WATER
PROGRESS IN CALIFORNIA
July 1, 1962-June 30, 1965
Calif. Dept. of Water Resources

Water

BULLETIN No. 151-65

Progress in California

July 1, 1962—June 30, 1965

October 1965

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...AM E. WARNE
Director
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Governor Edmund G. Brown and William E. Warne, Director, Department of Water Resources.

"TODAY WE HAVE KEPT another promise and we have reached another milestone in California History. Today we dedicated the first completed aqueduct of the greatest water project in the history of man."—Governor Edmund G. Brown, on July 1, 1965, dedication day for the South Bay Aqueduct, State Water Project.

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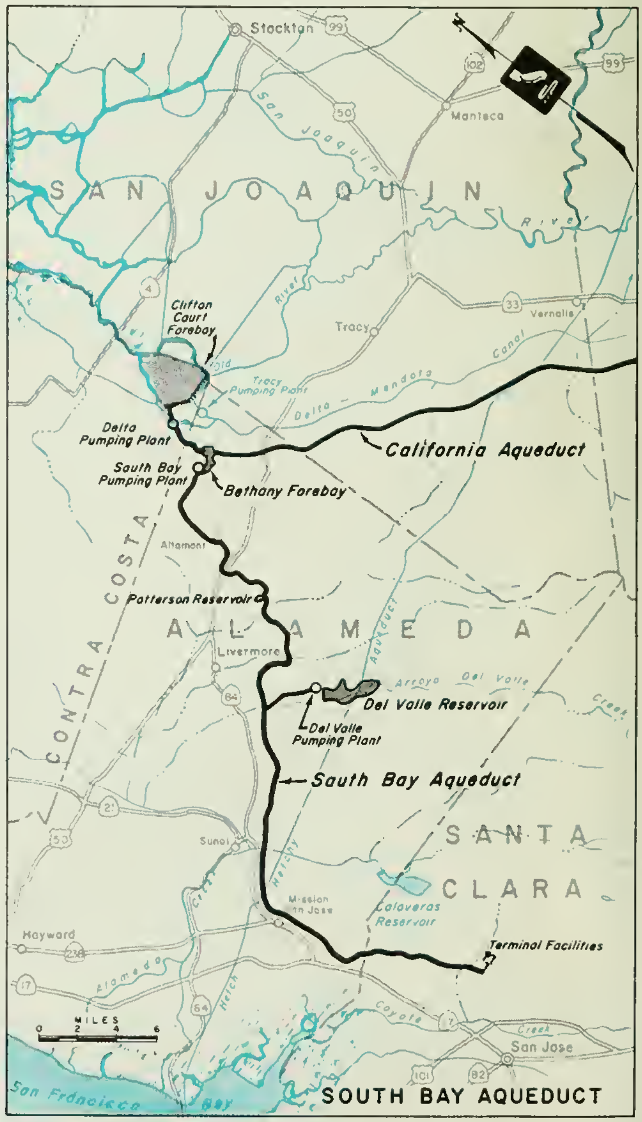


Three Years' Achievement

In 1956, the staff of the newly created Department of Water Resources numbered 450 persons, of whom 250 were engineers. Today, that same staff numbers some 3,260 persons, 1,000 of whom are engineers. In 1956, the Department was an organization with plans. Today, those plans are the roar and dust of rising earthworks and the quiet flow of water in lengthening aqueducts.

In building the largest single water development ever undertaken in the United States, the Department of Water Resources has become one of the most efficient construction organizations anywhere.

It has become so by in-the-field experience gained most dramatically during the three-year period from July 1, 1962 through June 30, 1965. Rising at either end of this period are milestones in the history of a State Water Project which is attracting worldwide attention.

Milestone one: construction of Oroville Dam embankment begins in July 1962.

Milestone two: in June 1965 construction of the South Bay Aqueduct ends; water for the first time flows throughout its length.

Between these milestones men and machines have been at work—and on schedule—building State Water Project facilities to meet the water needs of Californians, to control floods, to generate power, and to create new recreational opportunity. With a project of this magnitude—17 dams, 676 miles of aqueduct and pipeline, 9 powerplants, 18 pumping plants—engineering challenges of corresponding magnitude are encountered.

- The challenge of constructing the enormously complex Oroville-Thermalito reservoir and power facilities is being met today.

- The challenge, discussed for decades, of transporting pure, wholesome water across the Sacramento-San Joaquin Delta while satisfying the needs of the people of the Delta will be met by a canal skirting the Delta.

- The challenge of soil subsidence in the San Joaquin Valley—the danger that such subsidence might undermine the California Aqueduct—has been met where necessary along the aqueduct alignment by ponding water to consolidate the soils prior to construction and by providing extra freeboard in the aqueduct.

- The challenge of planning the crossing of the Tehachapi Mountains, of meeting the threat of earthquake and landslide, of pumping a river of water almost 2,000 feet uphill has been met and mastered by DWR engineers.

- The challenge of operating the aqueduct, of simultaneously controlling the 18 pumping plants which will help keep this man-made river moving, will be met by a remote control system adaptable to computer control.

Construction of the San Luis Pumping-Generating Plant began in February 1963. That of Dos Amigos Pumping Plant began in September of the same year; and that of the Delta Pumping Plant, in August 1964. By mid 1965, the Delta plant was 17 percent complete; the Dos Amigos, 52 percent complete; and the San Luis, 70 percent complete.

By 1968, water will flow from the Delta to a point about 50 miles south of Kettleman City; the northern half of the California Aqueduct will be complete.

By 1972, the finished aqueduct will deliver water to Riverside County in Southern California.

Construction of the State Water Project, enormous though the task be, is only a small part of the activities of the Department of Water Resources. The Department today must assure the availability of water for generations tomorrow. Its planning studies have taken it deeply into the fields of waste water reclamation, desalination, and ground water basin management.

Plans for the further development of surface waters are equally important. In 1964 for example, the Department completed a seven-year long-range planning study of the north coast. One result was the selection of a site for the initial north coastal conservation facility of the State Water Project. This will be the Upper Eel River Development. This will be followed by projects in the Trinity River, the Lower Eel River, and the Klamath River—projects which will carry into the next century. The plans for that century are being laid today.

William E. Warne

WILLIAM E. WARNE
Director of Water Resources

PLANNING

Major water development projects do not rise overnight. Planning by water resources engineers probes a tomorrow twenty-five years away. More people will require more water.

How many more people?

How much more water?

To find out, water resources engineers collect facts. Distribution of rainfall, depth of snow in the mountains, quality of ground water, amount of evaporation loss from reservoir surfaces—the relation of such facts to problems of water development is clear.

Other facts, more diverse, are equally important: the number of salmon returning to spawn in the Eel River, the number of water skiers in the Delta on the first Sunday in July, the distance boaters travel to use Antelope Lake and the extent of earth movement along the San Andreas Fault.

Electronic Computers

The volume and variety of fact which must be analyzed to determine the best ways to meet the water needs of the future is enormous. Pressed by the complexities of developing its vast State Water Project—the planning, the designing, the scheduling, the construction—the Department of Water Resources finds itself a pioneer in the civil engineering use of electronic computers to process facts. Facts stored on magetnic tape or on punched cards are retrieved quickly and accurately by computer, and in whatever order required.

Staged Development

The Department of Water Resources is using its estimates of the buildup of demand for water to plan the staged development of water projects. Such planning permits the wise scheduling of water projects proposed by the Department and by federal agencies.

State and federal agencies will have to construct the great bulk of future water projects in California. Water resources planners state that most low-cost water projects near water deficient areas already are built. Necessary now are larger, more costly export developments like the State Water Project. Construction of such developments is beyond the financial capability of most local agencies alone. By 2020, water development systems constructed by the Department of Water Resources and by federal agencies will supply more than half of California's water requirements.

The population of California will have tripled by 2020. The demand for water will have increased by 60 percent. And in 50 years, California will use ten times the electrical power it uses today.

Engineers predict that 80 percent of this power will be provided by nuclear energy.

Department of Water Resources planners have proposed construction of a nuclear plant to power the pumps of the California Aqueduct, construction of nuclear plants to convert saline water to fresh water, and consideration of the use of nuclear explosives to excavate waterway cuts.

Nuclear Powerplant

The Atomic Energy Commission (AEC) forecasts spectacular gains in energy conservation through use by California of a plant using a thorium seed-blanket nuclear reactor to generate power for the State Water Project. The reactor, known as a convertor, breeds fuel—will produce new fuel at the same time energy is released for electrical generation. Experimental fuel assemblies will demonstrate that the conversion process will produce more fuel than it consumes. The United States, through AEC, will pay part of the cost. This nuclear powerplant will further reduce the cost of water delivered to Southern California.

In mid 1965, the Department selected five areas for possible construction of such a powerplant. Four of these areas are coastal—those near Cayucos in San Luis Obispo County, near Oxnard and at the mouth of Big Spring Canyon in Ventura County, and in Corral Canyon in Los Angeles County. At any of these sites, a nuclear plant could provide the heat required for sea water desalination. The fifth possible area, inland near the Kern County site of the Tehachapi Pumping Plant, would put the power source close to the pumps and would require only short transmission lines. The Department will pick the site most acceptable from every standpoint.

Nuclear Excavation

One of the possible water development features in California which might use nuclear explosives for excavation would be the Westside Conveyance System, a series of reservoirs and interconnecting channels in Shasta and Tehama Counties (see map, rear cover). The 40-mile-long system, to be located some 20 miles west of Highway 99 as it proceeds through Redding, Red Bluff, and Corning, would convey water imported into the Cottonwood Creek Basin from north coastal streams to the Glenn Reservoir Complex (see map, page v). This is considered a probable route for any Klamath River water needed to supplement State Water Project deliveries.

PLANNING

PLANNING

The required conveyance channels would be deep and long. They might be excavated by nuclear explosives more easily and cheaply than by any other method.

The possible construction of the Westside Conveyance System lies many years in the future, a future beyond the 1990 date by which planners believe that excavation by nuclear explosives will be completely safe.

North Coast Development

The Westside Conveyance System is only one of many interrelated projects which planners in the Department of Water Resources propose for possible development of north coast waters. Planning studies show that, by 2020, water requirements within the north coast area will have grown from the present 700,000 acre-feet a year to two million acre-feet a year. Water to satisfy these requirements can be produced most economically in connection with the development of large export projects in the north coast area.

Such projects will be needed.

Unless north coast streams are developed, supplies of water to the Delta—and to State Water Project contractors—eventually will diminish. They will diminish as developing areas along Sacramento and San Joaquin River tributaries require more and more water to satisfy their own needs.

About 12 million acre-feet of water a year, enough to meet California's projected future water needs beyond 2020, could be developed through new construction works in the north coast area and the western Sacramento River Basin (see map, rear cover).

Recreation Development

Water development is by no means the only problem to confront planners. The danger from flood must be reduced. The demand for recreation opportunities must be met.

The Department of Water Resources is planning for the enhancement of fish and wildlife habitat and for the development of recreation areas as a part of the State Water Project. Recreation facilities will appear at all the Reservoirs and along the aqueducts. In addition, the Davis-Grunsky Act encourages the use of State Water Project funds for grants and loans to encourage local agencies to include recreation facilities within their water projects whenever possible.

HAND LENS tells engineering geologist the geologic history of a rock sample drilled from the earth at the site of Tehachapi Pumping Plant. His inspection indicates the suitability of the rock as dam foundation material.

California Water Commission

The California Water Commission, a nine man board appointed by the Governor for four-year terms, has responsibilities ranging from broad policy considerations to specific actions concerning purely local matters.

In carrying out its statutory functions during the past three years, the Commission conducted 36 regularly scheduled meetings and 11 public hearings on subjects ranging from the Pacific Southwest Water Plan to the problems of drainage disposal in the San Joaquin Valley and the proposal for a peripheral canal around the Delta.

The Water Code requires that the Commission members be selected on the basis of their knowledge of water resources development. The Commission Chairman is Ralph M. Brody of Fresno, Manager-Chief Counsel for the Westlands Water District. Vice-Chairman is William H. Jennings of La Mesa, a water lawyer who has been a member of the Irrigation Districts Association Executive Committee.

Other members include: John W. Bryant of Riverside, Chief Engineer of the Riverside County Flood Control District; John P. Bunker of Gustine, member of the Board of Directors of the Central California Irrigation District; Ira J. Chrisman of Visalia, former Mayor of Visalia; John J. King of Petaluma, member of the Eel River Flood Control Association; Edwin Koster of Grass Valley, Manager of the Nevada Irrigation District; Norris Poulson of La Jolla, former Congressman and former Mayor of Los Angeles; and Marion R. Walker of Ventura, a citrus farmer active in water development in Southern California.

The Commission approved or recommended approval of 8 Davis-Grunsky Act loans totaling $3,791,500 and 16 Davis-Grunsky recreation grants totaling $12,070,000. These developments resulted in 17 new reservoirs with a combined storage capacity of 1,500,000 acre-feet.

At the request of the Director of Water Resources, the Commission approved more than 200 condemnation proceedings involving hundreds of parcels of land needed for construction of the State Water Project.

The Commission made eight assignments or releases from priority of state water rights applications for five projects with a combined storage capacity of 1,800,000 acre-feet.

In addition, the Commission conducted three investigations into progress on construction of the State Water Project and made reports to the Governor and the people of the State.

WORKMAN checks alignment of forms during placement of concrete at the Delta Pumping Plant.

MAN CAGE

When existing machines have proved inadequate for the needs of the State Water Project, the Department of Water Resources has designed new machines to satisfy those needs. Such a machine is the Man Cage, a cage designed to drop a man 200 feet into the earth and 10,000 years into the past.

In studying sites for the enormous pumping plants required to lift California Aqueduct waters over the Tehachapi Mountains, the Department discovered its routine earth sampling procedures were inadequate. The sites are underlain with loosely consolidated material. Rock samples drilled from deep within such material fracture and intermix, and thus do not indicate the actual condition of the strata from which they are taken. The Man Cage enables the Department to send a geologist into the ground to conduct an on-the-spot examination.

Seven feet high and three and one-half feet in diameter, the Man Cage is suspended from a cable and lowered into a specially excavated shaft, all but the lowermost portion of which is protected with casing. The cage, designed by a departmental geologist, is supplied with lights, a telephone, and compressed air.

The doors of the Man Cage swing inward to permit access to the earth walls of the shaft. The floor lifts upward. Escape—should escape prove necessary—is through a hatch at the top and up the cable. The cage is cramped. Two hundred feet down, it is stifling.

The Department sends a man down into the earth for the same reason that our country will send a man up to the moon and beyond. There is no camera as good as the human eye. There is no sampling machine as curious as the human mind.

The geologist photographs the rock walls of the shaft. He scoops out samples. He notes in his log the nature of the material visible to him.

The geologist carries with him a machine which looks something like a dumbbell. This machine, expanded hydraulically, presses against opposite walls of the shaft. The pressure required to compress these walls gives a good indication of the slope stability of the material throughout the depths to be excavated.

METER READING engineer, in radio contact with his base, uses a stop watch to check the rate of flow of water into a pond built across the route of the California Aqueduct.

In the Wheeler Ridge area, such ponds consolidate dry, loose soils, which collapse rapidly when wet and leave deep depressions in the ground. Were the soils not so consolidated prior to construction, subsidence, brought about by seepage, eventually would undermine the aqueduct.

About 72 miles of aqueduct route require preconsolidation.

Assignment Abroad

To provide water where it is needed when it is needed, California has had to design a water delivery system which crosses vast delta lands, active earthquake faults, and high mountains.

The tremendous problems which California has solved in developing its water supplies—not only fresh surface waters of rains and snows, but also brackish ground waters and the salt waters of the sea—have led to the development of a team of water experts, engineers, and managers the equal of any anywhere. On occasion, members of this team are called upon to aid other areas in the solution of water development problems. Such today has happened in East Pakistan and Chile.

California and Chile have been called sister states. As California is long and narrow, so Chile is longer and narrower. As elevations in California range from minus 282 to 14,495 feet, so those of Chile range from sea level to 22,310 feet.

The Sierra Nevada and the Andes are parts of the same mountain chain. In both California and Chile lie arid lands where the winds of the deserts blow dry and water is dear. In both rise mountains where the snow lies deep, and rivers where the water flows full.

Differences exist.

In California, the great rivers meander southward and northward, following valley troughs along the length of the state. In Chile, the great rivers plunge down the Andes and race westward to the sea.

In Chile today, two Department of Water Resources engineers, assigned for two years to the Chile-California Program, assist Chileans with technical problems related to their country's development, chiefly with regard to water supply.

A geologist, an economist, and a land-and-water-use specialist, also from the Department of Water Resources, have completed shorter assignments in Chile.

These five men are part of a larger group of specialists from California who early in 1965 recommended a program which would define series of projects planned to develop the Maule River Basin of Chile. The studies continue.

The Chile-California Program is financed by the United States Agency for International Development (AID).

On the far side of the earth, a second team of DWR experts assists the Water and Power Development Authority in East Pakistan in resolving its major organizational and management problems.

This team, composed of management and program control specialists and also financed by AID, is designing procedural and reporting systems planned to ensure prompt information on the status of water development programs. The work will require two years. The team will assist the Authority in choosing and training personnel to operate the systems that are established.

California State Water Project

The California State Water Project will direct excess waters from the northern third of the state to southern areas of need.

In addition to supplying water, the Project will provide flood, salinity, and drainage control, power, and recreational opportunities.

Project water deliveries will reach areas from Plumas County south to Mexico, and from the Pacific Coast eastward almost to Nevada. The map on pages v–vii depicts these areas in green, and shows the total amount of water for which various agencies in each area have contracted.

The project begins in the high Sierra. Two reservoirs there—Frenchman and Antelope Lakes—have been built. The first was completed in 1961; the second, in 1964. Lake Davis, the third, will be completed in November 1966. Two more will be constructed later. These reservoirs provide recreational areas and water for domestic supply and for irrigation. They are improving the fisheries. In 1963 alone, 65,000 fishermen hooked 133,000 trout—100,000 pounds of fish—in Frenchman Lake.

The initial works of the project, authorized in 1960 and financed by $1,750,000,000 in general obligation bonds, were planned to distribute 4,000,000 acre-feet of water annually, an amount then believed sufficient to satisfy demand until 1990.

In 1964, however, a decree of the United States Supreme Court (Arizona vs. California) made necessary the increase of annual water deliveries to 4,230,000 acre-feet. The decree affected the water supply of Southern California by allocating (with certain restrictions) only 4,400,000 acre-feet of Colorado River water to California annually at a time when State Water Project plans assumed the continued availability of 5,362,000 acre-feet of Colorado River water annually.

The South Bay Aqueduct, an important segment of the State Water Project waterways, was completed in June 1965, five and one-half years after construction started. Water deliveries through its initial reaches began in May 1962. By July 1965, 44,591 acre-feet had been delivered to the Alameda County Flood Control and Water Conservation District, Zone 7, and to the Alameda County Water District.

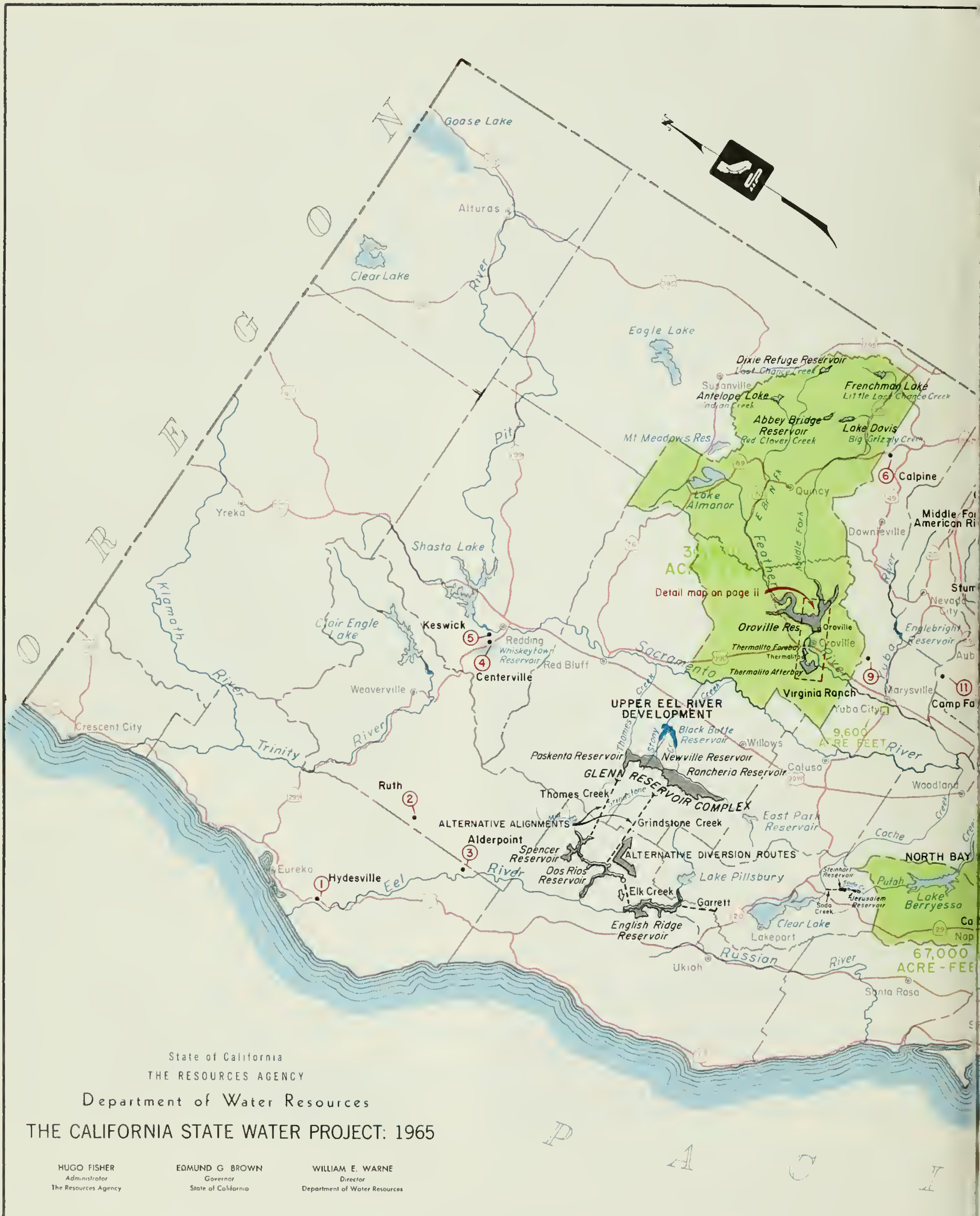
To the north, in the Feather River area, 24,500 acre-feet of State Water Project waters from Frenchman Lake were delivered to the Last Chance Creek Water District between the first deliveries in March 1963 and July 1965.

By 1972, deliveries will be under way to each of the 31 agencies which have contracted for State Water Project water.

The project is not static. As construction proceeds and water deliveries increase, studies for future works intensify.

On July 1, 1964, the Department began detailed study of the Upper Eel River Development, including the proposed Glenn Reservoir Complex. This will be the first of the additional water conservation facilities needed to maintain the minimum project yield of the State Water Project.

Current plans would divert Middle Fork Eel River water into the Sacramento Valley either by way of the Glenn Reservoir Complex or through the proposed Spencer, Dos Rios, and English Ridge Reservoirs and thence through Clear Lake, Lake Berryessa, and Putah Creek. These projects would provide local water service, flood control, recreational opportunities, and fisheries enhancement, as well as water for sport.



State of California
THE RESOURCES AGENCY
Department of Water Resources
THE CALIFORNIA STATE WATER PROJECT: 1965

HUGO FISHER
Administrator
The Resources Agency

EDMUND G. BROWN
Governor
State of California

WILLIAM E. WARNE
Director
Department of Water Resources

The Delta

Seven hundred miles of meandering waterways interlace the low-lying peaty islands of California's agriculturally rich Delta land. Into the Delta flow the surplus waters of the great Central Valley: south through the Sacramento River, north by way of the San Joaquin River.

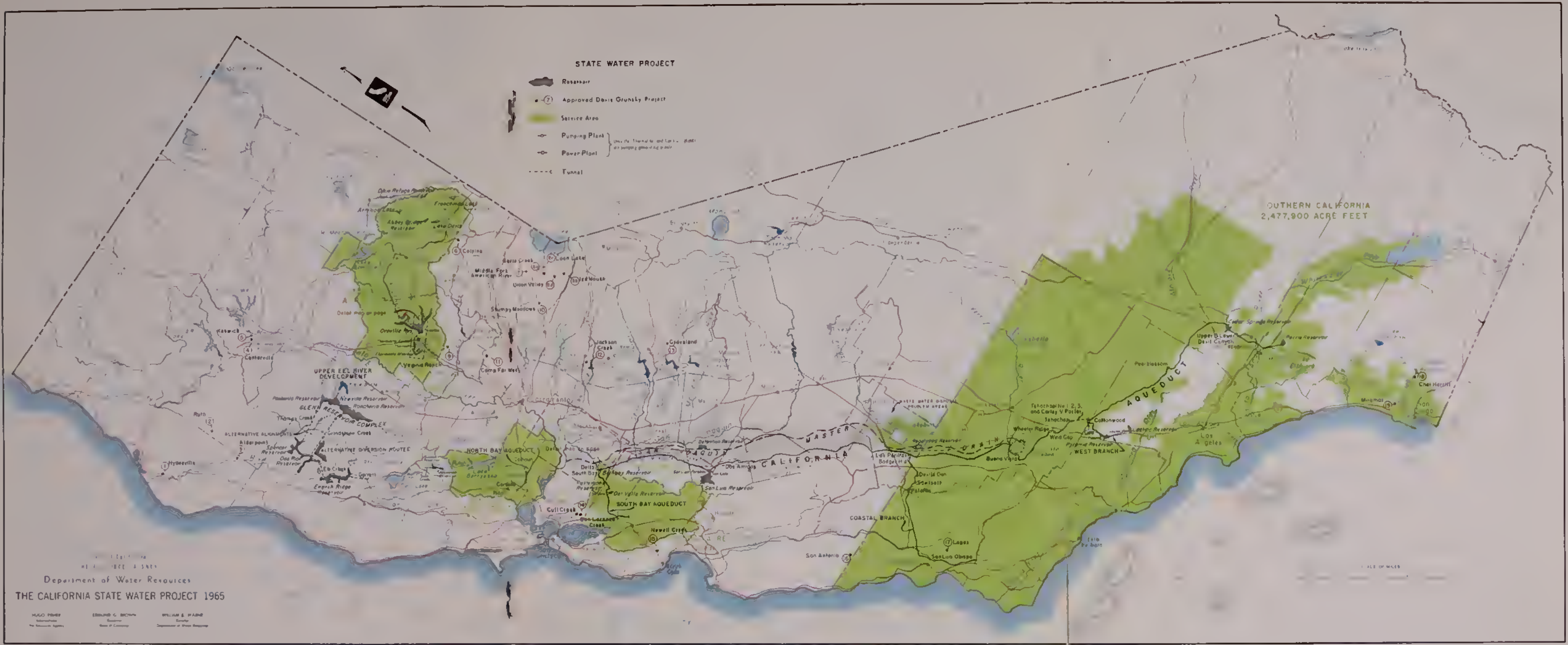
In times of winter and spring floods, these waters would overflow the Delta lands but for the miles of man-made levees which crawl like eels along the waterbanks. The same levees protect the land from direct inundation by the salt tides of the Pacific Ocean. At times of drought in the past, these tides have pushed far inland along the waterways. Their brackish waters have seeped into adjacent soils and injured crops.

The Delta—this area of waterway, farmland, and growing industry, of skin diver, asparagus clump, and smokestack — will benefit greatly from the State Water Project.

The plan to transfer water across the Delta and into the Aqueduct will insure adequate supplies of fresh water for use within the Delta, will provide means to repulse advancing salt tides, will protect Delta lands from flood and seepage waters, and will encourage navigation and recreation.

This plan will provide for a canal skirting the eastern edge of the Delta. Releases made from the peripheral canal would meet local water requirements. Boaters would have access to the canal from Delta channels. Swimmers, picnickers, campers, and water skiers would find appropriate facilities provided.

The peripheral canal will extend south from Hood on the Sacramento River. It will pass in siphons beneath the Mokelumne, San Joaquin, and Old Rivers and then branch both south to the Tracy Pumping Plant and west to the Delta Pumping Plant. Pumps of the Delta Plant will lift the canal waters into the California Aqueduct.



DAVIS-GRUNSKY: State Water Project Bon

As a part of the State Water Project, the Davis-Grunsky Act authorizes State grants, loans, or both to
agencies for local water projects. Grants may be authorized for dam and reservoir construction costs alloca
enhancement of fish and wildlife habitat and recreation and for initial water supply and sanitation facilities.
may be authorized for these purposes and also for water distribution systems. Grants and loans to the fol
agencies have been approved under the Davis-Grunsky Act. The numbers correspond to those printed in
the map to the left.

1 **Hydesville County Water District.** Water distribution from deep wells. Construction started 1965. $182,000 loan.

2 **Humboldt Bay Municipal Water District.** Dam and reservoir for water distribution and recreation. Completed 1964. $300,000 grant.

3 **Alderpoint County Water District.** Water distribution from horizontal collector wells under the Eel River bed. Construction started 1965. $112,000 loan.

4 **Centerville Community Services District.** Water distribution from Bureau of Reclamation Muletown Conduit. Authorized 1965. $380,000 loan.

5 **Keswick Community Services District.** Water distribution from Trinity River Division of Central Valley. Completed 1965. $63,000 loan.

6 **Sierra County Waterworks District No. 1.** Water distribution from diversion reservoir (existing dam rebuilt and reservoir area cleared). Completed 1964. $75,000 loan.

7 **Placer County Water Agency.** Dams and reservoirs for power, irrigation, and recreation. Dams under construction. Recreation project authorized 1965. $3,348,000 loan.

8 **Sacramento Municipal Utility District.** Dams and reservoirs for power and recreation. Dams completed 1963. Recreation facilities under construction. $1,157,000 grants.

9 **Browns Valley Irrigation District.** Dam and reservoir for irrigation, power, and recreation. Dam completed and recreation facilities authorized 1963. $700,000 grant.

10 **Georgetown Divide Public Utility District.** Dam and reservoir for irrigation and recreation. Dam completed 1961. Recreation facilities started 1963. $300,000 grant.

11 **South Sutter Water District.** Dam and re
for irrigation and recreation. Dam complete
Water distribution system and recreation fa
completed 1965. $1,323,000 grant. $2,810,00

12 **Jackson Valley Irrigation District.** Dam a
ervoir for irrigation, municipal water distr
and recreation. Completion scheduled 1966
000 grant.

13 **Groveland Community Services District.**
distribution from City of San Francisco
completed 1965. $138,000 loan.

14 **Alameda County Flood Control and Wate
servation District.** Dams and reservoi
ground water percolation (to maintain
water level), flood and debris control, and
tion. Dams completed 1964. Work continu
recreation facilities at San Lorenzo re
$334,000 grants.

15 **City of Santa Cruz.** Dam and reservoir fo
distribution and recreation. Completed 1965
300 grant.

16 **Monterey County Flood Control and Wat
servation District.** Dam and reservoir for
tion, flood control, and recreation. Const
started 1964. $3,620,000 grant.

17 **San Luis Obispo County Flood Control and
Conservation District.** Dam and reserv
water distribution and recreation. Authorize
$3,944,800 grants.

18 **Helix Irrigation District.** Terminal storag
voir for irrigation, domestic water distributi
recreation. To be completed by end o
$517,000 grant.

19 **City of San Diego.** Terminal storage r
for water distribution and recreation. Da
pleted 1960, recreation facilities authorize
$391,300 grant.

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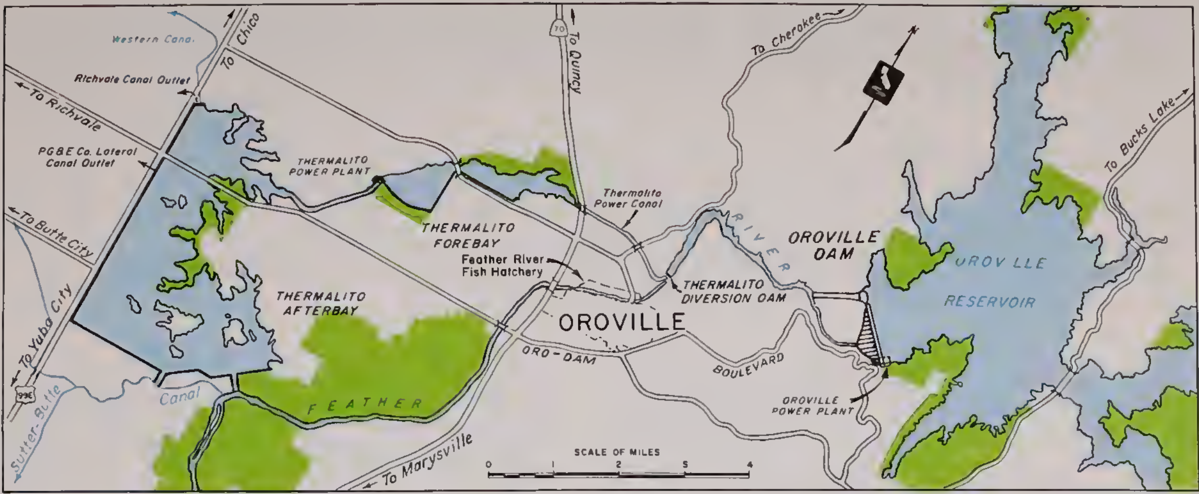


The Dam

December 1964. Flood waters rage in California. Oroville Dam—an Oroville Dam whose embankment is only partially complete—Oroville Dam saves Yuba City.

The city was not so fortunate in 1955. At midnight on December 23 of that year, the west Feather River levee suddenly gave way at a point just south of Yuba City. A torrent of water bursting onto lands 25 feet below spread west and north, wreaking havoc as it entered and inundated almost the entire city. The raging waters destroyed more than 400 homes; 36 people died.

This total destruction, this loss of life in Yuba City, occurred on a day when the floodflow at the site of Oroville Dam was at a maximum of 203,000 cubic feet a second. In December 1964, the maximum floodflow near that point was 250,000 cubic feet a second, almost 50,000 cubic feet a second greater than in 1955. But the reservoir behind the incomplete Oroville Dam and the two diversion tunnels which carry the water around the construction zone slowed the flow. The outflow from those two tunnels never exceeded 157,000 cubic feet a second. The river height along the levees below Yuba City held at 76.4 feet, never reaching the 82.5 feet which in 1955 proved greater than the levee could contain.

The State Water Project saved Yuba City.

Construction of Oroville Dam embankment began in July 1962. By July 1965, that embankment—to become the highest in the world—was 32 percent complete. When the embankment is completed in 1967, the mile-long dam will rise 770 feet. The reservoir shoreline will extend 167 miles and encompass 24 square miles of water surface.

Releases will pass through Oroville Powerplant, located underground in the left abutment of the dam. Downstream from Oroville Dam, Thermalito Diversion Dam will direct water through Thermalito Power Canal, Forebay and Powerplant and into Thermalito Afterbay. Afterbay water will release into the Feather River and into the Sutter-Butte, the Western, the Pacific Gas and Electric Company Lateral, and the Richvale Canals.

Construction of Oroville and Thermalito Powerplants began in May 1963 and December 1964, respectively. By March 1969, the two powerplants together will be generating about 710,000 kilowatts. The Department is negotiating to sell this power to private and public utilities.

Both powerplants are designed for pumped storage operation. Certain of their units are reversible. During periods of greater power demand, the turbine portion of the pump-turbine units will generate electricity as water passes downward from Oroville Reservoir and into Thermalito Afterbay. During periods of lesser power demand, the pump portion of the units will return water from the Afterbay back through Thermalito Power Canal and into Oroville Reservoir.

Opposite Oroville, the Feather River Fish Hatchery will handle 20,000,000 salmon and steelhead eggs yearly, and thus substitute for spawning areas obstructed by Oroville Dam. The Feather River Fish Barrier Dam, completed in 1964, will divert the migrating fish into a fish ladder leading to the hatchery. Until completion of the hatchery, state fisheries men are trucking those fish diverted from the river to spawning points upstream from Oroville Dam. Since September 1963, more than 10,800 salmon and steelhead had (by June 30, 1965) been trucked upstream in this fashion.

From the Feather River, releases from Oroville Dam flow into the Sacramento River and then into the Delta.

The Drain

Each year, the rivers and canals entering the San Joaquin Valley carry dissolved within their waters more than two million tons of mineral compounds. Industry, farm, and city use about another million tons, and these also enter the water supply of the valley. Industrial compounds find their way into industrial waste waters; agricultural compounds such as fertilizers, into irrigation waters. Although municipalities treat their waste waters to remove material detrimental to health, wasted mineral compounds remain dissolved within these waters.

Significant quantities of all of these mineral compounds—these salts—remain with the valley. From the valley's southern basin no rivers flush the salts to the sea. In the northern basin, the existing river system drains many areas only feebly. In either area, when the waters carrying them evaporate, the salts, in continually increasing concentrations, become a part of valley soils and underground water supplies.

In this great valley, where lie four-tenths of the irrigable land in California and more than five-tenths of the irrigated land, the increasing concentration of salts endangers crops, threatens the quality of water in the ground and in the streams, and imperils the soil itself. If agricultural production is to continue, if the surface and ground waters are to be protected, California must find a means to dispose of these salts.

In January 1965, the Department of Water Resources recommended that a San Joaquin Master Drain be constructed to remove saline waste waters from endangered portions of the valley. The 250-mile-long drain, to be built over a 25-year period with the first stage to be completed in 1970, would begin west of Bakersfield and extend to the Delta.

The problem of the disposal of waste waters from the San Joaquin Valley has been confused in the welter of questions raised by residents of the San Francisco Bay area. Some believe that the Bay would receive no agricultural drainage waters from the San Joaquin Valley if the drain were not built. Such waters, however, already drain into the Bay. They do not create the greater part of the problem. The inflow into the Bay of sewage and industrial wastes, already high in 1960 (700,000,000 gallons), will have more than doubled in 1990.

The plan for construction of the San Joaquin Master Drain focuses attention on the need for integrated planning for Bay Area waste disposal on a broad, regional scale. The Water Pollution Control Act of 1965, signed by Governor Brown in June, authorizes a comprehensive study of waste disposal in the entire Bay-Delta area. Such a study was recommended by the Department of Water Resources in January 1965.

The Aqueduct

Through the flat, hot, sparsely populated lands that sweep along the western edge of the San Joaquin Valley south from the Delta to the Tehachapi Mountains will pass the California Aqueduct. Closely parallel to its route is the alignment of the proposed Westside Freeway. Because of the Freeway, travel through the area will increase; local communities will grow; and recreation development, currently limited, will expand. Nowhere can recreation development more logically expand than along the California Aqueduct.

The Davis-Dolwig Act (Water Code Sections 11900–11925) authorizes the Department of Water Resources to develop recreation areas in connection with the State Water Project. With this authorization, the Department recommended, in January, 1965, initial development of 2,000 acres for campers, swimmers, boaters, and water skiers at the 550-acre Buena Vista Reservoir; of aquatic parks with recreation ponds at Kettleman City (440-acre area) and Ingram Creek (165-acre area); and of smaller parks at Wheeler Ridge (8 acres), Three Rocks (24 acres), and Sperry Road (24 acres). Each of these areas would provide shade trees, wildlife habitat, picnic grounds, and fishing access to the Aqueduct.

Rivers drain to the sea.

But the waters of the California Aqueduct move inland from essentially sea-level areas of the Delta and, at many points, flow uphill.

Along the 444 mile-long main line of the Aqueduct, the uphill push is provided by pumps at eight separate plants. Eight more pumping plants fall along the western and coastal branches of the Aqueduct and along the South Bay Aqueduct. These sixteen pumping plants live on power. Each year they will consume about 12,456,000 megawatt-hours of energy.

Some of this energy will be provided by the Aqueduct itself.

At San Luis Reservoir, for example, power will be either used or produced, depending on the needs of the moment. The pumps of the San Luis Pumping-Generating Plant will lift 11,000 cubic feet of water per second 320 feet up from San Luis Forebay and into San Luis Reservoir. The annual energy requirement of these pumps will be 200,000 megawatt-hours. Some of this energy will be recovered. As reservoir releases swirl downward for delivery farther south along the Aqueduct, the generating portion of the plant will produce, annually, 139,000 megawatt-hours of energy.

Annually, the seven powerplants along the California Aqueduct and its branches will recover 3,432,300 megawatts. This amount is more than one quarter of the energy which Aqueduct pumps will use.

The Tehachapi Crossing

Pumps of the State Water Project will lift 4,100 cubic feet of water a second almost 2,000 feet from the floor of the San Joaquin Valley over the Tehachapi Mountains.

The decision to place these pumps at the base of the mountains rather than at two or three points along the route to the top was made by Department of Water Resources engineers in mid-1965. The single-lift plan is the most reliable and the cheapest — by $7,000,000 — of the plans studied. In the earthquake country of the Tehachapi Crossing, it is also the safest plan. There are fewer structures to suffer damage.

The Aqueduct path over the mountains is preferable to that which might have been provided underground by a single 26-mile tunnel between Grapevine in the San Joaquin Valley and the southern Tehachapi slopes. A tunnel deep within the mountain would pass through the Garlock Fault.

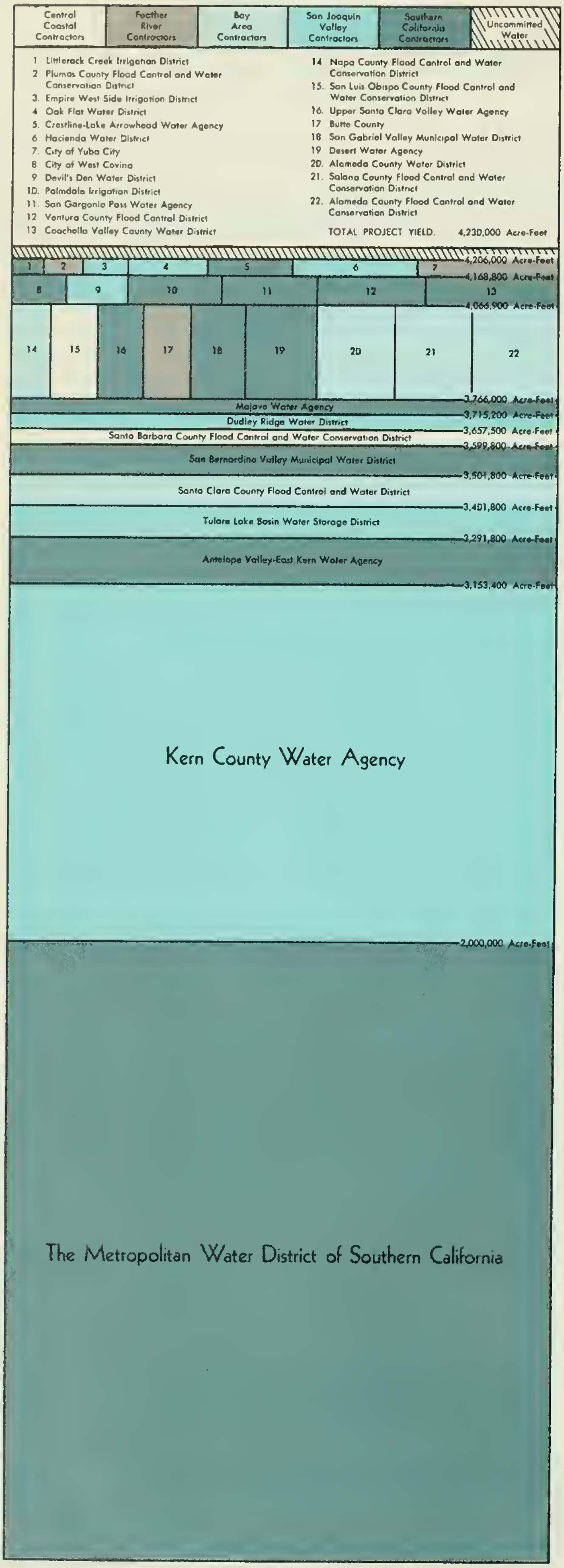
One earthquake along the Garlock Fault could drop a solid wall of rock—half the mountain—and, in a split second, dam the flow of a buried aqueduct. The California Aqueduct will carry water high over the mountain because its designers wish it to cross all geologic faults—the Garlock, the San Andreas—at or near the ground surface.

Repairs necessitated by a lateral or vertical shifting of a canal section—a shifting resulting from an earthquake—could take place with relative ease. Moving a mountain could not.

The design of aqueducts which will suffer only minor damage during earth movements—or which will withstand them altogether—demands an understanding of those movements. The Department of Water Resources is studying carefully the behavior of the San Andreas Fault. It has initiated a sophisticated project to measure crustal strain. Not only do such measurements help in the design of dams and aqueducts, they also aid in predicting earthquake probabilities.

↑ *HYDROMETER enables engineering aid to determine percentages of sand, silt, and clay in soil sample at Castaic Dam site laboratory. Particles settle at different rates depending upon their sizes and specific gravities. The proportions in which particles of sand, silt, and clay combine in part determine the suitability of material for use in permeable and impermeable zones of an earthfill dam such as Castaic Dam.*

ELECTRONIC optical device detects the instant of time which a beam of light requires to travel to and from a reflector (here not positioned) and translates this into a measurement of the exact distance between points several miles apart—plus or minus one inch! The instrument detects minute ground displacement brought about by seismic disturbances. →



CONTRACTS

Thirty-one water agencies have contracted for 99.5 percent of the annual 4,230,000 acre-feet of water to be delivered through the State Water Project.

An additional 23,600 acre-feet of the expected minimum project yield is yet uncommitted.

These agencies—the water users—will pay the costs of the water conservation and transportation features of the State Water Project. Already they have paid more than $5,500,000 to the Department of Water Resources even though it will be several years before many of them receive their first water deliveries. The chart at the left shows the proportion of the expected total project yield each agency has contracted to receive.

The fold-out map (pages v–vii) depicts the general areas of the state that will receive water from the project.

The first contract, with the Metropolitan Water District of Southern California, was signed in November 1960; the most recent, with the Oak Flat Water District in Stanislaus County, in March 1965. In addition to these agencies, the Last Chance Creek Water District of Plumas County is now receiving 12,000 acre-feet of water from Frenchman Lake under an annual interim contract.

Water from the project will supply areas in which two-thirds of all Californians live. Of the minimum project yield of more than four million acre-feet, two and one-half million acre-feet will be carried by the California Aqueduct over the Tehachapi Mountains to Southern California.

The bulk of the water to be delivered by the State Water Project will be for urban use. Although 90 percent of the annual demand for water in California is still for irrigation, urban use takes an ever-increasing proportion of the total supply. All of the water to be delivered south of the Tehachapi mountains by the State Water Project will be for urban use. The project is expected to meet the water needs of Californians until about the year 1990.

WATER pours into the South Bay Aqueduct's terminal reservoir near San Jose.

Ground Water

Not only will water delivered through the State Water Project satisfy domestic, industrial, and agricultural needs, it also will replenish ground water basins in California. These vast natural reservoirs are among the most valuable resources of the state. Their estimated storage capacity is 450,000,000 acre-feet.

Excessive pumping of the underground water depletes the supply. In coastal areas, sea waters seep slowly into those ground water basins from which fresh waters have been overdrawn. There and elsewhere, the land itself sinks as its ground waters are tapped faster than they are replaced. Such subsidence not only damages man-made surface structures but also compacts the land and reduces the storage capacity of the basin.

Underground storage is less expensive than surface storage because it requires no man-made reservoirs and few distribution works. A river, for example, carries water to a diversion point from which man must then construct numerous lengthy canals to carry the water to his thirsty fields. An underground storage basin, on the other hand, carries water not to a point but to a wide area throughout which man may sink wells directly to serve those same fields. Underground storage is almost invulnerable to earthquake. It reduces water loss through evaporation.

To combat the dangers of ground water depletion, State Water Project water will be used to recharge the basins artificially and to substitute for water that might be pumped from the basins.

Project water already is being put to work to replenish the ground water basins of Alameda and Santa Clara Counties, as well as to supply directly the homes, farms, and industries of these counties.

On July 1, 1965, completion of the South Bay Aqueduct was celebrated at the dedication of the terminal facility in Santa Clara County (see map, page 2). This is a 2½-million-gallon steel reservoir which can discharge into the water distribution system of the Santa Clara County Flood Control and Water District or, for ground water recharge, into a spreading ground on Penetencia Creek. The reservoir, about five miles northeast of downtown San Jose, will supply water for the use of 1½ million people.

FLOOD CONTROL

Flood danger will be substantially reduced for hundreds of thousands of Californians in years to come as a direct result of two laws passed by the legislature in 1965.

• • •

The passage of Assembly Bill 1051 and its approval by Governor Edmund G. Brown was the first step in 35 years to modernize the law on state supervision of dams. One aim of this law is to prevent disasters such as that which struck Baldwin Hills Reservoir in Los Angeles.

On the afternoon of December 14, 1963, millions of gallons of water burst through a huge breach in the downstream edge of the reservoir and poured down on a residential area below, inflicting damage estimated at more than $15,-000,000. Scores of homes collapsed. Five people died.

An intensified inspection program conducted by the Department of Water Resources following the Baldwin Hills disaster revealed that unsafe or questionable conditions existed in more than 100 dams in California. As many as 500 dams in the state, because of their locations near centers of population, would present extreme hazards to life and property if they failed.

The new law will expand the state's jurisdiction over dams to include those constructed away from natural stream channels and drainage areas. These are dams which form storage reservoirs into which water from stream channels is diverted for later agricultural, residential, and industrial use.

The law will bring under state supervision as many as 150 offstream dams, many of which are in urban areas similar to the Baldwin Hills area in Los Angeles. When improperly operated, such dams become potentially serious hazards.

The law requires dam owners to report promptly any occurrences that may adversely affect their reservoirs, to watch closely enough to be able to provide advance warnings of failure, and to make appropriate engineering and geologic investigations of their structures.

Under this law, the Department of Water Resources is authorized to cancel the certificate of approval should a reservoir become unsafe. In determining reservoir safety, the Department will consider hazardous conditions in its vicinity. The new law will greatly reduce the danger of dam failure in the future.

• • •

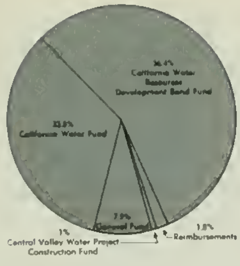
The Christmas 1964 floods hit hard along California's northern coast. The radio warnings which might have been given by remotely monitored river height measuring devices were muted when, within a few hours, flood waters washed most of the devices downstream. As a result, downstream communities had little warning of the impending disaster.

The Department of Water Resources immediately set to work to repair stream gages and to reduce the possibility of another such flood striking without warning.

The second new law designed to save human lives and property threatened by flood authorizes the Department of Water Resources, in cooperation with the United States Weather Bureau, to construct a reliable radio network to obtain hydrologic data from the North Coast and to expand the existing hydrologic telemetering network. The telemetering network automatically relays by radio to flood control centers in Eureka and Sacramento data from gages which measure stream heights and precipitation amounts at strategic locations.

CONSERVATION CAMP CREW, directed by the Department of Water Resources, shores up a weak Delta levee and saves 3,633 acre Twitchell Island from inundation during the high floods of Christmas 1964. Prisoners fought the swirling waters for 600 hours without a break. Twitchell Island, like many in the Sacramento-San Joaquin Delta, is irrigated farmland and produces asparagus, tomatoes, and pears for the markets of the world.

Financial Report July 1, 1962– June 30, 1965



Income

During the three-year period ending June 30, 1965, the Department of Water Resources disbursed $385,532,000. The pie chart below illustrates the various activities of the Department for which this money was used. The smaller chart above shows where the money came from.

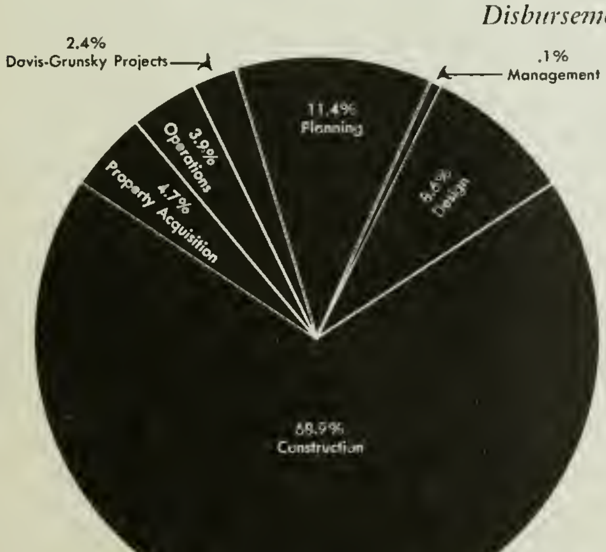
The General Fund is money which the Legislature appropriates for work of statewide interest, such as investigations of water resources and collection of basic data.

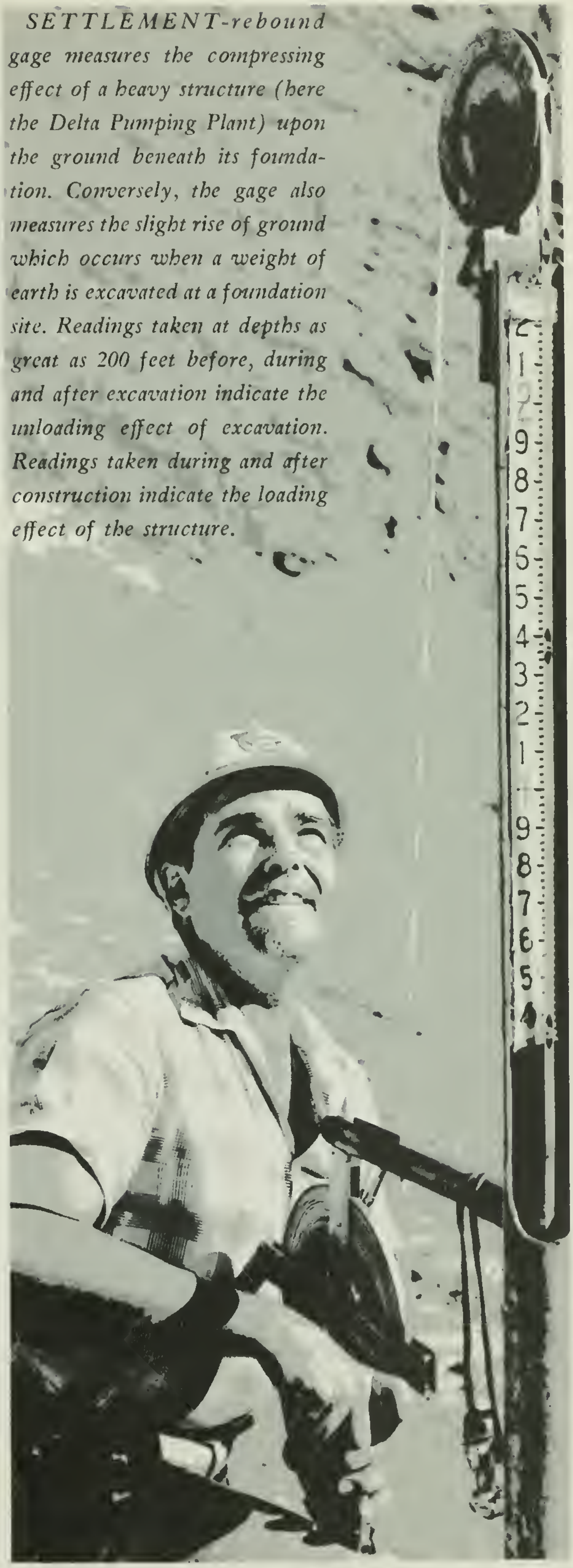
Reimbursements are funds returned to the Department for services which the Department has performed for the federal government or for counties, cities, and other state agencies.

The Central Valley Water Project Construction Fund consists of revenues from sale of power by the State Water Project. In years to come, and with the completion of the Oroville and Thermalito Powerplants, this fund will become substantial.

The bulk of the money for construction of the State Water Project has been appropriated by the Burns-Porter Act. This money includes both the California Water Fund, which is derived from tidelands oil revenues, and the California Water Resources Development Bond Fund, which is derived from general obligation bonds, commonly known as "water bonds". These bonds were approved by vote of the people of California in 1960.

Disbursements

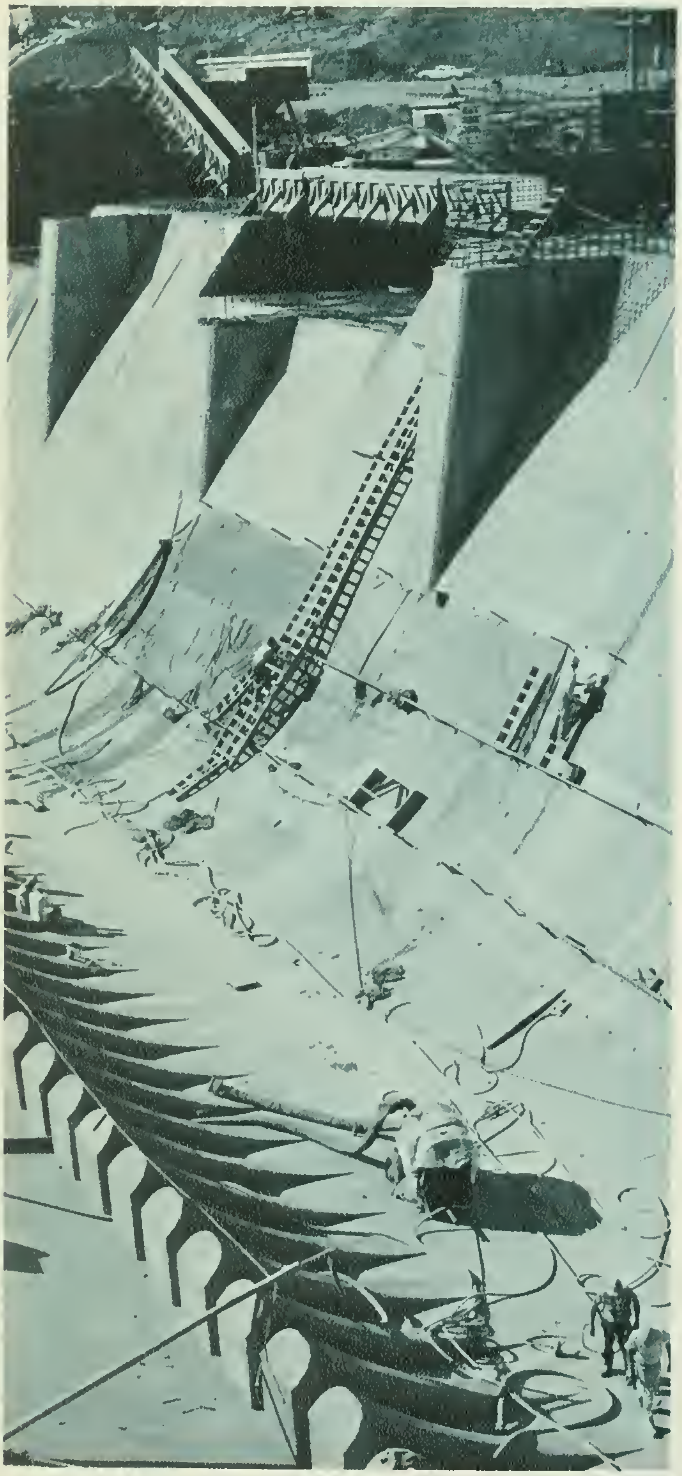




SETTLEMENT-rebound gage measures the compressing effect of a heavy structure (here the Delta Pumping Plant) upon the ground beneath its foundation. Conversely, the gage also measures the slight rise of ground which occurs when a weight of earth is excavated at a foundation site. Readings taken at depths as great as 200 feet before, during and after excavation indicate the unloading effect of excavation. Readings taken during and after construction indicate the loading effect of the structure.

BUCKET TEETH, curving upward from the base of Thermalito Diversion Dam, will create turbulence and thus dissipate the energy of falling water which otherwise would scour the downstream channel and endanger the dam foundation.

Thermalito Diversion Dam rises on the Feather River below Oroville reservoir. It will divert releases from the reservoir into Thermalito Power Plant.



Bulletins: 1963–1965

During the three-year period ending June 30, 1965, the Department of Water Resources published 211 major bulletins reporting its activities and the results of its many investigations.

Bulletin No. 132-65, "The California State Water Project in 1965", continues an annual series which treats the history of the project, describes its works, and supplies details relating to construction, progress, water supply, water contracts, water yield, and project operation, maintenance, costs, revenues, and financing.

Bulletin No. 130-63, "Hydrologic Data, 1963", is the first of a planned series of annual reports summarizing hydrologic conditions in California. Appendixes report data on climate, surface water flow, ground water measurements, and the quality of surface and ground waters. The new series presents data previously published annually in Bulletins No. 23, 39, 65, 66, and 77; the series is published in five volumes, each volume reporting data for one of five areas of the state.

The proposed San Joaquin Master Drain, described on page iv of the fold-out map, is reported in detail in Bulletin No. 127, "San Joaquin Valley Drainage Investigation: Preliminary Edition".

Bulletins of the No. 94 Series describe the use of land and water in various hydrographic units of the state. Released have been Bulletins No. 94-1, "Tule River"; 94-2, "Trinity River"; 94-3, "Yuba-Bear Rivers"; 94-4, "Smith River"; 94-5, "Shasta-Scott Valleys"; 94-6, "Klamath River"; 94-7, "Mad River-Redwood Creek"; 94-8, "Eel River"; 94-10, "Mendocino Coast"; 94-11, "Russian River"; 94-12, "Sacramento Valley West"; 94-13, "Putah-Cache Creeks"; and 94-14, "American River". Each bulletin reports surface water diversions and contains numerous maps showing details of land use (urban, agricultural, and recreational), surface water diversion systems, and land classification (urban, irrigable, and recreational). The data is being used to determine how much water each area will require in the future. These water requirements are reported in volumes of the companion, Bulletin No. 142 series, "Water Resources and Future Water Requirements". Of this series, Bulletin No. 142-1, "North Coastal Hydrographic Area, Volume I: Southern Portion", has been published.

Among the other reports published during the period have been Bulletins No. 16-64, "Weather Modification Operations in California"; No. 17, "Dams Within Jurisdiction of the State of California"; No. 98, "Northeastern Counties Ground Water Investigation"; No. 111, "Sacramento River Water Pollution Survey"; No. 129, "Snow Survey Measurements through 1964"; No. 136, "North Coastal Area Investigation"; No. 154, "Potential Recreation Areas Along the California Aqueduct"; No. 155, "General Comparison of California Water District Acts"; No. 161, "Flood! December 1964–January 1965"; "Architecture of the California State Water Project"; and "Investigation of Failure, Baldwin Hills Reservoir".

Sea Water Conversion

The State Water Project today is a project of preservation.

The falling rain, the flowing melt water—these fill the reservoirs Californians have constructed and pass along canals to fields and pastures and cities.

But look to the coast. Within the sea lie the thousands upon thousands upon thousands of acre-feet of water which California for centuries has wasted westward.

In part, the water project of tomorrow will be a project of conversion. Converted sea water will supplement reservoir storage. Brackish ground waters, today unused, will be made fresh. The great project to come—the big project beyond the present State Water Project—the project to redistribute additional water regionally within California—will make good use of the techniques of converting salt water to fresh water.

The Cobey-Porter Saline Water Conversion Law, passed by the California Legislature in June 1965, authorizes the Department of Water Resources to investigate the various possibilities of saline water conversion and, upon specific legislative authorization, to finance, construct, and operate saline water conversion facilities. Such facilities could eliminate the need for additional works to transport water over long distances and could provide a direct, easily managed water supply to help satisfy the future water requirements of California.

The Legislature also has authorized the Department, in cooperation with the United States Department of the Interior, to construct and operate a saline-water-conversion test center and to sell the fresh water produced by such a test center. The possible components of very large conversion plants would be tested in this center. The data obtained would be of considerable help in the design and construction of such large plants. This test center will be located in San Diego.

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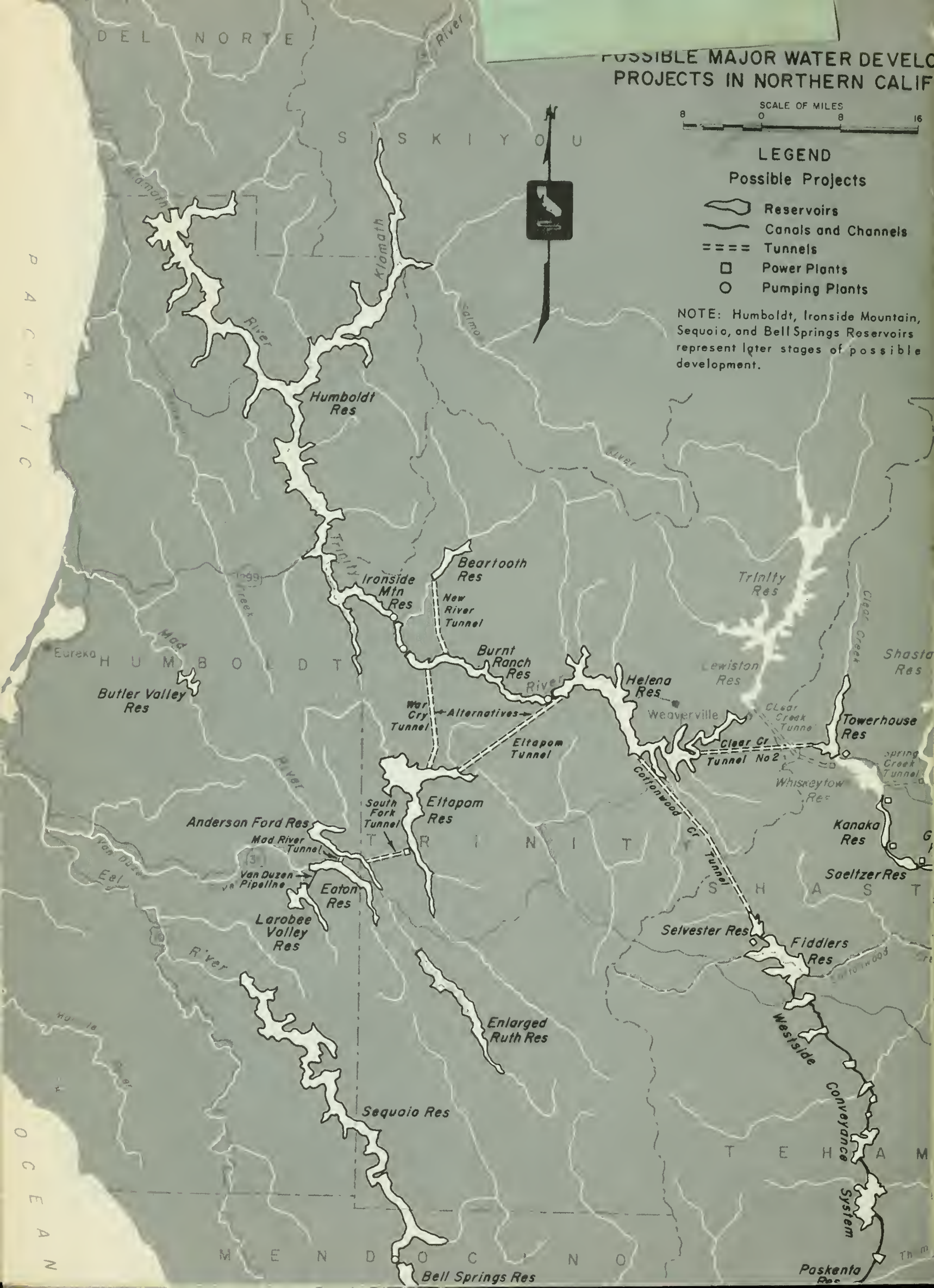

POSSIBLE MAJOR WATER DEVELO
PROJECTS IN NORTHERN CALIF
SCALE OF MILES
8 0 8 16
LEGEND
Possible Projects
Reservoirs
Canals and Channels
Tunnels
Power Plants
Pumping Plants
NOTE: Humboldt, Ironside Mountain, Sequoia, and Bell Springs Reservoirs represent later stages of possible development.
DEL NORTE
SISKIYOU
HUMBOLDT
TRINITY
SHASTA
TEHAMA
MENDOCINO
PACIFIC OCEAN
Klamath River
Salmon
Trinity
Mad River
Eel River
Van Duzen
Eureka
Humboldt Res
Beartooth Res
Ironside Mtn Res
New River Tunnel
Burnt Ranch Res
Helena Res
Weaverville
Trinity Res
Lewiston Res
Clear Creek
Clear Creek Tunnel
Clear Cr Tunnel No 2
Towerhouse Res
Shasta Res
Spring Creek Tunnel
Whiskeytown Res
Kanaka Res
Saeltzer Res
Butler Valley Res
War Cry Tunnel
Alternatives
Eltapom Tunnel
Eltapom Res
South Fork Tunnel
Anderson Ford Res
Mad River Tunnel
Van Duzen Pipeline
Eaton Res
Larabee Valley Res
Cottonwood Cr Tunnel
Selvester Res
Fiddlers Res
Westside Conveyance System
Enlarged Ruth Res
Sequoia Res
Bell Springs Res
Paskenta Res