STATE OF CALIFORNIA

The Resources Agency

Department of Water Resources

BULLETIN No. 172

EEL RIVER DEVELOPMENT ALTERNATIVES

Appendix

SUPPORTING STUDIES

JANUARY 1970

NORMAN B. LIVERMORE, JR.
Secretary for Resources
The Resources Agency

RONALD REAGAN
Governor
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FOREWORD

In 1968 the Corps of Engineers submitted its report on the Dos Rios Project to the State of California for review. In May 1969, Governor Reagan expressed his concern about the flooding of Round Valley and the displacement of the Indian community and asked for a study of project alternatives.

Bulletin No. 172 was prepared in response to the Governor's request. It summarizes the studies of six principal alternative developments and briefly describes several secondary alternatives.

This appendix presents detailed descriptions of the alternative developments investigated. It includes discussions of the formulation of the projects and provides cost data for each alternative.

William R. Gianelli

William R. Gianelli, Director
Department of Water Resources
The Resources Agency
State of California
January 27, 1970

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INTRODUCTION

On May 13, 1969, Governor Reagan directed the Department of Water Resources to work with the Corps of Engineers to make further analyses of possible developments within the Eel River watershed. In response to that directive, the Department prepared Bulletin No. 172, "Eel River Development Alternatives". This appendix outlines the criteria and procedures used in the study and presents detailed information on the various alternatives.

Definition of Alternatives

A primary need was to define what would constitute an alternative for purposes of this study. Ideally, each alternative would provide the same flood control, recreation, and water supply accomplishments as the proposed large Dos Rios Project. However, the physical and economic limitations preclude meeting such a criterion. The standard was adopted that an alternative, as a minimum, would have to produce a yield at the Sacramento-San Joaquin Delta equivalent to the 900,000 acre-feet of new yield which the Corps' Dos Rios Project could provide. To allow for local use, those alternatives employing the southern diversion route would have to produce about 200,000 acre-feet per year in addition to the basic 900,000-acre-foot yield. The flood control and recreation accomplishments varied with an individual alternative's capabilities.

Economic Criteria

In keeping with the Department's usual planning procedures, a 100-year period of analysis was used for the alternatives study. The beginning of the period of analysis was chosen as 1986, the year in which the State Water Project is expected to first need additional water supplies. An interest rate of 5 percent was used throughout the study. All cost estimates for the alternatives were adjusted to the same price basis, July 1969.

No attempt was made to differentiate between potential state and federal expenditures at this level of study. Nevertheless, the extent of federal participation could have a major impact on the attractiveness of the alternatives from the State's viewpoint.

Economic analyses of the various developments covered by this study were limited to direct project costs. The total cost of each project would be allocated among the various project purposes, including flood control, recreation, and water supply. These cost allocations, needed to determine the cost of water from each development, require detailed and lengthy evaluations of project benefits. Work on evaluation of benefits is being carried out as part of the Department's current reexamination of issues involved in routing of water from the Eel River.

GEOLOGY, DESIGN, AND COST STUDIES

Most of the features which are included in the alternative developments have been studied previously in connection with the investigations which led to the initial choice of the Dos Rios Project. The levels of study of the various features range from complete feasibility reports to low-level reconnaissance. Given these levels of prior study, special effort was made to achieve comparability in cost estimates.

The Dos Rios Project variations, the Spencer Project on the Middle Fork Eel, and the Rancheria Project were covered by investigations for Bulletin No. 171, "Upper Eel River Development -- Investigation of Alternative Conveyance Routes". Work on these projects for this report consisted mainly of indexing cost estimates to the selected price basis.

At the time the Governor requested this work, the Department was completing additional surface geologic studies of the sourthern route diversion facilities and the major damsites in the Cache Creek Basin. New designs and cost estimates of these features were prepared for use in this study. The Department also performed limited surface geologic investigations and prepared cursory cost estimates for the pumping plants and tunnels required to move water upstream from the lower Eel River developments.

The Corps of Engineers provided preliminary cost estimates for Yellow Jacket Dam and Reservoir and independently formulated various eastern route alternative projects. The Bureau of Reclamation furnished cost estimates for Mina Dam and Reservoir, the English Ridge Project, and the Paskenta-Newville Project. The Mina data are very preliminary, but the other two projects have been investigated at the feasibility level.

Four features, the Grindstone Tunnel and Bear Valley, Blue Ridge, and Mill Creek Dams, are of special significance to the six principal alternatives. Accordingly, the Department retained the firm of Bechtel, Incorporated, to evaluate the sites and to prepare cost estimates for each of these features. The consulting firm concluded that the available evidence made it reasonable to assume that each of the four features could be successfully constructed. The cost estimates for these features, which are shown in this appendix, have been derived from the Bechtel estimates, with adjustments only for differences in size of dam or diameter of tunnel.

Feasibility studies of all aspects of project development are needed prior to the implementation of any of the alternatives.

Rejected Alternatives

Bulletin No. 172 identifies ten secondary alternatives, in addition to the six principal alternatives. All of the principal alternatives and six of the secondary alternatives are described in detail in this appendix; the remaining four plans, discussed in the following paragraphs, were rejected because of unsuitable geologic conditions at key damsites.

Alternatives 9 and 11 were formulated as eastern and southern diversion route plans from an Indian Springs Reservoir on the main Eel River. Located just 2 miles downstream from the mouth of the Middle Fork Eel River, Indian Springs Dam could form a 1,750,000-acre-foot reservoir reaching to the extreme lower ends of both Round Valley and Little Lake Valley. From a physical standpoint, the Indian Springs Project appeared attractive because it could provide flood protection in addition to developing substantial water supply. However, surficial geologic examinations of the Indian Springs Dam site which were conducted during this study indicated that the site was unsuitable for the high dam (515 feet) which would be required. A shear zone, believed to be major, exists in the channel area and extensive landslides are present on the right abutment. For these reasons, study of Alternatives 9 and 11 was abandoned.

Alternatives 10 and 12 were investigated as eastern and southern diversion route plans from an Upper Island Mountain Reservoir on the lower Eel River. Upper Island Mountain Dam site is located about 20 miles downstream from the mouth of the North Fork Eel River. The project initially appeared attractive because it could develop essentially all of the runoff which would be available at Yellow Jacket Dam site farther downstream. However, investigation by the Department during this study revealed that the Upper Island Mountain Dam site is unsuitable for construction of the very high (700 to 800 feet) dam which would be required. Much of the foundation rock is sheared and crushed to such a degree that the integrity of the foundation is questionable. In addition, landslides and deep overburden cover much of the damsite and adjacent areas. Therefore, planning work on Alternatives 10 and 12 was halted.

Many other potential damsites within the Eel River Basin have been examined during earlier investigations. They have been rejected for various reasons before this study of alternatives was begun. These include Jarbow, Etsel, and Lower Etsel Dam sites on the Middle Fork Eel River, which were abandoned because of adverse foundation conditions. On the main Eel River between the Middle Fork and the North Fork confluences, Woodman and Bell Springs Dam sites have similarly been considered and rejected because of unsuitable geologic conditions. Sequoia Dam site, on the lower Eel River just upstream from the mouth of the South Fork, was rejected because the nearby Yellow Jacket site appears to be superior.

WATER SUPPLY STUDIES

Studies of the water supply capabilities of each alternative are based on meeting the projected needs for water in the Sacramento-San Joaquin Delta to maintain the contractual commitments of the existing State Water Project. In addition, those systems using a southern diversion route were formulated to supply an additional 200,000 acre-feet per year to meet projected demands in Mendocino, Lake, Sonoma, Napa, and Marin Counties; an analysis was also included for an independently-constructed English Ridge Project which could serve these needs if an eastern diversion route was constructed.

The need of the State Water Project for additional water will vary from year to year. In about half of the years, the natural runoff and the

yield of the initial conservation facilities (Oroville and San Luis Reservoirs and the Delta facilities) will be adequate and no additional water will be needed. In drier years, some additional water will be required and, in a prolonged dry spell such as occurred in 1928 through 1934, an additional supply averaging 900,000 acre-feet per year will be needed, after taking into account all allowable agricultural water deficiencies. The initial demand for additional water is projected to occur in 1986 and the full demand by about 1990.

Alternatives 3 and 6, involving the Yellow Jacket Project on the lower Eel River, would provide more water than the existing State Water Project and local demands will require. In these cases, it was assumed that the extra capacity would be used to deliver supplemental firm yield above the minimum State Water Project yield now under contract. This firm yield would be delivered every year, as contrasted to the State Water Project yield which would be coordinated with the supply in the Delta. For purposes of this study, the demand for supplemental firm yield was assumed to begin in 1990 and increase annually by 150,000 acre-feet per year.

Project Sizing

The traditional concept for sizing water projects is that of maximization of net benefits; the project scale is enlarged until the incremental costs of enlargement are equal to the incremental benefits produced. In this study, conventional reservoir operation analyses showed that some extremely large reservoirs could be justified since the incremental costs of yield were relatively low. However, these extremely large reservoirs would have carryover periods (the intervals between the times when the reservoir filled completely) approaching the length of the 50-year hydrologic study period. Thus, while the studies satisfied the conventional definition of yield, the carryover periods were without precedent, and the large yields were made possible only by the "wet-dry-wet" cycle in the 1911-60 hydrologic study period. The yields of the extremely large reservoirs would be statistically much less dependable than those of smaller reservoirs which could refill more easily. Therefore, an alternative method for limiting the sizes of reservoirs was needed.

To meet this need, a criterion was developed which allowed matching the amount of total active storage capacity in a reservoir system to the net water supply which would be available, on a long-term average basis, for refilling once the reservoirs were drawn down to minimum level. The Corps' Dos Rios Project was selected as a guide for matching storage capacities to the available water supplies. The 7,600,000-acre-foot Dos Rios Reservoir was found to have a ratio of active storage to net long-term average annual refilling supply of 13. Thus, when operating at full demand levels, the average refilling time of the large Dos Rios Reservoir would be 13 years. This refilling time was used as a guide to establish the amount of storage in a given system when no other constraint was applicable. After this method was used to determine the total storage needed in a system, an economic balance was employed to apportion the total storage among the various reservoirs.

Using this method of sizing, it was found that most of the principal alternatives would produce only slightly more yield than required to meet

State Water Project and local demands. Therefore, to facilitate comparison, minor adjustments were made in project formulation to make the principal eastern route projects yield 900,000 acre-feet per year and the southern route projects yield 1,100,000 acre-feet per year. The alternatives involving Yellow Jacket Reservoir on the lower Eel River could produce considerably more yield than any of the other systems. They could not be formulated to have yields comparable to the other alternatives without severe distortion of their actual capabilities. Therefore, the Yellow Jacket Reservoir alternatives illustrated were sized in accordance with the criterion described above and would produce much larger yields than any of the other alternatives.

Project Staging

Economic analyses of the alternatives were based upon staging plans which would allow the various dams and tunnels to be constructed as late as possible to still permit meeting the projected water demands. Recent studies indicate that a large Dos Rios Reservoir should be completed by about 1983 to allow time for reservoir filling to provide a reasonable chance of success in meeting the State Water Project demands projected to begin in 1986. This long filling interval is caused primarily by the large amount of dead storage in Dos Rios Reservoir. Based upon these Dos Rios Reservoir filling studies, the following criterion was developed for staging reservoirs in this study: The total active storage of a given reservoir system should be two-thirds full by the end of the demand buildup period, assuming that average inflow and demand conditions prevail during the filling period. The system should also be capable of meeting the initial possible demands in 1986, barring an extremely dry period during the first year or two of operation.

Using this criterion, it was found that most of the alternatives could be staged for somewhat later construction than the large Dos Rios Reservoir. These later construction dates would be made possible by the higher ratios of inflow to storage.

FLOOD CONTROL STUDIES

Early in this study, the Corps of Engineers furnished estimates of the flood benefits associated with varying amounts of flood reservations in the various Eel Basin reservoirs, as well as recommended amounts of flood reservation at each site. The estimates were based on the assumption that the Eel Delta Levee Project would be in operation.

Insofar as practical, each alternative was formulated to provide at least the same flood control as the Corps' Dos Rios Project. Provision was made for inclusion of specific flood control storage reservations where feasible. With the low incremental cost of storage in the large Dos Rios Reservoir with Round Valley storage, the Corps found that 600,000 acre-feet of flood control reservation was justifiable. For the small Dos Rios Reservoirs considered in this investigation, the limited amount of storage available would preclude the inclusion of any specific flood reservation, although some incidental flood protection would be afforded by the normal operation of the

reservoir. With the intermediate sizes of Dos Rios Reservoir (with Round Valley protected), projects were formulated to provide flood protection approximately equivalent to that which would be provided by the Corps' Dos Rios Reservoir plan. A large reservoir on the lower Eel River would be able to provide substantially greater flood protection than any Dos Rios Project.

FISH AND WILDLIFE STUDIES

The Department of Fish and Game furnished data on the average sizes of anadromous fish runs at the various damsites, estimates of the necessary flow releases for fish preservation, information on hatchery sizes and costs, and data on the lands and costs required for wildlife preservation. The estimates are preliminary and may be changed as more fish and wildlife data become available. Only the major cost items were estimated and some additional, but as yet unidentified, preservation measures may be necessary. However, the estimates are suitable for this comparison of alternative plans.

The question of possible enhancement of the downstream anadromous fishery has arisen often during discussions of the large Dos Rios Project. The same possibility applies to most of the alternative Eel River proposals. The Department of Fish and Game is continuing studies aimed at a full resolution of the fisheries preservation aspects of the Dos Rios Project. Until those studies are completed, there can be no firm definition of the enhancement potential. Thus, although there are potentials for anadromous fishery enhancement with various of the alternative projects, enhancement could not be included as a possible project purpose at this time.

RECREATION STUDIES

Estimates of reservoir recreation use and costs were furnished by the Department of Parks and Recreation. For some of the sites, this information was already available from previous detailed studies; for the remaining sites, cursory-level estimates were prepared. All of the recreation data has been coordinated with the U. S. Bureau of Outdoor Recreation and the Corps of Engineers.

Project releases for fishery preservation would result in greater summer flows downstream. This would be particularly significant in the Eel River Basin where very low flow conditions normally prevail in the late summer. The increased flows would provide a potential for enhancement of river recreation activities, including fishing, swimming, canoeing, and rafting. The approximate mileages of river which would be affected by releases from the various reservoirs include: English Ridge Reservoir, 133 miles; Willis Ridge Reservoir, 125 miles; Dos Rios Reservoir, 118 miles; and Yellow Jacket Reservoir, 59 miles.

POWER STUDIES

There are opportunities within the various alternatives for a minor amount of hydroelectric power generation, or in a few cases, major pumped storage power development. However, past studies have demonstrated that such developments are marginal under present economic conditions. Therefore, it was concluded at the start of the study that hydroelectric power generation could be omitted from consideration as a project purpose without causing any significant influence on the comparison of alternatives.

Costs of offpeak pumping power were calculated on the basis of an annual capacity charge of $2.00 per kilowatt and an energy charge of 2.00 mills per kilowatt-hour. The corresponding values used for continuous pumping power were $26.50 per kilowatt and 1.00 mill per kilowatt-hour.

DISCUSSIONS OF PROJECTS

The remainder of this appendix consists of separate sections which present data and discussions on the Corps' Dos Rios Reservoir with both an eastern and a southern diversion routing, an independent English Ridge Project which could meet local water demands in and adjacent to the Eel River Basin, and on each of twelve principal and secondary alternatives.

Each section begins with a description of the development, a plan and profile of the system, and a discussion of project formulation. Additional paragraphs cover the flood control and recreation potential. Related problems and the level of planning knowledge are summarized for each of the numbered alternatives. The section on each development concludes with four tables of numerical data as discussed in the following paragraphs.

Dam and Reservoir Data Summary Table

The first table presents physical data on the dams and reservoirs included in the system. It shows drainage areas, pertinent elevations, dam heights, construction times, reservoir areas, capacities and shoreline lengths, lengths of main stream inundated, populations displaced, sizes of fish runs affected, and predicted recreation usage.

The table also includes data showing the long-term average annual runoff at each damsite, allowances for future upstream impairments, releases for fishery preservation, and releases to satisfy existing and future downstream rights. The remainder is shown as storable inflow, which represents the long-term average annual amount of water available for development at each site. The main purpose of this tabulation is to illustrate the principal sources of water supply for each of the developments; future studies may necessitate revisions in some of the allowances for upstream impairments, fishery preservation, or mandatory downstream releases.

Conveyance Facility Data Summary Table

The second table in each section summarizes data on the major tunnels, pumping plants, and canals included in each system. Lengths, diameters, portal elevations, and construction times are shown for each conveyance tunnel. To illustrate the approximate flow rates which would be handled, the maximum and minimum capacities of each tunnel are also shown. These capacities represent the hydraulic capabilities of the respective tunnel, based on the minimum pool and top of flood control storage elevations of the upstream reservoir; control valves would be installed on each tunnel and the actual releases would not necessarily be made at the tunnel's maximum capacity.

The location, type, static heads, design flow, and installed horsepower are shown for each pumping plant. The maximum and minimum static heads represent the elevation differences between the pumping forebay and the reservoir or tunnel portal to which water would be pumped; total dynamic pumping heads would be greater because of hydraulic losses.

The type, length, and flow capacity are shown for the conveyance canals required to deliver project flows to the Sacramento River. The capacities of these canals are based on the peak monthly demands expected for the State Water Project, plus additional capacity to carry any supplemental yield which a given development could deliver. In all cases, canal capacity was included for the total project yield, even though part of the yield would eventually be used locally; the added capacity would be very inexpensive and would facilitate delivery of excess project yield to the Delta during the time local water demands were building up.

Design and Construction Schedule Table

Third among the tables in each section is a graphical presentation of project staging. Its purpose is to show the approximate dates when design and construction would have to be begun to meet the water supply demands used as a basis for this study. All of the design and construction periods are illustrated as a whole number of years and the time scale on the design and construction schedules shows each year as a point, without precise definition of the monthly schedule. Adjustments will be required with further study of the details of monthly scheduling.

Cost Summary Table

The final table in the section on each development is a summary of costs by major feature. The first two columns show the construction completion date and construction time from the design and construction schedule table. Next is shown the first cost, which represents the actual dollar outlay for

initial project construction, including costs of rights-of-way, relocations, engineering, administration, and allowances for construction contingencies.

The fourth column is the construction cost capitalized to 1986, which equals the first cost plus approximate interest during construction and interest on the investment between the construction date and 1986. With the interest rate of 5 percent, the calculation of cost capitalized to 1986 was performed as follows:

$$C_{1986} = C_f \left(1 + \frac{.05T}{2}\right)\left(1.05\right)^{(D-1986)}$$

where:

C_{1986} = Construction cost capitalized to 1986

C_f = First cost

T = Construction time in years

D = Construction completion date

As noted in the cost summary tables, a minor departure from the above procedure was made in the calculation of costs for recreation facilities, which would usually be constructed to meet increasing recreation demands over several decades; in those cases, the capitalized costs of future construction were added in with the capitalized first costs derived by the above calculation.

The fifth column in the cost summary table represents the present worth of all estimated future operation, maintenance, and replacement costs, capitalized to 1986. Costs of pumping power are also shown, but separately, under the fifth column. The final column is the sum of the capitalized construction and annual costs.

Average annual costs are shown at the bottom of the cost summary table. These represent the average annual equivalent of the capitalized costs, based on a 5 percent interest rate over the 100-year period of analysis. They are derived by multiplying the capitalized costs by the factor 0.05038.

USCE DOS RIOS PROJECT -- EASTERN ROUTE

This section briefly summarizes the Dos Rios Project as proposed by the Corps of Engineers in its "Interim Report on Water Resources Development for Middle Fork Eel River", April 1968. The project would consist of a 7,600,000-acre-foot Dos Rios Reservoir and a 21.0-mile Grindstone Tunnel to divert water to the Sacramento River via Stony Creek.

Tables 1 through 4 summarize the physical data on the project, the design and construction staging, and the total costs. A plan and profile of the proposed development are shown on the accompanying figure. All data are derived from the Corps of Engineers' report with the following modifications:

1. The Department's studies indicate that the reservoir should be completed by about 1983 to provide a reasonable certainty of being able to meet the water demands projected to begin in 1986. This relatively long initial filling period is a result of the high ratio of dead storage in the reservoir to annual runoff. Accordingly, the project staging plan shown in Table 3 was selected to illustrate this plan.

2. The Stony Creek-Sacramento River Canal was added to carry the project yield to the Sacramento River. The Corps' report referenced water supply benefits to the downstream end of the Grindstone Tunnel and thus did not include the canal as a project cost. However, for this study of alternatives, all plans were formulated to deliver water to the Sacramento River.

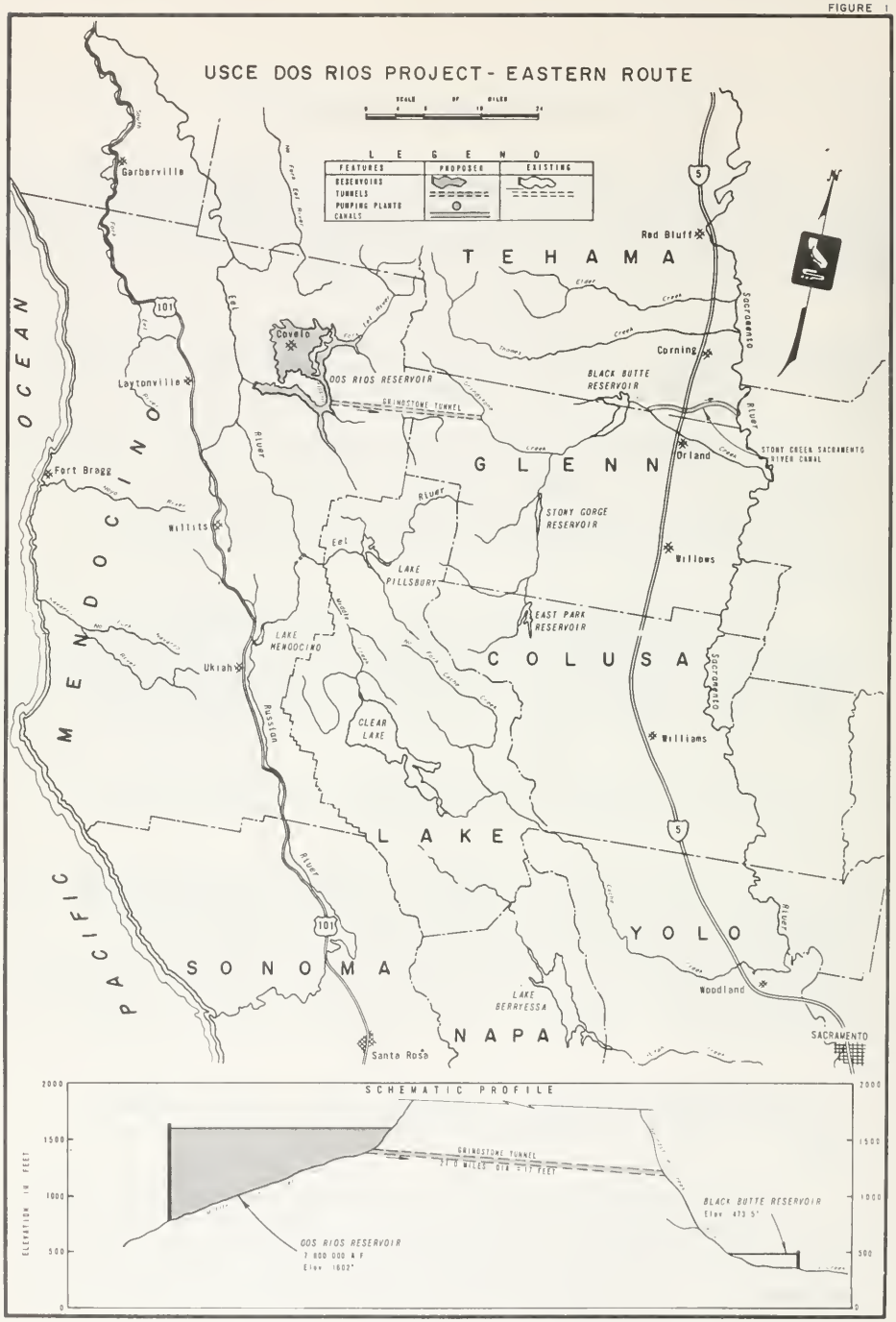
3. All calculations of capitalized cost were based on an interest rate of 5 percent. The calculations in the Corps' report are based on an interest rate of 3-1/4 percent.

4. The project first costs shown in Table 4 were derived from the Corps' report by indexing costs to July 1969 price levels. The estimated cost of the Grindstone Tunnel was also increased about 12 percent to reflect the comments of Bechtel, Incorporated, an engineering organization retained by the Department of Water Resources to review project costs. The net effect of these adjustments was to increase the Corps' September 1967 total project first cost by about 15 percent.

5. Operation, maintenance, and replacement costs, based on Department of Water Resources' standards, were included in order to be consistent with those of the other projects considered by this report.

The Corps' Dos Rios Project with an eastern diversion route would provide a new yield of 900,000 acre-feet per year, referenced to the Sacramento-San Joaquin Delta. The large Dos Rios Reservoir would facilitate control of the temperature and turbidity of both the fishery releases and diversions to the Sacramento River. With 2,000,000 acre-feet of inactive storage, the large reservoir would experience no operational problems from sedimentation and landslide debris encroachment.

FIGURE 1


USCE DOS RIOS PROJECT - EASTERN ROUTE
SCALE OF MILES
0 4 8 12 24
LEGEND
FEATURES
PROPOSED
EXISTING
RESERVOIRS
TUNNELS
PUMPING PLANTS
CANALS
OCEAN
MENDOCINO
PACIFIC
SONOMA
LAKE
NAPA
YOLO
COLUSA
GLENN
TEHAMA
Garberville
Covelo
Laytonville
Fort Bragg
Willits
Ukiah
Russian River
Eel River
Middle Fork Eel River
Dos Rios Reservoir
Grindstone Tunnel
Lake Mendocino
Lake Pillsbury
Stony Gorge Reservoir
East Park Reservoir
Clear Lake
Lake Berryessa
Santa Rosa
Red Bluff
Corning
Black Butte Reservoir
Orland
Stony Creek Sacramento River Canal
Willows
Williams
Woodland
SACRAMENTO
Sacramento River
Stony Creek
Thomes Creek
101
5
SCHEMATIC PROFILE
ELEVATION IN FEET
2000
1500
1000
500
0
GRINDSTONE TUNNEL
DOS RIOS RESERVOIR
7 800 000 A F
Elev 1602'
BLACK BUTTE RESERVOIR
Elev 473 5'

The reservoir proposed by the Corps would include a flood control reservation of 600,000 acre-feet. The effect of this reservation would be to reduce the December 1964 flood peak at Ferndale from 840,000 to 650,000 cubic feet per second, and at Scotia from 750,000 to 540,000 cubic feet per second. Thus, when combined with the authorized Eel Delta levees, Dos Rios Reservoir could provide, substantially, full protection against the 1964 flood.

The recreation potential of the large Dos Rios Reservoir is estimated as 7,000,000 recreation-days per year. However, constraints of existing and proposed road access limit the estimated annual use to 2,000,000 recreation-days. The Corps assumed that one-half of the recreation use would be served by Indian community developments which would be included as a mitigative measure in providing a substitute economy. The remainder of the recreation use would be provided for at project facilities. Full utilization of both recreation developments is expected to occur within 10 years after the start of project operation.

In joint studies, the Corps of Engineers and the Department of Water Resources have compiled detailed planning data on Dos Rios Dam and Reservoir and the Grindstone Tunnel.

TABLE 1
USCE DOS RIOS PROJECT - EASTERN ROUTE
DAM AND RESERVOIR DATA SUMMARY

	Dos Rios Dam and Reservoir (USCE Proposal)
Drainage area, square miles	745
Mean annual flows, million AF	
Runoff at damsite '1911-60)	1.036
Upstream impairments	---
Releases for fish	0.217
Other mandatory releases	---
Remainder = storable inflow	0.819
Elevations, feet	
Dam crest	1650
Maximum pool	1626
Top of flood reservation	1602
Top of conservation pool	1587
Minimum pool	1425
Streambed	920
Dam height, feet	730
Dam construction time, years	7
Capacities, million AF	
Flood reservation	0.600
Conservation storage	5.000
Inactive, dead, sediment	2.000
Gross	7.600
Areas, acres	
Reservoir @ gross storage	40,000
Wildlife preservation lands	16,000
Total land purchase required	89,000
Reservoir shoreline, miles	240
Main streams inundated, miles	36
Population displaced	1,500
Average fish runs at damsite	
Salmon, fish per year	13,000
Steelhead, fish per year	23,000
Recreation use, visitor-days/yr.	
Initial use	---
Maximum use	2,000,000
Years to reach maximum use	10

TABLE 2
USCE DOS RIOS PROJECT - EASTERN ROUTE
CONVEYANCE FACILITY DATA SUMMARY

Grindstone Tunnel	
Length, miles	21.0
Diameter, feet	17.0
Inlet elevation, feet	1,405
Outlet elevation, feet	1,221
Capacity, cfs (maximum/minimum)	4,200/3,000
Construction time, years	8
Stony Creek - Sacramento River Canal	
Type	Concrete-lined canal & creek channelization
Length, miles	15.0
Capacity, cfs	4,000

TABLE 3
USCE DOS RIOS PROJECT - EASTERN ROUTE
DESIGN AND CONSTRUCTION SCHEDULE

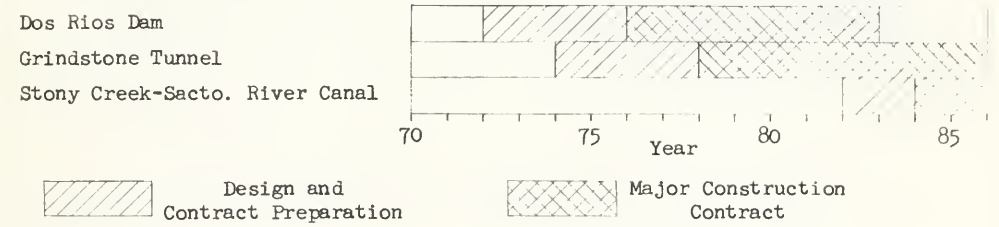


TABLE 4
USCE DOS RIOS PROJECT -- EASTERN ROUTE
COST SUMMARY
(Price basis, July 1969. Period of analysis, 1986-2085. Interest rate, 5%.)

Feature	Construction Completion Date	Construction Time (years)	Costs, in Millions of Dollars			
			First Cost (includes engr. & contingencies)	Construction Cost Capitalized to 1986	OM&R Cost Capitalized to 1986	Total Cost Capitalized to 1986
Dos Rios Dam and Reservoir	1983	7	253.2a	344.4	26.0	370.4
Fish and Wildlife Preservation			4.8a	5.8	4.6	10.4
Recreation Facilities			4.2a	4.9	12.0	16.9
Grindstone Tunnel	1986	8	192.0	230.4	3.7	234.1
Subtotal			454.2	585.5	46.3	631.8
Stony Creek-Sacto. River Canal[b]	1986	2	8.2	8.6	2.3	10.9
TOTALS			462.4	594.1	48.6	642.7
Average Annual Cost				29.9	2.5	32.4

a. From USCE report, adjusted to July 1969 price levels. Does not include $4 million for purchase of land for future recreation use.

b. Not included in USCE report, but added here to provide uniform basis for comparison of alternative plans.

USCE DOS RIOS PROJECT -- SOUTHERN ROUTE

This plan would combine the large Dos Rios Reservoir proposed by the Corps of Engineers with a southern diversion route through Clear Lake. Gravity releases would be made through a Dos Rios-Willis Ridge Tunnel to Willis Ridge Reservoir on the upper Eel River. Willis Ridge Reservoir would serve as a constant-level forebay to back water up to the toe of English Ridge Dam. A Willis Ridge-English Ridge pumping plant would lift the water into English Ridge Reservoir, from which it would flow by gravity to Clear Lake via the Garrett Tunnel and then down Cache Creek to the Cache Creek-Sacramento River Canal.

Tables 5 through 8 summarize the physical data on the project, the design and construction staging, and the total costs. A plan and profile of the proposed development are shown on the accompanying figure. Data for Dos Rios Dam and Reservoir are derived from the Corps of Engineers' report with the following modifications:

1. The Department's studies indicate that Dos Rios Reservoir should be completed by about 1983 to provide a reasonable certainty of being able to meet the water demands projected to begin in 1986. This relatively long initial filling period is a result of a high ratio of dead storage in the reservoir to annual runoff. Accordingly, the project staging plan shown in Table 7 was selected to illustrate this plan.

2. All calculations of capitalized costs were based on an interest rate of 5 percent. The calculations in the Corps' report are based on an interest rate of 3-1/4 percent.

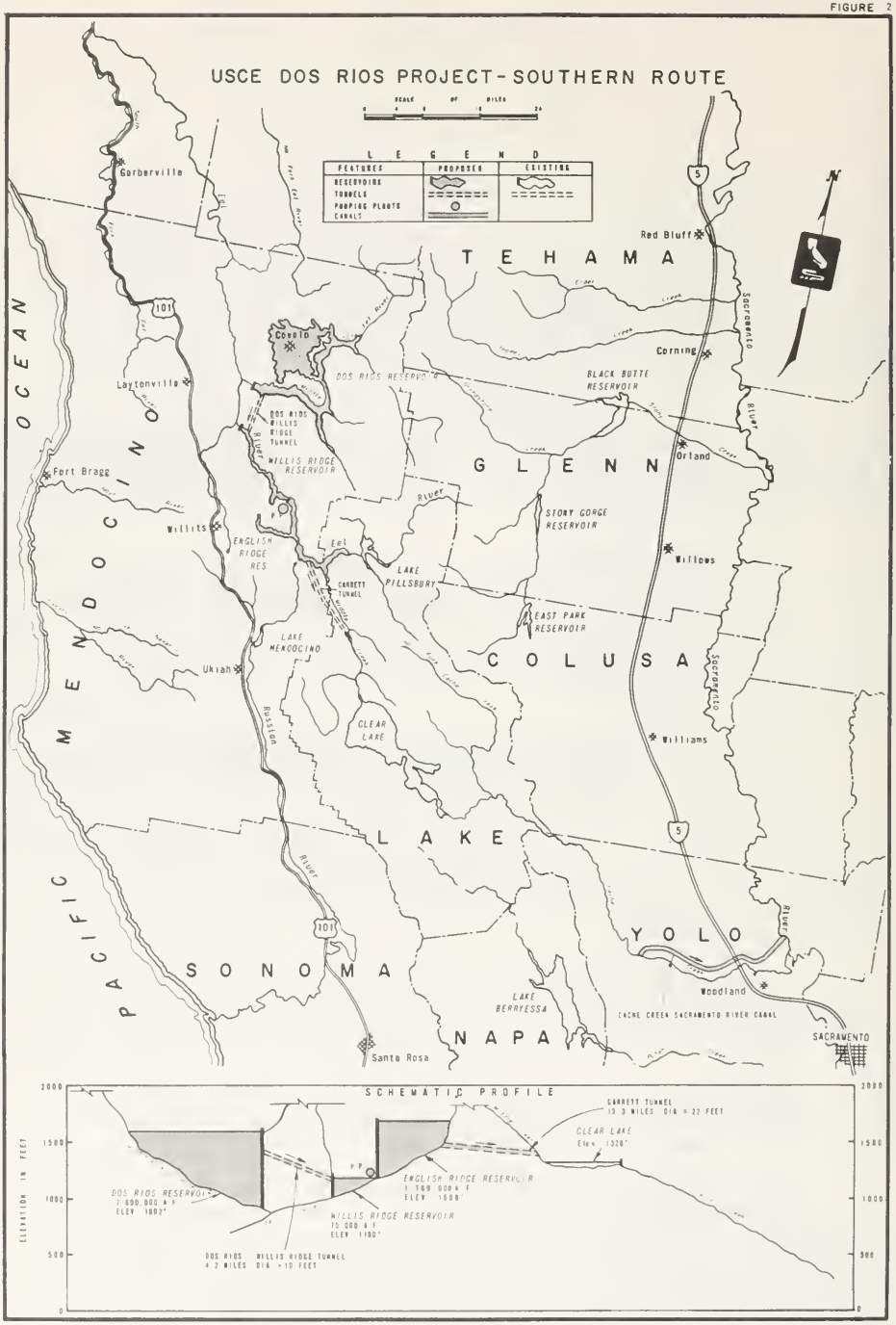
3. First costs for Dos Rios Dam and Reservoir were taken directly from the Corps' report, but were adjusted to reflect July 1969 price levels. The net effect of this adjustment was to increase the Corps' September 1967 dam and reservoir first cost about 9 percent.

4. Operation, maintenance, and replacement costs, based on Department of Water Resources' standards, were included in order to be consistent with those of the other projects considered by this report.

This project would provide a new yield of 900,000 acre-feet per year referenced to the Sacramento-San Joaquin Delta plus an additional 200,000 acre-feet per year on a firm schedule for local use.

Previous planning studies have shown a direct pump diversion from Dos Rios Reservoir to English Ridge Reservoir via the Elk Creek Tunnel. However, recent additional geologic investigations by the Department of the Elk Creek Tunnel route have led to an increase in the estimated cost of that feature. As a result, the diversion via Willis Ridge Reservoir now appears to be more economical and has been included to illustrate this plan. More investigation would be required for a definite selection of the best diversion method.

FIGURE 2


USCE DOS RIOS PROJECT - SOUTHERN ROUTE
SCALE OF MILES
L E G E N D
FEATURES
PROPOSED
EXISTING
RESERVOIRS
TUNNELS
PUMPING PLANTS
CANALS
Gorberville
Red Bluff
TEHAMA
Corning
Covelo
DOS RIOS RESERVOIR
BLACK BUTTE RESERVOIR
Laytonville
DOS RIOS WILLIS RIDGE TUNNEL
WILLIS RIDGE RESERVOIR
Fort Bragg
GLENN
Orland
Willits
STORY GORGE RESERVOIR
ENGLISH RIDGE RES
LAKE PILLSBURY
Willows
GARRETT TUNNEL
EAST PARK RESERVOIR
LAKE MENDOCINO
COLUSA
Ukiah
CLEAR LAKE
Williams
LAKE
YOLO
SONOMA
Woodland
LAKE BERRYESSA
CACHE CREEK SACRAMENTO RIVER CANAL
NAPA
SACRAMENTO
Santa Rosa
OCEAN
MENDOCINO
PACIFIC
SCHEMATIC PROFILE
ELEVATION IN FEET
2000
1500
1000
500
0
GARRETT TUNNEL
13.3 MILES DIA = 22 FEET
CLEAR LAKE
Elev. 1320'
DOS RIOS RESERVOIR
1 800 000 A F
ELEV 1802'
ENGLISH RIDGE RESERVOIR
1 189 000 A F
ELEV 1538'
WILLIS RIDGE RESERVOIR
15 800 A F
ELEV 1180'
DOS RIOS WILLIS RIDGE TUNNEL
= 2 MILES DIA = 10 FEET

As formulated, this project would require a very large Garrett Tunnel in order to meet peak water demands in the Delta during a dry spell. The overall project economics could be improved somewhat by the addition of a reservoir on Cache Creek. Releases could then be made from Cache Creek storage to meet peak demands, allowing a smaller Garrett Tunnel to divert water at a more uniform rate. The Cache Creek Reservoir would also provide flood protection on Cache Creek, allow stabilization of Clear Lake, and permit modifications to the Clear Lake outlet which would reduce flood damages around the lake. Because this study does not include analysis of benefits, the addition of storage on Cache Creek would have only a minor effect on project comparisons; however, consideration should be given to this modification in any future studies.

The 140,000 acre-feet of flood reservation in English Ridge Reservoir, along with the 600,000-acre-foot reservation in Dos Rios Reservoir, could have reduced the December 1964 flood peak at Fernbridge to below the proposed 600,000-cubic-foot-per-second design capacity of the authorized Eel Delta levees. When operated in conjunction with the Eel Delta levees, this project would have reduced the December 1964 flood peak at Scotia from 750,000 to 490,000 cubic feet per second. As shown in Table 5, the large Dos Rios Reservoir would provide for recreation use of 2,000,000 recreation-days annually. The use of English Ridge Reservoir is estimated to reach a maximum level of 2,200,000 recreation-days per year in about 50 years. Although it is small, Willis Ridge Reservoir would be operated at a constant level and would support an eventual use of approximately 400,000 recreation-days.

Joint studies by the Corps of Engineers and the Department of Water Resources have compiled detailed planning data on Dos Rios Dam and Reservoir. Only limited study has been given to the Dos Rios-Willis Ridge Tunnel and to Willis Ridge Dam site; additional investigation would be required for definite selection of the best diversion route to English Ridge Reservoir. The Bureau of Reclamation has conducted feasibility level studies of English Ridge Dam and Reservoir, and high level reconnaissance studies of Garrett Tunnel.

TABLE 5
USCE DOS RIOS PROJECT - SOUTHERN ROUTE
DAM AND RESERVOIR DATA SUMMARY

	Dos Rios Dam and Reservoir (USCE Proposal)	Willis Ridge Dam and Reservoir	English Ridge Dam and Reservoir (USBR Proposal)
Drainage area, square miles	745	39[a]	488
Mean annual flows, million AF			
Runoff at damsite (1911-60)	1.036	0.066[a]	0.675
Upstream impairments	---	---	0.009
Releases for fish	0.217	0.141	---
Other mandatory releases	---	---	0.175[b]
Remainder = storable inflow	0.819	-0.075[c]	0.491
Elevations, feet			
Dam crest	1650	1200	1733
Maximum pool	1626	1190	1723
Top of flood reservation	1602	---	1698[d]
Top of conservation pool	1587	1180	1686
Minimum pool	1425	1180	1507
Streambed	920	1010	1180
Dam height, feet	730	190	553
Dam construction time, years	7	3	5
Capacities, million AF			
Flood reservation	0.600	---	0.140[d]
Conservation storage	5.000	---	1.276
Inactive, dead, sediment	2.000	0.075	0.383
Gross	7.600	0.075	1.799
Areas, acres			
Reservoir @ gross storage	40,000	1,000	11,800
Wildlife preservation lands	16,000	570	8,800
Total land purchase required	89,000	2,500	42,000
Reservoir shoreline, miles	240	20	170
Main streams inundated, miles	36	14	28
Population displaced	1,500	10	200
Average fish runs at damsite			
Salmon, fish per year	13,000	12,000	---
Steelhead, fish per year	23,000	15,000	---
Recreation use, visitor-days/yr.			
Initial use	---	100,000	580,000
Maximum use	2,000,000	400,000	2,200,000
Years to reach maximum use	10	50	50

a. Values for incremental drainage between English Ridge and Willis Ridge sites.

b. Release to Russian River Basin via Potter Valley Powerplant.

c. This deficiency would be met from Dos Rios Reservoir.

d. Joint use -- flood control and conservation storage.

TABLE 6
USCE DOS RIOS PROJECT - SOUTHERN ROUTE
CONVEYANCE FACILITY DATA SUMMARY

Dos Rios-Willis Ridge Tunnel	
Length, miles	4.2
Diameter, feet	10.0
Inlet elevation, feet	1,410
Outlet elevation, feet	1,170
Capacity, cfs (maximum/minimum)	2,120/1,610
Construction time, years	4
Willis Ridge-English Ridge Pumping Plant	
Location	Toe of English Ridge Dam
Type	Conventional, above ground, off-peak
Minimum static head, feet	327
Maximum static head, feet	518
Design flow, cfs	2,330
Installed horsepower	166,000
Garrett Tunnel	
Length, miles	13.3
Diameter, feet	22.0
Inlet elevation, feet	1,495
Outlet elevation, feet	1,450
Capacity, cfs (maximum/minimum)	7,480/3,590
Construction time, years	4
Cache Creek-Sacramento River Canal	
Type	Concrete-lined canal
Length, miles	26.8
Capacity, cfs	4,400

TABLE 7
USCE DOS RIOS PROJECT - SOUTHERN ROUTE
DESIGN AND CONSTRUCTION SCHEDULE
(Does not include feasibility investigation time)

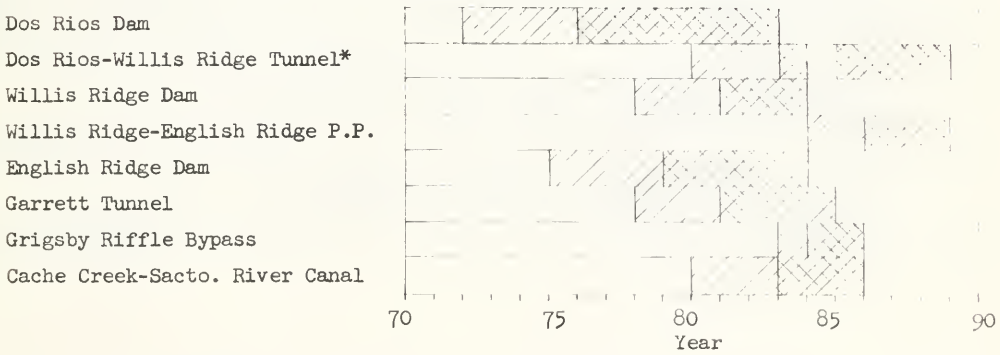


TABLE 8
USCE DOS RIOS PROJECT - SOUTHERN ROUTE
COST SUMMARY
(Price basis, July 1969. Period of analysis, 1986-2085. Interest rate, 5%.)

Feature	Construction Completion Date	Construction Time (years)	Costs, in Millions of Dollars			
			First Cost (includes engr. & contingencies)	Construction Cost Capitalized to 1986	OM&R Cost Capitalized to 1986	Total Cost Capitalized to 1986
Dos Rios Dam and Reservoir	1983	7	253.2[a]	344.4	26.0	370.4
Fish and Wildlife Preservation			4.8[a]	5.8	4.6	10.4
Recreation Facilities			4.2[a]	4.9	12.0	16.9
Dos Rios-Willis Ridge Tunnel	1989[b]	4	21.0	20.0	0.3	20.3
Willis Ridge Dam and Reservoir	1984	3	23.4	27.8	2.1	29.9
Fish Preservation			9.0	11.4	5.5	16.9
Wildlife Preservation (included with English Ridge)			-	-	-	-
Recreation Facilities[c]			1.6	2.6	3.1	5.7
Willis Ridge-English Ridge P.P.	1989	3	25.1	23.2	7.8	31.0
Power					10.0	10.0
English Ridge Dam and Reservoir	1984	5	112.8[d]	140.0	10.6	150.6
Wildlife Preservation			2.6	3.7	2.0	5.7
Recreation Facilities[c]			9.0	14.8	17.0	31.8
Garrett Tunnel	1985	4	141.0	162.0	2.4	162.4
Grigsby Riffle Bypass	1986	2	1.6	1.7	0.4	2.1
Cache Creek-Sacto. River Canal	1986	3	19.3	20.8	5.3	26.1
TOTALS			628.6	783.1	109.1	892.2
Average Annual Cost				39.4	5.5	44.9

a. From USCE report, adjusted to July 1969 price levels. Does not include $4 million for purchase of land for future recreation use.

b. Two-stage construction: intake by 1984, tunnel by 1989.

c. First cost includes initial recreation facilities only; capitalized costs include all future staged recreation developments.

d. From USBR draft report on English Ridge Project, adjusted to July 1969 price levels.

INDEPENDENT ENGLISH RIDGE PROJECT

This section briefly summarizes an English Ridge Project which could be constructed for independent operation to provide local water supplies. The project would consist of a 1,799,000-acre-foot English Ridge Reservoir behind a 553-foot-high dam, a 12-foot-3-inch diameter Garrett Tunnel to divert water to Clear Lake, and a Grigsby Riffle Bypass to convey project water out of Clear Lake during times of low lake level. These features are essentially the same as proposed by the Bureau of Reclamation in its draft report on the English Ridge Project. However, several additional features included in the USBR proposal for transportation of project water to specific areas of local demand were omitted from this presentation in the interest of comparability with the other projects presented. These distribution works have not been included in any of the plans presented in this report.

Tables 9 through 12 summarize the physical data on the project, the design and construction staging, and the total costs. A plan and profile of the proposed project are shown on the accompanying figure.

This project would yield approximately 200,000 acre-feet per year for use locally. During the early years of the project, prior to the buildup of maximum local demand, project yield could be utilized to augment water supplies in the Sacramento-San Joaquin Delta. As shown by Table 11, the project would be completed in 1990. By that year, a significant demand would exist for local water supplies and projected demand for additional water in the Delta would be large enough to provide an interim market for the early surplus yield of the English Ridge Project. Earlier staging of the project might be possible under federal construction in conjunction with the Central Valley Project.

The reservoir proposed by the Bureau would include a flood control reservation of 140,000 acre-feet. This would be joint-use space, available for storage purposes outside the flood season. The effect of this reservation would have been to reduce the December 1964 flood of record at Scotia from 750,000 to 660,000 cubic feet per second. The December 1964 flood peak reduction at Fernbridge would have been from 840,000 down to 765,000 cubic feet per second. This assumes the operation of English Ridge Reservoir with no other flood control projects on the Eel River.

Potential recreation use at English Ridge Reservoir is estimated to reach 2,200,000 recreation-day annually. This peak would be reached within 50 years after construction.

The Bureau of Reclamation has conducted feasibility level studies of English Ridge Dam and Reservoir, and high level reconnaissance studies of Garrett Tunnel.

FIGURE 3

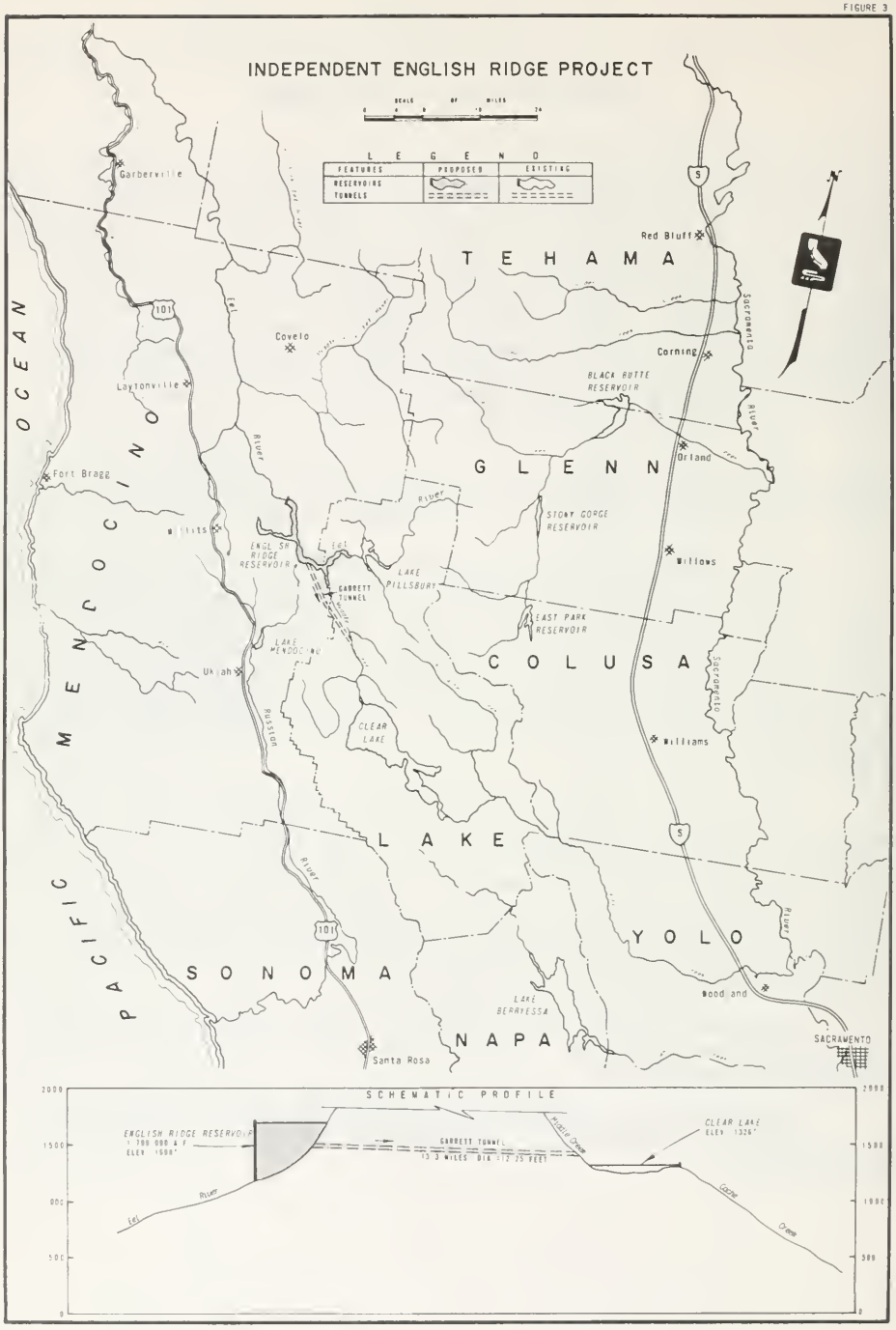

INDEPENDENT ENGLISH RIDGE PROJECT
SCALE OF MILES
L E G E N D
FEATURES
PROPOSED
EXISTING
RESERVOIRS
TUNNELS
N
Garberville
Laytonville
Covelo
Fort Bragg
Willits
Ukiah
Red Bluff
Corning
Orland
Willows
Williams
Woodland
Santa Rosa
SACRAMENTO
TEHAMA
GLENN
COLUSA
YOLO
LAKE
NAPA
SONOMA
MENDOCINO
OCEAN
PACIFIC
BLACK BUTTE RESERVOIR
STONY GORGE RESERVOIR
EAST PARK RESERVOIR
ENGL SH RIDGE RESERVOIR
GARRETT TUNNEL
LAKE PILLSBURY
LAKE MENDOCINO
CLEAR LAKE
LAKE BERRYESSA
Eel River
Russian River
Sacramento River
101
5
SCHEMATIC PROFILE
ENGLISH RIDGE RESERVOIR
1 709 000 A F
ELEV 1598'
GARRETT TUNNEL
13 3 MILES DIA 17 25 FEET
Middle Creek
CLEAR LAKE
ELEV 1326'
Eel River
Cache Creek
2000
1500
1000
500
0

TABLE 9
INDEPENDENT ENGLISH RIDGE PROJECT
DAM AND RESERVOIR DATA SUMMARY

	English Ridge Dam and Reservoir
Drainage area, square miles	488
Mean annual flows, million AF	
Runoff at damsite '1911-60'	0.675
Upstream impairments	0.009
Releases for fish	0.126
Other mandatory releases	0.175[a]
Remainder = storable inflow	0.365
Elevations, feet	
Dam crest	1733
Maximum pool	1723
Top of flood reservation	1698[b]
Top of conservation pool	1686
Minimum pool	1507
Streambed	1180
Dam height, feet	553
Dam construction time, years	5
Capacities, million AF	
Flood reservation	0.140[b]
Conservation storage	1.276
Inactive, dead, sediment	0.383
Gross	1.799
Areas, acres	
Reservoir @ gross storage	11,800
Wildlife preservation lands	8,800
Total land purchase required	42,000
Reservoir shoreline, miles	170
Main streams inundated, miles	28
Population displaced	200
Average fish runs at damsite	
Salmon, fish per year	10,000
Steelhead, fish per year	14,000
Recreation use, visitor-days/yr.	
Initial use	580,000
Maximum use	2,200,000
Years to reach maximum use	50

a. Releases to Russian River Basin via Potter Valley Powerplant.

b. Joint use -- flood control and conservation storage.

TABLE 10
INDEPENDENT ENGLISH RIDGE PROJECT
CONVEYANCE FACILITY DATA SUMMARY

Garrett Tunnel	
Length, miles	13.3*
Diameter, feet	12.25
Inlet elevation, feet	1,495
Outlet elevation, feet	1,450
Capacity, cfs (maximum/minimum)	1,570/750
Construction time, years	4

* DWR alignment; USBR draft report on English Ridge Project uses a different tunnel alignment with a length of 14.2 miles.

TABLE 11
INDEPENDENT ENGLISH RIDGE PROJECT
DESIGN AND CONSTRUCTION SCHEDULE*

* Earlier construction might be possible, depending on federal authorization and appropriations.

Design and Contract Preparation

Major Construction Contract

TABLE 12
INDEPENDENT ENGLISH RIDGE PROJECT
COST SUMMARY
(Price basis, July 1969 Period of analysis, 1986-2085 Interest rate, 5%.)

Feature	Construction Completion Date	Construction Time (years)	Costs, in Millions of Dollars			
			First Cost (includes engr. & contingencies)	Construction Cost Capitalized to 1986	OM&R Cost Capitalized to 1986	Total Cost Capitalized to 1986
English Ridge Dam and Reservoir	1990	5	112.8[a]	104.0	7.9	111.9
Fish and Wildlife Preservation			11.9	11.2	3.8	15.0
Recreation Facilities[b]			9.0	11.0	12.7	23.7
Garrett Tunnel	1990	4	57.3	51.8	0.8	52.6
Grigsby Riffle Bypass	1990	2	0.3[a]	0.2	0.1	0.3
TOTALS			191.3	178.2	25.3	203.5
Average Annual Cost				9.0	1.3	10.3

a. From USBR draft report on English Ridge Project, adjusted to July 1969 price levels.

b. First cost includes initial recreation facilities only; capitalized costs include all future staged recreation development.

ALTERNATIVE 1: SMALL DOS RIOS-RANCHERIA PROJECT

The major features of this alternative would be a small Dos Rios Reservoir which would not inundate Round Valley, a 23.4-mile Grindstone Tunnel, and a 5,000,000-acre-foot Rancheria Reservoir on Stony Creek. Tables 13 through 16 summarize the physical data on the various features, the staging of design and construction, and the project costs. A plan and profile of the system are shown on the accompanying figure.

This system would provide a new yield of 900,000 acre-feet per year, referenced to the Sacramento-San Joaquin Delta.

Project Formulation

To avoid any encroachment into Round Valley, Dos Rios Reservoir would have to be limited to an elevation of about 1,300 feet. However, at that size, the active storage capacity would be insufficient to permit economical development of the Middle Fork Eel River. A Dos Rios Reservoir elevation of 1,320 feet was selected to illustrate this alternative; this size would permit diversion of most of the available flows with a tunnel of reasonable size, but it would require flooding of about 700 acres of creek-bottom and grazing land in the southeast corner of the valley.

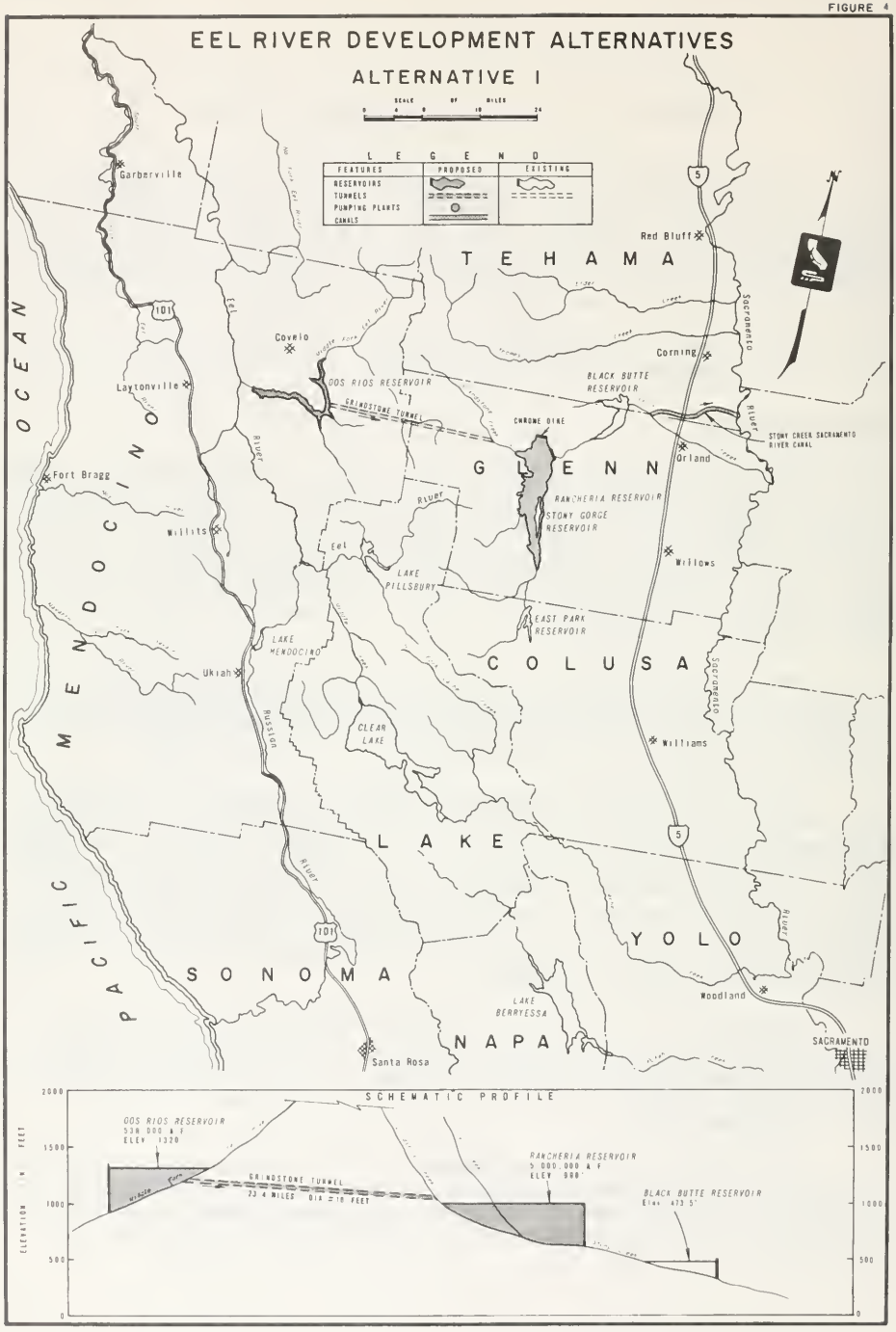
The Grindstone Tunnel diameter of 16 feet was selected as the minimum size which would divert the required volume of water into Rancheria Reservoir for refilling. A larger tunnel could divert more water and increase the project yield, but the cost of the additional yield would be very high.

The 5,000,000-acre-foot Rancheria Reservoir capacity was selected to balance the total system storage with the available water supply. Preliminary studies indicate that the 5,000,000 acre-feet of storage required in Rancheria Reservoir might be obtained more economically by building a smaller Rancheria Reservoir in combination with a Newville Reservoir. In that case, it would be logical to integrate the entire Paskenta-Newville Project with the Eel River Development. The effect on the Eel River Development costs would be relatively minor, but the possibility of expanding the project should be studied if future attention is given to this alternative.

The small Dos Rios Reservoir in this alternative could be enlarged by about 200,000 acre-feet by raising the dam about 30 feet and constructing levees within Round Valley to restrict flooding. This presents some potential for cost savings and improving project reliability, but would not alter the project yield appreciably.

Construction of the basic features of this system would be staged to meet State Water Project demands beginning in 1986. Initial filling of sufficient storage to be reasonably certain of meeting these demands would require one year. Therefore, construction of this system should be staged as shown in Table 15.

FIGURE 4


EEL RIVER DEVELOPMENT ALTERNATIVES
ALTERNATIVE I
SCALE OF MILES
0 4 8 16 24
L E G E N D
FEATURES
PROPOSED
EXISTING
RESERVOIRS
TUNNELS
PUMPING PLANTS
CANALS
N
Garberville
Red Bluff
Covelo
Corning
Laytonville
OOS RIOS RESERVOIR
GRINDSTONE TUNNEL
BLACK BUTTE RESERVOIR
CHROME DIKE
STONY CREEK SACRAMENTO RIVER CANAL
Orland
Fort Bragg
RANCHERIA RESERVOIR
STONY GORGE RESERVOIR
Willits
Willows
LAKE PILLSBURY
EAST PARK RESERVOIR
LAKE MENDOCINO
Ukiah
CLEAR LAKE
Williams
Woodland
LAKE BERRYESSA
Santa Rosa
SACRAMENTO
OCEAN
MENDOCINO
TEHAMA
GLENN
COLUSA
LAKE
YOLO
SONOMA
NAPA
PACIFIC
SCHEMATIC PROFILE
ELEVATION IN FEET
OOS RIOS RESERVOIR
538,000 A F
ELEV 1320
GRINDSTONE TUNNEL
7.3 MILES DIA 18 FEET
RANCHERIA RESERVOIR
5,000,000 A F
ELEV 980'
BLACK BUTTE RESERVOIR
Elev 473.5'
2000
1500
1000
500
0

Flood Control Potential

The Corps of Engineers recommended a specific flood control reservation of 600,000 acre-feet at Dos Rios Reservoir. However, the limited storage in the small Dos Rios Reservoir would preclude a specific flood control reservation, although the reservoir would provide some minor incidental flood protection.

The large Rancheria Reservoir might be able to provide additional flood protection for lower Stony Creek, and to provide some flood control benefits along the Sacramento River. This possibility should be considered in any future studies of this alternative.

Recreation Potential

Table 13 shows the expected recreation use at Dos Rios and Rancheria Reservoirs. The small Dos Rios Reservoir would provide relatively limited recreation potential because of its location in a steep canyon area and severe fluctuations in water level. Rancheria Reservoir would have a large surface area, fair access, and a generally stable water surface except during very dry periods; it would provide for a moderate amount of fairly high-quality recreation use.

In addition to recreation at the new reservoirs, this alternative would offer the possibility of increased recreation potential at the existing Black Butte and East Park Reservoirs. The construction of Rancheria Reservoir would offer the possibility of coordinated operation to stabilize the levels of these existing reservoirs.

Related Problems

The small Dos Rios Reservoir presents potentially serious problems which would require detailed additional investigation. The storage capacity of the reservoir would be considerably reduced by siltation and landslides. Preliminary data indicate that up to 330,000 acre-feet of storage would be lost during the 100-year economic life of the project. Allowance has been made for 330,000 acre-feet of storage loss in the reservoir chosen to illustrate this alternative, but any appreciably greater storage loss would lead to serious operational problems. The Salmon Creek Landslide, in a narrow portion of the canyon 10 miles upstream from the dam, would require special treatment. Because of the limited storage in Dos Rios Reservoir, turbidity and temperature problems could be encountered with water released for fishery preservation.

Some of the problems with sedimentation at Dos Rios Reservoir might be alleviated by construction of a debris dam at the Spencer site just upstream. The debris dam could be deferred until the magnitude of the problem could be definitely established. However, the debris dam was not included for this study.

As with any system involving Rancheria Reservoir, relocation of the community of Elk Creek would be required with this alternative. Another

necessary relocation would be the 80-acre Grindstone Indian Rancheria, which has a population of approximately 25 persons.

Level of Planning Knowledge

Past studies of the features of this system have compiled fairly detailed planning data for all features. The major needs for additional planning studies involve the sedimentation, landslide, fishery, and water quality problems associated with a small Dos Rios Reservoir.

TABLE 13
ALTERNATIVE 1
DAM AND RESERVOIR DATA SUMMARY

	Dos Rios Dam and Reservoir	Rancheria Dam and Reservoir
Drainage area, square miles	745	599
Mean annual flows, million AF		
Runoff at damsite '1911-60'	1.036	0.338
Upstream impairments	---	---
Releases for fish	0.217	---
Other mandatory releases	---	0.206[a]
Remainder = storable inflow	0.819	0.132
Elevations, feet		
Dam crest	1340	1018
Maximum pool	1325	1010
Top of flood reservation	---	---
Top of conservation pool	1320	998
Minimum pool	1272	710
Streambed	920	590
Dam height, feet	420	428
Dam construction time, years	3	5
Capacities, million AF		
Flood reservation	---	---
Conservation storage	0.206	4.900
Inactive, dead, sediment	0.330	0.100
Gross	0.536	5.000
Areas, acres		
Reservoir @ gross storage	4,300	35,200
Wildlife preservation lands	2,700	860
Total land purchase required	8,200	45,800
Reservoir shoreline, miles	70	130
Main streams inundated, miles	25	23
Population displaced	10	330
Average fish runs at damsite		
Salmon, fish per year	13,000	---
Steelhead, fish per year	23,000	---
Recreation use, visitor-days/yr.		
Initial use	100,000	375,000
Maximum use	300,000	685,000
Years to reach maximum use	100	20

a. Release for local use in Stony Creek area = 165,000 AF/yr.; presently exportable from Delta = 41,000 AF/yr.

TABLE 14
ALTERNATIVE 1
CONVEYANCE FACILITY DATA SUMMARY

Grindstone Tunnel	
Length, miles	23.4
Diameter, feet	16.0
Inlet elevation, feet	1,200
Outlet elevation, feet	1,000
Capacity, cfs (maximum/minimum)	2,840/2,620
Construction time, years	8
Stony Creek-Sacramento River Canal	
Type	Concrete-lined canal & creek channelization
Length, miles	15.0
Capacity, cfs	4,000

TABLE 15
ALTERNATIVE 1
DESIGN AND CONSTRUCTION SCHEDULE
(Does not include feasibility investigation time)

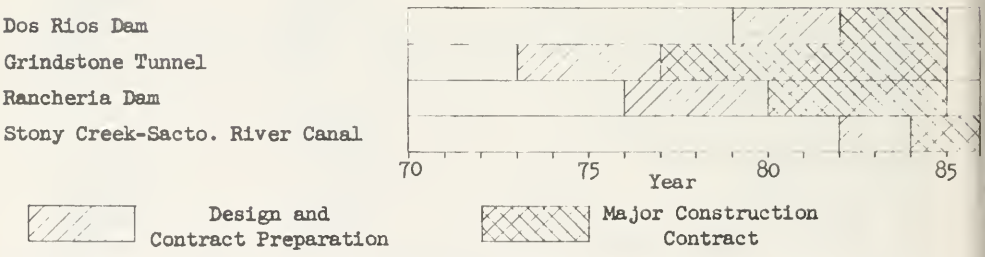


TABLE 16
ALTERNATIVE 1
COST SUMMARY
(Price basis, July 1969 Period of analysis, 1986-2085 Interest rate, 5%.)

Feature	Construction Completion Date	Construction Time (years)	Costs, in Millions of Dollars			
			First Cost (includes engr. & contingencies)	Construction Cost Capitalized to 1986	OM&R Cost Capitalized to 1986	Total Cost Capitalized to 1986
Dos Rios Dam and Reservoir	1985	3	67.0	75.6	5.7	81.3
Fish Preservation			9.7	11.3	6.8	18.1
Wildlife Preservation			0.7	0.9	0.5	1.4
Recreation Facilities[a]			0.6	0.8	1.5	2.3
Grindstone Tunnel	1985	8	197.0	248.2	3.9	252.1
Rancheria Dam and Reservoir	1985	5	182.7	215.8	16.3	232.1
Wildlife Preservation			0.2	0.3	0.2	0.5
Recreation Facilities[a]			5.3	6.6	7.8	14.4
Stony Creek-Sacto. River Canal	1986	2	8.2	8.6	2.3	10.9
TOTALS			471.4	568.1	45.0	613.1
Average Annual Cost				28.6	2.3	30.9

a. First cost includes initial recreation facilities only; capitalized costs include all future staged recreation development.

ALTERNATIVE 1A: SPENCER, SMALL DOS RIOS-RANCHERIA PROJECT

This project is a variation of Alternative 1; the changes consist of the addition of a 450,000-acre-foot Spencer Reservoir on the upper Middle Fork Eel River, and a reduction in the diameter of the Grindstone Tunnel from 16 to 15 feet. Dos Rios Reservoir would be the same as in Alternative 1. Tables 17 through 20 summarize the physical data on the various features, the staging of design and construction, and the project costs. A plan and profile of the system are shown on the accompanying figure.

This system would provide a new firm yield of 50,000 acre-feet per year in addition to the basic 900,000 acre-feet per year referenced to the Sacramento-San Joaquin Delta. The unit cost of the 50,000 acre-feet of additional yield obtained with this variation of Alternative 1 would be relatively high, as indicated by the increase in first cost of $66 million.

Project Formulation

On the basis of limited exploration of foundation conditions, Spencer Dam was limited to a crest elevation of about 1,720 feet, providing a gross storage capacity of 450,000 acre-feet. With a suitable allowance of storage space for sedimentation and landslide debris, Spencer Reservoir would add about 200,000 acre-feet of usable storage to the system shown as Alternative 1. The usable storage in Dos Rios Reservoir would be increased by about 100,000 acre-feet, since Spencer Reservoir would trap a portion of the sediments which would otherwise be deposited in Dos Rios Reservoir.

The addition of Spencer Reservoir storage to the basic system could be used in several ways: to provide additional yield from the same system; to provide the same yield from a reduced system; or, to provide flood control. Economic analysis showed that the best use of Spencer Reservoir storage would be to provide a slight increase in yield over that provided by Alternative 1, along with a reduction in the diameter of the Grindstone Tunnel from 16 to 15 feet.

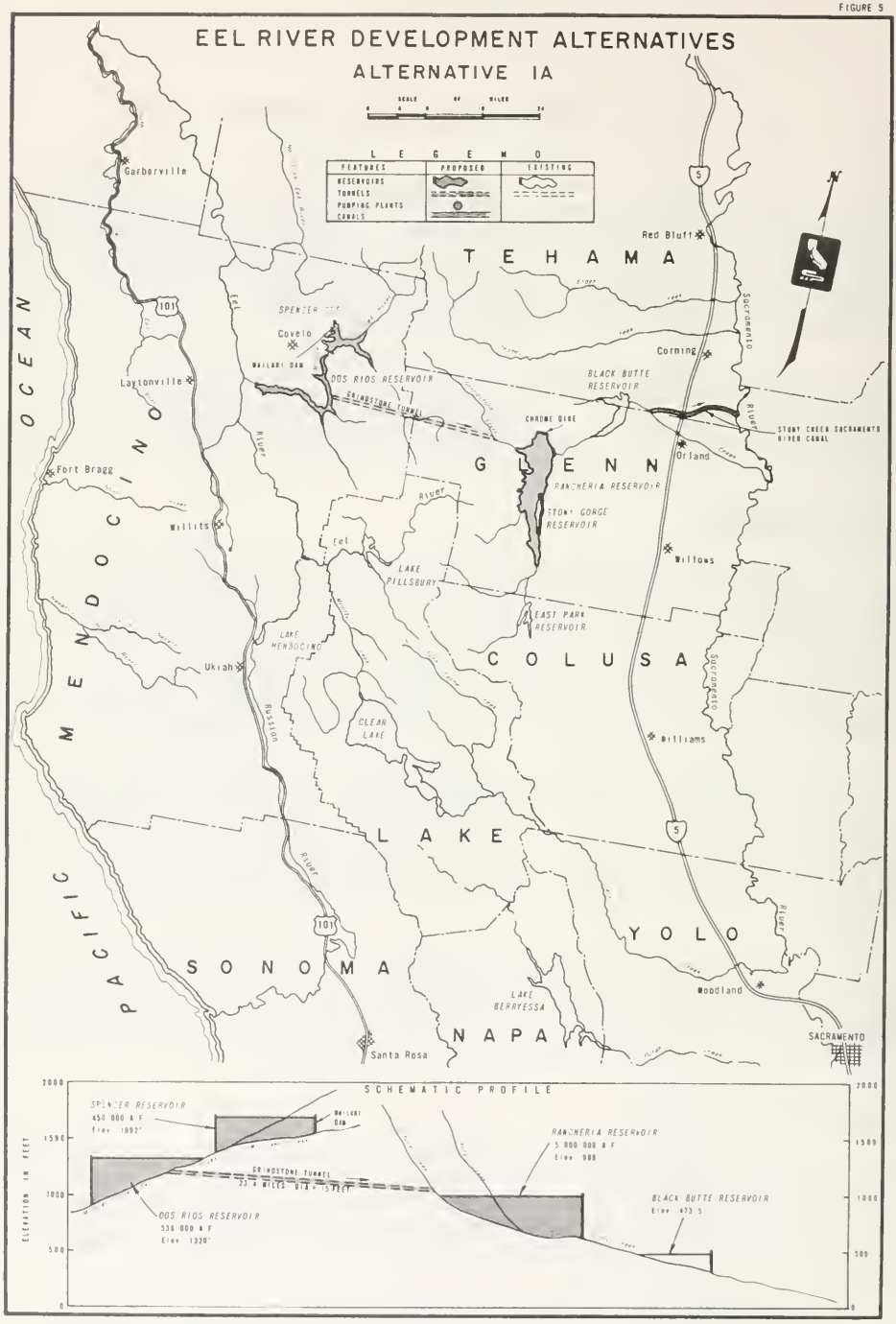
Construction of the basic features of this system would be staged as shown in Table 19 to meet State Water Project demands beginning in 1986. Since the Grindstone Tunnel would be smaller in this plan than in Alternative 1, Spencer Reservoir would have to be completed relatively early to allow adequate diversions for the initial filling of Rancheria Reservoir.

Flood Control Potential

The Corps of Engineers recommended a specific flood control reservation of 400,000 acre-feet at Spencer Reservoir. Economic studies showed that a specific flood control reservation could not be economically justified, due to the relatively high cost of storage. However, the combination of Spencer and small Dos Rios Reservoirs on the Middle Fork Eel River would provide some incidental flood protection.

The large Rancheria Reservoir might be able to provide additional flood protection for lower Stony Creek, and to provide some flood control

FIGURE 5


EEL RIVER DEVELOPMENT ALTERNATIVES
ALTERNATIVE IA
SCALE OF MILES
L E G E N D
FEATURES
PROPOSED
EXISTING
RESERVOIRS
TUNNELS
PUMPING PLANTS
CANALS
Garberville
Red Bluff
TEHAMA
Corning
Covelo
SPENCER
DOS RIOS RESERVOIR
BLACK BUTTE RESERVOIR
CRUMBSTONE TUNNEL
CHROME DIKE
STONY CREEK SACRAMENTO RIVER CANAL
Orland
GLENN
RANCHERIA RESERVOIR
STONY GORGE RESERVOIR
Laytonville
Fort Bragg
Willits
Willows
LAKE PILLSBURY
EAST PARK RESERVOIR
LAKE MENDOCINO
Ukiah
COLUSA
CLEAR LAKE
Williams
LAKE
YOLO
SONOMA
LAKE BERRYESSA
Woodland
NAPA
SACRAMENTO
Santa Rosa
OCEAN
MENDOCINO
PACIFIC
SCHEMATIC PROFILE
ELEVATION IN FEET
SPENCER RESERVOIR
450 000 A F
Elev 1892'
DOS RIOS RESERVOIR
530 000 A F
Elev 1320'
RANCHERIA RESERVOIR
5 000 000 A F
Elev 900
BLACK BUTTE RESERVOIR
Elev 473.5

benefits along the Sacramento River. This possibility should be considered in any future studies of this alternative.

Recreation Potential

Except for Spencer Reservoir, the recreation potential of the system is identical with that of Alternative 1. As shown in Table 17, Spencer Reservoir would add appreciably to the recreation potential in the Middle Fork Eel River area. Because of the greater developable recreation area around it, Spencer Reservoir would support more use than the small Dos Rios Reservoir.

Related Problems

The small Dos Rios and Spencer Reservoirs present serious problems which would require detailed additional investigation. First, the storage capacities of both reservoirs would be considerably reduced by siltation and landslides. Preliminary data indicate that a total of up to 480,000 acre-feet of storage would be lost during the 100-year economic life of these reservoirs. The Salmon Creek Landslide, in a narrow portion of the canyon 10 miles upstream from Dos Rios Dam, would require special treatment. Construction of Spencer Reservoir upstream from Dos Rios Reservoir would reduce the sediment inflow to Dos Rios Reservoir by about 100,000 acre-feet during the project life, but potential water temperature and turbidity problems with downstream releases would not be materially affected.

The relocations in the Rancheria Reservoir area, involving the community of Elk Creek and the Grindstone Indian Rancheria, would also be encountered with this alternative.

Level of Planning Knowledge

Past studies of Dos Rios Dam, Grindstone Tunnel, and Rancheria Dam have compiled fairly detailed geologic and design information for these features. Major additional planning work is required for sedimentation, landslide, and water quality problems associated with the Spencer and small Dos Rios Reservoirs.

Limited investigation has been made at Spencer Dam site. Spencer Dam was limited to a maximum crest elevation of 1,720 feet, based on reconnaissance-level data. Considerable additional investigation would be required before final sizing.

A 200-foot dam would be required at the Wailaki site to prevent Spencer Reservoir from spilling into Round Valley. Wailaki Dam site has been studied to only a low reconnaissance level and additional geologic studies are needed.

TABLE 17
ALTERNATIVE 1A
DAM AND RESERVOIR DATA SUMMARY

	Spencer Dam and Reservoir	Wailaki Dam	Dos Rios Dam and Reservoir	Rancheria Dam and Reservoir
Drainage area, square miles	426		319[a]	599
Mean annual flows, million AF				
Runoff at damsite '1911-60'	0.696		0.340[a]	0.338
Upstream impairments	---		---	---
Releases for fish	---		0.217	---
Other mandatory releases	---		---	0.206[b]
Remainder = storable inflow	0.696		0.123	0.132
Elevations, feet				
Dam crest	1720	1720	1340	1018
Maximum pool	1705		1325	1010
Top of flood reservation	---		---	---
Top of conservation pool	1692		1320	998
Minimum pool	1628		1237	710
Streambed	1356	1520	920	590
Dam height, feet	364	200	420	428
Dam construction time, years	3	1	3	5
Capacities, million AF				
Flood reservation	---		---	---
Conservation storage	0.200		0.306	4.900
Inactive, dead, sediment	0.250		0.230	0.100
Gross	0.450		0.536	5.000
Areas, acres				
Reservoir @ gross storage	3,700		4,300	35,200
Wildlife preservation lands	4,500		2,700	860
Total land purchase required	14,000		8,200	45,800
Reservoir shoreline, miles	40		70	130
Main streams inundated, miles	17		25	23
Population displaced	40		10	330
Average fish runs at damsite				
Salmon, fish per year	---		13,000	---
Steelhead, fish per year	---		23,000	---
Recreation use, visitor-days/yr.				
Initial use	155,000		100,000	375,000
Maximum use	900,000		300,000	685,000
Years to reach maximum use	100		100	20

a. Values for incremental drainage between Spencer and Dos Rios sites.
b. Release for local use in Stony Creek area = 165,000 AF/yr.; presently exportable from Delta = 41,000 AF/yr.

TABLE 18
ALTERNATIVE 1A
CONVEYANCE FACILITY DATA SUMMARY

Grindstone Tunnel	
Length, miles	23.4
Diameter, feet	15.0
Inlet elevation, feet	1,200
Outlet elevation, feet	1,000
Capacity, cfs (maximum/minimum)	2,390/2,050
Construction time, years	8
Stony Creek-Sacramento River Canal	
Type	Concrete-lined canal and creek channelization
Length, miles	15.0
Capacity, cfs	4,100

TABLE 19
ALTERNATIVE 1A
DESIGN AND CONSTRUCTION SCHEDULE
(Does not include feasibility investigation time)

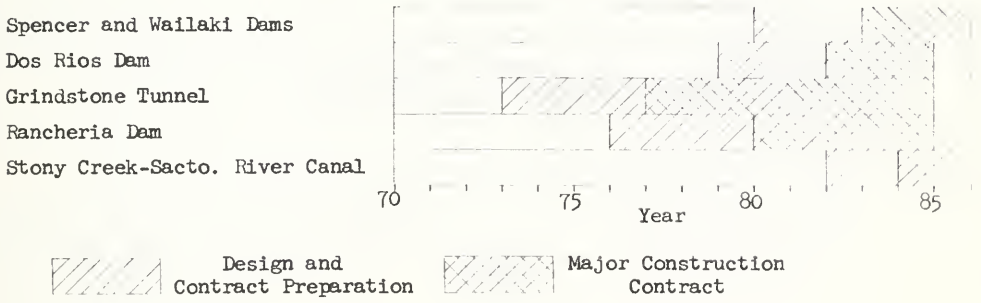


TABLE 20
ALTERNATIVE 1A
COST SUMMARY
(Price basis, July 1969. Period of analysis, 1986-2085. Interest rate, 5%.)

Feature	Construction Completion Date	Construction Time (years)	Costs, in Millions of Dollars			
			First Cost (includes engr. & contingencies)	Construction Cost Capitalized to 1986	OM&R Cost Capitalized to 1986	Total Cost Capitalized to 1986
Spencer Dam and Reservoir[a]	1986	3	77.6	83.4	6.3	89.7
Wildlife Preservation			1.2	1.4	0.8	2.2
Recreation Facilities[b]			2.3	3.5	3.9	7.4
Dos Rios Dam and Reservoir	1985	3	67.0	75.6	5.7	81.3
Fish Preservation			9.7	11.3	6.8	18.1
Wildlife Preservation			0.7	0.9	0.5	1.4
Recreation Facilities[b]			0.6	0.8	1.5	2.3
Grindstone Tunnel	1985	8	181.5	228.7	3.6	232.3
Rancheria Dam and Reservoir	1985	5	182.7	215.8	16.3	232.1
Wildlife Preservation			0.2	0.3	0.2	0.5
Recreation Facilities[b]			5.3	6.6	7.8	14.4
Stony Creek-Sacto. River Canal	1986	2	8.4	8.8	2.4	11.2
TOTALS			537.2	637.1	55.8	692.9
Average Annual Cost				32.1	2.8	34.9

a. Includes Wailaki Dam.

b. First cost includes initial recreation facilities only; capitalized costs include all future staged recreation developments.

ALTERNATIVE 1B: MINA, SMALL DOS RIOS-RANCHERIA PROJECT

This system is a variation of Alternative 1. The changes consist of the addition of a 550,000-acre-foot Mina Reservoir on the North Fork Eel River, a Mina-Williams Creek Tunnel and Pumping Plant, and an increase in the sizes of the Grindstone Tunnel and Rancheria Reservoir. Dos Rios Reservoir would be the same as in Alternative 1. Tables 21 through 24 summarize the physical data on the various features, the staging of design and construction, and the project costs. A plan and profile of the system are shown on the accompanying figure.

This system would provide a new yield of 900,000 acre-feet per year, referenced to the Sacramento-San Joaquin Delta, plus an additional firm annual yield of 170,000 acre-feet. The unit cost of the 170,000 acre-feet of additional yield obtained with this variation of Alternative 1 would be relatively high, as indicated by the increase in first cost of $198 million.

Project Formulation

Mina Reservoir was sized to divert essentially all of the available water from the North Fork Eel River, after provision for annual fishery preservation releases of 100,000 acre-feet. Operation studies showed that 350,000 acre-feet of active storage and an 800-cubic-foot-per-second continuous diversion for six months (April through September) would limit spills from Mina Reservoir to years of extremely high runoff. The minimum pool elevation of 1,420 feet in Mina Reservoir was selected to decrease the static head at the Mina Pumping Plant and to allow some margin of storage for sedimentation.

The Mina-Williams Creek Tunnel and Pumping Plant were sized for a six-month summer diversion season, thus making maximum use of the excess summer capacity of the more expensive Grindstone Tunnel. The diameter of the Grindstone Tunnel would still have to be increased over that shown in Alternative 1, from 16 to 16.5 feet.

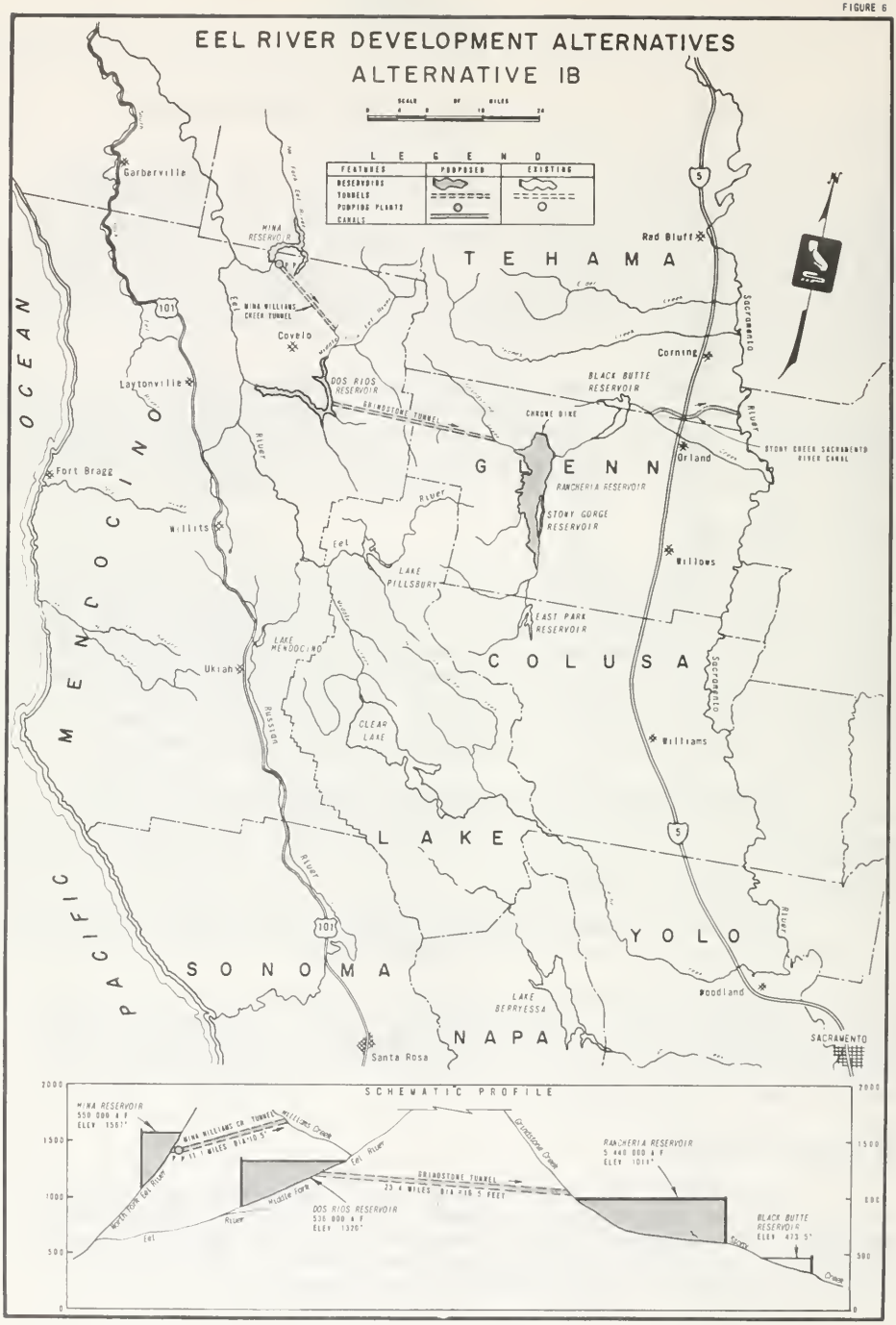
The 5,440,000-acre-foot Rancheria Reservoir was sized to balance the total system storage with the available water supply.

Construction of the basic features of this system would be staged to meet State Water Project demands beginning in 1986. Initial filling of sufficient storage to permit a reasonable certainty of meeting these demands would require one year. Therefore, construction of this system should be staged as shown in Table 23.

Flood Control Potential

Consideration was given to using some of the storage provided by Mina Reservoir for flood control purposes. It was found that, under present conditions, the incremental cost of storage would be too high for a specific flood reservation to be economically justified. However, Mina and Dos Rios Reservoirs would provide some incidental flood protection.

FIGURE 6


EEL RIVER DEVELOPMENT ALTERNATIVES
ALTERNATIVE 1B
SCALE OF MILES
0 4 8 16 24
L E G E N D
FEATURES
PROPOSED
EXISTING
DESERVOIRS
TUNNELS
PUMPING PLANTS
CANALS
Garberville
MINA RESERVOIR
MINA-WILLIAMS CREEK TUNNEL
Covelo
Laytonville
Fort Bragg
Willits
Ukiah
DOS RIOS RESERVOIR
GRINDSTONE TUNNEL
CHRONE DIKE
BLACK BUTTE RESERVOIR
Red Bluff
Corning
Orland
STONY CREEK SACRAMENTO RIVER CANAL
RANCHERIA RESERVOIR
STONY GORGE RESERVOIR
Willows
LAKE PILLSBURY
EAST PARK RESERVOIR
LAKE MENDOCINO
CLEAR LAKE
Williams
Woodland
LAKE BERRYESSA
SACRAMENTO
Santa Rosa
OCEAN
MENDOCINO
TEHAMA
GLENN
COLUSA
LAKE
YOLO
SONOMA
NAPA
Eel River
Russian River
Sacramento River
101
5
N
SCHEMATIC PROFILE
MINA RESERVOIR
550 000 A F
ELEV 1561'
MINA-WILLIAMS CR TUNNEL
11 MILES DIA 10.5'
Williams Creek
Eel River
Grindstone Creek
RANCHERIA RESERVOIR
5 440 000 A F
ELEV 1011'
GRINDSTONE TUNNEL
23.4 MILES DIA 21.5 FEET
DOS RIOS RESERVOIR
525 000 A F
ELEV 1370'
BLACK BUTTE RESERVOIR
ELEV 473.5'
Stony Creek
2000
1500
1000
500
0

The flood control potential of Rancheria Reservoir would be essentially the same as in Alternative 1.

Recreation Potential

As shown in the recreation use projections in Table 21, construction of Mina Reservoir would add only a minor amount of recreation use potential to the system. This is due to the limited access, rugged surrounding terrain, and mode of operation. The recreation potential of Dos Rios and Rancheria Reservoirs would be the same as in Alternative 1.

Related Problems

Problems with Dos Rios Reservoir would be the same as those described under Alternative 1. Due to the similarities of reservoir size, depth, operation, and regional geology, it seems reasonable to expect landslide, sediment, temperature, and turbidity problems at Mina Reservoir to be similar to those at a small Dos Rios Reservoir. Additional investigations of these aspects would be required.

Level of Planning Knowledge

The current level of information on all of the features of this system, except Mina Reservoir and the Mina-Williams Creek Tunnel, was covered under Alternative 1. Investigations of Mina Dam and Reservoir site have been very preliminary to date. Only very cursory attention has been given to the Mina-Williams Creek Tunnel alignment.

TABLE 21
ALTERNATIVE 1B
DAM AND RESERVOIR DATA SUMMARY

	Mina Dam and Reservoir	Dos Rios Dam and Reservoir	Rancheria Dam and Reservoir
Drainage area, square miles	246	745	599
Mean annual flows, million AF			
Runoff at damsite '1911-60'	0.368	1.036	0.338
Upstream impairments	---	---	---
Releases for fish	0.100	0.217	---
Other mandatory releases	---	---	0.206[a]
Remainder = storable inflow	0.268	0.819	0.132
Elevations, feet			
Dam crest	1589	1340	1031
Maximum pool	1583	1325	1023
Top of flood reservation	---	---	---
Top of conservation pool	1567	1320	1011
Minimum pool	1420	1272	710
Streambed	1067	920	590
Dam height, feet	522	420	441
Dam construction time, years	5	3	5
Capacities, million AF			
Flood reservation	---	---	---
Conservation storage	0.350	0.206	5.340
Inactive, dead, sediment	0.200	0.330	0.100
Gross	0.550	0.536	5.440
Areas, acres			
Reservoir @ gross storage	3,200	4,300	36,800
Wildlife preservation lands	2,000	2,700	860
Total land purchase required	6,200	8,200	47,200
Reservoir shoreline, miles	40	70	140
Main streams inundated, miles	19	25	23
Population displaced	10	10	330
Average fish runs at damsite			
Salmon, fish per year	500	13,000	---
Steelhead, fish per year	5,000	23,000	
Recreation use, visitor-days/yr.			
Initial use	60,000	100,000	375,000
Maximum use	300,000	300,000	685,000
Years to reach maximum use	100	100	20

a. Release for local use in Stony Creek area = 165,000 AF/yr.; presently exportable from Delta = 41,000 AF/yr.

TABLE 22
ALTERNATIVE 1B
CONVEYANCE FACILITY DATA SUMMARY

Mina-Williams Creek Pumping Plant	
Location	Left abutment of Mina Dam site
Type	Underground, on-peak
Minimum static head, feet	133
Maximum static head, feet	280
Design flow, cfs	800
Installed horsepower	45,000
Mina-Williams Creek Tunnel	
Length, miles	11.1
Diameter, feet	10.5
Inlet elevation, feet	1,400
Outlet elevation, feet	1,700
Capacity, cfs	800
Construction time, years	5
Grindstone Tunnel	
Length, miles	23.4
Diameter, feet	16.5
Inlet elevation, feet	1,200
Outlet elevation, feet	1,000
Capacity, cfs (maximum/minimum)	3,070/2,830
Construction time, years	8
Stony Creek-Sacramento River Canal	
Type	Concrete-lined canal and creek channelization
Length, miles	15.0
Capacity, cfs	4,350

TABLE 23
ALTERNATIVE 1B
DESIGN AND CONSTRUCTION SCHEDULE
(Does not include feasibility investigation time)

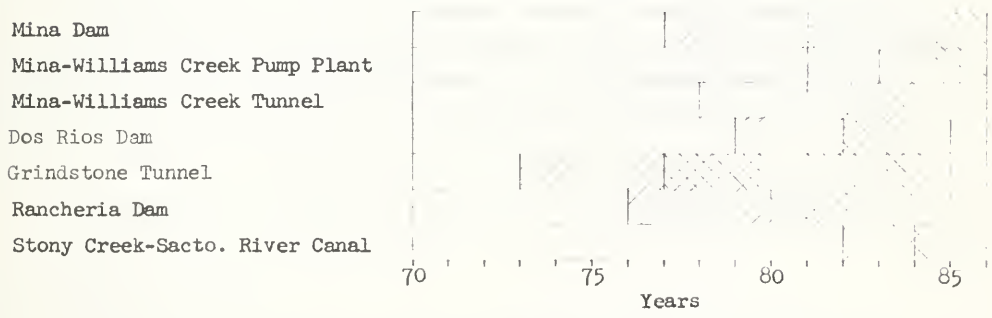


TABLE 24
ALTERNATIVE 1B
COST SUMMARY
(Price basis, July 1969 Period of analysis, 1986-2085 Interest rate, 5%.)

Feature	Construction Completion Date	Construction Time (years)	Costs, in Millions of Dollars			
			First Cost (includes engr. & contingencies)	Construction Cost Capitalized to 1986	OM&R Cost Capitalized to 1986	Total Cost Capitalized to 1986
Mina Dam and Reservoir	1986	5	107.7[a]	121.2	9.1	130.3
Fish Preservation			5.5	6.3	2.3	8.6
Wildlife Preservation			0.4	0.5	0.3	0.8
Recreation Facilities[b]			0.4	0.6	1.1	1.7
Mina-Williams Creek Pumping Plant	1986	3	10.4	11.2	3.8	15.0
Power					20.6	20.6
Mina-Williams Creek Tunnel	1986	5	44.7	50.3	0.8	51.1
Dos Rios Dam and Reservoir	1985	3	67.0	75.6	5.7	81.3
Fish Preservation			9.7	11.3	6.8	18.1
Wildlife Preservation			0.7	0.9	0.5	1.4
Recreation Facilities[b]			0.6	0.8	1.5	2.3
Grindstone Tunnel	1985	8	205.4	258.8	4.1	262.9
Rancheria Dam and Reservoir	1985	5	202.7	239.4	18.1	257.5
Wildlife Preservation			0.2	0.3	0.2	0.5
Recreation Facilities			5.3	6.6	7.8	14.4
Stony Creek-Sacto. River Canal	1986	2	8.6	9.0	2.4	11.4
TOTALS			669.3	792.8	85.1	877.9
Average Annual Cost				39.9	4.3	44.2

a. USBR preliminary cost estimate, adjusted to July 1969 price levels.

b. First cost includes initial recreation facilities only; capitalized costs include all future staged recreation development.

ALTERNATIVE 2: MEDIUM-SIZED DOS RIOS-RANCHERIA PROJECT

This alternative would provide for construction of a 605-foot-high Dos Rios Dam, combined with Mill Creek Dam to prevent inundation of Round Valley. A 17-foot-diameter tunnel, 4.8 miles long, would be used to drain the natural runoff entering Round Valley behind the protective dam. Dos Rios Reservoir would have a total storage capacity of 1,650,000 acre-feet, with 600,000 acre-feet reserved for flood storage. A 12-foot-diameter Dos Rios-Grindstone Tunnel would convey Middle Fork Eel River water to a 4,780,000-acre-foot Rancheria Reservoir.

Tables 25 through 28 summarize the physical data on the various features, the design and construction staging, and the project costs. A plan and profile of the system are shown on the accompanying figure.

This system would develop 900,000 acre-feet per year of new yield, referenced to the Sacramento-San Joaquin Delta.

Project Formulation

A Dos Rios Reservoir gross capacity of 1,650,000 acre-feet was selected to illustrate this alternative. This capacity would provide adequate dead storage to accommodate the estimated 100-year accumulation of sediment and landslide debris, a 600,000-acre-foot flood control reservation, and sufficient water conservation storage to permit economical development of the available water supply. The reservoir could be enlarged to provide additional long-term holdover storage to the system, but Rancheria Reservoir could provide enough storage capacity to balance the available water supply at lower cost.

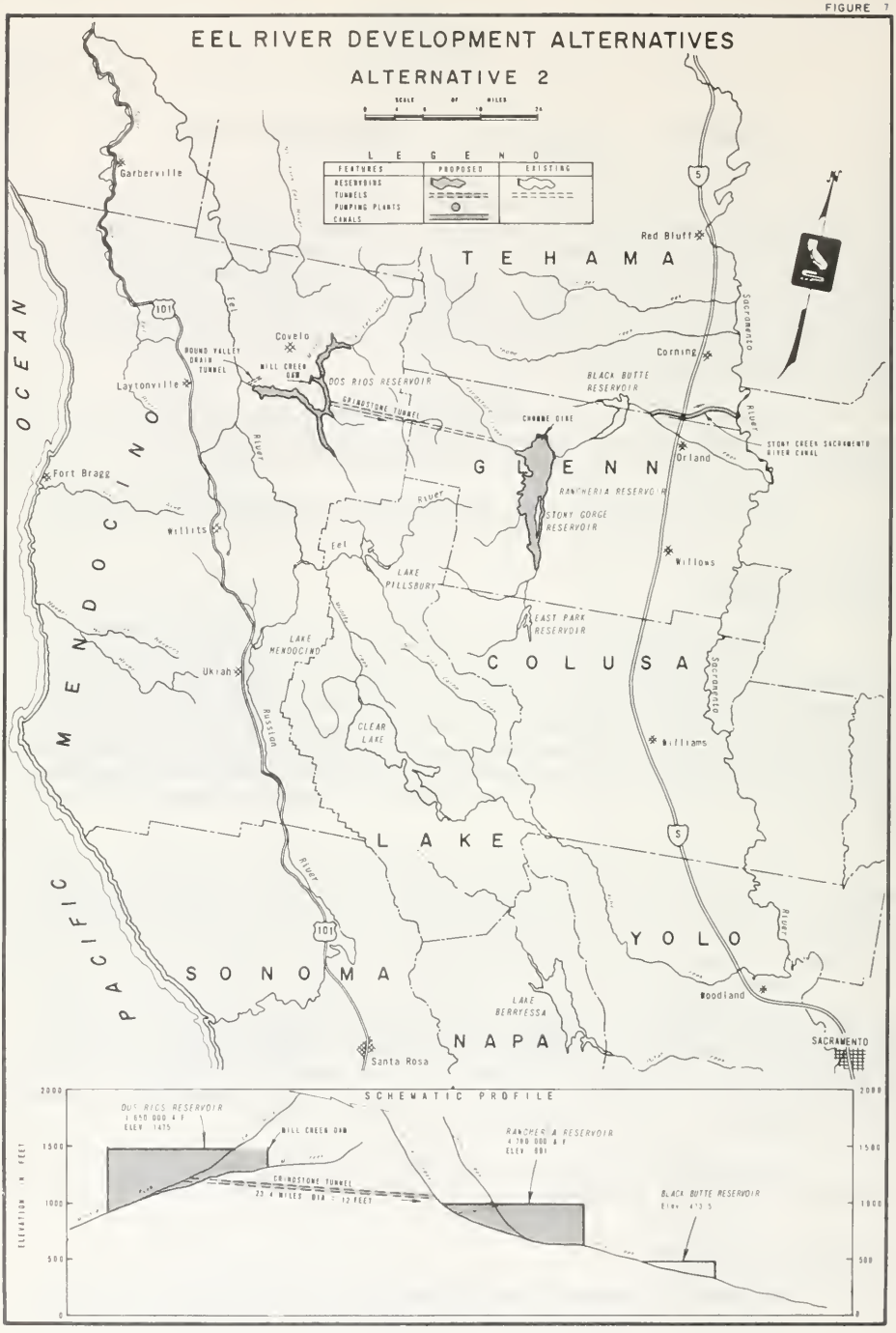
When formulated in this manner, Alternative 2 is essentially identical to Alternative 1 in terms of accomplishments, except it provides flood protection on the Eel River. Additional study may indicate that enlargement of Dos Rios Reservoir and construction of Mill Creek Dam and the Round Valley Drain Tunnel are not economically justified solely to furnish flood protection.

The Grindstone Tunnel was sized to a diameter of 12.0 feet, based on an economic comparison of tunnel sizes and reservoir capacities needed to develop 900,000 acre-feet of new yield. The water supply available to this system would be less than that of other Dos Rios Reservoir alternatives, since the 88,000-acre-foot mean annual inflow from Round Valley would spill through the drain tunnel to a point downstream from Dos Rios Dam.

The staging of design and construction of this system, which would be similar to that for Alternative 1, is shown in Table 27.

Flood Control Potential

The Corps of Engineers has recommended a specific flood reservation of 600,000 acre-feet in the large Dos Rios Reservoir. This reservation was


EEL RIVER DEVELOPMENT ALTERNATIVES
ALTERNATIVE 2
SCALE OF MILES
0 6 12 24
L E G E N D
FEATURES
PROPOSED
EXISTING
RESERVOIRS
TUNNELS
PUMPING PLANTS
CANALS
Garberville
Laytonville
Covelo
ROUND VALLEY DRAIN TUNNEL
MILL CREEK DAM
DOS RIOS RESERVOIR
CRYSTAL TUNNEL
CHROME DIKE
BLACK BUTTE RESERVOIR
Red Bluff
Corning
Orland
STONY CREEK SACRAMENTO RIVER CANAL
RANCHERIA RESERVOIR
STONY GORGE RESERVOIR
Willits
Fort Bragg
Ukiah
LAKE PILLSBURY
LAKE MENDOCINO
EAST PARK RESERVOIR
Willows
Williams
CLEAR LAKE
Woodland
LAKE BERRYESSA
Santa Rosa
SACRAMENTO
OCEAN
MENDOCINO
LAKE
YOLO
SONOMA
NAPA
COLUSA
TEHAMA
GLENN
PACIFIC
Eel River
Russian River
Sacramento River
101
5
SCHEMATIC PROFILE
DOS RIOS RESERVOIR
1 650 000 A F
ELEV 1475
MILL CREEK DAM
CRYSTAL TUNNEL
23 4 MILES DIA = 12 FEET
RANCHERIA RESERVOIR
4 700 000 A F
ELEV 881
BLACK BUTTE RESERVOIR
Elev 473 5
ELEVATION IN FEET
2000
1500
1000
500
0

included in the Dos Rios Reservoir in this plan; in combination with the authorized Eel Delta levees, it would provide, substantially, protection against a flood comparable to that which occurred in December 1964. The medium-sized Dos Rios Reservoir would have reduced the December 1964 flood peak at Scotia from 750,000 to 550,000 cubic feet per second and, at Fernbridge, from 840,000 to 660,000 cubic feet per second. These reductions are slightly less than those which could be effected by the Corps' large Dos Rios Reservoir because of the outflow from the Round Valley Drain Tunnel.

The large Rancheria Reservoir might be able to provide additional flood protection for lower Stony Creek, and to provide some flood control benefits along the Sacramento River. This possibility should be considered in any future studies of this alternative.

Recreation Potential

Table 25 shows the expected recreation use at Dos Rios and Rancheria Reservoirs. In spite of the increased size of Dos Rios Reservoir in this alternative, its recreation potential is expected to be essentially the same as that of a small Dos Rios Reservoir. Rancheria Reservoir, with its large surface area, fair access, and generally stable water surface, would provide for a moderate amount of fair-quality recreation use.

In addition to recreation at the new reservoirs, this alternative would offer the possibility of increased recreation potential at the existing Black Butte and East Park Reservoirs. The construction of Rancheria Reservoir would offer the possibility of coordinated operation to stabilize the levels of these existing reservoirs.

Related Problems

One problem associated with the illustrated Dos Rios Reservoir is that the substitution of a drainage tunnel for the natural outlet of the valley would necessitate occasional ponding of water in the lower end of the valley during floods. The area subject to occasional flooding is determined by the drain tunnel diameter. With the 17-foot tunnel illustrated, some 4,000 acres in the valley could be inundated by the probable maximum flood. Enlarging the tunnel to about 22 feet in diameter, at a cost of approximately $20 million, would reduce the possible area of ponding to a few hundred acres. More studies are needed to establish the best plan, but a satisfactory solution could probably be worked out with a combination of purchase of flowage easements and construction of levees to contain the ponded flows.

Because this alternative would provide 700,000 acre-feet of conservation storage in Dos Rios Reservoir, problems with landslides and sedimentation should be considerably less severe than with a lower Dos Rios Dam. However, adequate control of the temperature and turbidity of downstream water releases still might not be possible.

As with any system involving Rancheria Reservoir, relocation of the community of Elk Creek would be required with this alternative. Another necessary relocation would be the 80-acre Grindstone Indian Rancheria which has a population of approximately 25 persons.

Level of Planning Knowledge

Past studies of Dos Rios Dam, Grindstone Tunnel, and Rancheria Dam have compiled fairly detailed geologic and design information for these features. Further planning work is required for the sedimentation, landslide, and water quality problems associated with the medium-sized Dos Rios Reservoir. Mill Creek Dam site has been studied at only a low reconnaissance level; additional geologic investigation is needed.

TABLE 25
ALTERNATIVE 2
DAM AND RESERVOIR DATA SUMMARY

	Dos Rios Dam and Reservoir	Mill Creek Dam	Rancheria Dam and Reservoir
Drainage area, square miles	648[a]		599
Mean annual flows, million AF			
Runoff at damsite '1911-60'	0.948[a]		0.338
Upstream impairments	---		---
Releases for fish	0.217		---
Other mandatory releases	---		0.206[b]
Remainder = storable inflow	0.731[a]		0.132
Elevations, feet			
Dam crest	1525	1525	1011
Maximum pool	1505		1003
Top of flood reservation	1475		---
Top of conservation pool	1405		991
Minimum pool	1278		710
Streambed	920	1275	590
Dam height, feet	605	250	421
Dam construction time, years	6	2	5
Capacities, million AF			
Flood reservation	0.600		---
Conservation storage	0.700		4.680
Inactive, dead, sediment	0.350		0.100
Gross	1.650		4.780
Areas, acres			
Reservoir @ gross storage	10,400		34,500
Wildlife preservation lands	8,800		860
Total land purchase required	23,700		44,700
Reservoir shoreline, miles	80		130
Main streams inundated, miles	31		23
Population displaced	50		330
Average fish runs at damsite			
Salmon, fish per year	13,000		---
Steelhead, fish per year	23,000		---
Recreation use, visitor-days/yr.			
Initial use	180,000		375,000
Maximum use	320,000		685,000
Years to reach maximum use	100		20

a. After deduction for the 97 square miles and average annual runoff of 88,000 acre-feet tributary to Round Valley Drain Tunnel, which would discharge to the river downstream from Dos Rios Dam.

b. Release for local use in Stony Creek area = 165,000 AF/yr.; presently exportable from Delta = 41,000 AF/yr.

TABLE 26
ALTERNATIVE 2
CONVEYANCE FACILITY DATA SUMMARY

Grindstone Tunnel	
Length, miles	23.4
Diameter, feet	12.0
Inlet elevation, feet	1,200
Outlet elevation, feet	1,000
Capacity, cfs (maximum/minimum)	1,600/1,230
Construction time, years	8
Stony Creek-Sacramento River Canal	
Type	Concrete-lined canal and creek channelization
Length, miles	15.0
Capacity, cfs	4,000

TABLE 27
ALTERNATIVE 2
DESIGN AND CONSTRUCTION SCHEDULE
(Does not include feasibility investigation time)

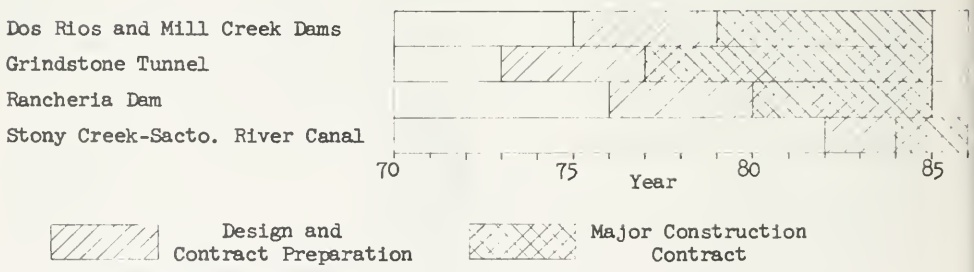


TABLE 28
ALTERNATIVE 2
COST SUMMARY
(Price basis, July 1969 Period of analysis, 1986-2085 Interest rate, 5%.)

Feature	Construction Completion Date	Construction Time (years)	Costs, in Millions of Dollars			
			First Cost (includes engr. & contingencies)	Construction Cost Capitalized to 1986	OM&R Cost Capitalized to 1986	Total Cost Capitalized to 1986
Dos Rios Dam and Reservoir[a]	1985	6	194.0	234.3	17.7	252.0
Fish Preservation			9.7	11.7	7.6	19.3
Wildlife Preservation			1.7	2.3	1.3	3.6
Recreation Facilities[b]			1.9	2.3	2.8	5.1
Grindstone Tunnel	1985	8	130.1	163.9	2.6	166.5
Rancheria Dam and Reservoir	1985	5	174.2	205.8	15.6	221.4
Wildlife Preservation			0.2	0.3	0.2	0.5
Recreation Facilities[b]			5.3	6.6	7.8	14.4
Stony Creek-Sacto. River Canal	1986	2	8.2	8.6	2.3	10.9
TOTALS			525.3	635.8	57.9	693.7
Average Annual Cost				32.0	2.9	34.9

a. Includes Mill Creek Dam and Round Valley Drain Tunnel.

b. First cost includes initial recreation facilities only; capitalized costs include all future staged recreation development.

ALTERNATIVE 3: YELLOW JACKET-RANCHERIA PROJECT

This alternative would provide for complete development of the main stem Eel River. An 8,680,000-acre-foot Yellow Jacket Reservoir would form the keystone of the plan, as shown in the accompanying figure. A pumping plant, located near the mouth of the North Fork Eel River, would pump water through the 11.1-mile Yellow Jacket-Round Valley Tunnel into Mill Creek in the northwest corner of Round Valley. The water would flow through Round Valley to a small Dos Rios Reservoir. This water, along with the water regulated by Dos Rios Reservoir, would be diverted through Grindstone Tunnel into Rancheria Reservoir in the Sacramento Valley.

The project would yield 900,000 acre-feet per year, referenced to the Sacramento-San Joaquin Delta, plus 570,000 acre-feet per year of supplemental firm supply. Tables 29 through 32 present details of this plan.

Project Formulation

This project was formulated using the assumption that English Ridge Reservoir was constructed independently and was diverting water out of the basin. Therefore, part of the water supply at English Ridge Reservoir would not be available to Yellow Jacket Reservoir. It was further assumed that the English Ridge Project would continue making fish releases of 126,000 acre-feet per year as its share of the total release of 1,053,000 acre-feet per year required below Yellow Jacket Dam.

In examining the Yellow Jacket-Dos Rios conveyance works, three different locations for the necessary pumping plant were examined. They were:

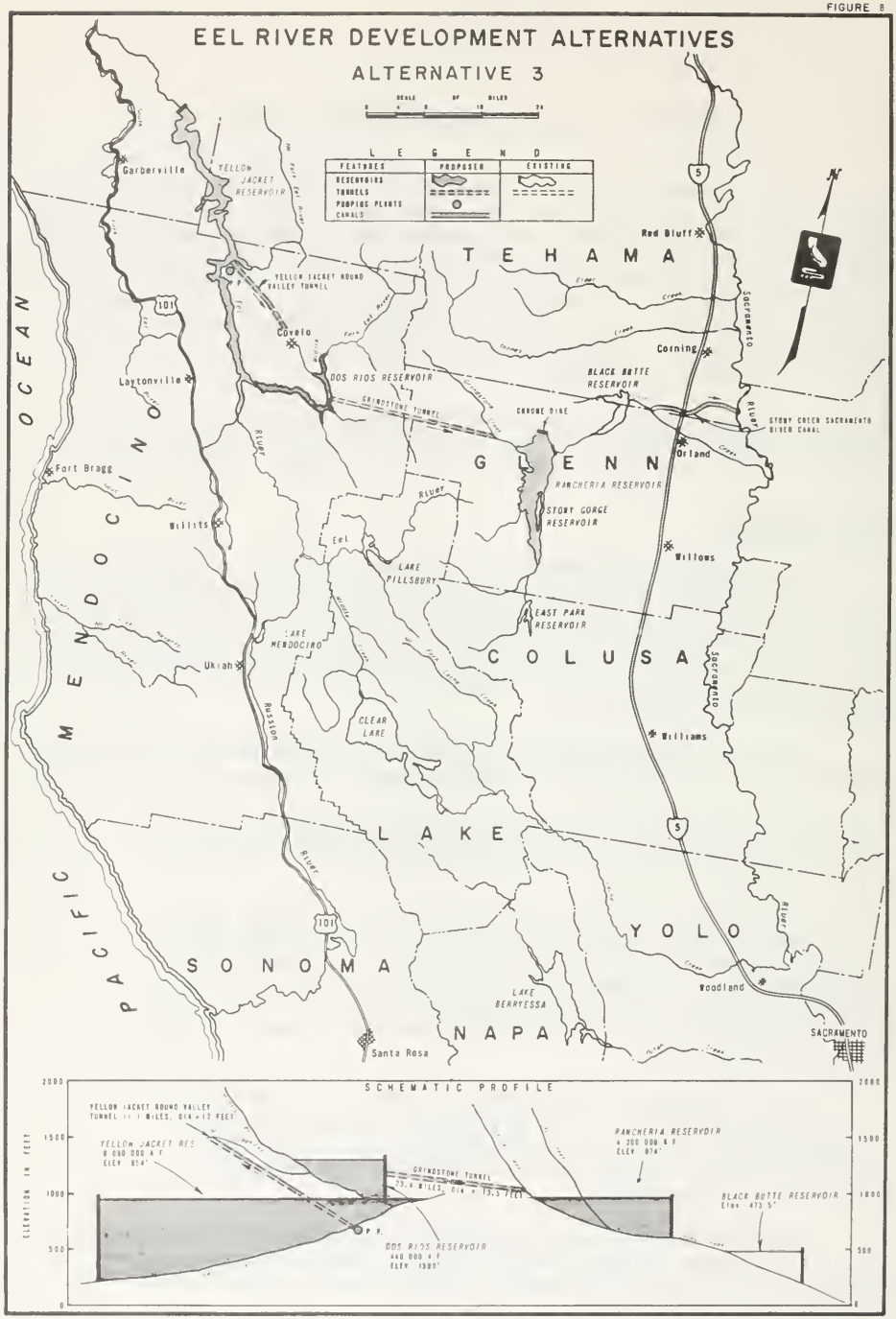
1. At the toe of the Dos Rios Dam, underground, giving a minimum pool elevation of 920 feet in Yellow Jacket Reservoir and an inactive storage of 7,600,000 acre-feet.

2. At River Garden on the main Eel River, midway between the Middle Fork and North Fork confluences. The plant would be an underground type with a 7.5-mile tunnel into Round Valley, from where the water would flow naturally into Dos Rios Reservoir. This would give a minimum pool elevation of 800 feet in Yellow Jacket Reservoir and a corresponding inactive storage of about 4,600,000 acre-feet.

3. At the mouth of the North Fork Eel River. The plant would be an underground type with an 11.1-mile tunnel into Round Valley. This would give a minimum pool elevation of 700 feet in Yellow Jacket Reservoir with an inactive storage of 2,780,000 acre-feet.

Examination and economic analysis of these three conveyance possibilities led to selection of the third one, which would result in the least inactive storage in Yellow Jacket Reservoir and the least overall cost of water development.

FIGURE 8


EEL RIVER DEVELOPMENT ALTERNATIVES
ALTERNATIVE 3
SCALE OF MILES
0 6 12 18 24
L E G E N D
FEATURES
PROPOSED
EXISTING
RESERVOIRS
TUNNELS
PUMPING PLANTS
CANALS
N
Garberville
YELLOW JACKET RESERVOIR
YELLOW JACKET ROUND VALLEY TUNNEL
Covelo
Laytonville
DOS RIOS RESERVOIR
GRINDSTONE TUNNEL
CHROME DIKE
BLACK BUTTE RESERVOIR
Red Bluff
Corning
STONY CREEK SACRAMENTO RIVER CANAL
Orland
RANCHERIA RESERVOIR
STONY GORGE RESERVOIR
Willows
LAKE PILLSBURY
EAST PARK RESERVOIR
Williams
Woodland
SACRAMENTO
Fort Bragg
Willits
Ukiah
LAKE MENDOCINO
CLEAR LAKE
Santa Rosa
LAKE BERRYESSA
OCEAN
PACIFIC
MENDOCINO
TEHAMA
GLENN
COLUSA
LAKE
YOLO
SONOMA
NAPA
101
5
SCHEMATIC PROFILE
ELEVATION IN FEET
2000
1500
1000
500
0
YELLOW JACKET ROUND VALLEY TUNNEL 11.1 MILES, DIA = 12 FEET
YELLOW JACKET RES
6 000 000 A F
ELEV 954'
GRINDSTONE TUNNEL
13.4 MILES, DIA = 13.5 FEET
P P
DOS RIOS RESERVOIR
440 000 A F
ELEV 1380'
RANCHERIA RESERVOIR
4 200 000 A F
ELEV 974'
BLACK BUTTE RESERVOIR
Elev 473 5'

Finally, the relative economics of apportioning the total storage required between Yellow Jacket and Rancheria Reservoirs was examined, resulting in the project sizes shown in Table 29.

Construction of the basic features of this system would be staged, as shown by Table 31, to meet State Water Project demands beginning in 1986 and supplemental demands beginning in 1990. Yellow Jacket Reservoir, the Grindstone Tunnel, and Dos Rios Reservoir would be completed in 1985; Rancheria Reservoir would be completed in 1988.

The relative merits of constructing this plan with or without Rancheria Reservoir were also subjected to a cost analysis. A project could be formulated without storage in the Sacramento Valley. However, it was found to be more costly than the illustrated plan, and to provide less yield. The reason for this is that the conveyance facilities would have to be much larger if no storage were available in the Sacramento Valley to meet peak demands in dry years. Since the pumping plant and about 34 miles of tunnel would have to be enlarged, the cost increase would be substantial.

Studies have also shown that it may be less costly overall to divide the total valley storage requirement between Newville and Rancheria Reservoirs. This possibility can be examined in detail in future planning studies.

Flood Control Potential

Because of its location below all major tributaries to the main Eel River except the South Fork, Yellow Jacket Reservoir has a great potential for flood control. As recommended by the Corps of Engineers, a specific flood control reservation of 900,000 acre-feet was selected for inclusion in this plan. Operating with the authorized Eel Delta levees, Yellow Jacket Reservoir would provide protection in the Eel River Delta against the Standard Project Flood. It would have reduced the December 1964 flood peak at Scotia from 750,000 to 490,000 cubic feet per second and at Fernbridge from 840,000 to 600,000 cubic feet per second, the design capacity of the proposed levee system.

Recreation Potential

Table 29 presents the estimated recreation use at Yellow Jacket, Dos Rios, and Rancheria Reservoirs. Recreation at Yellow Jacket Reservoir would be limited by poor access and rugged terrain. Dos Rios Reservoir would offer only limited potential due to its small size, poor access, and rugged terrain. Rancheria Reservoir with its better access and relatively stable water surface would offer a better quality of recreation, but the total use would be limited by the amount of surrounding land suitable for development.

Related Problems

A major problem with this alternative would be the loss of a substantial portion of the salmon and steelhead spawning areas in the Eel River system. Extensive studies would be necessary to determine the measures necessary for fishery preservation.

Another problem would be the necessity of relocating 93 miles of the Northwestern Pacific Railroad from Willits to the South Fork Eel River confluence. Problems might also be encountered from landslides in the Yellow Jacket Reservoir area.

Construction of Rancheria Reservoir would require relocation of the community of Elk Creek, and the 80-acre Grindstone Indian Rancheria, which has a population of approximately 25 persons.

Level of Planning Knowledge

Past studies of Dos Rios and Rancheria Dam sites and Grindstone Tunnel have compiled fairly detailed geologic and cost data for these features. The level of geologic knowledge of Yellow Jacket Dam site is at a good reconnaissance level. Geologic studies of the Yellow Jacket-Round Valley Pumping Plant and tunnel alignment have been very limited.

TABLE 29
ALTERNATIVE 3
DAM AND RESERVOIR DATA SUMMARY

	Yellow Jacket Dam and Reservoir	Dos Rios Dam and Reservoir	Rancheria Dam and Reservoir
Drainage area, square miles	1,450[a]	745	599
Mean annual flows, million AF			
Runoff at damsite '1911-60'	2.047a	1.036	0.338
Upstream impairments	0.415b	---	---
Releases for fish	1.053	---	---
Other mandatory releases	---	---	0.206c
Remainder = storable inflow	0.579	1.036	0.132
Elevations, feet			
Dam crest	974	1320	994
Maximum pool	959	1305	986
Top of flood reservation	954	---	---
Top of conservation pool	926	1300	974
Minimum pool	700	1272	710
Streambed	240	920	590
Dam height, feet	734	400	404
Dam construction time, years	6	3	5
Capacities, million AF			
Flood reservation	0.900	---	---
Conservation storage	5.000	0.110	4.100
Inactive, dead, sediment	2.780	0.330	0.100
Gross	8.680	0.440	4.200
Areas, acres			
Reservoir @ gross storage	33,500	3,800	31,700
Wildlife preservation lands	18,000	2,700	860
Total land purchase required	70,000	7,300	42,100
Reservoir shoreline, miles	210	70	130
Main streams inundated, miles	56	24	23
Population displaced	420	10	330
Average fish runs at damsite			
Salmon, fish per year	42,000	---	---
Steelhead, fish per year	62,000	---	---
Recreation use, visitor-days/yr.			
Initial use	900,000	100,000	375,000
Maximum use	2,100,000	300,000	685,000
Years to reach maximum use	30	100	20

a. Values exclude area and runoff above Dos Rios Dam site.

b. Depletions for existing Lake Pillsbury, existing diversions to Russian River Basin via Potter Valley Powerplant, and future effects of the English Ridge Project proposed by the U. S. Bureau of Reclamation.

c. Releases for local use in Stony Creek area = 165,000 AF/yr.; presently exportable from Delta = 41,000 AF/yr.

TABLE 30
ALTERNATIVE 3
CONVEYANCE FACILITY DATA SUMMARY

Yellow Jacket-Round Valley Pumping Plant	
Location	Mouth of North Fork Eel River
Type	Underground, on-peak
Minimum static head, feet	574
Maximum static head, feet	800
Design flow, cfs	1,050
Installed horsepower	123,000
Yellow Jacket-Round Valley Tunnel	
Length, miles	11.1
Diameter, feet	12.0
Inlet elevation, feet	700
Outlet elevation, feet	1,500
Minimum capacity, cfs	1,050
Construction time, years	5
Grindstone Tunnel	
Length, miles	23.4
Diameter, feet	13.5
Inlet elevation, feet	1,200
Outlet elevation, feet	1,000
Capacity, cfs (maximum/minimum)	1,740/1,660
Construction time, years	8
Stony Creek-Sacramento River Canal	
Type	Concrete-lined canal and creek channelization
Length, miles	15.0
Capacity, cfs	5,100

TABLE 31
ALTERNATIVE 3
DESIGN AND CONSTRUCTION SCHEDULE
(Does not include feasibility investigation time)

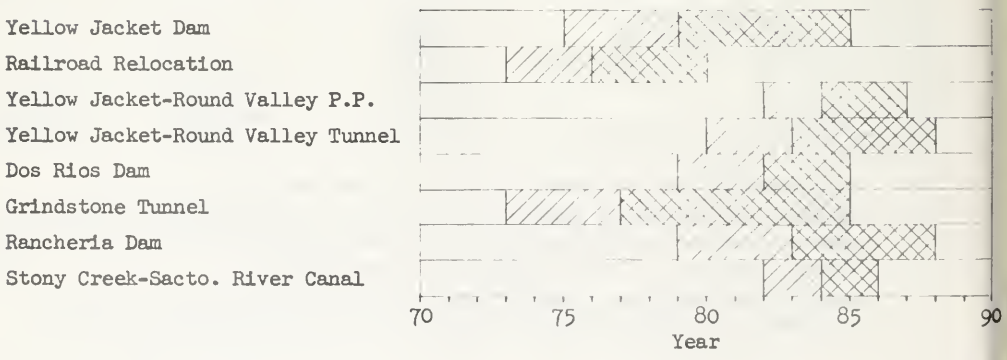


TABLE 32
ALTERNATIVE 3
COST SUMMARY
(Price basis, July 1969 Period of analysis, 1986-2085 Interest rate, 5%.)

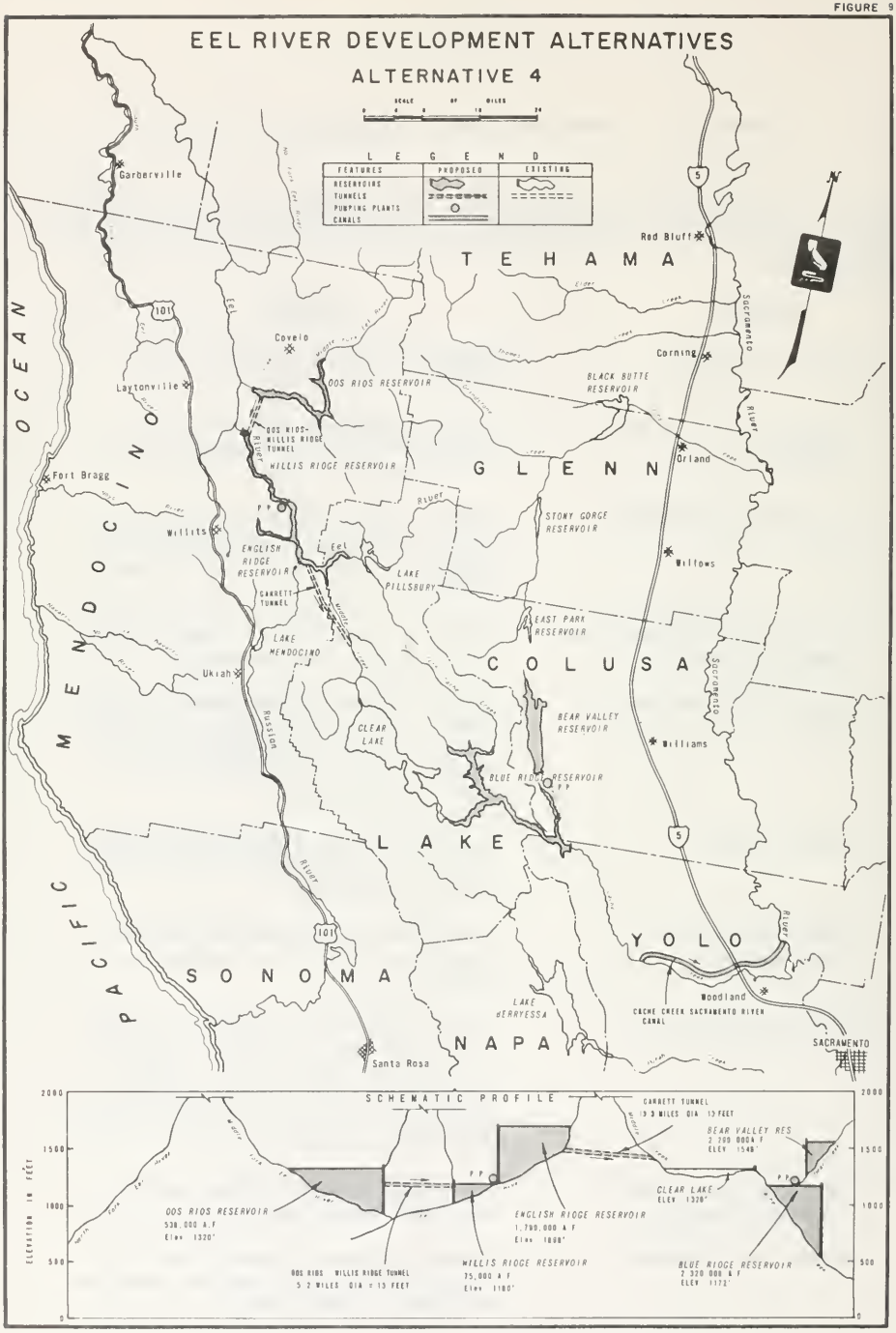
Feature	Construction Completion Date	Construction Time (years)	Costs, in Millions of Dollars			
			First Cost (includes engr. & contingencies)	Construction Cost Capitalized to 1986	OM&R Cost Capitalized to 1986	Total Cost Capitalized to 1986
Yellow Jacket Dam and Reservoir	1985	6	326.0	394.0	29.6	423.6
Fish Preservation			13.0	14.7	13.6	28.3
Wildlife Preservation			4.9	6.6	3.5	10.1
Recreation Facilities [a]			10.2	17.0	20.9	37.9
Railroad Relocation	1980	4	175.9	259.1	---	259.1
Yellow Jacket-Round Valley P.P.	1987	3	29.1	29.8	8.0	37.8
Power					49.8	49.8
Yellow Jacket-Round Valley Tunnel	1988	5	49.6	50.6	0.8	51.4
Dos Rios Dam and Reservoir	1985	3	57.0	64.5	4.9	69.4
Wildlife Preservation			0.7	0.8	0.4	1.2
Recreation Facilities [a]			0.6	0.8	1.5	2.3
Grindstone Tunnel	1985	8	155.3	195.7	3.1	198.8
Rancheria Dam and Reservoir	1988	5	151.2	154.3	11.7	166.0
Wildlife Preservation			0.2	0.2	0.1	0.3
Recreation Facilities [a]			5.3	5.7	6.7	12.4
Stony Creek-Sacto. River Canal	1986	2	9.2	9.7	2.6	12.3
TOTALS			988.2	1203.5	157.2	1360.7
Average Annual Cost				60.7	7.9	68.6

a. First cost includes initial recreation facilities only; capitalized costs include all future staged recreation development.

ALTERNATIVE 4: SMALL DOS RIOS -- SOUTHERN ROUTE PROJECT

This alternative would provide for construction of a low Dos Rios Dam on the Middle Fork Eel River and a southerly diversion via English Ridge Reservoir and Clear Lake. The development would consist of the following major features:

Feature	Purpose
Dos Rios Reservoir	Conserve and divert flows of the Middle Fork Eel River
Dos Rios-Willis Ridge Tunnel	Convey diversions from Dos Rios Reservoir to Willis Ridge Reservoir on the upper Eel River
Willis Ridge Reservoir	Serve as a conveyance link between the Dos Rios-Willis Ridge Tunnel and a pumping plant at the toe of English Ridge Dam
Willis Ridge-English Ridge Pumping Plant	Pump water from Willis Ridge Reservoir into English Ridge Reservoir
English Ridge Reservoir	Conserve flows of the upper Eel River, provide long-term storage, provide flood control, and serve as a conveyance link for diversions from Dos Rios Reservoir
Garrett Tunnel	Carry diversions from English Ridge Reservoir to Middle Creek, a tributary to Clear Lake
Clear Lake Outlet Enlargement	Reduce the flooding hazard around Clear Lake, allow more stable lake levels
Blue Ridge Reservoir	Provide long-term storage for diversions from the Eel River, conserve the flows of Cache Creek, provide flood control benefits on lower Cache Creek, and indirectly, flood control benefits around Clear Lake
Blue Ridge-Bear Valley Pumping Plant	Pump water from Blue Ridge Reservoir into Bear Valley Reservoir
Bear Valley Reservoir	Provide long-term storage for diversions from the Eel River and conserve the flows of Bear Creek


EEL RIVER DEVELOPMENT ALTERNATIVES
ALTERNATIVE 4
SCALE OF MILES
0 4 8 12 24
L E G E N D
FEATURES
PROPOSED
EXISTING
RESERVOIRS
TUNNELS
PUMPING PLANTS
CANALS
N
OCEAN
MENDOCINO
PACIFIC
TEHAMA
GLENN
COLUSA
LAKE
YOLO
SONOMA
NAPA
Garberville
Laytonville
Fort Bragg
Willits
Ukiah
Covelo
Rod Bluff
Corning
Orland
Willows
Woodland
Williams
Santa Rosa
SACRAMENTO
Eel River
Russian River
Sacramento River
101
5
OOS RIOS RESERVOIR
OOS RIOS-WILLIS RIDGE TUNNEL
WILLIS RIDGE RESERVOIR
ENGLISH RIDGE RESERVOIR
GARRETT TUNNEL
LAKE PILLSBURY
LAKE MENDOCINO
CLEAR LAKE
BLACK BUTTE RESERVOIR
STONY GORGE RESERVOIR
EAST PARK RESERVOIR
BEAR VALLEY RESERVOIR
BLUE RIDGE RESERVOIR
LAKE BERRYESSA
CACHE CREEK SACRAMENTO RIVER CANAL
SCHEMATIC PROFILE
ELEVATION IN FEET
2000
1500
1000
500
0
OOS RIOS RESERVOIR
530,000 A.F
Elev 1320'
OOS RIOS WILLIS RIDGE TUNNEL
5.2 MILES DIA = 13 FEET
WILLIS RIDGE RESERVOIR
35,000 A.F
Elev 1180'
ENGLISH RIDGE RESERVOIR
1,700,000 A.F
Elev 1898'
GARRETT TUNNEL
13.3 MILES DIA 13 FEET
CLEAR LAKE
ELEV 1320'
BEAR VALLEY RES
2,200,000A.F
ELEV 1548'
BLUE RIDGE RESERVOIR
2,320,000 A.F
ELEV 1172'

Cache Creek-Sacramento River Canal	Convey water from lower Cache Creek to the Sacramento River without seepage losses or erosion damages

Tables 33 through 36 summarize the physical data on the various features, the design and construction staging, and the project costs. A plan and profile of the alternatives are shown on the accompanying figure.

After allowing for prior water rights in the Russian River Basin via Potter Valley Powerplant and in the Cache Creek Basin, this system would develop 900,000 acre-feet per year of new yield, referenced to the Sacramento-San Joaquin Delta and 200,000 acre-feet per year of new firm yield for local use.

Project Formulation

To avoid any encroachment into Round Valley, Dos Rios Reservoir would have to be limited to an elevation of about 1,300 feet. However, the active storage in Dos Rios Reservoir at that size would be inadequate to permit economical development of the Middle Fork Eel River. A Dos Rios Reservoir elevation of 1,320 feet was selected to illustrate this alternative; this size would make the plan workable but would require flooding of about 700 acres of creek-bottom and grazing land in the southeast corner of the valley.

This system would divert water from Dos Rios Reservoir to Willis Ridge Reservoir, from which it would be pumped into English Ridge Reservoir. Previous planning studies have shown a direct pump diversion from Dos Rios Reservoir to English Ridge Reservoir via the Elk Creek Tunnel. However, recent additional geologic investigations by the Department of the Elk Creek Tunnel route have led to higher cost estimates for that feature. As a result, the diversion via Willis Ridge Reservoir now appears to be the more economical and has been included to illustrate this alternative. More investigations would be required for definite selection of the best diversion route.

The illustrated sizes of Dos Rios-Willis Ridge Tunnel and the Willis Ridge-English Ridge Pumping Plant were selected to carry all of the divertible flows from Dos Rios Reservoir during the 1928-34 critical period. The Garrett Tunnel size and Blue Ridge-Bear Valley Pumping Plant capacity are based on the capacities needed to refill Blue Ridge and Bear Valley Reservoirs after a severe drawdown, while still meeting full water demands.

English Ridge Reservoir would be built as proposed by the Bureau of Reclamation. The maximum pool level of Blue Ridge Reservoir would be limited by the need to avoid backwater on the outlet gates in Clear Lake Dam. This would require a Blue Ridge Dam about 800 feet high. Because of this great height and the limited geologic investigation which had been performed at the site, the Department concluded that Blue Ridge Dam should be limited to a maximum height of 675 feet for this study; the reduction in storage in Blue Ridge Reservoir could be made up, without any sacrifice in total cost, by construction of Bear Valley Reservoir. After its independent review of Blue Ridge Dam site, Bechtel Incorporated concluded that available evidence is sufficient to warrant an optimistic outlook that further investigations will confirm the feasibility of constructing a safe embankment type dam to the maximum height of about 800 feet.

As indicated in Table 33, appropriate allowances were made in the project yield calculations for depletions by: (1) the proposed Lakeport Project, (2) ground water recharge in the Clear Lake Basin, (3) the proposed Indian Valley Project, (4) present utilization of Cache Creek waters by Yolo County Flood Control and Water Conservation District, and (5) Cache Creek surplus flows presently utilized in the Sacramento-San Joaquin Delta.

The Clear Lake outlet would be enlarged. This would prevent the lake from rising to damaging levels during flood periods by passing excess flows into Blue Ridge Reservoir. It would also permit maintaining the lake at higher levels in the winter without increasing the risk of flooding. Arrangements could be worked out whereby the water demands in Yolo County could be met from Blue Ridge Reservoir and Clear Lake could be operated with a greatly reduced range of water surface fluctuation. In this case, Clear Lake would be lowered to its legal minimum level only at the end of a prolonged dry period.

To meet State Water Project demands, construction of this alternative would be staged as shown in Table 35.

The reservoirs in this system could supply additional water during average and wet years; only extra storage and conveyance capacity would have to be added to develop a yield of more than 1,100,000 acre-feet per year. Rancheria Reservoir could be linked to the system to provide additional storage capacity by diverting water through a low saddle at the north end of Bear Valley Reservoir. This possibility opens up numerous opportunities for project variations. Rancheria Reservoir storage might be substituted for storage at Blue Ridge Reservoir; then Wilson Valley Reservoir could be constructed further upstream on Cache Creek to serve as a link to the pumping plant to Bear Valley Reservoir. These variations would not cause a radical effect on the comparison of the various alternatives, but they should be investigated in future studies.

Flood Control Potential

Due to the limited storage capacity available, provision of a specific flood reservation in the small Dos Rios Reservoir would be precluded. The reservoir would provide some incidental flood protection, but no definite benefits would be assured.

Willis Ridge Reservoir would operate as a constant-level pumping forebay; therefore, the reservoir would not produce any flood control benefit.

The Bureau of Reclamation has determined that 140,000 acre-feet of flood storage reservation should be included in an English Ridge Reservoir built in conjunction with a large Dos Rios Reservoir and the Eel Delta levee project. The same reservation was used for analysis of this alternative, but future study may show that a larger reservation would be justified in the absence of the large Dos Rios Reservoir. The illustrated English Ridge Reservoir would have reduced the peak flow of the December 1964 flood at Fernbridge from 840,000 to 765,000 cubic feet per second and at Scotia from 750,000 to 660,000 cubic feet per second. The small Dos Rios Reservoir would have effected a further reduction of about 10,000 cubic feet per second.

Blue Ridge Reservoir would have 150,000 acre-feet of flood control reservation. This storage, operated in conjunction with the enlarged Clear Lake outlet, would provide substantial flood control benefits around Clear Lake and downstream from Blue Ridge Dam.

Recreation Potential

Table 33 shows the expected recreation use at the reservoirs in this system. The small Dos Rios Reservoir would provide relatively limited recreation potential because of large fluctuations in level and its location in a steep canyon area. Willis Ridge Reservoir, although smaller, would have a somewhat greater recreation potential because of its constant-level operation. English Ridge Reservoir would provide a major source of high quality recreation use. Blue Ridge and Bear Valley Reservoirs would be somewhat restricted in recreation potential by the amount of suitable land for development; however, because the reservoirs would be close to metropolitan areas, they should experience a very rapid buildup in recreation use.

Not shown in Table 33 is Clear Lake, where recreation enhancement could occur as a result of stabilization and possibly improved water quality. The Department is investigating Clear Lake recreation and water quality as a part of its additional studies of the southern diversion route; however, the studies were not complete, nor were the results available for inclusion in this report.

An additional recreation potential would exist at Lake Pillsbury. The construction of English Ridge Dam would permit Lake Pillsbury to be operated to minimize fluctuation. The net benefits would be relatively minor.

Related Problems

The small Dos Rios Reservoir presents potentially serious problems which would require detailed additional investigation, as discussed under Alternative 1.

Blue Ridge Reservoir would inundate a subdivision along the North Fork of Cache Creek. Several homes have been completed or are under construction at present.

Modification of the Clear Lake outlet and method of lake operation could be accomplished only after existing court decrees concerning the lake were modified.

Special attention should be given to potential water quality problems, particularly those related to boron and nutrient levels, in impoundments within the Cache Creek Basin. The Department is continuing water quality studies along the southern diversion route, with special emphasis on Clear Lake.

Level of Planning Knowledge

Both Dos Rios and English Ridge Reservoirs have been investigated to feasibility standards, but more study is essential for the problems peculiar

to a small Dos Rios Reservoir. Garrett Tunnel has been studied to high-level reconnaissance standards. Only limited study has been given to the Dos Rios-Willis Ridge Tunnel and to Willis Ridge Dam site; additional investigations would be required for definite selection of the best diversion route to English Ridge Reservoir. Blue Ridge Reservoir has been investigated to a low reconnaissance level; the potential problems have been identified and much more investigation will be required. Bear Valley Reservoir has received cursory level study and more investigation will be required for this feature also.

TABLE 33
ALTERNATIVE 4
DAM AND RESERVOIR DATA SUMMARY

	Dos Rios Dam and Res.	Willis Ridge Dam and Res.	English Ridge Dam and Res.	Blue Ridge Dam and Res.	Bear Valley Dam and Res.
Drainage area, square miles	745	39[a]	488	903[b]	57
Mean annual flows, million AF					
Runoff at damsite '1911-60'	1.036	0.066[a]	0.675	0.434[b,c]	0.018
Upstream impairments	---	---	0.009	0.033[d]	---
Releases for fish	0.217	0.141	---	---	---
Other mandatory releases	---	---	0.175[e]	0.200[f]	---
Remainder = storable inflow	0.819	-0.075[g]	0.491	0.201	0.018
Elevations, feet					
Dam crest	1340	1200	1733	1197	1565
Maximum pool	1325	1190	1723	1182	1555
Top of flood reservation	---	---	1698[h]	1172	---
Top of conservation pool	1320	1180	1686	1161	1548
Minimum pool	1272	1180	1507	770	1300
Streambed	920	1010	1180	522	1213
Dam height, feet	420	190	553	675	352
Dam construction time, years	3	3	5	7	3
Capacities, million AF					
Flood reservation	---	---	0.140[h]	0.150	---
Conservation storage	0.206	---	1.276	2.070	2.271
Inactive, dead, sediment	0.330	0.075	0.383	0.100	0.025
Gross	0.536	0.075	1.799	2.320	2.296
Areas, acres					
Reservoir @ gross storage	4,300	1,000	11,800	14,200	14,200
Wildlife preservation lands	2,700	570	8,800	8,000	8,600
Total land purchase required	8,200	2,500	42,000	25,600	25,800
Reservoir shoreline, miles	70	20	170	190	50
Main streams inundated, miles	25	14	28	34	---
Population displaced	10	10	200	60	20
Average fish runs at damsite					
Salmon, fish per year	13,000	12,000	---	---	---
Steelhead, fish per year	23,000	15,000	---	---	---
Recreation use, visitor-days/yr.					
Initial use	100,000	100,000	580,000	---	---
Maximum use	300,000	400,000	2,200,000	1,000,000	500,000
Years to reach maximum use	100	50	50	10	10

a. Values for incremental drainage between English Ridge and Willis Ridge sites.
b. Values for incremental drainage between Bear Valley and Blue Ridge sites.
c. Includes outflow from Clear Lake.
d. 15,000 AF/yr. Clear Lake Basin winter ground water recharge; 8,000 AF/yr. Indian Valley Reservoir evaporation; 10,000 AF/yr. Lakeport Project depletion.
e. Releases to Russian River Basin via Potter Valley Powerplant.
f. Release for surface diversions and ground water recharge on lower Cache Creek = 183,000 AF/yr. (assuming Indian Valley Project is in operation); presently exportable from Delta = 17,000 AF/yr.
g. This deficiency would be met from Dos Rios Reservoir.
h. Joint use -- flood control and conservation storage.

TABLE 34
ALTERNATIVE 4
CONVEYANCE FACILITY DATA SUMMARY

Dos Rios-Willis Ridge Tunnel	
Length, miles	5.2
Diameter, feet	13.0
Inlet elevation, feet	1,190
Outlet elevation, feet	1,170
Capacity, cfs (maximum/minimum)	2,210/840*
Construction time, years	5
Willis Ridge-English Ridge Pumping Plant	
Location	Toe of English Ridge Dam
Type	Conventional, above ground, off-peak
Minimum static head, feet	327
Maximum static head, feet	518
Design flow, cfs	1,200
Installed horsepower	86,000
Garrett Tunnel	
Length, miles	13.3
Diameter, feet	13.0
Inlet elevation, feet	1,495
Outlet elevation, feet	1,450
Capacity, cfs (maximum/minimum)	1,840/880
Construction time, years	4
Blue Ridge-Bear Valley Pumping Plant	
Location	9,000 feet downstream from Bear Valley Dam
Type	Conventional, above ground, off-peak
Minimum static head, feet	139
Maximum static head, feet	400
Design flow, cfs	1,100
Installed horsepower	60,000
Cache Creek-Sacramento River Canal	
Type	Concrete-lined canal
Length, miles	26.8
Capacity, cfs	4,400

* At Dos Rios Reservoir elevation 1,200 feet.

TABLE 35
ALTERNATIVE 4
DESIGN AND CONSTRUCTION SCHEDULE
(Does not include feasibility investigation time)

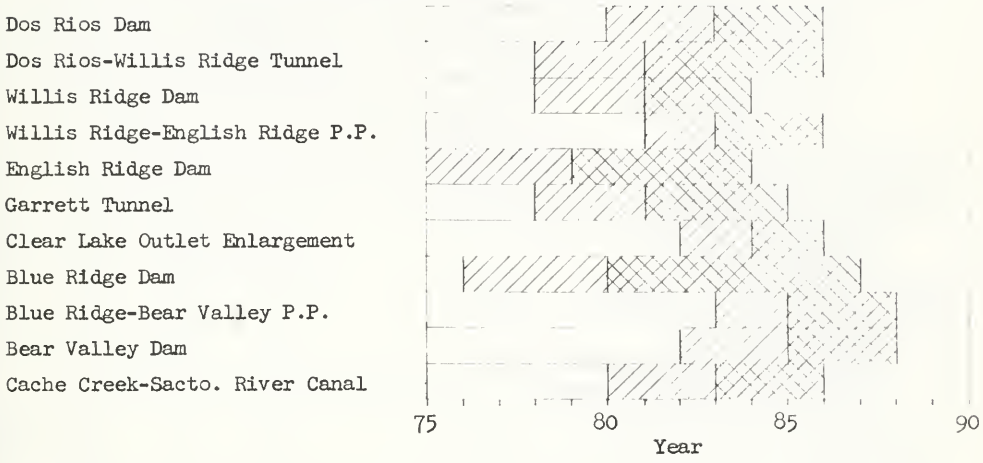


TABLE 36
ALTERNATIVE 4
COST SUMMARY
(Price basis, July 1969. Period of analysis, 1986-2085. Interest rate, 5%.)

Feature	Construction Completion Date	Construction Time (years)	Costs, in Millions of Dollars			
			First Cost (includes engr. & contingencies)	Construction Cost Capitalized to 1986	OM&R Cost Capitalized to 1986	Total Cost Capitalized to 1986
Dos Rios Dam and Reservoir	1986	3	67.0	72.0	5.4	77.4
Fish Preservation			9.7	10.8	6.5	17.3
Wildlife Preservation			0.7	0.8	0.5	1.3
Recreation Facilities[a]			0.6	0.8	1.4	2.2
Dos Rios-Willis Ridge Tunnel	1986	5	29.7	33.4	0.5	33.9
Willis Ridge Dam and Reservoir	1984	3	23.4	27.8	2.1	29.9
Fish Preservation			9.0	11.4	5.5	16.9
Wildlife Preservation (included with English Ridge)						
Recreation Facilities[a]			1.6	2.6	3.1	5.7
Willis Ridge-English Ridge P.P.	1986	3	12.6	13.5	4.6	18.1
Power					15.3	15.3
English Ridge Dam and Reservoir	1984	5	112.8[b]	140.0	10.6	150.6
Wildlife Preservation			2.6	3.7	2.0	5.7
Recreation Facilities[a]			9.0	14.8	17.0	31.8
Garrett Tunnel	1985	4	65.5	75.6	1.3	76.9
Clear Lake Outlet	1986	2	6.4	6.7	1.8	8.5
Blue Ridge Dam and Reservoir	1987	7	226.0	252.0	19.0	271.0
Wildlife Preservation			2.2	2.9	1.6	4.5
Recreation Facilities[a]			8.5	8.1	9.2	17.3
Blue Ridge-Bear Valley Pump. Plant	1988	3	14.3	14.0	4.8	18.8
Power					9.0	9.0
Bear Valley Dam and Reservoir	1988	3	58.3	57.0	4.3	61.3
Wildlife Preservation			2.4	2.5	1.4	3.9
Recreation Facilities[a]			4.2	3.9	4.4	8.3
Cache Creek-Sacto. River Canal	1986	3	19.3	20.8	5.3	26.1
TOTALS			685.8	775.1	136.6	911.7
Average Annual Cost				39.0	6.9	45.9

a. First cost includes initial recreation facilities only; capitalized costs include all future staged recreation developments.
b. From USBR draft report on English Ridge Project, adjusted to July 1969 price levels.

ALTERNATIVE 4A: SPENCER, SMALL DOS RIOS -- SOUTHERN ROUTE PROJECT

This project is a variation of Alternative 4; Eel River Basin storage would be increased by the addition of Spencer Reservoir to provide 200,000 acre-feet of additional active storage and increase the active storage in Dos Rios Reservoir 100,000 acre-feet by reducing sediment inflow to this downstream reservoir. The remaining features would be identical to those included in Alternative 4. Data on this project are summarized in Tables 37 through 40, with a plan and profile of the system appearing on the accompanying figure.

After allowing for prior water rights in the Russian River Basin via Potter Valley Powerplant and in the Cache Creek Basin, this system would develop 900,000 acre-feet per year of new yield referenced to the Sacramento-San Joaquin Delta and 240,000 acre-feet per year of new firm yield. This represents an increase of 40,000 acre-feet per year over Alternative 4, obtained at a relatively high incremental cost.

Project Formulation

On the basis of limited exploration of foundation conditions, Spencer Dam was limited to a crest elevation of 1,720 feet, providing a gross storage capacity of 450,000 acre-feet. All other features remained the same as for Alternative 4.

Staging in this plan is identical to that of Alternative 4, with Spencer Dam completed in 1990 to coincide with buildup of demand for new firm yield.

Flood Control Potential

Consideration was given to using the additional storage provided by Spencer Reservoir for flood control purposes. However, the incremental cost of storage would be too high for a specific flood reservation to be economically justified, although Spencer and Dos Rios Reservoirs would provide some incidental flood protection. Flood control potential for the remainder of the system would be the same as in Alternative 4.

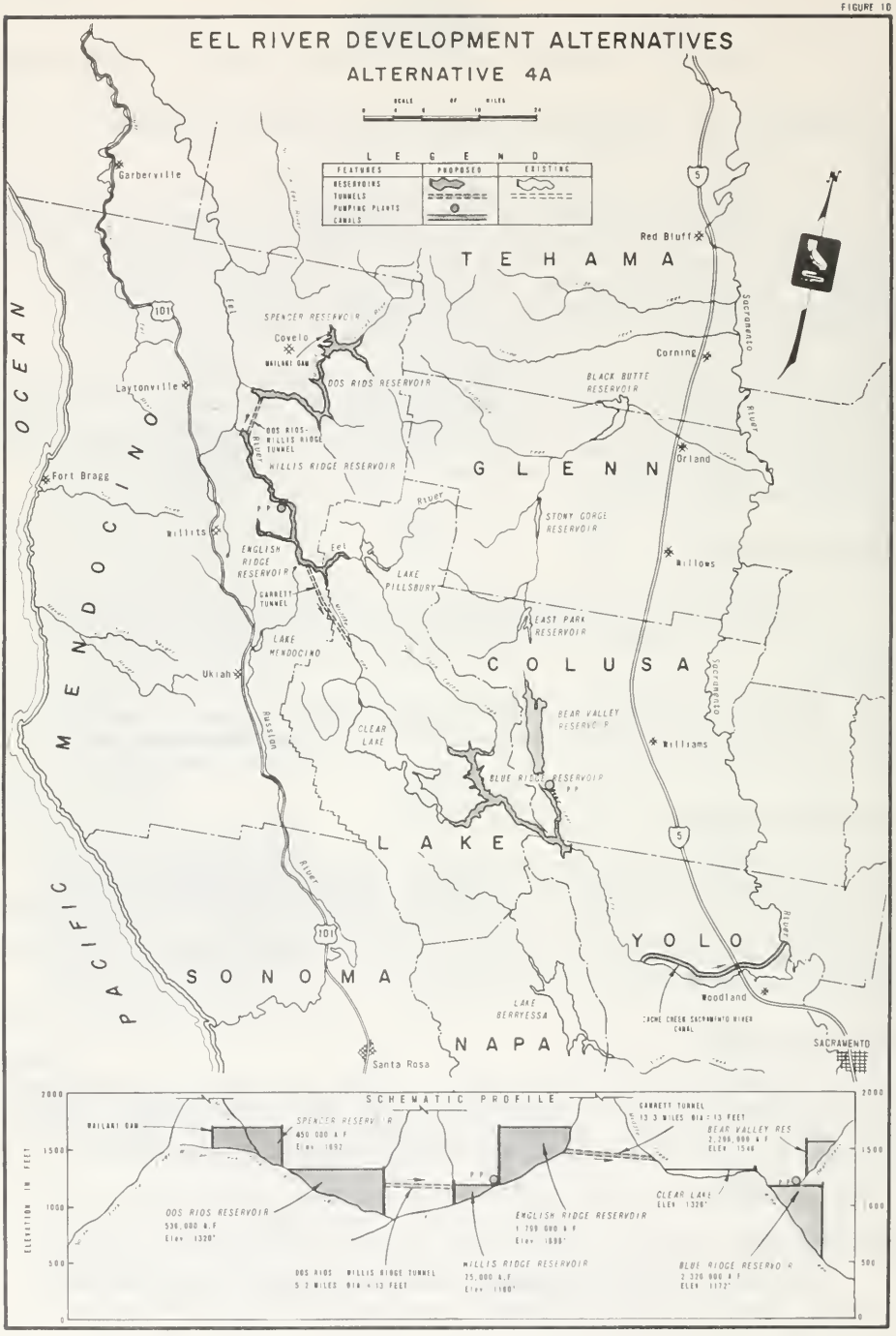
Recreation Potential

As shown in the recreation use projections in Table 37, construction of Spencer Reservoir would add appreciably to the recreation potential in the Middle Fork Eel River area. Because of the greater developable recreation area around it, Spencer Reservoir could support considerably more use than Dos Rios Reservoir.

Related Problems

The small Dos Rios and Spencer Reservoirs present serious problems which would require detailed additional investigation. First, the storage

FIGURE 10


EEL RIVER DEVELOPMENT ALTERNATIVES
ALTERNATIVE 4A
SCALE OF MILES
0 6 12 24
L E G E N D
FEATURES
PROPOSED
EXISTING
RESERVOIRS
TUNNELS
PUMPING PLANTS
CANALS
Garberville
Laytonville
Covelo
WAILAKI DAM
SPENCER RESERVOIR
DOS RIOS RESERVOIR
DOS RIOS-WILLIS RIDGE TUNNEL
WILLIS RIDGE RESERVOIR
Fort Bragg
Willits
ENGLISH RIDGE RESERVOIR
GARRETT TUNNEL
LAKE MENDOCINO
Ukiah
CLEAR LAKE
LAKE PILLSBURY
STONY GORGE RESERVOIR
EAST PARK RESERVOIR
BEAR VALLEY RESERVOIR
BLUE RIDGE RESERVOIR
Red Bluff
Corning
BLACK BUTTE RESERVOIR
Orland
Willows
Williams
Woodland
COLUSA
GLENN
TEHAMA
LAKE
YOLO
SONOMA
NAPA
MENDOCINO
OCEAN
PACIFIC
LAKE BERRYESSA
COLUSA-SACRAMENTO RIVER CANAL
Santa Rosa
SACRAMENTO
Eel River
Russian River
Sacramento River
101
5
N
SCHEMATIC PROFILE
ELEVATION IN FEET
WAILAKI DAM
SPENCER RESERVOIR
450 000 A.F
Elev. 1892
DOS RIOS RESERVOIR
536,000 A.F
Elev. 1320'
DOS RIOS-WILLIS RIDGE TUNNEL
5.2 MILES DIA = 13 FEET
WILLIS RIDGE RESERVOIR
25,000 A.F
Elev. 1180'
ENGLISH RIDGE RESERVOIR
1 759 000 A.F
Elev. 1595'
GARRETT TUNNEL
5.13.3 MILES DIA = 13 FEET
CLEAR LAKE
ELEV. 1320'
BEAR VALLEY RES
2,286,000 A.F
ELEV. 1540
BLUE RIDGE RESERVOIR
2,320,000 A.F
ELEV. 1172'

capacities of both reservoirs would be considerably reduced by siltation and landslides. Preliminary data indicate that a total of up to 480,000 acre-feet of storage would be lost during the 100-year economic life of these reservoirs. The Salmon Creek Landslide, in a narrow portion of the canyon 10 miles upstream from Dos Rios Dam, would require special treatment. Construction of Spencer Reservoir upstream from Dos Rios Reservoir would reduce the sediment inflow to Dos Rios Reservoir by about 100,000 acre-feet during the project life, but potential water temperature and turbidity problems with downstream releases would not be materially affected.

Level of Planning Knowledge

This subject was covered under Alternative 4 for all features except Spencer Reservoir. Spencer Dam was limited to a maximum dam crest elevation of 1,720 feet, based on reconnaissance-level data. Considerable additional investigation would be required before final sizing.

A 200-foot dam would be required at the Wailaki site to prevent Spencer Reservoir from spilling into Round Valley. Wailaki Dam site has been studied to only a low reconnaissance level and additional geologic studies are needed.

TABLE 37
ALTERNATIVE 4A
DAM AND RESERVOIR DATA SUMMARY

	Spencer Dam and Res.	Wailaki Dam	Dos Rios Dam and Res.	Willis Ridge Dam and Res.	English Ridge Dam and Res.	Blue Ridge Dam and Res.	Bear Valley Dam and Res.
Drainage area, square miles	426		319[a]	39[b]	488	903[c]	57
Mean annual flows, million AF							
Runoff at damsite '1911-60)	0.696		0.340[a]	0.066[b]	0.675	0.434[c,d]	0.018
Upstream impairments	---		---	---	0.009	0.033[e]	---
Releases for fish	---		0.217	0.141	---	---	---
Other mandatory releases	---		---	---	0.175[f]	0.200[g]	---
Remainder = storable inflow	0.696		0.123	-0.075[h]	0.491	0.201	0.018
Elevations, feet							
Dam crest	1720	1720	1340	1200	1733	1197	1565
Maximum pool	1705		1325	1190	1723	1182	1555
Top of flood reservation	---		---	---	1698[i]	1172	---
Top of conservation pool	1692		1320	1180	1686	1161	1548
Minimum pool	1628		1237	1180	1507	770	1300
Streambed	1356	1520	920	1010	1180	522	1213
Dam height, feet	364	200	420	190	553	675	352
Dam construction time, years	3	1	3	3	5	7	3
Capacities, million AF							
Flood reservation	---		---	---	0.140[i]	0.150	---
Conservation storage	0.200		0.306	---	1.276	2.070	2.271
Inactive, dead, sediment	0.250		0.230	0.075	0.383	0.100	0.025
Gross	0.450		0.536	0.075	1.799	2.320	2.296
Areas, acres							
Reservoir @ gross storage	3,700		4,300	1,000	11,800	14,200	14,200
Wildlife preservation lands	4,500		2,700	570	8,800	8,000	8,600
Total land purchase required	14,000		8,200	2,500	42,000	25,600	25,800
Reservoir shoreline, miles	40		70	20	170	190	50
Main streams inundated, miles	17		25	14	28	34	---
Population displaced	40		10	10	200	60	20
Average fish runs at damsite							
Salmon, fish per year	---		13,000	12,000	---	---	---
Steelhead, fish per year	---		23,000	15,000	---	---	---
Recreation use, visitor-days/yr.							
Initial use (millions)	0.155		0.100	0.100	0.580	---	---
Maximum use (millions)	0.900		0.300	0.400	2.200	1.000	0.500
Years to reach maximum use	100		100	50	50	10	10

a. Values for incremental drainage between Spencer and Dos Rios sites.
b. Values for incremental drainage between English Ridge and Willis Ridge sites.
c. Values for incremental drainage between Bear Valley and Blue Ridge sites.
d. Includes outflow from Clear Lake.
e. 15,000 AF/yr. Clear Lake Basin winter ground water recharge; 8,000 AF/yr. Indian Valley Reservoir evaporation; 10,000 AF/yr. depletion due to Lakeport Project.
f. Releases to Russian River Basin via Potter Valley Powerplant.
g. Release for surface diversions and ground water recharge on lower Cache Creek = 183,000 AF/yr. (assuming Indian Valley Project is in operation); presently exportable from Delta = 17,000 AF/yr.
h. This deficiency would be met from Dos Rios Reservoir.
i. Joint use -- flood control and conservation storage.

TABLE 38
ALTERNATIVE 4A
CONVEYANCE FACILITY DATA SUMMARY

Dos Rios-Willis Ridge Tunnel	
Length, miles	5.2
Diameter, feet	13.0
Inlet elevation, feet	1,190
Outlet elevation, feet	1,170
Capacity, cfs (maximum/minimum)	2,210/840*
Construction time, years	5
Willis Ridge-English Ridge Pumping Plant	
Location	Toe of English Ridge Dam
Type	Conventional, above ground, off-peak
Minimum static head, feet	327
Maximum static head, feet	518
Design flow, cfs	1,200
Installed horsepower	86,000
Garrett Tunnel	
Length, miles	13.3
Diameter, feet	13.0
Inlet elevation, feet	1,495
Outlet elevation, feet	1,450
Capacity, cfs (maximum/minimum)	1,840/880
Construction time, years	4
Blue Ridge-Bear Valley Pumping Plant	
Location	9,000 feet downstream from Bear Valley Dam
Type	Conventional, above ground, off-peak
Minimum static head, feet	139
Maximum static head, feet	400
Design flow, cfs	1,100
Installed horsepower	60,000
Cache Creek-Sacramento River Canal	
Type	Concrete-lined canal
Length, miles	26.8
Capacity, cfs	4,500

* At Dos Rios Reservoir elevation 1,200 feet.

TABLE 39
ALTERNATIVE 4A
DESIGN AND CONSTRUCTION SCHEDULE
(Does not include feasibility investigation time)

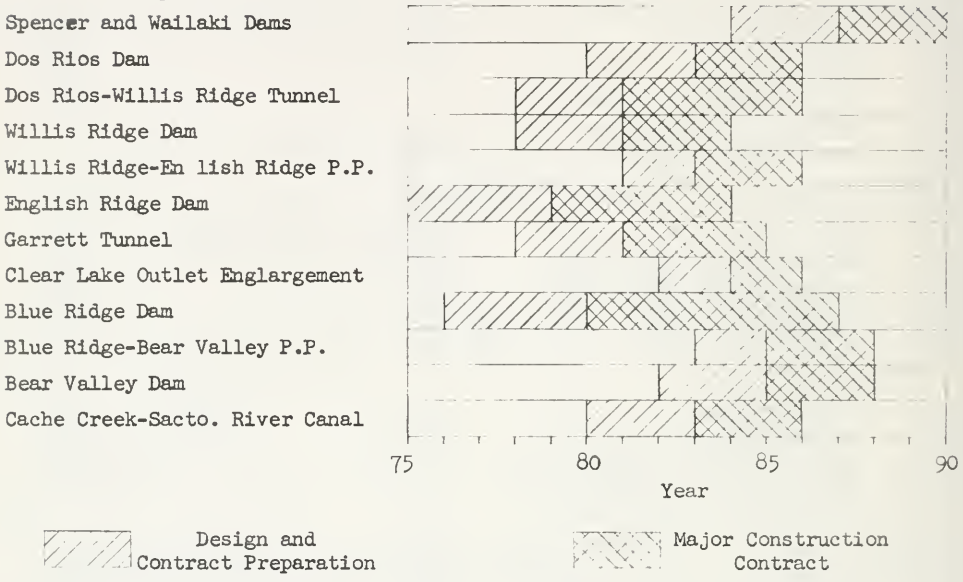


TABLE 40
ALTERNATIVE 4A
COST SUMMARY
(Price basis, July 1969 Period of analysis, 1986-2085 Interest rate, 5%.)

Feature	Construction Completion Date	Construction Time (years)	Costs, in Millions of Dollars			
			First Cost (includes engr. & contingencies)	Construction Cost Capitalized to 1986	OM&R Cost Capitalized to 1986	Total Cost Capitalized to 1986
Spencer Dam and Reservoir	1990	3	77.6	69.0	5.2	74.2
Wildlife Preservation			1.2	1.1	0.7	1.8
Recreation Facilities[a]			2.3	2.9	3.2	6.1
Dos Rios Dam and Reservoir	1986	3	67.0	72.0	5.4	77.4
Fish Preservation			9.7	10.8	6.5	17.3
Wildlife Preservation			0.7	0.8	0.5	1.3
Recreation Facilities[a]			0.6	0.8	1.4	2.2
Dos Rios-Willis Ridge Tunnel	1986	5	29.7	33.4	0.5	33.9
Willis Ridge Dam and Reservoir	1984	3	23.4	27.8	2.1	29.9
Fish Preservation			9.0	11.4	5.5	16.9
Wildlife Preservation (included with English Ridge)						
Recreation Facilities[a]			1.6	2.6	3.1	5.7
Willis Ridge-English Ridge P.P.	1986	3	12.6	13.5	4.6	18.1
Power					15.3	15.3
English Ridge Dam and Reservoir	1984	5	112.8[b]	140.0	10.6	150.6
Wildlife Preservation			2.6	3.7	2.0	5.7
Recreation Facilities[a]			9.0	14.8	17.0	31.8
Garrett Tunnel	1985	4	65.5	75.6	1.3	76.9
Clear Lake Outlet	1986	2	6.4	6.7	1.8	8.5
Blue Ridge Dam and Reservoir	1987	7	226.0	252.0	19.0	271.0
Wildlife Preservation			2.2	2.9	1.6	4.5
Recreation Facilities[a]			8.5	8.1	9.2	17.3
Blue Ridge-Bear Valley Pump. Plant	1988	3	14.3	14.0	4.8	18.8
Power					9.0	9.0
Bear Valley Dam and Reservoir	1988	3	58.3	57.0	4.3	61.3
Wildlife Preservation			2.4	2.5	1.4	3.9
Recreation Facilities[a]			4.2	3.9	4.4	8.3
Cache Creek-Sacto. River Canal	1986	3	19.3	20.8	5.3	26.1
TOTALS			806.1	848.1	145.7	993.8
Average Annual Cost				42.7	7.4	50.1

a. First cost includes initial recreation facilities only; capitalized costs include all future staged recreation developments.

b. From USBR draft report on English Ridge Project, adjusted to July 1969 price levels.

ALTERNATIVE 4B: MINA, SMALL DOS RIOS -- SOUTHERN ROUTE PROJECT

This alternative, like Alternative 4A, is a variation of Alternative 4; Eel River Basin storage would be increased by the addition of Mina Reservoir on the North Fork Eel River. The additional yield developed would be pumped through the Mina-Williams Creek Tunnel to the Middle Fork Eel River above Dos Rios Reservoir. Except for the capacity of some of the conveyance facilities, the remaining features would be identical to those included in Alternative 4. Data on this project are summarized in Tables 41 through 44, with a plan and profile of the system appearing on the accompanying figure.

After allowing for prior water rights in the Russian River Basin via Potter Valley Powerplant and in the Cache Creek Basin, this system would develop 900,000 acre-feet per year of new yield referenced to the Sacramento-San Joaquin Delta and 360,000 acre-feet per year of new firm yield for local use. This represents an increase of 160,000 acre-feet per year over Alternative 4, obtained at a relatively high incremental cost.

Project Formulation

A Mina Reservoir capacity of 835,000 acre-feet was chosen to illustrate this plan. The Mina-Williams Creek Pumping Plant and Tunnel were sized to divert the dry-period yield of Mina Reservoir. All other features would remain essentially the same as Alternative 4.

Staging in this plan is identical to that of Alternative 4. In addition, Mina Dam and the Mina-Williams Creek Tunnel and Pumping Plant would be completed in 1989 to coincide with the buildup of demand for new firm yield.

Flood Control Potential

Consideration was given to including flood control storage in Mina Reservoir. The incremental cost of storage would be too high for a specific flood reservation to be economically justified under present conditions. However, Mina and Dos Rios Reservoirs would provide some incidental flood protection. Flood control potential for the remainder of the system remains unchanged from Alternative 4.

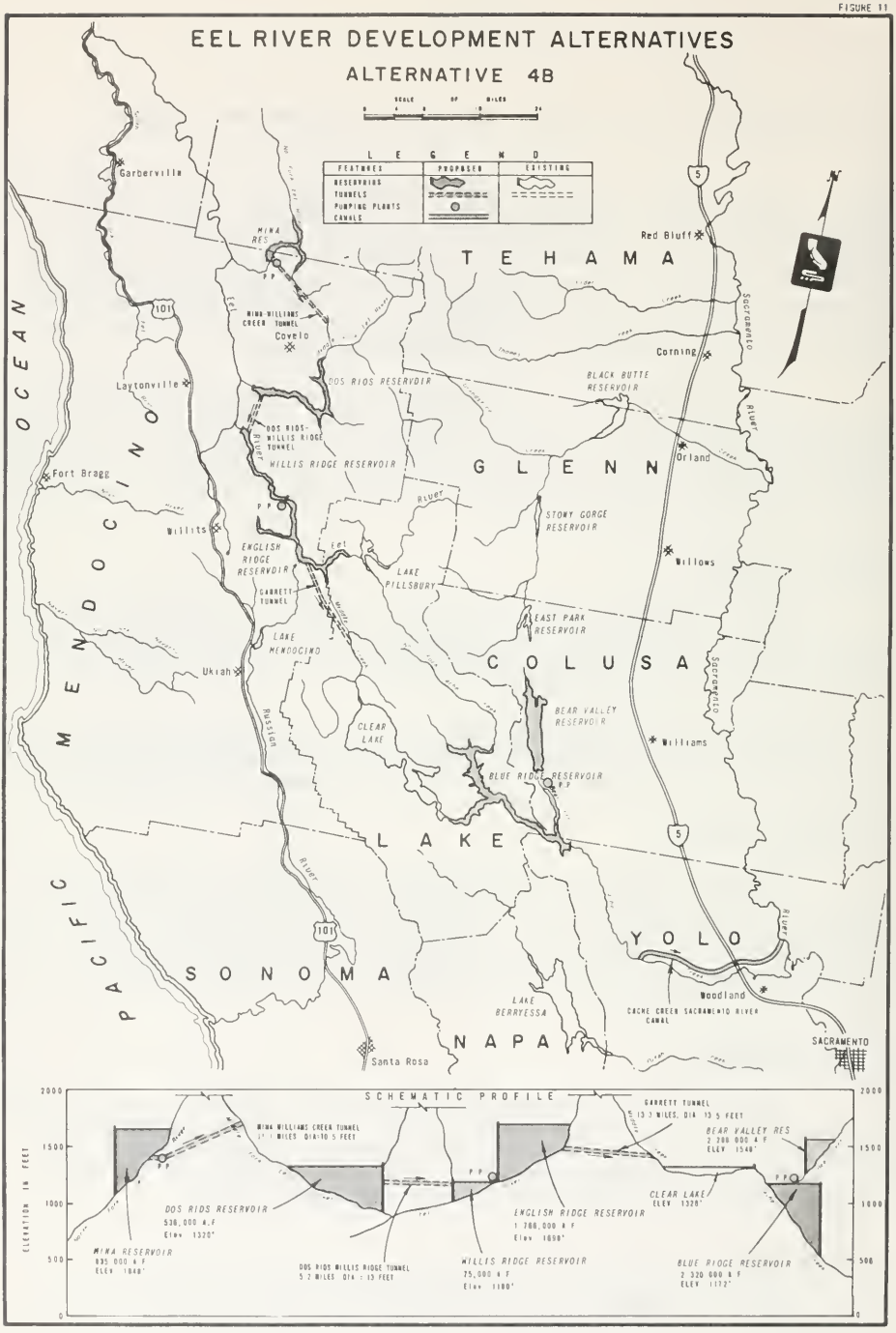
Recreation Potential

As shown in the recreation use projections in Table 41, construction of Mina Reservoir would add only a minor amount of recreation potential to the system. This is due to the limited access, rugged surrounding terrain, and mode of operation of Mina Reservoir. The recreation potential of the other reservoirs in the system would be the same as in Alternative 4.

Related Problems

Due to the similarities of reservoir size, depth, operation, and regional geology, it seems reasonable to expect landslide, sediment, water

FIGURE 11


EEL RIVER DEVELOPMENT ALTERNATIVES
ALTERNATIVE 4B
SCALE OF MILES
0 8 16 24
L E G E N D
FEATURES
PROPOSED
EXISTING
RESERVOIRS
TUNNELS
PUMPING PLANTS
CANALS
OCEAN
MENDOCINO
PACIFIC
Garberville
Laytonville
Fort Bragg
Willits
Ukiah
Covelo
MINA RES
MINA-WILLIAMS CREEK TUNNEL
DOS RIOS RESERVOIR
DOS RIOS-WILLIS RIDGE TUNNEL
WILLIS RIDGE RESERVOIR
ENGLISH RIDGE RESERVOIR
GARRETT TUNNEL
LAKE PILLSBURY
LAKE MENDOCINO
CLEAR LAKE
Eel River
Russian River
TEHAMA
GLENN
COLUSA
LAKE
YOLO
SONOMA
NAPA
Red Bluff
Corning
Orland
Willows
Williams
Woodland
Santa Rosa
SACRAMENTO
Sacramento River
BLACK BUTTE RESERVOIR
STONY GORGE RESERVOIR
EAST PARK RESERVOIR
BEAR VALLEY RESERVOIR
BLUE RIDGE RESERVOIR
LAKE BERRYESSA
CACHE CREEK SACRAMENTO RIVER CANAL
5
101
SCHEMATIC PROFILE
ELEVATION IN FEET
2000
1500
1000
500
0
MINA RESERVOIR
835 000 A F
ELEV 1848'
MINA WILLIAMS CREEK TUNNEL
DOS RIOS RESERVOIR
538,000 A.F
Elev 1320'
DOS RIOS WILLIS RIDGE TUNNEL
5.2 MILES DIA : 13 FEET
WILLIS RIDGE RESERVOIR
75,000 A F
Elev 1180'
ENGLISH RIDGE RESERVOIR
1 766,000 A F
Elev 1690'
GARRETT TUNNEL
CLEAR LAKE
ELEV 1320'
BEAR VALLEY RES
2 208 000 A F
ELEV 1548'
BLUE RIDGE RESERVOIR
2 320 000 A F
ELEV 1172'

temperature, and turbidity problems at Mina Reservoir to be similar to those at a small Dos Rios Reservoir. Additional investigations of these aspects would be required.

Problems related to the other features of this alternative are discussed under Alternative 4.

Level of Planning Knowledge

This subject was covered under Alternative 4 for all features except Mina Reservoir and the Mina-Williams Creek Tunnel. Investigations of Mina Dam and Reservoir site have been very preliminary to date. Only very cursory attention has been given to the Mina-Williams Creek Tunnel alignment.

TABLE 41
ALTERNATIVE 4B
DAM AND RESERVOIR DATA SUMMARY

	Mina Dam and Res.	Dos Rios Dam and Res.	Willis Ridge Dam and Res.	English Ridge Dam and Res.	Blue Ridge Dam and Res.	Bear Valley Dam and Res.
Drainage area, square miles	246	745	39[a]	488	903[b]	57
Mean annual flows, million AF						
Runoff at damsite '1911-60)	0.368	1.036	0.066[a]	0.675	0.434[b,c]	0.018
Upstream impairments	---	---	---	0.009	0.033[d]	---
Releases for fish	0.100	0.217	0.141	---	---	---
Other mandatory releases	---	---	---	0.175[e]	0.200[f]	---
Remainder = storable inflow	0.268	0.819	-0.075[g]	0.491	0.201	0.018
Elevations, feet						
Dam crest	1670	1340	1200	1733	1197	1565
Maximum pool	1664	1325	1190	1723	1182	1555
Top of flood reservation	---	---	---	1698[h]	1172	---
Top of conservation pool	1648	1320	1180	1686	1161	1548
Minimum pool	1420	1272	1180	1507	770	1300
Streambed	1067	920	1010	1180	522	1213
Dam height, feet	603	420	190	553	675	352
Dam construction time, years	5	3	3	5	7	3
Capacities, million AF						
Flood reservation	---	---	---	0.140[h]	0.150	---
Conservation storage	0.635	0.206	---	1.276	2.070	2.271
Inactive, dead, sediment	0.200	0.330	0.075	0.383	0.100	0.025
Gross	0.835	0.536	0.075	1.799	2.320	2.296
Areas, acres						
Reservoir @ gross storage	4,200	4,300	1,000	11,800	14,200	14,200
Wildlife preservation lands	2,400	2,700	570	8,800	8,000	8,600
Total land purchase required	8,200	8,200	2,500	42,000	25,600	25,800
Reservoir shoreline, miles	50	70	20	170	190	50
Main streams inundated, miles	20	25	14	28	34	---
Population displaced	10	10	10	200	60	20
Average fish runs at damsite						
Salmon, fish per year	500	13,000	12,000	---	---	---
Steelhead, fish per year	5,000	23,000	15,000	---	---	---
Recreation use, visitor-days/yr.						
Initial use (millions)	0.100	0.100	0.100	0.580	---	---
Maximum use (millions)	0.500	0.300	0.400	2.200	1.000	0.500
Years to reach maximum use	100	100	50	50	10	10

a. Values for incremental drainage between English Ridge and Willis Ridge sites.
b. Values for incremental drainage between Bear Valley and Blue Ridge sites.
c. Includes outflow from Clear Lake.
d. 15,000 AF/yr. Clear Lake Basin winter ground water recharge; 8,000 AF/yr. Indian Valley Reservoir evaporation; 10,000 AF/yr. depletion due to Lakeport Project.
e. Releases to Russian River Basin via Potter Valley Powerplant.
f. Release for surface diversions and ground water recharge on lower Cache Creek = 183,000 AF/yr. (assuming Indian Valley Project is in operation); presently exportable from Delta = 17,000 AF/yr.
g. This deficiency would be met from Dos Rios Reservoir.
h. Joint use -- flood control and conservation storage.

TABLE 42
ALTERNATIVE 4B
CONVEYANCE FACILITY DATA SUMMARY

Mina-Williams Creek Pumping Plant	
Location	Left abutment of Mina Dam site
Type	Underground, on-peak
Minimum static head, feet	52
Maximum static head, feet	280
Design flow, cfs	800
Installed horsepower	45,000
Mina-Williams Creek Tunnel	
Length, miles	11.1
Diameter, feet	10.5
Inlet elevation, feet	1,400
Outlet elevation, feet	1,700
Capacity, cfs	800
Construction time, years	5
Dos Rios-Willis Ridge Tunnel	
Length, miles	5.2
Diameter, feet	13.0
Inlet elevation, feet	1,190
Outlet elevation, feet	1,170
Capacity, cfs (maximum/minimum)	2,210/840*
Construction time, years	5
Willis Ridge-English Ridge Pumping Plant	
Location	Toe of English Ridge Dam
Type	Conventional, above ground, off-peak
Minimum static head, feet	327
Maximum static head, feet	518
Design flow, cfs	1,500
Installed horsepower	107,000
Garrett Tunnel	
Length, miles	13.3
Diameter, feet	13.5
Inlet elevation, feet	1,495
Outlet elevation, feet	1,450
Capacity, cfs (maximum/minimum)	2,040/980
Construction time, years	4
Blue Ridge-Bear Valley Pumping Plant	
Location	9,000 feet downstream from Bear Valley Dam
Type	Conventional, above ground, off-peak
Minimum static head, feet	139
Maximum static head, feet	400
Design flow, cfs	1,100
Installed horsepower	60,000
Cache Creek-Sacramento River Canal	
Type	Concrete-lined canal
Length	26.8
Capacity, cfs	4,700

* At Dos Rios Reservoir elevation 1,200 feet.

TABLE 43
ALTERNATIVE 4B
DESIGN AND CONSTRUCTION SCHEDULE
(Does not include feasibility investigation time)

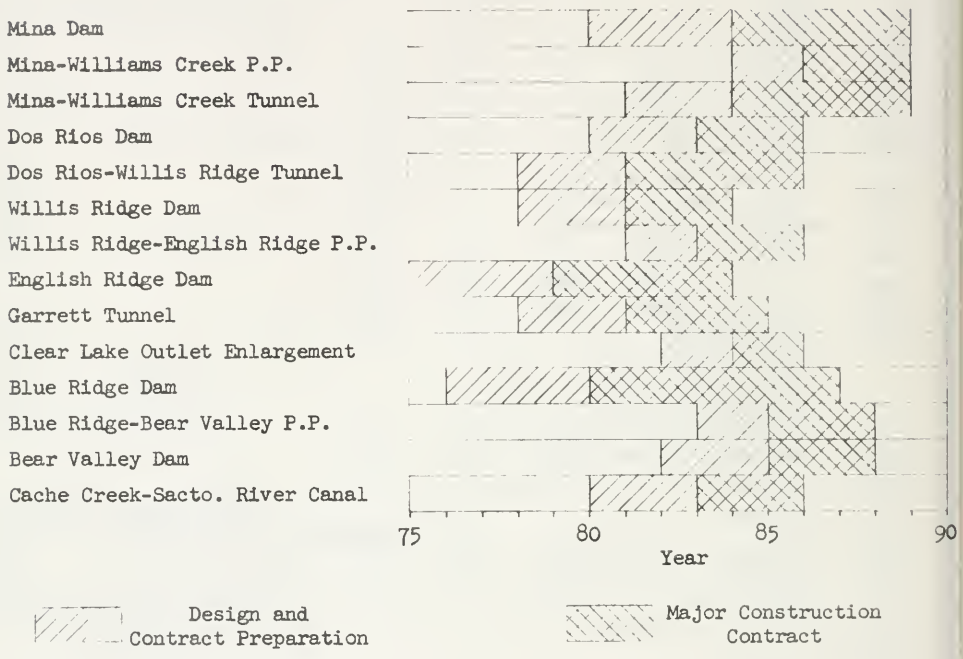


TABLE 44
ALTERNATIVE 4B
COST SUMMARY
(Price basis, July 1969 Period of analysis, 1986-2085 Interest rate, 5%.)

Feature	Construction Completion Date	Construction Time (years)	Costs, in Millions of Dollars			
			First Cost (includes engr. & contingencies)	Construction Cost Capitalized to 1986	OM&R Cost Capitalized to 1986	Total Cost Capitalized to 1986
Mina Dam and Reservoir	1989	5	134.7[a]	130.7	9.9	140.6
Fish Preservation			5.5	5.4	2.0	7.4
Wildlife Preservation			0.5	0.5	0.4	0.9
Recreation Facilities[b]			0.7	0.9	1.5	2.4
Mina-Williams Creek Pump. Plant	1989	3	10.4	9.7	3.3	13.0
Power					19.9	19.9
Mina-Williams Creek Tunnel	1989	5	44.7	43.6	0.8	44.4
Dos Rios Dam and Reservoir	1986	3	67.0	72.0	5.4	77.4
Fish Preservation			9.7	10.8	6.5	17.3
Wildlife Preservation			0.7	0.8	0.5	1.3
Recreation Facilities[b]			0.6	0.8	1.4	2.2
Dos Rios-Willis Ridge Tunnel	1986	5	29.7	33.4	0.5	33.9
Willis Ridge Dam and Reservoir	1984	3	23.4	27.8	2.1	29.9
Fish Preservation			9.0	11.4	5.5	16.9
Wildlife Preservation (included with English Ridge)						
Recreation Facilities[b]			1.6	2.6	3.1	5.7
Willis Ridge-English Ridge P.P.	1986	3	15.6	16.8	5.7	22.5
Power					19.1	19.1
English Ridge Dam and Reservoir	1984	5	112.8[c]	140.0	10.6	150.6
Wildlife Preservation			2.6	3.7	2.0	5.7
Recreation Facilities[b]			9.0	14.8	17.0	31.8
Garrett Tunnel	1985	4	68.1	78.8	1.3	80.1
Clear Lake Outlet	1986	2	6.4	6.7	1.8	8.5
Blue Ridge Dam and Reservoir	1987	7	226.0	252.0	19.0	271.0
Wildlife Preservation			2.2	2.9	1.6	4.5
Recreation Facilities[b]			8.5	8.1	9.2	17.3
Blue Ridge-Bear Valley Pump.Plant	1988	3	14.3	14.0	4.8	18.8
Power					9.0	9.0
Bear Valley Dam and Reservoir	1988	3	58.3	57.0	4.3	61.3
Wildlife Preservation			2.4	2.5	1.4	3.9
Recreation Facilities[b]			4.2	3.9	4.4	8.3
Cache Creek-Sacto. River Canal	1986	3	20.1	21.6	5.3	26.9
TOTALS			888.7	973.2	179.3	1,152.5
Average Annual Cost				49.0	9.1	58.1

a. USBR preliminary cost estimate, adjusted to July 1969 price levels.

b. First cost includes initial recreation facilities only; capitalized costs include all future staged recreation developments.

c. From USBR draft report on English Ridge Project, adjusted to July 1969 price levels.

ALTERNATIVE 5: MEDIUM-SIZED DOS RIOS -- SOUTHERN ROUTE PROJECT

This alternative would provide for construction of a 605-foot-high Dos Rios Dam, combined with Mill Creek Dam to prevent inundation of Round Valley. A 17-foot-diameter tunnel, 4.8 miles long, would be used to drain the natural runoff entering Round Valley behind the protective dam.

The remainder of the system would consist of the southerly routing features shown in Alternative 4 -- Willis Ridge, English Ridge, Blue Ridge, and Bear Valley Reservoirs, along with the associated conveyance features.

Tables 45 through 48 summarize the physical data on the various features, the design and construction staging, and the project costs. A plan and profile of the system are shown on the accompanying figure.

In addition to providing for prior water rights in the Russian River Basin via Potter Valley Powerplant and in the Cache Creek Basin, the system would develop 900,000 acre-feet per year of new yield referenced to the Sacramento-San Joaquin Delta and 200,000 acre-feet per year of new firm yield for local use.

Project Formulation

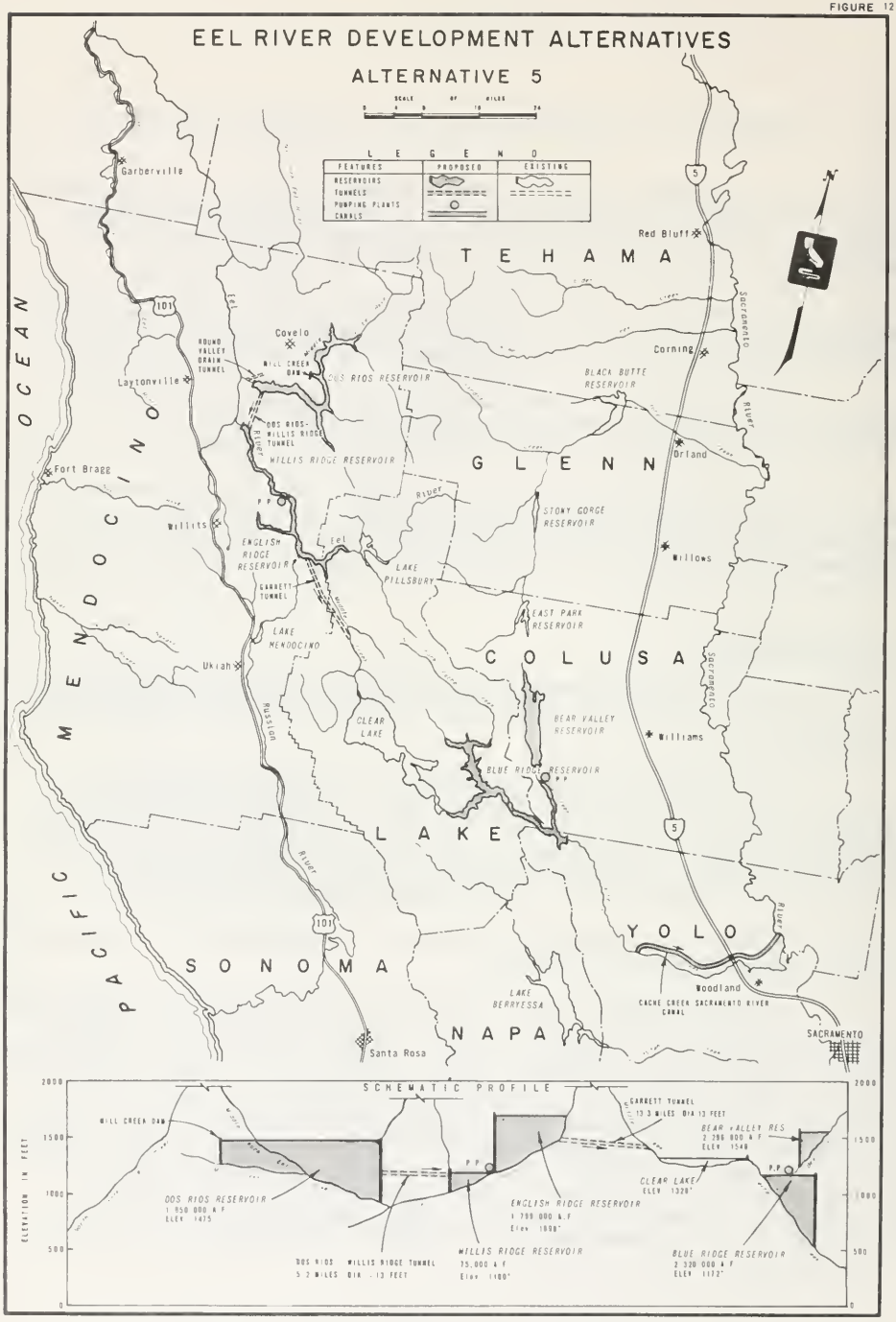
Dos Rios Reservoir would be constructed to the size described under Alternative 2. The remainder of the system would be the same as that shown for Alternative 4.

As indicated in Table 45, appropriate allowances were made in the project yield calculations for depletions by: (1) the proposed Lakeport Project, (2) ground water recharge in the Clear Lake Basin, (3) the proposed Indian Valley Project, (4) present utilization of Cache Creek waters by Yolo County Flood Control and Water Conservation District, and (5) Cache Creek surplus flows presently utilized in the Sacramento-San Joaquin Delta.

To meet State Water Project demands, construction of this alternative would be staged as shown by Table 47.

As in Alternative 4, the reservoirs in this system could supply additional water during average and wet years; only extra storage and conveyance capacity would have to be added to develop a yield of more than 1,100,000 acre-feet per year. Rancheria Reservoir could be linked to the system to provide additional storage capacity by diverting water through a low saddle at the north end of Bear Valley Reservoir. This possibility opens up numerous opportunities for project variations. Rancheria Reservoir storage might be substituted for storage at Blue Ridge Reservoir; then Wilson Valley Reservoir could be constructed farther upstream on Cache Creek to serve as a link to the pumping plant to Bear Valley Reservoir. These variations would not cause a radical effect on the comparison of the various alternatives, but they should be investigated in future studies.

FIGURE 12


EEL RIVER DEVELOPMENT ALTERNATIVES
ALTERNATIVE 5
SCALE OF MILES
L E G E N D
FEATURES
PROPOSED
EXISTING
RESERVOIRS
TUNNELS
PUMPING PLANTS
CANALS
OCEAN
PACIFIC
MENDOCINO
TEHAMA
GLENN
COLUSA
LAKE
YOLO
SONOMA
NAPA
Garberville
Laytonville
Fort Bragg
Willits
Ukiah
Covelo
Red Bluff
Corning
Orland
Willows
Williams
Woodland
SACRAMENTO
Santa Rosa
ROUND VALLEY GRAIN TUNNEL
MILL CREEK DAM
DOS RIOS RESERVOIR
DOS RIOS-WILLIS RIDGE TUNNEL
WILLIS RIDGE RESERVOIR
ENGLISH RIDGE RESERVOIR
GARRETT TUNNEL
LAKE PILLSBURY
LAKE MENDOCINO
STONY GORGE RESERVOIR
EAST PARK RESERVOIR
BLACK BUTTE RESERVOIR
CLEAR LAKE
BEAR VALLEY RESERVOIR
BLUE RIDGE RESERVOIR
LAKE BERRYESSA
CACHE CREEK SACRAMENTO RIVER CANAL
Eel River
Russian River
Sacramento River
SCHEMATIC PROFILE
ELEVATION IN FEET
MILL CREEK DAM
DOS RIOS RESERVOIR
1 950 000 A F
ELEV 1475
DOS RIOS - WILLIS RIDGE TUNNEL
5 2 MILES DIA 13 FEET
WILLIS RIDGE RESERVOIR
75,000 A F
Elev 1100'
ENGLISH RIDGE RESERVOIR
1 799 000 A F
Elev 1800'
GARRETT TUNNEL
13 3 MILES DIA 13 FEET
BEAR VALLEY RES
2 286 000 A F
ELEV 1548
CLEAR LAKE
ELEV 1320'
BLUE RIDGE RESERVOIR
2 320 000 A F
ELEV 1172'
P P

Flood Control Potential

The Corps of Engineers has recommended a specific flood reservation of 600,000 acre-feet in the large Dos Rios Reservoir. This alternative provided for the recommended flood control reservation in the medium-sized Dos Rios Reservoir. Similarly, the Bureau of Reclamation has determined that 140,000 acre-feet of flood storage reservation should be included in English Ridge Reservoir, so that reservation was used in this alternative. Operating in conjunction with the proposed Eel Delta levees, the two reservoirs would have reduced the December 1964 flood peak at Scotia from 750,000 to 490,000 cubic feet per second. The corresponding reduction at Fernbridge would have been from 840,000 to 600,000 cubic feet per second.

Blue Ridge Reservoir would incorporate 150,000 acre-feet of flood reservation. This storage, in conjunction with the enlarged Clear Lake outlet, would provide substantial flood control benefits around Clear Lake and downstream from Blue Ridge Dam.

Recreation Potential

Table 45 shows the expected recreation use at reservoirs in this system. The medium-sized Dos Rios Reservoir would provide a relatively small potential for recreation use. Willis Ridge Reservoir, although smaller, would have a slightly greater recreation potential because of its constant-level operation. English Ridge Reservoir would provide a major source of high quality recreation use. Blue Ridge and Bear Valley Reservoirs would be somewhat restricted in recreation potential by the amount of suitable land for development; however, because they are close to metropolitan areas, Blue Ridge and Bear Valley Reservoirs should experience a very rapid buildup in recreation use.

Not shown in Table 45 is Clear Lake, where recreation enhancement could occur as a result of stabilization and possibly improved water quality. The Department is investigating Clear Lake recreation and water quality as a part of its additional studies of the southern diversion route; however, the studies were not complete, nor were the results available for inclusion in this report.

An additional recreation potential would exist at Lake Pillsbury. The construction of English Ridge Dam would permit Lake Pillsbury to be operated to minimize fluctuation. The net benefits would be relatively minor.

Related Problems

One problem associated with the illustrated Dos Rios Reservoir is that the substitution of a drainage tunnel for the natural outlet of the valley would necessitate occasional ponding of water in the lower end of the valley during floods. The area subject to occasional flooding is determined by the drain tunnel diameter. With the 17-foot tunnel illustrated, some 4,000 acres in the valley could be inundated by the probable maximum flood. Enlarging the tunnel to about 22 feet in diameter, at a cost of approximately $20 million,

would reduce the possible area of ponding to a few hundred acres. More studies are needed to establish the best plan, but a satisfactory solution could probably be worked out with a combination of purchase of flowage easements and construction of levees to contain the ponded flows.

Blue Ridge Reservoir would inundate a subdivision along the North Fork of Cache Creek. Several homes have been completed or are under construction at present.

Modification of the Clear Lake outlet and method of lake operation could be accomplished only after existing court decrees concerning the lake were modified.

Special attention should be given to potential water quality problems, particularly those related to boron and nutrient levels, in impoundments within the Cache Creek Basin. The Department is continuing water quality studies along the southern diversion route, with special emphasis on Clear Lake.

Level of Planning Knowledge

Dos Rios Dam has been investigated to feasibility standards, but further studies are required for the sedimentation, landslide, and water quality problems associated with the medium-sized reservoir. Mill Creek Dam has been studied only at a low reconnaissance level; additional geologic investigation is needed. Only limited study has been given to the Dos Rios-Willis Ridge Tunnel and to Willis Ridge Dam site; additional investigations would be required for definite selection of the best diversion route to English Ridge Reservoir. English Ridge Dam has been studied to feasibility standards. Garrett Tunnel has been investigated to high-level reconnaissance standards. Blue Ridge Reservoir has been investigated to a low reconnaissance level; the potential problems have been identified and much more investigation will be required. Bear Valley Reservoir has received cursory-level study and more investigation will be required.

TABLE 45
ALTERNATIVE 5
DAM AND RESERVOIR DATA SUMMARY

	Dos Rios Dam and Res.	Mill Creek Dam	Willis Ridge Dam and Res.	English Ridge Dam and Res.	Blue Ridge Dam and Res.	Bear Valley Dam and Res.
Drainage area, square miles	648[a]		39[b]	488	903[c]	57
Mean annual flows, million AF						
Runoff at damsite '1911-60'	0.948[a]		0.066[b]	0.675	0.434[c,d]	0.018
Upstream impairments	---		---	0.009	0.033[e]	---
Releases for fish	0.217		0.141	---	---	---
Other mandatory releases	---		---	0.175[f]	0.200[g]	---
Remainder = storable inflow	0.731[a]		-0.075[h]	0.491	0.201	0.018
Elevations, feet						
Dam crest	1525	1525	1200	1733	1197	1565
Maximum pool	1505		1190	1723	1182	1555
Top of flood reservation	1475		---	1698[i]	1172	---
Top of conservation pool	1405		1180	1686	1161	1548
Minimum pool	1278		1180	1507	770	1300
Streambed	920	1275	1010	1180	522	1213
Dam height, feet	605	250	190	553	675	352
Dam construction time, years	6	2	3	5	7	3
Capacities, million AF						
Flood reservation	0.600		---	0.140[i]	0.150	---
Conservation storage	0.700		---	1.276	2.070	2.271
Inactive, dead, sediment	0.350		0.075	0.383	0.100	0.025
Gross	1.650		0.075	1.799	2.320	2.296
Areas, acres						
Reservoir @ gross storage	10,400		1,000	11,800	14,200	14,200
Wildlife preservation lands	8,000		570	8,800	8,000	8,600
Total land purchase required	23,700		2,500	42,000	25,600	25,800
Reservoir shoreline, miles	80		20	170	190	50
Main streams inundated, miles	31		14	28	34	---
Population displaced	50		10	200	60	20
Average fish runs at damsite						
Salmon, fish per year	13,000		12,000	---	---	---
Steelhead, fish per year	23,000		15,000	---	---	---
Recreation use, visitor-days/yr.						
Initial use (millions)	0.180		0.100	0.580	---	---
Maximum use (millions)	0.320		0.400	2.200	1.000	0.500
Years to reach maximum use	100		50	50	10	10

a. After deduction for the 97 square miles and average annual runoff of 88,000 acre-feet tributary to the Round Valley Drain Tunnel.
b. Values for incremental drainage between English Ridge and Willis Ridge sites.
c. Values for incremental drainage between Bear Valley and Blue Ridge sites.
d. Includes outflow from Clear Lake.
e. 15,000 AF/yr. Clear Lake Basin winter ground water recharge; 8,000 AF/yr. Indian Valley Reservoir evaporation; 10,000 AF/yr. depletion due to Lakeport Project.
f. Releases to Russian River Basin via Potter Valley Powerplant.
g. Release for surface diversions and ground water recharge on lower Cache Creek = 183,000 AF/yr. (assuming Indian Valley Project is in operation); presently exportable from Delta = 17,000 AF/yr.
h. This deficiency would be met from Dos Rios Reservoir.
i. Joint use -- flood control and conservation storage.

TABLE 46
ALTERNATIVE 5
CONVEYANCE FACILITY DATA SUMMARY

Dos Rios-Willis Ridge Tunnel	
Length, miles	5.2
Diameter, feet	13.0
Inlet elevation, feet	1,190
Outlet elevation, feet	1,170
Capacity, cfs (maximum/minimum)	3,210/840*
Construction time, years	5
Willis Ridge-English Ridge Pumping Plant	
Location	Toe of English Ridge Dam
Type	Conventional, above ground, off-peak
Minimum static head, feet	327
Maximum static head, feet	518
Design flow, cfs	1,200
Installed horsepower	86,000
Garrett Tunnel	
Length, miles	13.3
Diameter, feet	13.0
Inlet elevation, feet	1,495
Outlet elevation, feet	1,450
Capacity, cfs (maximum/minimum)	1,840/880
Construction time, years	4
Blue Ridge-Bear Valley Pumping Plant	
Location	9,000 feet downstream from Bear Valley Dam
Type	Conventional, above ground, off-peak
Minimum static head, feet	139
Maximum static head, feet	400
Design flow, cfs	1,100
Installed horsepower	60,000
Cache Creek-Sacramento River Canal	
Type	Concrete-lined canal
Length, miles	26.8
Capacity, cfs	4,400

* At Dos Rios Reservoir elevation 1,200 feet.

TABLE 47
ALTERNATIVE 5
DESIGN AND CONSTRUCTION SCHEDULE
(Does not include feasibility investigation time)

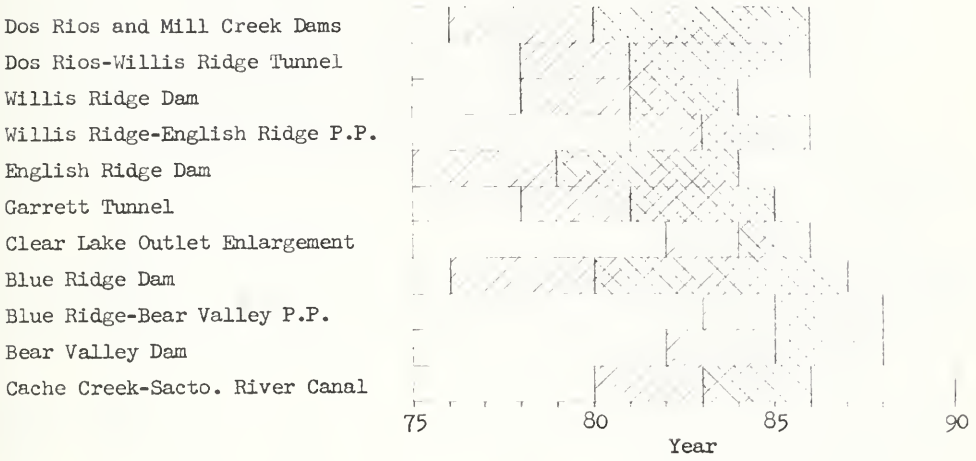


TABLE 48
ALTERNATIVE 5
COST SUMMARY
(Price basis, July 1969 Period of analysis, 1986-2085 Interest rate, 5%.)

Feature	Construction Completion Date	Construction Time (years)	Costs, in Millions of Dollars			
			First Cost (includes engr. & contingencies)	Construction Cost Capitalized to 1986	OM&R Cost Capitalized to 1986	Total Cost Capitalized to 1986
Dos Rios Dam and Reservoir[a]	1986	6	194.0	223.1	16.8	239.9
Fish Preservation			9.7	11.2	7.2	18.4
Wildlife Preservation			1.7	2.3	1.2	3.5
Recreation Facilities[b]			1.9	2.2	2.7	4.9
Dos Rios-Willis Ridge Tunnel	1986	5	29.7	33.4	0.5	33.9
Willis Ridge Dam and Reservoir	1984	3	23.4	27.8	2.1	29.9
Fish Preservation			9.0	11.4	5.5	16.9
Wildlife Preservation (included with English Ridge)			-	-	-	-
Recreation Facilities[b]			1.6	2.6	3.1	5.7
Willis Ridge-English Ridge P.P.	1986	3	12.6	13.5	4.6	18.1
Power					15.3	15.3
English Ridge Dam and Reservoir	1984	5	112.8[c]	140.0	10.6	150.6
Wildlife Preservation			2.6	3.7	2.0	5.7
Recreation Facilities[b]			9.0	14.8	17.0	31.8
Garrett Tunnel	1985	4	65.5	75.6	1.3	76.9
Clear Lake Outlet	1986	2	6.4	6.7	1.8	8.5
Blue Ridge Dam and Reservoir	1987	7	226.0	252.0	19.0	271.0
Wildlife Preservation			2.2	2.9	1.6	4.5
Recreation Facilities[b]			8.5	8.1	9.2	17.3
Blue Ridge-Bear Valley P.P.	1988	3	14.3	14.0	4.8	18.8
Power					9.0	9.0
Bear Valley Dam and Reservoir	1988	3	58.3	57.0	4.3	61.3
Wildlife Preservation			2.4	2.5	1.4	3.9
Recreation Facilities[b]			4.2	3.9	4.4	8.3
Cache Creek-Sacto. River Canal	1986	3	19.3	20.8	5.3	26.1
TOTALS			815.1	929.5	150.7	1080.2
Average Annual Cost				46.8	7.6	54.4

a. Includes Mill Creek Dam and Round Valley Drain Tunnel.

b. First cost includes initial recreation facilities only; capitalized costs include all future staged recreation developments.

c. From USBR draft report on English Ridge Project, adjusted to July 1969 price levels.

ALTERNATIVE 6: YELLOW JACKET -- SOUTHERN ROUTE PROJECT

This plan combines a large storage reservoir at the Yellow Jacket site with the reregulation and conveyance features of the southern route. A large Yellow Jacket Reservoir would regulate and conserve the flow of the main Eel River. Water would be pumped up a maximum of 800 feet through the Yellow Jacket-Round Valley Tunnel into Mill Creek in the northwest corner of Round Valley. Mill Creek would carry the diverted flows through Round Valley to a small Dos Rios Reservoir. A gravity tunnel would take water from Dos Rios Reservoir to Willis Ridge Reservoir. It would then be pumped by the Willis Ridge-English Ridge Pumping Plant into English Ridge Reservoir. The water would then flow through Garrett Tunnel and Clear Lake into Blue Ridge Reservoir. Releases from Blue Ridge Reservoir would reach the Sacramento River via the Cache Creek-Sacramento River Canal.

This plan would yield 900,000 acre-feet per year referenced to the Sacramento-San Joaquin Delta, plus 790,000 acre-feet per year of supplemental firm supply. Tables 49 through 52 present physical data on the various features, the design and construction staging, and the project costs. A plan and profile of the plan are shown on the accompanying figure.

Project Formulation

Two distinct project formulation possibilities were examined for this plan. They were:

1. An underground pumping plant at River Garden on the main Eel River below Dos Rios and a 7.5-mile tunnel into Round Valley. This scheme would require a minimum pool elevation of 800 feet in Yellow Jacket Reservoir and an inactive storage of 4,600,000 acre-feet.

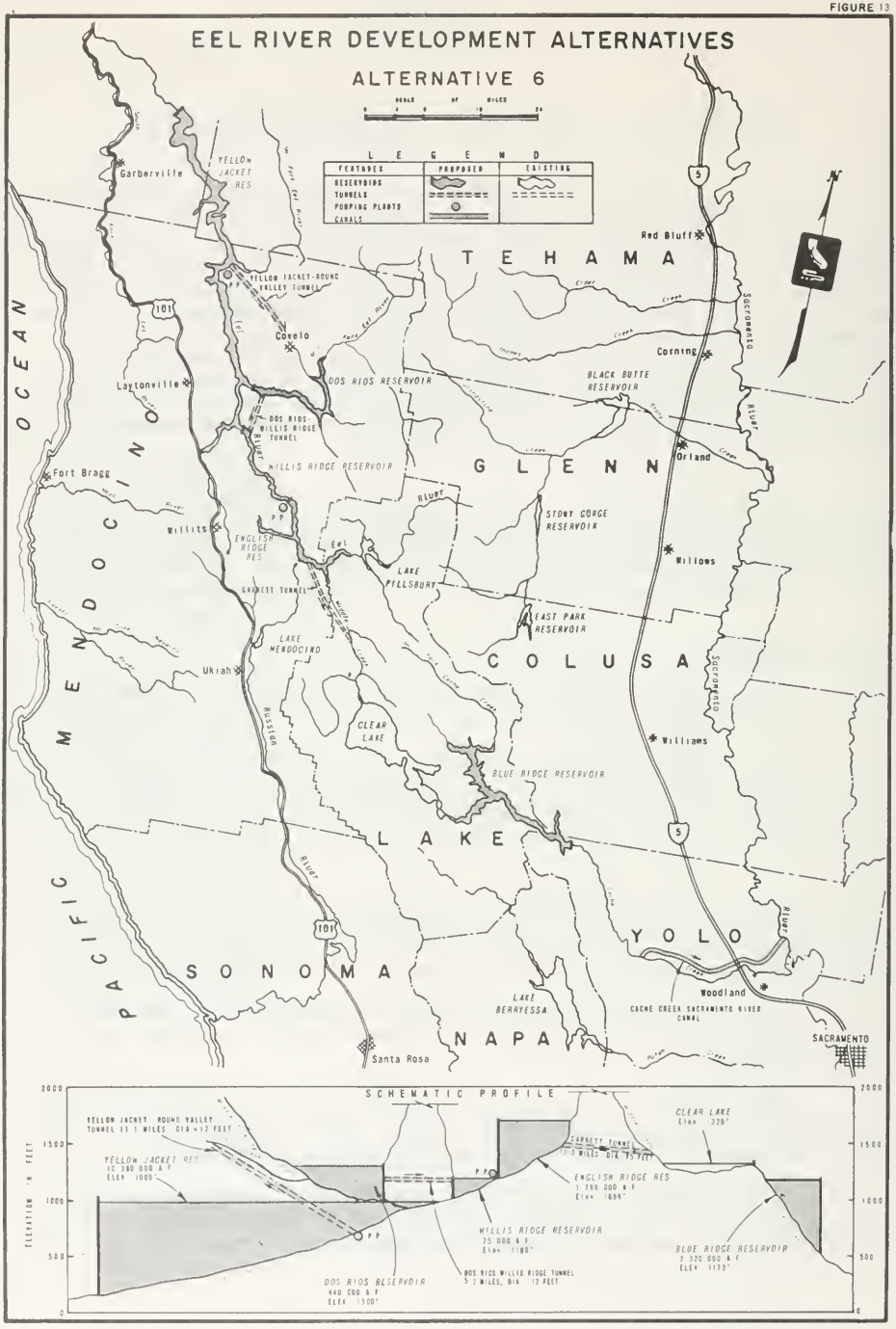
2. An underground pumping plant located at the mouth of the North Fork Eel River and an 11.1-mile-long tunnel into Round Valley. This would result in a Yellow Jacket Reservoir minimum pool elevation of 700 feet and an inactive storage of 2,780,000 acre-feet.

The latter plan with a minimum pool elevation of 700 feet was selected after an economic comparison of the two schemes. This plan gave the lowest overall cost.

Yellow Jacket and Blue Ridge Dams were sized to balance the total system storage with the available water supply. English Ridge Reservoir was sized at the capacity recommended by the U. S. Bureau of Reclamation.

To meet the projected demand buildup for the State Water Project and for supplemental water supplies, construction of the features of this alternative would be staged as shown by Table 51.

FIGURE 13


EEL RIVER DEVELOPMENT ALTERNATIVES
ALTERNATIVE 6
SCALE OF MILES
LEGEND
FEATURES
PROPOSED
EXISTING
RESERVOIRS
TUNNELS
PUMPING PLANTS
CANALS
Garberville
YELLOW JACKET RES
YELLOW JACKET-ROUND VALLEY TUNNEL
Covelo
DOS RIOS RESERVOIR
DOS RIOS-WILLIS RIDGE TUNNEL
WILLIS RIDGE RESERVOIR
Laytonville
Fort Bragg
Willits
ENGLISH RIDGE RES
SHARETT TUNNEL
LAKE PILLSBURY
LAKE MENDOCINO
Ukiah
CLEAR LAKE
BLUE RIDGE RESERVOIR
Santa Rosa
LAKE BERRYESSA
Red Bluff
Corning
BLACK BUTTE RESERVOIR
Orland
STONY GORGE RESERVOIR
Willows
EAST PARK RESERVOIR
Williams
Woodland
CACHE CREEK SACRAMENTO RIVER CANAL
SACRAMENTO
OCEAN
MENDOCINO
PACIFIC
SONOMA
LAKE
NAPA
COLUSA
GLENN
TEHAMA
YOLO
SCHEMATIC PROFILE
ELEVATION IN FEET
YELLOW JACKET ROUND VALLEY TUNNEL 11.1 MILES DIA 12 FEET
YELLOW JACKET RES 10 380 000 A F ELEV 1000'
DOS RIOS RESERVOIR 440 000 A F ELEV 1300'
DOS RIOS WILLIS RIDGE TUNNEL 5.2 MILES, DIA 12 FEET
WILLIS RIDGE RESERVOIR 25 000 A F ELEV 1180'
CARRETT TUNNEL 13.3 MILES DIA 15 FEET
ENGLISH RIDGE RES 1 100 000 A F ELEV 1696'
CLEAR LAKE ELEV 328'
BLUE RIDGE RESERVOIR 2 370 000 A F ELEV 1172'

Flood Control Potential

The Corps of Engineers' recommended specific flood control reservation of 900,000 acre-feet was included in the illustrated Yellow Jacket Reservoir. This amount of storage, in conjunction with the Eel Delta levees, would provide protection against the Standard Project Flood. When operated in conjunction with the Eel Delta levees, Yellow Jacket Reservoir would have reduced the December 1964 flood peak at Scotia from 750,000 to 490,000 cubic feet per second, and at Fernbridge from 840,000 to 600,000 cubic feet per second, the design capacity of the proposed levee system.

Control of flooding on Clear Lake and along Cache Creek would be provided by modification of the existing lake outlet and provision of flood control storage in Blue Ridge Reservoir.

Recreation Potential

The reservoirs of this plan would be capable of development to satisfy large recreation demands, as shown in Table 49. An estimated ultimate total use of some 6,000,000 recreation-days per year is based on preliminary estimates of demand, operation, and availability of suitable land for development.

Related Problems

A major problem with this alternative would be the loss of a substantial portion of the salmon and steelhead spawning areas in the Eel River system. Extensive studies would be necessary to determine the measures necessary for fishery preservation.

Another problem would be the necessity of relocating 93 miles of the Northwestern Pacific Railroad from Willits to the South Fork Eel River confluence. Problems might also be encountered from landslides in the Yellow Jacket Reservoir area.

Problems with other features in this alternative include the landslide and sedimentation effects on the small Dos Rios Reservoir, which are discussed under Alternative 1.

Level of Planning Knowledge

The level of geologic knowledge of Yellow Jacket Dam site is at a good reconnaissance level. Geologic studies of the Yellow Jacket-Round Valley Pumping Plant and tunnel alignment have been very limited. Considerable study has been given to the Dos Rios and English Ridge Dam sites and fairly detailed information is available concerning them. Only limited study has been given to the Dos Rios-Willis Ridge Tunnel and to Willis Ridge Dam site. Garrett Tunnel has been studied to high-level reconnaissance standards. Blue Ridge Reservoir has been investigated to a low reconnaissance level; the potential problems have been identified and much more investigation will be required.

TABLE 49
ALTERNATIVE 6
DAM AND RESERVOIR DATA SUMMARY

	Yellow Jacket Dam and Res.	Dos Rios Dam and Res.	Willis Ridge Dam and Res.	English Ridge Dam and Res.	Blue Ridge Dam and Res.
Drainage area, square miles	962[a]	745	---[b]	488	960
Mean annual flows, million AF					
Runoff at damsite '1911-60'	1.372[a]	1.036	---[b]	0.675	0.452[c]
Upstream impairments	---	---	---	0.009	0.033[d]
Releases for fish	1.053	---	---	---	---
Other mandatory releases	---	---	---	0.175[e]	0.200[f]
Remainder = storable inflow	0.319[g]	1.036	---	0.491	0.219
Elevations, feet					
Dam crest	1020	1320	1200	1733	1197
Maximum pool	1005	1305	1190	1723	1182
Top of flood reservation	1000	---	---	---	1172
Top of conservation pool	977	1300	1180	1698	1161
Minimum pool	700	1272	1180	1507	770
Streambed	240	920	1010	1180	522
Dam height, feet	780	400	190	553	675
Dam construction time, years	7	3	3	5	7
Capacities, million AF					
Flood reservation	0.900	---	---	---	0.150
Conservation storage	6.700	0.110	---	1.416	2.070
Inactive, dead, sediment	2.780	0.330	0.075	0.383	0.100
Gross	10.380	0.440	0.075	1.799	2.320
Areas, acres					
Reservoir @ gross storage	37,500	3,800	1,000	11,800	14,200
Wildlife preservation lands	20,000	2,700	570	8,800	8,000
Total land purchase required	78,000	7,300	2,500	42,000	25,600
Reservoir shoreline, miles	220	70	20	170	190
Main streams inundated, miles	61	24	14	28	34
Population displaced	420	10	10	200	60
Average fish runs at damsite					
Salmon, fish per year	42,000	---	---	---	---
Steelhead, fish per year	62,000	---	---	---	---
Recreation use, visitor-days/yr.					
Initial use	900,000	100,000	100,000	580,000	---
Maximum use	2,100,000	300,000	400,000	2,200,000	1,000,000
Years to reach maximum use	30	100	50	50	10

a. Values exclude area and runoff above Dos Rios and English Ridge Dam sites.
b. Included in values for Yellow Jacket Dam site.
c. Includes outflow from Clear Lake.
d. 15,000 AF/yr. Clear Lake Basin winter ground water recharge; 8,000 AF/yr. Indian Valley Reservoir evaporation; 10,000 AF/yr. depletion due to Lakeport Project.
e. Releases to Russian River Basin via Potter Valley Powerplant.
f. Release for surface diversions and ground water recharge on lower Cache Creek = 183,000 AF/yr. (assuming Indian Valley Project is in operation); presently exportable from Delta = 17,000 AF/yr.
g. Plus spills from Dos Rios and English Ridge Reservoirs.

TABLE 50
ALTERNATIVE 6
CONVEYANCE FACILITY DATA SUMMARY

Yellow Jacket-Round Valley Pumping Plant	
Location	Mouth of North Fork Eel River
Type	Underground, on-peak
Minimum static head, feet	523
Maximum static head, feet	800
Design flow, cfs	960
Installed horsepower	112,000
Yellow Jacket-Round Valley Tunnel	
Length, miles	11.1
Diameter, feet	12.0
Inlet elevation, feet	700
Outlet elevation, feet.	1,500
Minimum capacity, cfs	960
Construction time, years	5
Dos Rios-Willis Ridge Tunnel	
Length, miles	5.2
Diameter, feet	12.0
Inlet elevation, feet	1,260
Outlet elevation, feet	1,170
Capacity, cfs (maximum/minimum)	1,650/1,450
Construction time, years	5
Willis Ridge-English Ridge Pumping Plant	
Location	Toe of English Ridge Dam
Type.	Conventional, aboveground, on-peak
Minimum static head, feet	327
Maximum static head, feet	518
Design flow, cfs	1,580
Installed horsepower	112,000
Garrett Tunnel	
Length, miles	13.3
Diameter, feet	15.0
Inlet elevation, feet	1,495
Outlet elevation, feet	1,450
Capacity, cfs (maximum/minimum)	2,700/1,290
Construction time, years	4
Cache Creek-Sacramento River Canal	
Type.	Concrete-lined canal
Length, miles	26.8
Capacity, cfs	5,600

TABLE 51
ALTERNATIVE 6
DESIGN AND CONSTRUCTION SCHEDULE
(Does not include feasibility investigation time)

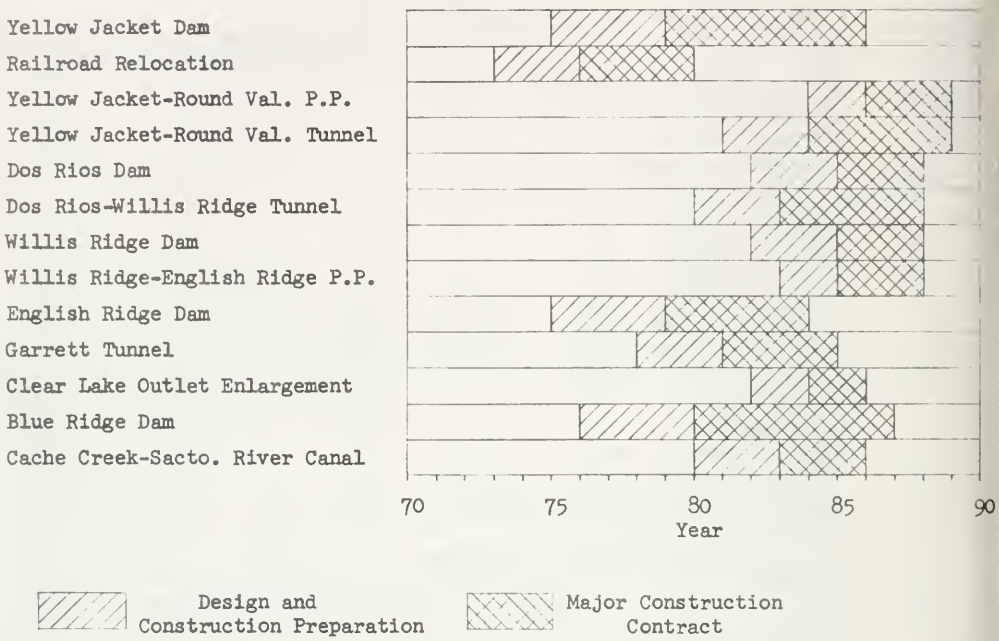


TABLE 52
ALTERNATIVE 6
COST SUMMARY
(Price basis, July 1969 Period of analysis, 1986-2085 Interest rate, 5%.)

Feature	Construction Completion Date	Construction Time (years)	Costs, in Millions of Dollars			
			First Cost (includes engr. & contingencies)	Construction Cost Capitalized to 1986	OM&R Cost Capitalized to 1986	Total Cost Capitalized to 1986
Yellow Jacket Dam and Reservoir	1986	7	365.0	428.9	32.4	461.3
Fish Preservation			13.0	15.4	14.2	29.6
Wildlife Preservation			4.9	6.6	3.5	10.1
Recreation Facilities[a]			10.2	16.1	20.0	36.1
Railroad Relocation	1980	4	175.9	259.1	---	259.1
Yellow Jacket-Round Valley P.P.	1989	3	27.5	25.7	6.9	32.6
Power				---	43.7	43.7
Yellow Jacket Round Valley Tunnel	1989	5	49.6	48.1	0.7	48.8
Dos Rios Dam and Reservoir	1988	3	57.0	55.7	4.2	59.9
Wildlife Preservation			0.7	0.8	0.4	1.2
Recreation Facilities[a]			0.6	0.7	1.3	2.0
Dos Rios-Willis Ridge Tunnel	1988	5	26.7	27.2	0.4	27.6
Willis Ridge Dam and Reservoir	1988	3	23.4	22.8	1.7	24.5
Recreation Facilities[a]			1.6	2.2	2.5	4.7
Wildlife Preservation			0.2	0.3	0.1	0.4
Willis Ridge-English Ridge P.P.	1988	3	16.6	16.2	4.4	20.6
Power				---	49.0	49.0
English Ridge Dam and Reservoir	1984	5	112.8[b]	140.0	10.6	150.6
Wildlife Preservation			2.6	3.7	2.0	5.7
Recreation Facilities[a]			9.0	14.8	17.0	31.8
Garrett Tunnel	1985	4	76.4	88.1	1.4	89.5
Clear Lake Outlet	1986	2	6.4	6.7	---	6.7
Blue Ridge Dam and Reservoir	1987	7	226.0	252.0	19.0	
Wildlife Preservation			2.3	2.9	1.5	4.4
Recreation Facilities[a]			8.5	8.1	9.2	17.3
Cache Creek-Sacto. River Canal	1986	3	23.5	25.3	6.8	32.1
TOTALS			1,240.4	1,467.4	252.9	1,720.3
Average Annual Cost				73.9	12.7	86.6

a. First cost includes initial facilities only; capitalized costs include all future staged recreation facilities.

b. From USBR draft report on English Ridge Project, adjusted to July 1969 price levels.

ALTERNATIVE 7: SPENCER-RANCHERIA, PASKENTA PROJECT

The major features of this alternative would be a 450,000-acre-foot Spencer Reservoir on the Middle Fork Eel River, with a 200-foot-high Wailaki Dam to prevent spilling water into Round Valley, a 20.0-mile Spencer-Grindstone Tunnel, a 5,450,000-acre-foot Rancheria Reservoir on Stony Creek, and a 130,000-acre-foot Paskenta Reservoir on Thomes Creek. Tables 53 through 56 summarize the physical data on the various features, the staging of design and construction, and the project costs. A plan and profile of the system are shown on the accompanying figure.

This system would provide a new yield of 900,000 acre-feet per year, referenced to the Sacramento-San Joaquin Delta.

Project Formulation

In order to obtain sufficient yield from the Spencer-Rancheria Reservoir combination, either the Mina Project on the North Fork Eel River or the Paskenta Project on Thomes Creek could be added. The addition of the Mina Project is described as Alternative 8. The system described here as Alternative 7 includes Paskenta Dam and Reservoir on Thomes Creek.

On the basis of limited exploration of foundation conditions, Spencer Dam was limited to a crest elevation of 1,720 feet, providing a gross storage capacity of 450,000 acre-feet. Paskenta Reservoir would divert part of the surplus flows of Thomes Creek to the existing Black Butte Reservoir for regulation to meet local demands, thus allowing the retention of presently used Stony Creek water in Rancheria Reservoir.

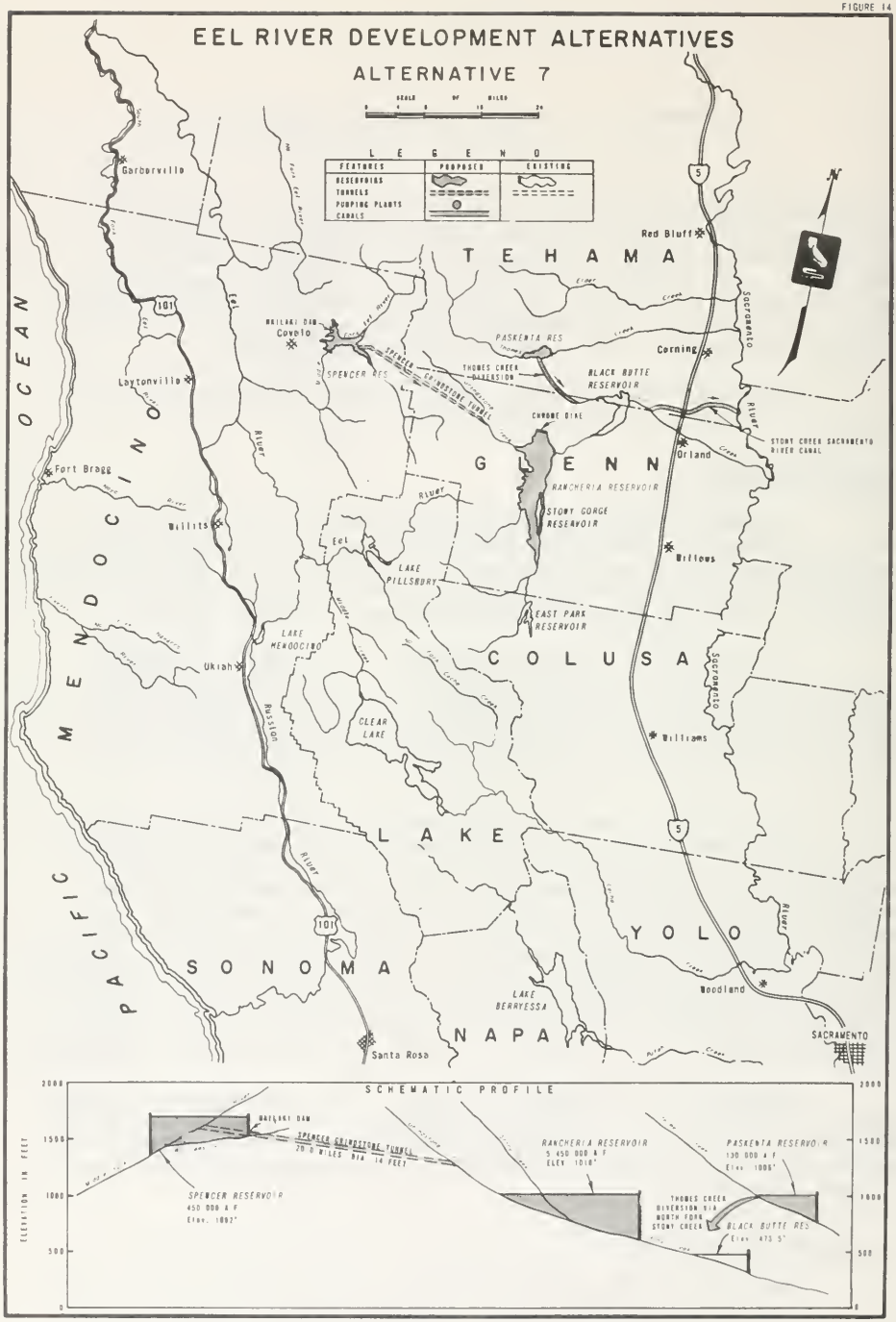
It was assumed that the 150,000-acre-foot flood control reservation in Black Butte Reservoir would be transferred to Rancheria Reservoir, and that the Black Butte Reservoir operation would be revised to regulate the diversions from Paskenta Reservoir. The combined operation of the Paskenta-Black Butte-East Park system would replace the capability of the existing Black Butte-Stony Gorge-East Park Reservoir development, thus allowing the retention in Rancheria Reservoir of water from Stony Creek equivalent to the diversion from Paskenta Reservoir. The efficiency of this plan could be improved by adding spillway gates at Black Butte Reservoir to increase its active storage capacity. Both the physical and operational modifications at Black Butte Reservoir would have to be worked out with the Corps of Engineers.

Construction of the basic features of this system would be staged to meet State Water Project demands beginning in 1986. Initial filling of sufficient storage to be reasonably certain of meeting these demands would require one year. Therefore, construction of this system should be staged as shown in Table 55.

Flood Control Potential

The Corps of Engineers recommended a specific flood control reservation of 400,000 acre-feet at Spencer Reservoir, but the limited storage

FIGURE 14


EEL RIVER DEVELOPMENT ALTERNATIVES
ALTERNATIVE 7
SCALE OF MILES
L E G E N D
FEATURES
PROPOSED
EXISTING
RESERVOIRS
TUNNELS
PUMPING PLANTS
CANALS
Garberville
Covelo
Laytonville
Fort Bragg
Willits
Ukiah
Red Bluff
Corning
Orland
Willows
Williams
Woodland
SACRAMENTO
Santa Rosa
TEHAMA
GLENN
COLUSA
YOLO
NAPA
SONOMA
MENDOCINO
LAKE
OCEAN
PACIFIC
SPENCER RES.
PASKENTA RES.
THOMES CREEK DIVERSION
BLACK BUTTE RESERVOIR
CHRome DIKE
STONY CREEK SACRAMENTO RIVER CANAL
RANCHERIA RESERVOIR
STONY GORGE RESERVOIR
LAKE PILLSBURY
EAST PARK RESERVOIR
LAKE MENDOCINO
CLEAR LAKE
LAKE BERRYESSA
Eel River
Russian River
Sacramento River
SCHEMATIC PROFILE
ELEVATION IN FEET
SPENCER RESERVOIR
450 000 A F
Elev. 1092'
SPENCER CRINDSTONE TUNNEL
20 0 MILES DIA 14 FEET
RANCHERIA RESERVOIR
5 450 000 A F
ELEV. 1010'
PASKENTA RESERVOIR
130 000 A F
Elev. 1008'
THOMES CREEK DIVERSION VIA NORTH FORK STONY CREEK
BLACK BUTTE RES
Elev. 473 5'

would preclude such a reservation. However, Spencer Reservoir would provide some incidental flood protection.

A Paskenta Reservoir flood control reservation of 60,000 acre-feet is shown to illustrate this plan. Further studies would be required to determine the optimum flood control storage in Paskenta Reservoir to reduce damages along Thomes Creek and the lower Sacramento River.

Recreation Potential

Table 53 shows the expected recreation use at the reservoirs included in this alternative. Spencer Reservoir would present a potential for a sizable amount of fair-quality recreation use in the Middle Fork Eel River area. Rancheria Reservoir would have a large surface area, fair access, and generally stable water surface except during very dry periods; it would provide for a moderate amount of fairly high-quality recreation use. Though much smaller than Rancheria Reservoir, Paskenta Reservoir would provide for a similar recreation potential due to the large area of developable land available. The revised operation of Black Butte and the potential stabilization of East Park Reservoir could provide a slight increase in recreation potential, but no estimates were prepared for this study.

Related Problems

Spencer Reservoir presents serious problems which would require detailed additional investigation. First, the storage capacity of the reservoir would be considerably reduced by siltation and landslides. Preliminary data indicate that up to 250,000 acre-feet of storage would be lost during the 100-year economic life of the project. The accumulation of sediment at the upstream portal of the Spencer-Grindstone Tunnel might present problems in keeping the tunnel in operation when the reservoir was drawn down. This problem could require relocating the tunnel intake farther downstream, with a consequent increase in tunnel length of about 3 miles. Second, because of the limited storage in Spencer Reservoir, turbidity and temperature problems could be encountered with downstream releases for fishery preservation.

The relocations in the Rancheria Reservoir area, involving the community of Elk Creek and the 80-acre Grindstone Indian Rancheria, would also be encountered with this alternative.

Level of Planning Knowledge

Limited investigation has been performed at Spencer Dam site. Spencer Dam was limited to a maximum dam crest elevation of 1,720 feet, based on reconnaissance-level data. Considerable additional investigation would be required. Major additional planning work is required for the sedimentation, landslide, and water quality problems associated with Spencer Reservoir.

A 200-foot dam would be required at the Wailaki site to prevent Spencer Reservoir from spilling into Round Valley. Wailaki Dam site has been

studied to only a low reconnaissance level and additional geologic studies are required.

The Spencer-Grindstone Tunnel alignment has been investigated at the reconnaissance level, with a limited amount of subsurface geologic exploration. Past studies of Paskenta and Rancheria Dams have compiled fairly detailed geologic and design information for these features.

TABLE 53

ALTERNATIVE 7
DAM AND RESERVOIR DATA SUMMARY

	Spencer Dam and Reservoir	Wailaki Dam	Rancheria Dam and Reservoir	Paskenta Dam and Reservoir
Drainage area, square miles	426		599	194
Mean annual flows, million AF				
Runoff at damsite (1911-60)	0.696		0.338	0.201
Upstream impairments	---		---	---
Releases for fish	0.130		---	---
Other mandatory releases	---		0.076[a]	0.053[b]
Remainder = storable inflow	0.566		0.262	0.148
Elevations, feet				
Dam crest	1720	1720	1030	1025
Maximum pool	1705		1022	1020
Top of flood reservation	---		1010	1006[c]
Top of conservation pool	1692		1006	969
Minimum pool	1628		710	881
Streambed	1356	1520	590	790
Dam height, feet	364	200	440	235
Dam construction time, years	3	1	5	2
Capacities, million AF				
Flood reservation	---		0.150[d]	0.060[c]
Conservation storage	0.200		5.200	0.060
Inactive, dead, sediment	0.250		0.100	0.010
Gross	0.450		5.450	0.130
Areas, acres				
Reservoir @ gross storage	3,700		36,800	1,940
Wildlife preservation lands	4,500		860	2,900
Total land purchase required	14,000		47,700	6,300
Reservoir shoreline, miles	40		140	20
Main streams inundated, miles	17		23	7
Population displaced	40		330	10
Average fish runs at damsite				
Salmon, fish per year	7,000		---	---
Steelhead, fish per year	17,000		---	---
Recreation use, visitor-days/yr.				
Initial use	155,000		375,000	85,000
Maximum use	900,000		685,000	575,000
Years to reach maximum use	100		20	100

a. Release for local and Delta downstream use, after allowance for part of demands being met by diversions from Thomes Creek.

b. Represents water which would have been utilized downstream without reservoir regulation.

c. Joint use -- flood control and conservation storage.

d. Flood control storage transferred from existing Black Butte Reservoir.

TABLE 54
ALTERNATIVE 7
CONVEYANCE FACILITY DATA SUMMARY

Spencer-Grindstone Tunnel	
Length, miles	20.0
Diameter, feet	14.0
Inlet elevation, feet	1,600
Outlet elevation, feet	1,250
Capacity, cfs (maximum/minimum)	2,530/2,340
Construction time, years	8
Stony Creek-Sacramento River Canal	
Type	Concrete-lined canal and creek channelization
Length, miles	15.0
Capacity, cfs	4,000

TABLE 55
ALTERNATIVE 7
DESIGN AND CONSTRUCTION SCHEDULE
(Does not include feasibility investigation time)

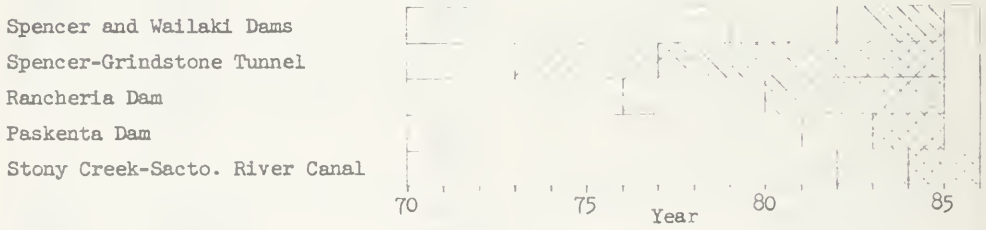


TABLE 56
ALTERNATIVE 7
COST SUMMARY
(Price basis, July 1969 Period of analysis, 1986-2085 Interest rate, 5%.)

Feature	Construction Completion Date	Construction Time (years)	Costs, in Millions of Dollars			
			First Cost (includes engr. & contingencies)	Construction Cost Capitalized to 1986	OM&R Cost Capitalized to 1986	Total Cost Capitalized to 1986
Spencer Dam and Reservoir[a]	1985	3	77.6	87.6	6.6	94.2
Fish Preservation			8.8	10.3	5.3	15.6
Wildlife Preservation			1.2	1.5	0.8	2.3
Recreation Facilities[b]			2.3	3.7	4.1	7.8
Spencer-Grindstone Tunnel	1985	8	143.6	180.9	2.9	183.8
Rancheria Dam and Reservoir	1985	5	203.6	240.4	18.2	258.6
Wildlife Preservation			0.2	0.3	0.2	0.5
Recreation Facilities[b]			5.3	6.6	7.8	14.4
Paskenta Dam and Reservoir	1985	2	21.0[c]	23.1	1.7	24.8
Recreation Facilities[b]			1.0	1.7	2.3	4.0
Stony Creek-Sacto. River Canal	1986	2	8.2	8.6	2.3	10.9
TOTALS			472.8	564.7	52.2	616.9
Average Annual Cost				28.5	2.6	31.1

a. Includes Wailaki Dam.

b. First cost includes initial recreation facilities only; capitalized costs include all future staged recreation development.

c. Includes $200,000 for wildlife preservation.

ALTERNATIVE 8: MINA, SPENCER-RANCHERIA PROJECT

As with Alternative 7, the key features of this plan would be Spencer Reservoir on the Middle Fork Eel River, a Spencer-Grindstone Tunnel, and Rancheria Reservoir on Stony Creek. To provide greater yield, the above system was expanded to include a 550,000-acre-foot Mina Reservoir on the North Fork Eel River, and an 11.1-mile Mina-Williams Creek Tunnel and Pumping Plant. Physical data on this system are summarized in Tables 57 through 60, with a plan and profile of the system shown on the accompanying figure.

This alternative would provide a new yield of 900,000 acre-feet per year, referenced to the Sacramento-San Joaquin Delta, plus an additional 70,000 acre-feet per year of firm supplemental yield.

Project Formulation

Mina Reservoir was sized to divert essentially all of the available water from the North Fork Eel River, after provision for annual fishery preservation releases of 100,000 acre-feet. Operation studies showed that 350,000 acre-feet of active storage and an 800-cubic-foot-per-second continuous diversion for six months (April through September) would limit spills from Mina Reservoir to years of extremely high runoff. The minimum pool level in Mina Reservoir was set at elevation 1,420 feet to decrease the static head at the Mina Pumping Plant and to allow some margin of storage for sedimentation.

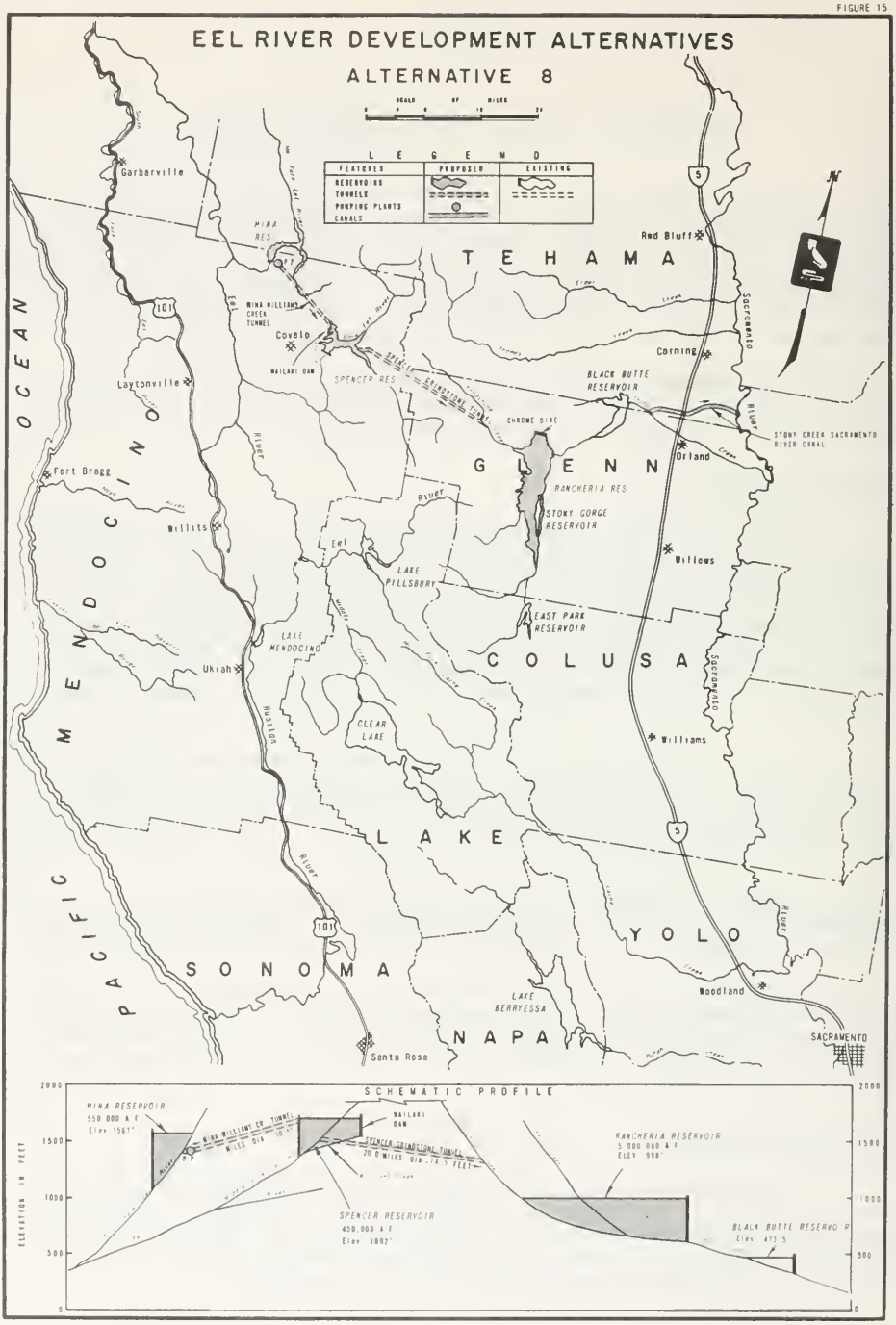
The Mina-Williams Creek Tunnel and Pumping Plant were sized for a six-month summer diversion season, thus making maximum use of the excess summer capacity of the more expensive Spencer-Grindstone Tunnel. The diameter of the Spencer-Grindstone Tunnel would still have to be increased over that shown in Alternative 7, from 14 to 14.5 feet.

Spencer Reservoir would be the same size as described under Alternatives 1A, 4A, and 7. The 5,000,000-acre-foot Rancheria Reservoir was selected to balance the total system storage with the available water supply.

Construction of the basic features of this system would be staged to meet State Water Project demands beginning in 1986. Initial filling of sufficient storage to permit a reasonable certainty of meeting these demands would require one year. Therefore, construction of this system should be staged as shown in Table 59.

Flood Control Potential

Consideration was given to using some of the storage provided by Mina Reservoir for flood control purposes. It was found that, under present conditions, the incremental cost of storage would be too high for a specific flood reservation to be economically justified. However, Mina and Spencer Reservoirs would provide some incidental flood protection.


EEL RIVER DEVELOPMENT ALTERNATIVES
ALTERNATIVE 8
SCALE OF MILES
L E G E N D
FEATURES
PROPOSED
EXISTING
RESERVOIRS
TUNNELS
PUMPING PLANTS
CANALS
Garberville
MINA RES.
MINA-WILLIAMS CREEK TUNNEL
Covelo
WAILAKI DAM
SPENCER RES.
SPENCER-CONDITIONE TUNNEL
Laytonville
Fort Bragg
Willits
Ukiah
LAKE MENDOCINO
Russian River
CLEAR LAKE
LAKE PILLSBORY
CHROME DIKE
BLACK BUTTE RESERVOIR
RANCHERIA RES
STONY GORGE RESERVOIR
EAST PARK RESERVOIR
LAKE BERRYESSA
Red Bluff
Corning
Orland
Willows
Williams
Woodland
SACRAMENTO
Santa Rosa
STONY CREEK-SACRAMENTO RIVER CANAL
TEHAMA
GLENN
COLUSA
LAKE
YOLO
NAPA
SONOMA
MENDOCINO
PACIFIC OCEAN
SCHEMATIC PROFILE
ELEVATION IN FEET
MINA RESERVOIR
550 000 A.F
Elev 1561'
MINA-WILLIAMS CR. TUNNEL
WAILAKI DAM
SPENCER-CONDITIONE TUNNEL
SPENCER RESERVOIR
450,000 A.F
Elev 1892'
RANCHERIA RESERVOIR
Elev 999'
BLACK BUTTE RESERVOIR
Elev 413.5

Recreation Potential

As shown in the recreation use projections in Table 57, construction of Mina Reservoir would add a minor amount of recreation use potential to the system. This is due to the limited access, rugged surrounding terrain, and mode of operation. The recreation potential of Spencer and Rancheria Reservoirs would be the same as in Alternative 7.

Related Problems

Problems with Spencer Reservoir would be the same as those described under Alternative 7. Due to the similarities of reservoir size, depth, operation, and regional geology, it seems reasonable to expect landslide, sediment, temperature, and turbidity problems at Mina Reservoir to be similar to those at a small Dos Rios Reservoir. Additional investigations of these aspects would be required.

Level of Planning Knowledge

The current level of information on all of the features of this system, except Mina Reservoir and the Mina-Williams Creek Tunnel, was covered under Alternative 7. Investigations of Mina Dam and Reservoir site have been very preliminary to date. Only very cursory attention has been given to the Mina-Williams Creek Tunnel alignment.

TABLE 57
ALTERNATIVE 8
DAM AND RESERVOIR DATA SUMMARY

	Mina Dam and Reservoir	Spencer Dam and Reservoir	Wailaki Dam	Rancheria Dam and Reservoir
Drainage area, square miles	246	426		599
Mean annual flows, million AF				
Runoff at damsite '1911-60;	0.368	0.696		0.338
Upstream impairments	---	---		---
Releases for fish	0.100	0.130		---
Other mandatory releases	---	---		0.206[a]
Remainder = storable inflow	0.268	0.566		0.132
Elevations, feet				
Dam crest	1589	1720	1720	1018
Maximum pool	1583	1705		1010
Top of flood reservation	---	---		---
Top of conservation pool	1567	1692		998
Minimum pool	1420	1628		710
Streambed	1067	1356	1520	590
Dam height, feet	522	364	200	428
Dam construction time, years	5	3	1	5
Capacities, million AF				
Flood reservation	---	---		---
Conservation storage	0.350	0.200		4.900
Inactive, dead, sediment	0.200	0.250		0.100
Gross	0.550	0.450		5.000
Areas, acres				
Reservoir @ gross storage	3,200	3,700		35,200
Wildlife preservation lands	2,000	4,500		860
Total land purchase required	6,200	14,000		45,800
Reservoir shoreline, miles	40	40		130
Main streams inundated, miles	19	17		23
Population displaced	10	40		330
Average fish runs at damsite				
Salmon, fish per year	500	7,000		---
Steelhead, fish per year	5,000	17,000		---
Recreation use, visitor-days/yr.				
Initial use	60,000	155,000		375,000
Maximum use	300,000	900,000		685,000
Years to reach maximum use	100	100		20

a. Release for local use in Stony Creek area = 165,000 AF/yr.; presently exportable from Delta = 41,000 AF/yr.

TABLE 58
ALTERNATIVE 8
CONVEYANCE FACILITY DATA SUMMARY

Mina-Williams Creek Pumping Plant	
Location	Left abutment of Mina Dam site
Type	Underground, on-peak
Minimum static head, feet	133
Maximum static head, feet	280
Design flow, cfs	800
Installed horsepower	45,000
Mina-Williams Creek Tunnel	
Length, miles	11.1
Diameter, feet	10.5
Inlet elevation, feet	1,400
Outlet elevation, feet	1,700
Capacity, cfs	800
Construction time, years	5
Spencer-Grindstone Tunnel	
Length, miles	20.0
Diameter, feet	14.5
Inlet elevation, feet	1,600
Outlet elevation, feet	1,250
Capacity, cfs (maximum/minimum)	2,770/2,560
Construction time, years	8
Stony Creek-Sacramento River Canal	
Type	Concrete-lined canal and creek channelization
Length, miles	15.0
Capacity, cfs	4,000

TABLE 59
ALTERNATIVE 8
DESIGN AND CONSTRUCTION SCHEDULE
(Does not include feasibility investigation time)

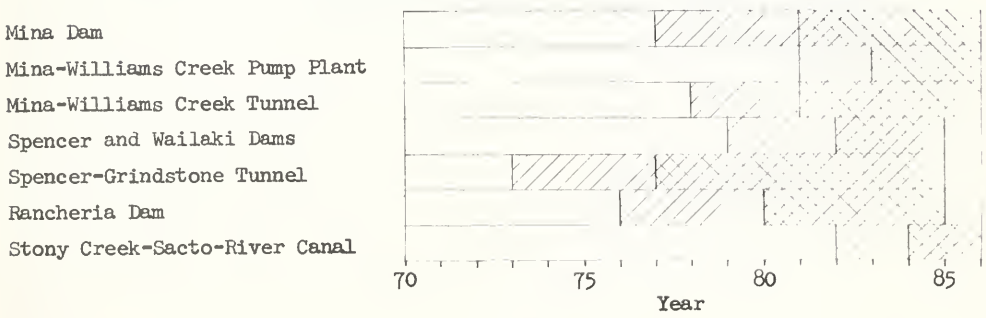


TABLE 60
ALTERNATIVE 8
COST SUMMARY
(Price basis, July 1969. Period of analysis, 1986-2085. Interest rate, 5%.)

Feature	Construction Completion Date	Construction Time (years)	Costs, in Millions of Dollars			
			First Cost (includes engr. & contingencies)	Construction Cost Capitalized to 1986	OM&R Cost Capitalized to 1986	Total Cost Capitalized to 1986
Mina Dam and Reservoir	1986	5	107.7[a]	121.2	9.1	130.3
Fish Preservation			5.5	6.3	2.3	8.6
Wildlife Preservation			0.4	0.5	0.3	0.8
Recreation Facilities [b]			0.4	0.6	1.1	1.7
Mina-Williams Creek Pumping Plant	1986	3	10.4	11.2	3.8	15.0
Power					20.6	20.6
Mina-Williams Creek Tunnel	1986	5	44.7	50.3	0.8	51.1
Spencer Dam and Reservoir [c]	1985	3	77.6	87.6	6.6	94.2
Fish Preservation			8.8	10.3	5.3	15.6
Wildlife Preservation			1.2	1.5	0.8	2.3
Recreation Facilities [b]			2.3	3.7	4.1	7.8
Spencer-Grindstone Tunnel	1985	8	152.9	192.7	3.0	195.7
Rancheria Dam and Reservoir	1985	5	182.7	215.8	16.3	232.1
Wildlife Preservation			0.2	0.3	0.2	0.5
Recreation Facilities [b]			5.3	6.6	7.8	14.4
Stony Creek-Sacto. River Canal	1986	2	8.2	8.6	2.3	10.9
TOTALS			608.3	717.2	84.4	801.6
Average Annual Cost				36.1	4.3	40.4

a. USBR preliminary cost estimate, adjusted to July 1969 price levels.

b. First cost includes initial recreation facilities only; capitalized costs include all future staged recreation development.

c. Includes Wailaki Dam.