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A Design Concept for Interstate 70
Glenwood Canyon, Colorado

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June 18, 1974

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A Design Concept for Interstate 70 Glenwood Canyon, Colorado

Glenwood Canyon is one of our country's greatest scenic resources—a precious heritage which must, at any cost, be protected for posterity. It is in every way deserving of the vigorous debate which has characterized consideration of a man-made and conceivably obtrusive and preemptive improvement such as an interstate highway. Any change in the status quo should be subjected to the most rigorously critical analysis and evaluation. The adversary positions which have developed relative to the interstate route are a healthy manifestation of the democratic process at work.

Few elements in our social and economic lives have provoked greater public ambivalence than the motor car. Its popularity, contrary to some belief, is not solely the result of a conspiracy between Detroit, the oil interests and road builders. The incredible growth of our economy in the last hundred years and the resulting economic democracy stems in very large part from our mechanized, interrelated and interdependent transport system—rail, aircraft, ships and motor cars. With regard to recreation and tourism, the motor car has been a more powerful economically leveling influence than all of the revolutionaries from Karl Marx up to and through the current crop. Outdoor recreation had been the exclusive prerogative of the wealthy and aristocratic who had the time and means to develop a taste for nature's beauty. The city boy had to be content to find his recreation on a dirty street, an unbuilt lot or, at best, in a trolley park at the end of a transit line.

A hundred years ago only a relative handful of people had had the opportunity to see Glenwood Canyon. All but a few of those were probably too concerned with the hardships of their journey to dwell long on the grandeur of the Canyon. Since the building of the railroad and later the highway, countless millions have been exposed to its wonder.

The modern limited-access highway in the Interstate System is a collateral descendent of the early parkways which were scenic roadways, restricted to pleasure cars, constructed within a generous, land-

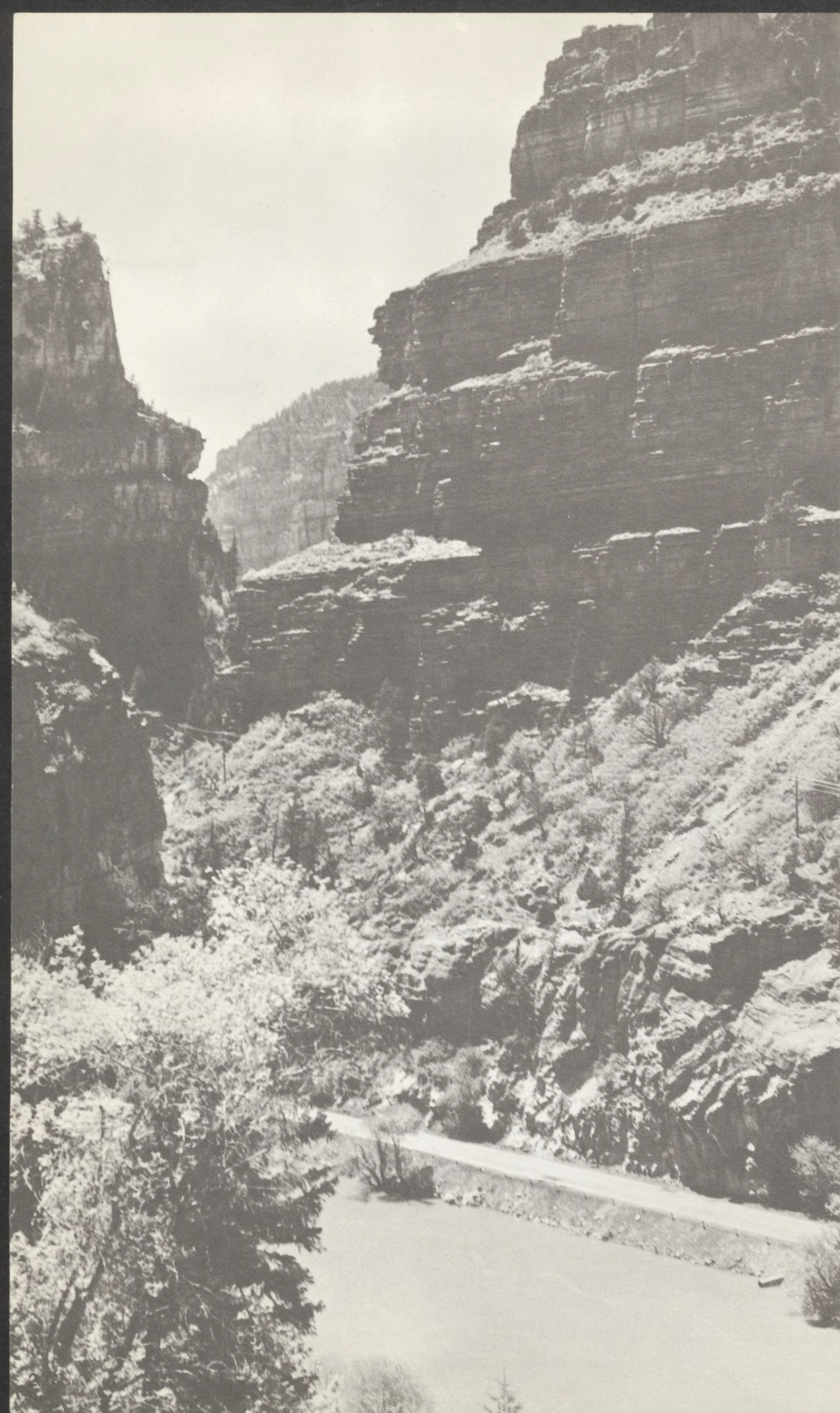
scaped right-of-way. (What was generally considered the first parkway was, in fact, basically a conservation undertaking and the roadway was only an incidental element.) There was little, if any, opposition to these early roads. When, after World War II, the parkway concept was extended to mixed traffic arteries, under most circumstances the new roads were welcomed and the pleasure car managed to exist in relative harmony with its commercial cousins.

Even now, however, at the current level of traffic on Colorado Route 6, there is clear functional and aesthetic conflict between the pleasure vehicles and the truck traffic. The trip purpose of almost 60 percent of the vehicles using this highway is recreation or tourist-related. This traffic, not unnaturally, tends to drive more slowly and should have frequent opportunities to stop and enjoy the scenery—in peace and quiet. Unfortunately, the noise of passing trucks as it bounces off the Canyon walls obtrudes on any area within reasonable reach of the highway.

Truckers, on the other hand, are understandably concerned with extra cost occasioned by delay and they demand only safe and reasonably swift passage. Stop-and-go sightseers are a constant impediment to their desired objectives.

Our assignment—to develop a design concept for I-70 within Glenwood Canyon corridor—required the fulfillment of apparently diverse objectives: providing rapid transport for through traffic and the opportunity for the recreation-bound traveler to enjoy the Canyon's visual beauty. And to do these without despoiling the Canyon in the process. In approaching the assigned problem, we initially investigated or, rather, reviewed the potential for removing through traffic entirely from the Canyon route. We quickly convinced ourselves that this is not a feasible alternative.

Within the context of our contractual criteria, our first design mandate has been the preservation of the Canyon. It is probably true that, with appropriate and sensitively devised construction and restoration techniques, it would be possible to cut the Canyon walls so that the resulting man-made faces would be visually



View of Canyon

indistinguishable from those wrought over the millennia by the forces of nature. There are, in fact, many such prominences dating no further back than the railroad construction of a hundred years ago or the original highway construction in the 20's and 30's. (Admittedly, badly done cutting has defaced some of the Canyon walls.)

But the wonder of the Canyon lies precisely in the fact that it is a work of nature, not of man. And, to what extent can one afford to alter the Canyon before it will have been transformed into a work of landscape architecture—beautiful perhaps, but man-made. It is our belief that this subtle, philosophical point is a valid one and our firm conviction is that only under the most extraordinary constraints should we, in any way and to any extent, tamper with the Canyon walls.

Our other major objective was to effect a means of separating the incompatible classes of traffic and thereby benefiting both—providing pleasure cars (and perhaps tourist buses) with a parkway without interference with or from trucking. Public comments made by critics of the highway-widening stressed the desirability of prohibiting, or at least limiting, interstate traffic through the Canyon while insisting that they, the public, be permitted to continue enjoying its scenic splendor. Our recommended concept was developed in response to these public desires for separating traffic.

Finally, it was felt that the character of the design should minimize the intrusion of the hand of man. Engineers and architects normally and properly take pride in their achievements. Their work tends to be assertive. There is little modesty in the Pyramids or the Parthenon, in St. Peters or Versailles, in our Federal Capitol or in the Golden Gate Bridge. Even if these works are built for the greater glory of one god or another, they are unashamedly the handiwork of man. They are great monuments to the creative skill of their makers and they make no bones about it. Many sections of our national system of highways are dramatic, exciting and beautiful assertions of man's mastery over nature.

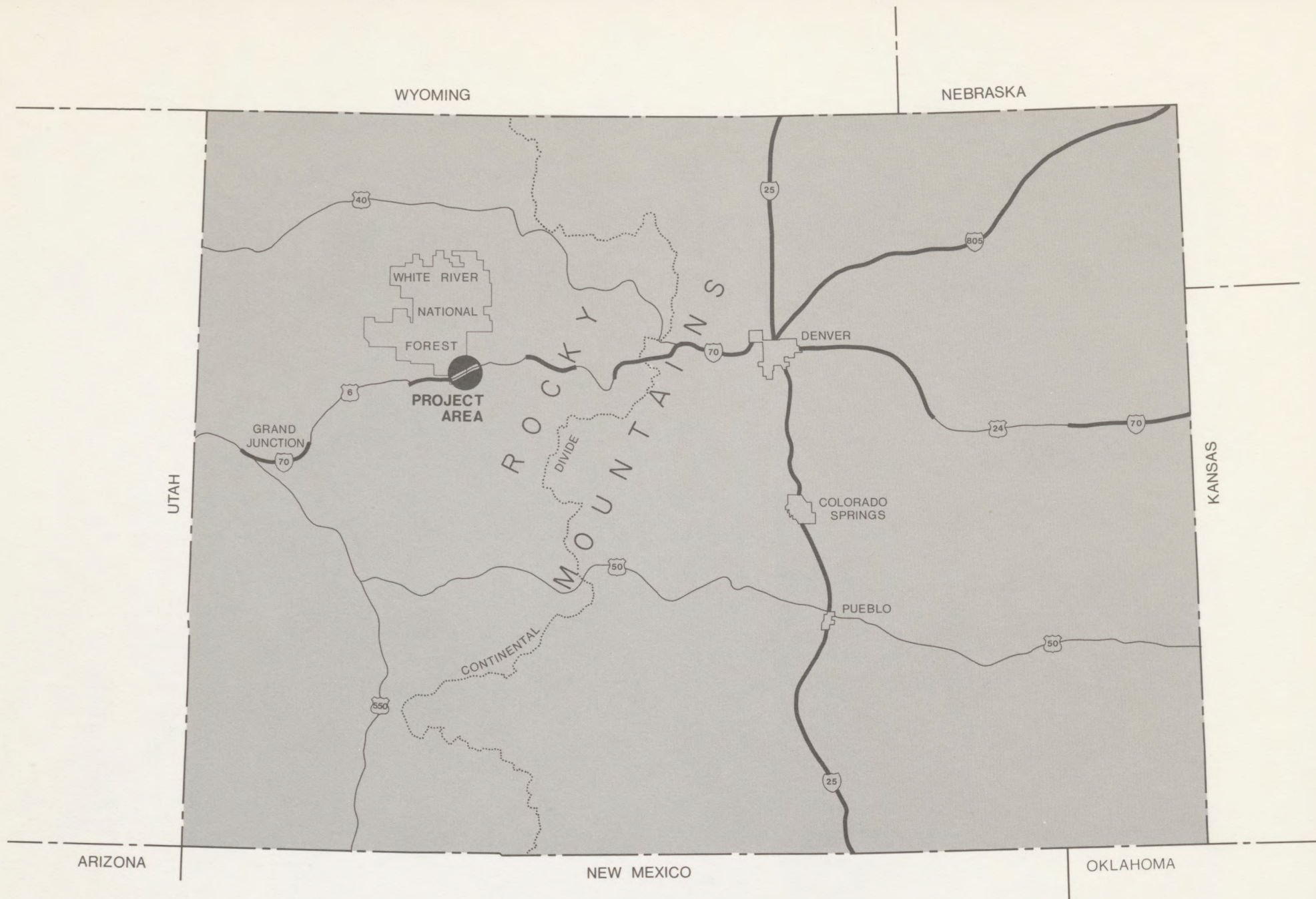
But is the Canyon the place for a virtuoso performance by a proud builder? Here again we face a philosophical dilemma. Should our work compete with the glory of the gorge?

What we build should be guided by the precept of one great architect that "less is more." The roadway should be the simplest, cleanest, most direct solution possible. There should be no false modesty or fakery, no attempt to disguise or conceal the purpose or character of what is clearly man-made construction to serve a legitimate human objective. But neither should this undertaking be the occasion for structural or architectural bravura.

Our study considered and compared all conceivable, physically feasible alternative cross-sections and alignments from the most conventional to the bizarre. A number of these are illustrated and our reasons for discarding them explained in later pages.

A so-called "autostrada" or "rim alternate" has been the subject of mention by both the Governor's Commission and the general public. Some of our earliest studies were directed at such a solution. It very quickly became apparent to us that such treatment would have an overwhelmingly inappropriate man-made impact on the Canyon, would be of questionable safety, awkward and uncomfortable to drive and unconscionably costly. We believe that the illustrations of this concept elsewhere in this report confirm these conclusions.

Our recommended treatment is unconventional in terms of traditional interstate highway design and would cost more to build than some alternatives. But it occupies little more horizontal space than the existing highway, stays close to the existing Canyon floor and separates pleasure traffic from commercial through the nine most significant miles of the Canyon. The extensive rest and recreational areas delineated as part of our plan would be totally insulated from the sight and sound of trucking. We also believe that this separation of traffic will be highly conducive to safety.



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DESIGN CONCEPT

Design Concept

The key to the design concept we recommend is separation of pleasure traffic from trucking for the nine miles from just west of the Highway Department's maintenance garage to just west of the Bair Ranch interchange. This section is the most scenic and constricted area of the Canyon. The concept is unconventional—functionally and operationally, if not structurally. (Highway structures somewhat similar in structural conformation have in fact been built in many areas, usually urban in character.) Pleasure traffic would travel on a two-way upper roadway with an unrestricted view of the Canyon. Trucks would travel on a two-way galleried roadway below.

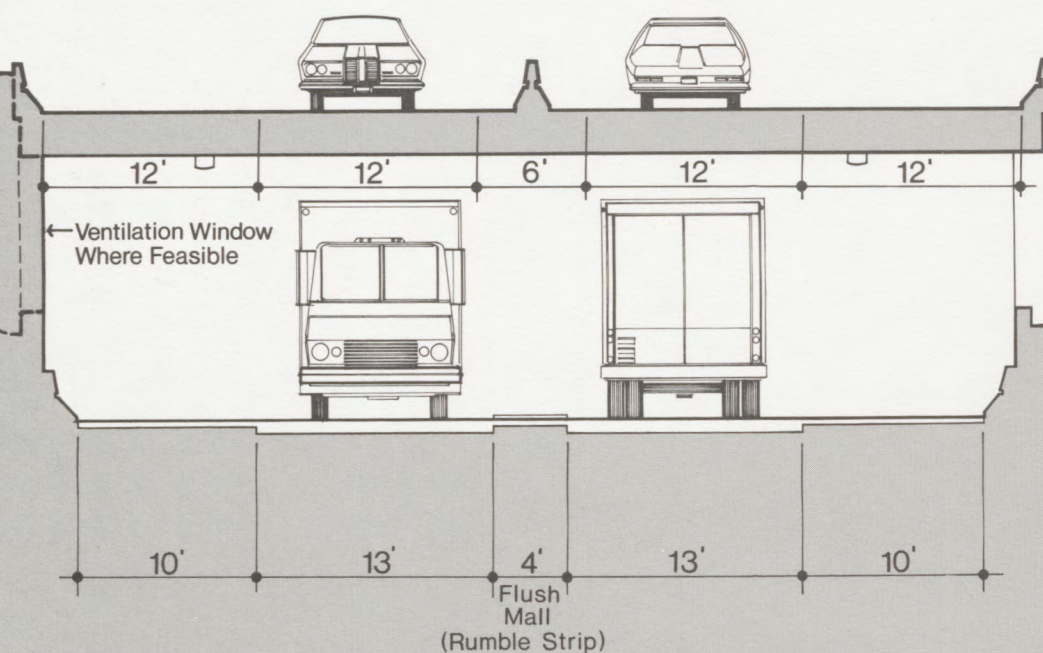
The upper "parkway" would consist of two twenty-four-foot roadways separated by a concrete New Jersey-type barrier set in a six-foot median. The inner (westbound) roadway would be flanked on the right by a similar barrier to permit the highway to hug the Canyon wall. Each roadway could operate in one of two ways: either with one moving lane and one parking shoulder with a no-passing restriction for the length of the applicable section; or, alternatively, with two moving lanes and no parking shoulders—a conformation effectively applied on long structures on many modern arteries. The one-moving-lane no-passing

alternative would be adequate from the point of view of capacity and there are five rest areas westbound and one eastbound which would alleviate the problems of disabled vehicles.

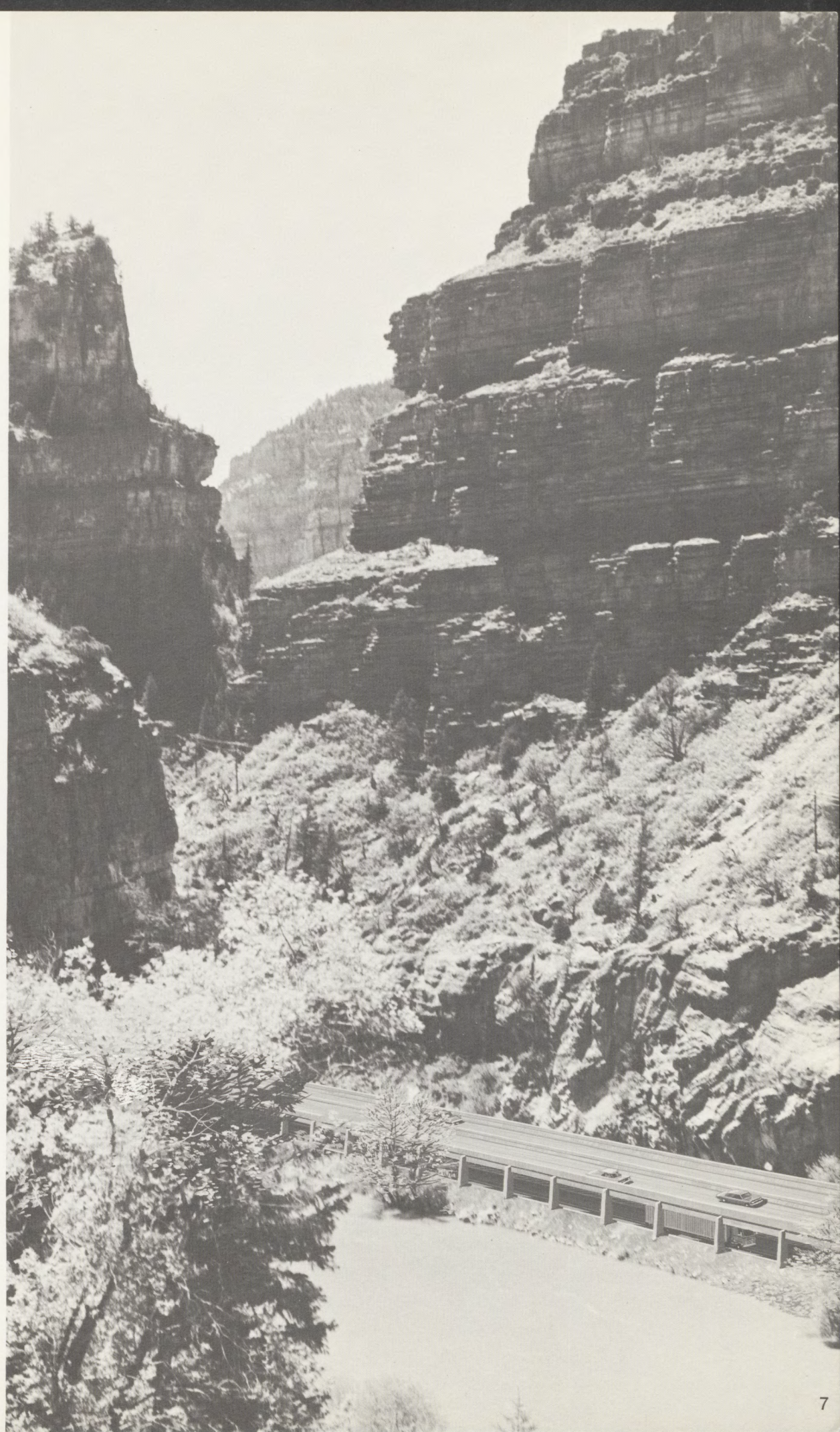
The lower truck level would consist of two operational lanes each thirteen feet wide with two ten-foot shoulders for disabled or slow-moving vehicles. Opposing traffic would be separated by a four-foot-wide "rumble" strip which could be crossed in emergencies.

Each of the two roadways—the upper "parkway" and the lower "truckway"—should be designed for the same structural loading in the interest of operational flexibility. Trucks would not ordinarily be permitted on the upper roadway, but pleasure vehicles could, at the drivers' option, travel on the lower roadway. In the event of heavy snows, this would greatly ease problems of traffic maintenance. A vertical clearance of 14'-6" is recommended for the lower roadway since the upper roadway will satisfy national defense requirements.

The Canyon slopes north of the highway would be, of course, completely shielded from the sight and, more important, the sound of truck traffic. The river



Parkway/Truckway



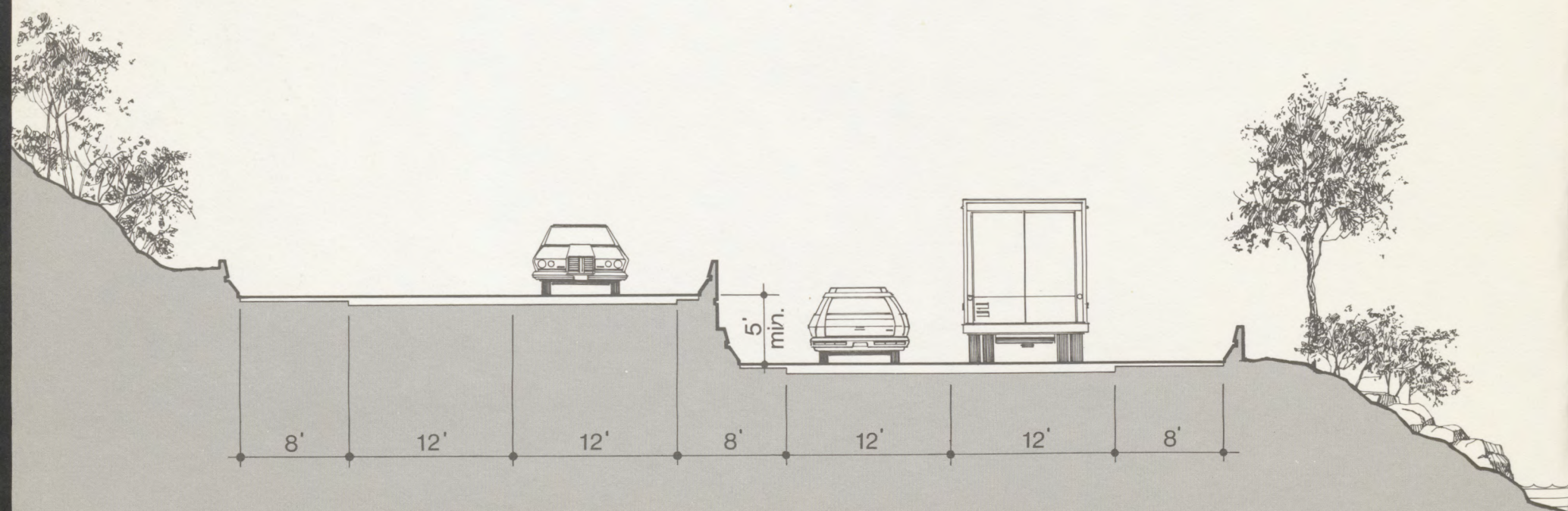
Design Concept

side of the highway would be generally shielded from the sight of trucking and substantially protected from the sound. In all rest areas on the south side of the road, landscaped earth berms would deflect the sound from rest, overlook and recreation areas.

The recreation areas along the parkway/truckway section which form part of our recommendations would be accessible only from the upper parkway. No trucks other than maintenance vehicles would be permitted in the rest areas. Access to the Shoshone power plant and the dam would be from the lower truckway.

To the east and west of this section we recommend a terraced cross-section with more conventional operating characteristics, i.e., mixed traffic on each of two unidirectional roadways. The westbound cliffside roadway would be a minimum of five feet higher than the eastbound river-side roadway to visually separate the roadways from one another and to enhance the view from the upper roadway. The precise limits of the application of these two cross-sections would be subject to refinement in the subsequent design process. This terrace section is illustrated below.

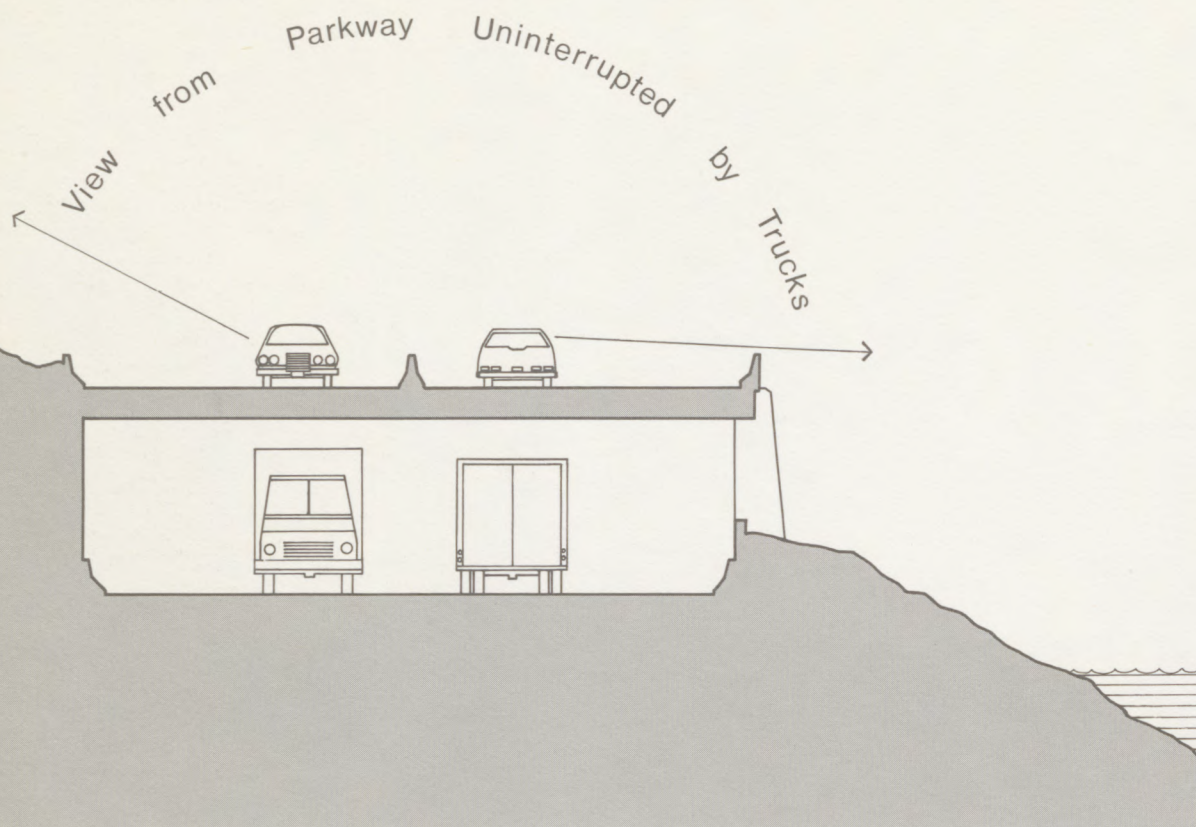
The cost of the parkway/truckway concept will be substantially higher than several of the other alternatives examined (although far less costly than a rim treatment.) We question, however, the validity of any cost comparison between alternatives which are not comparable in their environmental impacts and benefits. Significant cutting of the Canyon walls, encroachment on the river, the continuation of the pervasiveness of truck noise on a recreation resource of inestimable value may not be susceptible to rational quantification—but they clearly exact an intolerable price.



Terrace Section

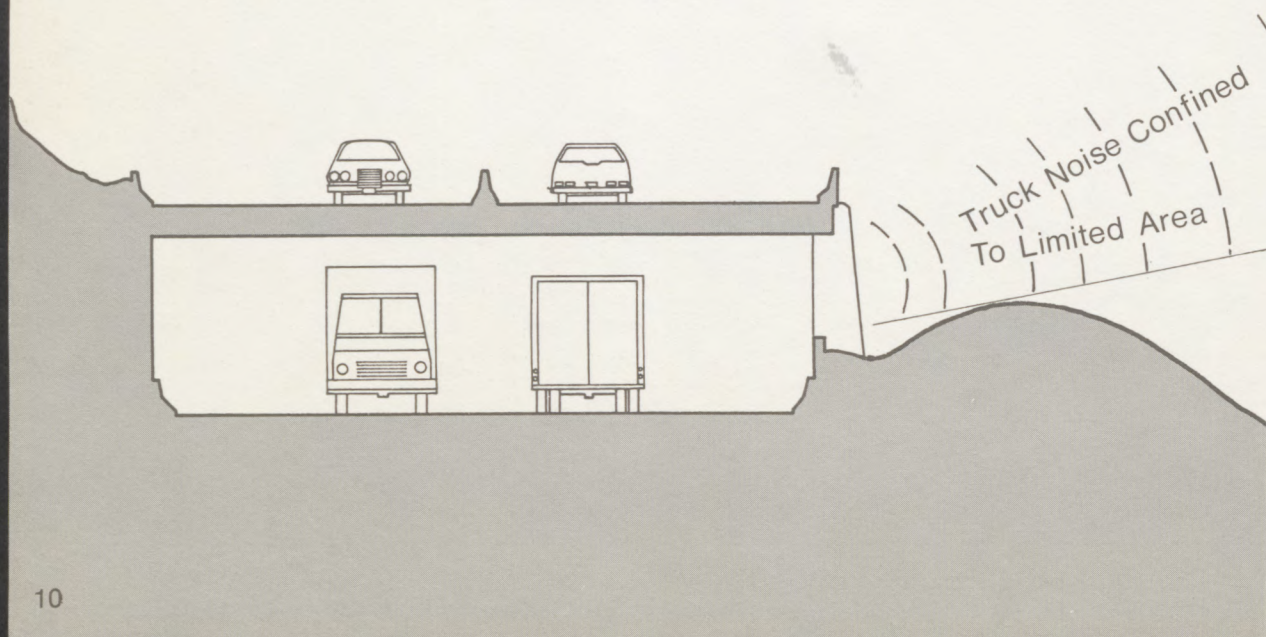


Design Concept



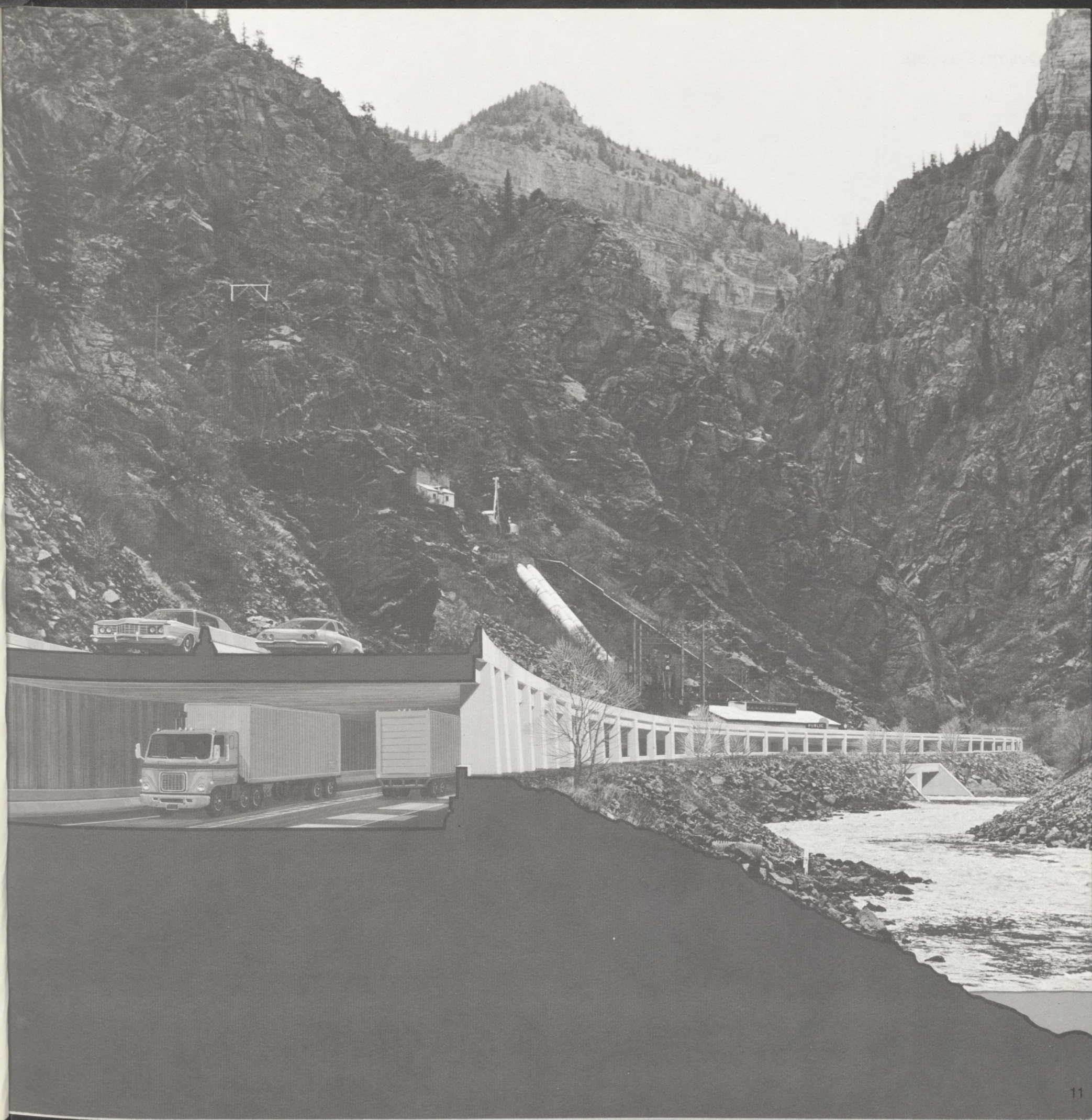
Sight

Preservation and enhancement of the view from the road and, conversely, minimizing the view of the road are keys to the recommended design concept. Travelers on the upper parkway will have an unobstructed view outward and—of particularly dramatic significance in the narrower portion of the Canyon—upward. Trucks, confined in their subway, will neither interrupt nor intrude on the field of vision of sightseers. (This segregation will probably benefit the truckers whose attention is properly directed normally on the road ahead.)

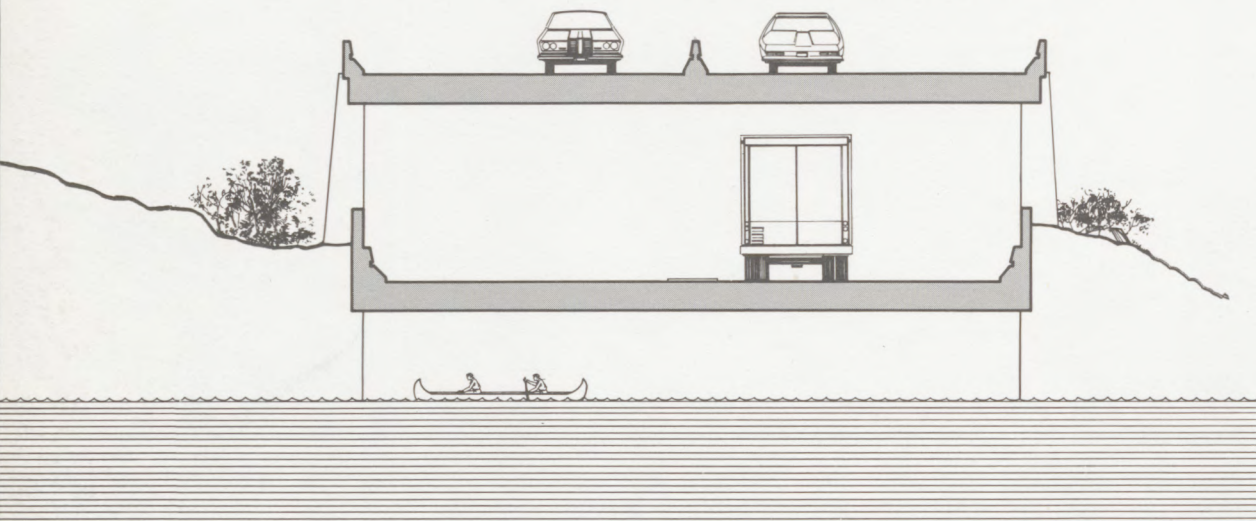


Sound

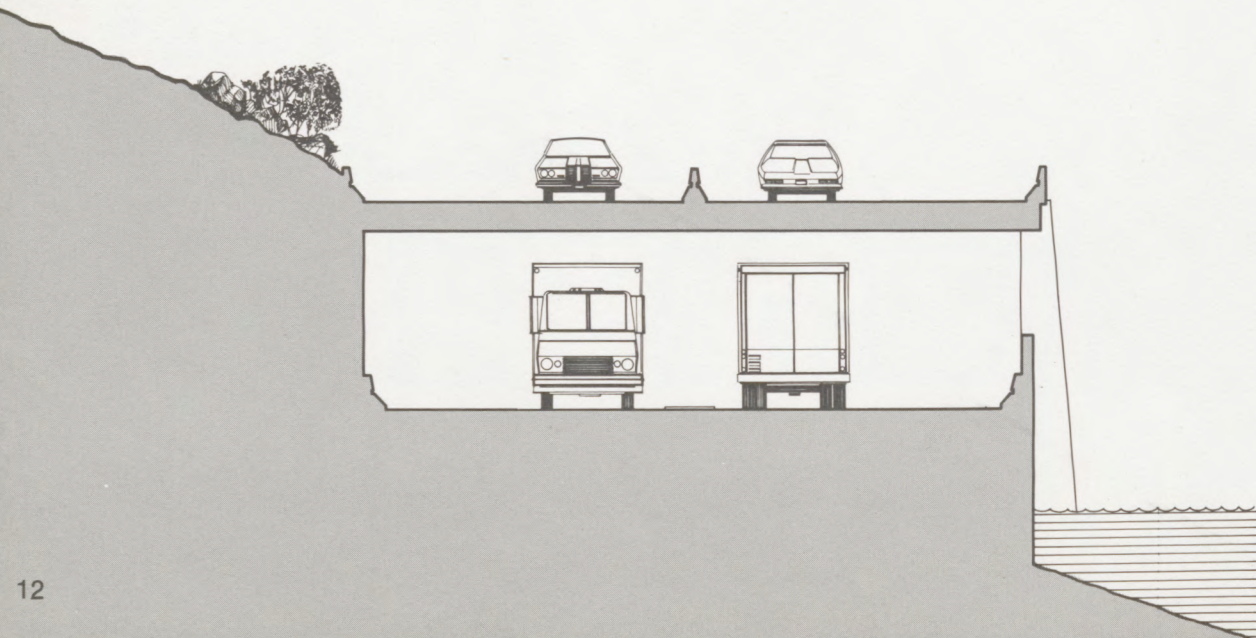
Paradoxically perhaps, enjoyment by man of the unique natural character of Glenwood Canyon demands that the apparent presence of man be kept to an absolute minimum. Today there are few accessible areas of the Canyon where one is not constantly aware of overwhelming truck noise. The parkway/-truckway section is designed to alleviate this nuisance. The interior surfaces of the truckway would be acoustically treated to minimize noise near the source and the conformation of the roadway structure and the earth berms at use areas would effectively control its residual impact.



Design Concept



Bridge Section



Constricted Section

LOCATION PLAN

West of Glenwood Canyon, Interstate 70 is completed through the City of Glenwood Springs to a point east of the No Name Creek interchange. The highway is a four-lane at-grade roadway with ten-foot-wide right shoulders. A New Jersey-type concrete barrier set within a six-foot median separates east and westbound traffic.

The length of Interstate 70 which is the subject of this report begins at the end of the completed highway and proceeds easterly through the Glenwood Canyon corridor for approximately thirteen miles to a point on existing Route 6 about 2,000 feet east of the Cottonwood Creek intersection.

The design speed for this portion of the interstate highway has been established at 50 miles per hour in recognition of the topographic constraints imposed by the Canyon. By and large, both the river and Canyon wall alignments are compatible with the seven and one-half degrees of curvature (Radius = 764 feet) required for 50-mile-per-hour design. However, anticipating that in constricted areas the combination of widening and realignment might encroach upon the river and/or Canyon slopes, limitations imposed by the river were investigated.

Hydraulic studies established that a maximum design flow (50-year frequency) of 25,000 cubic feet per second should be accommodated in the Colorado River. The minimum river channel required to carry this design flow—without causing excessive velocities or flooding of the roadway, railroad or Shoshone power plant facilities—was also determined and revealed that in certain sections the highway could be widened and the river narrowed without adversely affecting its hydraulic characteristics.

Our studies indicate that by carefully locating the galleried parkway/truckway concept and terrace section against the north Canyon wall it is possible to locate a 50-mile-per-hour design alignment for Interstate 70 without any need for cutting the Canyon's rock walls, tunneling or exceeding the river's hydraulic

limitations. Avoiding these constraints should be significant in preserving the Canyon's natural appearance and aesthetic quality. It may be necessary in some areas to construct retaining walls along the roadway shoulders to retain talus cut slopes and river embankments. However, during the detailed highway design phase of the project it may be found that many of these walls are actually unnecessary.

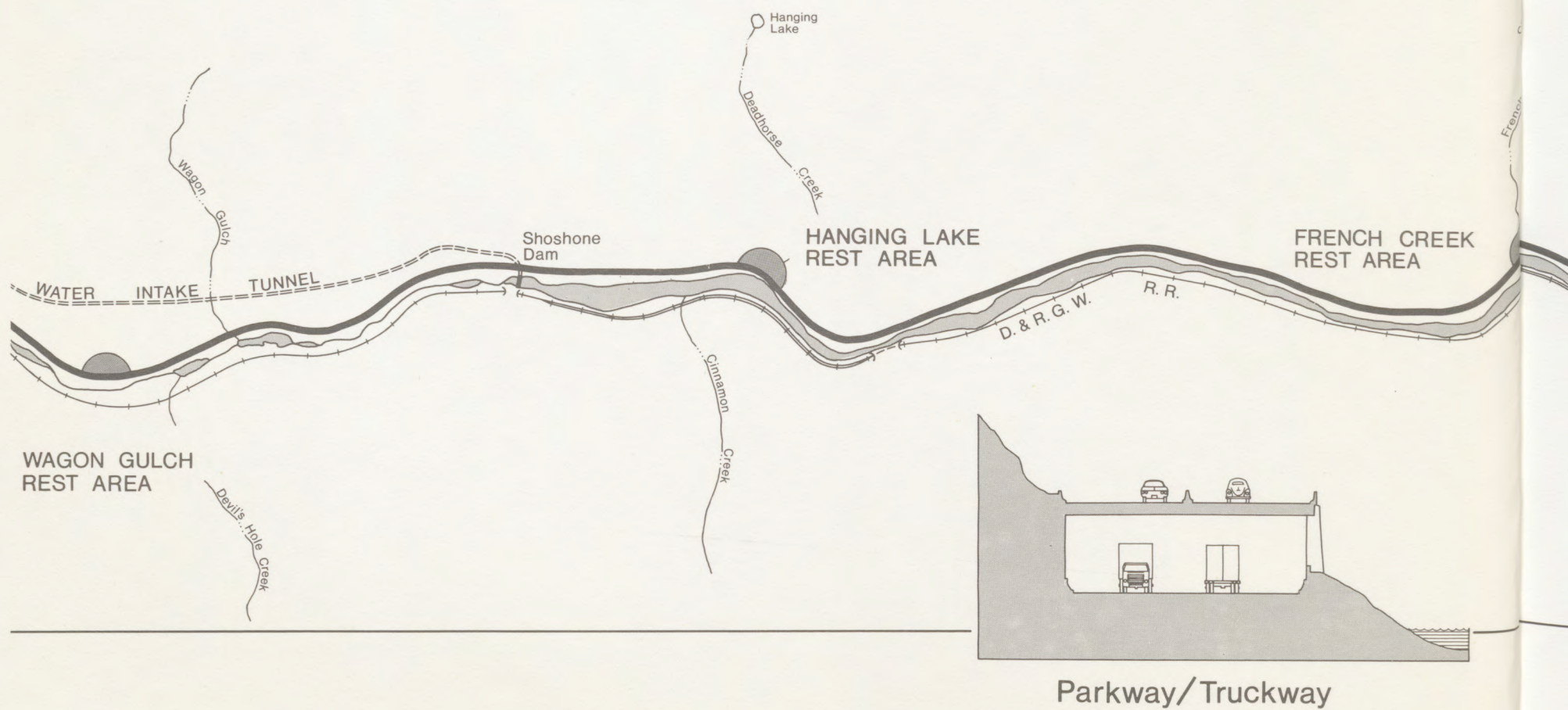
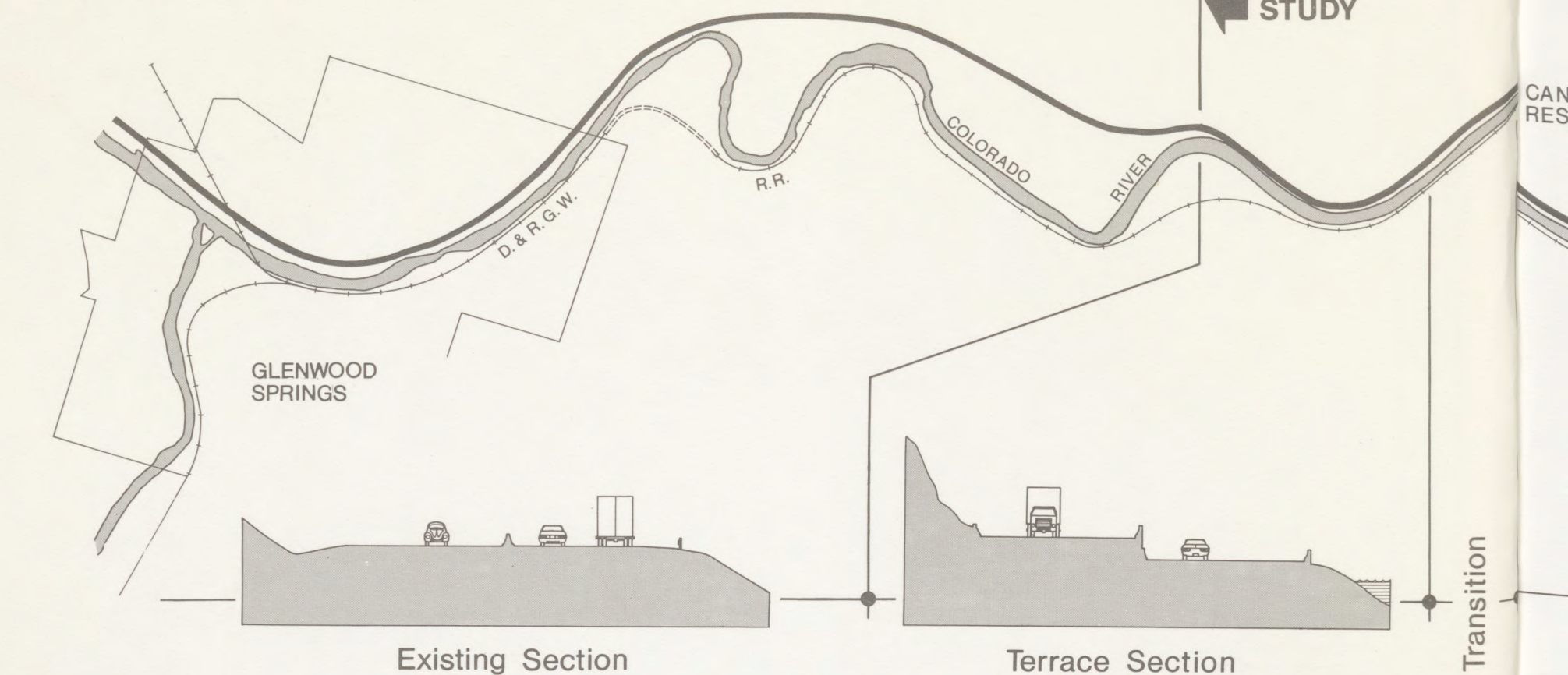
Throughout most of the project's length the parkway/truckway section is located against the hillside along the roadbed of existing Route 6. The recommended section is tucked further into the slope wherever the location avoids cutting above the parkway or westbound roadway elevation. In a few areas, where necessary to accommodate 50-mile-per-hour curvature, the roadways are located toward the river on embankment but never encroaching on the minimum river channel.

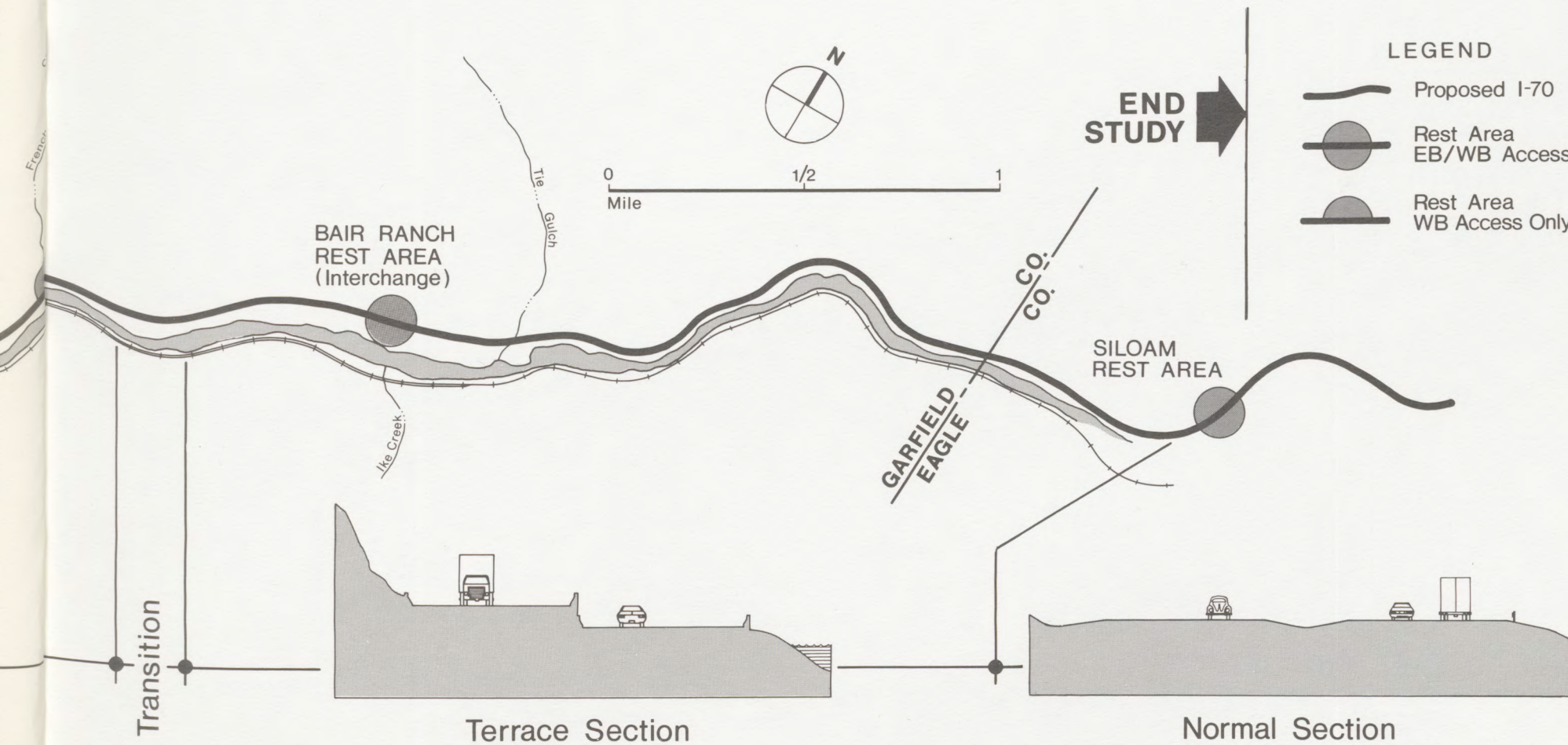
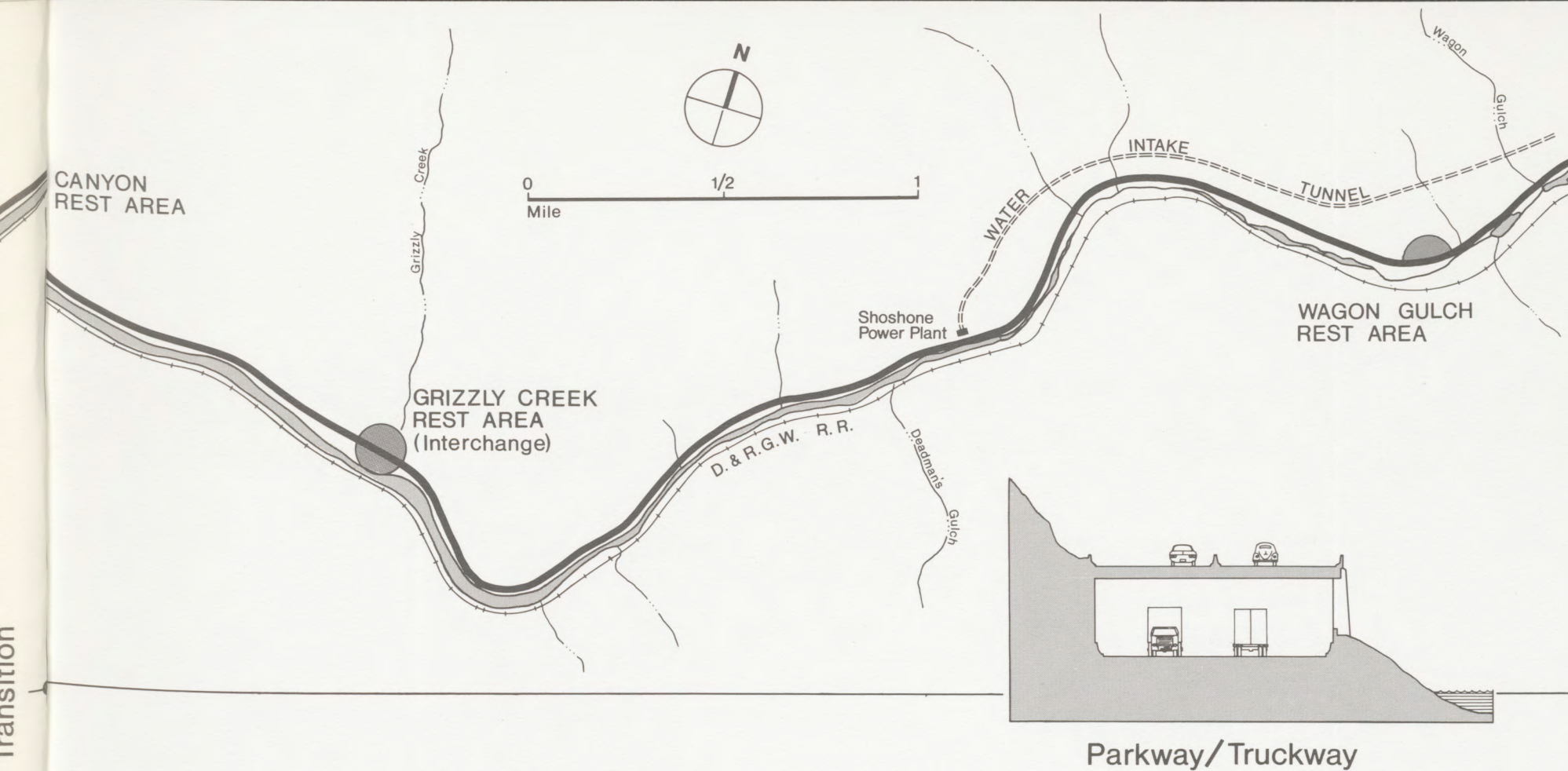
Two full diamond-type interchanges are planned within the Canyon's limits. One is at Grizzly Creek to serve the rest area and National Park Service's picnic area now existing along the creek. All private property and buildings in the interchange area will be taken for the highway. The other diamond interchange is in the vicinity of Bair Ranch to serve the ranch across the river and the proposed rest area.

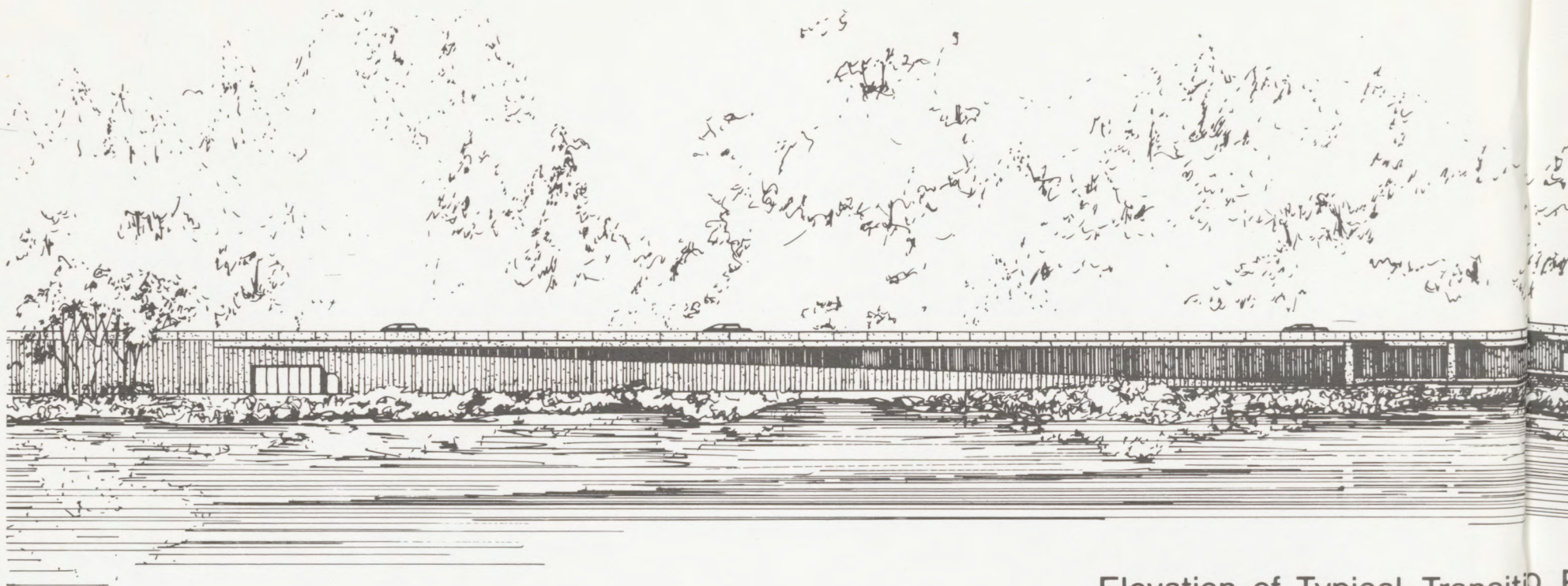
No other crossings of the interstate are planned and access to other rest areas is from ramps leading down from either the eastbound or westbound parkway lanes. Access to the Shoshone power plant, the water tunnel adits and dam sites would be provided via the lower truckway through openings in the northerly retaining wall. No unusual problems or unreasonable disruptions of the plant and dam operations are foreseen during construction. However, the height of the existing overhead cableways which cross the river at these points may have to be increased to adequately clear the upper parkway. In a desire to avoid these possible problems alternatives to the location were investigated and are discussed later in the report.

Location Plan

**BEGIN
STUDY**

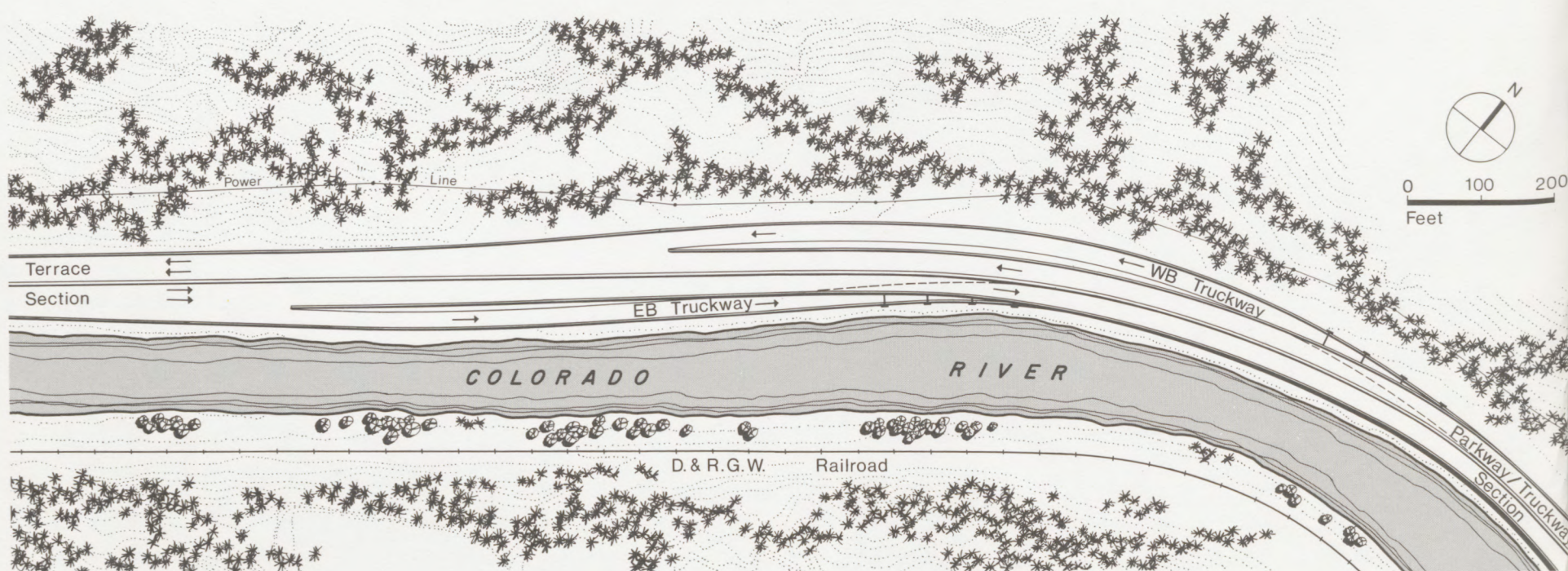




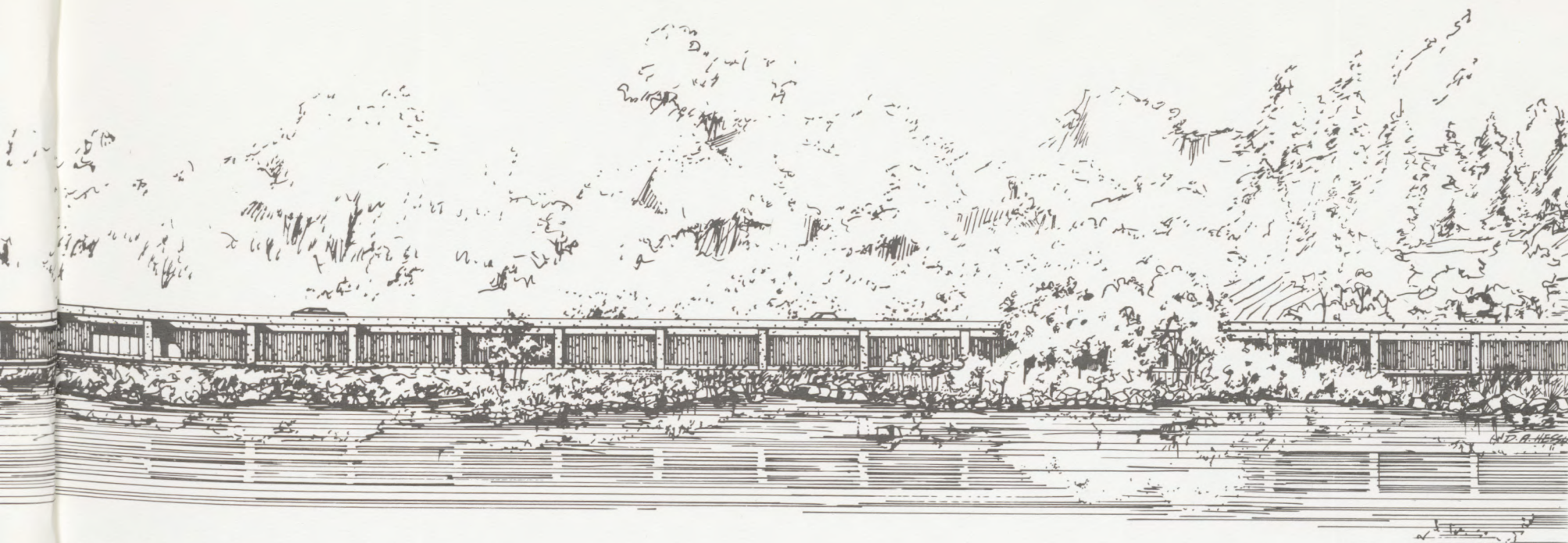


Elevation of Typical Transition

From the end of the completed construction east of the No Name interchange the eastbound and westbound roadways are separated five feet vertically to create the terrace section. This then transitions into the parkway/truckway section along the straightaway west of the existing Highway Department's maintenance garage buildings. This is a desirable area to locate the transition since it is straight enough to provide the required 1,000-foot sight distance to the gore where commercial traffic diverges from the terrace roadway to the truckway. Sufficient distance is also available for adequate signing to inform drivers of approaching maneuvers.



West Transition



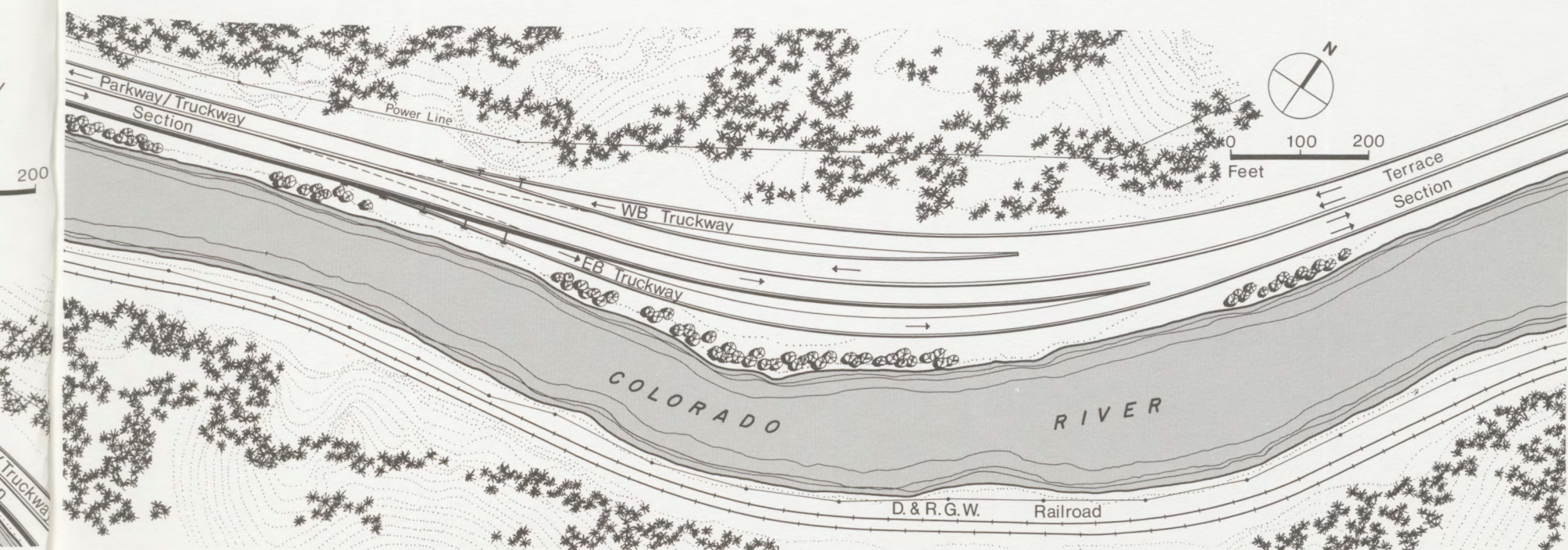
Transition Parkway/Truckway Section

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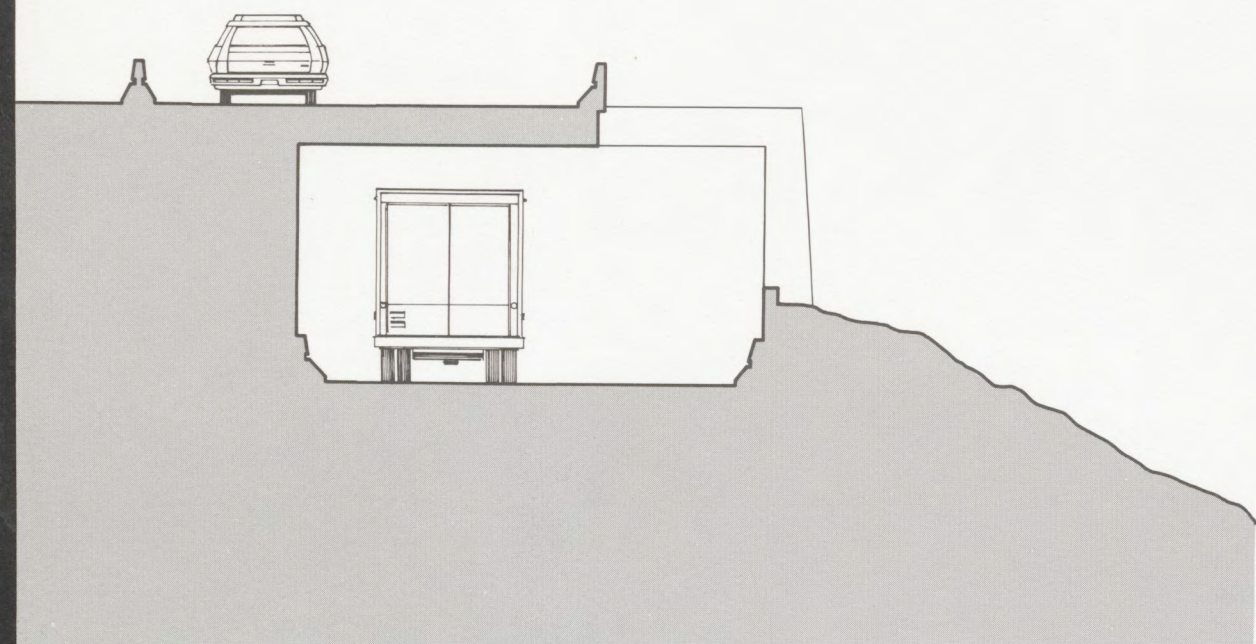
The east transition is located between the French Creek and Bair Ranch Rest Areas. This location was selected because the area is wide, provides sufficient sight distance and the Canyon to the east is less constricted.

The transition between the terrace and parkway/truckway sections causes several special conditions of roadway overhangs and structural outriggers. Architecture recommended for the viaduct, discussed later in the report, was developed with these special conditions in mind to create continuity and harmony within the transition.

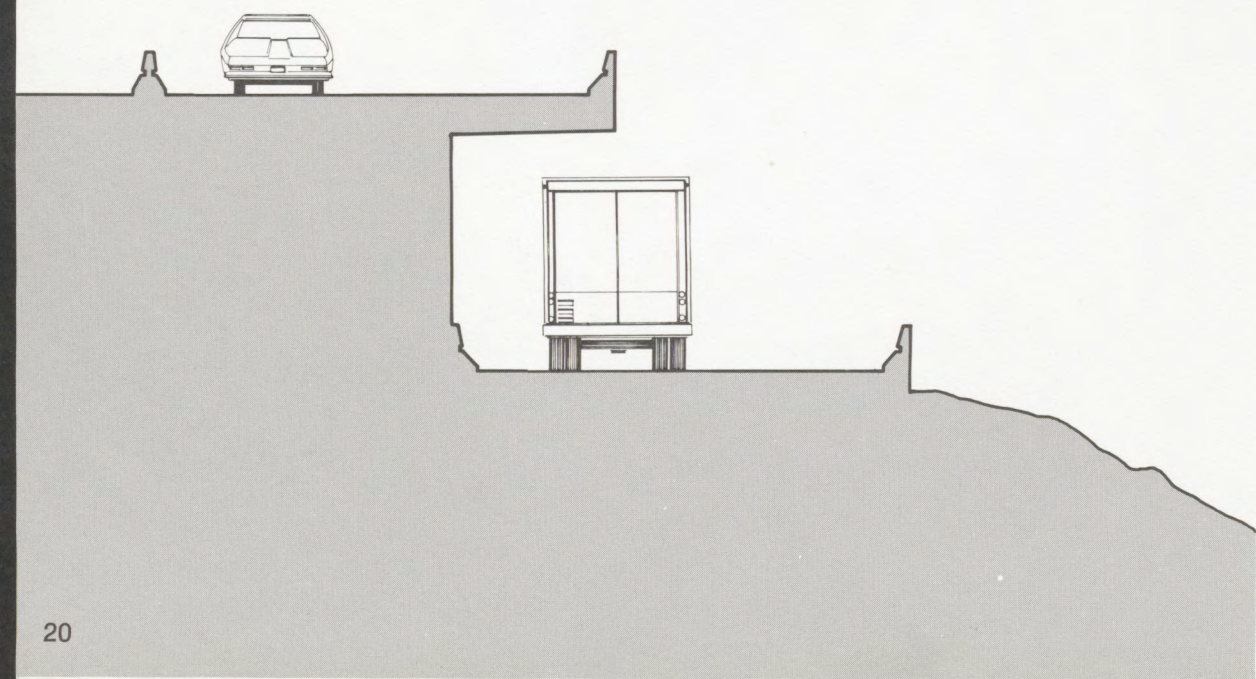


Truckwa
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East Transition



Outrigger Section



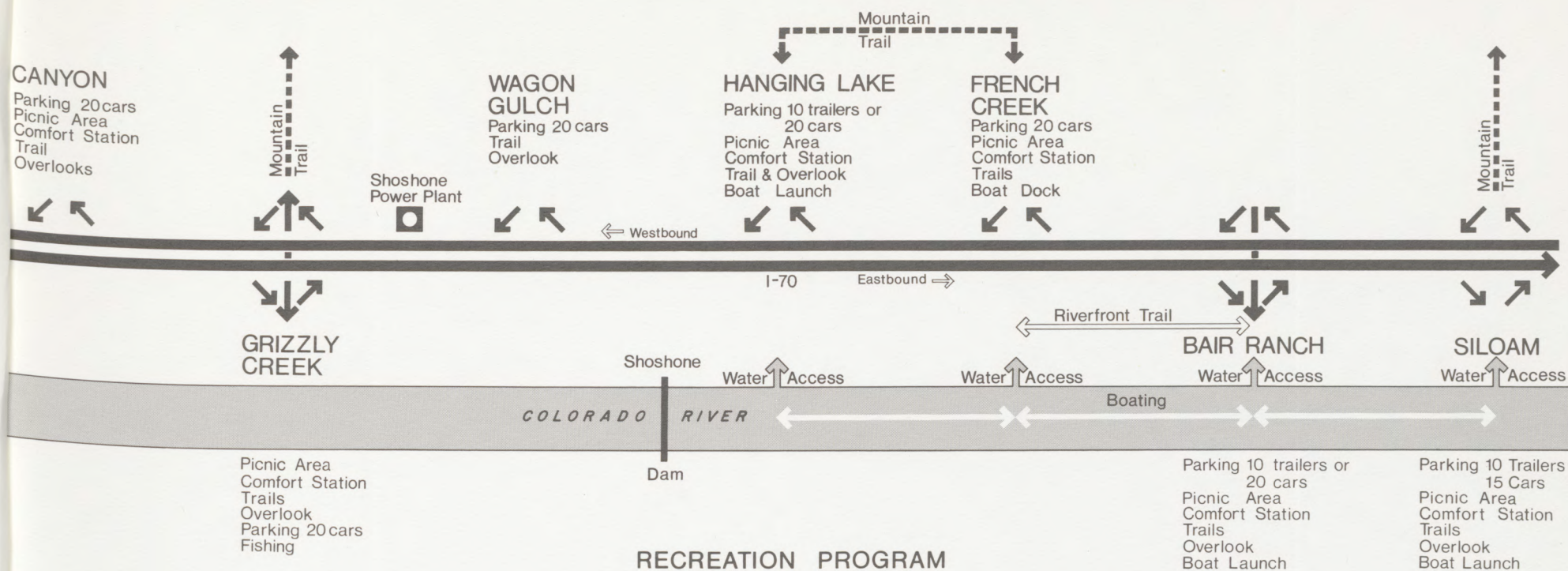
Overhang Section

RECREATION

Any plan for developing the recreation potential of the Canyon should have as its objective the satisfaction of the widest appropriate human enjoyment consistent with ecological, social and legal constraints. In judging which recreational activities are appropriate, the planner must be guided primarily by apparent current recreational demand evaluated in the light of historic patterns. The planner must also look to the future, as best he can, and endeavor to avoid memorializing at great cost what could be the offspring of whim or transitory fashion. The prophet business, of course, is a risky one. Notable practitioners such as the Delphic Oracle and Nostradamus achieved their success by couching their predictions so ambiguously that they could mean all things to all men. Whoever consulted them interpreted the pronouncements as they saw fit and acted accordingly; the results were so often fatal that complaints were at a minimum. Long-range prediction of recreation demand is particularly chancy. It would have taken a far less clouded crystal ball than most planners possess to predict forty or fifty years ago the widespread popularity of skiing, snowmobiling or rock climbing. Planners should also try to avoid playing God and imposing the strictures of their own higher wisdom as to how people should spend their leisure time.

The Canyon's physiographic character naturally suggests a linear "trailway" treatment with lateral dependencies for rest and specific recreational activities. Such a recreation corridor would cater primarily to hikers, horsemen and, probably, cyclists.

Despite the romantic appeal of such treatment for the Canyon, several influences militate against it. First and foremost, there is the general population pattern and the relatively low demand for this type



RECREATION PROGRAM

of recreation facility insofar as it is apparent. Glenwood Springs is the only major center within easy reach of the Canyon. Few hikers or riders could be expected to start from and return to Glenwood Springs; there would probably be even fewer through travelers. Secondly, such a recreation corridor would be completely enjoyable only if motor vehicles were banned from the Canyon. Even if a Cottonwood Pass alternative were feasible—which we do not believe to be the case—most traffic would most certainly continue to use Route 6 and no amount of ingenious physical structuring could effectively separate the horsemen, cyclists and pedestrians from the continuous company of vehicular traffic. Closing Route 6 completely to vehicular traffic is hardly to be considered seriously by other than visionaries completely out of touch with local needs and demands.

The parkway concept—a linear scenic vehicular road connecting and providing access to a series of recreational areas—which we have attempted to apply in our basic design recommendation appears to us to be a positive compromise. The following pages illustrate the application of this concept.

Our recommendations with regard to recreation development are based on day use with no provision for camping. We do not believe that the Canyon has the capacity to sustain major overnight development and statutory limitations on the responsibility and ability of the State Highway Department to provide such facilities are compelling.

Seven rest areas offering specific services and facilities are proposed along the parkway. All are accessible from the west and three from the east. These areas have been selected and designed to capitalize on the natural scenic value of the Canyon cliffs and the Colorado River. They would not be

accessible from the truck level of the interstate highway and would therefore better serve the motorist interested in sight-seeing and recreation. Rest areas and facilities along existing Route 6 would be replaced by these new facilities.

To preserve the natural setting and achieve isolation of the rest areas, the choice of man-made facilities was rigidly limited. Since the rest areas should be insulated insofar as possible from the sight and noise of the highway, landscaping would include sound deflection berms and appropriate indigenous planting.

Provision has been made for boating, fishing and picnicking. Trails that border the river and traverse the mountainous sections to interior lakes, caves and the Canyon rim have been planned for those interested in hiking, photography and exploring the unusual geology and vegetation of the Canyon. Some trails will offer additional access to local creeks identified as year-long fish habitats. Overlooks have been included in most areas and are designed to afford spectacular views from high vantage points without visual intrusion of the highway.

The spacing between rest areas is sufficient to permit adequate signing and safe sight distances at all exits and entrances.

In addition to the areas being linked via the highway, a system of trails will, where feasible, interconnect them as shown on the recreation program diagram. In the reservoir area above the Shoshone Dam, the Colorado River serves to unify the recreation areas by providing water access to them. Boat-launching ramps and docking facilities will be located at the four successive recreation areas above the dam. This five-mile reach of the river is a spectacularly scenic part of the Canyon.

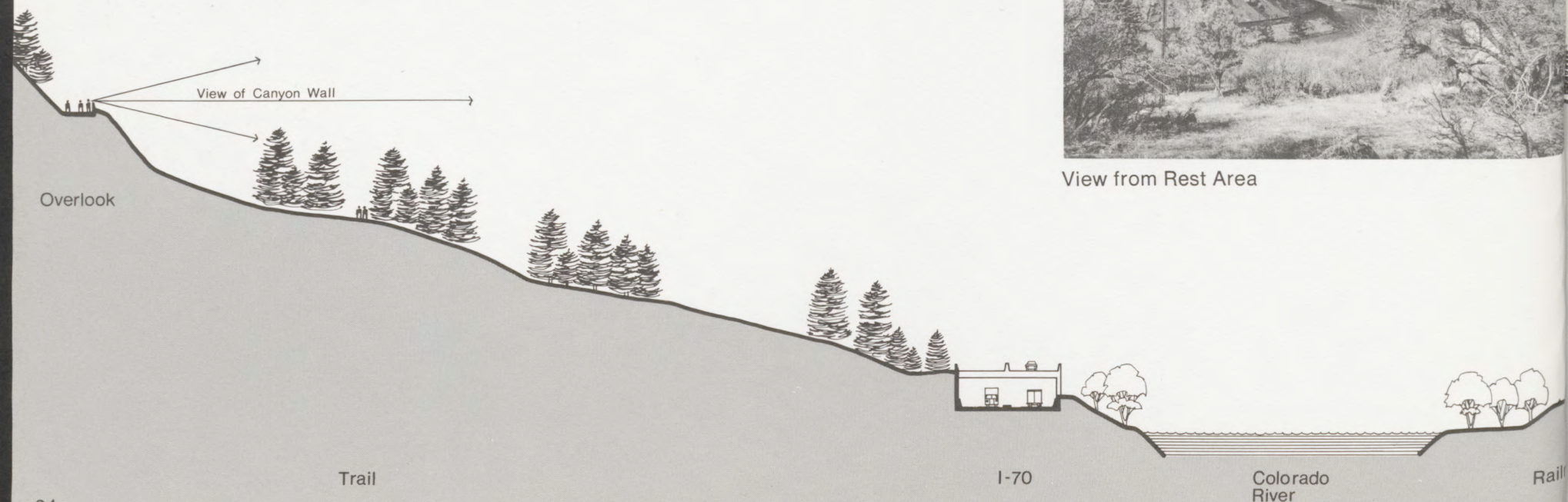


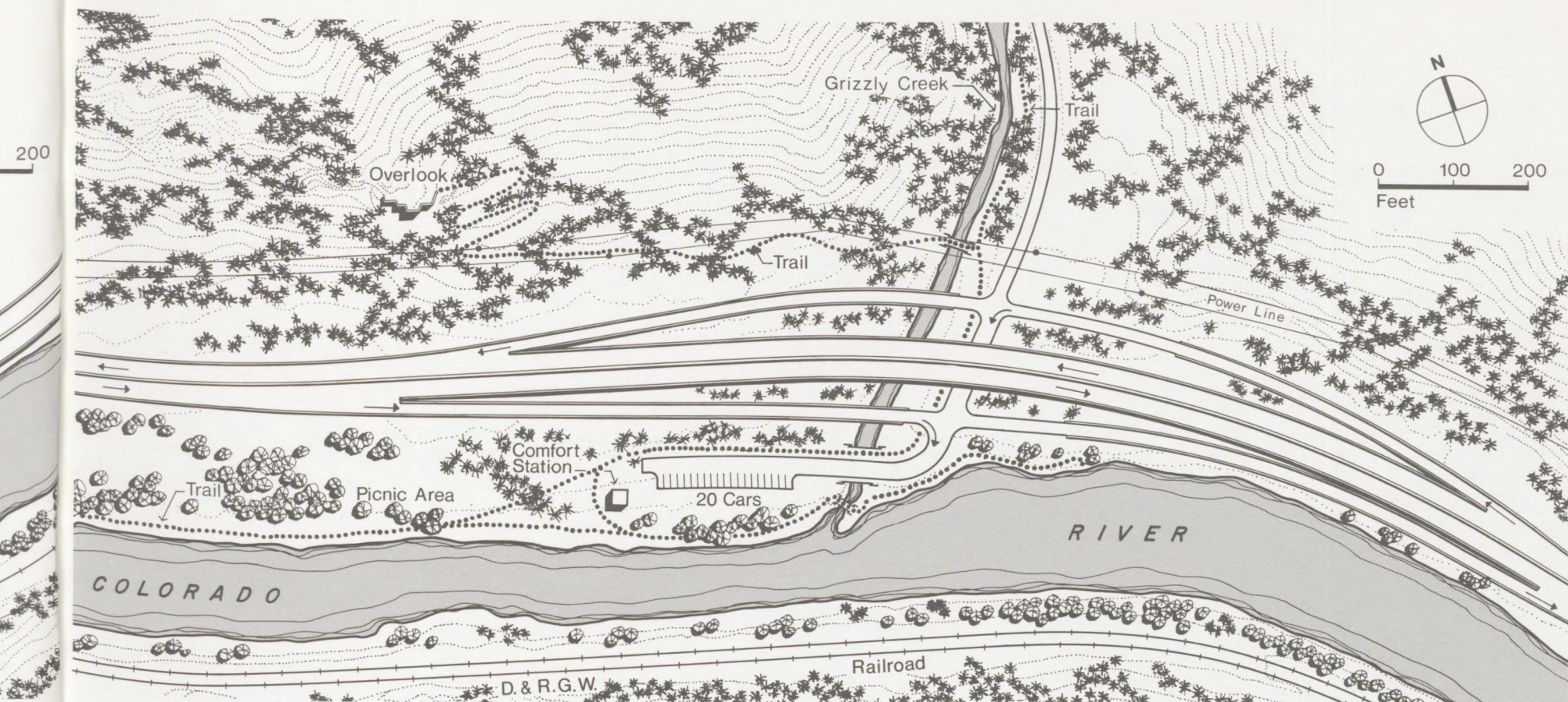
Canyon Rest Area

Canyon Rest Area, accessible to westbound traffic, is about three miles from Glenwood Springs on the site of the existing Highway Department maintenance garage. (These buildings would be eliminated by the proposed facility.) Two overlooks positioned on the Canyon slopes command an outstanding view of the rock cliffs. The overlooks, accessible only on foot, are connected by a system of trails. Parking facilities and a comfort station will also be provided at this site.



View from Rest Area





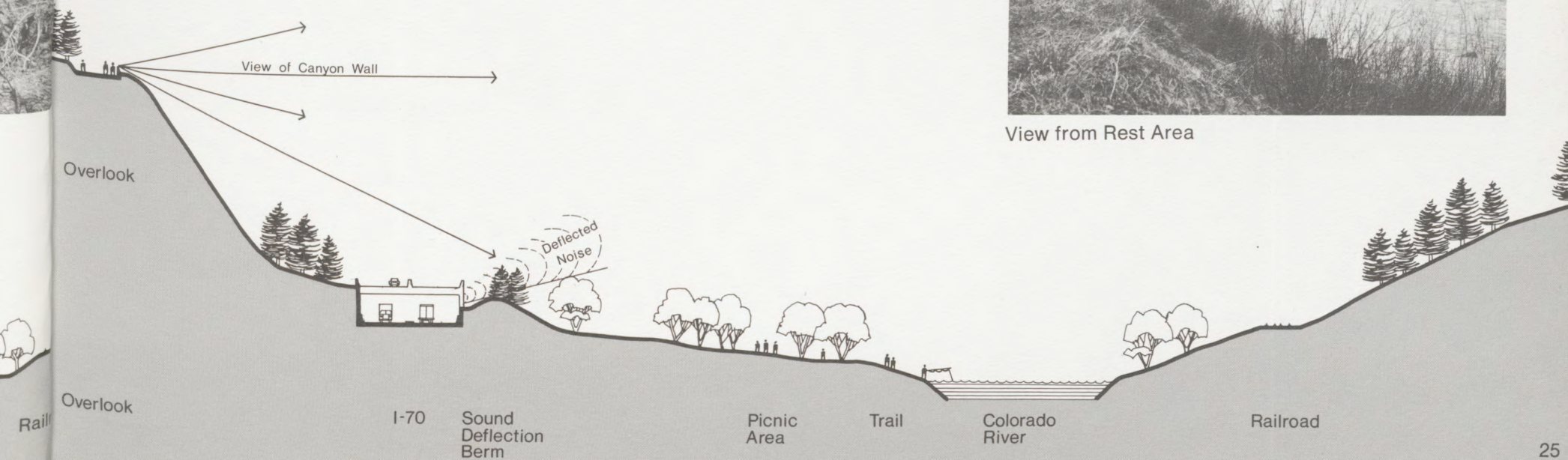
Grizzly Creek Rest Area

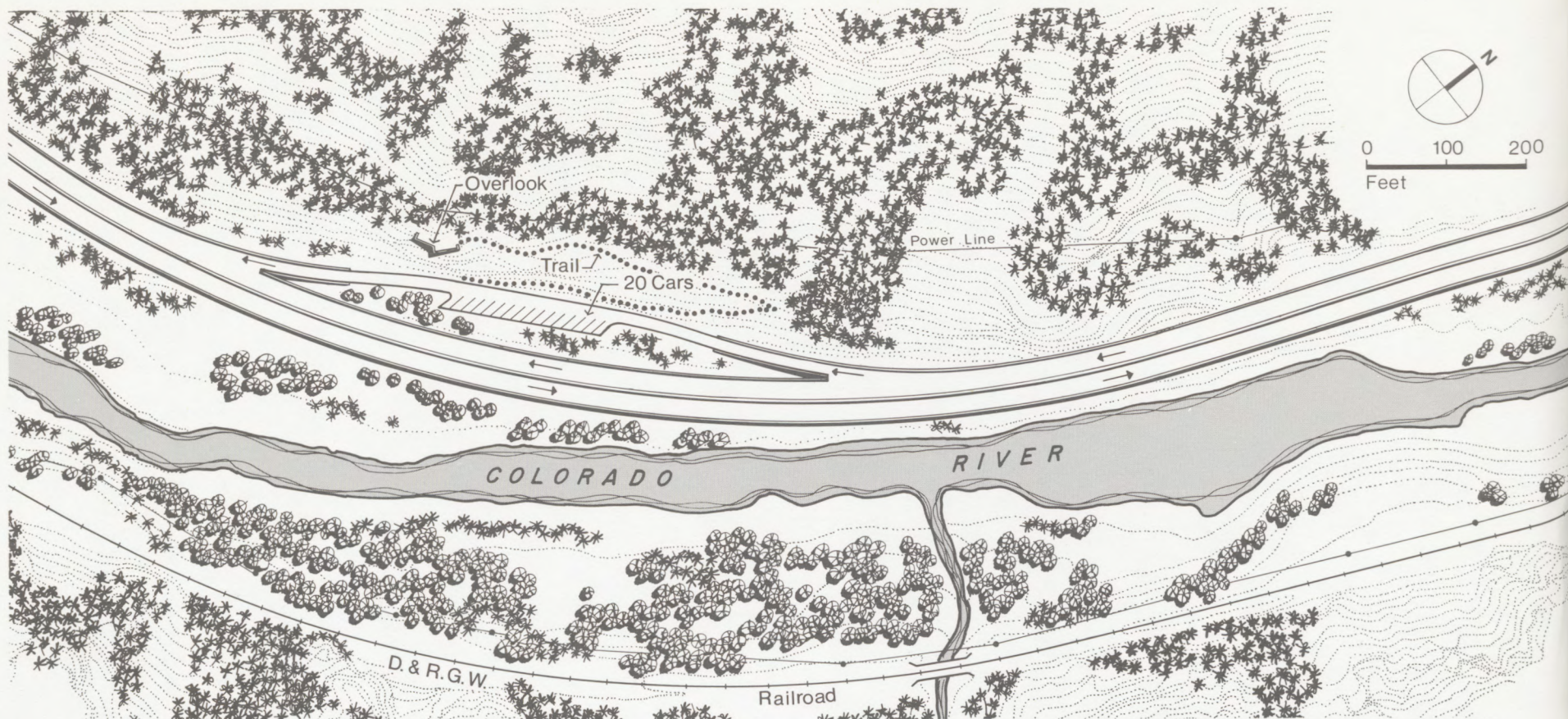
This rest area is oriented toward the river at its junction with Grizzly Creek, both of which can be fished. Recommended trail systems traverse river and cliffside sections. One trail along the creek will branch off to an overlook which affords a fine view of the surroundings.

This site, accessible to east and west traffic via a full interchange, has a comfort station and picnic area. Existing buildings and a dwelling will be acquired but access will be retained to Forest Service picnic grounds located above Grizzly Creek.



View from Rest Area



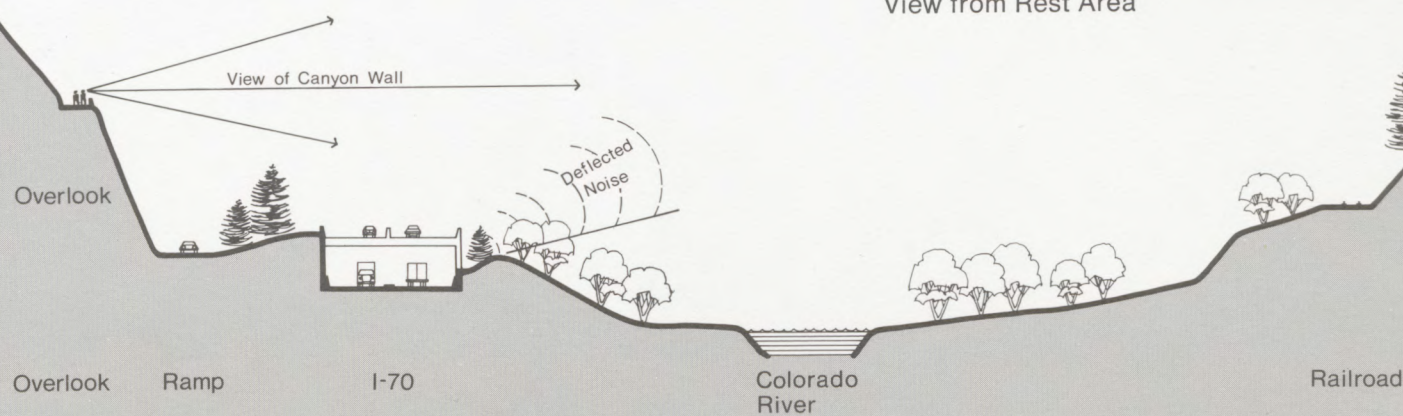


Wagon Gulch Rest Area

The surrounding rock walls, narrow riverbed and absence of man-made elements make the Wagon Gulch area one of the most striking portions of the Canyon. To keep this section as free from obtrusive structures as possible, the rest area which is accessible from the westbound roadway will consist only of parking, a trail and a scenic overlook which commands a view up and across the Canyon.



View from Rest Area





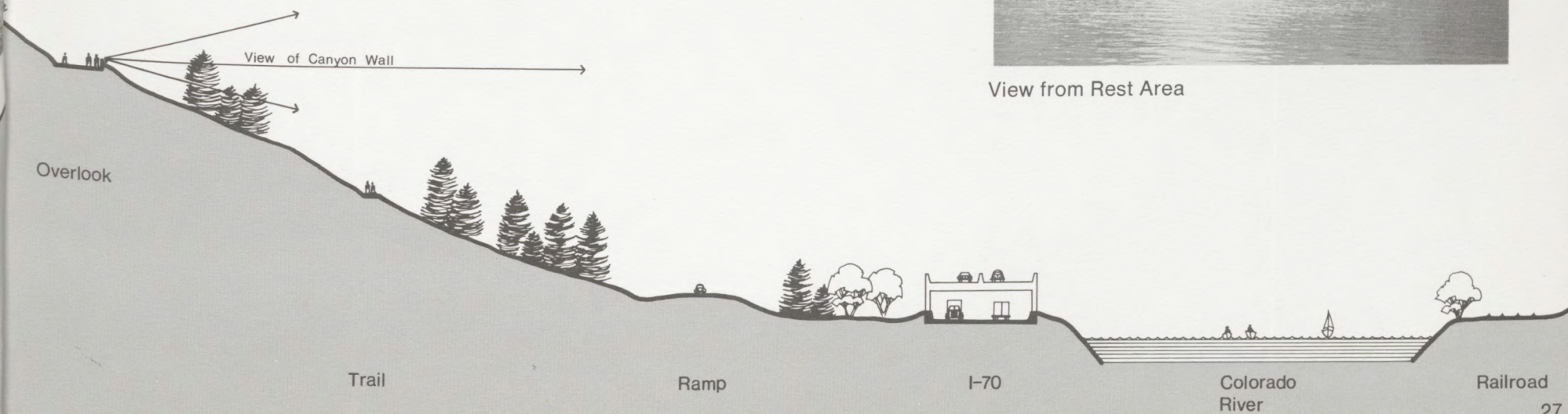
Hanging Lake Rest Area

This rest area, located where Dead Horse Creek flows into the Shoshone Reservoir, will serve westbound travelers. It has parking for automobiles and trailers. The reservoir is suitable for boating and a boat launch here could be the start of a trip ending at Siloam Rest Area.

A comfort station and picnic area will be located on the east bank of the creek. Planned trails focus on this area, lead to an overlook on the Canyon wall and provide access to Hanging Lake.



View from Rest Area

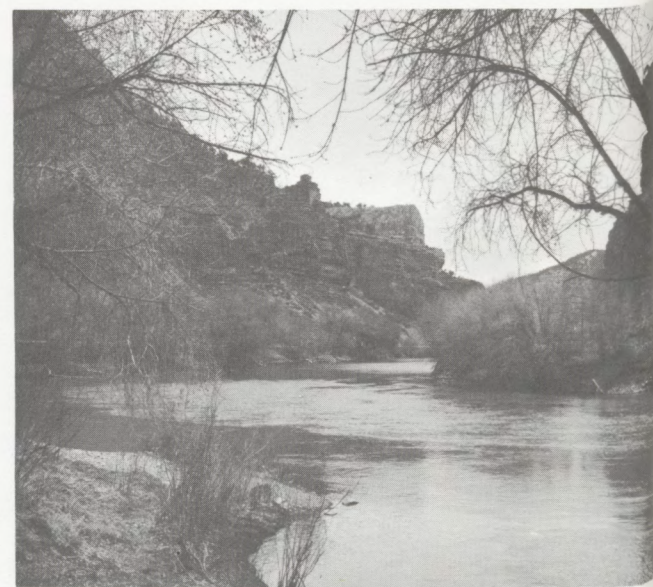




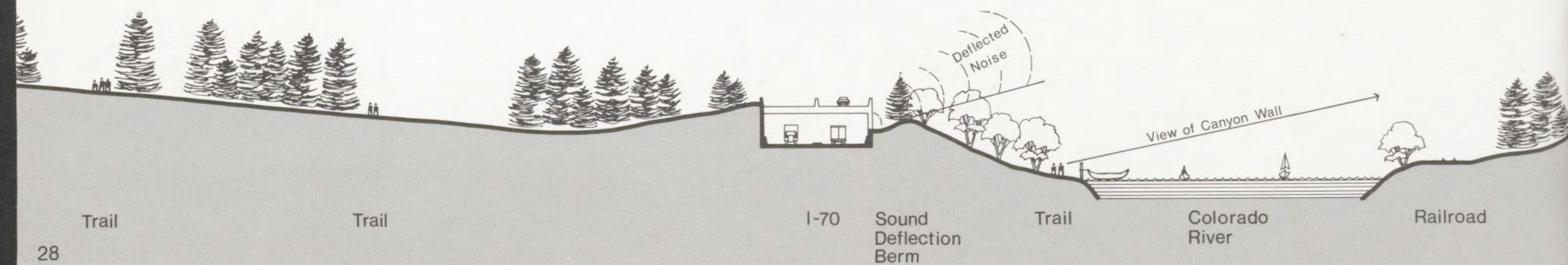
French Creek Rest Area

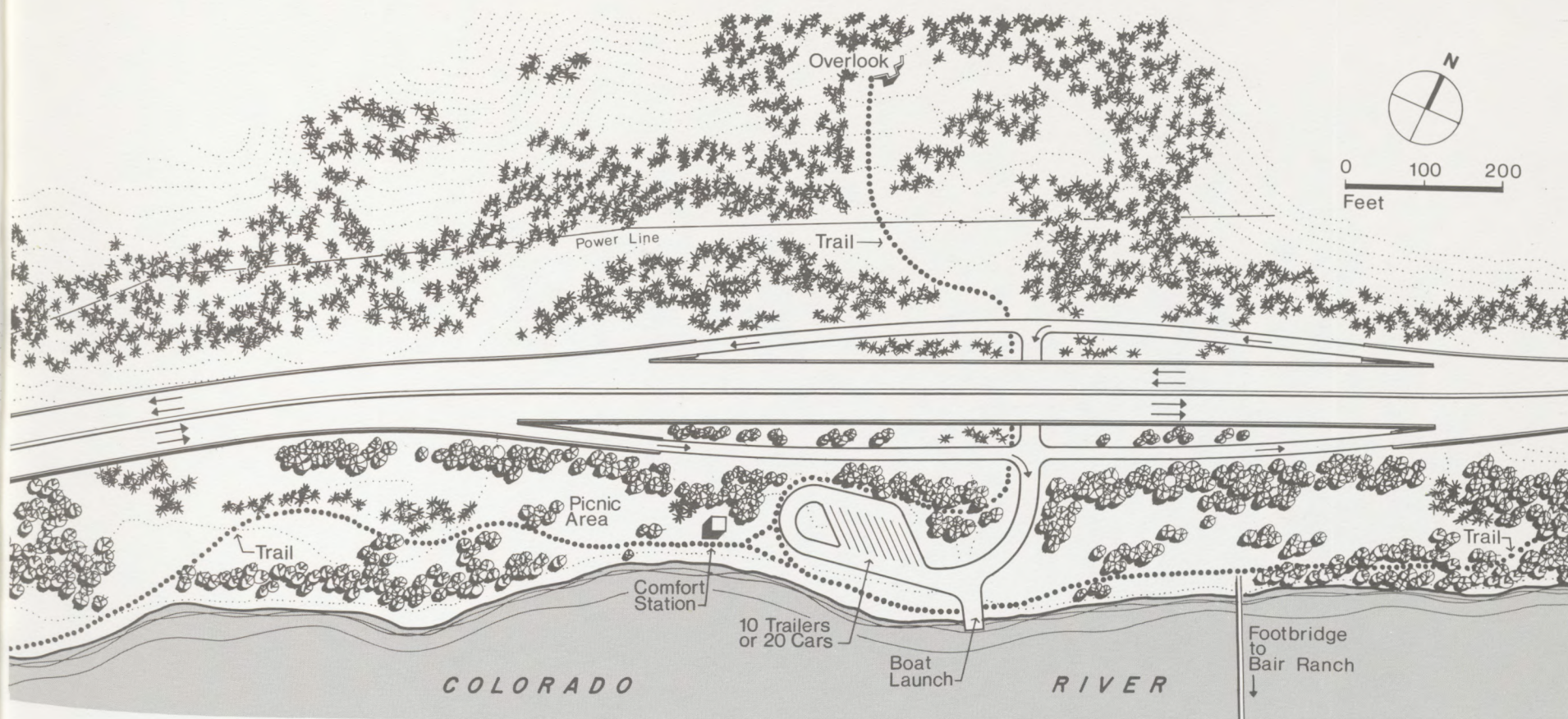
The rest area is characterized by widening of the Canyon walls and a scenic section of the river at its junction with French Creek. Recreation facilities, accessible to westbound traffic, are situated on both sides of the highway.

Planned facilities include parking, a comfort station, a picnic area and an extensive system of river and Canyon trails. One trail will underpass the highway and connect the two recreation areas. A boat dock at this site will allow boaters to rest but no provision will be made for launching.



View from Rest Area



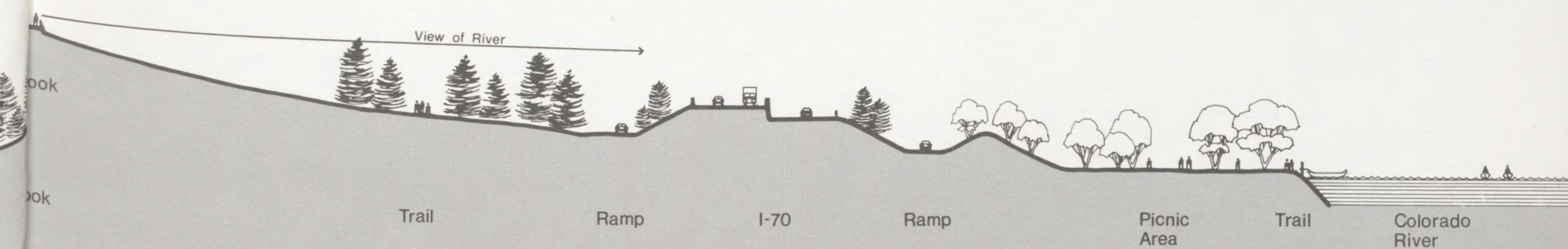


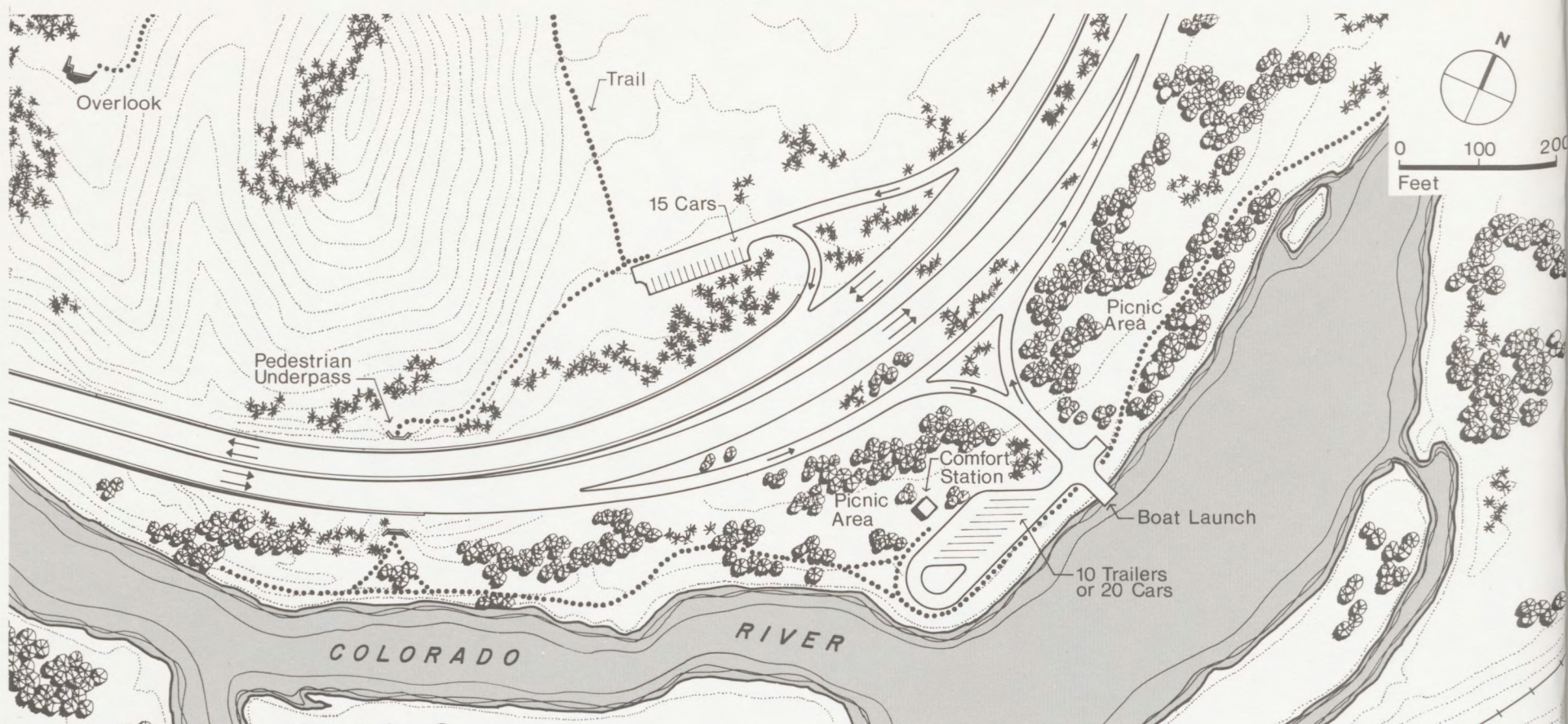
Bair Ranch Rest Area

This rest area will be accessible from east and westbound lanes and recreation areas will be provided on both sides of the highway. The Canyon here is wide and open and an overlook affords a fine view of the rock walls. A trail and pedestrian underpass link this site to parking, picnic and comfort station facilities on the river side. A boat launch, the second rest area launch site, is flanked by trails along the river's edge.



View from Rest Area



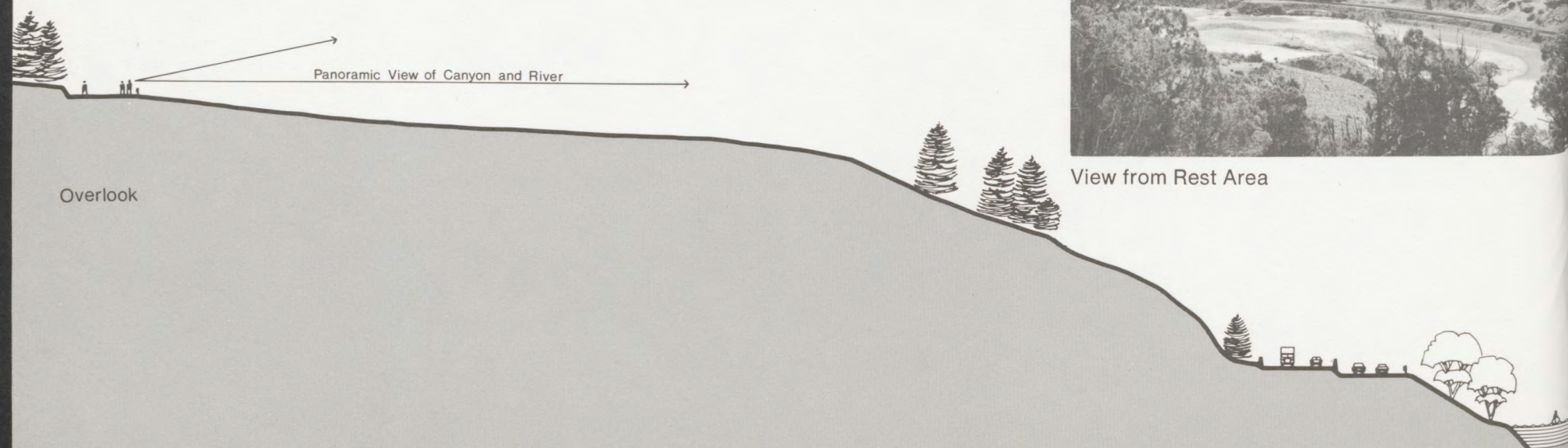


Siloam Rest Area

This scenic area at the easterly entrance to the Canyon is large enough to permit parking and recreation facilities on both sides of the highway—connected by a pedestrian underpass. A boat launching ramp, picnic facilities and comfort station are recommended for the south, riverfront rest area. On the north side a trail would lead to a high overlook providing a panoramic view of the Canyon.



View from Rest Area



DESIGN DETAILS

Architectural

The guiding principle behind all of the design efforts involved in this concept study has been to reduce the impact of the interstate highway on Glenwood Canyon. This principle suggested the parkway/truckway section which eliminates the need for extensive cutting of rock or talus on one side or encroachment into the Colorado River on the other. The primary architectural design problem was to further reduce the impact of the truckway.

First, the apparent height of the structure has been reduced by creating a six-foot-high berm along the river face of the truckway. This has the added advantage of screening the trucks acoustically as well as visually. As the rest area sections illustrate, the berming is increased at those points to screen the truckway almost entirely from sight and sound.

Second, the column spacing and articulation has been designed to create a pierced louvered wall rather than a solid surface. The proportion of the openings between the columns resulting from this spacing contributes greatly to the low, horizontal silhouette of the highway.

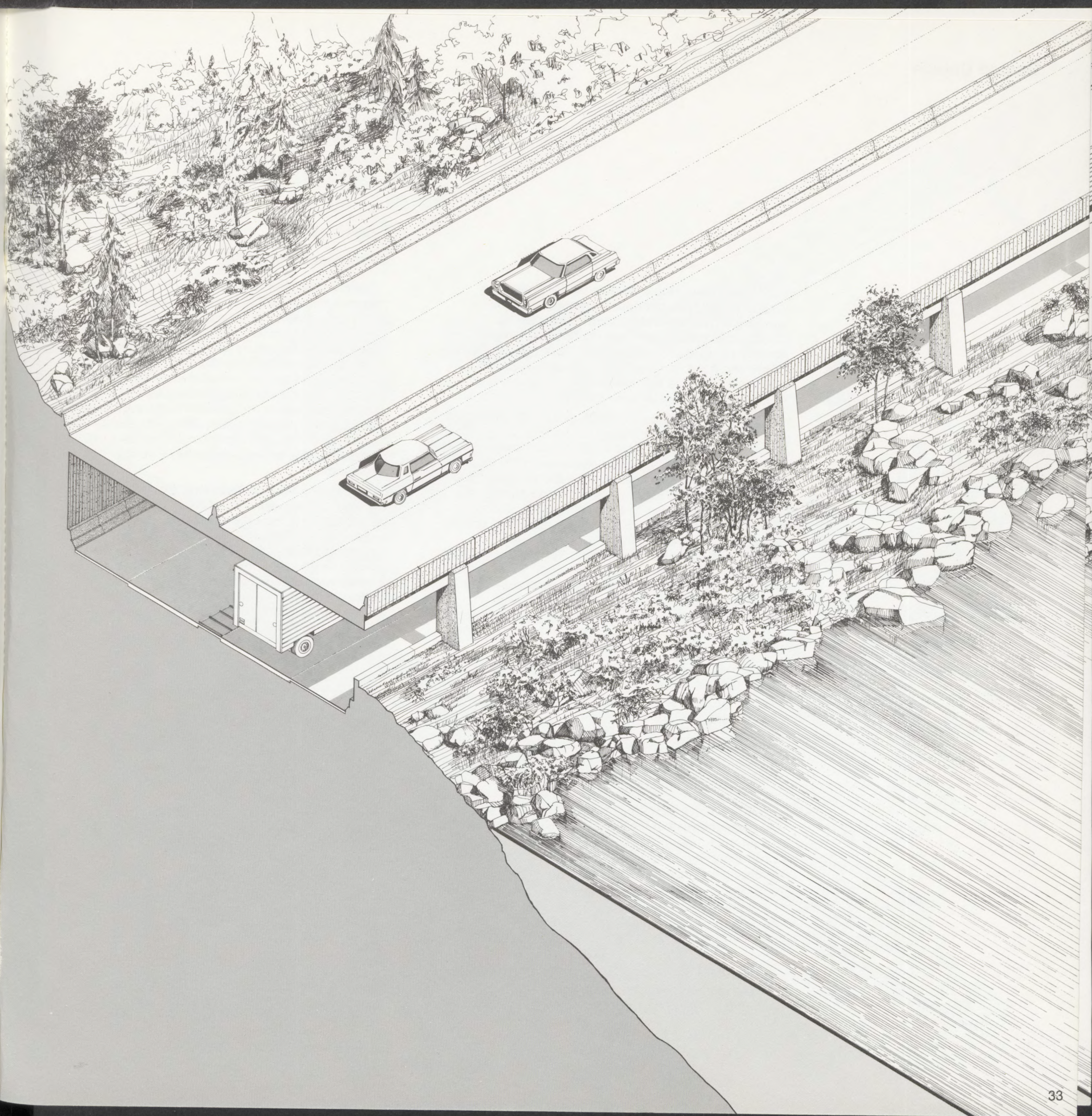
The articulation of the columns provides the solution to a third problem—the need to accommodate outrigger bents at the point of transition from the terrace section to the parkway/truckway section separating recreational traffic from truck traffic. The column with a typical articulation of nine inches or so at the parapet is simply extended outward to become the outrigger. The offsetting of the upper parapet, which is continuous throughout the project, also contributes to this detail.

Finally, a selection of natural aggregates and subtly textured surfaces is recommended to eliminate the usual sense of a raw new element imposed upon the landscape that seems to so often be the case with new construction. The total effect of the colors and textures of the Canyon carried directly into the elements of the highway and combined with the berms and planting along the river should be one of continuity and harmony.

Structural

For the past twenty years, innovative systems have evolved for constructing bridges with prestressed concrete, the most important new development in highway construction. These techniques are recommended for this project to produce a creative, yet economic design and, of the highest significance, easy maintenance of traffic on the existing highway.

The viaduct consists of a combination of precast elements—guard barriers, retaining walls and certain bridge components—together with a cast-in-place, post-tensioned deck slab erected from traveling



scaffolds. The portable staging would progress longitudinally from previously completed deck, supported by piers and temporary trestles. Construction equipment and material will employ the already completed structure and, with the absence of falsework, have minimum interference with traffic. The scaffold would be insulated, lengthening the relatively short construction season.

Final span selection would be dictated primarily by economics, while recognizing the excellent foundation conditions, and would reflect the particular demands of the project while maximizing the use of other considerations, such as load factor design and concrete pumping equipment. It would optimize the speed of construction by eliminating sophisticated forming, complex draped bars, tapered cut-off points and tendon congestion by employing straight threaded reinforcing. The continuous casting method would also reduce the number of "cold" field splices which have historically been less than satisfactory. Although the deck would also be prestressed transversely, this would not affect the development of rational work cycles and would allow several spans to be poured in one operation.

A protective asphalt-asbestos wearing course would be placed between curbs, which would protect the integrity of the prestressed deck while increasing the surface temperature in normal winter weather and reduce the number of freeze-thaw cycles. This would assist, along with the deck itself, in helping to eliminate the icing problems so prevalent with the thinner concrete decks employed with stringer-type construction.

Foundation conditions favor the use of drilled-in caissons founded in the solid crystalline gneiss and limestone formation, but surficial deposits will require careful handling and could prove troublesome during retaining wall construction and caisson installation.

At the present, there is insufficient concrete plant capacity in the immediate area, but a project of this magnitude could prove economical for the consideration of on-site plant facilities for both precasting and in situ concrete work.

The alternative of a steel supporting system (of, most probably, about the same cost range) of unpainted weathering steel could be considered, but with the clean, relatively dry air, an excessive length of time (exceeding five years) to develop the russet oxide coating would be untenable.

Construction

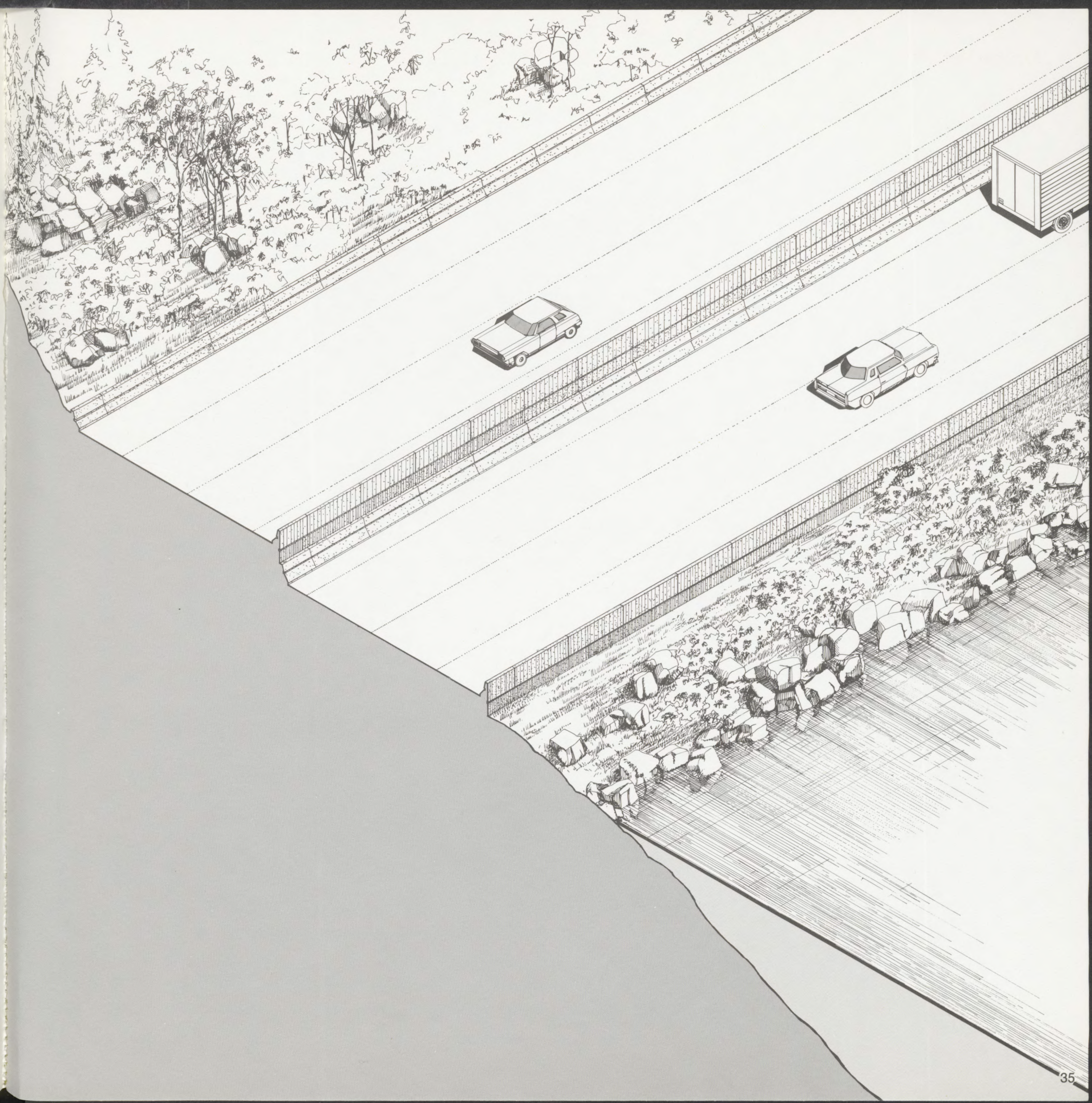
Maintenance of Traffic

Maintenance of traffic during construction is of paramount importance and led to advocating the continuous casting technique for the parkway viaduct. The procedure obviates the need for much of the usual falsework and leaves traffic on the lower roadway relatively unimpeded. Construction equipment and material would use the completed portions of the structure while traffic is maintained below on the existing roadway or on adjacent temporary pavement. This construction technique, along with the use of precast elements, will minimize disturbance of the highly erodible surficial deposits by construction equipment.

To construct the parkway/truckway section the existing roadway would first be modified and realigned as necessary to form the lower roadway. Piers and temporary scaffolding will then be constructed adjacent to each side of the existing or new roadbed leaving sufficient width for two lanes of traffic. The median and retaining wall curb barriers would be either precast or slipformed with precasting recommended for selected portions so the units may be used as movable, free-standing safety guards and lane delineators during construction; later they would be placed in their final position.

On the westerly portion of the terrace section, construction would begin on the eastbound roadbed while maintaining traffic on the existing pavement; on the easterly portion, construction of the westbound lane would be undertaken. In the design stage of the project a detailed sequence of construction operations would be determined which would be dependent upon the relationship of the new alignment with the existing road. Traffic would be maintained either on the existing road, temporary pavement or portions of the completed construction. Final paving would be done after the viaduct is completed and traffic detoured into the structure.

Construction should be carried out in stages consistent with available funding, but due to the nature of the project and anticipated methods of construction, contract sections larger than those normally awarded would be envisioned to make fullest use of the successful contractor's repetitive use of forming equipment. The specialized construction technique and procedures also make it advisable that an "incentive" clause be included in the contract documents whereby the builder's suggestions as to construction modifications would permit the State to benefit from available cost savings.



Lighting

It is recommended that all interchanges, rest areas and their approaches be illuminated; and that the entire truckway understructure be lighted with two rows of high intensity, sodium fixtures. The entrances to the truckway at each terminus of the parkway/truckway section should be lighted in a fashion similar to tunnel entrances. Consideration should also be given to lights being built into the bridge (possibly in railing elements) and retaining walls to clearly illuminate the transitional areas. This lighting would assist in eliminating driver indecision.

Signing

Signing would be accomplished using interstate criteria, however, smaller lettering should be used in recognition of the 50 mph design speed. Final delineation would produce smaller signs. Backlighted fixtures, integrated into the structure (for economical ease of maintenance), should be especially developed for the truck roadway. Only access signs (to the dam and power plant) and a minimum of cautionary signs would be required on this lower roadway.

Drainage

Drainage of the four-lane terrace section and the truckway portion of the interstate highway would be accomplished with catch basins, pipes and culverts to intercept all runoff. There are no major stream relocations required along the project and the several existing crossings over the creeks will be replaced with new bridges.

The deck of the viaduct structure and portions of the covered truckway would be drained by properly designed and adequately spaced scuppers. Systems which would pipe surface water from the upper deck should be avoided due to continued maintenance problems which become aggravated in freezing weather.

Requirements for snow removal have been carefully considered in the proposal for eliminating longitudinal ditches and introducing barrier curbs along the shoulders. Normal removal operations cast snow to the right and no special treatment of the shoulder is required where the roadway is banked to the right. But where the roadway is banked to the left, it is proposed that half the shoulder be laid level and the outside half be banked to the right to prevent melted snow from crossing the pavement. The longitudinal cross-over crowns introduced with this treatment would not adversely affect the use of the shoulder as an emergency lane during normal operating conditions.

Cost Estimates

Construction costs for the recommended design concept plan were estimated from prices furnished by the State Department of Highways and comparative analysis of current cost data compiled for work let in 1972 and 1973 for the mountainous areas of Colorado. The availability of material locally, as well as the present lack of skilled labor on the western slope, were recognized in preparing the estimate. Although possible stimulation of the local economy by oil shale industry could have considerable effect on the project (especially concerning nearby concrete plant development) no attempt was made to analyze its effect upon this project.

As proposed, the project is estimated to cost \$138,900,000 with the major construction items listed below. These include approximately 3.7 miles of terrace roadway at each end of the 8.9 mile parkway/truckway section.

Item	Estimated Cost
Paving, Grading, Drainage, Maintenance of Traffic Structures	\$ 17,900,000
Walls and Barriers	104,500,000
Rest Areas, Interchanges, Landscaping, Revegetation	12,900,000
	3,600,000
Total:	\$138,900,000
	SAY \$140,000,000

Costs include all items necessary to complete the project except funds for right-of-way acquisition and relocation of power and other utilities. These costs would be comparable and common for all concepts. Much of the land is now owned by the State but all private lands in the Canyon with the exception of Bair Ranch, the power company and railroad would be acquired.

An analysis of costs reveals that a significant portion naturally relates to the structural aspects of the parkway/truckway concept. A uniform cost for all bridges of \$40/S.F. as developed by the State Department of Highways for this project has been applied. However, our analysis indicates that a unit price at \$35/S.F. for the proposed parkway viaduct would be more realistic. Applying this lower unit price to the recommended design concept reduces the total construction cost by about \$13 million.

Of particular note in the quantities is the minimal amount of borrow and earthwork (approximately 500,000 cubic yards). This small quantity is indicative of the successful location achieved through the narrow restrictions of the Canyon made possible with the parkway/truckway. Rock blasting and cutting operations into the natural slopes would be largely avoided and is reflected in these quantities.

Revegetation

Construction of Interstate 70 will be approached with utmost concern and respect for the natural resources of Glenwood Canyon. However, any disturbance of natural vegetation will be restored, in so far as possible, to original appearance and function. A thorough study has been made of the Canyon's vegetation in order to make sound recommendations for the process of restoration and regeneration of affected plant life. The vegetation on the Glenwood Canyon side facing south can be categorized into three types and a summary of particular sites, species and rehabilitation recommendations follows.

Upland dry site with vegetation typical of south-facing slopes in semiarid western Colorado. The dominant grasses are Indian ricegrass and bluebunch wheat grass, with a few clumps of sand dropseed and galleta. Cheat grass, an exotic winter annual, is often abundant. Widely-spaced Utah juniper visually dominate the overstory which also includes scattered big sagebrush and fourwing saltbush.

Upland run-in sites are marked by stringers of Gambel's oak which extend from certain areas of rock outcrop to the river. Scattered clumps of wildrye are present within the oak thickets. These stringers of vegetation apparently tap water which runs off the rock outcrop and downhill beneath the soil surface.

Riparian Zone dominated by boxelder, willow and rose. Quack grass has invaded the edge of the road embankment next to the river.

The soils on the steep south-facing slopes would contain a high percentage of coarse fragments (possibly 30 to 70%) with the soil-size material clayey in soils derived from limestone and sandy in soils derived from igneous rock. The average annual precipitation for Glenwood Canyon varies between 12 and 18 inches and tends to be lower at its eastern end.

Late fall seeding is recommended in the Canyon although early spring seeding can be successful. Late spring seedings often perish during the period of low precipitation and high temperature in June and July.

In this semiarid area a seedbed must be prepared and the seed covered with soil. Seed should be drilled if possible. If this is not possible then the seedbed must be scarified and the seed covered by use of a chain harrow (Klodbuster). Seedings should be mulched with a straw mulch at the rate of 2 tons per acre. Straw should be crimped in if possible or asphalt tack can be used.

A temporary sprinkler system should be considered for use in the revegetation of upland and riparian sites. This system should be put out at a low rate

(.2"/hr). Two months of watering with a total application of about 18" of water should result in establishment of the seeded species. If irrigation is to be used, seeding rates must be carefully controlled or stands will be too thick.

Woody species are to be transplanted in the early spring. Evergreen transplants must be watered on a biweekly schedule through July with a final watering in October. Deciduous transplants should be severely top pruned ($\frac{1}{2}$ to $\frac{2}{3}$ of top removed), watered in, and then watered on a monthly schedule. Monthly watering of transplants should continue to the second growing season. After the second growing season some watering of woody transplants in the riparian zone may have to be continued until the plants have tapped water in the capillary zone.

The soil materials will be deficient in nitrogen and phosphorous. Phosphorous applied at the rate of 400 pounds of triple super phosphate per acre and worked in should supply phosphorous as needed over a period of years. An initial application of 60 pounds of nitrogen is suggested, followed by maintenance applications as indicated by nitrogen application on test stripes.

Because of the unique nature of the Canyon it is suggested that only those species native to the area be used in rehabilitation work. The following are all species native to western Colorado.

Upland dry sites

A. Grasses (all mentioned can be drilled)

Indian ricegrass (*Oryzopsis hymenoides*) has a high percentage of dormant seed, thus fall seeding is much preferred. It is a bunch grass and the seed is usually commercially available. The seed source should come from as close to the site as possible.

Bluebunch wheat grass (*Agropyron spicatum*). Seed probably available if needs contracted for a year ahead of time. It is a bunch grass. Beardless wheat grass, (*Agropyron inerme*) commercially available, is probably also present in the Canyon and would make a less desirable substitute.

Streambank wheat grass (*Agropyron riparium*). Rhizomatous, the variety Sodar is available commercially.

Sand dropseed (*Sporobolus cryptandus*). This bunch grass has very small seeds and is commercially available.

B. Forbs

Rocky Mountain penstemon (*Penstemon strictus*) has been successfully seeded in similar area in Western Colorado.

C. Shrubs (listed in order of possible success in seeding. Only with special attachments can these species be drill seeded, and some can only be broadcast.)

Winterfat (*Eurotia lanata*). Small wooly shrub, seed must be contracted for from collectors.

Fourwing saltbrush (*Atriplex canescens*). Fair to poor success in dry land seedings, good success with irrigation. Seed commercially available and seed source should be from the area.

Big sagebrush (*Artemisia tridentata*). Limited success in dryland seedings. If sprinkled and a viable seed source is found, stands can be established. However, seedlings are very small and have difficulty competing with grass. Seedlings can be produced by horticultural techniques and transplanted. Seed must be contracted for from private collectors.

Rabbitbrush (*Chrysothamnus nauseosus*). Limited success in direct seeding. Can be produced by horticultural techniques and transplanted. Large yellow flower heads persist into the fall. Seed must be contracted for from collectors.

Skunkbush (*Rhus trilobata*). Suggest use of nursery grown plants. Commercially available and also available from the Colorado State Forest Nursery. Good fall color.

Mountain mahogany (*Cercocarpus montanus*). Limited direct seeding success. Commercially grown but probably must be contracted for in advance.

Utah juniper (*Juniperus utahensis*). Suggest use of nursery grown plants. Must be contracted for in Colorado; may be commercially available in states to the west.

Upland run-in sites (Suitable for areas receiving runoff from the road or large rocks).

A. Grasses (See Upland dry sites, A)

Slender wheat grass (*Agropyron trachycaulum*). Short-lived bunch grass. Seed sparingly if used (not over 2#/acre) as seedling vigor is greater than the other species recommended.

B. Forbs (See Upland dry sites, B)

C. Shrubs (See Upland dry sites, C)

Rocky Mountain sumac (*Rhus glabra*). Excellent fall color. Commercially available on contract.

Currant (*Ribes species*). Earliest deciduous shrub to leaf out. Species in the Canyon could be identified and produced commercially.

Rocky Mountain juniper (*Juniperus scopulorum*). Commercially available, also available from the State

Forest Nursery in 2" x 2" x 9" pots.

Pinon pine (*Pinus edulis*). Excellent ornamental, commercially available.

Gambel's oak (*Quercus gambelii*). Slow growing, commercially available on contract. A nucleus of plants should be started below the road.

Riparian zone

A. Grasses

Reed canarygrass (*Phalaris arundinacea*). Somewhat difficult to establish from seed. Strongly rhizomatous. Transplants readily to a moist site and should be available from local stands. Seed commercially available.

Streambank wheat grass. (See Upland dry sites, A)

Slender wheat grass. (See Upland run-in sites, A) Will provide ground cover until woody species dominate the site.

B. Shrubs and trees

Boxelder (*Acer negundo*). This locally abundant tree should be able to establish from seed by use of irrigation. Seedlings could be contracted for.

Willow (*Salix species*). Several to many species are probably present and could be commercially produced from cuttings made on-site. Can be transplanted from native stands. With irrigation could be produced on-site from cuttings.

Rose (*Rosa species*). Sprouts from dense native stands can be transplanted and can be produced commercially by contract.

Dogwood (*Cornus stolonifera*). Bright red stem, can be produced commercially. May be commercially available.

Chokecherry (*Prunus virginiana*). Tall shrub, can be produced commercially.

Buffaloberry (*Shepherdia argentea*). This large shrub with distinctive silver-gray foliage is locally abundant on some streams in western Colorado. Commercially available.

Virgin's bower (*Clematis ligusticifolia*). Woody vine which can be produced commercially. The gabions just west of the tunnel on the west end of the Canyon have been partially covered with a *Clematis*.

Woodbine or Virginia creeper (*Parthenocissus vitacea*). Woody vine, with excellent fall color.

Engleman spruce (*Picea englemannii*). Might be used on shaded exposures. Commercially available, also available from the Colorado State Forest Nursery in 2" x 2" x 9" pots.

ALTERNATIVES CONSIDERED

Alternatives Considered

The various alternatives studied for Interstate 70 included both plan alternatives (local variations in alignment and location of the recommended concept) and alternative concepts applicable throughout the project length. Each alternative was studied in sufficient depth to permit its evaluation or establish its validity as a possible solution for the design of Interstate 70 through Glenwood Canyon.

Plan Alternatives

Once the physical constraints limiting the location of the recommended concept sections were established, a 50-mile-per-hour design alignment was achievable along the north riverbank and only a few segments of the Canyon presented any real problems or viable alternatives. These were at the power plant, dam, Hanging Lake and Bookcliff areas.

The problems presented by the power plant and dam are of both an aesthetic and operational nature. Physically the plant and its facilities now intrude upon the Canyon and the effects its purchase and removal would have on the interstate highway were evaluated. It was determined that except for a moderate improvement in alignment no other benefits would accrue to the highway itself. The location of the recommended design concept is virtually unaffected by the plant's presence. Any decision to improve the Canyon's aesthetics by purchasing the power company must be made on its own merits independent of the highway's location. It should be noted that the recommended parkway is elevated above many of the plant's most distracting features and should result in a more desirable view of the Canyon area.

In an effort to avoid the problems of clearance to the overhead cableways and access to the plant facilities during construction, the alternative of locating the eastbound roadway on the opposite bank adjacent to the railroad was considered at both the plant and dam

site. These have been rejected because of the more significant problems of construction adjacent to the railroad and in the river. It is also believed that the required river crossings would be visually obtrusive.

The segment of alignment at Hanging Lake with its severe reverse bend in the river presents the most difficult problem to the location of I-70. This area is one of the most scenic in the Canyon. The river widens into what seems a large lake with rock walls rising all about. In a desire to remove the highway's presence, a tunnel location was considered. But in providing access for the planned rest area, it is necessary to cross over and retain a portion of existing Route 6. An evaluation indicated that the tunnel is not a desirable solution. The visual impact caused by the elevated highway as it enters the tunnel would be imposing when viewed from the river area. In addition, considerable cutting of the Canyon wall would be required at the east portal of the 1000-foot long tunnel.

Another tunnel was considered at a location just east of Hanging Lake through the protruding cliff at Bookcliff. The roadway approaching the tunnel would require almost no cutting of the rock and the alignment would be slightly improved. However, a tunnel is not recommended since the location around the cliff provides a satisfactory alignment.

Alternative Concepts

Results of earlier studies and comments made at the public hearing have focused the project alternatives to a four-lane 50-mile-per-hour facility built to interstate standards. Within the boundaries of this general criteria all reasonable design concepts were reviewed and evaluated. The advantages and disadvantages of each, as compared to the recommended parkway/truckway concept, are listed for each alternative.

Rim Alternative

Prompted by a desire to remove through traffic from the Canyon floor, many concerned individuals have suggested a so-called "rim" alternative or "autostrada" which derives its name from the spectacular highway through the Italian Alps. This concept does not have the same validity as it did in Europe, however, since it is not possible to reach the Canyon's rim from the project's beginning. An "autostrada" generally implies the crossing of canyons and gorges rather than paralleling and ascending along their faces as would be the case in Glenwood Canyon. Most significantly, we believe the concept fails to achieve the two principle objectives conferred upon it by its supporters.

The "rim" alternative will attract mostly commercial traffic and the through traveler bent on his destination, but since almost 60 percent of the traffic using this portion of I-70 is making the trip for a recreation purpose it is likely that this traveler would choose to bypass the "rim" route. By remaining on the existing road through the Canyon, the leisurely traveler could include this scenic route on his recreational itinerary. The objective of removing traffic from the Canyon's floor would probably not be met with this alternative and, as a by-pass for commercial traffic, the steep grades needed to climb toward the rim would be most unsatisfactory. As pictured below, it would take five miles at the maximum grade of five percent to reach elevation 7,000' (far below the rim's average elevation), climbing from existing I-70 at the No Name inter-

change. This is an excessive grade for commercial vehicles, both in ascent and descent. After less than a mile the speed of large trucks would drop below 15 mph to a crawling speed for the remainder of the climb and, for safety reasons, would require auxiliary climbing lanes. Winter conditions on such a rim alternative would be questionably safe and operationally unsatisfactory. This alternative would not provide adequate service as an interstate route.

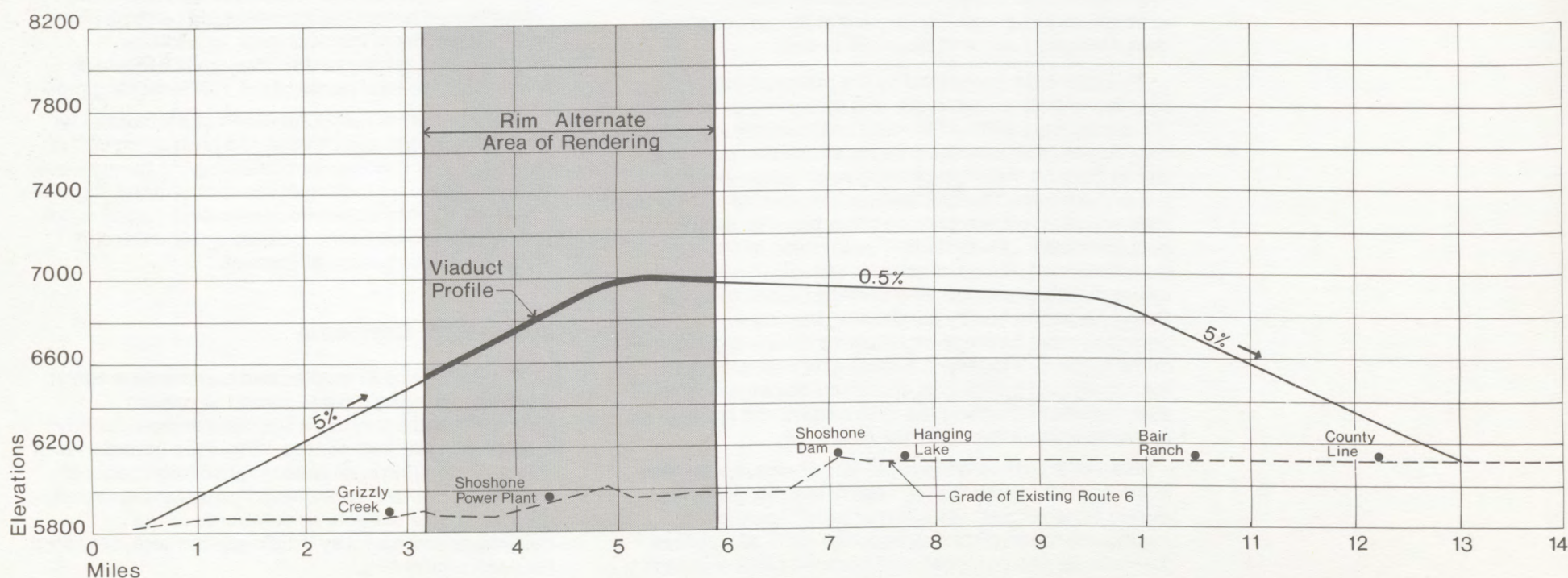
Architecturally the viaduct carrying the roadways above the Canyon floor can be handsome and attractive. But, as depicted opposite, it will also be a most imposing work of man and totally in conflict with the natural grandeur of the Canyon.

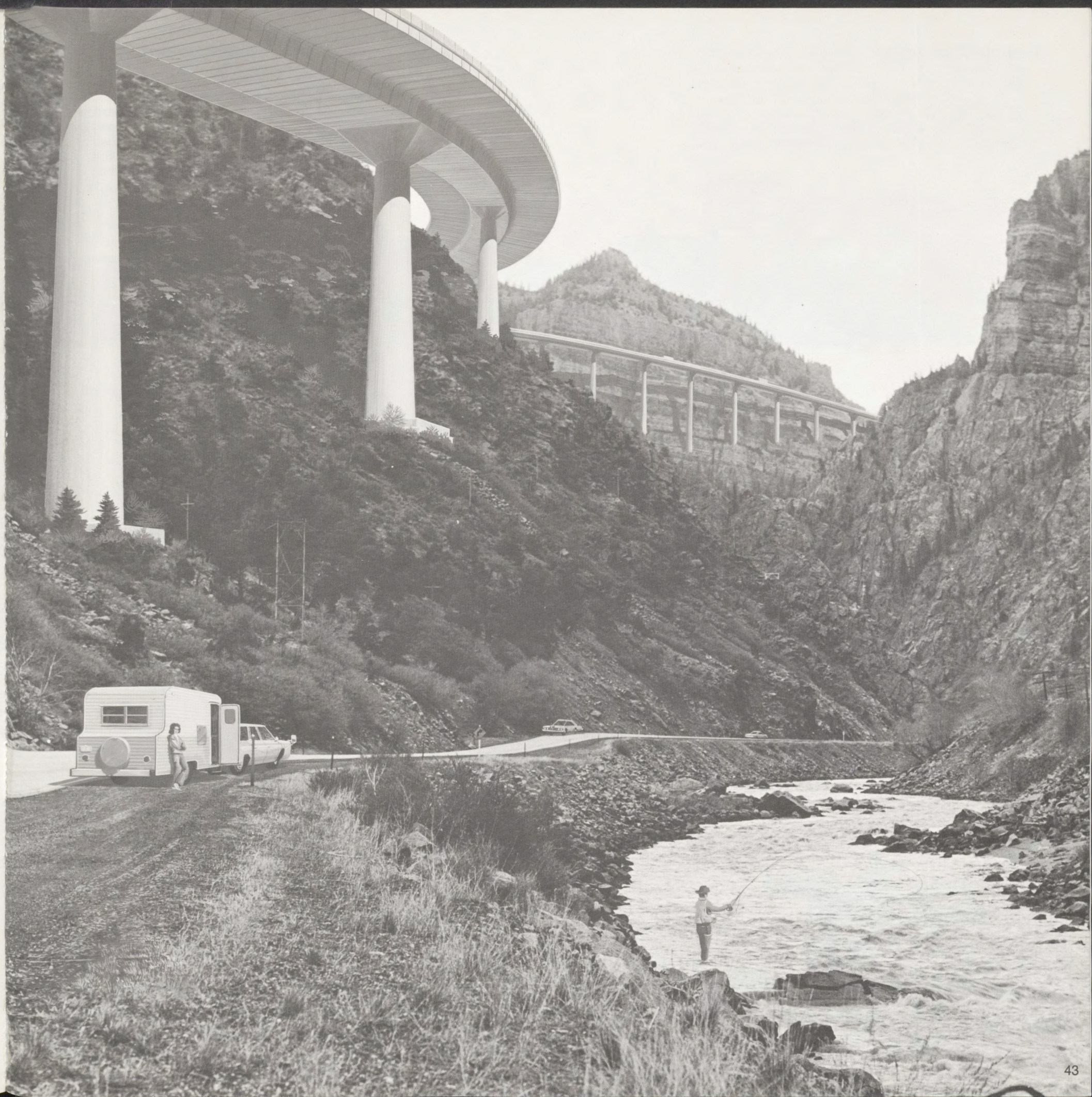
Advantages

- Separates through traffic from recreational traffic
- Attracts trucks, thereby lessening noise along Canyon floor
- Easy maintenance of traffic during construction

Disadvantages

- Does not remove substantial amounts of traffic from Canyon floor
- Visually obtrusive
- Construction of piers would cause substantial physical damage to Canyon walls
- Excessive grades adversely affect safety and operations
- Costly





Terrace Alternative

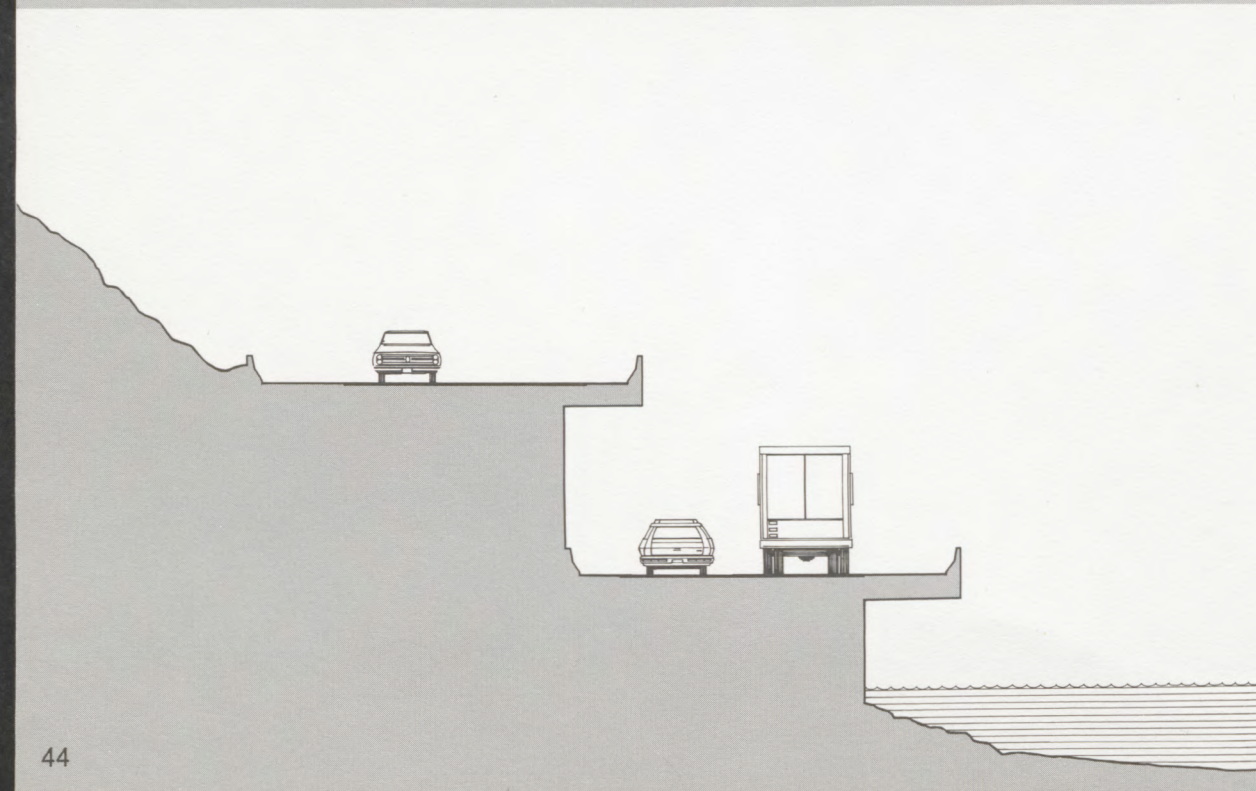
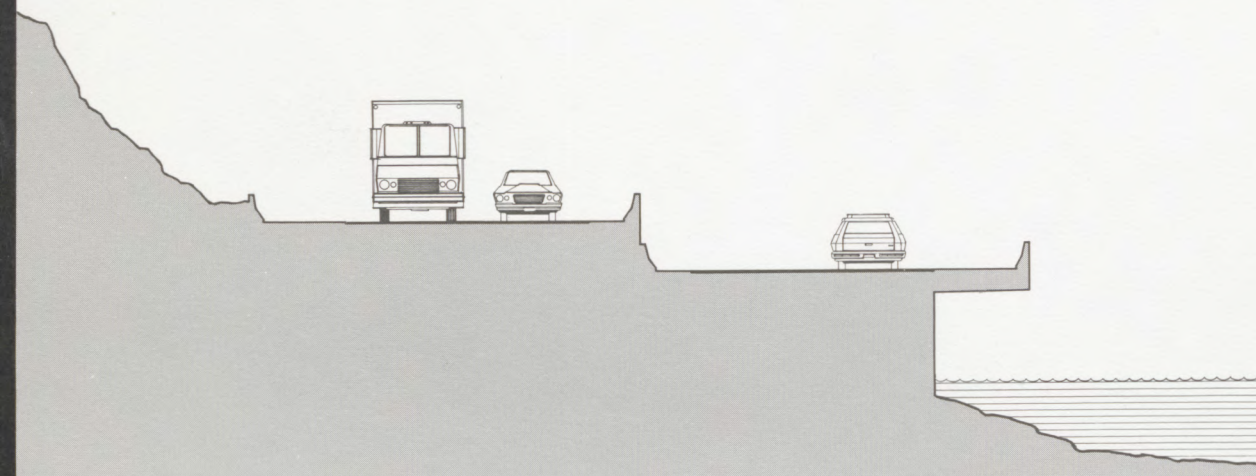
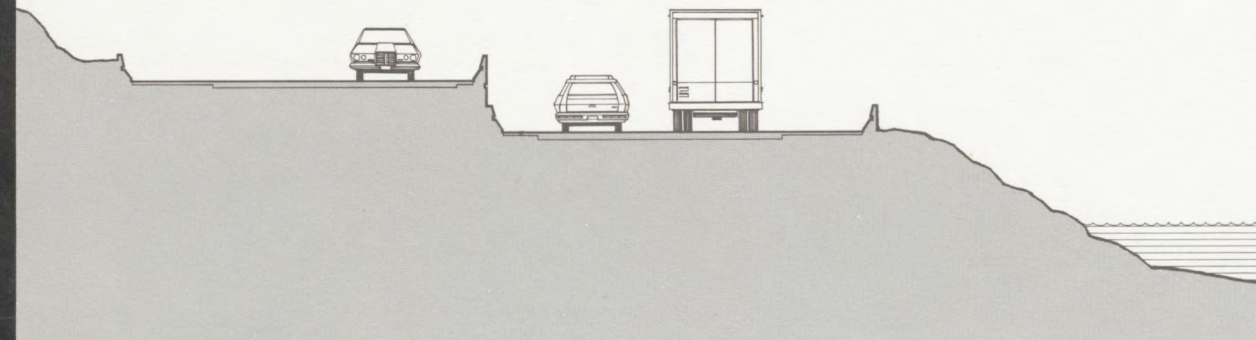
The terrace section applied throughout the Canyon was thoroughly studied as a possible alternative concept. Operationally it is a more conventional solution and is recommended in the less constricted portions of the Canyon. When applied in the narrower portions, it requires extending the lower roadway over the river for considerable distances. Sections which cantilever the upper over the lower roadway, and viaducts and tunnels are also required at specific locations to contain the concept within the Canyon's physical constraints.

Advantages

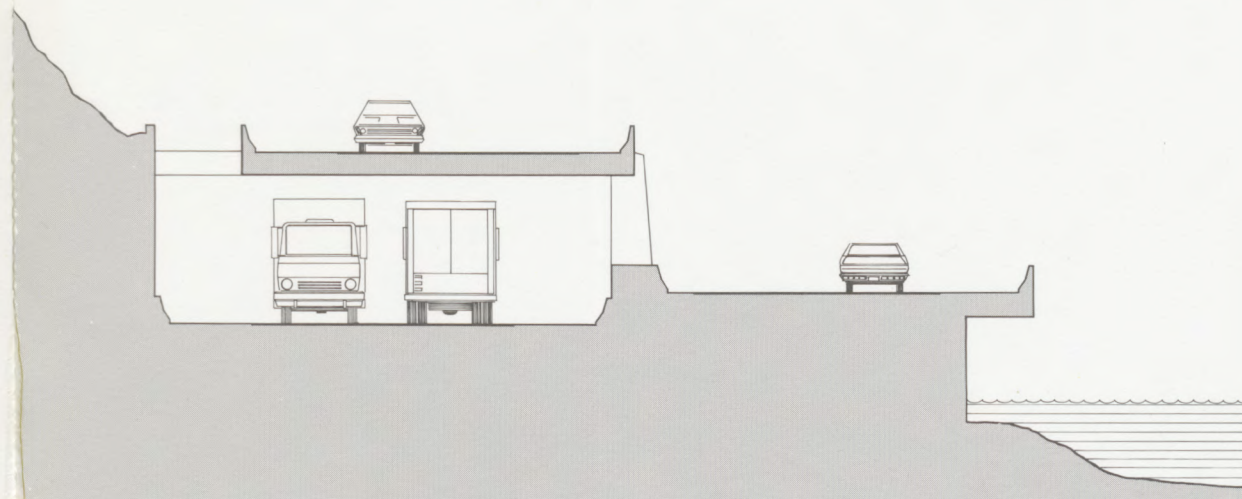
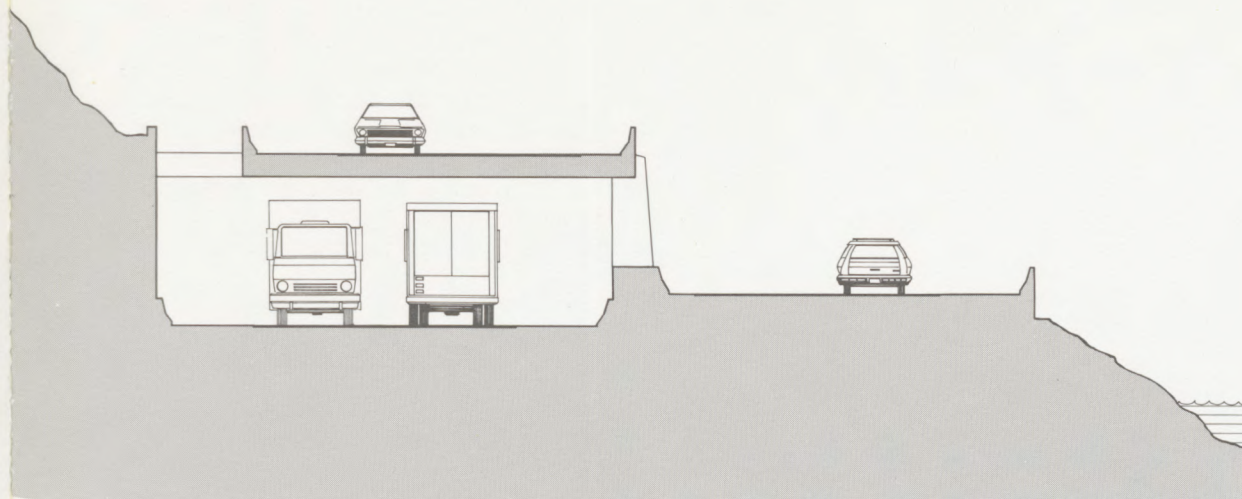
- Conventional operation of 4-lane divided highway
- Easier maintenance of traffic during construction
- Less costly

Disadvantages

- Commercial and passenger traffic are not separated
- Truck noise is not confined
- Views are interrupted by trucks
- Structural overhangs are visually intrusive
- Tunnel approaches require cutting of Canyon walls



Terrace/Truckway Alternative



A design concept combining the benefits of conventional operation of the terrace section and the separate truck roadway of the parkway/truckway was investigated. Since overall width of this section cannot be reduced by cantilevering over the lower roadway, as is possible with the terrace section, it encroaches substantially on the river and Canyon slopes.

Advantages

- Conventional operation of 4-lane divided highway
- Easier maintenance of traffic

Disadvantages

- Encroaches substantially on Canyon slopes and/or river in constricted areas
- More costly

Double Decked Alternative

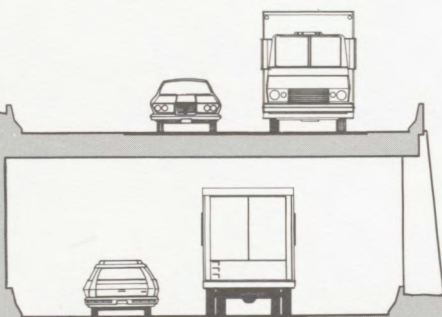
The traditional method of double decking the westbound roadway over the eastbound roadway was evaluated as a possible alternative. This sectional design concept, consisting of two lanes plus shoulders for each roadway, would be narrower than the parkway/truckway section, however, it would require 16'-6" clearance for the lower roadway, rather than the 14'-6" clearance of the parkway/truckway. Its location along the Canyon's base would be almost identical to the parkway/truckway section.

Advantages

- Conventional operation of 4-lane divided highway
- Occupies less width

Disadvantages

- Commercial and passenger traffic are not separated
- Truck noise from upper roadway is not confined
- Views from passenger cars on lower roadway are completely confined
- Views from passenger cars on upper roadway are interrupted by trucks
- Higher clearance requirement



South Bank Alternative

To reduce the impact and width required on the northern bank the possibility of locating the eastbound roadway on the south river bank adjacent to the railroad was analyzed. The eastbound roadway would cross the river just east of Grizzly Creek and continue along the south bank to a point east of Hanging Lake. This length is the narrowest portion of the Canyon. In this concept it is believed that the two river crossings on viaducts would be highly visible from both roadways as man-made structures crossing the Canyon.

Advantages

- Conventional operation of 4-lane divided highway
- Occupies less width on the north river bank
- Easier maintenance of highway traffic
- Less costly

Disadvantages

- Commercial and passenger traffic are not separated
- Truck noise is not confined
- Views are interrupted by trucks
- Major construction problems of building in water
- Major problems of maintaining uninterrupted railroad operations
- Visually obtrusive viaducts crossing the river



Westbound Roadway



Eastbound Roadway

D. & R. G. W.
RAILROAD

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