streams where erosion control features failed.

A sediment pond constructed of sandbags and straw bales along a highway fill.

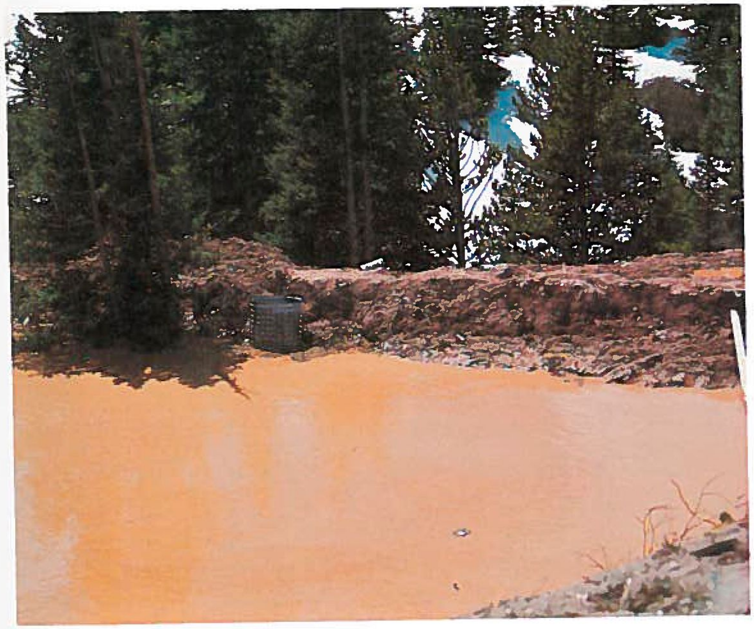
This large sediment pond collected storm runoff from a nearby construction area.

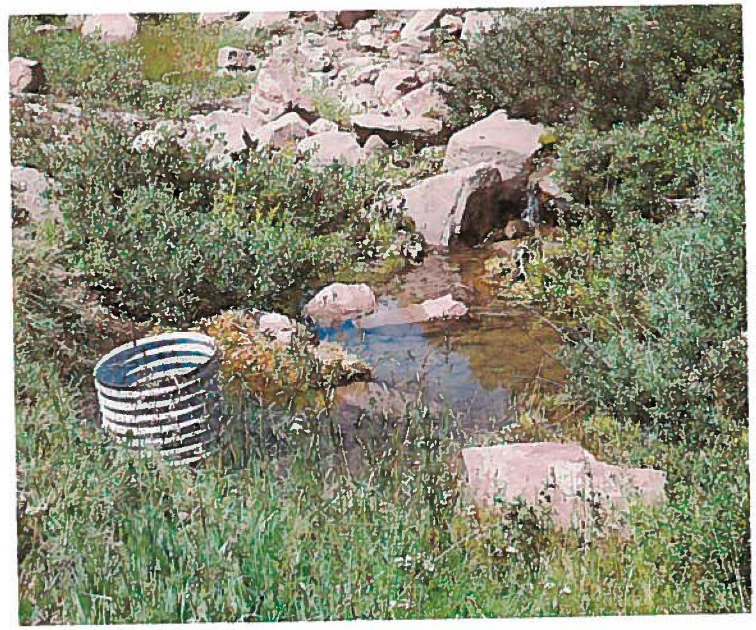


Plastic lined pond within a willow bog at the stream edge.

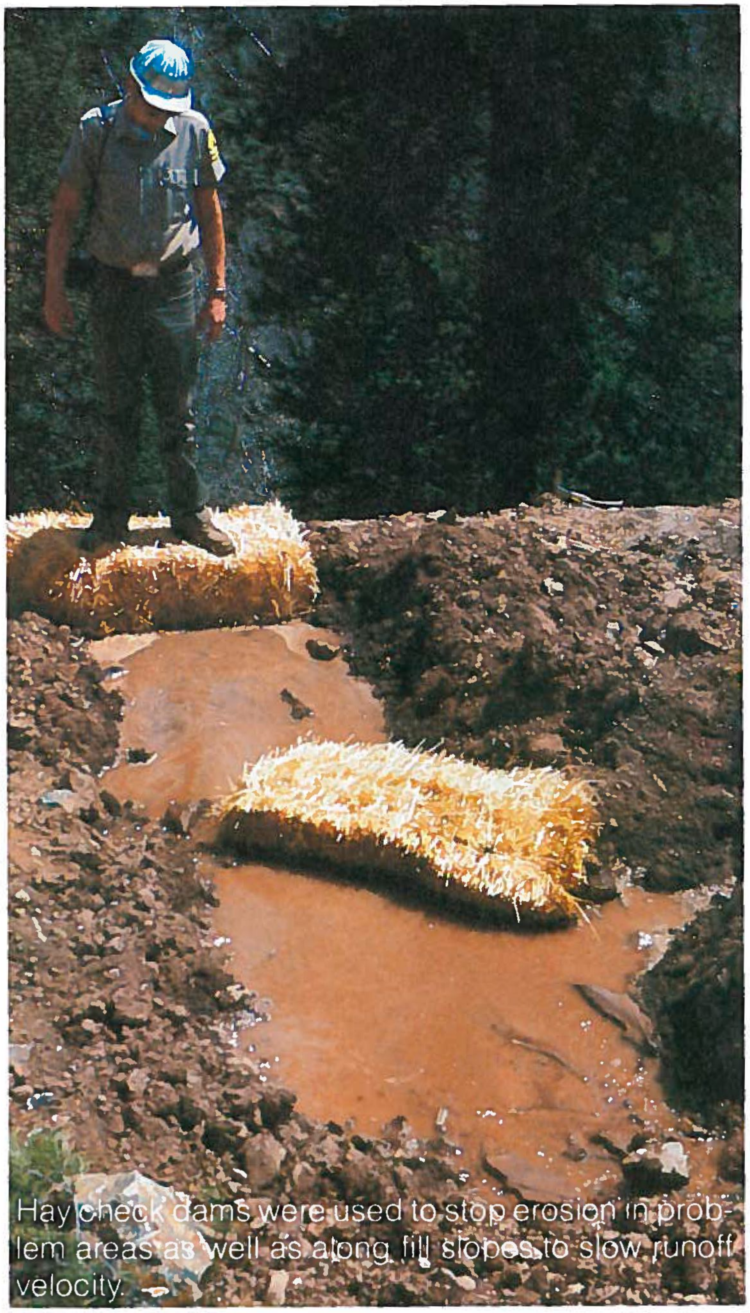


Clear water is piped into a stand pipe which is in the center of a sediment pond.





Sediment ponds were constructed large and small. Similar ponds generally served a short term purpose.



Hay check dams were used to stop erosion in problem areas as well as along fill slopes to slow runoff velocity.

The reasons for this success were their size and variety of uses possible. One man could effectively stop a sediment laden discharge with only a few erosion bales and yet have minimum disruption of the surrounding terrain. These bales also offered a usable modular form available for the construction of small sediment ponds, diversion ditches and ditch check dams, while being reusable either at other erosion sites or as mulch on the highway slope.

IRRIGATION AND PUMPING

Often sediment laden runoff could not be effectively treated in sediment ponds and it was found that by pumping this dirty water to less critical areas (or other sediment ponds) better treatment could be accomplished. Sediment ponds which were known to be under-designed often had provisions which allowed the water to be pumped to larger over-designed ponds. This method was used where grade or environmental problems negated the use of an additional diversion ditch.

Some ponds were pumped to remote areas and the dirty water was irrigated over a natural grass meadow or willow bog. In these cases dirty water is naturally filtered by existing vegetation.

PERMANENT EROSION CONTROL MEASURES

Realizing that temporary erosion control methods would be effective only during construction, permanent measures were designed into the Vail projects. These measures are intended to stabilize highway slopes, minimizing return maintenance and possible future water quality problems. It was intended that although these measures would satisfy specific slope stability and hydrologic problems they would also present an aesthetic roadside to the motorist.

Available permanent erosion control techniques were researched and specified on the construction plans. Grasses were chosen to be adaptable at the varying altitudes of Vail Pass. Several grass mixtures were developed and used. Areas were reseeded where the grass stand was not found to be satisfactory.

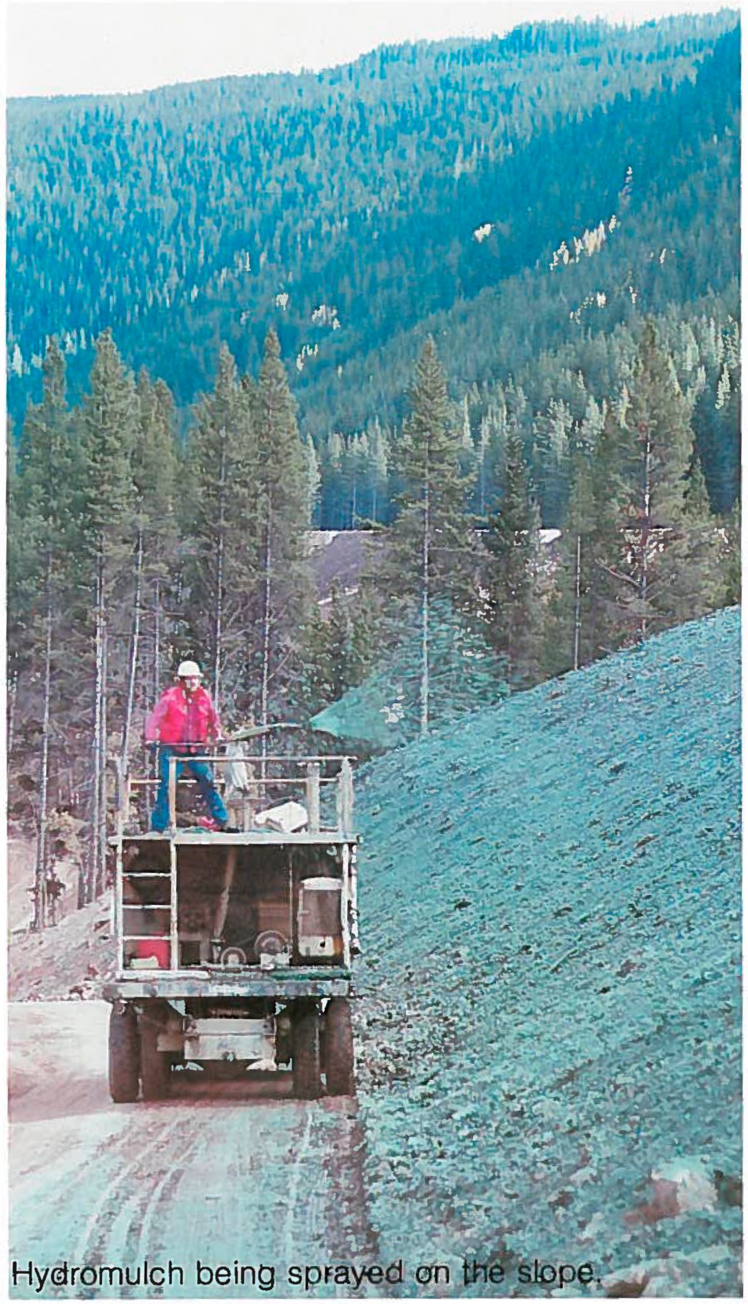
Several different measures were used. Grasses were seeded on all disturbed areas. The seeded areas were mulched and covered with a netting specially designed to minimize soil erosion. All culvert outlets were finished off with rock and aggregate to dissipate water energy and eliminate erosion. Small streams intercepted by cut slopes were rocked and planted with shrubs to stabilize the washes and reduce runoff.

These beaver ponds were used as collection basins from which sediment laden water was pumped to be irrigated over grasses and willows which would serve as a natural filter.

VEGETATION AND PRODUCTS RESEARCH

Prior to specifying grasses it was found that if any grass was to survive and establish dense ground cover, some measures to stabilize and protect the ground and germinating seed were needed. Several mulches were evaluated but no one mulch material was found to be effective in all situations. In consultation with the Forest Service, the Colorado Division of Highways decided to use a combination of mulching methods. Straw or native hay was applied over the seeded ground and covered with an erosion control netting called jute mat. This netting proved to be too expensive for an overall application and only applied on slopes steeper than 3:1 or in areas where even minor erosion was a problem. This mulch/netting method effectively stopped rill and gully erosion common on highway slopes at this altitude but was found to slow plant growth the first season. Subsequent years have shown that this growth delay only lasts the first year and healthy native grass crops appear after the first season. The improved erosion control feature is felt to be a favorable trade for a slower grass development.

Vail Pass also offered the opportunity to experiment with new mulch and netting products. Hydromulch, excelsior netting, and a variety of other erosion control and mulch netting materials were tested and are now being evaluated for their ability to prevent soil erosion and encourage grass growth.



Hydromulch being sprayed on the slope.


Straw mulch being inspected.


An erosion control fabric tested on Vail Pass.


Excelsior netting was also evaluated.

Jute netting covering a straw mulch was used extensively to minimize erosion during seed germination.

SEED BED PREPARATION

To establish an effective grass stand, other growth promoting factors were necessary. Topsoil was collected from the project site prior to construction, stockpiled, and later applied to the completed slopes. This topsoil provided not only needed fertility and a growing medium for the grasses, but also an abundance of native seeds. It was found that in areas where topsoil was applied to a minimum depth of 4″, grass growth was not only faster and dense but native forbs, weeds, and grasses were encouraged to spread from the forest onto the disturbed slopes. Hence, topsoil was applied to most Vail Pass highway slopes.

Fertilizer was also applied to the seeded slopes to compensate for the disturbed ground fertility. Soil samples were taken for each project and fertilizer application was adjusted to reflect soil fertility test results. Fertilizer applications were continued each spring season during the course of the project. Additional mid-growing season watering was used on later projects to speed germination and promote growth during the dryest months.

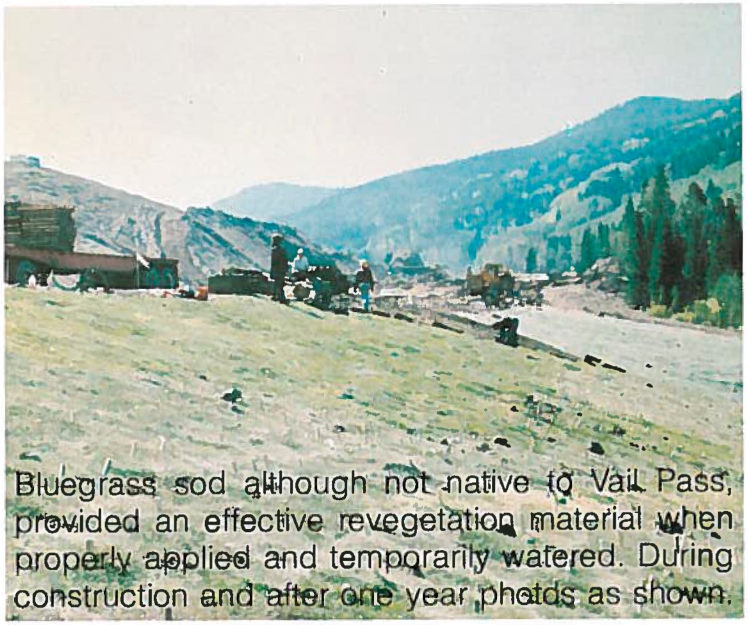
Special contract provisions limited contractor operations so that as 30 vertical feet of slope was exposed the seeding, fertilizer and mulching crews were to finish off the slope before the contractor could proceed further. This provision had the contractor topsoiling and seeding the slopes as they were constructed thus minimizing the total amount of exposed slope at any one time.

GRASSES AND SEEDING METHODS

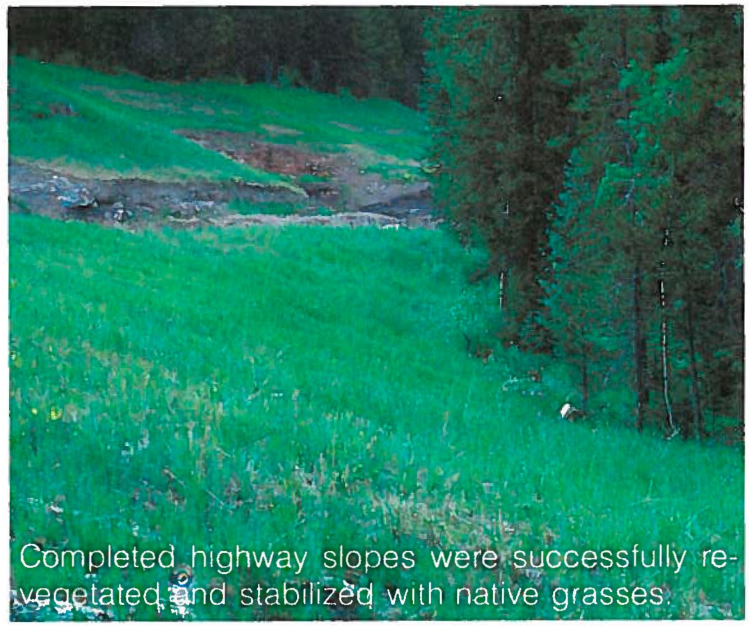
Seeding methods varied according to the conditions. Drill seeding was accomplished wherever possible but with considerable difficulty on slopes steeper than 3:1. Here hand broadcast seeding, followed with raking to cover the seeds, was used most. Hydroseeding was used on several sites. Generally, drill seeding gained better results on the flatter sites while broadcast seeding proved effective on steep slopes.

Bluegrass sod was applied to approximately two acres at nearly the same cost as the straw/netting feature. The sod was applied as in a lawn operation, staked to eliminate down-slope movement and irrigated for 8 weeks. Once root growth had secured the sod to the slope, watering was reduced and finally stopped altogether. After two seasons, the

Jute netting provides needed seedbed protection for the grasses during germination.



Bluegrass sod although not native to Vail Pass, provided an effective revegetation material when properly applied and temporarily watered. During construction and after one year photos as shown.



Completed highway slopes were successfully re-vegetated and stabilized with native grasses.

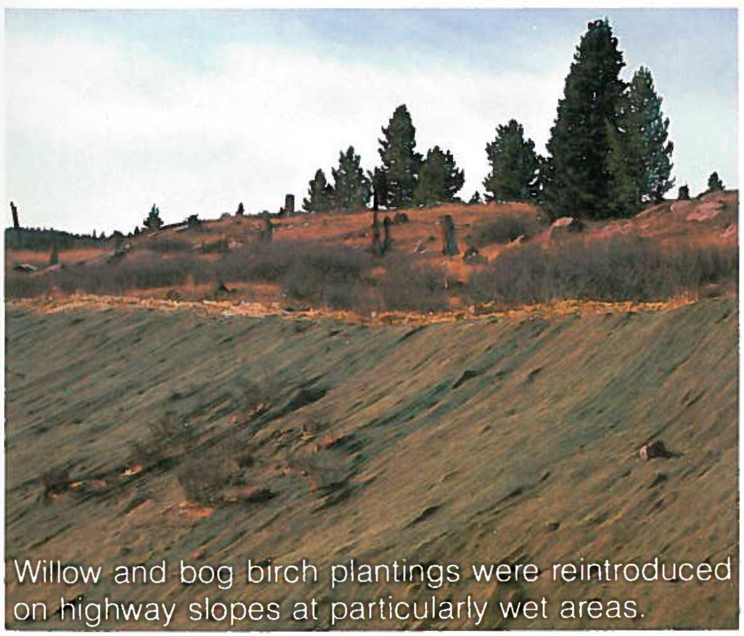
Bluegrass sod has shown to be an effective erosion control and plant establishment technique. It is not expected that the Bluegrass stand will remain at its cultured density but as it dies back, native grasses will take its place.

SHRUBS

As construction progressed numerous ground water source points were intercepted. These points were a constant source of erosion even though the slopes were flattened and covered with jute and mulch. These areas proved too unstable and too wet for dryland grasses to grow. Under natural conditions shrubs like Willow and Bog Birch thrive under these same high moisture conditions and it was observed that the root structure of these plants would be a stabilizing factor.

In these ground water source points, Willow and Bog Birch shrubs were planted to stabilize the slope and to provide natural cover for spreading native seeds.

Shrubs were collected from within the project limits before construction began, stockpiled and later planted where needed. The results of this method were impressive. Not only were willows easy to transplant but they quickly became established and stabilized the wet slopes.

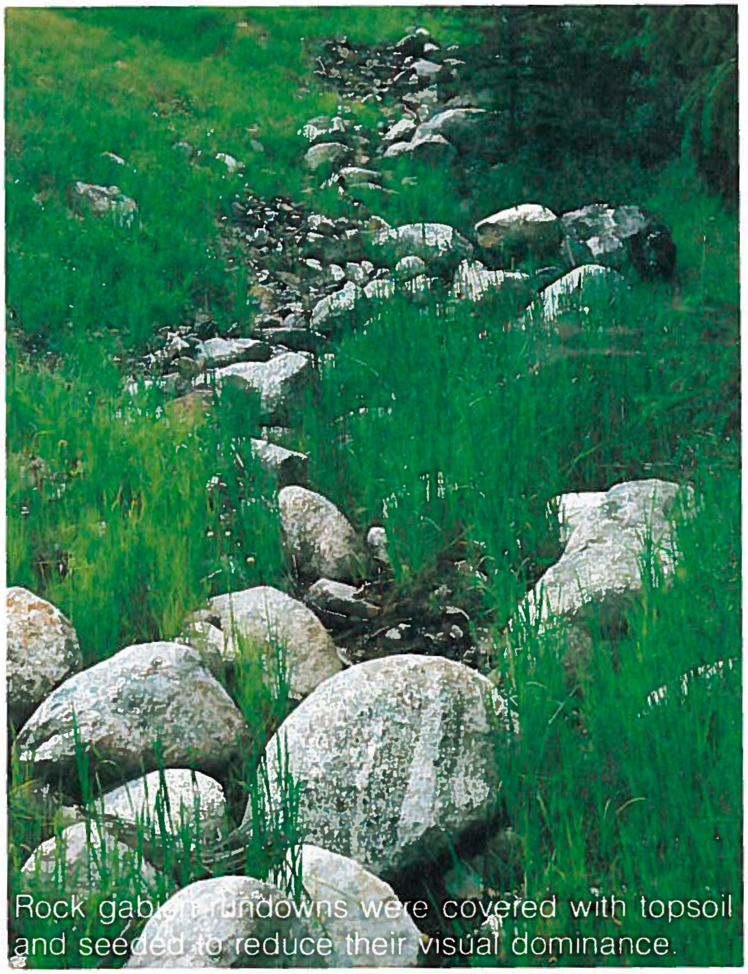


Willow and bog birch plantings were reintroduced on highway slopes at particularly wet areas.

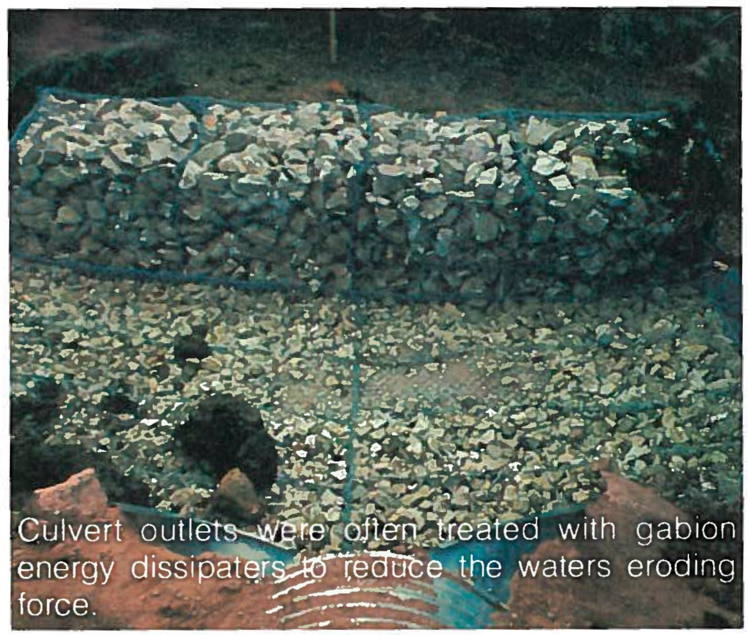
ROCK

Rock was randomly placed in drainage ways which crossed the highway slope. This rock slowed the water and limited the scouring action of the drainage. Rocks also were used to protect newly planted shrubs from the streams' scouring action.

Some cross slope drainage ways were constructed on least visible slopes.



Rock gabion rundowns were covered with topsoil and seeded to reduce their visual dominance.



Culvert outlets were often treated with gabion energy dissipaters to reduce the waters eroding force.

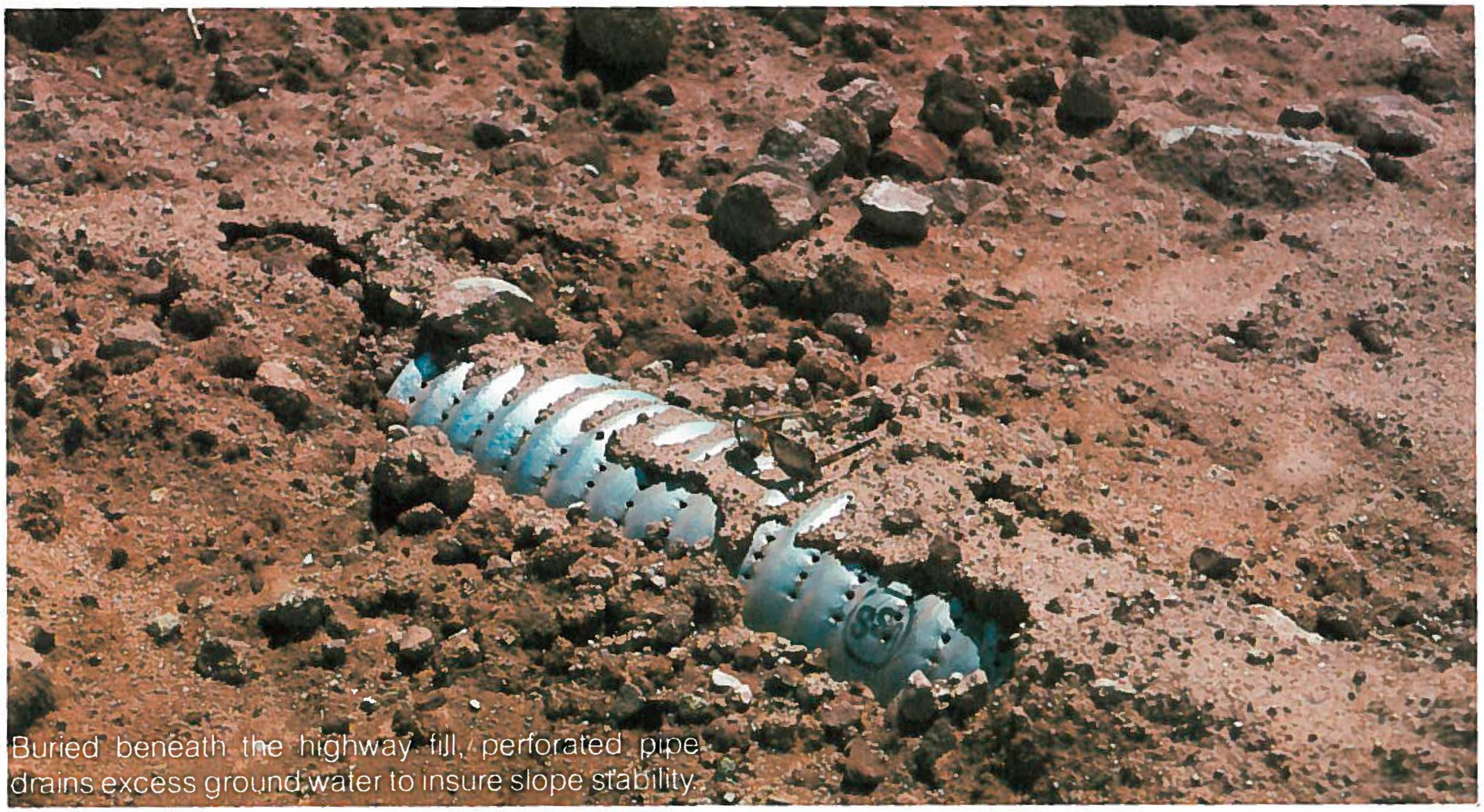
Drainage ways were lined with rock to prevent soil erosion while being aesthetically pleasing.

ENERGY DISSIPATERS

Soil erosion also occurs at points of water collection, such as at culvert outlets. Culvert inlets were stabilized with grass growth but the erosion energy at the culvert outlet was too great to allow grass to grow. On Vail Pass culvert outlets were treated with energy dissipaters which typically consisted of rock of varying sizes below the water outlet. Most energy dissipaters were constructed of rock gabions built of rock filled wire cages with a polyvinyl chloride (PVC) underliner.

PERFORATED PIPE

Vail Pass construction encountered considerable ground water which not only posed erosion control problems but also caused concern for highway stability. To remedy this problem perforated pipe was used to draw ground water from beneath the roadway. Perforated pipe has holes in it to allow water to seep into the pipe and keep soil out. These pipes were used extensively throughout the pass and added to the success of the overall project.



Buried beneath the highway fill, perforated pipe drains excess ground water to insure slope stability.

STRUCTURES

Early in the Vail Pass design stages it was recognized that to satisfy environmental engineering and aesthetic constraints special structures would be required. Bridges, retaining walls and sidehill structures were later individually identified as being required. Once the design parameters were set the Division contacted qualified engineering and architectural consultants to develop design concepts for the proposed structures. Inter-agency review and comment on the design of these structures was necessary to satisfy concerns expressed.

Environmental concerns centered on minimal disturbance especially to the many streams and wildlife habitat and migration routes. Aesthetic concerns were considered as important as environmental protection and the structures had to be designed to be compatible with the natural terrain.

Engineering constraints presented by the mountainous terrain were possibly the most complex problems encountered. Many slide areas were known to exist on Vail Pass. Retaining wall stability had to be tested under these conditions to assure structural stability. Construction conditions were also difficult. Building the necessary major structures on confined mountainous terrain during a short construction season called for special procedures and materials not commonly used on interstate projects.

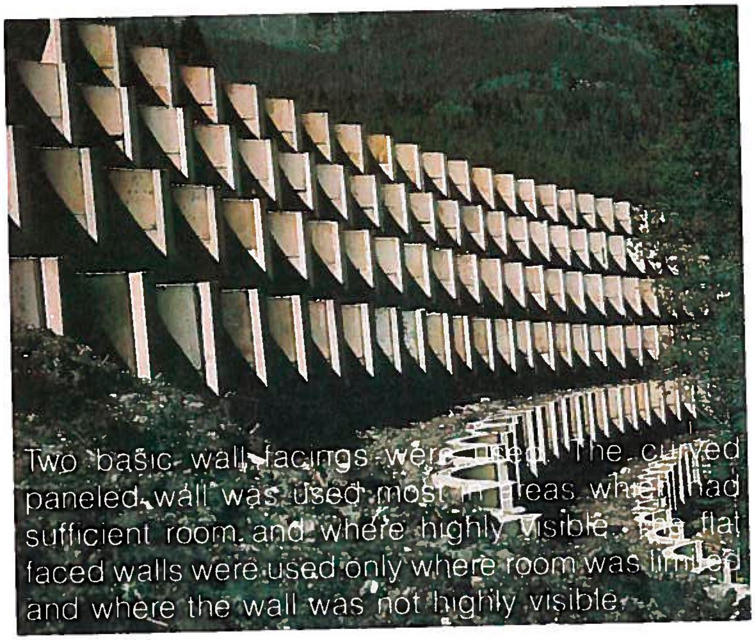
RETAINING WALLS

In addition to the normal requirements of adequate soils analysis, structural design, and economy in cost, the rugged scenic terrain and the short construction season at the high altitude of Vail Pass imposed requirements on retaining walls:
The wall had to be aesthetically compatible with the environment. Since some of the fill slope walls are quite high (60 to 70 ft.) a vertical wall was considered undesirable. A stepped wall, built in 8-ft lifts with a 4- to 6-ft set back between tiers was deemed architecturally desirable. The wall had to be modular and prefabricated to expedite construction. Cast-in-place concrete was ruled out because of the complexity in forming, especially in the high walls, and the curing time required before backfilling operations could begin.

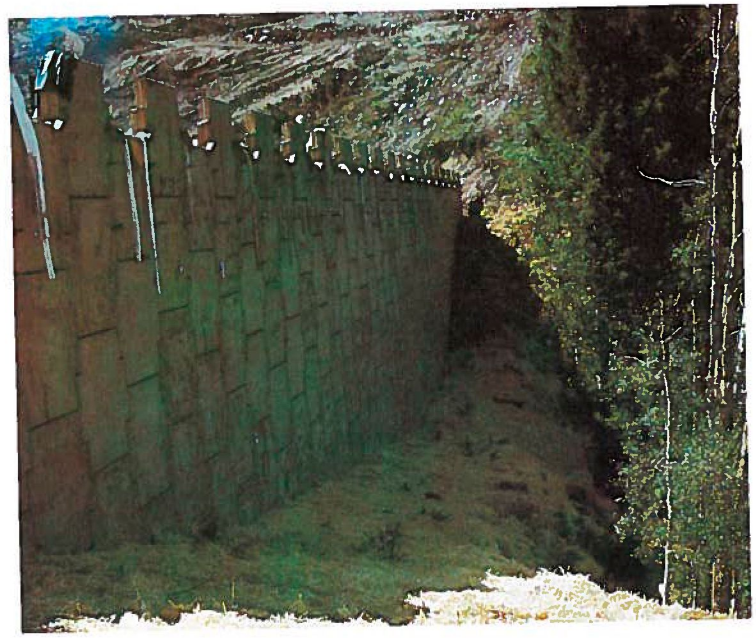
To confirm the basic design assumptions, a full scale section of wall was constructed, instrumented, and tested.

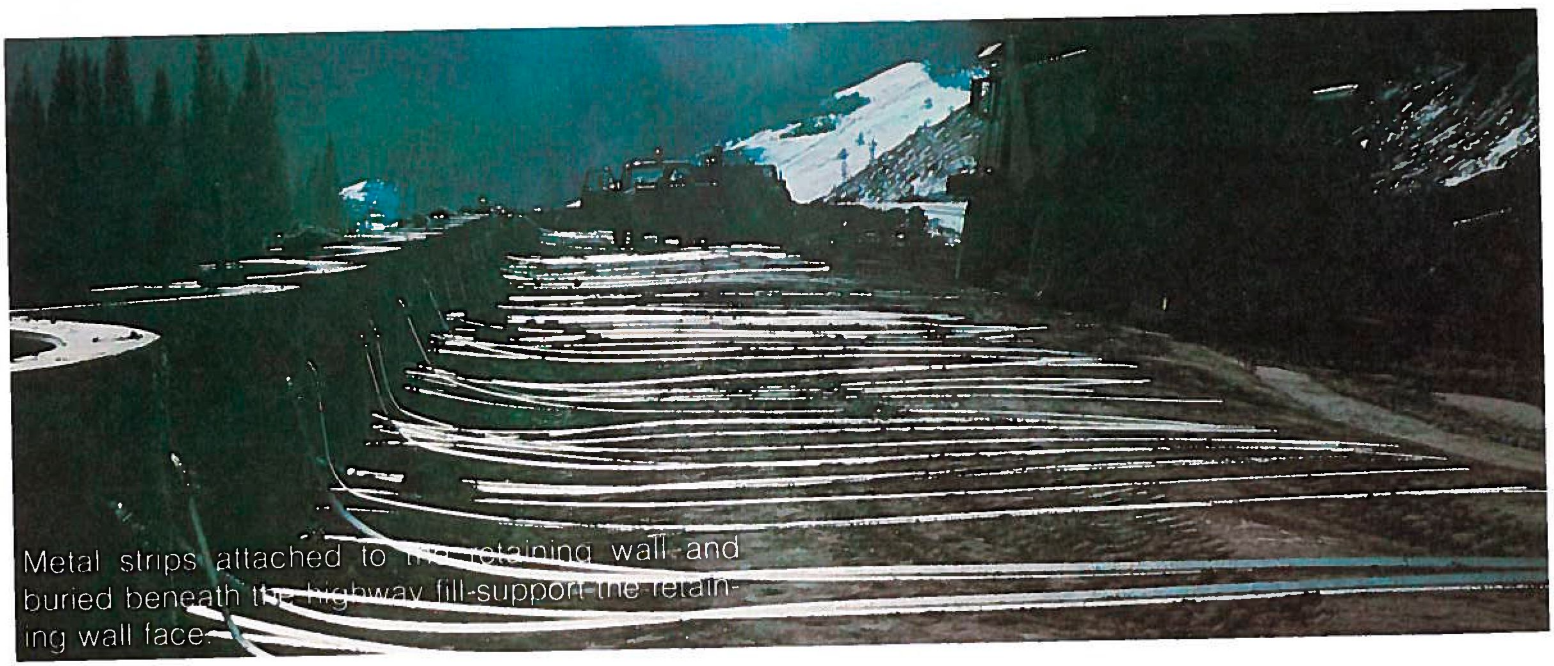
The wall panels between tiebacks are parabolic in shape to minimize bending stresses from horizontal soil pressure. In addition, the design is considered to be superior to other shapes from an appearance standpoint. A final touch was the addition of iron oxide to the cement to produce a reddish-tan color that would blend into the natural surroundings on Vail Pass.

Some walls were constructed vertical due to limited area available for the fills. In these cases the walls were constructed using reinforced earth, since the precast tieback system is not ideally suited to high walls with a vertical face.



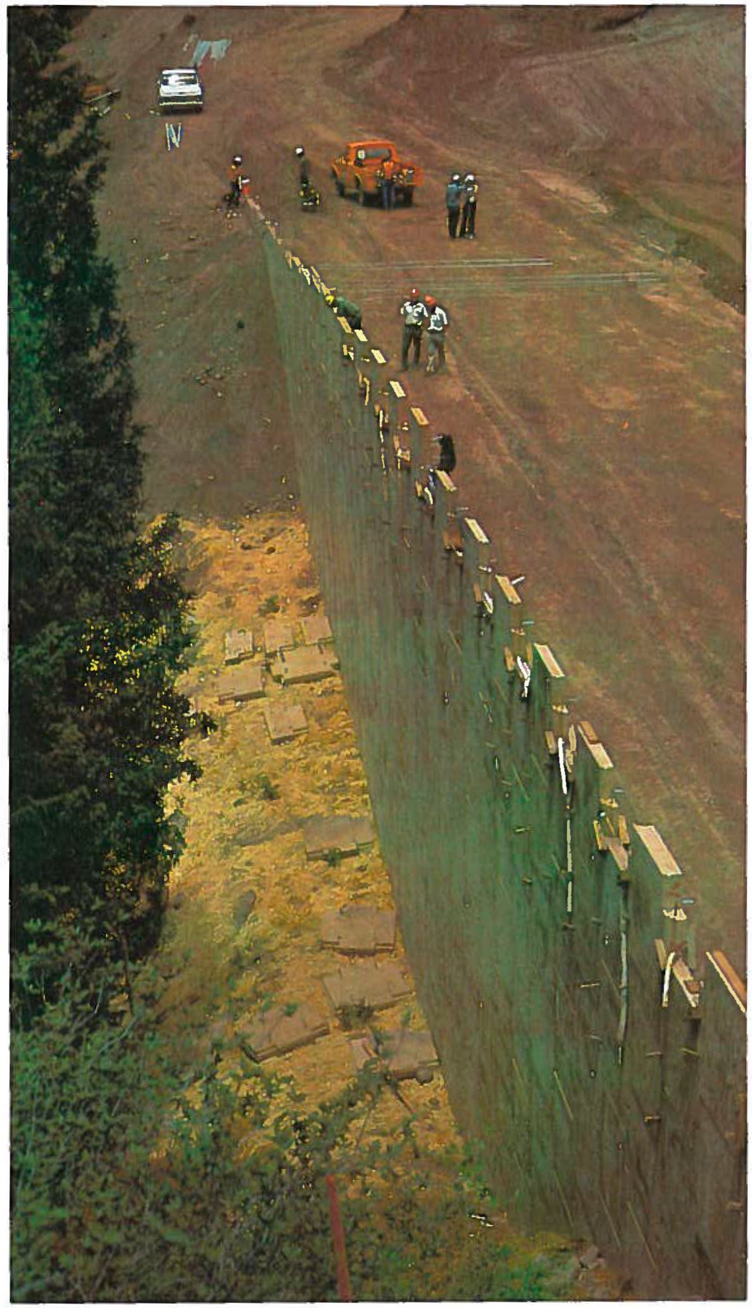
Two basic wall facings were used. The curved paneled wall was used most in areas which had sufficient room and where highly visible. The flat faced walls were used only where room was limited and where the wall was not highly visible.

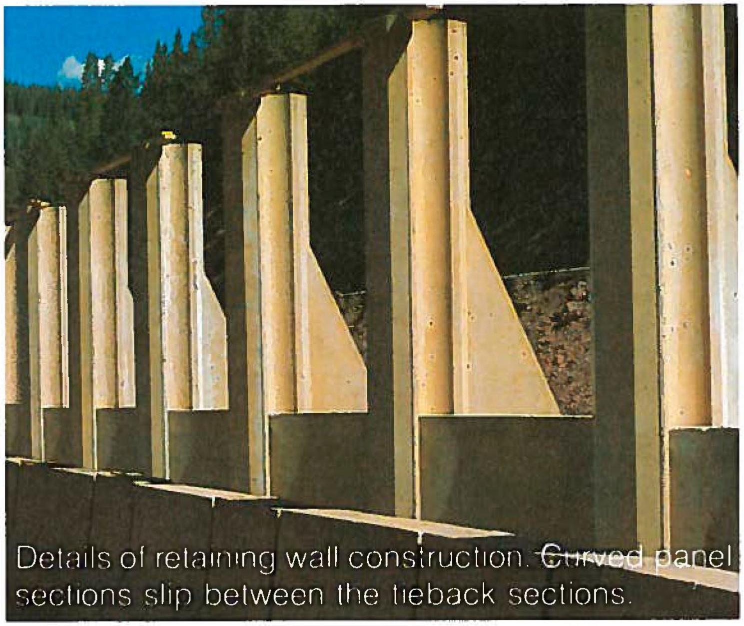


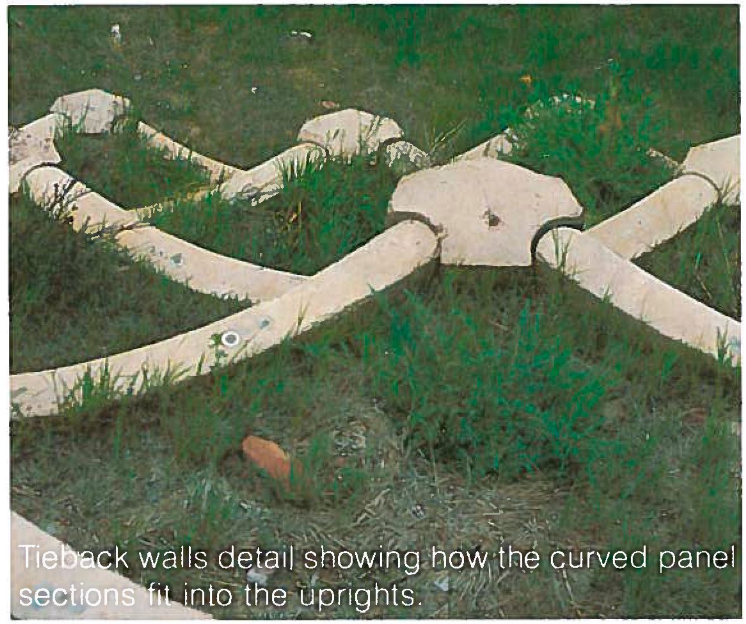


Metal strips attached to the retaining wall and buried beneath the highway fill support the retaining wall face.

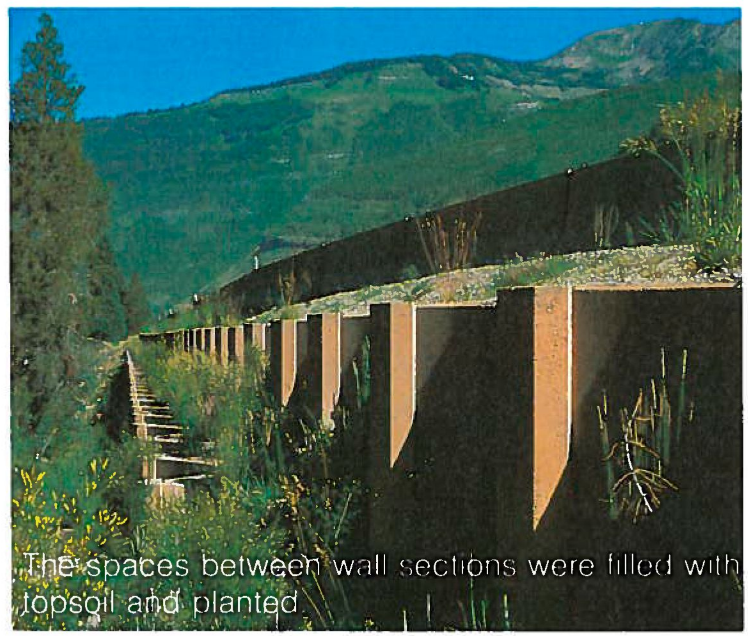

Because of the construction simplicity of these modular walls, erection time was minimized, limiting the potential environmental impacts.



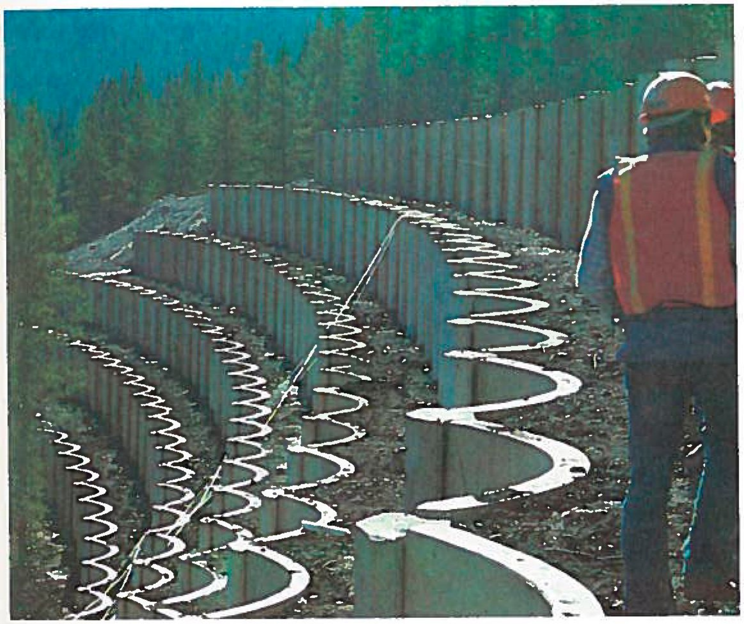

Details of retaining wall construction. Curved panel sections slip between the tieback sections.

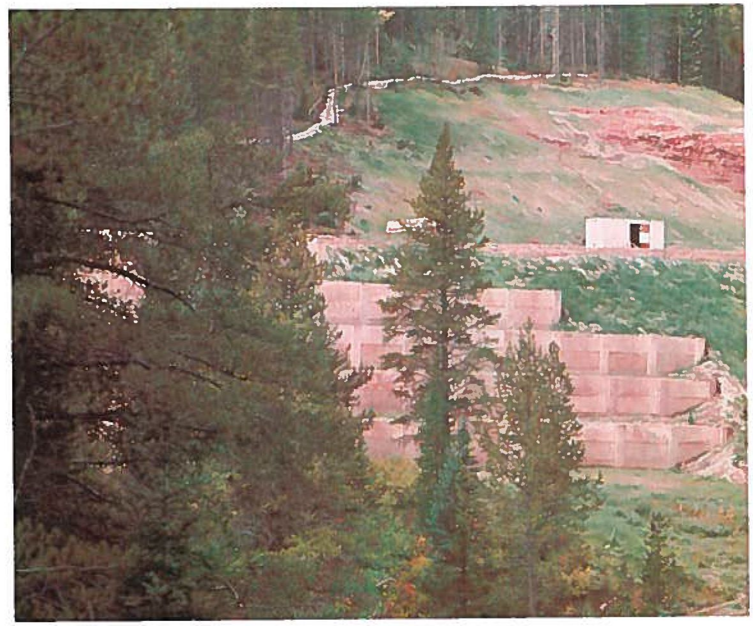

Tieback walls detail showing how the curved panel sections fit into the uprights.

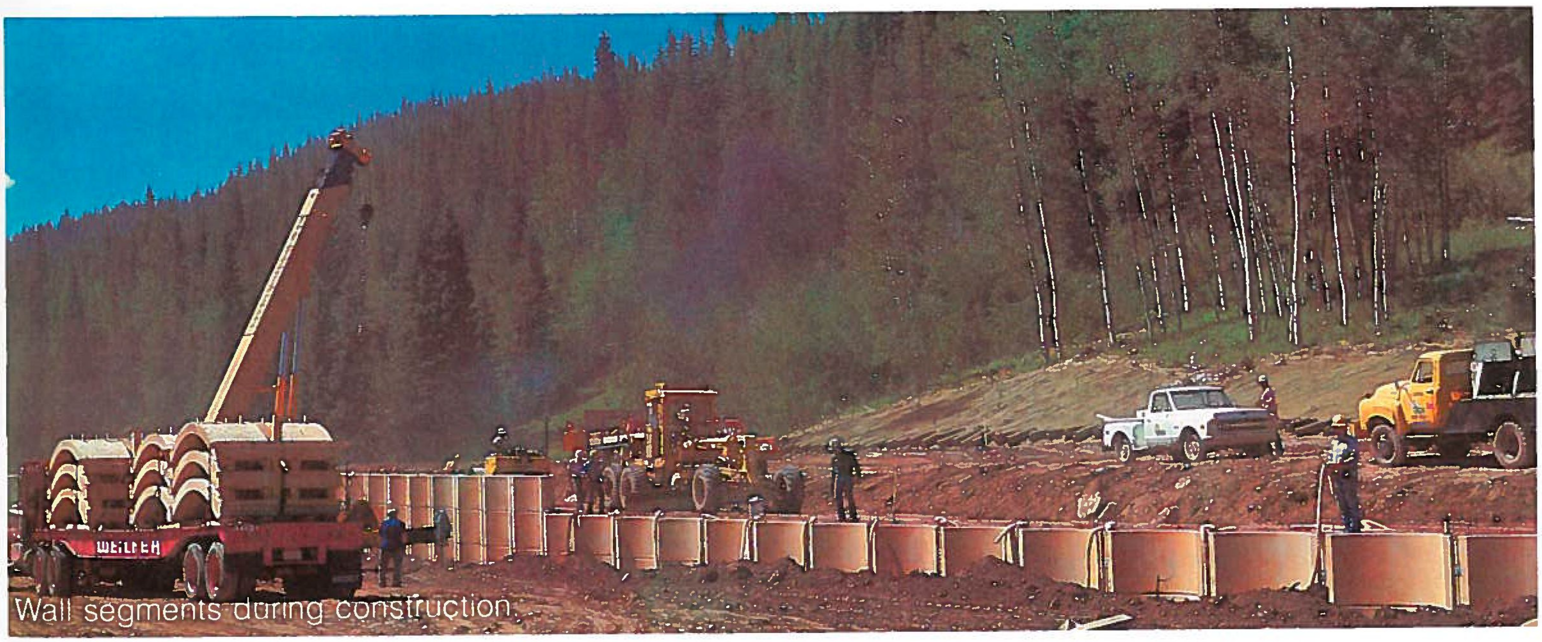

Curved reinforced earth wall detail illustrating pier-panel section attachment.


The spaces between wall sections were filled with topsoil and planted.

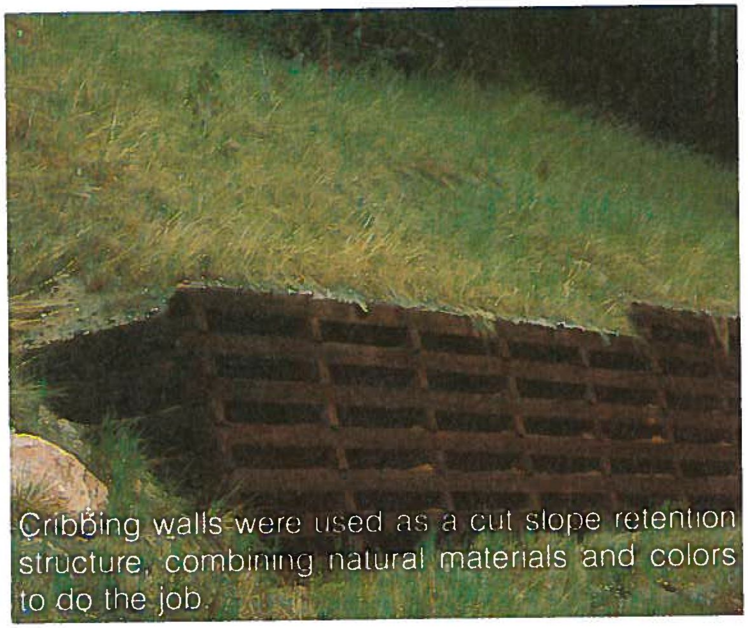
Wherever possible, plant materials were introduced into the retaining wall planting spaces. This material will minimize the visual massiveness of the retaining walls.



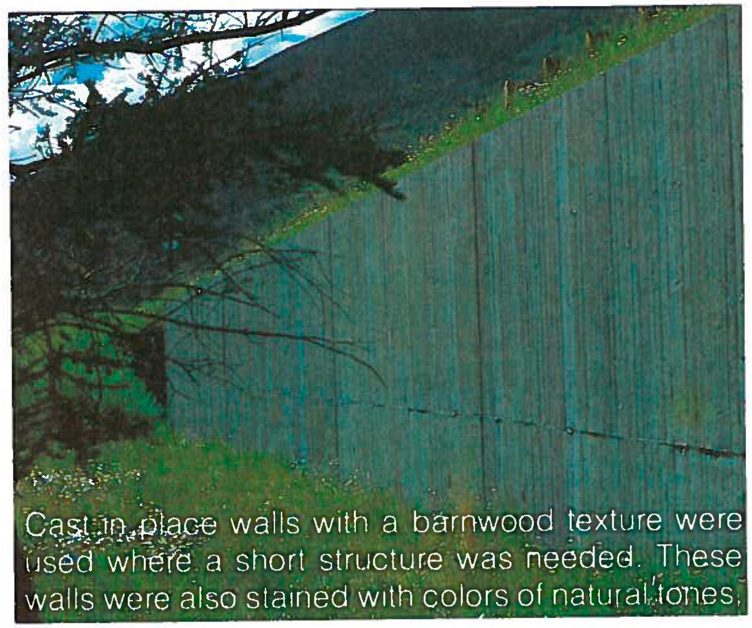




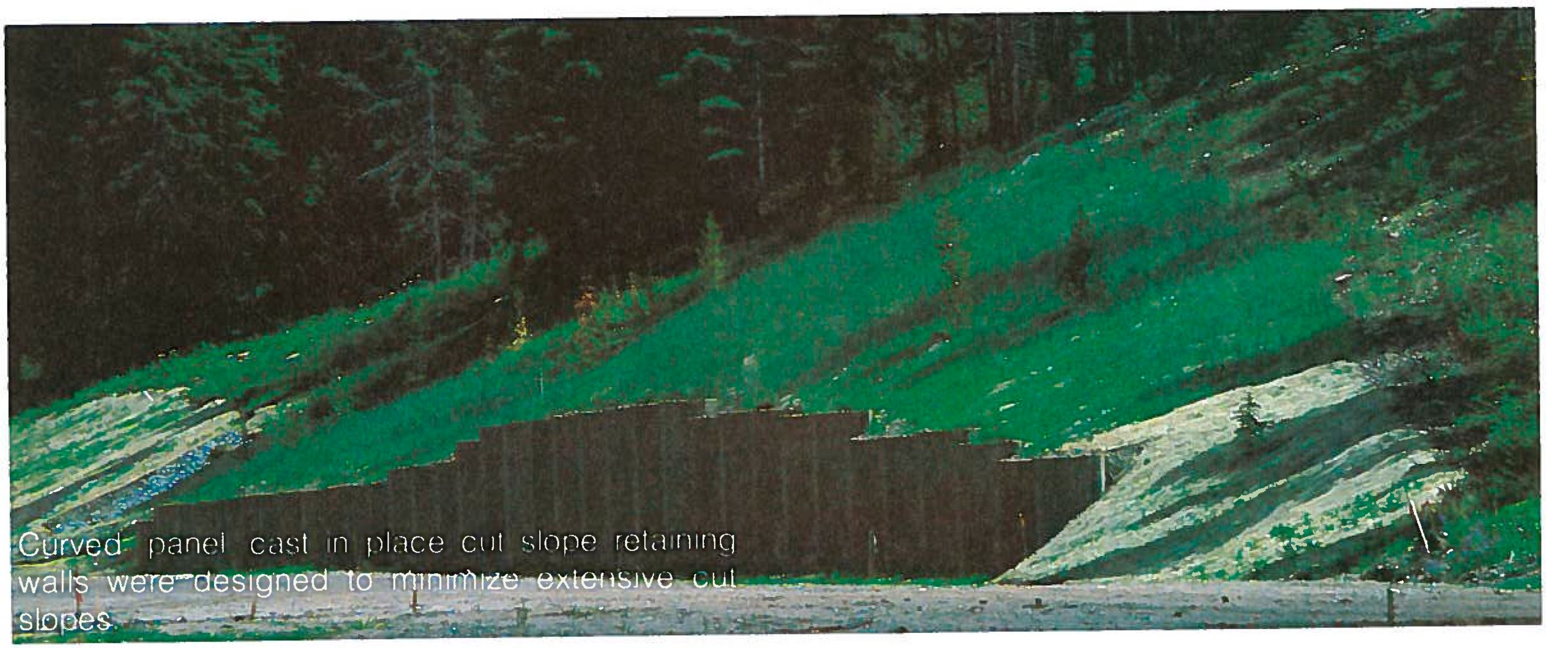
Wall segments during construction.



Cribbing walls were used as a cut slope retention structure, combining natural materials and colors to do the job.



Cast in place walls with a barnwood texture were used where a short structure was needed. These walls were also stained with colors of natural tones.



Curved panel cast in place cut slope retaining walls were designed to minimize extensive cut slopes.

BRIDGES

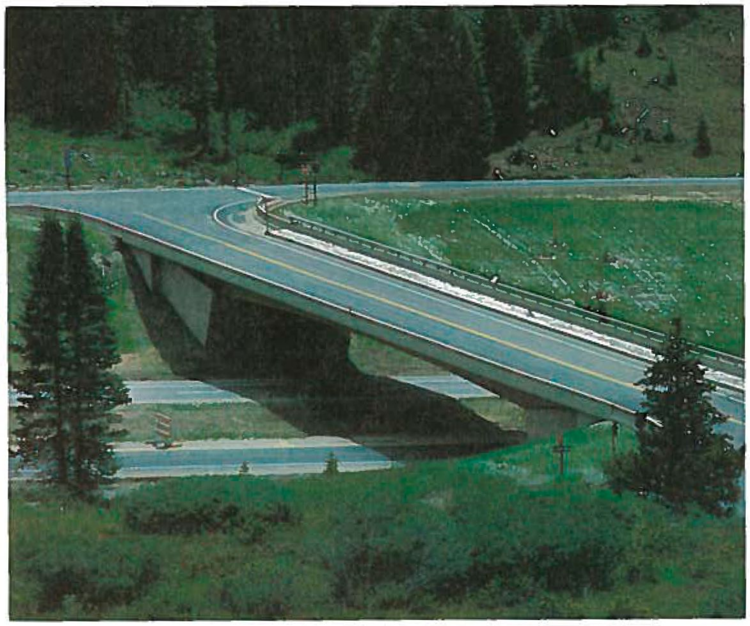
Bridge designs grew from the environmental, engineering and aesthetic guidelines set by the Division. Structures at this altitude had to be erected quickly during the short season, but protection of the underlying landscape was necessary. A common safety problem, bridge deck icing, was also hoped to be solved with the erection of these bridges. In Bighorn and East Vail bridge structures, box girder design provided dead air pockets under the pavement to allow the surface condition to match the rest of the roadway.

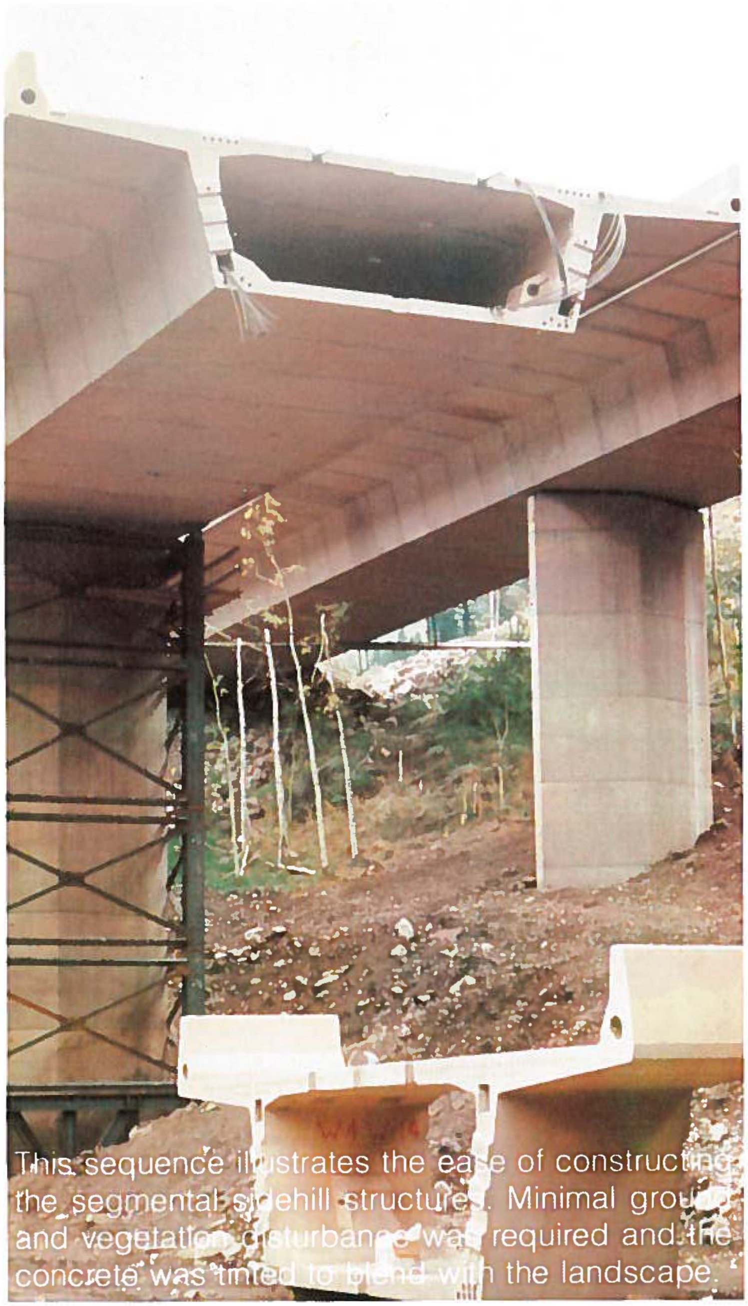
To satisfy these objectives two types of bridge were selected. They were: 1) Precast, segmental, postensioned concrete box girders, and, 2) welded steel box girders with a composite concrete deck. Alternate construction options were provided so that contractors could choose to use a cast-in-place or precast method of the concrete box girder type. Four bridges were constructed in this manner.

Concrete piers were designed to be precast and transported to the job site. Again a cast-in-place option was also used.

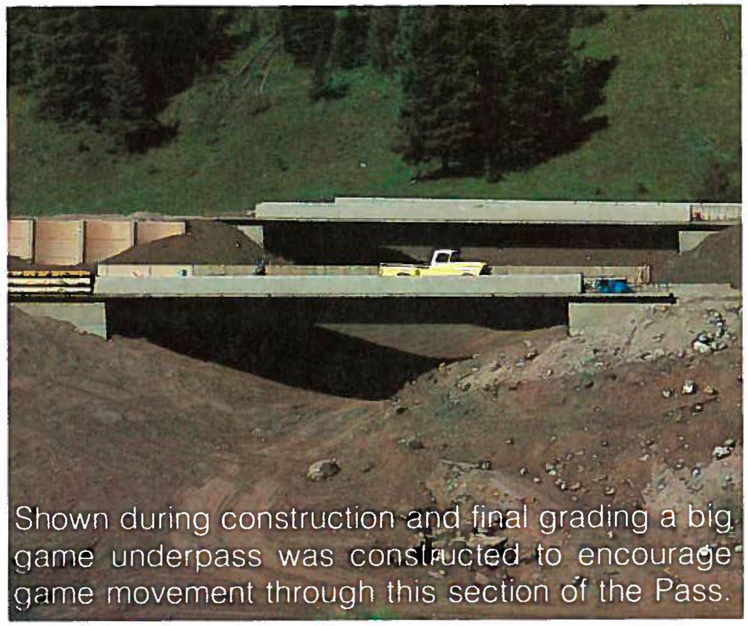
Preliminary cost estimates indicated little difference in the cost of steel box girders and concrete slab vs. precast concrete box girders. For this reason, it was decided that both types would be designed and detailed. Contractors were given both sets of plans and asked to bid on the alternative of their choice.

Sidehill structures were designed to minimize terrain disruption above the Big Horn subdivision. Due to the ease of precast construction, minimal vegetation was disturbed. Trees were allowed to grow between the two bridge decks and the only ground disturbed was that immediately surrounding the bridge piers. This disturbed ground was later regraded to a natural line around the piers to further limit any visual trace of construction.

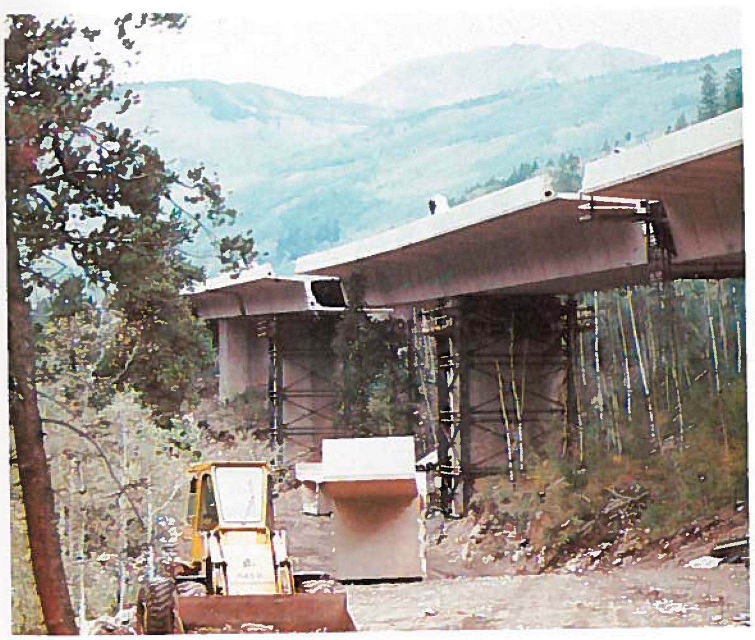


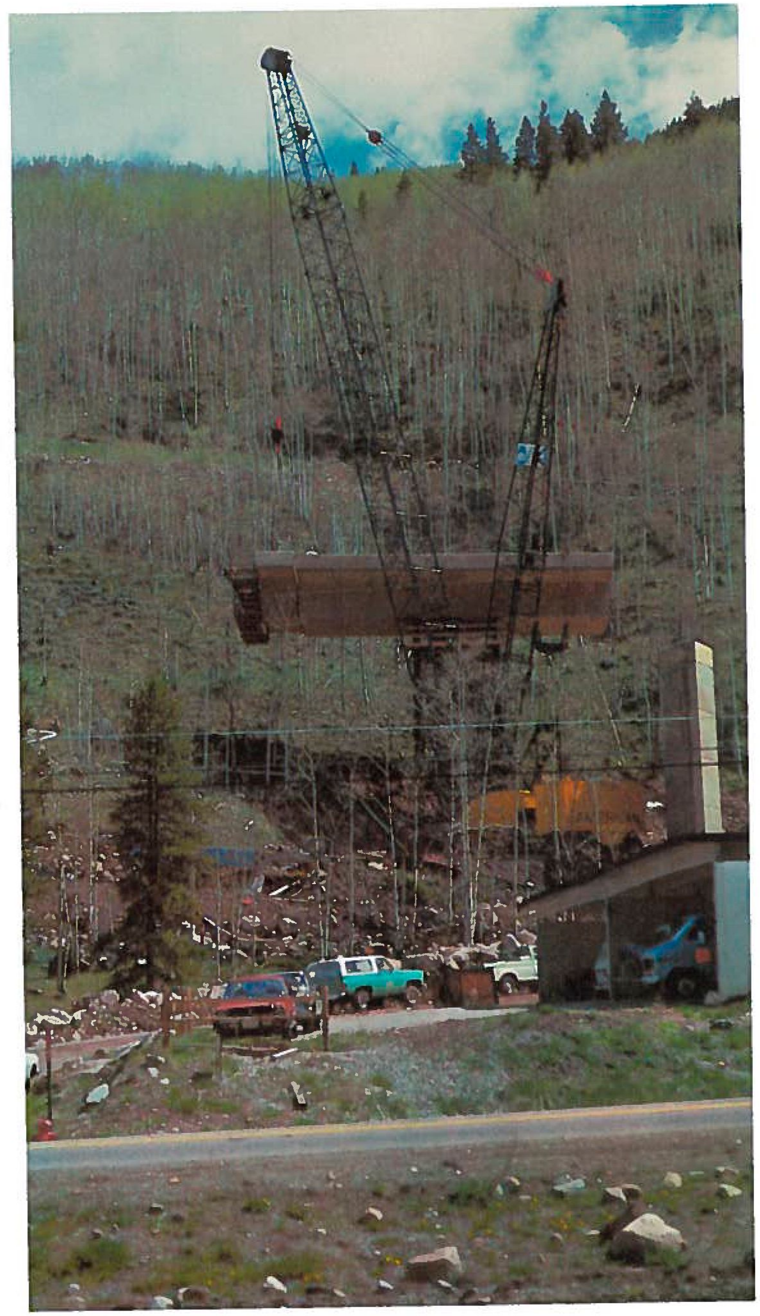


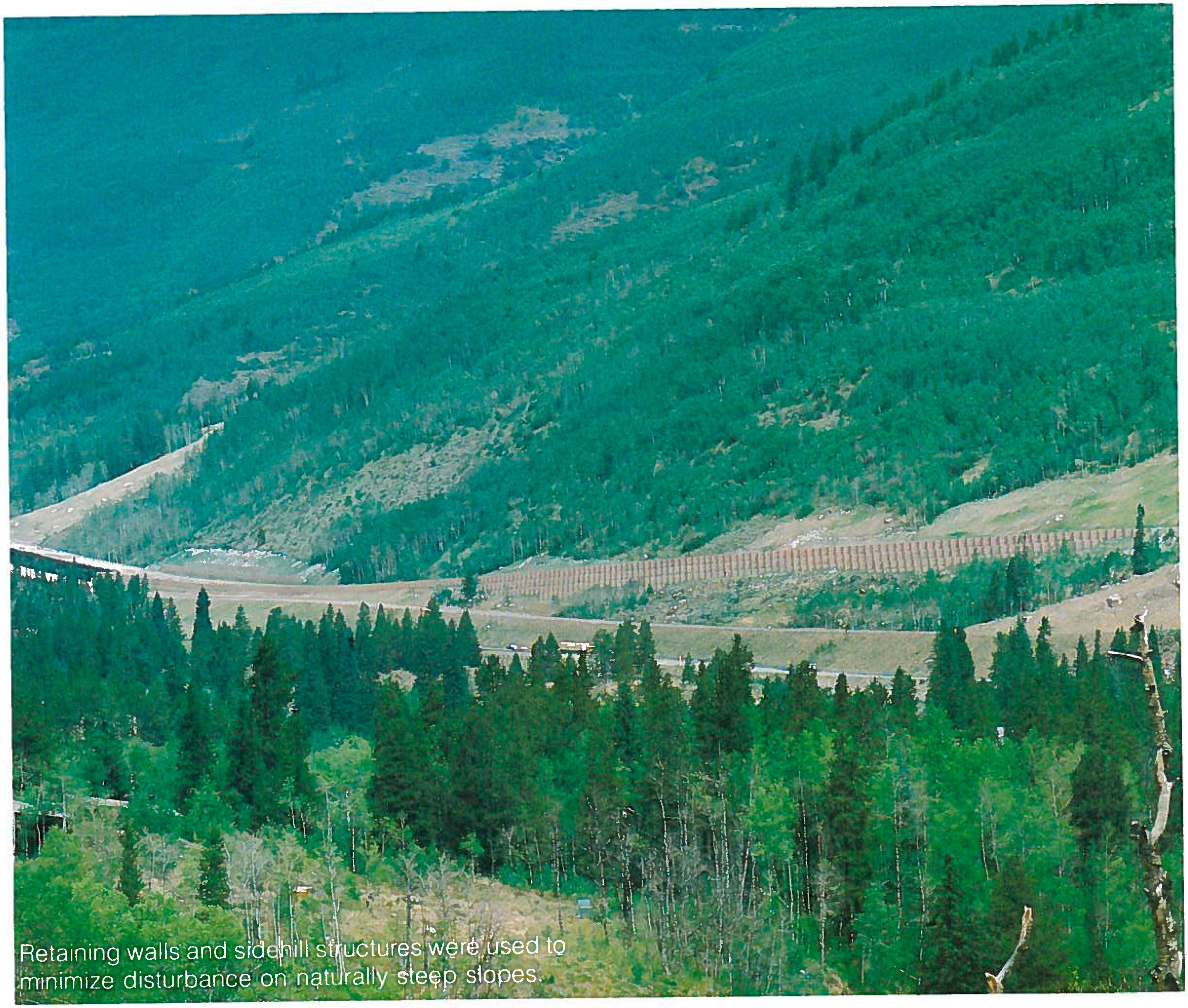
This sequence illustrates the ease of constructing the segmental sidehill structures. Minimal ground and vegetation disturbance was required and the concrete was tinted to blend with the landscape.



Shown during construction and final grading a big game underpass was constructed to encourage game movement through this section of the Pass.

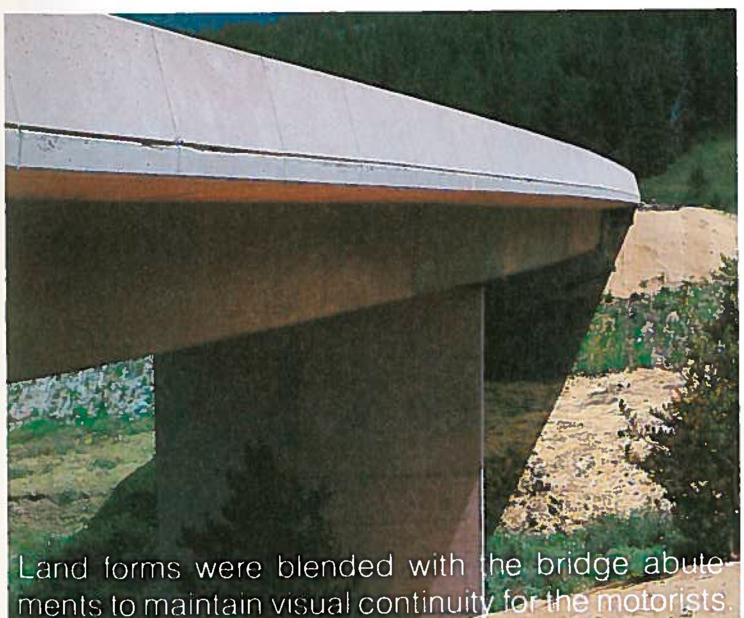




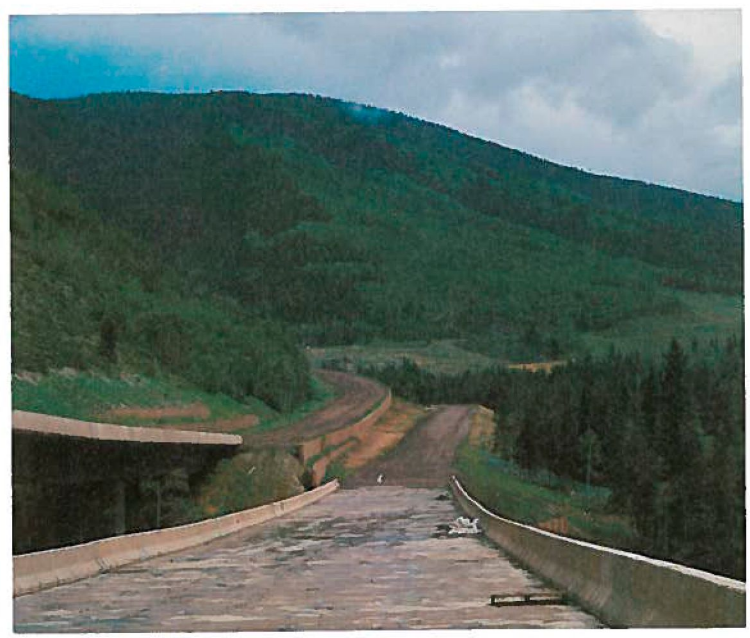


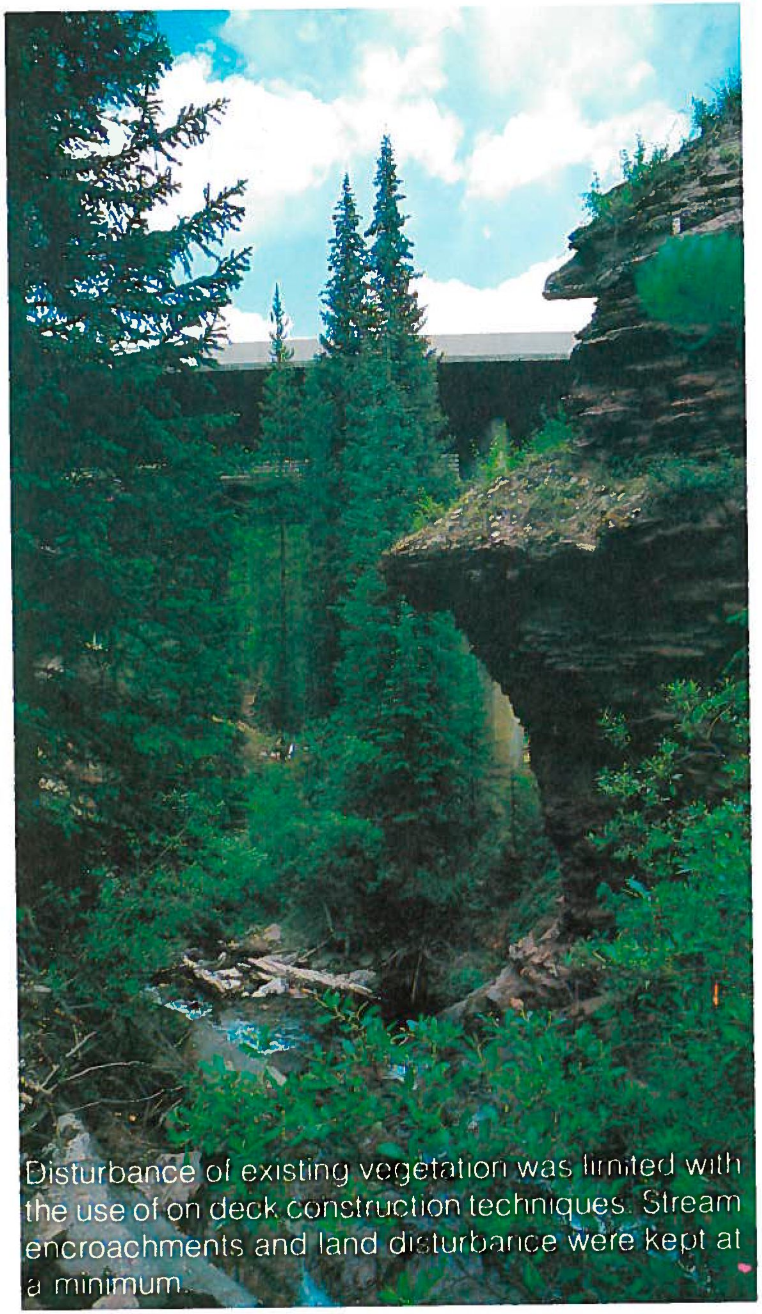
Retaining walls and sidehill structures were used to minimize disturbance on naturally steep slopes.

Slopes disturbed during construction were re-shaped and replanted to minimize environmental impact.

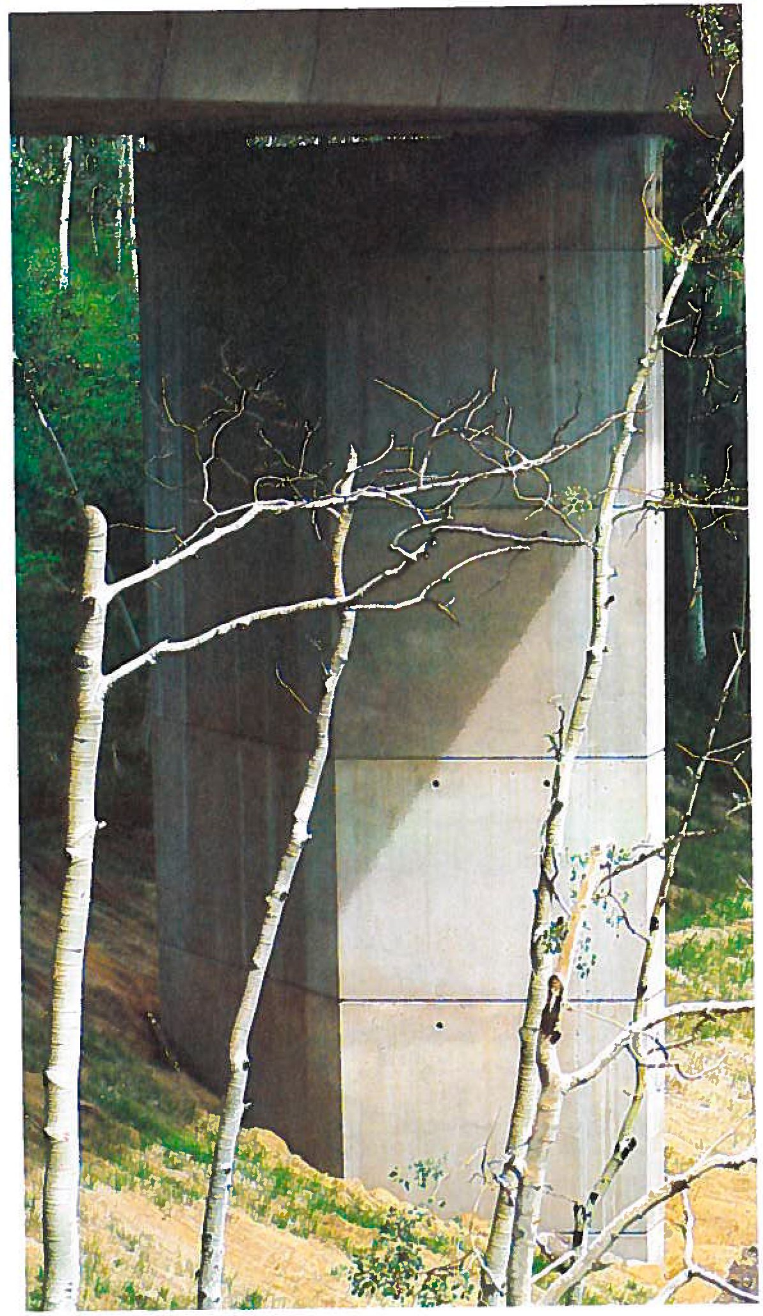


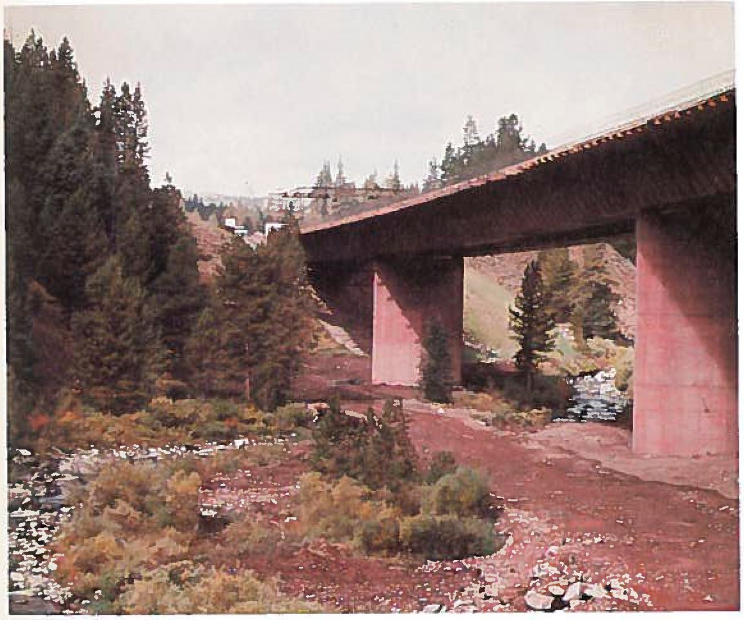
Land forms were blended with the bridge abutements to maintain visual continuity for the motorists.

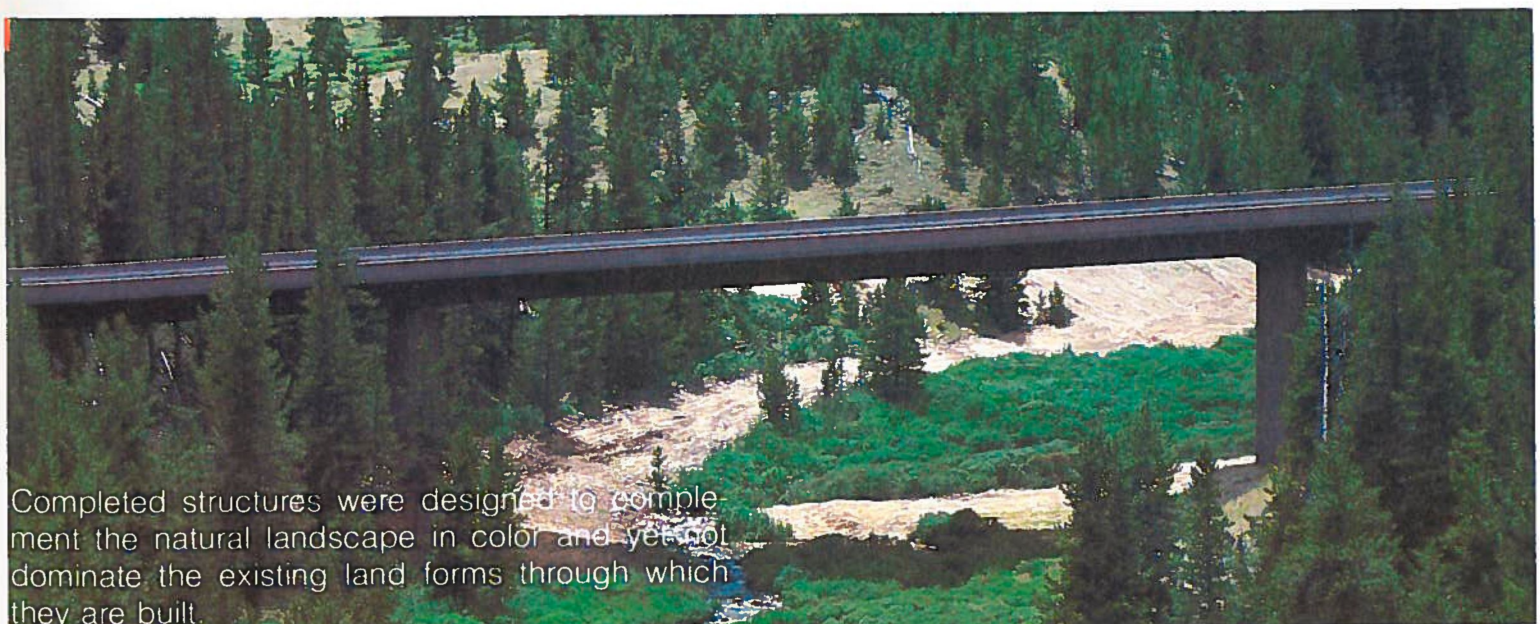




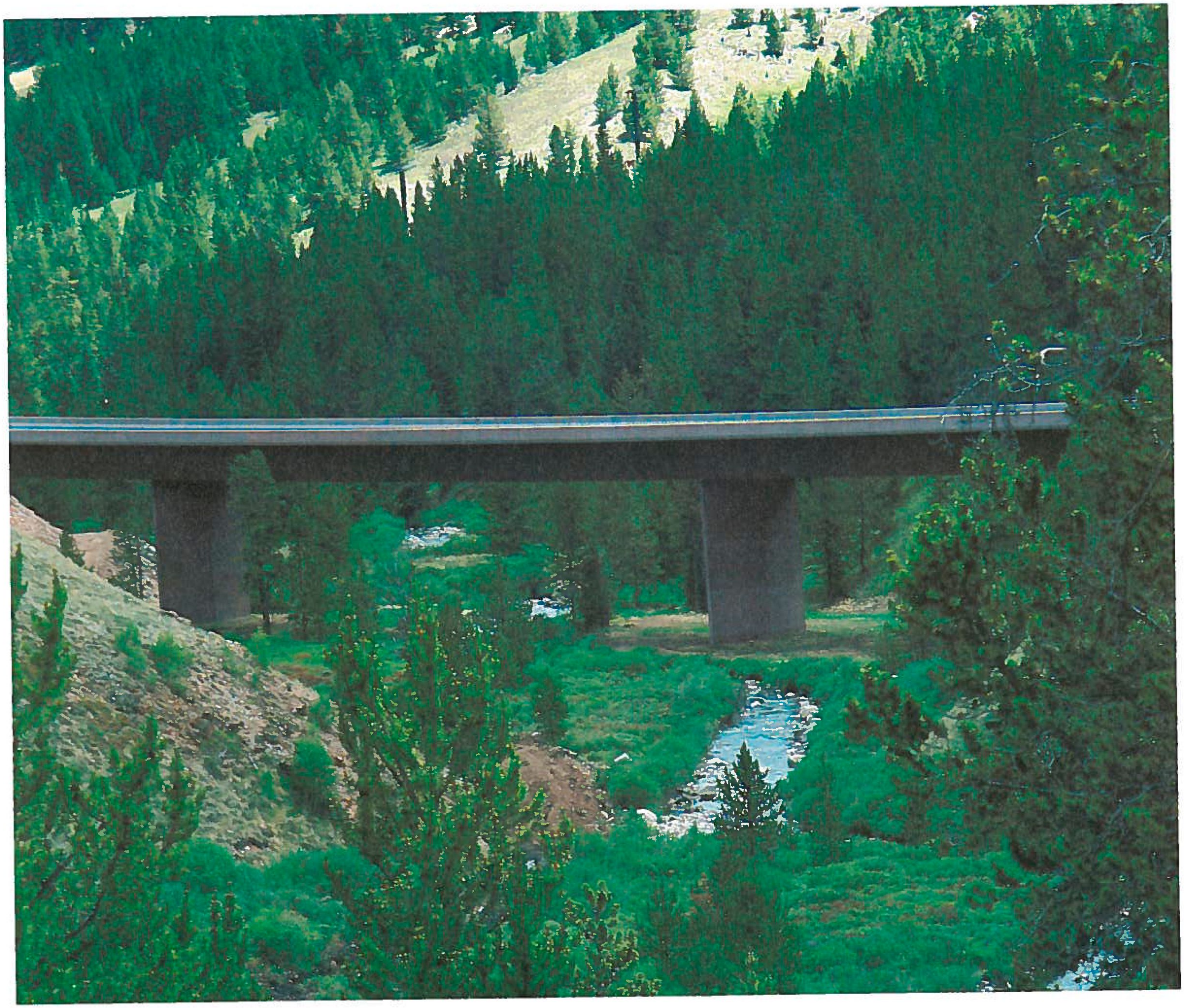
Disturbance of existing vegetation was limited with the use of on deck construction techniques. Stream encroachments and land disturbance were kept at a minimum.





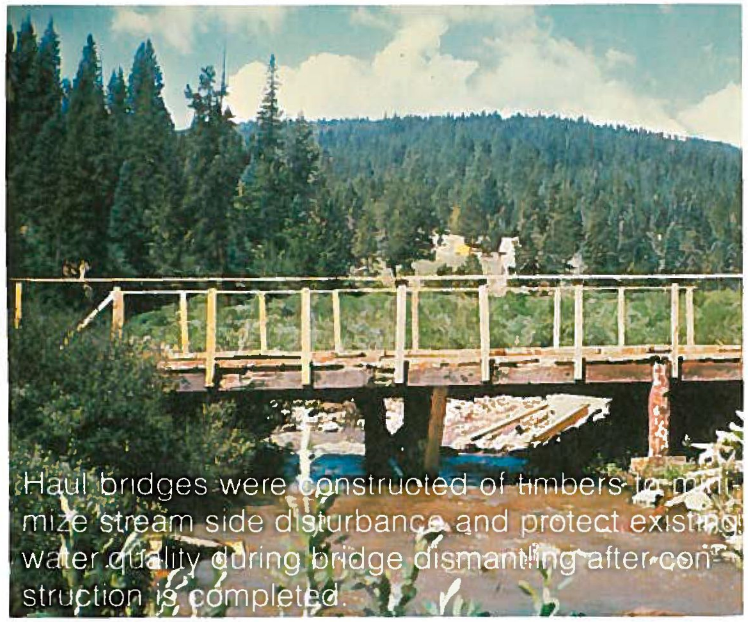


Completed structures were designed to complement the natural landscape in color and yet not dominate the existing land forms through which they are built.

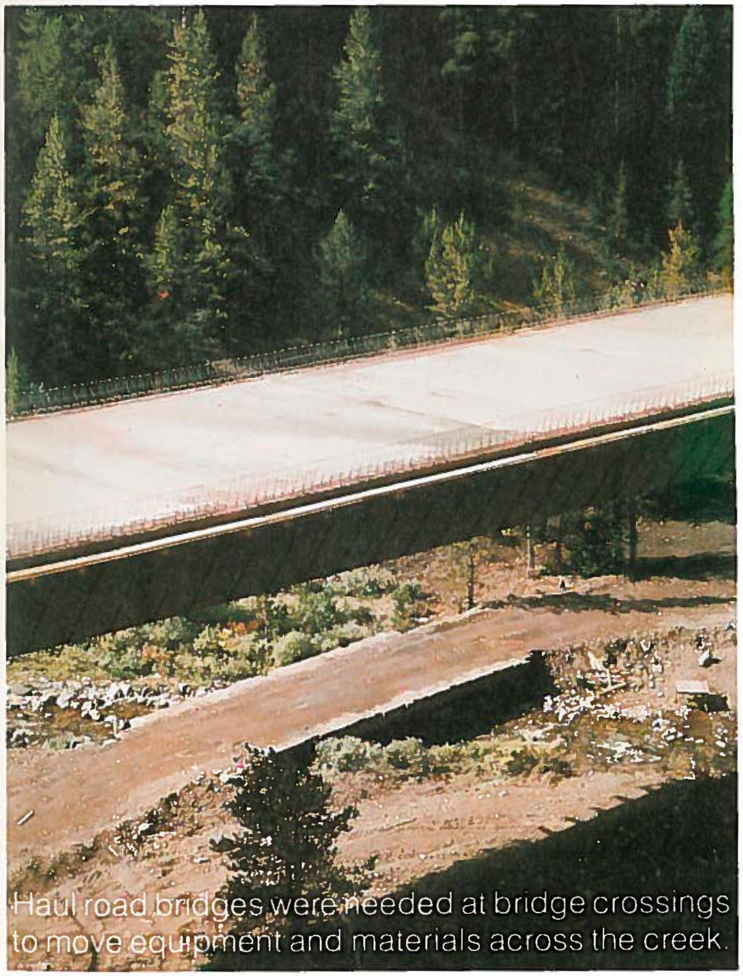


HAUL ROAD BRIDGES

Temporary bridges were also constructed to eliminate the need of crossing the many streams with construction equipment. Haul road bridges were constructed of timber for easy placement and removal without undue siltation of the stream.



Haul bridges were constructed of timbers to minimize stream side disturbance and protect existing water quality during bridge dismantling after construction is completed.



Haul road bridges were needed at bridge crossings to move equipment and materials across the creek.

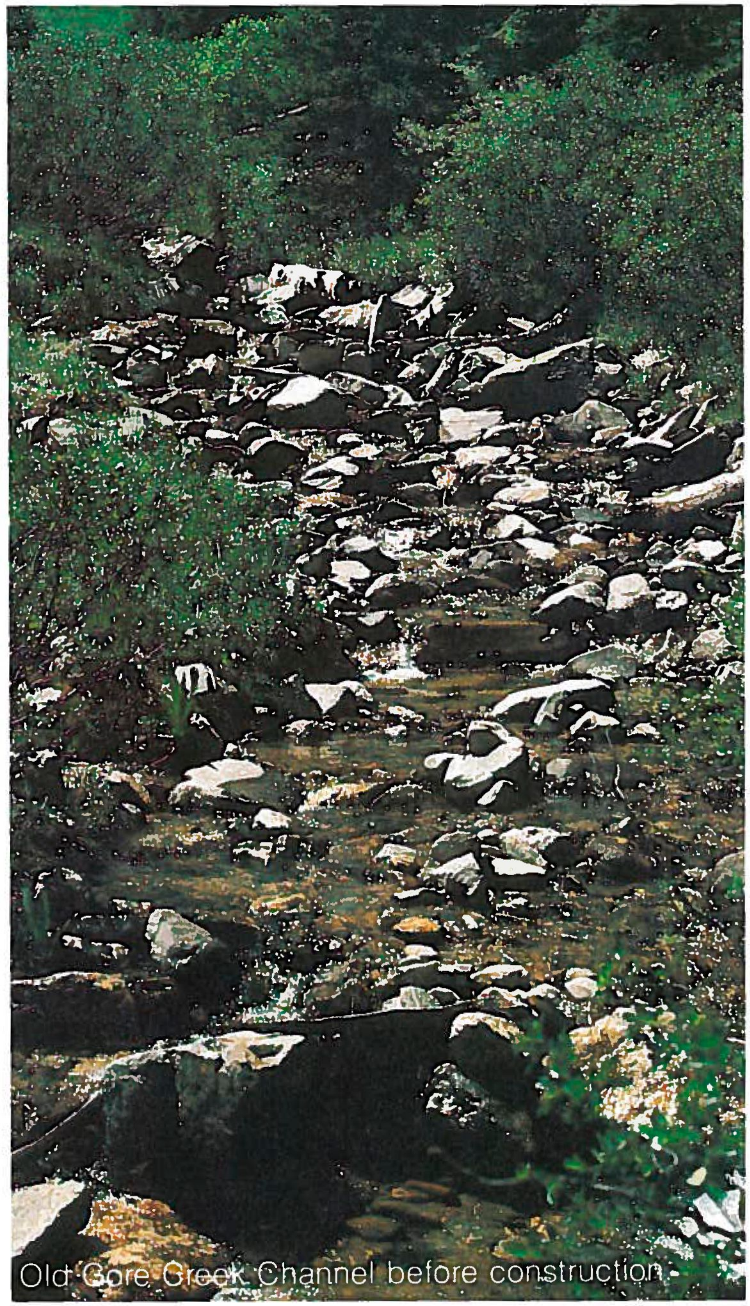
Bridges had to be constructed sturdy enough to support large earth moving equipment.

CHANNEL CHANGES

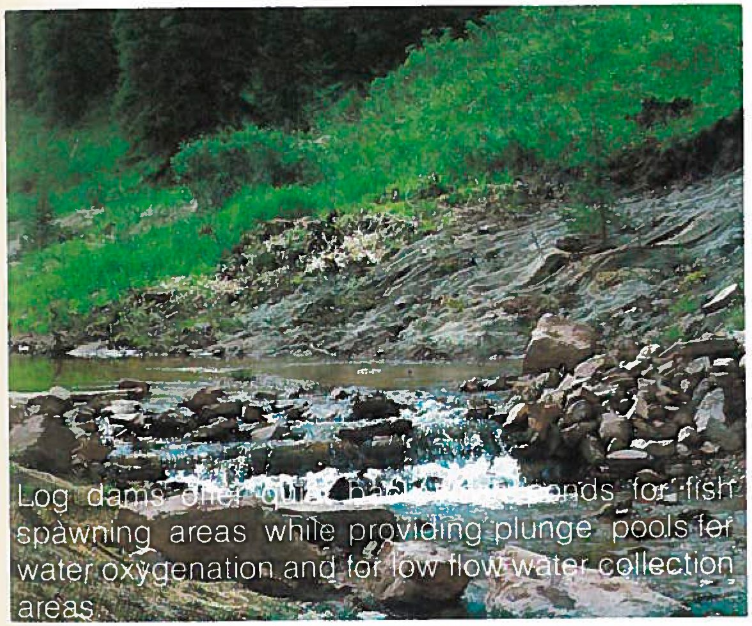
Highway construction within mountainous terrain often requires the relocation of streams and rivers. Vail Pass is no exception. Several narrow areas within the pass necessitated the relocation of Gore Creek on the west side of the pass and Tenmile Creek on the east.

Two areas required a channel change treatment on Gore Creek. The first area encountered was identified as a twin slide area encompassing Gore Creek. To build a stable highway both slide areas had to be buttressed with highway fill and the creek relocated on the fill. The proposal was presented to the Division of Wildlife and Forest Service for their input. Primary concern centered on providing fish habitat in the form of deep pools, riffle areas and a constant flow within the new channel. Gabion

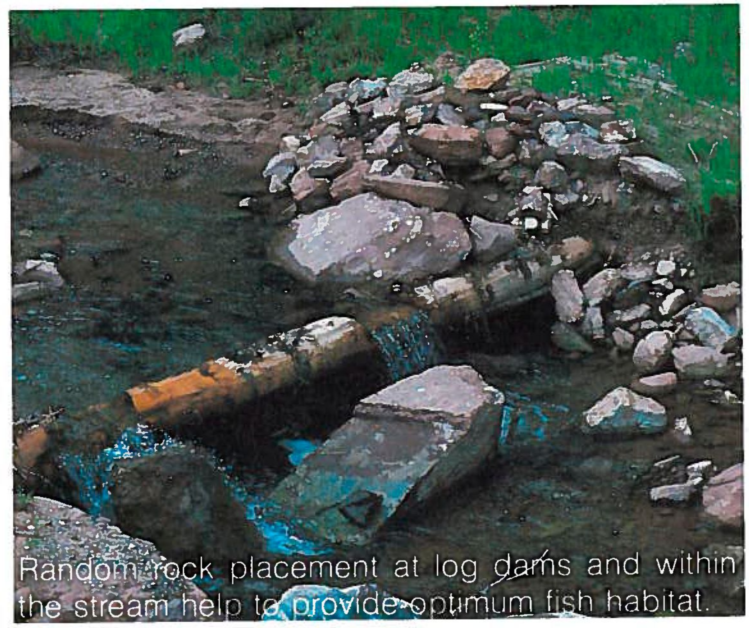
A constructed creek channel uses natural materials and plantings to make the new stream channel visually appealing and ecologically responsive to the fish population.



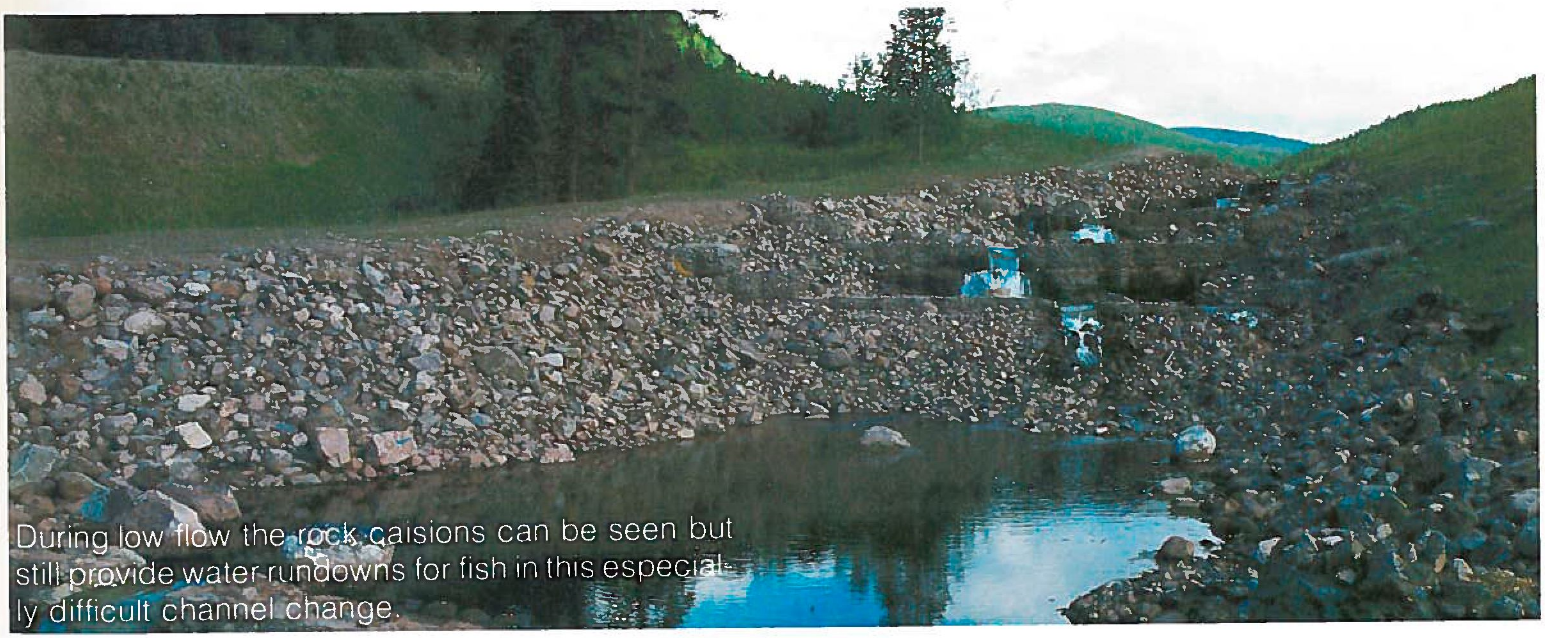
Old Gore Creek Channel before construction.



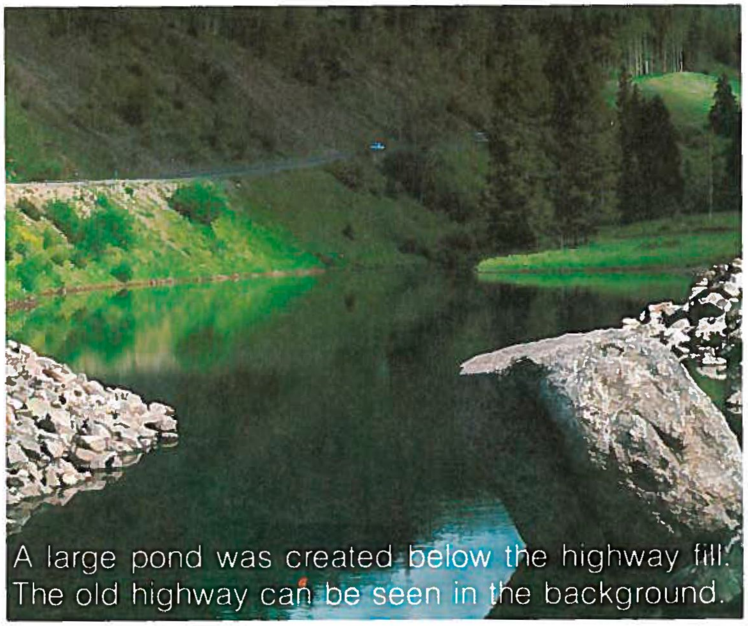
Log dams offer quiet [illegible] ponds for fish spawning areas while providing plunge pools for water oxygenation and for low flow water collection areas.

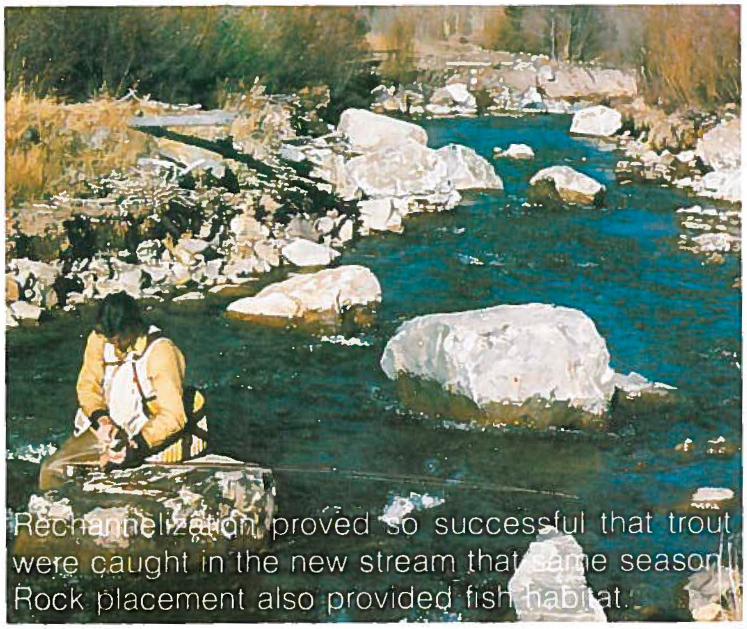


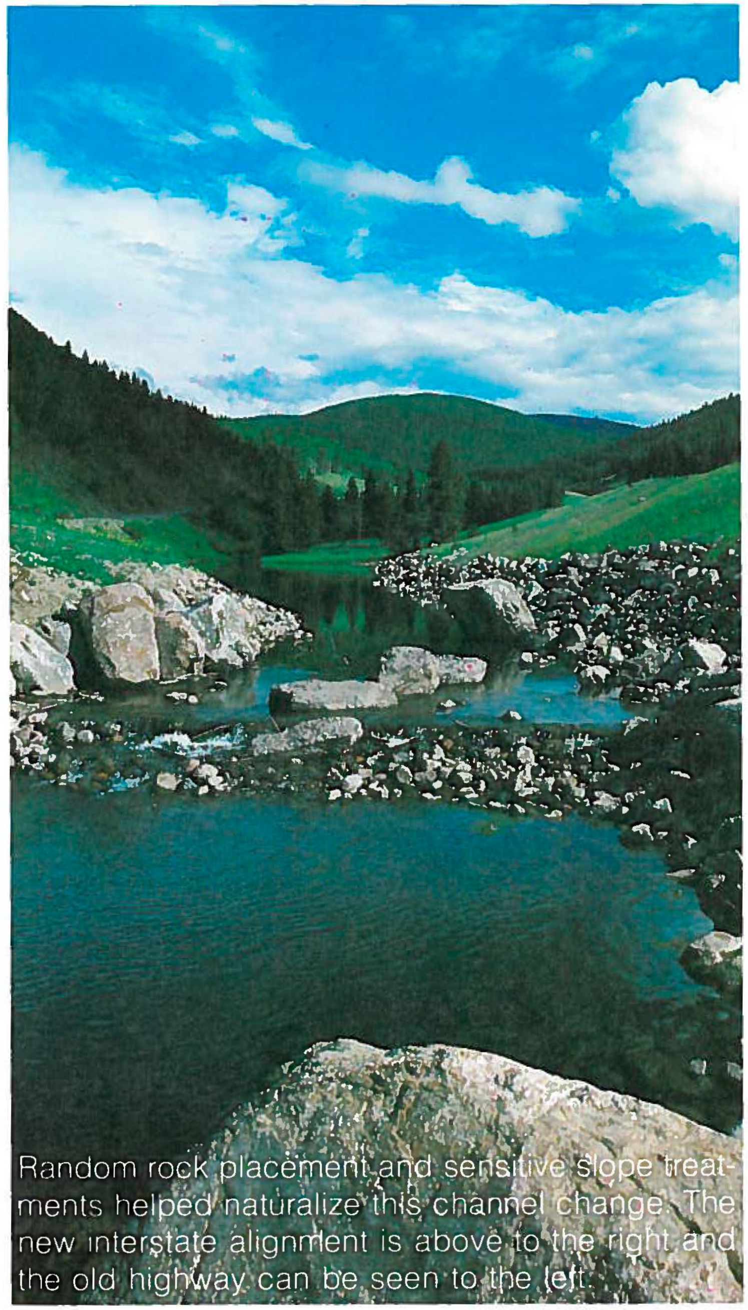
Random rock placement at log dams and within the stream help to provide optimum fish habitat.



During low flow the rock caisions can be seen but still provide water rundowns for fish in this especially difficult channel change.


A large pond was created below the highway fill. The old highway can be seen in the background.


Rechannelization proved so successful that trout were caught in the new stream that same season. Rock placement also provided fish habitat.


Random rock placement and sensitive slope treatments helped naturalize this channel change. The new interstate alignment is above to the right and the old highway can be seen to the left.

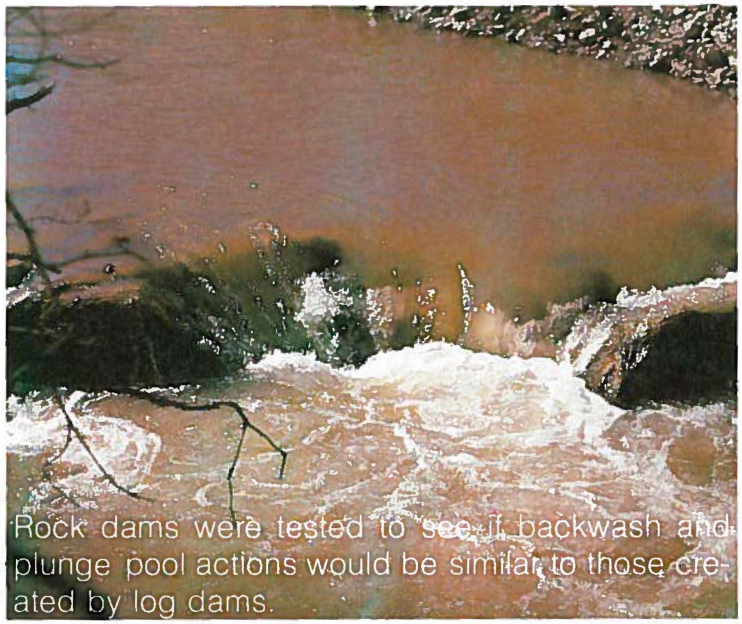
headwalls were designed to provide low flow water, accommodate high water flow and yet provide plunge pool and riffle area habitat for the fish. Large boulders were also worked into the channel to provide protection for smaller fish and insects and add aesthetic elements to the stream.

The second Gore Creek relocation was required within a narrow part of the Pass. Here the highway fill was designed to cover the old channel location and the creek was shifted to an older creek alignment, at the base of the fill. Although no new creek bed was totally constructed this channel change offered a chance to provide improved fish habitat. Plans were drawn for this new stream bed to include the necessary habitat elements outlined by the Colorado Division of Wildlife.

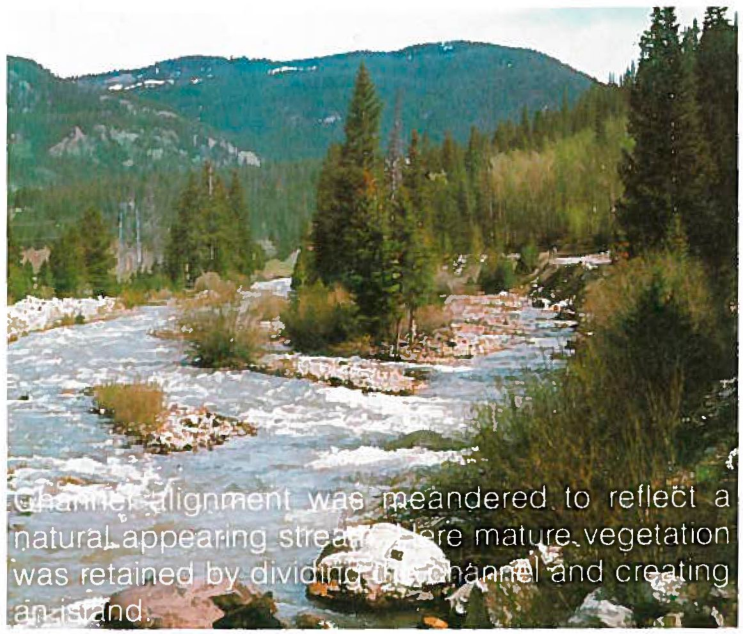
A major channel change was encountered within Tenmile Canyon at the east base of Vail Pass. In past years, when building or upgrading of a highway involved the relocation of a stream, the stream was generally either clogged, silted, or concreted to give the highway the most advantageous route.

A good example of this was Tenmile Creek. Near the turn of the century, two railroad grades, one to the east of the creek and one to the west were built as a result of growth and mining development in the area, considerably restricting the natural course Tenmile Creek would otherwise have taken. Further restrictions were placed on the creek in the 1930's with the paving and designation of U.S. 6 through the canyon.

However, in the summer of 1976, a chance to improve the stream's course and habitat occurred with the proposed upgrading of the U.S. 6 to interstate status. In order to facilitate two additional



Rock dams were tested to see if backwash and plunge pool actions would be similar to those created by log dams.



Channel alignment was meandered to reflect a natural appearing stream. Where mature vegetation was retained by dividing the channel and creating an island.

Channel side slopes were constructed to provide some degree of undercutting, feature requested by the wildlife experts.

Close up of log dam illustrating efforts made to stabilize the banks against spring runoff.

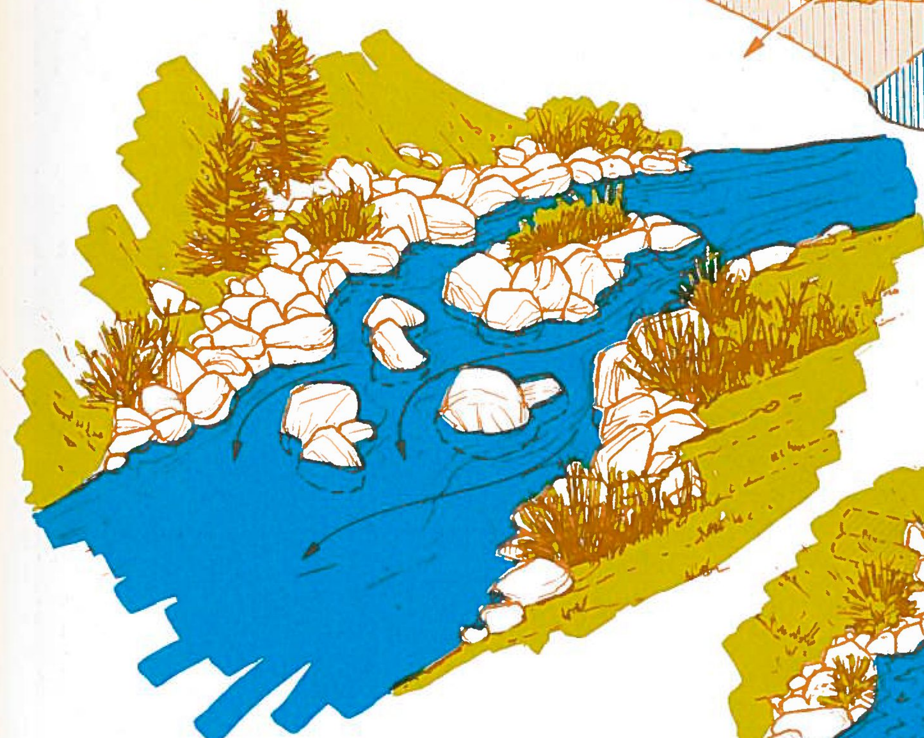
highway lanes, approximately three miles of Tenmile Creek had to be relocated.

With interagency coordination involving the Colorado Department of Highways, the Colorado Division of Wildlife, the U.S. Forest Service, and numerous private interest groups, preliminary design concepts were conceived.

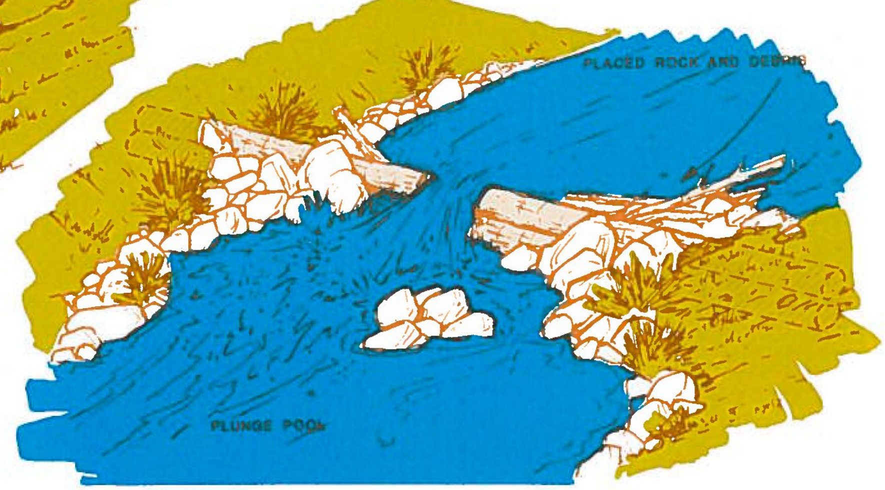
As the creek was composed of approximately 90% riffle and 10% pools, concepts were devised to improve this ratio for trout habitat. Log and rock dams were constructed to decrease the stream gradient and create scour pools for oxygen supply and winter habitat. Log and rock deflectors were built into the banks to provide pooling for winter habitat spawning and insect breeding areas. In addition, rocks were placed randomly throughout the realignment to provide calm water areas and add to the natural aesthetics of the stream's appearance.

OVERALL CHANNEL CHANGE LANDSCAPE INTEGRATION

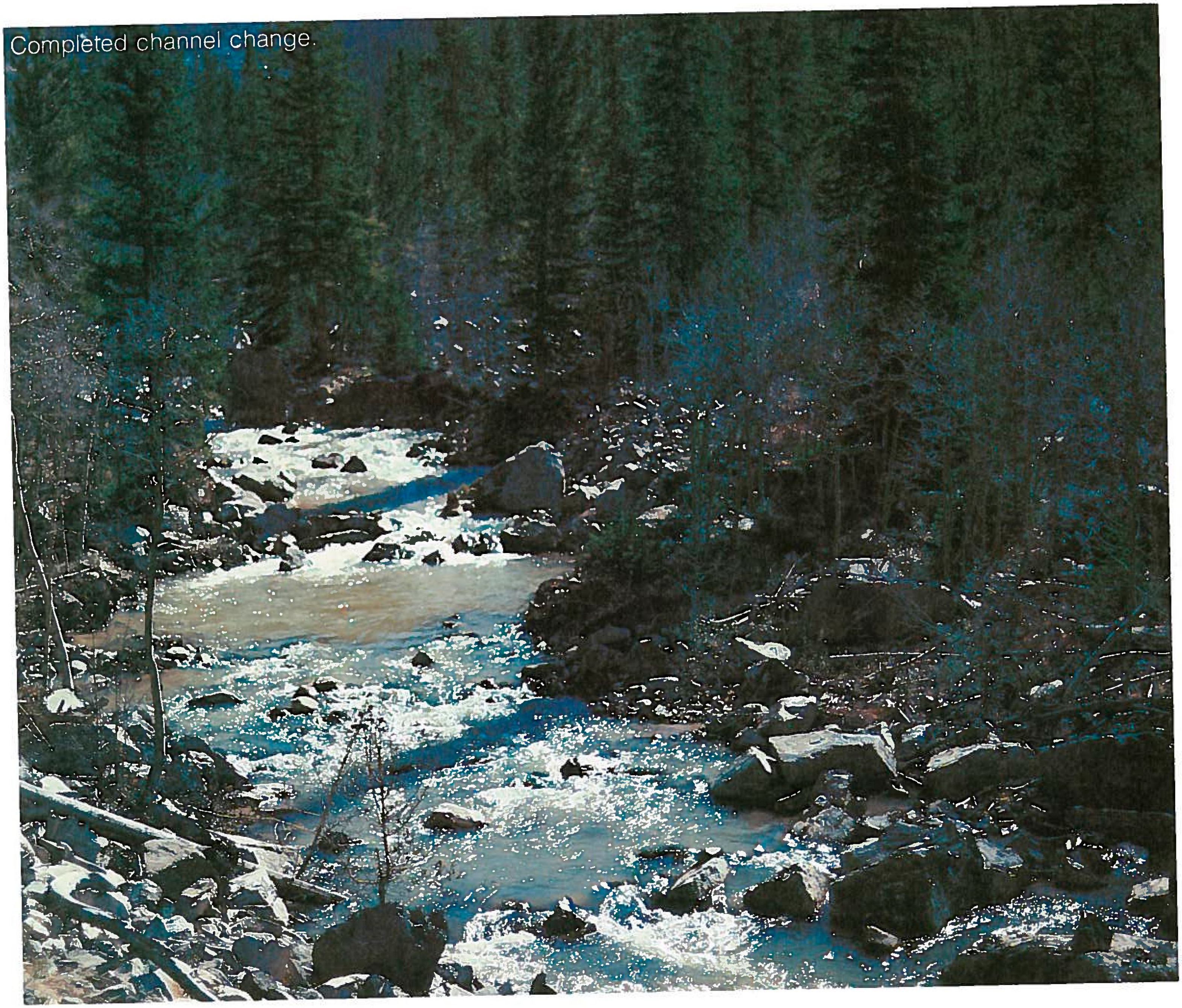
RANDOM ROCK PLACEMENT



LOG WEIR



Planned channel change concepts.


Completed channel change.

REST AREA

The top of Vail Pass lies in a subalpine meadow at the head of the Gore Creek and West Tenmile Creek drainages. In the summertime this meadow is dotted with wildflowers of various colors. Hikers use this site as a staging area for alpine hikes. Cross country skiers and snowmobilers have found this open meadow area a preferred winter recreation site. Shrine Pass, a Forest Service road over the mountains to the west, also starts at the top of Vail Pass allowing access for back country drivers and hikers.

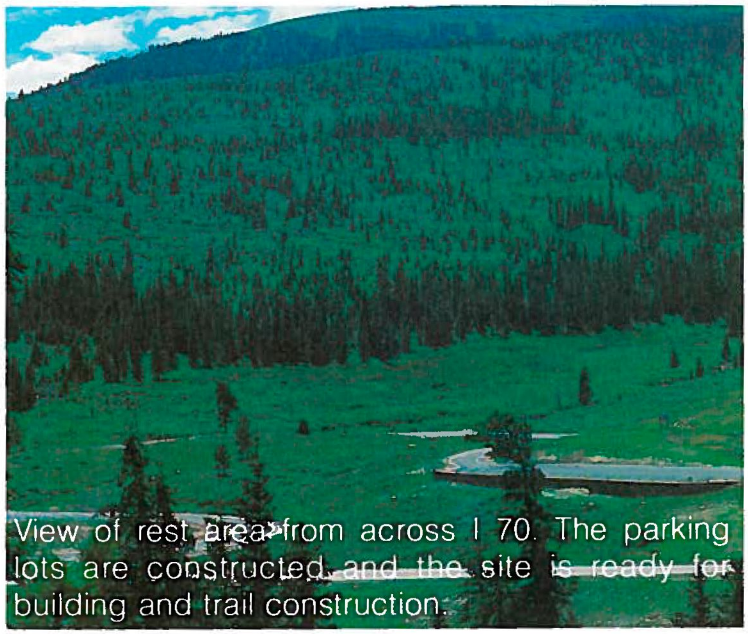
Realizing the recreation importance of the top of Vail Pass, the Division and Forest Service worked for the development of a full service rest area. This rest area could provide comfort and picnic facilities for the motorist but could also provide a focused starting and meeting area for the many recreationists.

The construction and operation of a facility of this type at this altitude posed many problems. Utilities were not available, the closest community (Copper Mountain) was 10 miles away and providing gas, water and sewer to the rest area was economically prohibitive. A telephone extention to the site is still under consideration. Electricity is to be cabled under the bike path up to the rest area and interchange. Providing heat for the building was considered the major obstacle until the possibility of solar heating was explored.

At the Vail Pass summit considerable solar radiation is received, even during the winter months. It was felt a warm air collector facility would be extremely efficient if certain precautions were taken. The building was designed to be half buried into a south facing slope and only the restrooms were to be heated. These restrictions were developed into an overall building design which may heat the restrooms to 45°F maximum during the coldest winter days. The remainder of the building was designed to passively retain solar heat for comfort. A fireplace was also designed for use by organized groups. A standby heating system was also provided.

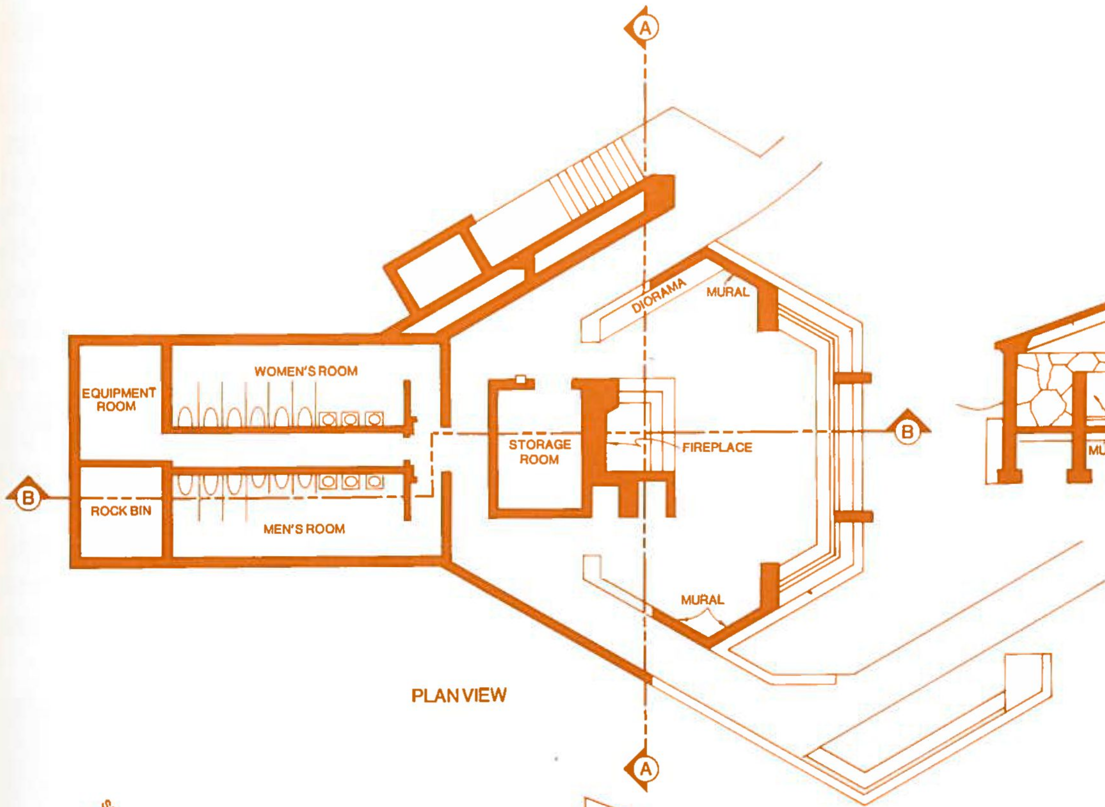
All persons involved with the design of the Vail Pass Rest Area Building are anxious to see the efficiency of the solar heating facility. This facility may be the nation's highest elevation solar collector when constructed.

Picnic and hiking trails are to be provided for those wishing a short hike around the rest area.

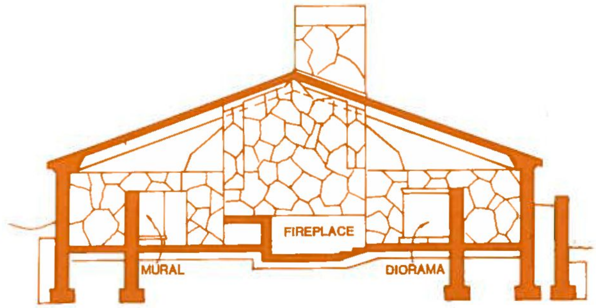


View of rest area from across I 70. The parking lots are constructed and the site is ready for building and trail construction.

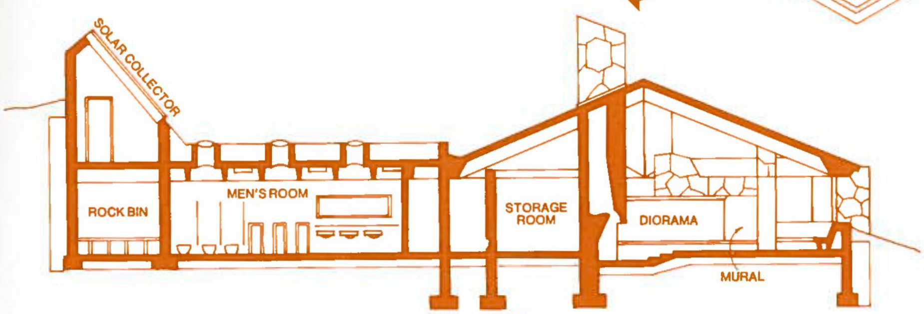
The Vail Pass rest area site is in a subalpine meadow which is especially sensitive to disruption. Plans were carefully drawn to minimize soil and vegetation disturbance and speed recovery time.



PLAN VIEW

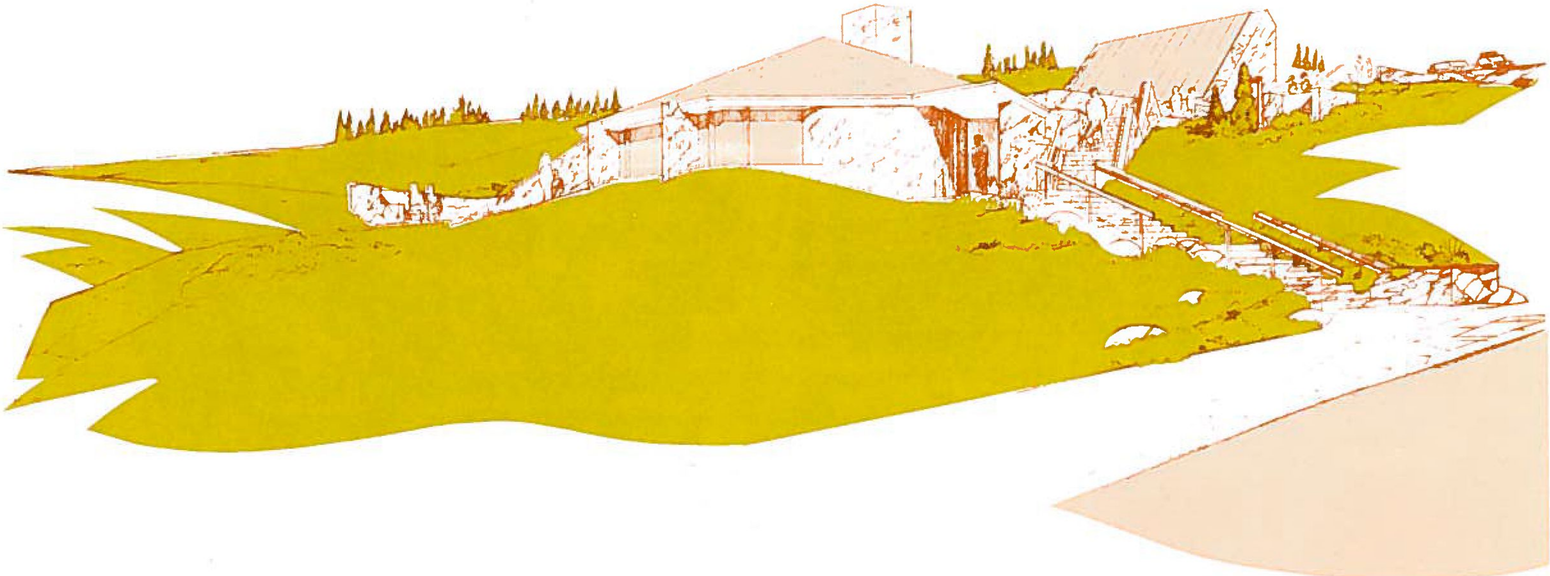


SECTION AA



SECTION BB

The rest area building is partially buried to conserve energy and utilizes a warm air solar collector to heat the building during the winter.



ARCHAEOLOGICAL FINDINGS

During the highway construction on Vail Pass, Colorado Division of Highways archaeologists surveyed construction areas for signs of prehistoric encampment and hunting areas. Evidence of one Pre-Historic occupation was found, dating from 6800 years ago to as recent as 1780. Tools found included projectile points, knives, scrapers, drills, ceramics and other assorted tools. Evidence of repeated campsite use was found, including remains of elk, deer, bison and mountain sheep. More than 50 firehearths of various styles and sizes substantiated repeated usage.

This site was deemed rare due to its size and altitude. Culturally, the site is associated with Plains and Northwest Plains Indians. Chronological habitation will be displayed within the rest area building along with castings of points, scrapers and firepits found on the Pass.

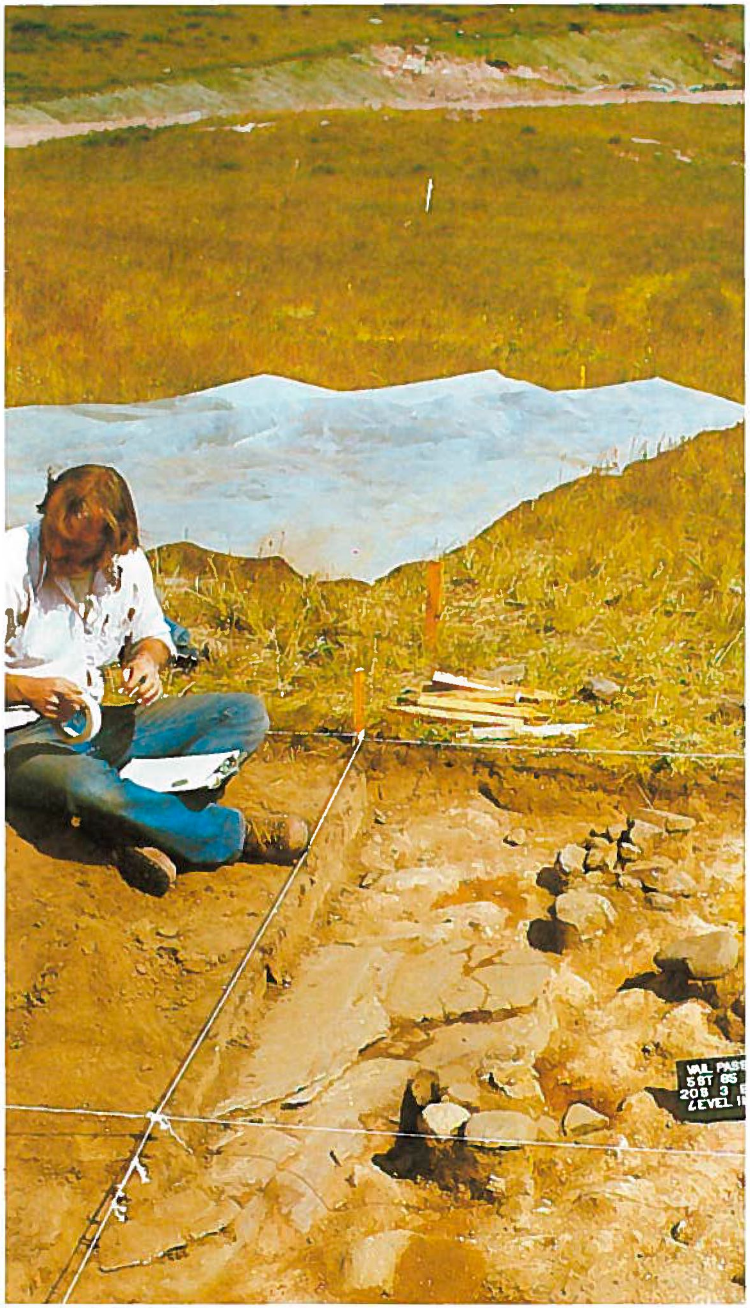
The Vail rest area also offers an excellent opportunity to provide visitor information and interpretive facilities. Few interstate rest areas are placed within an active recreation area and yet are located on a sub-alpine meadow of ecologic importance and scenic quality.

Recreation facilities can be shown on an area map at the rest area building. One stop at the Vail rest area will provide the motorist with his relative location to ski and recreation communities as well as a score of Forest Service recreation trails and camp sites.

Interpretive facilities will be included at the rest area to increase motorists' appreciation for the unique ecological, historical, geologic, archaeologic,

Archaeological dig site on Vail Pass.

A sketch of one artifact found.



and hydrologic features of the Vail Pass area. Displays will be changed to meet seasonal topics, and local organizations will be encouraged to assist in the rest area displays. The first display will feature archaeologic findings uncovered and salvaged during construction. Future displays may depict local wildlife, wildflowers, ecologic systems, or information on the difficulty of constructing an interstate highway through this environmentally sensitive area.

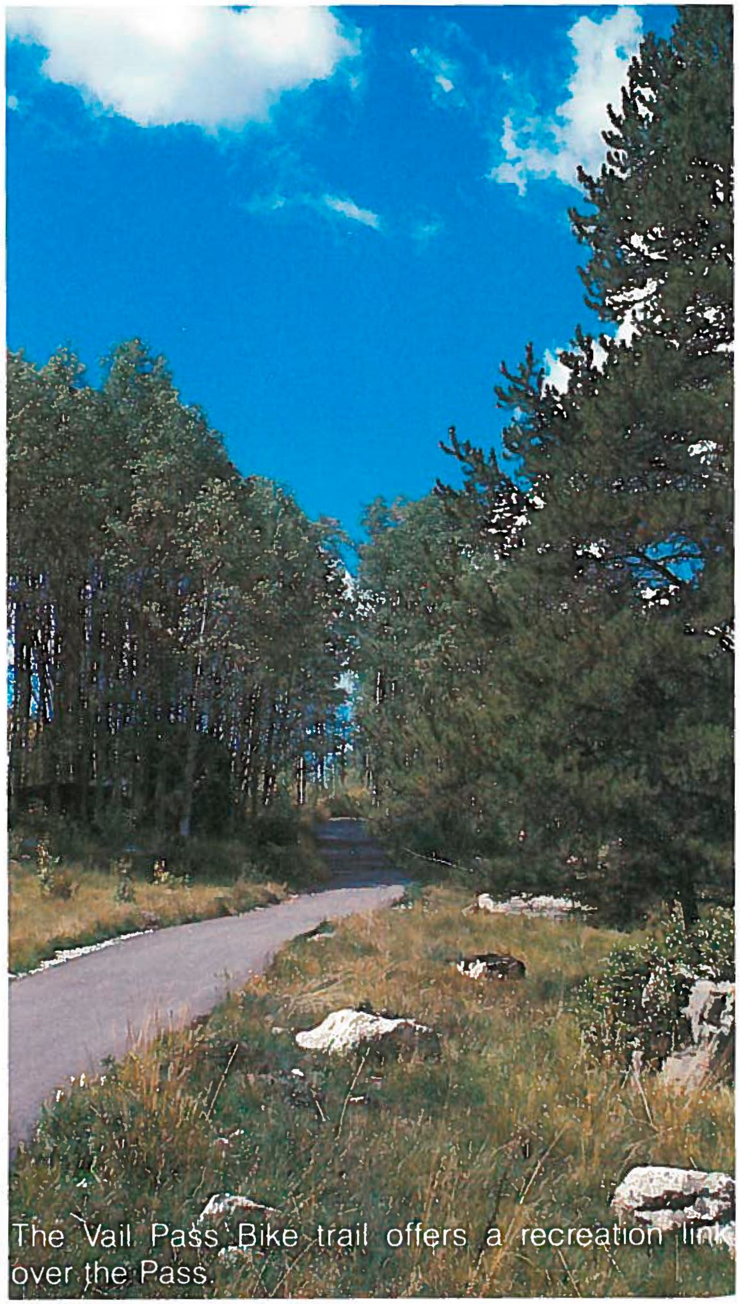
BIKE TRAIL OVER VAIL PASS

The Division received considerable support for the inclusion of a bike path in conjunction with the new highway. This recreational trail would link Vail with Copper Mountain with an 10-foot wide path, 13.3 miles long. The idea of providing this additional facility to accommodate bicyclists, hikers, fishermen, etc., was introduced early in the design development of I-70 in this area. The Environmental Study and Design Concept Reports mentioned the addition of this trail and at the design public hearing (June 1972) considerable discussion centered on the importance of a recreational trail.

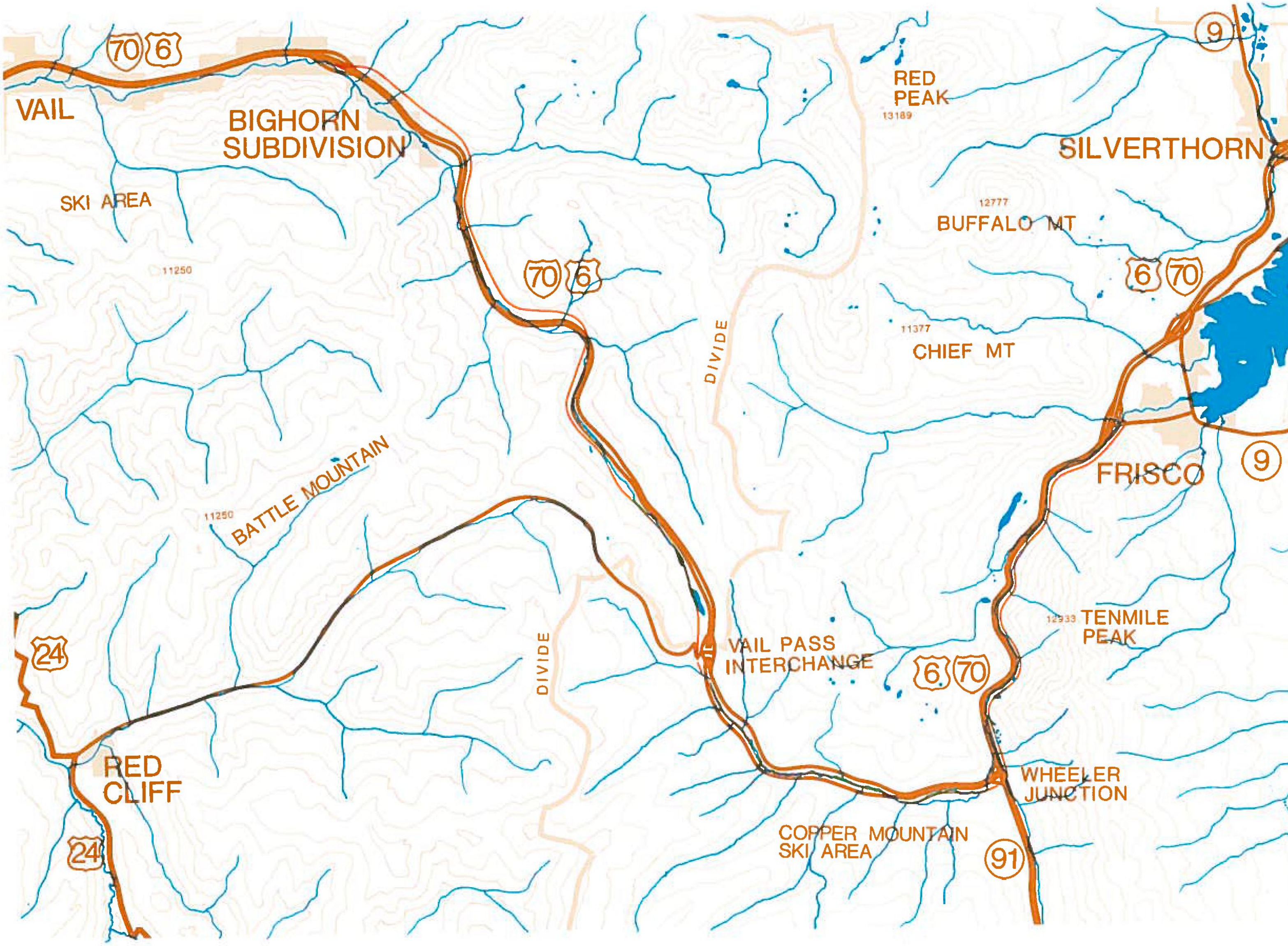
Many agencies, organizations, interested groups and individuals were involved in the planning process. Since the proposed trail project is within the White River and Arapahoe National Forest Boundaries the Forest Service continuously assisted in and encouraged its development.

Bicycling over Vail Pass was at one time considered a physical challenge limited to only a few ardent enthusiasts. Vail Pass cyclists shared U.S. 6 with motorists creating an unsafe condition. Any bike trail proposed over Vail Pass had to be physically separated from any possible automobile conflicts. A separate alignment was proposed, in some areas using the old U.S. 6 road bed along abandoned or low use stretches, and in other areas a virgin alignment. The bike trail does share right-of-way with the Interstate lanes through the narrow stretch of the pass but to the side of the traveled lane. Because of the generally separated alignment the bike trail does have stretches of steep grade (10%+) which may force less enthusiastic bikers to walk.

Trail design criteria called for a 10-foot asphalt



The Vail Pass Bike trail offers a recreation link over the Pass.

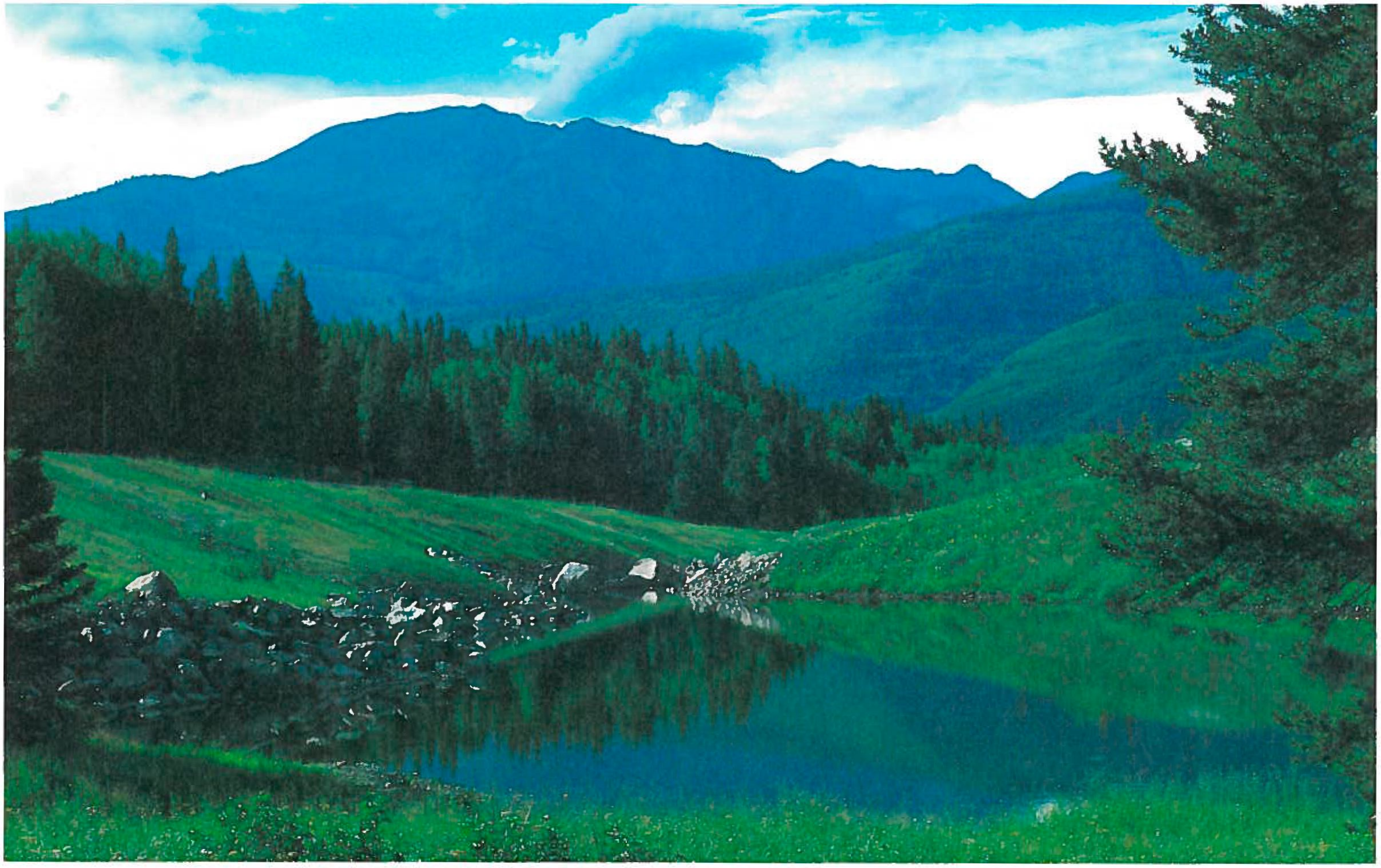

70
6
VAIL
BIGHORN
SUBDIVISION
SKI AREA
11250
70
6
RED
PEAK
13189
9
SILVERTHORN
12777
BUFFALO MT
6
70
11377
CHIEF MT
DIVIDE
BATTLE MOUNTAIN
11250
FRISCO
9
24
DIVIDE
VAIL PASS
INTERCHANGE
6
70
12933
TENMILE
PEAK
RED
CLIFF
24
WHEELER
JUNCTION
COPPER MOUNTAIN
SKI AREA
91

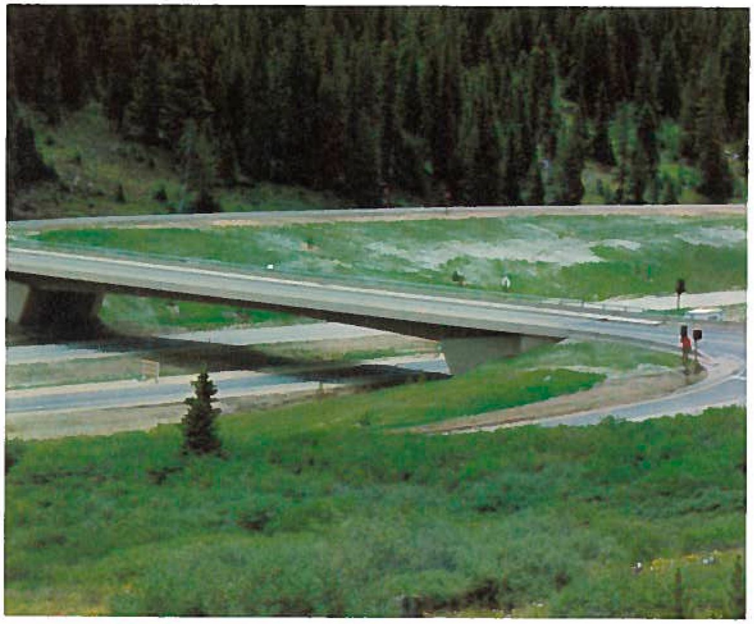
paved bike trail with appropriate drainage and grading allowances. A vertical clearance of eight feet was also required. Stream crossings required bridging and all disturbed areas were to be reseeded as on the other Vail Pass construction projects.

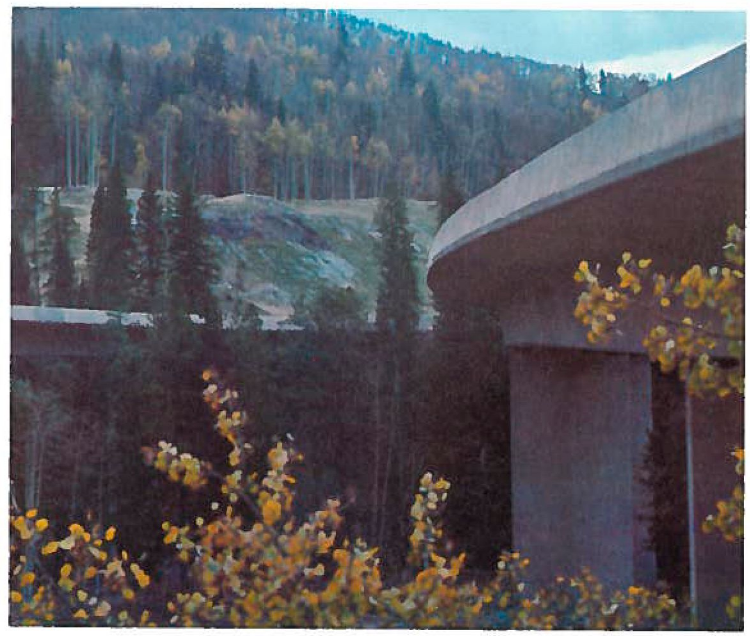
SUMMARY

The major objective of the Vail Pass project was to construct an interstate highway compatible with the mountain environment. Extensive inventories of the physical, ecological, socio-economic and visual aspects were made to accomplish this objective. Inventories then formed a basis to develop alternative highway alignments and to select the final alignment. As alternative alignments evolved, special designs were made based on specific information developed from the inventories.

The completed highway fits the land well, and has not had major landslide or erosion problems. All disturbance to the land has received extensive landscape treatment. Special considerations were given to grading, rock placements and the planting





of grass, shrubs and trees. Blasting techniques sculptured rock cuts to blend with the surrounding landscape.

Structures were used extensively to protect wildlife habitat and natural water courses as well as to prevent landslides, and the highway user can enjoy splendid scenery because excellent design and landscape management principles were used to protect and enhance the visual resource of the area.

A visitor center on the summit of Vail Pass will provide motorists an opportunity for rest and information. Exhibits will explain archaeological and historic features of the land, and display maps will show recreational trails and facilities.

A challenge of the land and the people has been met. Interstate 70 over Vail Pass serves as an example of the results achievable when agencies and citizens coordinate planning for the common good.