DRAFT REPORT

of

Kern River Canyon Highway Corridor Study State Route 178

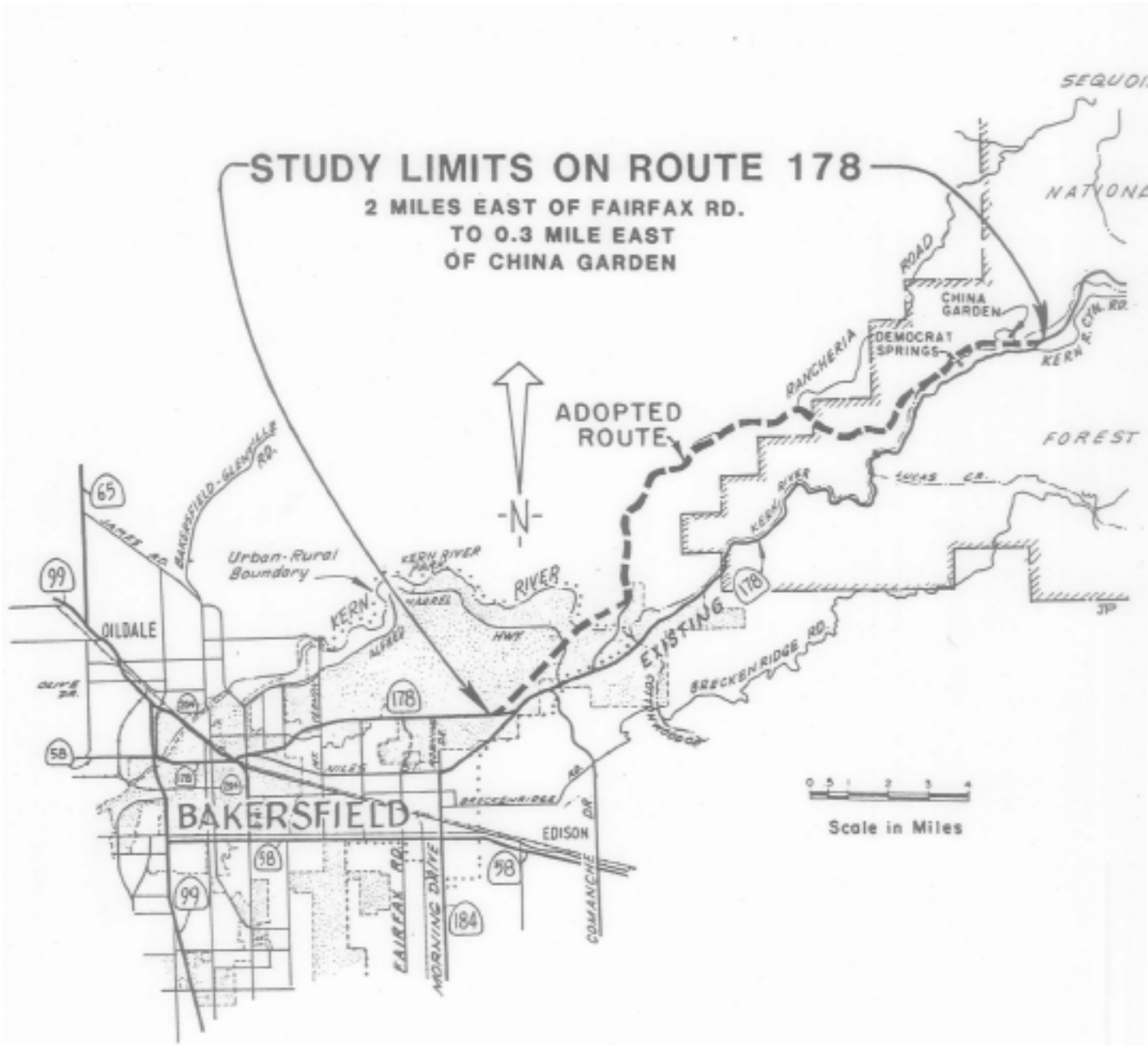
Joint Study By:

Kern County Council of Government Staff

Kakau Associates

Caltrans

September 1984


STUDY LIMITS ON ROUTE 178
2 MILES EAST OF FAIRFAX RD.
TO 0.3 MILE EAST
OF CHINA GARDEN
ADOPTED ROUTE
EXISTING
N
Urban-Rural Boundary
BAKERSFIELD
OILDALE
KERN RIVER
CHINA GARDEN
DEMOCRAT SPRINGS
RANCHERIA ROAD
BRECKENRIDGE RD.
FAIRFAX RD.
MORNING DRIVE
COMANCHE DR.
EDISON
Scale in Miles

6-Ker-178-R8.8/R30.6
06840-609310-30178
HE14 New Highways
2 miles east of Fairfax Rd. to 0.3 miles East China Garden. Federal Aid Primary/Secondary

PROJECT STUDY REPORT

PREFACE

In this report certain candidate highway projects are suggested for consideration both on the existing alignment and on a new alignment for a new highway facility. Prior to finalizing this report, Caltrans has determined that a reconnaissance geologic investigation must be conducted of all projects suggested in this report for consideration. This geologic study will be initiated by Caltrans geologists in the near future and the purpose of the study is to ensure that any proposed construction does not create geologic problems such as slides, slip outs and/or rock falls. Because of the high level of public interest in the Kern River Canyon highway corridor a draft report is being released prior to the completion of the geologic study. The final report will be made available to the Kern Council of Governments after the geologic investigation is completed and after the necessary adjustments are made to suggested projects and their related costs.

INTRODUCTION

As a result of road closures during the wet winter of 1982, a record rainfall year, there was a renewed interest on the part of elected officials and residents of the Lake Isabella - Kernville area in highway Route 178 between the mouth of the Kern River Canyon and 0.3 mile east of China Garden where it joins the existing expressway.

In June 1983, a petition signed by 1735 residents of the Isabella-Kernville area that asked for the completion of the adopted Route 178 freeway or the improvement of the existing highway along the Kern River, was presented to the Kern County Board of Supervisors. As a result of public and elected officials' concerns, discussions about the development and evaluation of feasible alternatives within the Route 178 corridor on the twenty two-mile section between 2.0 miles east of Fairfax Road and 0.3 miles east of China Garden were held between Caltrans and Kern County Council of Governments (Kern COG) in the summer and fall of 1983.

Subsequently, Caltrans agreed to undertake a cooperative study with Kern COG to investigate and evaluate alternative improvements within the Route 178 corridor. It was agreed that Kern COG would retain a consultant to collect data relative to growth, develop traffic forecasts, evaluate alternatives, examine financial resources and draft a final report. Caltrans agreed to evaluate the original project report data and to analyze other alternatives, including improving the existing route.

In addition, a Citizens Advisory Committee composed of residents from the Lake Isabella area appointed by Kern C.O.G. and a Technical Advisory Committee, made up of representatives from Kern C.O.G., Kern C.O.G. Consultant, Kern County,Sequoia National Forest, and Caltrans were set up to provide input into the study and to monitor its progress.

Three meetings were held with the Isabella Citizens Advisory Committee and 4 meetings were held with the Technical Advisory Committee. A briefing of elected public officials and candidates was held on July 12, and a Public Meeting at Isabella was held on July 17.

A major slide that closed the highway occurred near the mouth of the canyon on May 18, **1984.** It was not possible to reopen the highway to traffic until August 24, 1984. The magnitude of the debris was not the primary problem in this long road closure. The primary problem was an unstable vertical rock face which required stabilization through selective blasting and benching. The extensive road closure has had a substantial adverse economic impact on the entire Lake Isabella/Kernville area. An attempt was made to obtain some indication as to degree of economic impacts from the Franchise Tax Board. However, the attempt was unsuccessful since Lake Isabella is an unincorporated area. There seems to be little question that the economic loss was significant, and there are further indicators that real estate sales have declined during the summer months of the road closure. During the road closure there was also a large forest fire which destroyed 25,000 thousand acres. After the forest fire there was major rainfall and flooding in the Lake Isabella region and easterly of Lake Isabella in which there were some additional road closures on Route 178. Because of the combination of episodes, the Kern River Valley area was declared a "State of Emergency" by the Governor on July 31, 1984. The Kern County Board of Supervisors, by resolution (copy attached) further requested the Governor "to initiate those actions which will cause the immediate repair and reopening of State Route 178, through the Kern Canyon Area, and to commit all funds necessary for the completion of the uncompleted freeway

Over 400 people attended the public briefing that was held on June 17 in Lake Isabella. Because of the extensive road closure and the other major episodes that occurred, there was near unanimous support for a new highway facility.

HISTORICAL BACKGROUND

In 1960 the California Highway Commission adopted a location and declared Route 178 a freeway between 4.0 miles east of Mt. Vernon Avenue and 1.0 mile northeasterly of the junction with Route 155 at Isabella.

A freeway agreement was executed with Kern County in 1965 covering the ultimate freeway development from Democrat Springs to 1.0 mile N.E. of the junction of Route 155, R28.7/R43.9. A freeway agreement has not been executed for the remaining portion between 4 miles east of Mt. Vernon Avenue (2.0 miles east of Fairfax Road) and Democrat Springs.

In 1966 the U. S. Forest Service executed a Highway Easement Deed and approved the right of way appropriation for the adopted alignment within the Sequoia National Forest. The right of way outside the National Forest has not been acquired.

At the west end of the study, the 2-lane expressway section was completed in 1971. At the east end, the 13.6 mile 4-lane expressway/freeway section between 0.3 mile east of China Garden and Isabella was completed in 1974 at a cost of $15.8 million. This project was financed in part by a $3 million grant of Federal Economic Growth Center Funds.

Within the Kern River Canyon, the construction of the existing 2-lane conventional highway between Cottonwood Creek and Democrat Springs began in 1922 and was completed almost nine years later in 1931.

At the time of the 1974 Planning Program all major construction projects on adopted Route 178 were dropped from the program because of financial constraints. In subsequent planning programs only safety improvement projects on the existing highway have been programmed.

Route 178 is a Federal-Aid Primary route and is a principal arterial within the Bakersfield Urbanized Area and a minor arterial in the rural area. The Bakersfield city limit extends to just east of the mouth of the Kern River Canyon.

This route serves some commute traffic from the Isabella-Kernville area to Bakersfield but primarily serves recreational traffic on weekends, holidays, and during the summer months.

PROBLEM IDENTIFICATION

The problem area is a 15 mile section of the existing highway between the mouth of Kern River Canyon and its junction with the existing expressway 0.3 mile east of China Garden. This section of highway follows the Kern River through the steep-walled Kern River Canyon. The paved width of roadbed that has been carved out of the side of the canyon varies in width from 18-24 feet with no shoulder areas. Turnouts have been designated wherever possible to allow slow vehicles to pull off the roadway to permit passing. On the river side, slopes drop sharply to the water's edge. It has been necessary to construct crib walls in several locations to provide support for the roadbed. There are three viaduct bridges just inside the canyon's mouth. The south side of the canyon is either a vertical or overhanging rock wall or a steep unstable side slope covered with scattered large rocks. Sight distance within the canyon is limited to 65 percent and average speeds are 35 MPH. Both the accident rate of 5.63 per Million Vehicle Miles and Fatality + Injury rate of 3.20 per Million Vehicle Miles is nearly two times the state wide average for comparable facilities.

Because of rock falls and slides within the Kern River Canyon, Route 178 is closed to traffic several times a year. During the unusually wet winter of 1982 Route 178 was closed 12 times. Route 178 is not alone in this as many other state highways also experienced an unusual number of closures at this same time. The attached print of Exhibit "F" and "G" show the total closure times and average closure times since 1950.

As previously indicated, the existing highway was closed on May 18, 1984 as the result of a slide and an unstable vertical rock face and not reopened until the last week of August. This is the second major episode that has occurred **in** the Kern River Canyon which has resulted in extensive closures far in excess of the normal winter closures. The first major episode was an earthquake on the

White Wolf Fault that occurred in 1952. Kern River Canyon was closed 59.5 days as a result of this major episode. While both episodes have had a substantial detrimental effect on the Lake Isabella area, there appears to be no scientific way to predict or even estimate the probability or the timing of another such major incident.

There are three alternative routes to Lake Isabella from Bakersfield. These are:

- From the north via the Glennville Road and Route 155 over Greenhorn Summit, a length of approximately 60 miles and a driving time of approximately 2 hours.

- From the south via Route 58 and Caliente Road, a length of approximately 58 miles and a driving time of approximately 2 hrs.

- From the east via State Routes 58, 14 and 178, a length of approximately 140 miles and a driving time of approximately 2 hours and 45 minutes.

The existing route takes approximately 1 hour to drive between Bakersfield and Isabella.

TRAFFIC DATA

- Two miles east of Fairfax Road to mouth of the Kern Canyon.

  The current average daily traffic (ADT) volume on this segment is 3250. A significant increase in this volume is expected to occur if the proposed Rio Bravo development of 13,830 acres becomes a reality. The present highway is operating at a B50 level of service. ("Level of Service" is a technical term used in classifying different types of traffic congestion. Thus "B50 level of service" denotes a stable flow of traffic traveling at 50 miles per hour during the peak hour of traffic flow.)

- Mouth of Kern Canyon to 0.3 mile east of China Garden.

  .The current average daily traffic volumes range from 3250 at the mouth of the canyon to 3050 at 0.3 mile east of China Garden. In 20 years the average daily traffic **in** the canyon portion is expected to be 6,330. (See attached Exhibit "H" working paper - Travel Demand Forecasts Dated May, 1984 prepared by Kaku Associates, Kern COG consultants.)

Because of the recreational nature of Route 178 holiday traffic volumes are typically higher than any other day in the year. In 1983 in the Canyon section of Route 178 the daily traffic for Memorial Day was 8,810, for Independence Day was 6,480 and for Labor Day was 7,620.

The present highway is currently operating at its target level of service of D35 along the Kern River Canyon. ("035 level of service" is a technical term used in classifying different types of traffic congestion. Thus "D35 level of service" denotes traffic that is approaching unstable flow traveling at 35 miles per hour during the peak hour of traffic flow.) According to the traffic volumes projected by the consultant, the capacity on the Kern River Canyon portion will be exceeded within 20 years.

ACCIDENT AND SEVERITY RATES

The most recent three-year accident rate per million vehicle miles (MVM) and the severity rate (Fatality + Injury) per million vehicle miles for the two sections within the study limit and for the completed 4-lane expressway/freeway section from China Garden Road to Isabella are compared below to the statewide (SWA) average for a comparable facility.

	Accident Rate (MVM)		Severity Rate (MVM)	
	This Section	SWA	'Nis Section	SWA
2.0 miles east of Fairfax Road to mouth of Kern River Canyon	2.91	2.74	1.13	1.25
Mouth of Kern River Canyon to China Garden	5.63	2.95	3.28	1.59
China Garden to Isabella	0.74	1.00	0.49	0.47

Seventeen fatal accidents have occurred in the Canyon since 1978. Ten of the 17 fatal accidents occurred after dark, 7 of the 17 fatal accidents had been drinking, 5 of the 17 fatal accidents were speeding, 15 of the 17 fatal accidents ran off the road, 11 of the 17 fatal accidents hit an object, 10 of the 17 fatal accidents were passenger cars and 5 of the 17 fatal accidents were motorcycles.

An analysis was made on the accident trends for the past 10-year period. As indicated on Exhibit I, the 3-year accident rate has declined from 9.25 accidents per million vehicle miles (for the 3-year time frame 1975/1977) to an accident rate of 5.64 for the past three years. This decline in accident rate is in part accountable for by the safety improvements that have been made in previous years.

ALTERNATIVES

A wide range of alternatives, including the original alternatives examined during the route adoption process, were looked at in this joint study effort. The alternatives that were given consideration in the 1960's route adoption process are shown on Exhibit "A". A reevaluation of these alternatives strongly indicated that the most cost effective alternative that best served the long range transportation needs of the Lake Isabella area was the alternative which was adopted.

A portion of the adopted freeway between Lake Isabella and 0.3 mile east of China Garden (a length of 13.6 miles) was constructed in 1974. The actual cost of constructing this portion of the adopted route was $15.8 million. The current dollar value of that construction is estimated at $42.7 million.

To consider any of the other alternatives developed during the route adoption process would require the abandonment of that portion now completed and the development of an entire new route. Since reevaluation indicated that the other alternatives were not originally cost effective, they would be much less cost effective today because the constructed portion of the adopted alignment would have to be abandoned.

The study team examined the possibility of making some alignment modifications to the adopted alignment in an attempt to determine if there were lower cost construction options. Because of the rugged terrain and mountainous topography, it was determined that the adopted alignment, while very costly, is still the most economical if a new facility is to be constructed.

A member of the Citizens Advisory Committee, suggested a change in the alignment of the adopted route that would start near Saturday Peak and would continue along the north side of the Kern River Canyon until it joins the existing expressway at Delonegha Hot Springs (see attached Exhibit "D"). This alignment would require one less bridge over the Kern River but it is longer than the adopted alignment and would add approximately $5.8 million to the project's cost. In addition, almost two miles of the completed 4-lane section, including a Kern River bridge, would be abandoned by this alternative.

At the suggestion of the consultant, Caltrans undertook an evaluation to determine if the existing facility could be widened on its present alignment to a 4-lane highway. With very steep mountains to the south of the existing highway and the river on the north side, the type of 4-lane facility and its alignment are totally restricted. A 4-lane widening would basically have to follow the existing alignment. The maximum design speed with these constraints would be 45 miles per hour. This alternative was eliminated from further consideration because it is impractical, if not impossible, to construct. The construction of 4 lanes would require extremely heavy grading in mountainous terrain and it would be impossible to construct detours. Routing traffic through this type of construction is not possible. Routing traffic over any one of the three alternative routes between Bakersfield and Lake Isabella would be an undue hardship to the community and is unacceptable to everyone concerned.

The study indicates that there are only two realistic options that warrant consideration. These options are:

- Improve the existing highway to the maximum extent practical in order to improve safety conditions and operational characteristics.

- Complete the unconstructed portion of the adopted alignment from two miles east of Fairfax Road to 0.3 miles east of China Garden.

CONSTRUCTION PROPOSED FOR THE FINAL TWO ALTERNATIVES

Improve the Existing Highway to the Maximum Extent Practical

The maximum improvements that could be practically undertaken on the existing highway are restricted by the following considerations:

- The mountains along the existing highway prevents massive cuts.

- Since traffic must be handled through construction, the total amount of grading and/or blasting must be minimized so the time delay to traffic is within reasonable and acceptable levels to the traveling public.

- Since the existing highway is adjacent to the Kern River, an aesthetic recreation area, there are some environmental limitations also as to the impact of projects that are acceptable.

The improvements proposed under this option which are considered to be the maximum practical are shown on Exhibit "C" and are as follows:

- Safety improvement at 14 spot locations which would flatten curves and widen the highway to a width of 28 feet. These 14 locations have been identified as having an accident rate higher than expected. Six of these projects are in Caltrans' current 5-year program. The remaining 8 projects would be programmed for funding in future State Transportation Improvement Programs. These 14 spot location improvements would have a total combined construction length of approximately 4.1 miles, and the total cost in 1990 dollars is estimated at $7.9 million.

- Improve the horizontal alignment and widen the existing highway to 28 feet on a 3.2 mile section near China Garden. This improvement would provide for a design standard of 40 to 45 mph which would improve the current 25 mph design standard on the existing highway. The cost of this improvement is estimated at $7.1 million, in 1990 dollars.

- Provide for a passing lane approximately 0.5 mile in length for eastbound traffic near Richbar Campground. The estimated cost of this improvement is $1.4 million, in 1990 dollars.

- Improve the remaining 6.9 miles with rehabilitation/surfacing projects as the need occurs. Resurfacing needs are identified on a continuing basis when there is sufficient cracking of the existing pavement and when the pavement begins to ride rough. Once a resurfacing need is identified and a project programmed, the design can include some shoulder widening where the terrain and geologic conditions will allow. It should be emphasized that restoration projects can **only be** programmed as pavement structural deficiencies occur.

Complete the Unconstructed Portion of the Adopted Route from two miles east of Fairfax Road to 0.3 miles east of China Garden.

This alternative will provide for the construction of a new highway facility on the adopted alignment. The alignment adopted by the California Highway Commission in 1960 is shown on attached Exhibit "B". The exact location is not precisely controlled outside of the Sequoia National Forest. Some modifications can be made to the alignment **in** this segment in order to achieve the most economical design if this project is programmed at some future date and design is undertaken. Within the Sequoia National Forest the alignment has been set and is controlled by a Highway Easement Deed issued by the U. S. Forest Service. Three types of facilities that could be constructed on the adopted alignment are as follows:

o Construct a 2-lane controlled access highway facility for the entire 22-mile unconstructed segment. Since the adopted alignment traverses mountainous, rugged terrain, this facility would have many miles striped as "No Passing". There would also be substantial lengths of 6 percent grade. Constructing the cuts and embankments only for a 2-lane roadway would restrict future expansion. Construction costs and traffic delay costs would prohibit the additional grading necessary to widen this facility to **4 lanes in** the future. The cost of constructing a 2-lane highway on the adopted alignment is estimated to be $85.3 million in 1990 dollars.

o Construct a 2-lane controlled access highway on 4-lane graded roadbed. This proposal would have considerable lengths of "No Passing" areas and there would be substantial lengths of 6 percent grade. Since the grading would be completed for a 4-lane highway, some passing lanes could be provided at an additional cost. This alternative would allow, at some future date, the paving of an additional 2 lanes to provide a future 4 lane highway facility. The estimated cost of this construction option is $101.5 million in 1990 dollars.

o Construct a 4-lane controlled access highway for the entire 22-mile unconstructed segment. This facility would be a 4-lane divided highway from 2 miles east of Fairfax Road to Rancheria Road and 60' all paved. highway from Rancheria Road to 0.3 mile east of China Garden. It is estimated that this facility would cost $113.1 million in 1990 dollars.

Any of these three construction options, from a technical point of view, could be constructed in three separate stages. The three stages in which these could be built are shown on Exhibit "B" and are described below as follows:

o Stage 1 would provide for constructing that segment from 0.25 mile west of Willow Springs Creek to 0.3 mile east of China Garden. It would be connected to the existing highway by constructing a temporary connection across the Kern River. The total length of this segment would be 3.3 miles.

o Stage 2 would provide for that section from Rancheria Road to 0.25 mile west of Willow Springs Creek. This segment would be connected to the existing highway via Rancheria Road. The total length of this segment is 13.1 miles.

o Stage 3 would provide for the construction of the remaining portion from 2 miles east of Fairfax Road to Rancheria Road. The total length of this third stage is 5.9 miles.

To construct the adopted route in segments would cost considerably more money because each segment would require a temporary connection and a new bridge across the Kern River to the existing highway. The total cost for each of the three construction options by stages is shown on Exhibit "E".

EVALUATION OF THE FINAL TWO ALTERNATIVES

It is important to recognize that the final two alternatives are future financial options. The extent to which either can be completed in any given time frame, if one alternative is chosen over the other, would be totally dependent upon the availability of State highway funds and on the economic justification of the expenditure of these funds. The following evaluation is intended to be a technical evaluation of what each evaluation accomplishes in terms of operating, safety, and maintenance characteristics. Each alternative is evaluated based upon its own merits, and no attempt has been made to compare one alternative against the other.

Evaluation of Improving the Existing Highway to the Maximum Extent Practical

As previously indicated, this alternative would provide for the construction of spot safety improvements at 14 locations, 3.2 miles of improved horizontal alignment, one passing lane, and resurfacing and widening projects as needs occur. The evaluation of this alternative is as follows:

- It is anticipated that accidents would be reduced 40 to 50 percent at locations where improvements are made for the 14 spot locations previously identified. Reducing accidents by 40 to 50 percent at these highway locations would reduce the total accident rating on the existing highway segment by 15 to 20 percent.

- Improving the 3.2 mile section near China Garden would improve the operating speed on this segment by approximately 15 mph.

- The one proposed passing lane would provide an additional passing opportunity that does not exist now.

- Under this option, the total miles of highway maintained with public funds would remain the same.

- When the need for restoration/resurfacing projects occurs, some shoulder widening would be provided, where possible, in the design for these projects. When these projects are completed, the additional widening would provide for some increased comfort level in driving this section of highway.

While this alternative provides for some improvement to the existing highway, it does not accomplish any improvements, or only marginal improvements, in the following areas:

- The total capacity of a highway improved to the level as proposed in this alternative would not substantially increase the total vehicular capacity of the existing highway. The existing highway, however, has an average daily traffic of only 3,250, which is a low traffic volume.

- The total travel time under this alternative would only be very slightly improved.

- The proposed improvements would not alter the rockfall, slide, or slipout problems that have occurred in the past. It would therefore be anticipated that these types of problems would continue to occur in the future under this option.

Evaluation of the Unconstructed Portion of the Adopted Alignment from two Miles East of Fairfax Road to 0.3 mile East of China Garden

As previously indicated, there are three construction options as to type of highway constructed on the adopted alignment. These construction options are:

- Construct a 2-lane highway
- Construct a 2-lane highway on 4-lane graded roadbed
- Construct a 4-lane highway

Since each of the construction proposals has different operational characteristics, each is described separately in the following evaluation:

Accidents

o Construct a 2-lane highway.

On the new 2-lane highway we have an anticipated accident rate of 1.80 accidents per million vehicle miles as compared to the 3-year average accident rate on the existing highway of 5.63 accidents per million vehicle miles.

o Construct 2 lanes of paving on 4-lane graded roadbed.

A new 2-lane highway with a 4 lane graded roadbed would have the same accident rate as anticipated above; i. e., accident rate of 1.80 accidents per million vehicle miles as compared to a 3-year average accident rate of 5.63 accidents per million vehicle miles on the existing highway.

o Construct 4 lanes.

A new 4-lane facility would have an anticipated accident rate of 1.00 accidents per million vehicle miles as compared to a 3-year average accident rate of 5.63 accidents per million vehicle miles on the existing highway.

Operating Speeds

o Construct a 2-lane facility.

It is estimated that 20 to 30 percent of a new 2-lane roadway on the adopted alignment would be striped "No Passing" because of the vertical and horizontal sight restrictions. Therefore, the average operating speed on this facility is estimated at 45 mph as compared to an average operating speed of 35 mph on the existing highway in the canyon. The total time saved per trip on the adopted alignment is estimated at 9 minutes as compared to traveling the existing alignment.

o Construct 2 lanes of paving on a 4-lane graded roadbed.

The operating speed characteristics will be the same for this option as for the 2-lane option.

- Construct 4 lanes.

  This facility would operate at an average speed of 50 to 55 mph as compared to the existing operating speed of 35 mph. This would result in a time savings of approximately 13 minutes per trip.

Capacity

- Construct a 2-lane facility.

  This facility would. operate at a C45 level of service for a 20-year period.

- Construct 2 lanes of paving on a 4-lane graded roadbed.

  This facility would operate at a C45 level of service for a 20-year time period.

- Construct 4 lanes.

  This facility would operate at a B50 level of service for a 20-year time period.

Maintenance

- If a new highway facility is constructed on new alignment the existing highway will be relinquished to the County of Kern. The County of Kern, through negotiations with the Forest Service, might be able to abandon portions of the existing highway within the Forest boundary if it does not serve private property. It is anticipated that at least 6 miles (and perhaps more) will have to be maintained with public funds by Kern County. Since most of the traffic would be diverted from the existing to the adopted alignment, the level of maintenance service could be less than the State now provides on the existing highway. Nevertheless, a minimum of 6 miles of the existing highway would still have to be maintained with public funds.

The current cost of **maintaining** the relatively new completed 4-lane portion is approximately equal to the cost of maintaining the existing highway in the canyon on a per mile basis. The length of the incomplete portion of the adopted highway is slightly over 22 miles, and the length of the existing highway is also approximately 22 miles. Assuming only 6 miles of the existing highway that is relinquished to Kern County needs to be maintained (i. e., the remaining 16 miles can be abandoned), then the total length of highway that will require maintenance by public funds would be 28 miles. The total increase in the miles of highway that would be maintained is approximately 27 percent. Therefore, the total expenditure of public funds would increase proportionately to this direct increase of total miles of highway maintained.

Staging

As previously indicated, the construction of the adopted alignment could be done in stages. In addition to the additional cost which would be incurred in constructing connections back to the existing highway, there are other issues involved:

- The temporary connection connecting Stage 1 back to the existing highway would have an 8 percent grade and a sharp, low-speed curve at both the points where the connection leaves the adopted alignment and where it connects to the existing highway.

- The most logical sequence of constructing stages would be to construct Stage 1 first, which is that segment from 0.25 mile west of Willow Springs Creek to 0,3 mile east of China Garden. This segment in itself would cost approximately $26.6 million (1990 dollars for two lanes paved on 4-lane grading). The total length is only 3.3 miles. Construction of this phase would not eliminate the area where the highest accident rates are occurring and where there is the greatest potential for future major slide episodes or normal winter closures. Therefore, construction of Phase 1 would not eliminate the potential for additional maintenance cost nor would it eliminate the need for substantial expenditures for safety improvements in the worst part of the canyon area.

- If the adopted alignment should be constructed in stages, there is the potential issue as to who would retain maintenance responsibility for the temporary connections.

Cost Effectiveness

To evaluate how cost effective any proposed solution would be, a series of factors must be considered. First, there must be an analysis made of all the deficiencies on the existing highway and the magnitude of these deficiencies. As previously indicated in the report, the deficiencies of the existing highway and the magnitude are summarized below:

- The 3-year average accident rate from the mouth of the canyon to China Garden is 5.63 which is slightly less than twice the statewide average that could be anticipated on a similar highway. While this is a high accident rate, there are 264 other locations in the State which have even higher accident rates.

- The average daily traffic on this route is 3,250. This is a low volume as compared to other State highway routes in Kern County and as compared to other State highway routes in the State of California. It is recognized that during the Memorial Day, Fourth of July, and Labor Day weekends, etc., the traffic increases substantially, and the peak hour during these weekends is approximately 500 to 600 vehicles. During the average day and average weekend day, the peak hour volumes are significantly less, and congestion during these times is not a major problem.

- The average maintenance cost on the existing highway, even with some slides and minor rock falls during winter months, is still comparable with average maintenance cost of other State highway routes through mountainous terrain.

- There are times when the highway is closed due to rock falls and slides which isolates the Lake Isabella area from the Bakersfield area. These closures are unpredictable and result in direct costs to the public since a more circuitous route to Bakersfield must be used during these times. These closures are not unique to Route 178 and the Lake Isabella area as many other mountainous recreational routes are also closed from time to time due to winter snow conditions, washouts, etc. Such conditions also exist for the recreational areas of Mammoth Mountain, June Lake, and others.

- As previously indicated, there have been two major episodes which have resulted in extensive road closures. The first was the earthquake of 1952 and the second episode is the current slide and unstable vertical rock face. There are no technical or scientific means of predicting whether another major episode would occur or when such episode might occur.

The second phase of the cost effective analysis is to determine what is the most cost effective solution to the problems. For example, a new facility that could be built for a cost of $1 million per mile would be much more cost effective than building a new facility that cost $3 million per mile. Cost effectiveness, therefore, is a measure of what you accomplish in terms of accident savings to the public and in terms of reduced congestion in proportion to the cost of the proposed project.

In the specific case of Kern River Canyon the total cost of constructing a facility that would provide two lanes of paving on four lanes of grading would cost $101.5 million in 1990 dollars (if constructed as one unit and not staged). The length of constructing the adopted alignment is 22 miles which would give an average cost per mile of 4.6 million dollars per mile. This is a very high unit construction cost for a rural roadway that carries a relatively low traffic volume. A unit cost per mile of 4.6 milion dollars would be more typical of the construction cost of a suburban type project carrying several times more traffic volume.

The third phase of the cost effective analysis is to analyze the total cost and benefits that would be derived from an improvement on Route 178 as compared to the cost and benefits derived from other deficient highways in Kern County and in the State of California. This third process is commonly referred to as "Priority Setting", and the purpose is to determine what projects should be given the highest consideration for funding when there is not sufficient money to build all projects at one time.

Setting project priorities during the selection of projects for programming is undertaken both by Caltrans and regional planning agencies. The Regional Planning Agency in Kern County is the Kern County Council of Governments. Caltrans' method of establishing priorities is based on a very technical criteria which includes the traffic volume using the facility, the accident rate of existing facility, and the degree of public and elected official support for the project. Caltrans' priority setting process would not include a measurement of the economic loss to the community as a result of the current road closure. It is reemphasized once again, however, that there is no scientific method of predicting if or when another major episode would occur. As long as the existing highway can be kept open with only a minimum amount of closures, a rural project with a cost magnitude of over 100 million dollars would not be given a high priority.

The Regional Agencies also establish project priorities based on their own criteria and their perception of what is needed in their County. This process is extremely important as it allows tradeoff with other projects and it allows the mechanism by which a regional agency can plea their case to the California Transportation Commission. To date the Kern County Council of Governments has taken no position as to what priority they would give to the construction of a new highway facility in Kern River Canyon. The process of selecting projects for consideration is normally undertaken after the beginning of the calendar year.

Other Issues

If the adopted alignment should be constructed in segments there is an unresolved issue as to who assumes maintenance of the temporary connections that were constructed to connect the new alignment to the existing highway. Forest Service has indicated that they have no real interest or need to accept the maintenance of these facilities. It would be necessary to reach an agreement with Kern County for the acceptance of maintenance on these temporary facilities if such facilities should be constructed.

OVERVIEW OF THE POTENTIAL ENVIRONMENTAL IMPACTS

Assessing the potential environmental impacts of the alternatives under consideration is critical to determining the lead time necessary for delivering a project should funds become available for any of the options described in this report. The approach in this has been to develop an overview using existing information and documentation to begin studying the environmental aspects that are required under Federal rules to make use of Federal funds. To this end, extensive consultation has been undertaken with agencies having special expertise and knowledge of the area. In particular, extensive consultation took place with the U. S. Forest Service and Kern County due to their expert knowledge from previous land managing and planning studies.

There are a number of identified potential impacts on the natural and social environments for both of the highway alternatives being studied. However, it is important to point out that the "improve the existing alternative" would generally have significantly less potential for impacts on the environment than would the "adopted highway alignment" alternative. This is due to the lesser scale of improving the existing highway. As an example, the "improve the existing highway" alternative will involve the improvement of approximately 7.7 miles of highway with about 113 acres of new right of way and just under 3 million cubic yards of excavation. On the other hand, the "adopted alignment" alternative will involve the construction of over 22 miles of new highway taking over 900 acres of new right of way and approximately 7.6 million cubic yards of excavation.

While the actual depth of potential environmental impacts is difficult to fully assess based on an overview and lacking complete field studies, the following environmental considerations were identified and will require study if a project should emerge. These are discussed to the extent of our present knowledge for each of the alternatives.

Improve the Existing Highway Alternative

1. There will be short term impacts on air, noise, and water quality during construction. After construction water quality in the Kern River would be of particular concern due to the potential for erosion from new cut slopes.

2. There would be potential impacts on wildlife including rare and endangered species. The Kern River Canyon is classified as an important winter range for deer but not as a key habitat. This alignment is also in the normal range limits of the mountain lion and bear (in addition to smaller mammals and birds). The following rare and rare and endangered species may also be affected: a) San Joaquin Kit Fox; b) California Condor; c) Mojave Ground Squirrel; d) Yellow Billed Cuckoo; e) Blunt Nosed Leopard Lizard: f) pocket mouse; and g) Kern Canyon Slender Salamander. This last is of special concern as this species is only found along the side of the existing alignment from Democrat Hot Springs to the Live Oak Picnic area.

   Potentially, there could be an effect on any or all of these animals by reducing their habitat and through increased road kill.

3. There would be impacts on vegetation. Douglas Oaks and Greypines would be removed in the upper reaches of the canyon while Cottonwoods, Willows, Ash, and Sycamore trees would be removed along the river in the lower end of the canyon.

4. Federally protected lands could be affected including recreational lands such as the picnic area at Oak Flat as well as archaeological sites.

5. There would be aesthetic impacts from large cuts and fills and removal of vegetation.

6. Although there are no known active faults along the existing highway, there are active faults nearby. The present highway is also subject to severe problems from earth movements.

7. The alternative will at least initially have no effect on growth at Lake Isabella. There is a potential, however, that there could be a cumulative effect across time as travel is facilitated and made safer.

Construct the Adopted Alignment Alternative

1. There would be short term air, noise, and water quality impacts during construction. After construction, air and noise impacts would be introduced into a new area. Water quality on the other hand would probably improve in the Kern River by moving much of the highway to a new location away from the river.

2. There would be potential impacts on wildlife including rare and endangered species. Key winter range for deer exists nearby and moving the highway closer could cause deer to move *away.* A new highway in a new location could be a barrier to animal movements in addition to reducing available habitat. The list of animals which may be affected is similar to that of the "improve the existing alternative".

3. There would be impacts on vegetation including rare and endangered species of plants. Douglas Oaks and Greypines would be removed in the upper reaches of the canyon while Cottonwoods, Willows, Ash, and Sycamore trees would be removed in the area of the river crossing. Many acres of chaparral would also be removed.

4. One to two hundred acres of prime farmlands (depending on right of way width) would be removed.

5. There will be major aesthetic impacts from cuts and fills.

6. Encroachment on the floodplain of the Kern River would have to be considered at the crossing point(s) of the new alignment.

7. Specially protected lands under Federal law would be affected including the campground at China Gardens as well as archaeological and historic sites.

8. Although there are no recently active (within 200 years) faults along the adopted alignment, there are a number of active faults nearby. Should a project emerge along the adopted alignment, geological hazards would be a major design consideration.

9. The area of greatest potential controversy on environmental grounds is that of the potential growth inducing factors associated with constructing a new alignment. Safety problems and a perceived belief in delays in travel time are generally accepted as being constraints to growth in the Lake Isabella area.

   The Kern County Master Environmental Impact Report of 1981 indicates that there are a number of environmental problems that are likely to result or worsen should the Lake Isabella area develop to its ultimate population of 127,000. The Kern County assessment indicates that there would be potential problems in the following areas due to growth:

   - water quality
   - seismic disaster potential
   - flooding
   - impacts on rare and endangered species
   - air quality
   - impacts on schools and other government services
   - solid waste disposal
   - scenic and aesthetic impacts - particularly urban sprawl

Summary and Conclusions

In conclusion, improvement of the existiong highway could require preparation of a full environmental impact statement under Federal rules. It is possible that environmental clearance could be obtained under a lesser document for this alternative pending the completion of an environmental assessment including complete field studies. Improvement of the adopted alignment alternative will require preparation of a full environmental impact statement under Federal rules due to the scale of its impacts on both the natural and social environment.

PROGRAMMING

Traffic Safety Improvement projects on the existing 2-lane highway in Kern River Canyon in the 1983 and 1984 adopted STIPs are:

Location	Improvement	Cost	FY Fund
Major Project - HB1			
13.8/14.2	Widen/place Guard Rail	$372,000	85-86
17.0/17.7	Widen/place Guard Rail	699,000	85-86
Minor Project			
15.2/15.8	Widen	*267,000	83-84

*award delayed pending geological investigation

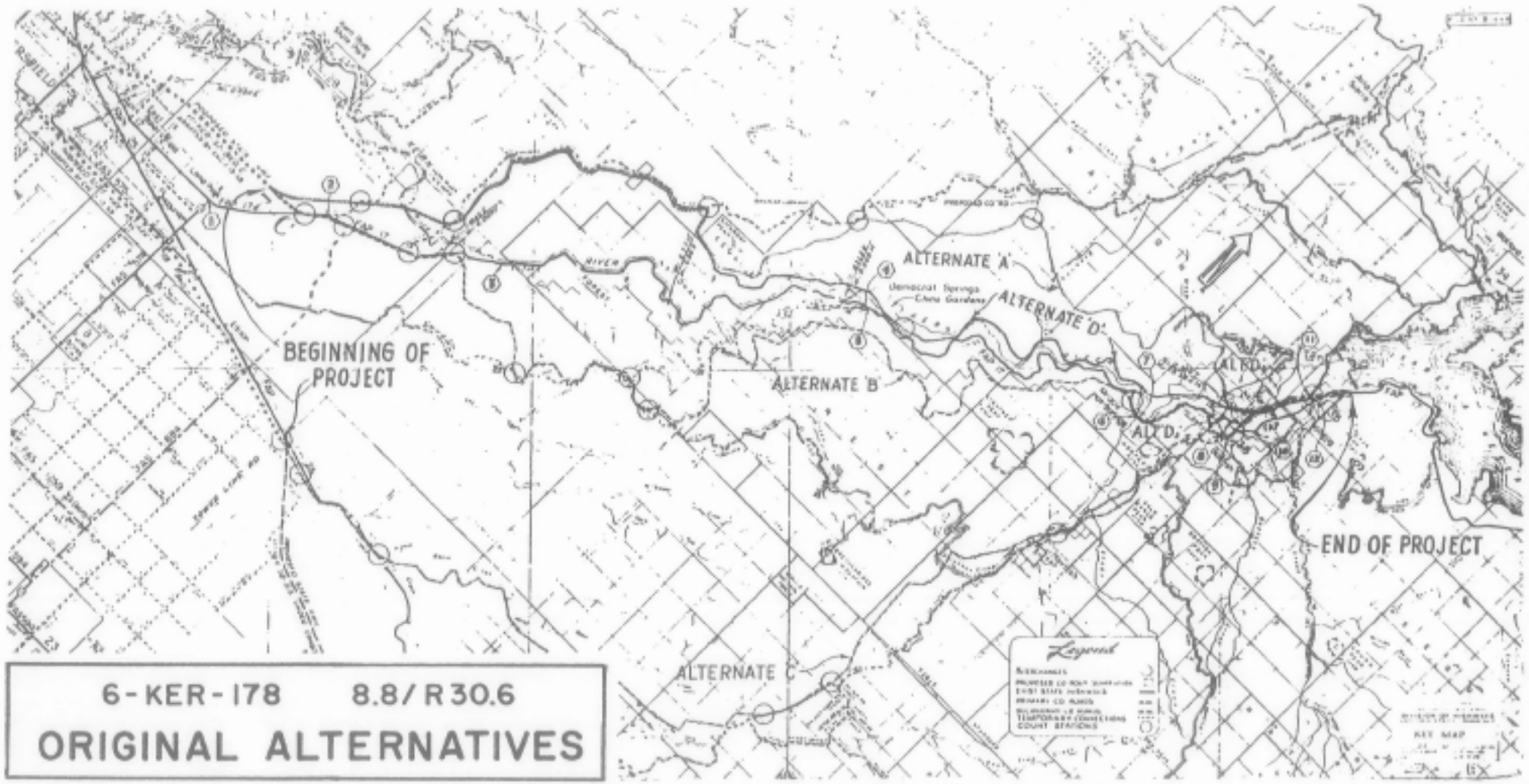
DISTRICT CONTACT

R. M. Nakagawa, District Systems Planning and Programming Engineer
(209) 488-4096 ATSS 422-4096

ATTACHMENTS

Exhibit A. Original Alternates
Exhibit B. Adopted Route-Stage Construction
Exhibit C. Improvements to existing Route 178
Exhibit D. Alternate Alignment
Exhibit E. Stage Construction Costs
Exhibit F. Road Closures - Total Time Closed
Exhibit G. Road Closures - Average Time Closed Exhibit H. Travel Demand Forecasts-Kakau Associates Exhibit I. Accident Trends

EXHIBIT A



6-KER-178 8.8/R30.6

ORIGINAL ALTERNATIVES

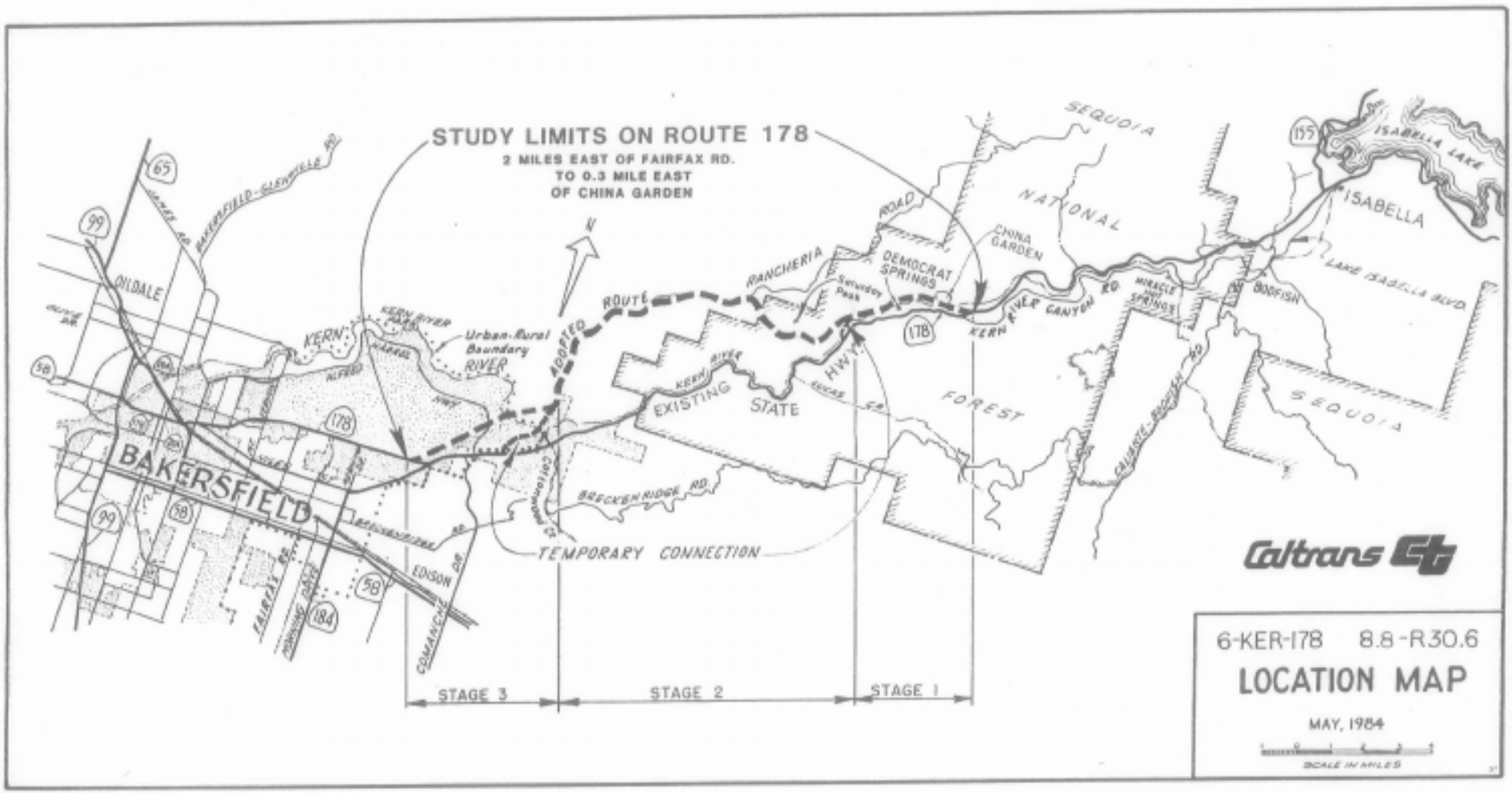
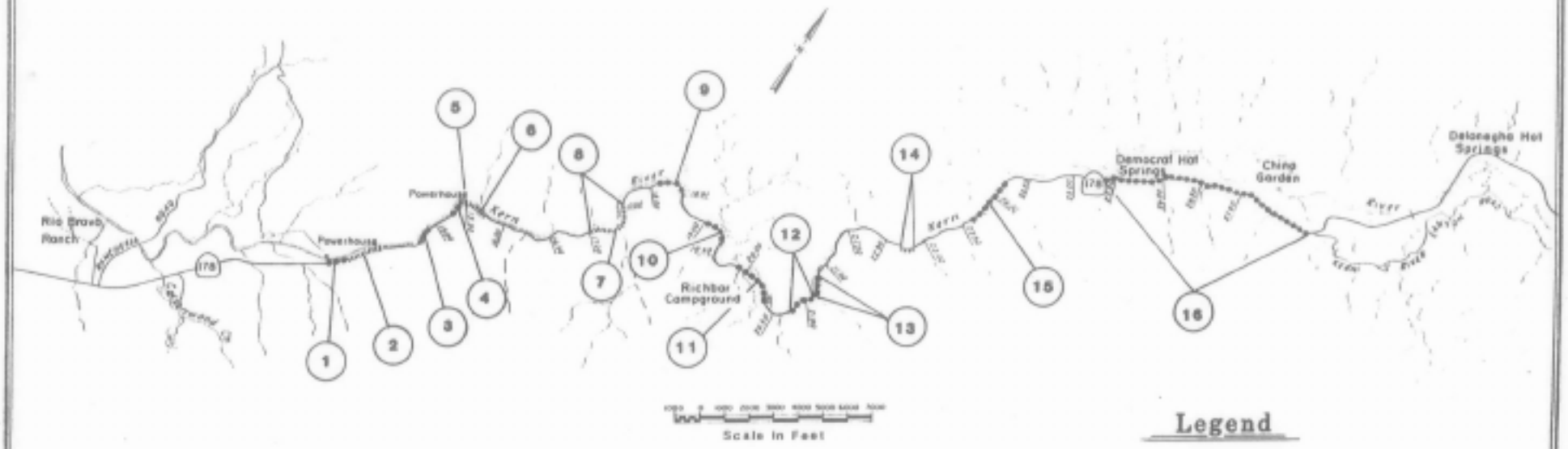

STUDY LIMITS ON ROUTE 178
2 MILES EAST OF FAIRFAX RD.
TO 0.3 MILE EAST
OF CHINA GARDEN
N
ADOPTED ROUTE
TEMPORARY CONNECTION
BAKERSFIELD
OILDALE
KERN
KERN RIVER PARK
Urban-Rural Boundary
RIVER
EXISTING STATE HWY.
FOREST
SEQUOIA NATIONAL
RANCHERIA ROAD
CHINA GARDEN
DEMOCRAT SPRINGS
Sawtooth Peak
KERN RIVER CANYON RD
MIRACLE HOT SPRINGS
ISABELLA
ISABELLA LAKE
LAKE ISABELLA BLVD
GOODFISH
QUARTZ-BROWN RD
BRECKENRIDGE RD.
EDISON
COMANCHE DR.
FAIRFAX RD.
STAGE 3
STAGE 2
STAGE 1
Caltrans
6-KER-178 8.8-R30.6
LOCATION MAP
MAY, 1984
SCALE IN MILES

EXHIBIT B

Caltrans



Scale in Feet

Legend

- Programmed Projects
- Planned Projects
- Future Projects

PROJECT NO.	POST MILE	DESCRIPTION
1.	13.55/13.85	Curve Correction, Widen 28'
2.	13.8/14.2	Curve Correction, Widen, Guard Rail
3.	14.7/14.9	Curve Correction, Widen, Guard Rail
4.	15.2/15.3	Curve Correction, Widen, Guard Rail
5.	15.3/15.5	Curve Correction, Widen, Guard Rail
6.	15.6/15.8	Widen Roadway
7.	17.3	Curve Correction, Drainage
8.	17.8/17.7	Widen Roadway, Guard Rail

PROJECT NO.	POST MILE	DESCRIPTION
9.	18.2/18.5	Widen Roadway, Curve Correction, Guard Rail
10.	19.0/19.2	Widen Roadway, Guard Rail
11.	19.8/20.4	Passing Lane (Richbar Camp Ground) Curve Correction, Widen
12.	20.8/21.1	Curve Correction, Widen, Guard Rail
13.	21.1/21.4	Passing Lane
14.	22.8	Widen Curve, Guard Rail
15.	23.5/24.1	Widen Road
16.	25.1/T30.0	Re-align, Widen

6 - KER - 178 13.5/T30.1

MAXIMUM IMPROVEMENTS TO EXISTING ROUTE

EXHIBIT C

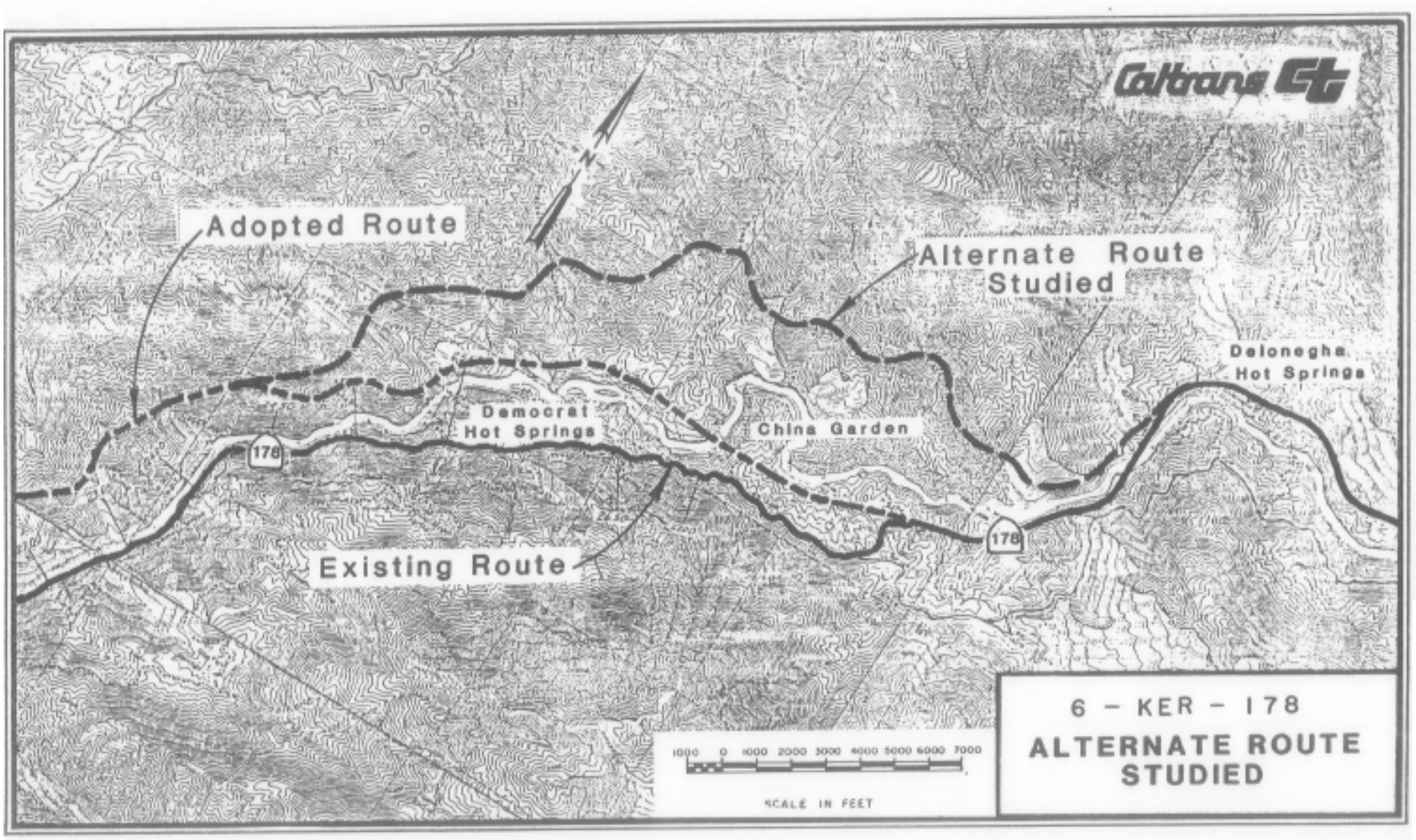

Caltrans
Adopted Route
Alternate Route Studied
Delonegha Hot Springs
Democrat Hot Springs
China Garden
178
178
Existing Route
1000 0 1000 2000 3000 4000 5000 6000 7000
SCALE IN FEET
6 - KER - 178
ALTERNATE ROUTE STUDIED

EXHIBIT D

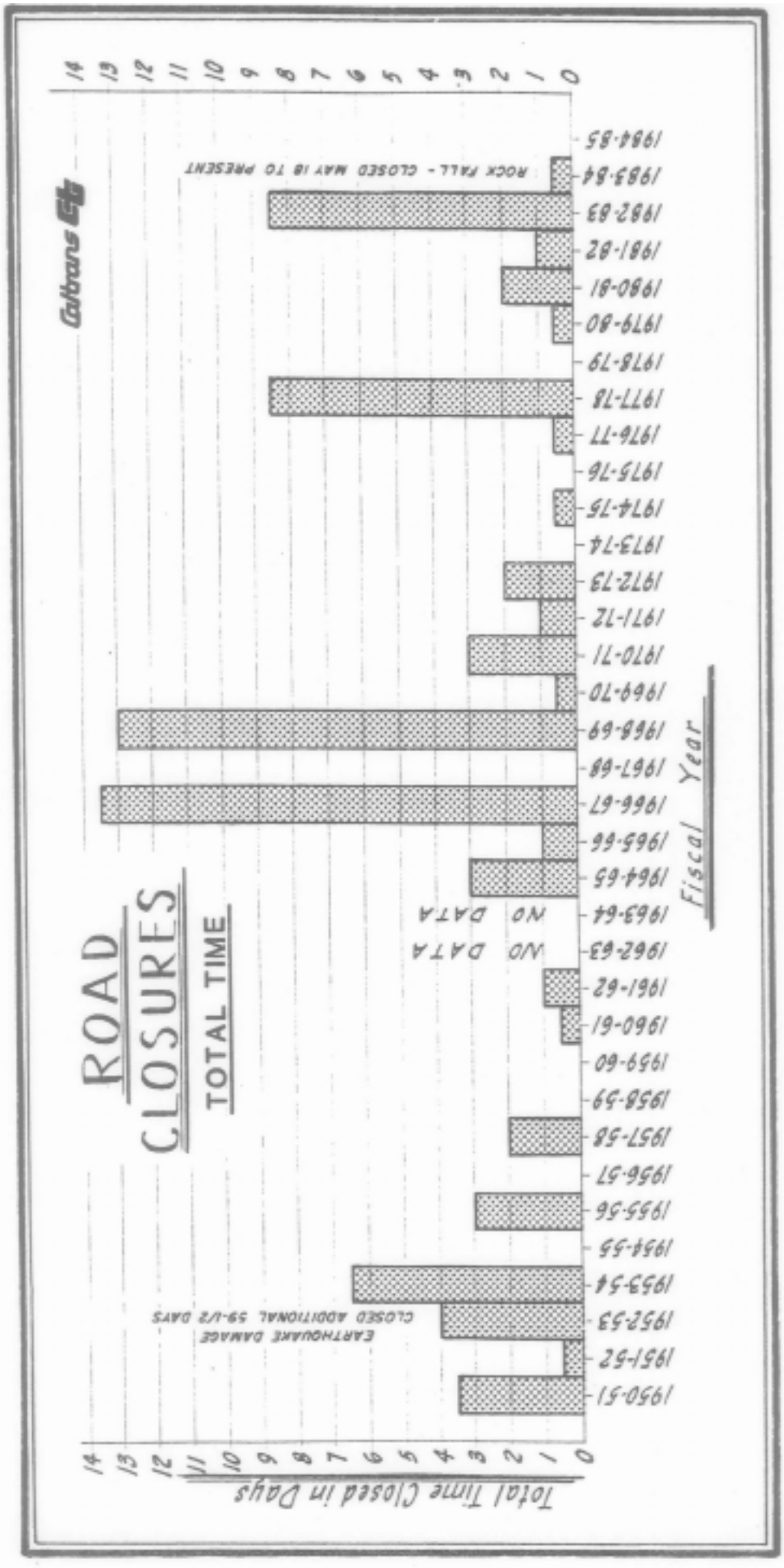
EXHIBIT E

CONSTRUCTION COSTS
STAGE CONSTRUCTION

Exhibit E

	1990Million Dollars (1984Million Dollars) 2-Lanes	2-Lanes (4-Lane Grad.)	4-Lanes
STAGE I			
0.25 mile W. Willow Spring Creek to 0.3 mile east China Garden.	17.04 (10.72)	20.67 (13.00)	21.94 (13.80)
Temporary Connection to existing Route 178 (2-Lanes)	5.88 (3.70)	5.88 (3.70)	5.88 (3.70)
Sub Total	22.92 (14.42)	26.55 (16.70)	27.82 (17.50)
STAGE II			
Rancheria Road to 0.25 mile west Willow Spring Creek	50.71 (31.89)	61.22 (38.50)	67.42 (42.40)
Temporary Connection to existing Route 178 along Rancheria Road (2-Lane)	3.66 (2.30)	3.66 (2.30)	3.66 (2.30)
Sub Total	54.37 (34.19)	64.88 (40.80)	71.08 (44.70)
STAGE III			
2 Miles east Fairfax Road to Rancheria Road	14.13 (8.89)	16.22 (10.20)	20.35 (12.80)
Construction Total	91.42 (57.50)	107.65 (67.70)	119.25 (75.00)
RIGHT OF WAY COSTS			
Stage I	0	0	0
Stage II	1.76 (1.11)	1.76 (1.U)	1.76 (1.11)
Stage III	1.61 (1.01)	1.61 (1.01)	1.61 (1.01)
Right of Way Total	3.37 (2.12)	3.37 (2.12)	3.37 (2.12)
CONSTRUCTION & RIGHT OF WAY TOTAL	94.79 (59.62)	111.02 (69.82)	122.62 (77.12)

EXHIBIT F


ROAD CLOSURES
TOTAL TIME
Caltrans
Total Time Closed in Days
Fiscal Year
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14
1950-51
1951-52
1952-53
1953-54
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1955-56
1956-57
1957-58
1958-59
1959-60
1960-61
1961-62
1962-63 NO DATA
1963-64 NO DATA
1964-65
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1972-73
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1979-80
1980-81
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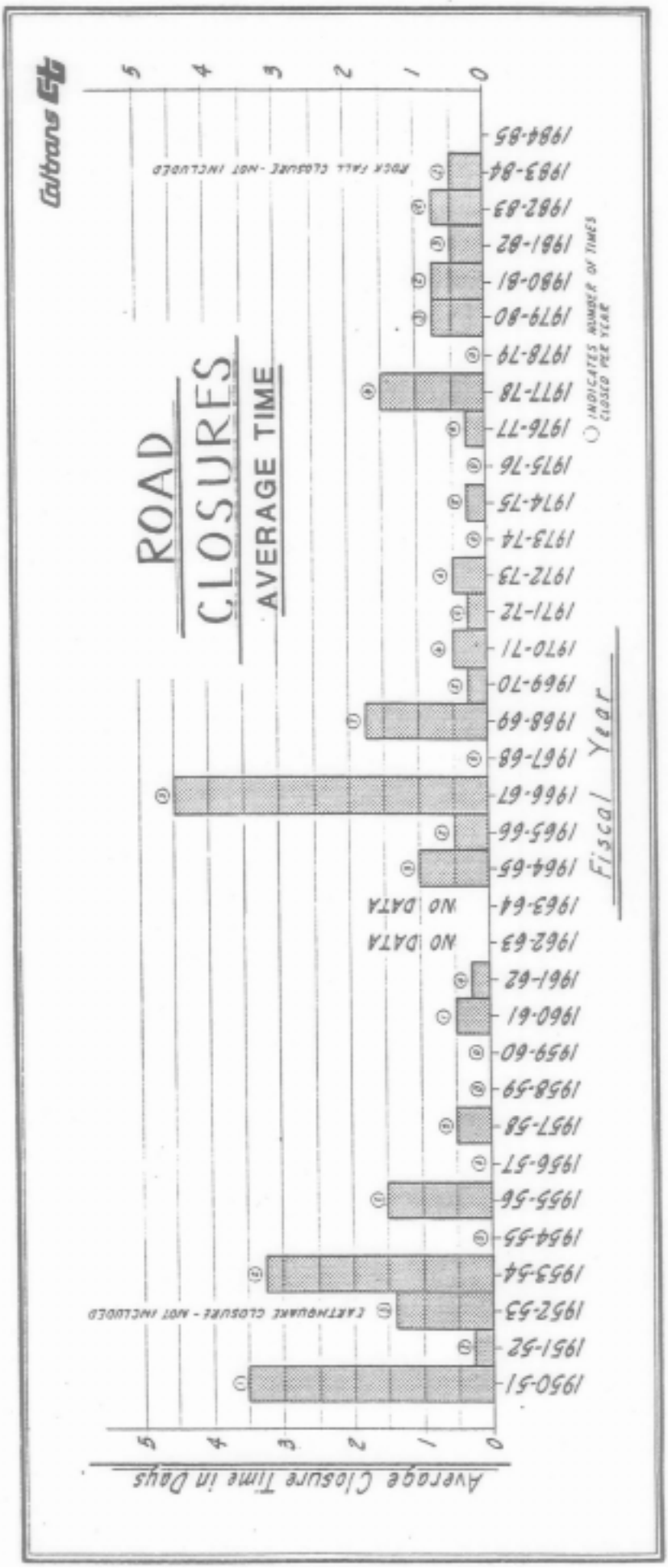
1982-83
1983-84
1984-85
EARTHQUAKE DAMAGE
CLOSED ADDITIONAL 59-1/2 DAYS
ROCK FALL - CLOSED MAY 18 TO PRESENT

EXHIBIT G


Caltrans
ROAD CLOSURES
AVERAGE TIME
Average Closure Time in Days
Fiscal Year
EARTHQUAKE CLOSURE - NOT INCLUDED
ROCK FALL CLOSURE - NOT INCLUDED
INDICATES NUMBER OF TIMES CLOSED PER YEAR
NO DATA
NO DATA
1950-51
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1981-82
1982-83
1983-84
1984-85

EXHIBIT H

TRAVEL DEMAND FORECASTS

A Working Paper

Prepared As Part Of The

Kern River Canyon Corridor Feasibility Study

May, 1984

Prepared for

Kern COG

Prepared by

KAKU ASSOCIATES
2001 Wilshire Boulevard, #600
Santa Monica, CA 90403

The need for improvements to the Route 178 highway Corridor is based on both the existing deficiencies in safety and traffic operations which have been identified, and to the need to accommodate the additional traffic expected to be generated by growth and development in the area. The interrelationship between growth in the Kern River Valley and on the increased travel demand through the corridor is a key issue which is to be addressed in this study.

PROJECTED GROWTH AND DEVELOPMENT

The population of Kern County has increased steadily since 1970 from 331,100 to an estimated 442,773 in July, 1983, a 42 percent growth in 13 years. In fact, the rate of growth has also been increasing since 1976 and has leveled off at about 3.5 percent per year. This rate of growth is expected to slow down but the population of the county is projected to increase to 664,430 by Year 2005.

One of the key areas of growth within the county is projected to be the Kern River Valley area. The growth in the Kern River Valley has been significantly higher than the county in general in recent years. In 1983, 13.4 percent of the completed dwelling units in the county (241 of 1804 units) were in the Kern River Valley, although the area represented only 4.9 percent of the population at the time (unincorporated area only). The county is projected to experience *a* 63.5 percent growth in population from 1980 to Year 2005. During this same period, the Kern River Valley area is expected to increase by more than 100 percent with a Year 2005 population of 29,720. Table 1 illustrates 5-year population forecasts from 1980 to Year 2005 for Kern County ana the Kern River Valley. It can be seen that the growth rate in the valley is expected to be higher than the county-wide rate in each

five-year time period.

TABLE 1

Population Growth in Kern County

	Kern County		Kern River Valley	
	Population	% Increase	Population	% Increase
1980	406,190	-	14,630	-
1985	471,200	16.0%	17,780	21.4%
1990	522,800	11.0	20,630	16.2
1995	569,800	9.0	23,000	11.1
2000	612,700	7.5	26,700	16.1
2005	664,430	8.4	29,720	11.2

In addition to this increase in population, there should be a recognition that major growth in commercial ana industrial developments can be expected. The Kern County General Plan allows the following at full buildout:

* Residential - 11,649 acres
* Commercial - 550 acres
* Industrial - 254 acres
* - 260 acres

Using the designated densities, the area designated as residential is capable of accommodating 35,460 dwelling units. Using a modest building coverage factor of 5000 square feet per acre, the commercial and industrial areas are capable of housing 2.75 million square feet and 1.27 million square feet of development, respectively. It should be recognized that these are ultimate densities that are allowed by the land use designations. The actual levels of development are likely to be much less than these.

As previously stated, the Year 2000 population for the Kern River Valley is projected to be 30,500. Using a proportional scale, it is possible that up to 1.0 million square feet of commercial and 0.50 million square feet of industrial could be developed in the study area in support of these population levels.

It can be seen that the potential densities of commercial, industrial and residential development in the Kern River Valley area represent significant increases over existing levels. If development even close to these numbers is achieved, the impacts could also be significant.

TRAVEL DEMAND

Changes to the travel demand within the Kern River Canyon Corridor are primarily affected by changes in growth and development within communities of the Kern River Valley and within Kern County in general. Although growth in the general Southern California area may affect the travel demand on S.R. 178, it is not nearly as significant a factor. Therefore, the techniques used to project future levels of travel demand on the highway were directed at the Kern River Valley and Kern County.

Forecasting Methodology

There are a variety of techniques used to forecast travel demand on a highway facility such as the SR 178. The most common methods include the straight-line growth rate, the growth factor method, and the FRATAR method. The straight-line growth rate method is based on the assumption that the rate of growth in traffic in the future will be identical to the rate which has been exhibited over the past

several years. Figure 1 illustrates the growth in traffic on S.R. 178 measured at the mouth of Kern River Canyon from 1978 to 1983. The figure also illustrates the travel demand at this point in 1995 and 2005 if this rate of increase continues in the future.

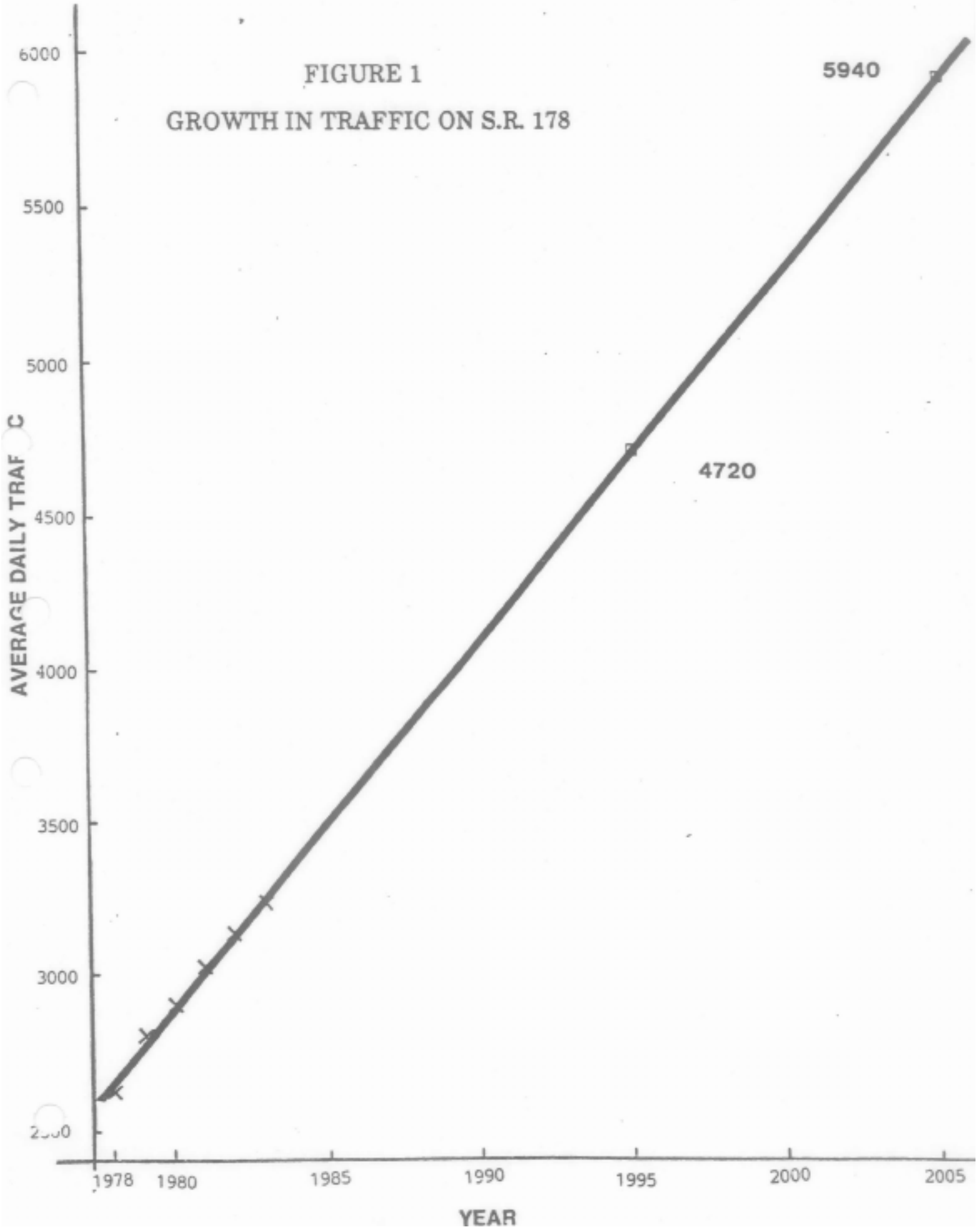
The graph indicates that the travel demand would be 4720 vpd in 1995 and 5940 vpd in 20U5. Although this technique is useful in developing estimates when very little additional data is available, it is not the most appropriate if forecasts of future population and/or land use are available. This is especially true when these population and/or land use forecasts reflect a significant change in the rate of growth as is projected in the Kern River Valley area. Therefore, a more precise method is suggested.

The FRATAR method is most useful when areawide travel forecasts are needed. Also, this technique requires a significant amount of data for all areas under investigation. Since a detailed analysis of other areas in Kern County is not needed, this technique would be unnecessarily complex.

The most appropriate method for Kern River Canyon Corridor is the Growth Factor technique. This concept uses existing volumes of traffic between two areas and then expands the volume between them in proportion to a measure of interaction. Several factors are available as a measure of this interaction between the Kern River Valley and the Metropolitan Bakersfield area. The most likely is the population in the Kern River Valley, Metropolitan Bakersfield, and Kern County. Other factors include the number of dwelling units and the amount of employment and/or commercial activity. Dwelling units were used for this analysis since this is the basic parameter used for estimating traffic generated by residential units. The

FIGURE 1

GROWTH IN TRAFFIC ON S.R. 178



general form of the method is as follows:

$$T_f = T_e \times \frac{f_{KR} \times g_{BK}}{F}$$

Where: T_f = future travel demand

T_e = existing travel demand

f_{KR} = growth factor associated with traffic from the Kern River Valley to Metro Bakersfield

g_{BK} = growth factor associated with traffic from Metropolitan Bakersfield to the Kern River Valley

F = growth factor combining growth throughout Kern County.

Future Volumes

The following forecasts for the Kern River Valley community were used as the basis for future travel on S.R. 178:

* 1995 - 12,255 Dwelling Units
* 2005 - 14,990 Dwelling Units
* Buildout - 35,460 Dwelling Units

Using these factors, the following travel demand forecasts for S.R. 178 were developed:

1995
* ADT = 5,260
* 2005 - ADT = 6,330
* Buildout - ADT = 15,060

LOCAL TRAFFIC

Another aspect of the travel demand forecasting exercise is the level of future traffic volume on the local street system in the Kern River Valley area. Using a technique similar to that used above, the traffic forecasts for various local streets and roads around Lake Isabella were developed. Figure 2 illustrates a schematic diagram of the local street system with an indication of 13 locations where existing traffic volumes are available. Table 2 provides the existing and projected traffic for these 13 locations. The table includes forecasts for 1995, 2005 and at buildout.

T A B L E 2

Traffic Volumes

		Forecast		
Location	Existing	1995	2005	Buildout
1	4,500	7,170	9,650	20,850
2	4,000	6,770	9,110	19,690
3	700	1,590	2,140	4,630
4	2,100	3,430	4,610	9,960
5	3,400	5,970	8,040	17,370
6	2,550	4,140	5,570	12,050
7	7,900	13,540	18,220	39,380
8	9,900	16,730	22,510	48,650
9	4,700	7,970	10,720	23,170
10	900	1,990	2,680	5,790
11	800	1,990	2,680	5,790
12	1,050	3,190	4,290	9,270
13	2,100	4,780	6,430	13,900

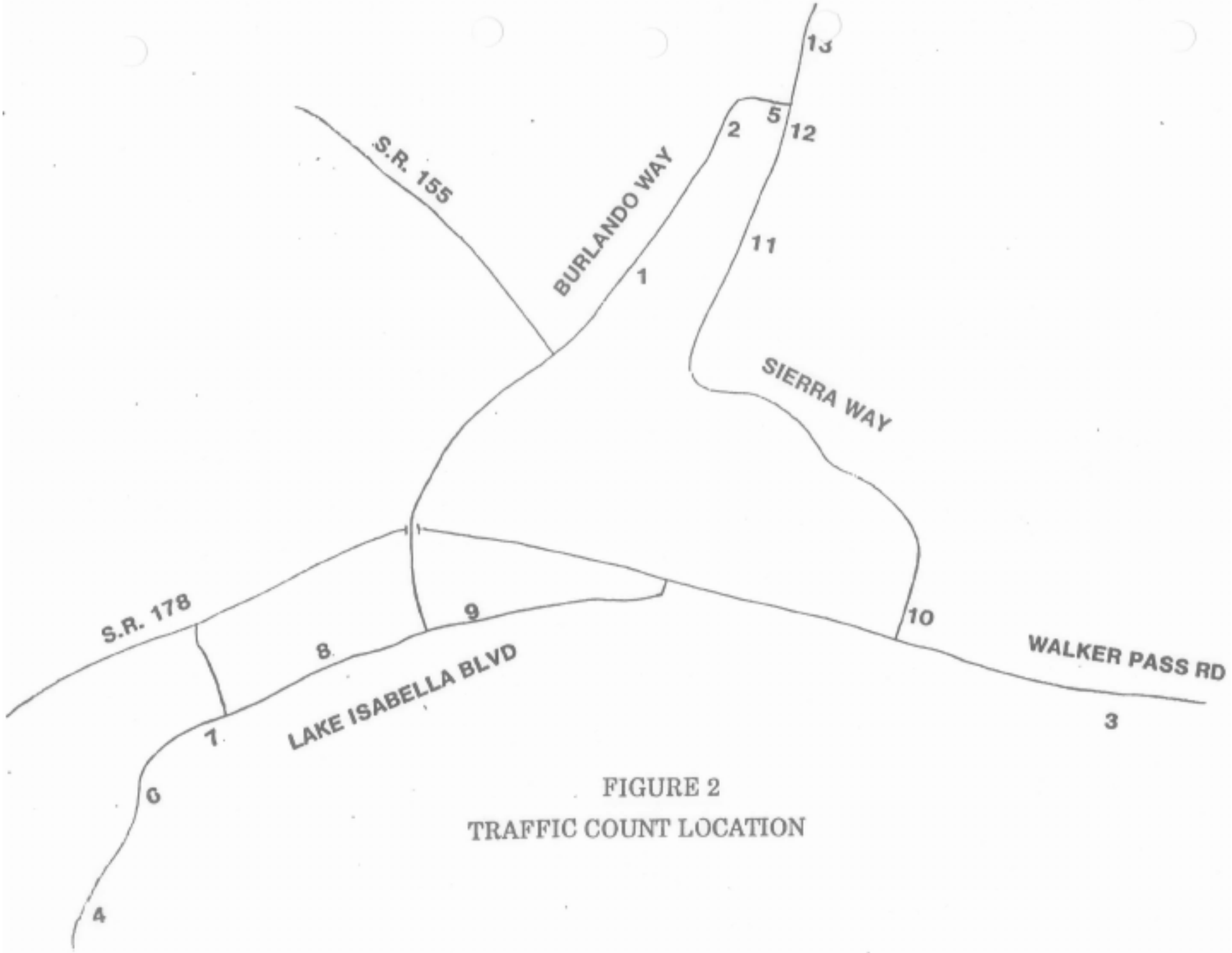


FIGURE 2

TRAFFIC COUNT LOCATION

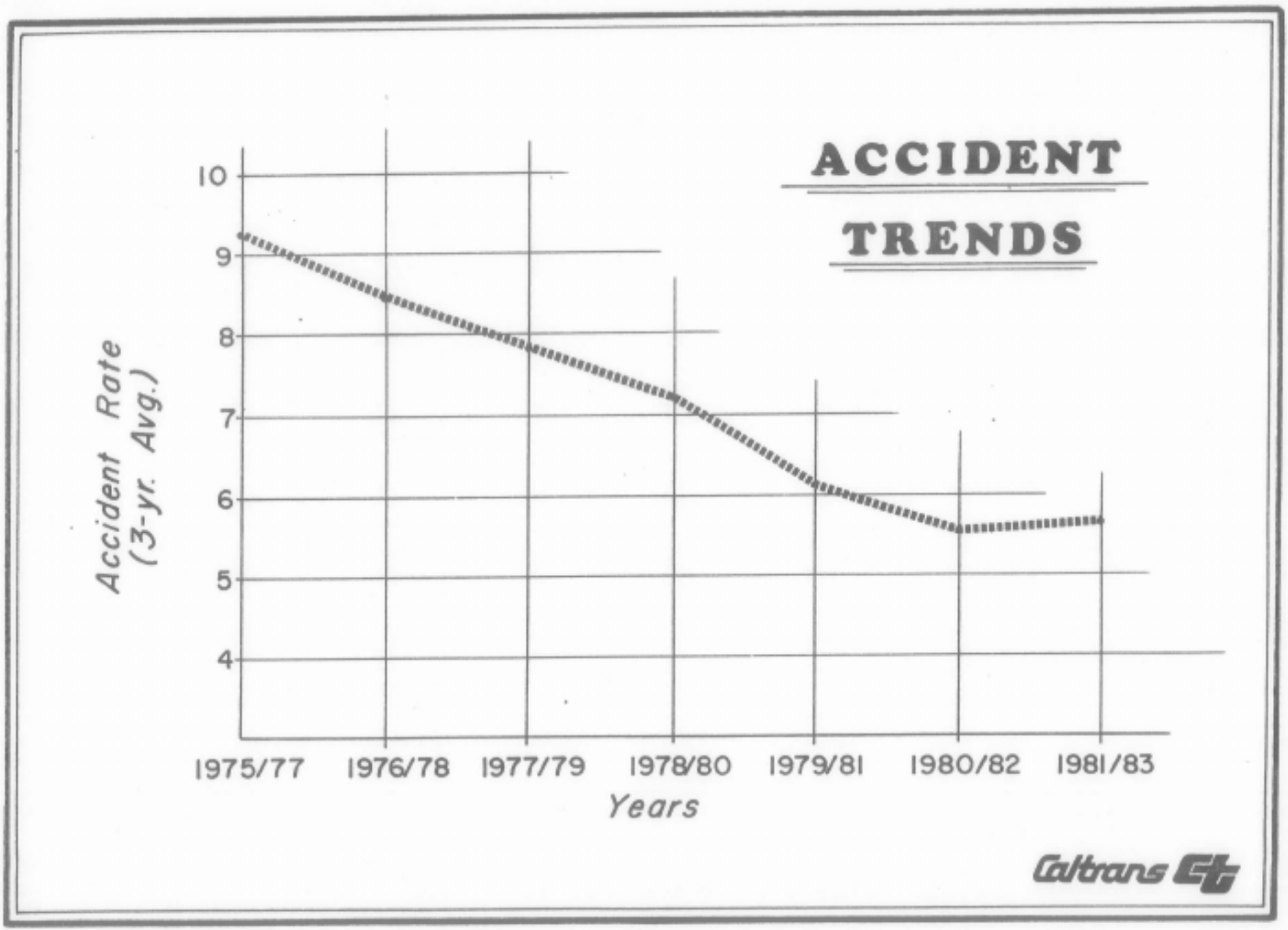

ACCIDENT
TRENDS
Accident Rate
(3-yr. Avg.)
10
9
8
7
6
5
4
1975/77
1976/78
1977/79
1978/80
1979/81
1980/82
1981/83
Years
Caltrans

EXHIBIT I

STATE OF CALIFORNIA—TRANSPORTATION AGENCY GEORGE DEUKMEJIAN, Governor

DEPARTMENT OF TRANSPORTATION
P.O. BOX 12616, FRESNO 93778

March 8, 1985

6-Ker-178 13.5/T30.1
06840-609310-30178

Mr. Mark Gibb, Executive Director
Kern County Council of Governments
1401 19th Street
Bakersfield, CA 93301

Dear Mr. Gibb:

We are attaching for your information a geology report for the adopted alignment of State Route 178 in the Kern River Canyor

This report, along with the four reports covering safety improvement projects on the existing route previously sent tc you, complete our geologic studies on Route 178.

If you need any further information, please contact me.

Very truly yours,

GORDON A. MARTS
Deputy District Director
Planning and Programming
District 6

RVD:ja
Attachment
CC: RMN
RVD

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION
DIVISION OF ENGINEERING SERVICES
OFFICE OF TRANSPORTATION LABORATORY

February 15, 1985

06-Ker-178-New Alignment
Sta. 776 - 2150

06840-609310-30178

Stan Lesneski
District Director of Transportation
District 06
Fresno, California

Dear Sir:

Submitted for your consideration is:

RECONNAISSANCE STUDY OF PROPOSED
NEW ALIGNMENT OF
STATE ROUTE 178 IN
LOWER KERN CANYON

Report By:

William R. Orr
Associate Engineering Geologist
Geotechnical Branch

Supervised By:

James Gamble, E.G. No. 779 Associate Engineering Geologist Geotechnical Branch

Attachments

cc: District 6 - Gordon Karts Dick
Nakagawa Bob
Dubel
Geotech (6)

Introduction

The reconnaissance study of the new alignment section of Highway 178 was made at the request of the District 6 office to provide geologic information necessary to finalize the Kern River Canyon Corridor Study report (6). The local geologic conditions were examined and geologic hazards were identified to enable the development of general recommendations for planning purposes.

The field work for the study was performed between October 15 and November 15, 1984, by James Gamble and William Orr, assisted by Richard Pratt, of the Transportation Laboratory. The study consisted of driving and walking along as much of the new alignment as feasible, and periodically intersecting it in less accessible areas. A photographic record was obtained by station with notes.

Additional detailed geologic work will be required in the design phase. This work will include foundation investigations for each of the structure sites and site specific cutslope design and rippability studies.

Summary

The proposed project is approximately 22 miles long and extends from the already completed portions of the Highway 178 expressway on either end. The new alignment veers away from the existing highway adjacent to the Mesa Marin Sports Complex and rejoins it just east of China Garden. It may be divided into ten reaches based on similiar topographic, geologic and engineering characteristics. A summary of these characteristics by reach is contained in Table 1. A summary of the major results and recommendations of this study is included below.

- The topography includes foothill, upland and rugged canyon regions.

- The alignment crosses sedimentary deposits of the San Joaquin Valley and granitic rock of the southern Sierra Nevada Range.

- The granitic rock is dissected by several steeply dipping regional joint sets and local intense shearing.

- The project is in an area of active seismicity with a maximum credible acceleration of 0.36g.

- Earthquake damage to the new highway may result from rockfall and surface ground rupture.

- The structures will be designed to withstand heavy seismic excitation without collapse.

TABLE 1 SUMMARY OF DESCRIPTION AND RECOMMENDATIONS

06-KER-178 New Alignment

REACH	STATIONING	ALIGNMENT CHARACTERISTICS	CUTS +30 FT	FILLS +30 FT	CUTS FOR PLANNING	TOPOGRAPHY	MATERIALS	COMMENTS
1	776 to 1040	Low cuts and fills	2	2	1.5:1	grass-coverd low, rolling hills	Alluvium, terrace and marine sediments	Alquist-Priolo Zone Sta 931-958
2	1040 to 1050+	Cut to descend to river Structure site	1	0	1.5:1	Bluff, river crossing and floodplain	Terrace, marine sediments and alluvium	
3	1050+ to 1130	Low cuts and fills	0	0	1.5:1	Flood plain and side gully	Alluvium and marine sediments	
4	1130 to 1223	Mostly long, moderately deep sidehill cuts and some long fills	6	6	1.5:1	Steep-sided, barren ravine	Marine sediments	
5	1223 to 1570	Predominantly long to very long and several deep cuts and mostly long and many deep fills	13	13	1.5:1Soil 1.1 Dg 0.75:1 Dg w/ Gr	Ridges and bouldery knolls	Black soil, Dg and granitic basement	Longest cut=4522ft @ Sta 1239+30-1284+22 Longest fill=2645ft @ Sta 1432+55-1459
6	1570 to 1843	Predominantly long and mostly deep cuts and mostly long and deep fills, Structure site	10	10	1:1 Dg only 0.75:1 Dg w/ Gr	Ridges and several side canyons	Dg and granitic basement	
7	1843 to 1930	Mostly long and high sidehill cuts and several long and deep fills	5	5	0.75:1	Very-steep, boulder-strewn inner-canyon	Granitic basement and Dg	
8	1930 to 2070	Several long and deep cuts and several very long fills	4	3	1.5:1 Qal 1:1 Dg 0.75:1 Dg w/ Gr	Low ridges and ravines	Dg and granitic basement	Deepest fill=134ft @ Sta 1930+70
9	2070 to 2080	Long and deep fill Structure site	0	1	1.5:1 Qal 1:1 Dg 0.75:1 Gr	River crossing	Dg, alluvium and granitic basement	
10	2080 to 2150	Long and deep cuts and long and deep fill	2	1	1.5:1 Qal 1:1 Dg 0.75:1 Dg w/ Gr	Meander neck and multiple drainages	Dg and granitic basement	Deepest cut=130ft @ Sta 2086+70

NOTES:

1) The location of cuts and fills are from profiles provided by the District.

2) The height of cuts and fills are at centerline and in most cases are a minimum value.

3) In addition to the listed angle, the recommended cutslope design incorporates presplitting, intermediate benches and widening at grade. See the text for details.

– For planning purposes the recommended cutslope angle is:
1.5:1 for alluvium and sedimentary deposits 1:1
for decomposed and weathered granitic rock 0.75:1
for fresher granitic rock

– Cuts steeper than 1.25:1 and higher than 15 feet should include additional width at grade for catchment areas depending on the slope angle and height of rock cut.

– Cuts 60 feet or higher should include additional width for 20-foot intermediate benches with equi-spaced 30-50 foot lifts.

- Cuts and fills near water will produce fine-grained sediment that must be prevented from entering the Kern River or any other stream.

- Native granular material excavated during construction should be suitable for use as fill material.

- It may be possible to reduce the amount of excavation by more closely paralleling Rancheria Road between Sta. 1100± and Sta. 1550±.

- Culverts in gullies and side-canyons should be designed to accommodate maximum flows resulting from occasional intense storms.

Geography

The new alignment starts on the eastern margin of the Great Valley, abruptly crossing into the Greenhorn Mountains of the Sierra-Nevada Geomorphic province at the scarp of the Kern River Fault. Elevations vary from 720 feet at the start of the project to 2120 feet at the terminous, with a maximum elevation of 3200 feet at Sta. 1603. The most prominent topographic feature in the immediate vicinity, Saturday Peak, attains a height of 4143 feet.

Originating in an area of subdued relief, the project crosses the eastern margin of the San Joaquin Valley that gently slopes away from the mountains to the east. This generally planar surface is dissected by occasional small dry gullies. The alignment skirts one well-defined gully before crossing the present Alfred Harrel Highway. **Hills** become more accentuated proceeding toward the Kern River.

The first conspicuous topographic feature encountered is the Kern River valley. The valley exhibits two orders of meanders. The river crossing bisects one of the larger-scale meanders, defined on the west by a nearly vertical undercut bluff and on the east by a depositional slope. The existing Kern River appears underfit and meanders within the floodplain contained in the larger meanders.

The alignment leaves the floodplain in an alluvial-filled side gully in the heart of Rio Bravo Ranch. It temporarily emerges from this gully as it crosses Rancheria Road. The gully enlarges to a barren, steep-sided, V-shaped ravine at this point and the alignment stays perched high above the existing road. This ravine finally begins to loose its topographic expression near the Kern River Fault.

The Kern River Fault forms the major demarcation of the project, separating the sedimentary rocks on the west from the granitic rocks on the east. The alignment emerges from the ravine, and crosses the fault near Sta. 1223. Beyond the initial scarp, a grassy upland region is entered consisting of rolling hills mantled by black soil and colluvium/decomposed granitic material with isolated bouldery outcrops. The natural slopes are moderate in this section and begin to steepen as the canyon narrows upon crossing a possible extension of the Poso Creek fault near Sta. 1350. The outcrops remain limited but the thickness of colluvium and decomposed granitic material is reduced.

The next section intersects the last major ravines of the Poso Creek drainage, before crossing the divide of the Kern River drainage at the crest. The alignment begins to descend, while skirting several major drainage amphitheatres, toward the extremely steep inner canyon. The outcrops increase in frequency, mostly exposed on the ridgetops and in the bottoms of the ravines as broken blocks of moderately fractured rock. Occasional imposing cliffs are formed by outcrops of massive granitic rock.

The inner-canyon stretch is formed by the rejuvenated, V-shaped portion of the Kern Canyon that contains the existing highway. The outcrops become common consisting of long boulder-strewn slopes and numerous intermediate cliffs. The cover of colluvium/decomposed granitic material is generally thin to non-existent.

Beyond Democrat Dam, the ruggedness of the inner-canyon diminishes and the valley begins to open up. The slopes again consist of thicker sections of colluvium and decomposed granitic material with discontinuous outcrop. The shear rocky cliffs are replaced by ridges of harder rock that form divides separating the side drainages. The alignment crosses the Kern River, the meander neck of China Garden and a large amphitheatre containing several side ravines, before joining the continuation of the completed new section of highway.

The project originates and terminates in the drainage of the Kern River, but crosses through the Poso Creek drainage in the section paralleling Rancheria Road. Aside from the Kern River which is the master drainage artery, there are few permanent streams. These streams include Rancheria and Rattlesnake Creeks of Poso Creek drainage, and several tributary streams of the Kern River, including Saturday Spring Creek (western ravine), Willow Spring

Creek, Prefedio Creek, Tenant Creek and an unnamed creek at Sta. 2112 east of China Garden. Although these streams are permanent, their flows are reduced to mere trickles in the late summer and fall.

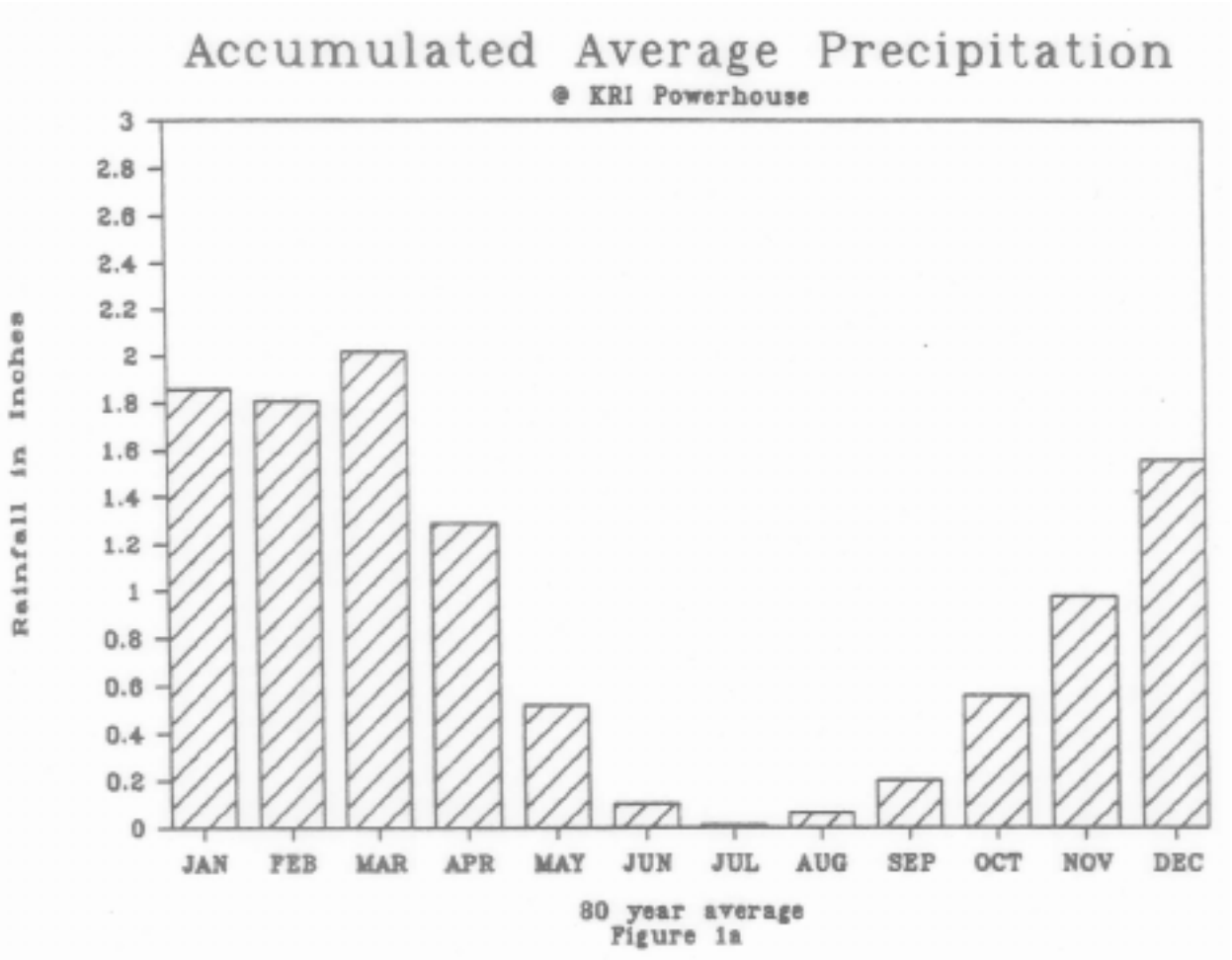
Temperatures may be **divided** into ranges based on the two well-defined seasons, summer and winter. The summers are hot with daytime temperatures frequently exceeding 100 degrees. The winters are moderately cold with snow limited to occasional dustings at the upper elevations.

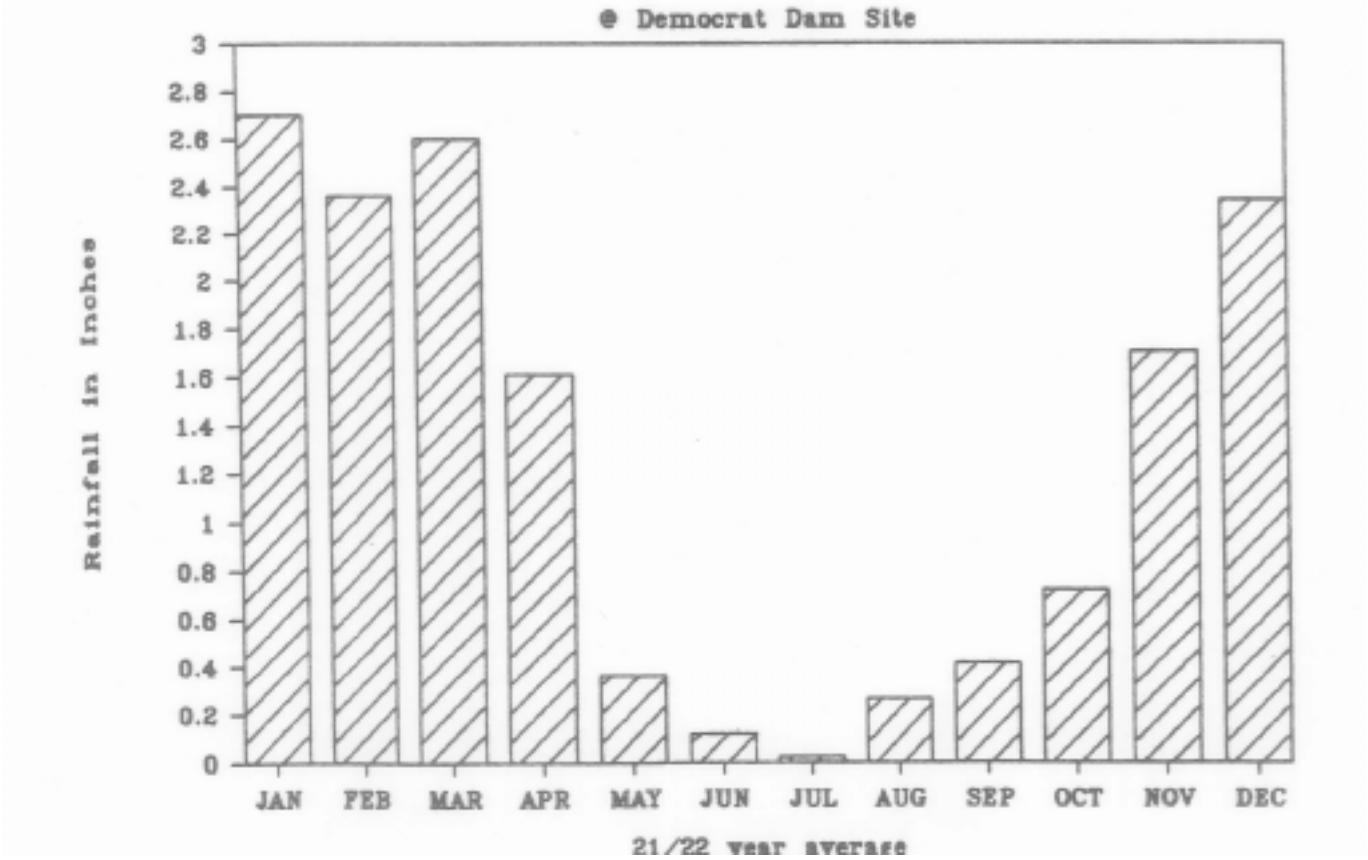
The low annual precipitation in the vicinity reflects the predominant arid valley influence in the extreme southern Sierra-Nevada. Two stations monitored by Southern California Edison Company, one located two miles inside the mouth of Kern Canyon adjacent to the existing highway and the other near the alignment at the Democrat Dam Site, show composite average annual rainfalls of 10.97 inches and 15.20 inches, respectively (see Figures la and lb). The Democrat Dam station has a significantly higher average as would be expected further up the canyon at a higher elevation. Essentially all rainfall occurs during winter storms between November and April.

The distribution and type of vegetation is controlled by elevation and soil/rock type. The valley portion is limited to grasses and is devoid of trees except at the crossing of the Kern River that is lined by willows and cottonwoods. The floodplain and lower terrace level is cultivated with irrigated vineyards and orchards of almonds, apricots, and oranges. The sedimentary foothill section, before crossing the Kern River Fault, is limited to grasses and is susceptible to wild fires. The upland granitic region beyond the fault continues in grassland. As the alignment gains elevation, the hillsides become dotted with an occasional live oak tree. The density of trees increases with elevation as the canyon of Rattlesnake Creek narrows. Occasional buckeye and digger pine become interspersed with the oak. Beyond the crest at the divide between the Poso Creek and Kern River drainages near Saturday Peak, the vegetation has taken on a forested chaparrel character with a mix of grass, low brush, oak, buckeye and digger pine. The Kern Canyon portion is a continuation of this zone, with the addition of sycamore in the wetter ravines and occasional cacti on the long grassy stretches.

Geology

The new alignment begins in Tertiary and Quaternary marine and non-marine sediments ,(1). After crossing the Kern River Fault, it remains in granitic terrain to its eastern terminous. Plio-Pleistocene Kern River Formation is exposed from the beginning of the project at Sta. 776 to Sta. 1010± and consists of mostly non-marine gravelly and sandy silt and silt. Miocene marine sediments of the Santa Margarita Formation and Round Mountain Silt are encountered from near the intersection with present Alfred Harrel Highway at Sta. 1010± to Sta. 1032±, on


Accumulated Average Precipitation
@ KRI Powerhouse
Rainfall in Inches
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
80 year average
Figure 1a


@ Democrat Dam Site
Rainfall in Inches
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
21/22 year average

the bluffs on the west side of the Kern River, and on the east side of the river from Sta. 1137± to the Kern River Fault contact at Sta. 1223±. The Round Mountain Silt consists of greenish-tan silt and sandy silt with isolated large boulders. The Santa Margarita Formation consists of a narrow band of sand and gravel, exposed between the Round Mountain Silt and the Kern River Formation on the bluff, west of the river.

The Santa Margarita Formation and Round Mountain Silt are overlain by Recent terrace material consisting of sandy and bouldery layers from Sta. 1032± to Sta. 1048±. The present floodplain consisting of Recent alluvium is crossed from Sta. 1048± to Sta. 1052±. Older alluvium or a low terrace deposit consisting of sandy silt is exposed from Sta. 1052± to Sta. 1062±. Recent alluvium consisting of reworked Round Mountain Silt is crossed before entering the eastern exposure of the Round Mountain Silt at Sta. 1084±.

East of the Kern River Fault contact, the remaining portion crosses granitic terrane with the main variables being the frequency of outcrop, the degree of weathering and slope steepness. Between Sta. 1225± and Sta. 1570, foothills and ridges are crossed consisting of colluvium, decomposed granitic material (Dg) and more resistant bouldery outcrops. The granitic rock consists of medium- to coarse-grained granodiorite to quartz diorite and is susceptible to deep weathering along the grain boundaries. The granitic rock throughout the project generally has a uniform appearance. The notable exceptions are common dark mineral inclusions that form ellipses and bands, a small body of predominantly dark minerals crossed on the southwest flank of Saturday Peak between Sta. 1585± and Sta. 1610±, and occasional light mineral veins. The dark mineral features tend to be more resistant to weathering and protrude above the surface of the lighter mass.

The granitic rock is extensively fractured by several steeply-dipping regional joint sets and is locally intensely fractured and sheared. The local fractures and shears tend to obscure and disrupt the more regularly-spaced regional joints. The most prominent joint set observed trends northwesterly and dips approximately 80 degrees to the southwest. Large blocks exposed in the steep inner-canyon stretch, between Sta. 1843± and Sta. 1920±, tend to be massive and prismatic.

Seismicity

The proposed project is in an area of active seismicity and the seismic risk is considered moderate to high. The map of maximum credible acceleration by Greensfelder shows the project to be within the 0.4g acceleration zone. The faults along which damaging earthquakes are most likely to occur are listed in the table below. Distances from the faults to the west and east end of the project are taken from the geologic atlas of California, **Bakerfield sheet**(17). The remaining data are from nomograms and

tables from various sources as compiled by Greensfelder (7).

Fault	Distance (Miles) West	East	Potential Magnitude	Maximum Expected Bedrock Acceler.	Predominant Period (Secs.)	Duration of Strong Motion (Secs.)
Kern Front	8	22	6.25	0.32g	0.35	18
White Wolf	15	15	7.75	0.36g	0.35	34
Garlock	35	33	7.75	0.20g	0.35	**34**
Owens Valley	47	**34**	8.25	0.23g	0.35	37
San Andreas	39	51	8.25	0.20g	0.35	37

The alignment crosses the topographically impressive inactive Kern River fault and several small faults and shears that reflect a previous tectonic regime.

Historical records show a multiplicity of seismic activity. The project area was most directly affected by the Arvin-Tehachapi earthquake of 1952, that closed the existing highway in the canyon by rockfall and produced ground cracking crossed by the alignment between Sta. 935± and Sta. 954±. Which of this cracking was primary fault rupture and which was secondary cracking is poorly documented and is unknown by this author.

Cracking associated with the 1952 earthquake was the basis for designating an Alquist-Priolo Special Studies Zone crossed by the alignment between Sta. 931 and Sta. 958. The Alquist-Priolo Special Studies Zones (APSSZ) Act requires the preparation of reports for construction of structures for human occupancy within zones containing active faults as delineated by the California Division of **Mines** and Geology. This Act is designed to avoid the construction of these structures across active fault traces. Geologic investigations for such reports would attempt to locate the active traces within these zones with respect to the proposed project. Although the proposed highway crosses this zone, no structures associated with this alignment are proposed within this zone and therefore no special studies report is required. However, special note is taken of this zone because of the likelihood of roadway damage by surface rupture.

In addition to the possibility of earthquake-induced rockfall and ground rupture from a similiar event on the White Wolf Fault, roadway damage may also result from an earthquake along the Kern Front Fault. The seismic hazard associated with any of the other aforementioned faults is comparatively low. Structural damage should be minimal from an earthquake on these faults because they may be expected to produce a lower acceleration at the site than that used to design the structures.

There are three proposed new structures on this project. They are at the crossing of the Kern River in Rio Bravo Ranch, at a deep side-ravine of Saturday Creek and at the Kern River, just west of China Garden. These structures will be designed in

accordance with criteria which utilize a seismic design force that is approximately 2.5 times greater than that used for bridges prior to the 1971 San Fernando earthquake. Factors which will be included in the design of the bridges include 1) seismicity of the site, 2) soil response of the site and 3) dynamic characteristics of the bridge.

Though exposure to seismic hazard is highly probable over time, studies show that these latest design procedures should enable such bridge structures, as proposed, to withstand heavy seismic excitation without collapse.

Description and Engineering Geology

The project extends from Sta. 776 to Sta. 2150 for a gross mileage of 26.02. This distance is reduced 4.55 miles by three equations for an adjusted total of 21.47 miles. The new alignment may be divided into ten reaches on the basis of similiar topography; soil/rock types and outcrop distribution; Eexcavation and alignment characteristics; and geologic hazards.

The position and location of cuts and fills are taken from profiles supplied by the District. The heights of cuts and fills were measured at centerline and in most cases represent a minimum value. The actual height of cuts and fills is dependent on the design cutslope angle and the adjacent natural slope geometry. Cuts and fills exceeding 30 feet in height at centerline were considered significant for emphasis in this report.

Cuts deeper than 15 feet and steeper than 1.25:1 are susceptible to rockfall and should be designed in accordance with the criteria established by Ritchie (14). These criteria include constructing adequate catchment *areas at* grade depending on the cutslope angle and height of the cut **(see** Table 2).

Cutslope design should include 20-foot wide intermediate benches for cuts 60 feet or higher with equi-spaced 30-50 foot lifts. This design will also require the stability analysis of granitic rock slopes that considers the intersection of joints and cut orientation.

Decomposed granitic material exposed in the new cuts in Reaches 5 through 10 will be susceptible to sloughing and erosion. The fresher coarse-grained granitic material that will be exposed in the new cuts will deteriorate with time due to physical weathering along grain boundaries.

Cuts and fills in close proximity to the Kern River or side tributaries, especially in Reaches 2,6,7,8,9 and 10, will supply a source of sediment that will eventually end up in the river during and after construction unless effective mitigation measures are taken. Fine sediments must be prevented from polluting the Kern River and all other stream courses along the alignment. The amount of sedimentation depends on 1) the amount

TABLE 2
RELATIONSHIP OF VARIABLES ON CATCHMENT WIDTH
FOR ROCKFALL AREAS (Modified from Ritchie, 1963)

ROCK SLOPE : NEAR VERTICAL	
H	W
15-30	10
30-60	15
OVER 60	20

ROCK SLOPE : 0.75 : 1	
H	W
15-30	10
30-60	15
OVER 60	15

ROCK SLOPE : 0.25:1 & 0.3:1	
H	W
15-30	10
30-60	15
60-100	20
OVER 100	25

ROCK SLOPE : 1:1	
H	W
15-30	10
30-60	10
OVER 60	15

ROCK SLOPE : 0.5:1	
H	W
15-30	10
30-60	15
60-100	20
OVER 100	25

ROCK SLOPE : 1.25:1

USE ROCK FENCE ON SHOULDER

NOTES:
H = Height of rock cut including existing ground above of similiar angle.

W = Width of catchment area between edge of shoulder and base of cutslope.

A fence or K-rail may be necessary if excessive material reaches the roadway.

of fine-grained material available to be transported, 2) the amount and intensity of precipitation, 3) the steepness of slopes, 4) the distance to the river and 5) the absorption characteristics of the intervening ground. Most of the erodible material will be sand and some silt sized particles derived from]Attie sedimentary deposits, the zone of weathered granitic rock and from the action of equipment during construction.

The new cuts and fills will tend to be sterile and should be hydro-mulched and seeded to encourage the establishment of vegetation to prevent the onset of accelerated erosion. The timing of this procedure will be critical and should take advantage of the local rainfall patterns. Steep cuts in granitic rock will not respond to seeding, tending to remain barren for an extended period of time.

The granular alluvial, marine and decomposed granitic materials produced in the excavation of the new cuts should prove of adequate quality for construction of the new fills, provided proper placement and compaction.

It may be possible to substantially reduce the required excavation and smooth out several curves by modifying the route between Sta. 1100± and Sta. 1550±. This alteration would encompass portions of Reaches 3,4 and 5 and consist of moving the alignment downslope to more closely parallel Rancheria Road. This modification would reduce the height of the cuts and take better advantage of the natural contour of the topography. The feasibility of this alternative may be limited by the need to maintain grade and keep Rancheria Road open during construction

Reach 1

Reach 1 begins in a swale at Sta 776. where the new alignment veers away from the existing highway adjacent to the Mesa Marin Sports Complex (see Photo 1). This reach crosses mostly grassy plains and low rolling hills that are gently inclined toward the center of the San Joaquin Valley to the west. The alignment starts its descent to the Kern River beginning at Sta. 970, passing through a dry wash that contains the old Harrel Highway, crossing the present Alfred Harrel Highway and stepping down two terraces to the river (see Photo 2). The material consists of mostly unconsolidated silt and gravelly silt of the Kern River Formation. The upper terrace reveals a narrow band of Miocene marine sediments.

Existing cuts along the old Harrel Highway are mostly low but stand at a fairly steep angle. The only cut in this material along the existing Highway 178 appears stable but tenuous at about 1:1. No deep-seated failures were noted in the natural or existing cut slopes. The new alignment contains two long cuts in this reach. For planning purposes the recommended slope for these cuts in gravelly terrace and silty sedimentary materials is 1.5:1.

The large CMP culvert crossing under the existing highway at the beginning of the alignment and the wash-out of old Harrel Highway in the dry wash right of Sta. 983, point out the need to have culverts in the fills designed to accommodate the heavy runoff resulting from the infrequent intense storms that account for most of the areas precipitation.

Reach 2

Reach 2 includes the proposed cut to be notched into the west bluff of the Kern River valley, the structure site crossing the Kern River, and the approach on the east side of the river. The 1:1 cut through the bluff on the existing Highway 178 is ragged and susceptible to rockfall from the zones of large boulders. However, no deep-seated failures were noted in the natural or existing cut slopes. For planning purposes the recommended slope for the new cut in this bouldery terrace material is 1.5:1. The design should include a fence at grade to keep rolling boulders off the traveled way. Recent alluvium of the present floodplain is exposed at the structure site and at the east approach. A separate foundation investigation will be required to determine the subsurface conditions for structure design.

Reach 3

Reach 3 extends from the floodplain of the Kern River, up a side gully containing the shop and loading areas in the heart of Rio Bravo Ranch, to where the alignment temporarily emerges from the gully at its intersection with Rancheria Road **(see** Photo 3). This section includes no high cuts or fills. The material crossed consists of reworked and inplace marine silt and silty sand. Only one small slip-out was noted on an undercut bank of the gully, apparently the direct result of water released from *a* tank above. For planning purposes the recommended slope for cuts in these sedimentary materials *is* 1.5:1. An adequate culvert should be provided where the alignment crosses the dry gully at Sta. 1084. The sediment-choked gully indicates heavy sediment transport during intermittent flow that may obstruct the culvert without periodic maintenance.

Reach 4

Reach 4 begins where the alignment re-enters the ravine and parallels Rancheria Road, well above on the sidehill, to where it crosses the Kern River Fault contact. The natural slopes are steep and the limited existing cuts along Rancheria Road stand nearly vertical due to the arid climate and intermittent nature of rainfall ***(see*** Photo 4). Inspection of these cuts indicates periodic maintenance in the past to remove sloughed material, probably following heavy rains. However, no deep-seated failures were noted in the natural or existing cut slopes.

This section will **have six** cuts, several over 500 feet long. For planning purposes the recommended slope for cuts in the silty sedimentary material is 1.5:1. The alignment emerges from this steep ravine before crossing into granitic terrain at the Kern River Fault.

Beach 5

Reach 5 is exclusively in granitic terrain, extending from the Kern Canyon Fault contact to the divide between the Poso Creek and Kern River drainages. The alignment generally parallels Rancheria Road passing across barren granitic uplands, high on the slope above the bottom of the valleys of Rancheria and Rattlesnake Creeks. The outcrops are limited to mostly isolated bouldery exposures protruding from the decomposed granitic slopes (see Photo 5).

This reach consists of long stretches of sidehill cut with through cuts bisecting the many spurs, and long fills bridging the numerous side-canyons **(see** Photos *6,7,8,9,* and 10). Thirteen long cuts are encountered along this section with many of these being over 1,000 feet long and over 60 feet high. They include the longest cut, at 4522 feet, along the new alignment. Existing cuts along Rancheria Road are limited, rarely exceeding 30 feet in height and generally standing near vertical. The existing cuts rarely extend beyond the zone of decomposed to moderately weathered rock. New cuts in the decomposed granitic material will be susceptible to erosion and sloughing. The existing cuts show evidence of periodic maintenance required to removed sloughed material, probably following heavy rainfalls.

For planning purposes the recommended slope for cuts exclusively in soil and decomposed granitic material is 1.5:1. Cuts entering moderately weathered granitic material may be increased to 1:1 and those extending into slightly weathered rock may be steepened to 0.75:1. The steeper cuts should utilize the presplitting method of blasting to insure stability. Additional width should be allowed for 20-foot intermediate benches in equi-spaced 30-50 foot lifts for cuts 60 feet or higher and catchment areas at grade according to Ritchie's criteria (see Table 2).

Several narrow and deep dry side-canyons are crossed that dictate 13 fills. Most of these fills are over 500 feet long, including the longest fill along the new alignment, at 2645 feet, and many are over 60 feet high. These side-canyons, although presently dry, are subject to torrential flows and will require adequate culvert design.

Reach 6

Reach 6 is also exclusively in granitic terrain, extending from the Poso Creek/Kern **River divide (see** Photos 11 and 12) descending toward the inner gorge of the Kern Canyon **(see** Photos 13,14,15,16,17, and 18). Three minor drainage systems are crossed on the flanks of Saturday Peak and include one structure site. Long stretches of sidehill cut are interspersed with through cuts, and fills bridging the elongated ridges that form the tributary divides. The outcrops become more frequent but are mostly limited to hard ribs that are expressed as ridges and limited exposures in the bottoms of gullies.

All ten cuts in this reach are long with two exceeding 1,000 feet. Most of these cuts exceed 60 feet in height. The decomposed granitic material is subject to erosion and the coarse granitic material is susceptible to weathering along grain boundaries with time. The depth of weathering is generally less than in Reach 5. For planning purposes the recommended slope for cuts in decomposed to moderately weathered granitic material is 1:1 and those extending into slightly weathered rock may be steepened to 0.75:1. Again, these steeper cuts should utilize the presplitting method of blasting to insure stability. Additional width should be allowed in cuts steeper than 1.25:1 for 20-foot intermediate benches in equi-spaced 30-50 foot lifts for cuts 60 feet or higher and catchment areas at grade according to Ritchie's criteria (see Table 2).

Several narrow and deep side-canyons are crossed, including one with perennial flow, that will require 10 fills. Many of these tills are over 500 feet long and most are over 60 feet high. Culverts should be designed to accomodate the intermittent, raging flows. A separate foundation investigation will be required to determine the subsurface conditions for structure design.

Reach 7

Reach 7 consists of the rugged, boulder-strewn, inner-gorge section from the end of the Saturday Creek drainage to the Democrat Dam site. The alignment continues to descend toward the river and consists of mostly long stretches of sidehill cut *(see* Photo 19), and intervening fills spanning the major side-canyons **(see** Photos 20,21,22, and 23). The outcrops become very frequent and the zone of decomposed granitic rock is generally thin to non-existent.

Five cuts are indicated in this reach. Most of these are long, with one exceeding 1,000 feet, and most exceed 60 feet in height. For planning purposes the recommended slope for cuts extending into slightly weathered rock is 0.75:1. These cuts should utilize the presplitting method of blasting to insure stability. The depth of weathering is generally less than in any other reach. Therefore, cuts will likely require blasting nearer to the surface than any other reach. Additional width should be allowed for 20-foot intermediate benches in equi-spaced 30-50 foot lifts for cuts 60 feet or higher and catchment areas at grade according to Ritchie's criteria **(see** Table 2).

Several narrow and deep side-canyons are crossed, including two with perennial flow, that will require five fills. Most of these are over 500 feet long and over 60 feet high. Culverts should be designed to accomodate the intermittent, maximum flows.

Reach 8

Reach 8 extends from where the upper Kern Canyon begins to open up, near Democrat Dam site (see Photo 24), to just before the east crossing of the Kern River. This reach remains in granitic

terrain with minor terrace material and alluvium adjacent to the river and in the side canyons. The alignment consists of long stretches of sidehill cut and through cuts where it bisects spurs that extend toward the river (see Photos 25,26,27, and 28). The outcrops become less frequent and are mostly limited to hard ribs that are expressed as ridges and limited exposures in the bottoms of gullies.

Four cuts are indicated in this reach. Most of these are greater than 500 feet long and are over 60 feet high. The cuts in this reach have been covered in a previous investigation (23) conducted at the time the upper section of the existing High 178 was constructed. For planning purposes the recommended slope for cuts in decomposed to moderately weathered granitic material is 1:1 and those extending into slightly weathered rock may be steepened to 0.75:1. The 0.75:1 cuts should utilize the presplitting method of blasting to insure stability. Additional width should be allowed in cuts steeper than 1.25:1 for 20-foot intermediate benches in equi-spaced 30-50 foot lifts for cuts 60 feet or higher and catchment areas at grade according to Ritchie's criteria (see Table 2).

Several narrow and deep side-canyons are crossed, including two with perennial flow, that will require 3 fills. Two of these fills are over 1,000 feet long and one is over 60 feet high. The highest fill along the new alignment is located at Sta. 1930+70. Culverts should be designed to accommodate the intermittent, maximum flows.

Reach 9

Reach 9 consists of the approach and structure site at the east crossing of the Kern River west of China Garden (see Photo 29). This section is in granitic terrain with terrace material and alluvium adjacent to the river. Granitic rock outcrops on the eastern side of the crossing, the western edge of the meander neck that makes up China Garden. This reach includes one fill that is longer than 500 feet and higher than 60 feet. A separate foundation investigation will be required to determine the subsurface conditions for structure design.

Reach 10

Reach 10 extends across the meander neck of China Garden **(see** Photo 30), across a multiple gully basin dropping down close to the river (see Photo 31), and connects with the excavated but unfinished extension of the existing highway **(see** Photo 32). The alignment remains in granitic terrain with minor alluvial accumulations adjacent to the river and in the side canyons. The outcrops are mostly limited to hard ribs on ridges, isolated boulder piles and limited exposures in the bottoms of gullies.

This reach includes one main through cut and one main fill. The cut is over 1,000 feet long and 130 feet deep, the deepest cut along the new alignment. The fill is over 1,000 long and higher than 60 feet, bridging the large basin east of China Garden. The

cuts in this reach have been covered in a previous investigation (22) conducted at the time the upper section of the existing highway 178 was constructed. For planning purposes the recommended slope for cuts exclusively in alluvium and decomposed granitic material is 1.5:1. Cuts entering moderately weathered granitic material may be increased to 1:1, and those extending into slightly weathered rock may be steepened to 0.75:1. Again, the 0.75:1 cuts should utilize the presplitting method of blasting to insure stability. Additional width should be allowed in cuts steeper than 1.25:1 for 20-foot intermediate benches in equi-spaced 30-50 foot lifts for cuts 60 feet or higher and catchment areas at grade according to Ritchie's criteria (see Table 2).

Several narrow and deep side-canyons, including one with perennial flow, make up the long fill section. Culverts should be designed to accomodate the intermittent, maximum flows. One spring is present on or near the alignment at Sta 2097+50 that should be cleaned of muck, backfilled with permeable material and allowed to drain out from under the fill.

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APPENDIX A

Photographic Log of New Alignment

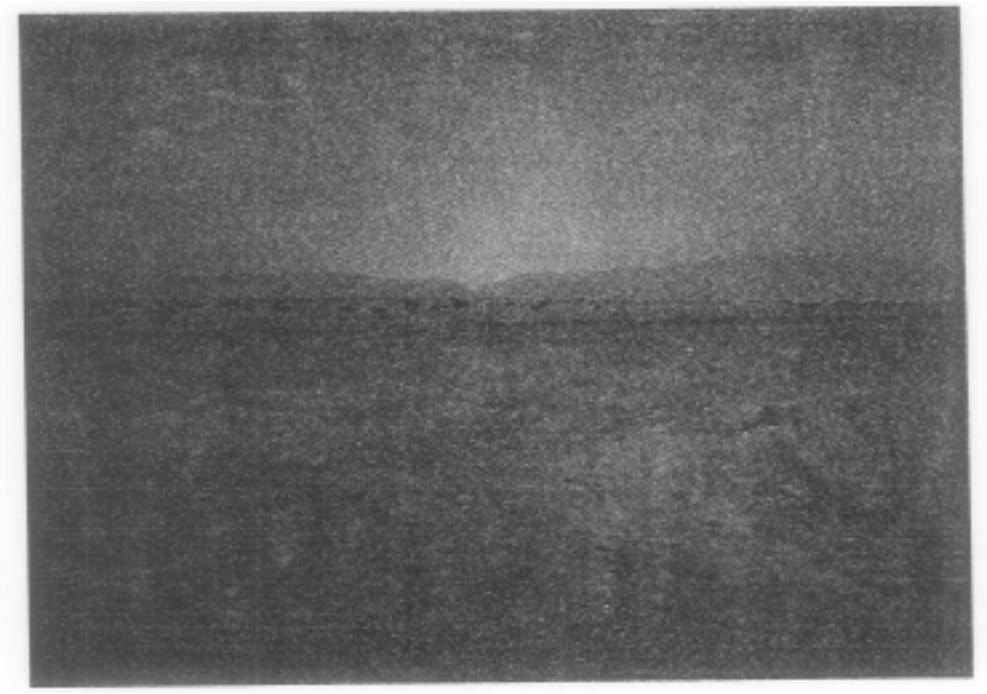

PHOTO 1 10-15-84
Ahead from Sta 776. View from beginning of project. Kern River Formation.

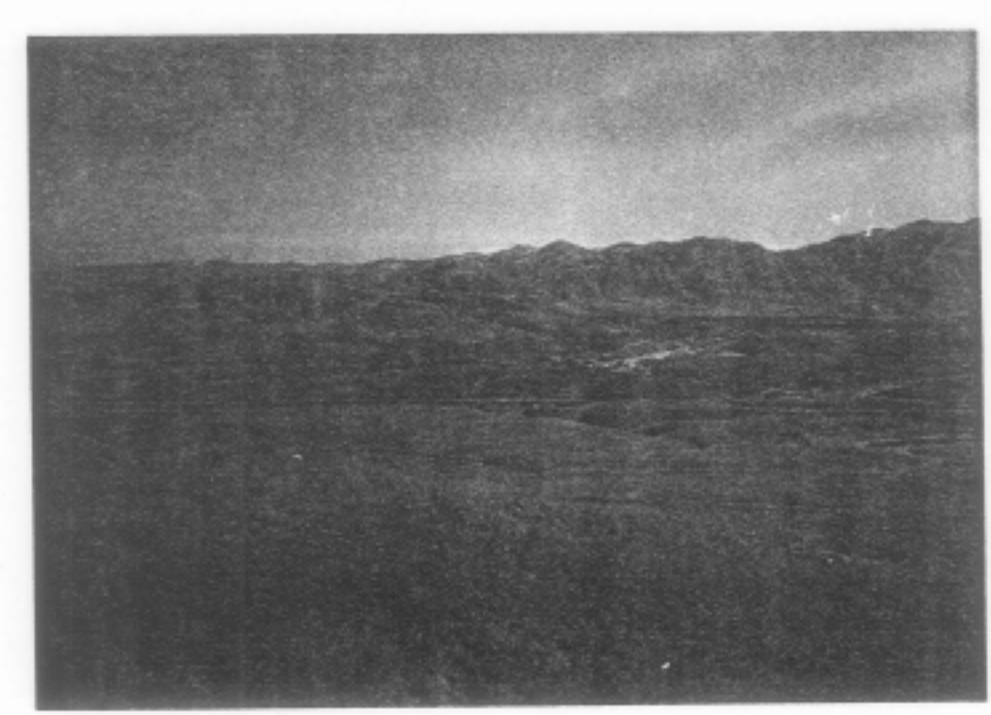

PHOTO 2 10-16-84
Ahead from Sta 1028. Greenhorn Mountains in background. Grass-covered hills in center form terrace deposits along the west side of the Kern River.

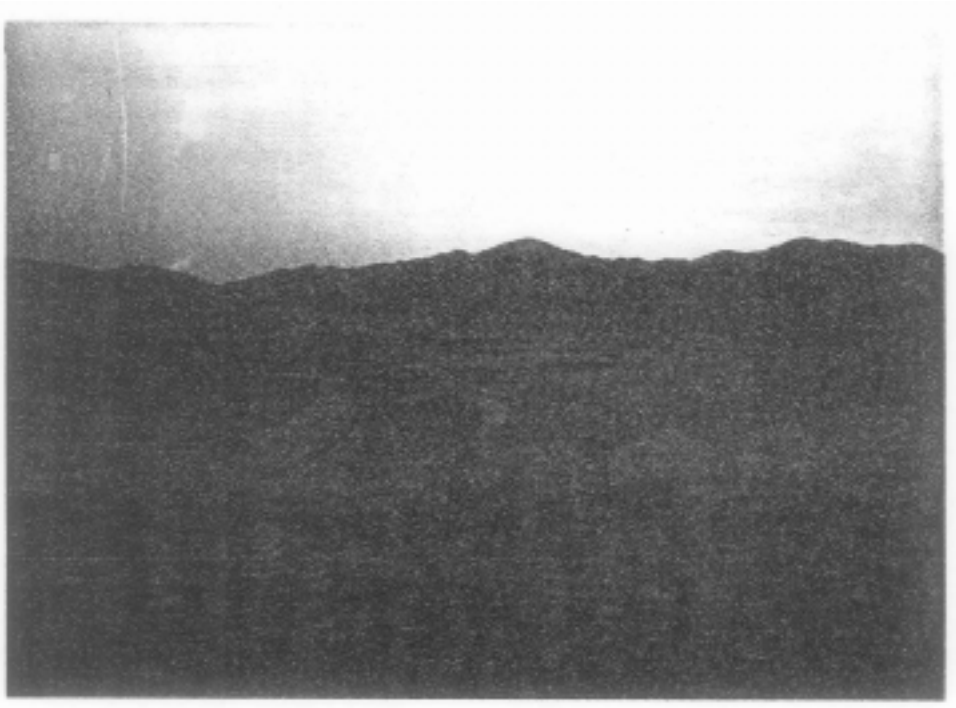

PHOTO 3 10-16-84
Ahead from Sta 1120. Alignment curves paralleling Rancheria Road. At point of curve centerline is 200ft Rt. of Rancheria Road then crosses high up on hill at Lt. center. Miocene marine silt. Scarp of Kern River Fault in background.

PHOTO 4 10-16-84
Ahead from Sta 1180. Rancheria Road in Miocene silt. Cuts are less than 30ft high and stand at a fairly steep angle. Material subject to sloughing and requires maintenance to remove slough.

PHOTO 5 10-17-84
At Sta 1245. Granitic outcrop. Typical of broken nature of outcrops.

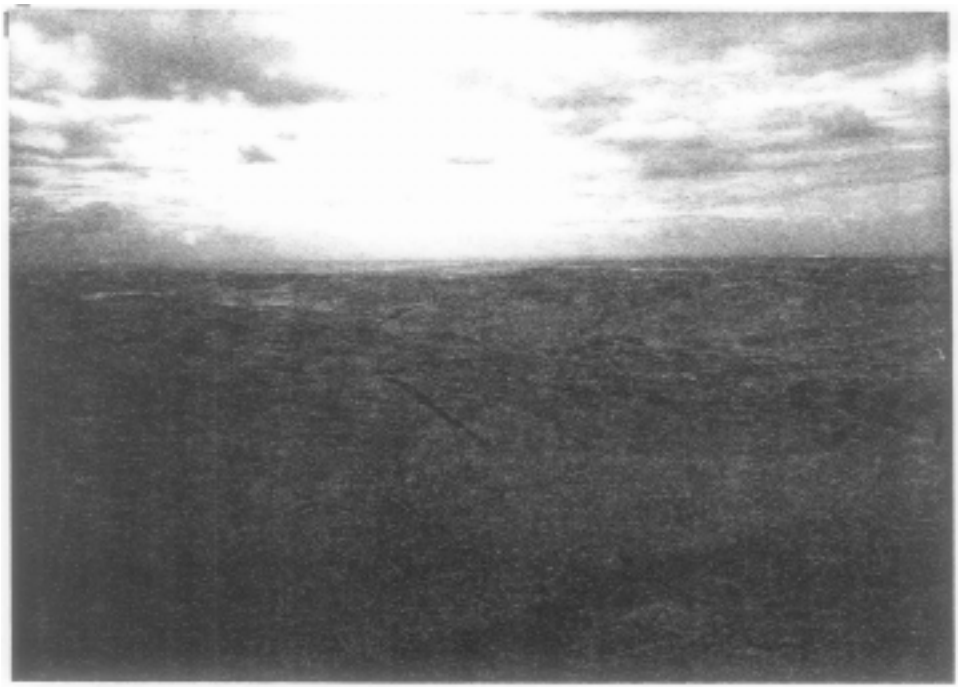

PHOTO 6 10-17-84
Back from Sta 1281. Area is mostly cut. Decomposed granitic material and broken granitic outcrop.

PHOTO 7 10-17-84
Ahead from Sta 1328 on line. Begin curve in middle distance. Rancheria Rd. on left.

PHOTO 8 10-17-84
Ahead from Sta 1426. Center of photo is on line. Long tangent section ahead in cut and fill terrain of decomposed granitic material. Green house is Lt.of Sta 1438.

PHOTO 9 10-18-84
Ahead from Rt. of Sta 1505 toward Sta 1532 near top (near side) of large hill in middle distance. **Tangent** section along this ridge. No outcrop visible along line. Large fill to cross drainage at Sta 1513.

PHOTO 10 10-18-84
Back from Sta 1552. Cut and fill in decomposed granitic material.

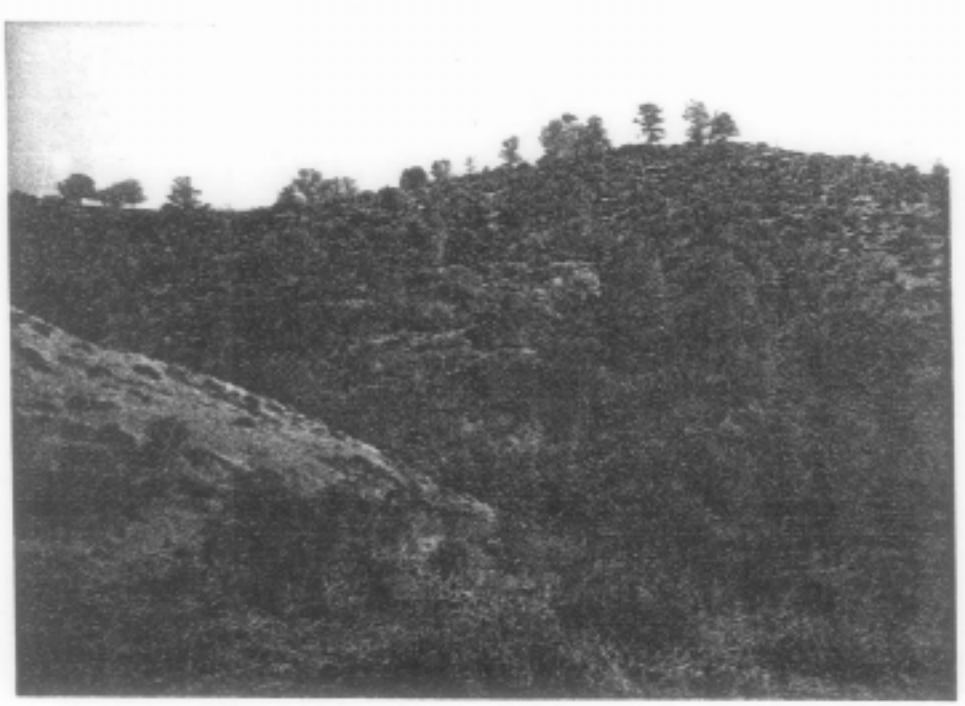

PHOTO 11 10-30-84
Ahead from Sta 1558 from fenceline at National Forest boundary. Line curves as it crosses ravine passing high on the slope to the right of the saddle at the crest of the alignment.

PHOTO 12 10-30-84
Ahead from Sta 1602 on Line. Alignment descends from crest into steep ravine. Line crosses inside of saddle in background.

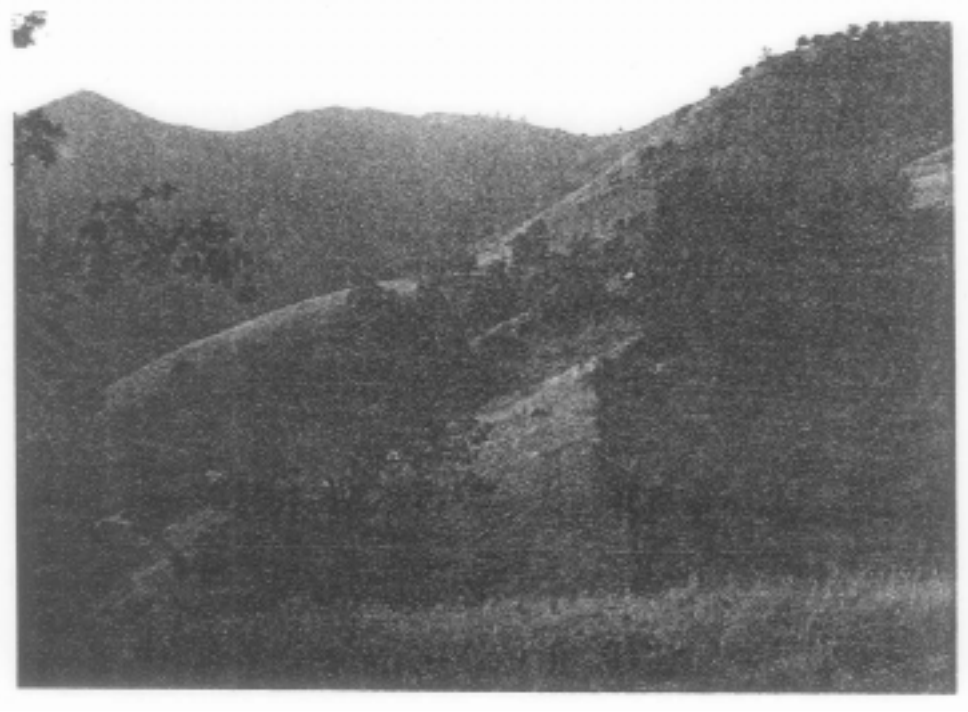

PHOTO 13 10-30-84
Back from Sta 1730. Alignment crosses two gullies in large amphitheater. Previous photo from 1602 taken just below trees on skyline at upper right.

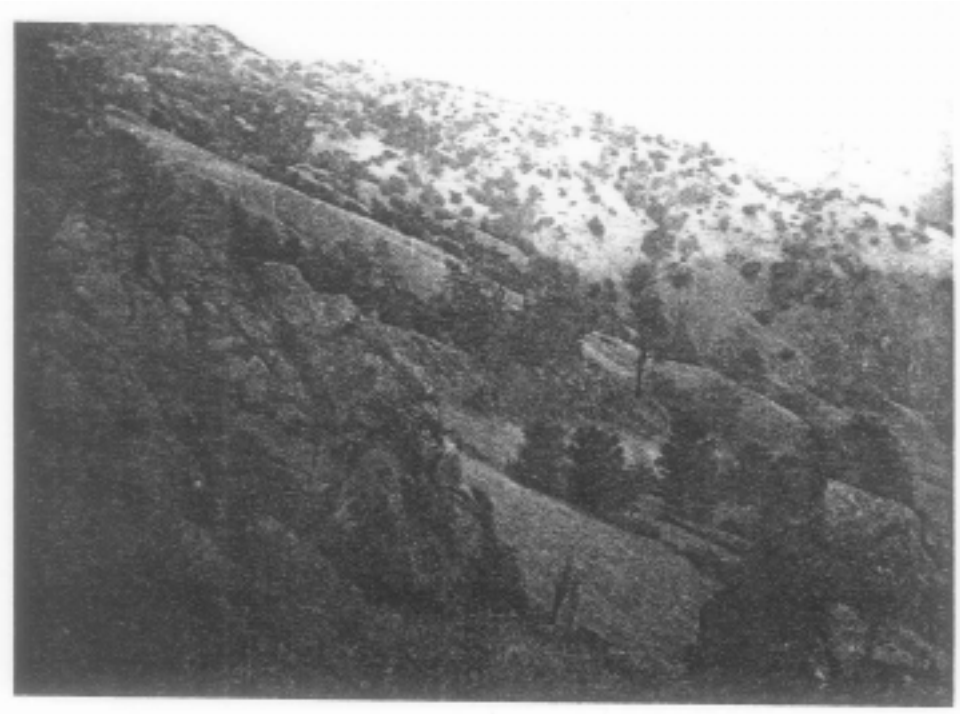

PHOTO 14 10-30-84
Ahead from Sta 1730. Alignment curves running along hillside crossing two main gullies and several outcrops.

PHOTO 15 11-01-84
Back from Sta 1775. Alignment crossing outcrop rib at Sta 1730. Boulders and outcrop exposed in several intervening gullies.

PHOTO 16 11-01-84
Ahead from Sta 1775. Alignment bends around ridge formed by rib of outcrop.

PHOTO 17 11-01-84
Ahead from Sta 1810. Line descends and bends through the three major ravines of Saturday Spring Creek drainage amphitheater.

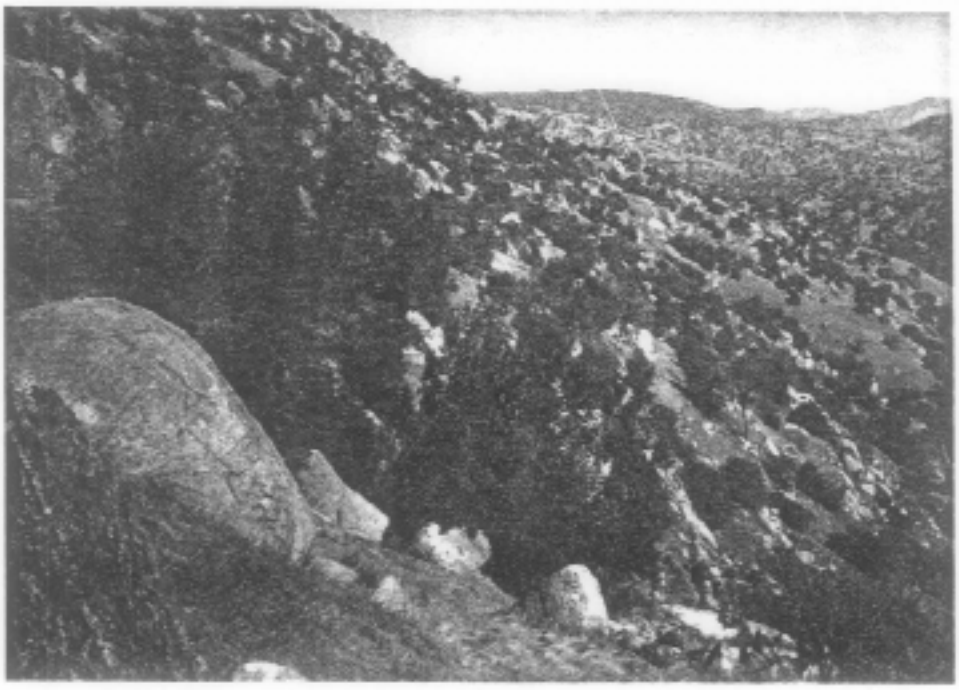

PHOTO 18 11-01-84
Ahead from Sta 1839. Descending into last ravine of Saturday Spring Creek drainage. Bouldery outcrop exposed above thin colluvial cover. Note the last alignment stake found in middleground.

PHOTO 19 11-01-84
Ahead from Sta 1880. Alignment crosses steep sidehill of inner canyon through bouldery outcrop and thin colluvial cover. Ridge in background is west of gauging station.

PHOTO 20 11-01-84
Back from Sta 1884. Alignment crosses long sidehill and narrow deep gullies of Saturday Spring Creek drainage.

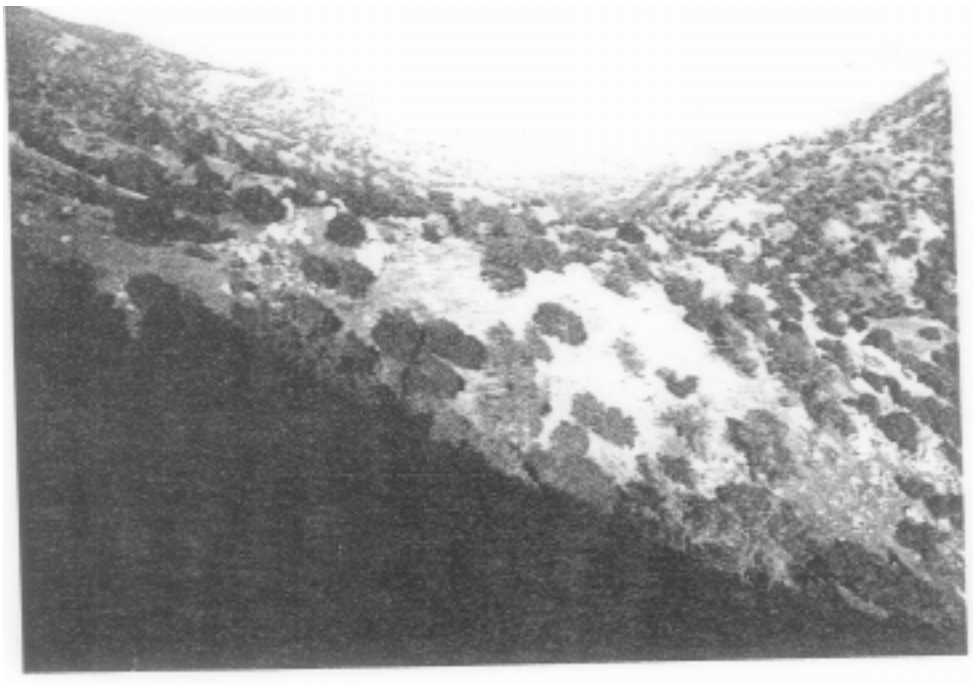

PHOTO 21 11-01-84
Ahead from Sta 1890. Alignment crosses deep ravine above cable crossing at gauging station. Outcrop is exposed in bottom of ravine and on ridges. Alignment continues to descend toward the river.

PHOTO 22 11-14-84
View downstream toward Saturday Spring Creek drainage from existing highway. Alignment runs along sidehill just below the skyline.

PHOTO 23 11-14-84
Opposite Sta 1910 from existing highway. Outcrop with well-defined joint set exposed just above the river downstream from Democrat dam. Attitude estimated at N10W and dip 35-40W.

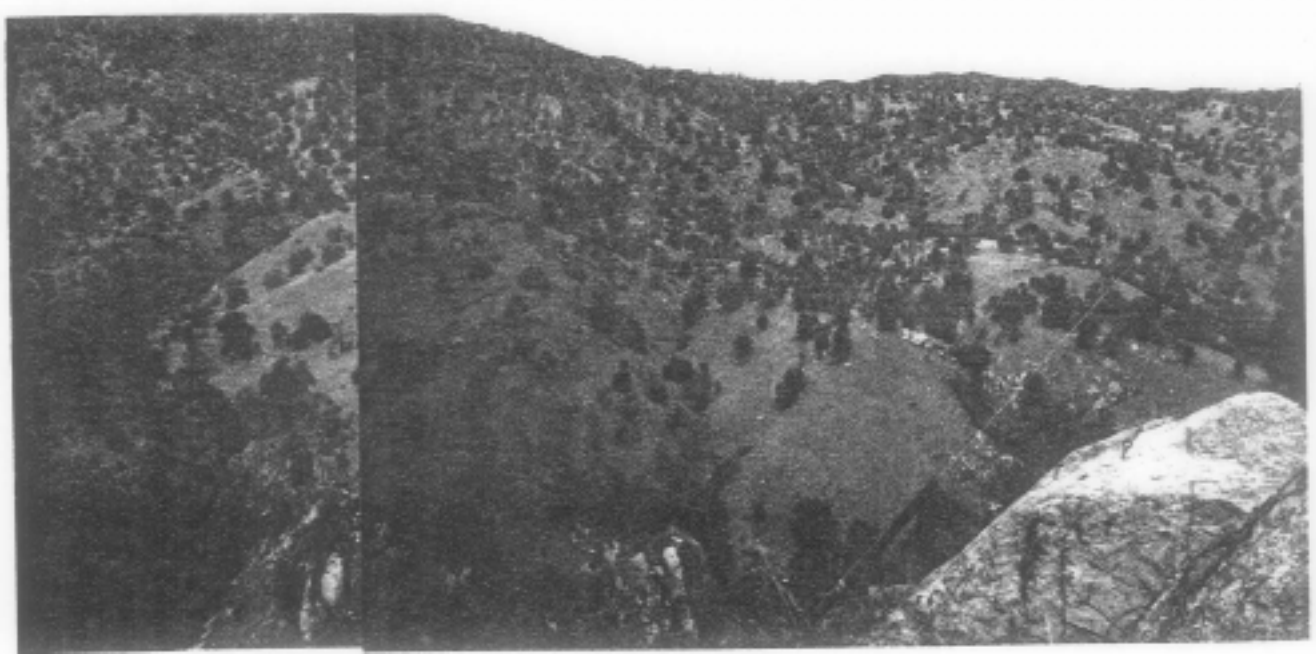

PHOTO 24 11-14-84
Opposite Sta 1932 directly above Democrat dam. Alignment crosses sidehill descending toward river from left to right near the center of the photo.

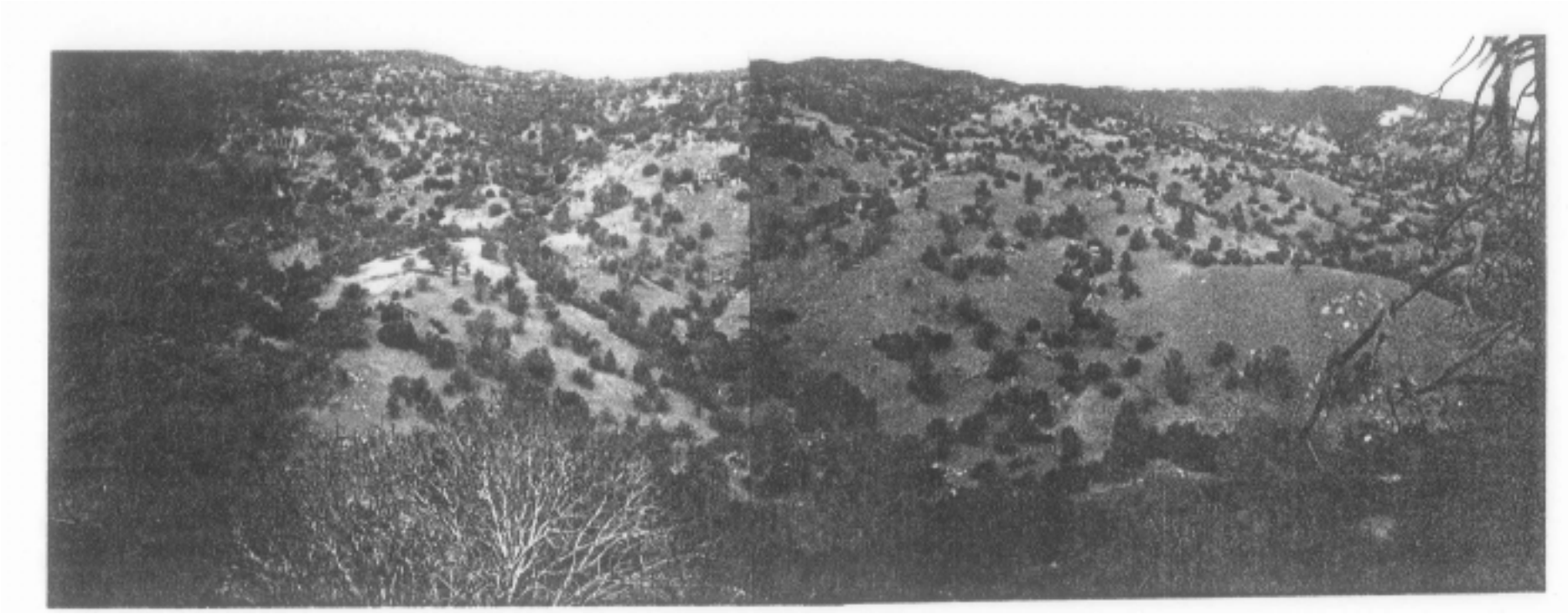

PHOTO 25 11-14-84
Opposite Sta 1940. Alignment runs from left to right across center of photo. Ridge at Sta 2015 on right protrudes into river opposite Democrat Hot Springs.

PHOTO 26 11-14-84
Opposite Sta 2020 across from Prefedio Creek. Alignment runs from left to right across photo beginning at saddle of ridge at Sta 2015.

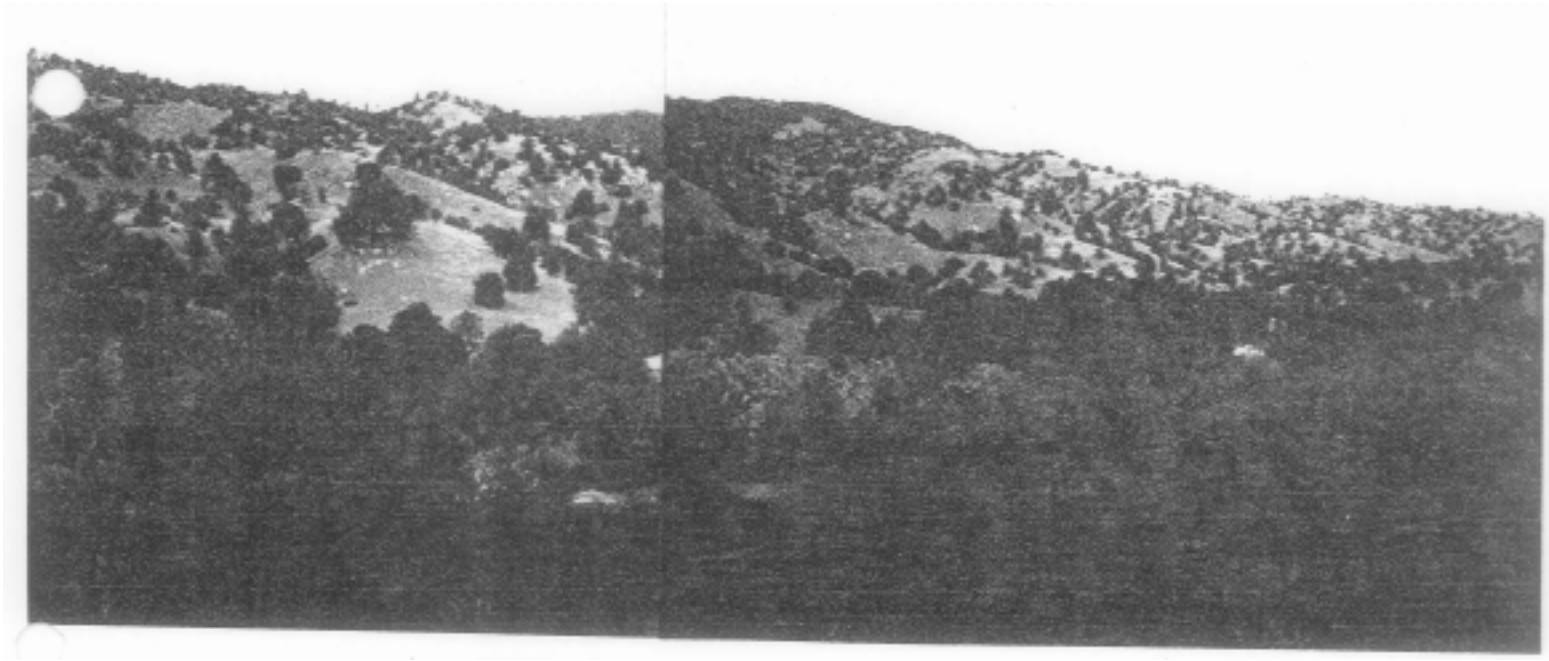

PHOTO 27 11-14-84
Opposite Sta 2030. Alignment crosses from left to right of photo just above change in slope near center of photo. Island in the middle of the river at Democrat beach is at right.

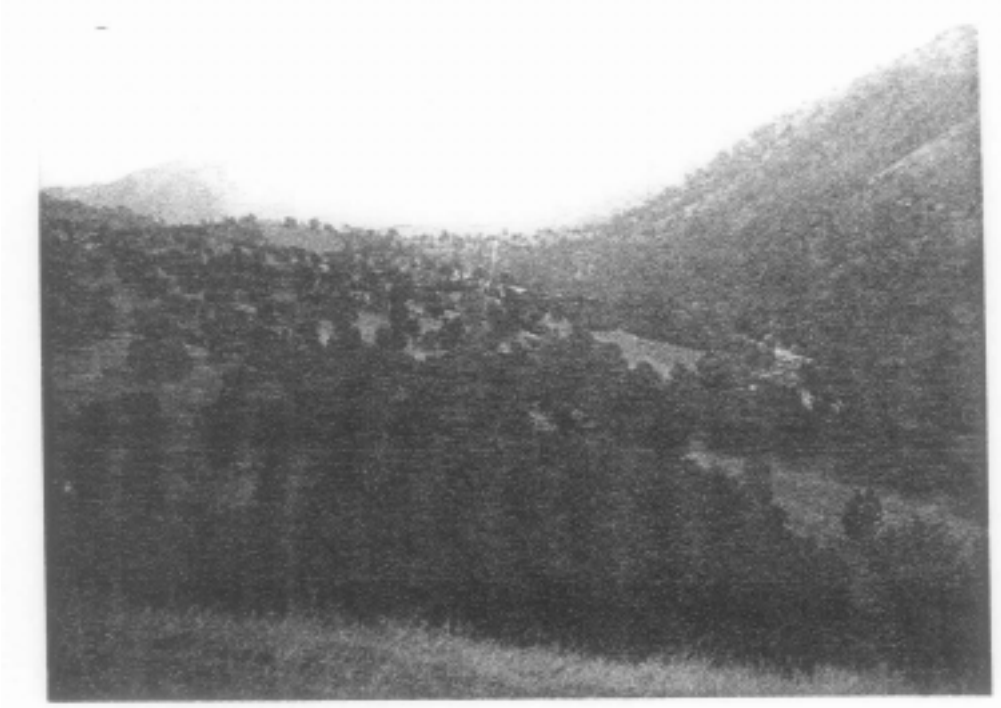

PHOTO 28 10-31-84
Ahead from Sta 2030 on Line toward Sta 2045. Outcrops exposed along ridges.

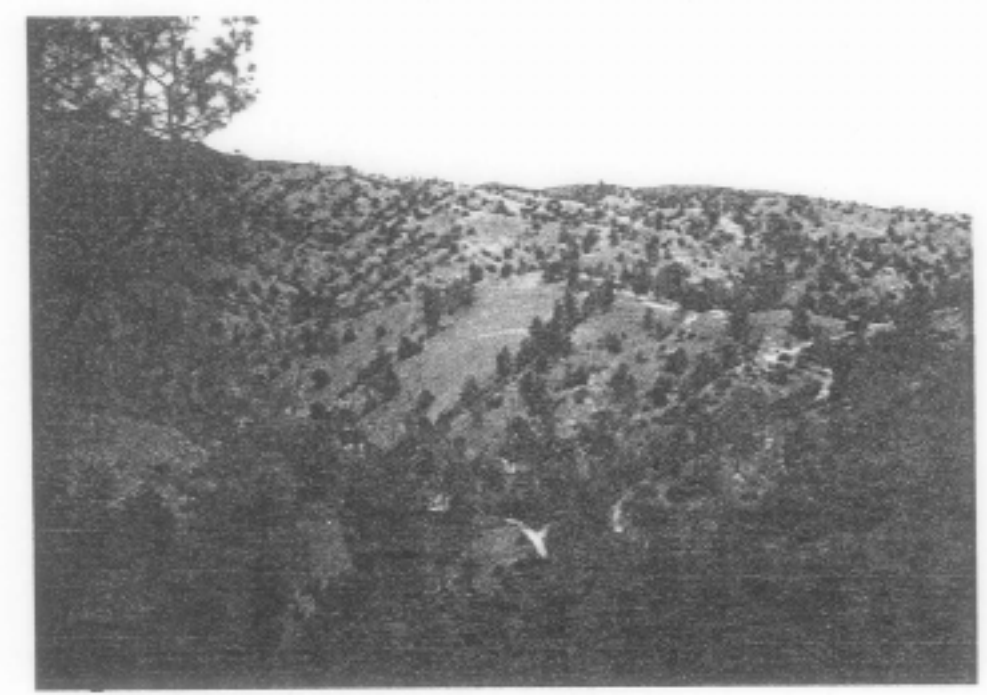

PHOTO 29 11-14-84
View upstream from existing Hwy 178 toward old suspension bridge. Alignment crosses river at Sta 2072 and meander neck of China Garden at Sta 2080 that will require the deepest cut of the alignment.

PHOTO 30 10-31-84
Ahead from Sta 2065 toward road heading down to foot bridge on east side of river. Knob of outcrop visible across river in background.

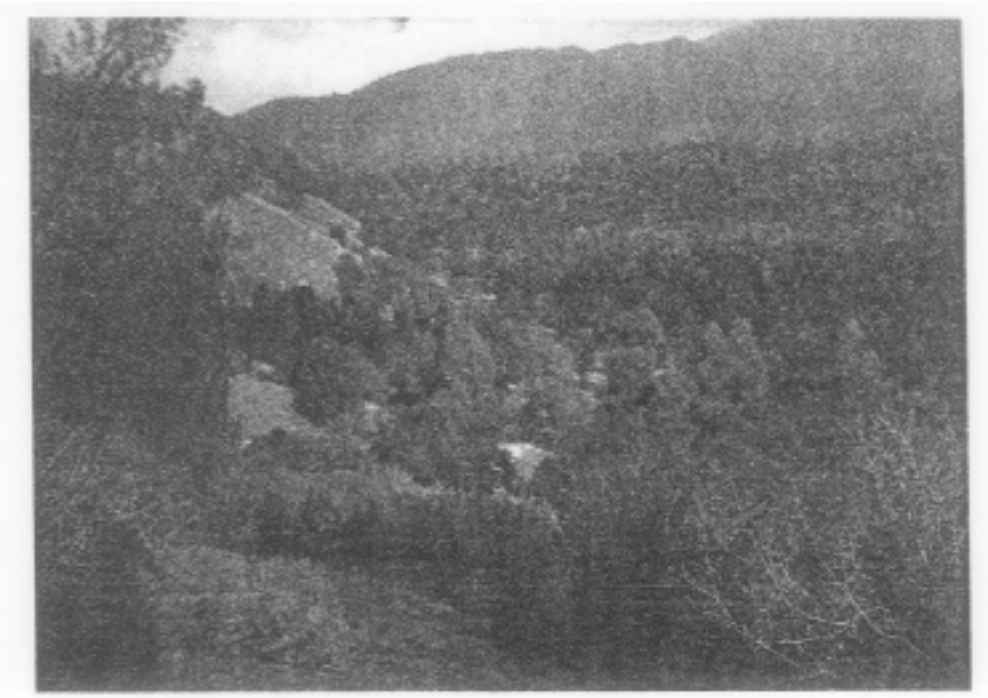

PHOTO 31 10-31-84
Ahead from Sta 2082 on line. Alignment requires high fill to span topographic low by river. New alignment joins with the existing road at cut in background.

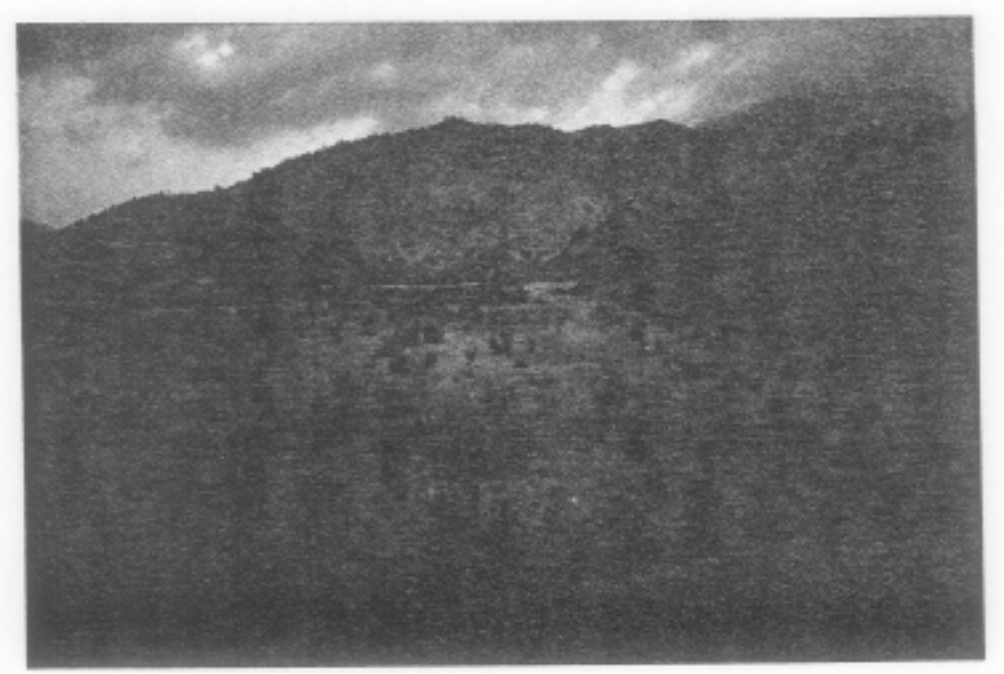

PHOTO 32 10-31-84
Ahead from Sta 2125 on line. Continuation of through cut toward second cut in background where alignment joins existing road at Sta 2150.