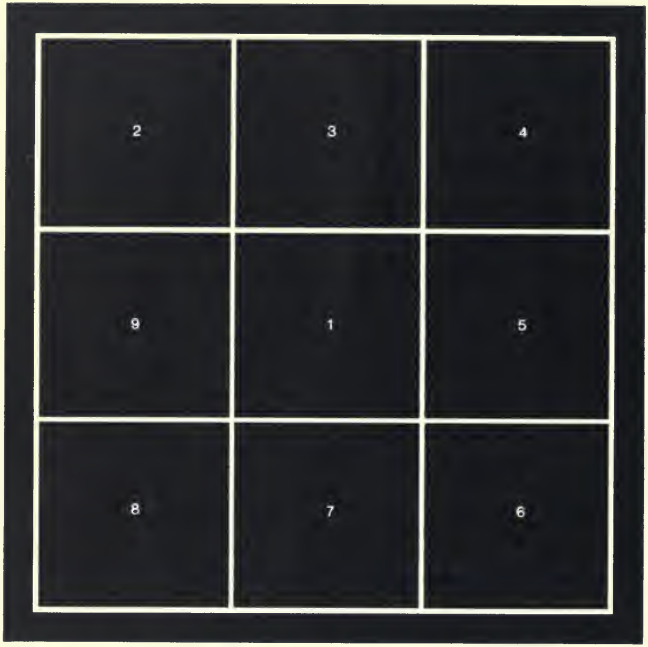
California State Water Project

Volume I
History, Planning, and Early Progress

Bulletin Number 200
November 1974



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STATE OF CALIFORNIA

The Resources Agency

Department of Water Resources

BULLETIN No. 200

CALIFORNIA STATE WATER PROJECT

Volume I

History, Planning, and Early Progress

November 1974

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

RONALD REAGAN
Governor
State of California

JOHN R. TEERINK
Director
Department of Water Resources

FOREWORD

This is the first of six volumes which record aspects of the planning, financing, design, construction, and operation of the California State Water Project.

The State Water Project conserves and distributes water to much of California's population and irrigated agriculture. It also provides generation of electric power, flood control, water quality control, new recreational opportunities, and enhancement of sports fisheries and wildlife habitat.

Construction of the first phase of the State Water Project was completed in 1973. The $2.3 billion reimbursable cost is being repaid by the water users and other beneficiaries. It is expected that another $0.7 billion will be spent during the next decade to construct authorized facilities for full operation.

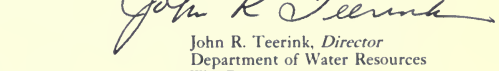
This first volume summarizes California's water development problems and planning considerations. It sketches the State's water development history through 1951, when the State Legislature authorized the basic elements of the State Water Project. The principal events which led to approval of the financial foundation for the Project—the $1.75 billion general obligation bond issue passed by the State Legislature in 1959 and approved by California voters in 1960—are recorded and pertinent water right provisions and issues are explained. The contract provisions made for water service to local agencies and for the agencies' reimbursement to the State are reported and other basic financial arrangements, including revenue bonds, sharing of costs of joint-use facilities with the United States, and federal payments for flood control, are discussed. It reports the current status of construction and financing, as well as significant dates in the construction and operations programs.

Project facilities now operating range over California from Plumas County in the north to Riverside County in the south, with major facilities serving the people of the San Francisco Bay and Southern California areas, as well as the agriculture of the San Joaquin Valley. In service are 20 reservoirs, 5 power plants, 17 pumping plants, and some 540 miles of aqueduct.

Finally, this volume summarizes the benefits Californians have realized during the first 12 years of the Project's operations. Its data show the steady growth in water deliveries, power production, recreational use, and other services from 1962 through 1973.

This volume was prepared by Arthur C. Gooch, Chief, Program Analysis Office, from material contained in prior Department reports and with extensive assistance from personnel throughout the Department.

The other volumes give the details of the design, construction, and operation of the Project. The subjects are: Volume II, Conveyance Facilities; Volume III, Storage Facilities; Volume IV, Power and Pumping Facilities; Volume V, Control Facilities; and Volume VI, Project Supplements.



John R. Teerink, *Director*
Department of Water Resources
The Resources Agency
State of California

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ABSTRACT

Two hundred years of western civilization have brought California to the nation's peak in population and agriculture and given the State an urgent need to provide a growing supply of fresh water for the people, the crops, and the industries within its borders.

From a water supply development that began in 1770 with a six-mile aqueduct to serve the San Diego Mission of the Spanish Franciscans, Californians have moved forward to today's unprecedented construction of the California Aqueduct—a man-made river extending 444 miles down two-thirds of the length of the State.

Although considered the prime facility in the vast State Water Project, which extends from the northern reaches of the Upper Feather River to the homes and farms of Southern California, the Aqueduct is not the final act in the story of the State's water development.

Planning must continue to meet growing needs that will outstrip those that can be met by features existing or being built today. Past experience has shown that the State must take the lead in such planning efforts toward implementation of local projects as well as federal projects within the State and the State Water Project itself. It must also assume a prominent role in the development of regional water concepts which will benefit the entire western United States, enabling California and the other states of the West to develop and utilize water resources most effectively.

The Legislature, in 1951, authorized California's State Water Project and subsequently adopted a number of modifications to the basic proposal. In 1959, legislation was passed to authorize the use of general obligation bond funding for the Project, and the voters of the State approved this method of financing in 1960, thus establishing the basic financial foundation for the construction of future project works.

The Project commences in the Upper Feather River region where three of five authorized dams have been constructed. Their reservoirs primarily provide for recreation with minor irrigation and domestic water uses.

Downstream from these dams (about 90 miles) are the Oroville Facilities. Dominant among these facilities is Lake Oroville, which provides the major conservation storage for the Project. Other primary benefits from these facilities include flood control, electrical energy generation, recreation, and enhancement of fisheries and wildlife habitat.

Water released from the Oroville Facilities flows down the Feather River until it joins the Sacramento River and continues to the Sacramento-San Joaquin Delta. An aqueduct branches from the Delta to serve the north San Francisco Bay area.

The California Aqueduct is the primary conveyance feature of the Project for delivery of water to the southern San Francisco Bay area, the San Joaquin Valley, and Central and Southern California. The Aqueduct begins on the southern extremity of the Delta, extends southward along the western side of the San Joaquin Valley, crosses the Tehachapi Mountains, follows the northern flank of the San Gabriel and San Bernardino Mountains, crosses the San Bernardino Mountains, and terminates in Riverside County, a total distance of 444 miles from the Delta. Branch aqueducts to the southern San Francisco Bay area, certain coastal counties, and the Los Angeles metropolitan area also are included.

The Project is by no means complete. Construction will continue through the years ahead to keep abreast of the Project's water delivery obligations under the contracts for water supply. Continuing long-term planning, financing, and construction will be required since the Project is but the initial work of the State Water Resources Development System.


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VALLEJO
PERIPHERAL CANAL
SAN FRANCISCO
SOUTH BAY
AQUEDUCT
FRESNO
CALIFORNIA
AQUEDUCT
COASTAL
BRANCH
BAKERSFIELD
TEHACHAPI DIVISION
WEST
BRANCH
LOS
ANGELES
SAN DIEGO

CHAPTER I. PROBLEMS AND PLANNING CONSIDERATIONS

California, through the years, has been faced with the problem of how best to control, protect, conserve, and develop her most vital resource—water. In fact, this subject was a matter for discussion at the first meeting of the State Legislature in 1850. The continued growth of the State's population, industry, and agriculture has served to compound the planning considerations that must be faced in arriving at balanced solutions to the problem. Plans for water resources development within the State must recognize the diverse needs that exist and show both imagination and foresight in meeting them.

California Contrasts

The State of California is a land of contrast, which complicates its water problems. Its 100 million acres include both the highest and the lowest elevations in the coterminous United States. Its northern and southern borders are separated by 10 degrees of latitude; 10 degrees of longitude separate its eastern and western extremities. Its climate ranges from subtropical to alpine. Annual precipitation varies from less than 2 inches to more than 100 inches. Floods and droughts occur often, sometimes in the same year. California has large heavily populated cities and vast desolate areas. Highly productive agricultural developments are located in arid and semiarid regions of the State. Most of the State's population lives in areas close to the sea coast and remote from abundant water supplies. These contrasts are responsible for most of California's water problems. To a large extent, they have determined the scope and direction of the water development planning effort in the State.

Water Requirements

California's population has doubled in almost every 20-year period since 1860, and its water requirements have increased correspondingly. In 1950, when planning for the State Water Project was well underway, total water requirements for the State were about 21 million acre-feet per year. By 1965, water requirements had increased to more than 33 million acre-feet per year. Although the growth rate has slowed in recent years, it is estimated that the total water requirements of the State could reach 48 million acre-feet by 2020, soon after the State Water Project reaches full operating capacity. Thus, during the span of 70 years which will have elapsed between design and full operation of the Project (1950–2020), the total water requirements of the State can have increased by almost 150 percent.

Maldistribution

Considering the State as a whole, California's basic water problem is one of maldistribution rather than inadequacy. The State's average annual runoff substantially exceeds its water requirements and is expected to continue to do so even under ultimate conditions of development. This runoff, however, does not occur at the right time or in the right place. Most of the runoff occurs during the winter and spring when the needs are usually at a minimum.

The major sources of water are in Northern California, while the major urban and agricultural lands are in the central and southern portions of the State. Great distances and rugged mountains intervene between the source areas and areas of demand. About 70% of the total streamflow occurs north of the latitude of Sacramento, while 80% of the ultimate water requirements lie south of that line. The large variations of runoff that occur from year to year are another part of California's water problem. The typical pattern consists of a dry period of several years followed by one or more years of above-normal runoff. Years of average runoff are the exception rather than the rule.

Natural Storage

Correction of the maldistribution of water in time and place is a primary planning objective. Winter flows must be stored for use during the summer growing season, and the excess runoff of wet years captured for use during drought periods. To a certain extent, this is accomplished naturally. Snow in the mountains accumulates during the winter, and its melting produces runoff during the ensuing spring and summer months. Huge quantities of runoff are stored in ground water basins and made available for future use.

The State's extensive ground water basins have served in the past as a natural mechanism for ironing out the irregularities and discrepancies in water supply. Over the years, these ground water reservoirs have furnished the major part of California's water supplies. Some of the largest and most productive of the ground water reservoirs are located in the San Joaquin Valley and in Southern California. Unfortunately, they have been heavily exploited to the point where extractions exceed replenishment. Overdraft conditions have existed for many years.


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Reservoirs and Canals

Since the natural processes are not adequate to meet California's water development needs, additional storage is needed, primarily in surface reservoirs. Additional quantities of water can also be stored in underground basins in many areas of the State. In addition to storage, transportation facilities are desired which are capable of moving the water from the places of occurrence to the areas of need. Large conduits must be considered, extending for hundreds of miles and crossing formidable mountain barriers, such as the Tehachapis and the Coast Range. Active faults may have to be crossed and major structures built in areas of seismic activity. Special problems are posed by areas of ground subsidence in the San Joaquin Valley. The conveyance of water through the channels of the Sacramento-San Joaquin Delta requires major engineering and environmental considerations.

Flood Control

Most of California's development has occurred on its low-lying flatlands, the flood plains, alluvial fans, and deltas that were subject to periodic inundation under natural conditions. Over the years, extensive flood control projects have been constructed to protect many of these areas. These efforts, however, have not been able to provide an adequate degree of protection throughout the State. Acute flood problems still exist, particularly in the north coastal area and the Sacramento-San Joaquin Delta.

Water Quality

Deficiencies in water supply almost invariably have generated problems of water quality, some of which can be met by water development. Persistent overdraft conditions in coastal ground water basins have lowered water table elevations below sea level, inducing a landward flow of sea water into the aquifers, sometimes to the point that the utility of the ground water basin, or at least its coastward fringe, is practically destroyed. In some Central Valley ground water basins, excessive pumping has allowed connate brines to invade the fresh waters and impair or destroy their usefulness as well as creating deep subsidence problems (see Chapter IX, San Luis Division).

The intrusion of sea water into the tidal estuary of the Sacramento-San Joaquin Delta creates a water quality problem of major significance to the entire State. This intrusion is kept under control by maintaining a substantial outflow of fresh water into Suisun Bay, much of it taken from reservoir storage.

Wastes and Drainage

Most uses of water by man add pollutants to the waters with resultant deterioration of quality. As these uses increase, the need for adequate treatment and disposal of the waste waters becomes increasingly important. This is particularly true in areas of deficiency, where maximum reuse of water is desirable.

A lack of adequate drainage can seriously reduce the productivity of irrigated land. The disposal of saline drainage waters is also an important factor in the maintenance of ground water quality. A serious drainage problem, manifested by waterlogged lands and impaired water quality, exists in parts of the San Joaquin Valley, particularly on the west side. Provision of adequate drainage and suitable disposal facilities is an integral part of the development and utilization of California's water resources.

Hydroelectric Power

Until the midpoint of this century, most of the electric power used in California was produced by hydroelectric plants, where the energy of falling water is converted into electrical energy. Since about 1950, however, other sources of electrical energy have become increasingly important. A phenomenal growth in electric power demands has been caused by increases in population coupled with both greater per capita power consumption and wider use of electricity in commercial industry. This is illustrated by the fact that in the decade between 1963 and 1973, California's total installed electric generating capacity almost doubled, rising to 34.3 million kilowatts. For the last 20 years (1953 through 1973) new hydroelectric plants accounted for only about 20% of the State's increase in capacity.

Recreation, Fish and Wildlife

Outdoor living and water-associated recreation have always been important aspects of the California way of life. As the population of the State grows, and the time and opportunity for recreational pursuits increase, the need expands rapidly for more and better facilities for camping, fishing, hunting, swimming, boating, and other water-associated sports. The maintenance of streamflow for preservation or enhancement of sport fisheries and wildlife habitat is equally important. The limitation of reservoir fluctuations in the interest of boating and swimming and the provision of shoreline facilities are other important points in a balanced planning concept.

Rights to the Use of Water

The acquisition or adjustment of water rights is another essential element of water development planning in California. From the early days until the first decades of the 20th century, each water development was usually for a single purpose and was executed by a single individual or group for local usage only. The coordination among diverters on each stream was through the fabric of water rights woven by agreements and court decisions. Little attempt was made to determine how a diversion or storage project would affect groups on other streams, and normally there was no great need to do so.

Soon the need was recognized, however, for storing water during wet periods for subsequent use in dry periods. This was vividly brought into focus by the

long dry periods of the 1920s and 1930s, and the need for long-term cyclic carryover storage as well as annual regulation became paramount.

Two principles significantly affected the rights to the use of unappropriated water. The first of these is set forth in the California Water Code, Division 1, Chapter 1, Section 102, which states, "All water within the State is the property of the people of the State, but the right to the use of water may be acquired by appropriation in the manner provided by law."

The second principle is set forth in the California Constitution, Article XIV, Section 3, which states:

> "It is hereby declared that because of the conditions prevailing in this State the general welfare requires that the water resources of the State be put to beneficial use to the fullest extent of which they are capable, and that the waste or unreasonable use or unreasonable method of use of water be prevented, and that the conservation of such waters is to be exercised with a view to the reasonable and beneficial use thereof in the interest of the people and for the public welfare. The right to water or to the use or flow of water in or from any natural stream or water course in this State is and shall be limited to such water as shall be reasonably required for the beneficial use to be served, and such right does not and shall not extend to the waste or unreasonable use or unreasonable method of use or unreasonable method of diversion of water. Riparian rights in a stream or water course attach to, but to no more than so much of the flow thereof as may be required or used consistently with this section, for the purposes for which such lands are, or may be made adaptable, in view of such reasonable and beneficial uses; *provided, however,* that nothing herein contained shall be construed as depriving any riparian owner of the reasonable use of water of the stream to which his land is riparian under reasonable methods of diversion and use, or of depriving any appropriator of water to which he is lawfully entitled. This section shall be self-executing, and the Legislature may also enact laws in the furtherance of the policy in this section contained."

To the extent that unused water was not subject to vested rights, it could be made available by construction of storage and diversion facilities. The law pertaining to the acquisition of rights to the use of unappropriated water for these purposes would be applicable, however. Where necessary, vested rights also can be acquired by agreement or condemnation.

A discussion of water rights, particularly as they relate to the State Water Project, is contained in Chapter IV.

CHAPTER II. EARLY WATER DEVELOPMENT

The history of California is written in the story of its water development. From the 18th and 19th centuries into the early 1900s, this development was carried out primarily by individuals and private companies. The period between World Wars I and II saw the initiation of statewide planning for water development, the preparation of the State Water Plan, and the Legislature's approval of the Central Valley Project as the first implementation of a part of the State Water Plan (see Appendix D, Definition of Terms). These plans incorporated the works constructed and planned for by local agencies, especially the metropolitan centers, and federal agencies and created the first coordinated, master plan for the State's water development.

18th and 19th Centuries

The record of water development in California goes back to the latter part of the 18th century when Spanish missionaries diverted water from streams to irrigate crops in the valleys of Southern California. The gold rush of 1849 gave impetus to water development, and many ditches were constructed in the Sierra Nevada for placer mining. Some of these ditches were later utilized for irrigation and power, and some of them are in use even today.

Information on California's water resources has been systematically recorded since 1849 when precipitation stations were established at Sacramento and San Francisco. The first streamflow gauging stations in California were established in 1878 under the direction of the first State Engineer, William Ham Hall. Systematic planning for the comprehensive development of California's water resources began in 1873, when a commission appointed by President Grant investigated the water resources of the Central Valley. The report of this study offered a plan for utilizing the water supply of the Sierra Nevada and pointed to the responsibility of the Federal and State Governments in providing guidance, direction and leadership in developing California's water supplies.

The State launched its first comprehensive investigation of its water resources and development in 1878 under direction of the State Engineer. He concurred in the 1873 study that the waters of the Central Valley should be developed in a systematic manner, and he published a series of maps and reports to substantiate his views.

Early 1900s

Until the present century, water developments in the State generally were accomplished by individuals or companies. As California grew and the need for water increased, private initiative was followed by community enterprises, irrigation districts, public utilities and municipal projects of steadily increasing size and complexity. The metropolitan centers, Los Angeles, San Francisco, and the Oakland area, were leaders in developing projects to import water.

Before the 1920s, water development planning in California was conducted primarily by local entities to solve local problems. These plans were conceived and executed without the benefit of a statewide framework to provide guidance and coordination.

Statewide Planning

Water development planning on a statewide basis was initiated by Colonel Robert B. Marshall, chief geographer of the U. S. Geological Survey, and outlined in a bulletin published in 1919 under the sponsorship of the California State Irrigation Association. Colonel Marshall proposed that waters of the Sacramento River and its tributaries be impounded and delivered to the Sacramento and San Joaquin Valleys through large canals for irrigation of 12,000,000 acres. He also proposed exporting water to Southern California.

In 1921, the State Legislature authorized the State's water officials, then in the Department of Public Works, to conduct a statewide water resources investigation. The Department made its first report to the Legislature on this investigation in 1923 (Ref. 1; see Appendix A, References and Other Sources). A supplemental report went to the Legislature in 1925 (Ref. 2), and a summary report was made in 1927 (Ref. 3). A related report was made in 1929 (Ref. 4).

State Water Plan

In 1931, State Engineer Edward Hyatt made a report (Ref. 5) to the Legislature on what he called the State Water Plan. (Mr. Hyatt was State Engineer from 1927 to 1950, and Chief of the Division of Water Resources within the Department of Public Works.) Nine years and $1 million were spent in preparation of the report on the State Water Plan. It discussed both the physical and economic aspects of the proposed development. It provided for an exchange of water between the north and south portions of the

Central Valley, recognized the national benefits, estimated the cost, and discussed possible methods of repayment. This report found that such a development of the Central Valley would cost $160,000,000.

Federal agencies also reported on various phases of the proposed development of the Central Valley. The most important reports were those by the Corps of Engineers in February 1931 (Ref. 6) and the Bissell report made cooperatively by the Bureau of Reclamation and the State of California in May 1931 (Ref. 7).

Central Valley Project

Two years after the State Water Plan was presented to the Legislature, it passed the Central Valley Project Act of 1933 (Chapter 1042, Statutes of 1933, now codified in Water Code Div. 6, Part 3, commencing at Sec. 11100) to implement the initial features of the State Water Plan in the Central Valley. This same act was later incorporated by reference in the Burns-Porter Act of 1959 (Water Code Div. 6, Chapter 8, Part 6, Sec. 12931, *et seq.*) and provided the vehicle for additional financing of the State Water Project (see Chapter III).

The Central Valley Project Act provided for dams, reservoirs, canals, pumping plants, and power plants in an extensive system to improve utilization of the Sacramento, San Joaquin, and other rivers. Facilities authorized were: Kennett Dam (now Shasta Dam), Contra Costa Conduit, San Joaquin Pumping System, Friant Dam, Madera Canal, Friant-Kern Canal, and "such other units as may be added from time to time".

The Act also provided financing through issuance of $170,000,000 in revenue bonds. After passage of the bill, it was subjected to a referendum, which placed it before the voters of the State in a special election held on December 19, 1933. The project won the voters' approval.

No funds, however, could be obtained to begin construction of the Central Valley Project, because the nationwide depression of the early 1930s made the revenue bonds unmarketable. Subsequently, federal authorization and financing through the Bureau of Reclamation of the U. S. Department of the Interior was arranged and construction began in 1935. Today, the Central Valley Project of the Bureau of Reclamation constitutes a major water development, storing water in many reservoirs and delivering several million acre-feet of water throughout the Central Valley.

Federal Agencies

The role of the federal agencies in water resources development in California extends well beyond the Central Valley Project. The U. S. Department of the Army, Corps of Engineers, has responsibility for flood control, river navigation, and harbor development. The Bureau of Reclamation has an interest in water resources conservation and land reclamation. Both agencies have constructed major single-purpose and multi-purpose projects in California. The U. S. Department of Agriculture, Soil Conservation Service, also has contributed by providing financial and technical assistance to local agencies in developing small watershed management and flood control projects to complement the larger developments by the Bureau of Reclamation and the Corps of Engineers.

CHAPTER III. MOVING TOWARD THE STATE WATER PROJECT

The planning that led to the State Water Project began after World War II and was stimulated by the unprecedented development of California and the corresponding increase in the need for water. The State's Division of Water Resources engaged in two series of studies, each with a separate objective. One concentrated on the collection of basic data and development of a statewide water plan, the California Water Plan. The other considered a specific project as an initial unit of the Plan, the State Water Project.

California Water Plan

The Legislature in 1945 authorized the State Water Resources Board to conduct an investigation of the water resources of California (Chapter 1514, Statutes of 1945, now codified in Water Code Div. 6, Part 6, Ch. 1, commencing at Sec. 12570, and Ch. 2, commencing at Sec. 12639). The investigation was designated the "Statewide Water Resources Investigation". Funds were provided in the 1947–48 budget for commencement of the investigation, and additional funds were provided by subsequent appropriations through 1955. These investigations were carried out by the Division of Water Resources of the Department of Public Works as a service for the State Water Resources Board.

This work brought about the publication in 1951 of Bulletin No. 1, "Water Resources of California" (Ref. 8). It reported data on precipitation, unimpaired stream runoff, floodflows and frequency, and quality of water throughout the State. In 1955, the State published Bulletin No. 2, "Water Utilization and Requirements of California" (Ref. 9). It included estimates of the current use of water throughout the State for all consumptive purposes and presented forecasts of probable ultimate water requirements, based in general on the capabilities of lands for development. The third and concluding phase of the Statewide Water Resources Investigation was reported in Bulletin No. 3, "The California Water Plan" (Ref. 10).

Bulletin No. 3 presents preliminary plans for full practical development of all the water resources of the State to meet its ultimate water needs. The Bulletin describes plans for local water resource development together with those works needed for the major transfers of water from the areas of surplus in the north to the water-deficient areas to the south.

Specific Project Planning

The Division of Water Resources also pursued the second type of study, i.e., a project that would meet the water requirements of the State in the immediate future. In May 1951, State Engineer A. D. Edmonston (State Engineer, 1950–1955) presented the first complete report on the Feather River Project (Ref. 11). This report proposed a multiple-purpose dam and reservoir on the Feather River near Oroville complete with power plant, and afterbay dam and power plant, a Delta Cross Channel, an electric power transmission system, an aqueduct to transport water from the Delta to Santa Clara and Alameda Counties, and an aqueduct to transport water from the Delta to the San Joaquin Valley and Southern California.

State Water Project Authorized

The proposed project was authorized by the Legislature in 1951 under the State Central Valley Project Act (Water Code Sec. 11260). It was designated "The Feather River and Sacramento-San Joaquin Delta Diversion Projects". Under the Central Valley Project Act, the Division of Water Resources was authorized to continue necessary investigations, surveys and studies, including the preparation of plans and specifications for the construction of the authorized works, and to submit its plans to the Water Project Authority for approval.

The Division of Water Resources continued its studies and investigations and, in 1955, after approval by the Water Project Authority, submitted another report to the Legislature on the proposed Feather River Project (Ref. 12).

Project Modified

The 1955 report showed that the project had engineering and financial feasibility and recommended that the Legislature appropriate funds to start construction. The report also recommended modifications of the original 1951 plan by adding San Luis Reservoir on the west side of the San Joaquin Valley and by including San Benito County to be served by the aqueduct primarily proposed for Santa Clara and Alameda Counties. In August 1955, the Legislature referred the report to independent consultants, the Bechtel Corporation, for review. The Bechtel report to the Legislature (Ref. 13) concluded:

> "Engineering concepts as proposed by the State Engineer are considered sound with respect to the scope of the Feather River Project . . . . The financial requirements of the project appear to be manageable in relation to probable population, income and wealth of the State, and therefore it is our considered judgment that, subject to the conditions outlined herein, it is feasible to

finance the Feather River Project with general obligation bonds of the State."

After receipt of the Bechtel report, the Legislature directed that the project incorporate the modifications which the Division of Water Resources had proposed in its 1955 report (California Stats. 1956 Ex. Sess., Ch. 54, amending Water Code Section 11260).

Winter Flood of 1955–56

During late 1955 and early 1956, Northern and Central California were subjected to the greatest flood in the area's history of recorded streamflow. The intense flood-producing precipitation covered an area of about 100,000 square miles, which represented over 60% of the area of the State. On many streams, the peak discharges are believed to have been greater than the near-legendary floods of 1861–62. Loss of at least 64 lives was attributed to the flood, most of which were lost in Sutter County in and around Yuba City. Damage to public and private property amounted to more than $200,000,000 in direct losses and immeasurable indirect losses.

Construction Begins

In February 1957, the Legislature, reacting to the floods of the previous year, made the first emergency appropriation ($25,190,000) to the Department of Water Resources (created July 1956 as discussed later) for actual construction of the State Water Project (Calif. Stats. 1957, Ch. 15). Construction began in May 1957 on facilities in the Oroville area. The first contract covered construction of tunnels numbers 4 and 5 on the Western Pacific Railroad relocation, part of the work necessary to clear the dam and reservoir site of the railroad. Appropriations were made from year to year through 1960 to continue the Oroville relocations and to start construction of the South Bay and California Aqueducts in 1959.

The Legislature, in 1959, reaffirmed its earlier declaration that the people of the State have a primary interest in the orderly and coordinated development, utilization, and protection of the water resources of the State. It also accepted the California Water Plan (Ref. 10) "with such amendments, supplements and additions as may be later necessary" as the guide in achieving that end (Water Code Sections 10004–10007).

Burns-Porter Act

Although units of the State Water Project had been authorized and construction begun in 1957, it was not until 1959 that the Legislature enacted the legislation necessary to fully implement these authorizations. A comprehensive water program was presented to the Legislature, and it adopted the California Water Resources Development Bond Act, known and cited as the Burns-Porter Act (Water Code Sections 12930–12944), subject to ratification by the voters at a 1960 general election. (The text of the Act as enacted in 1959 is reproduced in Appendix B.) This Act, together with other measures, was designed to assist in the financing of the State Water Resources Development System.

The Act authorized the issuance of $1.75 billion in general obligation bonds to assist in the financing of immediate construction of the State Water Facilities and later construction of specified additional works (Water Code Sec. 12935). The State Water Facilities, the first stage in the State Water Resources Development System, constitute what is widely known as the State Water Project.

As specified by the Burns-Porter Act, the State Water Resources Development System includes, in addition to the State Water Facilities, such additional facilities as the Department of Water Resources deems necessary and desirable to augment water supplies in the Delta and to meet local needs including flood control. These may consist of multiple-purpose dams, reservoirs, aqueducts, and appurtenant works in the watersheds of the Sacramento, Eel, Trinity, Mad, Van Duzen, and Klamath Rivers (Water Code Sections 12931 and 12938).

The Burns-Porter Act provides that the facilities financed thereunder shall be acquired, constructed, operated, and maintained pursuant to the provisions of the Central Valley Project Act (Water Code Sec. 12931). It thus includes a number of additional powers and limitations. Some of the more significant of these are:

(1) Area of origin law (Water Code Sections 11128 and 11460–11463),

(2) Authority to cooperate with the United States (Water Code Sec. 11500),

(3) Provisions concerning contracts for the furnishing of project services (Water Code Sections 11454–11455 and 11625–11671), and

(4) Authority to issue revenue bonds for the construction of facilities (Water Code Div. 6, Part 3, Ch. 8, commencing at Sec. 11700; 36 Ops. Cal. Atty. Gen. 160 [1960]; Calif. Assembly Journal 845–47 [Mar. 5, 1963]; *Warne* v. *Harkness*, [1963] 60 Cal. 2d 579, 387 P. 2d 377).

Another method of financing the State Water Resources Development System under the Burns-Porter Act was through its appropriation of the California Water Fund for project construction (Water Code Sec. 12938). The California Water Fund was created by the 1959 Legislature (Water Code Div. 6, Part 6, Ch. 7, commencing at Sec. 12900), and monies (almost $29 million) in the then existing Investment Fund were transferred to it. (The Investment Fund had been established by the 1956 Legislature from the State's share of Long Beach oil revenues.) Specified

portions of state lands revenues and revenues from oil produced in the Long Beach Harbor tidelands were also designated for deposit in the California Water Fund (Water Code Sec. 12912).

The State Water Facilities authorized for construction by the Burns-Porter Act include water development facilities for local areas (Water Code Sec. 12934) as provided in the Davis-Grunsky Act (Water Code Div. 6, Part 6, Ch. 5, commencing at Sec. 12880), discussed in Chapter X. The forerunner of this act had been adopted by the Legislature in 1957 (Calif. Stats. 1957, Ch. 2052) and established the policy of providing state loans and grants to public agencies.

The Burns-Porter Act authorized the issuance of bonds in the amount of $130 million (Water Code Sec. 12938) out of the $1.75 billion general obligation bond authorization to meet expenditures under the Davis-Grunsky Act to further the development, control, and conservation of the water resources of California.

Act Upheld and Ratified

Immediately following the passage of the Burns-Porter Act, the Department began studies to develop a coordinated financial, construction, and management program. Beginning in the spring of 1960, the proposed program was given comprehensive and independent review by engineering and financial consultants, whose separate reports were published in October 1960.

The engineering consultants, Chas. T. Main, Inc., included the following conclusions in their report (Ref. 14):

> "The various structures proposed for the system present no engineering problems which cannot be solved by proper design . . . The conservation facilities . . . would yield sufficient water to supply the 1990 demand throughout the repayment period . . . the project could pay back all costs if 1960 costs prevail . . . and if a master district is established in the San Joaquin Valley and in certain other agricultural areas . . . . The Burns-Porter Act falls slightly short of providing sufficient funds . . . and makes no provision for escalation."

The financial consultants, Dillon, Read & Co., Inc., said in their report (Ref. 15):

> " . . . the Program would meet our financial feasibility tests on the basis of present construction cost levels."

The bond act required the approval of a majority of the State's voters in order to become effective. It received the approval of the majority (51.47%) of the voters at the general election of November 8, 1960.

The constitutionality of the California Water Resources Development Bond Act was sustained by the California Supreme Court in *The Metropolitan Water District of Southern California* v. *Marquardt*, 59 Cal. 2d 159, 379 P. 2d 28 (1963). This was a mandate action brought under the original jurisdiction of the State Supreme Court to test the validity of the water supply contract between the State and The Metropolitan Water District of Southern California. The Court upheld the Burns-Porter Act against the various constitutional objections levied against it and upheld all the provisions of the contract.

Reorganization of Water Agencies

In 1956, the Legislature took an important step to further the development of the State's water resources program. It provided for a reorganization of the water agencies of State Government. Effective July 5, 1956, the State Department of Water Resources was created by act of the Legislature (Chapter 52, Statutes of 1956, First Extraordinary Session, see Water Code Sections 120–127).

The new department was created by transferring to it the functions of the Water Project Authority and the functions of the Division of Water Resources of the Department of Public Works, except those relating to the appropriation of water and the determination of water rights, which were vested in a new State Water Rights Board (now State Water Resources Control Board). The authority of the State Water Resources Board, relative to the conduct of statewide water resources investigations, special investigations, and the completion of Bulletin No. 3, "The California Water Plan", also was transferred to the Department of Water Resources.

In addition, the former State Water Resources Board was designated the State Water Board (later changed to California Water Commission) and was placed within the Department of Water Resources to confer with, advise, and make recommendations to the Director with respect to any matters and subjects under his jurisdiction and to perform other duties (Water Code Sections 150–166).

Subsequently, in October 1961, the Resources Agency of California was created bringing under one administrator (now Secretary) the State's programs for conservation and use of natural resources.

CHAPTER IV. WATER RIGHTS

The problems and solutions concerning the acquisition of water rights by the State for the operation of the State Water Project evolved during the planning period and have continued since that time. Even before the beginning of planning of the Project, much of the runoff had been appropriated for beneficial uses under water rights that date back, in some cases, to the early mining days more than a century ago.

Riparian and Appropriative Doctrines

In general, the surface water resources of the State flowing in any natural stream or watercourse may be diverted for beneficial use under the riparian or appropriative doctrines (Ref. 16).

There is no California statute defining riparian rights, but a modification of the common law doctrine of riparian rights has been established in this State by decisions of the courts and confirmed by the provision of Section 3, Article XIV of the State Constitution (see also Water Code Sections 100–101). Lands within the watershed of a natural watercourse which are traversed thereby and border thereon, with certain exceptions and limitations, are riparian, and each owner thereof has a right which is correlative with the right of each other riparian owner to share in the reasonable beneficial use of the natural flow of water which passes the land. No permit is required from the State Water Resources Control Board for such use.

Prior to 1872, appropriative water rights could be acquired by simply taking and beneficially using water. In 1872, Sections 1410 through 1422 of the Civil Code were enacted. These sections established a permissive procedure for perfecting an appropriation of water. Provision was made for posting a notice of appropriation at the proposed point of diversion and recording a copy thereof with the County Recorder. If the statutory procedure was followed and the appropriation completed with due diligence, priority related back to the date of posting. Subsequent to 1872, the priority of an appropriator who did not comply with the Civil Code procedure did not attach until water was beneficially used.

The two methods of appropriation existing prior to the effective date of the Water Commission Act, i.e., December 19, 1914, are no longer available for appropriating water in surface streams and other surface bodies of water and in subterranean streams flowing in known and definite channels. An appropriation of such water requires compliance with the provisions of Division 2, Part 2, of the Water Code, which is administered by the State Water Resources Control Board.

Unappropriated Water

The unappropriated water available to the State Water Project originates chiefly in the mountains bordering the Sacramento Valley, with lesser amounts coming from the mountains east of the San Joaquin Valley and from the floors of the Valleys. The return flows from upstream diversions also make up part of the water supply. While much of the runoff from these sources had been appropriated for beneficial uses under prior water rights, additional portions of unappropriated water were also needed in the future to meet the growing needs of the areas in which the water originates as well as in the areas of deficient water supplies.

State Filings

The acquisition of rights to surplus waters now being conserved and transported by the State Water Project began almost 50 years ago. In 1927, the Legislature took an important step to assist the State in obtaining water rights to implement the plans reported on by the Department of Public Works in the mid-1920s. It enacted a law to provide in effect for the reservation of unappropriated water for future development in accordance with statewide plans (Chapter 286, Statutes of 1927, now codified in Water Code Sec. 10500, *et seq.*).

The 1927 act gave the Department of Finance authority to file applications to appropriate unappropriated water for a general or coordinated plan of development. (Applications, pursuant to Water Code Section 10500, *et seq.*, are now filed by the Department of Water Resources, transferred to the State Water Resources Control Board, and held by the Board pending assignment to the developing agency.)

The law provided that the applications may be held up to a specific date prescribed by legislative enactment, without regard to diligence as required of other applicants, until the particular project is ready for construction. The applications then may be assigned to the agency which is prepared to implement the plan or a portion of the plan. Exemptions from diligence have been granted periodically by legislative enactment and now extend through 1975. They are expected to be continued in four-year increments until full project water deliveries are being made.

The Department of Finance filed a number of applications on July 30, 1927, the day after the law became effective, and thus initiated the legal process

to establish water rights under the plans of that time for coordinated statewide development of California's water resources. These applications have been assigned to and are now held by the State, the United States, or other agencies. Water right permits have been issued on many of these applications to the Department of Water Resources for the State Water Project, to the Bureau of Reclamation of the U. S. Department of the Interior for the Central Valley Project, and to other agencies.

Local Area Protection

During the water development planning of the 1920s, the Legislature was asked to give assurance to the counties wherein the water originates that they would always be entitled to as much of their local water supplies as they need. These counties wanted to ensure that any exportations of water would not leave them short at any time in the future. The first enactment along this line was made in 1931 as the County of Origin Law (Water Code Sec. 10505). This forbids assignment or release of priority of an application for which there was a state filing that would deprive a county in which the water covered by the application originates of any water necessary for the development of that county.

A second restriction on the exportation of water was included in the Central Valley Project Act, adopted in 1933. This provides that the construction and operation of the project shall not deprive areas in which water originates, or areas immediately adjacent thereto which can conveniently be supplied with water therefrom, of the prior right to all of the water needed for their development (Water Code Sections 11460–11463, watershed protection statutes).

The area and county of origin laws were the subject of two opinions of the State's Attorney General in 1955 (25 Ops. Cal. Attorney General 8 [1955] and 25 Ops. Cal. Attorney General 32 [1955]). These opinions confirmed problems which resisted solution and delayed progress of the State Water Project until 1959.

North-South Controversy

The opinions upheld the constitutionality of the area and county of origin laws. The State Attorney General held that, even though water was put to use through an export project constructed by the State, it could be recaptured whenever needed by the area of origin. This led to a controversy variously referred to as the North-South fight, the argument between the areas of surplus and the areas of deficiency, or the Senate-Assembly dispute (representatives from northern counties dominated the Senate at that time; those from the south, the Assembly).

This was the setting in which the 1956, 1957, and 1958 regular sessions of the Legislature convened, hoping to resolve this difficult and complex problem. In addition, the Second Extraordinary legislative session in 1958 was called by Proclamation of the Governor to obtain passage of the State Budget. The Budget had not been passed in the regular legislative session because of widespread disagreement among legislators regarding appropriations for continuing construction work on the State Water Project that had begun in 1957. Although the Budget was subsequently passed, the root problem still existed.

The Administration was confronted with an established state policy requiring that any area using water out of a state project must use the water subject to the right of recapture by the watershed of origin, if and when required for the beneficial use of the counties located in that area of origin.

Senate leadership in the Legislature was firm in its determination to preserve the historic state policy embodied in the County of Origin statutes. The Assembly was equally dedicated to the adoption of a modification of that basic policy that would assure continuance of the water rights upon which water supply contracts with the State were to be predicated.

Valiant attempts were made to find an acceptable solution to this problem. Constitutional amendments were drafted and redrafted. Some provided only the broad principles of reconciliation while others were specific and detailed, spelling out each and every right of the conflicting forces up to and including specific quantities of water available for use and recapture. Numerous committees, although composed in many instances of the most capable water leaders in the State, could not effect an acceptable solution, and eventually each was disbanded. Historic precedents and concepts built into state water policy over the prior century of California water law were too firmly entrenched to be modified by any individual or group. This was the setting in which the 1959 Legislature met in an attempt to break this deadlock.

Governor Edmund G. Brown, prior to the 1959 regular legislative session, was faced with an almost impossible job if he was to attempt to resolve all of the conflicting factors involved in the development of the state water program. The past legislative sessions had clearly demonstrated that the State, as an entity, would not operate a program that had inherent within it the power to impair the ability of one of its parts to expand and grow by depriving that part of the water necessary for growth. It was equally clear that the beneficiaries of the project could not be expected to support a program, either politically or through financial commitments, unless firmly convinced as to the power of the State to complete the program and the continued ability to deliver the quantities of water specified in contracts entered into.

In order to give the southern part of the State the assurances it needed, a program had to be planned and adopted that would circumvent the effect of the Watershed Protection Act and County of Origin statutes

by some means other than legislation affecting their legal status.

The Administration attempted to demonstrate that all the water required to service all of the interests involved could be supplied under a state program and thus was able to avoid facing the dilemma which had so completely disrupted the plans of prior administrations.

Assuming that demonstration of the fact that adequate water supplies existed would resolve the controversial recapture issues, there still remained the drafting of legislation that would provide funds for construction of the facilities required to store and distribute the water. This legislation was to be known as the Burns-Porter Act and was introduced as Senate Bill 1106. It is doubtful that the history of California can produce a single piece of legislation, the contents of which were more carefully and closely screened.

The Act was designed to meet three basic points stated by the south to be its minimum requirements for such legislation at the beginning of the 1959 legislative session. These points were:

1. That the possible effect of the Mallon decision be overridden to the extent that water contracts between the State and local entities not be subject to abrogation or interference by a future act of the Legislature.
2. That the bond authorization be in sufficient amount to cover the entire sum necessary to complete the Feather River facilities (State Water Project) notwithstanding the fact that other funds might be available for construction purposes.
3. That the facilities for which the bond money was to be spent be described.

The requirements of the north were:

1. That there be no constitutional amendment.
2. That the watershed protection and county of origin statutes not be modified or changed by this legislation.
3. That funds be made available for the construction of projects to serve the north.
4. That the Feather River facilities and the funds made available therefor should not be "a single shot deal" and that funds be assured for the construction of additional major storage to augment supplies of water in the Delta for export.

Argument Settled

All of these points were met by the Burns-Porter Act as finally approved by a two-thirds majority in both houses of the Legislature in 1959. The solution was based on two concepts. First, California had adequate water supplies, including the State's rights in and to the waters of the Colorado River, if properly conserved and conveyed to meet the needs of both the areas of origin and the areas of deficiency. Second, the problem was to assure adequate financing for projects to furnish water supplies to all areas and at the same time to provide flood control, power production, recreation, and enhancement of fisheries. The Burns-Porter Act dealt with these concepts by establishing (1) an assured system of financing for the initial conservation and transportation features of the State Water Project, and (2) offset bond financing for the later development of projects to meet local needs and to replenish water supplies available for export from the Sacramento-San Joaquin Delta when the Delta inflow and the State Water Project yield is reduced by increased use in the areas of origin upstream. Additionally, the Act provided $130 million for local projects under the Davis-Grunsky Act. The Burns-Porter Act thus provided an accommodation related to water rights arguments between north and south, as well as established the financial foundation for the Project's initial phase and for its later expansion through additional development.

Under the foregoing concepts, the Department was assigned applications previously filed by the Department of Finance under Water Code Section 10500, *et seq.* for water rights for the operation of the State Water Project.

State Water Resources Control Board Decision 1275

In 1967, after a 40-day water rights hearing, the State Water Resources Control Board (State Water Rights Board at that time) issued Decision 1275, which ordered that permits be issued to the Department subject to numerous terms and conditions. Included among the terms and conditions was the so-called "Blind Point" condition which prohibited the Department from diverting water from the Sacramento-San Joaquin Delta or collecting water to store in Oroville Reservoir any time during the period April 1 to June 30, when the maximum chloride content of the San Joaquin River at Blind Point in the Delta exceeds 250 parts per million. The Board also reserved jurisdiction for the purpose of formulating or revising terms and conditions relative to salinity control in the Delta.

State Water Resources Control Board Decision 1379

Exercising the jurisdiction reserved in Decision 1275, the Board convened a hearing on July 22, 1969 and, on the basis of a record developed during 93 days of hearings extending to October 5, 1970, issued on July 28, 1971 its Decision 1379. This decision ordered the Department and the Bureau of Reclamation, among other things, to prevent Delta channel water quality from degrading below specified standards. They must accomplish this either by discontinuing pumping from the Delta to supply the two water projects or by releasing natural flow or water stored in upstream reservoirs of the projects, or by a combination of both methods. Additionally, they are required to conduct studies in the Delta concerning

temperatures, velocity, algal growth, dissolved oxygen, scour, turbidity, and productivity. The Board recognized that much is yet to be learned about the Delta and provided in Decision 1379 that the hearing will be reopened not later than July 1, 1978 for the purpose of receiving further evidence concerning salinity control, protection of fish and wildlife, and other related matters.

Implementation of Decision 1379 was prevented by a Sacramento County Superior Court preliminary injunction issued on petition of several public agencies receiving or expecting to receive water from the federal and state projects (*Central Valley East Side Project Association, et al* v. *State Water Resources Control Board* and *Kern County Water Agency, et al* v. *State Water Resources Control Board*).

Until the litigation concerning Decision 1379 is settled and the provisions of the decision become effective, the Department is operating the State Water Project under the water right permits issued by the Board pursuant to its Decision 1275 but in doing so is in compliance with Decision 1379 thus far.

CHAPTER V. WATER SUPPLY

The water supply available to the State Water Project originates primarily in the drainage areas tributary to the Central Valley. Precipitation throughout the Central Valley occurs almost entirely during the winter months providing unstored flows into the Sacramento-San Joaquin Delta which are available for export. During the summer months, the export supplies are dependent upon multipurpose releases from upstream reservoirs and irrigation return flows.

Two basic concepts comprise the foundations for the operations studies necessary to determine the dependable yield of the State Water Project. The first is the Delta Pooling Concept, which requires that the yield of the State Water Project from water of the Central Valley be taken after local upstream requirements have been satisfied. The second concept is that the State Water Project and the Central Valley Project must coordinate their operations.

Delta Pooling Concept

The Delta Pooling Concept is premised on the counties of origin and watershed protection statutes of the California Water Code (Sections 10505 and 11460 through 11463). These statutes provide, in effect, that no water shall be exported from an area in which it originates, or from areas immediately adjacent that can be conveniently served by such water, if it is needed for the development of those areas. Water supplies may be depleted for upstream uses in the counties of origin, and local agencies in the area in and above the Delta also have a prior right to contract for water service from the State Water Project. These principles are incorporated into the contracts between the State and the water service contractors for water deliveries from the State Water Project. As these depletions to the water supply occur, the Department will provide additional project conservation facilities to sustain the project diversions. The costs of these facilities, together with costs of the initial conservation works, will be repaid by water service contractors under the "Delta Water Charge". Each contractor for a water supply will pay this charge annually as a uniform rate per acre-foot of annual entitlement. It is a conservation charge which will be the same for all contractors. It is designed to amortize, with interest, over the entire project repayment period the State's capital investment represented by each year's construction expenditures on conservation facilities, together with applicable operating expenses incurred during the year. Thus, a single price is charged for project water, at or upstream from the Delta, to recover the costs of all project conservation facilities. This rate varies over time, however, as additional costs of conservation facilities occur.

The effect of this principle is to average, for both present and future customers, the lower costs of the initial conservation features with the higher costs of later conservation facilities. This eliminates, for the State Water Project water contractors, the traditional appropriative water rights concept that "first in time is first in right" and places all customers on an equivalent footing under a utility framework.

Coordinated Operation Concept

On May 16, 1960, the Department of Water Resources, on behalf of the State of California, and the Bureau of Reclamation, on behalf of the United States, entered into an unprecedented history-making agreement. This agreement provides the basis for the coordinated operation of the State Water Project and the Central Valley Project.

This agreement dispelled the problem of a lengthy water right adjudication or lawsuit to establish rights of the State and Federal Government to water in the Central Valley. Instead it provides for coordination of the projects without respect to the relative priorities of water rights. The agreement also provides for a method of allocating shortages of water supplies. Article 16 of the agreement specifically recognizes that additional criteria will be needed for the actual day-to-day operation to produce the maximum accomplishment of the two projects.

This need for coordination was also set forth in the December 30, 1961 agreement for the construction of the San Luis Joint-Use Facilities.

Negotiations toward coordinated operation culminated in a draft document, dated May 13, 1971, entitled "Supplemental Agreement Between the United States of America and the State of California for Coordinated Operation of the Central Valley Project and the State Water Project". This draft has not been approved by the Secretary of Interior because of a lawsuit filed by the Environmental Defense Fund, Inc., and determination of whether an environmental impact statement should be prepared. In the meantime, the two agencies have used the draft agreement as a basic guideline on a year-to-year basis with complete satisfaction of its adequacy.

This draft agreement provides a computational procedure by which the two agencies shall coordinate the operations of their facilities to meet the Sacramento Valley in-basin uses, including water quality objectives, flood control operational criteria, and equitable division of unstored flows available for export. It was recognized that while this initial attempt to establish operational guidelines for a complex, dynamic, and unpredictable system might work perfectly, changing conditions will inevitably require changes in the agreement. Therefore, the parties will review the agreement at the end of every five years and adopt any necessary changes.

This draft agreement is also used as a measure of the impact that a proposed facility or a revised operating objective will have upon the yield of each project.

Project Yield

The dependable yield of the State Water Project was determined by operation studies for the historical water supply period from 1922 through 1954. This period was selected because (1) it contains the most severe drought period of record, from 1928 through 1934; (2) it includes the two driest years of record, 1924 and 1931; and (3) hydrologic conditions preceding and during the period were such that the reservoirs would be full at the beginning and at the end of the period.

Reductions in water available for agricultural use during the critical supply period amount to a maximum of 50 percent in any one dry year and a total of 100 percent of a year's supply in any series of seven consecutive years pursuant to standard contract provisions.

The yield capabilities of the conservation facilities of the State Water Project are determined by the relationship among total water demands, available water supplies, and the operational characteristics and capabilities of the project conservation facilities. The yield of the facilities will not remain static. It will gradually decrease as upstream depletions increase to meet the needs of future urban and agricultural development in the areas of origin.

The general procedure of the actual yield studies are discussed in the Department's Bulletin No. 132-65 (Ref. 17). A complete detailed description of a typical operation study was presented as evidence in the 1966 water rights hearings on the State's applications to store water at Oroville and San Luis and to divert water from the Sacramento-San Joaquin Delta. These department studies are documented in two reports, entitled "Sources of Data and Columnar Description for the Coordinated Operation of State Water Project and Central Valley Project", July 1966 and "Supplemental Information for DWR Exhibit No. 80, Coordinated State Water Project—Central Valley Project Operation Study", August 1966.

Water requirements of the Feather River service area downstream from Oroville Dam needed to be satisfied before releases from the reservoir could be considered available for export. The reservoir would make available a firm supply ranging from 730,000 to 970,000 acre-feet per year for irrigation use in the Feather River service area. Previously, about 450,000 acre-feet per year were available during a dry year (Ref. 12).

The Burns-Porter Act was designed to finance a 4,000,000-acre-foot project with a yield sufficient to accommodate growth of water needs in its service areas until 1990. This was predicated upon the continued availability of 5,326,000 acre-feet of water per year from the Colorado River.

The U.S. Supreme Court decree resulting from the decision of June 3, 1963, in *Arizona* v. *California* (1963) 83 S. Ct. 1468, 376 U. S. 340, lowered California's anticipated allocation by 962,000 acre-feet per year. This allocation was to be effective only as long as 7.5 million acre-feet are available annually. Should the River drop below that output, California's allocation would, accordingly, be even lower.

As a result of the 962,000-acre-foot loss per year, the largest burden will fall on The Metropolitan Water District of Southern California, one of the State's largest water contractors. Its portion of the loss is 662,000 acre-feet, while the remaining loss is absorbed by agricultural users outside the service area of the State Water Project.

The Metropolitan Water District asked the Department to consider increasing the District's maximum annual entitlement from the State Water Project by 500,000 acre-feet to offset its loss from the Colorado River. The additional 162,000 acre-feet would come from importations by the City of Los Angeles from the Owens River and Mono Basin. It was estimated that approximately 230,000 acre-feet not available from the 4,000,000-acre-foot yield would be needed by the District to fill out its requested 500,000-acre-foot increase.

The fact should be kept in mind that the 4,000,000-acre-foot yield of the Project was not an absolute figure that would be available for all time. Under the provisions of the Burns-Porter Act, it was fully known that additional conservation facilities would be required after the mid-1980s to maintain the 4,000,000-acre-foot project yield. This was because of the depletions that were expected to occur in meeting increased local development needs under the Watershed Protection Act and County of Origin statutes. The additional demands to increase the project yield to 4,230,000 acre-feet had the net effect of advancing by about one year the date when additional conservation facilities would be required or purchase of storage in an existing or future federal development would be necessary.

In view of this, the Department decided to increase the project yield and proceeded to obtain the neces-

sary concurrence of the California Water Commission and the water contractors. The Commission approved the increase in September 1964, and the water contractors executed contract amendments which changed the amount stated in Article 16(a) from 4,000,000 acre-feet to 4,230,000 acre-feet.

Coordinated operation studies of the State Water Project made in 1964 indicated that the yield of the initial facilities would satisfy demands until about the mid-1980s, at which time an additional conservation facility would be needed to develop a maximum of 700,000 acre-feet of new annual yield. This was based on a minimum project yield of 4,230,000 acre-feet per year, which represents the total net dependable supply to be made available to the water service contractors from the State Water Project. In addition to this net supply, the gross yield of the project conservation facilities must provide water consumptively used for project purposes other than water supply and water consumed or otherwise lost incidental to the normal operation of project facilities. This gross yield is considered to be equivalent to the demands on the water supply available in the Delta.

Water Resources Control Board Decision 1379 issued on July 28, 1971 provided water quality standards in the Sacramento-San Joaquin Delta that would have a severe impact on the water supplies available for export to the water service contractors. The average reduction in water supply to the State's water contractor would be about 300,000 acre-feet per year. The average dry year (1928–34 water supply) reduction to them would be about 650,000 acre-feet. Estimates of the effect vary to some extent depending upon assumptions as to future development within the Central Valley and the estimates of the amount of fresh water required to meet the quality standards set forth in Decision 1379 (see Chapter IV).

Bulletin No. 132-72 (Ref. 17) indicated that additional conservation facilities would not be needed until about 1996. If Decision 1379 standards are to apply, however, the additional conservation facilities will be needed in the late 1980s, probably 1988. These estimates of the date for completion of additional conservation works are based on the substantial decline in the expected rate of buildup of water demand in Southern California, as shown in Bulletin No. 160-70 (Ref. 83). These demand estimates are averaging about 1,000,000 acre-feet per year less than projected contractual commitments. The actual new orders for project water for the next five years (1975–1979) are running quite close to the original water demand buildup provided in the contracts.

CHAPTER VI. POWER SUPPLY

The importance of electric power to the State Water Project was recognized from the very beginning. Although substantial amounts of power will be generated during project operations, the requirement for even larger amounts of power for pumping purposes became paramount. Significant actions were taken during the formulative years of the Project and are continuing today to ensure that this critical need will be met.

Early Power Planning

The initial plan of development, as set forth in the Feather River Project feasibility report of May 1951, included both an Oroville and an afterbay power plant, some 39 pumping plants, a thermal power generating plant as a source of pumping power, and transmission facilities. Substantial changes were made to the plan as development progressed. A February 1955 report (Ref. 12) did not include any Oroville afterbay power plant, transmission lines, or thermal power plant. It presented alternative aqueduct routes with a considerable reduction in the number of pumping plants, and some of the alternatives included power recovery plants. Letters from the Pacific Gas and Electric Company concerning cost of power for pumping and the value of power generated were included in that report.

In order to coordinate the many complex issues being faced at that time, a Marketing Section was established in the Division of Design and Construction of the newly created Department of Water Resources in November 1956. The Section's primary role was to coordinate the many facets of project power development with market requirements. In 1958, a preliminary report was prepared on the possibility of developing Tehachapi pumped-storage power. This was subsequently dropped and the decision was made to make the Tehachapi crossing in a single lift. A preliminary report on Oroville pumped storage, dated November 1958, first established the Oroville power development plan. This plan was adopted substantially as proposed and provided the basis for final design of the Oroville power facilities (see Chapter IX, Oroville Facilities).

In May 1958, a Power Advisory Committee was established at the invitation of the Director consisting of representatives of privately and publicly owned Northern and Southern California utilities. The Committee reported to the Director on October 29, 1960 concerning the solution of problems relative to the utilization of power generated by, and the supply of power required for, the State Water Project.

A Director's special study group also was established which, in December 1959, recommended policy to implement the State Water Resources Development System. The study group's recommendations covered power policy as well as other project matters.

In April 1961, a Division of Operations was established, including a Power Branch responsible for developing the power program and for negotiating and administering power sale, purchase, transmission and interchange contracts. A power consultant was employed to assist in this work, and a power purchase and sales program was submitted by him on May 8, 1962.

A contract was made with the Fluor Corporation for an energy source study in January 1963, and their final report was submitted in September 1964 (Ref. 18). A study of Oroville-Delta transmission lines was contracted for in January 1964 with Sverdrup & Parcel and Associates, and their report was submitted in October 1964 (Ref. 19).

These foregoing studies set the stage for the power contracts that were executed concurrently with, or subsequent to, study completion. They also laid the groundwork for the negotiations going on today and into the future.

Power Procurement

Negotiations for the first major project power contract began in January 1959 with the Bureau of Reclamation for a supply of Central Valley Project power for South Bay Aqueduct pumping. The State had planned a transmission interconnection with the Bureau's Tracy Pumping Plant switchyard, but Pacific Gas and Electric Company offered use of their facilities at a lower cost. This contract was signed on December 8, 1961, and service was initiated that same month over PG&E facilities.

The Big Bend Powerplant of the Pacific Gas and Electric Company, which would be inundated by Oroville Reservoir, was acquired by the State and a contract was negotiated, dated December 2, 1965. The Pacific Gas and Electric Company operated the plant and purchased the power output until September 1967 when the facilities were about to be inundated by a rising Lake Oroville.

Studies and negotiations looking toward a supply of low-cost pumping power from the Pacific Northwest also began in 1959, and contracts were entered into in

August 1966 for firm "Canadian Entitlement Power" (firm power developed on the Columbia River in the United States by virtue of water storage in reservoirs constructed in Canada) and for surplus and other power and transmission services from the Bonneville Power Administration System. In August 1967, a contract was signed with three California utilities for transmission of Northwest power to points in California and for their purchase of Northwest power and transmission capability contracted for by the State when not required for project use.

In September 1966, a contract was executed with the City of Los Angeles Department of Water and Power for the cooperative development of the Castaic power potential of the West Branch of the California Aqueduct (see Chapter IX, West Branch).

In November 1966, four major California utilities contracted to supply power for project pumping requirements to supplement other sources.

Negotiations for the sale of power from the Oroville and Thermalito facilities began in December 1964 and were concluded November 29, 1967 with the signing of a contract for sale of the entire output to three California electric utilities for 50 years, subject to withdrawal (see Chapter VIII, Power Sales Backing).

Negotiations with the Atomic Energy Commission were begun in November 1963, looking forward to the construction of a nuclear power plant as a power source for the Project. It was proposed to develop a "seed and blanket" reactor which was an early concept for a breeder reactor. The plant would be a prototype of commercial size with the Federal Government paying the research and development costs. A breeder is a reactor that produces more fuel than it consumes. In a nuclear power plant, this type of reactor would provide the heat necessary to produce steam for the generation of electricity and simultaneously produce an excess of fissionable material that could also be used to fuel other plants. It produces fissionable material (plutonium-239) from comparatively useless but fertile material (uranium-238). The breeder concept comes from the fact that it produces fissionable material faster than the reactor consumes the original fuel in the fission process. The contractor for the Atomic Energy Commission encountered technical difficulties with the fuel elements, and the Department's negotiations with the AEC were subsequently discontinued when it became evident that the technical difficulties could not be resolved in the foreseeable future.

The Department, the Los Angeles Department of Water and Power, and the Southern California Edison Company entered into an agreement on May 26, 1971 to investigate the feasibility of the Piru Creek Project, a proposed pumped-storage installation on the West Branch of the California Aqueduct. Geological exploration and preliminary engineering were accomplished on several alternatives. It was subsequently decided by the parties to the agreement that the Department would construct Pyramid Powerplant on the West Branch as the first phase of construction and that the pumped-storage facilities would be deferred for reconsideration at a later time.

Continuing Power Planning

The Department established a separate Power Office in May 1972 reporting to the Directorate level. The primary role of the Office is to assure that the Project has a continuing supply of power at a reasonable cost. One of the most important parts of this program is to investigate the economic feasibility of state participation, together with several electric utilities, in the construction and operation of nuclear generating plants. In 1974, the State entered into an agreement with the Los Angeles Department of Water and Power, the Pacific Gas and Electric Company, the Southern California Edison Company, and the San Diego Gas and Electric Company for the preparation of a feasibility study of a proposed, 4,400-megawatt, nuclear plant to be located near Wasco in the San Joaquin Valley. Another prospective area for cooperative development of a nuclear plant is in the southeastern part of the State.

CHAPTER VII. WATER SERVICE CONTRACTS

The contracts between the State and local agencies to provide the agencies with water service from the State Water Project in return for payment of the major portion of the capital and operating costs of the Project were basic to its construction and operation.

Water Contract Negotiations

The first water service contract was signed with The Metropolitan Water District of Southern California on November 4, 1960, just four days before the general election in which the California voters approved the bond provisions of the Burns-Porter Act. This contract was negotiated by the Department of Water Resources and the District on the basis of Governor Edmund G. Brown's Statement of Contracting Principles for Water Service Contracts, which he announced January 20, 1960. These Contracting Principles set forth some of the most rigid terms ever devised for a water project. The issuance of these Contracting Principles early in 1960 contributed significantly to the subsequent approval of the Burns-Porter Act provisions by the voters of the State at the 1960 general election. (The text of the Contracting Principles is reproduced in Appendix C.)

Actual negotiations with The Metropolitan Water District took place throughout most of the 1960 calendar year. Major points of difference that had to be resolved early concerned the scheduling of repayments and the method of cost allocation, i.e., proportionate use on the basis of annual entitlement v. a second-foot capacity basis. These points required fundamental policy decisions at the highest levels of the organizations concerned and necessarily had to be resolved first. In addition, numerous changes and conditions had to be worked out in the introductory, water service, and general sections of the contract.

Throughout the negotiations, it had to be kept in mind that the contract in its finished form would be the prototype for all subsequent water contracts and future water users had a strong interest in its formulation to ensure that provisions were not incorporated that would be totally unacceptable to them in future negotiations.

The extended negotiation with The Metropolitan Water District of Southern California finally reduced the major points of disagreement to three significant items. These were:

1. The effective date of the contract which hinged on possible unacceptable legislative action subsequent to the time of signing.
2. Surcharge costs on water deliveries to lands in excess of 160 acres.
3. Timing and scheduling of deliveries to the District through the East (main) and West Branches of the California Aqueduct.

A compromise of these differences was reached late in October 1960 and finally resolved the last roadblock to the signing of the contract on November 4, 1960.

This contract provided that The Metropolitan Water District was entitled to a maximum water supply of 1,500,000 acre-feet annually out of the total project yield, which was then calculated at a minimum of 4,000,000 acre-feet annually. The contract was amended to provide a maximum annual entitlement of 2,011,500 acre-feet under the U.S. Supreme Court decision of June 3, 1963, in *Arizona* v. *California* (see Chapter V, Project Yield). This decision curtailed the water supplies The Metropolitan Water District of Southern California could expect from the Colorado River in the years ahead.

Contracts similar to the prototype contract with The Metropolitan Water District of Southern California were negotiated with other public agencies in the service areas contemplated in the planning. The concept followed in this planning is discussed in the Department's Bulletin No. 78 (Ref. 20). Essentially, it envisioned that after the aqueducts are built, the local agencies will assume the engineering and financial responsibility for building the systems necessary to distribute the water throughout the various areas of use and to the individual users. Before executing a service contract with the agencies, the Department evaluated each application on the basis of:

(1) Future demand for supplemental water;
(2) Legal ability to contract with the State for water, to make ad valorem assessments in accordance with benefits, and to contract to supply water to member units;
(3) Engineering feasibility of providing water service;
(4) Economic justification of providing the service; and
(5) Capability of each agency and the area represented to assume the financial burden of the proposed contract.

The results of these investigations were published in Bulletins 119-1 through 119-29, titled "Feasibility of Serving (the agency's name) from the State Water Project". Because of the increasing significance of these investigations, they are identified individually in Appendix A by reference numbers 21 through 49.

Negotiations between the Department and the various agencies moved forward rapidly and, by the end

TABLE 1: LONG-TERM WATER SUPPLY CONTRACTING AGENCIES

Location no.	Contracting agency	Total deliveries through Dec. 31, 1973 (acre-feet)	Maximum annual entitlement (acre-feet)	Total payments through Dec. 31, 1973 (dollars)	Gross area as of July 1, 1973 (acres)	Assessed valuation 1973-74 (dollars)	Estimated population (July 1, 1973)
	UPPER FEATHER AREA						
1	City of Yuba City	0	9,600	0	2,600	38,000,000	15,400
2	County of Butte	431	27,500	172,000	1,067,600	314,808,600	110,600
3	Plumas County Flood Control and Water Conservation District	1,318	2,700	85,000	1,644,000[a]	127,819,000[a]	13,100[a]
	Subtotal	1,749	39,800	257,000	2,714,200	480,627,600	139,100
	NORTH BAY AREA						
4	Napa County Flood Control and Water Conservation District	17,479	25,000	1,458,000	508,000	246,814,700	86,200
5	Solano County Flood Control and Water Conservation District	0	42,000	46,000	528,400	432,679,700	181,100
	Subtotal	17,479	67,000	1,504,000	1,036,400	679,494,400	267,300
	SOUTH BAY AREA						
6	Alameda County Flood Control and Water Conservation District, Zone 7	81,444	46,000	4,506,000	272,000	326,305,100	94,000
7	Alameda County Water District	182,297	42,000	6,088,000	61,700	519,765,100	160,000
8	Santa Clara Valley Water District	580,286	100,000	21,808,000	832,300	3,417,884,200	1,163,600
	Subtotal	844,027	188,000	32,402,000	1,166,000	4,263,954,400	1,417,600
	SAN JOAQUIN VALLEY AREA						
9	County of Kings	7,600	4,000	130,000	893,000	162,468,400[b]	67,600
10	Devil's Den Water District	69,008	12,700	1,114,000	8,500	1,257,600	50[d]
11	Dudley Ridge Water District	216,887	57,700	2,112,000	29,900	6,528,100	50[d]
12	Empire West Side Irrigation District	23,575	3,000	214,000	7,500	754,000	50[d]
13	Hacienda Water District	33,437	8,500	266,000	15,300	129,200	50[d]
14	Kern County Water Agency	1,829,458	1,153,400	32,593,000	5,057,200[c]	1,093,415,800[c]	342,000[c]
15	Oak Flat Water District	31,616	5,700	216,000	4,000	275,000	50[d]
16	Tulare Lake Basin Water Storage District	512,101	110,000	4,665,000	193,000	9,628,000	50[d]
	Subtotal	2,723,675	1,355,000	41,310,000	6,208,400	1,274,456,100	408,900
	CENTRAL COASTAL AREA						
17	San Luis Obispo County Flood Control and Water Conservation District	0	25,000	828,000	2,131,300	396,189,300	117,800
18	Santa Barbara County Flood Control and Water Conservation District	0	57,700	1,859,000	1,756,900	796,856,100	275,900
	Subtotal	0	82,700	2,687,000	3,888,200	1,193,045,400	393,700
	SOUTHERN CALIFORNIA AREA						
19	Antelope Valley-East Kern Water Agency	73	138,400	10,472,000	1,524,900	491,882,600[d]	90,600
20	Castaic Lake Water Agency	0	41,500	4,535,000	125,000	213,220,900	52,600
21	Coachella Valley County Water Agency	5,800	23,100	2,631,000	620,500	262,840,200	67,600
22	Crestline-Lake Arrowhead Water Agency	925	5,800	741,000	53,700	57,940,300	10,800
23	Desert Water Agency	9,000	38,100	4,333,000	209,300	216,971,100	40,200
24	Littlerock Creek Irrigation District	708	2,300	213,000	43,300	3,707,600	1,400
25	Mojave Water Agency	55	50,800	5,161,000	3,160,400	340,765,100	71,300
26	Palmdale Water District	0	17,300	1,382,000	73,800	28,217,100	23,200
27	San Bernardino Valley Municipal Water District	33,701	102,600	15,642,000	208,900	685,443,800	339,400
28	San Gabriel Valley Municipal Water District	0	28,800	4,025,000	16,200	413,960,700	148,200
29	San Gorgonio Pass Water Agency	0	17,300	2,371,000	140,600	59,803,300	28,600
30	The Metropolitan Water District of Southern California	231,821	2,011,500	280,895,000	3,126,800	32,838,476,400	10,700,000
31	Ventura County Flood Control District	0	20,000	1,992,000	1,179,500[f]	1,353,099,300	423,000
	Subtotal	282,083	2,497,500	334,393,000	10,482,900	36,966,328,400	11,996,900
	TOTAL STATE WATER PROJECT	3,869,013[a]	4,230,000	412,553,000	25,496,300[e]	44,857,906,300[e]	14,623,500[e]
	NET AREA TOTAL, STATE WATER PROJECT	3,869,013[a]	4,230,000	412,553,000	24,159,800[h]	43,886,594,000[h]	14,339,250[h]
	TOTAL, STATE OF CALIFORNIA	--			100,314,000	59,619,684,300	20,741,000
	PERCENT, STATE WATER PROJECT OF TOTAL	--			24.1	73.6	69.1

[a] Total for Plumas County, including Last Chance Creek Water District.
[b] Total for Kings County, including Dudley Ridge Water District, Empire West Side Irrigation District, Hacienda Water District, most of Tulare Lake Basin Water Storage District, and about 40% of Devil's Den Water District.
[c] Total for Kern County, including about 60% of Devil's Den Water District, and about 50% of Antelope Valley-East Kern Water Agency.
[d] Total for Antelope Valley-East Kern Water Agency includes California City which was reannexed in June 1972.
[e] Includes duplicate values for overlapping agency areas.
[f] Total for Ventura County, including about 8,400 acres in Antelope Valley-East Kern Water Agency, 219,200 acres in The Metropolitan Water District of Southern California and about 8,400 acres in Castaic Lake Water Agency.
[g] Excludes 4,256 acre-feet delivered to Mustang Water District and 137,341 acre-feet delivered to Last Chance Creek Water District under one-year contracts. Also excludes 70,449 acre-feet of deliveries for repayment of water that was borrowed for aqueduct preconsolidation.
[h] Excludes all overlapping areas.
[i] Exclusively agricultural area.

Figure 1: CONTRACTOR AGENCIES' AREAS

of 1963, 30 agencies had contracted for more than 85% of the minimum project yield of 4,000,000 acre-feet annually (see Chapter V, Water Supply, for discussion of project yield).

Service Areas

Thirty-one agencies have now contracted for a long-term water supply from the State Water Project totaling 4,230,000 acre-feet annually. The service areas of the 31 agencies extend from Plumas County in the north to the Mexican border (Ref. 50). As compared with the total State, the boundaries of the agencies include almost one-quarter of the land area, more than two-thirds of the population, and almost 70% of the assessed valuation. It should be recognized that, while many of the contracting agencies had been in existence through the years, a number of new districts were formed for the express purpose of contracting for and delivering water. At the time these contracts were written, it was estimated the water requirements of each agency would be assured through the year 1990. Reduced growth rates now indicate this supply will meet needs until after the year 2000 unless outflows from the Sacramento-San Joaquin Delta required by the State Water Resources Control Board prove to be greater than planned.

Table 1 lists the contracting agencies and presents data about each and their water service. Figure 1 shows the agencies' locations and the areas they serve.

All water supply contracts are substantially uniform with respect to their basic provisions (see Appendix C). They run for 75 years or until all Burns-Porter bonds have been repaid, whichever period is longer. Each contract estimates the year of initial water delivery and sets a schedule of annual amounts of water the agency is entitled to. The scheduled amounts increase yearly and generally reach the maximum annual entitlement in about 1990. Subject to the availability of funds, the State is required to make all reasonable efforts, consistent with sound fiscal policies, reasonable construction schedules, and proper operating procedures, to complete the facilities necessary for water deliveries at the time and in the amounts specified.

The total combined annual entitlement of all water contracting agencies is limited to 4,230,000 acre-feet of water. The State must make all reasonable efforts to perfect and protect necessary water rights and must report at least every five years on its ability to meet future water demands.

Surplus Water Provisions

During the buildup period, the Project has capacity to deliver water in excess of the entitlement rights of all contracting agencies. When this surplus is available, agencies may purchase the surplus water for agricultural and ground water replenishment use under specified circumstances, at a price equal to the incre-

mental cost of delivery plus a charge to cover the costs of administering the program. For other uses, the agencies are charged, in addition to the foregoing, one-half the Delta Water Charge. If the agencies do not take all the surplus water, the State shall offer to sell the balance to noncontractors at the Delta Water Charge plus the equivalent unit rate of the Transportation Charge for facilities used in making deliveries.

In arriving at these charges, the State determines which costs are reimbursable to the State by the contractors. Costs allocated to flood control, recreation, and fish and wildlife enhancement have been designated by the State as nonreimbursable. Both costs and revenues of power facilities are included in the determination of charges. Reimbursable costs of facilities which develop and conserve the project water supply are paid as a uniform charge per acre-foot of annual entitlement, called the Delta Water Charge (see Chapter V, Water Supply).

Reimbursable costs of aqueduct facilities which convey water from the Delta to the agency are paid through the Transportation Charge. Costs of each reach of aqueduct are allocated among all agencies receiving water through that reach. Each year's capital expenditures are allocated among the agencies and the allocated amount is required to be repaid, together with interest, in 50 equal annual installments. (In contracts with agricultural water agencies, these capital costs are repaid by a uniform charge per acre-foot of water entitlement, which is computed to return the costs with interest to the State during the contract term.) Capital costs included in the Transportation Charge and all costs included in the Delta Water Charge are paid with interest at the weighted average of the rates paid on securities issued to finance the project facilities. Operation costs included in the Transportation Charge are paid currently (see Chapter VIII, Project Cost Allocations).

Tax Levy Obligation

An agency's failure or refusal to accept delivery of water does not relieve the agency of its payment obligations. An agency as a whole is obligated to make payments to the State notwithstanding any individual default by its constituents or others in the payment to the agency of charges levied by the agency. The contract requires that whenever the agency fails or is unable to raise sufficient funds by other means, the agency must levy upon all property in the agency area not exempt from taxation a tax or assessment sufficient to provide for all payments under the contract.

Since the original contracts were signed by the State and the local agencies, a number of amendments have been discussed and entered into in order to make changes that were mutually desired. From 1 to 11 amendments have been made in various contracts among the 31. The amendments cover such points as increased or decreased annual entitlements, peaking service, the Delta Water Charge, and excess capacity.

Acreage Limitation

The Contracting Principles for Water Service Contractors, dated January 20, 1960 (see Appendix C), state that:

> "In addition to the extent that from time to time any power is available for sale, it will be sold at its market value. Preference will be given to public agencies in such sale as required under existing law. The difference between the actual cost and the market value of such power will result in income to reduce project costs. This added income (power credit) will be applied, and the computed economic benefit will be made available, to reduce the cost of project water except for water used on land in single ownership in excess of 160 acres (320 acres in the case of community property)."

Article 30 of the standard water service contract incorporated this principle into its text. Due to wide variations in the amount of power being generated and thus the credit to be applied, the power credit was established at $2 per acre-foot. This was to remain in effect until all the facilities for generation of electrical energy in connection with operation of initial project conservation facilities (Edward Hyatt and Thermalito Powerplants and San Luis Pumping-Generating Plant) were installed and in operation. The power credit per acre-foot of water would be redetermined annually thereafter to accurately reflect increases or decreases from year to year in the power credit.

Since the power credit of $2 appeared to be in excess of actual net revenues attributable to initial project conservation facilities, under later amendment of water service contracts, those provisions related to the surcharge were not effective for water deliveries during the years ending December 31, 1967 through 1971.

In 1972, sufficient information on the costs and revenues of the power operation had been developed to make a redetermination practicable. Estimates indicated that the power credit would amount to only about 15% of the original estimate—$0.30 per acre-foot—and even this nominal amount would be further offset by the associated administrative costs. As a result of this redetermination of the power credit and a reevaluation of the merits of Article 30, it was deleted by contract amendment in 1972.

CHAPTER VIII. BASIC FINANCING

The basic financing plan and the various approaches to bond sales, appropriations, and contributions that comprised the overall financing package for the State Water Project were prime considerations in the construction and operation of the various project facilities.

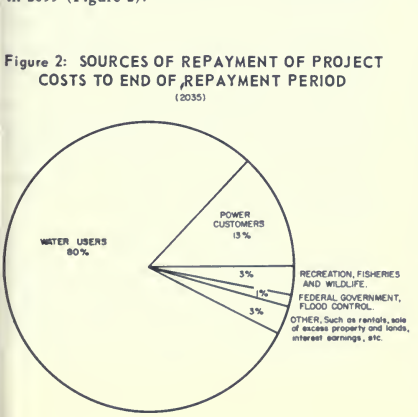
Basic Financing Concept

The basic concept of financing which the Legislature established for the State Water Project is that the costs are paid by those who benefit from the Project. The Burns-Porter Act provides that those who receive the direct benefits of the Project repay the entire principal and interest cost of the $1.75 billion general obligation bond issue plus all other construction and operation costs of the Project.

The water users, the major beneficiaries, are paying the major costs. Power users pay the next largest share of the costs. State funds cover the cost of the broad benefits for all Californians—the costs allocated to recreation and fish and wildlife enhancement. The Federal Government meets its responsibilities for flood control by paying the share of costs allocated to flood control as authorized by Congress. The flood control costs are nonreimbursable in that they are funded by the general tax base of the nation. Miscellaneous revenues of the Project cover a small part of the costs.

Project beneficiaries will share in the repayment of project costs to the end of the bond repayment period in 2035 (Figure 2).

Figure 2: SOURCES OF REPAYMENT OF PROJECT COSTS TO END OF REPAYMENT PERIOD (2035)



General Obligation Bonds

The Department had scheduled its initial water bond sales for late 1963, but as the time approached, it was still without a decision in a lawsuit to clear up a technical question concerning the relationship of the pledge of revenues in the general obligation bonds to the proposed issuance of revenue bonds. The Legislature opened a way for alternative initial financing by adopting an amendment to the General Obligation Bond Law to permit issuance of bond anticipation notes (Government Code Section 16736). While awaiting the decision, the Department took advantage of the new law and sold $50 million of bond anticipation notes in November 1963. This was the first time in the history of financing by the State of California that this type of short-term borrowing was used.

The Department's interpretation of the pledge of revenues question was supported by the State Supreme Court in its decision in *Warne* v. *Harkness* (1963) and in *California Water Resources Development Bond Committee* v. *Betts,* (1963) 60 Cal. 2d 595, 387 P. 2d 387. This cleared the way for the initiation of the water bond sales and permitted the Department to proceed with plans for revenue bonds.

First General Obligation Bond Sale

The first series of the general obligation bonds, totaling $100 million, was sold in February 1964. Half of the total was used to retire the bond anticipation notes. The interest rate was 3.520%, well within the 4.0% rate which was assumed for the financial calculations in the planning of the Project.

Interest rates in the national bond market for the State's water bonds and similar issues have trended generally upward most of the time since. Five additional series of project bonds, totaling $450 million, were sold by mid-1966 at interest rates less than 4%, but climbing toward that figure. The interest rate passed 4% at a water bond sale in 1966 and kept climbing.

Interest Ceiling

By 1969, the upward movement of interest rates in the national bond market reached the point where it became impossible to market the water bonds under the 5% interest ceiling set by the State Constitution for general obligation bonds.

The State met this problem with three moves in 1969:

1. The Legislature increased the maximum interest rate payable on revenue bonds (Calif. Stats. 1969, Ch. 14) and the Department obtained a part of the capital required to maintain construction through a revenue bond sale.
2. The Legislature proposed an amendment to the State Constitution (Calif. Stats. 1969, Res. Ch. 299) permitting the Legislature to raise the interest rate on authorized but unsold general obligation bonds. This was approved by the voters at a special election on June 2, 1970. Approval of the proposed constitutional amendment by the voters of the State also ratified a statute (Calif. Stats. 1969, Ch. 740) to increase the interest ceiling on general obligation bonds from 5% to 7% and to remove the interest ceiling on bond anticipation notes.
3. Arrangements were made for the Department to borrow up to $100 million from the State General Fund, to be drawn down as needed and to be repaid with interest at the same rate that would be earned by the State if the funds were invested in the open market. The Department borrowed $46,761,000 from the General Fund in early 1970 and repaid it with interest in July 1970, after outside borrowing again became possible.

After ratification of the 1969 legislation, the Department went ahead with its general obligation bond financing, combining it with use of bond anticipation notes on two occasions in 1970 and 1971.

History of General Obligation Bond Sales

The sale of $40 million of water bonds in March 1972 represented a landmark in this financing, since under the provisions of the Burns-Porter Act, this was the last sale of water bonds available for financing construction of the 1973 project facilities.

Over the preceding 10 years, a total of $1.55 billion of water bonds were sold. The peak period of sales was during 12 months in 1966 and 1967, when over $400 million of bonds were sold. No sales were made in 1969 and 1970 when prevailing interest rates grew beyond the then statutory ceiling of 5%.

The interest rate for the $1.55 billion of water bonds sold ranged from a low of 3.520% on the first sale in February 1964 to a high of 5.830% in June 1970. The weighted average interest rate for all general obligation bonds sold through December 31, 1973 was 4.459%. This compares with the 4.0% interest rate that was assumed for the financial calculations made during the planning in 1960.

The difference between the authorized total of $1.75 billion and the $1.55 billion of bonds actually sold ($200 million) represents those remaining water bonds restricted by law to use for loans and grants to local projects under the Davis-Grunsky Act (about $33 million) or for construction at a later date of additional water conservation facilities to maintain the Project's water supply and thus fulfill the State's water contract obligations to its customers ($167 million).

The most recent sale of water bonds was made in March 1973, when a $10 million issue was sold to provide funds for financial assistance to local projects under the Davis-Grunsky Act.

Revenue Bond Financing

The Department's plan to use revenue bonds authorized under the Central Valley Project Act to supplement general obligation bond financing under the Burns-Porter Act underwent several court tests before it could be implemented. An action was instituted by the Department in a petition to the California Supreme Court for a writ of mandamus to direct the State's Director of Finance to proceed with the initial sale of revenue bonds backed by the revenue from the sale of hydroelectric power produced at the Oroville power plants.

The Supreme Court upheld the authority of the Department to issue revenue bonds under the provisions of the Water Code governing the Central Valley Project. The significant decision was made in *Warne* v. *Harkness* (1963). It cleared the way for the sale of the Oroville revenue bonds and established the authority for the Department's continuing use of revenue bond financing.

Power Sales Backing

The first revenue bond issue was supported by a 50-year contract for the sale of the hydroelectric power generated by the Edward Hyatt and Thermalito Powerplants at Oroville. The contract was entered into in November 1967 between the Department and the three major, investor-owned, electric utility companies of California—the Pacific Gas & Electric Company, Southern California Edison Company, and San Diego Gas and Electric Company.

The companies contracted to pay the Department $16.15 million annually for the total energy generated by the power plants up to full generating capacity. If generation exceeds 2.1 billion kilowatt-hours of energy annually, additional payments are made. More than $800 million will be paid to the Department during the life of the existing contract.

Revenue Bond Issues

The contract for the sale of the hydroelectric power generated by the Edward Hyatt and Thermalito Powerplants at Oroville formed the basis for the subsequent sale, on April 3, 1968, of $150 million of Series A Bonds to a syndicate of more than 180 financial

firms. The interest rate on the Series A Bonds was 5.197%. This was followed by the sale of an additional $94,995,000 of Series B Bonds on April 1, 1969. This latter sale was permitted only after enactment of Assembly Bill 516 (Calif. Stats. 1969, Ch. 14), which raised the maximum interest rate payable on revenue bonds issued under the Central Valley Project Act from 5½% to 6½%. The interest rate on the Series B Bonds was 5.763%. The net proceeds from these two revenue bond issues provided about $213 million to help finance project construction costs.

Additional negotiations for the financing of Southern California plants based on power generation and power revenues were concluded successfully in 1972 with the six Southern California water service contractors whose deliveries are conveyed through the Devil Canyon and Castaic Powerplants.

The agreements reached with these local agencies were the basis on which the Department sold an issue of $139,165,000 Devil Canyon-Castaic revenue bonds in August 1972. This sale provided about $127 million for construction of the Devil Canyon and Castaic power facilities, with the remainder being used for financing interest and operating expenses.

Federal Funds

The costs of Oroville Dam and Del Valle Dam that were allocated to flood control have been paid by the Federal Government. In addition, federal funds paid for the federal share of costs in the joint-use facilities at San Luis Reservoir and in the joint-use reach of the California Aqueduct downstream from San Luis.

A contract for federal payment of funds for the flood protection to be provided by Oroville Dam and Reservoir was entered into with the United States on March 8, 1962. The contract provided for a federal payment equal to 22% of the construction cost of the Dam and Reservoir, not to exceed $85 million.

The initial federal payment for Oroville flood control was $13.95 million, which was received from the Corps of Engineers November 27, 1962. By the end of 1973, the total federal contributions for Oroville reached $68.2 million with $0.8 million more expected.

Federal flood control payments for Del Valle Dam and Reservoir totaled $4.9 million by the end of 1973. Possible additional contributions of $0.6 million are pending.

The United States and the Department reached agreement concerning the San Luis Joint-Use Facilities December 30, 1961. The agreement provided for the construction of the facilities by the Bureau of Reclamation, for the sharing of the costs of construction between the Department and the Bureau, and for operation of the joint-use facilities by the Department. Costs were shared in proportion to the use planned, with the State paying 55% and the Federal Government 45%. The percent varies with the reach.

Appropriated Funds

The Davis-Dolwig Act enacted in 1961 (Water Code Sections 11900–11925) declares that recreation and fish and wildlife enhancement features of state water projects benefit all of the people of California. The Act provides that the General Fund is to bear the costs of these recreation and enhancement features rather than the water users. The Act established a procedure through which the Department is reimbursed for the recreation and fish and wildlife enhancement expenditures that are financed by project funds.

Under this procedure, the Department reports the expenditures to the Legislature annually. Legislative approval of the costs then releases a like amount of the State's tideland gas and oil revenues or other state lands revenues to the Department from a continuing $5 million annual appropriation of tideland gas and oil revenues or other state lands revenues which has been authorized specifically for that purpose (Calif. Stats. 1964 1st Ex. Sess. Ch. 138; Calif. Stats. 1966 1st Ex. Sess. Ch. 27; Public Resources Code Section 6217).

Annual legislative action through 1973 approved release of a total of $56,905,162 to the Department for joint capital costs allocated to recreation, fish and wildlife enhancement, and for expenditures for acquiring lands for recreation developments.

Though not directly affecting the financing of the Project itself, legislation passed in 1970 provided an assured source of funds to plan and construct future recreation and fish and wildlife enhancement developments that will be associated with the Project. Enactment of Senate Bill 1268 (California Statutes of 1970, Chapter 782) authorized, subject to approval of the voters at a November 1970 election, issuance of general obligation bonds in a total amount not to exceed $60,000,000 for these developments. The bonds are repaid by the State General Fund. Voter approval was subsequently provided.

The limited recreation developments constructed for the Project up until passage of this legislation had been financed by direct appropriations from the General Fund. With completion of more and more facilities, the Legislature and the State Administration determined that the investments required for immediate recreation development on a pay-as-you-go basis would be too heavy a financial burden for the General Fund to bear in view of the pressing needs of the State.

Although the Davis-Dolwig Act charges the Department with responsibility for acquiring sufficient lands to accommodate recreational use in conjunction with state water projects and provides for reimbursement of such land acquisition expenditures, together with joint project costs allocated to recreation and fish and wildlife enhancement, the Act does not provide any funds for construction of recreation developments themselves. Thus, Senate Bill 1268 closed a sizable gap by providing funds to construct recreation

developments that otherwise would have been delayed or excluded. It also provided for continued availability of all such bond funds developed by committing their use solely for state and local park and recreation projects.

Moving into another area of appropriations, the Burns-Porter Act provides that any available money in the California Water Fund shall be applied to pay project costs in lieu of proceeds from the sale of Water Bonds. Deposits to the Fund are derived from a portion of the State tideland oil and gas revenues or other state lands revenues under a continuing authorization. In the past, the Legislature has acted both to decrease and increase the level of deposits. Money may be expended from the Fund only for the construction of project facilities and for the Davis-Grunsky program. The Department has received $403 million through 1973 from this source and under present appropriations, expectations are that an additional amount of $169 million will be received from 1974 through 1980, at the rate of $25 million annually plus interest earnings.

Offset Bonds

A feature of the Burns-Porter Act which contributed to its passage through the Legislature and its ratification by the electorate was the provision of offset bond financing for additional project facilities when the need for them arises years after construction of the initial conservation and transportation features.

This reserved a portion of the authorized $1.75 billion in water bonds to finance the development of later projects to meet local needs and to augment water supplies in the Sacramento-San Joaquin Delta after they are reduced by increased upstream use.

The Act provides that to the extent California Water Fund monies are expended for construction of the State Water Facilities, an equal amount of water bonds are offset or reserved for financing the later required additional project facilities.

By the end of 1973, the net amount of bonds offset amounted to $167 million.

Project Cost Allocations

The Department's administrative obligations under the Project's water supply contracts and the Davis-Dolwig Act require detailed allocations of project construction and operating costs. These comprehensive allocations are required to be reviewed periodically and maintained to reflect actual costs and benefits of the Project.

There are at least five layers of different types of allocations between the costs of project construction and operations programs as incurred by the Department and those costs as eventually reflected in charges under the water supply contracts.

The first layer of allocation deals with association of the costs of all the Department's project-funded programs with the individual physical facilities and aqueduct reaches of the Project. Literally thousands of program items and allocations are involved in this association. Commercial auditors retained by the water contractors have spent many hours with the Department's accountants reviewing and revising these numerous allocations to reflect properly the character and purposes of the programs involved.

Once all costs have been associated with project facilities, the second layer of allocation deals with the separation of facility costs among project partners in accordance with percentages set forth in authorizing agreements. For instance, the Bureau of Reclamation and the Department share the costs of joint-use facilities of the San Luis Division on a 45/55 basis. In the future, plans are that the Bureau and the Department will share the joint costs of the Peripheral Canal on a 50/50 basis. In addition, the City of Los Angeles Department of Water and Power and the Department share certain costs of the West Branch between Pyramid and Castaic Lakes under cooperative power development.

The third layer consists of the allocation of the Department's costs of facilities among the purposes served by the respective facilities. The costs of certain purposes are reimbursable by the water contractors (such as water supply and power generation, all as reduced by power revenues) while the costs of other purposes are not (such as flood control, recreation, and fish and wildlife enhancement). This type of allocation is based on the Separable Cost-Remaining Benefits method, specified by the contracts, and involves the translation of the total benefits currently expected to be realized for the respective purposes into appropriate shares of historic and projected costs. Costs allocated to flood control are paid by the United States up to certain limits stated in authorizing agreements. Costs allocated to recreation and fish and wildlife enhancement, since incurred for the benefit of the people of the State as a whole, are paid by state general funds under the Davis-Dolwig Act (see this chapter, Appropriated Funds). The Department reports initial allocations of project facilities—generally in the year following the year construction of each facility is completed—and periodically reviews and revises such allocations. Through the Appendix D series of the Department's annual Bulletin 132, allocations have been developed, reported, and approved for Frenchman Lake, Antelope Lake, Lake Davis, Lake Oroville, San Luis Reservoir, and Lake Del Valle. Estimates are that eventually $147 million of such costs will be reported when project construction is complete.

The fourth layer of allocation deals with the subdivision of water supply costs into categories necessary for the allocation of water bills, i.e., into the two major functions of water conservation and water transportation, and into the three types of costs recog-

nized by the contracts (capital; minimum *O*peration, *M*aintenance, *P*ower and *R*eplacement; and variable OMP&R costs). For instance, the contracts provide that the water supply costs of reaches of the California Aqueduct between the Delta and San Luis Reservoir shall be suballocated between conservation and transportation by the proportionate use of facilities method. Furthermore, a portion of the annual power costs of a pumping plant may be assigned to capital costs (e.g., reservoir fill), to minimum OMP&R costs (to replace downstream aqueduct evaporation and seepage losses), and to variable OMP&R costs (for actual deliveries to water contractors).

Also under the fourth layer, certain water supply costs of the Aqueduct are assigned directly to water contractors outside of the general charge structure of the contracts. Such costs are for the construction of turnouts and excess conveyance capacity as specifically requested by the water contractors and are allocated on the basis of the additional (incremental) costs caused by such requests.

The final layer of allocation deals with the distribution of remaining reimbursable costs among water contractors for each charge component. Reimbursable costs of facilities which develop and conserve the project water supply are paid as a uniform rate per acre-foot of annual entitlement (the Delta Water Charge). This rate varies over time, however, as additional costs of conservation facilities occur. Reimbursable costs of aqueduct facilities which convey water from the Delta to the water contractors' turnouts are paid through the Transportation Charge. Costs of each reach of Aqueduct are allocated among all water contractors entitled to receive water through that reach. The basis of the allocation is the "average-of-the ratios" of: (1) the water contractor's maximum annual entitlement as a ratio of all other such entitlements to be conveyed through the reach, and (2) the capacity installed in the reach to convey the water contractor's maximum annual entitlement as a ratio of all other such capacity provided in the reach. Each year's allocated capital expenditure is required to be repaid, with interest, in 50 equal annual installments. (In contracts with agricultural water agencies, allocated capital costs are repaid by a uniform charge per acre-foot of water entitlement, which charge is computed so as to return to the State during the contract term such costs with interest.) The applicable rate of interest is the weighted average of the rates paid on securities issued to finance the construction of project facilities. Operating (OMP&R) costs included in the Transportation Charge are paid currently. Minimum OMP&R costs (those that do not vary with water deliveries) are allocated on the same factors as capital costs. Variable OMP&R costs (those that do vary with water deliveries—consisting primarily of the costs of pumping power) are allocated on the basis of respective downstream delivery quantities.

The total cost allocation and accounting effort for administering the State Water Project is probably unprecedented in the area of water development—and is indicative of the lengths required to achieve the goal that those interests who realize the benefits of the Project pay their rightful share of the costs of the Project.

Due to the complexities of this subject, the qualifications that would be necessary, and the constantly changing costs to be allocated, the specific allocations to purpose are not shown here. These can be found in Appendix D of the Department's annual Bulletin 132 series (Ref. 17). Preliminary allocations are shown in Table 4 of this report. Prior to the issuance of Bulletin 132-69, Appendix D, cost allocations were shown in the Department's annual Bulletin 153, titled "Allocation of Costs Among Purposes of the California State Water Project". This bulletin was first published in January 1966 and was discontinued in 1969.

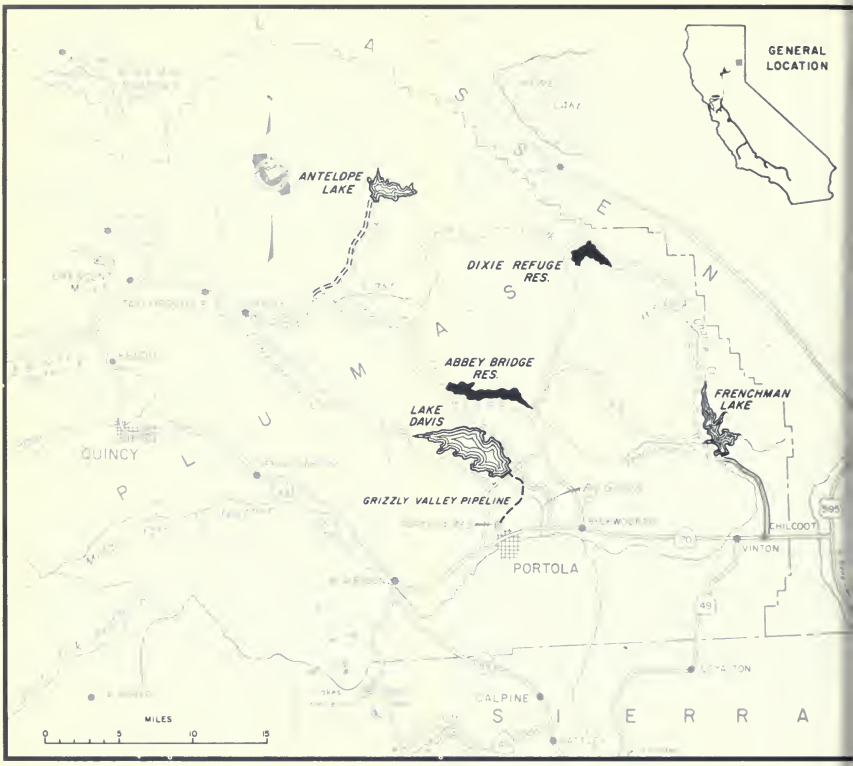


Figure 3

UPPER FEATHER RIVER

FACILITIES

CHAPTER IX. PLANNING THE MAJOR FACILITIES

The planning of the major facilities of the State Water Project took place many years before the Legislature passed the Burns-Porter Act in 1959 and the voters of the State approved it in 1960. Most of the facilities resulting from detailed planning studies were in operation in 1973, and many of these began operations in the early and middle 1960s. The Project today bears a remarkable similarity to the planning proposals advanced in 1951 when it was authorized.

Upper Feather River Basin

Studies of the water requirements of the Upper Feather River Basin were initiated in 1954 as part of the Northeastern Counties Investigation, one of the studies that was conducted contemporaneously with the overall Statewide Water Resources Investigation. Plans for meeting these water requirements were developed as part of the California Water Plan, and five units recommended for initial construction in the Plan were incorporated in the State Water Project. These were the Grizzly Valley and Frenchman units in the watershed of the Middle Fork Feather River and three units, Antelope, Dixie Refuge and Abbey Bridge, in the North Fork Feather River watershed (Refs. 51 and 52). In general, these five units would fill immediate needs for irrigation, flood control and, especially, development of water-based recreation (Figure 3).

Although each proposed reservoir would provide some measure of flood protection to downstream reaches, in most cases the benefits realized would be relatively insignificant because of the small proportion of runoff that would be controlled and the relatively small amount of damage under present development. Frenchman Reservoir, however, would provide a significant degree of flood control along Little Last Chance Creek, and the resulting flood control benefit was credited to that unit. Recreational benefits were based on an evaluation of the increased recreational use attributable to each facility. Future use of the streams and reservoirs in terms of increased visitor days was projected to the year 2050 and evaluated at the rate of $2 per visitor-day (Ref. 51).

In evaluating financial feasibility of the Upper Feather River Basin units, no allocation of cost was made for flood control since all flood control benefits were incidental to other reservoir purposes. All other project costs were allocated by the Separable Cost-Remaining Benefits method.

Operation studies to assess the magnitude of upstream developments on the yield of Oroville Reservoir showed that the water available during the critical dry period (1928–1934) would be reduced by less than 1%. (This 1928–1934 period was one of the most severe drought periods of record in California, with an average precipitation of less than 60% of the mean. It is incorporated into most operations study periods.) This would cause a loss of primary power generation capacity of about 2,900 kilowatts at Oroville. Furthermore, since flood waters from the upper drainage areas normally arrive at Oroville considerably after the flood crest at Oroville has occurred, these developments would have little or no beneficial effect for flood control below Oroville (Ref. 51).

Subsequent studies were conducted to develop a basinwide plan for the Upper Feather River Basin, incorporating the five units recommended for initial construction in the plan. All of the additional projects considered for the North Fork and Middle Fork of the Feather River were found to be unjustifiable from an economic basis, or only marginally justified, and no further projects were recommended (Ref. 51).

Frenchman Unit

Sierra Valley, located in the upper reaches of the Middle Fork Feather River, is the largest mountain valley located completely within the State. Most of its land is potentially irrigable. Also, it is located in one of the most attractive recreation areas in California, and its recreation potential could be considerably enhanced. Frenchman Reservoir, with a capacity in excess of 50,000 acre-feet, would store waters of Little Last Chance Creek and provide 12,000 acre-feet of new water supplies to irrigators in Sierra Valley. No specific reservation of storage space was contemplated for flood control.

Floodflows, however, would be substantially reduced by temporary surcharge above the spillway crest. The reservoir would provide a base for recreation developments and firm downstream flow releases for additional recreational development (Ref. 53). Reimbursable costs would be repaid from sales of water to the Last Chance Creek Water District. On the basis of studies of these factors, it was concluded that the Frenchman project was engineeringly practicable, economically justified, and financially feasible. Construction of the dam was completed in 1961 and operations were started later in that same year. The completed facility stores 55,477 acre-feet of water.

Grizzly Valley Unit

As originally envisioned, the Grizzly Valley Unit would consist of an 80,000-acre-foot reservoir on Big Grizzly Creek and a conduit which would divert wa-

ter downstream from the dam and convey it to Sierra Valley. It would provide a regulated water supply of about 15,100 acre-feet per year, of which 14,900 acre-feet would be new yield.

Access roads, basic public utilities, and a campsite area, which were presumed to be augmented by privately owned developments, would be provided for recreational use (Ref. 54). The project was found to be engineeringly feasible and justifiable from economic and financial standpoints (Ref. 51).

Consideration was also given to a modification of this project that would use the waters of Big Grizzly Creek to maintain the flow of the Middle Fork of the Feather River rather than to irrigate in Sierra Valley. This would enhance the recreational potential of 33 miles of natural stream channel by providing a firm controlled flow. The project could be operated exclusively to enhance the recreational potential of the area, thus all costs would be nonreimbursable and borne entirely by the State.

Despite the apparent sizable benefits of this modification, it was determined that Sierra Valley as an area of origin has an inherent prior right to the waters required for its full development, and the public interest could best be served by providing the waters of Grizzly Creek to Sierra Valley.

In view of the foregoing, the multipurpose Grizzly Valley reservoir (named Lake Davis) was developed and began operation in 1966 to provide recreational use at the lake, streamflow maintenance below the dam and, subsequently, domestic water to the town of Portola by means of the Grizzly Valley Pipeline. The completed facility stores 84,371 acre-feet of water.

Grizzly Valley Pipeline

The only project transportation facility located above the Sacramento-San Joaquin Delta is the Grizzly Valley Pipeline, which extends six miles from the Grizzly Valley Dam to the vicinity of Portola. Under the provisions of a Joint Exercise of Power Agreement executed with the Plumas County Flood Control and Water Conservation District, dated June 14, 1968, the District agreed to design and construct the Grizzly Valley Pipeline with funds advanced by the State and funds provided by a grant from the Economic Development Administration of the United States Department of Commerce. The federal grant was in an amount equal to 60% of the cost of the Pipeline and the District-related treatment facilities.

On June 10, 1970, an agreement was executed whereby responsibility for operation, maintenance, and replacement of the Grizzly Valley Pipeline was transferred from the Department to the Plumas County Flood Control and Water Conservation District.

Antelope Dam and Lake

Antelope Dam (Figure 4) was completed in 1963. Installation of initial recreation facilities was completed in July 1964 (Ref. 55). It is an earthfill structure 120 feet high and stores 22,566 acre-feet of water used entirely for recreation and fish and wildlife purposes. It has a surface area of 931 acres and a shoreline of 15 miles. The Dam is located on Indian Creek about 25 miles northeast of Crescent Mills.

Dixie Refuge Dam

Dixie Refuge Dam, which is not yet scheduled for construction, will be an earthfill structure about 100 feet in height. It will impound a reservoir of about 16,000 acre-feet to be used for recreation and fish and wildlife purposes. The reservoir will have a surface area of about 900 acres and a shoreline of 15 miles. The damsite is located on Last Chance Creek about 30 miles east of Crescent Mills.

Abbey Bridge Dam

Abbey Bridge Dam, which is not yet scheduled for construction, will be an earthfill structure about 117 feet in height. It will impound a reservoir of about 45,000 acre-feet to be used for recreation and fish and wildlife purposes. The reservoir will have a surface area of about 1,950 acres and a shoreline of 21 miles. The damsite is located on Red Clover Creek about 24 miles east of Crescent Mills (Ref. 56).

Oroville Facilities

Oroville Reservoir, with its auxiliary facilities, is the keystone of the State Water Project (Figure 5). Its major function is to conserve and regulate the flows of the Feather River for subsequent release to the Sacramento-San Joaquin Delta, where they can be diverted by various facilities of the State Water Project and also provide salinity control against the incursion of saline water from the ocean. Many additional functions were incorporated in its planning concept. Its hydroelectric potential represented a major source of revenue for the Project that was to be fully utilized. Its flood control capabilities were considered vital for the protection of downstream communities and developed lands.

Numerous opportunities for recreational development were offered by the several facilities. The environmental and economic impact on the surrounding area had to be assessed and necessary corrective or preventive measures taken. These considerations were incorporated in the planning for the Oroville Facilities to an extent seldom, if ever before, followed in water development planning.

The potential for water development on the Feather River was recognized during the Statewide Water Resources Investigation of the 1920s, and a reservoir at Oroville to provide water conservation, flood control, and hydroelectric power was designated as a unit of the State Water Plan in 1930 (Ref. 5).

Damsites

Studies of the Feather River by the Bureau of Reclamation and the Corps of Engineers indicated that res-

Figure 4

ANTELOPE DAM AND LAKE

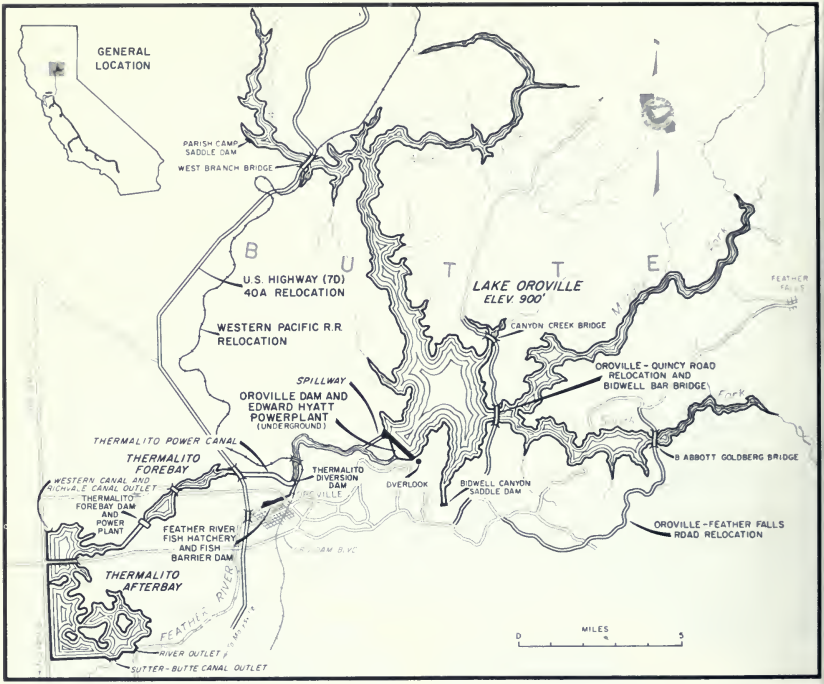


Figure 5

OROVILLE FACILITIES

Figure 6

OROVILLE DAM AND LAKE OROVILLE

ervoir storage could be obtained more economically than at the Department-favored Oroville site by a combination of dams at Bidwell Bar on the Middle Fork of the Feather River and Big Bend on the North Fork. In order to resolve these conflicting viewpoints, joint studies were made to compare all three of the sites. Cost estimates were prepared for various reservoir sizes at each of these sites, and allocations were made to flood control, irrigation, and power generation. These costs were analyzed to determine the unit cost of irrigation water, assuming that flood control benefits would be nonreimbursable and that electric power revenue would be applied to the gross annual charges, with the remainder representing the net annual cost of new irrigation water.

Unit water costs at Oroville would vary from a low of $2.18 per acre-foot for a 1.7 million-acre-foot reservoir to $3.73 for a 1.0 million-acre-foot reservoir. The largest reservoir studied, 3.0 million acre-feet, showed a unit cost of $2.60. All of these costs were considerably lower than the two Bidwell Bar-Big Bend combinations that were studied, for which estimated costs ranged from $3.85 to $4.19 per acre-foot (Ref. 57).

From these joint studies, it was concluded that major storage capacity on the Feather River could be most feasibly and economically provided at the Oroville Reservoir site (Figure 6). Further studies by a board of consultants of proposed projects at Bidwell Bar and Oroville found that only a reservoir at Oroville would be economically feasible for flood control, power generation, and water conservation purposes (Ref. 58).

Flood Control

The original Feather River Project proposal in 1951 included a 3.5 million-acre-foot reservoir at Oroville, and all subsequent planning studies of the State Water Project were based on this storage capacity. A primary function of the reservoir would be flood control (Ref. 11). Flood protection would justify an allocation of $75 million for flood control purposes of Oroville Dam and form the basis for evaluating the federal contribution for these purposes. A federal payment in the interest of flood protection equal to 22% of the actual construction cost of Oroville Dam and Reservoir was authorized by Congress in PL 85-500 (Federal Flood Control Act of 1958). This was estimated to be about $66 million in the initial contract; however, the amount has been increased subsequent to the authorization and will eventually total about $69 million.

Power Facilities

Hydroelectric power production at Oroville represents a major source of revenue for financing the State Water Project, and the maximization of these revenues without interfering with other project purposes was a major planning objective. Sizing the power facilities was an evolutionary process.

The early studies in 1951 contemplated that an afterbay and power plant would be provided below Oroville, in addition to the power installation at the Dam. These facilities would have a dependable capacity of 348,100 kilowatts when operated primarily for power generation. If Oroville Reservoir was operated to provide water at the Delta to allow continuous diversion of 3,930 cubic feet per second, a dependable power generation capacity of 232,000 kilowatts could be attained (Ref. 11). In the original concept, a transmission line from Oroville to a load center at Bethany was also included, but this was later omitted when the power was sold at the Oroville switchyard bus.

Further studies demonstrated that additional revenues could be obtained by operating the Oroville power facilities on a peaking schedule. This would require additional afterbay capacity which could not be provided at the original site without losing head at Oroville. A second site was consequently proposed farther downstream on the Feather River. These studies also showed that no advantage would be gained by constructing the originally proposed power plant at the Oroville Afterbay. With these facilities, Oroville could produce only 410,000 kilowatts of dependable peaking capacity (Ref. 12). Further studies showed that the dependable capacity could be increased and greater revenues could be realized by providing pumped-storage facilities at Oroville, and this was adopted as the final plan for development.

In large electric utility systems, economics dictate the installation of large, thermal power-generating units which have the lowest possible incremental cost of construction, maintenance, and operation. Economical operations of such large efficient thermal units requires that substantial loads be carried even at times of minimum system power requirements. This leads to the utilization of pumped-storage hydroelectric development by which power is used off-peak, when excess thermal power is available, to pump water into storage. When the utility system load is at a maximum, this water then can be released to generate power on-peak. Pumped storage serves a double function by converting off-peak energy surpluses, which occur mostly during the night, to on-peak energy required during the day.

The Oroville pumped-storage scheme was the first such facility constructed in California, and it is one of the largest in the United States.

The power plant at Oroville (now named Edward Hyatt Powerplant) is an underground installation (Figure 7). The underground location was justified on the basis of economics. Substantial savings were realized in (1) design of short power penstocks constructed in solid rock which is capable of withstanding most of the internal water pressure; and (2) use of the diversion tunnels as tailrace tunnels, thus eliminating the cost of the tailrace water passages which are normally attributable to the overall project cost in other similar installations.

Figure 7

EDWARD HYATT POWERPLANT

The Powerplant contains six units, three of which are reversible and can be used to pump water back into Lake Oroville. The two afterbays of the earlier proposals on the Feather River below Oroville Dam have been replaced by offstream storage at Thermalito of 68,809 acre-feet and 13,328 acre-feet of onstream storage in the Thermalito Diversion Pool. Releases from Lake Oroville are diverted from the River to a forebay from where they pass through the Thermalito Powerplant into the Thermalito Afterbay. The Thermalito Powerplant (Figure 8) contains four generating units, three of which are reversible for pumpback operations. The Oroville-Thermalito installation has a total dependable power capacity of 725,000 kilowatts.

Oroville offers further potential for power development in the future. An intake stub was built in the right abutment of the Dam and can be utilized in any future power plant constructed at the site.

Alternative Dam Types

An application to the Federal Power Commission for a license to construct facilities at Oroville was filed on January 31, 1952. This application was based on a concrete gravity dam, and the original license (2100) issued on December 14, 1956 by the Commission was based on this type of structure.

The State Legislature, in 1956, appropriated funds for the preparation of final designs, plans, and specifications for Oroville Dam. In the studies leading to the final type of dam to be constructed at the site, five different types of design were seriously considered. The dam types were gravity, multiple arch, massive head buttress, arch buttress, and the zone-type fill dam that was finally selected. Preliminary designs and cost estimates were prepared for the five types of dams as a basis for the final decision. The fill-type design was selected on the basis of engineering feasibility and economy.

In view of the foregoing, an amendment to the Federal Power Commission license was filed on October 30, 1959 to reflect, among other things, the decision to change from a concrete dam to an embankment dam. This amendment, with subsequent modifications, was approved by the Federal Power Commission on July 11, 1962.

The dam, as constructed, is an 80,000,000-cubic-yard, zoned, earthfill embankment 770 feet in height, with a gross storage capacity of 3,537,577 acre-feet.

Fisheries

Since Oroville Dam would prevent salmon and steelhead from reaching upstream spawning areas in the Feather River, facilities were developed to replace these spawning grounds. The Feather River Hatchery, with a capacity of about 20 million eggs, has been constructed for this purpose. Salmon and steelhead migrating up the River are diverted to a fish ladder by a low dam across the River and then conveyed to the Hatchery, where the eggs are taken and hatched. The hatched fingerlings are later returned to the River to maintain the fish runs. In the 1973–74 fiscal year, approximately 9,600 fish (salmon and steelhead) were taken into the Hatchery and nearly 18 million eggs were taken.

As an interim measure to avoid interruption of the fish runs prior to completion of the Hatchery, fish were collected below the Dam and transported in tank trucks to a location above the Dam, where they were released. Planning for the Hatchery included provision for facilities to accommodate sightseeing visitors. Visitor provisions were incorporated into both interim and final facilities.

Water at the lower levels of Oroville Reservoir remains cold indefinitely, and releases from these depths average about 42 degrees in May. This is considerably colder than the natural runoff near Oroville, where the water temperatures have varied from an average of about 52 degrees in May to 72 degrees in August. Such a change in temperature would have a detrimental effect on the uses of Feather River water, particularly on the existing fishery and for irrigation of rice. Optimum temperatures for rice irrigation range from 59 to 77 degrees Fahrenheit, while the Fish Hatchery requires water at around 55 degrees for best operational results. To help avoid these difficulties, a multiple-level outlet was provided which controls the temperature of Oroville discharges by selectively drawing water from different levels in the Reservoir. Water drawn from the reservoir surface is as much as 20 degrees warmer than water from lower levels. In operation, water is released from Oroville at a temperature suitable for use in the Feather River Hatchery. Downstream in the Thermalito Forebay and Afterbay, the shallow depths and large surface area permit the sun to warm the water to temperatures suitable for irrigating rice, for preserving the warmwater fishery below the Afterbay, and for water sports as well. Essentially, the water approximates the long-term preproject, mean temperatures and falls within a range extending from about 57 degrees Fahrenheit in mid-April to a high of about 65 degrees Fahrenheit in July.

Recreation

Oroville Reservoir and its appurtenant units offer extensive opportunities for recreational use, and extensive planning was done to take advantage of that potential. Plans were developed to accommodate over six million visitors per year, which are anticipated by about 2020 (Refs. 59 and 60).

The plans call for 10 separate areas at Oroville to provide for picknicking, camping, and boating with additional day-use areas at Thermalito Forebay and Afterbay and at the Oroville borrow area. Visitor facilities at Oroville Dam, the Edward Hyatt Powerplant, and the Feather River Fish Hatchery were included.

Figure 8

THERMALITO POWERPLANT AND FOREBAY

Local Impact

Studies were made of the impact of the Oroville area project work force on the surrounding area. During construction of the Project, the contractors' work forces reached a maximum of 2,000 and the Department of Water Resources' Staff about 350. This influx of workers and their families, together with the service personnel attracted by the Project, severely strained the limited housing facilities of the area. Supplemental housing for Department employees was constructed, consisting of 50 family units. When major construction was completed, the houses were sold.

The expenditure of over $400 million for construction of the Oroville facilities had a tremendous economic impact over the surrounding area. The study to evaluate this impact showed that the payrolls for project workers totaled over $115,000,000 during the construction period. Business activity increased and land values rose, resulting in greater revenues to local government. However, costs to the community also rose, particularly police and fire protection and other municipal services. Provisions for the Project to share in these increased costs were adopted by the Legislature in 1959 (the Bryne Act, Water Code Div. 6, Part 7, commencing at Sec. 12950). A total of $661,931 was paid to the City of Oroville, and $481,061 was paid to Butte County during the years of construction. The law applied to all areas where project construction had a major impact.

Sacramento-San Joaquin Delta

The Sacramento-San Joaquin Delta receives all the runoff from the Central Valley drainage and is the last place where these surplus waters can conveniently be diverted for beneficial use before they flow out into the ocean. It represents the connecting link between the streams carrying the surplus waters of Northern California and the conveyance systems required to transport these waters southward to areas of deficiency in the San Francisco Bay area, San Joaquin Valley, and Southern California. In addition, the Delta constitutes a significant element in California's economy. Its rich peat soils are intensively cultivated, and its many channels are heavily utilized for boating, fishing, and other forms of recreation, as well as for the maritime commerce of ocean-going vessels. An extensive industrial complex has developed along its western shores.

The Delta is a tidal estuary and forms a transition zone between the saline waters of San Francisco Bay and the fresh water runoff from the Central Valley. Its waters, which are heavily used for local development, are then subject to degradation by intrusion of sea water, waste discharges from municipalities and industries, and return flow of agricultural drainage. In determining the availability of water for export from the Delta, full consideration was given to local water requirements.

The Delta is vulnerable to flood damage. Its peat soils are subsiding at an average rate of about 3 inches per year through oxidation, wind erosion, compaction by farm equipment, and withdrawal of ground water to the point where much of the land lies below sea level. These peat soils constitute an uncertain foundation for the levees that are required to protect the farming lands and cause extensive maintenance problems. These problems have been given full consideration in planning for the Delta facilities of the State Water Project. The plans also cover the needs of the area for maintenance and development of water-based recreation, navigation, and vehicular transportation (Ref. 61).

Salt Water Barrier

The problem of sea water intrusion from San Francisco Bay into the Delta was recognized as early as the 1860s, when a salt water barrier was proposed. In 1880, State Engineer William Ham Hall investigated the feasibility of constructing a barrier across San Francisco Bay primarily for flood control in the Delta. He concluded that while such a barrier could be constructed, the cost would exceed the benefits. Prior to 1920, the City of Antioch instituted legal action against upstream water users because of sea water intrusion in the Delta. As an outgrowth of the suit, several potential barrier sites were extensively investigated (Ref. 62). These studies pointed out that salinity conditions in the area would become more acute unless upstream waters were stored for later release during periods of low river discharge, thus being of sufficient magnitude to repel sea water intrusion. Further studies established that protection from sea water intrusion could be accomplished more advantageously by maintenance of fresh water outflow rather than by construction of salt water barriers, and this method was adopted for the State Water Plan (Ref. 5). Since 1944, when Shasta Reservoir was constructed, the Central Valley Project has been operated by the U. S. Bureau of Reclamation on this basis to protect the water quality of its diversions from the Delta in the Contra Costa Canal and Delta-Mendota Canal. This mode of operation also provided protection to most of the agricultural lands of the Delta.

The accelerated growth in the San Francisco Bay area following World War II fostered investigations by various agencies of different types of barrier projects. The studies involved transportation and navigation conditions, land reclamations, national defense, and industrial and agricultural expansion, as well as water conservation and water quality protection.

Hearings were held by committees of the Congress and the Legislature, and four court actions were filed on various phases of the San Francisco Bay problem (Ref. 63). To resolve the controversies generated by the various barrier plans, the Legislature in 1953 enacted the Abshire-Kelly Salinity Control Barrier

Act of 1953 (Statutes of 1953, Chapter 1104) which provided for the study of the feasibility of constructing a barrier across San Francisco Bay and adjoining waters, including the Delta, for reclamation, salinity and flood control, and provision of a supply of fresh water for use in the area. This study was conducted concurrently with the Statewide Water Resources Investigation, and much of the data utilized was mutually developed and jointly shared.

Seven proposals for barriers at locations ranging from South San Francisco Bay to the Sacramento River were evaluated. These by no means represented all of the plans that had been set forth but were considered typical. As a result of the various studies, all of the proposals were found to be feasible from an engineering standpoint (Ref. 63). However, they would all create navigation hazards and increase shipping costs without compensating benefits. They would also have a detrimental effect on anadromous fish, although creation of a fresh water pool would improve the resident fresh water fishery. Except for the proposal for a barrier across South San Francisco Bay, they would all conserve considerable quantities of water, although water quality problems would be created if barrier pools were created downstream from the Delta. Only barriers upstream from San Pablo Bay would be economically feasible (Ref. 63).

The report on feasibility of construction of barriers in San Francisco Bay recommended that further consideration be given only to barriers at, or upstream from, Chipps Island and that detailed studies be made of the Biemond Plan. (This plan was named for Cornelius Biemond, a consulting engineer from the Netherlands.) It proposed construction of a barrier across the Sacramento River at Junction Point, together with a system of flood control works for the Delta for inclusion as a possible unit of the California Water Plan. The report recommended that the interest of the United States Bureau of Reclamation in jointly participating with the State of California to provide an isolated fresh water channel across the Delta should be determined. Another recommendation was that the United States Army Corps of Engineers should be urged to investigate the flood control aspects of the Biemond Plan.

A board of consultants reviewed the reports on the various studies and reported its own findings and recommendations. The board generally concurred in the findings of the investigation and recommended that the Biemond Plan be adopted as the long-range solution for Delta problems (Ref. 63).

Further studies of the Chipps Island Barrier and the Biemond Plan led to development of the single-purpose Delta water project (Ref. 64). This would provide control structures on the channels of the Sacramento, Mokelumne, and San Joaquin Rivers and would utilize the existing Delta-Cross Channel of the Central Valley Project rather than provide an isolated channel to convey fresh waters across the Delta. Other economically justified facilities for local flood and seepage control, transportation, and recreation benefits could be added to this facility if requested by local authorities and if appropriate agreements were made for repayment of reimbursable costs.

The Burns-Porter Act definition of State Water Facilities includes "master levees, control structures, channel improvements, and appurtenant facilities in the Sacramento-San Joaquin Delta for water conservation, water supply in the Delta, transfer of water across the Delta, flood and salinity control, and related functions" (Water Code Sec. 12934). The State Water Project contemplated facilities in the Delta that would (1) salvage water otherwise required for repulsion of ocean salinity, (2) protect the Delta from damage of salinity intrusion, flooding and seepage, and (3) provide transportation and navigation benefits. The facilities plan included control structures and channel improvements to convey water from the Sacramento River across the Delta to the state and federal pumping plants and provide flood control levees, irrigation and drainage facilities, relocated and improved roads, small craft locks and transfer facilities, and public recreation areas.

The views of the State regarding facilities required for the Delta were not shared by all agencies. The Corps of Engineers generally favored the Chipps Island Barrier Plan, while the Bureau of Reclamation indicated that additional facilities were not required in the Delta at that time (1960). Additional objections were raised by the State Department of Fish and Game regarding the adverse effects on the anadromous fishery and wildlife, while others were concerned with yachting restrictions, commercial steamship operations, flood control, water quality, etc.

Interagency Committee

In an effort to resolve these differences and formulate a mutually acceptable plan for the Delta, the Interagency Delta Committee was formed of representatives from the Department of Water Resources, the U.S. Bureau of Reclamation, and the U.S. Corps of Engineers. To compare the various plans on a uniform basis with respect to their relative advantages and costs, the various proposals were grouped into three planning concepts: (1) the hydraulic barrier concept, using fresh water outflow for salinity control protection; (2) the physical barrier concept, represented by the Chipps Island Barrier, to keep salinity and tidal waters from entering the Delta area; and (3) the Delta waterway control concept. The waterway control concept contemplated the transfer of export water across the Delta through the central Delta channels with control structures to maintain a separation between Delta and export waters, thus protecting the central Delta from salinity intrusion by controlled outflow, and with releases being made to meet local water requirements.

The Committee's studies led it to conclude that pre-

vious approaches did not satisfy requirements of fish and wildlife, and a fourth category was established, the Peripheral Canal concept. The Peripheral Canal would divert water from the Sacramento River at Hood, about 20 miles south of Sacramento. It would skirt the eastern edge of the Delta and transport water to the intake facilities for the federal and state export pumping plants near Tracy. The Canal would be hydraulically isolated from Delta channels. Facilities would be provided to release water along the route to meet local water requirements, to achieve environmental control, to protect fisheries, and to protect the central Delta from salinity intrusion (Figure 9).

Peripheral Canal

Determination was made that the Peripheral Canal would provide the greatest environmental and economic advantages of all the plans considered, with the waterway control plan ranking second (Ref. 64). Furthermore, the Peripheral Canal would provide the greatest potential for development and the least interference with established and planned activities. The Committee concluded that the Peripheral Canal would best serve the general planning objectives and would provide for balanced development of the Delta.

The Committee considered the U. S. Bureau of Reclamation and the California Department of Water Resources to be the agencies that could most appropriately undertake the responsibility of building the Peripheral Canal on a cooperative basis.

The recommendation was made that recreational opportunities along the Canal should also be developed and operated by the constructing agency. Other appurtenant facilities, which would provide drainage and flood control for the Stone Lake area in southern Sacramento County, waterways for recreational boating, and environmental control, could be constructed and operated either by the agency responsible for the Peripheral Canal or by the U. S. Corps of Engineers, or by local agencies as appropriate. Both the California Department of Water Resources, by Project Order Number 12 dated March 16, 1966, and the U. S. Bureau of Reclamation have adopted the Peripheral Canal as a joint-use, state-federal, Delta water facility to serve as the Delta link in both the State Water Project and the Federal Central Valley Project. Project orders may be issued by the Director of the Department of Water Resources to document modifications to basic project facilities authorized by the Legislature in Water Code Section 12934d pursuant to provisions contained in Water Code Div. 6, Part 3, Chapter 1, Section 11260.

The State has the authority from the Burns-Porter Act to construct the Canal alone or by joint venture. The Bureau of Reclamation, however, must receive authorization from Congress before entering into an agreement with the State for construction and operation of the Canal.

The Peripheral Canal will have a design capacity ranging from 23,300 second-feet at the intake down to 18,300 second-feet at the canal terminus. It will convey approximately 10.2 million acre-feet of water annually, of which 1.7 million acre-feet will be used for local purposes and 8.5 million acre-feet used for export by the state and federal projects (4.4 million acre-feet by the State Water Project and 4.1 million acre-feet by the Federal Central Valley Project).

An interagency agreement (No. 460526) dated January 18, 1968 was entered into between the Department of Water Resources and the Division of Highways of the Department of Public Works (now called Department of Transportation). This agreement recognized that Interstate Route 5 would parallel the alignment of the Peripheral Canal in Sacramento and San Joaquin Counties and that coordination of the two projects could achieve a reduction in the amount of land acquired and also result in a substantial savings of public funds if material excavated from the canal prism was used in the highway fill. Although a number of amendments subsequently have been made to the basic agreement, the intent and overall plan are still in effect and work is progressing toward their accomplishment.

Water quality is the principal planning consideration in the Delta. Extensive studies have been conducted to determine the extent to which it is affected by natural phenomena, such as sea water intrusion and fresh water inflow, and by man-made factors, such as water use, diversion, and waste discharges (Ref. 65).

Agricultural drainage wastes discharged through more than 200 pump installations and municipal and industrial waste discharges from a population of approximately 1.5 million people contribute to the water quality problems in the Delta. These discharges are expected to increase between two- and threefold by 1995. The Central Valley Project and the State Water Project have been successful in controlling sea water intrusion into the Delta up to this time through fresh water outflow (Ref. 66). The Peripheral Canal, however, would provide a better degree of water quality control within the Delta, with resultant improvement of water quality conditions (Ref. 67).

Legislation authorizing the State Water Project and other provisions of the California Water Code specifically provide for protection of water quality and the use of water within the Delta. To resolve the problems of Delta water entitlements, lengthy negotiations were conducted in the early 1960s between the Department of Water Resources, the Federal Bureau of Reclamation, and representatives of many local water users' organizations. This led to development of water quality criteria to guide project operation in the Delta, known as the November 19, 1965 Delta Water Quality Criteria. These criteria set forth quality limits for Delta waters and specified the location of monitoring stations.

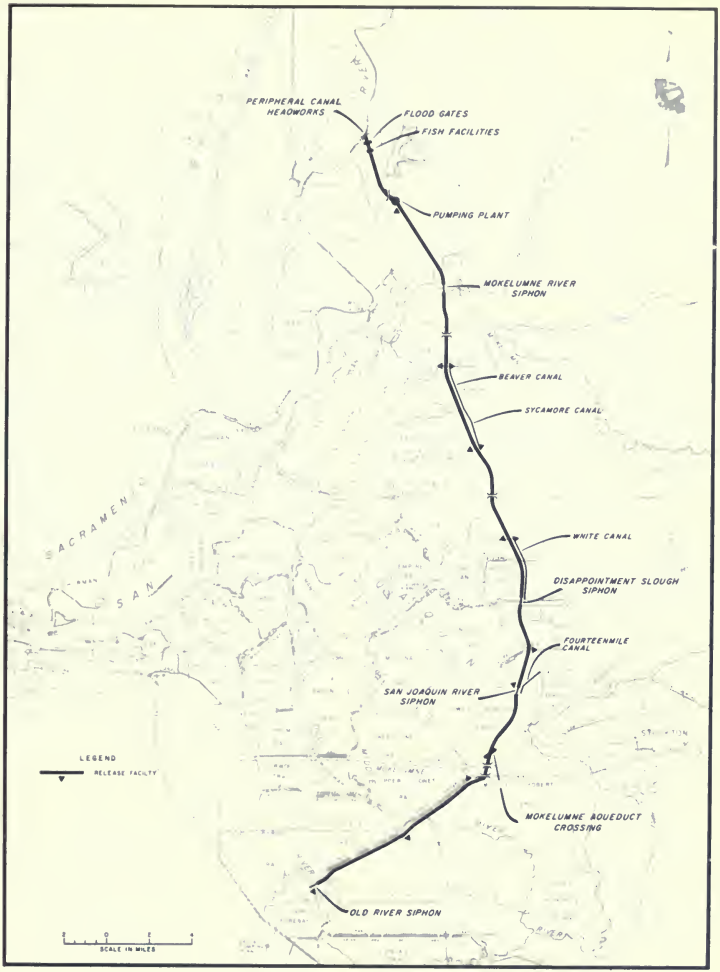


Figure 9 : PERIPHERAL CANAL

The maintenance of these water quality standards by controlled releases of fresh water, together with provision of a direct overland supply of water to users in the western Delta, formed a basis for establishing water entitlements and operational criteria for the Delta. These criteria were included in Decision 1275, which was handed down by the State Water Rights Board May 31, 1967, on the State's applications for water rights permits. Portions of the Board's Delta water quality standards as set forth in Decision 1275 have been submitted to and approved by the Environmental Protection Agency. Other portions have not yet been submitted to EPA because of pending litigation concerning Decision 1379 (see Chapter IV).

San Francisco Bay Area

North Bay Aqueduct

Plans for supplying water from the Sacramento-San Joaquin Delta to lands in the northern parts of the San Francisco Bay area date back to the Statewide Water Resources studies of the 1920s.

As part of a plan for protecting and utilizing the waters of the Delta, the Solano-Napa County conduit was proposed in 1932 to serve lands in the north San Francisco Bay area (Ref. 68). The study showed that a conduit of this type would be required to serve these lands regardless of the method used to protect the Delta from sea water intrusion. However, the conduit was not included as an element of the State Water Plan. Subsequent studies of the feasibility of salt water barriers included consideration in 1955 of an aqueduct to divert water from various points in the Delta and to convey it as far as Marin County (Ref. 63). These studies concluded that the North Bay Aqueduct, diverting water from Lindsey Slough on the Sacramento River, was the best method to provide supplemental water to those portions of the North Bay counties within the San Francisco Bay drainage. It was recommended in 1957 that the Aqueduct be authorized for construction as a feature of the California Water Plan (Ref. 69).

The Legislature adopted this recommendation and subsequently included the North Bay Aqueduct as a feature of the State Water Project (Figure 10). As studies continued, it became apparent that there was no unanimity of interest in the Aqueduct among the four North Bay counties of Solano, Marin, Sonoma, and Napa. Alternative sources of water from the Russian River were available to Sonoma and Marin Counties. A reevaluation of the project concluded that construction of the Aqueduct should be initiated in time to ensure delivery of water to Napa County by 1966. As a minimum, the reach from Lindsey Slough to the vicinity of Napa should be initially constructed to provide service to Solano and Napa Counties with provision for later extension to Marin and Sonoma Counties (Ref. 70).

After negotiations, agreements were consummated with the Napa County and Solano County Flood Control and Water Conservation Districts for the State to provide these agencies with an annual water supply from the State Water Project of 25,000 acre-feet and 42,000 acre-feet, respectively. The Solano County agreement specified initial deliveries to be scheduled for 1980 and required that construction of the Aqueduct from Calhoun Cut to Cordelia be deferred until 1975. On the other hand, Napa County requested that construction of the North Bay Aqueduct from Cordelia to Napa County be initiated in time to enable water deliveries to be made by December 31, 1967.

Since the Solano County facilities, including the diversion from the Delta, would not be constructed until after 1975, it was necessary to make interim provisions to obtain a water supply for the Napa County phase. Alternatives available were the Cache Slough system of the City of Vallejo and the Solano Project of the Bureau of Reclamation, with the latter being considered more desirable.

For the first phase, an interim pumping plant was found to be more economical than including the Cordelia Pumping Plant in the initial construction schedule. Thus, the permanent facilities for the first phase of the North Bay Aqueduct originate at the storage tank for the proposed Cordelia Pumping Plant and extend westerly to the Aqueduct terminal at the Napa turnout. Until 1980, the Aqueduct will receive an interim water supply from the terminal reservoir of the Solano Project. A temporary pumping plant lifts this water to the Cordelia Pumping Plant storage tank. The capacity of this reach of Aqueduct is 46 cubic feet per second.

The second phase of the Aqueduct will originate at Calhoun Cut, a man-made extension of Lindsey Slough. The water will be lifted about 33 feet at the Calhoun Pumping Plant and conveyed across Solano County to the Cordelia Pumping Plant, which will lift the water an additional 448 feet to the Cordelia storage tank, thus replacing the interim facilities constructed for the first phase of the Aqueduct. The Phase II facilities will have a capacity of 115 cubic feet per second from the Delta to the Cordelia Pumping Plant.

South Bay Aqueduct

Lands in the southern part of the San Francisco Bay area have attained a high degree of development, supported to a large extent by exploitation of the local ground water resources, particularly in Alameda and Santa Clara Counties (Ref. 10). Although supplemental water supplies have been imported from a number of sources to support the growing economy, the continuing heavy demands on the ground water basins had resulted in serious overdraft conditions resulting in a lowering of ground water levels, which in some cases had dropped below sea level and subjected the aquifers to the danger of destruction by sea water intrusion.

The South Bay Aqueduct (Figure 11) was proposed

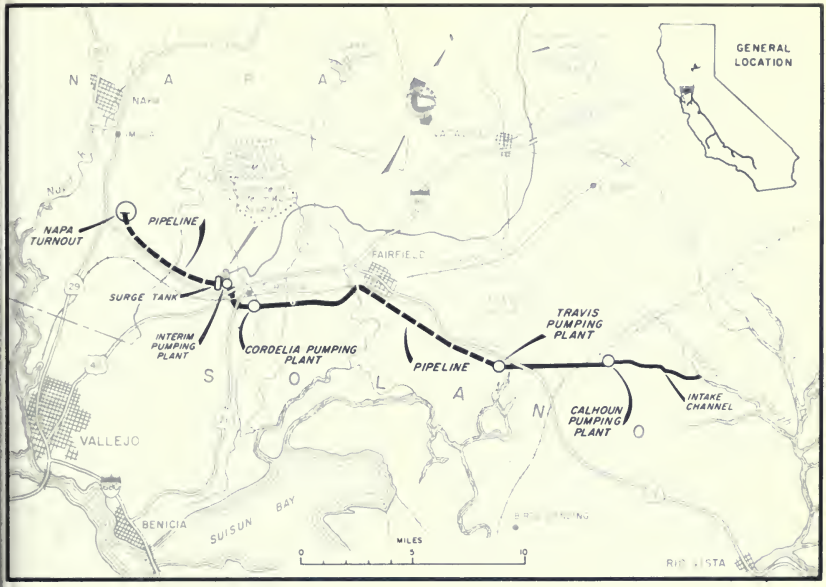


Figure 10

NORTH BAY AQUEDUCT

to alleviate these problems and provide supplemental water supplies to these water-deficient South Bay areas from the State Water Project. The South Bay Aqueduct plan stems from the proposed Santa Clara-Alameda Counties diversion, which was included as a feature of the original Feather River Project proposal (Ref. 11). Water would be lifted from Italian Slough at the southern edge of the Sacramento-San Joaquin Delta and conveyed by pipeline across the Coast Range to Livermore Valley, where the conduit would divide into two branches to serve lands in Alameda and Santa Clara Counties (Ref. 11).

The mid-1950 plans proposed that a total of 127,000 acre-feet of water would be supplied to the South Bay service areas annually. Subsequent modification of the Project resulted in substantial increases in project yield (Ref. 12). As part of this modification, the Santa Clara County branch would be extended from Evergreen Reservoir to a terminus on Pacheco Creek north of Hollister to serve Upper Santa Clara Valley and San Benito County, delivering a total of 240,000 acre-feet per year to this enlarged service area. The enlarged facility was designated the Alameda-Santa Clara-San Benito Branch.

This facility was recommended in the California Water Plan for initial construction as part of the Feather River Project and redesignated as the first phase of the South Bay Aqueduct (Ref. 10). The second phase of the South Bay Aqueduct would consist of additional regulatory and conveyance facilities, generally paralleling the initial line. The initial route would be modified, if necessary, to convey water along the northern edge of Livermore Valley to a regulatory reservoir in Doolan Canyon and then proceed southwesterly across the Valley to the basic alignment west of La Costa. The initial phase could also be extended from its terminus on Pacheco Creek an additional seven miles to Harper Canyon Reservoir, where additional regulatory storage would be provided.

Also under consideration was the possibility of further subdividing the first phase into two parts, each of which would provide 120,000 acre-feet per year. (Ref. 71).

The timing and sizing of the South Bay Aqueduct hinged, to a large extent, upon the amount of water that could be supplied from other sources and a determination of the desires of the local agencies involved (Ref 69). Subsequent water development and planning by local water agencies led to consideration of alternative means of supplying supplemental water to San Benito County. The feasibility of constructing a tunnel from San Luis Reservoir through the Coastal Range at Pacheco Pass was considered in lieu of the extension of the South Bay Aqueduct from Evergreen Reservoir.

Further studies were made to delineate the service area and the features of the South Bay Aqueduct. These had an important consideration going beyond the requests to provide water service in portions of Santa Clara and southwestern Alameda County. Geologic exploration at the proposed damsites showed that the Airpoint and Evergreen damsites would require costly treatment because of poor foundation conditions,while conditions at Del Valle Dam site were satisfactory. The most desirable route consisted of a shortened South Bay Aqueduct terminating at the proposed Airpoint Reservoir. Primary regulation would be accomplished at the Del Valle Reservoir site to serve water to Alameda and Santa Clara Counties. The Pacheco Pass Tunnel would divert water from San Luis Reservoir to Pacheco Creek to supply San Benito County.

A branch to serve the northern Livermore Valley was contemplated but was subsequently eliminated (Ref. 49). The Bureau of Reclamation was authorized to investigate the possibility of making a federal project of the Pacheco Pass Tunnel to serve Santa Clara, San Benito, Santa Cruz and Monterey Counties, and no further work was done by the Department on this feature.

Further geologic studies of the Airpoint damsite found that it was unsatisfactory for terminal storage, and consequently it was deleted from the South Bay Aqueduct facilities.

The South Bay Aqueduct, in the final plan, originates at Bethany Reservoir, a wide reach on the California Aqueduct a short distance south of the Delta Pumping Plant (Figure 12). This facility functions as a forebay for the South Bay Pumping Plant as well as a balancing pool for the discharge from the Delta Pumping Plant. Water is lifted across the divide into Livermore Valley by the South Bay Pumping Plant, which contains 9 pumping units capable of lifting 334 cubic feet per second through a static head of 545 feet. The Aqueduct then continues southwesterly and southerly across Alameda County to a terminus in Santa Clara County near San Jose, almost 43 miles from its starting point. The capacity of the Aqueduct at its terminus is 184 cubic feet per second.

Patterson Reservoir, at the head of Livermore Valley near Altamont, provides a small amount of storage (100 acre-feet) for emergency purposes, but most of the regulatory and operational storage is provided by Del Valle Reservoir (Lake Del Valle) located on Arroyo Del Valle near Livermore. The Lake has a gross storage capacity of 77,106 acre-feet and is used for flood control, fishery enhancement and recreation (Ref. 72) in addition to its basic conservation and regulatory functions (Figure 13). Depending on the need, water can be pumped from the Aqueduct into Lake Del Valle by a small pumping plant (4 pumping units with a total capacity of 120 cubic feet per second) located at the downstream toe of the dam. Releases can be made from the Lake to augment aqueduct flows in this reach up to a maximum of 363 cubic feet per second.

A contract between the State and the United States was signed in May 1966 providing for a federal flood

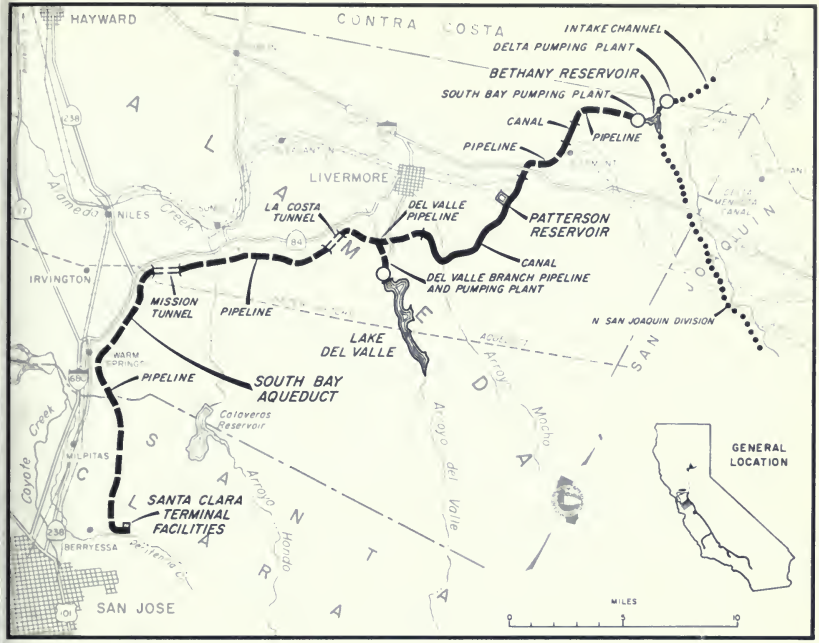


Figure 11

SOUTH BAY AQUEDUCT

Figure 12

BETHANY RESERVOIR

control payment to the cost of Del Valle Dam and Reservoir. The payment was authorized by Congress (Federal Flood Control Act of 1962, PL 87-874). Under the contract, the Federal Government would pay 30.7% of all construction costs incurred subsequent to October 14, 1958, up to a maximum of about $4,900,000. Execution of the contract was delayed when unfavorable geological conditions were discovered at the site, and the Dam had to be redesigned. These conditions materially increased the estimated cost of the facility, and the portion allocable to flood control was estimated to exceed the contractual limit.

Following the exchange of considerable correspondence, on January 26, 1967, the Senate Public Works Committee of Congress directed the U.S. Army Corps of Engineers, to determine whether any modification of the recommendation within its original report would be justified with respect to federal payments to project costs. By letter dated June 4, 1971, the District Engineer of the San Francisco District of the Corps transmitted a draft report with the conclusion that the federal contribution should be increased by about $570,000. A final report completed in December 1972 recommended the same figure, and this supplemental allocation may become available in 1975. Meanwhile, payments up to the contractual limit have been made.

The South Bay Aqueduct was designed to deliver 210,000 acre-feet per year. Water agencies in Alameda and Santa Clara Counties have contracted for 188,000 acre-feet, leaving 22,000 acre-feet of surplus transportation capacity in the Aqueduct, which will be supplied from future supplemental sources not now included in the State Water Project. It is estimated that this maximum delivery capacity will not be required until after 1990 (Ref. 49).

Deliveries from the South Bay Aqueduct were initiated in 1962, before water was available from the California Aqueduct. Interim facilities were provided to obtain water from the Delta-Mendota Canal of the Federal Central Valley Project and pump it into Bethany Reservoir Forebay.

California Aqueduct

The California Aqueduct is the largest conveyance facility of the State Water Project (Figure 14). Its basic function is to transport water supplies from the Delta to the San Joaquin Valley and Southern California and through branch aqueducts to the South San Francisco Bay area and to Santa Barbara and San Luis Obispo Counties. The Aqueduct implements the concept developed for the San Joaquin Valley-Southern California Diversion Project, which constituted a part of the original Feather River Project proposal in 1951 (Ref. 11).

It was originally conceived as a canal originating at the Sacramento-San Joaquin Delta and extending along the west side of the San Joaquin Valley to the foothills of the Tehachapi Mountains, with pumping plants provided as required to both lift the water from the Delta and make further lifts as required by the topography en route.

The Aqueduct would cross the Tehachapi Mountains by a major pump lift and a series of tunnels and would then extend all the way to San Diego County at a high elevation to permit most of the potential service area in Southern California to be served by gravity. This was the so-called High Line Route. Subsequent studies resulted in many modifications of this Route, but the basic concept has survived to a remarkable extent.

Earlier a study was made of a tunnel at elevation 1,870 feet which would terminate in Elizabeth Lake Canyon, a distance of 26.7 miles from the north portal in the San Joaquin Valley (Ref. 12). This study was undertaken to determine whether an appropriate balance could be achieved between the technical demands of a very high pumping lift and the economics of tunneling v. pumping costs.

The Tehachapi Mountains constitute an area of high seismic activity with numerous large faults, such as the Pastoria, Garlock, and San Andreas, all of which may be considered active.

In locating a tunnel, a major consideration is the future security of the facility. Since a tunnel at the 1,870-foot elevation would intersect nearly all of the aforementioned fault systems in the area and would have cover up to 3,900 feet in depth, such an alignment raised questions as to the hazards involved in the construction of an aqueduct system, and the High Line Route was later selected since it would cross all faults on the surface.

The original proposal was authorized for construction by the Legislature, and planning studies were initiated to refine the original ideas and prepare plans and specifications for the project. These studies demonstrated the desirability of providing additional regulatory storage for the project to conserve further the surplus flows in the Delta and to enable pump operations to be conducted on an intermittent off-peak schedule, and thus take advantage of lower power rates during off-peak periods. These capabilities were provided by adding San Luis Reservoir and its associated facilities to the Project. The Federal Bureau of Reclamation was also interested in San Luis Reservoir as an addition to its Central Valley Project, and a joint-use facility was established consisting of the San Luis Reservoir and the aqueduct reach from San Luis to Kettleman City. Studies were also conducted to delineate a possible distribution system for serving the Southern California area from the High Line Route.

During these studies, various possibilities were set forth for providing regulatory storage along the Aqueduct and generating hydroelectric power at certain turnouts from the Aqueduct. Two basic modifications of the original route were suggested for further study and consideration. One of these involved a power de-

Figure 13

DEL VALLE DAM AND LAKE DEL VALLE

Figure 14

THE STATE WATER PROJECT

velopment at Devil Canyon in the San Bernardino Mountains. A power plant also was suggested for the other branch of the Aqueduct, now called West Branch. This Branch extends from near the south portal of the Tehachapi Tunnels to a terminal reservoir at the junction of Castaic Creek and Elizabeth Lake Canyon in Los Angeles County.

Further studies were conducted to resolve a number of questions regarding the delivery of water. Prominent among these was the selection of a route for the southern part of the Aqueduct, particularly whether to cross the Tehachapi Mountains directly with a high pumping lift or to carry the Aqueduct along the coast, skirting the mountains at a lower elevation.

More than 100 different aqueduct alignments were investigated in the reach south of Avenal Gap near the Kings-Kern County line. While it was found that the inland approach to Southern California was shorter and more direct with a minimum of construction problems, it would require a major pump lift to an elevation of 3,000 feet above sea level or more to cross the Tehachapi Mountains. The other possibility was a coastal route extending through San Luis Obispo, Santa Barbara, and Ventura Counties and then into the San Fernando Valley. This route would require less pumping than the inland approach but would involve more expensive conduit construction because of the rugged topography and adverse geologic conditions encountered (Ref. 20).

An alignment generally following the original inland route across the Tehachapi Mountains was found to be most desirable. Beyond the Tehachapi crossing, the Aqueduct divided into two branches. The west branch generally followed the route that had been previously suggested for a power development at Castaic. The east branch conformed closely with the original high-line alignment along the southern boundary of Antelope Valley and the Mojave Desert to Cedar Springs Reservoir on the west fork of the Mojave River. It then crossed the San Bernardino Mountains into Devil Canyon, utilizing the concept previously suggested for the San Bernardino power drop development. The east branch then terminated at Perris Reservoir in Riverside County rather than continuing on to San Diego County as originally planned.

San Diego County could be supplied from Perris Reservoir through a new aqueduct constructed by The Metropolitan Water District of Southern California (MWD), substantially as recommended by the Department in studies that it had conducted for providing service to San Diego County. The MWD conduit was designed so that it could obtain water from MWD's Colorado River Aqueduct and also from the California Aqueduct at Perris Reservoir (Ref. 73).

With these modifications, the California Aqueduct was incorporated into the Burns-Porter Act as part of the State Water Facilities and set forth as the San Joaquin Valley-Southern California Aqueduct. Later, the name was changed officially to the California Aqueduct.

With the passage of the Burns-Porter Act, planning for the California Aqueduct passed from the broad conceptual stage to the more detailed studies involved in developing the specific features of the Aqueduct.

The California Aqueduct extends 444 miles from the Sacramento-San Joaquin Delta to Perris Reservoir in Southern California. For most of its length, the Aqueduct parallels the San Andreas fault. It also crosses a number of other active faults, all of which present seismic hazards to the aqueduct structures. Extensive studies were conducted to evaluate these hazards, and plans were developed to minimize possible damage to the Aqueduct and to facilitate repairs (Refs. 74, 75, 76, 77). All structures were designed to preclude catastrophic failure in the event of an earthquake.

Near active faults, the aqueduct alignment is located on hard rock wherever possible. Where active faults must be crossed, the crossing was planned at or near ground surface in order to facilitate quick repairs. The canal sections or pipelines at these crossings were designed to withstand reasonable amounts of movement. Automatically controlled check gates were installed just upstream from fault crossings so that flows can be stopped immediately in the event of rupture by an earthquake. Reaches of the Aqueduct are provided with access for heavy equipment should emergency repairs be needed.

The California Aqueduct is divided into the North San Joaquin, San Luis, South San Joaquin, Tehachapi, Mojave, and Santa Ana Divisions of the so-called "main line" and the West and Coastal Branches. The total of these components is 572 miles in length. The significant features of each will be discussed under the appropriate heading.

North San Joaquin Division

This Division includes those units required for the conveyance of water from the Sacramento-San Joaquin Delta to San Luis Forebay. Principal features include the Clifton Court Forebay, an unlined intake channel about 3 miles in length, a fish protective facility, the Delta Pumping Plant, Bethany Reservoir, and about 64 miles of concrete-lined canal (Figure 15).

During the early operation of the Aqueduct, water from the Delta was conveyed to the Delta Pumping Plant by the existing Delta channels. It was recognized that the demands of the Aqueduct would exceed the capacity of this intake by about 1969. A solution to this problem was seen in the Clifton Court Forebay, a 28,653-acre-foot reservoir at sea level (Figure 16). Studies showed that this reservoir could serve as an interim intake to the Aqueduct prior to construction of the Peripheral Canal and thus eliminate the necessity of increasing the capacity of the existing channels. It would also provide forebay storage for the Delta Pumping Plant to permit a large part of the pumping

to be done with off-peak power. Since there would be a constant draft into the forebay from the natural channels, scour would be minimized during off-peak pumping operation. Advantage could also be taken of the high-tide elevations to admit water into the forebay, thus reducing the pumping lift during part of the pumping mode.

The unlined intake channel conveys water from Clifton Court Forebay to the Delta Pumping Plant. Facilities to prevent fish from being drawn into the Pumping Plant are located near the beginning of the intake channel. The Delta Pumping Plant lifts water from sea level to an elevation of 244 feet where it flows by gravity to the San Luis Division. The Pumping Plant will ultimately house 11 pumping units with an aggregate capacity of 10,300 cubic feet per second. Pending the buildup in water demand, only 7 of these units have been installed, providing a 6,035-cubic-foot-per-second rated capacity. From the pump discharge lines, a concrete-lined canal with a capacity of 10,300 cubic feet per second conveys water about 1 mile to Bethany Reservoir.

Bethany Reservoir was designed to serve initially as the forebay for the South Bay Pumping Plant of the South Bay Aqueduct. The Reservoir was enlarged when it was required to serve the additional function of water transportation in lieu of a canal through this area. Essentially it is a wide, unlined section in the Aqueduct for a length of about 1½ miles and has a gross storage capacityof 4,804 acre-feet. The Aqueduct from Bethany Reservoir to San Luis Forebay is a concrete-lined canal with a capacity of 10,000 cubic feet per second (Figure 17). The 300-cubic-foot-per-second reduction through the Reservoir reflects the diversions to the South Bay Aqueduct.

San Luis Division

As initially proposed, the Feather River Project (State Water Project) included only one storage unit for conservation purposes—Oroville Reservoir. It contemplated a continuous diversion from the Delta of 3,930 cubic feet per second, representing a water supply of 2,845,000 acre-feet annually (Ref. 11). Oroville Reservoir would augment the lower summer flows into the Delta, but no means were provided to conserve the surplus winter runoff into the Delta. Operation studies showed that an average of more than 10,000,000 acre-feet per year was available in the Delta in excess of the Delta diversions and other requirements. A substantial part of this surplus could be utilized if additional conservation storage was provided. An opportunity to obtain such storage was available on San Luis Creek near Los Banos on the west side of the San Joaquin Valley. Consequently, San Luis Reservoir, with a capacity of about 2,100,000 acre-feet, was added to later plans as part of the State Water Project (Ref. 12).

A forebay reservoir was also proposed, together with facilities to pump from the forebay either into the project canal extending southward or into San Luis Reservoir. Water from the Delta would be diverted as available to the forebay, where it would be pumped into the project canal when needed. Any surplus flows would be pumped into San Luis Reservoir and stored for later use. When water available from the Delta was insufficient to supply project needs, water would be released from storage in San Luis Reservoir to make up the deficiency. The state proposal for an enlarged project would divert about 4,000,000 acre-feet per year from the Delta.

Consideration was also given to the possibility of initially using the excess capacity in the Delta-Mendota Canal during the winter months to convey water to the San Luis Forebay, thus permitting postponement of construction and use of the Delta-San Luis reach of the California Aqueduct. Under this concept, water from the Delta-Mendota Canal would be pumped to San Luis Forebay when not needed for the Central Valley Project and then lifted either into the State Water Project Canal or San Luis Reservoir (Ref. 11). This proposal, of course, was contingent on a mutually satisfactory arrangement between the United States and the State of California.

The desirability of providing additional storage to conserve the surplus flows in the Delta was also recognized by the U. S. Bureau of Reclamation in a concurrent proposal to develop a storage reservoir at San Luis as an extension of the Central Valley Project (Ref. 78). The Bureau of Reclamation envisioned a one million-acre-foot reservoir at San Luis, together with a forebay and a pumping plant. The excess capacity of the Tracy Pumping Plant and the Delta-Mendota Canal of the Central Valley Project would be utilized to deliver surplus water from the Delta to the San Luis Pumping Plant Forebay. From there, water would be pumped into storage in San Luis Reservoir or pumped directly into the San Luis Canal for conveyance southward to the proposed federal service area in Merced, Fresno, and Kings Counties.

In their report, the Bureau indicated that the proposed San Luis unit was similar to plans being studied by the State and could be coordinated with features of the State Water Project. They recommended that the project be built and operated by the Bureau as part of the Central Valley Project or, alternatively, be built by the Bureau with necessary modifications and be operated by the State as an integral part of the State Water Project. They further recommended that no construction be undertaken until necessary distribution and drainage systems were authorized (Ref. 78).

In commenting on the Bureau's proposal, the State pointed out that the San Luis unit of the Central Valley Project would have objectives which were similar to those of the State but were of different magnitude. Integration of both projects was feasible and would provide financial advantages to both the State and the Federal Government. Analyses of several plans for

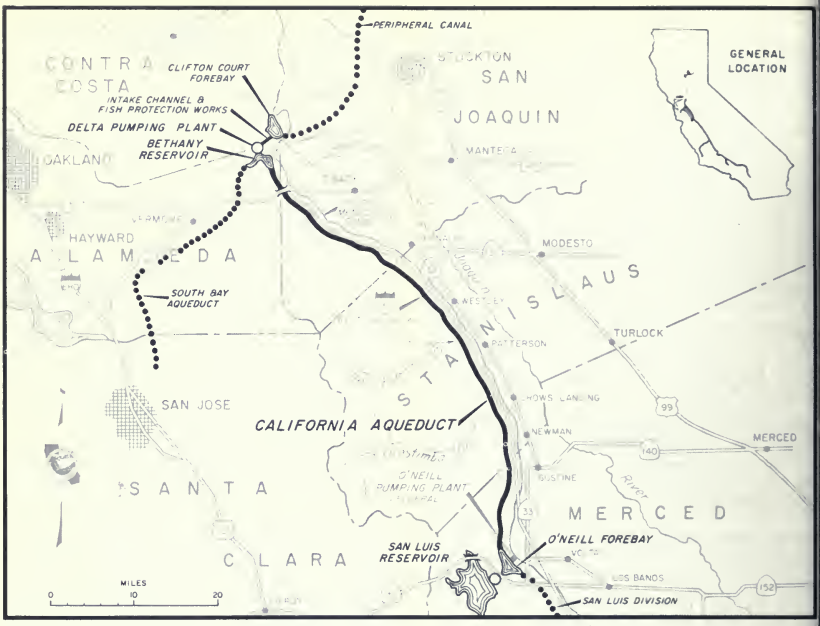


Figure 15

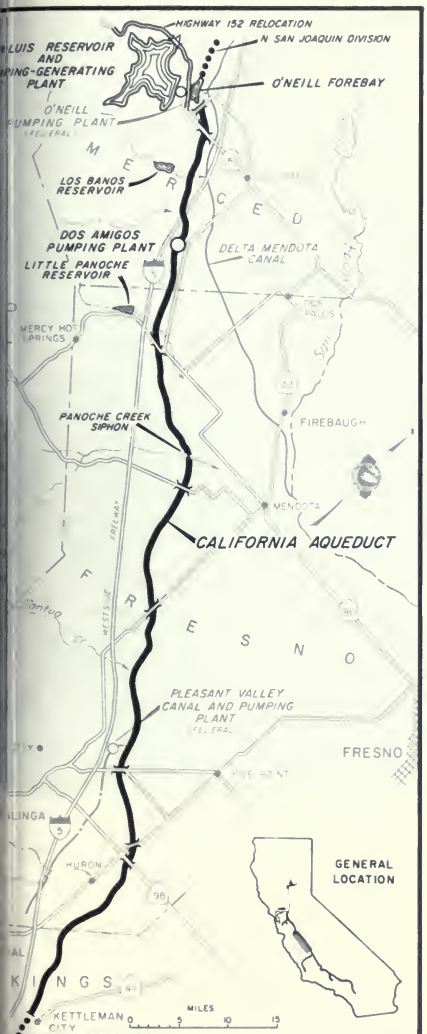
NORTH SAN JOAQUIN DIVISION
CALIFORNIA AQUEDUCT

Figure 16

CLIFTON COURT FOREBAY
AND FISH PROTECTIVE FACILITY

Figure 17

CALIFORNIA AQUEDUCT



integration indicated that the greatest benefits would result from an arrangement whereby the Bureau would build San Luis Reservoir and the State would share the cost with the Federal Government and operate the entire integrated project.

The financial benefits of integration would be substantially enhanced if Central Valley Project power were used. The State recommended that the San Luis unit should be integrated with the State Water Project and should be authorized for immediate construction by the Bureau of Reclamation and for operation by the State. While it was further recommended that the State contract with the Federal Government for use of Central Valley Project power facilities associated with the San Luis unit and pay for their use on an interest-free installment basis, agreement could not be reached on this point (Ref. 79).

The San Luis unit was authorized for construction as part of the Central Valley Project to furnish water to approximately 500,000 acres of land in Merced, Fresno, and Kings Counties under Congress' San Luis Act of June 3, 1960 (Public Law 86-488, 86th Congress). On December 30, 1961, the State entered into an agreement with the United States for joint construction and operation of facilities of the San Luis unit (Figure 18). The agreement provided that San Luis Reservoir would have a gross storage capacity of 2.1 million acre-feet, of which 1 million acre-feet would be for federal use and the remaining 1.1 million acre-feet for state use. The dam, as constructed, is a 77,645,000-cubic-yard, earthfill embankment about 385 feet in height, with a gross storage capacity of 2,038,771 acre-feet (Figure 19).

The San Luis Forebay (now called O'Neill Forebay) has a storage capacity of 56,426 acre-feet. A pumping-generating plant with a pumping capacity of 11,000 cubic feet per second lifts the water 327 feet under maximum head with 8 motor-generation units and, when operated in the reverse mode, generates about 424 megawatts of power under the same maximum head conditions.

The San Luis Canal, extending southward from O'Neill Forebay to Kettleman City, a distance of about 103 miles, is a joint-use facility with a maximum design capacity of 13,100 cubic feet per second, of which 7,100 cubic feet per second is provided for state use. The capacity decreases to 7,050 cubic feet per second at the lower end of this Division, all of which is for state use.

Project demands in the future could require an increase in the state use capacity to 8,100 cubic feet per second at the head of the joint-use facilities. This is not anticipated until the late 1980s when annual demands approach maximum values. While the exact amount of

Figure 18
SAN LUIS DIVISION
CALIFORNIA AQUEDUCT

the deficiency has varied through the years, this shortage of capacity will probably be met by a future transportation facility designed primarily to meet the growth of water demands in southern portions of the State after 1990. Provisions were made, however, to accommodate these flows by oversizing downstream aqueduct facilities.

The joint-use facilities were designed and constructed by the United States with cooperation and consultation by the State. The State's share of the total construction cost was determined to be 55% and the United States' the remaining 45%. The joint facilities are maintained and operated by the State with both agencies sharing in the cost of operation, maintenance, and replacement.

First delivery of water to O'Neill Forebay was through the Delta-Mendota Canal (Figure 20). Deliveries from the California Aqueduct were initiated in 1968. The pumping plant on the joint-use canal of the San Luis Division south of the Reservoir was designated the Dos Amigos Pumping Plant. The Plant has 6 pumping units that can lift 13,200 cubic feet per second of water 113 feet under normal static head from where it flows by gravity to Kettleman City in a concrete-lined canal, a distance of 86 miles. Two detention reservoirs are formed by dams located on Los Banos and Little Panoche Creeks, with gross storage capacities of 34,562 and 13,236 acre-feet, respectively. Their purpose is to intercept and reduce peak floodflows sufficiently to permit them to cross the aqueduct alignment through culverts.

In the same manner that studies were made of the impact of the Oroville area project work force on the surrounding areas, studies were made of the impact of the San Luis Division work force on that area. Based on these studies and pursuant to 1959 legislation on local impact payment (the Bryne Act, Water Code Div. 6, Part 7, commencing at Sec. 12950), Merced County was paid $79,956 and the City of Los Banos $77,948, with smaller sums going to the City of Gustine and Merced County Mosquito Abatement District (see Chapter IX, Oroville Facilities).

Commencing with the San Luis Division and extending southward to the foothills of the Tehachapi Mountains, land subsidence constituted a problem of major significance that had to be dealt with. Subsidence through this area of California can occur in two forms: (1) deep subsidence, which occurs as a result of ground water pumpage and extraction of gas and oil; and (2) shallow subsidence, which is caused by the consolidation of surface soils when they become saturated with water. With a canal grade of approximately 3 inches per mile, very little ground movement could be tolerated.

Deep subsidence was not anticipated to be a problem since the need for pumping from ground water basins was expected to be reduced with the start of project water deliveries. Such was not the case with shallow subsidence.

The route of the California Aqueduct crosses a number of alluvial fans and mudflows along the eastern foothills of the Coast Range. Flood runoffs down these slopes deposited soils to great depths that are essentially dry, never having been resaturated as a result of being blanketed by more recent deposits. Some of these soils undergo diminution of volume on saturation and such shallow subsidence has created extensive damage to roadways, irrigation canals, and pipelines.

To cope with the shallow subsidence problem, the Department conducted a research program to delineate the extent and area of shallow subsidence and to develop effective solutions. A soil sampling program was conducted to define the problem areas, and small test plots were established. As much as 11 feet of subsidence resulted when water was applied to these test areas. Further tests conducted with prototype canal sections demonstrated that preconsolidation by water ponding was an effective method of avoiding damage by shallow subsidence.

The procedure entailed constructing a series of ponds measuring 200 feet by 500 feet, extending along the aqueduct alignment. In each pond, as many as 14 infiltration wells, varying from 45 to 145 feet deep, were spaced in a regular pattern. A minimum of 2 feet of water was then applied and maintained in each pond for a period of from two to six months, after which no further significant subsidence was detected. The concrete-lined canal was then constructed on these strips of preconsolidated right of way.

The San Luis facilities, featuring two large lakes located in a dry area with a long season of clear, warm days, provide great opportunities for recreation. Planning for the development of this recreation potential required close cooperation between numerous federal, state, and local agencies to achieve the needed coordination. The San Luis Recreation Coordinating Committee, composed of representatives from interested agencies, was formed as an advisory group.

Recreation plans for the reservoirs and forebay envisioned picnic sites, campsites, boat ramps, and beach areas, with appropriate auxiliary facilities, to be constructed over five decades. A fishery would be maintained and the possibility of hunting was considered. The cost of the initial development was estimated at almost $5 million, which would be shared by the State and Federal Governments. The projected recreation use of these reservoirs was estimated at more than 4 million visitor-days per year by 2020 (Refs. 80 and 81).

Studies also indicated that a visitor center at San Luis could attract from 400,000 to as many as 1 million visitors per year. A facility has now been constructed at the Romero Overlook site and contains displays and other audio-visual exhibits. A visitor center was also provided at the San Luis Pumping-Generating Plant, which is a self-guided operation with displays, exhibits, and models.

Figure 19

SAN LUIS DAM AND RESERVOIR

Figure 20

O'NEILL FOREBAY

Figure 22

WIND GAP PUMPING PLANT
AND SAN JOAQUIN
OPERATIONS AND MAINTENANCE CENTER

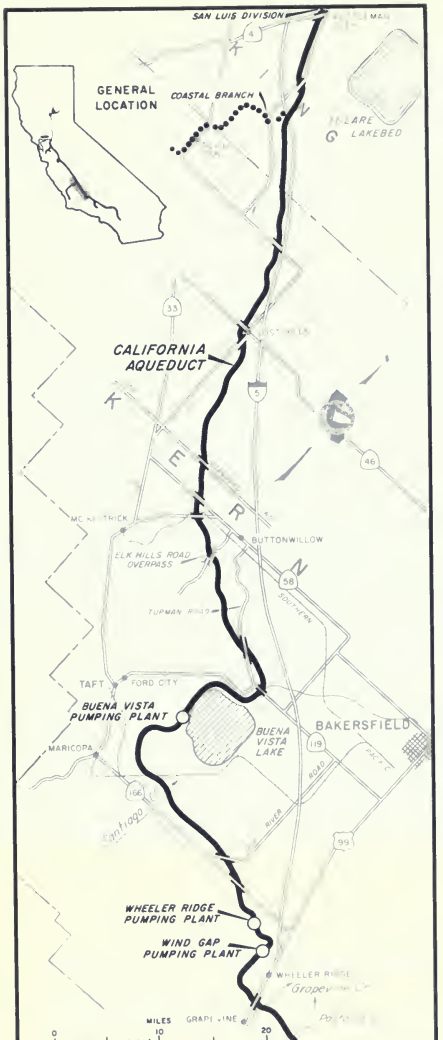


Figure 21

SOUTH SAN JOAQUIN DIVISION
CALIFORNIA AQUEDUC

South San Joaquin Division

This Division includes those facilities required t the conveyance of water from Kettleman City to t Tehachapi Pumping Plant (now named A. D. Edm ston Pumping Plant). In addition to about 120 m of concrete-lined canal, the Division includes Buena Vista, Wheeler Ridge, and Wind Gap Pump Plants (Figure 21). The capacity decreases from 8, cubic feet per second to 4,400 cubic feet per sec through this Division reflecting water deliveries the various water contractors along the way as wel the diversion of flow to the Coastal Branch.

Under the San Luis Division, the 1,000-cubic-f per-second deficiency in canal capacity was m tioned. While construction had progressed too fa that reach to make needed changes in canal size, s was not the case in this Division, and the 8,100-cu foot-per-second capacity at the head of this reach flects the enlargement made to meet increased fut demands. The single most important event t brought about this need for increased water deliv capability was the addition of 511,500 acre-feet year to The Metropolitan Water District contract lowing the U. S. Supreme Court Decision in *Ariz* v. *California* in 1963.

From Kettleman City to Buena Vista Pump Plant, there are about 79 miles of concrete-lined c with gravity flow. The Buena Vista Pumping Plan the starting point for the series of pumping lifts quired in this Division to bring water to the foot o Tehachapi Mountains. The Buena Vista Pump Plant, with 10 pumping units, including one sp unit, has the capacity to lift 5,365 cubic feet per sec about 205 feet. From this point, the canal (5,05 capacity) follows a route near the 500-foot eleva contour to the base of Wheeler Ridge.

The Wheeler Ridge Pumping Plant, with 9 pu ing units, including one spare unit, and a comb capacity of 4,926 cubic feet per second, lifts the w an additional 233 feet. From that point, the canal 600 cfs capacity) follows the 725-foot-elevation tour along the base of Wheeler Ridge to a gap nea eastern edge of the Ridge.

The Wind Gap Pumping Plant provides the 518 feet of lift in this chain, with 9 pumping u including one spare unit, that have a combined ca ty of 4,725 cubic feet per second. The canal (4,40 capacity) then follows a route near the 1,240-foot tour to the base of the Tehachapi Mountains ea Pastoria Creek (Figure 22).

Tehachapi Division

This Division consists of a single reach about 10.6 miles long including the A. D. Edmonston Pumping Plant, the tunnel and pipeline crossing of the Tehachapi Mountains, and the Tehachapi Afterbay (Figure 23).

Planning for the crossing of the Tehachapi Mountains was a major engineering endeavor (Ref. 82). The elevation required for a surface crossing of the Garlock fault in the Tehachapi Mountains necessitated a pumping plant of unprecedented capability. Studies were made of high-lift pumping installations in Europe and the United States to take full advantage of the technology in this area. Large-scale model pumps were built and tested for efficiency and performance. A single-lift installation employing four-stage pumps was judged to be more reliable, safer, and more economical than the multiple-lift proposals considered earlier.

Two possible alignments were considered for the pump lift. One would extend up Pastoria Creek and the other would be located along a rock ridge about a mile east of Pastoria Creek. The ridge route was selected because good rock suitable for underground penstocks was found along the entire reach.

The A. D. Edmonston Pumping Plant is located at the north base of the Tehachapi Mountains. Its configuration is U-shaped with seven 315-cubic-foot-per-second pumping units on each side feeding into parallel discharge lines. Initially, 11 of the 14 units have been installed. When all units are installed, the plant will have a total capacity of 4,410 cubic feet per second and raise the water 1,926 feet to an elevation of 3,165 feet above sea level in a single lift. Each of the parallel discharge lines is almost 8,000 feet in length and each is 12½ feet in diameter, enlarging to a 14-foot diameter about halfway up the slope.

The actual crossing of the Tehachapis is accomplished through four concrete-lined tunnels, totaling 41,500 feet in length (Figure 24). The last and longest of these is the Carley V. Porter Tunnel, with a total length in excess of 25,000 feet. The tunnels have been oversized to carry 5,360 cubic feet per second if future demands justify the contruction of additional upstream canal and pumping facilities. Interconnections between the tunnels are accomplished by two single-barrel, cast-in-place, concrete siphons and one multi-barrel, steel siphon, only one barrel of which has been constructed. These siphons are strategically located to ensure that any crossing of faults is done on the surface and thus more easily repaired than if in tunnel section.

The Tehachapi Afterbay is a section of concrete-lined canal, some 3,300 feet in length, which functions as a control for the regulation of water between the Mojave Division of the "main line" aqueduct and the West Branch.

Mojave Division

This Division extends from the Tehachapi Afterbay through Cedar Springs Reservoir (Silverwood Lake) and includes the Pearblossom Pumping Plant and about 102 miles of canal and pipeline (Figure 25). Before this Division was established, the alignment of the West Branch was pending determination as to whether it would proceed through Elizabeth Lake Canyon or along a Pyramid-Piru alignment to the north and west. Indications were that the Elizabeth Lake Canyon alignment would prevail, and the separation of the West Branch from the "main line" aqueduct was planned to take place some 23 miles farther along the Aqueduct. Subsequent decisions resolved this matter in favor of the Pyramid-Piru alignment for the West Branch, and future facility planning from then on considered the bifurcation of the Aqueduct as taking place at the lower end of the Tehachapi Afterbay. This is discussed further in the West Branch section.

The "main line" aqueduct, including the Mojave and Santa Ana Divisions, extends along the northern base of the San Gabriel and San Bernardino Mountains at the periphery of Antelope Valley. It crosses the San Bernardino Mountains near Hesperia and includes Silverwood Lake, the Devil Canyon power development, and a terminal reservoir at Perris in Riverside County. Capacity decreases from 2,388 cubic feet per second at the head of the "main line" aqueduct to 444 cubic feet per second at its terminus.

The proximity of the main aqueduct to the San Andreas fault raised questions regarding its vulnerability to earthquake damage and the desirability of relocating the route. A consulting board studied this problem and concluded that the selected route was preferable to its alternative, which extended along the southern base of the San Gabriel Mountains.

A power plant had been considered for construction at Cottonwood Creek only a mile from Tehachapi Afterbay; however, a restudy of this in 1967 resulted in the decision to construct only drop-chute, energy dissipaters and defer construction of the generating features. In 1974, considering the changing energy situation and the anticipated costs for energy after 1983, a feasibility study was made of the Cottonwood Powerplant in light of present conditions. This study confirmed the economic and financial feasibility of constructing a 15-megawatt plant at the site, and its construction is now planned for completion in 1983.

From the Cottonwood Powerplant site, water flows by gravity through concrete-lined canals and pipelines about 55 miles to the Pearblossom Pumping Plant. This plant, with 6 pumping units, lifts the water (about 1,380 cubic feet per second) 540 feet to an elevation 3,465 feet above sea level, the highest point along the entire California Aqueduct. From this high point, water flows by gravity an additional 44 miles to Silverwood Lake.

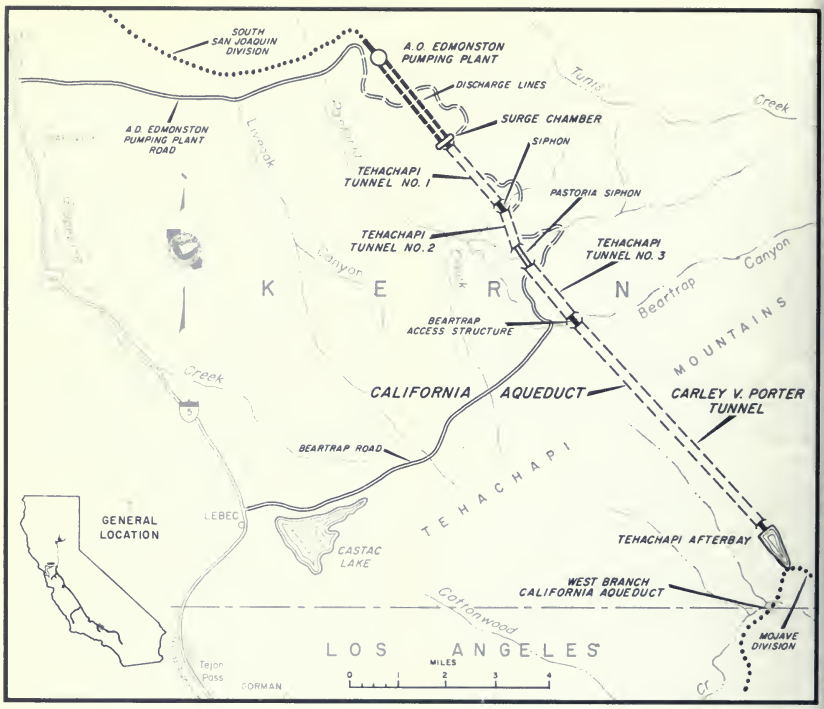


Figure 23

TEHACHAPI DIVISION

CALIFORNIA AQUEDUCT

Figure 24

TEHACHAPI CROSSING

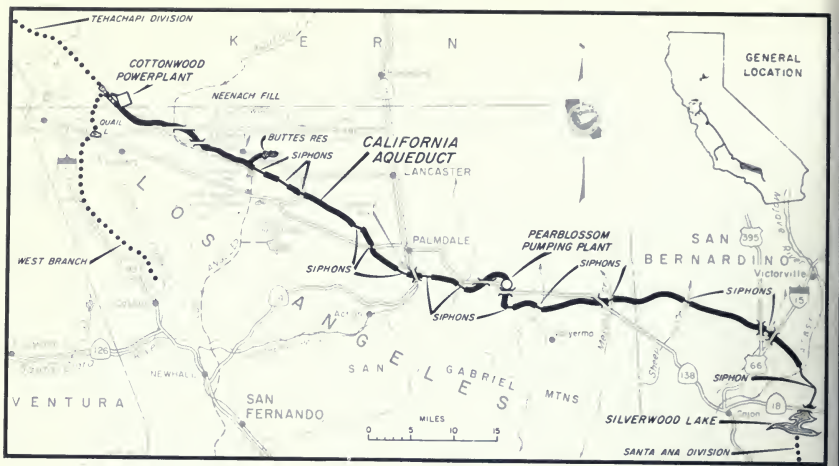


Figure 25

MOJAVE DIVISION CALIFORNIA AQUEDUCT

Silverwood Lake (Figure 26) was originally planned to be a 200,000-acre-foot reservoir capable of providing considerable downstream regulatory storage capacity. Intensive geological and seismological studies by the Department resulted in the reformulation of this facility, and it was resized to 75,000 acre-feet capacity in August 1968 (74,970 acre-feet as constructed). The conveyance capacity of the Mojave Division was increased by 100 cubic feet per second to compensate for this loss of downstream storage capacity.

A future facility, Buttes Dam and Reservoir, may be needed by 1985 to regulate project water deliveries to Antelope Valley-East Kern Water Agency. Under the Agency's water supply contract, construction of an off-aqueduct dam and reservoir by the State is conditioned by engineering and financial feasibility. Present plans envision a 21,800-acre-foot reservoir to be formed by a dam about 190 feet in height.

Santa Ana Division

This Division extends about 35 miles from Silverwood Lake through Perris Reservoir (Figure 27). The significant features consist of the San Bernardino Tunnel, Devil Canyon Powerplant, Perris Reservoir, and about 28 miles of pipeline. Water flows by gravity from Silverwood Lake through the four-mile-long San Bernardino Tunnel before the drop through the Devil Canyon Powerplant at the southern base of the San Bernardino Mountains. A previous Department plan to construct two power plants in Devil Canyon was reassessed in 1966 and the decision made to construct a single installation. The change was made on the basis of operational reliability and economic advantage. A surface alignment was chosen for the penstocks between the San Bernardino Tunnel and the Powerplant because of lower overall construction cost and greater accessibility for repair in the event of seismic damage. The Devil Canyon Powerplant operates under a static head of 1,418 feet. Under maximum flow conditions, it will pass 1,200 cubic feet per second and generate about 120,000 kilowatts of power.

From this point, 28 miles of pipeline, the southernmost conveyance facility of the California Aqueduct, carries water to the terminal reservoir at Perris in Riverside County (Figure 28). Although the construction contract for Perris Dam was awarded in 1970, the final capacity of the facility was not established until 1971. The required basic capacity of Perris Reservoir (now named Lake Perris) for the multiple purposes of the Project was established at 100,000 acre-feet. The Metropolitan Water District of Southern California, the only contractor taking deliveries from this facility, was given the option at any time during the construction contract of increasing the capacity of the Lake up

Figure 26

CEDAR SPRINGS DAM AND
SILVERWOOD LAKE

to 500,000 acre-feet. The District was obligated to cover all costs beyond the basic 100,000-acre-foot lake. The District did not choose to exercise this option prior to the award of the construction contract for the Perris Dam in October 1970. Therefore, the contract was for a 100,000-acre-foot facility designed so that it could be enlarged to a 500,000-acre-foot facility at any future time. Subsequently, the District requested the Department to construct the earth dam so as to form a lake of 120,000 acre-feet and abandon any plans for future enlargement. The lake now receives water from the California Aqueduct and has a gross storage capacity as constructed of 131,452 acre-feet.

West Branch

This Division includes those portions of the aqueduct system that extend from the southern end of the Tehachapi Afterbay to Castaic Reservoir near Newhall (Figure 29). The aqueduct has a capacity near its head of 3,129 cubic feet per second. Principal features include the Oso Pumping Plant, 22 miles of canal and pipeline, Pyramid Powerplant, Pyramid Dam and Reservoir, Castaic Powerplant, Elderberry Forebay, and Castaic Dam and Reservoir.

Two alternative routes were given serious consideration for the West Branch. One route would follow Elizabeth Lake Canyon to a terminal reservoir near its confluence with Castaic Creek. The other would extend down Piru Creek and then tunnel through the mountains to a terminal reservoir at the confluence of Elizabeth Lake Canyon and Castaic Creek. Studies indicated that the Elizabeth Lake Canyon route would be the more economical for water delivery schedules where only moderate amounts of regulatory storage were required; however, since the requests of the water contractors indicated the need for large amounts of storage, the Piru Creek route was adopted for the West Branch.

The Oso Pumping Plant is located about one and one-half miles downstream from the Tehachapi Afterbay. It lifts the water through a maximum static head of 231 feet (the difference between the minimum operating level for Tehachapi Afterbay and the maximum design depth for Quail Canal) with 8 pumping units (rated at 3,128 cubic feet per second) to Quail Canal which conveys the water to Quail Lake, a small facility in the system for the purpose of balancing the discharge of Oso Pumping Plant. Due to the slow buildup in demand for water supplies and studies of alternative power development schemes, it was determined that interim facilities would be constructed

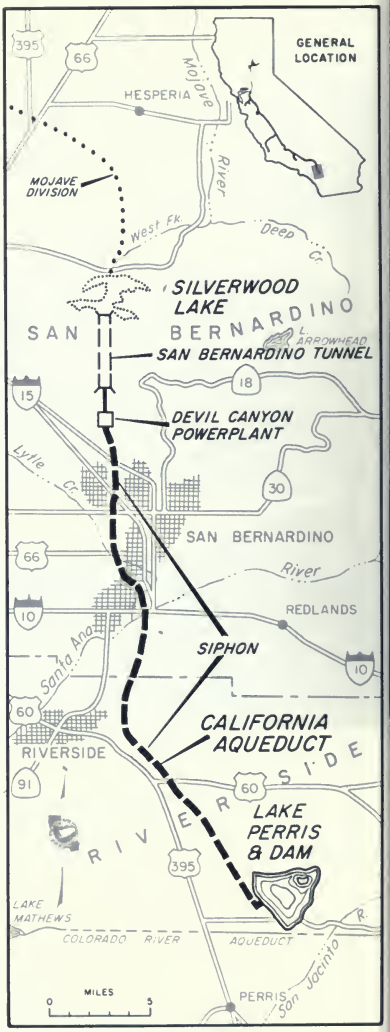


Figure 27

SANTA ANA DIVISION
CALIFORNIA AQUEDUCT

Figure 28

PERRIS DAM AND LAKE PERRIS

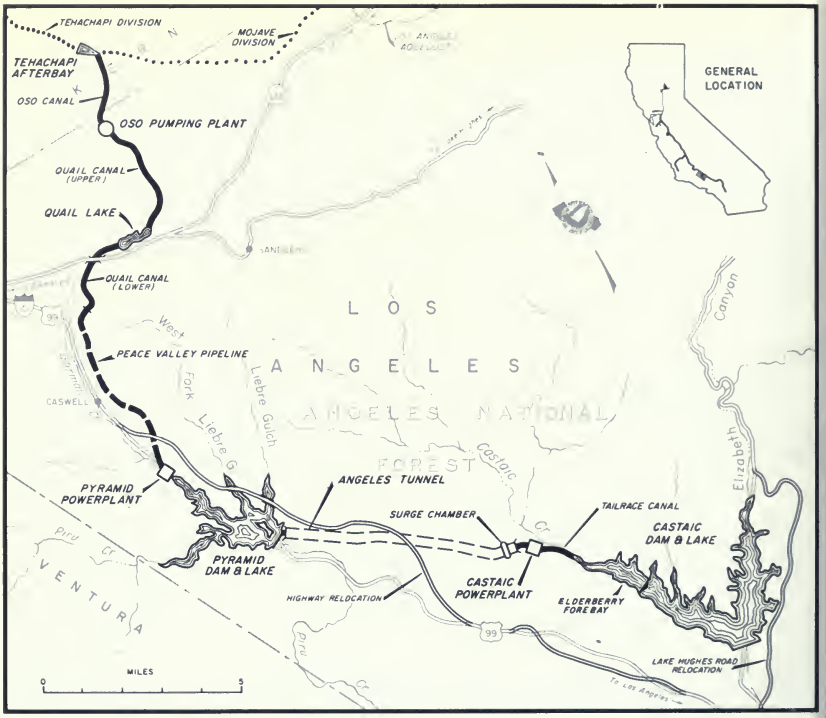


Figure 29

WEST BRANCH

CALIFORNIA AQUEDUCT

through this reach, thus preserving future options without the commitment of sizable capital investments.

In light of the changing energy situation, however, the Department in 1974 reviewed all aspects of power development on the West Branch of the State Water Project. As a consequence of this review, it was determined that construction of a 157-megawatt Pyramid Powerplant should be undertaken on a schedule calling for initial operation in 1982. The existing interim facilities will be replaced by an enlarged Quail Lake and canal facilities and a permanent 3,092-cubic-foot-per-second Peace Valley Pipeline. These facilities will allow an increase in flow rates sufficient to permit the development of the Pyramid Powerplant potential and the recovery of further energy from water deliveries to Southern California. The Pyramid Powerplant will be the first phase of an installation which may later include pumped-storage operation, if it is economically feasible to do so.

Discharges from Pyramid Powerplant will flow into an upper reach of Pyramid Reservoir which is formed by a 6,860,000-cubic-yard, earthfill, embankment dam capable of storing 171,196 acre-feet of water (Figure 30).

Regulatory storage on the West Branch is provided at Pyramid Reservoir on Piru Creek and at Castaic Reservoir on Castaic Creek. Both of these Reservoirs provide opportunities for generation of large blocks of hydroelectric power. The State and the City of Los Angeles entered into an agreement for joint development of the power potential between Pyramid and Castaic Reservoirs. Under this agreement, the tunnel between these Reservoirs was enlarged to a 30-foot diameter. Only a 17-foot-diameter tunnel had originally been contemplated by the State. The power plant was enlarged from 213,984 kilowatts to a capacity of 1,250,000 kilowatts and will be used primarily to generate peaking power for the City. The City will operate the plant and furnish power to the State equivalent in value to that which the State would have generated itself. The State benefits from the savings offered by realizing both a net reduction in capital costs and the avoidance of operation costs.

The Castaic Powerplant is under construction by the City of Los Angeles. It will have 6 pump-generating units and 1 small pump-starting unit (a Pelton wheel), all operating under a maximum static head of 1,063 feet with a power generation output of 1,250,000 kilowatts. A small 50-megawatt unit began operation in January 1972, and the first of the six 200-megawatt pump-generating units went into operation in October 1973. Under maximum generating conditions, a flow of about 18,400 cubic feet per second will pass through the plant.

Discharges from the Castaic Powerplant flow into Elderberry Forebay, which is formed by a 6,000,000-cubic-yard, earthfill, embankment dam capable of storing 28,231 acre-feet of water. It functions as an afterbay when the Castaic Powerplant is operating in a generating mode and as a forebay when the Powerplant is pumping back into Pyramid Lake.

Castaic Dam (Figure 31) is located on Castaic Creek two miles north of the junction of Highway 99 and Elizabeth Lake Canyon Road. It serves as the terminal reservoir on the West Branch. The earth dam was constructed with 46,000,000 cubic yards of fill, has a structural height of 425 feet, and has a crest length of about one mile. It stores 323,702 acre-feet of water.

Coastal Branch

The current water requirements of the San Luis Obispo-Santa Barbara area are met entirely from local resources. Development of limited surface water supplies and increasing problems of ground water overdraft, accompanied by sea water intrusion and water quality degradation, suggest that these local water supplies will not sustain the continuing growth of the area. Estimates of future development indicate that importation of water will be required in the early 1980s (Ref. 27).

The Coastal Branch of the State Water Project was planned to meet this need as well as supply water to lands in western Kern and Kings Counties where the need was more immediate.

Original planning efforts considered ways to provide water supplies to Santa Barbara County, Ventura County, and part of San Luis Obispo County. Studies were made of a Santa Barbara-Ventura diversion which would lift water from the San Joaquin Valley and pump it across the mountains to the coastal areas. However, the studies were not completed in time to be incorporated into the report as a part of the proposed Feather River Project (Ref. 11).

In subsequent studies, a coastal alignment was considered for the California Aqueduct as an alternative route for serving Southern California. The first alternative route studies did not contemplate delivery of water to San Luis Obispo County or to northern Santa Barbara County (Ref. 12). Although later comprehensive studies demonstrated that the coastal route was not the most desirable location for the California Aqueduct, they did establish the need for a coastal aqueduct extending from Avenal Gap across the mountains to a terminus in the Santa Maria Valley, substantially at the location finally adopted to serve San Luis Obispo and Santa Barbara Counties (Ref. 20). These studies suggested that the need for water deliveries in these areas would start in about 1980. Accordingly, the Coastal Branch was adopted as a unit of the State Water Project as set forth in the Burns-Porter Act (Figure 32).

The difference in timing of water requirements between the San Joaquin Valley and the coastal service area led to a plan for constructing the Coastal Branch in two phases. The initial phase, designated the Coastal Stub, includes the first 15-mile portion extending from the California Aqueduct. It includes Las Perillas

Figure 30

PYRAMID DAM AND LAKE

(Figure 33) and Badger Hill Pumping Plants. This unit was constructed concurrently with the main line of the California Aqueduct to permit early project water deliveries to agricultural areas in the vicinity of Devil's Den.

Original plans called for the initial installation of 3 of the 6 pumping units ultimately required in each of these plants. However, because of the urgent need for water in this part of the service area, the Berrenda Mesa Water District, a member unit of the Kern County Water Agency, at its own expense installed the remaining 3 units required to bring the plants up to full capacity, under an arrangement whereby the State will ultimately take over these units.

The Coastal Stub is sized to meet the full entitlements of the entire service area of the Coastal Branch, including San Luis Obispo and Santa Barbara Counties. Construction of the remainder of the Coastal Branch is planned to start in 1977 with completion in 1982.

The second phase will consist of 3 pumping plants (Devil's Den, Sawtooth, and Polonio), 1 power plant (San Luis Obispo), and about 81 miles of pipeline. The economics of the power plant will be reevaluated before any construction is undertaken. The Branch will terminate at the Santa Maria River about one mile northeast of the City of Santa Maria. Planned capacities will decrease from 450 cubic feet per second, where the canal branches from the California Aqueduct, to about 102 cubic feet per second at its terminus.

Recreation

Planning for recreation development and the enhancement of fish and wildlife resources has been an integral part of the California Aqueduct studies (Refs. 83–95). Such planning is made a departmental responsibility by the Davis-Dolwig Act (Water Code Sections 11900–11925), and the Department has coordinated this work extensively with the Departments of Parks and Recreation and Fish and Game and other state and federal agencies. Local viewpoints and advice have been provided through recreation coordinating committees in both the San Joaquin Valley and Southern California.

Recreation and fish and wildlife planning began early enough to permit these interests to be considered in many of the major decisions affecting the aqueduct system, such as the sizing and operation of the California Aqueduct and the major reservoirs. Innovative concepts were adopted to provide recreation opportunities not previously found in the portions of California affected by the aqueduct system, as well as opportunities not usually associated with water projects. Recreation planning considered not only the obvious potential for public enjoyment of reservoirs but such concepts as aquatic recreation areas developed alongside the Aqueduct in locations providing no other recreation, fishing access sites, wildlife habitat plantings and development within the aqueduct right of way, and use of the aqueduct operating roads for bicycling and hiking.

The California Aqueduct Bikeway has been a very popular recreational feature of the State Water Project. A 67-mile section stretches from Tracy to Los Banos, and two additional sections have been opened in Antelope Valley, a 28-mile section extending from Pearblossom Pumping Plant south to Interstate 15 near Hesperia and a 40-mile section extending from Quail Lake to the vicinity of Palmdale. These latter two sections were opened in September 1973 and April 1974, respectively. They will be part of the 102-mile Antelope Bikeway, which is planned to be fully open to the public late in 1974.

In the planning, acquisition, and development of these State Water Project features, the procedures and policies of the Department had to be modified a number of times to accommodate new recreation concepts. Experience with recreation and fish and wildlife programs and facilities has shown them to be consistent with other project purposes. The Department has found that fishing in the California Aqueduct has been very popular with few problems due to public access. As a result of this experience, policies have evolved from (1) no fishing or access, to (2) access at specified fishing sites, to (3) a policy which permits fishing along major segments of the entire Aqueduct. This has been carried out in cooperation with the State Wildlife Conservation Board. This Board, which is within the Department of Fish and Game, provided most of the funds for access and safety facilities at fishing locations.

San Joaquin Drainage Facilities

Irrigated acreage in the San Joaquin Valley has steadily expanded, and the increase has been particularly rapid since World War II. The water supplies required to support this ever-increasing irrigation demand have been obtained by extensive development of local water resources, together with importation of steadily increasing amounts of water. A large part of the water supply has come from the ground water basins in the area. The extensive water development has reduced the streamflow in the area, while return flows from irrigated land have steadily increased.

The combined effect of these changes has been deterioration in the quality of the water supply along lower reaches of the streams in the San Joaquin Valley, together with problems of drainage and waterlogging in the lower lying lands. The seriousness of these drainage problems was recognized in the California Water Plan, and a master drainage channel extending from Buena Vista Lake in Kern County to the Delta was proposed to rectify the situation (Ref. 10).

The California Water Plan recognized that further expansion of irrigated agriculture in the Valley, particularly with an imported water supply, would probably aggravate drainage problems unless the development was accompanied by preventive or cor-

Figure 31

CASTAIC DAM AND LAKE

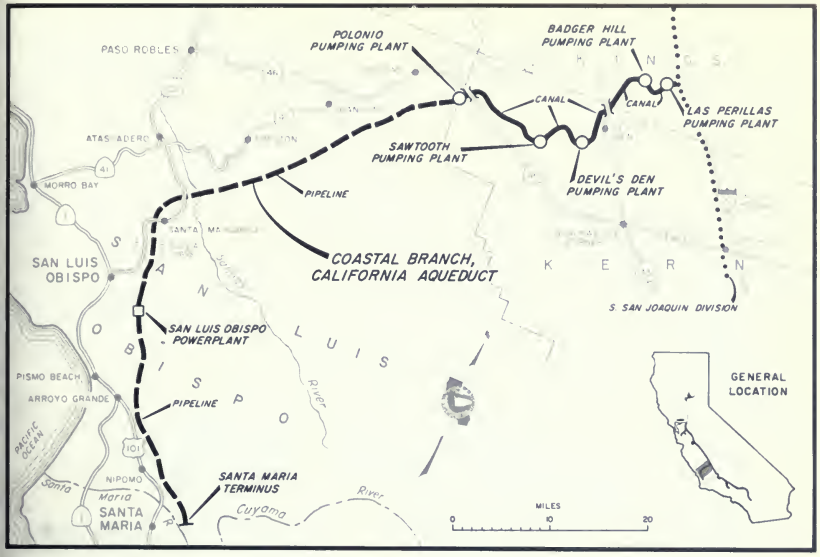


Figure 32

COASTAL BRANCH

CALIFORNIA AQUEDUCT

Figure 33

LAS PERILLAS PUMPING PLANT

rective measures. Accordingly, the San Joaquin Drain was included in the Burns-Porter Act as a facility of the State Water Project. The Department's studies of the drainage and water quality problems in the San Joaquin Valley date back to 1957, when funds were first provided by the Legislature and various alternatives for disposing of San Joaquin Valley drainage were investigated. Among these were evaporation, desalination, discharge directly into the Pacific Ocean along the coast of San Luis Obispo County, and discharge into San Francisco Bay. The studies showed the most economical method of disposal would be a master drain discharging into the Sacramento-San Joaquin Delta near Antioch.

Studies of a drainage facility in the San Joaquin Valley were also conducted by the Bureau of Reclamation as part of the proposed San Luis unit. An interceptor canal was proposed to carry saline waste water from the San Luis Project area to Suisun Bay (Ref. 79).

The Federal San Luis Act required that a drainage facility be incorporated into the Federal San Luis Project. The development of a joint-use master drain that would meet the needs in the service area of the State Water Project, the Federal San Luis area, and the rest of the San Joaquin Valley was an obvious possibility that drew considerable attention. The Department and the Bureau of Reclamation formed a task force to coordinate the studies of the Federal San Luis interceptor drain and the San Joaquin Valley master drain and to formulate plans for joint use of the drainage facilities.

A report submitted by the Department in 1964 (Ref. 96) contained recommendations for construction of a San Joaquin master drain which would be a joint Federal-State facility for two-thirds of its length. The report visualized a drain approximately 276 miles long, starting at a point southwest of Bakersfield and discharging into the Delta near the Antioch Bridge. A surveillance system would be provided to monitor the quality of receiving waters and to detect any detrimental changes that might occur due to operation of the drain. If the surveillance system indicated that the discharge was adversely affecting the quality of receiving water, the drain could be extended farther into the Bay system to the west from its initial terminus near the Antioch Bridge.

The Department and the Bureau in 1967 arrived at a general agreement regarding a contract for joint use of the drain. Local agencies were notified of the potential contract and were requested to indicate whether they desired to participate in the use of the drainage facilities and whether they would be willing to pay their share of the reimbursable cost of the State's portion, which would approximate $16 to $20 per acre-foot. Local responses indicated an unwillingness or inability to assume these repayment costs. Accordingly, the Department withdrew its participation in the proposed Federal-State drainage facility, and the Bureau was requested to proceed with construction of a federal drain as provided in the Federal San Luis Act.

A San Joaquin Valley drainage advisory group was formed with membership from local water interests to assist the Department in developing a drainage facility for the State Water Project. The purpose of the group was to develop both a plan for agricultural waste water disposal and a means of repaying the reimbursable costs of the works required. The group presented a plan for a master San Joaquin drain that was similar to the plans previously proposed and recommended that the State and Federal Governments take the necessary action to allow construction of the single facility and permit the joint use of the Federal and State disposal facilities (Ref. 97).

In view of the lack of agreement for a joint Federal-State master drain for the San Joaquin Valley, the Bureau of Reclamation has proceeded unilaterally to construct the first stage of the San Luis Drain, which terminates at Kesterson Reservoir.

The Department also has joined in a number of cooperative studies to evaluate the water quality aspects of a master drain for the San Joaquin Valley.

Joint Federal-State studies were initiated to determine the economic feasibility of removing nitrogen from drainage waters. Funds and personnel were provided by the Federal Water Pollution Control Administration, the Bureau of Reclamation, and the Department of Water Resources (Ref. 98).

In order to conduct studies of various treatment processes for agricultural drainage, an interagency test facility was established at Firebaugh in Fresno County. A number of studies were conducted at that site to evaluate various processes for removing nitrogen from agricultural wastes. Three processes were found to be effective in removing nitrogen. These are (1) an anaerobic bacterial process using deep ponds or filters, (2) an algae stripping process in which algae grown in drainage water take up the nitrogen in their cellular structure so that the nitrogen is removed when the algae is taken from the water, and (3) a symbiotic process involving both algae and bacteria.

Tests were also conducted to evaluate the desalination of drainage by both reverse osmosis and electrodialysis. Both processes were found to be technically feasible, although not necessarily economically feasible. The anaerobic filter process was the only process which provided an effluent of the desired quality with less than 2 ppm of total nitrogen. The most economic process was anaerobic denitrification in ponds at an estimated cost of $88 per million gallons with the anaerobic filter process next at $92 per million gallons (Ref. 99).

Five of a planned series of 12 reports have been published. They report on the study of the occurrence of nitrogen in the subsurface agricultural waste waters of the Valley and on the study of nitrogen removal treatments (Refs. 99–103).

A joint surveillance program already has been es-

tablished by the Bureau of Reclamation and the Department of Water Resources to monitor representative stations in the Delta and the Bay so that background information can be obtained before any drainage facility begins to discharge into the Bay-Delta system. This monitoring program will be continued to determine if any adverse conditions are created in the receiving waters.

Additional Facilities

The water resources of the north coastal area of the State have often been termed the water bank of California. These resources far exceed the ultimate needs of the area and are still largely undeveloped. For many years they have been considered a potential source for export to the water-deficient areas of the State.

Studies were made in the 1920s of a possible diversion at the head waters of the Trinity River into the Sacramento Valley for irrigation and power development. Such a project was included as part of the original State Water Plan and was constructed by the Bureau of Reclamation as part of the Central Valley Project.

The California Water Plan identifies facilities (Figure 34) capable of accomplishing the ultimate annual export of more than 11.5 million acre-feet of water from the north coastal area of the State to meet water requirements throughout the rest of the State (Ref. 10).

As a preliminary step to the orderly development of the water resources of the north coastal area, the Department conducted a reconnaissance study on which to base an areawide plan to meet local water requirements and export surplus water to the deficient areas of the State. This study also considered conservation and conveyance facilities which would result in fishery enhancement, flood control, recreation, and hydroelectric power generation.

The study found that a multiple-purpose project on the Upper Eel River was the most favorable initial north coastal development to augment the water supplies of the State Water Project. This development would include reservoirs on the Middle Fork of the Eel and associated works to convey the surplus waters to the Sacramento-San Joaquin Delta (Ref. 104).

Two potential conveyance routes were pointed out in the report on the study. One route would extend southward via Clear Lake to the Delta, and the other would extend easterly into a proposed Glenn Reservoir complex on the west side of the Sacramento Valley.

The study recommended that the upper Eel River development be officially selected as the initial additional facility of the State Water Project and that formal agreements be negotiated with federal agencies for cooperative planning of the project.

Public hearings were then conducted by the Department and the California Water Commission to consider the reactions to the study. Most of the comments stressed the need for flood control in both the north coastal area and the upper Sacramento Valley. Strong support was given to both proposed conveyance routes for transferring Eel River water to the Delta.

Subsequently, on March 9, 1964, the Upper Eel River development was authorized, in accordance with provisions in the Burns-Porter Act (Water Code Sections 12931 and 12938), by the Director of Water Resources as an additional facility of the State Water Resources Development System and the State Water Project and as an additional unit of the Central Valley Project, as authorized under Water Code Section 11290.

In August 1967, the Department recommended that: (1) future planning be concentrated on a dam at the Dos Rios site, (2) further studies be conducted of reservoir sizing, and (3) the Glenn (easterly) route which was determined to be superior to the Clear Lake (southerly) route be selected as a means for diverting surplus Eel River water to the Sacramento River Basin (Ref. 105). Concurrently, the Corps of Engineers concluded that a large Dos Rios Reservoir should be the initial Eel River Basin development to provide flood control, water supply, and recreation.

In that same month, the Department entered into a memorandum of understanding with the Corps of Engineers under which the Corps would design, construct, and operate the Dos Rios Dam and Reservoir. The Department would contract for conservation storage under the Water Supply Act of 1958 and would construct conveyance facilities to the Sacramento Valley. The Corps of Engineers subsequently transmitted its final Dos Rios Project report for official state review in July 1968.

The proposed Dos Rios Project became the subject of widespread interest and controversy. The Assembly Committee on Water and the Senate Committee on Water Resources held two public hearings and prepared reports on the Project. In May 1969, Governor Reagan expressed his concern about the Project because it would flood Round Valley and displace the attendant Indian community. He requested that the Department work with the Corps of Engineers to analyze further possible water development plans and alternatives within the Eel River watershed that would not flood Round Valley. In November 1969, the Governor announced that he had asked the Corps of Engineers to withhold further action on Eel River development until the State determined which major projects should be developed to meet the needs of all Californians. He pointed out that the Department will give additional consideration to large-scale desalination plants and waste water reclamation.

In December 1969, the Department released the report requested by the Governor on Eel River development alternatives (Ref. 106). The report described 16 alternative projects analyzed by the Department and identified 6 principal alternatives to the large Dos

Rios Project. Each of the 6 alternatives would provide at least 900,000 acre-feet of annual water supply to the Sacramento-San Joaquin Delta but would differ in flood control, recreation potential, local water yield, and environmental effects (Ref. 107).

The federal census of 1970 had a significant affect on the timing of future water requirements in California. Population projections based on this census indicated a slower population growth than previously estimated. The Department used those figures in its Bulletin 160-70 (Ref. 108) to show that future water demands in California were expected to grow more slowly than had been indicated by previous projections. The report suggested that an additional conservation facility to maintain the yield of the State Water Project would not be needed until the mid-1990s. This time could be shortened, however, if outflows from the Sacramento-San Joaquin Delta required by the State Water Resources Control Board proved to be greater than planned, if water use in areas tributary to the Delta increased, or if additional service areas were added to the State Water Project (Ref. 108).

The Eel River development picture was affected significantly by a measure adopted by the 1972 Legislature and signed into law by the Governor. Enactment of Senate Bill 107 (Calif. Stats. 1972, Ch. 1259) created the California Wild and Scenic Rivers System, which includes portions of the Smith, Trinity, Klamath, Eel, and American Rivers and various tributaries. The Resources Agency is required to administer the System and to prepare plans for approval by the Legislature. It precludes construction of dams on the aforementioned rivers unless the act is subsequently modified. It does, however, authorize planning studies of the Eel River.

With respect to the Eel River and its tributaries, the law declared the Legislature's intent "that after an initial period of 12 years following the effective date of this chapter, the Department of Water Resources shall report to the Legislature as to the need for water supply and flood control projects." The Legislature will then hold public hearings to determine whether legislation should be enacted to delete all or any segment of the Eel River from the System.

The law also authorized geologic, hydrologic, economic, or any other technical studies deemed necessary or desirable by the Department during the interim period in order to determine the feasibility of alternative sites for dams on the Eel River and its tributaries.

Consistent with the foregoing, a number of studies were initiated in 1972 to evaluate the environmental impact and enhancement opportunities of any proposed Upper Eel River development. These studies included:

§ A determination of the conditions needed for salmon and steelhead fishery enhancement, together with an outline of enhancement possibilities with and without multiple-purpose water development.

§ An analysis of fishery preservation problems and an outline of preservation measures.

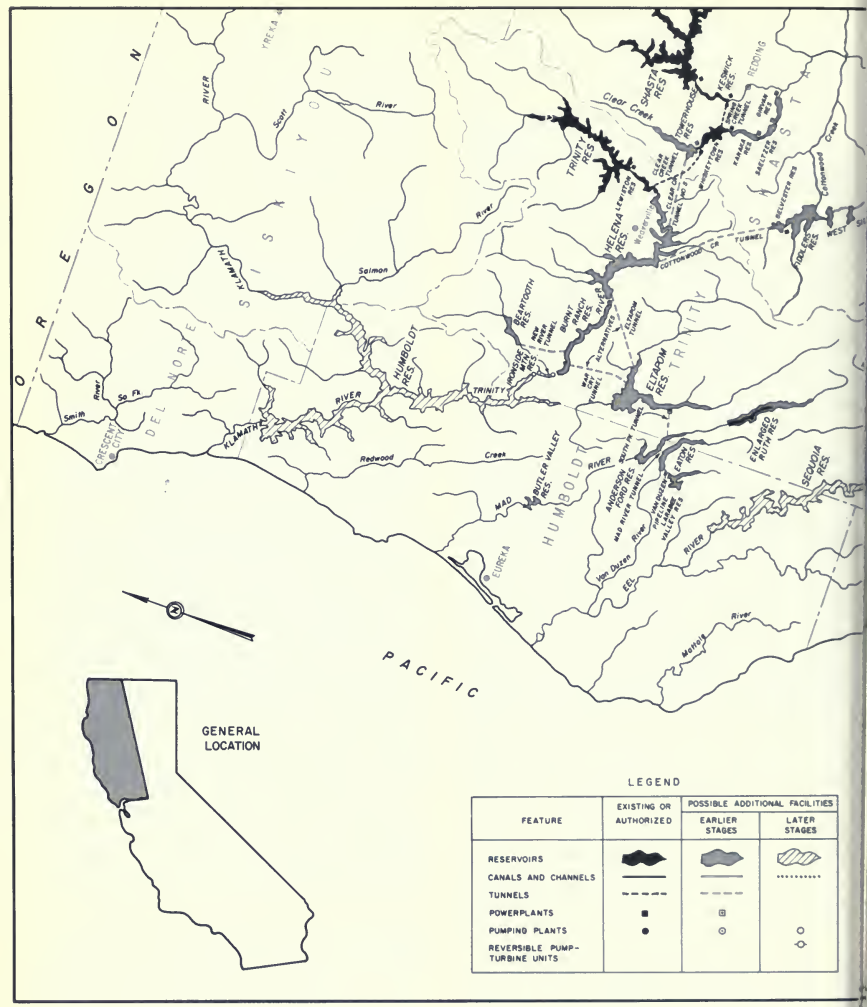
§ Studies to provide a basis for estimating post-project channel conditions on the Eel River, involving sediment transport calculations, geologic mapping of landslides, and establishment and monitoring of 30 river cross sections.

§ Collection and analysis of water temperature, nutrient and benthos data and projections of postproject water quality conditions.

§ A survey to determine the type, extent, and location of present recreation use.

§ Development of operational procedures for improving downstream conditions.

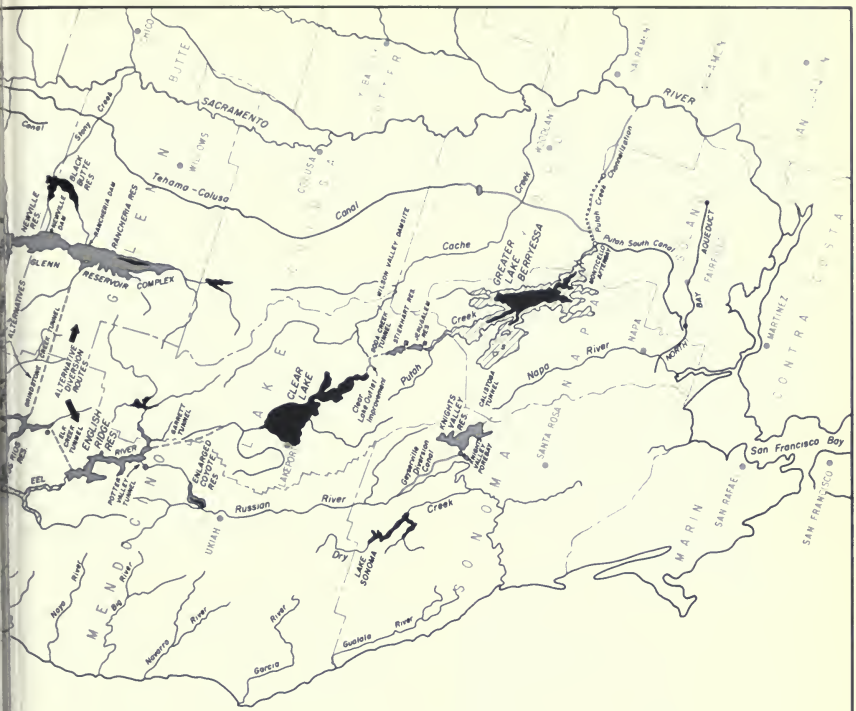
The first two study items have been undertaken by the Department of Fish and Game. A progress report is scheduled for late 1974.



LEGEND

FEATURE	EXISTING OR AUTHORIZED	POSSIBLE ADDITIONAL FACILITIES	
		EARLIER STAGES	LATER STAGES
RESERVOIRS			
CANALS AND CHANNELS			
TUNNELS			
POWERPLANTS	■	⊡	
PUMPING PLANTS	●	⊙	○
REVERSIBLE PUMP-TURBINE UNITS			◇

Figure 34



STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
ADDITIONAL FACILITIES
STATE WATER RESOURCES DEVELOPMENT SYSTEM
(PROPOSED IN BULLETIN 136)
1964

CHAPTER X. FINANCIAL AID FOR LOCAL PROJECTS

The State Water Facilities authorized for construction by the Burns-Porter Act include water development facilities for local areas as provided in the Davis-Grunsky Act (see Chapter III).

This Act is administered by the Department of Water Resources and the California Water Commission. Administrative regulations have been adopted to set forth the procedure for making applications for assistance and have been incorporated into the California Administrative Code, Title 23, Chapter 2, Subchapter 2.

Types of Assistance

There are seven types of assistance available to local public agencies under the Davis-Grunsky Act. These are (1) grants for the part of the construction cost of any dam and reservoir of the proposed project properly allocated to recreation, (2) grants for the part of the construction cost of the proposed project properly allocated to the enhancement of fish and wildlife, (3) grants for the construction of initial water supply and sanitary facilities which are needed for public recreational use of each dam and reservoir, (4) construction loans for local water projects, (5) reservoir site loans for proposed water projects, (6) feasibility report loans to establish the feasibility of proposed projects for which construction loans are requested, and (7) state participation as a partner in a project larger than the one the local agency proposes to construct on its own.

The Department, with prior approval of the California Water Commission, may (1) make grants for recreation and fish and wildlife enhancement up to $400,000 for any one project and, in addition, grants for initial water supply and sanitary facilities in an amount not to exceed 25% of the total amount granted for recreation and fish and wildlife enhancement; (2) lend up to $4,000,000 toward the construction of any one project and $400,000 toward the advance acquisition of reservoir sites. The Department also may lend up to $50,000 for the preparation of a feasibility report for the proposed projects: and (3) expend up to $1,000,000 for state participation. Financial assistance exceeding these amounts must be specifically authorized by the Legislature.

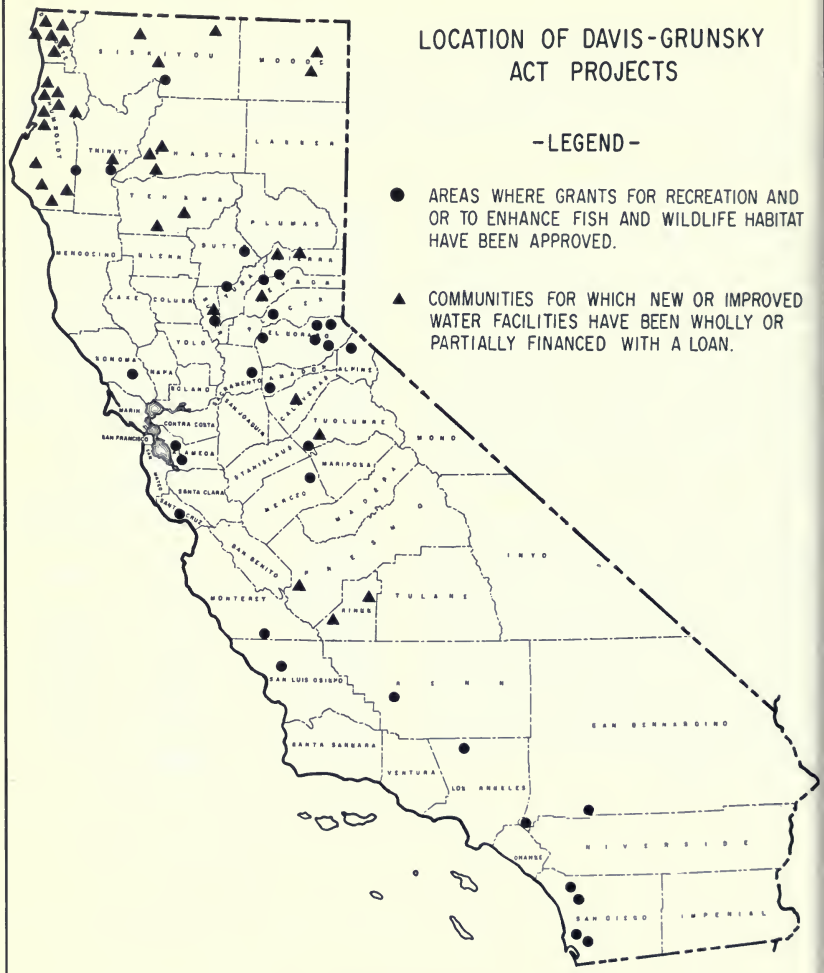
Administrative Policies

In addition to the administrative regulations, the Department of Water Resources and the California Water Commission have jointly adopted certain administrative policies. These policies have been amended from time to time as the Department and the Commission gained experience with the program. The policies, as well as the regulations mentioned above, are contained in a brochure entitled "State Financial Assistance for Local Water Projects Under the Davis-Grunsky Act", dated September 1968.

Table 2 gives statistics on this program and Figure 35 locates the agencies which have benefited from the Davis-Grunsky Act program.

TABLE 2. FINANCIAL AID FOR LOCAL PROJECTS

	As of December 31, 1971	
	Completed	*Approved, But Not Completed*
New Distribution System Projects		
Number	10	4
Loan Amounts	$5 million	$2 million
Reconstructed Distribution System Projects		
Number	21	6
Loan Amounts	$15 million	$10 million
Storage Projects		
Number	26	7
Grant Amounts	$52 million	$13 million
Total Storage Capacities	5.7 million acre-feet	nil acre-feet
Recreation Use (1972)	2.8 million visitor-days	—


LOCATION OF DAVIS-GRUNSKY ACT PROJECTS
-LEGEND-
AREAS WHERE GRANTS FOR RECREATION AND OR TO ENHANCE FISH AND WILDLIFE HABITAT HAVE BEEN APPROVED.
COMMUNITIES FOR WHICH NEW OR IMPROVED WATER FACILITIES HAVE BEEN WHOLLY OR PARTIALLY FINANCED WITH A LOAN.
DEL NORTE
HUMBOLDT
MODOC
TRINITY
SHASTA
LASSEN
TEHAMA
PLUMAS
MENDOCINO
BUTTE
SIERRA
LAKE
COLUSA
YOLO
SONOMA
NAPA
SOLANO
SACRAMENTO
ALPINE
MARIN
CONTRA COSTA
SAN FRANCISCO
NAPA
TUOLUMNE
MONO
STANISLAUS
MARIPOSA
SANTA CLARA
SAN BENITO
INYO
MONTEREY
KINGS
TULARE
SAN LUIS OBISPO
SAN BERNARDINO
SANTA BARBARA
VENTURA
LOS ANGELES
RIVERSIDE
ORANGE
SAN DIEGO
IMPERIAL

CHAPTER XI. PROJECT MANAGEMENT

Many aspects of the financing and planning of the State Water Project were continuing a decade and more after construction was begun. The basic framework of the Project is now a physical reality, stretching from Frenchman Dam in Plumas County to Perris Dam in Riverside County. The Project is by no means complete, however. Construction, while on a less spectacular scale than that required in the preceding decade, must continue during the years immediately ahead to keep abreast of the Project's water delivery obligations under the contracts for water supply. Furthermore, continuing long-term planning, financing, and construction will be required since the Project is but the initial works of the State Water Resources Development System.

Detailed Reports

The Department developed the Bulletin 132 series in order to document the year-to-year details of the continuing financing and planning, along with progress in design, construction and operations, of the State Water Project. The series began with Bulletin No. 132-63, "The California State Water Project in 1963", and a new report is published each year.

Continuing planning for the Project as a part of the California Water Plan was reported in two other important Department publications: Bulletin No. 160-66, "Implementation of the California Water Plan", March 1966, with six appendixes, and Bulletin No. 160-70, "Water for California, the California Water Plan, Outlook in 1970", December 1970. The essence of the latter bulletin is contained in a "Summary Report" with the same main title, bulletin number, and publication date.

Financial developments through the years also are contained in the annual "Report of the California Water Resources Development Finance Committee and the Department of Water Resources to the Legislature on the State Water Resources Development System". This report is made each January.

Another series of annual reports on various phases of the Project is one which was instituted with publication of "State Water Project, Annual Report for 1970" and continued thereafter.

Reassessment of Financing

Governor Reagan, soon after taking office in January 1967, appointed a special task force of experts to evaluate the financial status and schedule of the State Water Project in view of escalating costs and inflationary trends. A four-month study led the task force to the conclusion that the Project would require capital construction funds in addition to those then available. The additional funds required were estimated to total as much as $300 million more to meet capital expenditures expected through 1972 and an additional $300 million more from 1972 through 1985 in order to complete all facilities (Ref. 109).

A number of corrective actions were taken which proved successful in averting the predicted funding deficiency. Principal among these steps were:

§ Deferral of construction of certain project facilities not essential to fulfill near-term water and power contracts.

§ Exercise of strict cost controls.

§ Pursuit of legislation which resulted in an increase of available capital financing by $74.6 million through 1972, with an additional $14 million annually thereafter, from tideland oil revenues (Calif. Stats. 1968, Ch. 411).

§ Development of additional financing through revenue bonds associated with project power development at Oroville-Thermalito and power recovery plants on the Aqueduct in Southern California. Although it had been planned to use this funding source from the beginning, the funding deficiency brought into focus the need to proceed aggressively in firming up details and marketing bonds associated with the various power developments.

These actions provided sufficient funds to meet all necessary project financial requirements through 1980 and, in turn, to maintain the financial integrity of the Project. The balance of capital demands and funds was reached despite escalation in construction costs of almost 6% per year during the four-year period 1967–1970.

Federal Power Commission Licenses

The Federal Power Act provides for licenses to be issued by the Federal Power Commission for hydroelectric projects developing power from navigable streams or affecting federal lands.

The Department has been issued a license by the Commission for the facilities at Oroville (FPC Project No. 2100) since it involves both a navigable stream and public lands. The State's application dates back to 1952 and the original license back to 1956. Amendments have been issued since then to cover changes in plans.

The Department applied to the Commission for a preliminary permit for the California Aqueduct in 1963 and for a license in 1965 since it involved federal

lands. The California Aqueduct was designated Project No. 2426 by the FPC. The Commission granted the Department's request to proceed with prelicensing construction.

After hearings, the Presiding Examiner issued his Initial Decision in January 1972, ordering that a license be issued, subject to review by the Commission.

Since the license had not been granted before the passage of the National Environmental Policy Act of 1969, the Commission requested the Department to prepare an environmental impact statement (EIS). The statement was prepared and submitted under date of May 1971. As a result of later litigation, it was determined that the Commission staff also must prepare an environmental impact statement. In February 1974, by Opinion No. 688, the Commission remanded the case to an administrative law judge for further proceedings and requested its staff to prepare an independent environmental impact statement on the jurisdictional portions of the Project: Devil Canyon, Castaic, and Pyramid power drops. The EIS must also include consideration of the proposed Cottonwood development and the proposed power drop on the Coastal Branch.

The California Environmental Quality Act

On November 23, 1970, the Environmental Quality Act of 1970 became effective (Statutes of 1970, Chapter 1433). This Act is more commonly referred to as the "California Environmental Quality Act" (CEQA) (Public Resources Code Sections 21000–21174).

In December 1972, the Legislature amended and clarified CEQA in response to findings of legislative intent by the California Supreme Court in the "Friends of Mammoth Decision" (*Friends of Mammoth* v. *Board of Supervisors*, 8 Cal. 3d 247, 502 P. 2d 1049) (1972). The amended act was partially implemented on December 5, 1972 and became fully effective on April 4, 1973. This latter date is the date by which all state and public agencies in California were required to have regulations or ordinances implementing CEQA.

The Act requires, basically, that all Department of Water Resources activities be evaluated for potential effect on the environment. It specifically requires that all planning activities of the Department incorporate consideration of environmental factors as early as possible in the planning process. Thus, the California Legislature has added a requirement to the Department's planning process for consideration of environmental objectives along with the social and economic objectives that have been a part of the past planning process.

Sacramento-San Joaquin Delta Ecological Studies

Assuring continuing compatibility of the State Water Project with the fish and wildlife resources of the Sacramento-San Joaquin Delta has been a prime objective of the planners, builders, and operators of the Project.

The environmental impact of water development on the Delta was considered and reported on in most of the studies cited in Chapter IX (Refs. 52–58). The highlights of 10 years of "Ecological Studies of the Sacramento-San Joaquin Estuary" are summarized in a publication with that title published by the California Department of Fish and Game in June 1972 (Ref. 110).

The foreword of that report explains:

"This document is intended to summarize existing knowledge about the principal fish and wildlife resources of the Sacramento-San Joaquin estuary, their ecological relationships and their environmental requirements, with emphasis on requirements bearing some relationship to water development.

"It represents an accumulation of knowledge spanning many years, but particularly the results of the 10 years of intensive study by the Delta Fish and Wildlife Protection Study between 1961 and 1971."

The report points out that construction of a Peripheral Canal offers the best solution to correct serious ecological problems of the Delta in 1972. The report states:

"It is the conviction of the biological staff of the Department of Fish and Game that enough is known of the resources and their requirements to:

"(1) demonstrate that the Peripheral Canal should be built to correct existing adverse conditions; and

"(2) recommend the broad physical and environmental conditions that should prevail in the Delta."

Sacramento Valley Seepage Study

Among Department investigations into possible side effects of the State Water Project was the Sacramento Valley Seepage Investigation, which was reported on in August 1967 in Bulletin No. 125 (Ref. 111).

The area of investigation was bound on the north by Ord Ferry on the Sacramento River and a point near Marysville on the Feather River. The southern boundary was Walnut Grove. The primary objectives of the investigation were to: (1) document present levels of seepage; (2) determine how the operation of future water projects, such as Oroville Reservoir, will affect seepage and determine the relationship between river stages and seepage conditions; and (3) determine the need for additional detailed studies of measures to reduce seepage.

Infrared aerial photographs were taken of areas where seepage has occurred, and electrical-resistivity measurements were used to establish the extent of seepage and resulting damage. These techniques were used in six areas along the Sacramento River system.

The results indicated that: (1) seepage damage is

greater in agricultural areas (as opposed to urban areas); (2) operation of Oroville Reservoir should reduce seepage along the Feather River, particularly from December through June, although seepage caused by long-duration high flows will not be significantly changed; (3) seepage along the Feather River does not occur during the summer and will not be increased during the summer by the operation of Oroville Reservoir; (4) the Sacramento River can accommodate a maximum flow of 9,000 cubic feet per second without seepage problems; (5) the operation of Oroville Reservoir should not increase seepage along the Sacramento River prior to 1990; however, increased imports after 1990 could result in seepage during the summer; (6) a drainage system along the Sacramento River would best control any future seepage that might occur during the summer; (7) alternative routes for the transportation of water that may be imported after 1990 should be studied; and (8) action at the state level to reduce seepage is not required at this time; however, in some areas, seepage should be studied by local agencies.

Desalting Studies

Late in 1969 the Department, as part of a continuing cooperative effort with the Federal Office of Saline Water (OSW), agreed to intensify efforts in development of potential desalting applications and a large-capacity prototype desalting plant. The prototype plant was to be the best opportunity for construction and operation of a desalting plant with a capacity in the range of 30 to 50 million gallons per day (MGD) on the coast of California.

In 1970 and 1971, the Department, together with OSW, studied the feasibility of a large prototype sea water desalting plant with a capacity of 40 MGD. The desalted water could be integrated with other water supplies and delivered in San Luis Obispo and Santa Barbara Counties. Both counties have contracted with the Department for delivery of water from the State Water Project in the early 1980s. The delivery of blended desalted water could meet most of the same supplemental water demands and defer construction of costly conveyance works.

The proposed location of the desalting plant was adjacent to the 2,120-megawatt, twin-unit, nuclear power generating plant under construction by the Pacific Gas and Electric Company on the coast of the Pacific Ocean in San Luis Obispo County. The two desalting units, each with a capacity to desalt 20 MGD of sea water, would be the first of a kind, full-size desalting units. The operation of these units would have met the urgent need to demonstrate at an early date the practicability of sea water desalting plants of this capacity. The 20 MGD capacity would have been of sufficient size to permit scale-up with confidence to 200 to 250 MGD future desalting plants. The desalting plant was a key element of the Diablo Canyon desalting project.

The project included the desalting plant, sea water intake, waste water disposal facilities, and water conveyance and storage facilities to deliver blended desalted water to service areas in San Luis Obispo and Santa Barbara Counties. The objective of this project was to provide realistic information on:

1. The actual construction, operation, and maintenance costs of a large-scale desalting plant.
2. The operation of a prototype desalting plant in conjunction with a steam source from a nuclear power plant.
3. The delivery and integration of desalted water with other water supplies.
4. The effects on the environment caused by discharging desalting plant effluent to the ocean.

The project's feasibility report (March 1972) recommended that the California Legislature authorize the construction and operation of the project and Congress authorize the Secretary of Interior to participate with the Department in its construction and operation (Ref. 112). However, in August 1972, the Department of Interior reported to Congress "the Department of Interior does not believe it to be advantageous at this time to make a firm recommendation as to the best opportunity for the early construction of a large-scale prototype desalting plant". As a result, the project did not proceed.

Manpower Planning

The Department's manpower planning program enabled it to accomplish an orderly buildup of personnel from about 450 in July 1956 when the Department was established to a peak of nearly ten times that—about 4,480—in July 1967. At this peak, approximately 3,700 employees were involved with work on the State Water Project.

A nationwide recruiting effort was necessary to obtain a qualified staff of engineers and members of other disciplines with the qualifications required to carry out the myriad details of a project of this unprecedented magnitude. The fact that the Project was completed on time and within funding limitations attests to the success of this effort.

At the peak of employment, in 1967, the Department had about 1,250 engineers and nearly the same number of technicians. It had some 450 construction inspectors and supervisors, 750 clerical and allied employees, 350 trades and maintenance craftsmen, and 450 persons in professional and general administration classifications.

Manpower planning was again effective in smoothing the reduction in force from the 4,480 peak in 1967 to about 2,410 in December 1973. As design and construction work on the Project dwindled in the late 1960s and early 1970s, the work force was reduced by 7 to 12% each year. Retirements, departures for other employment, and transfers within the Department ac-

counted for most of the reduction, with only a minimum of enforced separations.

An organization chart of the Department of Water Resources as it is today is shown in Figure 36. Table 3, utilizing this present organizational structure, traces in broad terms the position assignments from 1965 through 1973. This time period covers the build-up to peak employment as well as the subsequent reduction in force of some 2,070 employees through 1973.

TABLE 3: STRENGTH OF THE DEPARTMENT OF WATER RESOURCES

As of December 31—1965 through 1973

Divisions	1965	1966	1967	1968	1969	1970	1971	1972	1973
Executive	122	130	122	108	106	101	89	87	81
Administration and Technical Services Office	483	561	575	586	522	461	401	334	331
Division of Resources Development	156	173	172	159	161	156	151	170	166
Division of Land and Right of Way	131	144	122	110	161[b]	151	107	81	81
Division of Safety of Dams	37	49	57	57	62	55	51	52	54
Division of Operations and Maintenance									
Headquarters Office	72	79	100	116	118	130	126	125	123
Oroville Field Division	--	6	41	104	106	105	102	95	93
Delta Field Division	--	37	89	124	126	116	107	97	96
San Luis Field Division	--	41	95	126	132	127	128	128	127
San Joaquin Field Division	--	--	17	69	106	134	163	174	180
Southern Field Division	--	--	--	6	12	56	102	134	155
Power Office	32	32	33	32	29	32	31	25	23
Division of Design and Construction									
Design	810	859	769	622	445	306	234	227	210
Construction	1,077	1,487	1,504	1,279	1,176	969	599	373	201
Northern District	145	172	161	147	142	132	124	117	121
Central District	268	282	252	211	191	182	169	168	181
San Joaquin District	106	110	100	100	84	74	66	65	67
Southern District	207	224	203	199	182	137	118	116	120
DEPARTMENT TOTAL	3,646	4,386	4,412[a]	4,155	3,861	3,424	2,868	2,568	2,410

[a] Peak of 4,480 reached in midyear.

[b] The Reclamation Board was created in 1911 to participate in controlling the floodwaters of the Sacramento and San Joaquin River Systems. In 1957 the Legislature placed the Board within the newly created Department of Water Resources but authorized it to retain its independent power, responsibilities, and jurisdictions. In 1969, staff associated with Board work, but not the Board itself, was transferred to the Department and incorporated within its work and budget structure.

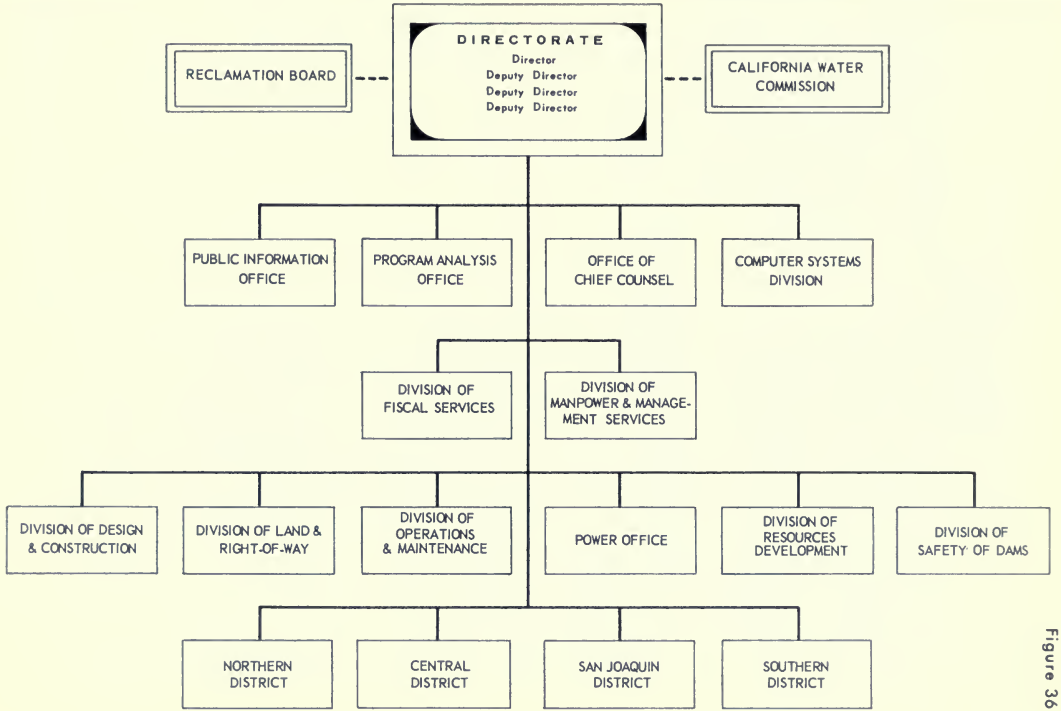


Figure 36

DEPARTMENT OF WATER RESOURCES

ORGANIZATION CHART

CHAPTER XII.
STATUS OF CONSTRUCTION AND FINANCING

Construction of the "1973 Project Facilities"—the facilities required to initiate service to all agencies who contracted for water deliveries prior to 1980—was essentially complete as 1973 came to a close. Project management action centered on (1) providing funds for financing the construction of future facilities needed beyond the 1973 Project Facilities in anticipation of growing demands for full project services, (2) defining the plan and schedule of these future facilities, and (3) investigating and implementing ways of expanding the benefits to be realized from completed project facilities for purposes not originally envisioned when the Project was conceived.

The State Water Project is a financially viable project, producing revenues which are sufficient to pay all costs of operation and maintenance, repay all capital expenditures with interest, and eventually producing surplus revenues for any future additions to the State Water Resources Development System that may be authorized.

The following series of tables (4, 5, 6, 7, and 8) and figures (37 and 38) from Bulletin No. 132-74, illustrate these accomplishments.

TABLE 4: PROJECT CONSTRUCTION EXPENDITURES

(In thousands of dollars)

Facilities and construction divisions	Incurred thru 1973	Future construction program	Total	Preliminary allocations among project purposes			
				Water supply and power generation	Flood control[b]	Recreation and fish and wildlife enhancement	Other[a]
Feather River Facilities:							
Upper Feather Division	14,193	21,875	36,068	1,235	0	34,833	0
Oroville Division	503,318	5,664	508,982	428,941	68,424	11,617	0
North Bay Aqueduct	4,159	16,877	21,036	21,037	0	0	−1
Delta Facilities	19,758	332,829	352,587	162,052	0	26,357	164,178
South Bay Aqueduct	67,946	182	68,128	47,932	6,997	13,174	25
California Aqueduct:							
North San Joaquin Division	155,786	20,124	175,910	169,784	0	6,126	0
San Luis Division	177,407	19,597	197,004	189,426	0	7,356	222
South San Joaquin Division	255,981	6,186	262,167	254,276	0	7,891	0
Tehachapi Division	253,643	40,308	293,951	285,141	0	8,810	0
Mojave Division	200,237	44,716	244,953	237,168	0	7,785	0
Santa Ana Division	172,948	12,417	185,365	175,072	0	10,293	0
West Branch	345,123	113,488	458,611	442,226	0	16,187	198
Coastal Branch	14,265	94,218	108,483	108,378	0	0	105
Subtotal	1,575,390	351,054	1,926,444	1,861,471	0	64,448	525
Additional Conservation Facilities	7,751	327,218	334,969	330,810	0	444	3,715
San Joaquin Drainage Facilities	6,494	102,127	108,621	0	0	6,494	102,127
Unassigned	4,310	4,523	8,833	0	0	0	8,833
Total	2,203,319	1,162,349	3,365,668	2,853,478	75,421	157,367	279,402

[a] Includes costs currently unassigned to purpose, planning costs of deleted features of project facilities, initial costs of inventoried items, and joint costs assigned to the Federal Government.

[b] Reflects Department's allocation to this purpose, irrespective of federal payments.

TABLE 5: PROJECT FINANCIAL

(in thousands

Line no.	Line item	Calendar 1952–1973	1974	1975	1976	1977	1978	1979
	PROJECT CONSTRUCTION EXPENDITURES							*Capital*
1	Initial Project Facilities	2,159,848	0	0	0	0	0	0
2	Abbey Bridge and Dixie Refuge Dams and Reservoirs	758	0	0	31	188	785	358
3	Phase II of the North Bay Aqueduct	4,159	294	385	719	1,055	5,695	7,972
4	Delta Facilities	19,758	4,694	13,699	31,410	69,829	75,028	48,391
	California Aqueduct:							
5	Final Four Units at Delta Pumping Plant	2	52	271	737	1,409	2,362	2,474
6	San Luis Canal Modifications	0	100	50	0	0	0	414
7	Final Three Units at A. D. Edmonston Pumping Plant	0	0	0	0	0	69	748
8	Staged Units and Pipelines South of A. D. Edmonston	411	6,538	7,896	1,226	12	72	98
9	Buttes Dam and Reservoir	50	0	0	0	0	0	0
10	Final Three Units at Las Perillas and Badger Hill	0	0	0	0	749	18	123
11	Peace Valley Pipeline and Pyramid Powerplant	1,723	25	601	1,446	8,192	20,790	27,457
12	Cottonwood Powerplant	2,365	0	0	0	115	332	1,823
13	Phase II of the Coastal Branch	0	0	0	0	1,578	3,600	7,813
14	General Costs	0	33,150	10,700	3,834	1,369	1,159	2,956
15	SUBTOTAL, California Aqueduct	4,551	39,865	19,518	7,243	13,424	28,402	43,906
16	Miscellaneous Project Costs	0	4,306	2,651	833	582	377	262
17	Additional Conservation Facilities, Conveyance Works	7,751	252	193	199	204	210	216
18	San Joaquin Drainage Facilities	6,494	113	144	149	153	158	163
19	TOTAL PROJECT CONSTRUCTION EXPENDITURES	2,203,319	49,524	36,590	40,584	85,435	110,655	101,268
	OTHER CAPITAL REQUIREMENTS							
20	Davis-Grunsky Act Program	86,751	5,690	8,531	10,284	10,193	8,533	18
21	Additional Conservation Facilities, Storage Works	0	0	0	0	0	0	0
22	Special Capital Requirements under Revenue Bond Financing	39,122	0	0	0	0	3,700	0
23	TOTAL OTHER CAPITAL REQUIREMENTS	125,873	5,690	8,531	10,284	10,193	12,233	18
24	TOTAL CAPITAL EXPENDITURES	2,329,192	55,214	45,121	50,868	95,628	122,888	101,286
								Financing of
25	APPLICATION OF CALIFORNIA WATER FUND MONEYS	210,311	42,582	31,417	27,640	25,750	25,750	25,750
	APPLICATION OF PROCEEDS FROM SALE OF BONDS							
26	Oroville Revenue Bonds	244,995	0	0	0	0	0	0
27	Devil Canyon-Castaic Revenue Bonds	52,382	5,044	4,747	12,745	42,464	6,500	4,000
28	Supplemental Revenue Bonds	0	0	0	0	0	3,700	0
29	Water Bonds, Davis-Grunsky Program	86,751	5,690	8,531	10,284	10,193	8,533	18
30	Water Bonds, Additional Facilities	7,261	252	193	199	204	210	216
31	Water Bonds, Initial Project Facilities	1,443,753	0	0	0	0	0	0
32	TOTAL, Application of Proceeds from Sale of Bonds	1,835,142	10,986	13,471	23,228	52,861	18,943	4,234
33	APPLICATION OF MISCELLANEOUS RECEIPTS TO CONSTRUCTION	283,739	1,646	233	0	17,017	78,195	71,302
34	TOTAL FINANCING OF CAPITAL EXPENDITURES	2,329,192	55,214	45,121	50,868	95,628	122,888	101,286

ANALYSIS, DECEMBER 31, 1973

of dollars)

Years												
1980	1981	1982	1983	1984	1985	1986–1995	1996–2005	2006–2015	2016–2025	2026–2035	Total 1952–2035	Line no.
Expenditures												
0	0	0	0	0	0	0	0	0	0	0	2,159,848	1
6,315	4,522	5,796	3,850	0	0	0	0	0	0	0	22,603	2
639	75	23	19	1	0	0	0	0	0	0	21,036	3
15,485	12,898	20,571	23,958	12,445	4,421	0	0	0	0	0	352,587	4
1,133	837	1,600	2,682	2,785	972	0	0	0	0	0	17,316	5
1,239	2,436	2,065	1,558	6,427	4,513	0	0	0	0	0	18,802	6
2,806	5,617	7,878	5,001	1,923	0	0	0	0	0	0	24,042	7
1,342	2,371	1,453	345	0	0	0	0	0	0	0	21,764	8
0	0	616	1,635	7,217	8,668	0	0	0	0	0	18,186	9
376	466	87	0	0	254	0	0	0	0	0	2,073	10
25,218	6,426	2,127	0	0	0	0	0	0	0	0	94,005	11
3,506	2,461	1,007	0	0	0	0	0	0	0	0	11,609	12
39,725	33,796	3,613	436	157	0	0	0	0	0	0	90,718	13
2,988	638	85	94	71	46	0	0	0	0	0	57,090	14
78,333	55,048	20,531	11,751	18,580	14,453	0	0	0	0	0	355,605	15
329	280	278	220	161	120	0	0	0	0	0	10,399	16
225	529	798	799	3,688	3,427	263,372	53,106	0	0	0	334,969	17
168	170	170	170	170	20,050	80,349	0	0	0	0	108,621	18
101,494	73,522	48,167	40,767	35,045	42,471	343,721	53,106	0	0	0	3,365,668	19
0	0	0	0	0	0	0	0	0	0	0	130,000	20
0	0	0	0	0	0	0	90,554	127,500	127,500	127,500	473,054	21
6,066	0	0	0	0	0	0	0	0	0	0	48,888	22
6,066	0	0	0	0	0	0	90,554	127,500	127,500	127,500	651,942	23
107,560	73,522	48,167	40,767	35,045	42,471	343,721	143,660	127,500	127,500	127,500	4,017,610	24
Capital Expenditures												
27,660	25,750	28,924	34,489	33,072	40,031	343,721	143,660	127,500	127,500	127,500	1,449,007	25
0	0	0	0	0	0	0	0	0	0	0	244,995	26
11,283	0	0	0	0	0	0	0	0	0	0	139,165	27
0	32,991	4,102	0	0	0	0	0	0	0	0	40,793	28
0	0	0	0	0	0	0	0	0	0	0	130,000	29
225	529	0	0	0	0	0	0	0	0	0	9,289	30
0	0	0	0	0	0	0	0	0	0	0	1,443,753	31
11,508	33,520	4,102	0	0	0	0	0	0	0	0	2,007,995	32
68,392	14,252	15,141	6,278	1,973	2,440	0	0	0	0	0	560,608	33
107,560	73,522	48,167	40,767	35,045	42,471	343,721	143,660	127,500	127,500	127,500	4,017,610	34

Figure 37 APPLICATION OF PROJECT OPERATING REVENUES

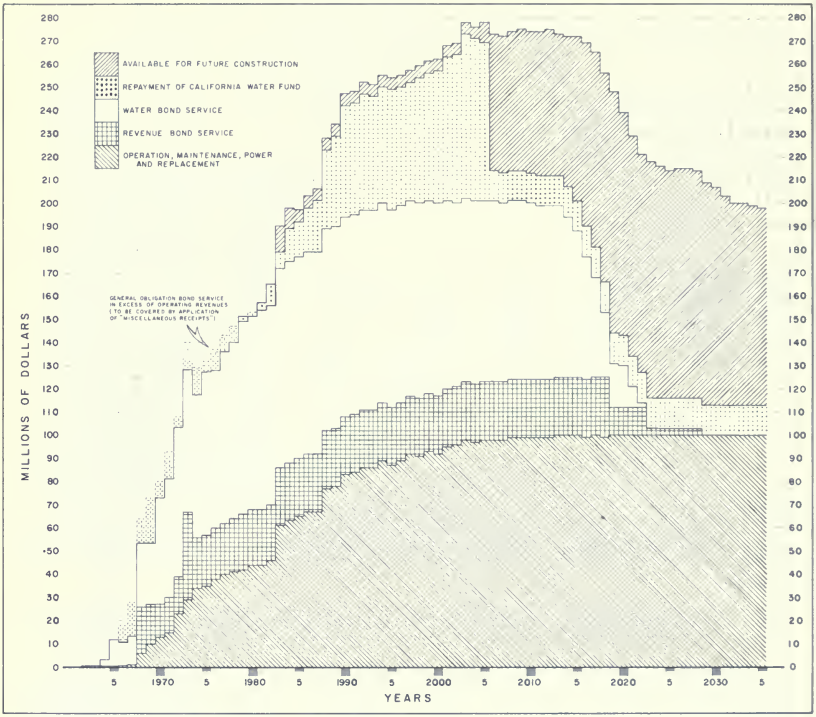


Figure 38 FINANCING OF CONSTRUCTION EXPENDITURES 1952-1985

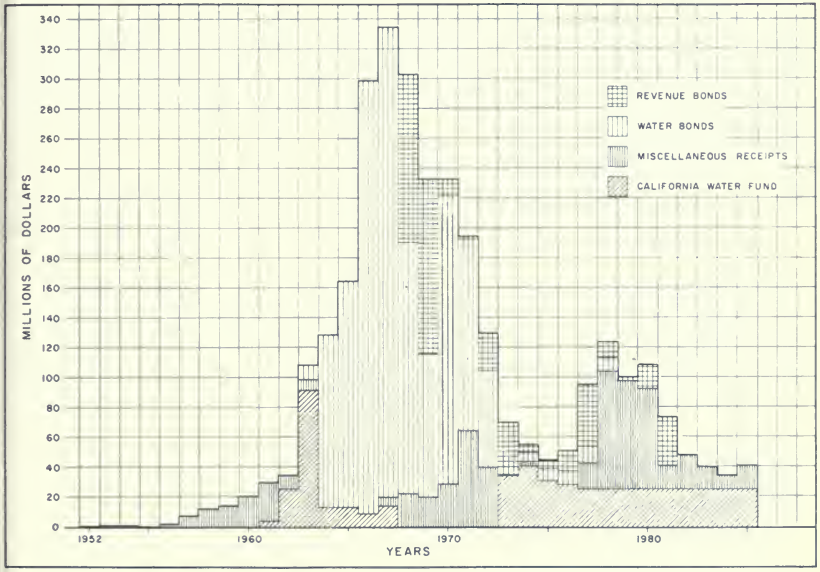


TABLE 6: PROJECT

(In thousands

Feature	Calendar 1962–1973	1974	1975	1976	1977	1978	1979
BY PROJECT FACILITY:							
Feather River Facilities	19,251	5,439	5,215	5,198	5,152	5,133	5,143
North Bay Aqueduct	364	62	55	57	59	64	64
Delta Facilities	0	0	0	0	0	0	0
South Bay Aqueduct	8,797	1,449	1,307	1,376	1,421	1,471	1,492
California Aqueduct:							
Main Line—Delta to A. D. Edmonston	51,236	14,541	16,001	17,062	18,507	19,042	20,319
Main Line—A. D. Edmonston to Lake Perris	10,756	9,944	10,427	12,729	13,333	14,130	14,054
West Branch	3,850	876	895	483	151	57	−407
Coastal Branch	3,857	715	729	726	747	771	782
Additional Conservation Facilities:							
Trans-Basin Diversion Works	0	0	0	0	0	0	0
Payments to Corps for Operating Costs	0	0	0	0	0	0	0
San Joaquin Drainage Facilities	0	0	0	0	0	0	0
Water Quality Monitoring Program-Sacramento-San Joaquin Delta	338	584	411	383	373	373	373
Davis-Grunsky Act Program (continuing administrative costs)	241	65	73	81	88	96	100
TOTAL OPERATING COSTS	98,690	33,675	35,113	38,095	39,831	41,137	41,920
BY COMPOSITION:							
Salaries and Expenses of Headquarters Personnel	62,817	10,711	9,824	9,020	8,305	8,302	8,311
Salaries and Expenses of Field Personnel	66,699	17,253	17,847	17,865	17,865	17,865	17,865
Pumping Power:							
Used by Pumping Plants	24,612	13,003	13,141	17,519	20,686	22,418	24,347
Produced by Recovery Plants	−4,052	−3,361	−3,879	−6,348	−7,492	−7,839	−9,081
Deposits to Replacement Reserves	2,902	862	864	900	900	900	900
Other Costs[a]	1,326	330	330	330	330	330	330
Less, Portion of Costs Incurred During Construction	−55,614	−5,123	−3,014	−1,191	−763	−839	−752
TOTAL OPERATING COSTS	98,690	33,675	35,113	38,095	39,831	41,137	41,920
BY PROJECT PURPOSE:							
Water Supply and Power Generation	85,723	29,931	31,277	34,152	35,906	37,209	37,976
Recreation and Fish and Wildlife Enhancement	4,488	1,692	1,635	1,728	1,706	1,704	1,715
Flood Control	148	26	25	26	26	26	26
Miscellaneous Purposes:							
Federal Share, San Luis and Delta Facilities	8,051	1,898	1,944	1,950	1,945	1,943	1,946
Other (Davis-Grunsky, Drainage, City of Los Angeles)	280	128	232	239	248	255	257
TOTAL OPERATING COSTS	98,690	33,675	35,113	38,095	39,831	41,137	41,920

[a] Includes other costs such as annual Oroville-Thermalito insurance premiums and payments to Corps for operating costs, Additional Conservation Facilities.

OPERATING COSTS

of dollars)

Year

1980	1981	1982	1983	1984	1985	1986–1995	1996–2005	2006–2015	2016–2025	2026–2035	Total 1962–2035
5,149	5,163	5,215	5,223	5,244	5,253	52,385	52,302	52,310	52,310	52,310	343,395
244	241	244	269	268	267	2,759	2,827	2,996	3,567	3,840	18,247
1,217	1,216	1,209	2,023	2,004	3,158	31,347	23,513	23,646	23,676	23,730	136,739
1,439	1,535	1,543	2,240	2,246	2,230	20,756	20,125	20,381	20,575	20,530	130,913
21,290	20,043	20,247	24,642	25,955	28,093	372,586	446,906	474,218	468,476	471,163	2,530,327
13,889	14,558	16,471	25,941	26,736	26,899	360,040	427,677	458,633	464,939	463,280	2,384,436
−634	−506	−546	−1,573	−2,107	−2,814	−69,575	−97,342	−114,608	−112,207	−111,540	−507,547
762	810	1,237	1,696	1,716	1,755	17,757	20,446	23,207	24,567	24,620	126,900
0	0	0	0	0	0	0	14,064	17,407	17,407	17,407	66,285
0	0	0	0	0	0	0	10,300	14,500	14,500	14,500	53,800
0	0	0	0	0	0	9,360	15,601	15,609	15,613	15,610	71,793
373	373	373	373	373	373	3,730	3,730	3,730	3,730	3,730	23,723
100	100	100	100	100	100	1,000	1,000	1,000	1,000	1,000	6,344
43,829	43,533	46,093	60,934	62,535	65,314	802,145	941,149	993,029	998,153	1,000,180	5,385,355
8,295	8,300	8,343	9,203	9,218	9,218	90,795	81,865	85,971	84,914	84,927	598,339
18,700	18,711	19,433	19,633	19,633	20,179	210,936	229,760	229,760	229,760	229,760	1,419,524
24,289	24,171	27,725	45,339	47,348	49,639	703,706	858,671	914,874	921,122	922,220	4,674,830
−8,475	−8,661	−10,591	−14,405	−14,785	−14,876	−214,760	−252,476	−265,309	−265,376	−264,460	−1,376,226
935	935	935	935	980	993	9,933	9,933	9,933	9,933	9,933	63,606
330	330	330	330	330	330	3,300	13,600	17,800	17,800	17,800	75,586
−245	−253	−82	−101	−189	−169	−1,765	−204	0	0	0	−70,304
43,829	43,533	46,093	60,934	62,535	65,314	802,145	941,149	993,029	998,153	1,000,180	5,385,355
39,047	38,836	41,295	55,853	57,403	59,743	736,577	869,382	921,076	926,447	928,410	4,966,243
2,016	1,929	2,028	2,309	2,364	2,530	25,848	25,814	25,991	25,737	25,800	157,034
26	26	26	30	30	30	286	270	273	270	270	1,840
2,480	2,483	2,484	2,484	2,479	2,753	27,482	27,488	27,490	27,490	27,490	172,280
260	259	260	258	259	258	11,952	18,195	18,199	18,209	18,210	87,958
43,829	43,533	46,093	60,934	62,535	65,314	802,145	941,149	993,029	998,153	1,000,180	5,385,355

TABLE 7: FINANCIAL STATEMENT OF OPERATIONS

(See Appendix A, Bulletin 132-74 for notes)

	Cumulative total 1962–1973
OPERATING REVENUES	
Water Sales	
Water Supply Contractors	$82,209,114
Federal Government (San Luis Facilities)	8,201,296
State Government (Recreation)	2,357,839
	92,768,249
Power Sales	97,395,774
	190,164,023
OPERATING EXPENSES	
Water Plant	95,579,941
Power Plant	6,366,324
Provisions for Replacements	3,286,591
	105,232,856
NET OPERATING REVENUES	84,931,167
OTHER INCOME	
Capital Costs Repayments	
Water Supply Contractors	343,666,088
Federal Government (Flood Control)	75,142,774
State Government (Recreation)	40,000,000
West Branch Cooperative Power Development	33,106,662
Investment Earnings	69,766,454
Other	3,652,620
	650,265,765
INCOME DEDUCTIONS	
Interest Expense	
General Obligation Bonds	408,619,016
Oroville Power Revenue Bonds	72,056,636
Devil Canyon-Castaic Revenue Bonds	11,392,382
Other	345,991
	492,414,025
NET REVENUES	$157,851,740
RESULTS OF OPERATIONS	
Water Deliveries (acre-feet)	4,081,059
Power Sold (kilowatthours)	14,443,000,000

TABLE 8: SOURCES AND APPLICATIONS OF FUNDS

(See Appendix A, Bulletin 132-74 for notes)

	Cumulative total 1952–1973
SOURCES OF FUNDS	
Net Revenues	$157,851,740
Provisions for Replacements	3,286,591
Bond Proceeds	
General Obligation Bonds and Notes	1,550,000,000
Oroville Power Revenue Bonds	244,995,000
Devil Canyon-Castaic Revenue Bonds	139,165,000
State Advances	
California Water Fund	218,783,011
General Fund	46,761,000
State Appropriations	
Tidelands Oil & Gas Appropriations	82,661,202
Special Appropriations Made Prior to Burns-Porter Act	98,877,474
Advances for Construction	
Water Supply Contractors	11,280,035
City of Los Angeles, Department of Water and Power	17,205,368
Loan Repayments from Local Agencies	392,430
Real Property Income	7,716,749
	$2,578,975,600
APPLICATIONS OF FUNDS	
Construction Expenditures	
State Water Resources Development System	$2,207,711,266
Castaic Power Plant Surge Chamber	17,196,123
Bonds Redeemed	3,790,000
State Financial Aid to Local Water Agencies	
Loans	26,511,592
Grants and Administrative Expense	60,239,230
Investments in Mobile Equipment	5,614,234
Funds Returned to State Treasury	
General Fund	46,761,000
Special Appropriations	2,584,673
Interest on Condemnation Deposits	851,927
Reserves for:	
Construction	116,147,792
Operations and Maintenance	2,913,294
Replacements	3,286,591
Debt Service and General Reserve	85,367,878
	$2,578,975,600

CHAPTER XIII. TWELVE YEARS OF OPERATIONS

The State Water Project is now in its second decade of operation since Frenchman Lake and the South Bay Aqueduct started service in 1962. Operations activities extend from the northern limits of the Project in the Upper Feather River Basin through Lake Perris at the southern extremity.

The Division of Operations and Maintenance, comprised of five field divisions and a Sacramento headquarters unit, has responsibility for the operation and maintenance activities associated with the Project.

Water Deliveries and Use

Water deliveries from State Water Project facilities during the 12 years from 1962 through 1973 totaled 4,081,059 acre-feet. Table 9 lists the project customers and the amounts of water they received each year, as well as the Department's category of service and the use to which the water was put.

More than half of the water delivered was classified as entitlement water under long-term contracts. Other categories are: regulated delivery of local supply, water purchased from the Bureau of Reclamation in the early days of operation of the Project, surplus water (in excess of entitlement rights), and water delivered to local water agencies in repayment for water used for preconsolidation of foundation soils in the San Joaquin Valley preceding construction of the California Aqueduct through subsidence areas.

More than three-quarters of the Project's water deliveries have been used in agriculture, with the remainder for municipal and industrial purposes.

Nearly all of the municipal and industrial uses of project water have occurred in the south San Francisco Bay area and in Southern California. Most of the agricultural lands served by the Project are located in southwestern San Joaquin Valley.

Well over one-half of the acreage devoted to agricultural use was formerly barren land and was newly developed for agriculture. Estimates are that the Project will ultimately irrigate nearly 250,000 acres of newly developed lands, thus helping to replace the California farmlands which are being converted to residential subdivisions and other urban-related uses.

The Project has created significant benefits for the State in addition to the direct value of water served to Californians and to agricultural lands, and the indirect benefits to allied services, food processing plants, and related uses. Project water deliveries are enhancing the long-term productivity of local water resources. Deliveries are helping to relieve ground water overdraft and, in turn, to arrest deep subsidence, improve ground water quality, and repulse sea water intrusion into ground water reservoirs. A year-by-year summary of the major benefits is given in Table 10.

TABLE 9: WATER DELIVERIES

(In acre-feet)

	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	Total
DELIVERIES TO PROJECT CUSTOMERS													
*Last Chance Creek Water District	9,383	9,811	11,596	10,079	13,015	8,380	13,563	10,137	13,855	10,119	14,432	12,971	137,341
Alameda County Water District	8,412	10,914	19,238	16,407	14,864	12,882	24,817	6,818	20,607	14,777	27,786	7,901	185,423
Alameda County Flood Control and Water Conservation District, Zone 7	494	1,731	1,673	2,605	5,511	4,780	6,133	6,635	9,249	11,652	14,141	13,040	77,644
Santa Clara Valley Water District	0	0	0	15,014	34,538	39,101	70,105	62,264	80,311	87,606	100,266	91,081	580,286
Napa County Flood Control and Water Conservation District	0	0	0	0	0	0	1,214	2,687	3,618	2,521	3,647	3,792	17,479
Kern County Water Agency	0	0	0	0	0	0	127,384	141,265	204,634	360,151	490,781	505,243	1,829,458
Dudley Ridge Water District	0	0	0	0	0	0	26,360	31,375	40,407	41,053	42,443	35,249	216,887
Devil's Den Water District	0	0	0	0	0	0	7,382	9,970	11,739	12,490	13,905	13,522	69,008
Oak Flat Water District	0	0	0	0	0	0	3,084	3,016	5,911	7,212	8,166	4,227	31,616
Tulare Lake Basin Water Storage District	0	0	0	0	0	0	25,100	7,081	0	115,826	252,542	111,552	512,101
Empire West Side Irrigation District	0	0	0	0	0	0	1,978	56	3,942	5,990	5,795	5,814	23,575
County of Kings	0	0	0	0	0	0	900	100	0	3,700	1,400	1,500	7,600
Hacienda Water District	0	0	0	0	0	0	0	2,842	9,578	6,659	5,851	8,500	33,430
*Mustang Water District	0	0	0	0	0	0	0	0	1,176	1,438	1,642	0	4,256
Plumas County Flood Control and Water Conservation District	0	0	0	0	0	0	0	0	70	64	505	679	1,318
County of Butte	0	0	0	0	0	0	0	0	0	192	186	53	431
*Buena Vista Farms, Inc.	0	0	0	0	0	0	0	0	0	7,113	25,542	0	32,655
*Pleasanton Township County Water District	0	0	0	0	0	0	0	0	0	674	0	0	674
*Buena Vista Water Storage District	0	0	0	0	0	0	0	0	0	8,241	19,250	5,945	33,436
*J. G. Boswell Company	0	0	0	0	0	0	0	0	0	0	0	4,358	4,358
Antelope Valley-East Kern Water Agency	0	0	0	0	0	0	0	0	0	0	53	20	73
Coachella Valley County Water District	0	0	0	0	0	0	0	0	0	0	0	5,800	5,800
Crestline-Lake Arrowhead Water Agency	0	0	0	0	0	0	0	0	0	0	464	461	925
Desert Water Agency	0	0	0	0	0	0	0	0	0	0	0	9,000	9,000
Littlerock Creek Irrigation District	0	0	0	0	0	0	0	0	0	0	338	370	708
Mojave Water Agency	0	0	0	0	0	0	0	0	0	0	55	0	55
San Bernardino Valley Municipal Water District	0	0	0	0	0	0	0	0	0	0	1,275	32,426	33,701
The Metropolitan Water District of Southern California	0	0	0	0	0	0	0	0	0	0	71,938	159,883	231,821
TOTAL	18,289	22,456	32,507	44,105	67,928	65,143	308,020	284,246	405,097	697,478	1,102,403	1,033,387	4,081,059
CLASSIFICATION OF WATER SERVED													
Regulated Delivery of Local Supply	9,383	9,811	11,596	10,079	13,015	8,380	14,777	18,829	38,080	28,765	21,846	32,208	216,769
Bureau Water	8,906	12,645	20,911	34,026	54,913	45,225	0	0	0	0	0	0	176,626
Entitlement Water	0	0	0	0	0	11,538	171,709	193,020	233,993	357,340	611,801	694,460	2,273,861
Surplus Water	0	0	0	0	0	0	121,534	72,397	133,024	296,019	423,964	296,416	1,343,354
Repayment Water	0	0	0	0	0	0	0	0	0	15,354	44,792	10,303	70,449
TOTAL	18,289	22,456	32,507	44,105	67,928	65,143	308,020	284,246	405,097	697,478	1,102,403	1,033,387	4,081,059
USES TO WHICH WATER APPLIED													
Municipal and Industrial	4,594	6,686	11,293	17,642	27,529	28,736	52,686	40,123	61,915	103,550	207,702	309,144	871,600
Agricultural	13,695	15,770	21,214	26,463	40,399	36,407	255,334	244,123	343,182	593,928	894,701	724,243	3,209,459
TOTAL	18,289	22,456	32,507	44,105	67,928	65,143	308,020	284,246	405,097	697,478	1,102,403	1,033,387	4,081,059

* Not a water contracting agency.

TABLE 10: STATE WATER PROJECT BENEFITS THROUGH 1973

Year	Water delivered (acre-feet)[a]			Recreation supported (recreation days)[b]	Electrical energy generated (megawatthours)
	Municipal and industrial use	Agricultural use	Total		
1962	4,594	13,695	18,289	30,000	--
1963	6,686	15,770	22,456	105,000	--
1964	11,293	21,214	32,507	331,600	-
1965	17,642	26,463	44,105	499,800	--
1966	27,529	40,399	67,928	482,700	-
1967	28,736	36,407	65,143	455,200	
1968	52,686	255,334	308,020	931,300	628,000
1969	40,123	244,123	284,246	1,554,800	2,614,000
1970	61,915	343,182	405,097	1,804,800	2,679,000
1971	103,550	593,928	697,478	2,085,900	3,302,000
1972	207,702	894,701	1,102,403	1,971,150	1,922,000
1973	309,144	724,243	1,033,387	2,503,000	3,298,000
Total through 1973[c]	871,600	3,209,459	4,081,059	12,755,250	14,443,000

[a] An acre-foot of water (325,851 gallons) will cover one acre of land to a depth of one foot.

[b] A recreation day is the visit of one person to a recreation area for any part of one day.

[c] In addition, dams of the State Water Project have prevented millions of dollars worth of flood damage, the most notable to date being an estimated $30,000,000 in probable damage prevented by operation of partially completed Oroville Dam during the storm of December 1964 and January 1965.

Electric Power Generation

The Department of Water Resources is vitally concerned with the adequacy of energy in California, because energy has such a significant impact on the ability of the State Water Project to deliver the amounts of water needed by the water users. While the State Water Project has contributed large amounts of electric energy to help satisfy the overall requirements of the State, the Project will ultimately require more energy than it can generate to convey water to areas of need.

Generation of hydroelectric power began at the Edward Hyatt and Thermalito Powerplants in March 1968, at the San Luis Pumping-Generating Plant in June 1968, at Castaic Powerplant in January 1972, and at Devil Canyon Powerplant in October 1972.

From 1968 through 1973, 23.5 billion kWh of electric energy were made available for use in California from State Water Project hydroelectric facilities and from imports of hydroelectric generation from the Pacific Northwest. During this same period, 6.2 billion kWh were required by project pumping plants, and 17.3 billion kWh were sold to electric utilities in California. In the period 1974–76, project generation and imports will be approximately equal to project energy requirements.

Table 11 gives the amount of power generated each year by project power plants since they began operation.

TABLE 11. HYDROELECTRIC POWER GENERATION
(in millions of kilowatthours)

YEAR	*Edward Hyatt-Thermalito Power-plants*	*San Luis Pumping-Generating Plant (State Share)*	*Devil Canyon Powerplant*	*Castaic Powerplant (State Share)*	*TOTAL*
1968	617	11	0	0	628
1969	2,611	3	0	0	2,614
1970	2,635	44	0	0	2,679
1971	3,268	34	0	0	3,302
1972	1,658	175	1	88	1,922
1973	2,997	34	125	142	3,298
TOTAL	13,786	301	126	230	14,443

Frenchman Lake was the first facility of the State Water Project to provide recreation. Thirty thousand persons were counted as visitors in 1962 after the reservoir first went into operation. Ten times that number and more used Frenchman annually in following years. A similar rapid rate of increasing recreational use occurred at other facilities. This buildup of use is shown in Table 12.

TABLE 12: RECREATION USE

(Recreation days)*

	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	TOTAL
Frenchman Lake	30,000	105,000	320,000	474,000	360,000	306,900	312,000	394,500	396,800	344,400	179,100	148,800	3,371,500
Antelope Lake	--	--	11,600	25,800	105,000	95,100	54,300	99,300	76,400	71,400	85,700	122,800	747,400
San Luis, O'Neill-Los Banos	--	--	--	--	17,700	53,200	67,000	105,300	251,400	346,600	531,000	361,800	1,734,000
Lake Davis	--	--	--	--	--	--	210,000	439,300	419,700	549,800	230,700	295,900	2,145,400
Oroville-Thermalito	--	--	--	--	--	--	288,000	516,400	483,400	546,900	424,500	560,600	2,819,800
Lake Del Valle	--	--	--	--	--	--	--	--	160,900	211,000	183,800	188,400	744,100
Aqueduct Bikeway & Fishing Access Sites	--	--	--	--	--	--	--	--	16,200	15,800	50,850	89,700	172,550
Castaic Lake	--	--	--	--	--	--	--	--	--	--	231,600	358,200	589,800
Silverwood Lake	--	--	--	--	--	--	--	--	--	--	53,900	376,800	430,700
ANNUAL TOTAL	30,000	105,000	331,600	499,800	482,700	455,200	931,300	1,554,800	1,804,800	2,085,900	1,971,150	2,503,000	12,755,250

* A recreation day is the visit of one person to a recreation area for any part of one day.

APPENDIX A:

REFERENCES AND OTHER SOURCES

APPENDIX A

REFERENCES AND OTHER SOURCES

A list of published source material about the history, planning, and early progress of the State Water Project is given hereafter. Those items marked with an asterisk offer broad and general information on the subject – in essence an overview or bibliography. The references not so marked extend to some reports of the Department's predecessor agencies, pertinent report by others, and Department publications limited to specific aspects of the Project.

Additional sources of information about Project-related and other activities of the Department of Water Resources are listed, abstracted, and indexed in the Department's Bulletin 170 series, **Department Publications.** Bulletin 170-69 covers bulletins and some additional publications issued by the Department and its predecessor agencies from 1922 through 1969. Bulletins issued since then are covered in subsequent issues of the 170 series, with two volumes each year through 1972 and one volume annually thereafter. The total number of bulletins published since 1922, and included in the abstracts and indexes of the Bulletin 170 series, exceeds 1,000.

Publications cited in the text by reference numbers enclosed in parentheses are identified hereafter. Publications with an asterisk beside the reference number provide a project overview.

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(3) _____, Bulletin No. 12, "Summary Report on the Water Resources of California and a Coordinated Plan for Their Development: A Report to the Legislature of 1927", January 1, 1927.

(4) ___ , Bulletin No. 20, "Kennett Reservoir Development, An Analysis of Methods and Extent of Financing by Electric Power & Revenue", 1929.

(5) ___ , Bulletin No. 25, "Report to Legislature of 1931 on State Water Plan", 1930.

(6) House Document 791, 71st Congress, "Partial Report on Sacramento, San Joaquin and Kern Rivers, California", 1931.

(7) C. A. Bissel, "California Water Resources", Vols. I and II, May 1931, unpublished manuscript in files of U. S. Bureau of Reclamation, Sacramento.

(8) California State Water Resources Board, Bulletin No. 1, "Water Resources of California", 1951.

(9) _____, Bulletin No. 2, "Water Utilization and Requirements of California", June 1955.

(10) California Department of Water Resources, Bulletin No. 3, "The California Water Plan", May 1957.

*(11) California State Water Resources Board, "Report on Feasibility of the Feather River Project and Sacramento-San Joaquin Delta Diversion Projects Proposed as Features of the California Water Plan", May 1951.

*(12) California Department of Public Works, "Program for Financing and Constructing the Feather River Project as the Initial Unit of the California Water Plan", February 1955.

*(13) Bechtel Corporation, "Report on the Engineering, Economic and Financial Aspects of the Feather River Project to the Joint Committee on Water Problems, California State Legislature", December 31, 1955.

*(14) Charles T. Main, Inc., "General Evaluation of the Proposed Program for Financing and Constructing the State Water Resources Development System of the State of California, Department of Water Resources", October 1960.

(15) Dillion, Read & Co., Inc., "Report of Financial Consultants to the State of California Department of Water Resources on Financial Aspects of Programs for State Water Resources Development System", October 26, 1960.

(16) California Department of Water Resources, "State Water Right Applications for Unappropriated Water, Assignments Thereof, Reservations for Counties or Origin, and Other Related Matters", January 1959.

*(17) _____, Bulletin No. 132 series, "California State Water Project in (year)", annually since 1963 and Appendices A, B, C, D, and E since 1964.

(18) The Fluor Corporation for the California Department of Water Resources, "Energy Source Study for the California State Water Project", September 1964.

(19) Sverdrup & Parcel and Associates for the California Department of Water Resources, "Oroville-Delta Transmission Lines", October 1964.

*(20) California Department of Water Resources, Bulletin No. 78, "Investigation of Alternative Aqueduct Systems to Serve Southern California", December 1959 and Appendices A, B, C, D, E, and F.

(21) _____, Bulletin No. 119-1, "Feasibility of Serving Desert Water Agency Service Area from the State Water Facilities", November 1962.

(22) _____, Bulletin No. 119-2, "Feasibility of Serving San Gorgonio Pass Water Agency from the State Water Facilities", February 1963.

(23) _____, Bulletin No. 119-3, "Feasibility of Serving Coachella Valley County Water District from the State Water Facilities", May 1963.

(24) _____, Bulletin No. 119-4, "Feasibility of Serving Palmdale Irrigation District and Pearland Area from the State Water Facilities", May 1963.

(25) _____, Bulletin No. 119-5, "Feasibility of Serving Solano County Flood Control and Water Conservation District from the State Water Facilities", November 1964.

(26) _____, Bulletin No. 119-6, "Feasibility of Serving San Gabriel Valley Municipal Water District from the State Water Facilities", May 1964.

(27) _____, Bulletin No. 119-7, "Feasibility of Serving San Luis Obispo County Flood Control and Water Conservation District from the State Water Facilities", August 1963.

(28) _____, Bulletin No. 119-8, "Feasibility of Serving Kern County Water Agency from the State Water Project", September 1963.

(29) California Department of Water Resources, Bulletin No. 119-9, "Feasibility of Serving Napa County Flood Control and Water Conservation District from the State Water Project", February 1965.

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(31) _____, Bulletin No. 119-11, "Feasibility of Serving Tulare Lake Basin Water Storage District from the State Water Project", May 1965.

(32) _____, Bulletin No. 119-12, "Feasibility of Serving Mojave Water Agency from the State Water Project", December 1965.

(33) _____, Bulletin No. 119-13, "Feasibility of Serving Devil's Den Water District from the State Water Project", February 1965.

(34) _____, Bulletin No. 119-14, "Feasibility of Serving Dudley Ridge Water District from the State Water Project", August 1964.

(35) _____, Bulletin No. 119-15, "Feasibility of Serving Oak Flat Water District from the State Water Project", December 1965.

(36) _____, Bulletin No. 119-16, "Feasibility of Serving Plumas County Flood Control and Water Conservation District from the State Water Project", May 1965.

(37) _____, Bulletin No. 119-17, "Feasibility of Serving Ventura County Flood Control District from the State Water Project", July 1965.

(38) _____, Bulletin No. 119-18, "Feasibility of Serving Upper Santa Clara Valley Water Agency from the State Water Project", August 1964.

(39) _____, Bulletin No. 119-19, "Feasibility of Serving Crestline-Lake Arrowhead Water Agency from the State Water Project", February 1965.

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APPENDIX B

CALIFORNIA WATER RESOURCES DEVELOPMENT BOND ACT, 1959 (Burns-Porter Act)

APPENDIX B

CALIFORNIA WATER RESOURCES DEVELOPMENT BOND ACT

Chapter 1762, Statutes of California, 1959

(Assembly Concurrent Resolution 151 | Resolution Chapter 241| of the 1959 Regular Session provides that this act shall be known and cited as the "Burns-Porter Act.")

Senate Bill No. 1106

CHAPTER 1762

An act to add Chapter 8 (commencing with Section 12930) to Part 6 of Division 6 of the Water Code, relating to provision for the development of the water resources of the State by providing the funds necessary therefor through the issuance and sale of bonds of the State of California, and by providing for the handling and disposition of said funds, and providing for the submission of this act to a vote of the people at the general election to be held in the month of November, 1960.

[Approved by Governor July 10, 1959. Filed with Secretary of State July 13, 1959.]

The people of the State of California do enact as follows:

SECTION 1. Chapter 8 (commencing at Section 12930) is added to Part 6 of Division 6 of the Water Code, to read:

CHAPTER 8. WATER RESOURCES DEVELOPMENT BONDS

12930. This chapter shall be known and may be cited as the California Water Resources Development Bond Act.

12931. The object of this chapter is to provide funds to assist in the construction of a State Water Resources Development System for the State of California. Said system shall be comprised of the State Water Facilities as defined in Section 12934(d) hereof and such additional facilities as may now or hereafter be authorized by the Legislature as a part of (1) the Central Valley Project or (2) the California Water Plan, and including such other additional facilities as the department deems necessary and desirable to meet local needs, including, but not restricted to, flood control, and to augment the supplies of water in the Sacramento-San Joaquin Delta and for which funds are appropriated pursuant to this chapter. The enactment of this chapter shall not be construed as creating any right to water or the use thereof nor as affecting any existing legislation with respect to water or water rights, except as expressly provided herein, nor shall anything herein contained affect or be construed as affecting vested water rights. Any facilities heretofore or hereafter authorized as a part of the Central Valley Project or facilities which are acquired or constructed as a part of the State Water Resources Development System with funds made available hereunder shall be acquired, constructed, operated, and maintained pursuant

to the provisions of the code governing the Central Valley Project, as said provisions may now or hereafter be amended. For the purposes of this chapter the Sacramento-San Joaquin Delta shall be deemed to be within the watershed of the Sacramento River. No facility constructed in whole or in part with funds made available by this chapter shall be used to transport water the right to which was secured through eminent domain by others than the State unless approved by the Legislature by concurrent resolution with a majority of the members elected to each house voting in favor thereof.

12932. Insofar as it is not inconsistent with the express provisions of this chapter, the State General Obligation Bond Law (Chapter 4 (commencing at Section 16720) of Part 3, Division 4, Title 2 of the Government Code), is adopted for the purpose of the issuance, sale, and repayment of, and otherwise providing with respect to, the bonds authorized to be issued by this chapter, and the provisions of that law are included in this chapter as though set out in full in this chapter. All references in this chapter to "herein" shall be deemed to refer both to this chapter and such law.

12933. There is hereby created a California Water Resources Development Finance Committee composed of the Governor, the State Treasurer, the State Controller, Director of Finance and Director of Water Resources, all of whom shall serve without compensation, and the majority of whom shall be empowered to act for said committee. The Director of Finance shall provide such assistance, and the Attorney General shall furnish such legal advice, to the California Water Resources Development Finance Committee as it may require.

12934. As used in this chapter and for the purposes of this chapter as used in the State General Obligation Bond Law, the following words shall have the following meanings:

(a) "Committee" shall mean the California Water Resources Development Finance Committee created by Section 12933.

(b) "Board" or "department" shall mean the Department of Water Resources.

(c) "Fund" shall mean the California Water Resources Development Bond Fund created by Section 12935.

(d) "State Water Facilities" shall mean the following facilities:

(1) A multiple purpose dam and reservoir on the Feather River in the vicinity of Oroville, Butte County, and dams and reservoirs upstream therefrom in Plumas County in the vicinity of Frenchman, Grizzly Valley, Abbey Bridge, Dixie Refuge and Antelope Valley;

(2) An aqueduct system which will provide for the transportation of water from a point or points at or near the

Sacramento-San Joaquin Delta to termini in the Counties of Marin, Alameda, Santa Clara, Santa Barbara, Los Angeles and Riverside, and for delivery of water both at such termini and at canal-side points en route, for service in Solano, Napa, Sonoma, Marin, Alameda, Contra Costa, Santa Clara, San Benito, Santa Cruz, Fresno, Tulare, Kings, Kern, Los Angeles, Ventura, San Bernardino, Riverside, Orange, San Diego, San Luis Obispo, Monterey and Santa Barbara Counties.

Said aqueduct system shall consist of intake and diversion works, conduits, tunnels, siphons, pipelines, dams, reservoirs, and pumping facilities, and shall be composed of a North Bay aqueduct extending to a terminal reservoir in Marin County; a South Bay aqueduct extending to terminal reservoirs in the Counties of Alameda and Santa Clara; a reservoir near Los Banos in Merced County; a Pacheco Pass Tunnel aqueduct from a reservoir near Los Banos in Merced County to a terminus in Pacheco Creek in Santa Clara County; a San Joaquin Valley-Southern California aqueduct extending to termini in the vicinity of Newhall, Los Angeles County, and Perris, Riverside County, and having a capacity of not less than 2,500 cubic feet per second at all points north of the northerly boundary of the County of Los Angeles in the Tehachapi Mountains in the vicinity of Quail Lake and a capacity of not less than 10,000 cubic feet per second at all points north of the initial offstream storage reservoir; a coastal aqueduct beginning on the San Joaquin Valley-Southern California aqueduct in the vicinity of Avenal, Kings County, and extending to a terminal at the Santa Maria River;

(3) Master levees, control structures, channel improvements, and appurtenant facilities in the Sacramento-San Joaquin Delta for water conservation, water supply in the Delta, transfer of water across the Delta, flood and salinity control, and related functions.

(4) Facilities for removal of drainage water from the San Joaquin Valley.

(5) Facilities for the generation and transmission of electrical energy.

(6) Provision for water development facilities for local areas as provided in Chapter 5 (commencing at Section 12880) of Part 6 of Division 6 of the Water Code as the same may now or hereafter be amended.

(7) Including for the foregoing (1 through 5) the relocation of utilities and highways and acquisition of all lands, rights of way, easements, machinery, equipment, apparatus, and all appurtenances necessary or convenient therefor.

12935. For the purpose of creating a fund, herein designated the California Water Resources Development Bond

Fund, to provide for the acquisition, construction and completion of the State Water Facilities herein specified and, to the extent provided in Section 12938, for additions to the State Water Resources Development System, the committee shall be and is hereby authorized and empowered to create a debt or debts, liability or liabilities of the State of California in the aggregate principal amount of one billion seven hundred fifty million dollars ($1,750,000,000) in the manner and to the extent herein provided, but not otherwise nor in excess thereof.

12936. All bonds herein authorized, which shall have been duly sold and delivered as herein provided, shall constitute valid and legally binding general obligations of the State of California, and the full faith and credit of the State of California is hereby pledged for the punctual payment of both principal and interest thereof. Notwithstanding the provisions of subdivision (b) of Section 16731 of the Government Code, the first date or dates of maturity of any series of bonds issued under this chapter shall be not more than 10 years, and the last dates of maturity of any such series of bonds may be fixed at any date or dates to and including 50 years, after the date of that series. The committee may fix different dates for the bonds of each series and the bonds of any series may be made to mature and become payable at different times from those of any other series; provided, that the maturity dates of each separate series shall comply with the provisions of this section.

12937. The ways and means for the payment of the interest on and the principal of such bonds shall be as follows:

(a) There shall be collected annually in the same manner and at the same time as other state revenue is collected such a sum, in addition to the ordinary revenues of the State, as shall be required to pay the principal and interest on said bonds as herein provided, and it is hereby made the duty of all officers charged by law with any duty in regard to the collection of said revenue, to do and perform each and every act which shall be necessary to collect such additional sum.

There is hereby appropriated from the General Fund in the State Treasury such sum annually as will be necessary to pay the principal of and the interest on the bonds issued and sold pursuant to the provisions of this chapter, as said principal and interest become due and payable.

On the several dates on which funds are remitted pursuant to Section 16676 of the Government Code for the payment of the then maturing principal and interest on the bonds, to wit, on the several dates of maturity of said principal and interest in each fiscal year there shall be transferred into the General Fund in the State Treasury from revenues deposited in the fund as provided in subdivision (b) of this Section 12937, and from any accrued interest and premiums received on any sale, or sales of the bonds, so far as available therein, amounts equal

to, but not in excess of, all sums so becoming due for principal and interest and in the event such money received from such sources and so returned on said remittance dates is less than the principal and interest. then due and payable then the balance remaining unpaid shall be transferred to the General Fund out of moneys in the fund received from such sources as soon thereafter as it shall become available, together with simple interest thereon, from such remittance dates until so returned at the same rate as borne by the bonds.

(b) All revenues derived from the sale, delivery or use of water or power, and all other income or revenue, derived by the State, from the State Water Resources Development System shall be deposited in a special account or accounts in the California Water Resources Development Bond Fund and shall be accounted for and used annually only for the following purposes and in the following order, to wit:

1. The payment of the reasonable costs of the annual maintenance and operation of the State Water Resources Development System and the replacement of any parts thereof.

2. The annual payment of the principal of and interest on the bonds issued pursuant to this chapter.

3. Transfer to the California Water Fund as reimbursement for funds utilized from said fund for construction of the State Water Resources Development System.

4. Any surplus revenues in each year not required for the purpose specified in the foregoing subparagraphs (1), (2) and (3) of this subdivision (b) of Section 12937 and not required to be transferred to the General Fund pursuant to subparagraph (a) of this Section 12937, shall, during the time any of the bonds authorized herein are outstanding, be deposited in a special account in the California Water Resources Development Bond Fund and are hereby appropriated for use and shall be available for expenditure by the department for acquisition and construction of the State Water Resources Development System as described in Section 12931 hereof.

All such revenues shall constitute a trust fund and are hereby pledged for the uses and purposes above set forth and such pledge shall inure to the direct benefit of the owners and holders of all general obligation bonds issued under this chapter. The department, subject to such terms and conditions as may be prescribed by the Legislature, shall enter into contracts for the sale, delivery or use of water or power, or for other services and facilities, made available by the State Water Resources Development System with public or private corporations, entities, or individuals. Such contracts shall not be impaired by subsequent acts of the Legislature during the time when any of the bonds authorized herein are outstanding

and the State may sue and be sued with respect to said contracts. Said contracts shall be for a stated term and, insofar as practicable and feasible, for the full term of the life of the general obligation bonds issued under this chapter and each such contract shall recite (i) that it is entered into for the direct benefit of the holders and owners of all general obligation bonds issued under this chapter, and (ii) that the income and revenues derived from such contracts are pledged to the purposes and in the priority herein set forth. Such pledge of revenues as herein set forth is hereby declared to be and shall constitute an essential term of this chapter and upon its ratification by the people of the State of California shall be binding upon the State so long as any general obligation bonds authorized hereunder are outstanding and unpaid. Such income and revenues, subject to the priorities herein set forth, shall constitute additional security for all of the bonds authorized and issued hereunder irrespective of the date of their issuance and sale and so long as any of the bonds authorized and issued hereunder, or the interest thereon, are unpaid, such income and revenues shall not be used for any other purpose. The bonds authorized hereunder shall be equally secured by a lien upon all income and revenues derived from the State Water Resources Development System without priority for number, amount, date of bonds, of sale, of execution, or of delivery pursuant to this chapter. Notwithstanding the pledge of revenues herein contained, the State of California shall remain liable for the payment of the principal of and interest upon all of the bonds authorized and issued under this chapter.

12938. All proceeds from the sale of the bonds herein authorized shall be deposited in the fund as provided in Section 16757 of the Government Code and shall be available for the purpose provided in Section 12935, but, except only as to accrued interest and any premiums received on any sale, or sales, of the bonds, shall not be available for transfer to the General Fund. All moneys deposited in the fund are hereby appropriated to the department for expenditure and allocation by the department without regard to fiscal years for the State Water Facilities as herein defined and, to the extent provided in this Section 12938, for additions to the State Water Resources Development System. Of the total amount of the bonds authorized herein, one hundred thirty million dollars ($130,000,000) and no more shall be available exclusively for the provision of water development facilities for local areas as set forth in subdivision (d)(6) of Section 12934. Any money in the California Water Fund, and any surplus revenue as described in Section 12937(b)4, available for expenditure for the State Water Resources Development System shall be used for the construction of the State Water

Facilities in lieu of the proceeds of bonds authorized by this chapter. The use of the proceeds of bonds for such construction shall be decreased by an amount equal to that hereafter expended from the California Water Fund for the construction of State Water Facilities. To the extent that money is expended from the California Water Fund for construction of the State Water Facilities, proceeds from the sale of bonds authorized pursuant to this act in an equal amount, is appropriated and shall be expended for the construction of such additional facilities of the State Water Resources Development System as the department shall determine to be necessary and desirable to meet local needs, including, but not restricted to, flood control, and to augment the supplies of water in the Sacramento-San Joaquin Delta from multiple purpose dams, reservoirs, aqueducts and appurtenant works in the watersheds of the Sacramento, Eel, Trinity, Mad, Van Duzen and Klamath Rivers for use in the State Water Resources Development System, and the department is authorized to construct any and all facilities for which funds are appropriated to it for expenditure pursuant to this chapter. Such additional facilities for local needs shall include those necessary to conserve or develop water which is tributary to the stream upon which any of the facilities of the State Water Resources Development System are constructed and it shall be the duty of the department to diligently plan such full development and submit plans and reports thereon to the Legislature. All moneys in the California Water Fund and all accruals thereto are hereby appropriated to the department for expenditure and allocation by the department without regard to fiscal years for the State Water Resources Development System as defined in Section 12931 except that in any fiscal year the Legislature may appropriate for any lawful purpose any money in the California Water Fund which is unexpended at the beginning of that fiscal year and any money accruing to that fund during the fiscal year.

12939. Upon the written request of the board, supported by a statement of the expenditures made and to be made for the State Water Resources Development System, the committee shall determine whether or not it is necessary or desirable to issue any bonds authorized under this chapter in order to make such expenditures and, if so, the amount of bonds then to be issued and sold. The committee and the board shall file with the Legislature detailed reports of all expenditures from the California Water Resources Development Bond Fund and the California Water Fund, setting forth descriptions of the purposes of all such expenditures. Such reports shall be filed on or before the fifteenth day of each regular legislative session and shall show schedules of expenditures and the dates on

which additional water will be available for sale from principal termini of the State Water Resources Development System and the total amount then available for sale at these termini. Successive issues of bonds may be authorized and sold to make such expenditures progressively and it shall not be necessary that all of the bonds herein authorized to be issued shall be sold at any one time.

12940. If any resolution determining that the sale of all or any part of the bonds herein authorized is necessary or desirable, the committee may in its discretion provide for the interexchange of bonds of different denominations, which may be in any multiple of one thousand dollars ($1,000), the issuance of bonds of different denominations in lieu of or in exchange for bonds of a like aggregate principal amount but of different denominations, the issuance of registered bonds in such denominations as may be specified by the committee and the exchange of such registered bonds for coupon bonds of a like aggregate principal amount but of different denominations. The committee may also provide for the authentication of any bonds by the State Controller or by any deputy state controller. If authentication is so required, no bond authorized hereunder shall be valid unless so authenticated in the manner so required.

12941. In computing the net interest cost under Section 16754 of the Government Code, the committee may determine that interest shall be computed either from the date of sale or from the date of the bonds or from the last preceding interest payment date to the respective maturity dates of the bonds then offered for sale at the coupon rate or rates specified in the bid, such computation to be made on a 360-day year basis, and the committee shall make appropriate provision therefor in the form of notice of sale of the bonds.

12942. The committee may authorize the State Treasurer to sell all or any part of the bonds herein authorized at such date or dates as may be fixed by the State Treasurer and no direction of the Governor shall be required. The provisions of Sections 16750 and 16754 of the Government Code respecting the direction of the Governor shall not be applicable to such sale.

SEC. 2. Section 1 of this act shall take effect upon the adoption by the people of the California Water Resources Development Bond Act, as set forth in Section 1 of this act. Sections 2 to 4 of this act contain provisions relating to and necessary for the submission of the California Water Resources Development Bond Act to the people, and for returning, canvassing, and proclaiming the votes thereon, and shall take effect immediately.

SEC. 3. The California Water Resources Development Bond Act, as set forth in Section 1 of this act, shall be submitted to the people of the State of California for their ratification at the next general election, to be held in the month of November, 1960, and all ballots at said election shall have printed thereon and in a square thereof, the words: "For the California Water Resources Development Bond Act," and the same square under said words the following in 8-point type: "This act provides for a bond issue of one billion seven hundred fifty million dollars ($1,750,000,000) to be used by the Department of Water Resources for the development of the water resources of the State." In the square immediately below the square containing such words, there shall be printed on said ballot the words, "Against the California Water Resources Development Bond Act," and in the same square immediately below said words, in 8-point type shall be printed "This act provides for a bond issue of one billion seven hundred fifty million dollars ($1,750,000,000) to be used by the Department of Water Resources for the development of the water resources of the State." Opposite the words "For the California Water Resources Development Bond Act," and "Against the California Water Resources Development Bond Act," there shall be left spaces in which the voters may place a cross in the manner required by law to indicate whether they vote for or against said act, and those voting for said act shall do so by placing a cross opposite the words, "For the California Water Resources Development Bond Act," and those voting against the said act shall do so by placing a cross opposite the words "Against the California Water Resources Development Bond Act." Provided, that where the voting of said general election is done by means of voting machines used pursuant to law in such manner as to carry out the intent of this section, such use of such voting machines and the expression of the voters' choice by means thereof, shall be deemed to comply with the provisions of this section. The Governor of this State shall include the submission of this act to the people, as aforesaid, in his proclamation calling for said general election.

SEC. 4. The votes cast for or against the California Water Resources Development Bond Act shall be counted, returned and canvassed and declared in the same manner and subject to the same rules as votes cast for state officers; and if it appears that said act shall have received a majority of all the votes cast for and against it at said election as aforesaid, then

the same shall have effect as hereinbefore provided, and shall be irrepealable until the principal and interest of the liabilities herein created shall be paid and discharged, and the Governor shall make proclamation thereof; but if a majority of the votes cast as aforesaid are against this act then the same shall be and become void.

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APPENDIX C

CONTRACTING PRINCIPLES FOR WATER SERVICE CONTRACTS, 1960

APPENDIX C

CONTRACTING PRINCIPLES FOR WATER SERVICE CONTRACTS

January 20, 1960

1. Cost allocations shall be on the separable costs-remaining benefits basis for multi-purpose facilities and on a proportionate use basis by areas for water transportation facilities.

2. For purposes of project commodity pricing, costs will be allocated among water supply, flood control, recreation, enhancement of fish and wildlife, drainage, quality control, and such other functions as may be authorized and performed by the particular facility or facilities under consideration.

3. Rates for water and power and for other reimbursable items will be established so as to return to the State all costs of project operation, maintenance and replacement, all principal and interest on (1) bonds, (2) expenditures from the California Water Fund, and (3) other monies used in the construction of the project works. Those costs declared by the Legislature to be nonreimbursable and the federal contributions for flood control and for other items will not be included in the rate structure.

4. The project will require more power for pumping purposes than it will produce. Power required in the operation of the project must be paid for by the water users whether it is obtained from project or nonproject sources. Therefore, the costs of the project facilities producing the power is properly a cost of water supply and in the project cost allocation no separate allocation of the capital costs of power facilities will be made. The capital cost of power will be included in the costs allocated to water supply. The difference between the actual cost of power, that is, the amount necessary to repay the capital and operation and maintenance costs of the power facilities, and the market value of the power provides an economic benefit. A cost allocation study will be made with reference to power facilities for the purpose of determining the economic benefit to be derived from the use of project power for project purposes.

In addition, to the extent that from time to time any power is available for sale, it will be sold at its market value. Preference will be given to public agencies in such sale as required under existing law. The difference between the actual cost and the market value of such power will result in income to reduce project costs. This added income (power credit) will be applied, and the computed economic benefit will be made available, to reduce the cost of project water except for water used on land in single owenrship in excess of 160 acres (320 acres in the case of community property).

5. Under the Delta Pooling Concept, there will be a single price for state project water at the Delta and for state project service areas above the Delta which will be referred to as the

Delta Water Rate. The Delta Water Rate will consist of an annual (1) capital cost component, (2) necessary minimum operation, maintenance and replacement component; and (3) an operation and maintenance component which will vary with the amounts of water furnished.

The Delta Water Rate will be based on the cost of construction and the cost of operation, maintenance and replacement of these conservation facilities allocated to water supply upstream from and within the Delta. The capital cost component and the minimum maintenance and replacement component will be collected irrespective of the amount of water furnished. The operation and maintenance component will be collected from the contractors receiving water in proportion to the amount of water furnished. Increases and decreases in the capital cost component of the Delta Water Rate will be made from time to time to reflect the then outstanding unpaid reimbursable cost incurred in the construction of facilities necessary to make water available at the Delta.

6. Those contracting for water from a project aqueduct will pay, in addition to the Delta Water Rate, a charge herein referred to as the "Transportation Rate." The Transportation Rate will consist of an annual (1) capital cost component, (2) necessary minimum maintenance and replacement component, and (3) maintenance and operation component which will vary with the amount of water furnished.

The capital cost component, and the minimum maintenance and replacement component will be allocated to service areas by reaches of aqueduct, using the proportionate use method of cost allocation and will be collected annually irrespective of the amount of water furnished. The maintenance and operation component which varies with the quantity of water delivered will be computed for the same reaches of aqueduct as used for the other components of the Transportation Rate and will be allocated among, and collected annually from, the contractors receiving water in proportion to the amounts of water received. Provision will be made for reserve funds to be used for the purpose of meeting large, unforeseen cost of operation and maintenance, repair and replacement of works.

The total annual charge to project water contractors will be the sum of the Transportation Rate plus the Delta Water Rate.

7. The following is a breakdown of the Delta Water Rate and the Transportation Rate. The Transportation Rate is stated for reaches of the aqueducts where the rate will be set by reaches. These rates are based upon estimated costs. Provision will be made in the contracts for revision of the rates when actual costs become known.

(While the following table is out of date, it is used here to illustrate the principles involved in arriving at annual charges to the project water contractors.)

Areas of Water Service by Aqueduct Reaches	Estimated Operation and Maintenance Costs Plus the Delta Water Rate, in Dollars per Acre-Foot	Estimated Annual Capital Cost Component *, in Dollars
1. Areas within and upstream from Delta (Delta Water Rate)	$ 3.50**	--
2. Entire North Bay Aqueduct to terminus in Marin County	7.50	$ 1,440,000
3. Entire South Bay Aqueduct (includes cost of possible future extension to Airpoint Reservoir in Santa Clara County if later found necessary)	13.00	1,910,000
4. Pacheco Pass Tunnel Aqueduct	14.00	980,000
SAN JOAQUIN VALLEY		
5. San Luis Reservoir to Avenal Gap	11.50	330,000
6. Avenal Gap to Buena Vista Lake	11.50	4,700,000
7. Buena Vista Lake to Wheeler Ridge	13.00	2,610,000
8. Wheeler Ridge to Tehachapi Tunnel	18.50	560,000
COASTAL AQUEDUCT		
9. San Joaquin Valley east of Devils Den	14.00	1,580,000
10. San Joaquin Valley west of Devils Den	19.00	1,070,000
11. In San Luis Obispo and Santa Barbara Counties	22.00	4,420,000
WEST BRANCH AQUEDUCT IN SOUTHERN CALIFORNIA		
12. Entire service area	25.00	24,530,000
EAST BRANCH AQUEDUCT IN SOUTHERN CALIFORNIA		
13. Tehachapi Tunnel to Pearblossom	32.00	1,910,000
14. Pearblossom to Perris Reservoir	35.50	22,580,000

* Average annual payment necessary to repay, with interest, the portion of the aqueduct system capital cost allocated to each service area, based on a 50-year pay-out period.

** Delta Water Rate shown includes capital cost component for conservation facilities within and above Delta. Power credit has been deducted.

8. Contracts for dependable water supply shall be for at least 50-year terms, but shall contain provision for changes in rates and operating provisions. Upon expiration of the term of the contract, the contracting agency shall have the option of continued service on terms and conditions prescribed by the State, but at no greater cost than would have been the case had the original contract continued in effect. Should the terms and conditions provide for the furnishing of such continuing water service for only a specified period of years, the contracting agency shall have a like right to continued service at the expiration of such succeeding term during which it was receiving project water.

9. To insure continuity and dependability of water supplies the contracts will provide:

(a) That contracts for dependable water supply will aggregate no more than a stated amount based upon the yield of the project. This amount, which will be approximately 4,000,000 acre-feet annually, is to be increased by the yield due to added storage facilities when and as constructed. In addition, contracts may be executed for interim or nondependable water supply subject to reduction or termination by the State at any time.

(b) For the furnishing of stated maximum annual amounts of project water. The time and rate of furnishing of water delivery during any year by the State will be pursuant to schedules and amendments thereof submitted by the contracting agency for such year. The State will comply with such schedules consistent with its delivery ability taking into account all such schedules submitted by agencies entitled under contract to a dependable project water supply.

(c) That in the event of a shortage in the dependable project supply available in any year for export, project water will be prorated among all export contractors. Each contracting agency will receive an amount of water which bears the same relationship to the available supply, computed on the same basis as the project yield studies, that the amount called for in the agency's contract for a particular year bears to the total amount of water required to be delivered pursuant to all contracts in the respective year. However, the Department will reserve the right to prorate on some other basis if required to meet necessary demands for domestic supply, fire prevention, or sanitation in the respective year or season.

(d) That bond funds will be used to construct added storage facilities and related facilities for local needs to meet commitments to export from the Delta to the extent that California Water Fund monies are used for construction of the original facilities and to the extent such added construction is required by virtue of a reduction, occasioned by operation of area of origin statutes, in the amount of water available for export. This will be subject to the proviso, however, that to the extent that the Director at any time after 1985 finds that any such funds are not then required to meet such reduction and will not be required for

such purpose within the next succeeding 10 years, any such funds may be used for the construction of added storage facilities to meet increased demands for export to or from the Delta and to meet local needs.

(e) That the State will plan the availability of water from the Delta so that deliveries can be made at the time and in the amounts scheduled in the contracts. To the extent possible, five years notice shall be given of any reduction in deliveries which will occur as a result of operation of area of origin statutes.

10. Construction of any transportation facility financed wholly or in part through the sale of bonds, will not be started unless water service contracts have been executed which will insure recovery of at least 75 percent of the cost of such facility.

11. Local contracting agencies may make funds available for construction or completion of construction of initial or ultimate facilities and will be credited to the extent of such contributions.

12. As a general policy, contracts for project water will be executed with public agencies having the taxing, assessment or equivalent power and all other powers required in order to comply with the terms of the contract. Contracts will be executed with others not having the taxing, assessment or equivalent power only when the State can be provided with security sufficient to insure that the obligations incurred will be paid.

13. Each contracting agency will agree that, in the event in any year it is unable or fails through other means to raise the funds necessary in any year to pay to the State the sum required under the contract, it will use its taxing or assessment power to raise such sum.

APPENDIX D

DEFINITION OF TERMS, DEFINITION OF AGENCIES, SIGNIFICANT LEGISLATION AND COURT DECISIONS

APPENDIX D

DEFINITION OF TERMS

Throughout this bulletin, a number of plans, acts and funds are referred to. In order to provide a ready reference as to what they consist of and their interrelationship to each other, the following definitions are provided:

1. State Water Plan - A coordinated plan for conservation, development and utilization of the water resources of California (Bulletin 25, 1930). It brought together findings of earlier studies dating back to the 1880s and presented the next comprehensive plan to that time. While it envisioned a transfer of water between the north and south portions of the Central Valley, it did not foresee a transfer of water from Northern to Southern California.

2. Central Valley Project - This project is a multi-purpose development designed to supply water for irrigation, municipal, industrial, and other uses; improve navigation on the Sacramento River; provide adequate flows to maintain suitable water quality in the Sacramento-San Joaquin Delta; control floods in the Central Valley; and produce hydroelectric power. The State was unable to obtain funds to begin its construction because of the depression in the early 1930s. Subsequently, it was constructed and is operated by the U. S. Bureau of Reclamation substantially in accord with the State Water Plan as published in Bulletin 25 of the Division of Water Resources and reported to the Legislature in 1931.

3. Feather River Project - The initial unit of the California Water Plan. It provides for a multi-purpose development for firming water supplies, providing flood protection in the Feather River area, generating hydroelectric energy, and exporting surplus water available in the Sacramento-San Joaquin Delta to areas of deficiency in the San Joaquin Valley, San Francisco Bay area, and Southern California, with incidental fish, wildlife, and recreational benefits (1951). Essentially the Feather River Project proposal became the State Water Project of today.

4. California Water Plan - A comprehensive master plan for the control, protection, conservation, distribution, and utilization of the waters of California to meet present and future needs for all beneficial uses and purposes in all areas of the State to the maximum feasible extent (Bulletin 3, 1957). It includes not only state development but federal and local development as well. The State Water Project is but one of the component parts of the California Water Plan.

5. State Water Resources Development System - The California Water Resources Development Bond Act, passed by the Legislature in 1959 and approved by the voters in 1960 (known and cited as the "Burns-Porter Act"), is the financing vehicle for the State Water Resources Development System. This System is comprised of the State Water Facilities as defined in Section 12934(d) of the Burns-Porter Act and such additional facilities as may now or hereafter be authorized by the Legislature as part of (1) the Central Valley Project, or (2) the California Water Plan, and including such other additional facilities as the Department deems necessary and desirable to meet local needs, including flood control, and to augment the supplies of water in the Sacramento-San Joaquin Delta.

6. State Water Project - The term "State Water Project" can be used interchangeably with the State Water Facilities, except that it also includes the additional facilities required to meet depletions in the present project yield. It is a working term adopted by the Department to refer to those works identified in the Burns-Porter Act, Section 12934(d) as the State Water Facilities, plus the aforementioned additional facilities.

7. Additional Facilities - The Burns-Porter Act specifies that the State Water Resources Development System include, in addition to the State Water Facilities, such additional facilities as the Department of Water Resources deems necessary and desirable to augment water supplies in the Delta and to meet local needs including flood control (Water Code Sections 12931 and 12938). These may consist of multi-purpose dams, reservoirs, aqueducts, and appurtenant works in the watershed of the Sacramento, Eel, Trinity, Mad, Van Duzen, and Klamath Rivers.

8. California Water Fund - This fund was created by the 1959 Legislature (Water Code Div. 6, Part 6, Chap. 7, commencing at Sec. 12900) and monies in the then existing Investment Fund were transferred to it. (The Investment Fund had been established by the 1956 Legislature from the State's share of the Long Beach oil revenues.) All revenues received by the State from Long Beach tideland revenues and certain other state lands revenues were designated for deposit in the fund, but these are presently limited to $25,000,000 annually (Calif. Stats. 1964, First Ex. Session, Ch. 138, Sec. 12; Public Resources Code Section 6217).

9. Davis-Dolwig Act - This Act was enacted in 1961 (Water Code Sections 11900-11925) and declares that recreation and fish and wildlife enhancement features of the State Water Project benefit all of the people of California. The Act provides that the people are to bear the costs of these recreation and enhancement features. The Act establishes a procedure through which the Department is reimbursed for the recreation and fish and wildlife expenditures that are financed by Project Funds.

10. Davis-Grunsky Act - The State Water Facilities authorized for construction by the Burns-Porter Act include water development facilities for local areas as provided in the Davis-Grunsky Act (Water Code Div. 6, Part 6, Ch. 5, commencing at Sec. 12880). The Burns-Porter Act authorized the issuance of bonds in the amount of $130 million of the $1.75 billion general obligation bonds authorized to meet expenditures under the Davis-Grunsky Act. These expenditures may take the form of loans, grants, or both to public agencies.

11. Delta Projection Act - The Legislature in 1959 (Water Code Div. 6, Part 4.5, Sections 12200-12220) found that the water problems of the Sacramento-San Joaquin Delta are unique within the State. It declared that a general law cannot be made applicable to the Delta and that the enactment of this Act was necessary for the protection, conservation, development, control, and use of the waters in the Delta for the public good.

DEFINITION OF AGENCIES

Throughout this bulletin, a number of agencies, departments, boards, commissions, and offices are referred to. In order to provide a ready reference as to what they consist of, their interrelationship to each other and their evolution, the following definitions are provided:

1. Department of Public Works - A former department of state government under the control of an executive officer known as the Director of Public Works. Principal divisions included the Division of Architecture, the Division of Contracts and Rights of Way, the Division of Highways, and the Division of Water Resources. The Department was absorbed into the Department of Transportation by Chapter 1253, Statutes of 1972 (Government Code Sections 14000 and 14001).

2. Division of Water Resources - A division of the Department of Public Works (former Government Code Section 14005; former Water Code Section 200). The Division of Water Resources was abolished and its functions transferred to the Department of Water Resources by Chapter 52, Statutes of 1956, First Extraordinary Session (Water Code Sections 120, 123).

3. State Engineer - The State Engineer was Chief of the Division of Water Resources and was appointed by the Director of Public Works (former Water Code Section 201). The position was abolished when the Department of Water Resources was created in 1956.

4. Water Project Authority - This was the authority set up in the Central Valley Project Act (Chapter 1042, Statutes of 1933) to construct and operate the Central Valley Project. It consisted of five members who were the Attorney General, the State Controller, the State Treasurer, the Director of Finance, and the Director of Public Works (former Water Code Section 11400). The Water Project Authority was abolished in 1956 and its functions transferred to the Department of Water Resources (Water Code Section 123).

5. Department of Water Resources - A department of the state government created in 1956. It is in the Resources Agency and under the control of the Director of Water Resources (Water Code Section 120).

6. State Water Resources Board - This Board was created by the State Water Resources Act of 1945, Chapter 1514, Statutes of 1945, to make investigations of the water supplies of the State, to make plans for their development, and to reallocate funds to local agencies for payment of the costs of lands, easements, and rights of way for federal flood control projects (former Water Code Section 12572, et seq.). These functions were transferred to the Department of Water Resources when it was created in 1956 (Water Code Section 123).

7. California Water Commission - The Commission is the continuation of the State Water Resources Board. When the Department of Water Resources was created in 1956, the State Water Resources Board was renamed the State Water Board, which was later changed to California Water Commission to distinguish it from the State Water Rights Board, which also was created in 1956. (Chapter 52, Statutes of 1956, First Extraordinary Session; Water Code Section 150). It is in the Department of Water Resources and has been given various functions to perform.

8. State Water Resources Control Board - A board in the Resources Agency with jurisdiction over water rights and water quality. It was created as the State Water Rights Board in 1956 when the Division of Water Resources was abolished. It succeeded to the powers of the Division of Water Resources with respect to water rights (Chapter 52, Statutes of 1956, First Extraordinary Session). It is now designated the State Water Resources Control Board (Water Code Section 175).

9. Director of Water Resources - The executive officer in control of the Department of Water Resources appointed by the Governor (Water Code Section 120).

10. Resources Agency - An agency of the state government created in 1961 (Stats. 1961, Chapter 2037). It now consists of the State Air Resources Board, the Colorado River Board, the Office of Nuclear Energy, the State Water Resources Control Board, each regional water quality control board, and the following departments: Conservation, Fish and Game, Navigation and Ocean Development, Parks and Recreation, and Water Resources (Government Code Section 12805).

11. Department of Fish and Game - A department of the state government administered through a director (Fish and Game Code Sections 37, 700).

12. Department of Finance - A department of state government under the control of an executive officer known as Director of Finance (Government Code Sections 13000, 13001).

13. Department of Parks and Recreation - A department of state government created in 1961. It is in the Resources Agency and under the control of the Director of Parks and Recreation (Public Resources Code Section 501).

14. Department of Navigation and Ocean Development - A department of state government created in 1970. It is in the Resources Agency and is administered by the Director of Navigation and Ocean Development (Harbors and Navigation Code Sections 50, 50.2; Government Code Section 12805).

15. Wildlife Conservation Board - A state board within the Department of Fish and Game. It is composed of the President of the Fish and Game Commission, the Director of the Department of Fish and Game, and the Director of Finance (Fish and Game Code Section 1320).

SIGNIFICANT LEGISLATION (CALIFORNIA)

Stats. 1927, Ch. 286	State filings for the appropriation of water in aid of a coordinated plan authorized. (Codified in Water Code Section 10500.
Stats. 1929, Ch. 832	Appropriation of funds in furtherance of preparation of a coordinated plan for conservation and development of the water resources of the State.
Stats. 1931, Ch. 720	County of origin law enacted with regard to state filings for the appropriation of water. (Codified in Water Code Section 10505).
Stats. 1933, Ch. 1042 Approved upon referendum by vote of the people at a special election December 19, 1933; effective January 13, 1934.	Central Valley Project Act enacted. (Codified in Water Code, Div. 6, Part 3, commencing at Section 11100.)
Stats. 1941, Ch. 1185	State Water Plan adopted. (Codified in Water Code Section 10000.)
Stats. 1945, Ch. 1514	The State Water Resources Act of 1945. (Codified in Water Code, Div. 6, Part 6, Chapters 1 and 2, commencing at Section 12570.)
Stats. 1951, Ch. 1441	Feather River Project authorized. (Water Code Section 11260.)
Stats. 1951, Ch. 1104	Abshire-Kelly Salinity Control Barrier Act of 1953.
Stats. 1956, Ex. Sess., Ch. 54	Feather River Project modified. (Water Code Section 11260.)
Stats. 1956, Ex. Sess., Ch. 52	Department of Water Resources created. (Water Code Section 120 et seq.)
Stats. 1956, Ex. Sess., Ch. 29	Investment Fund (later renamed California Water Fund) created.
Stats. 1956, Ch. 1	Budget Act of 1956. Included appropriation of $9,350,000 for preparation of plans and acquisition of land for the Feather River Project (Item 419.5).

Stats. 1957, Ch. 15	$25,190,000 appropriated from the Investment Fund to the Department to begin relocation of the Western Pacific Railroad and State Highway Route 21 around Oroville Reservoir.
Stats. 1957, Ch. 600	Budget Act of 1957. Item 417 appropriated from the Investment Fund to the Department $673,000 to study aqueduct routing for delivering water to the Lower San Joaquin Valley and Southern California. In addition, Item 263 appropriated $2,682,418 from the General Fund for water resources studies and preparation of plans.
Stats. 1957, Ch. 2252	North Bay Aqueduct added to State's Central Valley Project (Water Code Sections 11270, 11271); $1,340,000 appropriated from the Investment Fund to the Department for completion of studies and preparation of plans and specifications for the aqueduct.
Stats. 1957, Ch. 2359	Feather River Project modified to exclude from the Upper Feather River Service Area features on the South Fork of the Feather River. (Water Code Section 11260.)
Stats. 1957, Ch. 2092	Abshire-Kelly Salinity Control Barrier Act of 1957 authorized the Department of Water Resources to continue salinity control studies in the Delta.
Stats. 1957, Ch. 2052	Established state policy to provide grants and loans to cities, counties, and districts in aid of construction of projects for water development. (Water Code Section 12880, et seq.)
Stats. 1958, Second Ex. Sess., Ch. 1	Budget Act of 1958. Item 425 appropriated $3,723,672 to the Department of Water Resources from the Investment Fund for preparation of plans and specifications and acquisition of rights of way for the Feather River Project.
Stats. 1958, First Ex. Sess., Ch. 101	Department of Water Resources required to plan recreation development associated with state-constructed water projects. (Water Code Section 345.)
Stats. 1959, Ch. 140	Investment Fund abolished and California Water Fund created. (Water Code Sections 12900-12915.)

Stats. 1959, Ch. 1762 Approved by the voters at the General Election in November 1960	Enacted California Water Resources Development Bond Act, also referred to as the Burns-Porter Act. (Water Code Sections 12930-12942.) Authorized sale of general obligation bonds in the amount of $1,750,000,000 and expenditure of money in the California Water Fund for construction of the State Water Project.
Stats. 1959, Ch. 2043	Feather River Project further modified in accordance with Bulletin No. 78 of the Department entitled "Preliminary Summary Report on Investigation of Alternative Aqueduct Systems to Serve Southern California", dated February 1959. (Water Code Section 11260.)
Stats. 1959, Ch. 2053	California Water Plan adopted. (Water Code Section 10004, et seq.)
Stats. 1959, Ch. 1752	Water Code Sections 12880, et seq. expanded and named the Davis-Grunsky Act.
Stats. 1959, Ch. 2019	The Byrne Act enacted to provide state assistance to local governments where construction of water resources projects financed in whole or in part by the State creates a burden on the local government. (Originally added as Div. 19 to the Water Code, but transferred by Stats. 1963, Ch. 464, to Div. 6, Part 7, Sections 12950-12961.)
Stats. 1959, Ch. 2143	Department of Water Resources authorized to acquire land for recreational development at state-constructed water projects. (Water Code Section 346.)
Stats. 1959, Ch. 1300	Budget Act of 1959. Appropriations from the Investment Fund (California Water Fund) to the Department included $4,136,159 appropriated by Item 382 for investigations, preparation of plans and specifications, and acquisition of rights of way for the Feather River Project; $27,972,000 by Item 383 for acquisition of rights of way for the San Joaquin Valley-Southern California Aqueduct system and for the San Luis Reservoir site; $1,000,000 by Item 383.5 for acquisition of lands for the North Bay Aqueduct; $8,013,000 by Item 384 for construction and land acquisition for the South Bay Aqueduct; $11,883,000 by Item 386 for a bridge over the west branch of the Feather River for railroad and highway relocation around Oroville Dam;

Stats. 1959, Ch. 1300 (Cont'd)	$2,394,000 by Item 387 for construction and land acquisition for the Upper Feather River Dams and Reservoirs; and $13,562,000 by Item 388.1 for construction and land acquisition for Oroville Dam and relocation of the Western Pacific Railroad.
Stats. 1959, Ch. 1698	Appropriated $70,000 to the Department from the California Water Fund to investigate use of electrical power sources from the Pacific Northwest.
Stats. 1959, Ch. 1765	Appropriated from the California Water Fund $200,000 to the Department to investigate water supplies for the Sacramento-San Joaquin Delta and $23,000 for additional salinity control studies and levee construction methods.
Stats. 1959, Ch. 1766	Part 4.5 (commencing at Section 12200) added to Div. 6 of the Water Code to provide for protection of the Sacramento-San Joaquin Delta.
Stats. 1960, Ch. 11	Budget Act of 1960. Appropriations from the California Water Fund to the Department, pending approval of the Burns-Porter Act by the voters in November 1960, included $21,537,721 appropriated by Item 353 for construction and land acquisition at the Oroville site; $8,362,922 by Item 354 for construction of the South Bay Aqueduct; and $4,095,059 by Item 355 for construction of the California Aqueduct.
Stats. 1961, Ch. 867	Davis-Dolwig Act enacted. Declares policy re recreation and fish and wildlife enhancement at state water projects. (Water Code Sections 11900-11925.)
Stats. 1962, First Ex. Sess., Ch. 24	Cameron-Unruh Park and Recreation Bond Act. Authorized $150,000,000 general obligation bonds for park and recreational facilities, including those at state water project reservoirs.
Stats. 1964, First Ex. Sess., Ch. 138	California Water Fund limited to $11,000,000 annually from Long Beach tideland oil and gas revenues.
Stats. 1965, Ch. 991 and 993	Cobey-Porter Saline Water Conversion Law (Water Code Sections 12945-12949) authorized the Department to investigate saline water conversion and, when specifically authorized by the Legislature, to construct and operate saline water conversion facilities.

Stats. 1966, First Ex. Sess., Ch. 27	$5,000,000 annually appropriated from tideland oil and gas revenues for joint costs of state water projects allocated to recreation and fish and wildlife enhancement and separate recreation land costs, in accordance with Davis-Dolwig Act (Water Code Sections 11912-11915.)
Stats. 1966, First Ex. Sess., Ch. 55	California Water Fund limited to $11,000,000 annually from all state lands revenues, including those other than Long Beach. (Public Resources Code Section 6816.)
Stats. 1967, Ch. 1672	First annual cost allocation bill. Provides legislative approval of costs of the State Water Project allocated to recreation and fish and wildlife enhancement and the separate recreation land costs, as provided in Water Code Sections 11912-11915.
Stats. 1967, Ch. 1610	Establishes program for aiding sale of bonds by state water contractors for construction of distribution systems taking water from the State Water Project. (Water Code Sections 12894-12894.2.)
Stats. 1968, Ch. 411	Appropriated an additional $14,000,000 for a total of $25,000,000 annually to the California Water Fund commencing in 1970. The Act also diverted money from the California Water Fund and all accruals that would have been deposited therein until 1972 to the Central Valley Water Project Construction Fund so as to eliminate offset of an equal amount of bond proceeds for use of additional facilities and to permit use of such proceeds on the initial facilities.
Stats. 1968, Ch. 897	Second annual cost allocation bill approved.
Stats. 1968, Ch. 842	Department authorized to make loan commitments to designated water contractors to help them pay for distribution system bonds.
Stats. 1969, Ch. 14	Interest rate ceiling on revenue bonds issued under the Central Valley Project raised from 5½ percent to 6½ percent. (Water Code Section 11731.)
Stats. 1969, Ch. 740	Interest rate ceiling on state general obligation bonds raised from 5 percent to 7 percent and interest rate ceiling on bond anticipation notes eliminated. (Government Code Sections 16731, 16736.)

Stats. 1969, Ch. 741	Interest rate ceiling removed on bond anticipation notes for bonds authorized prior to September 15, 1961, i.e., Burns-Porter Act bonds, and for bonds authorized in the future. (Government Code Section 16737.)
Stats. 1969, Senate Constitutional Amendment No. 26, Res. Ch. 299. Approved by voters at a special election on June 2, 1970	Ratified Stats. 1969, Ch. 740, supra, and authorized Legislature to change bond interest ceiling in the future if bonds cannot be sold at the then existing ceiling.
Stats. 1969, Ch. 663	Third annual cost allocation bill approved.
Stats. 1969, Res. Ch. 298	Requests Director of Water Resources to give 90-day notice to Legislature of all proposed significant changes in Department water supply contracts or in policy determinations thereunder.
Stats. 1969, Res. Ch. 281	Requests Director of Water Resources to report to Legislature after authorizing or adopting any water project or major feature of any water project.
Stats. 1970, Ch. 833	Fourth annual cost allocation bill approved.
Stats. 1970, Ch. 992 and 993	State program for aiding sale of bonds issued by local agencies to finance distribution systems taking water from the State Water Project amended.
Stats. 1970, Ch. 782 Approved by the voters in November 1970	Recreation and Fish and Wildlife Enhancement Bond Act, authorized issuance of $60,000,000 in general obligation bonds for construction of recreation and fish and wildlife facilities at the State Water Project.
Stats. 1970, Ch. 1433 Public Resources Code Secs. 21000-21174	The Environmental Quality Act of 1970.
Stats. 1971, Ch. 371	Fifth annual cost allocation bill approved.
Stats. 1971, Ch. 750	Interest rate ceiling on revenue bonds issued under Central Valley Project Act increased from 6½ percent to 7½ percent. (Water Code Section 11731.)
Stats. 1971, Ch. 758	Authorized Department of Water Resources to agree in a contract with a state agency that payments to be made for joint development of water conveyance and hydroelectric facilities on the west branch of the California Aqueduct

Stats. 1971, Ch. 758 (Cont'd)	shall be made only from funds under the management and control of the state agency derived from revenues from the sale of electric energy and not from funds derived from taxes.
Stats. 1971, Ch. 1068	Department authorized to issue short-term notes for emergency repairs to State Water Project. (Water Code Section 11807.)
Stats. 1971, Ch. 1078	Department authorized to make construction loans to state water contractors for construction of distribution systems taking water from the State Water Project. (Water Code Sections 12894.3-12894.8.)
Stats. 1972, Ch. 1197	Sixth annual cost allocation bill approved.
Stats. 1972, Ch. 1259	California Wild and Scenic Rivers System established.
Stats. 1973, Ch. 584	Seventh annual cost allocation bill approved.

SIGNIFICANT LEGISLATION (FEDERAL)

Act of August 26, 1937, 50 Stat. 844, 850; reauthorized under the Act of October 17, 1940, 54 Stat. 1198, 1199; the Act of October 14, 1949, 63 Stat. 852; the Act of September 26, 1950, 64 Stat, 1036; and the Act of August 27, 1954, 64 Stat. 879; amended by P.L. 91-502, 84 Stat. 1097	Central Valley Project, California, authorized, reauthorized and amended.
Section 204, Flood Control Act of 1958, Public Law 85-500, 85th Congress; 72 Stat. 297	Authorized federal contribution for flood control at Oroville Reservoir.
Section 302, Flood Control Act of 1958, Public Law 85-500, 43 U.S.C. Section 390 b	Water Supply Act of 1958.
Public Law 86-488, 86th Congress; 74 Stat. 156	Authorized Secretary of the Interior to construct the San Luis Unit of the Central Valley Project and to enter into agreements with the State with respect to the construction and operation of such unit.
Sec. 203, Flood Control Act of 1962, Public Law 87-874, 87th Congress; 76 Stat. 1173	Authorized federal contribution for flood control at Del Valle Reservoir.
Public Law 91-190, 42 U.S.C. Sections 4321-4347	National Environmental Policy Act.

SIGNIFICANT COURT DECISIONS
STATE WATER PROJECT

The Metropolitan Water District of Southern California v. Marquardt, (1963) 59 C.2d 159, 379 P.2d 28.

Upheld validity of the Burns-Porter Act and provisions of the water service contract between the State and the District.

Warne v. Harkness, (1963) 60 C.2d 579, 387 P.2d 377.

Upheld the authority to issue revenue bonds pursuant to the Central Valley Project Act to finance Oroville power facilities.

California Water Resources Development Finance Committee v. Betts, (1963) 60 C.2d 595, 387 P.2d 387.

Companion case to Warne v. Harkness.

APPENDIX E

PROJECT AWARDS, ENGLISH TO METRIC CONVERSIONS AND PROJECT STATISTICS

APPENDIX E

PROJECT AWARDS

Actions and events with respect to receipt of awards by the State Water Project or units of the Project are summarized below.

1974 -- The San Joaquin Valley section of the California Aqueduct Bikeway was incorporated into the National Recreation Trail System. The award was presented by the Regional Director of the U. S. Bureau of Outdoor Recreation, Department of the Interior. This designation means that the Bikeway is an "outstanding trail worthy of national recognition".

1972 -- The American Society of Civil Engineers selected the California State Water Project for "The ASCE Outstanding Civil Engineering Award for 1972" for its contribution to the well-being of people and communities, the resourcefulness in planning and solving design problems, the pioneering use of materials and methods, its innovations in construction, in unusual aspects, and in esthetic values.

This award is presented annually to that engineering project which best demonstrates the greatest engineering skill and which represents the greatest contribution to civil engineering and to mankind.

1972 -- The Steel Plate Fabricators Association named the Tehachapi Discharge Lines as the winner of the Steel Pipeline of the Year Award.

1971 -- The National Society of Professional Engineers named the State Water Project as one of the nation's top ten engineering achievements in 1971.

1971 -- Two units of the State Water Project were singled out by the American Public Power Association in its biennial awards program for utility design.

The Association's First Honor Award, the highest made, went to the Delta Pumping Plant, and an Honor Award went to the Oroville-Thermalito hydroelectric power complex.

1969 -- The American Society of Civil Engineers selected the State Water Project's Oroville Dam and Edward Hyatt Powerplant as the "Outstanding Engineering Achievement of 1969".

Oroville Dam is the key conservation unit of the State Water Project, and the Edward Hyatt Powerplant is the largest underground powerplant in the United States.

1968 -- The South Fork Feather River Bridge, opened on October 19, 1967, was selected for the "Award of Merit" by the American Institute of Steel Construction in the long span category. The bridge has been acclaimed as one of America's most beautiful bridges.

The prize-winning bridge was designed and built by the Department of Water Resources as a unit of the Oroville Division of the State Water Project.

This award recognizes the imaginative and esthetic use of fabricated structural steel.

1967 -- Oroville Dam was named by the California Society of Professional Engineers as one of the seven wonders of engineering in California for 1967.

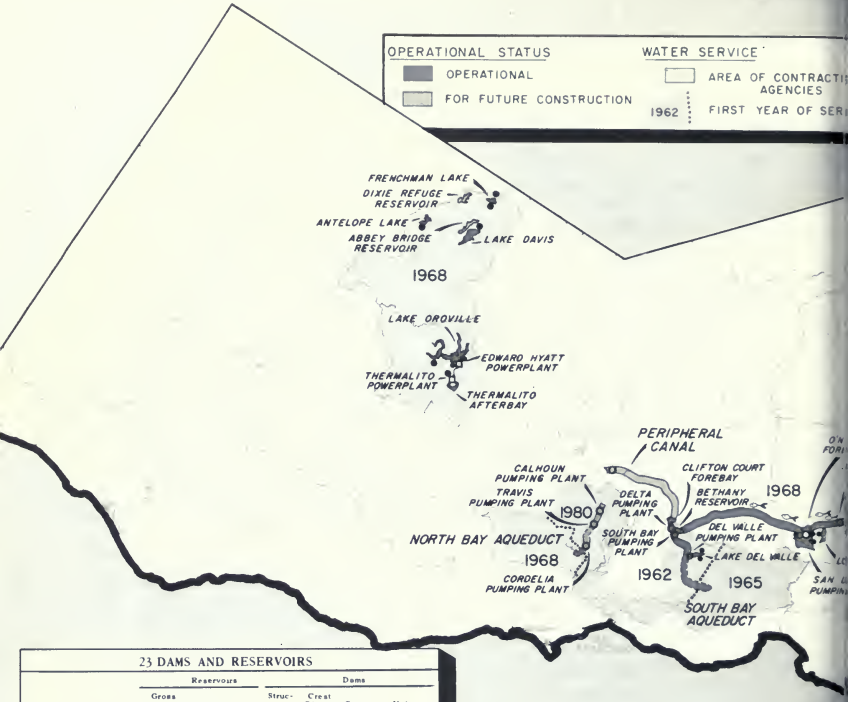
The successful completion of this great structure is a tribute to the capability of the many professional engineers who worked on its design and construction.

Additionally, there have been individual and collective awards presented to the staff and employees of the Department by outside organizations in recognition of their contributions and talents in planning, designing, and constructing the State Water Project.

CONVERSION FACTORS

English to Metric System of Measurement

Quantity	English unit	Multiply by	To get metric equivalent
Length	inches	2.54	centimeters
	feet	30.48	centimeters
		0.3048	meters
		0.0003048	kilometers
	yards	0.9144	meters
	miles	1,609.3	meters
		1.6093	kilometers
Area	square inches	6.4516	square centimeters
	square feet	929.03	square centimeters
	square yards	0.83613	square meters
	acres	0.40469	hectares
		4,046.9	square meters
		0.0040469	square kilometers
	square miles	2.5898	square kilometers
Volume	gallons	3,785.4	cubic centimeters
		0.0037854	cubic meters
		3.7854	liters
	acre-feet	1,233.5	cubic meters
		1,233,500.0	liters
	cubic inches	16.387	cubic centimeters
	cubic feet	0.028317	cubic meters
	cubic yards	0.76455	cubic meters
		764.55	liters
Velocity	feet per second	0.3048	meters per second
	miles per hour	1.6093	kilometers per hour
Discharge	cubic feet per second or second-feet	0.028317	cubic meters per second
Weight	pounds	0.45359	kilograms
	tons (2,000 pounds)	0.90718	tons (metric)
Power	horsepower	0.7460	kilowatts



23 DAMS AND RESERVOIRS

Name of Reservoir	Reservoirs: Gross Capacity[1] (Acre-feet)	Reservoirs: Surface Area (acres)	Reservoirs: Shoreline (miles)	Dams: Structural Height (feet)	Dams: Crest Elevation[2] (feet)	Dams: Crest Length (feet)	Dams: Volume (cubic yards)
Frenchman Lake	55,477	1,580	21	139	5,607	720	537,000
Antelope Lake	22,566	931	15	120	5,025	1,320	360,000
Lake Davis	84,371	4,026	32	132	5,785	800	253,000
Abbey Bridge	45,000	1,950	21	117	5,475	1,150	500,000
Dixie Refuge	10,000	900	15	100	5,754	1,050	400,000
Lake Oroville	3,537,577	15,805	167	770	922	6,920	80,000,000
Thermalito Diversion Pool	13,328	323	10	143	213	1,300	154,000
Fish Barrier Pool	580	52	1	91	181	600	10,500
Thermalito Forebay	11,768	630	10	91	231	15,900	1,840,000
Thermalito Afterbay	57,041	4,302	26	39	142	42,000	5,020,000
Clifton Court Forebay	28,653	2,109	8	30	14	38,500	2,440,000
Bethany	4,804	161	6	121	250	3,940	1,400,000
Lake Del Valle	77,100	1,060	16	235	773	880	4,150,000
San Luis	2,038,771	12,700	65	385	554	18,600	77,645,000
O'Neill Forebay	56,426	2,700	12	88	233	14,150	3,000,000
Los Banos	34,562	823	12	167	384	1,370	2,100,000
Little Panoche	13,230	334	10	152	676	1,440	1,210,000
Buttes	21,800	380	6	190	2,790	2,230	3,130,000
Silverwood Lake	74,970	976	13	249	3,378	2,230	7,600,000
Lake Perris	131,452	2,318	10	128	1,600	11,000	20,000,000
Pyramid Lake	171,196	1,297	21	400	2,606	1,090	6,860,000
Elderberry Forebay	28,231	460	7	200	1,530	1,990	6,000,000
Castaic Lake	323,702	2,235	29	425	1,533	4,900	46,000,000
Totals	6,846,617	38,072	533			172,860	270,629,500

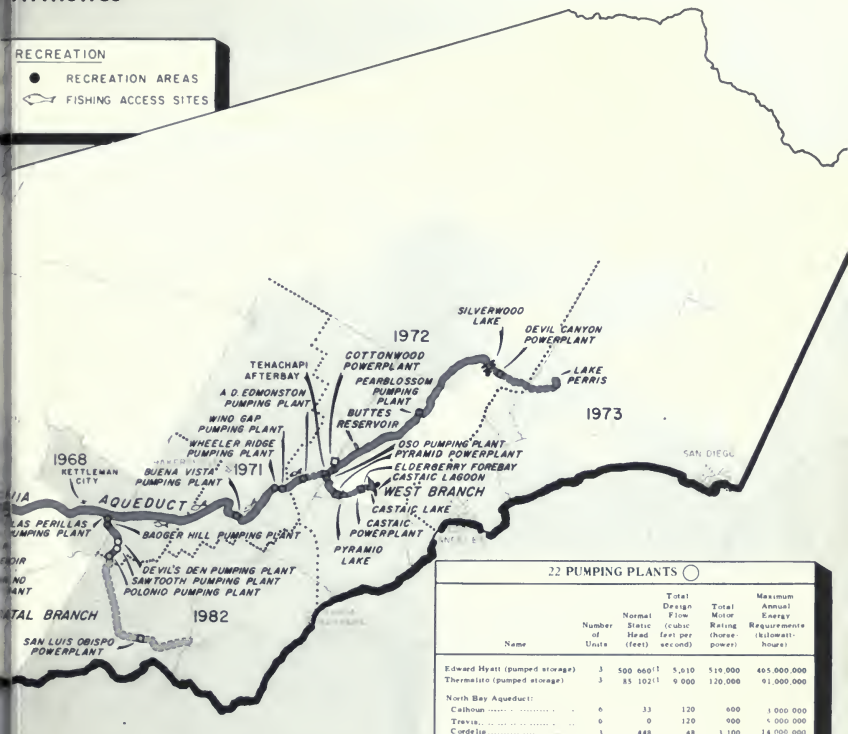
1) At maximum normal operating level

2) Above sea level

AQUEDUCTS

Name	Length (miles): Total	Canal	Pipeline	Tunnel	Channel and Reservoir
North Bay Aqueduct	26.3	14.3	12.2	0	0
South Bay Aqueduct	42.9	6.4	32.0	1.6	2.9
Peripheral Canal	43.0	42.0	1.0	0	0
Subtotal	112.4	64.7	46.1	1.6	0
California Aqueduct (main line):					
Delta to O'Neill Forebay	68.4	67.0	0	0	1.4
O'Neill Forebay to Kettleman City	105.7	103.5	0	0	2.2
Kettleman City to A. D. Edmonston Pumping Plant	120.9	120.9	0	0	0
A. D. Edmonston Pumping Plant thru Tehachapi Afterbay	10.5	0.2	2.3	7.6	0
Tehachapi Afterbay thru Lake Perris	138.4	63.4	38.3	3.8	2.9
Subtotal, main line	444.0	365.0	40.5	11.7	6.3
California Aqueduct (branches):					
West Branch	31.0	9.1	8.4	7.2	6.2
Coastal Branch	46.2	14.8	31.4	0	0
Subtotal, branches	128.1	23.9	47.8	7.2	6.2
Totals	684.3	473.8	176.7	20.5	13.7

STATISTICS



8 POWERPLANTS

Name	Number of Units	Normal Static Head (feet)	Total Design Flow (cubic feet per second)	Power Generator Output (kilowatts)	Maximum Annual Energy Output (kilowatt-hours)
Edward Hyatt	6	418 878[1]	14,550	678,750	2,475,000,000
Thermalito	4	85 100[1]	18,900	119,600	383,000,000
San Luis					
Total	8	99 327[1]	13,120	424,000	
State Share			9,872	222,100	170,000,000
Cottonwood	2	140	1,617	14,000	114,000,000
Devil Canyon	2	1,414	1,200	114,100	1,003,000,000
Pyramid	2	740	3,100	157,000	1,001,000,000
Castaic					
Total	7	1,063	18,400	1,260,000	
State Share[2]			3,092	216,000	1,457,000,000
San Luis Obispo	1	738	111	5,900	41,000,000
Total, State Share					3,645,000,000

1) Minimum and maximum static heads

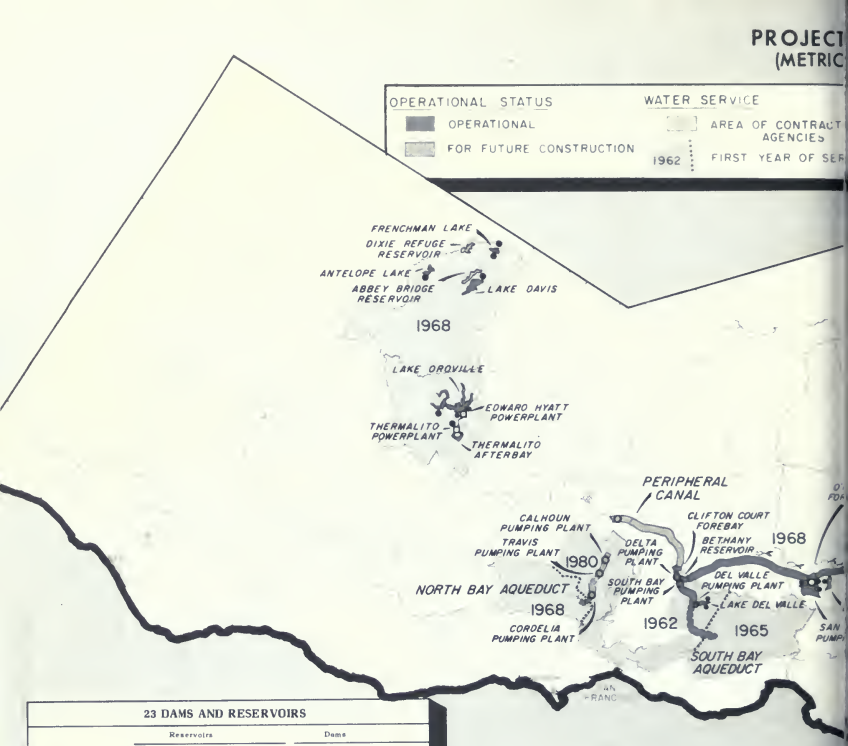
2) The City of Los Angeles Department of Water and Power will construct and operate a 1,250,000-kilowatt Castaic Powerplant and will supply the Project with electrical power and energy equivalent to the generation from a 213,984-kilowatt powerplant the State originally planned to construct

22 PUMPING PLANTS

Name	Number of Units	Normal Static Head (feet)	Total Design Flow (cubic feet per second)	Total Motor Rating (horsepower)	Maximum Annual Energy Requirements (kilowatt-hours)
Edward Hyatt (pumped storage)	3	500 660[1]	5,010	510,000	405,000,000
Thermalito (pumped storage)	3	85 102[1]	9,000	120,000	91,000,000
North Bay Aqueduct:					
Calhoun	6	33	120	900	1,000,000
Travis	6	0	120	900	1,000,000
Cordelia	3	448	48	3,100	14,000,000
South Bay Aqueduct:					
South Bay	9	545	330	27,750	106,000,000
Del Valle	4	0 381[2]	120	1,000	2,000,000
California Aqueduct (main line):					
Delta	11	244	10,303	333,000	1,355,000,000
San Luis					
Total	8	99 327[2]	11,000	504,000	
State Share			9,762	264,000	313,000,000
Dos Amigos					
Total	6	113	13,200	240,000	
State Share			7,100	130,000	807,000,000
Buena Vista	10[3]	204	5,040	136,000	746,000,000
Wheeler Ridge	9[3]	233	4,598	140,000	797,000,000
Wind Gap	9[3]	518	4,410	308,000	1,761,000,000
A.D. Edmonston	14[3]	1,926	4,095	1,040,000	5,916,000,000
Pearblossom	6	540	1,380	113,200	647,000,000
California Aqueduct (branches):					
Oso	8	231	3,128	93,800	446,000,000
Las Perillas	6	55	450	4,050	20,000,000
Badger Hill	6	151	450	10,500	56,000,000
Devil's Den	4	409	126	8,000	51,000,000
Sawtooth	4	331	126	6,500	41,000,000
Polonio	4	810	126	16,000	101,000,000
Peripheral Canal					
Total	9[3]	10	21,800	15,200	
State Share			10,900	[illegible] 440	88,000,000
Total, State Share					13,641,000,000

1) Minimum and maximum total pumping heads
2) Minimum and maximum static heads
3) Includes one spare unit

PROJECT
(METRIC



23 DAMS AND RESERVOIRS

Name of Reservoir	Reservoirs: Gross Capacity[1] (millions of cubic meters)	Reservoirs: Surface Area (hectares)	Dams: Shoreline (kilometers)	Dams: Structural Height (meters)	Dams: Crest Elevation[2] (meters)	Dams: Crest Length (meters)	Dams: Volume (cubic meters)
Frenchman Lake	68.43	630	33.6	42	1709	219	410,600
Antelope Lake	27.64	377	24.1	37	1532	402	290,500
Lake Davis	104.07	1,629	51.5	40	1763	244	193,400
Abbey Bridge	55.51	749	33.8	36	1669	351	362,300
Dixie Refuge	19.74	364	24.1	30	1754	320	305,800
Lake Oroville	4,363.00	6,306	268.8	235	261	2,109	61,104,000
Thermalito Diversion Pool	16.44	131	16.1	44	71	396	117,700
Fish Barrier Pool	0.72	21	1.6	26	55	183	8,000
Thermalito Forebay	14.52	255	16.1	28	70	4,846	1,406,800
Thermalito Afterbay	70.36	1,741	41.8	12	43	12,602	3,836,000
Clifton Court Forebay	35.34	853	12.9	9	4	11,125	1,865,500
Bethany	5.93	65	9.7	37	76	1,201	1,070,300
Lake Del Valle	95.11	420	25.8	72	236	268	3,172,900
San Luis	2,514.82	5,140	104.6	117	160	5,669	59,363,500
O'Neill Forebay	69.60	1,093	19.3	27	71	4,374	2,293,700
Los Banos	42.63	252	19.3	51	117	416	1,605,600
Little Panoche	16.33	143	16.1	46	206	430	925,100
Buttes	26.89	235	9.7	58	650	680	2,303,000
Silverwood Lake	92.48	385	20.9	76	1,030	680	5,810,600
Lake Perris	162.15	938	16.1	39	468	3,538	15,291,000
Pyramid Lake	211.17	525	33.8	122	794	332	5,244,800
Elderberry Forebay	34.82	186	11.3	81	472	607	4,587,300
Castaic Lake	398.29	004	96.7	130	468	1,494	35,169,300
Totals	8,447.79	23,500	857.9			52,694	206,909,700

1/ At maximum normal operating level.
2/ Above sea level.

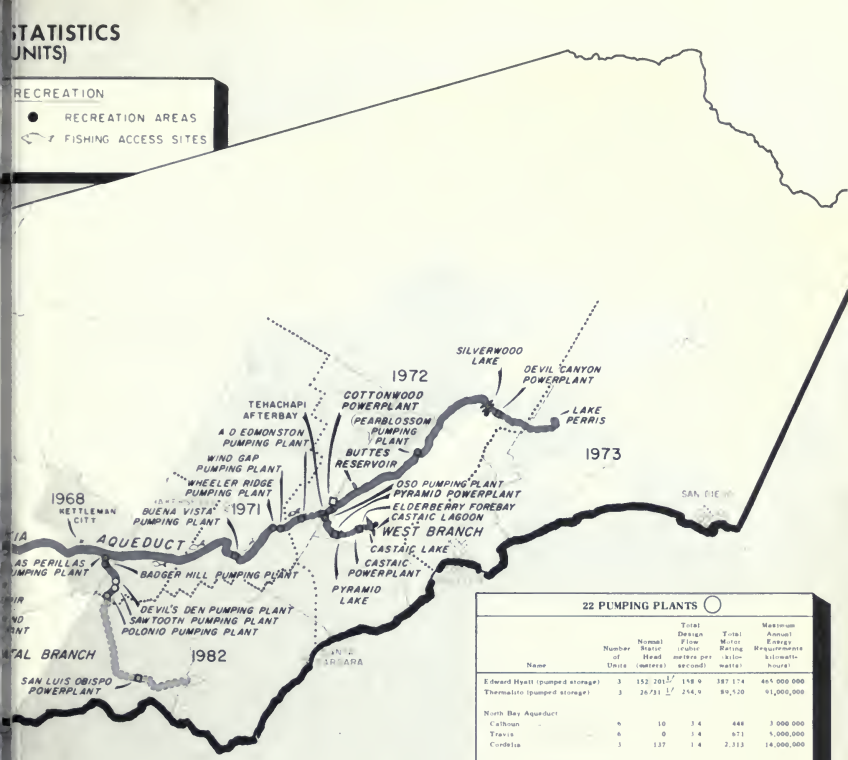
AQUEDUCTS

Name	Length - kilometers: Total	Canal	Pipeline	Tunnel	Channel and Reservoir
North Bay Aqueduct	42.6	23.0	19.6	0	0
South Bay Aqueduct	66.1	13.5	53.0	2.6	8
Peripheral Canal	69.2	67.6	1.6	0	0
Subtotal	180.9	104.1	74.2	2.6	0
California Aqueduct (main line): Delta to O'Neill Forebay	110.1	107.8	0	0	2.3
O'Neill Forebay to Kettleman City	170.1	166.6	0	0	3.5
Kettleman City to A.D. Edmonston Pumping Plant	194.4	194.4	0	0	0
A.D. Edmonston Pumping Plant thru Tehachapi Afterbay	17.9	0.3	4.0	12.7	0
Tehachapi Afterbay thru Lake Perris	222.7	140.3	61.6	6.1	4.7
Subtotal, main line	714.5	616.6	65.6	18.8	10.5
California Aqueduct (branches): West Branch	51.3	14.6	10.3	11.6	14.8
Coastal Branch	154.8	23.8	131.0	0	0
Subtotal, branches	206.1	38.4	141.3	11.6	14.8
TOTALS	1,101.5	763.1	281.1	33.0	25.3

STATISTICS (UNITS)

RECREATION

- RECREATION AREAS
- FISHING ACCESS SITES



22 PUMPING PLANTS

Name	Number of Units	Normal Static Head (metres)	Total Design Flow (cubic metres per second)	Total Motor Rating (kilowatts)	Maximum Annual Energy Requirements (kilowatt-hours)
Edward Hyatt (pumped storage)	3	152.201/	148.9	387 174	465 000 000
Thermalito (pumped storage)	3	26/31 1/	254.9	89,520	91,000,000
North Bay Aqueduct					
Calhoun	6	10	3 4	448	3 000 000
Travis	6	0	3 4	671	5,000,000
Cordelia	3	137	1 4	2,313	14,000,000
South Bay Aqueduct					
South Bay	9	166	9 1	20,702	166,000,000
Del Valle	4	0/12 2/	3 4	746	2,000,000
California Aqueduct (main line)					
Delta	11	76	291 8	248 418	1,355,000,000
San Luis					
Total	8	30/100 2/	331.5	375,984	
State Share			163.2	196,944	113,000,000
Dos Amigos					
Total	5	34	373 8	179 040	
State Share			201 1	96 980	607 000 000
Buena Vista	10 3/	62	143.0	101,496	240,000,000
Wheeler Ridge	6 3/	71	130 2	104 440	247 000 000
Wind Gap	6 3/	158	124 9	229,768	1,761,000,000
A D Edmonston	14 3/	487	116 0	775 840	5 910,000,000
Pearblossom	6	165	30 1	84 447	547 000 000
California Aqueduct (branches)					
Oso	8	70	86 6	69 675	446 000 000
Las Perillas	6	17	12 7	3 021	20 000 000
Badger Hill	6	96	12 7	7 851	50 000 000
Devil's Den	4	125	3 5	5,968	41,000,000
Sawtooth	4	101	3 5	4,845	41,000,000
Polonio	4	24*	3 5	11 936	101 000 000
Peripheral Canal					
Total	9	1	41* 1	26,259	
State Share			10a *	13 810	48 000 000
Total, State Share					11 681 000 000

1/ Minimum and maximum total pumping heads
2/ Minimum and maximum static heads
3/ Includes one spare unit

8 POWERPLANTS

Name	Number of Units	Normal Static Head (metres)	Total Design Flow (cubic meters per second)	Power Generator Output (kilowatts)	Maximum Annual Energy Requirements (kilowatt-hours)
Edward Hyatt	5	129/206 1/	412.0	678 750	2 474 000,000
Thermalito	4	26/38 1/	478.8	119,600	383,000,000
San Luis					
Total	8	38/100 1/	371.8	424,000	
State Share			194.6	222,100	170,000,000
Cottonwood	1	43	46 4	35,000	115,000,000
Devil Canyon	2	433	34 0	119,700	1 003,000,000
Pyramid	2	228	87 8	157 000	1 081,000 000
Castaic					
Total	7	324	521 0	1,250,000	
State Share 2/			87 6	214,000	1,457,000,000
San Luis Obispo	1	223	3 1	4 900	41 000 000
Total State Share					6 645,000 000

1/ Minimum and maximum static heads

2/ The City of Los Angeles Department of Water and Power will construct and operate a 1,250 000-kilowatt Castaic Powerplant and will supply the Project with electrical power and energy equivalent to the generation from a 213 984-kilowatt powerplant the State originally planned to construct

APPENDIX F

ADDITIONAL POSITIONS OF RESPONSIBILITY, DEPARTMENT OF WATER RESOURCES AND CONSULTANTS

APPENDIX F

POSITIONS OF RESPONSIBILITY

Positions of responsibility in the Department of Water Resources, in addition to those shown immediately following the FOREWORD of this volume, were held by the following individuals. Only the highest position held is reflected in this listing. The time in that position is shown by the years following the name of the individual.

Chief Engineer	Alfred R. Golze'	1961-1967
Assistant Chief Engineer	Wesley E. Steiner	1966-1967
	John R. Teerink	1961-1967
Division Engineer or Division Chief*	Paul L. Barnes*	1957-1963
	William L. Berry	1956-1964
	Clifford J. Cortright	1973-
	J. Kenneth Cummings	1964-1972
	Haywood G. Dewey, Jr.	1959-
	Herbert W. Greydanus	1969-
	Robert B. Jansen	1968-1971
	Thomas H. T. Morrow*	1963-
	Robin R. Reynolds	1961-1968
	Walter G. Schulz	1956-1959
	Clyde E. Shields	1972-1973
	Edward J. Terhaar	1973-
	Jeff A. Wineland	1971-1972
Deputy Division Engineer	James J. Doody	1973-
	Donald P. Thayer	1965-1969
Assistant Division Engineer	Charles H. Carter	1962-1967
	John W. Keysor	1974-
	Theodore Neuman	1956-1961
Chief Counsel	Porter A. Towner	1957-
Comptroller	Peter D. Mysing	1970-
	Donald A. Sandison	1961-1969
Financial Adviser	John E. Hunt	1959-1971
Chief Geologist	Laurence B. James	1959-

District Engineers	Max Bookman	1956-1959
	Jack J. Coe	1973-
	Albert J. Dolcini	1971-
	Gordon W. Dukleth	1964-1971
	William R. Gianelli	1959-1960
	John M. Haley	1961-1964
		1970-1973
	Herbert A. Howlett	1961-1962
	Charles A. McCullough	1961-1968
	Carl L. Stetson	1961-
	Carl A. Werner	1961-1970

CONSULTANTS

Several major consulting boards were employed by the Department to advise on various engineering aspects of the State Water Project. These boards were composed of men, acknowledged to be experts in their fields, who could bring to the Project many years of experience gained from their work on other major water projects around the world.

A number of these boards have been in existence for several years, and some of their activities continued into 1974. Members of the boards and a summary of their basic charge to comment and recommend on the design and construction of specific features of the State Water Project follow.

Board of Consultants on Alternative Aqueduct Routes to Southern California

Mr. Adolph Ackerman
Mr. A. H. Ayers
Mr. John S. Longwell
Mr. Carl Rankin
Mr. Roger Rhoades
Dr. Ralph A. Tudor
Mr. David Weeks

The Board assisted and reviewed studies by the Department directed toward selection of the best route or combination of routes to convey Northern California water from the Kings-Kern county line to Southern California. The Board was requested to:

(a) determine probable future water requirements.

(b) determine probable time when water from Northern California will be required.

(c) designate areas to be served by the aqueduct system to Southern California.

(d) select the most favorable aqueduct system.

Control System Consulting Board

Mr. Theodor H. Braun
Mr. John Clabby
Mr. Russell Homberger
Mr. Edward W. Messinger

The Board reviewed and passed judgment on the plans and design for the State Water Project's control system and other telemetry and control requirements of the Department.

Earth Dams Consulting Board

Mr. Wallace L. Chadwick
Mr. Julian Hinds
Mr. Roger Rhoades
Dr. Phillip C. Rutledge
Mr. B. E. Torpen

The Board advised the Department's engineers with regard to design and construction of earthfill dams.

Earthquake Analysis Board

Dr. Clarence Allen
Dr. Hugo Benioff
Dr. John Blume
Dr. Bruce Bolt
Dr. George Housner
Dr. H. Bolton Seed
Dr. James.L. Sherard
Mr. Nathan D. Whitman

The Board advised the Department concerning the evaluation of seismic effects to be anticipated at any given site or area and on the development of rational procedures for seismic design in regard to hydraulic structures.

Oroville Dam Consulting Board

Mr. A. H. Ayers
Mr. John Hammond
Mr. Raymond A. Hill
Mr. J. Donovan Jacobs
Mr. Thomas A. Lang
Mr. Roger Rhoades
Dr. Phillip C. Rutledge
Mr. Byram W. Steele
Mr. B. E. Torpen

The Board advised the Department's engineers in the fields of design and construction criteria for Oroville Dam and appurtenances.

Tehachapi Crossing Consulting Board

Major General John R. Hardin, Ret.
Mr. Russell Hornberger
Mr. Thomas Leps
Mr. Elmer C. Marliave
Dr. Frank A. Nickell
Mr. John Parmakian
Mr. Louis Puls
Mr. Robert Sailer

The Board advised the Department's engineers on the design and construction of the Tehachapi Crossing. The Tehachapi Crossing, insofar as the Board's assignment was concerned, extends from the Buena Vista Pumping Plant on the California Aqueduct to Castaic Reservoir outlet works at the end of the West Branch but excludes both Pyramid and Castaic Dams. Their assignment also included the Pearblossom Pumping Plant, Devil Canyon Powerplant, and the San Bernardino Tunnel on the East Branch of the California Aqueduct.

In addition to the foregoing boards, Dillon, Read and Co., Inc. represented by principal staff of Messrs. John F. Fowler, Robert E. Christie, and Harold Ostergren advised and assisted the Department extensively through the years in effecting the financing and financial structure that had such a significant impact on the State Water Project.

Likewise, Arthur Young & Company carried out a major role in developing the accounting system, aiding in its implementation, and refining it in the light of changing requirements, to meet the myriad demands of the State Water Project, one of the most complex utility operations in the world.

It is important to recognize that in addition to the major consulting boards and firms identified herein, individuals numbering in the hundreds, as well as significant numbers of additional major firms and specialized consulting boards,contributed extensively of their talents and services in effecting the planning, financing, design, construction, and operation of the State Water Project.

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