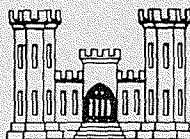


# EEL RIVER BASIN CALIFORNIA

## INTERIM REPORT ON WATER RESOURCES DEVELOPMENT FOR MIDDLE FORK EEL RIVER

APRIL 1968



U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO  
CORPS OF ENGINEERS  
SAN FRANCISCO, CALIFORNIA

EEL RIVER BASIN, CALIFORNIA

INTERIM REPORT  
ON  
WATER RESOURCES DEVELOPMENT  
FOR  
MIDDLE FORK EEL RIVER

APRIL 1968

SYLLABUS

The Eel River drainage basin lies entirely within the North Coastal Ranges geologic province of California. The basin is about 140 miles long, 40 miles wide and encompasses an area of about 3,600 square miles, including portions of Humboldt, Mendocino, Trinity, Glenn and Lake Counties, California. The Eel River flows in a northwesterly direction and empties into the Pacific Ocean about 15 miles southwesterly from Eureka, California, which is about 285 miles by highway northwesterly from San Francisco, California. The principal tributaries of the Eel River are the Van Duzen River, North Fork Eel River, South Fork Eel River and Middle Fork Eel River draining a total of about 60 percent of the basin. The Middle Fork Eel River drainage area is located in the southeast quadrant of the Eel River basin and contains an area of about 750 square miles, with an average annual runoff of over one million acre-feet.

Basin and regional studies show that construction of a plan of improvement on the Middle Fork Eel River, California, consisting of a multiple-purpose dam and reservoir and conveyance tunnel, is economically justified, providing a benefit-cost ratio of 1.9 to 1. The proposed plan of improvement would provide for a substantial degree of flood protection, sufficient water to meet in-basin needs and water for export to State facilities, a small increment of hydro-power for in-basin uses, and recreation benefits. The proposed plan is compatible with other potential developments in the basin.

The District Engineer therefore recommends:

a. Adoption of a plan of improvement for flood control, water supply, recreation and hydroelectric power on the Middle Fork Eel River, California, consisting of a dam and reservoir at the Dos Rios site and conveyance facilities to the Sacramento River Basin at an estimated construction cost of \$398,000,000;

b. Authorization for construction by the Federal Government of the dam and reservoir and appurtenant features, exclusive of the

conveyance facilities, at an estimated construction cost to United States of \$245,000,000 and an estimated annual maintenance, operation and major replacement cost of \$160,000 all generally in accordance with the plans of the District Engineer and subject to such modification and cooperative joint construction endeavor as in the discretion of the Chief of Engineers may be deemed advisable; provided that prior to construction and subject to final allocations based on conditions prevailing at the time of construction and actual costs incurred, responsible non-Federal interests:

(1) Give assurances satisfactory to the Secretary of the Army that they will:

(a) Hold and save the United States free from damages due to the construction and operation of the works specifically required to deliver water to the areas of need.

(b) Adjust all claims concerning water rights arising from the construction and operation of the improvements, including the acquisition of water rights needed for preservation of fish and wildlife resources affected by the project.

(c) Determine the manner in which the releases will be regulated for water supply.

(d) Prevent any encroachments which would interfere with the proper functioning of the improvements or lessen their beneficial effects.

(e) Design and construct the necessary conveyance facilities, under their own method of financing, in a scheduled manner that would insure its timely completion consistent with that for the dam and its appurtenant works.

(2) Enter into a contract or contracts, satisfactory to the Secretary of the Army, providing for:

(a) Reimbursement to the United States in accordance with the Water Supply Act of 1958, as amended, that part of the construction cost and annual operation, maintenance, and major replacement costs allocated to municipal and industrial water supply, presently estimated at \$186,000,000 and \$300,000, respectively.

(b) Reimbursement to the United States, in accordance with the Federal Water Project Recreation Act of 1965, one-half the separable construction cost for recreation, presently estimated at \$2,000,000 and agree to operate, maintain and make major replacements of the recreation facilities being provided, presently estimated at \$110,000 annually.

c. Relocation of the town of Covelo if local interests desire and provided required local participation.

d. Subject to specific advance agreement on plans between the State of California and the Chief of Engineers, credit be given for actual expenditures performed after authorization of the project by the California Department of Water Resources for necessary advance planning activities on the dam and reservoir project.

e. The District Engineer further recommends that immediately following authorization of the reservoir and during the advanced engineering and design phase, detailed site investigation and design be made for the purpose of accurately defining the project lands required so that, acquisition may be made of title to such lands as may be required to preserve the site against incompatible developments; and that the Chief of Engineers be authorized to participate in the construction, or reconstruction, of transportation and utility facilities in advance of project construction, as required to preserve such areas from encroachments and avoid increased costs for relocations.

f. As an element of the overall development of the project, the District Engineer also recommends that Congress give consideration to adoption of the following mitigative measures, the costs of which are included in project estimates.

(1) Fish conservation by construction of a fish hatchery and appurtenant features; acquisition of strips of land in the three-mile reach from the dam to the confluence of the mouth of the Middle Fork Eel River; and minimum releases from reservoir as may be reasonably determined by the Federal and State of California fish and wildlife conservation agencies.

(2) Acquisition and preparation by the United States of approximately 16,000 acres of land as a wildlife habitat at an estimated cost of \$4,000,000.

(3) Acquisition by the United States of about 5,000 acres of land to provide a solid and continuous area of Indian development along the north edge of the Round Valley and adjacent to the reservoir, site preparation on acquired lands necessary for relocation of Indian residential lands occupied and facilities for disrupted Indian economy, at an estimated cost of \$24,000,000 but with no cost chargeable to the project for subsequent maintenance and operation.

EEL RIVER BASIN, CALIFORNIA

INTERIM REPORT  
ON  
WATER RESOURCES DEVELOPMENT  
FOR  
MIDDLE FORK EEL RIVER

APRIL 1968

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DEPARTMENT OF THE ARMY  
SAN FRANCISCO DISTRICT, CORPS OF ENGINEERS  
100 McALLISTER STREET  
SAN FRANCISCO, CALIFORNIA 94102

IN REPLY REFER TO  
SPNGP

April 1968

SUBJECT: Interim Report on Water Resources Development for  
Middle Fork Eel River, California

THRU: Division Engineer  
U.S. Army Engineer Division, South Pacific  
San Francisco, California

TO: Office, Chief of Engineers  
Department of the Army  
Washington, D.C.

AUTHORITY

1. AUTHORIZATION OF INVESTIGATION

The 1936 Flood Control Act authorized a preliminary examination and survey of the Eel River and Mad River in Humboldt County. By resolution adopted 5 August 1939, the Committee on Flood Control of the House of Representatives, authorized a review survey on the Eel River, in Mendocino County. By letter dated 19 February 1940, the Chief of Engineers directed preparation of a basin survey of the Eel River under the authority of the two acts noted above. Additional Congressional authority was given by the following resolution of the Committee on Public Works, House of Representatives, adopted 13 June 1956.

"Resolved by the Committee on Public Works of the House of Representatives, United States, That the Board of Engineers for Rivers and Harbors be, and is hereby, requested to review the reports on Eel River, California, published in House Document Numbered 194, Seventy-third Congress, Second Session, to determine the need for modification of the recommendations in such reports and the advisability of adopting improvements for flood control and allied purposes in view of the heavy damages caused by recent floods."

The House Document referred to in the above resolution is the report prepared in accordance with previous authority and known as the "308" report. The present report is in partial response to the authorizations cited above.

2. Authorization for study of the Eel River Basin is also contained in Section 209 of the Flood Control Act of 1962 (Public Law 87-874), 87th Congress which states, in part, as follows:

"Section 209. The Secretary of the Army is hereby authorized and directed to cause surveys for flood control and allied purposes \* \* \* \* \* to be made under the direction of the Chief of Engineers, in drainage areas \* \* \* \* \* which include the following named localities."

\* \* \* \* \*

"Sacramento River Basin and streams in northern California draining into the Pacific Ocean for the purposes of developing, where feasible, multiple-purpose water resource projects, particularly those which would be eligible under the provisions of title III of Public Law 85-500."

\* \* \* \* \*

The findings of this report on the Eel River will be incorporated in the report on the Northern California streams draining into the Pacific Ocean.

#### EXTENT OF INVESTIGATION

### 3. SCOPE

In accordance with the authorizing Congressional Flood Control Acts and Resolutions, this report is an investigation made to determine the scale, features and functions of the most suitable plan as the next step in the development of the water resources of the Eel River Basin, justification of such improvement and the degrees of Federal and non-Federal participation therein. This report is regional in broad scope with the primary emphasis on the development of a plan of improvement for the Middle Fork Eel River. One of the primary considerations is the exportation of water to other areas of the State of California. The presentation summarizes basin and regional water-related needs, effect of water exportation from the Middle Fork on meeting these needs, and results of investigation findings on potential projects, and discusses the adopted plan of improvement including expected project benefits. Water resources developments considered include flood control, conservation of water principally for exportation, hydroelectric power, water quality control, recreation, and conservation of fish and wildlife. Sufficient studies were made of the basin to insure that the plan of improvement and its feasibility

are fully resolved to support the conclusions and recommendations. The plan as proposed constitutes another increment in the plan of development of the entire basin and will not be inconsistent with any combination of projects proposed in the future for the remainder of the basin. This report includes as an appendix, an economic base study of the Eel River Basin that shows past trends and future projections of population and economic growth indicators such as employment and personal income. It also compares these economic projections of the Eel River Basin with the State of California and with those for the Nation as a whole.

#### 4. FIELD SURVEYS AND INVESTIGATIONS

Field investigations, including a reconnaissance by the District Engineer, were conducted throughout the basin. Investigations were made to determine the amount of flood damages to urban and commercial property, agricultural land, crops, public property and utilities. Estimates of damages by past floods were used as a basis for determining the average annual damages from future uncontrolled floods giving consideration to the Federally authorized, but not yet constructed levees in the Eel River Delta Area. Soils investigations and core drillings were made at the selected damsite and alternative damsites along the Middle Fork Eel River. Field investigations included a study of sources of construction materials. Available topographic maps prepared by the U.S. Geological Survey and the State of California Department of Water Resources were utilized whenever possible.

#### 5. OFFICE STUDIES

Office studies were conducted of various reservoir development schemes. Basin hydrologic studies were conducted including investigation of flood frequencies, magnitudes, runoff and design floods. Analyses were made of the basin economy, flood damages, water supply, water quality, hydroelectric power, potential multiple-purpose storage requirements, recreation needs, design of dam and reservoir features, project costs and benefits, and cost allocations and apportionments. Conclusions were drawn and recommendations made on the advisability of the Federal Government adopting a project on the Middle Fork Eel River.

#### 6. CALIFORNIA STATE-FEDERAL INTERAGENCY GROUP

Continuous coordination was maintained with various Federal agencies and the State of California through the California State-Federal Interagency Group. This group, comprised of the State of California Department of Water Resources, U.S. Bureau of Reclamation,

U.S. Soil Conservation Service, and the U.S. Army Corps of Engineers, was formed in 1958 for purposes of minimizing duplication of effort and for achieving a more effective program for planning relative to water resources development for the North Coastal California Basins. Member agencies of the Interagency Group hold conferences periodically to discuss the many aspects of water resources development and to agree upon, adopt and disseminate engineering data for prospective developments. These conferences serve to keep all inter-agency members abreast of significant developments throughout the entire planning process for water resources development in Northern California.

7. By June 1966, it became evident to the members of the Interagency Group that information had been developed sufficiently to best serve the public interest by preparing an agreement reflecting a joint work program to formulate a single plan of water resources development for the Eel and Mad River Basins. The agreement assigned primary function responsibilities: U.S. Bureau of Reclamation--irrigation water requirements, and power planning pertaining to Federal transmission and marketing; U.S. Corps of Engineers--flood control on main stream and tributaries; U.S. Soil Conservation Service-watershed management; and State Department of Water Resources--estimates of statewide water requirements and overall coordination of the joint planning effort. Furthering the effectiveness of joint planning efforts, subbasin planning areas were assigned to member agencies. Among several areas assigned, the Corps of Engineers and State Department of Water Resources became jointly responsible for water resources developments on the Middle Fork Eel River. The agreement was finalized and signed in September 1966.

#### PRIOR REPORTS

##### 8. REPORTS BY CORPS OF ENGINEERS

Early Corps of Engineers investigations in the Eel River Basin were concerned with navigation. In 1900, the San Francisco District Officer submitted an unfavorable report on a proposal to construct an inland waterway connecting Humboldt Bay and Eel River, California (House Document 683, 61st Congress, 2d Session). In 1916 the San Francisco District Officer submitted an unfavorable report on a proposal to improve the Eel River for navigation (House Document 2100, 64th Congress, 2d Session). An earlier Corps of Engineers report (Ex Doc 1, 51st Congress, 1st Session) on the Proposal to Improve the Eel River Entrance for Navigation was published in 1889.

9. In 1931 and 1932, on the basis of criteria contained in House Document 308, 69th Congress, 1st Session, the San Francisco District

Engineer submitted comprehensive reports on Mad River (including Van Duzen River, a major tributary of Eel River) and Eel River, California (House Documents 188 and 194, 73d Congress, 2d Session, 1934). These investigations were concerned with the orderly development and control of basin water resources to meet not only local needs but also the water export requirements for neighboring water-deficient areas. Major study emphasis was devoted to evaluation of the water-resource development potential of the basins, including consideration of local water supply problems, navigation, flood control, power supply, irrigation and transport of surplus water to neighboring water-deficient areas. Although no development features were constructed at that time, these "308" reports marked the beginning of the more comprehensive basinwide approach to development and control of the water resources of the Eel River Basin.

10. Although the Eel River "308" report indicated the economic feasibility of immediate construction of levees, bank protection and stabilization works to provide relief from flood damages for the basin Delta Area, the extent of Federal interest, under then existing governmental policies, was considered not sufficient to justify participation by the United States. Enactment of the Flood Control Act of 22 June 1936 (Public Law No. 738, 74th Congress) reflected a marked change in governmental policy to provide for increased Federal participation in the cost of such projects. The Act further provided authorization for construction of the Delta Area improvements as recommended in the "308" report; however, local interests considered the project as inadequate in scope and the project was classified as inactive. The Corps of Engineers report on the Eel River at Sandy Prairie, California (House Document No. 80, 85th Congress, 1st Session, 1957) recommended construction of a levee in the upper Delta Area on the East bank of the Eel River at Sandy Prairie (construction was completed in 1959) to provide flood protection for the city of Fortuna.

11. The latest authorized Corps of Engineers' report on the Eel River (House Document No. 234, 89th Congress, 1st Session) discusses water resources problems for the entire Eel River Basin and potentials for water resources development. The recommendations in the report are that further studies of the basin be undertaken; that the Delta levee project authorized in the Flood Control Act of 1936 be rescinded; that a system of local flood protection works consisting of levees and appurtenant works be adopted by the United States for the Delta Area as the next unit of basin water resources development and that the estimated Delta Area Project first cost as contained in the project document was \$16,792,000 of which \$13,732,000 would be Federal. Water resources data and problems on the Middle Fork Eel River are briefly presented in various portions of the report.

## 12. REPORTS BY OTHERS

The State of California, Department of Water Resources, has prepared several reports of which portions cover the Eel River Basin. These reports include: Bulletin No. 136, "North Coastal Area Investigations Preliminary Edition" dated September 1964, presenting results of reconnaissance investigations of the North Coastal Area; Bulletin No. 94-8, "Land and Water Use in Eel River Unit" dated August 1965, presenting data on historical and existing water systems and land usage in the Eel River Basin; Bulletin No. 160-66, "Implementation of the California Water Plan" dated March 1967, presenting the first of a series on activities pertaining to implementation of the California Water Plan; and Bulletin No. 171, "Upper Eel River Development, Investigation of Alternative Conveyance Routes" dated July 1967, presenting results of studies directed toward determination of the best diversion route for delivering project water from the Middle Fork Eel River to the Sacramento-San Joaquin Delta. Other pertinent reports by the State of California include: Bulletin No. 3, "The California Water Plan;" Bulletin No. 132-66, "The California State Water Project;" and Bulletin No. 125, "Sacramento Valley Seepage Investigation." Appendices to most of the reports mentioned above covering fish and wildlife and recreation were prepared by the California Departments of Fish and Game and Parks and Recreation. The California Department of Fish and Game also prepared, "Fish and Wildlife Problems and Study Requirements in Relation to North Coast Water Development," dated January 1966. This report's primary purpose was to serve as a master plan for the investigation of fish and wildlife in the North Coast area.

13. A renewed Federal interest in the water resources development of the Eel River Basin has occurred during recent years. This interest has been concerned with drainage, land treatment measures, and matters relating to recreation and fish and wildlife, irrigation, and export of large quantities of water to adjacent areas principally for domestic use. The U.S. Department of Health, Education and Welfare has been concerned with quality of the waters of the basin and in November 1962 published a preliminary report on Eel River Basin future municipal and industrial water uses and future water quality control flow. The U.S. Department of Commerce continues to maintain data collection and activities pertinent to navigation and climatology. Regional publications include, "Natural Resources of Northwestern California," prepared by the Pacific Southwest Field Committee of the U.S. Department of the Interior, published in 1956.



## DESCRIPTION

### 14. LOCATION AND EXTENT

The Eel River drainage basin lies entirely within the North Coastal Ranges geologic province of California. The basin is about 140 miles long, 40 miles wide and encompasses an area of about 3,600 square miles, including portions of Humboldt, Mendocino, Trinity, Glenn and Lake Counties. The Eel River flows in a northwesterly direction and empties into the Pacific Ocean about 15 miles southwesterly from Eureka, which is about 285 miles by highway northwesterly from San Francisco, California.

### 15. STREAMS AND STREAM CHARACTERISTICS

The principal tributaries of the Eel River are the Van Duzen River, North Fork Eel River, Middle Fork Eel River and South Fork Eel River, draining a total of about 60 percent of the basin. Basin tributary areas and their average annual runoffs are illustrated in Figure 1. The Eel River has a streambed slope ranging from five feet per mile near the Van Duzen River to about 22 feet per mile at Van Arsdale Dam, which is at river mile 150. Slopes of Eel River tributaries are generally steeper than those of the main stream at points of confluence. The basin drainage pattern is principally trellis, and although the major streams are chiefly parallel to the structural grain of the area, in some places they are markedly transverse. Eel River streams flow through narrow, steep-walled, V-shaped canyons throughout most of their length. Their channel sections vary widely, however, because of the canyon type topography of the upper watershed. In the Delta Area, near the mouth of the Eel River, the channel is about 20 feet deep and 1,000 to 2,000 feet wide above Fernbridge. Downstream from Fernbridge, the river is an estuary. The bankfull capacity of the river channel at Fernbridge is about 120,000 cubic feet per second.

### 16. TOPOGRAPHY

The Eel River Basin is occupied by a series of rugged, deeply trenched, northwest-trending ridges and mountains that are controlled by folding and faulting. The mountains along the east side of the basin rise to elevations<sup>1/</sup>between 5,000 and 7,500 feet and those in the western part of the basin range from 1,000 to 2,000 feet in altitude. One of the most prominent inland topographical features of the basin is Round Valley, a semi-circular, flat-floored, seven-mile wide valley. The floor of the valley slopes from about elevation 1,400 feet mean sea level in the northwest to about 1,300 feet mean sea level in the southeast. Flood plains begin to appear in the lower sections of major river tributaries and progressively widen on the Main Stem. Near the mouth, the Eel River flows over the wide flat-floored Delta Area near mean sea level.

<sup>1/</sup>All elevations mentioned in this report refer to mean sea level unless otherwise noted.

## 17. GEOLOGY

Over 90 percent of the Eel River basin area is underlain by Late Jurassic to Late Cretaceous rocks of the Franciscan assemblage. Graywacke sandstones containing subordinate amounts of shale and conglomerate are the principal rock types in the assemblage, but interlayered submarine volcanic rocks of extrusive origin and serpentine and related rocks are important constituents. All of the Franciscan rocks have been subjected to several episodes of intense folding and faulting during the geologic past. As a result, most of them are highly fractured and the individual rock members and structures lack continuity. Nevertheless, despite the complexities of the geologic structures and pervasive shearing, local areas contain rocks that are structurally competent from a standpoint of suitability for dam foundations and use as construction materials. A thick accumulation of Tertiary and Quaternary marine sedimentary rocks overlies the Franciscan assemblage in the Delta Area at the extreme downstream end of the basin. Subsequent compressional forces in the earth's crust folded these sediments into a broad, east-west-trending syncline which was later filled with deltaic deposits. Isolated patches of Tertiary rocks are found in down-faulted blocks and on or near ridge crests in the upper basin area. Their presence, coupled with other geologic evidence in this region, indicates that the magnitude of the latest episodes of crustal deformation was of a large scale. Records of the regional seismic activity show that some of these forces are still at work. Therefore, engineering structures proposed for this region should be designed to resist the forces generated by earthquakes.

## 18. SOILS

Soils in the Eel River Delta Area are excellent, varying from sandy loam to clay loam. These soils have good fertility, retain moisture well and are moderately easy to cultivate. The material along the river bottom, except for gravel bars, appears to be a soft clay. In general, the soils of the basin may be divided into two groups: (1) residual soils which have developed by the disintegration and weathering of underlying bedrock; and (2) alluvial soils which have been formed from transported sediments of pre-existing soils and other materials. In Round Valley about 50 percent of the flat valley floor has deep, well drained soils of medium texture. Most of the remainder has medium textured soils with restricted rooting depth. In the vicinity of Laytonville the relatively flatlands have deep medium textured soils. The soils of the rougher and more rolling lands are shallow. In the Willits area about half of the flatlands have deep, well drained soils. The remainder are shallow and subject to a high water table.

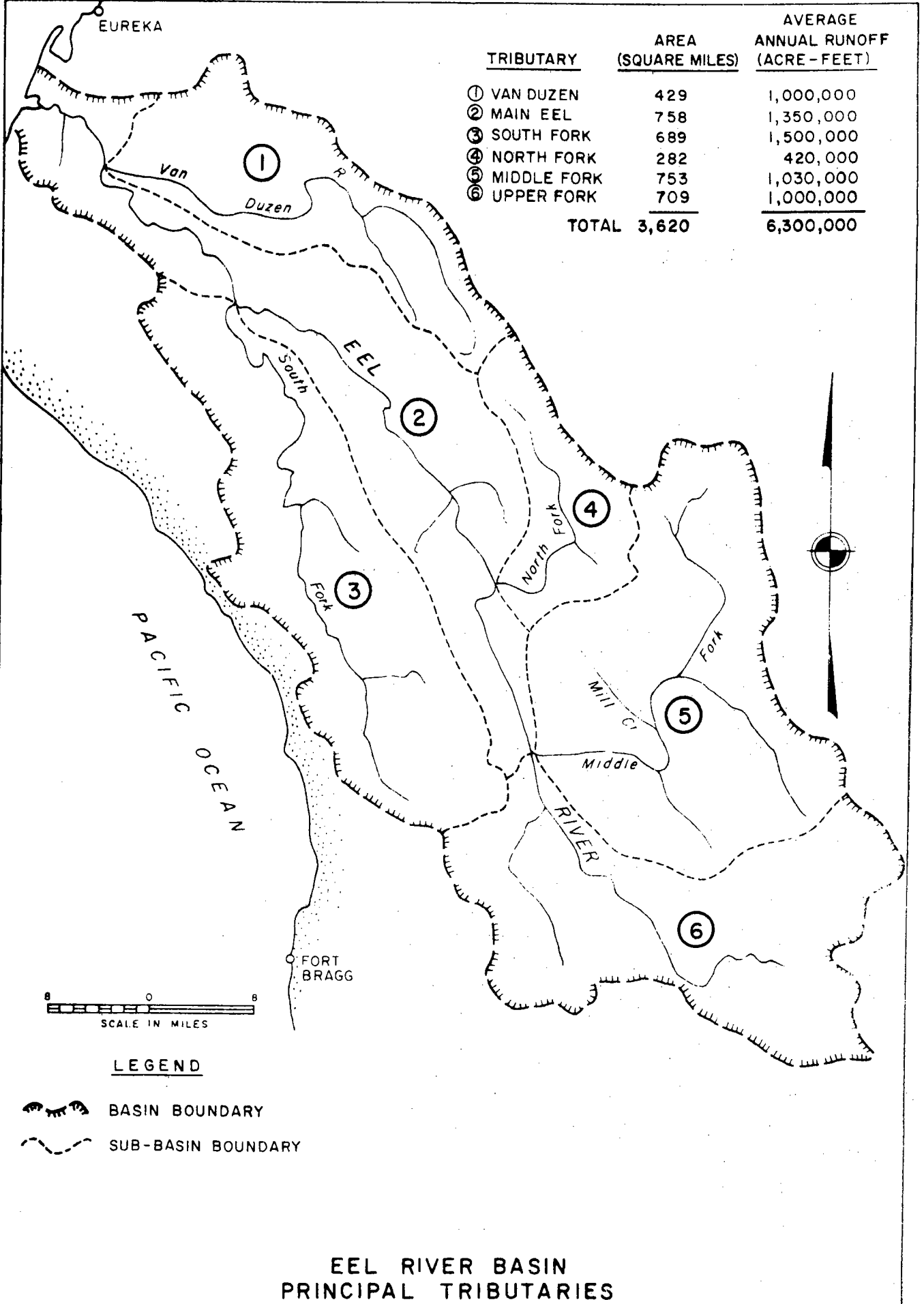


FIGURE 1

## 19. VEGETATION

About 70 percent of the Eel River drainage basin is moderately to heavily forested with California redwood, pine, fir and juniper. About 20 percent of the area is in grazing with lands having a cover of native grasses and scattered growths of brush. The remainder of the basin, including the Delta Area, a major dairying community, is utilized in pasture type lands.

## 20. SURFACE AND GROUND WATER RESOURCES

The Eel River Basin has a water supply far in excess of its present requirements. The mean annual surface runoff is over six million acre-feet with negligible amounts being used within the basin for consumptive purposes. Ground water occurs in both confined and unconfined conditions in four principal areas of the basin, namely, Round Valley, Laytonville Valley, Little Lake Valley and the Delta Area. Throughout most of the confined areas the pressure surface varies from five to ten feet above ground level during the winter and spring and is below ground level during the summer and fall. Unconfined water occurs locally in shallow zones overlying the confined waters and has an average fluctuation of about 20 feet ranging from about 5 feet to 25 feet below ground surface. It is estimated that about a million acre-feet of usable ground water at depths from 10 to 200 feet below the surface is available with an estimated annual yield of 90,000 acre-feet. Most water supplies for consumptive use are obtained from wells within the basin.

## 21. FISH AND WILDLIFE RESOURCES

The Eel River Basin possesses a wealth of economically and aesthetically valuable fish and wildlife resources. These resources are mainstays to the recreation service industry, which is second only to lumbering in economic value. The Eel River system is widely known for the salmon and steelhead angling it provides. The fish produced in this stream contribute substantially to sport and commercial fisheries in the ocean. Species of greatest importance are king salmon, silver salmon and steelhead trout. Large numbers of game animals with a lesser number of waterfowl and furbearers inhabit the basin. There are also many species of non-game wildlife; black-tailed deer are the most important big game species. Black bears are common to the area and are abundant in winter on salmon spawning tributaries. Small game animals common to the area are band-tailed pigeons, blue grouse, California and mountain quail, mourning doves, gray squirrels and rabbits. In addition, ring-necked pheasants are found in Round Valley and the lower Eel River Delta. In the winter, bald eagles are numerous in the deer wintering areas and along those tributaries where salmon spawn.

## 22. MINERAL RESOURCES

Mineral commodities are estimated to be of minor significance in the Eel River Basin. Natural gas and river-bed sand and gravel deposits are the major basin mineral products. Deposits of limestone, manganese, chromite, copper, jade and clay also occur in small commercial quantities. There is intermittent small-scale production of these latter products, but they are generally undeveloped and largely in very inaccessible locations. Within the general area of the Middle Fork Eel River drainage basin a coal bed crops out over a length of about ten miles, and is between 12 and 14 feet thick. This coal is of sub-bituminous rank and non-cooking grade, and the deposits are estimated to have reserves of about 23 million tons.

## ECONOMIC DEVELOPMENT

### 23. POPULATION

The United States Bureau of Census reports indicate a 1960 Eel River Basin population of 40,500, with about 70 percent of the population residing in Humboldt County, and about 35 percent residing in the Ferndale-Fortuna area. The population of the basin has shown a constant growth in the last several decades. Future predictions indicate the basin population is expected to increase to about 130,000 by year 2020 and 240,000 by year 2080. The population of the State of California increased from 7,000,000 in 1940 to 15,700,000 in 1960. Projections for the State into the future indicate a continued increase with estimates of about 35,000,000 by year 1990 and 54,000,000 by year 2020 and 82,000,000 by year 2080.

### 24. LAND USE, DEVELOPMENT AND INDUSTRY

The Eel River Basin is essentially rural in character. The economy is based on logging and lumber mills throughout the basin and agricultural enterprises, the most important of which is dairying, in the northern part of the basin. For the most part, communities are small, but indications are that economic forces adjacent to the basin, such as the Eureka-Arcata area, plus phased installation of demanded recreational facilities by the public will govern future growth in a rapid expansion pattern. About 60 percent of the total land mass in the basin is covered with stands of timber (redwood, fir and pine) which are of commercial character. These timber stands are the basis of the potential industrial economy of the basin. The contemplated level of future economic development presupposes the continued availability and

orderly harvesting of the extensive forest resources. It is expected, therefore, that lands presently classified as commercial timberland will remain essentially in that category.

25. Future urban developments are expected to occur in and near presently developed areas. While economic growth is expected to result in an expansion of all existing urban settlements, the most intensive development should occur in the northernmost part of the basin. This prospect is the result of the anticipated growth of the Eureka-Arcata area. The dominant "growth factor" for the basin as a whole, including the northernmost part, is the intensified use of the forest resource. Development of the forest resource is expected to result in enlarged and new lumber mills, and also the establishment of secondary lumber product manufacturing in the basin. Successive availability of new recreation facilities is expected to contribute to the development of the central and southern portions of the basin. Urbanization is likely to reduce the number of acres in agriculture to less than half the present number. However, the impact on the agricultural economy will probably be less severe than the acreage figures suggest. Dairying is the most important agricultural enterprise, and much of the land which is expected to pass from agricultural to urban use is low-lying cropland rather than grazing land. A comparatively small portion of the acreage, presently used for grazing, is expected to pass to urban use during the study period. Moreover, it is believed that the economic forces will result in the highest utilization of remaining cropland. Indications are that ultimate economic development will not be reached in the basin during the next hundred years.

#### 26. TRANSPORTATION

U.S. Highway No. 101 is the main highway through the north coastal region, and over 100 miles of this highway run through the Eel River Basin. Sections of U.S. Highway No. 101 are built to freeway standards and plans are for a freeway along its entire length. The main communities in the basin, and on U.S. Highway No. 101, are Willits, Garberville, Scotia, Rio Dell, Rohnerville and Fortuna. Additional state highway and county road systems serve such communities as Dos Rios, Covelo, Mina, Bell Springs, Island Mountain, Harris, Alderpoint, Zenia, Blocksburg, Dinsmores and Bridgeville and Ferndale. The Northwestern Pacific Railroad runs from Marin County in the San Francisco Bay Area northward through the Eel River Basin to Eureka. About two freight trains per day pass through the basin. The major commodities shipped by railroad are lumber and lumber products. Humboldt Bay, just north of the mouth of the Eel River, is the major port on the northern California coast and services both foreign trade and

coastal shipments. The major import commodity is petroleum products and the major export commodity is lumber products. Major air travel demands of the area are served by airports at Ukiah and Arcata. Air passenger traffic on a per capita basis at the Arcata Airport is only slightly less than traffic at San Francisco International Airport relative to service area populations.

## 27. WATER SUPPLY

The U.S. Public Health Service estimates the current domestic, municipal and industrial water use of the basin at from 8,500 to 13,000 acre-feet annually. Preliminary estimates furnished by the U.S. Department of Interior indicate about 25,000 acre-feet of water annually is used for irrigation purposes in the basin. The water supplies for the major communities in the Eel River Basin, except for Scotia and Garberville, originate from ground water sources. Scotia and Garberville obtain water by direct diversion from the Eel River and South Fork Eel River, respectively. Ground water is at the present time the most prevalent source of water supply in the basin. The tabulation below indicates the major basin ground water supplies:

### GROUND WATER RESOURCES\* - EEL BASIN

Ground Water Basin	Estimated Storage Capacity (acre-feet)	Estimated Storage Annual Yield (acre-feet)
Lower Eel-Van Duzen	125,000	30,000
Round Valley	207,000	32,000
Little Lake Valley	575,000	15,000
Laytonville Valley	18,000	15,000

\*From: U.S. Department of Interior, Pacific Southwest Field Committee, Natural Resources of Northwestern California, Appendix on Plans of Water Development, 1960.

Existing development of Eel River Basin surface water resources consists of four reservoirs, three of which are small. The Lake Pillsbury and Van Arsdale Reservoirs (94,000 and 700 acre-feet respectively) are on the upper reach of the Eel River with drainage areas of 280 and 345 square miles. Waters from these reservoirs are diverted through Pacific Gas and Electric Company's Potter Valley

Tunnel into the East Fork of the Russian River Basin. This diversion is made primarily for power generation purposes. The total annual diversion varies, but in recent years has averaged approximately 180,000 acre-feet. The diverted waters annually generate approximately 11,000 KVA for a gross generation of about 71.6 million kilowatt-hours. The diverted flow is now reregulated by the Corps of Engineers Coyote Dam and Lake Mendocino flood control and water conservation project which was completed in 1959. This project is located on the East Fork of the Russian River Basin. Other reservoirs: Benbow Reservoir (1,000 acre-feet) on the South Fork Eel River is used for recreation and Morris Reservoir (800 acre-feet) on James Creek is utilized to supply water to the town of Willits, California.

## 28. RECREATION

Recreational resources in the Eel River Basin are second in economic importance only to the forest product industry. A large segment of recreational activities in the basin is forest-based, and at the present time, the redwood forests are the foremost recreational asset. There are more of these majestic, world-famous forests, both public and private, in the Eel River Basin than in any river basin in the State. Visitations to the five State Parks and recreation areas in the basin were nearly two and one-half million in 1961, doubling the number in 1959, and a continued rapid increase is indicated. The basin is of major fishery importance in California, ranking it second in Coho salmon and steelhead trout and third in Chinook salmon production. It is second only to the Klamath River in northwestern California in sport fisheries values. Other valuable basin recreation assets include water fowl and big game hunting; the primitive splendor of the Yolla Bolly-Middle Eel Wilderness Areas; and relatively undeveloped winter sports resources of the east-central portion of the basin. There are substantial land areas within various governmental jurisdictions in the upper watershed areas for present and future recreation activities. Only a small percentage of the water-related recreation potential of the Eel River Basin has been developed. Lack of water-surface areas and access to streams are the primary problems. Present and future recreation projections for the basin indicate that recreation will be a major consideration in water resources development.

## 29. ROUND VALLEY

Round Valley (Figure 2) is an alluvial basin of about 18,000 acres in northern Mendocino County and within the Middle Fork Eel River Basin. Covelo, with a population of about 600 is the only town in the valley. An Indian Reservation is located in the northern end of the valley. The Round Valley Indian Reservation, established in 1858, was populated by Indians of several different tribes of northern California. By 1868 the reservation area was about 102,000

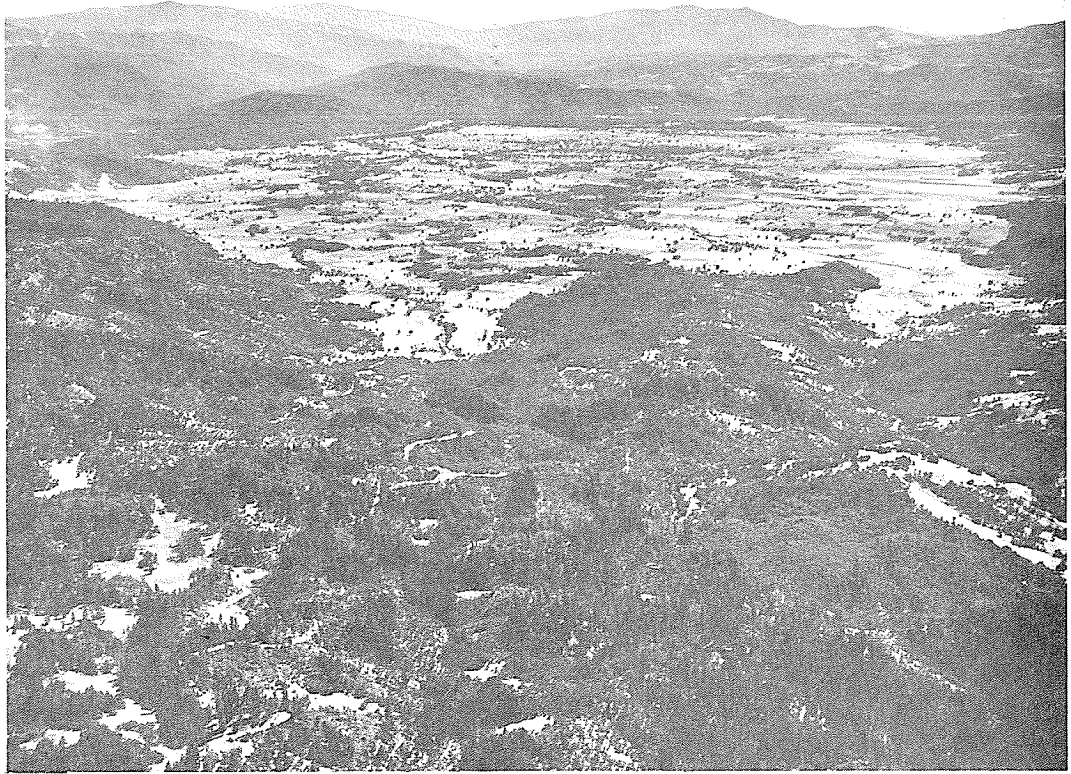


acres. Allotments of land to individuals were made between 1885 and 1910. There were over 1,200 allotments affecting about 42,000 acres of reservation land, most of which are outside the valley. Valley lands were allotted in 10-acre tracts and hill lands in larger tracts, with most individuals receiving tracts of both valley and hill lands. Since allotment, the Indians have disposed of their valley land individually in 10-acre tracts resulting in a large number of small holdings in the northern part of the valley. The Round Valley Indian population is presently estimated at about 350 persons, with about 1,000 to 1,500 valley-area relatives being located in all parts of the United States.

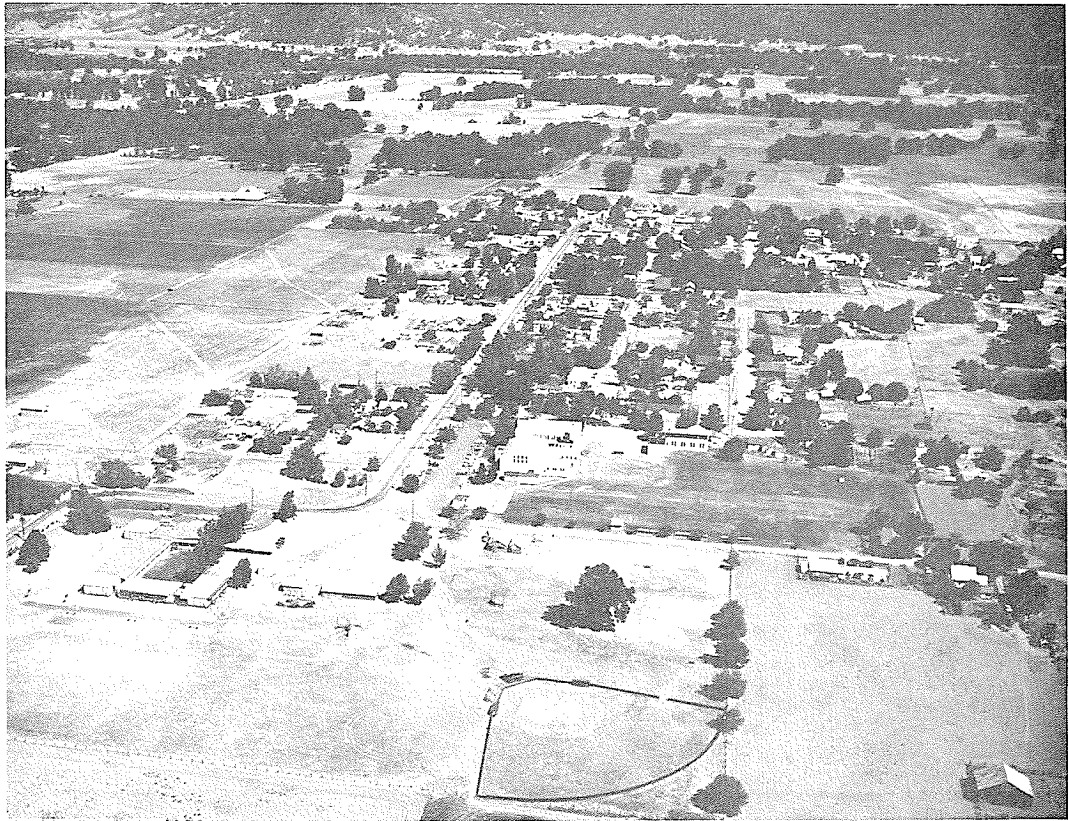
30. Covelo (Figure 2), the only town in the valley, is some 12 miles by paved road to a railroad, and some 13 additional miles to U.S. Highway No. 101. The isolated location of the valley and the limited transportation facilities available hampers development. The Indian school located near Covelo was discontinued and the buildings abandoned about five years ago. Both the Round Valley Union Elementary and High Schools, serving the valley and the surrounding areas, are located in Covelo. The importance of the valley to the economy of the remainder of the county is relatively small. Lumber production is less than two percent of that for the county. Agricultural productions in the valley represent about 15 percent of the county total, but the economy of the county is based mainly upon the wood industries rather than upon agriculture. About three percent of the total population of the county lives in Round Valley. It is not anticipated, therefore, that the economic importance of the valley to that of the remainder of the county will change, under current use patterns, within the foreseeable future.

### 31. TRENDS OF GROWTH AND DEVELOPMENT

The State of California has been experiencing a tremendous population growth, and the indications are that the State will increase at a faster rate than the nation until year 2020 and thereafter increase at a lesser rate than the nation as a whole. The Eel River Basin is expected to increase at a lesser rate than California but at a greater rate than the nation until about 2020 and then at a faster rate than both the nation and State. Employment will follow the same trends as population growth. The per capita income of California is currently above the national and Eel River Basin levels. Sharp increases in per capita income in the Eel River Basin are expected with increased urbanization. Ultimately the basin is expected to remain essentially rural and resource based, but in long-range terms a significant shift toward urban land use can be expected. A dynamic growth is forecast for the Eel River Basin over the next 100 years with a shift away from reliance on the lumber industry toward a more diversified economy. The relative



ROUND VALLEY



TOWN OF COVELO

decline of the industrial sector does not mean that the lumbering industry will not be a major sector of the basin economy over the long term. It is expected to remain important in the value of production as it shifts toward better management and more efficient processing. The very substantial increase in the service sector is effected by demands stemming from secondary manufacturing and the expected tremendous increase in recreational activities in the Eel River Basin.

## CLIMATOLOGY

### 32. CLIMATE

The climate of the Eel River Basin, characteristic of most of California, is divided into a wet and a dry season. Most of the rainfall occurs from storms during the winter months. Due to the nearness to the Pacific Ocean, fogs are prevalent in the lower part of the basin. Summer is characterized by cool weather along the coast and warm dry weather in the interior mountain valleys. Winter is characterized by frequent precipitation with cool but seldom freezing temperatures along the coast and more severe weather further inland.

### 33. TEMPERATURES

The following data for the coastal area and the upper basin of the area demonstrate temperature variations within the basin.

	<u>Elev.</u>	<u>Average Annual</u>	<u>Average Max.Month</u>	<u>Average Min.Month</u>	<u>Highest Recorded</u>	<u>Lowest Recorded</u>
Coastal area (Eureka)	43'	52°	Aug 57°	Jan 47°	Sep 85°	Dec 22°
Middle Fork Basin (Covelo)	1,385'	56°	Jul 74°	Jan 40°	Sep 114°	Jan 7°

### 34. PRECIPITATION

Distribution of precipitation is closely related to topographic features of the basin with areas of high seasonal rainfall coinciding with mountain ridges. There is a marked division of the year into wet and dry seasons with July and August being months of consistently low rainfall and with over 95 percent of the rainfall occurring during the months of October and April. Normal annual precipitation within the basin ranges from about 40 inches in the Eel River Delta to 100

inches near the crest of the westerly ridge of the South Fork Eel River. The average annual precipitation for the entire basin is about 57 inches as compared to about 74 inches for the South Fork and 56 inches for the Middle Fork. Snow occurs occasionally at elevations above 2,500 feet but seldom accumulates to a significant depth at elevations below 5,000 feet. The Middle Fork Eel River displays the most significant quantity of streamflow runoff from snowmelt. Precipitation records are available from about 40 rain gages in or adjacent to the Eel River Basin. Ten of these are recording type, and data from about 28 are published in the monthly "Climatological Data, California" by the U.S. Weather Bureau. Data from these gages are presented in Appendix B.

### 35. STORM RECORDS

Subsequent to the installation of the gaging station on Eel River at Scotia in 1910 major storms producing floods occurred during January 1914, February 1915, December 1937, February 1940, January 1943, December 1955, February 1960 and December 1964. Perhaps the two greatest storms during the past century were those of December 1955 and December 1964. Comparison of 3-day rainfall from major storms recorded at five long-term U.S. Weather Bureau stations follows:

Date	Rainfall in Inches				
	Eureka	Upper Mattole	Willits	Dos Rios	Covelo
20-22 January 1914	2.70	10.76	7.32	--	7.26
31 Jan - 2 Feb 1915	6.53	17.24	9.21	--	7.84
10-12 Dec 1937	2.76	8.67	13.10	9.81	11.39
27-29 Feb 1940	1.16	11.28	10.41	9.11	5.78
20-22 Jan 1943	2.87	5.62	11.03	--	7.71
21-23 Dec 1955	2.73	10.59	9.99	13.42	7.33
7-9 Feb 1960	2.83	7.73	11.69	10.85	9.16
21-23 Dec 1964	3.27	12.49	13.58	18.65	13.10

### STREAMFLOW, RUNOFF AND FLOODS

#### 36. STAGE DISCHARGE RECORDS

A stream gaging station on the Eel River at Scotia has been maintained by the United States Geological Survey since December 1910, except for the period from February 1915 to October 1916. The United States Weather Bureau has maintained a station on Eel River at Fernbridge since December 1938, to record stages experienced

from December to March, inclusive, each year. Twenty-six stream gaging stations are currently in operation in the Eel River Basin. Of these, five are on the main stem of the Eel River. The long-term stream gage record at Scotia and Van Arsdale diversion dam was used to adjust mean annual runoff at other points within the basin to a common base period of 50 years (1911-60). Monthly runoff estimates at numerous damsites and gaging sites were made by the U.S. Geological Survey and the California Department of Water Resources. These estimates were adopted by the California State-Federal Interagency Hydrology Subgroup. Data on active gaging stations are published in the annual publication "Surface Water Records of California," U.S. Geological Survey. Data on selected gaging stations follow:

Location	Drainage Area [sq.mile]	Period of Record	Maximum Discharge		50-Year Mean <sup>1/</sup> Natural Runoff [acre-feet]
			[cubic feet per second]	[c.s.m.] <sup>3/</sup>	
Eel River at Scotia	3,113	1910-67	752,000	240	5,200,000
Eel River at Alderpoint	2,079	1955-65 <sup>4/</sup>	561,000	270	2,800,000
Eel River below Dos Rios	1,484	[1911-13 1951-67] <sup>2/</sup>	460,000	310	2,050,000
Middle Fork Eel River below Black Butte River, near Covelo	367	1951-67	133,000	360	630,000
Eel River above Dos Rios	705	1950-65 <sup>4/</sup>	184,000	260	1,000,000
South Fork Eel near Miranda	537	1939-67 <sup>2/</sup>	199,000	370	1,200,000

<sup>1/</sup> Adjusted to 1911-60 natural [unregulated] conditions.

<sup>2/</sup> These estimates appear high when related to overall basin data. For this report, values of 400,000 cubic feet per second at Dos Rios and 186,000 cubic feet per second at Miranda were adopted.

<sup>3/</sup> c.s.m. represents c.f.s. per square-mile of drainage area; maximum at all locations occurred on 22 December 1964.

<sup>4/</sup> Discontinued. All others are active stations.

### 37. RUNOFF CHARACTERISTICS

Mean annual runoff of the Eel River Basin is estimated at 6.3 million acre-feet with about one million acre-feet originating from the Middle Fork Eel River. The year of greatest runoff from the Eel Basin was 1958 with about 225 percent of normal, and the year of least runoff was in 1924 with a runoff of about 17 percent of normal. About 90 percent of the annual runoff occurs during the winter months from November through April. The Middle Fork Eel River is the only subbasin with appreciable area above 3,000 feet elevation and consequently is the only tributary with late season runoff extending into June because of snowmelt. Seasonal peak flows have been recorded in the Eel Basin as early as 19 November and as late as 16 April, with the average date being 1 February. The discharge of Eel River is always relatively low during the summer and early fall, but unlike most Coast Range streams, a small flow is always maintained. Records of stream flow at Scotia show that the discharge rate decreases to less than 100 cubic feet per second every year, and to less than 50 cubic feet per second in about 40 percent of the years. The least flow reported at Scotia was ten cubic feet per second for a three-day period in August of 1924. Minimum flows usually occur in either September or October. The greatest discharge on the Eel River at Fernbridge was about 840,000 cubic feet per second during the December 1964 flood. The flood of December 1955 produced a peak discharge of about 600,000 cubic feet per second.

### 38. FLOOD CHARACTERISTICS

Floods on the Eel River rise very rapidly. Peak discharges at Fernbridge from a flood producing storm occur about 18 hours after the highest rainfall intensity of the storm. Flood inundation begins in the adjacent delta agricultural lands at a discharge of about 120,000 cubic feet per second and significant bank erosion occurs in the canyon reaches when the discharge past Scotia exceeds about 150,00 cubic feet per second. Duration of overbank flow may last for four to five days during the occurrence of severe floods such as December 1955 and December 1964.

### 39. HISTORICAL FLOODS

Prior to 1964, the flood of 18-24 December 1955 was the maximum flood of record since records began in 1910 and exceeded the next highest flood by over 50 percent. The catastrophic damage caused by this event received national publicity. Then nine years later another holiday season was marred by an even more destructive flood with a peak discharge that exceeded the December 1955 flood by nearly 40 percent. All historical evidence indicates that this

most recent flood (December 1964) is the largest event during at least the past 100 years. Flood runoff at Scotia for the period 20-28 December 1964 was about four and a half million acre-feet, the equivalent of almost 27 inches of runoff from the 3,113 square-mile basin above the gaging station. Runoff during the maximum four or five days approached the amount usually received during 12 months everywhere within the basin. The long-term record at Scotia shows other floods of lesser magnitude have occurred in January 1914, February 1915, February 1917, December 1937, February 1940, January 1943, February 1960, and February 1963. Highwater data indicate that the flood of January 1862 was about equal to December 1955 flood and there is evidence that major flooding may have occurred in 1881 and 1890.

#### 40. FLOOD FREQUENCY

The frequency with which flood peaks of varying heights will probably be equaled or exceeded in the future has been estimated by statistical methods. The stages and corresponding peak discharges at the Fernbridge gaging station for various estimated frequencies of annual occurrence are indicated in the tabulation below:

<u>Frequency [equaled or exceeded]</u>	<u>Peak Stage [above mean sea level]</u>	<u>Corresponding peak discharge at Fernbridge [in cubic feet per second]</u>
once in 100 years	32.3	745,000
once in 50 years	31.3	620,000
once in 20 years	29.9	470,000
once in 10 years	28.6	370,000
once in 5 years	26.8	280,000
once in 2 years	22.4	165,000

#### 41. STANDARD PROJECT FLOOD

The standard project flood represents critical concentration of runoff that may be expected from the most severe combination of meteorological and hydrologic conditions considered reasonably characteristic of the geographical region involved. Thus, the standard project storm is centered over the Eel River Basin in such a way as to produce a high rate of runoff. Such runoff established the upper limit to which protection against floods might be sought. For the entire basin, the 20-23 December 1964 storm with its center transposed from near Laytonville, California

was found to be the most critical and was adopted as reasonably characteristic of the region to produce the standard project flood. Based on Unit Hydrology application, the estimated peak flow of the standard project flood at Fernbridge was determined to be 920,000 cubic feet per second or ten percent greater than the record discharge of 840,000 cubic feet per second of the December 1964 flood. The estimated peak flow of the standard project flood at the Dos Rios damsite, assuming the storm is centered over the 745 square-mile basin, is 275,000 cubic feet per second as compared to 216,000 cubic feet per second estimated for the flood of record (December 1964). The 96-hour rainfall associated with the standard project flood discharge at Fernbridge is about 23 inches over a drainage area of about 3,600 square miles and over 25 inches for the basin tributary to Dos Rios damsite.

#### 42. PROBABLE MAXIMUM FLOOD

The maximum probable flood identifies hypothetical flood characteristics that are considered to be the most severe reasonably possible at a particular location, based on a comprehensive hydro-meteorological analyses of critical runoff producing precipitation factors favorable for maximum runoff. This flood is derived primarily to establish criteria for spillway design for earth dams. The spillway design flood hydrograph was developed for the proposed Dos Rios Dam on Middle Fork Eel River using unit hydrograph application similar to those used in the standard project flood but incorporating the adopted probable maximum precipitation values. The resulting peak inflow to the reservoir from the 72-hour precipitation of 35.5 inches is 470,000 cubic feet per second. This is a 70 percent greater peak inflow and 50 percent greater rainfall than the adopted standard project flood. Derivation of the spillway design flood is described in Appendix B.

### WATER RELATED PROBLEMS AND NEEDS

#### 43. FLOODS AND EXTENT OF FLOODING

Flooding in the Eel River Basin has posed a severe hazard to the population in the basin and has exerted a major negative effect on the economic growth of the area. Major floods have occurred on the average of once every three to four years during the past 30 years, with two of the highest floods being recorded in December 1955 and 1964. The peak flow of the 1964 record flood was about 840,000 cubic feet per second, or about 40 percent greater than the 600,000 cubic feet per second flow of the previous record flood of 1955. The principal areas subject to flooding are the Eel River Delta from the mouth of Eel River to its confluence with Van Duzen River



Van Duzen River to Dyerville, the South Fork Eel River to upstream of Garberville, the main Eel, Little Lake Valley, Round Valley and the lower portion of Van Duzen River. About 45 square miles of the 80 square miles flooded by the December 1964 flood in this basin are in the Delta Area. Other areas flooded and practically devastated were Pepperwood, Myers Flat, McCann and Weott. The Eel River Delta is one of the major damage areas in the basin. The maximum depth of flooding in the Delta in December 1964 was about ten feet. Examples of the havoc and devastation left behind by the December 1964 record flood are shown in Figures 3, 3A and 4. During the December 1964 flood, the communities of Pepperwood and Myers Flat were completely destroyed, with damages being somewhat less severe at Weott, Shively, Stafford, and Phillippsville; a few buildings were left standing after the flood. Some of the above communities, as well as others that suffered less damage, were completely isolated. One example was the city of Rio Dell, which was cut off from all directions by land routes and from outside telephone communications. The city's electric power, water supply system and sewage treatment plant were also out of service. The damage inflicted to the lumber mills was disastrous. The agricultural areas in the Delta Area in the vicinity of Loleta and Ferndale were left as a sea of mud and slush. Valuable pasture lands were eroded and scoured. Debris also was left scattered over the Delta. Farm buildings and homes were destroyed and livestock losses were high. The dairy industry suffered extensively from livestock losses and building and equipment damages. Subsequent to the flood, the industry was further hampered by not being able to transport dairy products out of the disaster area. The Northwestern Pacific Railroad was damaged severely. Along the 100-mile reach from Rio Dell to Outlet Creek, adjacent to the Eel River, 30 miles of track and roadbed were totally destroyed and three major bridges were lost. Because of the December 1964 flood, service on the railroad from the San Francisco Bay Area to Humboldt County was interrupted for 177 days. Flooding in the Eel Basin has caused great human suffering, hardships, and losses which are not measurable in tangible economic terms. During the 1964 flood, 19 human lives were lost. Intangible losses in the Eel Basin are judged to be of great significance and probably exceed tangible economic losses in terms of social and economic growth.

#### 44. FLOOD DAMAGES SURVEYS

Flood damages are based on data gathered from property owners, industrial, commercial, and utility interests, public officials, representatives of State and county departments and railroads that experienced flood damage. The estimated damages in the Eel River Basin from the December 1964 flood of record, the December 1955 flood, and the January 1953 flood are discussed in subsequent paragraphs.

#### 45. AREAS SUBJECT TO FLOODING

The principal areas subject to flooding affected by the proposed project are designated by reaches. Reach I (Delta Area), from the mouth of the Eel River to the confluence of the Van Duzen River, suffers major losses to agriculture and agricultural products, farm equipment, buildings and farm animals. During the high-stage floods, roads, bridges and railroads are washed out and traffic delays are frequent and prolonged. Reach III (Scotia Area) is from the confluence of the Van Duzen River to Dyerville at the confluence of the South Fork Eel and the Eel River. Damage in this reach is primarily to the lumber industry, urban developments, railroad property and roads and bridges. Substantial damages occur in virtually all categories. Reach V (Alderpoint Area) is from confluence of the South Fork to the town of Alderpoint. The principal damages in this area are to railroad property. Bank erosion caused roadbed subsidence, slides and washout of railroad tracks. Traffic delays are of major proportions. Reach VI (Dos Rios Area) is from the town of Alderpoint to the confluence of the Middle Fork Eel River. Damages in this reach are comparable in kind to those in the Alderpoint Area. Round Valley Reach is located in the Middle Fork Eel River Basin about seven miles northeast of the town of Dos Rios in Mendocino County. It is flooded by waters of several small creeks including Mill, Town, Short and Grist Creeks. Major damages are to industrial facilities and to agriculture.

#### 46. HISTORICAL FLOOD DAMAGES

Flood hazard areas within the Eel River Basin not included in this presentation of historical flood damages are Van Duzen River (Reach II), South Fork Eel River (Reach IV), Outlet Creek, Little Lake Valley and the Eel River upstream from the confluence of the Middle Fork Eel River. Flood plains in these areas are not affected by the proposed project on the Middle Fork presented subsequently in this report. A tabulation of the monetary value of damages in the areas affected by the proposed project, based on 1967 price levels and conditions for the 1953, 1955 and 1964 floods is given below.

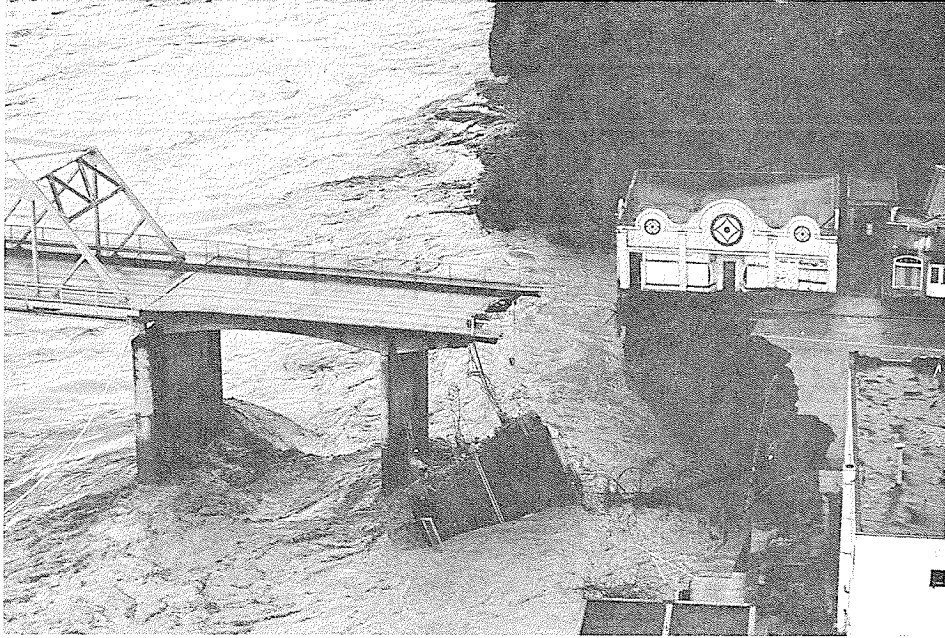


EEL RIVER DELTA AT FERNBRIDGE



COURTESY GILLARD PHOTO

NORTHWESTERN PACIFIC RAILROAD  
AT SCOTIA BLUFFS



COURTESY GILLARD PHOTO

SCOTIA BRIDGE AT RIO DELL



TOWN OF PEPPERWOOD



PHILLIPSVILLE



WEOTT

FIGURE 4

SUMMARY OF HISTORICAL FLOOD DAMAGES  
1967 Prices and Conditions  
(In \$1,000)

Date and Type of Damage	Reach I	Reach II	Reach V	Reach VI	Round Valley	Total
<u>January 1953</u>						
Agricultural	\$ 93	\$10	-	-	\$163	\$266
Roads and bridges	64	7	-	-	-	71
Bank erosion	27	3	-	-	-	30
Total	<u>\$184</u>	<u>\$20</u>			<u>\$163</u>	<u>\$367</u>
<u>December 1955</u>						
Residential	\$ 516	\$ 902	\$ 312	-	-	\$ 1,730
Commercial	449	1,220	781	-	-	2,450
Agricultural	3,950	455	52	-	33	4,490
Public utilities	125	247	130	-	-	502
Roads and bridges	970	706	834	-	-	2,510
Public facilities	-	-	28	-	-	28
Transportation	-	-	-	-	-	-
Emergency aid	950	500	83	67	-	1,600
Railroad	-	1,060	1,030	-	-	2,090
Total	<u>\$6,960</u>	<u>\$5,090</u>	<u>\$3,250</u>	<u>\$ 67</u>	<u>\$ 33</u>	<u>\$15,400</u>
<u>December 1964</u>						
Residential	\$ 412	\$ 2,220	\$ 312	\$ 177	\$ 29	\$ 2,990
Commercial	294	1,030	439	50	17	1,830
Industrial	-	11,500	814	378	608	13,300
Agricultural	8,520	3,690	483	153	254	13,100
Livestock	1,280	190	-	-	-	1,470
Public utilities	104	1,140	156	-	-	1,400
Roads and bridges	911	4,460	849	-	-	6,220
Public facilities	25	100	17	1	1	144
Emergency aid	321	893	216	-	-	1,430
PL/99 assistance	339	-	-	-	-	339
PL/875 assistance	1,040	2,630	631	-	19	4,320
Bank erosion	54	77	23	-	2	157
Railroad	-	2,770	5,830	2,500	-	11,100
Total	<u>\$13,300</u>	<u>\$30,700</u>	<u>\$9,770</u>	<u>\$3,100</u>	<u>\$930</u>	<u>\$57,800</u>

#### 47. RAILROAD DAMAGE

The canyon area of the main Eel River from Rio Dell in Reach III to the confluence of the Middle Fork is subject to major flood damage. The principal damage is to Northwestern Pacific Railroad property and is caused by both inundation and bank erosion. Bank erosion results in roadbed subsidence, slides and washouts of roadbed and tracks. Inundation destroys or damages tracks, roadbed, tunnels and operating facilities. In addition to physical loss, monetary losses due to traffic delays are of major proportions. As a result of the December 1955 flood on Eel River, it is estimated that the Northwestern Pacific Railroad sustained monetary damages of about \$2 million. The Eel River flood of December 1964 caused damages that have required an expenditure of over \$10 million to repair. The December 1964 flood carried away three major bridges, inundated a number of stretches of the railroad right-of-way, and washed away many sections of roadbed, tracks and riprap. As a result of the 1964 flood, service on the railroad was interrupted for the 177-day period from 22 December 1964 to 16 June 1965. Although service on the railroad was restored on 16 June 1965, the service provided was limited in that traffic during daylight hours consisted of work cars and rail cars transporting work crews and construction materials needed to complete rehabilitation and protection of the railroad embankment. Revenue freight moved only during evening and night hours for many days. Analysis of available information on damages caused by erosion of the banks adjacent to the Northwestern Pacific Railroad along the Eel River indicates that the damages include destruction of railroad embankment and loss of revenue to the railroad. At 1967 price levels, the total average annual railroad damages are estimated to be \$540,000. Section 218 of the River and Harbor Act of 1965, Public Law 89-298, 89th Congress, approved 27 October 1965, directed the Secretary of the Army to reimburse any common carrier by railroad for the cost of protective works constructed by such carrier during the years 1965 and 1966 along the banks of the Eel River, California, to deter damage to such banks by floods and high waters. Reimbursement was limited to three million dollars.

#### 48. AVERAGE ANNUAL DAMAGES

Average annual damages were computed for areas affected by the proposed project by standard analysis from correlation of various relations between damages, discharge and frequency of flood occurrence. Curves were developed from these relations and form the basis for estimating the average annual flood damages. The estimates of damages include physical losses to homes, commercial establishments, roads, railroads, bank erosion and utilities; the cost of flood fighting by local people and governmental organizations and agricultural

and business losses resulting from decreased production, sales and earnings. The damages thus obtained were then adjusted to reflect the expected future growth in the flood plains for the period 1980-2080 in the absence of a flood control project. Compilation and analysis of the average annual damages based on June 1967 prices and conditions, and those reflecting future growth are developed in Appendix E and summarized in the following tabulation:

<u>Damage Reach</u>	<u>Average Annual Damages</u>	
	<u>1967 Prices &amp; Conditions</u>	<u>1967 Prices &amp; Future Conditions</u>
REACH I Delta <sup>1/</sup>	\$ 270,000	\$ 357,000
REACH III Scotia	785,000	977,000
REACH V Alderpoint	420,000	454,000
REACH VI Dos Rios	154,000	156,000
ROUND VALLEY REACH	<u>31,000</u>	<u>36,000</u>
TOTAL	\$1,660,000	\$1,980,000

1/ Assumes the authorized Delta levee system is constructed and is providing protection for 600,000 cubic feet per second flow. The system is discussed later in the report.

#### 49. FLOOD PLAIN MANAGEMENT

There is at present limited flood plain management in effect throughout the Eel River Basin. However, a general plan designed to constitute a long-term guide for future land use has been prepared for the Eel River Delta Area. The preparation of the plan was financed in part through an urban planning grant from the U.S. Housing and Home Finance Agency under the provisions of Section 701 of the Housing Act of 1954. This plan was adopted by the Humboldt County Board of Supervisors, the Fortuna City Council, and the Ferndale City Council in early 1967. It is expected that this plan for physical growth and development of the Eel River Delta land area will be implemented by city and county zoning ordinances. This plan has provisions for an effective flood plain management program. The principal designation of land within the historical flood plain is for "Exclusive Agriculture" or "Conservation" for floodway or recreation purposes. The classification of "Exclusive Agriculture" provides for minimum parcels of 20 acres where soils are of good quality for agricultural production purposes and where protection and preservation of such use is desirable and in the public interest. "Conservation-Floodway" classification



provides for designation of channels of rivers and streams, including the areas which carry normal flood waters or the areas between existing or planned levees, dikes or other flood control features. Agricultural and recreational uses are permissible in this classification. "Conservation-Recreation" classification is planned for areas of substantial acreage where natural scenic, historical, geological, vegetation or other features of a recreational nature prevail. Public interest would require preservation for recreational purposes or for passive private use. A study to provide a general plan for land use along the Eel River from the Delta to the Mendocino County boundary is expected to be completed by mid-1968. This general plan is expected to provide similar classifications of land use as prepared for the Delta Area to provide effective flood plain management. This study for a general plan is expected to include the communities of Rio Dell, Scotia, Pepperwood, Weott, Myers Flat, Miranda, Redway and Garberville.

#### 50. WATER SUPPLY (IN-BASIN REQUIREMENTS)

Within the Eel River Basin, present and projected water needs are small when compared with the supplies which are naturally available. At present, water needs are met by utilization of ground water supplies and many small-scale surface diversions. Topography limits potential service areas to the Eel River delta and communities contiguous to it. These communities are Ferndale, Fortuna and Scotia, which presently obtain urban supplies from ground water sources. Municipal and industrial requirements are derived from United States Public Health Service projections and irrigation needs are based upon estimates of the California State Department of Water Resources and the U.S. Bureau of Reclamation. Municipal and industrial requirements in 1960 were about 5,000 acre-feet, and are projected to increase gradually to 95,000 acre-feet by the year 2080. Irrigation in 1960 used about 19,000 acre-feet, all from ground water. These needs increase to a maximum of 38,000 acre-feet in 2000 and thereafter decline gradually to 31,000 acre-feet in 2080. Combined and agricultural uses were about 24,000 acre-feet in 1960 and increases to 126,000 by 2080. The Bureau of Reclamation estimates that the ground water basin can yield 30,000 acre-feet annually on a sustained yield basis. This amount was deducted from the total requirement to indicate supplemental water requirements. In 1960 after supplying municipal and industrial needs and irrigation, there was a surplus of 6,300 acre-feet in the ground water basin. By 1980 the ground water basin will be overdrawn and a supplemental requirement of 9,300 acre-feet must be provided from surface sources. This supplemental requirement increases an average of 15,000 acre-feet and each duo-decade until by 2080 a supplemental flow of 96,000 acre-feet is needed. Maximum in-basin water requirements by 2080 are approximately 135,000 acre-feet. This represents only about two percent of the annual runoff in the basin. Development of the remainder of this supply for export would permit full use of the Middle Fork for multiple-purposes which would have a beneficial stimulus on the economy of the Eel River Basin.

## 51. REGIONAL WATER NEEDS

The rapidly expanding population of the State of California, and the corresponding increase in economic activity, provide good indicators of future trends of needs for water and related resources. On the basis of these indicators, a dramatic increase in regional needs can be expected.

52. In March 1966, the State Department of Water Resources published Bulletin No. 160-66, "Implementation of the California Water Plan." This publication presents analyses, not only of projected water needs up to the year 2020, but also of the need for other allied water resources developments such as flood control, recreation, fish and wildlife and water quality control. It is a comprehensive and excellent source of information covering the entire region represented by the State of California.

53. At present, the State is in the position of having the principal concentrations of population, industry and agriculture situated in the southern three-fourths of its area and the principal untapped potentials for development of water supplies in the northwestern portion which is commonly referred to as the "North Coastal Area." This necessitates not only developing supplies at the sources of water, but of conveying these supplies over relatively long distances to areas of use. In brief, the planning by the State contemplates such a system whereby excess supplies of water in the northern part of the State would be developed and conveyed to water deficient areas in the southern part. This system is discussed later in the report. It is in the north coastal area that the proposed Dos Rios Dam and Reservoir project would be situated. Its construction, therefore, would be in consonance with the State Water Plan as now conceived.

54. Projections by the State indicate a total growth in net water requirements for the entire State from about 23,000,000 acre-feet annually in 1960 to about 38,000,000 by 2020. Of this total, the net water requirements in the north coastal area would have increased from 350,000 acre-feet annually in 1960 to about 1,000,000 in 2020. A summary of gross applied water requirements for the north coast area and for the State as a whole is shown below:

<u>By year and use</u>	<u>Annual requirement in acre-feet annually</u>	
	<u>North Coastal Area</u>	<u>Total for State</u>
<u>1960</u>		
Agricultural	420,000	28,500,000
Urban	20,000	3,300,000
Totals	<u>440,000</u>	<u>31,800,000</u>
<u>1990</u>		
Agricultural	650,000	32,300,000
Urban	170,000	8,500,000
Totals	<u>820,000</u>	<u>40,800,000</u>
<u>2020</u>		
Agricultural	930,000	35,700,000
Urban	320,000	14,000,000
Totals	<u>1,250,000</u>	<u>49,700,000</u>

Since tabulated values represent gross applied amounts, some of this water is recoverable for reuse and, when deducted from applied requirements, results in the overall net requirements as given earlier in this paragraph. By year 2080, gross State applied requirements are expected to exceed 60 million acre-feet annually.

#### 55. WATER QUALITY

In general, the natural waters of the Eel River Basin are of excellent quality. Lack of highly concentrated urban industrial developments and adequate waste treatment precludes discharge of significant amounts of effluents directly into basin streams at the present. Consistent with expected future economic development of the basin and continued adequate treatment of wastes, the U. S. Public Health Service estimated, in 1962, minimum guideline flows that should be maintained during critical low-water periods to provide for acceptable water quality. These flows, in cubic feet per second for the main stem and for the South Fork Eel River are summarized below:

<u>Year</u>	<u>Main Stem</u>		<u>South Fork</u>	
	<u>Miles above mouth</u>	<u>Flow c.f.s.</u>	<u>Miles above main stem</u>	<u>Flow c.f.s.</u>
<u>1960</u>	5	36	20	12
	20	7	50	12
	120	7	100	4
<u>2020</u>	5	156	20	47
	20	14	50	47
	120	14	100	8
<u>2060</u>	5	223	20	64
	20	46	50	64
	120	46	100	10

It is considered that these minimum flows would be adequately met, at least on the main Eel River, by releases made for fish and wildlife purposes as potential projects for developing water resources are realized. Therefore, it is anticipated that, under these conditions, storage for water quality control appears unnecessary in the foreseeable future.

56. With regard to water quality aspects of water diverted from the Eel River Basin, the Federal Water Pollution Control Administration, in cooperation with other agencies having an interest in development of water resources, has underway a continuing study to define the regulation of outflows from the Delta of the Sacramento-San Joaquin Rivers to control water quality in the San Francisco Bay-Delta system. Water storage projects planned or under construction in northern California are related to this Bay-Delta system outflow. The outflow problem involves salinity incursion, fisheries, wildlife and adjacent land development. However, until such time as water quality standards are established for the Bay-Delta system, the need for, or the extent of, storage in reservoirs for water quality control cannot be determined. Such standards would be related to a system of developments and not necessarily to a single project in the system.

#### 57. RECREATION, FISH AND WILDLIFE

Demand for outdoor recreation has been increasing during the last 20 years in California and this experience has been reflected throughout the nation as a whole. The major contributing factors are increased population, leisure time, per capita income and mobility. Based on trends and related factors, a comprehensive review of recreation opportunities in Eel River Basin was made and it is estimated that by the year 2080 a total demand of about 98 million recreation-days

may be expected in the basin. The total demand related to freshwater recreational opportunities is shown below:

<u>Year</u>	<u>Annual Recreation-day Demand</u>
1960	500,000
1980	1,700,000
2000	5,000,000
2020	12,500,000
2040	25,500,000
2060	47,000,000
2080	56,000,000

58. Depending on the type and number of recreational attractions which may be available in the future the composition of local, regional and national visitors will vary. The basin contains some of the world's unique recreational attractions which are expected to be significantly enhanced by any fresh-water-oriented recreational facilities. The possibility of developing a comprehensive outdoor recreation system in the basin incorporating existing natural resources, such as scenery, fishing and hunting, with major water resources developments appears promising. In fact, with time, recreation could become the prominent economic resource of the basin.

59. Enhancement of the fishery resource is an ever-present social desire and any undertaking which would increase the quantity and quality of this resource would be beneficial. Provision for protection and enhancement of aesthetic considerations of the natural environment are in demand now and are expected to be more so in the future.

#### 60. ELECTRIC POWER

Power needs for Federal Power Supply Area 46 are considered to be pertinent to possible hydroelectric power developments in the Eel River Basin. Power Supply Area 46 is composed of the northern half of California, except for a strip at the extreme northern portion, and the northwest quarter of the State of Nevada. Expected power requirements in this market area have been estimated on a preliminary basis by the U.S. Federal Power Commission to be as follows:

<u>Year</u>	<u>Annual Energy Requirements in Million Kilowatt- hours</u>	<u>Annual Peak Demand in Megawatts</u>
1970	63,300	11,400
1975	93,500	16,600
1980	137,000	24,300
1985	200,000	35,600
1990	291,000	52,200

The rate of increase in peak demand somewhat more than doubles during every decade and this trend may be expected to continue beyond 1990. This rapid load-growth imposes requirements for substantial additions to existing power generating capacity. Recent studies by the Federal Power Commission indicate that, in the absence of hydroelectric power projects, future baseload power generating plants, in the range of 40 to 90 percent annual capacity factor, will depend on nuclear energy as the prime power source and that peaking power plants with capacity factors less than about 35 percent will utilize gas-fueled steam-turbines as prime movers. Atmospheric pollution and conservation of stock resources may well favor low values for fossil fuels. Because of these latter considerations, development of hydroelectric power in conjunction with multiple-purpose reservoir projects appears to be a desirable and prudent utilization of water resources developments. Pumped-storage hydroelectric installations appear particularly attractive for their ability to add capacity to the regional power system without being consumptive water users and for improving the overall efficiency of the power system into which they would be incorporated.

#### EXISTING IMPROVEMENTS

##### 61. CORPS OF ENGINEERS IMPROVEMENTS

The Sandy Prairie levee project, authorized by the 1958 Flood Control Act and completed in 1959, provides about 4 miles of levees on the right bank of the Eel River at Sandy Prairie near Fortuna. The Federal first cost of this project was \$679,000 and the non-Federal cost of meeting requirements of local cooperation was \$300,000, including a cash contribution of \$203,000. This project was modified by the 1965 Flood Control Act, which provides for the construction of new levees and modification of existing levees in the Delta Area below mile 15 on the Eel River and below mile 4.1 on the Salt River. The act, also, de-authorized the retards and levee project which was authorized by the Flood Control Act of 1936. Construction has not been initiated for the modified project; however, advance engineering and designs are currently in progress.

##### 62. IMPROVEMENTS BY OTHER FEDERAL AGENCIES

There are no known improvements for flood control or for beneficial uses of water in the basin which have been constructed by other Federal agencies.

##### 63. IMPROVEMENTS BY NON-FEDERAL INTERESTS

Surface water developments by State and local interests in the Eel River Basin consist of four small reservoirs. Benbow reservoir

on the South Fork Eel River, with a storage capacity of about 1,000 acre-feet, is a California State Division of Beaches and Parks recreational facility completed in 1932 at a cost of \$78,000. Morris reservoir on James Creek, with a storage capacity of about 800 acre-feet, is owned by Pacific Gas and Electric Company and serves as a water supply reservoir for the town of Willits. Construction of this reservoir was completed in 1927 at a cost of \$66,000. Van Arsdale reservoir on the upper Eel, with a storage capacity of 700 acre-feet and completed in 1907 at a cost of \$25,000, is a Pacific Gas and Electric Company facility for diverting water to their Potter Valley generation plant and into the East Fork of the Russian River. Scott Dam (Lake Pillsbury) on the upper Eel, with a storage capacity 93,700 acre-feet, is a Pacific Gas and Electric Company reservoir for storage and regulation of releases to the Van Arsdale diversion facility and was completed in 1921 at a cost of about \$2,450,000. Flood control works constructed by local interests consist of about six miles of low levees at the mouth of the Eel River in the lower Salt River delta area. Levee construction authorized by the 1965 Flood Control Act includes raising and enlarging portions of these levees.

#### IMPROVEMENTS DESIRED

##### 64. PUBLIC HEARINGS

Public hearings were held in Willits, California on 24 November 1964, and in Eureka, California on 23 June 1965. The Willits hearing was held to obtain views on overall comprehensive development of the Eel River Basin water resources with emphasis on upper basin developments. The Eureka hearing was held to receive views as an aftermath of the December 1964 flood and was concerned primarily with flood problems on the South Fork and lower Eel River. In attendance were about 50 and 150 persons, respectively, including representatives of interested agencies from Federal, State, county and city governments, in addition to local civic, conservation groups and private companies and landowners. Transcripts of the hearings are on file in the office of the reporting officers including the District Engineer, U.S. Army Engineer District, San Francisco. In addition to these public hearings several public meetings were held during 1965 in areas sustaining heavy losses from the December 1964 flood.

##### 65. JOINT PUBLIC HEARING

A joint Corps of Engineers and California Department of Water Resources public hearing was held in Willits, California on 15 December 1967. The purpose of this hearing was to report on findings of

cooperative studies and investigations and to present to local interests the proposed plan of improvement. In attendance were about 300 persons representing Federal, State, counties, cities, regional and local governments, organizations and groups. Before, during and after the public hearing much interest and controversy on the proposed development was generated.

#### 66. MEETINGS

Numerous meetings with national and regional conservation groups, local organizations and individuals were held in 1967 and 1968 to obtain their views and desires relative to the proposed development of the Middle Fork Eel River. Several meetings were also held with the Round Valley Indian Tribal Council to outline the proposals of the planned development as pertains to the Indians and to solicit their views.

#### 67. IMPROVEMENTS DESIRED AND LOCAL PARTICIPATION

Local interests expressed their desire for early construction of flood protective measures and for comprehensive development of Eel River Basin water and related land resources to include: conservation of Eel River Basin waters to meet future needs in accordance with the State of California Water Plan; provision of storage for control of basin flood waters; and full development of the recreational potential of the Eel River Basin. No major objections were raised to constructing dams on the Eel River during the 1964 and 1965 hearings. At the earlier hearings local interests indicated a favorable attitude toward meeting requirements of local cooperation if acceptable plans could be developed. After the 15 December 1967 hearings local opposition (of tremendous proportions) developed relative to the conveyance route selected for delivery of water out of the basin into the Sacramento-San Joaquin Delta. Opponents of the easterly conveyance route are of the opinion that this route deprives the southerly area of urgently needed water for control of pollution presently plaguing Clear Lake. The State of California, the responsible entity for water supply and the agency that made detailed studies of the conveyance facilities are of the opinion that the easterly route is the more favorable route and has made recommendations that the State finance, construct, maintain and operate this easterly conveyance facility.

68. Numerous counties and local organizations within the North Coastal Area have expressed willingness to cooperate. Opponents led by Lake County Board of Supervisors and Lake County Lions Club, have banded together to oppose the presently selected conveyance route. Mendocino County, the county of origin, has indicated its unwillingness to participate in recreation unless the water supply



beneficiaries offer the county of origin financial assistance toward supporting recreation on a per acre-foot basis for waters derived from the project. In summary, despite the opposition, it is estimated that support of the proposed Middle Fork Eel River development outweighs the opposition by a substantial margin.

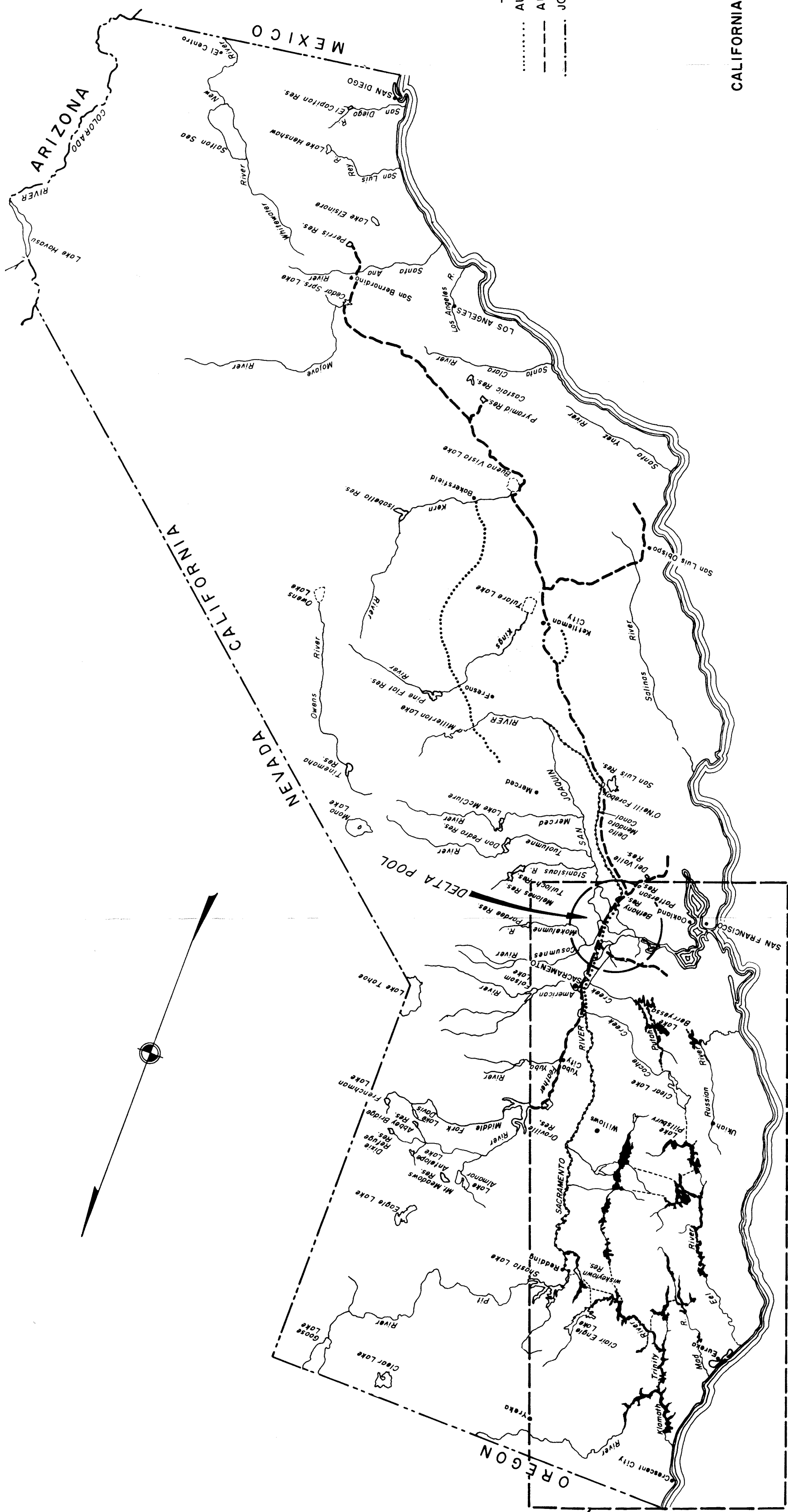
## REGIONAL FRAMEWORK FOR DEVELOPMENT OF CALIFORNIA WATER RESOURCES

### 69. THE CALIFORNIA WATER PLAN

The California Water Plan is a master plan developed to guide and coordinate the planning and construction by all agencies of work required for the control, protection, conservation and distribution of California's water resources for the benefit of all areas of the State and for all beneficial purposes. The California Water Plan envisages the construction of reservoirs, tunnels, conduits, power plants and other facilities to develop the State's water resources to meet local needs and export surplus waters to areas of deficiency. The California Water Plan was developed from the accumulation of decades of collected data and surveys of needs and requirements. The plan anticipates that private enterprises and non-Federal agencies will build those units of the comprehensive plan that fall into their programs and are of sufficient interest to them to warrant their efforts. The comprehensive plan looked to the ultimate future. Some of the projects are in the future, beyond the ability to see plainly all needs and possibilities of satisfying them. By adopting the Water Plan, the State recognized the importance of assuming a leading role in the coordination of its own comprehensive water development and further recognized that the State itself must finance and build some essential elements of the plan.

### 70. THE CALIFORNIA STATE WATER PROJECT

The California Water Plan presented a blueprint for conserving and distributing water from the water-rich north to the arid populous south, so that all water needs within the State could be met for all time. The California State Water Project was the first major step by the State to bring the engineering concept of the Water Plan into reality. The State authorized the construction and operation of facilities to develop further the water resources of California. The State Water Project is shown on Figure 5. The northern and key facility of the State Water Project is Oroville Dam, located on the Feather River and scheduled for completion in 1968. The Oroville Dam is being financed in part by the United States, with the Federal participation being related to flood control. The San Luis Unit, a feature of both the State Water Project and the Federal Central Valley Project, is being financed, built and operated



NORTH COASTAL DEVELOPMENT AREA (SEE FIGURE 5A)

CALIFORNIA WATER RESOURCES DEVELOPMENT SYSTEM

jointly by California and the Federal Government. California is to pay 55 percent and the Federal Government 45 percent of the construction cost because of service areas involved.

#### 71. THE CENTRAL VALLEY PROJECT

The Central Valley Project, originally conceived by the State, was adopted and constructed by the U.S. Bureau of Reclamation. The Federal Central Valley Project is designed to supply water for irrigation and municipal purposes, to provide navigation on the Sacramento River, to provide adequate stream flows to halt sea water intrusion in the Sacramento-San Joaquin River Delta, to control floods in the Central Valley, to generate hydroelectric power, and to serve other purposes such as providing expanded recreation facilities. Major facilities are also indicated on Figure 5. Authorized joint-use with the State Water Project consists of the San Luis Reservoir, a canal from the reservoir to Kettleman City, and the San Joaquin Valley drainage canal. Consideration is being given to the Peripheral Canal, the purpose of which would be to convey fresh water across the Sacramento-San Joaquin Delta to points of exportation, as a joint Federal-State facility. Not shown are the existing Contra Costa Canal in the vicinity of Martinez and the Delta Area, a Kellogg Unit proposal to improve the canal system and a proposal to convey water from San Luis Reservoir in a westerly direction toward Hollister and San Jose.

#### 72. MASTER CONVEYANCE SYSTEM

The master water conveyance route for California is the Central Valley drainage basin, a 50-mile wide area, about 470 miles long from Shasta Lake to 30 miles south of Bakersfield. Within the valley most of the water supply comes via the Sacramento River and its tributaries. The Feather River, tributary of the Sacramento River with the Oroville developments, and the Upper Sacramento River with the Shasta developments, all conveying water via the Sacramento River, make for a combined State-Federal Project operational system. The Sacramento-San Joaquin Delta provides a convenient focal point from which the surplus flows, traveling through the Central Valley drainage basin, can be collected, reregulated and exported to those portions of the State with inadequate local water supplies. The network of reservoirs, powerhouses, conduits, and channels comprising the Central Valley Project-State Water Project system is very complex. Estimating the potential water yield of this system requires complicated operation studies which, in turn, depend on a long chain of supporting water supply studies.

73. The State of California Department of Water Resources conducted electronic computer studies of systems operation to determine estimates

of water yields of the Central Valley-State Water Projects under given conditions of future development, and to show the timing and amounts of water needed to be added to the system to fully satisfy the future projected water demands within the areas of origin and the demands of export water from the Delta. The operation framework is predicated upon the "Delta Pooling Concept" which recognized the Sacramento-San Joaquin Delta as a central point through which surplus Central Valley waters flow and guarantees that "areas of origin," where surplus flows originate, will not be deprived of their supply.

#### 74. THE DELTA POOL CONCEPT

Fundamental to the operation studies were the assumptions that there would be coordinated operation of the Federal Central Valley Project and the State Water Project, and that the two agencies would export water from the Delta only after upstream requirements have been satisfied. Additional facilities would be constructed when total demands for water from the State Water Project and the Central Valley Project exceed the yields available to projects from the Delta. The purpose of the coordinated operation of the system was to combine the production of projects in a system to obtain the greatest yield and optimum output from the two projects. It was determined from the operation studies that the State Water Project facilities and its annual dependable water supplies would be adequate until about 1985. Additional water supplies and conveyance facilities would be needed after 1985, and water demands would continue to expand even after that date. Under the "Delta Pooling Concept," as utilized surplus flows are gradually diminished by future developments within the areas of origin, additional facilities would be constructed in Northern California to maintain project delivery concepts. This "Pooling" concept permits a single rate, for water used above or exported from the Delta, to be charged in recovering cost of conservation facilities necessary to develop project supply.

75. The results of the operation studies indicated the service areas expected for the State Water Project and Central Valley Project would require about 21 million acre-feet of water by year 2020. Study of existing, underway and authorized projects indicated that about 17 million acre-feet could be available by 1970. Consideration of "areas of origin" demand for future water showed that the total shortage of water in year 2020 should be estimated at six million acre-feet. Estimates also indicated that between 1980 and 1990 additional water conservation facilities would be required to meet demand. A recent opinion rendered by the U.S. Supreme Court on use of Colorado River water by the State of California required major reconsideration of future State water needs and contributed significantly toward future projected water demands.

## 76. FUTURE FACILITIES REQUIRED FOR WATER SUPPLY

The large quantities of water required to meet expected future water supply needs could be met only by water developments in the North Coastal Area of California (see Figure 5A), even after consideration of an advance state-of-art in desalinization. Thus, further studies of the Mad River, Eel River and Klamath River basins were undertaken. A seven-year study of the area was conducted by the California Department of Water Resources, and the Upper Eel River Development was authorized by the State as the next additional facility for the State Water Project. Response to Congressional Resolutions cited in the first paragraph of this report is directly related to the State authorization and has led to an integrated study by Federal and State agencies.

## POTENTIAL BASIN WATER RESOURCES DEVELOPMENT

### 77. GENERAL

The objective of studies for the development of the water and related resources in the Eel River Basin was to consider all factors in developing the best and most timely and practicable plan to meet present and foreseeable water resource needs of the basin and the State. As indicated in the previous paragraphs concerning "Needs and Problems," development is needed now and in the foreseeable future for flood control, water supply, recreation and power. The following standards were considered in formulating a project to meet these needs: (1) provide a practical and economic solution; (2) assure benefits at least equal to the cost of including that purpose in the multiple-purpose project; (3) total evaluated benefits must exceed total project economic costs; (4) there is no more economical means, evaluated on a comparable basis of accomplishing the same purpose, which would be precluded if the plan were undertaken; and (5) where other considerations do not limit scale of development, the plan to be selected should provide a maximum excess of net benefits over costs.

### 78. PROJECTS CONSIDERED

To meet adequately the needs previously outlined and to determine the most feasible Eel River Basin plan of improvement to serve these needs, several projects were considered. They are as follows:

#### a. Lower Eel River Projects:

- (1) Authorized Delta Levees
- (2) Sequoia Multiple-Purpose Dam & Reservoir

(3) Yellow Jacket Dam and Upper Sequoia Reservoir Multiple-Purpose Project

(4) Bells Springs Multiple-Purpose Dam & Reservoir

b. South Fork Eel River Projects:

(1) Branscomb Multiple-Purpose Dam & Reservoir

(2) Streeter Multiple-Purpose Dam & Reservoir

(3) Local Protection Works at Weott, Myers Flat and Pepperwood

c. Upper Eel River Project:

(1) English Ridge Multiple-Purpose Dam & Reservoir

d. Middle Fork Eel River Projects:

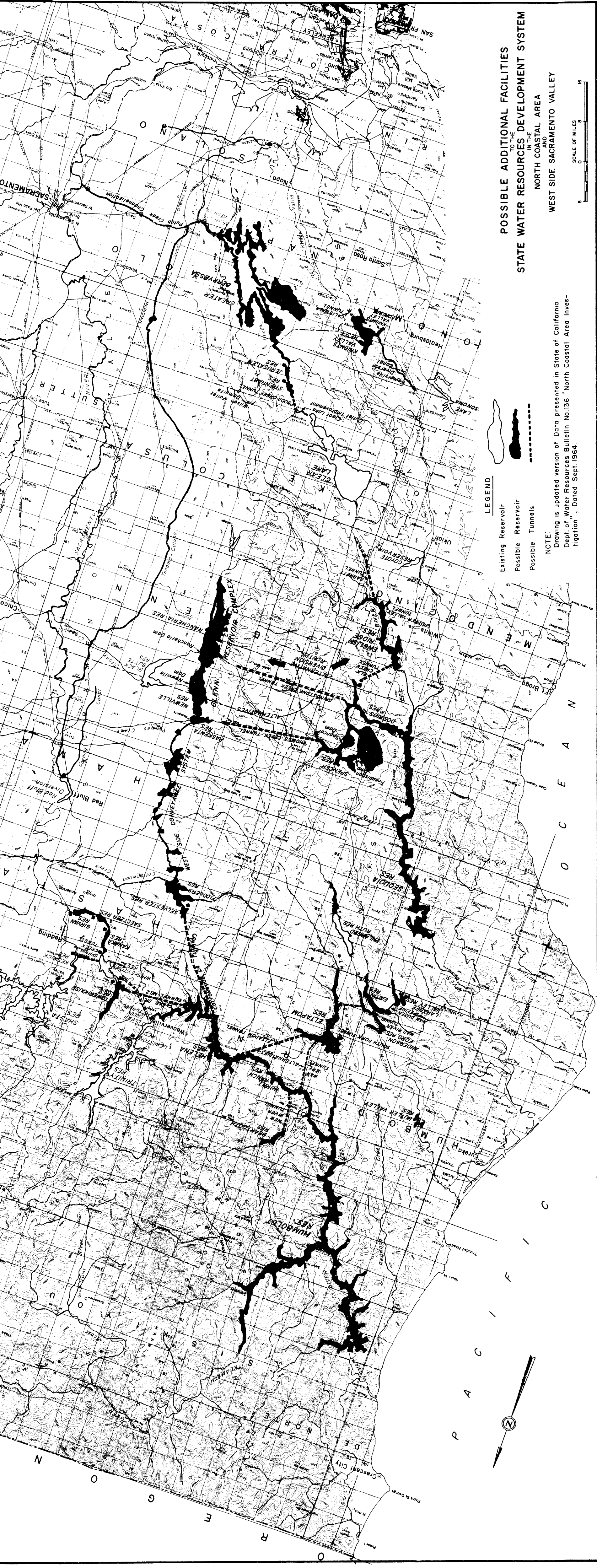
(1) Spencer-Franciscan Multiple-Purpose Dams & Reservoir

(2) Etsel-Franciscan Multiple-Purpose Dams & Reservoir

(3) Jarbow Multiple-Purpose Dam & Reservoir

(4) Dos Rios Multiple-Purpose Dam & Reservoir

79. Combinations of various multiple-purpose dams and reservoirs mentioned above were also studied and considered in the project formulation schemes. House Document No. 234, 89th Congress, 1st Session, the first interim report on the Eel River Basin, California, water resources development, summarizes the potential projects, their contemplated system of operation, and their relationship to the California Water Plan. These studies indicated that with initial development of reservoirs in the headwaters of the basin, comprehensive development of the water resources would produce about three million acre-feet of water to meet future economic needs of which about 80 percent would be exported to water deficient areas without adversely affecting the future economy of the basin. Appendix F of this report discusses in detail the potential and alternative projects cited and Plate 2 of this report shows project locations. Project formulation studies of the Eel River Basin showed that local flood protection works must augment reservoirs for ultimate Eel River Basin development. House Document No. 234 demonstrated the need for levees in the lower reaches of the Eel River Basin. Analyses in this report indicated the Dos Rios Project as the next project that should be developed in the Basin.



**POSSIBLE ADDITIONAL FACILITIES  
TO THE  
STATE WATER RESOURCES DEVELOPMENT SYSTEM  
IN THE  
NORTH COASTAL AREA  
AND  
WEST SIDE SACRAMENTO VALLEY**

NOTE:  
Drawing is updated version of Data presented in State of California  
Dept. of Water Resources Bulletin No. 136 "North Coastal Area Invest-  
igation", Dated Sept. 1964.

## 80. SELECTION OF INITIAL RESERVOIR PROJECT

After publication of House Document No. 234, extensive studies of reservoirs and conveyance systems for exporting water from the headwaters of the Eel River were undertaken by the joint California State-Federal Interagency Group. Conclusions resulting from these studies and investigations were:

a. The first conveyance system for export water from the Upper Eel River Basin should be via an east-west gravity tunnel to the Sacramento River Basin.

b. A large Dos Rios Dam and Reservoir should be developed including the Round Valley area, with flood control, water supply, hydroelectric power and recreation as project purposes.

c. Development of potential English Ridge Dam and Reservoir is not precluded by the Dos Rios Project development.

d. Investigation of Yellow Jacket Dam and Upper Sequoia Reservoir should continue and the determination made of its order of priority for meeting future water requirements of the State of California. All studies indicate and conclude that initial development should be on the Middle Fork Eel River. The Dos Rios Project was selected as having the most favorable capability of meeting the water resources needs of the area compared to the potential projects.

## PLAN FORMULATION - DOS RIOS PROJECT

### 81. GENERAL

The principal purpose for developing the water resources in the Eel River Basin is to satisfy present and future human needs and desires in the Basin, region and Nation in a manner consistent with economic growth and economic efficiency policy objectives. The guiding principles used in plan formulation are: (a) the goods and service which may be provided by any development have value limited by the extent that there will be a need and demand for the product; (b) the overall plan should include consideration of all types of water and related needs which it is capable of producing and provide a product mix which meets the criterion of (a) above with the least investment; (c) that the scale of development and allocation to purposes is such as to provide maximum excess of benefits over costs, taking into account the other formulation principles and incorporating the weight of intangible values; and (d) the plan of development be such as to permit the optimum utilization of the resources of the host basin when and if need for their utilization arises. All of the above



principles, goals, and objectives were used in formulating the proposed plan of development. The time period of economic analysis used in this study was 1980-2080, or 100 years after estimated time of project completion, and an interest rate of three and one-quarter percent was used in computations involving values related to time.

## 82. FLOOD CONTROL

Formulation of the flood control plan was based upon maximization of net tangible benefits. Adjustments, however, were made to take into account other tangible and intangible values. The authorized Federal Delta Levee Flood Control Project was considered in combination with various reservoirs. A multitude of flood control systems was analyzed in search of a combination that would provide maximum benefits and afford a high degree of protection. It was found that flood control storage in the proposed multi-purpose Dos Rios Unit is less expensive than similar storage in all other major reservoirs in the basin. The Middle Fork Eel River contributes about 17 percent of the total annual runoff of the Eel River Basin and somewhat more than 20 percent of the flood flows while draining about 21 percent of the Basin drainage area. In addition to the favorably low cost of flood control storage, the Dos Rios project was found to be capable of providing effective control of flood flows. It was determined that a reservation of 600,000 acre-feet of flood control storage in the reservoir in conjunction with surcharge storage and a Delta Levee system designed to contain a flow in the magnitude of 600,000 cubic feet per second would provide an optimum measure of control against flood flows of the magnitude of the flood of record, that of December 1964, of 840,000 cubic feet per second. Additional flood protection up to standard project flood could be provided optimally by a major Lower Eel Unit upstream of the Delta Area or in combination with flood control storage being included in other possible Upper Eel developments.

83. The authorized Delta levees of the Lower Eel River, recommended for construction in House Document No. 234, were designed to provide a channel and floodway capacity which would be approximately equal to the peak discharge of the December 1955 flood, the maximum of record at that time. However, the December 1964 flood peak of 840,000 cubic feet per second at Fernbridge exceeded the previous historical flood of record by an appreciable amount. The standard project flood peak, as presently determined, is 920,000 cubic feet per second in the Delta Area. Advance planning studies to date for the authorized levee project indicate that it would not be prudent to provide flood protection for any flow less than the 1964 historical flood and that this degree of protection can be accomplished in the most economical manner by a combination of levees and flood control storage in a reservoir on the Lower Eel River or in the proposed Dos Rios and potential English Ridge reservoirs, the latter presently

under study by the U.S. Bureau of Reclamation. The effect of the Dos Rios reservoir would be to reduce the December 1964 discharge of 840,000 cubic feet per second in the Delta to 650,000 cubic feet per second. With English Ridge the peak would be further reduced to 580,000 cubic feet per second. The combined effect of the two reservoirs would reduce the standard project flood from 920,000 cubic feet per second to 620,000 cubic feet per second. It was found, also, that the costs for levees in the Delta increased rapidly for design flows much above 600,000 cubic feet per second because of required relocations of a main highway and a railroad and, therefore, the design flow should be of the general magnitude of 600,000 cubic feet per second.

#### 84. WATER SUPPLY

Determination of the water supply storage allocation was dependent on several factors. The most important of these are: (a) In-basin releases for fish mitigation and other purpose; (b) the availability of water; and (c) the water supply demand schedule and the nature of the water supply system in which the project will operate. Related factors to be considered are the cost of facilities needed to produce specific water supply yields and the value of water in its various uses.

a. In-basin releases. In order to provide for mitigative measures to preserve the fishery value of Eel River which would otherwise be affected by construction of Dos Rios reservoir, the U.S. Fish and Wildlife Service advised a schedule of releases from the dam. This schedule, which was adopted for purposes of this report, provides for the following:

<u>Period</u>	<u>Release from Dam</u> (Cubic feet per second)
1 October - 31 May	350
1 June - 30 September	200

These releases are equivalent to an average annual flow of approximately 300 cubic feet per second, or 217,000 acre-feet per year. All references to firm yields in the discussions which follow are the net amounts over and above the adopted releases for fish mitigation.

b. Availability of water. The average annual runoff from the Middle Fork Eel River above the proposed Dos Rios damsite is approximately 1,000,000 acre-feet. According to the presently adopted schedule for fish mitigation releases, a little over 200,000 acre-feet would not be available annually for out-of-basin exportation. The estimated amount of water which could be exported on an annual firm

yield basis would be in the magnitude of 600,000 to 700,000 acre-feet annually after consideration is given to the losses from evaporation and other causes and to economics of capturing remaining runoff involving control of runoff from flood-producing storms.

c. Water supply demand schedule. Water exported from the Dos Rios Reservoir would be transported by means of tunnels and other conveyance facilities to the Sacramento-San Joaquin Delta and become part of the Delta Pool. Under such a concept, any unregulated and excess flows to the Delta could form part of the available runoff in establishing the firm yield of supplemental water which could be developed by the Dos Rios project. In the initial absence of more detailed analyses, computations of firm yield were made on the basis of several assumptions. In all of these and, as described in more detail in Appendix B, Hydrology and Hydraulics, water was assumed to be exported from the reservoir during a 5-month dry period of each year. For active storage of 5,000,000 acre-feet, varying values of yield were obtained depending on the percentage of demand during normal years that could be met from other sources. The yield as measured at the Sacramento-San Joaquin Delta Pool is 900,000 acre-feet, assuming 50 percent of the demand during normal years can be met from other sources. The results of a recent analysis based on a more detailed study by the State of California of Delta Pool inflows, outflows and diversions, confirmed the 900,000 acre-feet yield obtained by the more approximate method. This yield value has been adopted for this report as representing the amount of supplementary water which can be developed in the Delta Pool from 5,000,000 acre-feet of active storage in Dos Rios reservoir. The 900,000 acre-feet reflects essentially the expected "area-of-origin" demands between 1985 and 2035 which affect delivery capabilities of the State Water Project. Any water supply schedule must reserve about 7,000 to 10,000 acre-feet annually for lands and developments within and adjacent to the project area.

#### 85. WATER QUALITY

It is estimated that about 18,000 acre-feet of water annually could be required by year 2080 for releases related to water quality. Available information indicates the need would start in year 2000 and gradually increase to the 2080 estimate. This amount represents about eight percent of required fish releases. Since all indications are that water quality releases are for the preservation of beneficial uses related to the fishery, allocation of fish release values against a water quality purpose is not considered appropriate.

#### 86. RECREATION

Formulation of the recreation plan was governed by the expected high projected demand and the availability of project related resources.

The water supply formulation established a relatively large reservoir pool which became the basis for developing the recreation plan. The potential for recreation use has been estimated at 7,000,000 recreation-days by the end of the adopted 100-year project economic life. About 2,000,000 of these recreation-days could be accommodated by the proposed relocated Indian community development. Area potential and project features combine to make the development of the site as a National Recreation Area appear desirable, but inclusion of recreation as a project purpose is being pursued, herein, under the provisions of the Federal Water Project Recreation Act of 1965.

87. There is a major access constraint on the potential of recreational development approaching full realization. The existing roads leading to the project area are inadequate for providing necessary access except for a very limited number of recreationists. A new State Route 261 is currently being planned from the Sacramento Valley, westerly through the project area and thence further, west to U.S. Highway No. 101. This road is scheduled for completion prior to expected beginning of project operation. It is estimated that the new road will permit a recreation attendance of two million visitor-days annually. Further access improvements would entail multi-million dollars in road expenditures.

88. It is estimated that one million of the two million visitor-day access capacity would be related and accommodated by Indian community development as a mitigative measure in providing a substitute economy and, therefore, the remaining one million visitor-day capacity should be provided for by a recreational project purpose. Full utilization of both Indian development and recreational purpose facilities is estimated to occur within ten years after start of project operation.

89. In order not to foreclose the possibility of additional recreation development in the future should further improvements in access to the area are made for one reason or another, all the lands required for ultimate recreation facilities would be purchased at time of project construction and held in reserve in accordance with provisions in the 1965 Recreation Act. Appendix D, "Recreation and Fish and Wildlife" contains the details on potential plans for recreation.

#### 90. FISH AND WILDLIFE

In planning for water resource development in the basin, facilities for fish and wildlife were provided to the maximum extent practicable for satisfying the enhancement potential and protecting and conserving the fish and wildlife resource. The proposals of the U.S. Fish and Wildlife Service and the California Department of Fish and Game have been given full consideration under the Fish and Wildlife Coordination Act. Measures to mitigate losses to this natural resource have been

included in analyses made in connection with this report. Studies indicate that neither of these resources could be enhanced by integral facilities. Without enhancement by integral facilities it is concluded that fish and wildlife conservation and development should not be a project purpose.

#### 91. EXISTING FISHERY

The U.S. Fish and Wildlife Service and the California Department of Fish and Game concurrently studied the effects of the proposed improvements on fish and wildlife resources in the basin watershed. These two agencies indicate that the Eel River supports large populations of coho and fall-run Chinook salmon, steelhead trout, and lesser populations of American shad, brown bullhead, cutthroat trout, green sturgeon, green sunfish, suckers and Pacific lamprey. An estimated annual average of 13,000 fall-run Chinook salmon and 23,000 steelhead trout spawn in the Middle Fork Eel River and tributaries upstream from the Dos Rios damsite. It is estimated that these resources support an average annual 46,500 angler-day use, a commercial salmon catch of 394,000 pounds annually, and a 1,000 pound annual catch of Chinook salmon and steelhead trout by the Indian community.

#### 92. EXISTING WILDLIFE

The proposed development area is reported to be used by large numbers of game animals, lesser numbers of furbearers and waterfowl, and numerous nongame wildlife. Wildlife such as black bears, resident and migratory herds of deer comprise the big game sector. It is estimated that the area supports about 270,000 deer-days annually, with an average annual hunter use of 10,500 hunter-days. The average annual hunter use for black bears are estimated to be about 320 hunter-days. Upland game such as pigeons, grouse, quail, doves, pheasants, squirrels and rabbits also inhabit the area. The average annual hunter use for upland game is estimated to be about 2,500 hunter-days.

#### 93. MITIGATIVE MEASURES

The U.S. Fish and Wildlife Service claim that construction of a dam at the Dos Rios site would block passage of anadromous fish, and destroy about 90 percent of the fishery resource. In order to minimize possible adverse effects of the reservoir project on this resource, mitigative measures, and the costs for providing these measures, have been included as features of the project. The mitigative measures would consist of a hatchery and related structures to maintain the Chinook salmon and steelhead trout runs; augmentation of stream flow through releases from the water supply pool, totaling about 217,000 acre-feet annually; provide multiple-level outlets for

quality and temperature control; and strips of land along the reach between the dam and the confluence of the Middle Fork and the main Eel River for fishery management and public access.

94. The principal wildlife forms which would be affected by the proposed project are the resident and migratory herds of deer and game and upland fowl which utilize the reservoir area. The fish and wildlife agency estimates that 16,000 acres acquired and managed for wildlife purposes would compensate for the loss of game habitat. It is proposed that acquirement of 16,000 acres at the southeast portion of the reservoir adjoining the east side of the Elk Creek arm would be suitable for this purpose. Preparation would consist of fencing certain areas to preclude grazing by domestic and Federal livestock, development of springs and construction of rudimentary access roads and trails. The wildlife area would be managed by the California Department of Fish and Game. That department would initiate and maintain wildlife developments in accordance with a program developed cooperatively with the Bureau of Sport Fisheries and Wildlife. Coordination and finalization of fish and wildlife requirements would be continued through the advance design and construction stages in accordance with existing policies.

#### 95. INDIAN COMMUNITY

Fullest consideration has been given to procedures which might be taken to mitigate any adverse impact the proposed Dos Rios Reservoir project would have on Indian interests and economy. The problem is significant, as about two thousand acres of Indian land and the future of about 350 Indian residents are directly involved. To indicate the scope of the problem and permit a reasonable introduction of it into this report, a rationale for solution has been adopted which is considered to permit evaluation comparable to other proposed project features and, more important, give a starting basis for further concept consideration.

96. To compensate for loss of relatively flat land taken, an exchange of two acres of hilly land for each acre of land taken would be made. This ratio would not provide the same amount of similar terrain, which is not possible, but would tend to compensate for quality reduction in soil available for family production to be used within the family group. Site preparation to exchanged lands would include water, sanitation, and power facilities plus road access. Onsite improvements would be provided by individuals as existing displaced improvements would be purchased. Non-resident services now being used, such as schooling, medical and commercial outlets, would be provided by the proposed relocated town of Covelo which is discussed under the Plan of Improvement.

97. Replacement of disturbed Indian economy is conceived as being centered around utilization of the reservoir attributes created by the proposed project. Exchanged lands would be obtained to provide a solid and continuous area of Indian development along the north edge of Round Valley. The western end of such development would be centered around recreation and Indian cultural history and related industry. Estimates of this type of development are predicated upon providing recreation facilities for one million recreation-days annually which is one-half of the estimated recreation pressure which has been adopted considering project access limitations on foreseeable roads.

#### 98. HYDROELECTRIC POWER

The possibility of developing hydropower with export water was considered. Major rates of diversions, however, are expected to be made during only a part of each year. Depending upon the pattern of regulation to provide the estimated yield from the Dos Rios project as measured in the Sacramento-San Joaquin Delta Pool, it is possible that in many years only minor amounts of water will need to be exported through the conveyance tunnel to the Sacramento River Basin. The flow for power development, therefore, would not be dependable without the inclusion of a relatively large afterbay for reregulation for water supply requirements which could extend over a period of several years. A whole system of large reservoirs in the afterbay area is currently under consideration by various Federal and State agencies. The scope of development as well as the time of need is yet to be established, but it is anticipated that a minimum of twenty years will elapse after completion of the Dos Rios project before these other developments would be constructed. It is concluded, therefore, that potential hydropower development utilizing exportation flow should properly be a feature to be considered during the plan formulation of these possible future developments in the afterbay area.

99. The possibility of developing pumped storage hydroelectric power generation was also investigated. The high cost for constructing an afterbay in the main Eel River downstream from the junction with the Middle Fork for power, alone, would not make such a development economically feasible. As mentioned earlier, planning is continuing for possible development of other reservoir projects on the main Eel River for multiple-purposes, including exportation of water, flood control, recreation and power, but the determination of the timing of such development is still subject to detailed formulation studies. It is considered, therefore, that pumped storage hydroelectric generation is more closely allied with the main Eel River developments and should be evaluated in connection with the project formulation being made in connection therewith. Studies thus indicated

that except for capacities which would utilize the flow released as fish mitigation measures, the inclusion of hydropower as a project purpose could not be economically justified.

100. Minimum releases for fish are one of the project features and the possibility of utilizing these flows to operate a hydropower plant was also given consideration. In this case, the power developed would depend entirely upon the releases for fish with no withdrawals from storage specifically for power purposes. In effect, the power plant would be simply inserted into the fish water release system and would utilize available flow and head. Studies were made to establish optimum capacity utilizing available flows and head. In cases where peaking capacity was considered, high added costs for necessary afterbay storage and enlargement of conduits leading to the powerhouse made these proposals economically unfavorable. Installation of capacity sufficient only to provide for utilization of the 350 cubic feet per second releases for part of the year and 200 cubic feet per second for the remainder as a base load station proved to be only marginally economically justified. As a result of these studies, the conclusion was reached that a base load plant, operating under a discharge of 200 cubic feet per second and a head of 340 feet, is the optimum development that can be justified on an incremental basis to utilize fish releases. This would result in a plant capacity of 4,800 kilowatts operating year-round at full capacity.

#### 101. SEDIMENTATION

Preliminary estimates for the Middle Fork Eel River indicate that the average annual loss of storage resulting from deposition of sediment would be about two acre-feet per square mile. Storage depletion during an assumed 100-year economic life would amount to about 150,000 acre-feet, or about two percent of the initial gross storage. In addition to the storage reserved for suspended sediment, consideration was given to the loss of storage from possible landslides. It is estimated that 500,000 acre-feet of material constitutes a slide potential, of which 50 percent would occur at elevations within the inactive pool. Thus, the total possible deposition from the above two sources is small when compared to the total reservoir capacity and it is assumed that all of the material would be deposited within the inactive pool.

#### 102. MINIMUM POOL

The storage in the minimum pool for the Dos Rios Project must consider several factors both physical and economic. These factors are: sedimentation, fishery, recreation, relocated developments, aesthetics, and the export conveyance system. Under planning concepts adopted, sedimentation and slide potential require 500,000 acre-feet.



A self-sustaining reservoir fishery, important to recreation and Indian interests, is estimated to require a minimum water surface at about 10,000 to 15,000 acres of water surface or a minimum pool containing about one million acre-feet. Analyses of the frequency of exposure of reservoir-bottom land and remoteness of water limits to recreation and Indian land developments indicated a desirable minimum pool of about 1.75 million acre-feet.

103. The conveyance tunnel relates to the minimum pool through length and diameter factors to meet elevation and discharge requirements, respectively. Studies of tunnel costs and diameters showed that one mile of length would cost from five to ten million dollars and a one-foot change in diameter over a minimum 20-mile length would cost about seven million dollars. Hydraulic studies indicated the most favorable combinations of tunnel size and length to economically deliver export water. A tunnel invert elevation of 1,405 and 1,221 feet mean sea level is required at the reservoir portal and exit portal, respectively. The reservoir elevation at 1,405 feet, mean sea level, indicates a storage capacity of about 1.5 million acre-feet. To insure favorable hydraulic entrance conditions the bottom of the water supply pool was placed at elevation 1,425 feet mean sea level, indicating a desirable minimum pool of two million acre-feet.

104. Consideration of findings related to sedimentation, fishery, recreation, relocation, aesthetics and the conveyance tunnel resulted in adopting a minimum pool of two million acre-feet in combination with a 17-foot diameter tunnel.

#### PLAN OF IMPROVEMENT

##### 105. GENERAL

The plan of improvement, proposed in this report, consists of a multiple-purpose dam and reservoir for flood control, water supply, recreation and hydroelectric power to be located on the Middle Fork Eel River about three miles upstream of the community of Dos Rios. At this location the dam would control runoff from about 745 square miles, which is approximately 21 percent of the Eel River drainage basin. General features of the basin are shown on Plate 1. A transbasin conveyance tunnel about twenty-one miles long and seventeen feet in diameter would be required to divert water eastward into the Sacramento Valley where the water would be incorporated in the California State Water Project. A complex of recreational facilities to include camping, picnicking, swimming, boat-launching facilities, a historical Indian archives center, and monuments and other features would be included as part of plan of development.

#### 106. RESERVOIR

The proposed Dos Rios dam would form a reservoir on the Middle Fork Eel River having a water surface area of about 40,000 acres and a capacity of 7,600,000 acre-feet at elevation 1,602, the top of the flood control pool. The body of the reservoir would include the Round Valley and Williams Valley areas and arms of the Middle Fork Eel River extending up Salt Creek, Elk Creek, Thatcher Creek, Poor Mans Creek, Murphy Creek and Black Butte River. The reservoir area is shown on Plate 3. The proposed reservoir capacity would be distributed as follows:

Flood control pool	600,000 acre-feet
Water supply, recreation & power pool	5,000,000
Minimum pool including silt and landslide reservation	<u>2,000,000</u>
Total	7,600,000 acre-feet

#### 107. SOURCES OF CONSTRUCTION MATERIALS

Adequate supplies of suitable materials for use in construction of the dam are available within a haul of approximately two miles. For the embankment, impervious materials for the core element would be obtained from an explored source two miles northeast of the dam-site. Pervious sands and gravels are available from streambed sources or by crushing the sandstone from the rock sources. Concrete aggregate for the appurtenant structures could be obtained from the stream channel excavation in the foundation area of the damsite. However, the channel deposits are coarse, consisting of poorly-graded rounded gravels, cobbles and boulders, indicating considerable crushing and processing may be necessary. Adequate supplies of suitable rock for use as riprap are available from several sources within approximately one mile of the damsite. Additional information relative to construction materials is contained in Appendix C.

#### 108. DAM

At the crest the dam would have an elevation of 1,650 feet above mean sea level, a length of about 2,100 feet and a maximum height of 730 feet above the streambed. The axis of the dam would curve upstream on a radius of 4,000 feet, the top width of the dam would be 30 feet and the average upstream and downstream slopes would be one vertical on 2.5 horizontal. Except for an impervious core element, the dam would be constructed of various zones of rolled rockfill grading from finer rock near the core to a maximum size of 24 inches on the outer slopes. The immediate damsite area

(see Figure 6) would be stripped of all overburden materials, allowing the dam to rest on a foundation of sound rock. The foundation of the dam would be grouted along the axis. Drainage tunnels would be provided for drainage of seepage passing through or around the grout curtain. The tunnels would be located in both abutments and would be driven parallel to the dam axis just downstream from the downstream transition section of the embankment. The plan, typical dam section, appurtenant works and their profiles are shown on Plate 4.

#### 109. CONSTRUCTION DIVERSION TUNNEL

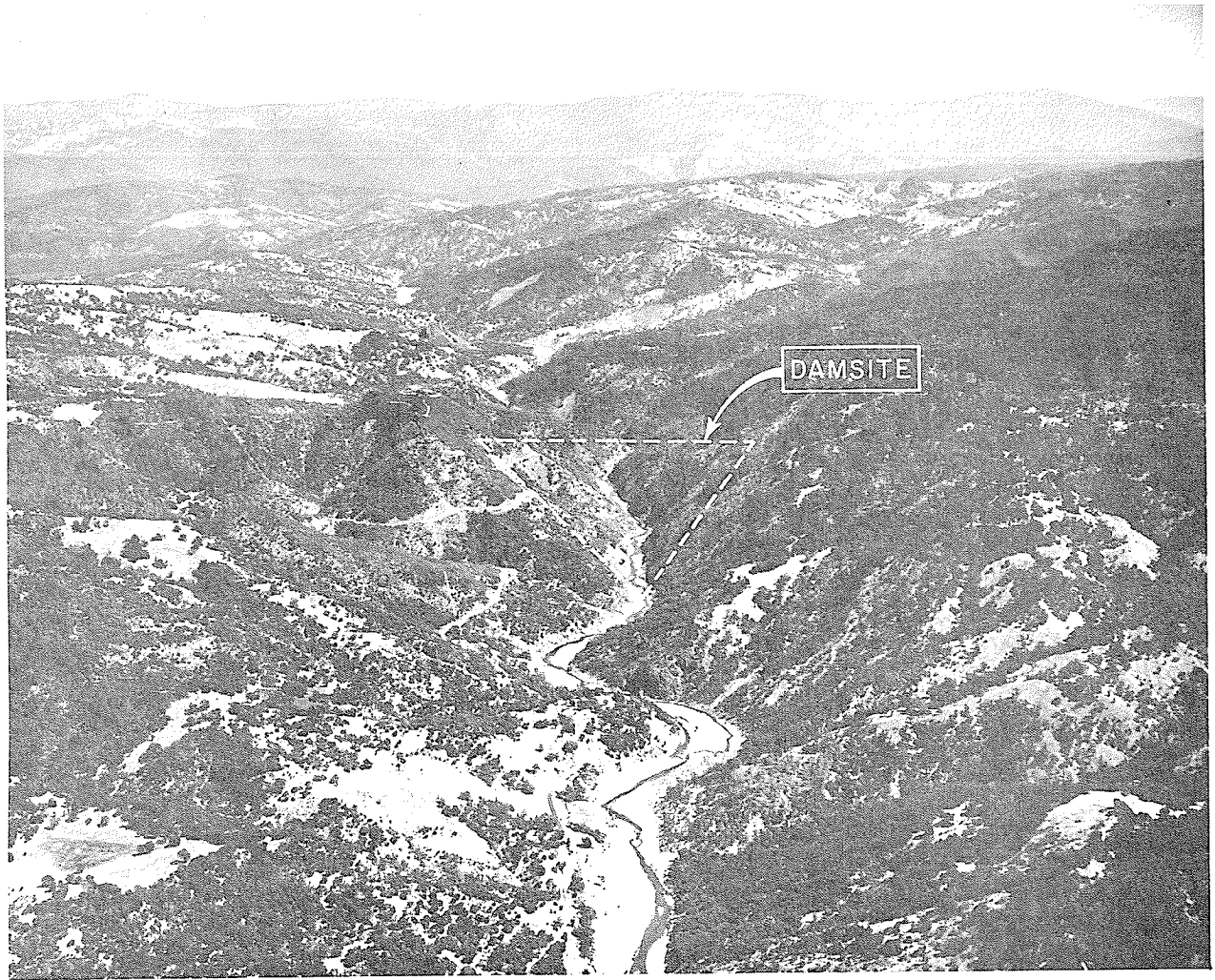
Diversion of the river during the construction period would be provided for by a diversion tunnel, 50 feet in diameter, located in the left abutment. It would be about 4,500 feet long and would discharge into the spillway stilling basin downstream from the toe of the dam. The inlet elevation would be at 940 and the outlet elevation would be at 925. The plan and profile of tunnel and emergency outlet are shown on Plate 4.

#### 110. SPILLWAY

The spillway would be located in the left abutment approximately 1,000 feet upstream from the dam axis. The spillway would consist of a gated, side channel structure which would discharge into a sloping tunnel, 50 feet in diameter, which joins the diversion tunnel. Downstream discharge would be from the diversion tunnel with a stilling basin located about 400 feet below the downstream toe of the dam. The spillway crest structure would be a concrete ogee section, and flood control releases would be regulated through the spillway by three tainter gates, 30 feet wide and 44 feet high.

#### 111. OUTLET WORKS.

Water for fishery needs and downstream flow regulation would be controlled by means of a concrete inlet structure constructed on the steep slope of the left abutment near the entrance of the proposed spillway. This structure would contain four inlets located at various elevations to provide temperature and turbidity control, and flexibility of operation. Flow control would be accomplished by four pairs of gates with stoplogs for emergency repairs. The outlet tunnel downstream from the gate chamber would emerge along the left abutment at the downstream toe of the dam and flow into the power plant. From the power plant afterbay water could be discharged to the stream below, or conveyed in a surface pipe to the fish hatchery. A general layout of the outlet works structure and tunnel is shown on Plate 4.



DOS RIOS DAMSITE

#### 112. EMERGENCY DRAINAGE STRUCTURE

A low level outlet system would be provided to permit draining the reservoir in the event of an emergency. This system would consist of three eight-foot diameter conduits, with high pressure gates, that would be placed in the concrete plug in the diversion tunnel after construction of the dam and spillway. The releases would flow through the combined diversion and spillway tunnel to the stilling basin. The capacity of the emergency outlets, in conjunction with the other outlets, would be sufficient to drain the reservoir in about two months.

#### 113. GRINDSTONE DIVERSION TUNNEL

Water from the proposed Dos Rios Reservoir would be diverted eastward to the Sacramento Valley via the Grindstone Tunnel and incorporated into the California State Water Project. The tunnel would be gravity flow, concrete-lined, having a diameter of 17 feet and a length of 21 miles. The tunnel intake and outlet elevations would be at 1,405 feet and 1,221 feet above mean sea level, respectively. Flow through the tunnel would normally be from 2,000 to 3,000 cubic feet per second and would be regulated by a control tower and two regulation gates located near the upstream portal; similar gates would also be provided for emergency. The intake structure would contain a trash rack and stoplog closure for emergency repair of the control gates.

#### 114. RELOCATIONS

Numerous relocations would be necessary due to construction of the Dos Rios Dam and Reservoir. It is estimated that 34 miles of telephone lines and 32 miles of power lines would require realignment in order to bypass the reservoir area. The relocated utility lines would generally follow the relocated county roads, discussed later. There are three known cemeteries in Round Valley, totalling about 1,000 graves that would need to be relocated. It is proposed to relocate the graves either to existing cemeteries in the general vicinity or develop new cemeteries, depending upon future negotiations with local people. The Covelo Airport, a small county airport located generally west of the town of Covelo, would require relocation. A suitable site for the airport exists about two miles southwest of its present location.

115. About 52 miles of county road would require relocation. This road, County Road 261, provides access to Covelo, via Dos Rios from U.S. Highway 101 to the west and to U.S. Highway 99W (Interstate 5) to the east. The relocated route would generally extend from about six miles northeast of the damsite and extend around the west and north

sides of the reservoir and connect with an existing road about a mile from the confluence of Middle Fork Eel River and Black Butte River. From this point, a local relocated road, about six miles long would follow upstream along Black Butte River, cross at the lakehead and turn downstream again to connect with an existing road serving private properties at the east side of the reservoir. It is expected the existing road serving these properties would be improved and extended to provide access for construction of Grindstone Tunnel. The required road relocations are shown on the Reservoir Map, Plate 3.

116. The town of Covelo, and other valley residences that are presently located in the general vicinity, would need to be removed from the proposed reservoir area. A suitable townsite location, generally four miles south of the existing town of Covelo and on the southwestern rim of Round Valley, could fulfill the need for a new community. It is envisioned that the new settlement would consist of approximately 800 acres with 400 residences to serve a community population of 1,200. An Indian community presently situated in the northern area of Round Valley would need to be reestablished as previously discussed. Appendix F contains additional detailed information on relocations which is shown on Plate 3.

#### 117. FISH AND WILDLIFE FACILITIES

The fish facilities would consist of a fish hatchery and appurtenant features which include a selective water outlet structure and water conveyance system from the dam to the hatchery. The hatchery would have sufficient capacity to accommodate about 16 million Chinook salmon eggs, 13 million Chinook salmon smolts, and 4.7 million steelhead trout eggs, and 2.3 million yearling, steelhead trout. The minimum releases to be made from the reservoir for low flow augmentation would consist of 200 cubic feet per second from June through September and 350 feet per second from October through May and corresponds to an annual amount of approximately 217,000 acre-feet. Strips of land along the reach between the dam and the confluence of the Middle Fork and the Main Eel River would be acquired for fishing management and public access. The loss of wildlife habitat would be compensated for by acquiring 16,000 acres of land as a wildlife preserve. This land would be located near the southeast portion of the reservoir, adjoining the east side of the Elk Creek arm, would be acquired and managed as wildlife area. Appendix D contains additional information relative to fish and wildlife mitigation measures.

#### 118. RECREATIONAL FACILITIES

Recreational facilities would be provided as a project purpose to accommodate one million recreation-days, annually. It is planned to provide 190 picnic sites, 500 campsites, one swimming area, nine

lanes of boat-launching ramps, and access roads. A total of approximately 800 acres of lands would be required over and above those for other project purposes to accommodate these facilities.

119. Approximately 14,000 acres of land would be purchased and held in reserve for a period of not less than ten years, in accordance with the Federal Water Project Recreation Act of 1965, at which time the probability for further recreational development could be better ascertained. As previously discussed, elimination of a major project access problem would automatically permit consideration of an additional five million recreation-days being accommodated by the project. The reserved lands would provide for such an eventuality. Details relative to the recreational facilities are discussed in Appendix D.

#### 120. HYDROELECTRIC POWER FACILITIES

To develop hydroelectric power from the anticipated fish releases, the facilities required would consist of a 4800 kilowatt turbine-generator unit, necessary buildings and control equipment, and switchyard and transmission lines to connect with an existing 60 kilovolt line near Dos Rios. In addition, a small afterbay structure for regulating short-period surges and for maintaining tailwater elevations within proper turbine operating criteria would be required along with necessary valving to regulate flows to the hatchery.

#### 121. METHOD OF RESERVOIR REGULATION

The proposed Dos Rios dam, reservoir and appurtenant works would be maintained and operated by the Corps of Engineers. Regulation for flood control would be accomplished in such a manner as to provide the maximum reductions possible in downstream peak discharge. A downstream point near Scotia, with a water travel time from the Middle Fork of approximately 12 hours, would be used as an index for determining flood control releases. When discharges at Scotia exceed 150,000 cubic feet per second, minor bank erosion and flood damages begin to occur. Thus, whenever the flow at this point exceeded the damaging rate, releases from the reservoir would be restricted to fish hatchery operation requirements. Releases from the reservoir would be curtailed, exclusive of hatchery releases, until discharges at Scotia have peaked and receded to about 200,000 cubic feet per second and are forecasted to continue to recede. Thereafter, water stored in the flood control pool as a result of such operation, would be released downstream at a non-damaging rate. Diversions from the reservoir into Grindstone Tunnel for exportation of water would be determined and implemented by the State of California Department of Water Resources, the non-Federal agency sponsoring the water supply purpose. Reservoir regulation is discussed in more detail in Appendix B.

**122. SUMMARY**

Details on the plan of improvement selected and discussed in previous paragraphs are presented in the following tabulations:



PERTINENT DATA - DOS RIOS DAM AND RESERVOIR

Item	Unit	Quantity
<u>HYDROLOGIC DATA</u>		
Location of dam	On Middle Fork Eel River about 3 miles upstream from Eel River	
Drainage Area	Square Miles	745
Standard Project Flood Inflow Peak	c.f.s.	275,000
Spillway Design Flood Inflow Peak	c.f.s.	470,000
Maximum Flood of Record Inflow Peak (December 1964)	c.f.s.	216,000
<u>RESERVOIR STORAGE</u>		
Sediment deposition reservation <sup>1/</sup>	Acre-feet	See note
Minimum pool-recreation and fishery <sup>2/</sup>	"	2,000,000
Water supply pool	"	5,000,000
Flood control pool	"	600,000
Gross storage (top of flood control pool)	"	7,600,000
Maximum induced surcharge of spillway design flood (above flood pool)	"	970,000
<u>RESERVOIR ELEVATION</u>		
Streambed	Ft. m.s.l.	920
Top of minimum pool	"	1,425
Average recreation pool (mid- season)	"	1,530
Top of water supply pool	"	1,587
Top of flood control pool	"	1,602
Water surface spillway design flood	"	1,626
<u>RESERVOIR AREA</u>		
Top of minimum pool	Acres	22,500
Top of average recreation pool	"	33,000
Top of water supply pool	"	38,500
Top of flood control pool	"	40,000

<sup>1/</sup> Included in minimum pool.

<sup>2/</sup> Includes sedimentation and slide potential.

PERTINENT DATA - DOS RIOS DAM AND RESERVOIR

Item	Unit	Quantity
<u>DAM</u>		
Type - Rockfill impervious core		
Elevation at crest	Ft. m.s.l.	1,650
Length of crest	Feet	2,120
Height	"	730
Width of crest	"	30
<u>SPILLWAY</u>		
Type - Side channel with 50' diameter tunnel		
Gates (30' x 44')	Each	3
Elevation at crest	Ft. m.s.l.	1,581
At top of gate	"	1,625
Design discharge	c.f.s.	109,000
Tailwater elevation	Ft. m.s.l.	940
<u>OUTLET WORKS (Bottom outlet for dewatering reservoir)</u>		
Type - (Gated conduits in diversion tunnel plug)		
Conduits (8.0' diameter)	Each	3
Gates (8.0' diameter)		
Emergency	"	3
Service	"	3
<u>OUTLET WORKS (fishery release outlet)</u>		
Type - Multiple-level inlet gate chamber in tunnel in left abutment of dam		
Length of tunnel (6.5' diameter)	Feet	4,700
Steel pipeline to hatchery and return to stream (4.0' diameter)	"	10,600
Gates		
Quality control (mixing - 6.5'x6.5' slide gate)	Each	4
Emergency (6.5' x 6.5' slide gate)	"	2
Discharge control(6.5'x6.5' slide gate)	"	2
Capacity at minimum pool elevation	c.f.s.	400
Invert elevation (from highest to lowest intakes)	Ft. m.s.l.	1,565
	"	1,510
		1,440
		1,364

PERTINENT DATA - DOS RIOS DAM AND RESERVOIR

Item	Unit	Quantity
<u>DIVERSION TUNNEL (Diversion during construction)</u>		
Diameter (50' diameter)		
Approximate length	Feet	4,500
Invert elevation at entrance	Ft. m.s.l.	94.0
Maximum expected diversion requirement	c.f.s.	188,000
<u>GRINDSTONE TUNNEL (Water Supply)</u>		
Diameter (17 feet)		
Approximate length	Miles	21.0
Invert elevation at entrance	Ft. m.s.l.	1,405.0
Top of control tower	"	1,635.0
Maximum expected diversion requirement	c.f.s.	3,000
Gates (8.5' x 15.5' slide gates)		
Emergency	Each	2
Service	"	2
<u>FISH HATCHERY</u>		
Rearing capacity	No. of eggs annually	
Salmon	"	16,250,000
Steelhead		<u>4,600,000</u>
Total		20,850,000
<u>RECREATIONAL FACILITIES</u>		
Developed recreation areas	Acres	800
Campsites	Each	500
Picnic sites	"	190
Swimming beaches	Area	1
Boat-launching lanes	Each	9
<u>GAME MANAGEMENT AREA</u>		
Managed area	Acres	16,000

ESTIMATES OF COST

123. ESTIMATES OF FIRST COST

The total estimated first cost of the proposed project based on September 1967 prices is \$245,000,000 for the dam, reservoir and appurtenances and \$153,000,000 for the Grindstone Tunnel, for a total of \$398,000,000. Construction cost items include contingencies commensurate with the degree of detail on which the estimates are based. Details of the cost estimates are given in Appendix F, and are summarized by major features below:

ESTIMATED FIRST COST

<u>Item</u>	<u>Cost</u>
<u>Reservoir project</u>	
Lands and damages	\$ 37,800,000
Relocations	41,500,000
Reservoirs	6,300,000
Dams	121,020,000
Fish and wildlife facilities	4,000,000
Powerplant	1,800,000
Roads, railroads and bridges	2,500,000
Recreation facilities	3,400,000
Buildings, grounds and utilities	290,000
Permanent operating equipment	490,000
Engineering and design	11,500,000
Supervision and administration	<u>10,400,000</u>
Total, initial reservoir project	\$241,000,000
Lands, future recreation	<u>4,000,000</u>
Total reservoir project	\$245,000,000
<u>Grindstone Diversion Tunnel</u>	
Lands and damages	\$ 100,000
Tunnel	136,900,000
Engineering and design	8,400,000
Supervision and administration	<u>7,600,000</u>
Total Grindstone Diversion Tunnel	<u>\$153,000,000</u>
Total, Project First Costs	\$398,000,000 <u>1/</u>

1/ Exclusive of preauthorization study costs of \$200,000.

#### 124. ESTIMATES OF ANNUAL CHARGES

The estimated annual charges are composed of the following: (1) Interest on first costs, including interest during construction, computed at three and one-quarter percent; (2) the amount necessary to amortize the investment over an assumed project economic life of 100 years at the three and one-quarter percent interest rate; (3) the annual cost of operation and maintenance; (4) the annual amount necessary for major replacement of items having an estimated life of less than 100 years; and (5) the annual net loss of productivity on lands that would be acquired for the project. Based on uses for similar areas which were studied in conjunction with projects developed in the adjacent Russian River Basin, the average net return for the project area will not differ substantially from the project interest rate. Therefore the gain or loss in productivity on project lands are only of minor significance and are not a factor of the project economics. The annual charges on the additional lands required for maximum potential recreation usage, are not included, since it is expected return on these lands if disposed after a ten-year period or leased during the period before development is undertaken would be sufficient to compensate for initial investment plus accumulated interests. Details of the annual charges analysis are presented in Appendix F and summarized below.

ESTIMATED ANNUAL CHARGES

<u>Item</u>	<u>Costs</u>
<u>Economic Investment</u>	
<u>Reservoir project</u>	
Estimated first cost	\$241,000,000
Interest during construction	<u>27,500,000</u>
Total, reservoir project investment	\$268,500,000
<u>Grindstone Diversion Tunnel</u>	
Estimated first cost	\$153,000,000
Interest during construction	<u>17,000,000</u>
Total, diversion tunnel investment	<u>\$170,000,000</u>
Total project investment	\$438,500,000
<u>Annual charges</u>	
<u>Reservoir project</u>	
Interest and amortization	\$ 9,100,000
Operation, Maintenance and replacement	<u>570,000</u>
Total, reservoir project annual charges	\$ 9,670,000
<u>Grindstone Diversion Tunnel</u>	
Interest and amortization	\$ 5,780,000
Operation, Maintenance and replacement	<u>90,000</u>
Total diversion tunnel annual charges	<u>5,870,000</u>
Total, project annual charges	\$15,540,000

ESTIMATES OF BENEFITS

125. GENERAL

The benefits expected to result from the proposed improvements are comprised of flood control, water supply, recreation and hydro-electric power benefits.

## 126. FLOOD CONTROL BENEFITS

Benefits expected to accrue by providing flood control storage in the Dos Rios Reservoir consist of two principal categories, namely, flood damages prevented and higher land utilization as discussed below.

a. Reduction in flood damages. Construction of the proposed reservoir would result in flood control benefits through reduction in peak flows on the main Eel River and reduction of damage from inundation and bank erosion. The recommended improvement together with the authorized levee project would combine to provide protection against floods of a one-percent chance of occurrence in the Eel River Delta. The average annual damages accruing in Reaches I, III, V, VI and the Round Valley Reach, with the authorized Delta levees constructed, would be reduced from \$1,980,000 to \$760,000. Equivalent average annual benefits over the adopted economic life of the recommended project therefore are \$1,220,000 consisting of: \$191,000 residential; \$128,000 commercial; \$28,000 industrial; \$200,000 agricultural; \$54,000 utilities; \$210,000 railroad; and \$409,000 for other categories. The detailed development of flood control benefits is described in Appendix E.

b. Higher land utilization benefits. The proposed reservoir would increase the degree of protection in the Delta, over that which would be afforded by the levee system, to a one-percent chance flood of occurrence. This degree of protection should permit the development in the Eel River Delta to attain its projected potential of becoming more urbanized than at present. In the Delta an estimated 4,500 acres of primarily native pasture or unused lands would realize enhancement benefits as the result of the proposed project and the Delta levees. Studies indicate that under project conditions these lands would be converted to a higher use, such as low density residential, light industrial and commercial, and intensified agricultural developments. Land enhancement benefits after adjusting for benefits attributable to the Delta levees, development costs and the original value of the land, and on the basis of a 100-year project life, are estimated to be \$290,000. Detailed derivation of the benefits are explained in Appendix E. The investigation for windfall benefits involved a site analysis of the large ownerships. The average total benefits per owner were computed from the values of specific large parcels over 300 acres. For parcels under 300 acres average values were used. Analysis indicate that there are no benefits of an unconscionable magnitude as to constitute basis for additional requirements of local cooperation.

c. Total Flood Control Benefits. The estimated flood control benefits expected to accrue from the project are \$1,220,000 from reduction in flood damages and \$290,000 due to higher land utilization for a total of \$1,510,000.

## 127. WATER SUPPLY BENEFITS

Additional water will be needed to augment State of California water supply facilities beginning about 1985, based on studies conducted by the State of California Department of Water Resources. The firm annual yield of 900,000 acre-feet, as measured in the Sacramento-San Joaquin Delta Pool, available from the 5,000,000 acre-feet of storage allocated for water supply in the proposed Dos Rios Reservoir would be the logical next step in development of North Coastal area water resources to meet these needs. Benefits from developing supplemental water supplies are based on the least cost of producing an equivalent annual yield from an alternative source. Except for the alternative sites on the Middle Fork which have been demonstrated to be more costly than the Dos Rios site, other potential water resources developments in the Eel River Basin also will be needed in the foreseeable future. In addition to their costs being greater than Dos Rios, they, therefore, cannot be considered as true alternatives, but rather as priorities of construction. On the Middle Fork, therefore, a single-purpose water supply reservoir at the proposed Dos Rios site would provide the least cost alternative. The annual cost of such a project is estimated at \$14,900,000, as determined in Appendix F, of which \$9,030,000 is the cost exclusive of the Grindstone Diversion Tunnel.

128. A truer index of the measure of water supply benefits, particularly for the Southern California area where a large part of the exported water is to be delivered, can be taken as the cost for desalinization of brackish or sea water. The State Department of Water Resources has made an analysis of probable value of water in the Sacramento-San Joaquin Delta based, in part, on obtaining water from the sea through desalinization processes, giving consideration to expected improvements in techniques in the future. The State also estimated the cost of delivering water from the Delta to the areas of utilization and adjusted the total benefits to arrive at a figure of \$30 per acre-foot in the Delta. To allow for additional minor water conveyance facilities from the exit portal of Grindstone Tunnel to the Sacramento River and the Delta, a value of one dollar per acre-foot was assumed. The resulting net benefit of \$29 per acre-foot was then adopted as the unit benefit for water supply for the Dos Rios project at the exit portal. For the estimated 900,000 acre-foot yield, the water supply benefits amount to \$26,100,000 annually.

## 129. RECREATION BENEFITS

The number of visitation-days for which recreation facilities are being provided as a project purpose is 1,000,000 annually, as discussed in previous paragraphs. Allowing for the expected progressive buildup of recreation use during the first several years



after project completion and applying the derived unit value of one dollar and forty cents (\$1.40) for an activity day, results in an estimated recreation benefit of \$1,210,000 annually. The basis for deriving this benefit is given, in more detail, in Appendices D and E.

#### 130. HYDROELECTRIC POWER BENEFITS

By utilizing the fishery releases, and the available head of water in the reservoir, the installation of a small hydroelectric power plant below the proposed Dos Rios Dam was determined to be a justified project purpose. Power developed would depend entirely on fishery releases and no reservoir storage would be provided specifically for power purposes, since, such provision cannot be economically justified by the added benefits. A 4,800 kilowatt generator unit operating yearly at full capacity was selected. Utilizing data furnished by the Federal Power Commission, the average annual benefits from power produced by the plant were determined to be \$210,000, as shown in more detail in Appendix E.

#### 131. IMPACT OF FLOODS ON NATION, STATE AND COUNTY

Another type of flood damage loss subject to monetary evaluation is the detrimental effect, or impact, of floods on the economy of the nation, State and local environs. The effect of the 1964 floods in northwestern California upon national lumber and construction markets was substantial. Major floods have had a serious effect on portions of the State economy utilizing dairy and lumber products from the Eel River flood plains. The Northwestern Pacific Railroad often becomes inoperative from flood damages, and such disruption has a detrimental impact on the economy of Humboldt County. Freight service was not restored along the Eel River until six months after December 1964 flood. The proposed flood protection would considerably lessen disruptions in the flow of valuable Eel River Basin commodities to State and national markets. A study initiated by the U.S. Army Engineer District, San Francisco, Corps of Engineers, indicated that the impact of the December 1964 flood on the national economy was a loss that ranged from \$22 to \$31 million. The estimated average annual damages is \$200,000 for the Eel River Basin. The average annual reduction of these losses by construction of the Dos Rios project is estimated to be \$170,000.

#### 132. PUBLIC WORKS AND ECONOMIC DEVELOPMENT ACT BENEFITS

The Dos Rios Reservoir site is in upper Mendocino County, and in close proximity to Humboldt, Tehama, Trinity and Glenn Counties. The Grindstone Tunnel project feature extends into Glenn County. Humboldt and Glenn Counties and Trinity and Mendocino Counties

qualify under Titles I and IV, respectively, for assistance under the Public Works and Economic Development Act of 1965 (P.L. 89-136). An appreciable portion of the labor force required for project construction would come from local residents of these counties. The benefits to the local and national economy that would result from construction of the Dos Rios project are estimated to be \$3,400,000 annually. Neither these benefits nor the reduction in impact losses has been used for project justification or cost allocations.

### 133. INTANGIBLE BENEFITS

Although not subject to monetary evaluation, important evaluation, important benefits would result from construction of the proposed Dos Rios Reservoir. By reducing the probability of severe flooding the project would greatly reduce human suffering and the hazard of loss to human life. The 1964 flood resulted in the death of 19 persons in the Eel River Basin. Recurring flood events have caused greivous human suffering from loss of personal property, homes, animals and destruction of entire communities and the accompanying chaos and isolation. The proposed flood protection would greatly reduce these extremely severe intangible losses.

### 134. SUMMARY OF EVALUATED BENEFITS

The average annual tangible benefits discussed in the preceding paragraphs are summarized below:

<u>Type of Benefits</u>	<u>Total</u>
Flood control	
a. Damages prevented	\$1,220,000
b. Higher land utilization	290,000
Total flood control	\$ 1,510,000
Water Supply	\$26,100,000
Recreation	1,210,000
Power	<u>210,000</u>
Total	\$29,030,000

### 135. ECONOMIC JUSTIFICATION

Comparison of the total average annual benefits \$29,030,000 with the total annual economic project cost \$15,540,000, indicates an overall benefit-cost ratio for the proposed multiple-purpose

project of 1.9 to 1. The breakpoint of the benefits and costs for the economic life of the project are shown on Figure 9. If the impact and Public Works and Economic Development Act benefits of \$170,000 and \$3,400,000, respectively, are included, the average annual benefits would total \$29,200,000 and \$32,600,000 and the respective benefit-cost ratios would be 1.9 and 2.1 to 1.

## MAXIMIZATION OF NET BENEFITS

### 136. PROJECT OPTIMIZATION

The Dos Rios project would include the four identifiable purposes of flood control, water supply, recreation and hydroelectric power. In deriving the degree of development for each purpose the concept of maximization of net benefits was given primary consideration. There are other factors, however, of intangible nature which also have an important bearing on decisions to be made. The desirable level of development for one purpose can be determined by fixing the scopes of development for the other purposes while varying the scope of development of the purpose in question. The selection of the optimum degree of development is based on judgment factors reflecting conditions of formulation constraints and tangible and intangible considerations. For flood control, hydrologic factors such as intangibles, degree of protection, and type of improvements proposed by contiguous and related downstream projects, may dictate the amount of storage to be provided in a reservoir; the storage for water supply may well be governed by willingness and ability of local interests to meet repayment requirements under the Water Supply Act of 1958, and the amount of storage or runoff available for impoundment; where there are definite physical constraints that limit the degree or size of development, limited or lesser than optimum degrees of improvement may be pertinent; and where there is competition among the various purposes for space in a reservoir, there is a need for establishing priorities of purpose or use. In the case of incidental project developments that make use of primary project features, the degree of development is that generated by the resource available. The paragraphs which follow present a procedure and results of optimization study for each of the project purposes, along with explanations for deviation when adopted degree of developments vary from the point of net benefit maximization.

### 137. FLOOD CONTROL

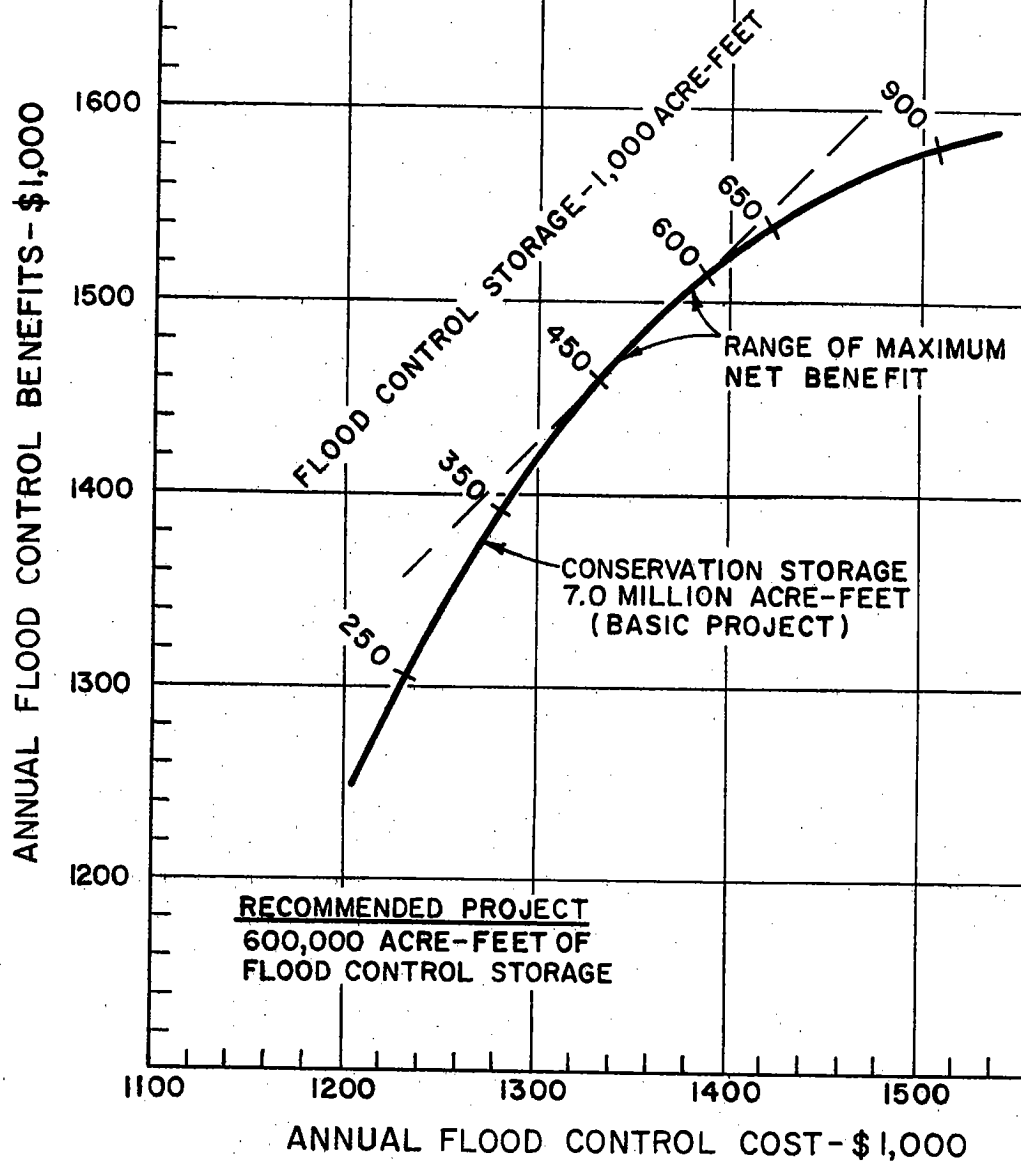
Maximization analysis of the flood control function was determined by fixing the conservation storage at 7.0 million acre-feet (5,000,000 acre-feet for water supply, recreation and

fish release pool, and 2,000,000 acre-feet minimum pool including storage for sedimentation and slide potential) and allowing the flood control storage to vary from 250,000 acre-feet to 900,000 acre-feet. The results of this analysis are shown on Figure 7. The approximate range of maximum net benefit occurs with flood-control storages of 450,000 to 600,000 acre-feet. The 600,000 acre-feet adopted for the proposed project falls within the maximum range. This amount of storage would provide the maximum reduction in peak flood flows, up to and including the standard project flood, along the Eel River downstream from the mouth of the Middle Fork.

138. One of the important areas in the Eel River Basin where adequate flood control is of major concern is in the Eel River Delta. As has been mentioned previously it is not expected that the authorized levee project for this reach will be constructed to contain a flow much in excess of 600,000 cubic feet per second because of the added costs which would be necessary for raising U.S. Highway 101 and the adjacent railroad track. A 600,000 cubic feet per second capacity would still leave the delta area subject to extensive residual damages from a flood comparable to the December 1964 historical flood of 840,000 cubic feet per second. With the adopted 600,000 acre-feet flood control storage in Dos Rios Reservoir, the December 1964 flood peak could be reduced to near capacity of the levees in the Delta and would provide flood protection up to approximately a one percent chance of occurrence (one hundred year flood). Under such conditions the full potential of development of the Delta area could be realized, and would result in appreciable additional benefits due to increased land utilization which would be assignable to Dos Rios Reservoir. It is also considered inadvisable to provide protection for a flood of less magnitude than that of the historical flood, particularly one of recent occurrence and as devastating as that of the December 1964 flood. As indicated in the previous paragraph, the flood control storage would reduce the December 1964 flood to zero on the main Eel River, therefore, the 600,000 acre-feet flood control storage in Dos Rios Reservoir is considered maximized.

#### 139. WATER SUPPLY

From the basic water supply routings, it was estimated that 5.0 million acre-feet of active storage will produce 660,000 acre-feet of annual yield at the project site, and about 900,000 acre-feet when considered under the "Delta Pool Concept." Operation of the Dos Rios project in conjunction with other facilities of the State Water Project and uncontrolled flows along the Sacramento-San Joaquin Rivers account for the difference in yields at the project site and yields at the Sacramento-San Joaquin Delta. Complete operational criteria of the total system is not firm and construction of certain out of basin facilities are in the distant future. Maximization studies were therefore based on yields at the project site that assumes uniform annual demand on the reservoir.



DOS RIOS RESERVOIR  
 MAXIMIZATION OF NET  
 FLOOD CONTROL BENEFITS

FIGURE 7

140. Maximization of the water supply function has been based on the following: (a) maximization of net benefits from available yield within reasonable limits of basin runoff and storage capability; (b) water supply cost being that cost determined from a single-purpose water supply project at the proposed and recommended multiple-purpose project site; (c) water supply benefits as derived from the yields at the reservoir site with the adopted value of \$29.00 per acre-foot; and (d) a fixed minimum pool of 2,000,000 acre-feet of storage for sedimentation and potential slides. The results are shown by the curve on Figure 8. As may be noted, maximization occurs just above the 660,000 acre-foot yield with corresponding active storage amounting to 5.0 million acre-feet. The 660,000 acre-foot yield would result in capturing about 95 percent of the average annual runoff above the site. Increasing the yields above this amount would involve longer carryover periods. The uncertainties involved in obtaining the increased yields are judged to be too great to place reasonable confidence in the values which are obtained from them. It was considered prudent, therefore, to accept the storage requirement for the 660,000 acre-foot firm yield at the site. It also appears reasonable that with a 5.0 million acre-feet of active storage the Dos Rios project could produce greater yields at the Delta when operated in conjunction with possible future systems of the region.

#### 141. RECREATION

The potential of the reservoir for accommodating the public, providing adequate facilities are constructed, and assuming there were no constraints, has been estimated at 7,000,000 recreation-days, annually. This full potential cannot be realized with the limited road access to the area which is expected to be in existence at the time of project completion. It is therefore estimated that recreation attendance would be limited to about 2,000,000 recreation-days annually, of which one-half is considered to accrue to the Indian Community recreation developments as a mitigation measure. Extensive road improvements at a high cost would be required for any appreciable increase in this number of recreation attendance, and these improvements do not appear to be justified on the basis of recreation benefits alone. No maximization curves are shown for the recreation function as the physical constraint of the road system limits the degree of development to a far lesser magnitude than that indicated by the potential benefits.

#### 142. POWER

The potential for development of hydroelectric power at the Dos Rios Project was found to be limited to utilization of in-basin releases for fish mitigation and available head. The provision of

added storage or increased releases was determined not to be economically justified. It was found, also, that the optimum development would be a plant with an installed capacity of 4,800 kilowatts operating as a continuous base load at full capacity. The added costs for increasing the capacity for peaking, which would require enlarging the conduits to the powerhouse and construction of an afterbay for flow reregulation, would exceed the incremental benefits; therefore, such enlargement would not be economically justified. It is considered therefore that the power function is an incidental project development, and the degree of development is limited to that which is generated by the available resource. No further maximization analysis is considered to be required at this time.

#### LOCAL COOPERATION

##### 143. REQUIRED LOCAL COOPERATION

In accordance with existing Federal legislation and established policies, non-Federal interests would be required to furnish assurances of local cooperation that they will:

a. Hold and save the United States free from damages due to the construction and operation of the works specifically required to deliver water to the areas of need.

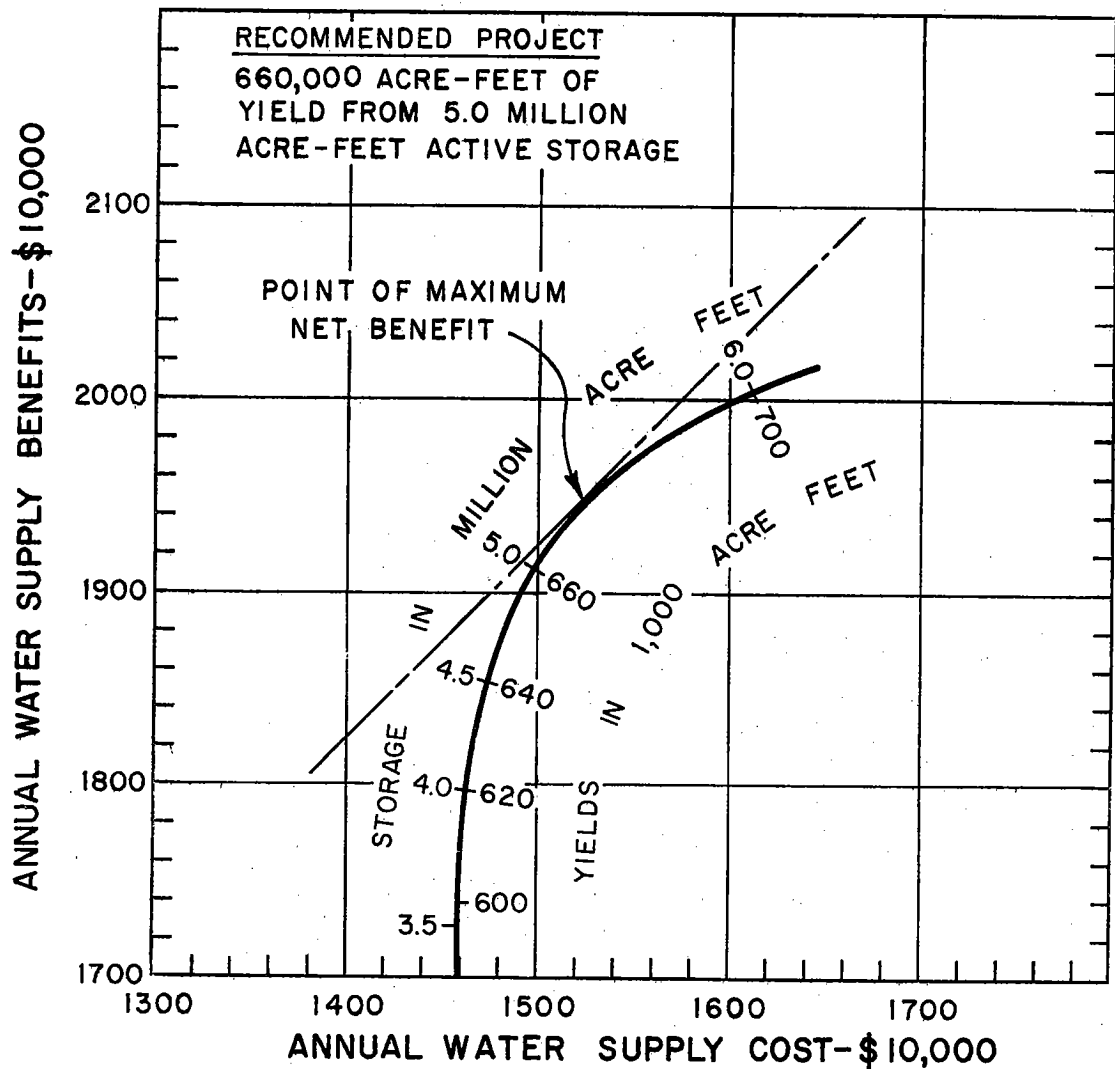
b. Adjust all claims concerning water rights arising from the construction and operation of the improvements, including the acquisition of water rights needed for preservation of fish and wildlife resources affected by the project.

c. Determine the manner in which the releases will be regulated for water supply.

d. Prevent any encroachments which would interfere with the proper functioning of the improvements or lessen their beneficial effects.

e. Design and construct the necessary conveyance facilities, under their own method of financing, in a scheduled manner that would insure its timely completion consistent with that for the dam and its appurtenant works.

f. Prior to start of construction of the dam and reservoir project enter into a contract or contracts, satisfactory to the Secretary of the Army, providing for:



**NOTE:**

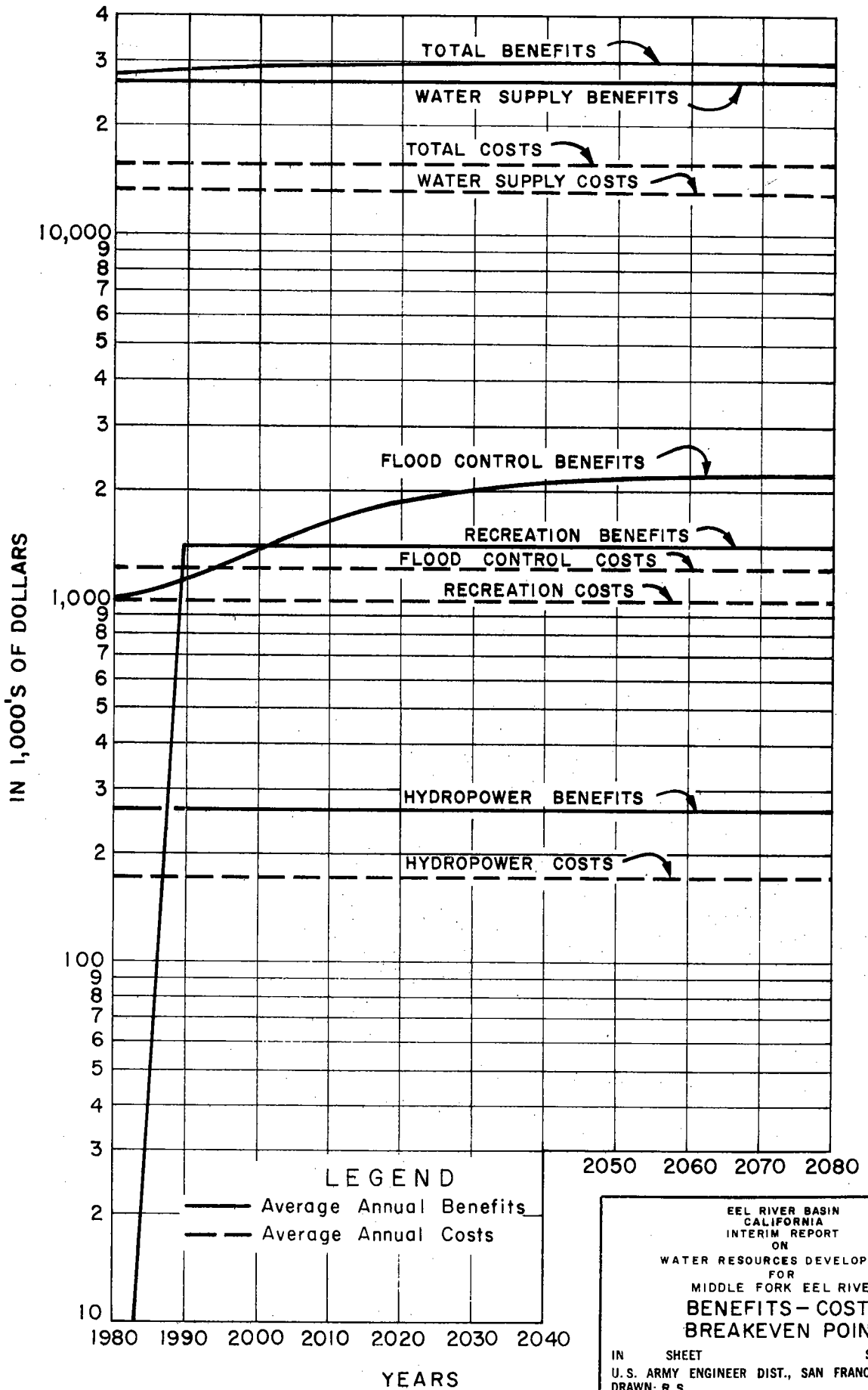
1. ANNUAL BENEFIT IS BASED ON YIELD AT RESERVOIR SITE WORTH \$ 29.00 /ACRE-FOOT.
2. ANNUAL COST IS BASED ON A SINGLE-PURPOSE WATER SUPPLY PROJECT AT THE DOS RIOS SITE.

DOS RIOS RESERVOIR

MAXIMIZATION OF NET  
 WATER SUPPLY BENEFITS

FIGURE 8





EEL RIVER BASIN  
 CALIFORNIA  
 INTERIM REPORT  
 ON  
 WATER RESOURCES DEVELOPMENT  
 FOR  
 MIDDLE FORK EEL RIVER  
**BENEFITS-COSTS  
 BREAK-EVEN POINT**

IN SHEET SHEET NO.  
 U.S. ARMY ENGINEER DIST., SAN FRANCISCO, C. OF E.  
 DRAWN: R.S. FILE NO.  
 TRACED: A.L.G. TO ACCOMPANY REPORT 60-34-11  
 CHECKED: R.S. DATED: APRIL 1968

FIGURE 9

(1) Reimbursement to the United States, with interest at a rate established by the Secretary of Treasury for that portion of the reservoir construction cost allocated to water supply in accordance with the Water Supply Act of 1958.

(2) Annual payment to the United States of the maintenance and operation cost allocated to water supply beginning when such supply is first used.

(3) Reimbursement to the United States of one-half the separable cost for construction for recreation, in accordance with the Federal Water Project Recreation Act of 1965.

(4) Agreement to operate, maintain and make major replacements of the recreation facilities being provided in the initial project construction.

#### ALLOCATION OF COSTS

##### 144. ALLOCATION OF FIRST COST TO PURPOSES

Allocation of cost to purposes are composed of three components which are important factors in apportionment of costs among interests, namely (1) specific costs which are the costs of project features serving only one purpose; (2) separable costs which represent for each project purpose the cost of adding that feature as a project purpose; and (3) joint costs representing costs of facilities serving more than one purpose and are equal to total project cost minus separable costs. For the selected plan of improvement, the specific costs are comprised of facilities for recreation, Grindstone Diversion Tunnel for water supply and the plant and appurtenances for hydroelectric power. The joint costs are subject to allocation between all project purposes in accordance with the "Separable Costs - Remaining Benefits" method. The allocation of first costs of construction to purposes is shown in the following tabulation and details of the cost allocation are contained in Appendix F.

**ALLOCATION OF FIRST COSTS**  
(Thousands of Dollars)

<u>Item</u>	<u>Purpose</u>				<u>Total</u>
	<u>Flood Control</u>	<u>Water Supply</u>	<u>Recreation</u>	<u>Hydro-electric Power</u>	
<u>Reservoir Project</u>					
Allocation of Joint First Costs	\$23,700	\$131,400	\$17,500	\$ 300	\$172,900
Separable Cost	6,700	54,600	4,500	2,300	68,100
Total Allocation	30,400	186,000	22,000	2,600	241,000
Percent of Total First Costs	12.7	77.0	9.2	1.1	100.0
Less Specific Costs	0	0	4,000	2,000	6,000
Remaining Joint-Use Costs	30,400	186,000	18,000	600	235,000
Percent of Remaining Joint-Use Costs	12.9	79.0	7.8	0.3	100.0
<u>Grindstone Diversion Tunnel</u>					
Allocation of Joint First Costs	0	0	0	0	0
Separable Cost	0	153,000	0	0	153,000
Total Allocation	0	153,000	0	0	153,000
Total Allocation Project Cost	\$30,400	\$339,000	\$22,000	\$2,600	\$394,000
Percent of Total Allocation	7.7	86.0	5.6	0.7	100.0

145. ALLOCATION OF ANNUAL CHARGES TO PURPOSES

Annual charges are comprised of two principal components: (1) interest on, and amortization of, the project first cost including interest during construction; and (2) annual cost for operation, maintenance and major replacements. An economic life of 100 years and an interest rate of three and one-quarter percent were used. Details on the allocation of annual charges to purposes are given in Appendix F and are summarized in the following tabulation, along with related benefits to show resulting economic justification.

ANNUAL CHARGES AND BENEFITS BY PROJECT PURPOSE  
(Thousands of Dollars)

Item	Purpose				Total
	Flood Control	Water Supply	Recreation	Hydro-electric Power	
<u>Reservoir Project</u>					
Interest and amortization	\$1,154	\$ 7,010	\$ 837	\$ 99	\$ 9,100
Operation, maintenance and major replacement	56	300	143	71	570
Total Annual Charges	1,210	7,310	980	170	9,670
<u>Grindstone Diversion Tunnel</u>					
Interest and amortization	0	5,780	0	0	5,780
Operation, maintenance and major replacement	0	90	0	0	90
Total Annual Charges	0	5,870	0	0	5,870
Total Project Annual Charges	1,210	13,180	980	170	15,540
Total Project Annual Tangible Benefits	1,510	26,100	1,210	210	29,030
Benefit-Cost Ratio					1.9

APPORTIONMENT OF COSTS

146. APPORTIONMENT OF FIRST COSTS AMONG INTERESTS

All costs allocated to flood control and hydroelectric power have been apportioned to the Federal Government, and all costs allocated to water supply have been apportioned to non-Federal interests. Construction of the Grindstone Diversion Tunnel will be accomplished under its own method of financing by the State Department of Water Resources. Under the Federal Water Project Recreation Act of 1965, one-half of the separable recreation costs and all of the allocated joint costs for recreation would be assumed by the Federal Government. The total Federal first cost for construction on the basis of apportionment would be \$57,000,000 and the non-Federal cost would be \$341,000,000 including \$153,000,000 for the Grindstone Diversion Tunnel, for a total of \$398,000,000 as indicated below:

	<u>Federal</u>	<u>Non-Federal</u>	<u>Total</u>
Flood control	\$30,400,000	\$ 0	\$ 30,400,000
Water Supply	0	339,000,000	339,000,000
Dam and Reservoir		(186,000,000)	(186,000,000)
Grindstone Diversion Tunnel		(153,000,000)	(153,000,000)
Recreation	24,000,000	2,000,000	26,000,000
Hydroelectric power	<u>2,600,000</u>	<u>0</u>	<u>2,600,000</u>
Totals	\$57,000,000	\$341,000,000	\$398,000,000

147. APPORTIONMENT OF ANNUAL CHARGES AMONG INTEREST

Federal annual charges are comprised of interest on, and amortization of, all costs allocated to flood control, hydroelectric power and one-half the separable and all of the joint costs for recreation, and annual operation, maintenance and major replacement cost allocated to flood control, hydroelectric power, and all such costs for recreation in excess of the specific costs for operation, maintenance and major replacement of such facilities. Non-Federal annual charges are comprised of the interest on, and amortization of, all costs allocated to water supply and one-half the separable cost allocated to recreation, and annual operation, maintenance and major replacement costs allocated to water supply and for recreational lands and facilities. For the proposed construction, the Federal and non-Federal annual charges amount to an estimated \$2,170,000

and \$13,370,000, respectively, including annual operation, maintenance and major replacement costs of \$160,000 and \$500,000, respectively. Total average annual charges amount to \$15,540,000. The distribution, by project purposes, to Federal and non-Federal interests is shown in the following tabulation.

APPORTIONMENT OF ANNUAL CHARGES

<u>Purpose</u>	<u>Federal</u>	<u>Non-Federal</u>	<u>Total</u>
<u>Reservoir Project</u>			
<u>Interest and Amortization</u>			
Flood control	\$1,154,000	\$ 0	\$ 1,154,000
Water supply	0	7,010,000	7,010,000
Recreation	757,000	80,000	837,000
Hydroelectric power	<u>99,000</u>	<u>0</u>	<u>99,000</u>
Total	\$2,010,000	\$ 7,090,000	\$ 9,100,000
<u>Operation, Maintenance and Major Replacement</u>			
Flood control	\$ 56,000	\$ 0	\$ 56,000
Water supply	0	300,000	300,000
Recreation	33,000	110,000	143,000
Hydroelectric power	<u>71,000</u>	<u>0</u>	<u>71,000</u>
Total	\$ 160,000	\$ 410,000	\$ 570,000
Total Reservoir Project Annual Charges	\$2,170,000	\$ 7,500,000	\$ 9,670,000
<u>Grindstone Diversion Tunnel</u>			
<u>Interest and Amortization</u>			
Water supply	0	\$ 5,780,000	\$ 5,780,000
<u>Operation, Maintenance and Major Replacement</u>			
Water supply	<u>0</u>	<u>90,000</u>	<u>90,000</u>
Total Grindstone Diversion Tunnel	0	\$ 5,870,000	\$ 5,870,000
Total Project Annual Charges	\$2,170,000 <u>1/</u>	\$13,370,000	\$15,540,000

1/ Because of the nature and purpose of the expenditure the annual charges on land required for future recreation development are not included in the economic evaluation.

#### 148. WILLINGNESS AND ABILITY OF LOCAL INTERESTS

During the course of the investigations for this report, coordination and contacts were maintained with local interests through the State-Federal Interagency Group, and informal meetings to discuss the project formulations, needs, methods of accomplishment and general requirements of local cooperation. An agreement of understanding was entered into with the Director of the State Department of Water Resources giving support to the proposed Dos Rios Project, and stipulating that the State of California would construct and finance the conveyance facilities necessary to export waters to the Sacramento San-Joaquin Delta. On February 14, 1968 a bill was introduced to the California Legislature to authorize the Administration of the Resources Agency to indicate in writing the State's intent to agree to participate in recreation at the Dos Rios Dam and Reservoir Project as provided for in Public Law 89-72. The State of California also indicates its intent to sponsor the water supply requirements of the project as shown by their report presented in Appendix G, "Comments of Other Agencies." It is considered that local interests are willing and able to meet all requirements of local cooperation.

#### COORDINATION WITH OTHER AGENCIES

##### 149. GENERAL

Studies of the recommended plan of improvement presented herein were cooperated in by, or coordinated with, all Federal, State, and local agencies which were known to be interested in any phase of Eel River Basin water resources development. Many formal and informal meetings were held with members of other organizations and agencies and the Indian Tribal Council throughout the course of these studies. Some of the basic information presented herein was furnished by other agencies and much was obtained through cooperative efforts. Good working relations were maintained with other agencies and the resident population throughout the course of the studies. Formal comments received from interested and concerned agencies are presented in Appendix G and are summarized in the following paragraphs.

##### 150. COORDINATION WITH FEDERAL AGENCIES

Coordination was initiated and maintained with the Soil Conservation Service and the Forest Service of the Department of Agriculture, the Bureaus of Reclamation, Land Management, Indian Affairs, Public Roads, Outdoor Recreation, the Federal Water Pollution Control Administration, the National Park Service, the Fish and Wildlife Service and the Geological Survey, all of the Department of Interior. Coordination was also effected with the Federal Power Commission and others.



151. DEPARTMENT OF AGRICULTURE

The Soil Conservation Service reviewed this report and indicated that their work in the basin is largely that of furnishing technical assistance within the area. Most of their assistance pertains to the rehabilitation and permanent improvement of agricultural lands.

152. The U.S. Forest Service advises that the proposed improvements will inundate portions of the Mendocino National Forest, and much of the transbasin tunnel will also be within the Forest. This agency stated that the project will have impacts on recreation, fire protection, transportation, wildlife, timber management, watershed management and range activities. The Forest Service has therefore started an impact study as a result of this report and will outline in detail the effects of the proposed project on their activities. During the period of this study coordination and close working relations will be effected between the Forest Service and the Corps of Engineers to facilitate improvement affecting National Forest Lands.

153. DEPARTMENT OF INTERIOR

The Bureau of Reclamation indicated that further study might be desirable for enlarging the power installation for optimum water and power potential in the future if conditions should change. Further study on this feature will be made during the advance design stage. Arrangements for power marketing and transmission will also be coordinated with the bureau and responsibilities will be adhered to according to Federal law and policy as outlined in the Interagency agreement.

154. The Bureau of Land Management was not prepared to comment on the report in detail. However, official comments will be provided in the fall of 1968 in an impact study which will identify effects that the proposed reservoir will have on Bureau of Land Management resources and programs. Findings and recommendations contained in this agency's impact study will be considered during the advance design stage. It is believed that the findings of this study will not necessitate changes in project formulation or concepts, inasmuch as recommendation will be mainly concerned with management of lands within and adjoining the project area.

155. The Bureau of Indian Affairs did not offer any objections to the project nor to its proposals, providing the proposals were in no way objectionable to the Council and members of the Round Valley Tribe. This Bureau suggested that the Corps of Engineers assume full responsibility for coordination and negotiations with the Tribe regarding project proposals. Throughout the course of this study, many meetings and conferences were held between the Corps of Engineers and the Round Valley Indian Tribe and the Bureau of Indian Affairs.

156. The Bureau of Outdoor Recreation reportedly believes that the proposed recreation features for both the Indians and general recreation development plan to be adequate and in accordance with the California Public Outdoor Recreation Plan. This agency also stated that the proposal to mitigate loss to the Indian economy through recreation development had considerable merit. Since this approach is believed to be applicable to other projects in the region, the Bureau would like to be kept informed of the progress of this program with the Indians. Throughout all stages of this project the Corps of Engineers will coordinate with the Bureau of Outdoor Recreation.

157. A water quality control study was prepared by the U.S. Public Health Service in November 1962. This report was used in the first interim Eel River report and published in House Document 234. Presently the Federal Water Pollution Control Administration is evaluating the impact on water quality of exporting conservation yield through the alternative Clear Lake route. This report has not yet been made available to the reporting officers, however, consideration will be given to this report upon receipt and recommendations will be noted.

158. The National Park Service agreed that the archeological values have been fully considered in the report, and funds allotted for the study and salvage of this resource appear to be sufficient.

159. The Fish and Wildlife Service comments on the effect of the project on fish and wildlife, together with recommendations for measures to mitigate damage to this resource, as well as assurances that local interests will acquire the necessary water rights for the protection of this resource have been made a part of this report.

160. The Geological Survey stated that the only parts of the report that fell within the scope of their activities were the sections on hydrology. Nothing in those sections were inconsistent to any significant degree with their data and analyses.

161. The Bureau of Mines reported that coal beds were in the area. There is no present demand for coal of this quality and the future outlook is probably poor. However, the Bureau believes it advisable to conduct a reconnaissance survey of the beds and make an economic appraisal of their potential market. An appraisal will be conducted during future studies of this project.

#### 162. DEPARTMENT OF TRANSPORTATION

The Bureau of Public Roads noted that 52 miles of county road required relocation. A portion of this road consists of Federal-Aid Secondary Route 505, and a part of this road is also designated Forest Highway Route 7.

#### 163. FEDERAL POWER COMMISSION

The Commission expressed concern that the development of pumped-storage power between Dos Rios and Yellow Jacket reservoirs should be investigated, and if found feasible, construction of Dos Rios should include provisions for pumped-storage power facilities. No objections were interposed on the selection of a 4800 kilowatt power plant utilizing in-basin fish releases. However, the Commission will want to review this installation at the advance planning stage along with the pumped-storage facilities. Further studies were also suggested in the advance planning stage for the possible addition of power facilities in connection with the conveyance tunnel. During the advance planning stage of the Dos Rios Dam, concurrent survey investigations of the Yellow Jacket Dam will determine the feasibility of pumped-storage. In the future if other works of the California water plan can be adjusted to improve power characteristics of the Grindstone conveyance tunnel, these features will also be outlined in the Dos Rios post-authorization report. During all stages of the study, coordination will be effected with the Federal Power Commission.

#### 164. COORDINATION WITH THE STATE OF CALIFORNIA

The Resources Agency of the State of California distributed copies of the proposed report to all State departments and boards concerned. Attached to the report of the Resources Agency were the recommendations of the State of California and the comments of the State Departments of Water Resources, Parks and Recreation, Harbors and Watercraft, Conservation, Fish and Game, Public Works (Division of Highways) and the State Water Resources Control Board. The comments of the Department of Fish and Game also constitute the State's review under provisions of the Fish and Wildlife Coordination Act. The proposed project is an important feature of the California Water Plan and the State Water Project, and in the agency's considered judgment is needed by the mid-1980's to maintain yield of the project. The State plans to contract for the conservation storage in Dos Rios Reservoir under terms of the Water Supply Act of 1958, and plans to construct the conveyance facilities to the Sacramento-San Joaquin Delta.

165. The State is supporting Assembly Bill 552, which has been introduced in the legislature to grant the Resources Agency the authority to indicate in writing the State's intent to participate in administering the recreation and fish and wildlife enhancement features of the project under provisions of PL 89-72. If the legislation passes, a letter will be submitted outlining the conditions under which the State will participate in recreation and fish and wildlife enhancement at the Dos Rios Dam and Reservoir project. The State recognizes that additional studies will be required to define the specific measures necessary to achieve mitigation of project-incurred fish and wildlife losses. The State

indicates that they will work with the Corps and the Fish and Wildlife Service to achieve a mutually satisfactory program after authorization. The detailed recommendations contained in the Department of Fish and Game's report represent their present thinking and is reflected in their report attached and shown in Appendix G.

#### 166. COORDINATION THROUGH STATE-FEDERAL INTERAGENCY GROUP

Continuous coordination was maintained with various Federal agencies and the State of California through the State-Federal Interagency Group. This group, comprised of the State of California Department of Water Resources, U.S. Bureau of Reclamation, U.S. Soil Conservation Service, and the U.S. Army Corps of Engineers, was formed in 1958 for purposes of minimizing duplication of effort and for achieving a more effective program for planning relative to water resources development for the North Coastal California Basins. Member agencies of the Interagency Group hold conferences periodically to discuss the many aspects of water resources development and to agree upon, adopt and disseminate engineering data for prospective developments. These conferences serve to keep all Interagency members abreast of all significant developments throughout the entire planning process for water resources development in Northern California. The Interagency Group endorsed the proposed plan of improvement and indicated that the report presented a comprehensive analysis of all study aspects. The Group further stated that the proposed development was in conformance with the California Water Plan and is needed to provide supplemental water supplies to the State Water Project.

#### 167. COORDINATION WITH LOCAL INTERESTS

In addition to the public hearings held during the course of the investigation for the Eel River Basin, coordination was maintained with responsible local interests and organizations. This includes the Board of Supervisors, the Chambers of Commerce for Humboldt and Mendocino Counties, the Eel River Association, the community of Round Valley, including the Round Valley Indian Reservation, Tribal Council, and many others. The Eel River Association, a local public entity formed for the purpose of protecting and developing the resources of the Eel River Basin, holds periodic public meetings to discuss and coordinate developments in the basin.

#### 168. THE EEL RIVER ASSOCIATION

The Eel River Flood Control and Water Conservation Association by resolution endorsed the proposed plan of improvement. The Association further resolved that the conveyance facilities to be constructed be in the best interests of all concerned, and that the State of California participate in the recreation development.

169. LAKE COUNTY

The Lake County Board of Supervisors at the 15 December 1967 public hearing opposed the Dos Rios dam and reservoir and the easterly conveyance facilities. The County endorsed the project provided the routing of export waters was southerly through Clear Lake. The County further claimed the easterly routing was a threat to the economic development of the area and preservation of Clear Lake, and that in seeking an unbiased study had hired Kaiser Engineers to prepare a study of the benefits attributable to Lake County and others not previously considered.

170. Humboldt County endorsed the proposed plan of improvement but further endorsed Lake County's study being made by Kaiser Engineers. Additional consideration of the conveyance route was believed desirable. Marin County expressed concern about the conveyance routing and requested that if future investigations demonstrate that benefits can be derived by transporting large amounts of water through Clear Lake, authorizing language be so worded that the project can be revised.

171. Mendocino County Board of Supervisors after review declared its firm policy not to participate as the non-Federal sponsoring agency for recreation since the benefits were statewide. The Board urged the State to act as sponsor for recreation, and in the event the State did not agree, Mendocino County would participate only if financial assistance was provided by the water users.

172. The Board of Supervisors of Sonoma County fully support the proposed recommendation for construction of the Dos Rios dam and reservoir, but requested that assurances be obtained that the report does not preclude construction of an alternate conveyance route should such alternate route be found more feasible. The Yolo County Board of Supervisors is of the same opinion as Sonoma County as regards the conveyance route. However, expressed concern was made by Yolo County about the possibility of increased seepage along the Sacramento River caused by the introduction of additional waters from the Eel River. Colusa County was also greatly concerned about the possible seepage damage along the Sacramento River. Colusa County is in favor of the selected conveyance route provided positive assurance is given to provide them with additional fiscal aid in levee seepage and drainage maintenance.

173. ROUND VALLEY INDIAN TRIBAL COUNCIL

During the planning phases of this study due consideration was given to the Covelo Indian community, and coordination efforts to fully inform the Indians were adhered to at each step of the project formulation. In January and February of 1968, several conferences were held with the Tribal Council in Covelo, with the District Engineer participating on a "ground roots" level, to outline and explain to the Council

the proposals of the intended plan of improvement. Indications during January and February 1968 were that the Indians were favorably impressed with the project proposals, and they stated that a resolution endorsing the project would be forthcoming. In March 1968 an election was held and the Chairmanship of the Tribe changed. Contact with the Tribe in late March 1968 disclosed that a decision had not been reached regarding the proposed project. Indications were that the Tribal Council would agree with the proposed plan of improvement but would hold in abeyance any resolution until a later date. A poll conducted in February indicated the Tribe was equally divided in attitude towards the inundation of Round Valley. It is presently believed that no formal opposition will be forthcoming from the Tribal Council.

#### 174. THE KAISER ENGINEERS REPORT

Kaiser Engineers at the request of Lake County made an investigation with the purpose of presenting the findings of an independent engineering and economic review of the plans proposed for the development of the Upper Eel River and adjacent watersheds by the State, the Corps of Engineers, and the Bureau of Reclamation. The findings reported by Kaiser Engineers are: (1), that further engineering and economic studies should be undertaken of the Southerly routing possibilities of Upper Eel River waters, including alternative project configurations, in order to assure that the one finally selected will result in the most economic development of the water resources under consideration for export to the Sacramento-San Joaquin Delta; (2), Financial, cost allocation and project repayment studies, should be initiated with regard to the aforementioned Southerly routing possibilities, particularly with respect to the benefits that would accrue to the Northwestern California Counties; (3), The water quality and algae problems of Clear Lake should be the subject of further study and research in order to find and implement measures which will result in significant improvements. The conclusions indicate that routing of Upper Eel River water through Clear Lake will result in enhancement of the quality of Clear Lake water, but will not by itself solve its problems; and (4), Release of the contemplated quantities of Eel River waters in accordance with a pattern proposed in a recent unpublished study of the Department of Water Resources indicates that adverse seepage effects are not likely to occur along the Sacramento River. However, it should be pointed out that, if care is not exercised as to the period of such imports, it is possible that additional seepage problems could result. This question should be given further continuing study, in view of the fact that additional imports beyond those contemplated could aggravate present seepage problems.

175. A recently completed study by the State, "Sacramento Valley Seepage Investigation," of Bulletin No. 125, showed that seepage problems will probably not be increased by Middle Fork Eel River input. This is because the Sacramento River channel would be used to convey imported waters

during those months when there is a low flow in the river. The California State Legislature in 1959 added Section 12627.3 to the State Water Code which requires the cost of solution of seepage problems which may arise as the result of construction and operation of a water project, to be borne by the project. The State intends to monitor conditions after the project is in operation and to take necessary measures to alleviate increased seepage conditions should they occur.

176. Foremost within the Kaiser report was the ever present fact that the most important feature in the entire Upper Eel River development was the large Dos Rios dam and reservoir. Kaiser Engineers reported that it is common to all proposals and multiple project configurations and is needed regardless of the selected conveyance route, and maximizes net potential benefits.

## DISCUSSION

### 177. GENERAL

The Eel River Basin, in Northwestern California, is unique in many ways. Tributary to the Pacific Ocean, it is essentially isolated from adjacent land areas by the Coastal Range Mountains. Terrain is rugged and mountainous, heavily wooded and sparsely populated in pockets of limited, flat areas. Hydrologic location and terrain result in the 3,600 square miles of basin producing an average annual stream runoff of over six million acre-feet which empties into the Pacific Ocean. International and national interest has been established because of redwood groves, fisheries and recreation resources in the basin. The basin is traversed by main highways, a railroad and the northern end is close to airline service. Much of the basin is, however, accessible with difficulty. Agricultural lands, populations and developments are situated essentially along streams and main highways. The population and economy of the basin has not grown as rapidly as the State of California or the nation as a whole. Multi-purpose development of the ample water supply in the basin would minimize, if not correct, these development disparities. The population of the basin has a desire to develop, conserve and utilize basin resources in the best interests of the basin, the State of California and the Nation.

### 178. BASIN AND REGIONAL NEEDS

Present Eel River Basin needs related to water resources development include flood control and recreation. Future basin needs will include flood control, recreation, fish and wildlife enhancement, water quality control, generation of hydroelectric power and water supply. Present and future regional needs that can be directly related to water resources development in the Eel River Basin include water supply, hydroelectric power generation, recreation and fish and wildlife enhancements. Indirectly, basin flood control and water quality aspects are regional needs.

## 179. STUDIES

Basin studies of an overall scope have been made and are continuing to be refined relative to water resources development. Regional water resources studies are continuously integrated with basin studies. Studies involve coordinated effort of many Federal and State of California agencies concerned with various phases of water control and development. Local and State interests are continually apprised of the progress of studies and consideration is given to all suggestions received. This report presents findings on water developments for the Middle Fork Eel River which have been shown to be the next logical step of water development for the Eel River Basin and the State of California.

## 180. FLOOD PROBLEM

The Middle Fork Eel River produces flood flows which, when combined with that of other Eel River tributaries, have caused devastating damages to towns, lumber mills, railroads, highways, agricultural lands, loss of livestock and loss of human life. Flows from the Middle Fork Eel River are estimated to be related to future average annual flood damages of \$1,980,000 over the next 100 years. Unless protective measures are provided, future floods could cause recurrent and greater damages than previously experienced because of the continuing development in historical and potential damage areas. The annual damage estimate reflects reasonable flood plain management and Federally authorized levees being constructed.

## 181. WATER SUPPLY PROBLEM

Present and projected Eel River Basin water needs are small when compared to the total available water resources of the basin. Forecasted increases in State water needs have led to consideration of developing the Eel River Basin water resources to meet California State Water Project requirements beginning about 1985. Studies revealed that additional water needs of the basin and State by year 2080 would be about 135,000 and 60 million acre-feet, respectively. The State Water project projections show a need of about 900,000 acre-feet by year 2035 from the North Coast Area.

## 182. RECREATION PROBLEM

Studies show a need for recreational development over the next 100 years in the Eel River Basin. About 60 percent of such development should be water-oriented. By year 2080, basin total is estimated at 98 million recreation-days. Within a 150 mile zone of influence of the Middle Fork Eel River, estimated water-oriented recreation demand is 60 million recreation days. Investigation indicates that ten to fifteen percent of the 60 million could use a reservoir for water-oriented recreation activities in the Middle Fork Eel River Basin.



### 183. HYDROELECTRIC POWER

Analysis of hydroelectric power for reservoirs on the Middle Fork Eel River showed that consideration should be limited to the feasibility of using continuous mandatory releases, such as for fisheries. Thus, a relatively small amount of power generation would be introduced into a regional area of large future demand. Arrangements for power marketing will be made through consultation with and by the Bureau of Reclamation.

### 184. OTHER PROBLEMS

Reservoir development on the Middle Fork Eel River would cause fishery and wildlife losses that should be mitigated. The adopted fishery releases would accommodate estimated future water quality demands for at least the next 40 years and probably the next 100 years. An Indian community near Round Valley would be disturbed by reservoir creation and an exchange of lands plus a substitute new economy should be considered adjacent to any reservoir. Inclusion of Round Valley in a reservoir or protecting Round Valley was thoroughly considered relative to local and regional problems. The town of Covelo is also located in Round Valley.

### 185. FINDINGS OF STUDIES

Studies were made of various sites and capacities of single and multiple-purpose reservoirs on the Middle Fork Eel River relative to estimated needs and problems. From these studies, it was determined that the most feasible plan of improvement would be a dam at Dos Rios creating a multiple-purpose reservoir for flood control, water supply, hydroelectric power and recreation. The reservoir would inundate Round Valley; however, disruption to the Indian community should be adjusted and the town of Covelo should be relocated, if local interests desire. Extensive fish and wildlife resources would be affected and require mitigation measures to minimize losses. Also, conveyance of water supply to the State Water Project by a conveyance facility into the Sacramento River Basin must be considered an integral part of a reservoir development plan. Other proposals analyzed were either more costly, would not provide benefits of equal or greater magnitudes, or would result in less excess net benefits than the most feasible plan.

### 186. PROPOSED PROJECT

It is proposed that a rock-fill dam be constructed at Dos Rios which would create a reservoir with a gross storage of 7,600,000 acre-feet consisting of 600,000 acre-feet for flood control, 5,000,000 acre-feet for water supply and 2,000,000 acre-feet for minimum pool. The reservoir would regulate runoff from 745 square miles. The rock-fill dam is selected, at this time, rather than a concrete dam based on available data and estimated costs.

187. Flood control storage would reduce the maximum historical flood discharge at Fernbridge (Delta Area) from 840,000 cubic feet per second to about 650,000 cubic feet per second. This reduced discharge corresponds essentially to the capacity for which the Federally-authorized Delta Levee Project is to be constructed. Such control would eliminate about 60 percent of estimated future average annual damages over the next 100 years along the Eel River downstream from the junction with the Middle Fork.

188. Water supply storage is estimated to provide about 900,000 acre-feet of firm annual yield for the State Water Project under the concept of the Sacramento-San Joaquin Delta Pool. Conveyance of the water from the reservoir would be by a 17-foot diameter, 21-mile tunnel from the reservoir to the Sacramento River Basin. Under the "Delta Pool Concept" any available excess unregulated flow into the Delta from the Sacramento and San Joaquin Rivers would be utilized to provide all, or a part of the supplemental yield, thus requiring less releases of stored water from Dos Rio reservoir. Regulation in this manner, that is, taking advantage of the excess runoff at the point of diversion in the Delta, results in a greater amount of supplemental water that can be developed on a firm yield basis than would be the case from utilizing only the runoff into Dos Rios reservoir. Therefore, the 660,000 acre-feet yield at the reservoir can be reasonably taken as 900,000 acre-feet at the Delta.

189. The benefit for water supply has been determined to be \$30 per acre-foot at the Delta. However, in addition to the main conveyance facility, that is, the presently considered Grindstone Tunnel, some improvement would be required of the lower reaches of Stony Creek channel in which the diverted waters would flow prior to its entering the Sacramento River. Indications are that the cost of such improvement would be equivalent to about one dollar per acre-foot. This amount has been subtracted from the \$30 to give a value of \$29 per acre-foot as the estimated unit water supply benefit at the exit portal of the diversion tunnel. For the estimated 900,000 acre-feet yield, the water supply benefits amount to \$26,100,000, annually.

190. The project presents a potential for accommodating five million recreation-days annually exclusive of Indian community development. Foreseeable access problems, however, result in proposing that recreation facilities for one million recreation-days be provided and additional lands be purchased and reserved to preserve the total recreation potential in the event the access problem be eliminated in the future. Some of the facilities proposed are: campsites, picnic sites, boat-ramps, and swimming beaches.

191. Proposed hydroelectric power consists of utilizing the adopted within basin fish releases. This results in a plant with an installed capacity of 4,800 kilowatts operating as a continuous base load at full capacity.

192. To minimize loss to wildlife, a 16,000-acre game management area is proposed. Preservation of the fishery resource consists of within basin releases ranging from 200 to 350 cubic feet per second, a hatchery and channel improvement on the Middle Fork Eel Eiver downstream of the proposed dam. Under the Federal Recreation Act 89-72, enhancement of the fishery resource has been effected by creation of a new fishery within the reservoir. The fish enhancement benefits are included in the general recreation benefits outlined in previous paragraphs. It is considered that recreation and fish and wildlife enhancement will be further studied in the advance planning phases, and enhancement of the resource will be coordinated with the responsible agencies.

193. Adjustment to the Indian community, for report purposes, is provided by exchange of lands for new residence adjacent to the proposed reservoir and a new economy centered around one million recreation days. Lands and recreation facilities would be provided to realize the recreation economy. Indian residential adjustment and related recreation developments represent mitigative measures and as such, costs associated therewith are chargeable project purposes.

194. Fullest consideration has been given to steps which might be taken to mitigate, to the greatest possible extent, any adverse impact on the Indian interests and economy. As a means of arriving at a reasonable estimate of cost for the relocation, certain concepts of what such a plan might entail were adopted. Discussions were held with representatives of the Bureau of Indian Affairs during the formulation of the project in which it was indicated that the suggested approach was reasonable and workable.

195. The problem is significant, as about two thousand acres of Indian land and the future of about 350 Indian residents are directly involved. To indicate the scope of the problem and permit a reasonable introduction of it into this report, a rationale for solution has been adopted which is considered to permit evaluation comparable to other proposed project features and, more important, give a starting basis for future concept consideration. It is not believed that this feature, relative to the Indians, constitutes an enhancement measure.

196. Relocations resulting from proposed dam and reservoir include roads, utilities, county airport, government-agency facilities and the town of Covelo, and the new Indian development.

#### 197. ESTIMATED COSTS

The estimated first cost of the project is \$398,000,000 consisting of \$241,000,000 for dam and reservoir, \$153,000,000 for water supply conveyance tunnel to the Sacramento River Basin and \$4,000,000 for lands to be reserved for future recreation potential. The estimated Federal first cost is \$57,000,000 for dam and reservoir improvements related to flood control, recreation and hydroelectric power purposes. Non-Federal first costs associated with reservoir purposes are estimated

to be \$186,000,000 for water supply and \$2,000,000 for recreation. Conveyance tunnel first costs would be non-Federal. Estimated annual cost for the total project is \$15,540,000, over a 100-year economic project life including interest during construction, and \$660,000 for operation, maintenance and major replacements. The Federal portion of annual costs would be \$2,170,000.

#### 198. ESTIMATED BENEFITS

The proposed project is estimated to provide average annual benefits totalling \$29,030,000, comprised of \$1,510,000 from flood control, \$26,100,000 from water supply, \$1,210,000 from recreation, fish and wildlife enhancement and \$210,000 from hydroelectric power. The benefit-to-cost for the overall project is 1.9 and each of the proposed project purposes has a ratio greater than unity. Each purpose shares equitably in the joint savings resulting from multiple-purpose development.

#### 199. REQUIREMENTS OF LOCAL COOPERATION

As herein proposed, the Federal government would perform construction of all improvements and purchase of all lands, easements and rights-of-way required for construction of Dos Rios Dam and Reservoir. Local interests would be required to repay all costs allocated to water supply, including the proportionate share of annual operation, maintenance and replacement, and to repay one-half the separable cost of recreation, fish and wildlife enhancements, and operate and maintain the lands and facilities. Repayment, with interest, could be made under the Water Supply Act of 1958 and the Federal Water Project Recreation Act of 1965. Costs allocated to flood control and hydroelectric power would be assumed by the Federal Government. The Federal Government would maintain and operate the dam and reservoir with the exception of the recreation facilities. The conveyance facility to the Sacramento River Basin would be constructed, operated, maintained and financed by non-Federal interests.

200. Meetings between the State Department of Water Resources and the Corps of Engineers have shown a definite need for several phases of studies to continue. The items of work that would expedite the construction program and be of mutual benefit to both agencies are: (1) all formulation evaluations related to final selection of the conveyance facility location and size and utilization of storage in the reservoir; (2) current landslide studies underway, with special consideration to the slide area on the left abutment of the Dos Rios damsite; (3) continued monitoring of present earthquake investigation; and (4) continuation of basic hydrologic data program of water quality problems in the Dos Rios Reservoir.

#### 201. SENATE RESOLUTION 148

Information called for by Senate Resolution 148, 85th Congress, adopted 28 January 1958, is presented as Attachment I to this report. It contains additional information on the recommended project and the alternative plans considered during the preparation of this report.

## CONCLUSIONS

202. The District Engineer concludes that:

a. A definite need exists in the Eel River Basin and the State of California for development of water resources for flood control, water supply, recreation, fish and wildlife enhancement, and hydroelectric power.

b. A multiple-purpose reservoir, on the Middle Fork Eel River at the Dos Rios site with a water supply conveyance tunnel to the Sacramento River Basin, would substantially and economically meet the needs of both State and Basin for water resources development and would be compatible with future statewide and basinwide developments. Reservoir purposes would be flood control, water supply, recreation, fish and wildlife enhancement, and hydroelectric power.

c. Creation of a reservoir on the Middle Fork Eel River would require conservation measures for the fish and wildlife resources, relocation of an Indian community, the town of Covelo and roads and utilities.

d. The dam and reservoir would be constructed, operated and maintained by the Federal Government and the water supply conveyance tunnel would be constructed, financed, operated and maintained by non-Federal interests. Recreation facilities would be operated and maintained by non-Federal interests.

e. Regulation of flood control and hydropower features would be established by the Federal Government. Water supply regulation would be established by non-Federal interests with Federal Government guidance provided for Indian community needs. Fishery and wildlife regulation would be established by the Federal Government in cooperation with non-Federal interests.

f. Repayments by non-Federal interests to the Federal Government of the costs allocated to water supply and recreation, and fish and wildlife enhancement would be made in accordance with the Water Supply Act of 1958 and the Federal Water Project Recreation Act of 1965, respectively.

g. The multiple-purpose reservoir at Dos Rios site is estimated to produce an overall benefit-to-cost ratio of 1.9 with each project purpose being justified individually.

## RECOMMENDATIONS

203. THE DISTRICT ENGINEER RECOMMENDS:

a. Adoption of a plan of improvement for flood control, water supply, recreation, fish and wildlife enhancement, and hydroelectric

power on the Middle Fork Eel River, California consisting of a dam and reservoir at the Dos Rios site and conveyance tunnel to the Sacramento River Basin at an estimated construction cost of \$398,000,000;

b. Authorization for construction by the Federal Government of the dam and reservoir and appurtenant features, exclusive of the conveyance tunnel, at an estimated construction cost to United States of \$245,000,000 and an estimated annual maintenance, operation and major replacement cost of \$160,000 all generally in accordance with the plans of the District Engineer and subject to such modification and cooperative joint construction endeavor as in the discretion of the Chief of Engineers may be deemed advisable; provided that prior to construction and subject to final allocations based on conditions prevailing at the time of construction and actual costs incurred, responsible non-Federal interests:

(1) Give assurances satisfactory to the Secretary of the Army that they will:

(a) Hold and save the United States free from damages due to the construction and operation of the works specifically required to deliver water to the areas of need.

(b) Adjust all claims concerning water rights arising from the construction and operation of the improvements, including the acquisition of water rights needed for preservation of fish and wildlife resources affected by the project as set forth in this report.

(c) Determine the manner in which the releases will be regulated for water supply.

(d) Prevent any encroachments which would interfere with the proper functioning of the improvements or lessen their beneficial effects.

(e) Design and construct the necessary conveyance facilities, under their own method of financing, in a scheduled manner that would insure its timely completion consistent with that for the dam and its appurtenant works.

(2) Enter into a contract or contracts, satisfactory to the Secretary of the Army, providing for:

(a) Reimbursement to the United States in accordance with the Water Supply Act of 1958, as amended, that part of the construction cost and annual operation, maintenance, and major replacement costs allocated to municipal and industrial water supply, presently estimated at \$186,000,000 and \$300,000, respectively.

(b) Reimbursement to the United States, in accordance with the Federal Water Project Recreation Act of 1965, one-half the separable construction cost for recreation, and fish and wildlife enhancement, and agree to annually operate, maintain and make major replacements of the recreation facilities being provided, presently estimated at \$2,000,000 and \$110,000, respectively.

c. Relocation of the town of Covelo if local interests desire and provide required local participation.

d. Subject to specific advance agreement on plans between the State of California and the Chief of Engineers, credit would be given for actual expenditures performed after authorization of the project by the California Department of Water Resources for necessary advance planning activities performed on the dam and reservoir project.

e. The District Engineer further recommends that immediately following authorization of the reservoir and during the advanced engineering and design phase, detailed site investigation and design be made for the purpose of accurately defining the project lands required, so that acquisition may be made of title to such lands as may be required to preserve the site against incompatible developments; and that the Chief of Engineers be authorized to participate in the construction, or reconstruction, of transportation and utility facilities in advance of project construction, as required to preserve such areas from encroachments and avoid increased costs for relocations.

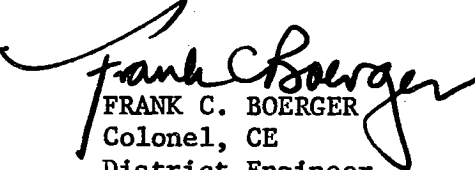
f. As an element of the overall development of the project, the District Engineer also recommends that Congress give consideration to adoption of the following mitigative measures, the costs of which are included in project estimates.

(1) Fish conservation by construction of a fish hatchery and appurtenant features; acquisition of strips of land in the three-mile reach from the dam to the confluence of the mouth of the Middle Fork Eel River; and minimum releases from reservoir as may be reasonably determined by the Federal and State of California fish and wildlife conservation agencies.

(2) Acquisition and preparation by the United States of approximately 16,000 acres of land as a wildlife habitat at an estimated cost of \$4,000,000.

(3) Acquisition by the United States of about 5,000 acres of land to provide a solid and continuous area of Indian development along the north edge of the Round Valley and adjacent to the reservoir, site preparation on acquired lands necessary for relocation of Indian residential lands occupied and facilities for disrupted Indian economy, at an estimated cost of \$24,000,000 but with no cost chargeable to the project for subsequent maintenance and operation.

204. The net construction cost to the United States for the project development after financial cooperation by non-Federal interests for water supply and recreation is presently estimated at \$57,000,000. After all payments by local interests, the net annual cost to the United States for maintenance, operation and replacements will be an estimated \$160,000.

  
FRANK C. BOERGER  
Colonel, CE  
District Engineer



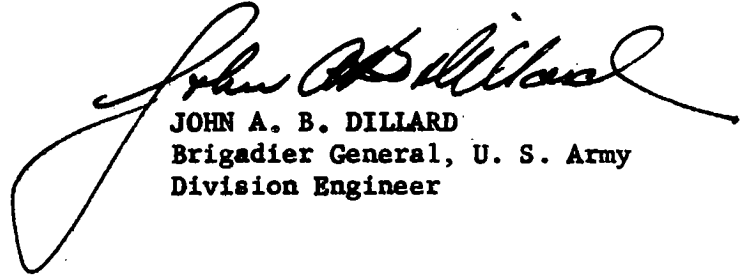
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SUBJECT: Interim Report on Water Resources Development for Middle Fork  
Eel River, California

Division Engineer, South Pacific 4 Apr 68

TO: Chief of Engineers

I concur in the conclusions and recommendations of the District Engineer.

A handwritten signature in cursive script, appearing to read "John A. B. Dillard". The signature is written in dark ink and is positioned above the typed name and title.

JOHN A. B. DILLARD  
Brigadier General, U. S. Army  
Division Engineer