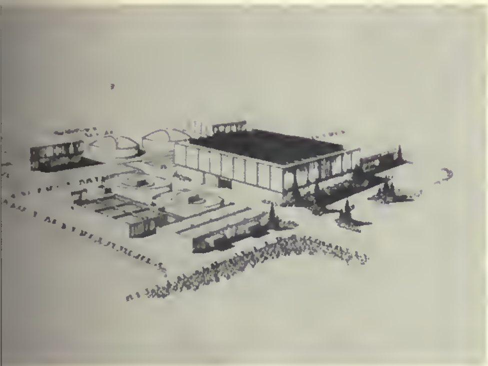

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DWR

State Water Project— Status of Water Conservation and Water Supply Augmentation Plans

ulletin 76-81
ovember 1981

The photographs on the cover depict methods of conserving and au
water supplies — through drip irrigation, desalting of agricultural waste
use of ground water spreading basins, and surface water storage. Sho
lower right is a portion of the California Aqueduct in the San Joaqu
service area

Department of
Water Resources
Bulletin 76-81

State Water Project— Status of Water Conservation and Water Supply Augmentation Plans

November 1981

Huey D. Johnson
Secretary for Resources

The Resources
Agency

Edmund G. Brown Jr.
Governor

State of
California

Ronald B. Robie
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Department of
Water Resources

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FOREWORD

This bulletin supplements and updates information provided in the Department of Water Resources' Bulletin 76, "Delta Water Facilities", published in July 1978. That bulletin outlined a comprehensive program proposed by the Department for protecting the Sacramento-San Joaquin Delta and for meeting water needs of the State Water Project through the year 2000.

The water management program proposed by the Department is embodied in the measures that would be authorized under Senate Bill 200. The program places emphasis on (1) water conservation measures to reduce demands for new supplies, thus stretching the use of existing supplies; (2) water augmentation measures which will increase future supplies for use by the contracting agencies of the State Water Project; and (3) environmental protection facilities. It is an integrated and balanced program to conserve water whenever possible and to also develop additional supplies when this becomes necessary to ensure the socioeconomic well-being of the citizens of California.

Senate Bill 200 was passed by the California Legislature in July 1980 and was signed by Governor Edmund G. Brown Jr. At the same time that the Governor signed SB 200, he also issued Executive Order B-68-80, which contained three major requirements:

(1) The Department of Water Resources is directed to prepare a plan of water conservation, reclamation and management for the State Water Project to be submitted to the State Water Resources Control Board, such plan to recommend actions that could be undertaken by the State and its water service contractors to reduce the demand for water, to reclaim urban and agricultural waste water, to store water underground in order to provide for dry years, and to provide for consideration of pricing changes, water exchanges, and other methods for reducing the demand for new water facilities.

(2) The Department of Water Resources is hereby directed to implement as quickly as possible a program to desalt 400,000 acre-feet of agricultural waste water and other brackish water.

(3) And finally, the State Water Resources Control Board is urged to require water conservation plans in the exercise of their water rights authority.

In 1980 a referendum qualified, and voters will be asked to either approve or reject SB 200 at the general election in June 1982. SB 200 and its companion constitutional measure, ACA 90 (Proposition 8, approved at the November 1980 election), will become law only if there is a favorable vote by the people on the measure.

The water management measures envisioned under the Department's program include extensive water conservation, the Peripheral Canal Facility in the Sacramento-San Joaquin Delta, other Delta and Suisun Marsh water quality and environmental protection facilities, as well as extensive use of underground storage basins south of the Delta, new surface water reservoirs, and the potential for water exchange plans to augment the dependable supplies of the State Water Project.

This bulletin reports on the current status of the investigation work in progress toward implementing the adopted program in an economically and environmentally sound manner.

Ronald B. Robie

Ronald B. Robie, Director
Department of Water Resources
The Resources Agency

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The California Water Commission serves as a policy advisory body to the Director of Water Resources on all California water resources matters. The nine-member citizen Commission provides a water resources forum for the people of the State, acts as a liaison between the legislative and executive branches of State Government, and coordinates Federal, State, and local water resources efforts.

CONVERSION FACTORS

Quantity	To Convert from Metric Unit	To Customary Unit	Multiply Metric Unit By	To Convert to Metric Unit Multiply Customary Unit By
Length	millimetres (mm)	inches (in)	0.03937	25.4
	centimetres (cm) for snow depth	inches (in)	0.3937	2.54
	metres (m)	feet (ft)	3.2808	0.3048
	kilometres (km)	miles (mi)	0.62139	1.6093
Area	square millimetres (mm^2)	square inches (in^2)	0.00155	645.16
	square metres (m^2)	square feet (ft^2)	10.764	0.092903
	hectares (ha)	acres (ac)	2.4710	0.40469
	square kilometres (km^2)	square miles (mi^2)	0.3861	2.590
Volume	litres (L)	gallons (gal)	0.26417	3.7854
	megalitres	million gallons (10^6 gal)	0.26417	3.7854
	cubic metres (m^3)	cubic feet (ft^3)	35.315	0.028317
	cubic metres (m^3)	cubic yards (yd^3)	1.308	0.76455
	cubic dekametres (dam^3)	acre-feet (ac-ft)	0.8107	1.2335
Flow	cubic metres per second (m^3/s)	cubic feet per second (ft^3/s)	35.315	0.028317
	litres per minute (L/min)	gallons per minute (gal/min)	0.26417	3.7854
	litres per day (L/day)	gallons per day (gal/day)	0.26417	3.7854
	megalitres per day (ML/day)	million gallons per day (mgd)	0.26417	3.7854
	cubic dekametres per day (dam^3/day)	acre-feet per day (ac-ft/day)	0.8107	1.2335
Mass	kilograms (kg)	pounds (lb)	2.2046	0.45359
	megagrams (Mg)	tons (short, 2,000 lb)	1.1023	0.90718
Velocity	metres per second (m/s)	feet per second (ft/s)	3.2808	0.3048
Power	kilowatts (kW)	horsepower (hp)	1.3405	0.746
Pressure	kilopascals (kPa)	pounds per square inch (psi)	0.14505	6.8948
	kilopascals (kPa)	feet head of water	0.33456	2.989
Specific Capacity	litres per minute per metre drawdown	gallons per minute per foot drawdown	0.08052	12.419
Concentration	milligrams per litre (mg/L)	parts per million (ppm)	1.0	1.0
Electrical Conductivity	microsiemens per centimetre (uS/cm)	micromhos per centimetre	1.0	1.0
Temperature	degrees Celsius (°C)	degrees Fahrenheit (°F)	(1.8 × °C)+32	(°F−32)/1.8

CHAPTER I. INTRODUCTION AND SUMMARY

Bulletin 76-81 reports on the progress and status of planning studies for future water supply alternatives for the State Water Project (SWP). Except for the Peripheral Canal and other Delta facilities, these studies are being conducted by the Department of Water Resources (DWR) under its SWP future supply planning investigation, which was established in 1976 to consolidate planning for future SWP facilities. The program elements being studied include:

Combined management of ground water storage and surface water supplies.

Increased reuse of present supplies through waste water reclamation and agricultural waste water desalination.

Expanded regulation of surface water, from both offstream and onstream storage facilities.

Intensity of study varies from reconnaissance through feasibility and advanced planning levels, depending on the specific stage of planning for the various measures being considered.

Background

The 1959 Burns-Porter Act, which was ratified by a majority of the voters in November 1960, together with amendments to the State Central Valley Project Act during the period 1951 through 1959, provides the legislative authority for funding and constructing the SWP. Together, these acts provide for DWR to develop excess waters in Northern California for delivery to areas of need in Northern, Central, and Southern California.

Following voter approval of the Burns-Porter Act, DWR entered into contracts with 31 public agencies[1/] throughout the State, which now supply water to more than two-thirds of the population of the State and thousands of acres of irrigated land (Figure 1). These contracts provide for progressive increases in annual water deliveries up to a maximum of 5.22 million cubic dekametres (dam^3) (4.23 million acre-feet) of dependable supply. Although the major aqueducts and initial reservoirs have been built (Figure 2), the SWP, at its present stage of development, can provide only about one-half of its contractually designated yield (maximum annual entitlements) on a dependable basis during dry periods.

During wetter periods, the delivery capability from existing SWP facilities is only about three-quarters of the maximum annual entitlements. This water delivery capability will diminish over the next 20 years due to increased use of water in the areas of origin. Furthermore, Delta facilities authorized by the Burns-Porter Act have not been built. Instead, natural Delta channels are currently used by both the SWP and the federal Central Valley Project (CVP) to transport project water across the Delta. This causes problems in controlling salinity intrusion and has also

1/ With the merger of Hacienda Water District and Tulare Lake Basin Water Storage District (effective January 1981), there are now only 30 water service contractors, but the total obligations remain unchanged.

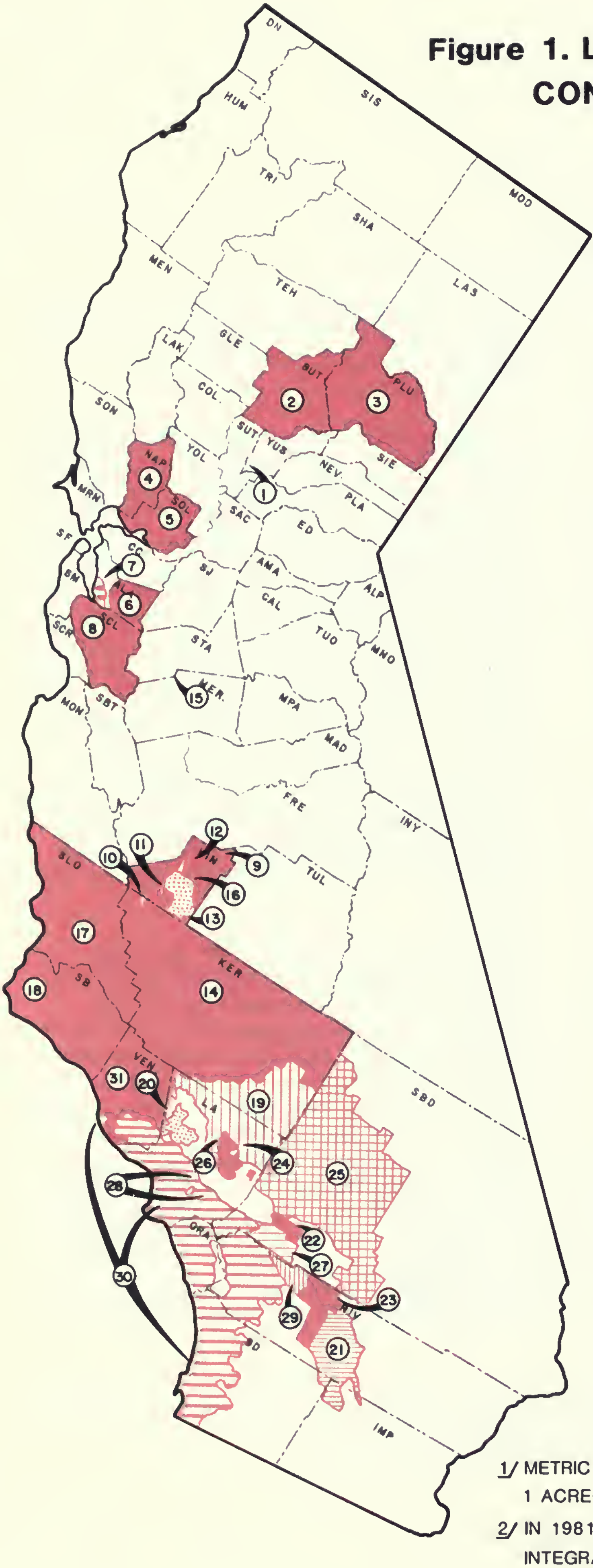

Figure 1. LONG-TERM WATER SUPPLY CONTRACTING AGENCIES

Location No.	Contracting Agency	Maximum Annual Entitlement (acre-feet)1/
	(1)	(3)
	UPPER FEATHER AREA	
1	City of Yuba City	9,600
2	County of Butte	27,500
3	Plumas County Flood Control and Water Conservation District	2,700
	Subtotal	39,800
	NORTH BAY AREA	
4	Napa County Flood Control and Water Conservation District	25,000
5	Solano County Flood Control and Water Conservation District	42,000
	Subtotal	67,000
	SOUTH BAY AREA	
6	Alameda County Flood Control and Water Conservation Dist., Zone 7	46,000
7	Alameda County Water District	42,000
8	Santa Clara Valley Water District	100,000
	Subtotal	188,000
	SAN JOAQUIN VALLEY AREA	
9	County of Kings	4,000
10	Devil's Den Water District	12,700
11	Dudley Ridge Water District	57,700
12	Empire West Side Irrigation District	3,000
13	Hacienda Water District2/	8,500
14	Kern County Water Agency	1,153,400
15	Oak Flat Water District	5,700
16	Tulare Lake Basin Water Storage District	110,000
	Subtotal	1,355,000
	CENTRAL COASTAL AREA	
17	San Luis Obispo County Flood Control and Water Conservation District	25,000
18	Santa Barbara County Flood Control and Water Conservation District	57,700
	Subtotal	82,700
	SOUTHERN CALIFORNIA AREA	
19	Antelope Valley-East Kern Water Agency	138,400
20	Castaic Lake Water Agency	41,500
21	Coachella Valley County Water Dist.	23,100
22	Crestline-Lake Arrowhead Water Agency	5,800
23	Desert Water Agency	38,100
24	Littlerock Creek Irrigation Dist.	2,300
25	Mojave Water Agency	50,800
26	Palmdale Water District	17,300
27	San Bernardino Valley Municipal Water District	102,600
28	San Gabriel Valley Municipal Water District	28,800
29	San Gorgonio Pass Water Agency	17,300
30	The Metropolitan Water District of Southern California	2,011,500
31	Ventura County Flood Control Dist.	20,000
	Subtotal	2,497,500
	TOTAL STATE WATER PROJECT	4,230,000

1/ METRIC CONVERSION:
1 ACRE-FOOT = 1.2335 CUBIC DEKAMETRES

2/ IN 1981 HACIENDA'S WATER CONTRACT BECAME INTEGRATED WITH TULARE LAKE BASIN'S CONTRACT.

Figure 2. THE STATE WATER PROJECT

drastically depleted fishery resources of the estuary.

Without corrective action, we can expect the continued decline of the fishery that is dependent on the Delta estuary. Even with continuing efforts to foster conservation and more reuse of existing supplies, the Department foresees temporary water shortages in the early 1980s, if a drought occurs, and prolonged water shortages in the 1990s, even without drought conditions, unless additional dependable water supplies are developed.

In recognition of these conditions, the Department began an earnest study to plan for the State Water Project Future Water Supply Program in 1975. It was recognized that no single action could protect the environment and meet the increasing water needs in areas that receive a portion of their water supplies from the Delta through the SWP. In July 1978, DWR published Bulletin 76, "Delta Water Facilities -- Program for Delta Protection and Water Transfer, Water Conservation, Water Recycling, and Surface and Ground Water Storage". This program involved the identification, evaluation, and screening of numerous alternatives for both reducing demands and increasing water supplies relative to the SWP. In addition to technical studies, this process involved numerous and extensive public hearings. The recommended plan identified a combination of the most viable measures -- physical, institutional, and statutory -- that could meet the reasonable demands for water from the Delta in an environmentally sound manner.

Beginning in 1977 and continuing through 1980, the Legislature was considering legislation that would include the Department's selected program and provide the necessary environmental protections. Senate Bill 200 passed the Legislature on July 7, 1980, and was signed by the Governor on July 18, 1980. It essentially incorporates DWR's recommended plan in Bulletin 76. It is designed to be a comprehensive means of meeting the water needs of the SWP, while imposing strict environmental safeguards for the Delta, the Suisun Marsh, and San Francisco Bay.

In a companion bill to SB 200, the Legislature also passed, and the voters approved at the statewide election in November 1980, Assembly Constitutional Amendment 90 (ACA 90) which gives the SB 200 environmental safeguards of Delta, Suisun Marsh, and San Francisco Bay added protection under the California Constitution. It also gives similar constitutional protection in Northern California to the State's Wild and Scenic Rivers Act, which prohibits the building of dams or the exporting of water from North Coast rivers. It would speed up any lawsuits on the Peripheral Canal so that it could be constructed in a timely manner.

Besides authorizing construction of the Peripheral Canal and related Delta facilities, and requiring agreements to ensure protection of Delta water quality and fish and wildlife, SB 200 provides for studies and implementation of additional surface and ground water storage facilities, water conservation, and reclamation programs to meet the water needs of the SWP through the year 2000.1/ Key elements of SB 200 are shown in Figure 3 and a copy of the bill is found in Appendix B of this report.

A referendum has now qualified and voters will be asked to approve or reject

---

1/ It also authorizes the Mid-Valley Canal to restore falling ground water levels on the east side of the San Joaquin Valley and facilities to transport water to Alameda, Contra Costa, San Joaquin, San Francisco and San Mateo Counties. These are separate from the SWP, however, and are not discussed in this report.

Figure 3. KEY ELEMENTS S.B. 200

SB 200 at either the next general election in 1982 or a special election called by the Governor. SB 200 will not be law unless there is a favorable vote by the people on the measure. If SB 200 is not approved by the voters, the constitutional protections in ACA 90 will be nullified, even though they were approved by the voters last November, because ACA 90 has a provision that it will only go into effect when SB 200 goes into effect.

The studies in this bulletin are a continuation of the work reported in Bulletin 76, and they have been adjusted to be fully compatible with SB 200 and ACA 90.

Need for Additional Dependable Water Supply

In studies leading to Bulletin 76, it was established that the present dependable water supply (firm yield) of the existing SWP facilities is 2.8 million dam^3 (2.3 million ac-ft) per year. By the year 2000, this will decrease to about 2.0 to 2.2 million dam^3 (1.6 to 1.8 million ac-ft) per year as a result of increased water use in the areas of origin, maturity of contractual obligations of the federal Central Valley Project, and other prior rights. During the same 20-year period, the demand for SWP contracted water will grow to about 3.95 million dam^3 (3.2 million ac-ft) per year by the year 2000, after allowing for slower population growth and water conservation and waste water reclamation programs in SB 200 (Bulletin 76). In the absence of the Peripheral Canal and other additional water supply facilities, the potential water shortages by the year 2000 are between 1.7 and 2.0 million dam^3 (1.4 and 1.6 million ac-ft) per year. These supply and demand relationships for the existing SWP facilities are illustrated by Figure 4 and are described in greater detail later in this chapter.

Sources of Additional Supply

Surface water runoff in California is extremely variable and unpredictable, in terms of both annual and monthly amounts. Natural flow tributary to the Sacramento-San Joaquin Delta during the past 60 years varied from a low of 8 400 000 dam^3 (6,800,000 ac-ft) in 1977 to a high of 69 700 000 dam^3 (56,500,000 ac-ft) in 1938.[1/] (Natural flows are historic flows corrected for upstream use and regulation by storage reservoirs.)

The Delta's two most severe drought periods in recorded history occurred during the periods of 1928-1934 and 1976-1977. Monthly distribution of the natural runoff occurs out-of-phase with most demands for water. Usually most of the precipitation occurs in the winter, whereas the greatest demand for water occurs in the summer.

Developments of surface water supplies from onstream reservoirs, under normal sizing criteria, usually provide relatively high amounts of average period yield, compared to dry period yield. However, some onstream reservoirs and most offstream reservoirs (using pump-diversion facilities) are located at sites which have small average inflow. Reservoirs at such sites cannot consistently provide large annual amounts of water. However, they can provide carry-over storage for large releases during dry periods, if they are maintained nearly full, with relatively small releases during normal years, to ensure maximum dry period yield. This fits the SWP system very well because during normal and wet years project deliveries can be met from intermittent excess

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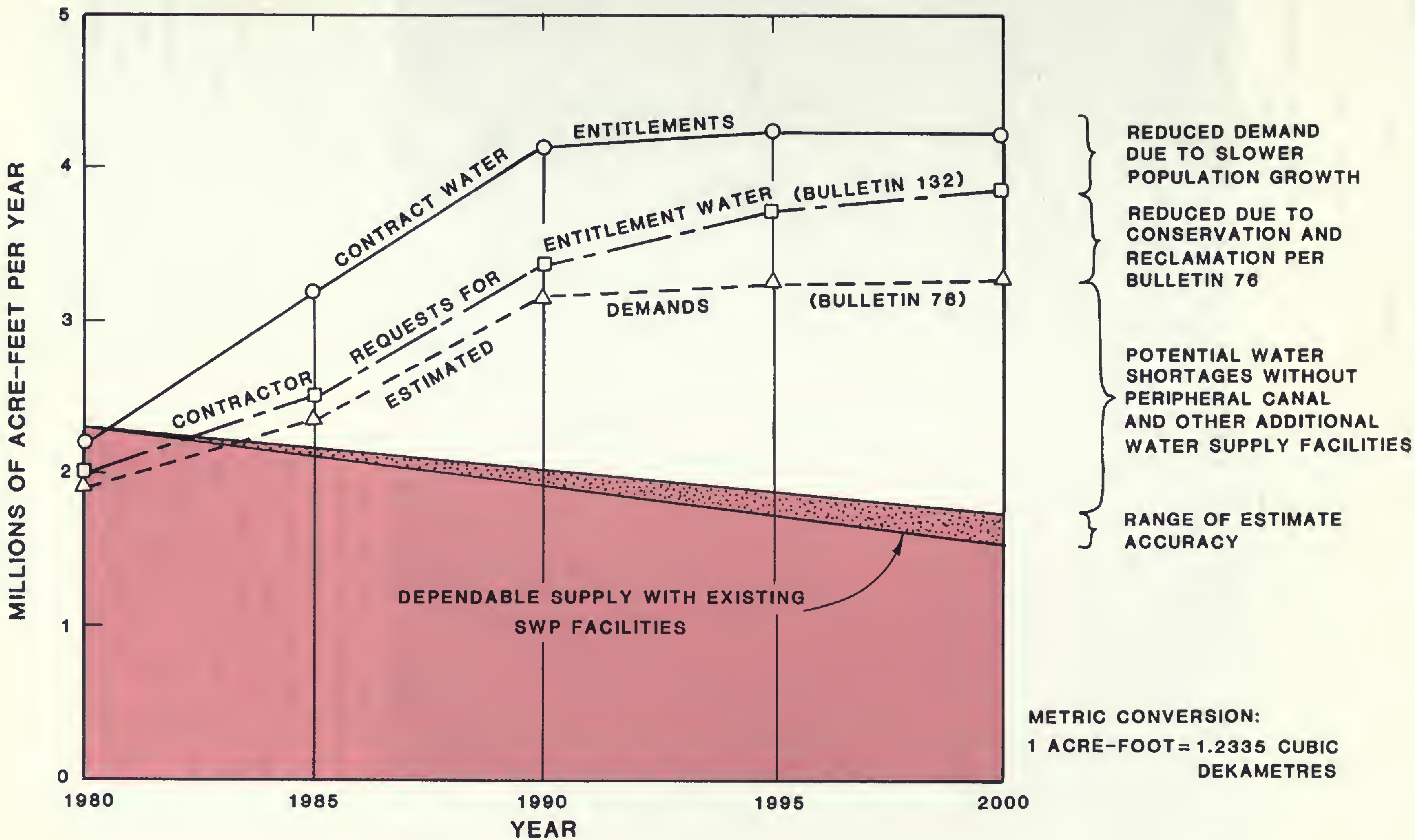
1/ Department of Water Resources, Division of Planning Report, California Central Valley Natural Flow Data, April 1980.

Figure 4. ESTIMATED SUPPLY AND DEMAND FOR STATE WATER PROJECT



water in the Delta, with reregulation at San Luis Reservoir.

There are many millions of acre-feet of empty storage space in ground water basins located in the general vicinity of State Water Project service areas in the South Bay, South Coastal area, and San Joaquin Valley. Filling these basins with excess Delta supplies in the wetter years will provide additional long-term carryover storage for development of dry-period yield. Under current plans of the Department of Water Resources, most of the initial filling would occur during the next 20 to 30 years. There would be a conjunctive operation among the ground water basins, the California Aqueduct, and surface water reservoirs in order to maximize the water yield of existing and future SWP facilities. Underground storage is more advantageous than surface storage from the standpoint of relatively low capital cost and no evaporation loss.

Waste water reclamation projects provide yield quantities in relatively constant annual amounts, compared to some of the surface and ground water storage plans described above. This is primarily because the surface and ground water plans have a fluctuating source of water supply (large in wet periods and small in dry periods) and releases are made in conjunction with supplemental demands of the State Water Project.

Since most new surface water storage and underground storage plans favor either average-period yield or dry-period yield, and because of cost and environmental considerations, the Department proposes a mix of water management and development strategies to reduce the rate of demand buildup and to increase the yield of the State Water Project. In addition, the federal Central Valley Project (CVP) may also need an augmentation of its supplies, and some of the facilities under investigation could ultimately become joint Federal-State units similar to the existing San Luis Project.

General proposals by the Department of Water Resources include:

° Water Conservation.

° Waste Water Reclamation and Brackish Water Desalination.

° Conjunctive use of the California Aqueduct (a SWP facility) and available storage space in ground water basins.

° Installation of the remaining pumps (four units totaling 120 cubic metres per second (m^3/sec) - 4,268 cubic feet per second (ft^3/s) at the Delta Pumping Plant.

° Construction of the Peripheral Canal.

° Construction of additional surface storage facilities. This includes onstream and offstream storage at locations north and south of the Delta, and a possible water exchange plan to use available storage space at Lake Mead (Colorado River Banking plan).

° Possible purchase of agricultural water during drought periods.

Also, as part of its conservation and reclamation studies, the Department is preparing a plan of water conservation, reclamation, and management for the State Water Project to be submitted to the State Water Resources Control Board (SWRCB) in compliance with the Governor's Executive Order B-68-80, which he issued simultaneously with the signing of SB 200. The plan will recommend actions that could be undertaken by the State and its water service contractors to reduce the demand for water, to reclaim urban and agricultural waste water, to store water underground in order to provide for dry years, and to provide for consideration of pricing changes, water exchanges, and other methods for reducing the demand for new water facilities. In that same executive order, the Governor urged the SWRCB to require such water conservation and management

The California Aqueduct transports water from the Delta
to State Water Project service areas.

plans in the exercise of its water rights authority.

State Water Project Yield

State Water Project yield (firm yield) is defined as the annual supply of water that can be sustained in all years, except that, during critically dry periods, lower supplies (or deficiencies) are permitted in accordance with predetermined provisions in the SWP water supply contracts. The contracts allow deficiencies in annual agricultural water deliveries of up to 50 percent in any one year and up to a total of 100 percent in any seven consecutive years.

SWP yield is made up of a combination of direct diversions from the Delta (excess flows over those not needed to meet Delta water quality criteria) and releases of water previously stored in reservoirs during wet periods for use in dry periods. Studies of project operation for the historic 50-year period, 1922-1971, have shown that the firm annual yield from existing SWP facilities is about 2.8 million dam^3 (2.3 million ac-ft), without exceeding the allowable deficiencies in agricultural water deliveries. Historically, the period 1928 to 1934, included within the 50-year historic period, constitutes the driest seven consecutive years for determining project yield, even though the 1976-1977 drought was the most severe two-year sequence of record.

Just as there are dry years when deficiencies must be taken, there are also wetter years when water over and above the dependable yield is available. For example, in five of the last nine years, we estimate that total delivery capability of the SWP exceeded 3.7 million dam^3 (3.0 million ac-ft), and in two of those years, exceeded 3.3 million dam^3 (2.7 million ac-ft).

Without adding any new facilities, the firm annual yield at SWP service areas will decrease to between 2.0 and 2.2 million dam^3 (1.6 and 1.8 million ac-ft) per year by the year 2000, as a result of upstream uses in the areas of origin and as CVP contractual obligations mature. Availability of intermittent excess supplies in the Delta will also diminish during this 20-year period. This lower yield estimate and the reduced intermittent excess supplies constitute the base water supply conditions used by DWR in planning for future water supply augmentations for SWP by the year 2000.

Yield from a new facility depends on how it is operated and integrated into the SWP system. Water yield from new facilities (including ground water basins) under study is described herein as "incremental project yield". Incremental project yield is the difference in the annual amount of dependable water supply that would be available from the integrated SWP system, with and without the particular facility under study. Incremental project yield includes the specific contribution of the new facility plus the firming up of what otherwise would be intermittent excess water from the Delta. The incremental project yield was determined to be the amount of additional yield that could be sustained by the State Water Project throughout the 50-year study period, which included the critical drought of 1928-1934.

It is also possible that the yield accomplishment of certain new facilities will be enhanced if the new facility is operated conjunctively with other new facilities. An example of this, which is currently under study, would be to combine the operation of Los Vaqueros offstream storage facilities in Contra Costa County with the conveyance and storage of surplus Delta flows in ground water basins in the San Joaquin Valley and Southern California. In July 1981, DWR developed a computer simulation model to perform this type of yield analysis, but the results of such yield studies are not yet available. However, early indications point toward the potential of perhaps doubling the yield otherwise attainable from Los Vaqueros.

The Delta and the Peripheral Canal

While advanced planning and EIR studies for the Delta and Peripheral Canal are being conducted outside the Department's SWP Future Water Supply planning investigation, the Delta and Canal are of sufficient importance to the operation and effectiveness of existing and future SWP facilities to warrant summarizing their role here. The Peripheral Canal is a key element in the State's plan because it will reduce the carriage water and Delta outflow requirements to meet Delta water quality standards required by law during Delta export operations (see following section). Hence, the most effective use of future surface and ground water storage projects is dependent upon prior completion of the Peripheral Canal or some equivalent Delta transfer facility.

Delta Export and Water Quality Relationship

Most of the water available for export in the Delta enters from the north via the Sacramento River either as unregulated flow, return flow from upstream uses, or releases from reservoir storage. The main export pumps of the State Water Project (SWP) and the federal Central Valley Project (CVP) are located at the southeastern edge of the Delta, far removed from the normal route of the

Waterways and island farms in the Sacramento-San Joaquin Delta.

Sacramento River. Since the water level throughout the Delta-Bay estuary is almost flat and approximately at sea level, the water from the Sacramento River can be drawn across the Delta to the export pumps.

Existing channel capacities limit the amount of water that can be transferred from the Sacramento River via the Delta cross channel and Georgiana Slough through the central Delta to the main SWP and CVP export pumps. This limitation causes a portion of water to flow into the western Delta and then back upstream (reverse flow), where it blends with the cross-Delta flow on the way to the pumps (Figure 5). The route of the export water is important because the water becomes more saline due to seawater intrusion as it approaches the western edge of the Delta. The salinity of the water in the western Delta depends on the amount of water flowing out of the Delta to repulse the sea water.

Under controlled flow conditions, the rates of Delta inflow, outflow, and export must be carefully balanced to avoid exceeding the water quality criteria in the Delta and at project diversion facilities for the Contra Costa Canal and the Delta-Mendota Canal of the CVP, and for the California and South Bay Aqueducts of SWP. As export rates are increased, more water is drawn from the western Delta and, to maintain the salinity balance, the sea water must be repelled farther west by additional Delta outflow called "carriage water". During periods of low natural flow, most of this carriage water must be released from upstream storage reservoirs of the SWP and CVP. This general relationship is illustrated qualitatively by the curved line on Figure 6. The specific relationship varies at different times of the year because of variations of Delta consumptive use for the various Delta uses at different times of the year.

Peripheral Canal Operation and Yield

With the Peripheral Canal in operation, the point of diversion for the exports would be moved to the Sacramento River in the northern Delta. This change in diversion point, coupled with releases[1/] from the Canal, would restore positive downstream flow in the main channels of the Delta and eliminate the drawing of saline water from the western Delta (see Figure 5).

With water no longer being drawn from the western Delta, the outflow would not have to be increased to maintain water quality as exports are increased. Water quality standards could then be met independently of Delta export rates, as shown qualitatively by the horizontal line of Figure 6. As with the curved line, the specified relationship varies throughout the year, depending on the particular quality criteria -- agricultural, municipal, industrial, or fish and wildlife -- that control the project operation at various times of the year.

The distance between the curved and horizontal lines on Figure 6 conceptually represents the potential conservation of Delta outflow that could be realized with the Peripheral Canal, while meeting the same Delta water quality standards. The exact savings depends on the level of export and the quality standards established by the State Water Resources Control Board (SWRCB), both of which vary from year to year and at different times during the year.

On the basis of quality criteria in SWRCB Decision 1485 and project exports in the year 2000, the new yield made available for SWP Delta exports as a result of constructing and operating the Peripheral Canal (including the installation of the four remaining pumps at the Delta Pumping Plant) is about 860 000 dam^3 (700,000 ac-ft) per year. This "new water" comes about primarily

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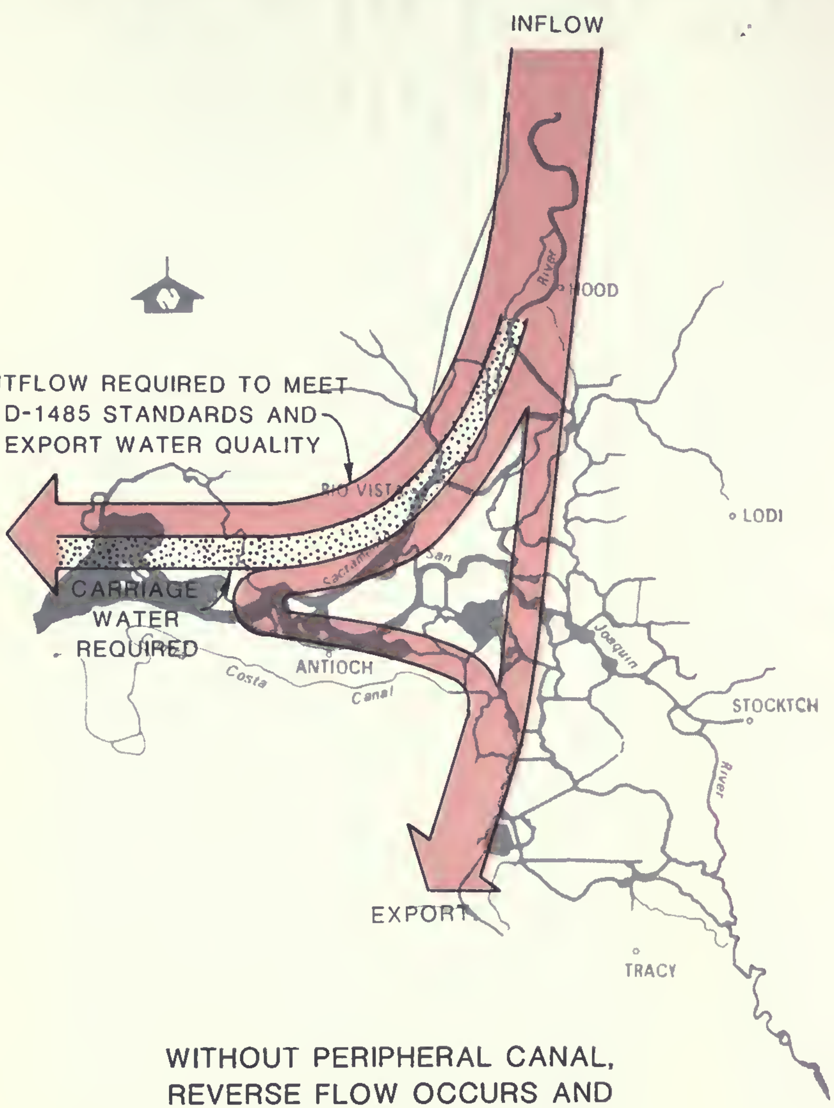
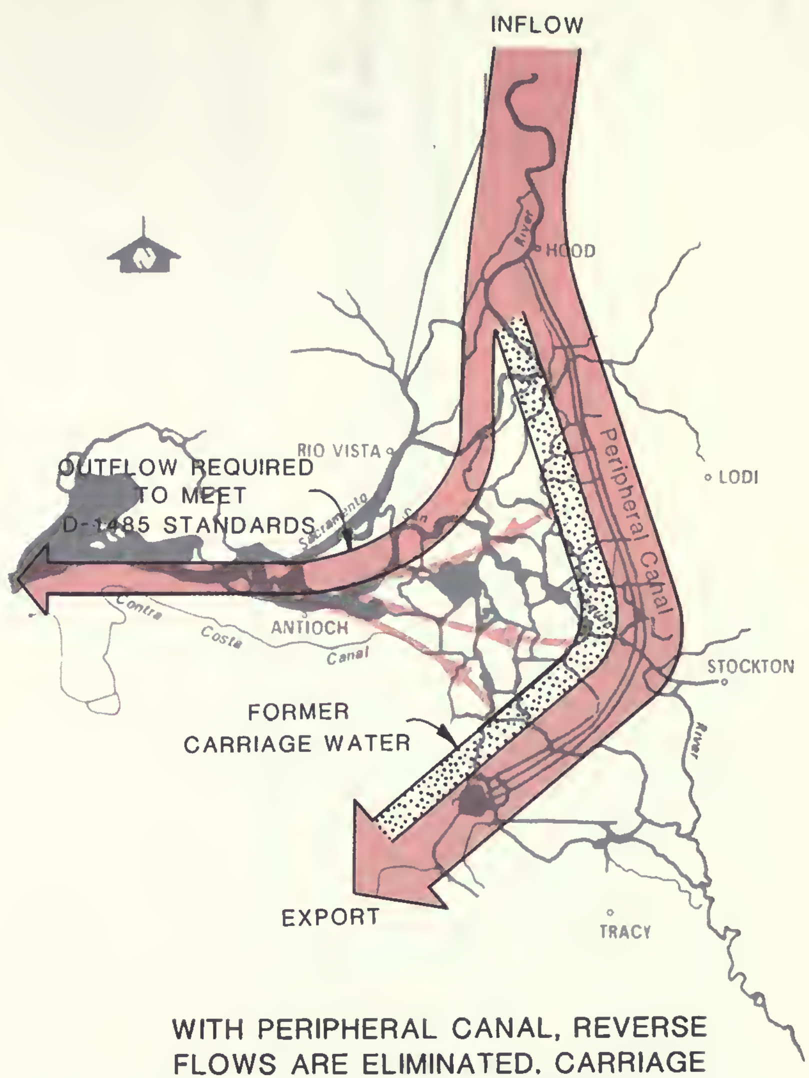
1/ Shown conceptually by three arrows to simulate the 14 separate release points.

Figure 5. DIAGRAMS OF DELTA OUTFLOW-EXPORT WATER DISTRIBUTION

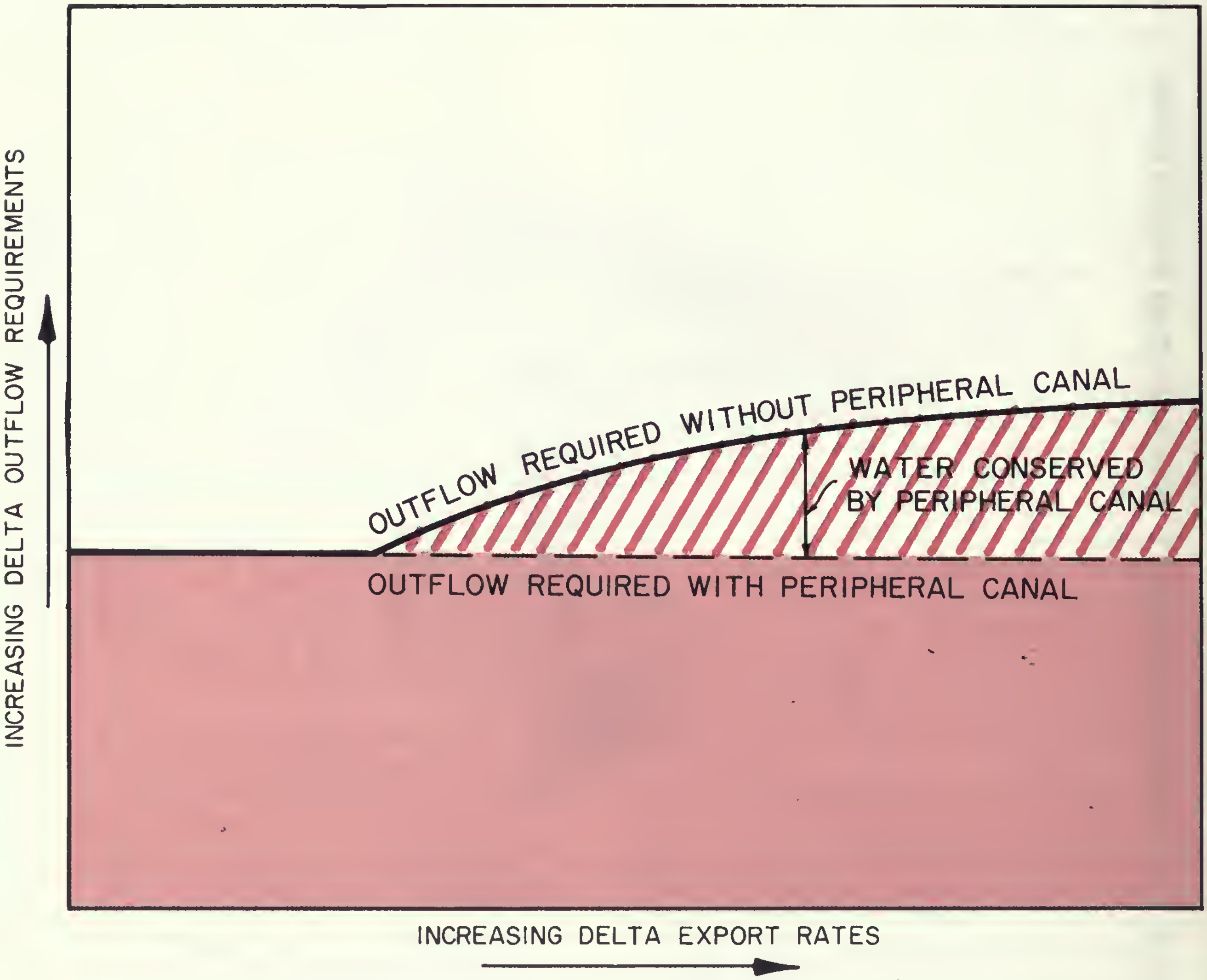


WITHOUT PERIPHERAL CANAL, REVERSE FLOW OCCURS AND CARRIAGE WATER IS NEEDED TO MAINTAIN WATER QUALITY.



WITH PERIPHERAL CANAL, REVERSE FLOWS ARE ELIMINATED. CARRIAGE WATER IS NO LONGER NEEDED AND BECOMES ADDITIONAL YIELD.

Figure 6. PERIPHERAL CANAL YIELD



through elimination of carriage water requirements, which would otherwise be be necessary during a critical drought period in the absence of the canal, while continuing to meet the Delta water quality standards required by the SWRCB Decision 1485.

For this bulletin, the Peripheral Canal was assumed to be built and operating when the potential yield from future surface and ground water facilities was computed. It is of particular importance because without it (or some equivalent water transfer facility), the incremental yield from such storage facilities would be less. For alternatives south of the Delta, there would be less intermittent excess outflow available for diversion and storage, which in turn would reduce the potential yield from these sources. For projects north of the Delta, some of the newly developed supplies would have to be devoted to additional carriage water when transporting such supplies across the Delta during dry periods. As an example, the deliverable yield from Cottonwood Creek Project was computed to be about 15 percent greater with the Peripheral Canal than without it. Similar computations have not been made for the other facilities.

Summary of Specific Proposals

The general location and statewide nature of the SWP water supply augmentation plans under investigation are shown on Figure 7. For discussion purposes, these are grouped under these general headings:

- Water Conservation and Reclamation (Chapter II)
- Ground Water Basin Storage (Chapter III)
- Surface Water Facilities (Chapter IV)
- Agricultural Water Purchase Plan (Chapter V)

Water Conservation and Reclamation

Water conservation and reclamation are considered together for planning purposes because of their interrelationship. Effective water conservation practices tend to reduce the quantity of waste water supply available for reclamation.

Water conservation is the saving, or reduction in use, of existing water supplies through such practices as (1) increased efficiency of crops and lawn irrigation, (2) use of salt tolerant crops, (3) elimination of nonessential water use, and (4) use of efficient devices such as low-flow shower heads and low-flush toilets. Strong evidence of the ability of California's citizens and communities to conserve water was demonstrated during the 1976 and 1977 drought. Major reductions of water use were made throughout the State during that period, particularly in municipal water use.

For water conservation due to reuse is to be considered as an alternative to developing new supplies, the savings must be comprised of water that has not previously been reused. This is the case with much of the municipal and industrial (M&I) water use in the three coastal areas served by the SWP. There, large quantities of water are used once and then disposed of to saline waters without the opportunity for reuse.

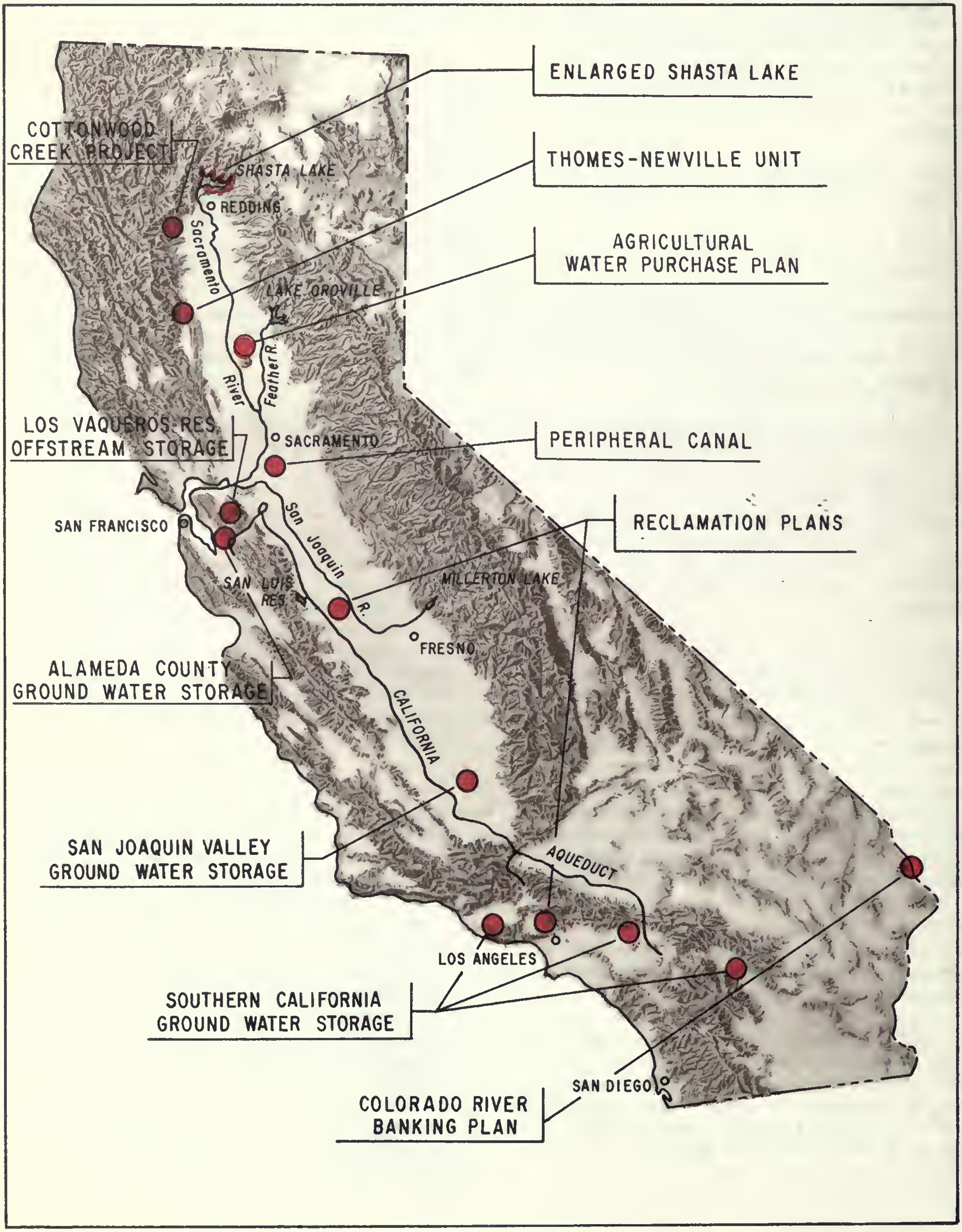
In contrast, the vast majority of irrigation use of SWP water occurs in the southern San Joaquin Valley in the Tulare Lake Basin. In this closed basin, many methods of conserving water would save water that is now being reused; i.e., water that either percolates to ground water or appears as return flow where it becomes part of the supply for other farmers or is otherwise reused. A reduction in net irrigation demand can only come from conservation methods which reduce the evapotranspiration or capture return flows that would otherwise drain to saline water bodies.

Water reclamation, as used herein, is the process of collecting and treating either municipal, industrial, or agricultural waste water or other brackish water that would otherwise be disposed of, to produce water of suitable quality for additional beneficial uses. Reclamation projects treating municipal waste water generally use conventional waste water treatment plants capable of either primary, secondary, or advanced treatment processes. Reclamation projects treating agricultural waste water or brackish water generally use a desalter.

The State Department of Health Services has issued a statement regarding the use of reclaimed municipal waste water. The statement declares the direct mingling of reclaimed municipal waste water in a domestic water system and the direct injection of such reclaimed waste water into aquifers supplying domestic water is unacceptable. Such water can be useful for many purposes, however, including instream flow augmentation and irrigation of pasture land, golf courses, and crops. In this way it can free fresh water for other uses.

Considering the foregoing factors, DWR established the goal of reducing SWP water demands by 860 000 dam^3 (700,000 ac-ft) annually by year 2000

Figure 7. WATER AUGMENTATION PLANS UNDER INVESTIGATION



by conservation and reclamation in coastal M&I service areas. This goal was set forth in Bulletin 76 and is also contained in SB 200. While this goal is currently being refined on a SWP contractor-by-contractor basis as part of the studies pursuant to the Governor's Executive Order B-68-80, it remains the DWR's goal for the present and is the basis for estimating future SWP demands (Figure 4) in this bulletin.

Water conservation and locally sponsored reclamation projects only defer (rather than reduce) the SWP demands because they do not contribute toward meeting the maximum annual water entitlements in SWP contracts. However, if a waste water reclamation development is made part of the SWP, its yield would contribute to meeting the 5.22 million dam^3 (4.23 million ac-ft) maximum annual entitlements of the SWP and thus would represent a permanent reduction in SWP exports from the Delta. SB 200 would require that any such additions to the SWP be economically competitive with alternative new water supply sources. As part of its SWP future water supply planning program, DWR is investigating a number of waste water reclamation projects as possible additions to the SWP. (See Chapter II, Figure 9.)

Additional and more detailed information on DWR water conservation and reclamation planning is presented in Chapter II. Table 1 (at the end of Chapter 1) presents a list of more promising reclamation projects with information regarding status, accomplishments, economic and environmental considerations.

Ground Water Basin Storage

Alternative plans for development of additional yield in SWP service areas through conjunctive use of the California Aqueduct and ground water basins are discussed in Chapter III and Appendix A. The ground water basins would provide regulatory and long-term carryover storage space for excess flows transported from the Sacramento River Delta by the California Aqueduct. Basins which are under study or being considered for future study include:

Basin	Location (County)
Chino	San Bernardino, Riverside
Kern River Fan	Kern
Bunker Hill-San Timoteo-Yucaipa	San Bernardino, Riverside
San Fernando	Los Angeles
Orange	Orange
Raymond	Los Angeles
Livermore Valley	Alameda

Specific information on plans for ground water basin storage is summarized at the end of this chapter in Table 2.

Surface Water Facilities

Alternative plans for surface water development are discussed in Chapter IV and Appendix A. The surface water projects which are under study or which are being considered for future study include:

- Cottonwood Creek Project
- Thomes-Newville Plan
- Los Vaqueros
- Shasta Lake Enlargement
- Colorado River Banking Plan

Specific information on surface water plans is summarized in this chapter in Table 3. For comparison, data on the Peripheral Canal is also included.

Agricultural Water Purchase Plan

The Agricultural Water Purchase Plan (AWPP) is a nonstructural means of increasing the yield of the State Water Project by purchasing water upstream from the Delta from farmers or water districts willing to sell such water.

While the goal of an AWPP would be to prevent severe water shortages and economic impacts in agricultural areas served by the SWP, it appears such a plan is not without social and environmental impacts, as well as certain economic costs to the area foregoing the use of water. Nevertheless, in a reconnaissance investigation of a potential AWPP, DWR concluded that during emergency periods such a plan is worthy of further consideration as a means of augmenting the SWP yield. An assessment of the local socioeconomic impacts of this plan is contained in a January 1981 report by SRI International, acting as a consultant to DWR, and the conclusions are summarized in Chapter IV.

For an AWPP to be acceptable, it would need to be voluntary. The plan could become implementable upon agreement among all parties that adequate safeguards to the farmers and to the environment can be assured. It can be envisioned that the role of DWR would be to negotiate with willing participants to meet its contractual commitments in drought years.

The Agricultural Water Purchase Plan is discussed in greater detail in Chapter V and information on the plan is summarized in Table 3.

Comparison of Alternatives

Descriptive information and data relating to the status of investigation, planning and environmental factors, project accomplishments, and estimated costs are summarized and compared in Tables 1, 2, and 3. The information in these tables is a concise summary of a large group of extremely complex water development possibilities. Many engineering, economic, environmental, social and/or political issues related to each project cannot be fully described in the tables. It is important, therefore, that the project descriptions provided in the following chapters, and Appendix A, be read in conjunction with these tables.

The comparisons in Tables 1, 2 and 3 are grouped under these general headings: "Reclamation Projects"; "Ground Water Basin Developments"; and "Surface Water Facilities" (includes Agricultural Water Purchase Plan). A brief description of the information shown under the various column headings for Tables 1, 2, and 3 follows:

Column 1 - Name of water supply source (size or capacity is included for Table 3).

Column 2 - Status of Investigation.

Column 3 - Incremental Project yield is indicated as follows:

Table 1 -- the values indicate the amount of water supply produced annually by the reclamation plant.

Tables 2 and 3 -- the values are the amounts of dependable yield increase to the SWP (or a joint SWP/CVP system) due to adding the indicated source of new supply.

Column 4 - Net energy requirements in kilowatthours per cubic dekametre and per acre-foot of new water yield for each source of water supply are listed as follows:

Table 1 -- the upper values are the energy required for the indicated relamation plant. The lower values are the alternative energy requirement for transportation of water from the Delta to the same vicinity via SWP facilities.

Table 2 -- the upper values are the energy required for transportation from the Sacramento River Delta. The lower values are the energy required to recapture the ground water. The total energy requirement would be the sum of the two values.

Table 3 -- the value shown is the additional energy required (or generated in the case of a negative value), measured at the Sacramento-San Joaquin Delta, as the result of adding the indicated source of new supply. Additional energy requirements for transportation of water from the Delta to SWP service areas are listed in Table 4.

Column 5 - Land needs are for the following:

Table 1 -- Area required for the reclamation project.

Table 2 -- Area required for ground water recharge.

Table 3 -- Area inundated by the indicated new reservoir; the possible area required for wildlife mitigation purposes is not included.

Column 6 - Values indicate the estimated cost of the indicated source of new water supply, based on 1981 price levels. First cost is the cost required for construction of facilities, land and rights of way, relocation, and engineering costs. Unit cost of water is the cost per cubic dekametre (per acre-foot) of dependable incremental project yield to repay total project costs, including interest (7-3/8 percent per year over a 50-year period, plus the period of construction), energy, and reservoir filling costs. Costs in Tables 1 and 2 include cost of water development plus transportation to the area of use. Table 3 costs are for water supply at the Sacramento Delta. Variable transportation costs (operation, maintenance, power and replacement) from the Delta to the various SWP service areas are listed in Table 4. The combined costs from Tables 3 and 4 are comparable to costs shown in Tables 1 or 2. This adjustment must also be made to the cost of yield from San Francisco Area Waste Water Reclamation Plan that delivers water to the western Delta for salinity outflow (Table 1), since the water it replaces must be transported to the SWP service areas.

Columns 7-11 - Indicate engineering, environmental, social, legal and other considerations related to sources of new water supply. An explanation of items marked with an asterisk (*) is listed in the Remarks column.

Table 4 presents energy requirements and cost to transport one cubic dekametre (one acre-foot) of water from the Sacramento Delta to the various service areas served by the SWP aqueduct. This information can be combined with the energy and cost requirements shown in Columns 4 and 6 of Table 3 to help compare the listed surface water projects to reclamation projects and ground water storage developments shown in Tables 1 and 2.

TABLE 1. RECLAMATION PROJECTS-- PLANNING AND ENVIRONMENTAL CONSIDERATIONS [1/]

WATER SUPPLY ALTERNATIVES	STATUS	INCREMENTAL PROJECT YIELD 1 000 DAM³/ YR (1,000 AC-FT/YR)	NET ENERGY REQ'D KWH/DAM³ (KWH/AC-FT) [(SWP ALTERN. SUPPLY)] [2/]	LAND NEEDS HECTARES (ACRES)	1981 COSTS AT PROJECT SITE: FIRST COST $1,000,000	UNIT COST $/DAM³ ($/AC-FT)
1	2	3	4	5	6	
I. LOCAL PROJECTS - PART OF SWP						
A. LAS VIRGENES (MUNICIPAL WASTE WATER RECLAMATION)	UNDER STUDY	6.2 to 7.4 (5.0 to 6.0)	550 (680) [SWP 2 100 (2,600)]	565 (1,400)	6.0 to 6.5	220 to 245 (275 to 300)
B. GOLETA (MUNICIPAL WASTE WATER RECLAMATION)	UNDER STUDY	1.2 to 10.6 (1.0 to 8.6)	2 760 (3,400) [SWP 2 760 (3,400)]	NOT AVAILABLE	34	570 (700)
C. CITY OF SIMI VALLEY (BRACKISH GROUND WATER DESALTING)	FUTURE [4/] STUDY	2.5 (2)	2 030 (2,500) [3/] [SWP 2 100 (2,600)]	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE
D. LOWER CHINO BASIN (BRACKISH GROUND WATER DESALTING)	UNDER STUDY	21 (17)	2 030 (2,500) [3/] [SWP 2 350 (2,900)]	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE
E. SAN JUAN BASIN (BRACKISH GROUND WATER DESALTING)	FUTURE [4/] STUDY	5.1 (3.9)	2 030 (2,500) [3/] [SWP 2 350 (2,900)]	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE

1 COLUMN DESCRIPTIONS ARE GIVEN ON PAGE 18 2, SWP ENERGY CANAL SIDE ONLY IN VICINITY OF RECLAMATION PLANT

3 PLANT PROCESSING ENERGY ONLY · PRELIMINARY STUDY HAS NOT DEFINED EXACT SERVICE AREA

SHEET 1

ENGINEERING CONSIDERATIONS	ENVIRONMENTAL CONSIDERATIONS	SOCIAL FACTORS	LEGAL / INSTITUTIONAL / POLITICAL CONSIDERATIONS	REMARKS
7	8	9	10	11
• DISTRIBUTION SYSTEM WOULD BE LOCATED IN CONGESTED AREA.				• USE OF WATER WOULD BE FOR MAINTAINING GREENBELTS, ORCHARDS, GOLF COURSES AND HIGHWAY AND RESIDENTIAL LANDSCAPES.
• REQUIRES CONSTRUCTION OF 3,500 AF RESERVOIR AND DISTRIBUTION SYSTEM. • SYSTEM WOULD USE REVERSE OSMOSIS METHOD FOR SOME OF THE WATER.	• HIGH ENERGY REQUIREMENTS FOR WASTE WATER TREATMENT IS OF PRIMARY CONCERN.			• USE OF WATER WOULD BE FOR LANDSCAPE MAINTENANCE AND AGRICULTURAL IRRIGATION.
• PLANT SITE IS CLOSE TO SWP RELATED FACILITIES, WATER SUPPLY, AND SERVICE AREA OF USE.	• GROUND WATER EXTRACTION WILL CONTROL HIGH WATER TABLE BUT MAY HAVE MINIMAL EFFECT ON NATURAL HABITAT. • CLASS I WASTE DISPOSAL SITE EXISTS TO HANDLE BRINE.		• DEPARTMENT OF FISH AND GAME WOULD OBJECT TO PROJECT IF STREAM HABITAT WERE ADVERSELY AFFECTED. • CITY IS CONCERNED IT MIGHT HAVE TO PAY ESCALATING SWP WATER COSTS EVEN THOUGH CITY IS PROVIDING GROUND WATER FOR DESALTING PLANT.	• BENEFICIAL USE WOULD BE FOR MUNICIPAL, INDUSTRIAL, AND AGRICULTURE. • PRELIMINARY EVALUATION OF SITE IS COMPLETED. NEXT LEVEL OF STUDY WOULD BE RECONNAISSANCE. 4/
• EXISTING BRINE DISCHARGE LINE TO OCEAN IS AVAILABLE. • NEW EXTRACTION WELLS MAY BE REQUIRED IF PRESENT WELLS ARE INADEQUATE.	• GROUND WATER EXTRACTIONS WOULD REDUCE RISING WATER AND IMPROVE WATER QUALITY OF LOCAL SUPPLY.		• USE OF SWP WATER FOR GROUND WATER RECHARGE MAY BE ULTIMATE FACTOR IN PROPOSED DESALTING PLANT AND LONG-TERM USEFULNESS OF PLANT	• BENEFICIAL USE WOULD BE FOR MUNICIPAL, INDUSTRIAL, AND AGRICULTURE. • PRELIMINARY EVALUATION OF SITES IS COMPLETED.
	• DESALTING OF HIGH TDS-LOW FLOWS WOULD ELIMINATE A SOURCE OF DEGRADATION OF GROUND WATER. • EXTRACTION OF GROUND WATER COULD ADVERSELY AFFECT SURFACE FLOWS, HENCE WILDLIFE.		• DEPARTMENT OF FISH AND GAME WOULD OBJECT TO PROJECT IF STREAM HABITAT WERE ADVERSELY AFFECTED.	• BENEFICIAL USE WOULD BE MUNICIPAL, INDUSTRIAL, AGRICULTURAL, AND POTENTIAL FOR GROUND WATER RECHARGE. • PRELIMINARY EVALUATION OF SITE IS COMPLETED. NEXT LEVEL OF STUDY WOULD BE RECONNAISSANCE. 4/

4/ DWR WILL NOT BEGIN RECONNAISSANCE STUDY UNTIL REQUESTED BY METROPOLITAN WATER DISTRICT.

TABLE 1. (Cont.) RECLAMATION PROJECTS-- PLANNING AND ENVIRONMENTAL CONSIDERATIONS 1/

WATER SUPPLY ALTERNATIVES	STATUS	INCREMENTAL PROJECT YIELD 1 000 DAM^3/YR (1,000 AC-FT/YR)	NET ENERGY REQ'D. KWH/DAM^3 (KWH/AC-FT) [(SWP ALTERN. SUPPLY)] 2/	LAND NEEDS HECTARES (ACRES)	1981 COSTS AT PROJECT SITE	
					FIRST COST $1,000,000	UNIT COST $/DAM^3 ($/AC-FT)
1	2	3	4	5	6	
II. REGIONAL PROJECTS (MUNICIPAL WASTE WATER RECLAMATION)						
A. SAN FRANCISCO AREA						
° AT DELTA - (FOR OUTFLOW)	UNDER STUDY	296 (240)	1 130 (1,400) [SWP-0]	NOT AVAILABLE	640	195 (240)
° SOUTH SAN JOAQUIN VALLEY SERVICE SITE	UNDER STUDY	418 (340)	1 620 (2,000) [SWP 360 (450)]	NOT AVAILABLE	1240	285 (350)
B. ORANGE & LOS ANGELES COUNTIES						
°L.A. CO. SERVICE SITE	UNDER STUDY	153 (124)	590 (730) [SWP 2 350 (2,900)]	NOT AVAILABLE	200	280 (345)
° ORANGE CO. SERVICE SITE NORTH	UNDER STUDY	15 (12)	1 280 (1,580) [SWP 2 350 (2,900)]	NOT AVAILABLE	12	285 (350)
SOUTH	UNDER STUDY	15 (12)	540 (670) [SWP 2 350 (2,900)]	NOT AVAILABLE	24	170 (210)
C. SAN DIEGO COUNTY	UNDER STUDY	41 (33)	2 190 (2,700) [SWP 2 350 (2,900)]	NOT AVAILABLE	41	760 (940)
D. VENTURA COUNTY	UNDER STUDY	105 (85)	NOT AVAILABLE [SWP 2 100 (2,600)]	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE
E. SO. SANTA CLARA VALLEY GROUND WATER RECHARGE (USING RECLAIMED WATER)	UNDER STUDY	NOT AVAILABLE	NOT AVAILABLE [SWP 920 (1,130)]	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE

1/ COLUMN DESCRIPTIONS ARE GIVEN ON PAGE 18

2/ SWP ENERGY CANALSIDE ONLY IN VICINITY OF RECLAMATION PLANT.

SHEET 2

ENGINEERING CONSIDERATIONS	ENVIRONMENTAL CONSIDERATIONS	SOCIAL FACTORS	LEGAL/ INSTITUTIONAL/ POLITICAL CONSIDERATIONS	REMARKS
7	8	9	10	11
• BOTH ALTERNATIVES INVOLVE TRANSPORTATION OF PRODUCT WATER CONSIDERABLE DISTANCE TO LOCATION OF USE. • DRAINAGE FROM SAN JOAQUIN VALLEY SERVICE ARE NOT INCLUDED IN COSTS.	• ENERGY REQUIREMENTS FOR TRANSPORTATION OF PRODUCT WATER IS VERY HIGH FOR BOTH ALTERNATIVE AREAS. • THE RECLAIMED WATER WILL TRANSPORT ADDITIONAL QUANTITIES OF SALT (900-1000 PPM) INTO THE SAN JOAQUIN VALLEY. THIS WILL REQUIRE SALT REMOVAL FROM THE SERVICE AREA AND SUITABLE DISPOSAL METHODS.	• CONCERN FOR HEALTH RELATING TO USE OF WASTE WATER WILL RE-STRICT SPECIFIC USES.	• LACK OF GENERAL ACCEPTANCE BY AGRICULTURAL INTERESTS TO USE RECLAIMED WATER IN LIEU OF PRESENT SWP SUPPLY WOULD REQUIRE AN EX-CHANGE AGREEMENT BETWEEN M&I USERS.	• WATER COULD BE USED FOR DELTA SALINITY CONTROL TO ALLOW INCREASED FRESH WATER EXPORTS TO SWP. • USE OF THE RECLAIMED WATER WOULD BE FOR CERTAIN TYPES OF AGRICULTURE IN SAN JOAQUIN VALLEY AND SOME COULD BE USED IN HEAVY OIL EXTRACTION.
		• CONCERN WITH HEALTH ASPECTS OF REUSE WILL RESTRICT UTILIZATION OF TREATED WASTE WATER.		• WATER FOR USE IN THESE SERVICE AREAS COULD BE FOR GREENBELTS, GOLF COURSES, PARKS AND GROUND WATER RECHARGE.
	• HIGH ENERGY REQUIREMENTS FOR WASTE WATER TREATMENT IS OF PRIMARY CONCERN.			• WATER COULD BE USED FOR GOLF COURSES, PARKS, AND AGRICULTURE.
				• WATER COULD BE USED FOR GOLF COURSES, PARKS, AND AGRICULTURE.
				• THIS 18-MONTH STUDY IS A MUTUAL EFFORT BETWEEN EPA, SWRCB, AND DWR. STUDY BEGAN JANUARY 15, 1981.

TABLE 1. (Cont.) RECLAMATION PROJECTS-- PLANNING AND ENVIRONMENTAL CONSIDERATIONS 1/

WATER SUPPLY ALTERNATIVES	STATUS	INCREMENTAL PROJECT YIELD 1 000 DAM^3/YR (1,000 AC-FT/YR)	NET ENERGY REQ'D. KWH/DAM^3 (KWH/AC-FT) [(SWP ALTERN. SUPPLY)] 2/	LAND NEEDS HECTARES (ACRES)	1981 COSTS AT PROJECT SITE FIRST COST $1,000,000	1981 COSTS AT PROJECT SITE UNIT COST $/DAM^3 ($/AC-FT)
1	2	3	4	5	6	
III. BRACKISH WATER DESALTING PROJECTS						
A. SAN JOAQUIN VALLEY DESALTING DEMONSTRATION						
° 1.0 MGD (DEMONSTRATION SCALE)	UNDER STUDY	1.2 (1)	2 030 (2,500) 3/ [SWP 360 (450)]	24 (60)	5.5	NOT AVAILABLE
° 25.0 MGD (FULL - SCALE)	UNDER STUDY	31 (25)	2 030 (2,500) 3/ [SWP 360 (450)]	610 (1,500)	25	245 (300)
B. EXECUTIVE ORDER: B - 68 - 80 DESALTING PROGRAM	UNDER STUDY	490 (400)	2 030 (2,500) 3/ [SWP 360 (450)]	9 700 (24,000)	NOT AVAILABLE	NOT AVAILABLE

1/ COLUMN DESCRIPTIONS ARE GIVEN ON PAGE 18

2/ SWP ENERGY CANAL SIDE ONLY IN VICINITY OF RECLAMATION PLANT.

3/ PLANT PROCESSING ENERGY ONLY--PRELIMINARY STUDY HAS NOT DEFINED EXACT SERVICE AREA.

SHEET 3

ENGINEERING CONSIDERATIONS	ENVIRONMENTAL CONSIDERATIONS	SOCIAL FACTORS	LEGAL/ INSTITUTIONAL/ POLITICAL CONSIDERATIONS	REMARKS
7	8	9	10	11
• THIS SERIES OF UNITS IS SEQUENCED TO PROVIDE SCALE UP-DATA AS SIZE INCREASES.	• LOSS OF SOME TERRESTIAL HABITAT DUE TO POND AND FACILITY CONSTRUCTION. • SALT POND REQUIRES SEALING TO PROTECT GROUND WATER FROM SALT WATER INTRUSION.			• THIS STEP-DESIGN PROCESS WILL RESULT IN ONE OF THE LARGEST REVERSE OSMOSIS DESALTERS IN THE UNITED STATES. • SOLAR SALT PONDS MAY MAKE FACILITY INDEPENDENT OF EXTERNAL ENERGY SOURCES. • THE DESALTING PLANTS ANNUAL YIELD WOULD BE EVALUATED SO THESE PLANTS CAN BE DEVELOPED AS COST-EFFECTIVE SWP FACILITIES. • THE DESALTED WATER COULD BE USED FOR AGRICULTURAL OR M&I PURPOSES EITHER DIRECTLY OR BY EXCHANGES.
• DESALTER AND SOLAR ENERGY PONGS ARE DEPENDENT ON RESULTS OF 1 MGD STUDIES.	• WILL IMPROVE QUALITY OF WATER PERMITTING MORE REUSE. • SALT PONDS MUST BE SEALED TO PROTECT GROUND WATER FROM SALT WATER INTRUSION. • BRINE DISPOSAL MUST BE PROPERLY CON-TROLLED. • LOSS OF TERRESTIAL HABITAT WILL RESULT FROM THE AMOUNT OF LAND REQUIRED. FOR THE PRETREATMENT AND OTHER ENERGY PONDS. • AVAILABILITY OF WASTE WATER FOR DESALTING IN IMPERIAL AND COACHELLA VALLEYS MAY BE AFFECTED BY THE GOAL TO STABILIZE THE SALTON SEA.		• MEANS MUST BE ESTABLISHED TO RECOVER COSTS OF DESALTING AND ASSOCIATED FACILITIES. • WATER SUPPLY EXCHANGES MAY BE NECESSARY TO BENEFIT FROM DESALT-ING IN SOME AREAS. • DELTA AGENCIES ARE CONCERNED WITH PROPOSED DISPOSAL OF SAN JOAQUIN VALLEY PROJECTS' WASTE WATER, SUG-GEST IN-AREA DISPOSAL.	

TABLE 2. GROUND WATER BASIN DEVELOPMENT-- PLANNING AND ENVIRONMENTAL CONSIDERATIONS[1/]

	WATER SUPPLY ALTERNATIVES	STATUS	INCREMENTAL PROJECT YIELD [2/] 1000 DAM³/YR (1,000 AC-FT/YR)	NET ENERGY REQ'D KWH / DAM³ (KWH / AC-FT)	LAND NEEDS HECTARES (ACRES)	1981 COSTS AT BASIN FIRST COST $ 1,000,000	1981 COSTS AT BASIN UNIT COST $ / DAM³ ($ / AC-FT)
	1	2	3	4	5	6	6
SELECTED FOR FEASIBILITY STUDY	BUNKER HILL - SAN TIMOTEO - YUCAIPA BASINS	UNDER STUDY	13.6 (11)	TRANSPORTATION 2 350 (2,900) RECAPTURE 75 (90)	NONE	6	150 (165)
	CHINO BASIN	UNDER STUDY	169 (137)	TRANSPORTATION 2 350 (2,900) RECAPTURE 260 (320)	NOT AVAILABLE	104	170 (210)
	ORANGE COUNTY BASIN	FUTURE STUDY	21 (17)	TRANSPORTATION 2 350 (2,900) RECAPTURE 150 (180)	NONE	7	150 (185)
	RAYMOND BASIN	FUTURE STUDY	7.4 (6)	TRANSPORTATION 2 350 (2,900) RECAPTURE 270 (330)	NONE	2	155 (190)
	SAN FERNANDO VALLEY BASIN	FUTURE STUDY	26 (21)	TRANSPORTATION 2 110 (2,600) RECAPTURE 150 (180)	NONE	1	125 (155)
	KERN RIVER FAN AREA BASIN	FUTURE STUDY	255 (207)	TRANSPORTATION 365 (450) RECAPTURE 240 (300)	NOT AVAILABLE	62	56 (69)
	LIVERMORE VALLEY BASIN	FUTURE STUDY	7.4 (6)	TRANSPORTATION 915 (1,130) RECAPTURE 140 (170)	NONE	NONE	47 (58)

1/ — COLUMN DESCRIPTIONS ARE GIVEN ON PAGE 18

2/ — YIELD VALUES ASSUME PERIPHERAL CANAL IN OPERATION. YIELD VALUES CANNOT BE ADDED TOGETHER FOR ALL PROJECTS LISTED IN TABLE 2, SINCE TO SOME EXTENT ALL OF THE ALTERNATIVE GROUND WATER BASINS COMPETE FOR THE SAME SOURCE OF WATER SUPPLY AND AQUEDUCT CAPACITY.

SHEET 1

ENGINEERING CONSIDERATIONS	ENVIRONMENTAL CONSIDERATIONS	SOCIAL FACTORS	LEGAL/ INSTITUTIONAL/ POLITICAL CONSIDERATIONS	REMARKS
7	8	9	10	11
• REQUIRES ENLARGEMENT OF THE EAST BRANCH CALIFORNIA AQUEDUCT. • SBVMWD FOOTHILL PIPELINE MUST BE EXTENDED TO SERVE YUCAIPA BASIN. • NO WATER TREATMENT FACILITIES AVAILABLE.	• BASIN IS SUBJECT TO MINOR SUBSIDENCE. • POTENTIAL FOR WATER-LOGGING IN THE PRESSURE AREA OF THE BUNKER HILL BASIN. • NO ADDITIONAL ENERGY REQUIRED FOR EXTRACTION. • WATER LEVELS WILL RISE, REDUCING PUMP LIFTS.	• NONE ADVERSE TO PLAN.	• BASIN IS PARTIALLY ADMINISTERED BY A WATER- MASTER. • PORTION OF THE BASIN IS SHARED BY SBVMWD AND SGPWA.	• A SWP GROUND WATER STORAGE DEMONSTRATION PROGRAM IS CURRENTLY UNDERWAY.
• ADDITIONAL EXTRACTION FACILITIES, TURNOUTS, AND SPREADING BASIN IMPROVEMENTS ARE NEEDED. • REQUIRES ENLARGEMENT OF THE EAST BRANCH CALIFORNIA AQUEDUCT. • NO WATER TREATMENT FACILITIES ARE AVAILABLE.	• BASIN IS SUBJECT TO MINOR SUBSIDENCE. • ADDITIONAL ENERGY WILL BE REQUIRED FOR EXTRACTION DURING RECOVERY PERIODS. • WATER LEVELS WILL RISE, REDUCING PUMP LIFTS.	• NONE ADVERSE TO PLAN.	• BASIN HAS BEEN ADJUDICATED. • MAY RESULT IN POOR QUALITY RISING WATER IN SANTA ANA RIVER. • PROGRAM MAY BE IN COMPETITION WITH MWD AND CBMWD FOR USE OF STORAGE SPACE.	• JOINT DWR-MWD FEASIBILITY STUDY IS CURRENTLY UNDERWAY.
• DIRECT STORAGE WOULD REQUIRE CONSTRUCTION OF MWD'S DIEMER BYPASS. • REQUIRES ENLARGEMENT OF THE EAST BRANCH CALIFORNIA AQUEDUCT.	• SEAWATER INTRUSION HAS OCCURRED IN THE PAST. GROUND WATER RECHARGE COULD LESSEN OR PREVENT THIS FROM REOCCURRING. • ADDITIONAL ENERGY WILL BE REQUIRED FOR EXTRACTION DURING RECOVERY PERIODS. • WATER LEVELS WILL RISE, REDUCING PUMP LIFTS.	• NONE ADVERSE TO PLAN.	• OCWD CAN CONTROL PUMPING THROUGH A BASIN EQUITY ASSESSMENT.	
• REQUIRES ENLARGEMENT OF THE EAST BRANCH CALIFORNIA AQUEDUCT. • ADDITIONAL CONVEYANCE FACILITIES NEEDED.	• ADDITIONAL ENERGY WILL BE REQUIRED FOR EXTRACTION DURING RECOVERY PERIODS. • WATER LEVELS WILL RISE, REDUCING PUMP LIFTS.	• NONE ADVERSE TO PLAN	• BASIN HAS BEEN ADJUDICATED. • LOCAL AGENCIES WANT TO RETAIN A PORTION OF THE AVAILABLE STORAGE SPACE. • MWD IS NEGOTIATING A CYCLIC STORAGE PROGRAM.	• BASIN WILL LOSE WATER ACROSS THE RAYMOND FAULT IF WATER LEVELS ARE TOO HIGH.
• JENSEN WATER TREATMENT PLANT DOES NOT HAVE THE CAPACITY TO TREAT FULL SWP ENTITLEMENTS. GROUND WATER PROGRAM WITH DIRECT RECHARGE WOULD CIRCUMVENT THIS LIMITATION. • ADDITIONAL CONVEYANCE FACILITIES NEEDED.	• ADDITIONAL ENERGY WILL BE REQUIRED FOR EXTRACTION DURING RECOVERY PERIODS. • WATER LEVELS WILL RISE, REDUCING PUMP LIFTS.	• NONE ADVERSE TO PLAN	• BASIN IS ADMINISTERED BY A WATER- MASTER. • LOS ANGELES CITY CHARTER DOES NOT PERMIT EXCHANGES OF THE CITY'S WATER OR WATER RIGHTS. • OVERLYING CITIES HAVE ACTIVE GROUND WATER STORAGE PROGRAMS.	
• ADDITIONAL EXTRACTION FACILITIES AND SPREADING BASIN IMPROVEMENTS ARE NEEDED.	• RARE OR ENDANGERED SPECIES ARE PRESENT. • BASIN IS SUBJECT TO SUBSIDENCE. • POTENTIAL FOR WATER-LOGGING IN SOME AREAS. • POTENTIAL DEGRADATION OF NEARBY NATURAL AREAS. • ADDITIONAL ENERGY WILL BE REQUIRED FOR EXTRACTION DURING RECOVERY PERIODS. • WATER LEVELS WILL RISE, REDUCING PUMP LIFTS.	• NONE ADVERSE TO PLAN	• WILL REQUIRE WATER EXCHANGES. • BASIN HAS NOT BEEN ADJUDICATED. • WILL REQUIRE WHEELING WATER THROUGH THE CROSS VALLEY CANAL.	• A 20-YEAR DEMONSTRATION PROGRAM IS CURRENTLY BEING NEGOTIATED WITH KCWA AND SEMITROPIC WSD.
• USE OF LOCAL STREAMS FOR RECHARGE WOULD REQUIRE MODIFIED OPERATION OF DEL VALLE RESERVOIR. • SOUTH BAY AQUEDUCT CANNOT OPERATE AT DESIGN CAPACITY.	• RARE OR ENDANGERED SPECIES ARE PRESENT IN THE AREA. • ADDITIONAL ENERGY WILL BE REQUIRED FOR EXTRACTION DURING RECOVERY PERIODS • POTENTIAL FOR PRESERVING RIPARIAN HABITAT. • POTENTIAL FOR WATER LOGGING IN THE PLEASANTON AREA.	• NONE ADVERSE TO PLAN	• PROGRAM WILL CONFLICT WITH GRAVEL EXTRACTION. • REOPERATION OF DEL VALLE MAY REQUIRE REQUIRE REALLOCATION OF COSTS. • MAY REQUIRE RESCHEDULING OF ENTITLEMENT DELIVERIES.	• MAY REQUIRE PURCHASE OF WATER IN STORAGE TO INITIATE PROGRAM. • PERIODIC EXPORT OF GROUND WATER WOULD ASSIST IN MAINTAINING BASIN SALT BALANCE.

TABLE 2. (Cont.) GROUND WATER BASIN DEVELOPMENT-- PLANNING AND ENVIRONMENTAL CONSIDERATIONS[1]

	WATER SUPPLY ALTERNATIVES	STATUS	INCREMENTAL PROJECT YIELD[2] 1 000 DAM³/YR (1,000 AC-FT/YR)	NET ENERGY REQ'D KWH / DAM³ (KWH/AC-FT)	LAND NEEDS HECTARES (ACRES)	1981 COSTS AT BASIN FIRST COST $1,000,000	1981 COSTS AT BASIN UNIT COST $ / DAM³ ($/AC-FT)
	1	2	3	4	5	6	6
BASINS WITH POTENTIAL	ANTELOPE VALLEY BASIN	DEFERRED	8.6 (7)	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE
BASINS WITH POTENTIAL	LAS POSAS BASIN	DEFERRED	18.5 (15)	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE
BASINS WITH POTENTIAL	SAN GABRIEL BASIN	DEFERRED	21 (17)	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE
BASINS WITH POTENTIAL	SANTA CLARA RIVER VALLEY BASIN	DEFERRED	29 to 51 (23.5 to 41)	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE
BASINS WITH POTENTIAL	UPPER COACHELLA VALLEY BASIN	DEFERRED	167 (135)	NOT AVAILABLE	36 (90)	NOT AVAILABLE	NOT AVAILABLE
BASINS WITH POTENTIAL	WHITE WOLF BASIN	DEFERRED	30 (24)	NOT AVAILABLE	280 (690)	NOT AVAILABLE	NOT AVAILABLE

1/ COLUMN DESCRIPTIONS ARE GIVEN ON PAGE 18

2/ YIELD VALUES ASSUME PERIPHERAL CANAL IN OPERATION. YIELD VALUES CANNOT BE ADDED TOGETHER FOR ALL PROJECTS LISTED IN TABLE 2, SINCE TO SOME EXTENT ALL OF THE ALTERNATIVE GROUND WATER BASINS COMPETE FOR THE SAME SOURCE OF WATER SUPPLY AND AQUEDUCT CAPACITY.

SHEET 2

ENGINEERING CONSIDERATIONS	ENVIRONMENTAL CONSIDERATIONS	SOCIAL FACTORS	LEGAL/ INSTITUTIONAL/ POLITICAL CONSIDERATIONS	REMARKS
7	8	9	10	11
• NO ARTIFICIAL RECHARGE FACILITIES PRESENT AND NO SUITABLE SITES AVAILABLE. • MAY REQUIRE ENLARGEMENT OF THE EAST BRANCH CALIFORNIA AQUEDUCT.	• BASIN IS SUBJECT TO SUBSIDENCE • ADDITIONAL ENERGY WILL BE REQUIRED FOR EXTRACTION DURING RECOVERY PERIOD. • WATER LEVELS WILL RISE, REDUCING PUMP LIFTS.	• NONE ADVERSE TO PLAN.	• BASIN HAS NOT BEEN ADJUDICATED.	
• RECHARGE AND CONVEYANCE FACILITIES ARE NEEDED. • EXTRACTION FACILITIES MAY BE NEEDED. • COULD REQUIRE EXPANSION OF MWD'S JENSEN TREATMENT PLANT.	• POTENTIAL DISTURBANCE OF RARE AND ENDANGERED SPECIES. • ADDITIONAL ENERGY WILL BE REQUIRED FOR EXTRACTION DURING RECOVERY PERIODS. • WATER LEVELS WILL RISE, REDUCING PUMP LIFTS.	• NONE ADVERSE TO PLAN.	• BASIN HAS NOT BEEN ADJUDICATED.	• INDIRECT RECHARGE MIGHT REQUIRE USING TREATED SWP WATER FOR IRRIGATION.
• REQUIRES ENLARGEMENT OF THE EAST BRANCH CALIFORNIA AQUEDUCT	• ADDITIONAL ENERGY WILL BE REQUIRED FOR EXTRACTION DURING RECOVERY PERIODS. • WATER LEVELS WILL RISE, REDUCING PUMP LIFTS.	• NONE ADVERSE TO PLAN.	• BASIN HAS BEEN ADJUDICATED.	
• ADDITIONAL RECHARGE, CONVEYANCE, AND EXTRACTION FACILITIES ARE NEEDED. • INFILTRATION RATES ARE LOW AND LAND SUITABLE FOR RECHARGE SITES IS LIMITED.	• RARE OR ENDANGERED SPECIES PRESENT. • POTENTIAL PROBLEMS WITH WATER-LOGGING, SUBSIDENCE, AND SEAWATER INTRUSION. • ADDITIONAL ENERGY WILL BE REQUIRED FOR EXTRACTION DURING RECOVERY PERIODS. • WATER LEVELS WILL RISE, REDUCING PUMP LIFTS.	• NONE ADVERSE TO PLAN.	• SWRCB INVESTIGATING TAKING ACTION UNDER WATER CODE SECTION 2100 TO LIMIT SEAWATER INTRUSION AND OTHER QUALITY INDUCING PROBLEMS TO PROTECT BASIN. • BASIN HAS NOT BEEN ADJUDICATED.	
• REQUIRES ENLARGEMENT OF THE EAST BRANCH CALIFORNIA AQUEDUCT. • ADDITIONAL RECHARGE FACILITIES NEEDED. • WOULD REQUIRE CONSTRUCTION OF AN AQUEDUCT TO DELIVER SWP WATER DIRECTLY.	• SUBSTITUTION OF SWP WATER FOR COLORADO RIVER WATER WOULD IMPROVE WATER QUALITY. • WATER LEVELS WILL RISE, REDUCING PUMP LIFTS. • LOSS OF SOME TERRESTRIAL HABITAT.	• NONE ADVERSE TO PLAN.	• BASIN HAS NOT BEEN ADJUDICATED.	• SWP ENTITLEMENTS ARE PRESENTLY BEING DELIVERED BY EXCHANGE WITH MWD.
• ADDITIONAL EXTRACTION AND CONVEYANCE FACILITIES ARE NEEDED. • GROUND WATER BASIN DEPTH TO WATER RANGES 400 FEET TO 1,000 FEET.	• RARE OR ENDANGERED SPECIES PRESENT. • ADDITIONAL ENERGY WILL BE REQUIRED FOR EXTRACTION DURING RECOVERY PERIODS. • WATER LEVELS WILL RISE, REDUCING PUMP LIFTS.	• NONE ADVERSE TO PLAN.	• BASIN HAS NOT BEEN ADJUDICATED. • ARVIN-EDISON WSD IS A U.S.B.R. CONTRACTOR.	

TABLE 3. SURFACE WATER FACILITIES-- PLANNING AND ENVIRONMENTAL CONSIDERATIONS 1/

WATER SUPPLY ALTERNATIVES (SIZE OR CAPACITY)	STATUS	INCREMENTAL PROJECT YIELD 2/ 1 000 DAM³/ YR (1,000 AC-FT/YR)	NET ENERGY 3/ REQ'D KWH/DAM³ (KWH/AC-FT)	AREA HECTARES (ACRES)	1981 COSTS AT DELTA 3/	
					FIRST COST $1,000,000	UNIT COST $ / DAM³ ($/AC-FT)
1	2	3	4	5	6	
PERIPHERAL CANAL 518 M³/SEC (18,300 CFS)	UNDER STUDY	863 (700)	80 (100)	2 670 (6,600)	680	81 (100)
COTTONWOOD CREEK 1.97 MILLION DAM³ (1.60 MILLION AC-FT)	UNDER STUDY	247 (200)	*	8 700 (21,400)	600	162** (200)
THOMES - NEWVILLE 2.05 MILLION DAM³ (1.66 MILLION AC-FT)	UNDER STUDY	270 (220)	*-55 -(88)	5 380 (13,300)	482	200 (246)
GLENN RESERVOIR - RIVER DIVERSION PLAN 10.7 MILLION DAM³ (8.70 MILLION AC-FT)	*DEFERRED	1 490 (1,210)	-53 -(65)	21 600 (53,400)	2 370	190 (230)

1/ COLUMN DESCRIPTIONS ARE GIVEN ON PAGE 18

2 YIELD VALUES FOR RESERVOIRS ASSUME PERIPHERAL CANAL IN OPERATION. YIELD VALUES CANNOT BE ADDED TOGETHER FOR ALL PROJECTS LISTED IN TABLE 3, SINCE SOME OF THE PROJECTS WOULD COMPETE FOR THE SAME EXCESS WATER SUPPLY.

ENGINEERING CONSIDERATIONS	ENVIRONMENTAL CONSIDERATIONS	SOCIAL FACTORS	LEGAL / INSTITUTIONAL/ POLITICAL CONSIDERATIONS	REMARKS
7	8	9	10	11
• AVAILABILITY OF CONSTRUCTION MATERIALS. • PREVENTION OR CONTROL OF SEEPAGE • FISH SCREEN REQUIREMENTS. • REQUIREMENTS FOR SIPHONS AND BRIDGES. • MAINTAIN ADEQUATE DRAINAGE CHANNELS.	• PROJECT WILL CORRECT FISHERY-RELATED PROBLEMS ATTRIBUTED PRESENTLY TO LARGE WATER EXPORTS FROM THE DELTA AND RESTORE FISHERY TO HISTORICAL LEVELS. • PROVIDE BETTER WATER QUALITY TO EASTERN PORTION OF DELTA. • POTENTIAL IMPACT ON RARE AND ENDANGERED ANIMALS AND PLANTS.	• LESS THAN 100 PEOPLE DISPLACED	• RESOLVE STATE/FEDERAL PARTICIPATION PLANS FOR FINANCING AND WATER WHEELING.	• IMPLEMENTATION DEPENDS UPON PASSAGE OF SB 200 IN STATE REFERENDUM.
• PROJECT REQUIRES TWO RESERVOIRS. • CREST LENGTH OF EACH DAM IS ABOUT 4 MILES. • PREVENTION OR CONTROL OF SEEPAGE AT PROJECT SITE.	• DEGRADATION OF ANADROMOUS FISHES SPAWNING HABITAT: INCREASED TURBIDITY: ALTERED STREAMFLOW, LOSS OF DEER AND UPLAND GAME HABITAT: LOSS OF RIPARIAN HABITAT: INUNDATION OF FOOTHILL WOODLAND COMMUNITY.	• ABOUT 200 PEOPLE DISPLACED.	• RESOLVE STATE/FEDERAL PARTICIPATION PLANS TO MARKET WATER SUPPLY VIA THE STATE WATER PROJECT.	* PROJECT HAS POTENTIAL FOR AVERAGE ENERGY GENERATION OF 30 MILLION KWH/YR. ** BASED UPON COST ALLOCATED TO WATER SUPPLY PURPOSE.
• SEDIMENTATION PROBLEMS AT THOMES CREEK DIVERSION DAM.	• DEGRADATION OF ANADROMOUS FISHES SPAWNING HABITAT; ALTERED STREAMFLOW, CREATION OF FISH BARRIERS; LOSS OF RIPARIAN HABITAT; INUNDATION OF FOOTHILL WOODLAND, GRASSLAND, AND CHAPARRAL COMMUNITIES.	• ABOUT 50 PEOPLE DISPLACED. • POSSIBLE IMPACT ON GRINDSTONE RANCHERIA.	• PLAN REQUIRES COORDINATION WITH U.S.C.E. (BLACK BUTTE RESERVOIR) U.S.B.R. (TEHAMA-COLUSA CANAL) AND/OR GLENN COLUSA I.D. (CANAL).	• THOMES CREEK DIVERSION = 10,000 CFS; STONY CREEK PUMPING = 3350 CFS. * NET ENERGY DERIVES FROM 43 MILLION KWH/YR GENERATION AND 28 MILLION KWH/YR REQUIRED PUMPING.
• REQUIRES MAJOR CONVEYANCE SYSTEM FROM SACRAMENTO RIVER, WITH FISH SCREEN FACILITIES.	• POTENTIAL IMPACTS ON THE ENDANGERED SOUTHERN BALD EAGLE, DEGRADATION OF ANADROMOUS FISHES SPAWNING HABITAT, LOSS OF RIPARIAN AND MARSH HABITATS, ALTERED STREAMFLOW, INUNDATION OF GRASSLAND, WOODLAND-GRASSLAND AND CHAPARRAL COMMUNITIES; POTENTIAL DEGRADATION OF CULTURAL RESOURCES. • LOSS OF RIPARIAN AND MARSH HABITATS; WATERFOWL RAFTING, LOSS OF STREAM HABITAT, FISH BARRIERS FOR ANADROMOUS FISHES--KING SALMON, STEELHEAD.	• ABOUT 730 PEOPLE DISPLACED INCLUDING AN INDIAN RANCHERIA.	• RESERVOIR WOULD INUNDATE EXISTING FEDERAL RESERVOIR (STONY GORGE)	PLANNING IS DEFERRED EXCEPT TO EVALUATE THIS PLAN AS AN ALTERNATIVE TO SHASTA LAKE ENLARGEMENT. • PROJECT INCLUDE THOMES-NEWVILLE FACILITIES.

3/ VALUES IN COLUMNS ④ AND ⑥ DO NOT INCLUDE TRANSPORTATION FROM THE DELTA TO SWP SERVICE AREA. NET ENERGY REQUIREMENTS AND UNIT COSTS FOR TRANSPORTATION OF WATER FROM DELTA ARE SHOWN IN TABLE 4.

* SEE REMARKS COLUMN

TABLE 3. (Cont.) SURFACE WATER FACILITIES-- PLANNING AND ENVIRONMENTAL CONSIDERATIONS 1/

WATER SUPPLY ALTERNATIVES (SIZE OR CAPACITY)	STATUS	INCREMENTAL PROJECT YIELD 2/ 1 000 DAM³/YR (1,000 AC-FT/YR)	NET ENERGY 3/ REQ'D KWH / DAM³ (KWH/AC-FT)	AREA HECTARE (ACRES)	1981 COSTS AT DELTA 3/ FIRST COST $1,000,000	1981 COSTS AT DELTA 3/ UNIT COST $ / DAM³ ($/AC-FT)
1	2	3	4	5	6	
LOS VAQUEROS 1.31 MILLION DAM³ (1.06 MILLION AC-FT)	UNDER STUDY	*327 (265)	165 (204)	1 955 (4,800)	866	*263 (325)
SHASTA LAKE ENLARGEMENT 12. 3 MILLION DAM³ (10.0 MILLION AC-FT) ADDITIONAL	FUTURE STUDY	1 730 (1,400)	* NOT AVAILABLE	12 140 (30,000) ADD'L	1800	*142 (175)
COLUSA -- (INCREMENT NORTH OF SITES RESERVOIR) 1.60 MILLION DAM³ (1.30 MILLION AC-FT)	DEFERRED	234 (190)	235 (290)	6 270 (15,500)	600	230 (285)
LAKE BERRYESSA ENLARGEMENT 13.0 MILLION DAM³ (10.5 MILLION AC-FT) ADDITIONAL	DEFERRED	2 035 (1,650)	140 (170)	16 200 (40,000) ADD'L	1900	100 (125)

1/ COLUMN DESCRIPTIONS ARE GIVEN ON PAGE 18

2/ YIELD VALUES FOR RESERVOIRS ASSUME PERIPHERAL CANAL IN OPERATION YIELD VALUES CANNOT BE ADDED TOGETHER FOR ALL PROJECTS LISTED IN TABLE 3, SINCE SOME OF THE PROJECTS WOULD COMPETE FOR THE SAME EXCESS WATER SUPPLY.

ENGINEERING CONSIDERATIONS	ENVIRONMENTAL CONSIDERATIONS	SOCIAL FACTORS	LEGAL/ INSTITUTIONAL/ POLITICAL CONSIDERATIONS	REMARKS
7	8	9	10	11
• AVAILABILITY OF CONSTRUCTION MATERIALS.	• POTENTIAL IMPACTS ON RARE, ENDANGERED, OR THREATENED ANIMALS--SAN JOAQUIN KIT FOX, ALAMEDA STRIPED RACER, GIANT GARTER SNAKE, CONTRA COSTA LAND SNAIL, DELTA GREEN GROUND BEETLE. • LOSS OF STREAM HABITAT; INCREASED WATERFOWL HABITAT; INUNDATION OF FOOTHILL-WOODLAND, GRASSLAND, AND CHAPARRAL COMMUNITIES. • UNIQUE HABITAT -- VERNAL POOLS • POTENTIAL DEGRADATION OF CULTURAL RESOURCES.	• ABOUT 65 PEOPLE DISPLACED.	• RESOLVE STATE/FEDERAL PLANS FOR JOINT PROJECT.	* THERE IS POTENTIAL FOR ADDITIONAL YIELD THROUGH CONJUNCTIVE OPERATION WITH GROUND WATER, AND THE UNIT COST OF WATER WOULD BE REDUCED. • ENERGY AT DELTA PUMPING PLANT IS NOT INCLUDED. • A SUBDIVISION IS PROPOSED IN THE RESERVOIR AREA.
• RELOCATION OF THE EXISTING RAILROAD AND INTERSTATE HIGHWAY WILL BE REQUIRED. • RESERVOIR WOULD INUNDATE PIT RIVER POWER PLANT NO. 7.	• LOSS OF STREAM HABITAT, ALTERED STREAMFLOW, WATER QUALITY CONSIDERATIONS. • POTENTIAL IMPACTS ON RARE, ENDANGERED, THREATENED OR PROTECTED ANIMALS--OSPREY, GOLDEN EAGLE, AND SPOTTED OWL; INUNDATION OF FOOTHILL WOODLAND, GRASSLAND, AND CHAPARRAL COMMUNITIES, LOSS OF RIPARIAN HABITAT.	• ABOUT 1,000 PEOPLE DISPLACED PLUS EXISTING RECREATION DEVELOPMENT.	• NEW YIELD WOULD BE SHARED BY CVP AND SWP.	* PROJECT HAS POTENTIAL FOR ADDITIONAL ENERGY PRODUCTION. COST AND REVENUE FROM ADDITIONAL POWER FACILITIES ARE NOT INCLUDED.
• COLUSA RESERVOIR REQUIRES FOUR DAMS. • SITES RESERVOIR PORTION REQUIRES TWO DAMS.	• LOSS OR RIPARIAN AND MARSH HABITATS;ITS; LOSS OF STREAM HABITAT. • WATERFOWL RAFTINGS. • POTENTIAL WATER QUALITY PROBLEMS. • INUNDATION OF GRASSLAND AND WOODLAND COMMUNITIES.	• LESS THAN 100 PEOPLE DISPLACED.	• PART OF COLUSA RESERVOIR WOULD BE USED FOR SITES RESERVOIR UNDER (USBR) PLANS. PLAN USES CANALS OWNED BY OTHER AGENCIES: TEHAMA-COLUSA (USBR) AND GLENN-COLUSA I. D.	
• REQUIRES EXTENSIVE IMPORT SYSTEM FROM THE SACRAMENTO RIVER (32 MILES LONG) WITH FISH SCREEN.	• POTENTIAL SERIOUS IMPACTS ON MIGRATORY FISH. • LOSS OF STREAM HABITAT. • POTENTIAL WATER QUALITY PROBLEMS. • WATERFOWL RAFTING. • INUNDATION OF WOODLAND AND GRASSLAND COMMUNITIES.	• ABOUT 1,000 PEOPLE DISPLACED PLUS 1,800 MOBILE HOMES.	• PROJECT WOULD BE OPERATED IN CONJUNCTION WITH EXISTING FEDERAL SOLANO PROJECT.	

3/ VALUES IN COLUMNS ④ AND ⑥ DO NOT INCLUDE TRANSPORTATION FROM THE DELTA TO SWP SERVICE AREA. NET ENERGY REQUIREMENTS AND UNIT COSTS FOR TRANSPORTATION OF WATER FROM DELTA ARE SHOWN IN TABLE 4.

* SEE REMARKS COLUMN

TABLE 3. (Cont.) SURFACE WATER FACILITIES-- PLANNING AND ENVIRONMENTAL CONSIDERATIONS 1/

WATER SUPPLY ALTERNATIVES (SIZE OR CAPACITY)	STATUS	INCREMENTAL PROJECT YIELD 2/ 1 000 DAM^3/YR (1,000 AC/FT/YR)	NET ENERGY 3/ REQ'D KWH/DAM^3 (KWH/AC-FT)	AREA HECTARE (ACRES)	1981 COSTS AT DELTA 3/	
					FIRST COST $1,000,000	UNIT COST $/$DAM^3$ ($/AC-FT)
1	2	3	4	5	6	
CORRAL HOLLOW 1.36 MILLION DAM^3 (1.10 MILLION AC-FT)	DEFERRED	200 (160)	*300 (375)	2 830 (7,000)	1000	485 (600)
LOS BANOS GRANDES 2.71 MILLION DAM^3 (2.20 MILLION AC-FT)	*DEFERRED	308 (250)	*180 (220)	6 070 (15,000)	780	265 (330)
COLORADO RIVER BANKING PLAN	UNDER STUDY	100 to 460 * (80 to 370)	NOT AVAILABLE	NONE	NOT AVAILABLE	NOT AVAILABLE
AGRICULTURAL WATER PURCHASE PLAN	UNDER STUDY	123 (100) 1-YEAR ONLY	REDUCES NEEDS COMPARED TO NORMAL OPERATIONS	NONE	NONE	TO BE NEGOTIATED

1/ COLUMN DESCRIPTIONS ARE GIVEN ON PAGE 18

2/ YIELD VALUES FOR RESERVOIRS ASSUME PERIPHERAL CANAL IN OPERATION. YIELD VALUES CANNOT BE ADDED TOGETHER FOR ALL PROJECTS LISTED IN TABLE 3, SINCE SOME OF THE PROJECTS WOULD COMPETE FOR THE SAME EXCESS WATER SUPPLY.

SHEET 3

ENGINEERING CONSIDERATIONS	ENVIRONMENTAL CONSIDERATIONS	SOCIAL FACTORS	LEGAL/ INSTITUTIONAL/ POLITICAL CONSIDERATIONS	REMARKS
7	8	9	10	11
• COST OF DAM IS EXCESSIVE.	• POTENTIAL LOSS OF RARE OR ENDANGERED PLANTS AND ANIMALS; LOSS OF STREAM HABITAT. (LOSS OF RIPARIAN HABITAT.) • WATERFOWL RAFTING. • INUNDATION OF GRASSLAND, FOOTHILL-WOODLAND AND CHAPARRAL COMMUNITIES; • POTENTIAL DEGRADATION OF CULTURAL RESOURCES.	• LESS THAN 50 PEOPLE DISPLACED.	• WOULD REQUIRE RELOCATION OF LAWRENCE LIVERMORE LAB. INSTALLATION.	* ENERGY AT DELTA PUMPING PLANT IS NOT INCLUDED.
• USES CALIFORNIA AQUEDUCT EXCESS CAPACITY FOR FILLING. MAY BE DIFFICULT TO REFILL.	• LOSS OF STREAM HABITAT; LOSS OF RIPARIAN HABITAT; ALTERED STREAMFLOW; • POTENTIAL WATER QUALITY PROBLEMS. • CREATION OF FISH BARRIERS. • INUNDATION OF GRASSLAND, FOOTHILL-WOODLAND AND CHAPARRAL COMMUNITIES; • WATERFOWL RAFTING. • POTENTIAL DEGRADATION OF CULTURAL RESOURCES.	• LESS THAN 50 PEOPLE DISPLACED.	• RESERVOIR WOULD BE OPERATED IN COORDINATION WITH SWP AND CVP.	* PLANNING IS DEFERRED EXCEPT TO EVALUATE THIS PLAN AS AN ALTERNATIVE TO LOS VAQUEROS. * ENERGY AT DELTA PUMPING PLANT IS NOT INCLUDED.
• USES EXISTING STORAGE AND CONVEYANCE FACILITIES. • COMPETES WITH GROUND WATER PROGRAM FOR CALIFORNIA AQUEDUCT CAPACITY.	• NONE IDENTIFIED	• NONE IDENTIFIED.	• PLAN REQUIRES COORDINATION WITH MANY AGENCIES WHICH PRESENTLY USE WATER FROM THE COLORADO RIVER.	* YIELD IS DEPENDENT ON AQUEDUCT CAPACITY, COLORADO RIVER STORAGE LEVELS, AND INSTITUTIONAL AGREEMENTS. • A COOPERATIVE STUDY IS NOW UNDER-WAY BY METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA, COLORADO RIVER BOARD, U. S. BUREAU OF RECLAMATION, AND DEPARTMENT OF WATER RESOURCES.
• NONE ADVERSE TO PLAN.	• NO KNOWN ENDANGERED SPECIES EXIST WITHIN THE PROPOSED OPERATIONAL AREA. HOWEVER, THE AREA PROVIDES CRITICAL HABITAT FOR WATERFOWL MAINTENANCE. REDUCTION OF AGRICULTURAL LANDS IN DRY YEARS WOULD FURTHER REDUCE WINTERING HABITAT FOR WATERFOWL ALREADY REDUCED BECAUSE OF GENERAL DRY CONDITIONS. CONCENTRATIONS OF WATERFOWL INCREASES INCIDENCE OF DISEASES. • PHEASANT POPULATION COULD BE ENHANCED IF IDLE AGRICULTURAL LAND WERE ALLOWED TO REMAIN IN VOLUNTEER VEGETATION. • THERE IS CONCERN FOR FISHERIES FROM DETERIORATION OF RETURN WATER QUALITY.	• SECONDARY IMPACTS FROM LOST AGRICULTURAL PRODUCTION INCLUDE LABOR, MATERIAL SUPPLIES, AND PROCESSING. SHIPPING AND SELLING OF CROPS COULD ARISE AT LOCAL REGIONAL AND/OR STATE LEVEL. • ECONOMIC AND SOCIAL IMPACTS COULD OCCUR TO FARMING AREAS OUTSIDE THE IMMEDIATE AREA FOREGOING WATER USE BECAUSE THE OUTSIDE AREAS ARE NORMALLY DEPENDENT ON RETURN FLOWS FOR PART OF THEIR WATER SUPPLY.	• LEGAL RIGHTS TO TEMPORARILY TRANSFER APPROPRIATIVE WATER RIGHTS IS PERMITTED BY STATE LAW CLEARING WAY FOR VOLUNTARY PARTICIPATION. • INSTITUTIONAL RESTRICTIONS BY U.S. BUREAU OF RECLAMATION AND DWR ON SALE AND OTHER DISPOSAL OR RIGHT TO THE USE OF WATER ARE CONTAINED IN CONTRACTS WITH WATER USERS REQUIRING WRITTEN PERMISSION FROM THESE WATER PURVEYING AGENCIES BEFORE INITIATING AGRICULTURAL PURCHASE PLAN. • PURCHASERS OF CVP WATER MUST ABIDE BY 160-ACRE LIMITATION AT AREA OF USE IF WATER IS TO BE USED FOR AGRICULTURE.	• DWR IS CONTINUING TO DISCUSS THE AWPP WITH THE LOCAL WATER ENTITIES.

3/ VALUES IN COLUMNS ④ AND ⑧ DO NOT INCLUDE TRANSPORTATION FROM THE DELTA TO SWP SERVICE AREA.
NET ENERGY REQUIREMENTS AND UNIT COSTS FOR TRANSPORTATION OF WATER FROM DELTA ARE SHOWN IN TABLE 4.

* SEE REMARKS COLUMN

Table 4. WATER TRANSPORTATION COSTS[1/] FROM DELTA TO SWP SERVICE AREAS IN YEAR 2000 AND UNIT ENERGY REQUIREMENTS

NORTH BAY AQUEDUCT		SOUTH BAY AQUEDUCT		VIA CALIFORNIA AQUEDUCT			
				SAN JOAQUIN VALLEY		SOUTHERN[2/] CALIFORNIA	
COST $/DAM^3 ($/AC-FT)	ENERGY KWH/DAM^3 (KWH/AC-FT)	COST $/DAM^3 ($/AC-FT)	ENERGY KWH/DAM^3 (KWH/AC-FT)	COST $/DAM^3 ($/AC-FT)	ENERGY KWH/DAM^3 (KWH/AC-FT)	COST $/DAM^3 ($/AC-FT)	ENERGY KWH/DAM^3 (KWH/AC-FT)
6.50 to 31 (8 to 38)	810 (1000)	31.50 (39)	915 (1130)	13 to 27.50 (16 to 34)	445 (550)	81 to 102 (100 to 126)	2350 (2900)

1/ VARIABLE UNIT COSTS OF OPERATION, MAINTENANCE, POWER AND REPLACEMENT DERIVED FROM TABLE B-17, DWR BULLETIN 132-80: DATA IN 1980 DOLLARS WITH ALLOWANCES FOR FUTURE INCREASES IN POWER RATES.

2/ EXCLUDING ANTELOPE VALLEY.

SWP Demand-Yield Outlook Between 1980 and 2000

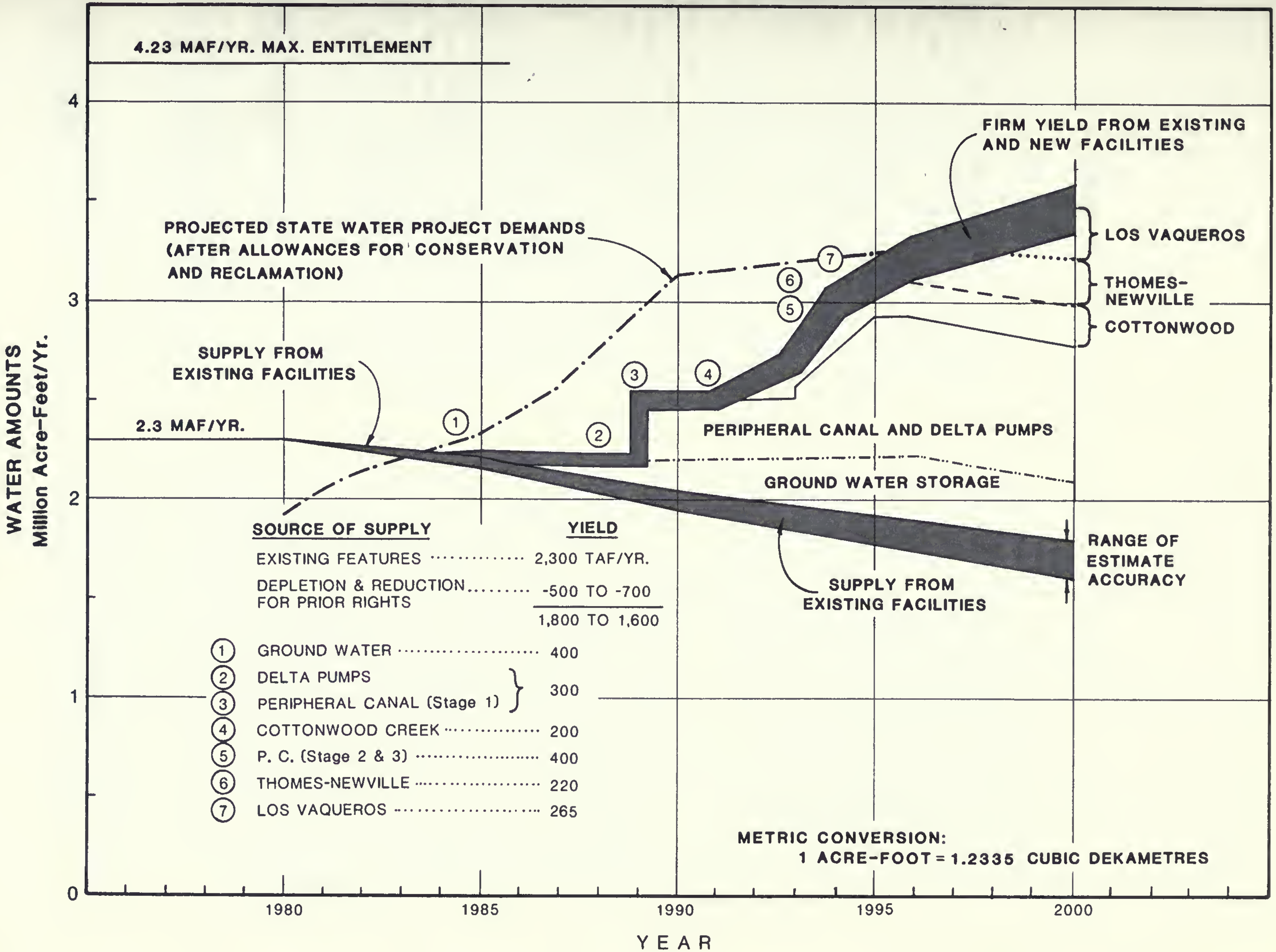
The major thrust of the Department's current planning for future water supplies for the SWP is to meet the reasonable needs within SWP service areas through the year 2000. After allowances for local water conservation and reclamation to reduce or defer preconservation estimates of need[1/], the reasonable needs will be met through a combination of ground water storage and development of additional surface water supplies.

Figure 8 shows the relationship between water demand (reduced for conservation) and the dependable yield of the existing SWP facilities and the additional yield from the tentatively selected future SWP facilities through the year 2000. The staging sequence and dates for these new facilities are based on what can be considered the most optimistic schedule for completing the planning, environmental documentation, design and construction, assuming SB 200 is approved by a majority of the voters by June of 1982 or earlier.

The 12-year gap between dependable supply and demand from 1983 to 1995 means that, if an extended drought similar to that which occurred from 1928 to 1934 occurs during that 12-year period, the SWP will not be able to meet requests for contract entitlement water, and water shortages will be experienced. Of course, if normal supplies occur, the probability and magnitude of shortages will be reduced. Further, it may be possible to bring some waste water reclamation facilities on line ahead of the more conventional facilities to reduce the potential water shortages. DWR will continue to work toward that end.

1/ The 860 000 dam^3 (700,000 ac-ft) conservation-reclamation goal set forth in Bulletin 76 will, in cooperation with SWP water service contractors, be refined during development of the SWP water management plan called for in the Governor's Executive Order B-68-80. This study is scheduled for completion in July 1982.

Figure 8. STAGING OF DELTA FACILITIES AND ADDITIONAL CONSERVATION FACILITIES



CHAPTER II. WATER CONSERVATION AND RECLAMATION

The Department of Water Resources is enthusiastic over the potential role water conservation and reclamation will play in meeting water needs, not only for the State Water Project (SWP), but for non-SWP service areas as well. Water conservation will reduce or delay the build-up of future water demands, making more water available for instream use and ground water recharge, or stretching resources to meet the needs of an expanding economy. Water reclamation will augment present water supplies. Both could delay the need to build new project facilities for imported water supplies. As an additional benefit, substantial amounts of energy will be saved from water conservation. Some water reuse projects located in or near water service areas have lower energy requirements than alternative fresh-water supplies imported from distant sources. Consequently, the Department, in cooperation with others, is expending considerable effort to accomplish both water conservation and reclamation in California. The Department estimates that waste water reclamation and water conservation in the urban areas served by the State Water Resources Development System will total 860 000 dam^3 (700,000 ac-ft) annually by year 2000.

Conservation and Reclamation -- A Relationship

Water conservation and municipal water reclamation are considered together for planning purposes because of their relationship. For example, where conservation reduces the volume of flow to a sewage treatment plant, it results in a reduction in the amount of water available for reclamation and reuse. On the other hand, conservation may also increase the salinity of the sewage because of reduced dilution, which would thereby render the reclaimed water less suitable for certain purposes without additional treatment. A recent Department of Water Resources summary report[1/] indicates this problem is likely to be minimal.

Conservation Possibilities

Water use in the State is approximately 15 percent by the municipal, urban, and industrial sector and 85 percent by agriculture. Water-savings opportunities exist in both these water-using sectors. While water use in the municipal and industrial (M&I) sector is low compared to agriculture, immediate savings could be more readily accomplished in the M&I sector without water users' sacrifices, as well as provide important additional potential in the future. In the San Francisco Bay, Central Coastal, and South Coastal regions, which are partially served by the SWP and Central Valley Project, it is estimated a potential exists for annual conservation savings from 1 040 000 to 1 780 000 dam^3 (840,000 to 1,440,000 ac-ft) by year 2000. Valid reasons for significant water savings are:

1/ Koyasako, J., Effects of Water Conservation-Induced Waste Water Flow Reduction - A Perspective, Department of Water Resources, Division of Planning Report, June 1980.

- Toilets and showers account for 15 percent of total residential use. Laws which now require low-flush toilets and low-flow fixtures in new construction, coupled with success of continuing retrofit programs for existing toilets and shower fixtures, promise real future water savings.

- Expectation of future law that will require low water-using appliances.

- Continuing education programs on water conservation and energy costs relating to residential water use.

- Success of the pilot water conservation program throughout the State, demonstrating the general willingness of people to cooperate in water conservation.

Agricultural water demands from the SWP occur mainly in the southern San Joaquin Valley in the Tulare Lake Basin. In this closed basin, most methods of conserving water (increasing irrigation efficiency, for example) would save water that is now being reused; i.e., water that either percolates to ground water or appears as surplus return flow, where it becomes part of the supply for other farmers or is otherwise reused. A reduction in net irrigation demand can only come from conservation methods which reduce the evapotranspiration or reduce the amount of return flows that would otherwise percolate to saline water bodies (such as perched water tables).

The opportunities for agricultural water conservation exist primarily through (1) more efficient irrigation methods that would reduce the evapotranspiration from crops and (2) increased use of brackish water for some type of irrigation.

The Department is placing major emphasis on demonstration projects for agricultural water conservation that involve the user in various methods for accomplishing agricultural water conservation. The Department in May 1979 cosponsored a week-long assembly of a panel of distinguished experts in the field who concluded that there is a potential for agricultural water conservation and for greater use of brackish water for irrigation. The Department, through its expanded agricultural water conservation program, will implement many of the panel's recommendations.

Drip irrigation of a young pistachio tree, a method of water conservation.

DWR Conservation Programs

Water conservation programs incorporated by SB 200 will be initiated within the boundaries of agencies that have contracted for water from the State Water Resources Development System. Implementation of water conservation programs are contingent upon contracts between such agencies and DWR. Elements of these plans could include:

° distributing water-saving devices to all households within each area;

° encouraging or requiring hot water pipe insulation;

° installing water pressure regulators;

° developing architectural and zoning standards which would reduce landscaping water needs;

° developing a rainwater cistern program;

° developing leak detection and repair programs for both water delivery systems and industry;

° developing comprehensive public education programs aimed at school children and adults;

° developing water pricing methods which would encourage water conservation; and

° developing a program for reducing agricultural water use in a way which is relevant to the specific area.

Statewide studies by DWR to improve water conservation in California are generally paid for out of non-Project sources. Implementation of conservation programs in SWP service areas are dependent upon voter approval of SB 200.

Current conservation efforts of DWR include (1) distribution of water-saving devices to over 3.3 million households, (2) preparation of research documenting conservation potentials in the urban sector for use in outreach programs to effect water savings, (3) a landscape water conservation program which presently emphasizes demonstration gardens as an educational tool, (4) an in-school water conservation program which has reached 10 percent of the State's elementary school children and (5) an agricultural water conservation program which focuses on developing new research in this field, as well as on demonstration projects.

These water conservation plans will need to be integrated with other programs designed to reduce reliance on imported water. These other programs include water reclamation and improved water management practices, including ground water management and conjunctive use of ground and surface water, watershed management, banking of water supplies for use in water-deficient years, interbasin and intrabasin transfers of developed water supplies, and development of conventional in-basin water supplies.

Agricultural water savings could be implemented under SB 200 by developing a cooperative program with farmers, farm advisors, and Cooperative Extension Service to reduce conveyance losses and improve irrigation efficiency in the Coachella Valley; by supporting an operation in the San Joaquin Valley to grow salt-tolerant crops with brackish drain and ground water; and by cooperating with the Soil Conservation Service, local water purveyors, and the Cooperative Extension Service.

Reinforcing the foregoing efforts, DWR is establishing a California Irrigation Management Information Service in which the Cooperative Extension Service will develop a system to improve irrigation practices and pest management statewide. In fiscal year 1980-1981, funds of a little more than $1 million have been available to provide a system of small computers in the County Extension Service offices that can be contacted by farmers for information and assistance in irrigation scheduling and pest problems. This system, when fully implemented, should result in a net savings of water in the Central Valley and throughout the statewide agricultural sector.

Reclamation Possibilities

The criterion for crediting the creation of a new water supply through water reclamation is if the waste water would not otherwise be recovered and put to beneficial use.

Municipal Waste Water

The long-range plan of the State Water Resources Control Board's (SWRCB) Office of Water Recycling is the use of 990 000 dam^3 (800,000 ac-ft) of reclaimed municipal waste water per year by year 2000. Some reuse projects that are part of this plan are in design or or construction stage. However, other projects that were part of this plan are in the planning stage and may be delayed due to lack of federal financial assistance. Most of this reuse is expected to occur in the SWP service areas, primarily the Los Angeles-Orange County metropolitan area, and to a lesser extent, in the San Diego and San Francisco Bay areas (see Figure 9).

The Department of Health Services is concerned with the health risks from the use of renovated waste water that may arise from pathogenic organisms, toxic chemicals, and stable organic material. The nature of pathogens and heavy-metal toxicants are well enough understood to set limits of use and prescribe treatment control. However, unknown long-term health effects associated with some stable organic material that remains after treatment prompted Health Services to establish limiting use criteria for treated waste water. Consequently, health aspects are important in evaluating the potential for reusing waste water because of the creation of a possible health hazard through direct human contact or entry into a potable water supply.

Local Reclamation Projects. Reuse of municipal waste water can be accomplished in a SWP service area through use of water from local reclamation projects in exchange for existing SWP water supplies. The net effect would be to reduce the use of imported water in a SWP service area in the amount of effective reuse or to make available an equivalent amount of imported water for use in other SWP service areas. This reuse would be a shared benefit among the SWP service areas because it would delay or reduce the need for additional project conservation features.

The Department has the authority to provide additional units to the State Water Resources Development System. A local water supply project such as a water reclamation project could be constructed to provide project yield. Water from a local water supply project may be furnished to a project contractor, either directly or by water exchange. A local water supply project would be designated for State financing if it is feasible on an engineering and financial basis, economically justified, environmentally sound, and competitive with other water supply alternatives.

Local agencies within the SWP service areas are encouraged to develop their own water reclamation systems and to propose water reclamation projects to the Department. The Department will analyze the proposed projects for technical and financial feasibility and economic justification. If the reclamation projects are constructed by DWR, they could be operated either by DWR alone or possibly by DWR jointly with a local agency.

As a first step toward integrating local water supply projects in the SWP, the Department in February 1979 issued "Guidelines on Funding Local Water Supply Projects for Inclusion in the State Water Project".1/ These guidelines not only relate to financing but also pro-

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1/ See Appendix C.

Figure 9. WATER RECLAMATION PROJECTS UNDER CONSIDERATION

vide for repayment of reimbursable project costs. Water development costs would be expected to vary from project to project, depending on the specifics of each, but all such appropriate costs would be included in the Delta Water Charge. Cost of transportation facilities would be assessed to the Transportation Charge element of the Contractor's water supply contracts. Yield resulting from local projects under these guidelines would be used in lieu of deliveries from other SWP facilities.

Reclamation and reuse of waste water originating within a SWP service area could be locally developed and not be a part of the SWP. While such reuse would have no effect on SWP contractual commitments, it nevertheless could reduce the demand for SWP water.

Two incentives for the implementation of local water reclamation projects as part of the SWP are the use of SWP funding for construction and operation of the local project and the use of SWP energy rates. The energy rates would be melded rates. If a SWP contractor proposes a local project and submits a formal request, the Department will investigate the local project to determine if it is feasible on an engineering and financial basis, economically justified, environmentally sound, and competitive with other water supply alternatives. If the local agency is not a SWP contractor, then the SWP contractor which supplies water to the local agency must request the Department to make the evaluations. Under the foregoing guidelines, the Department has evaluated, to varying degrees, proposed local reclamation and reuse projects in which several projects would use effluent from sewage treatment plants and several projects would use brackish ground and/or surface water supplies. A brief description of these proposed projects follows. (They are also summarized in Chapter I, Table 1.)

° A Las Virgenes MWD reuse project would be located in the southwestern corner of Los Angeles County. The project would expand existing reuse of reclaimed urban waste water between 6 200 and 7 400 dam^3 (5,000-6,000 ac-ft) annually. The project has been determined to be engineeringly feasible, using conventional treatment processes, at an approximate cost between \$220-245/dam^3 (\$275-300/ac-ft). The reclaimed water would be used for irrigation of greenbelts, orchards, golf courses, and highway and residential landscapes; and for industrial use.

° A Goleta Water District reuse project would be located along the south coast of Santa Barbara County west of the City of Santa Barbara. The project area comprises a mixture of urban and agricultural lands which would receive the reclaimed water for irrigation of orchards, golf courses, and landscapes. A preliminary evaluation has identified a two-phase development that could produce between 1 200 and 10 600 dam^3 (1,000-8,600 ac-ft) annually. The cost would be about \$570/dam^3 (\$700/ac-ft) under Phase I and \$485/dam^3 (\$600/ac-ft) under a combined project of Phase I and II.

° The City of Simi Valley in southeastern Ventura County is considering a reuse project to desalt brackish ground water in western Simi Valley. The water supply of 2 500 dam^3 (2,000 ac-ft) at 2 200 milligrams per litre total dissolved solids (mg/l TDS) is available each year from the control of high water table conditions. The preliminary evaluation determined this proposed project to be worthy of further detailed evaluation.

° The Lower Chino Basin area of Riverside County has 21 000 dam^3 (17,000 ac-ft) of rising ground water (800-1200 mg/l TDS) annually which must be disposed of to protect the subbasins. A desalting project could reclaim a usable supply and improve the quality of local ground water. A local agency is proposing to construct and operate the project and sell the desalted water to the SWP. This project is worthy of more detailed study.

Reclaimed waste water being used to irrigate pasture lands.

° San Juan Basin is located in southwestern coastal Orange County. About 4 000 dam^3 (3,000 ac-ft) of ground water (1 000-1 800 mg/l TDS) plus 1 100 dam^3 (900 ac-ft) of surface flow (12 800 mg/l TDS at low flows and 330 mg/l TDS at high flows) would be available annually for a potential desalting project. The proposed project appears to be worthy of more detailed study.

Regional Reclamation Projects. Regional water reuse studies are in progress in various locations around the State. In larger metropolitan areas, there is potential for reuse of reclaimed water resulting from the large-scale construction of advanced waste water treatment facilities, in compliance with the State and federal requirements for waste water discharge. Reuse of water from these facilities could serve significant water needs.

Recognizing this potential, SWRCB in 1977 adopted a Policy and Action Plan for Water Reclamation in California to study the feasibility of reclaiming and reusing waste water in the San Francisco Bay area, Orange/Los Angeles County area, and the San Diego area. Other regional water reuse studies have been initiated since then as a result of DWR or local interests in Ventura County and in southern Santa Clara County. The results of the DWR evaluation of these projects are expected to lead to a determination of the feasibility of constructing and operating these projects as SWP facilities. A brief description of the regional studies follows. (They are also summarized in Chapter I, Table 1.)

° The San Francisco Bay Area Regional Water Reuse study is sponsored by a 14-member Joint Powers Agency. The goal of this study is to develop a regional long-range waste water reclamation facilities plan to provide for maximum reuse of Bay Area water and to develop an implementation program consistent with on-going and proposed sub-regional programs. By 1985, 418 000 dam^3 (340,000 ac-ft) per year of highly treated waste water will be available for export from the Bay Area. Markets with the greatest potential are (1) for salinity control in the Western Delta at a cost of \$195/dam^3 (\$240/ac-ft) and (2) for irrigated agriculture in the southwestern parts of the San Joaquin Valley at a cost of \$285/dam^3 (\$350/ac-ft). Because of the salinity content of the treated waste water, when used in the Delta, only about 70 percent of as much fresh water yield would result and become available for other use. Also, the salinity content of the treated municipal waste water may be a major consideration when the waste water is used for irrigation in the San Joaquin Valley and must be carefully evaluated.

° The Orange and Los Angeles Counties Water Reuse study is a joint venture among six local water management, supply, and reclamation agencies in those counties with federal, State and regional planning agencies. Seventeen reclamation projects for local reuse and export are being evaluated up to year 2000. The goal of this study is to identify and assist in the implementation of currently feasible water reclamation-reuse projects and to establish the feasibility of constructing facilities for a large-scale future expansion of water reuse in the planning area. A potential market has been identified for reuse at three service sites of about 183 000 dam^3 (148,000 ac-ft) of reclaimed water per year by the year 2000. The cost in current dollars is estimated in the range of \$170 to \$285/dam^3 (\$210 to \$350/ac-ft), depending on the distance from the reclamation project to the use site.

° The San Diego Water Reuse study is a joint venture by the City of San Diego and the County of San Diego. The goal of this study is to develop financial plans and revenue programs for 12 local water reclamation projects, along with environmental impact assessment reports which will satisfy the Step One facilities plan requirements of the Clean Water Grant program. A total of about 41 000 dam^3 (33,000 ac-ft) per year has been identified for potential reuse in the 12 project areas. The cost is estimated at \$760/dam^3 (\$940/ac-ft).

° The Ventura County Water Reuse Study is being conducted by Ventura County Sanitation District. Funded by the Clean Water Grant Program, the 18-month study is looking at the engineering, economic, facility requirements, marketing, financial and institutional aspects of reclaiming waste water. Oxnard Plains has been proposed as the service area for use of the reclaimed water to repel sea-water intrusion and for irrigation. The quantity of potential reuse is estimated to be 105 000 dam^3 (85,000 ac-ft) annually by year 2000.

° The South Santa Clara Valley Water Reuse Study, initiated earlier this year, will be an 18-month effort to examine the feasibility of using reclaimed waste water to recharge ground water supplies. Water quality analysis of existing fresh and waste water supplies will allow definition of water recharge standards. Alternative reclamation projects will be identified and evaluated. Recommendation will be made on future actions for the study area.

Agricultural Waste and Brackish Water

Agricultural waste water is that water captured by subsurface drainage systems and conveyed to a disposal system. It is generally too brackish to be reused for direct irrigation without first being blended with fresh irrigation water. Where the quantity of waste water collected exceeds the amount that can be blended or where it is impractical to blend, the waste water must be disposed of. Disposal could be accomplished by evaporation ponds and marshes or by discharge to a saline body of water such as the ocean.

Desalting is one alternative to disposal of agricultural waste waters. The quantity of waste water requiring disposal can be reduced by 80 to 90 percent; the 10 to 20 percent of the waste water remaining in the form of brine from the desalting plant will contain most of the original salt load, and must be either evaporated in ponds or discharged to the ocean.

Reclaimed brackish agricultural waste water can be considered another possible source of new water yield to the SWP. Studies by the Department show that this water can be desalted at a cost that appears competitive with the cost of new water supplies from alternative SWP facilities.

In the San Joaquin Valley, more than 60 000 dam^3 (50,000 ac-ft) per year (1979) was disposed of within the Valley. By the year 2000, the San Joaquin Valley is expected to produce more than 490 000 dam^3 (400,000 ac-ft) of agricultural waste water per year. In Coachella Valley, about 100 000 dam^3 (81,000 ac-ft) of agricultural waste water now drains into Salton Sea. Because there will be a disposal problem in the future, the Department is formulating an advanced planning activity based upon extensive experience with a 95 000-litre- (25,000-gallon)-per-day agricultural waste water desalting pilot plant near Firebaugh to help resolve this problem. As part of this activity, the Department will construct and place in operation in 1982 a nominal 3.8-megalitre- (1 million-gallon)-per-day demonstration membrane desalting module which will provide the scale-up data necessary to make an accurate design, cost estimate, and development schedule for large-scale agricultural waste water desalting plants. The Governor's budget for F.Y. 1980-81 included a $777,500 appropriation from the Energy and Resources Fund to initiate the development of the demonstration desalting

Agricultural waste water desalting pilot plant near Firebaugh in San Joaquin Valley.

module. The 1981-82 budget includes $3,880,000 for construction of the facility.

In July 1980, the Governor issued Executive Order B-68-80[1/] to implement a program of recycling agricultural drainage and other brackish water to increase the supplies available in the SWP with the objective of desalting 490 000 dam^3 (400,000 ac-ft) per year by the year 2000. Several desalting plants would have to be planned in the areas where the brackish waters exist. The plants would be evaluated to determine the cost of reclaiming and reusing the brackish water. The Department's previous and current planning studies to investigate feasibility of desalting agricultural drainage and other brackish water will be an important aid to meeting this objective. The studies are considering the location and potential construction of 31 000-dam^3- (25,000-ac-ft)-per-year agricultural waste water desalting plants in the San Joaquin Valley and the location and potential construction of several brackish ground water desalting plants in Southern California. The construction of agricultural waste water desalting plants will depend on the successful results of the demonstration module cited above.

The schedule for proposed construction of desalting plants will be influenced by the cost effectiveness of producing water by a specific desalting plant, the demand for water in the SWP service areas, environmental concerns, and energy requirements. To minimize the energy demands for the desalting plants, each plan will be made as energy self-sufficient as possible through energy recovery, biomass conversion, solar energy ponds, and use of natural systems for pretreatment of the waste water, where feasible.

Membrane desalting processes, which would be used to desalt agricultural waste water and other brackish water, require considerable amounts of energy but significantly less energy than evaporation desalting processes or pumping water from the Delta to Southern California. In any case, energy requirements would be made minimal by adapting relevant procedures mentioned above.

The SWP desalting facilities will be integrated into drainage disposal and water supply systems. In the San Joaquin Valley, biological and solar salt gradient pond systems recommended by the Interagency Drainage Program as part of a comprehensive drainage and salt management program will be made part of the desalting plant. The biological ponds for part of the pretreatment and the solar ponds for energy generation would thereby reduce the cost of desalting.

The Department plans either to integrate the reclaimed agricultural waste water into the SWP aqueduct system or to dedicate it to local irrigation systems within the SWP service area.

1/ See Appendix D.

CHAPTER III. GROUND WATER BASIN STORAGE

Water from California's ground water basins has been an important factor contributing to the present development of the State's economy. As this development has occurred, partial dewatering of these ground water basins has made vast volumes of space to store additional water available. The Department has recognized the potential for using this storage space in conjunction with surface water to increase the yield of SWP.

Using available ground water storage space has many advantages. Ground water storage reduces evaporation, stores water at a lower unit cost, reduces the chances of organic pollution, does not require an extensive distribution system, and is generally more environmentally acceptable than surface storage. A ground water storage program would reduce pump lifts, thereby saving energy and also providing a dependable water supply source for local use during emergency situations.

The Department of Water Resources has completed reconnaissance-level ground water investigations in 12 areas of the southern one-third of the State. All areas studied have storage space available for additional ground water. From these 12 areas, DWR selected five in Southern California and one in the San Joaquin Valley as the more promising candidates for feasibility-level evaluation over the next several years (Figure 10). In addition, a reconnaissance-level study has been conducted to evaluate ground water storage potential in Livermore Valley in the South Bay area of Alameda County.

This chapter summarizes the progress and findings of the seven selected ground water basins. (The other five areas with completed reconnaissance-level studies are described in Appendix A.) The discussion here explores the operation of underground storage basins in conjunction with the California Aqueduct to provide long-term carryover storage of Delta surplus flows.

The three requisites of conjunctive operation of the SWP and ground water basins are:

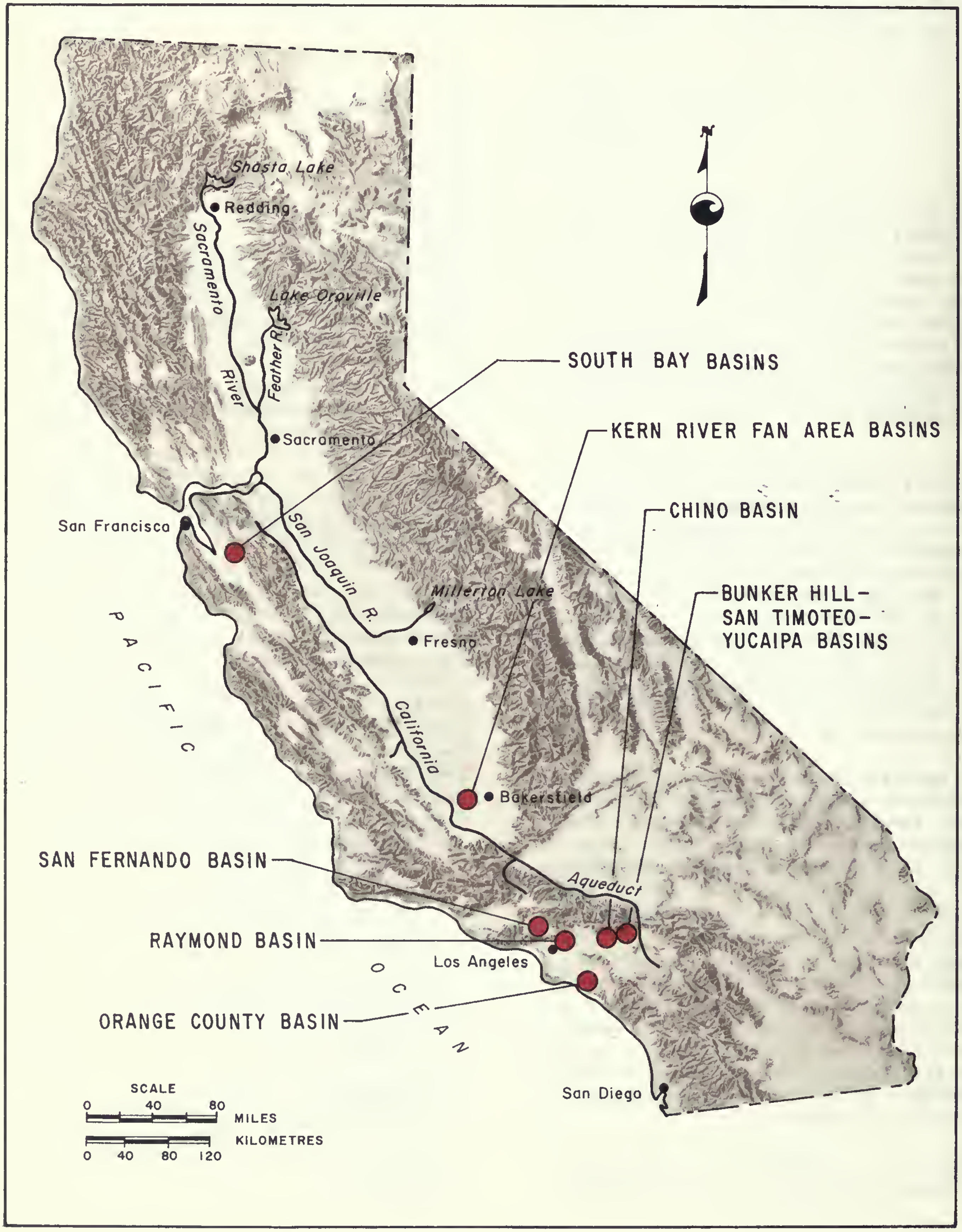
- Availability of basins having suitable location, storage space, infiltration and transmission ability, and good water quality.
- Availability of excess water at the Delta for basin recharge after all SWP entitlements and water quality standards have been met.
- Availability of capacity in the California Aqueduct between the Delta and the selected ground water basin at the same time excess water is available at the Delta.

Study Methods and Comparison of Findings

The seven reconnaissance-level study areas presented in this chapter are:

- Southern California Region -- Bunker Hill-San Timoteo-Yucaipa, Chino, Orange County, Raymond, and San Fernando basins.
- San Joaquin Valley Region -- Kern River Fan Area.
- San Francisco Bay Region -- Livermore Valley Basin.

Figure 10. SELECTED GROUND WATER FEASIBILITY STUDY AREAS



The essential elements examined were the amount of SWP water to be stored and recaptured, method to be used, time required initially to place the water in storage, preliminary cost evaluation, average energy requirements, and preliminary environmental comparison.

Storage Options

Two methods of augmenting water yield of the SWP were investigated -- the direct method and the indirect method.

The direct method would use SWP water, when available coincident with available capacity in the California Aqueduct, to recharge the ground water basins. The recharged water would be extracted and delivered to SWP Contractors during dry years. Surface facilities for this type of operation consist of spreading areas, means of conveyance of the water to such areas, and pumping units for future water extraction.

The requirements for direct storage operation are:

- Ample ground water storage space.
- Highly permeable materials in the vertical zones between the ground surface and the water table.
- Ability of the underlying aquifers to transmit water at a significantly high rate.
- No threat to water quality of stored water.

The indirect method can be applied when a water service agency agrees to take delivery of SWP water in wet years, in lieu of pumping water from the underlying ground water basin. Thus, ground water would be allowed to increase naturally due to local recharge of the basin. During drought periods, the surface water supply would be discontinued and the ground water in storage pumped and used.

For the indirect method to be most effective, the ground water basin should:

- Have ample available storage space.
- Be capable of receiving SWP water on the surface, either by existing facilities or by facilities which can be built at minimal cost.
- Have a sufficient volume of current annual pumpage to allow usage of a large amount of SWP water in lieu of pumping.
- Be capable of retrieving stored SWP water in a reasonable amount of time when needed during drought years, either by existing facilities or by facilities which can be built at minimal cost.

Ideally, the indirect method of operation would be more advantageous than the direct method because it would require less energy. Moreover, social and environmental impacts caused by construction of spreading facilities for a large-scale, direct-method operation may be avoided by use of the indirect method.

Water Yield Analysis

Water yield estimates for the ground water basins under study are summarized in Chapter I, Table 2. Water supplies available for a ground water program were determined from an analysis of the existing State Water Project and Central Valley Project with certain additional surface water developments (as planned under Senate Bill 200). New yield is the estimated incremental effect of adding a SWP ground water storage program to the base system.

In the reconnaissance-level studies, each basin was treated as though it were the only one in a ground water program and was assumed to be full at the beginning of the operational period. To obtain a better picture of the ground water program and of California Aqueduct delivery capability, an operation study was performed in which the basins discussed in this chapter were operated simultaneously. The incremental project yield of the ground water basins was computed over a 50-year historic hydrologic period including the 1928-1934 dry period.

Costs of Water Storage

Estimated costs of water storage for each ground water basin are necessarily preliminary at this time. Costs were evaluated on an incremental basis only. The actual costs and methods of financing and repayment will be the subject of further discussions and negotiations among the water supply contractors and DWR when specific projects have been defined. Preliminary cost estimates of construction of facilities required for each basin are shown in Chapter I, Table 2, based on 1981 price levels.

Unit costs of incremental project yield listed in Table 2 include (1) repayment of capital costs of construction, based on a 50-year period of analysis and a 7-3/8 percent interest rate, (2) annual operational costs for storing water in the basins and extracting this stored ground water, (3) cost required for initial filling of water in the ground water basins, and (4) year 2000 transportation costs from Delta to the ground water basin for annual operation.

The annual costs per unit of annual yield shown in Table 2 were obtained by dividing the project annual equivalent cost by the average annual yield. These estimated costs are useful only for comparison with similar costs developed for other reconnaissance level studies and should not be considered as the negotiated price of new water supply.

Institutional Constraints

Successful implementation of a ground water storage program to increase SWP yield must be founded on overall agreement by DWR, local SWP contractors and local water users. Many issues such as the equitable sharing of basin storage space, allocation of costs and benefits, and appropriate management procedures have not yet been resolved. For example, current SWP operation allows for the sale of "surplus water" at a cost well below that for contract entitlements. Under a ground water storage plan, some of this more favorably priced water could be diverted instead to basin storage. As a result, some San Joaquin Valley agricultural contractors have expressed opposition to the ground water basin storage concept.

Economic and Environmental Comparison

Economic and environmental (including social) concerns must be defined early during project planning. These issues can include both the detriments associated with each potential project and the benefits that may be derived.

During the reconnaissance phase of planning, each of the proposed ground water basin storage plans was examined to identify potential environmental effects. The ground water basin storage projects studied by DWR would have three common environmental concerns. First, if ground water levels are increased or falling levels slowed, pump lifts would be reduced, with resultant reduction in energy use by local water well users during the period when water would be in storage. The longer the period of storage, the more benefits derived. However in most basins, recapture of stored water might use more energy than would be saved during the storage period.

Second, ground water quality can be beneficially or detrimentally affected. Many of the ground water basins have poorer water quality than do SWP supplies. Where this occurs, SWP water placed underground would benefit overall ground water quality in the basin. However, when the stored water is recaptured and delivered to the consumer, it would be blended and, therefore, of poorer quality than would direct SWP surface deliveries. Other possible impacts were identified, as were possible mitigation measures. Specific environmental issues relating to each ground water basin storage program are discussed in sections describing each program. Studies to date have been cursory, and more intensive environmental evaluations will be necessary during feasibility studies.

Summary of the Seven Areal Reconnaissance Studies

The results of the studies conducted for the ground water program are described below and are also summarized in Chapter I, Table 2. Full use of all these basins would require enlarging the East Branch California Aqueduct.

Bunker Hill-San Timoteo-Yucaipa Basins

The Bunker Hill-San Timoteo-Yucaipa basins study area is situated in southwestern San Bernardino County and northwestern Riverside County (Figure 11). The water-bearing portion encompasses 563 square miles (217 square kilometres [km^2]) and lies in a structural depression between the San Jacinto Fault on the west and the San Bernardino Mountains on the north and northeast.

Approximately 24 faults are located in the San Bernardino Valley. Chief among them are the San Andreas fault zone, which lies along the base of the San Bernardino Mountains, and the San Jacinto fault zone. Most of the faults impede ground water movement because displacement of permeable beds against impermeable beds acts as a barrier.

The major fresh-water-bearing unit in the study area is the older alluvial fan material, ranging in thickness up to 244 metres (m) (800 feet [ft]). Locally confined aquifers are situated in the study area.

Ground water in storage in the area was estimated to be 6 780 000 dam^3 (5.5 million ac-ft) in 1965. This figure includes only the actual amount that can be extracted. Historically, ground water in storage has fluctuated as the pumping, artificial recharge, and natural recharge rates have varied. Storage decreased from base year 1934 until 1965 in all but two years. During the late 1960s, however, increases in storage were noted. Between 1970 and 1977, ground water storage declined; since 1978, however, the basins have been recovering because of the wet conditions in Southern California.

Water level declines have caused land surface subsidence in the study area. The maximum drop, measured by the U. S. Geological Survey (USGS), has been 0.3 m (1.0 ft) above the confined aquifer (pressure zone). If future water demands were met by maximum ground water extraction, 1.2 m (4 ft) of subsidence could take place in one area by 2015 (USGS estimate). This would result in a decrease of 2.1 million dam^3 (1.7 million ac-ft) in storage.

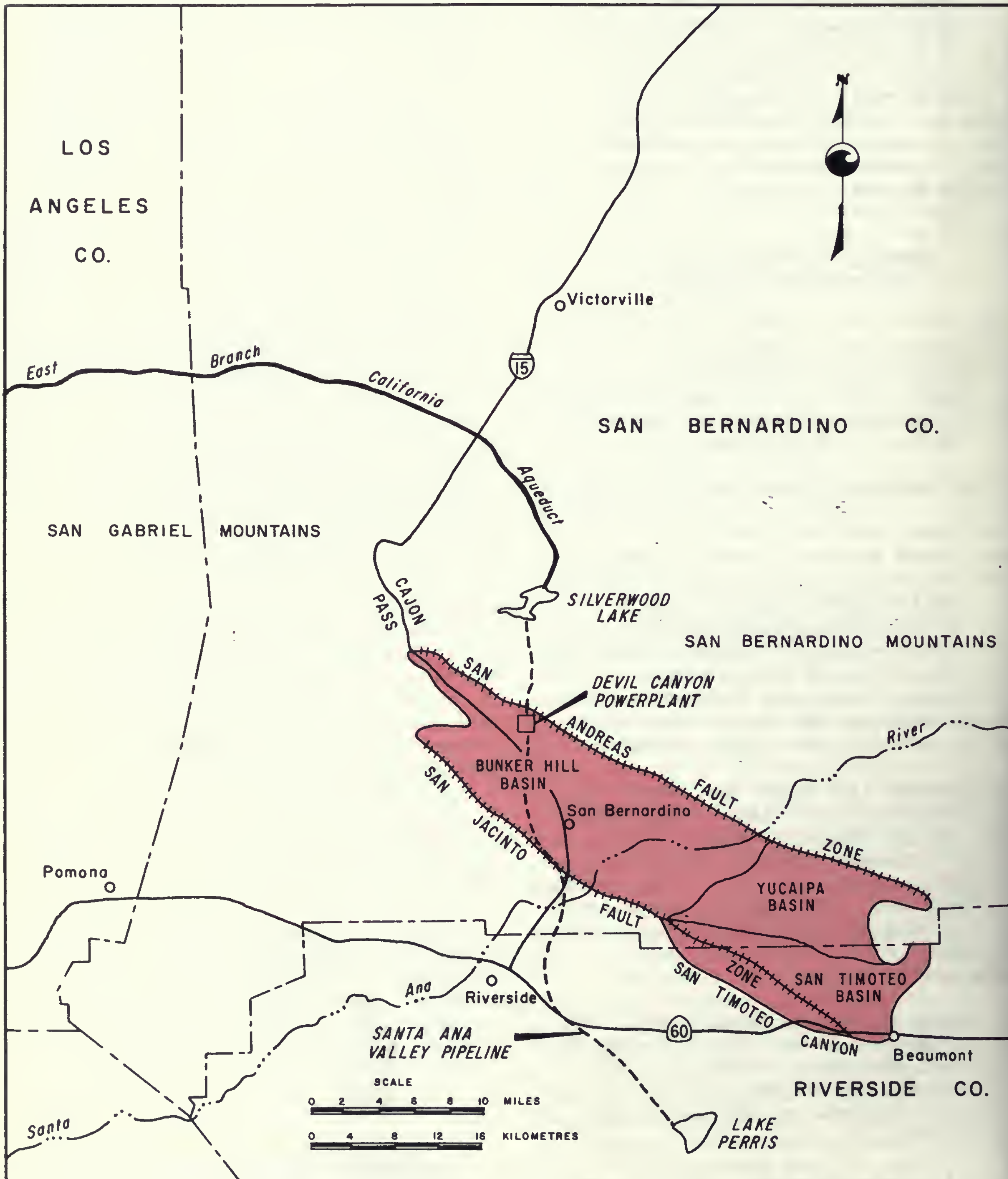
Ground water quality is generally acceptable for domestic and irrigation uses. Deeper aquifers have better quality water than do shallow ones. Flexibility in overall water supply operation allows water that does not meet quality requirements to be blended with better quality water before distribution.

In some parts of the study area, nitrate concentrations have exceeded U. S. Public Health Service maximum levels in the upper 15 m (50 ft) of the aquifer.

Recharge Facilities. Available recharge and recapture facilities include spreading grounds, wells, and transmission features. Seven agencies operate 31 spreading grounds encompassing about 1 960 hectares (ha) (4,850 acres [ac]) and two injection wells. Twenty-two agencies operate extraction wells in the basins.

The San Bernardino Valley Municipal Water District (SBVMWD) delivers SWP water to this area. The Foothill Pipeline of SBVMWD has turnouts at six spreading

Figure 11. BUNKER HILL-SAN TIMOTEO-YUCAIPA GROUND WATER BASINS



grounds. The pipeline has more than sufficient capacity to deliver its SWP entitlements to these spreading grounds.

The average annual artificial recharge for the spreading grounds from 1934 to 1965 was almost 34 500 dam^3 (28,000 ac-ft), ranging from a low of 4 400 dam^3 (3,600 ac-ft) to a high of 92 500 dam^3 (75,000 ac-ft). Artificial recharge can also also take place by release of water into the river and creek channels.

Findings. The advantages and disadvantages of each of several possible plans for ground water storage were examined. Direct storage was chosen as the best alternative for the Bunker Hill Basin, based on a study conducted for SBVMWD. The reason for this selection was the presence of the SBVMWD Foothill Pipeline, with its excess capacity and turnouts and spreading ground capabilities, which would provide the less expensive means, compared to the cost of building treatment facilities required of an indirect plan.

The San Timoteo and Yucaipa basins are not proposed in present plans because they lack conveyance facilities to spread SWP water. The cost of adding a conveyance facility would increase the cost above that of the Bunker Hill alternative. However, DWR is studying ways to deliver SWP entitlement water to the Coachella Valley Water District, Desert Water Agency, and San Gorgonio Pass Water Agency. If a route through Yucaipa and San Timoteo Basins is selected, the direct storage alternative for the Yucaipa and San Timoteo Basins should be reevaluated.

Storage space in the Bunker Hill Basin for conservation would be limited to a maximum of 123 000 dam^3 (100,000 ac-ft). Storage amounts larger than this are not feasible because of insufficient space in the confined zone and because subsidence could occur when large quantities of water are withdrawn. This development would provide an incremental project yield of 13 600 dam^3 (11,000 ac-ft) at the basin at a unit cost of $150 per dam^3 ($185 per ac-ft).

Bunker Hill ground water basin spreading area on upper Santa Ana River.

Present Status. An agreement between DWR and the local SWP contractors for a feasibility study has been negotiated and is expected to begin in 1981. Operation of the SWP ground water storage demonstration project in the basin is currently allowing DWR to evaluate the benefits and costs of the ground water storage concept. (See discussion under Ground Water Demonstration Program, page 70.)

Environmental and Social Considerations. After years of above-average natural recharge, artesian water has been surfacing from wells in the pressure zone. Aggravation of this condition could damage overlying structures via abandoned wells in the area. Key wells are monitored by the local water agencies to check this problem. No construction would be necessary because all facilities exist.

Chino Basin

Chino Basin (Figure 12) is the largest ground water basin in the Upper Santa Ana Valley. It lies beneath the broad alluvial plains in the central and western portion of the valley and is within the counties of San Bernardino, Riverside, and Los Angeles. The basin has a surface area of about 600 km^2 (230 mi^2).

The basin's sediments consist largely of a mixture of gravel, sand, silt, and clay that varies widely in composition and in relative permeability. A highly permeable mixture, designated as older alluvium, fills the basin to depths varying from 91 to 914 m (300 to 3,000 ft) and constitutes the major aquifer in the basin.

The basin has an estimated 20 million dam^3 (16 million ac-ft) of storage space. About 1.5 million dam^3 (1.2 million ac-ft) of space is available for storing additional water. Ground water is the major source of water supply in the area and the basin has been overdrafted in the past. The Metropolitan Water District of Southern California (MWD) provides supplemental supplies of SWP water to Chino Basin Municipal Water District (CBMWD).

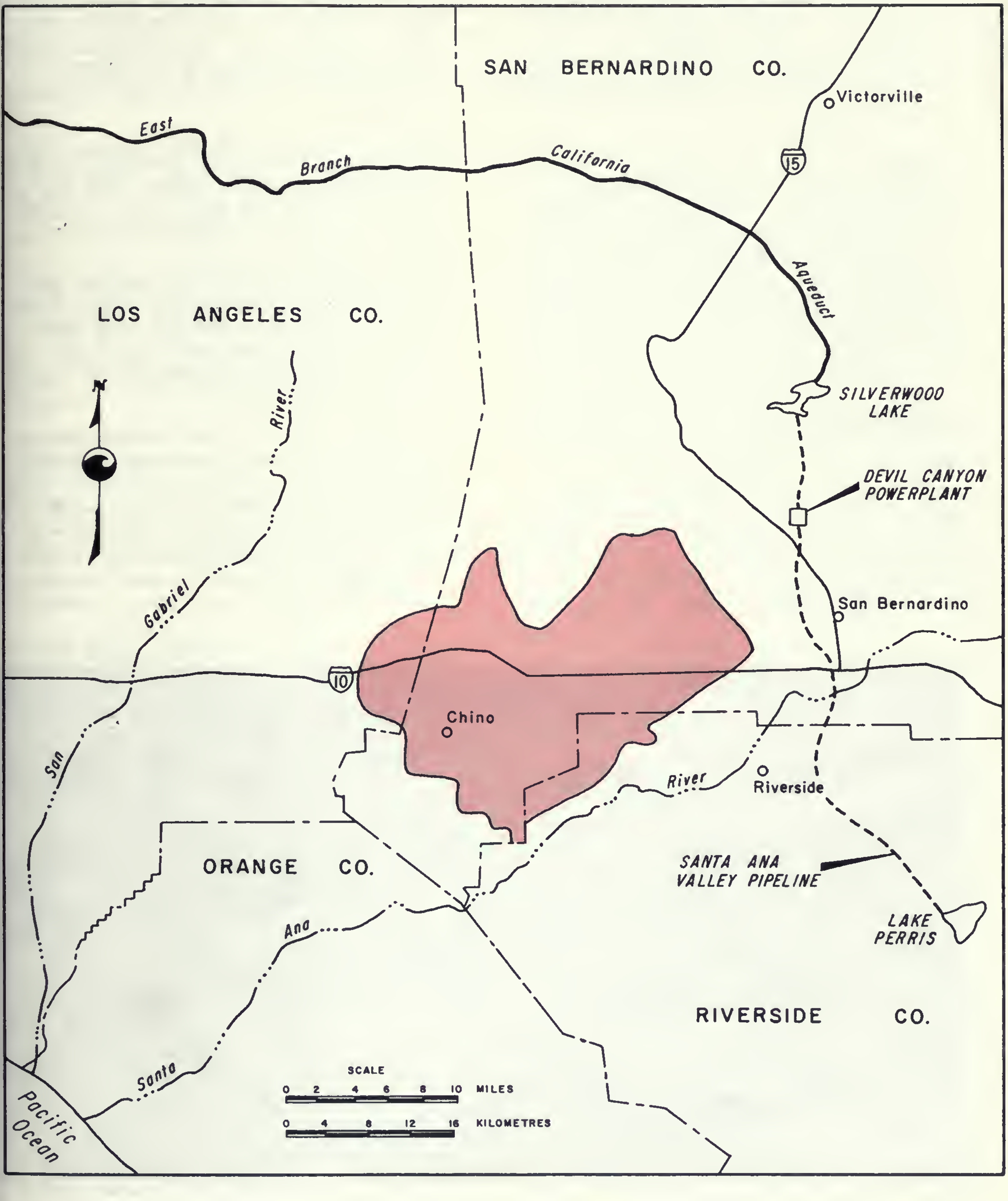
The basin is presently operated under a 1978 San Bernardino County Superior Court Judgment, with administration by the Chino Basin Municipal Water District as the court-appointed Watermaster. The 1978 Judgment resolved the adjudication of water rights and developed the administration capable of carrying out a physical solution to the overdraft condition. The Judgment states that the declared safe yield of Chino Basin limits ground water extractions by the overlying agricultural users to an aggregate of 510 000 dam^3 (414,000 ac-ft) in any five consecutive years; it limits the overlying nonagricultural users to 9 000 dam^3 (7,366 ac-ft) per year and the appropriative users to 61 000 dam^3 (49,834 ac-ft) per year. The average annual safe yield from natural infiltration is 173 000 dam^3 (140,000 ac-ft).

Water quality is best in the northernmost portions of the basin. The quality declines toward the south, where it exceeds drinking water standards and is unacceptable for domestic use.

Recharge Facilities. The facilities necessary for direct storage of SWP water in the Chino Basin are generally available for use in such a program. San Bernardino County Flood Control District owns and operates eight spreading areas with a monthly available capacity of 13 300 dam^3 (10,800 ac-ft). Natural channels are also available for recharging Chino Basin, and MWD has conveyance facilities for importing water from SWP-East Branch. However, to effectuate a ground water storage program, additional service connections from MWD's conveyance facilities would be required for most spreading areas; recapture facilities for large-scale operation would also be required.

The East Branch of the California Aqueduct has the capability to deliver 1 040 000 dam^3 (846,000 ac-ft) per year to water contractors south of Devil Canyon Powerplant. These contractors

Figure 12. CHINO GROUND WATER BASIN



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have requested entitlement water in excess of this amount to be delivered in the 1980s. Thus, after meeting all entitlements, capacity of the East Branch, unless enlarged, will be a limiting factor during periods in which excess water is available.

Findings. The direct method of recharge was selected as the best storage plan for Chino Basin. The indirect method was ruled out at this time for lack of facilities for treatment and large-scale distribution of surface supplies. The development would provide an incremental project yield of 169 000 dam^3 (137,000 ac-ft) per year at the basin at a unit cost of \$170 per dam^3 (\$210 per ac-ft).

Present Status. The Metropolitan Water District of Southern California and the Department of Water Resources have entered into an agreement to fund the feasibility level study for the Chino Basin and to have it conducted by a consultant firm. The study will investigate the geological, engineering, economic, institutional, legal, and environmental considerations of using the basin for additional ground water storage programs. Taking into account projection by DWR of available imported water supply for the basin, the study will be directed toward achieving the following objectives:

A. Determination of the feasibility of using the basin for State, regional, and local ground water basin storage programs, and a combination thereof;

B. Delineation of optimal storage capacity of the basin, operational modes, and methods of implementation which will include consideration of new wells, spreading basins, turnouts and distribution systems; and

C. Identification of the impacts of the ground water basin storage programs.

Relating to the evaluation of the physical framework and ground water flow system of the upper Chino ground water basin, DWR awarded a contract for construction of seven test holes in the

Ground water spreading facility in Chino Basin.

Rancho Cucamonga portion of the basin. The contract is part of a cooperative study with the U. S. Geological Survey. Study results will be available to aid the consulting firm in its findings, conclusions, and recommendations early in 1982.

Environmental and Social Considerations. Rising water levels in the southern end of the basin caused by a ground water storage program could contribute substantial quantities of dissolved solids to the water at Prado Reservoir. Ground water in the lowermost portions of the basin currently has TDS (total dissolved solids) and nitrate concentrations unsuitable for direct domestic consumption. A monitoring program would be needed.

As previously stated, the facilities necessary for direct storage are generally available, but some construction would be necessary for additional service connections and recapture facilities. Potential impacts of this construction are unknown but will be studied.

Orange County Basin

Orange County Basin encompasses 923 km^2 (355 mi^2) in the county's western area. The basin includes part of the Santa Ana River watershed, the principal watershed in the area (Figure 13).

A portion of the Coastal Plain overlies this ground water basin. Fresh-water-bearing sediments reach depths greater than 1 200 m (4,000 ft). Ground water exists under both confined and unconfined conditions.

Total storage capacity of the Orange County Basin is estimated to exceed 18.5 million dam^3 (15 million ac-ft). Only 1.9 million dam^3 (1.5 million ac-ft) is considered economically usable. Of this, 185 000 dam^3 (150,000 ac-ft) would be available to a SWP storage program.

Ground water quality in the basin averages about 450 milligrams per litre total dissolved solids (mg/l TDS). The State Water Resources Control Board has established a basin objective not to exceed 600 mg/l TDS in the northeastern forebay and 500 mg/l TDS in the southwestern pressure area. The quality of SWP water makes the yield augmentation plan attractive in this basin.

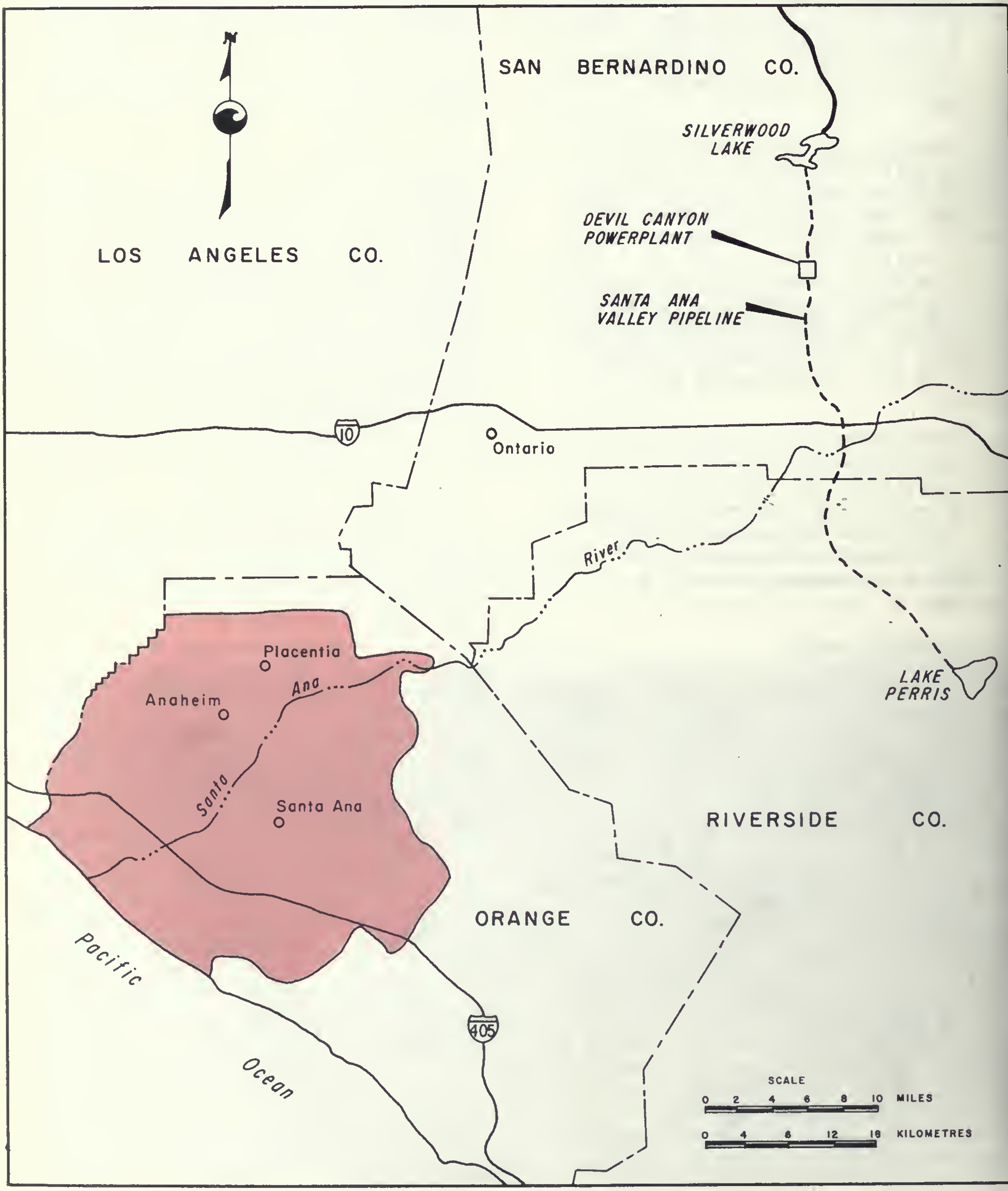
Recharge Facilities. Spreading grounds, conveyance facilities, and extraction wells are available for a ground water storage program in Orange County. Orange County Water District (OCWD) is responsible for the management of the ground water basin, including both quality and quantity of water. MWD delivers SWP water to OCWD, Municipal Water District of Orange County, Coastal Municipal Water District, City of Anaheim, City of Fullerton, and City of Santa Ana.

Seven spreading grounds are in operation, as well as the Santa Ana River instream channel facilities. The Santa Ana River spreading facilities are the major ground water replenishment areas. They extend a distance of 9.7 km (6.0 mi). Recharge capacity is estimated to be 370 000 dam^3 (300,000 ac-ft) per year.

Recapture would be facilitated by the 16 local agencies that operate hundreds of wells in the basin. The pumps are estimated to have a reserve pumping capacity of 52 000 dam^3 (42,000 ac-ft). Under a direct storage plan, part of this capacity could be used to pump SWP water.

Findings. Both the indirect and direct methods of storing ground water were found to be feasible for Orange County. The capacity of storage was determined by considering not only excess SWP aqueduct capacity and availability of SWP conservation water but also space available in spreading grounds and transmission, distribution, and extraction facilities. In addition, the indirect ground water storage program would be controlled by the available excess capacities of existing treatment facilities. The Orange County program would provide

Figure 13. ORANGE COUNTY GROUND WATER BASIN



an incremental project yield of 21 000 dam^3 (17,000 ac-ft) per year at a unit cost of \$150 per dam^3 (\$185 per ac-ft).

Present Status. A feasibility study may be scheduled for Orange County, pending the results of the Chino Basin study, which is due in the first part of 1982.

Environmental and Social Considerations. A beneficial aspect of implementing a ground water storage program in this area would be to improve overall water quality. No potential adverse impacts of such a program are known.

Raymond Basin

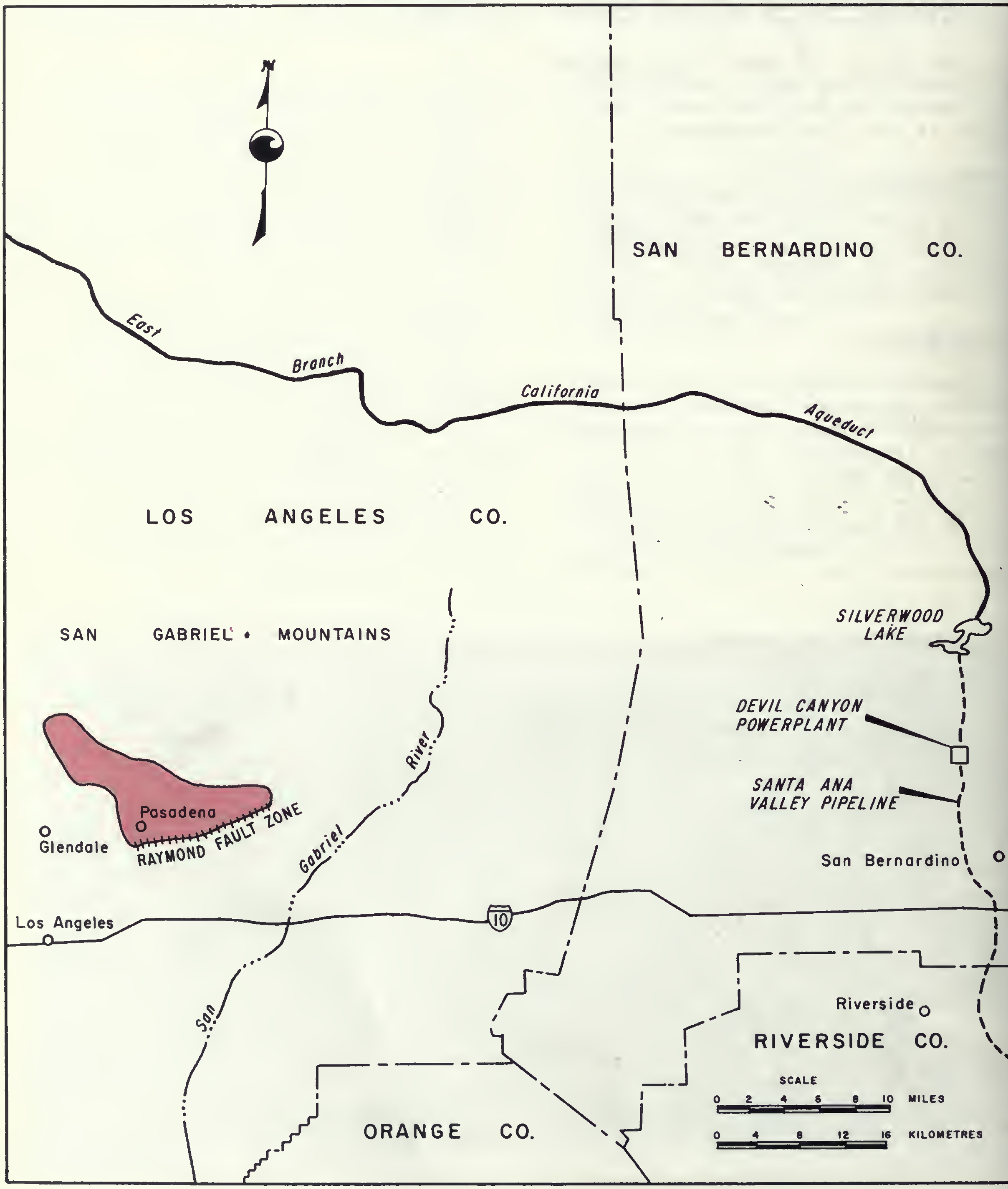
The Raymond Basin lies within the northwestern portion of San Gabriel Valley, immediately northeast of the City of Los Angeles (Figure 14). The basin has an area of 104 km^2 (40 mi^2). It is separated from the rest of San Gabriel Valley by the Raymond Fault. The Raymond Fault is not a complete barrier to ground water flow. Should the ground water level rise too high, some of the stored water could be lost to San Gabriel Basin.

Raymond Basin consists of alluvial fill material deposited by streams flowing from the mountains. The material is typically coarse, with equal amounts of gravel and clay and a small amount of sand. The water-yielding capacity is typical of similar material found elsewhere in Southern California.

Stored ground water in 1970 was estimated to be 1.2 million dam^3 (1 million ac-ft). The basin's storage capacity between depths of 6 and 69 m (20 and 225 ft) is estimated to be 1.8 million dam^3 (1.5 million ac-ft). However, not all the remaining space would be available to store SWP water. Local water users want to retain an unspecified portion of it for their own use. The amount of usable space is estimated to be 61 700 dam^3 (50,000 ac-ft).

Ground water recharge at Anaheim Lake in Orange County.

Figure 14. RAYMOND GROUND WATER BASIN



Although the quality of ground water is generally within the limits set by regulating agencies for drinking water standards, fluoride or nitrate concentrations in a few wells are high.

SWP water is delivered by MWD to the Foothill Municipal Water District and City of Pasadena, which overlie Raymond Basin.

The basin is being operated under a 1944 Los Angeles County Superior Court Judgment, which appointed the Department of Water Resources as Watermaster. Under the Judgment, ground water extractions are limited to 37 800 dam^3 (30,622 ac-ft) per year to prevent the basin from being seriously damaged by rapid depletion.

Recharge Facilities. Several agencies operate spreading grounds that have adequate capacity to recharge the amount of SWP water available. Additional pipelines and other facilities would need to be constructed to convey all available water from importation facilities to the spreading grounds. Local agencies are capable of pumping and distributing additional water, should a SWP ground water storage program be initiated.

Findings. Both the indirect and direct methods of water yield augmentation were found to be feasible. Both methods are necessary due to the lack of conveyance capacity which would be required to fill the available ground water storage space by the direct method. The incremental project yield of 7 400 dam^3 (6,000 ac-ft) per year could be developed at Raymond Basin at a unit cost of \$155 per dam^3 (\$190 per ac-ft).

Present Status. Raymond Basin is scheduled for a feasibility-level study, to be completed in June 1983. Recently, local agencies and individuals having an interest in Raymond Basin ground water operations have taken steps to implement a regional ground water storage program in cooperation with MWD. However, space may still be available for a SWP ground water storage program.

Environmental and Social Considerations. Additional pipelines and other facilities would be needed for direct recharge. Potential impacts due to this construction would need to be further defined.

San Fernando Basin

The San Fernando Basin underlies the main portion of the 455-km^2 (175-mi^2) San Fernando Valley in Los Angeles County (Figure 15).

The total ground water storage capacity for the San Fernando Basin has been estimated to exceed 4 million dam^3 (approximately 3.3 million ac-ft). A more precise estimate cannot be made because the depth of water-bearing deposits in the east-central part of the basin is unknown. In 1979, approximately 3.6 million dam^3 (2.9 million ac-ft) of water were determined to be in storage. Assuming that similar conditions still exist, 500 000 dam^3 (400,000 ac-ft) of storage space could be available.

Water quality varies from poor in the western sector to somewhat better in the eastern sector. Basically, the quality reflects the composition of the sediments through which the water percolates.

The safe annual yield for the San Fernando Basin is 112 000 dam^3 (90,680 ac-ft). Between 1954 and 1968, the basin was in a continual state of overdraft. In 1968, the basin was placed under the administration of a Watermaster. Since then, the amount of water pumped from the basin each year has been under Court jurisdiction. During the last few years, extractions have been exceeding the safe yield. However, water levels in the basin have not significantly declined because of these extractions.

Although it is estimated 500 000 dam^3 (400,000 ac-ft) of storage space may be available in San Fernando Basin, the amount available for the storage of SWP water has been limited to approximately 185 000 dam^3 (150,000 ac-ft) because the

Figure 15. SAN FERNANDO GROUND WATER BASIN

cities holding water rights in the basin want to reserve a portion of the available space for their use.

Recharge Facilities. The facilities now being used by the various local agencies in the basin include spreading grounds, extraction wells, and surface conveyance facilities for water distribution.

The existing spreading grounds are adequate for recharging the basin with SWP water; no new development would be necessary. However, a small amount of additional construction would be necessary before SWP water could be stored by the direct method because there are no turnouts or service connections at the present time to convey water to any of the existing recharge sites.

To implement a ground water storage program, SWP water would be delivered through the West Branch of the California Aqueduct to Castaic Reservoir, from which MWD would convey the water via the Foothill Feeder to San Fernando Valley. At present, the Foothill Feeder from Castaic Reservoir to San Fernando Valley has sufficient capacity to convey SWP water for storage, as well as regularly scheduled entitlement deliveries to the treatment plant; but, by 1989, scheduled deliveries of SWP water to MWD will exceed the present treatment capacity of the plant. The plant does have potential for expansion, however.

A limiting factor to use of the indirect storage method relates to the charter of the City of Los Angeles, which prohibits the exchange of the city's water or its water rights. The city believes this provision prevents it from implementing such a program. Unless Los Angeles amends its charter, only Glendale and

Tujunga spreading grounds in San Fernando Basin.

Burbank would be able to store SWP water by the indirect method.

Findings. The incremental project yield of 27 000 dam^3 (22,000 ac-ft) per year could be developed in San Fernando Valley at a unit cost of $125 per dam^3 ($155 per ac-ft).

Present Status. A feasibility-level study is scheduled for completion by June 1984. There are indications that, once a regional program has been negotiated to the satisfaction of local users, there will be a greater chance to implement a SWP ground water storage program in the basin.

Environmental and Social Considerations. As previously stated, some additional construction would be necessary to recharge by the direct method, but because the construction would occur within right of way owned by MWD, impacts should not be significant. Elsewhere in the basin, no other potentially significant impacts would seem likely to occur.

Kern River Fan Area

The Kern River Fan Area, depicted in Figure 16, encompasses 2 900 km^2 (1,100 mi^2) of Kern County in the southern San Joaquin Valley. The Coast Range Mountains on the west side of the valley shield the area from moist Pacific air and promote a warm, semiarid climate where the rainfall averages about 15 cm (6 in) a year.

Geologically, the Kern River Fan Area consists of thick alluvial deposits containing a great deal of sand and gravel and extensive clay beds. Despite the clay beds, the fan is well-suited for ground water storage and recovery. In all, there are approximately 7.8 million dam^3 (6.3 million ac-ft) of available storage space in the fan. Some of this space will probably never be used, however, because rising water levels could intensify existing drainage problems in adjacent areas.

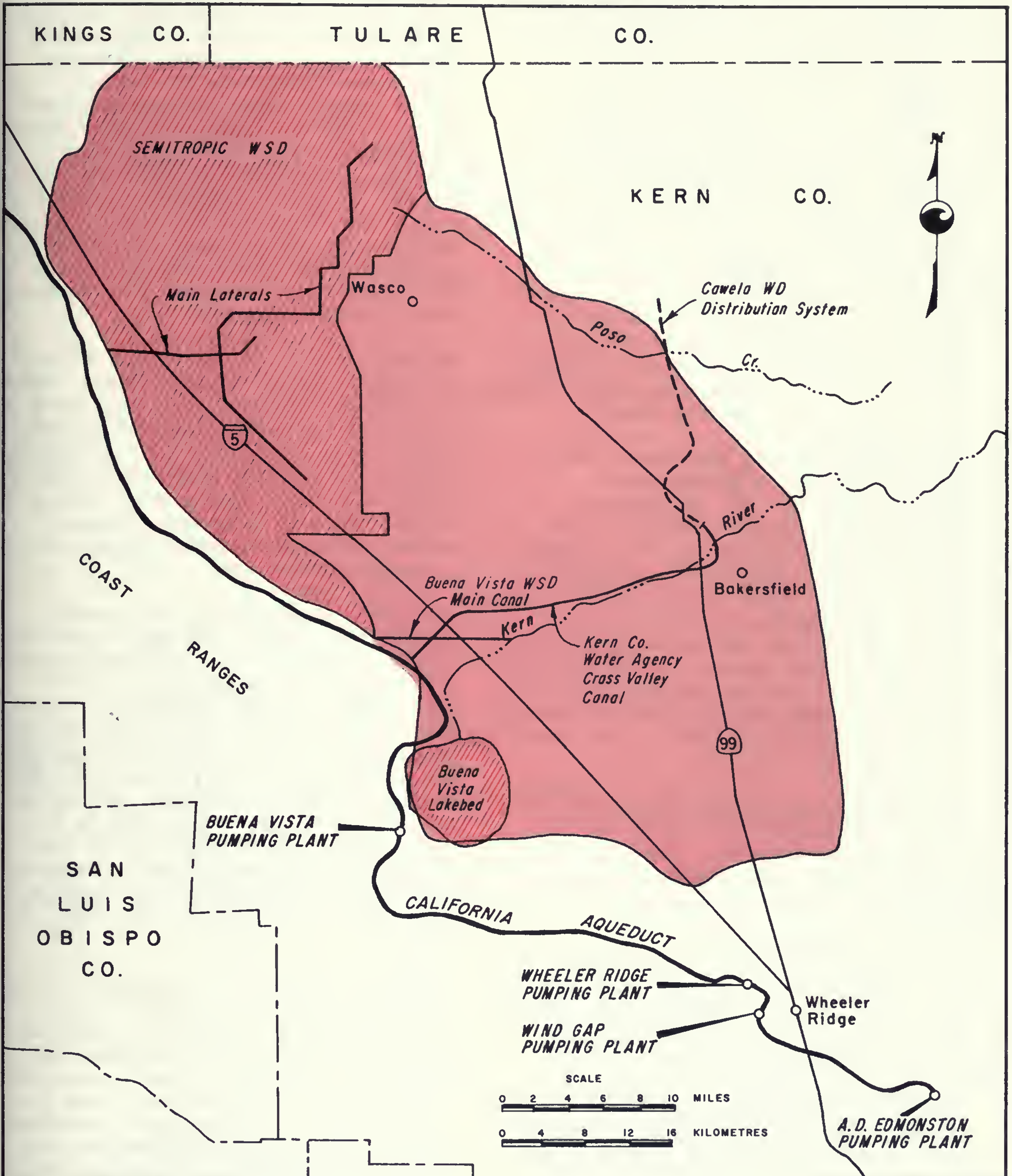
Recharge Facilities. Although ground water is being recharged naturally to a limited extent, the combination of low annual precipitation and a high annual demand for ground water necessitates artificial recharge on a long-term basis. Thus, to help its underground basin meet the local demand for ground water, and to encourage certain growers to use more surface water and less ground water, the Kern County Water Agency built the 34-km (21-mi) Cross Valley Canal to convey SWP water to users east and northeast of Bakersfield.

The Main Canal of the Buena Vista Water Storage District (which is 10 km [6 mi] long) could be used as a spreading basin to recharge the ground water basin in Kern County. Although this canal is seldom used, it could be converted into six recharge basins. DWR estimates that 2 700 dam^3 (2,200 ac-ft) of water could be recharged monthly by this means.

The Kern River channel and Poso Creek are two natural recharge sites. The recharge capacity of the Kern River Channel is 31 500 dam^3 (25,500 ac-ft) per month. No additional work would be required to bring these two natural channels into use. SWP water for recharge could be conveyed to the Poso Creek channel via the Cross Valley Canal and the Cawelo Water District's distribution system. Both Cawelo Water District and Semitropic Water Storage District have the potential for recharging the ground water basin by "indirect" use of SWP water for lands currently using ground water.

Recharge Program. In 1979, when large amounts of surplus water were available from the California Aqueduct, the Kern County Water Agency initiated an artificial recharge program with its member units that resulted in storage of about 246 000 dam^3 (200,000 ac-ft) of water in the local ground water basin. The Agency plans to continue this program in the 1980s. When capacity in the recharge areas is available, excess water from the State Water Project can be used to recharge the underground basin.

Figure 16. KERN RIVER FAN AREA BASIN



Findings. The Kern River Fan Area has the capacity to store approximately 1 850 000 dam^3 (1,500,000 ac-ft) of SWP water underground. The ground water basin can be artificially recharged by existing facilities and naturally recharged by "indirect" surface water deliveries to lands presently irrigated with ground water. The basin would provide 255 000 dam^3 (207,000 ac-ft) per year of incremental project yield at a unit cost of $56 per dam^3 ($69 per ac-ft). In the near future, a joint DWR-Kern County Water Agency demonstration program in the Semitropic Water Storage District could provide a basis for a solution to at least some of the existing institutional problems and help promote a continuing program to enhance the yield of the State Water Project.

Present Status. The Kern County Water Agency (KCWA) has a ground water recharge program. The recharge of 247 000 dam^3 (200,000 ac-ft) in 1979 as a part of this program was the first time hydrologic conditions were favorable since the Cross Valley Canal was built. Negotiations between the KCWA and the Department are currently under way to determine methods to increase the amount of water being recharged. In the Semitropic Water Storage District, the use of the indirect method is now under investigation.

Environmental and Social Considerations. There is potential for impacts on rare and endangered species. Some minor construction would take place. Potential impacts were not investigated.

Livermore Valley Basin

The Livermore Valley ground water basin is located in eastern Alameda County about 69 km (40 mi) southeast of San Francisco (Figure 17). The valley, which contains the cities of Livermore, Pleasanton, Dublin and San Ramon, is largely urbanized, although substantial areas are devoted to agriculture and aggregate (sand and gravel) extraction at present.

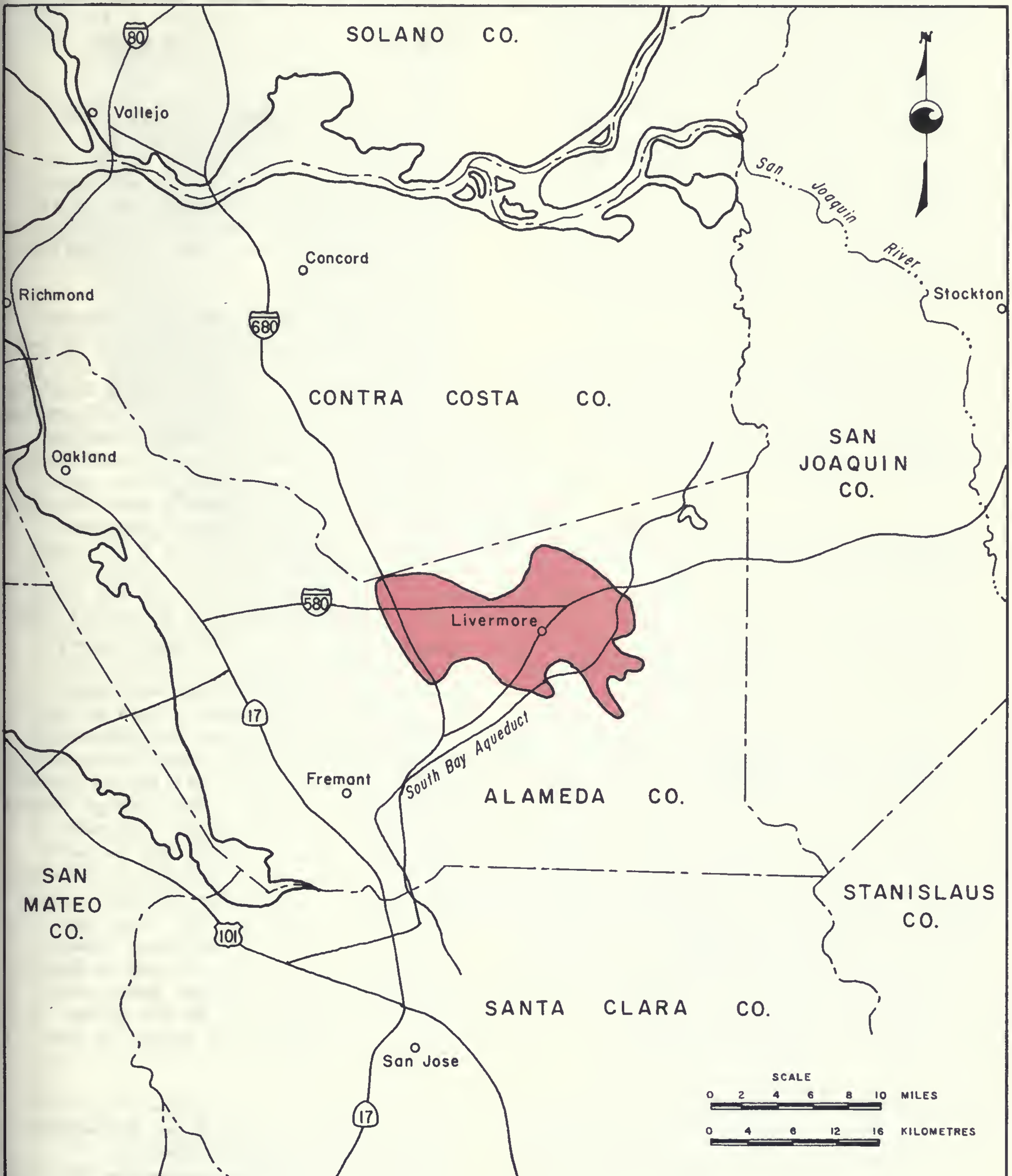
The basin lies in a structural depression within the Coast Range and is essentially a closed basin with little or no ground water outflow. The basin's sediments consist of consolidated to semi-consolidated beds of rounded gravel, with a sandy clay matrix, sandstone, tuff, and shale of the Livermore and Tassajara Formations. These are overlain by extensive alluvial deposits of sand and gravel containing extensive clay beds. The basin is cut by six major faults and at least five other faults of a more local nature. These faults impede the movement of ground water between subbasins.

The basin has in excess of 493 000 dam^3 (400,000 ac-ft) of storage space. About 173 000 dam^3 (140,000 ac-ft) of space is potentially available for storing additional water. However, filling of this space would conflict with the aggregate industry because working pits would be flooded and more expensive dragline operations would be required for continued gravel extraction.

The basin is managed by the Alameda County Flood Control and Water Conservation District, Zone 7. Although the basin has not been adjudicated, extractions are limited by agreements between Zone 7 and the major pumpers in the valley. Zone 7 is presently operating under a policy of actively recharging the basin while relatively low cost SWP water is available. This policy is expected to remain in effect until 1983 when SWP water costs will rise dramatically. Zone 7 has not yet developed a long-range management plan for the basin.

Water quality is best in the central and western portions of the basin. Poor quality water is found in the northern and eastern portions of the basin and is unsuitable for domestic use. Since the basin is essentially closed, there is a trend toward increasing total dissolved solids content. This problem can only be solved by exporting the poorer quality ground water from the basin.

Figure 17. LIVERMORE VALLEY GROUND WATER BASIN



Recharge Facilities. Recharge of SWP water for direct storage in the Livermore Valley Basin could be accomplished by release from the South Bay Aqueduct to natural stream channels, as is currently done by Zone 7. The South Bay Aqueduct has sufficient unused capacity to deliver the water needed for recharge. However, the times when space is available in the aqueduct and when infiltration capacity exists only partially coincide. This problem could be alleviated by operational changes for the aqueduct or by increasing its usable capacity up to its design capacity.

If it is not possible to use natural channels for recharge, offstream spreading basins could be developed but only at greatly increased program costs. Existing local facilities have ample capacity to extract SWP ground water while meeting local needs.

Findings. The direct method of recharge was selected as the best storage plan for the Livermore Valley Basin. The potential exists for a 61 800 dam^3 (50,000 ac-ft) SWP ground water program in Livermore Valley. The planned program would provide 7 400 dam^3 (6,000 ac-ft) per year of incremental project yield in Livermore Valley at a unit cost of $47 per dam^3 ($58 per ac-ft). However, significant water management and operations issues must be resolved before project feasibility can be determined.

Present Status. The Livermore Valley Basin's reconnaissance study was recently completed. An 18-month reconnaissance study is scheduled to begin later this year in the South Bay Aqueduct Service Area (exclusive of Livermore Valley). Then, if warranted, a feasibility study of the South Bay Aqueduct Service Area would follow, including Livermore Valley Basin.

Environmental and Social Considerations. Rising water levels in the basin could adversely impact the aggregate industry and could result in water logging conditions near Pleasanton. Use of natural stream channels for recharge should have a beneficial impact on riparian habitat. The program is not expected to have any significant adverse impact on the natural environment.

Ground Water Demonstration Programs

Two demonstration programs are being conducted by the Department and local agencies to gain experience and to test the feasibility of using ground water basins for additional SWP conservation storage.

Above-normal precipitation and runoff conditions throughout California in late 1977 and early 1978, especially in southern San Joaquin Valley and Southern California, were a factor in influencing the negotiation of the demonstration programs. Natural disposition of Kern River flood flows to the Tulare and Buena Vista lakebeds would have flooded large acreages of valuable farmland. The Kern River Intertie, a U. S. Corps of Engineers flood control project, can divert Kern River flows into the California Aqueduct. In the spring of 1978, large amounts of runoff were passed through the Intertie to relieve the flood threat on the river and other waterways in the region. Part of this water was conveyed over the Tehachapi Mountains. Normally, these waters would be stored in Southern California surface reservoirs. However, due to high runoff at that time, these reservoirs were essentially full. Since DWR is presently studying the feasibility of using ground water basins for storage, and conditions were such that water was available, negotiations began toward implementation of a ground water basin storage program. Storage space was available in both the Mojave River Valley and Bunker Hill basins of San Bernardino County.

Negotiations were held separately with Mojave Water Agency and San Bernardino Valley Municipal Water District (SBVMWD), each agency being the SWP contractor. On May 9, 1978, Mojave Water

Figure 18. DEMONSTRATION PROGRAM GROUND WATER BASINS

Agency (MWA) began storing SWP conservation water in Mojave River Valley ground water basins; and on July 7, 1978, SBVMWD began storing SWP conservation water in Bunker Hill ground water basin (Figure 18).

The demonstration programs serve as model projects to study the economic, legal, and institutional problems that may arise in a ground water storage program. The objectives of the programs are to:

° Provide actual basin management experience

° Test management and administrative procedures

° Develop storage agreements

° Test the efficiency of contract administration

° Test the storage and recapture procedures

° Develop scheduling techniques

° Test economic assumptions

° Establish cost factors

° Evaluate methods of charging and crediting costs

° Evaluate cash flow effects

During 1978, releases from Silverwood Lake totaling 29 200 dam^3 (23,700 ac-ft) were made to Mojave River. It was assumed that five percent of the releases would be lost before the water reached the ground water basin. Starting in the spring of 1979 and continuing through 1982, MWA is being assessed for the stored water on a regular basis as if it were being delivered at the time of assessment.

The DWR-SBVMWD operating agreement provides for ultimate storage of up to 61 700 dam^3 (50,000 ac-ft). Storage may continue until 1985, while all recapture must be completed by 1993. Releases from Devil Canyon Afterbay are transported by the SBVMWD's Foothill Pipeline to a turnout at the San Bernardino County Flood Control District's Devil Canyon Spreading Grounds for percolation.

An important point regarding these demonstration projects is that their primary purpose is to serve only as prototypes for future efforts. It is not the intention to store large volumes of water until agreement on procedures and problems can be worked out, after which DWR would be willing to store additional water, all conditions permitting. Detailed information on the demonstration projects can be found in the DWR Southern District Report, "State Water Project Ground Water Demonstration Programs: Summary of Operations May 1978-June 1980" (November 1980).

CHAPTER III

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CHAPTER IV. SURFACE WATER FACILITIES

Five plans for adding new yield to the State Water Project or joint State-Federal facilities by adding surface water storage are described in this chapter. The plans under consideration are:

Name	Stream	Location (County)
Cottonwood Creek Project	Cottonwood Creek	Shasta, Tehama
Thomes-Newville	Stony and Thomes Creek	Glenn, Tehama
Los Vaqueros	Offstream	Contra Costa
Shasta Lake Enlargement	Sacramento River	Shasta
Colorado River Banking Plan		

The U. S. Corps of Engineers (USCE) is studying the Cottonwood Creek Project under a General Design Memorandum Phase I Investigation. DWR completed reconnaissance planning studies and engineering feasibility studies on the Thomes-Newville Plan.[1/] DWR studied Los Vaqueros at the reconnaissance level, and an engineering feasibility analysis is now under way. Only a preliminary analysis has been made, however, of the enlarged Shasta Plan (refer to U. S. Bureau of Reclamation (USBR) Working Document No. 13, November 1978) and the Colorado River Banking Plan.

DWR also conducted reconnaissance studies on offstream storage at five sites -- Glenn, Colusa, Enlarged Berryessa, Corral Hollow, and Los Banos Grandes -- which are not proposed for further study at this time. They are described in Appendix A at the back of this report.

The Department completed an engineering report covering the Glenn Reservoir--River Diversion Plan in November 1980. The report concludes that the plan is feasible from an operational and engineering viewpoint, but the Thomes-Newville development would better meet expected future water demands. Accordingly, the Department is concentrating its further Sacramento Valley planning efforts on the Thomes-Newville development. Additional planning on the Glenn Reservoir--River Diversion Plan has been deferred (except as needed to help evaluate alternatives during the upcoming feasibility studies of enlarging Lake Shasta).

Study Objectives

The primary objectives of DWR's reconnaissance surface water studies to date have been to develop comparative information relating to:

- Water Yield
- Net energy requirements
- Total first cost
- Unit cost per acre-foot of new water yield
- Environmental and social considerations

1/ DWR Report "Thomes-Newville and Glenn Reservoir Plans, Engineering Feasibility", November 1980.

Water Yield

Each of the alternative projects studied for possible future integration into the SWP-CVP system was considered individually during the reconnaissance investigation as the next increment of development to a system of Central Valley facilities, including the Peripheral Canal. Yield quantities of several projects may not be additive, however, under this type of incremental analysis. To some extent, all reservoirs north of the Delta would compete for future regulation of excess water in the Sacramento River Basin, and the surface and ground water reservoirs south of the Delta would compete for both available excess water and unused California Aqueduct space.

A proposed project which has high average yield and low dry period yield will probably be enhanced, if it is combined with another project that has opposite yield characteristics. Reservoirs proposed near the Delta or the California Aqueduct could provide carryover storage for dry period release, plus short-term storage of excess Delta water for transfer to long-term ground water basin storage when excess capacity becomes available in the California Aqueduct. Excess capacity in the California Aqueduct is not a fixed quantity, however. Its availability is affected by several variable factors, such as Central Valley runoff to the Delta, annual and seasonal demand from the SWP, and storage levels in existing SWP off-aqueduct reservoirs. Yield studies of conjunctive storage and aqueduct facilities will be performed during the feasibility phase of the study of future water supply facilities.

Evaluation of each alternative project as if it were next on line is a means of analyzing a large number of potential alternatives on comparative bases. However, the projects must be subjected to more intensive economic evaluation to determine (1) their joint effect on system yield and (2) the optimum construction sequence to meet increasing needs for water supplies. This will be the objective of continuing DWR studies.

Energy

Average annual quantities of energy required and/or generated at the Thomes-Newville and Los Vaqueros offstream reservoir sites during long-term operation are described under those sections in this chapter. Energy requirements for pumping are greater than energy generation amounts at Los Vaqueros because of pumping-generating plant efficiency losses, reservoir evaporation losses, and very little local inflow. A significant portion of energy generation at the Thomes-Newville development originates from Stony and Thomes Creek flows, and this development would be a net energy producer after the reservoir is initially filled. There is considerable potential for energy generation at the enlarged Shasta Lake and some potential at the Cottonwood Creek Project. Energy requirements or trade-offs associated with the Colorado River Banking Plan will require further study.

Costs of Water Storage

Construction costs shown herein are based upon January 1981 prices. Annual unit water costs are evaluated at an interest rate of 7-3/8 percent per year and a 50-year period of analysis. The present worth of generated energy was subtracted from project costs to obtain the net capitalized cost. Except for the Cottonwood Creek Project, no allowance was made for allocation of project costs to recreation or flood control functions in calculating the unit water costs, nor were the separable costs of flood control or recreation facilities included in the cost estimate. Unit costs of water for the Cottonwood Creek Project are derived from the cost allocated to water supply by the U. S. Corps of Engineers in their General Design Memorandum Report, Phase 1 (to be issued in 1981).

The Colorado River Banking Plan would probably not require construction of new facilities; studies are now under way to determine the net operational costs, if the plan should be implemented.

Environmental and Social Considerations

Important environmental and social issues must be defined early in the project planning process. These issues can include both detriments and benefits associated with each potential project as it affects:

- ° Wildlife (migratory, resident, rare and endangered)
- ° Fisheries (anadromous, resident, in reservoir)
- ° Vegetation (inside site, outside site, fire potential, rare and endangered)
- ° Resources (unique, scarce, important)
- ° Water Quality (at site, off site)
- ° Archaeology (relating to life or culture of ancient peoples)
- ° Paleontology (relating to plant or animal fossils)
- ° Recreation (preproject, postproject)
- ° Land Use
- ° Society (population, relocations, community change, housing available during construction)
- ° Economics - Postproject (population, employment, tax base)
- ° Energy (requirements and production of energy and capacity)

These items are discussed, as appropriate, in the following sections on specific surface water developments.

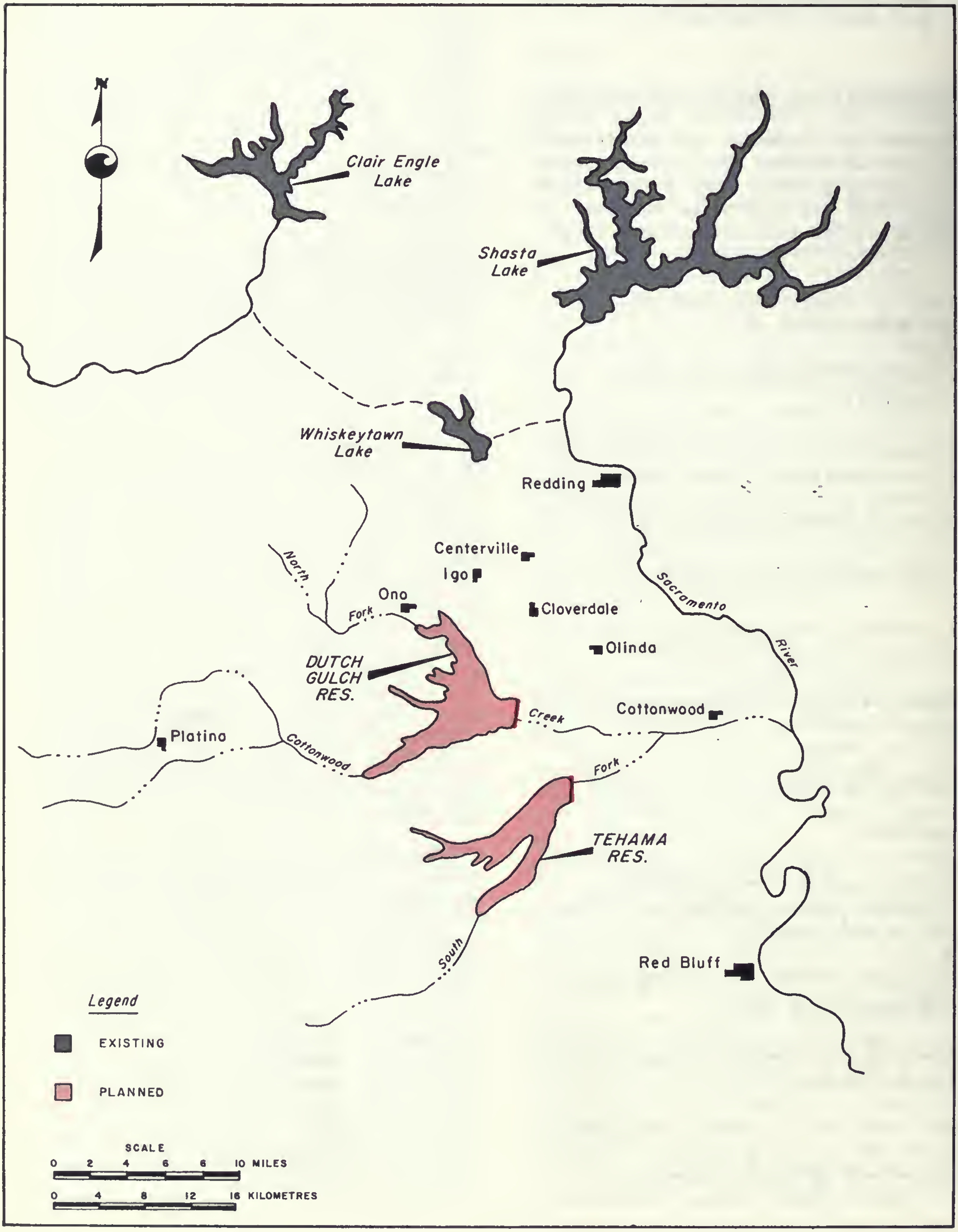
Cottonwood Creek Project

Cottonwood Creek is the largest remaining uncontrolled Sacramento River tributary. It drains an area of 241 000 hectares (ha) (600,000 acres [ac]) on the west side of the Sacramento River in Shasta and Tehama Counties. Mean annual flow (1911-1978) at the mouth of Cottonwood Creek is approximately 687 000 dam^3 (557,000 ac-ft).

State and federal agencies investigated a number of potential small reservoir sites in the Cottonwood Creek Basin over a 20-year period following World War II. In 1965, the U. S. Corps of Engineers began a comprehensive study of the Cottonwood Creek Basin. The Corps examined all the previous reservoir sites but selected two new sites much lower in the basin than any previously considered. These sites are illustrated in Figure 19. Dutch Gulch Dam would be located on the main stem of Cottonwood Creek, about 17.5 kilometres (about 11 miles) west of the town of Cottonwood and some 30.4 kilometres (19 stream miles) from the mouth. Tehama Dam would be located on the South Fork of Cottonwood Creek, about 11.2 kilometres (7 stream miles) above the main stem and 24 kilometres (15 stream miles) from the Sacramento River. Together, the two reservoirs would control 82 percent of the Cottonwood Creek watershed, with a combined mean annual inflow (1911-1978) of about 608 000 dam^3 (493,000 ac-ft).

The Corps reported on the twin-reservoir project in its "Interim Survey Report on Northern California Streams--Water Resources Development for Cottonwood Creek, California", September 1970. The report proposed a multiple-purpose project to provide flood control, water supply, recreation, anadromous fishery enhancement, and area redevelopment benefits. Dutch Gulch Reservoir was sized at 1 357 000 dam^3 (1,100,000 ac-ft) and Tehama Reservoir at 1 110 000 dam^3 (900,000 ac-ft). Local irrigation requirements within the Cottonwood Creek Basin were estimated to require annual

Figure 19. COTTONWOOD CREEK PROJECT



Upstream view of Dutch Gulch Reservoir area on Cottonwood Creek.

Upstream view of Tehama Reservoir area on South Fork of Cottonwood Creek.

releases of 50 000 dam^3 (40,600 ac-ft) from the project. The remainder of the project water supply potential was assumed to be available for municipal and industrial service via the State Water Project under the terms of the federal Water Supply Act of 1958 (PL 85-500). The yield potential of the project was estimated as 290 000 dam^3 (235,000 ac-ft) per year in the Corps' 1970 report, and municipal and industrial water supply accounted for 66 percent of the total project primary benefits. In its official comments on the report, the State reaffirmed its interest in contracting for conservation storage space in the project and recommended that the Corps proceed toward authorization.

Congress authorized the Cottonwood Project in the Flood Control Act of 1970 but provided no funds for further studies until October 1976, when the Corps began advanced engineering and design studies. Phase I of those studies is still under way; it is scheduled for completion in early 1982 and will culminate in completion of a combination General Design Memorandum, Phase I, Report and a draft environmental impact statement. Additional detailed investigations (Phase II studies) will then be undertaken to set forth the technical design criteria for the project, which will serve as the basis for preparation of construction drawings and specifications. Phase II studies are expected to be completed in 1986. Under that schedule, construction could begin in 1986 and be completed in 1991 (if no major legal, institutional, funding, or other problems are encountered).

DWR and the Corps have now reached agreement on the general wording of a water supply contract for the use of storage space in the Cottonwood Creek Project (letter from Ronald B. Robie to Colonel Paul F. Kavanaugh of December 28, 1979). DWR will execute the contract with the Corps at the appropriate time, after the two agencies reach mutual agreement on all of the specific details.

Size and Yield of Facilities

Although the Corps' Phase I studies have not yet been completed, it appears that the final recommended reservoir sizes will be somewhat smaller than those authorized on the basis of the 1970 interim report. The smaller reservoirs would still provide 100-year flood protection, but their water supply yield capabilities would be reduced somewhat from the 1970 plan.

Under current conditions, local irrigation yield is not considered economically feasible as an initial project purpose, and there is no current demand in the local Cottonwood Creek area for additional municipal and industrial water supply. Future demands by local water agencies for additional municipal and industrial water supply could be served from the Cottonwood Creek Project, if and when there is a demand for such service. This is pursuant to California Water Code county of origin statutes and can be provided for under the SWP supplemental water contracting principles.

The incremental project yield for municipal and industrial use, after allowing for fishery mitigation releases, is estimated to be 247 000 dam^3 (200,000 ac-ft) per year.

Key statistics of the plan, as now being considered, are:

Reservoir	Dutch Gulch	Tehama
Drainage area		
hectares	102 000	96 100
(square miles)	(394)	(371)
Mean annual inflow (1911-1978)		
cubic dekametres	370 000	238 000
(acre-feet)	(300,000)	(193,000)
Dam		
Type	Both: random fill with impervious core	
Top of dam elevation		
metres	231	218
(feet)	(759)	(714)
Dam height above streambed		
metres	75	66
(feet)	(247)	(215)
Length of crest		
metres	6 310	7 020
(feet)	(20,700)	(23,040)
Lake		
Gross pool elevation		
metres	226	212
(feet)	(740)	(696)
Gross pool storage		
cubic dekametres	1 110 000	863 000
(acre-feet)	(900,000)	(700,000)
Gross pool area		
hectares	4 530	4 130
(acres)	(11,200)	(10,200)
Inactive pool elevation		
metres	178	172
(feet)	(584)	(564)
Inactive pool storage		
cubic dekametres	38 100	35 900
(acre-feet)	(30,900)	(29,100)

Energy

Preauthorization and early (General Design Memorandum, Phase I) studies by the Corps indicated that including hydropower in the project would not be economically feasible. The Phase I General Design Memorandum does not include power plant costs and benefits in the project cost allocation analysis. However, the report indicates that now, including a power plant of each dam would be feasible, if the plants are operated incidentally to the project's other purposes (flood control, water supply, recreation, and fish enhancement).

The Corps currently estimates that the project has the potential to provide total generation capacity of 9 megawatts, with an average annual generation of about 30 million kilowatthours. The Corps expects to recommend that penstocks and related facilities be included in the initial project to allow for future addition of generating facilities. In all probability, the electric power would be marketed by the Western Area Power Administration and sold to preference customers served by the Central Valley Project.

Cost of Facilities

In a preliminary draft of the General Design Memorandum, Phase I Report, the Corps estimated total first cost of the Cottonwood Creek facilities to be $585 million at October 1980 prices. That amount included $65 million for anticipated escalation of costs during construction. The Corps' estimates of cost allocation were (in millions of dollars):

Flood Control	$101
Water Supply	437
Recreation	3
Fishery Enhancement	19
Subtotal	$560
Nonallocable Costs1/	25
Total	$585

At January 1981 prices, the total first cost would be about $600 million, and the cost allocated to water supply would be about $450 million. The unit cost of the Project's annual yield would be about $162 per dam^3 ($200 per ac-ft). The Corps' geotechnical investigations currently in progress may result in future modifications of dam design and cost.

Environmental and Social Considerations

Dutch Gulch and Tehama Reservoirs would inundate about 8 700 ha (21,400 ac) of predominantly oak-woodland terrain used primarily for cattle grazing. The entire project would displace approximately 200 people. The principal environmental concerns are centered on project impacts on wildlife (both within the immediate project area and in downstream areas affected by flow changes) and project impacts on salmon and steelhead resources. Both resident and wintering deer inhabit the project area; other wildlife species in the area include Southern bald eagles, wild turkeys, and California quail. Cottonwood Creek supports modest runs of salmon and steelhead, but the project could also have impacts on anadromous fish elsewhere in the upper Sacramento River Basin.

The Corps has contracted with the California Department of Fish and Game to evaluate potential project impacts on fish and wildlife and to recommend appropriate mitigation measures. These studies are nearing completion, and it appears that satisfactory solutions will eventually be developed. However, a significant amount of negotiation and institutional arrangements have yet to be completed. The main problem remaining concerns the extent of the requirements for land acquisition outside the reservoir areas to mitigate the loss of inundated wildlife areas.

Dutch Gulch Reservoir would significantly inundate some of the best Creta-

1/ Includes costs of highway betterment, cultural resources preservation, and minimum facilities for future power development.

ceous fossil beds in North America. Those portions that would be inundated most of the time may require salvage prior to project construction. Also identified within the project area are 10 historical sites and 35 aboriginal sites. Additional sites may be found before construction is completed. The Corps expects to implement a protective salvage and curation program to mitigate the impacts on these resources. Under current federal regulations, up to one percent of project construction cost can be spent on archeological investigations.

Thomes-Newville Development

The Thomes-Newville development (Figure 20) would be located in the western part of Glenn and Tehama Counties, approximately 32 km (20 mi) west of the city of Orland. The development would include a reservoir on the North Fork of Stony Creek and conveyance facilities for filling the reservoir, using surplus flows from Stony and Thomes Creeks. Stony Creek surplus flows would be pumped from Millsite Reservoir via a tunnel and canal system; the total static pumping lift would be about 94 m (307 ft). Thomes Creek surplus flows would be diverted by gravity directly into Newville Reservoir.

Water to meet SWP needs in the Sacramento-San Joaquin Delta would be released through a generating plant at Newville Dam and would flow down North Fork Stony Creek to Black Butte Reservoir. It was initially proposed that project releases from Black Butte Dam be allowed to flow down the natural channel of Stony Creek to the Glenn-Colusa Irrigation District, under an exchange agreement whereby the district would forgo pumping a like amount of water from the Sacramento River. Recent studies indicate that such a scheme would lead to unacceptable losses and possible bank erosion along Stony Creek. Therefore, planning studies are now being made of separate conveyance channels from below Black Butte Dam; possible water exchanges with the CVP Tehama-Colusa Canal will be considered since that would minimize the length of conveyance channel needed.

Final formulation of the Thomes-Newville development will depend on the pattern of water supply demands it would be expected to meet. This demand pattern, in turn, will depend on what other facilities are to be added to the SWP system. The following discussion describes an example that should be reasonably representative of the final plan, but the sizes of the various facilities are subject to change as studies progress.

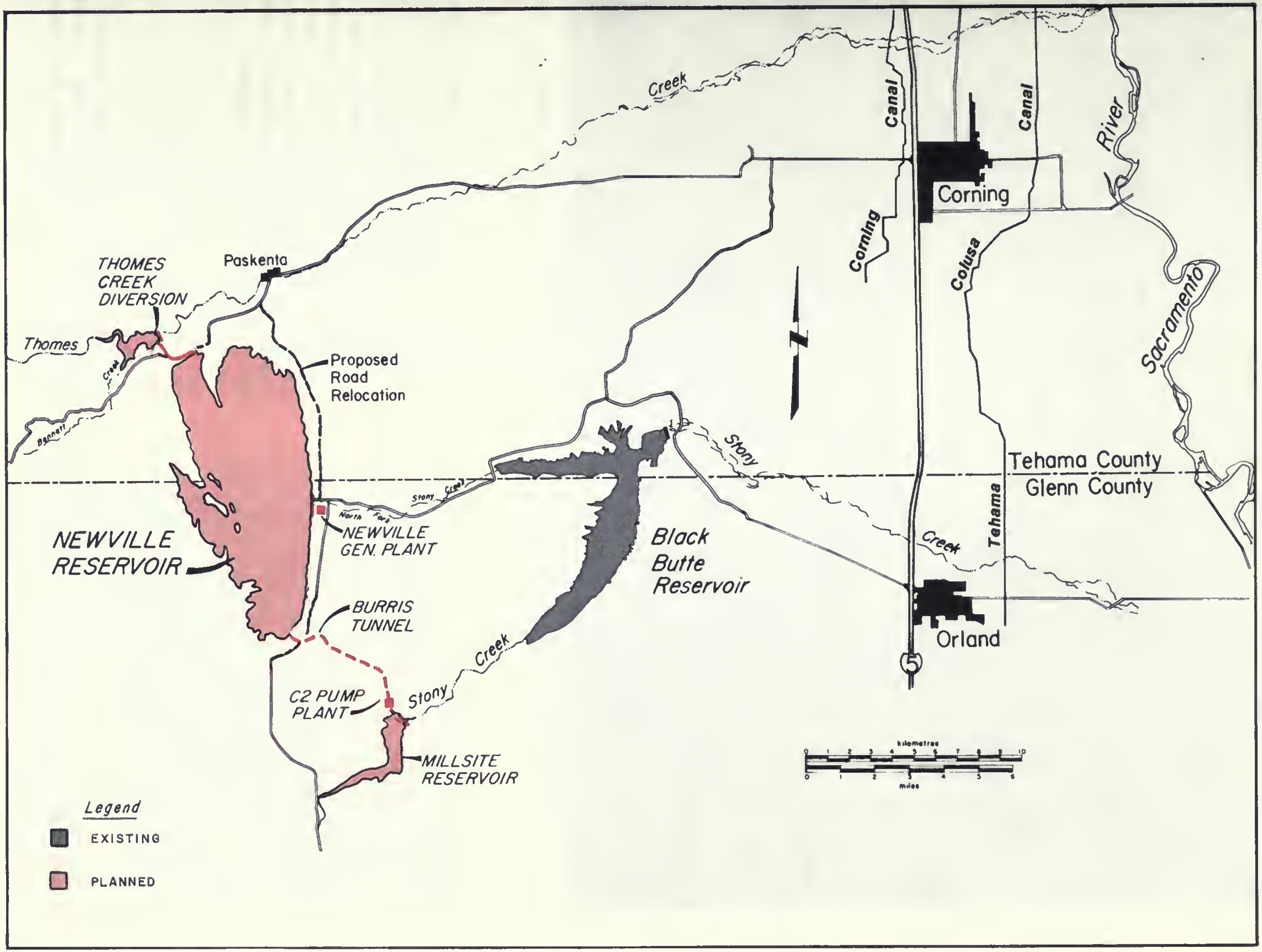
Storage Facilities

Storage is planned at the Newville site on North Fork Stony Creek approximately 10 km (6 mi) west of the existing Black Butte Reservoir. Newville Dam would be constructed at a narrow gap in a low undulating ridge of Coast Range foothills called Rocky Ridge. Newville Reservoir would extend along the western side of Rocky Ridge. A saddle dam would be required at one low point on the ridge. The area that would be inundated by the reservoir is used primarily for cattle grazing and is sparsely populated. About 16 km (10 mi) of county roads would require relocation.

Physical dimensions of Newville Dam and Reservoir, as sized under reconnaissance studies, are listed below:

Normal pool (spillway) elevation	270 m (887 ft)
Reservoir gross storage	2 050 000 dam^3 (1,660,000 ac-ft)
Reservoir area	5 380 ha (13,300 ac)
Height of main dam	93 m (307 ft)
Type of dam	Earth and rock or earth and gravel embankment

Figure 20. THOMES-NEWVILLE PLAN



View to southeast over Newville Reservoir area. Black Butte Reservoir is visible in upper left.

Conveyance Facilities

Conveyance facilities required for the Thomes-Newville development include the following:

Thomes Creek Diversion Facilities. A concrete gravity diversion dam and a gravity flow conveyance channel are planned for diversion of surplus flood-flows of Thomes Creek into the Newville compartment of Glenn Reservoir. The conveyance channel would have a length of about 1 200 m (4,000 ft) and a capacity of about 280 m^3/s (10,000 ft^3/s).

The crest of the diversion dam would be at elevation 288 m (944 ft), about 29 m (94 ft) above streambed level. When surplus flow was available in Thomes Creek (during winter and spring months of high runoff), the structure's radial gates would generally remain closed so that most of the inflow would be diverted to Newville Reservoir. The water surface in the diversion pool would fluctuate between elevation 275 and 282 m (901 and 926 ft), depending on the incoming flow. Nominal reservoir storage over this operating range would be from 1 800 to 5 900 dam^3 (1,500 to 4,800 ac-ft). Stream releases to Thomes Creek would be made via an outlet conduit through the main dam section. When it was not desired to divert to Newville Reservoir, the gates would be fully opened and the diversion pool level would drop to about elevation 271 m (890 ft). The gates would also be opened during floods to release excess water and to help flush accumulated sediment from the diversion pool.

Sediment considerations play a major role in the layout and design of the Thomes Creek diversion structure. Annual bedload deposition in the diversion pool on Thomes Creek would average about 19 dam^3 (15 ac-ft), but would range from none up to 270 dam^3 (220 ac-ft). A portion of the suspended load would also be deposited in the diversion pool. If half the sand portion of the suspended load were deposited, the average annual storage loss would be about 86 dam^3 (70 ac-ft). The total infilling rate, including both bedload and suspended sediment, would average about 105 dam^3 (85 ac-ft). Under current plans, the diversion structure would have gate sills placed relatively low, about 12 m (40 ft) above original streambed level. Only about 950 dam^3 (770 ac-ft) of storage would initially be present below the gate sill elevation and sediment would fill that space within a few years of operation. From that time on, coarser sediments would be flushed on downstream through the gates during periods when floodflows exceeded the diversion capacity. During periods with lower flow, sediment would be temporarily stored in the upper portion of the diversion pool until the next major flood. If an excessive amount of such material accumulated, physical removal might be necessary. Because of the limited storage capacity in the diversion pool, the trap efficiency would be low and most of the suspended sediment load, particularly the finer portion, would flow on through to Newville Reservoir or Thomes Creek.

Stony Creek Diversion. These facilities would intercept a portion of the Stony Creek flow that would otherwise be spilled at Black Butte Dam, and transfer it for storage in Newville Reservoir. The diversion would begin at Millsite Reservoir, which would be formed by a 22 m (72 ft)-high concrete dam. At its normal pool elevation of 183 m (600 ft), the reservoir would have an initial capacity of 16 200 dam^3 (13,100 ac-ft). The total (suspended and bedload) sediment volume passing Millsite Dam site averages about 420 dam^3 (340 ac-ft) per year; however, reservoir trap efficiency would be fairly low and most of the sediment would be flushed through the reservoir. Calculations indicate that sediment deposits near the dam after a century of operation should not extend above the spillway gate crest elevation of 177 m (580 ft). Some deposition would be expected at the upstream end of the reservoir, and this could cause backwater effects above the normal pool level.

From Millsite Reservoir, surplus Stony Creek water would be lifted about 94 m (307 ft) to flow by gravity to Newville Reservoir via a tunnel-canal system. Total pumping capacity would be 95 m^3/s (3,350 ft^3/s). The diversion alignment shown in Figure 20 has been investigated. It would include a 2 800 m (9,200-ft)-tunnel and 1 280 m (4,200 ft) of connecting channels. An alternative alignment about 1.6 km (1 mi) to the south is currently being studied; it would require substantially less tunnelling and has promise of being less costly.

Water Supply

Total surplus water available for storage from Stony Creek and Thomes Creek would average about 450 000 dam^3 (365,000 ac-ft) per year, if the events of the 50-year period of hydrology from 1922-1971 were repeated. However, the average annual storable supply would be only about 16 000 dam^3 (13,000 ac-ft) during a repeat of the historical dry period of 1928-1934. Approximately half the water stored in Newville Reservoir would be derived from Stony Creek and half would be derived from Thomes Creek.

New Water Yield

Yield analysis of Newville Reservoir is based on the assumption that the reservoir would be operated to reduce deficiencies of the State Water Project, which are large in dry years and small in wet years. Under that operating mode, the reservoir and conveyance facilities would develop approximately 270 000 dam^3 (220,000 ac-ft) per year of firm incremental yield for the SWP.

Energy

Preliminary studies of electrical energy generation and consumption indicate that the Thomes-Newville development would produce a small net surplus of energy, as follows:

	Average Annual Amount in kilowatthours
Energy generated	43 000 000
Energy required for pumping	28 000 000
Net generation	15 000 000

The amounts above are long-term averages. During the initial filling period of Newville Reservoir, estimated to be about seven years, the average annual energy required for pumping would exceed the annual energy generated, but the cumulative energy deficit would be offset after about the first decade of normal operation.

Additional power generation would be possible if power facilities were installed at the existing Black Butte Dam. That potential is already being investigated by others for early development. The Thomes-Newville development would increase the total release at Black Butte Dam by the average diversion from Thomes Creek (less Newville Reservoir evaporation) and so would increase potential generation. This added power potential will be examined during future studies.

Cost

Preliminary cost estimates for the previously described Thomes-Newville development (at January 1981 prices, including contingencies and engineering costs) are:

	Cost in $1,000
Storage Facilities	
Newville Dam and Reservoir	$188,000
Land and right-of-way	9,000
Subtotal (storage)	$197,000
Conveyance Facilities	
Thomes Creek Diversion Facilities	$ 53,000
Stony Creek Diversion Facilities	201,000
Newville Generating Plant	30,000
Black Butte--Tehama-Colusa Canal Conveyance	*
Land and right-of-way	1,000
Subtotal (conveyance)	$285,000
Total first cost	$482,000
Interest during construction (at 7-3/8%)	66,000
Total capital cost	$548,000

* Planning, design, and cost studies are in progress; cost will be around $30 million.

The incremental project yield from the Thomes-Newville development would have an annual unit cost of approximately $200 per dam^3 ($245 per ac-ft).

Present Status

The Department completed an engineering feasibility report covering the Thomes-Newville development in November 1980. The report concludes that the plan is feasible from an operational and engineering viewpoint, although many details remain to be worked out. Based on this finding, the Department has elected to move ahead with advanced planning studies that will culminate in a plan formulation report and draft environmental impact report in June 1983. If the Thomes-Newville development meets the necessary environmental, economic, and financial criteria, it could be scheduled for early construction. Planning studies conducted to date, and those currently being undertaken, will emphasize the following aspects:

Geology. A major portion of the study effort is being directed at a wide array of geologic aspects of the potential development. A private consulting firm, Earth Sciences Associates, was retained to analyze fault and seismic conditions in the project area and to advise on the possibility of reservoir-induced seismicity; these studies revealed no active faulting at the sites of any of the proposed structures, and concluded that the Stony Creek fault, which lies about 5.6 km (3.5 mi) southeast of Newville Dam site, would be the most critical in terms of seismic design criteria. Another consultant was engaged to appraise the potential for stability or leakage problems along Rocky Ridge, which would form the east rim of Newville Reservoir. At the consultant's suggestion, eight exploratory holes were drilled and water-pressure tested. This work verified that the ridge would be safe, even for a much higher reservoir than any presently being considered.

Other geologic studies currently under way are directed at identifying adequate quantities of suitable construction materials for Newville Dam and the other features of the Thomes-Newville development. Earlier efforts concentrated on exploratory drilling and testing of potential quarry rock; more recently, emphasis has shifted to evaluating local stream gravels for possible use in the outer shells of Newville Dam.

Appraisal of foundation conditions for Newville Dam and appurtenant structures has been based on extensive past work by the U. S. Bureau of Reclamation (USBR), supplemented by a substantial amount of exploration and testing carried out by the Department. Additional geologic studies are being conducted for the Stony and Thomes Creek diversion facilities.

Other geology-related studies are also under way to evaluate the potential impacts of the proposed development on ground water levels along lower Thomes and Stony Creeks; these studies will recommend facilities and operating and release criteria to avoid any impacts detrimental to downstream water users.

Designs and Cost Estimates. A number of reconnaissance-level designs and cost estimates have been prepared since 1978 for a wide range of sizes of the various potential features (and alternative features) that would be included in a Thomes-Newville development. Design and cost studies are continually being refined to incorporate the results of geologic investigations and to focus on the sizes recommended in the preliminary formulation studies. These studies will continue throughout the advanced planning phase of investigation, progressively approaching the final design for the project size that will eventually be selected.

Hydrology. Detailed analyses of daily flow records have been performed to determine the amounts of water that could be delivered by various sizes of facilities diverting from Thomes and Stony Creeks. These studies will be revised in the future as operation studies of the SWP/CVP systems are updated to reflect changes in Delta water quality criteria and other operating criteria. Additional studies will also be required to account for prospective additions of other new water supply facilities to the SWP/CVP systems. However, the nature of surplus flows on Thomes and Stony Creeks is such that the water supply for the Thomes-Newville development is changed relatively little by changes elsewhere in the system.

Environmental and Social Considerations

The main areas of environmental concern with the Thomes-Newville development would be the impacts of (1) diverting and storing surplus winter and spring runoff from Thomes and Stony Creeks, (2) inundating a major area of the North Fork Stony Creek basin for storage of this surplus runoff, and (3) releasing this stored water during dry periods.

The Newville Reservoir area is used for cattle grazing by a few ranches, and enlarging the reservoir would affect only a few residents. Substantial numbers of migratory deer winter in the northwestern portion of the reservoir area and in the adjacent area proposed for the Thomes Creek diversion facilities; the Department of Fish and Game has been contracted to evaluate potential impacts on deer and other wildlife and to propose appropriate mitigation.

Presently, Thomes Creek is unregulated. Diversion of substantial quantities of water during the winter and spring would have some effects on the flora and fauna, as well as on the physical character of that stream below the point of diversion. Reduction of flood flows in Thomes Creek under this plan would also have a slight regulating effect on the Sacramento River and associated habitat. It would have only a very minor effect on the Sacramento-San Joaquin Delta and on the San Francisco Bay.

Stony Creek flows are presently regulated in East Park, Stony Gorge, and Black Butte Reservoirs. The Thomes-Newville development would capture some of the remaining surplus Stony Creek water, but the diversion would be limited to flows not storable in the existing reservoirs (water that would otherwise spill at Black Butte Dam and flow to the Sacramento River). As with Thomes Creek, reduction of flows in Stony Creek below Black Butte Reservoir might have some effect on the flora, fauna, or physical character of Stony Creek, a slight effect on the Sacramento River, and very minor effects on the Sacramento-San Joaquin Delta and San Francisco Bay.

The Thomes-Newville development would profoundly alter all but the upper reaches of North Fork Stony Creek. The North Fork is only about 18 km (11 mi) long and typically carries little or no flow from June through November. Newville Reservoir would inundate the upper 10 km (6 mi) of the North Fork, and project releases would substantially increase flows in the remainder.

Possible Staged Development

The Glenn Reservoir Plan (described in Appendix A) would develop the Newville Reservoir site as a part of a large offstream storage project to capture surplus Sacramento River runoff. During the initial planning of the Thomes-Newville development, consideration was given to building in provisions to allow Newville Reservoir to be raised later in conjunction with a Glenn Reservoir Plan. These studies showed that provision for later enlargement would add substantial cost to the Thomes-Newville development and it was concluded to be impractical.

However, the selected configuration of the Thomes-Newville facilities would be compatible with a revised version of the Glenn Reservoir Plan in which Rancheria Reservoir would be higher than Newville Reservoir; with this "split-level" Glenn Reservoir, water diverted from the Sacramento River would be conveyed via Black Butte and Millsite Reservoirs to Glenn Reservoir.

It should be emphasized that the Thomes-Newville development described in this section is a viable and complete water supply storage unit in its own right. It has the advantage of being compatible with a possible large offstream storage development in the future, but no additional costs would be incurred to achieve this compatibility and no further development would be necessary to allow the Thomes-Newville development to fulfill its objectives.

Los Vaqueros Offstream Storage Facilities

Los Vaqueros Dam and Reservoir (Figure 21) would be located in southern Contra Costa County about 12 km (7.5 mi) west of Clifton Court Forebay. The reservoir is planned primarily to provide storage of excess flows which are available intermittently in the Delta during wet seasons. The excess Delta water would be diverted into Clifton Court Forebay by the planned Peripheral Canal. The excess water would then be pumped from Clifton Court Forebay into Los Vaqueros Reservoir and subsequently released to the California Aqueduct through power generation units when supplemental supplies are needed in the project service area. The reservoir site is advantageous from an operational standpoint because of its proximity to the Delta, the California Aqueduct, and the Delta-Mendota Canal.

Los Vaqueros can be compared with the existing San Luis Reservoir in that each is an offstream pumped-storage reservoir located south of the Delta with a direct connection to the California Aqueduct. San Luis Reservoir at 2.5 million dam^3 (2.04 million ac-ft) has about twice the capacity planned for Los Vaqueros Reservoir and is about 72 m (236 ft) lower in elevation than Los Vaqueros.

Los Vaqueros Reservoir would be operated in coordination with the California Aqueduct and San Luis Reservoir, and these facilities would be operated conjunctively with ground water basins in Central and Southern California. Los Vaqueros storage would facilitate increased flows in the Aqueduct for direct use in water service areas or for delivery to ground water storage basins. The water stored underground would be recovered during periods of drought. Conjunctive operation studies of the SWP and ground water basins have revealed many occasions when excess water is available at the Delta in wet seasons but cannot be delivered for recharge of ground water basins because of a concurrent lack of aqueduct capacity. This is caused by the need for refilling San Luis Reservoir from excess flows, in addition to serving demands in SWP service areas. The addition of Los Vaqueros Reservoir and its Delta diversion facilities could provide temporary storage for excess water and thereby allow greater use of the full capacity of the California Aqueduct. The extent of new yield accomplishments of the combined storage and conveyance facilities will be determined by system operation studies to be conducted under the SWP Future Supply Program.

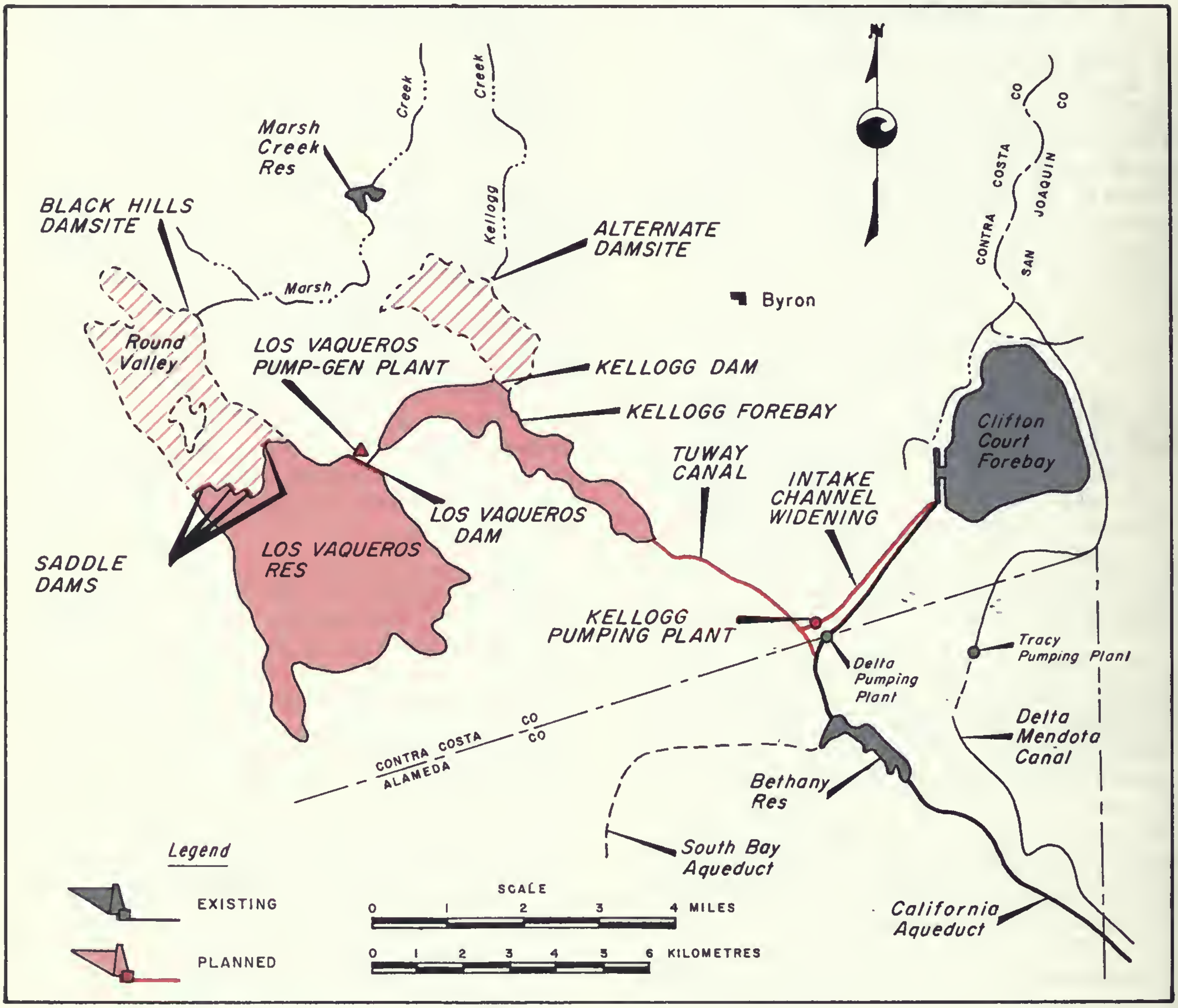
The Los Vaqueros facilities could be operated on a joint use basis among the Department of Water Resources and other water agencies.

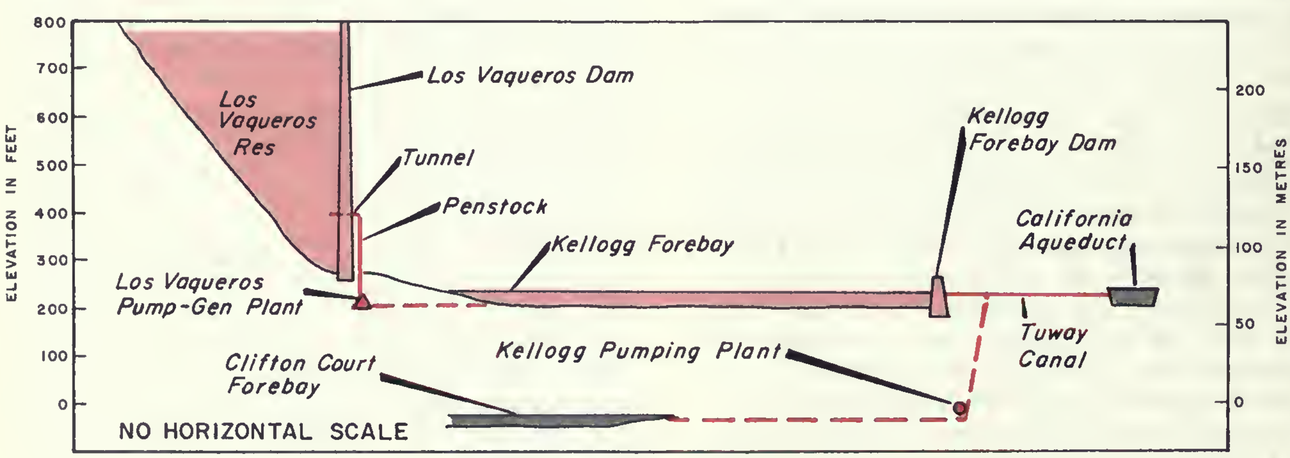
- A letter of intent has been prepared and signed between the Department and the U. S. Bureau of Reclamation (USBR) to conduct a joint study of the potential for constructing and operating Los Vaqueros as a joint Federal-State facility, similar to San Luis Reservoir.

- The Department has also executed a Memorandum of Understanding with the Kings River Conservation District, in the proposed service area of the Mid-Valley Canal, that permits the District to purchase Los Vaqueros Reservoir storage. Although a joint Federal-State facility is preferred, this arrangement assures local interests of their needed supplies.

- Los Vaqueros could be planned to serve local water agencies north and west of the reservoir (Figure 22). In this regard, Contra Costa County Water District, East Contra Costa Irrigation District, and the Department are studying relocation of the Districts' aqueduct intakes to the vicinity of Clifton Court Forebay. One alternative plan would involve use of Los Vaqueros facilities. The intake relocation would assure the District of a more

Figure 21. LOS VAQUEROS OFFSTREAM STORAGE PLAN





SCHEMATIC PROFILE

reliable water source with better quality than is presently available.

° Los Vaqueros Reservoir could also be used as a reserve or emergency water source for the above water agencies in the event of pumping system outages. East Bay Municipal Water District (Figure 22) is presently studying the need for an emergency water supply in the event of an outage of the Mokelumne Aqueduct.

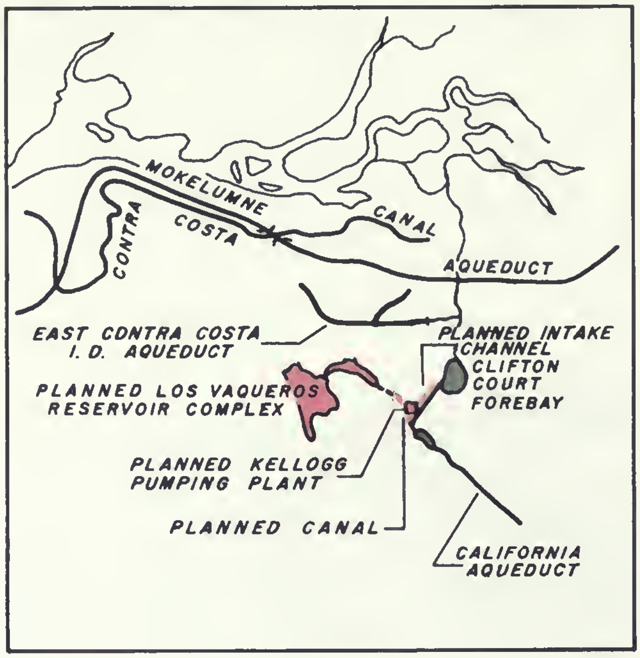
Until agreements for the above arrangements are negotiated, the Department is considering the Los Vaqueros facilities to be used for SWP water deliveries only.

Storage Facilities

The main damsite for Los Vaqueros Reservoir is located on Kellogg Creek about 6.3 km (4 mi) upstream from the damsite the USBR previously proposed for Kellogg Reservoir. (Refer to the U.S. Bureau of Reclamation Report of August 1967, "A Report on the Feasibility of Water Supply Development - Kellogg Unit Central Valley Project California".) Under the federal plan, Kellogg Reservoir, with a capacity of 167 000 dam (135,000 ac-ft), was planned as offstream storage to improve the water supply for the Contra Costa Canal.

During the reconnaissance investigation phase of DWR studies, Los Vaqueros Reservoir was planned with the main Los Vaqueros Dam on Kellogg Creek and a major auxiliary Black Hills Dam on an unnamed tributary of Marsh Creek, as illustrated in Figure 21. The Black Hills Dam would have allowed Los Vaqueros Reservoir to extend west into Round Valley. Of the total reservoir capacity, about 260,000 dam^3 (210,000 ac-ft) was in the portion overlying Round Valley, under the initial plan. Geologic investigations, which included a drilling program conducted in 1978 by DWR, have revealed, however, that the Black Hills damsite has serious landslide problems. Those findings have

Figure 22. LOCATION MAP-LOS VAQUEROS RESERVOIR, MOKELUMNE AQUEDUCT AND CONTRA COSTA CANAL



changed the project configuration as follows:

° Black Hills Dam has been eliminated from the plan.

° Additional auxiliary dams will be constructed to prevent inundation of Round Valley.

° The main Los Vaqueros damsite was found suitable for an embankment type dam with a normal pool elevation of up to 240 m (780 ft) and storage capacity of 1 315 000 dam^3 (1,065,000 ac-ft). This is the size recommended under current plans. The reservoir area would be 1 955 hectares (ha) (4,830 acres [ac]).

° The dam under consideration has been designed to maximize the use of the local sand and gravel materials and to minimize the use of high-cost rock material which is scarce in that area.

Northward view to dam site in Los Vaqueros Reservoir area.

Conveyance Facilities

Conveyance facilities are planned for transfer of water in two directions: (1) from Clifton Court Forebay to Los Vaqueros Reservoir and (2) from Los Vaqueros Reservoir to the California Aqueduct. The main components of the conveyance facilities consist of:

Fish Protection Facilities. A screen system would be provided at the entrance to the proposed intake channel from Clifton Court Forebay.

Kellogg Intake Channel and Pumping Plant. Facilities would be provided to transfer water from Clifton Court Forebay at elevation 1.3 m (4.3 ft) to the proposed Kellogg Forebay at elevation 74 m (243 ft). The channel would have a length of about 3 km (2 mi); diversion capacity is planned to be 85 m^3/s (3,000 ft^3/s).

Kellogg Forebay. Kellogg Forebay would be situated on Kellogg Creek in the southeastern corner of Contra Costa County about 5 kilometres (about 3 miles) southwest of the town of Byron. It would have a gross storage capacity of 24 800 dam^3 (20,100 ac-ft) and would be formed by constructing Kellogg Dam at a height of 28 m (92 ft) and three saddle dams in the eastern Coast Range foothills.

The forebay would have a water surface elevation of 74 m (243 ft). It would convey the water from Kellogg Pumping Plant to the intake at Los Vaqueros Pumping-Generating Plant, where it would be pumped up and into Los Vaqueros Reservoir for storage. The existing Delta Pumping Plant would also pump into Kellogg Forebay during periods when surplus flows are available in the Delta after SWP service area demands and San Luis Reservoir storage requirements are met. During demand periods, Los Vaqueros Reservoir would release stored water through its power plant into Kellogg Forebay, to be used locally or south of the Delta via the California Aqueduct. The forebay would also facilitate local water release down Kellogg Creek.

Two damsites are available on Kellogg Creek for Kellogg Forebay. The site currently recommended is located about 3.7 km (2.3 mi) downstream from Los Vaqueros damsite. The second damsite is located farther downstream at the site originally selected by the U. S. Bureau of Reclamation in its Kellogg Reservoir proposal.

Los Vaqueros Pumping-Generating Plant. This plant would pump water from Kellogg Forebay into Los Vaqueros Reservoir and generate electrical energy when water is released from the main reservoir back to the forebay. It would pump at a rate of 85 m^3/s (3,000 ft^3/s) when Los Vaqueros Reservoir is full. Under that condition, the plant would have an operating head of about 168 m (550 ft) and a power requirement of 157 000 kW. It could pump at higher flow (approximately 30 percent) when the reservoir is at low storage level. The plant's reversible pump-turbines would be capable of generation at flow rates up to 170 m^3/s (6,000 ft^3/s) with an output capacity of 212,000 kW. Because of its excessive cost, the generation capacity and flow rate may be reduced to about 85 m^3/s (3,000 ft^3/s) during the next phase of investigation. Pump-turbine plants of this type can provide large amounts of power for brief periods to meet a peak load; however, their total long-term energy requirements (kilowatthours) for pumping will exceed their total energy recovery amounts by a ratio of about 3 to 2.

Los Vaqueros Penstocks and Tunnel. Water would be transferred between Los Vaqueros pumping-generating plant and Los Vaqueros Reservoir through penstocks and a tunnel through the left abutment of the main dam. The tunnel would have a length of 1 380 m (4,580 ft).

Tuway Canal. This canal would provide a connection between Kellogg Forebay and the California Aqueduct. Under current plans it would have a capacity of 170 m^3/s (6,000 ft^3/s) and a length of 4 800 m (3 mi).

Right of Way and Relocation Requirements. Los Vaqueros Reservoir and its conveyance works, including Kellogg Forebay, would require acquisition of about 40 ownership parcels and relocation of a county highway (Vasco Road) and several utility lines. The land is presently used for agriculture and grazing; total population in the reservoir area is less than 100 permanent residents. Total land area required for Los Vaqueros Reservoir, Kellogg Forebay, a buffer zone and for construction of facilities is 3 480 ha (8,600 ac).

A new road replacing Vasco Road would be about 13 km (8 mi) long. Utilities requiring relocation include two electrical transmission lines, three gas pipelines, two oil pipelines, and an underground telephone cable.

Water Supply

Hydrology. Monthly and annual quantities of excess water available in the Delta were derived from operation studies of the base SWP/CVP system covering the 50-year historic period of 1922-1971.

Excess water is defined as water that would flow through the Delta in excess of requirements for (1) mandatory Delta outflow for water quality maintenance standards, (2) irrigation needs in Delta service areas, (3) direct exports to meet year 2000 contractual water demands of the SWP and CVP, (4) diversions to fill San Luis Reservoir, (5) upstream diversions and reservoir storage (including the Cottonwood Creek Project), and (6) the State's planned ground water development program.

The water supply study indicated that there would be some excess water in the Delta during the winter or spring seasons in 44 of the 50 years examined. In many instances, such as during flood conditions, the monthly and annual amounts were quite large, and would far exceed the capacity of the planned diversion system to Los Vaqueros Reservoir.

Based upon median water supply conditions, the annual supply divertible from Clifton Court Forebay to Kellogg Forebay with the Kellogg Pumping Plant and unused capacity of the existing Delta Pumping Plant would be about 660 000 dam^3 (536,000 ac-ft). Not all of the potential supply to Kellogg Forebay, however, would be divertible into Los Vaqueros Reservoir due to the constraints of storage capacity and pumping capacity at Los Vaqueros Pumping-Generating Plant. Operation studies are under way to define the storable quantities and to evaluate the potential for operating the Los Vaqueros facilities in conjunction with ground water basin storage near SWP service areas.

The study indicated that there were only three months during the 1928-34 critical period when significant amounts of excess flow occurred at the Delta. A total of 895 000 dam^3 (726,000 ac-ft) could have been pumped into Los Vaqueros Reservoir during that critical period by the planned Kellogg and Los Vaqueros Pumping Plants at 85 m^3/s (3,000 ft^3/s).

New Water Yield. Relationships of storage capacity to firm yield at Los Vaqueros using 85-m^3/s (3,000-ft^3/s) conveyance facilities, based upon reconnaissance studies and without consideration of conjunctive operation with ground water storage, are indicated below:

Total Capacity		Active Capacity		Firm Yield	
dam^3	(ac-ft)	dam^3	(ac-ft)	dam^3/yr	ac-ft/yr
1 314 000	1,065,000	1 163 000	943,000	327 000	265,000
1 170 000	950,000	1 048 000	850,000	308 000	250,000

Energy

Energy requirements and generation at Los Vaqueros Reservoir are calculated as:

	Amount of Energy in Kilowatthours
Pumping Requirement (average/year)	148 000 000
Power Generation (average/year)	94 000 000
Net Requirement	54 000 000

These quantities are based upon pumping and releasing flows at Los Vaqueros Reservoir, including evaporation losses, to add a firm supply of 327 000 dam^3 (265,000 ac-ft) per year to the base SWP/CVP system. They do not include energy required for lifting the water from the Delta to the elevation of the California Aqueduct because the same pump lift would be required by each of the alternative reservoir proposals.

Cost of Facilities

First costs of construction of the Los Vaqueros storage and conveyance facilities are listed below. They are based upon 1981 price levels and include relocations, land and rights-of-way, contingencies, and engineering costs.

	Capacity	Cost in $1,000
Los Vaqueros Dam and Reservoir	1 314 000 dam^3 (1,065,000 ac-ft)	$488,000
Kellogg Forebay	24 800 dam^3 (20,100 ac-ft)	42,000
Fish Protection Facilities	--	8,000
Kellogg Intake Channel	85 m^3/s (3,000 ft^3/s)	11,000
Kellogg Pumping Plant	85 m^3/s (3,000 ft^3/s)	55,000
Los Vaqueros Pumping-Generating Plant and Intake Channel	85 m^3/s (3,000 ft^3/s)	137,000
Los Vaqueros Penstocks and Tunnel	170 m^3/s (6,000 ft^3/s)*	98,000
Tuway Canal (Kellogg to Bethany)	170 m^3/s (6,000 ft^3/s)	27,000
	TOTAL	$866,000

* Import capacity = 3,000 cubic feet/second,
Export capacity = 6,000 cubic feet/second.

The foregoing facilities would provide firm yield of 327 000 dam^3/yr (265,000 ac-ft/yr) at a unit cost of $263/$dam^3$ ($325/ac-ft).

Los Vaqueros is proposed for additional study because of its potential for additional firm dry-period yield development through conjunctive operation with ground water storage basins which have a very low ratio of average-yield-to-dry-period-yield and because of its location, which is advantageous for serving the California Aqueduct, the federal Delta-Mendota Canal, and the East Bay area.

Present Status

Los Vaqueros offstream storage facilities are tentatively planned by DWR for future construction in the early 1990s. An engineering feasibility analysis of the Los Vaqueros plan is now under way, and a report on that study is scheduled for 1981. Current investigations emphasize geologic exploration and mapping, engineering designs and cost estimates, fish and wildlife impacts, cultural and archeological evaluations, and water supply and water operation studies.

Two earthquake shocks exceeding magnitude 5.0 (Richter Scale) occurred in the vicinity of the Los Vaqueros Reservoir site along the Greenville fault in southern Contra Costa County in January 1980. In a preliminary report, "Faults and Seismicity at Los Vaqueros Dam Site", February 1978, the largest anticipated earthquake on the Greenville fault was estimated by DWR geologists to be magnitude 5.5 for dam design purposes. Seismic data on the recent events are now being collected and reviewed by DWR in reference to Los Vaqueros Dam design.

Environmental and Social Considerations

The potential impact on rare or endangered animal species could be significant and will require intensive study. The San Joaquin kit fox, a federally listed endangered species, is known to occur in the Los Vaqueros Reservoir project area.[1/]

The State-protected Alameda striped racer snake also inhabits this general geographic region but has not actually been observed within the project area. Two potentially rare, although not protected, amphibian species -- the California red-legged frog and the tiger salamander -- are found along Kellogg Creek.

Los Vaqueros Reservoir would inundate a number of mature valley oak trees and other riparian habitat along Kellogg Creek. While none of the flora species is listed as rare or endangered, the importance of flora relates to its value as wildlife habitat and the general scarcity of this resource along the western coastal foothills.

The proposed operation of Los Vaqueros to divert water from Clifton Court Forebay may require some additional screening facilities to safeguard the fishery resource at that point.

Social impacts would include the relocation of approximately 65 residents within the project area.

The importance of archaeological and historical resources within the project area has not been investigated. Studies will be conducted during the feasibility phase of this investigation to determine the extent to which such resources exist and their significance to California's heritage.

1/ Stephen Morrell, "San Joaquin Kit Fox Distribution and Abundance in 1975", Department of Fish and Game, Wildlife Management Branch Administrative Report #75-3, October 1955.

Shasta Lake Enlargement

Shasta Lake (Figure 23) is the principal water storage facility for the federal Central Valley Project (CVP). During the 1930s, when construction of Shasta Dam began, economic conditions and budget and technical constraints limited the capacity of the Lake to 5.61 dam^3 (4.55 million ac-ft). This storage capacity is only 80 percent of the long-term average annual runoff at the dam site; consequently, there is unregulated runoff available for storage in most years. The enlargement of Shasta Lake, therefore, may be one of the best of the remaining opportunities to develop additional water supply anywhere in California.

Enlargement of Shasta Lake would have a significant influence on the physical, ecological, and economic aspects of the Sacramento River. Therefore, extensive studies will be needed before the plan can be fully evaluated in comparison with other alternatives.

In 1978, the U. S. Bureau of Reclamation (USBR) completed an appraisal-level study of enlargement potentials of Shasta Lake at sizes ranging up to 33 300 000 dam^3 (27,000,000 ac-ft). General information derived from the examination is presented in the following sections.

Design Features and Relocations

Shasta Lake might be enlarged either by adding to the height of the existing concrete dam or by constructing a new earth and rockfill dam immediately downstream.

Increasing the storage to 17.3 million dam^3 (14 million ac-ft) would require relocation of the Southern Pacific Railroad and Interstate Highway 5, which now cross the reservoir. Other roads, the resorts, and business and recreation facilities which now fringe the lake shore would also require relocation. The enlarged lake would completely inundate the Pacific Gas and Electric Company's Pit River #7 Powerplant, and could have a slightly adverse effect on the operation of Pit River #6 Powerplant.

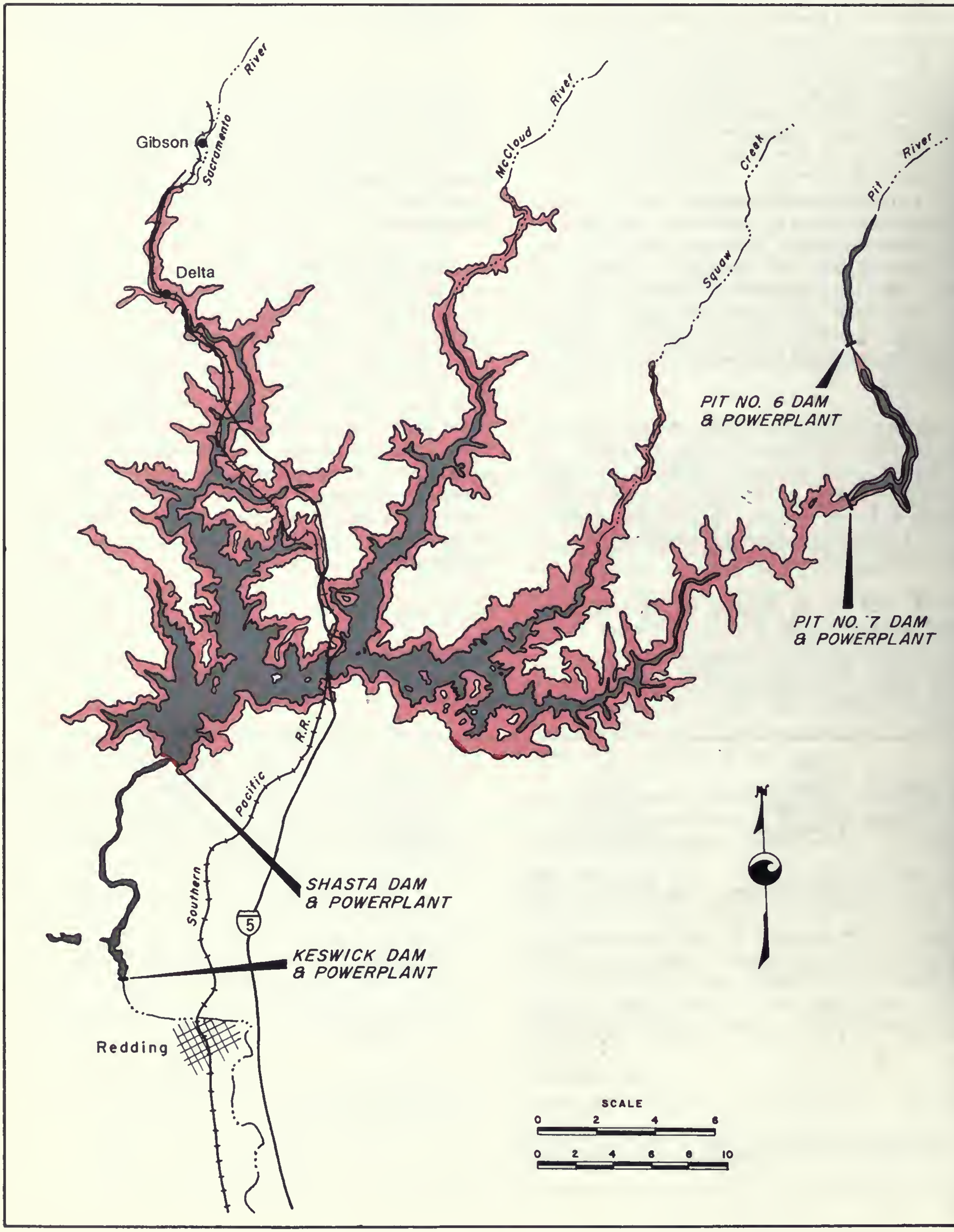
Additional Yield

Preliminary estimates of additional dependable yield from enlarged Shasta at various sizes are indicated below:

Increase in Dam Height1/	New Water Surface Elevation	Total Storage Capacity	Increase in Storage Capacity	Additional Annual Firm Yield
Existing	325 m (1067 ft)	5 610 000 dam^3 (4,550,000 ac-ft)		
10 m (33 ft)	335 m (1,100 ft)	6 910 000 dam^3 (5,600,000 ac-ft)	1 300 000 dam^3 (1,050,000 ac-ft)	310 000 dam^3 (250,000 ac-ft)
41 m (133 ft)	366 m (1,200 ft)	12 300 000 dam^3 (10,000,000 ac-ft)	6 700 000 dam^3 (5,450,000 ac-ft)	1 230 000 dam^3 (1,000,000 ac-ft)
62 m (203 ft)	387 m (1,270 ft)	17 300 000 dam^3 (14,000,000 ac-ft)	11 700 000 dam^3 (9,450,000 ac-ft)	1 730 000 dam^3 (1,400,000 ac-ft)

1/ The present dam is 162 m (533 ft) high.

Figure 23. SHASTA LAKE ENLARGEMENT PLAN



Shasta Lake at low stage during the 1976-77 drought.

Energy

The existing powerplant below Shasta Dam has installed generating capacity of 539 000 kW and generates about 2 billion kWh of electrical energy during an average year. An enlarged reservoir would provide the opportunity to increase average annual generation by some 30 percent for the 61.9 m (203 ft) height increase and to increase the installed capacity of the power plant. These increases would be attained both from increased head and from greater quantities of water passing through the power plant.

Increasing the power capability may necessitate enlarging the downstream Keswick Afterbay to reregulate the additional releases. Further study is required to determine the required capacity of the afterbay. Further study should also explore the possibility of operating to maximize peaking power or a combination of conventional peaking and base load operation.

Total First Cost

The USBR's cursory evaluation of alternative costs of enlarging Shasta Lake to about 17.3 million dam^3 (14 million ac-ft), based on January 1981 prices, are:

Raising the existing concrete dam	$1.8 billion
New earth and rockfill dam downstream	$3.3 billion

Both alternatives include relocation costs estimated at about $600 million.

Unit Water Cost

Assuming the total cost of construction, plus the cost of interest during construction and reservoir filling, are allocated to water supply, the unit cost of water would be about $142/$dam^3$ ($175/ac-ft). In future studies, the benefits of flood control, hydroelectric power, and recreation will be included in the economic analysis. This may result in a significant reduction in the costs allocated to the water supply function, thereby reducing the unit cost of water.

Flood Control

Flood damage occurs along the Sacramento River below Shasta Dam. Enlargement of Shasta Lake would provide regulation of its total inflow, thereby essentially eliminating flood releases from the dam when downstream Sacramento River tributary runoff is excessively high. Flood damage due to inflow from unregulated downstream tributaries could still occur, however.

Fish and Wildlife

The U. S. Fish and Wildlife Service (USFWS) has made a preliminary or "threshold" evaluation of possible effects of enlargement on fish and wildlife resources. It noted that enlargement of Shasta Lake would have an extremely significant impact on the immediate project area, the Sacramento River, the Central Valley, and the entire Sacramento-San Joaquin estuarine complex.

The evaluation by USFWS notes that the enlargement would present significant environmental problems, as well as considerable opportunities. If operated for the benefit of fish and wildlife, as well as other uses, the enlargement could be one of the least damaging alternatives for additional water development.

The USFWS evaluation points out that the terrestrial and aquatic ecosystems both above and below Shasta Lake would be altered by the enlargement. Among the effects of raising the dam 62 m (203 ft) would be the flooding of 68 km (42 mi) of live streams and flooding of 12 140 ha (30,000 ac) of terrestrial wildlife habitat, including that of the endangered bald eagle and the State-designated rare Shasta salamander. Downstream effects would include the influence of altered flows on fish and riparian habitat and the effects of increased water use on wildlife in the areas to which the water is supplied.

Recreation

Shasta Lake is extensively developed for water-oriented recreation. The principal attractions are camping, boating, fishing, swimming, and water skiing. Recreation use in recent years, in millions of visitor-days, has been:

1975	4.4
1976	2.7
1977	1.9
1978	2.1
1979	2.2
1980	1.9

Decreases in recreation use after 1975 were caused by the severely reduced lake levels during the 1976-77 drought and probably by higher gasoline prices.

With an enlarged lake at 17.3 million dam^3 (14 million ac-ft), the maximum reservoir area would be doubled from 12 140 ha to 24 280 ha (30,000 ac to 60,000 ac); however, fluctuations in the reservoir stages would occur. Further studies would be needed to determine how the recreational opportunities provided by the increased maximum lake surface area would balance against wide fluctuations in lake levels and the possibilities and advantages of establishing a larger minimum pool.

The Secretary for Resources, who heads the State Resources Agency, has proposed a Sacramento River Parkway, which would extend about 475 km (295 mi) from Brannan Island State Recreation Area in the Delta to Keswick Dam near Redding. The Parkway would integrate existing and future flood control facilities into a linear river park, with hiking and bicycle trails along the river. The proposal would include acquisition and protection of nearly 7 700 ha (19,000 ac) of remaining riparian habitat. It would provide increased opportunities for recreational activities such as fishing, boating, picnicking, camping, hiking, bicycling, wildlife observation, and sight-seeing. A preliminary estimate of cost for the Parkway (1979 dollars) would be $70-75 million for acquisition and development and $3 to $4 million for annual operation and maintenance. The Resources Agency believes that studies of the Shasta Lake enlargement offer a good opportunity to consider implementation of the Parkway concept.

Other Considerations. In addition to the foregoing discussion of accomplishments and effects of project purposes, there are other considerations at issue. Such items as water rights, water quality degradation, seismicity, and erosion and seepage will require thorough study and resolution before any enlargement plan could be implemented.

Enlargement of Shasta Lake or any of the alternatives that modify the regime of the Sacramento River will affect water users along the river and in the Delta. Resolution of water rights may be a complex and lengthy process.

Storage of water in an enlarged lake and regulation of releases could affect water quality in the Sacramento River, Sacramento-San Joaquin Delta, and San Francisco Bay. However, these impacts would relate primarily to fish and wildlife and would logically be evaluated in the fish and wildlife studies referred to earlier.

Concern has been raised over the possibility that an enlarged Shasta Lake could induce earthquakes. In recognition of the very great importance of safety, geologic and seismologic studies must be undertaken to evaluate factors contributing to seismic activity.

Concern has also been raised regarding bank erosion and seepage damage under present conditions. This will necessitate studies both to evaluate present or "baseline" seepage and erosion conditions and to evaluate the additional impact of operations of an enlarged Shasta Lake.

Present Status

Federal legislation has been passed (Public Law 96-375, enacted October 3, 1980) which authorizes the U. S. Bureau of Reclamation (USBR) to participate with the Department of Water Resources (DWR) in joint feasibility studies of Shasta Lake enlargement. The Department supported this legislation.

On December 26, 1979, USBR and DWR executed a letter of intent for funding and carrying out a feasibility study on the enlargement plan. The letter provides that USBR will be program manager, with a management committee of representatives from each agency who will keep records of the investigation. Study costs will be shared equally. The cost of the investigation may be reallocated, if a joint project is implemented on other than a 50-50 basis. The two agencies are currently preparing a joint scope of study document which will outline investigative activities and each agency's input to the investigation.

The Colorado River Banking Plan

The Colorado River Banking Plan is a potential means of creating an additional supply of water for the SWP for an interim period extending beyond the year 2010 by making use of available Delta surplus flows.

The plan (Figure 24) is premised on the availability of unused storage capacity in Lake Mead, beginning in the late-1980s when the Central Arizona Project (CAP) is scheduled to be placed in operation. Under this plan, The Metropolitan Water District of Southern California (MWD) would adjust its Colorado River apportionment deliveries in accordance with the availability of water from the SWP.

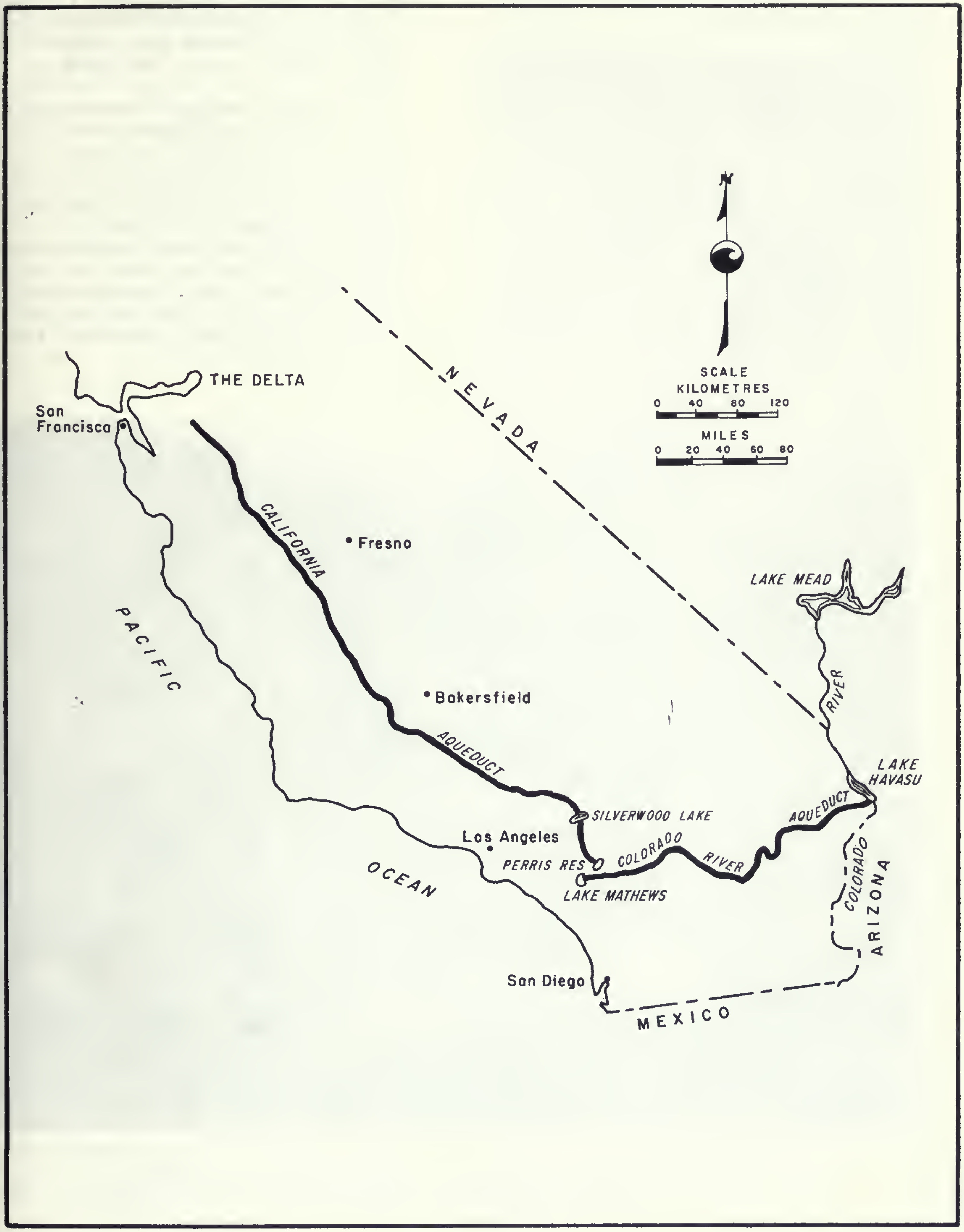
In years when SWP supplies from Northern California are plentiful and the SWP could provide MWD with greater amounts of water than are specified by contract, MWD would take more SWP water and correspondingly less of its apportionment of Colorado River water. An amount of water equal to the difference between MWD's apportionment and actual diversions from the Colorado River would remain in Lake Mead and be credited to MWD, less any water lost by spills from Lake Mead and by incremental evaporation and seepage losses resulting from the additional stored water.

In periods of drought in Northern California, when the delivery capability of the SWP would be reduced, MWD would draw on its accumulated net water credits in Lake Mead up to its Colorado River Aqueduct capacity, in place of taking SWP water. Except for poorer quality of water, the effect of this exchange would be the same as if unused storage capacity in Lake Mead were transferred to the Delta to capture excess Northern California runoff in high-flow years and release it for use in low-flow years.

To gain the support of Arizona and Nevada, those states have been offered the right to participate in the use of MWD's accumulated storage credits in Lake Mead. This right would be exercised whenever shortage conditions on the Colorado River are declared by the Secretary of the Interior and deliveries are reduced to the two states. At that time, by paying a proportionate share of costs, Arizona and Nevada would be able to take a portion of the accumulated storage, with total diversions limited by their basic apportionment.

The plan would depend on the occurrence of several factors: (1) availability of water in the Delta, (2) availability of storage space on the Colorado River, (3) excess capacity in the California and Colorado River Aqueducts, (4) flexibility in the distribution systems involved in the plan, (5) agreement among the participating agencies, and (6) legal acceptability. These and other factors affecting the plan are subjects of a current cooperative study by MWD, the Colorado River Board (CRB), USBR, and DWR, which are examining all engi-

Figure 24. LOCATION OF COLORADO RIVER AQUEDUCT AND CALIFORNIA AQUEDUCT



neering and institutional considerations, including cost allocations and legal constraints.

Contractual and Legal Constraints

The federal government; the states of New Mexico, Utah, Colorado, Wyoming, Arizona and Nevada; Mexico; the water contractors in California; and the Hoover power allottees exercise control of, or have a vested interest in, the waters of the Colorado River. Because of the large number of interested parties and the importance of water in this area, the rights to the use of Colorado River water are extremely complex. The rights are predicated upon interstate compacts, federal legislation, water contracts, State legislation, a treaty and other agreements with Mexico, a United States Supreme Court decree, and federal administrative decisions.

Any necessary changes in laws, regulations, and contracts, and the U. S. Supreme Court decree required to implement the banking proposal would necessarily have to be developed to the mutual agreement of all entities affected to assure that implementation of the banking concept would not in any way reduce water supply deliveries to any of the concerned parties in all of the states in the Colorado River Basin and Mexico.

Whitsett Intake pumping plant, a facility of the Colorado River Aqueduct, at Lake Havasu.

Water Quality

Since the quantity of Colorado River water delivered to MWD over a period of several years will be no greater under the banking plan than without the plan, the average salinity of water in MWD's service area during that period will not change. However, it is recognized that in any one year salinity problems may arise from the difficulty of distributing the varying proportions of SWP and Colorado River water in MWD's service area, due to the lack of physical facilities for delivering the same proportion of both waters throughout the area. This problem will have to be analyzed as part of the banking plan studies.

Potential Yield

The potential yield of the Colorado River Banking Plan would range between 100 000 to 460 000 dam^3 (80,000 to 370,000 ac-ft) per year. It relates directly to the conveyance capacities of the California and Colorado River Aqueducts, the availability of water at the Delta, the availability of empty reservoir space in Lake Mead, and the incremental evaporation and seepage losses incurred at Lake Mead. The banking plan is seen to continue for an interim period, which may extend beyond 2010, until it is no longer feasible as a joint operation of the SWP/MWD facilities. Additional operation studies are required, however, before the Colorado River Banking Plan can be comparatively evaluated with other plans to increase SWP yield.

Energy

Energy needs, availability, and costs will be quantitatively examined in the cooperative multi-agency study by MWD, CRB, and DWR discussed below under "Present Status of Plan". Primary considerations are for (1) the revisions in projected energy requirements for the California and Colorado River Aqueducts and (2) the revision of projected annual amounts of energy generation at Hoover

Open canal portion of the Colorado River Aqueduct.

Dam due to differences of water surface elevations in Lake Mead caused by the banking plan.

Costs

The primary cost of this plan would be for the purchase of peaking energy to convey additional water to Southern California from the California Aqueduct. Additional costs may result if construction is required for California Aqueduct enlargement.

Preliminary examination indicates an enlargement of the East Branch of the California Aqueduct may be required early in the operation of the banking plan. This would result if the MWD distribution system lacks the flexibility to accommodate the availability of flows. To meet demands in year 2000 and beyond, an offstream regulation reservoir may also be required to coordinate available Delta water with reserve California Aqueduct capacity.

Present Status of Plan

A reconnaissance-level cooperative study is now under way by The Metropolitan Water District of Southern California, the Colorado River Board, the U. S. Bureau of Reclamation, and the Department of Water Resources to examine all engineering and institutional considerations, including cost allocations and legal constraints of the Colorado River Banking Plan. Reservoir and aqueduct system operation studies are being developed or modified to illustrate annual quantities of banked water and reservoir storage levels on the Colorado River, after allowing for evaporation, seepage, and spill losses. The study will also include energy, financial, environmental, and legal analyses. A cooperative report is scheduled to be issued by the Colorado River Board in 1982.

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CHAPTER V. AGRICULTURAL WATER PURCHASE PLAN

The Department of Water Resources (DWR) has identified the Agricultural Water Purchase Plan as a nonstructural alternative worthy of consideration to increase dry-period yield of the State Water Project. Under the plan, DWR would increase Delta supplies by purchasing water upstream from the Delta from farmers or water districts who are willing to forego available supplies for financial incentives that would more than compensate for losses incurred from use of less water in dry years. This would necessitate fallowing land or shifting from rice to less water intensive crops such as wheat.

From the outset, DWR has recognized that a plan to purchase agricultural water could impose adverse social and environmental impacts and economic costs to an area foregoing the use of its water and that certain legal and institutional questions would require consideration. To this end, DWR conducted a reconnaissance study1/ to better evaluate the plan's potential and associated problems.

During the study, it was assumed DWR would be able to negotiate long-term agreements with farmers or districts, under which DWR would secure the option to purchase water if needed to meet SWP contractual commitments, particularly during dry years. The study also considered water purchases through short-term (most probably yearly) agreements which would not contribute to the project's contractual firm yield commitment.

The study focused on 12 water districts situated within a 65-km (40-mi) radius of the Sutter Buttes, an area that is the rice-producing center of the Sacramento Valley. The region also has a wide diversity of other agricultural crops. Water rights are held by large irrigation, reclamation, and water districts. Water costs are typically low to the farmer, and supplies generally are abundant. The study area includes vital wildlife habitat and is particularly important for the many migratory waterfowl that winter there.

The economic analyses in this study are based on the assumption that actual purchase of water, under either long- or short-term agreements, will take place infrequently, perhaps only once every 10 or more years, on the average.

Background

Under the State Water Project Future Supply Program, the Department is looking for ways to meet SWP contractual commitments. One component of the program authorized a study of agricultural water purchase potential. A multidisciplinary team of land and water use analysts, economists, engineers, fish and wildlife biologists, recreation planners, and attorneys was formed to begin this study, with the goal for the next few years of establishing the legal and institutional mechanisms necessary to make the agricultural water purchase concept a reality.

1/ California Department of Water Resources, Northern District, "Agricultural Water Purchase Plan", July 1979.

Study Area

The area selected for the Agricultural Water Purchase Plan (AWPP) comprises 12 irrigation districts in the Sacramento Valley lying between the latitude of Chico on the north to within several miles of Sacramento on the south. The Feather River limits the eastern side, while the Tehama-Colusa Canal limits the area to the west.

Land and water use data for these districts were collected for 1976 (a normal year from a carry-over storage standpoint) and 1977 (a drought year), providing the base for estimating land areas and range of water quantities which could be made available through the AWPP.

Water Use Within the Study Area

Under average conditions, the 12 districts have large, firm supplies of water from the Feather or Sacramento Rivers. All use surface water as their main supply; nearly all recapture some drain water, and two districts are capable of pumping ground water. The district managers can select the water supply that will be the least expensive.

In 1976, although precipitation was light, surface water was abundant. By spring of 1977, the drought had worsened and reservoir storage in the State was down generally. As a result, severe cuts in water allotments were being forecast. Rice acreage for 1977 was cut 25 percent because of reduced water supplies and because of a surplus of stored rice from the previous year. District water supplies from all sources in 1977 were reduced nearly 993 000 dam^3 (805,000 ac-ft) from the 1976 level. Average applied water and conveyance losses were reduced 30 percent from 2.1 m/ha (6.5 ft/ac) in 1976 to 1.5 m/ha (4.7 ft/ac) in 1977. While prime river diversions were much lower in 1977, the percentage of reuse of drain water increased over the 1976 season (from 19 percent in 1976 to 23 percent in 1977). Consequently, drought impacts were greatest on water users outside the major districts who rely on recapture of surface return flow for their prime water supply.

Estimated Cost of Water Purchase

The feasibility of instituting a program of agricultural water purchase was determined by estimating the cost of acquiring the water. This was done by using 1977 data to calculate the income a farmer could expect, had he planted certain crops. The cost of water calculated in this manner was the lowest value that would assure that the farmer would be "no worse off" financially than if he had not sold his water. This method would include no cash incentive to the farmer but merely presents a starting point in negotiating for water. The dollar value calculated in this study would change in accordance with changes in produce prices, production costs, and other factors at the time of purchase.

The unit value of water was estimated for each of the major crops1/ in the 12 districts on the basis of supplemental water requirements at the point of diversion. This supplemental quantity is equal to the evapotranspiration of applied water (ETAW) for the initial crop use of the water, the ETAW for any use of surface return flow water, and conveyance losses. The quantity of water acquired by the purchaser would exclude any flow which would have returned to the river system, if the purchase had not been made. Because drought affects ETAW (including reuse ETAW), the unit value of water was derived for both normal and drought water years to estimate the range of prices to be anticipated. The results are shown in the following table.

1/ Orchard crops were not included because of the likelihood of loss of trees, a major capital cost.

Average Unit Values of Irrigation Water
For Specified Crops

Crop	Per Cubic Dekametre 1976	Per Cubic Dekametre 1977	Per Acre-foot 1976	Per Acre-foot 1977
Rice	$ 41	$ 47	$ 50	$ 58
Misc. Field*	50	67	61	83
Grain	207	163	251	201
Truck and Seed	196	251	243	308
Pasture	51	64	63	79
Alfalfa	53	71	65	88
Sugar Beets	78	87	96	107

* Field corn, milo, dry beans.

Alternative to Complete Nonirrigation

Although the study primarily stressed analysis of the cost of not irrigating, this is not the only option for transferring water between locations and types of uses. It might be feasible to negotiate the purchase of a partial water supply where the seller chooses to plant crops requiring less water and therefore does not require a full water supply. In such a case, a reasonable price would be derived from the difference in net income expected from growing a low water-using crop (wheat, for example) instead of a higher water-using crop (rice, for example). The study assumed that the reason a farmer grows crops requiring greater amounts of water is the higher expected net return. Although the water acquired per unit crop area would be less, the same impact considerations would apply as in the case of not irrigating.

Legal Considerations

Federal law on land reclamation and water contract restrictions may bar the success of an AWPP. However, recent changes in water rights law opens the way for implementation of an AWPP.

Federal Law on Land Reclamation, 160-Acre Limitation

If the proposed seller's water is purchased from the U. S. Bureau of Reclamation (USBR), then the prospective buyer must abide by the 160-acre limitation. DWR might be required to identify users of the purchased water who comply with the 160-acre limitation before it can obtain the water. Municipal and industrial water users, however, are exempt from this ruling.

Restrictive Clause in Federal Contracts

The USBR has a clause in its Sacramento River water supply settlement contracts with water rights appropriators which reads: "No sale or other disposal of any water or the right to the use thereof for use on land other than that shown in the Contractor's Exhibit B shall be made by the Contractor without first obtaining the written consent of the United States thereto." Failure to obtain such consent would be a breach of the contract and subject contractors to a law suit for damages or an enjoinment from disposing of its water. (The Department of Water Resources has a similar clause in its Feather River water rights contracts.) The AWPP would only purchase water derived under local water rights, and these restrictive clauses would not apply to that source of supply.

Water Rights Law

The Governor's Commission to Review Water Rights Law recognized that restrictions on the sale of district water is an impediment to increasing the total productivity of water. As an example, the Commission cited the production of rice in the Sacramento Valley, with its heavy use of water, as a likely means of providing water to San Joaquin Valley for "higher productive value". The Commission recommends removing water export restrictions in existing district law and revising water law to ensure that sellers of water rights on a short-term basis do not risk the forefeiture of those rights.

With regard to institutions for water transfer, the Commission's recommendations were:

1. The State Water Resources Control Board (SWRCB) be authorized to approve trial transfers of appropriative rights where injury to other water users would be difficult to determine in advance of the transfer. Further, the Commission recommended SWRCB be authorized to approve subsequent long-term transfers of appropriative rights where any change would not result in "substantial injury" to any other water user;
2. A temporary transfer procedure be adopted to encourage short-term water transfers; and
3. Provisions in district law be repealed which restrict the sale of water outside of district boundaries to "surplus" water.

The passage of AB 1147 (Filante) in 1980 eliminates potential hindrances attributable to water rights law and alleviates certain concerns of the Governor's Commission previously discussed. Effects of the bill are:

1. Preclusion of a forefeiture doctrine where the reduction in the use of water is due to water conservation efforts;
2. Equalization of the pre-1914 and post-1914 appropriative right forefeiture periods at five years and activation of the forefeiture requirement automatically upon the lapse of the five-year period;
3. Declaration that a transfer of water or water rights, in itself, does not constitute non-use or an unreasonable use of water;
4. Provision to expedite transfer of water or water rights where the duration of the proposed transfer does not exceed one year;
5. Authorization for trial transfers where the actual impact on downstream beneficial uses is difficult to determine in advance; and
6. Authorization of long-term transfers requiring a change in place of use, point of diversion, or purpose of use, unless the transfer results in substantial injury to any legal user of water.

Socioeconomic Considerations

An agricultural water purchase plan of the type discussed in this chapter would have impacts beyond the direct purchase of water from participating farmers and districts. The ensuing discussion recognizes these impacts but does not attempt to evaluate them.

Secondary Costs and Impacts of the AWPP

In addition to the direct cost of payments to obtain the water, additional or secondary impacts arising from lost farm production may occur at the local, regional and/or State level. These effects relate to labor and materials normally used to cultivate, harvest, process, ship, wholesale, and retail the crops normally planted. A specific determination of these losses at the local or regional level was not included in the study.

Where the purchase involves water that would have been used to grow rice, some of the losses sustained by those who produce, process, and distribute rice could be avoided because rice can be readily stored for long periods. If a predictable time table for selling water could be established, rice production could be increased and the rice stored (possibly by the State) during the years in which the AWPP is not used, and subsequently processed and distributed during the years the AWPP is used. (Increased production would also generate additional income.). The additional cost of rice storage would be borne by those wishing to purchase a water supply. It should be pointed out, however, that the state of the art of long-range water supply forecasting would not enable more than an empirical schedule for rice production for storage.

Third-Party Impacts

Many farmers who operate in areas outside the major water districts participating in the AWPP depend on surface return flows from those districts for their irrigation supply. Under the AWPP, the supplies of these operators would be temporarily decreased or even entirely eliminated. This would be especially true for rice growers in a drought year.

In the AWPP study, the Department found that in 1977 (a drought year) rice was the only crop that provided a return flow. The amount was only about half as much as in a year of normal water supply, based on an initial unit area of irrigation. (In contrast, in a normal year, most crops provide some return water.)

The Governor's Commission to Review California Water Rights Law recognized the importance of considering third-party injuries. The Department would need to study the effects of the AWPP on growers who depend on the use of drain water from the districts in the study area, even if the changes recommended by the Commission are made.

Rice fields in Sacramento Valley.

In-Area (Sellers) Concerns

Farmers and officials in several districts in the study area have met informally with DWR representatives to discuss the concept of agricultural water purchase. At the meetings, rice was propounded as the crop best suited for reduction because of its high water use, low labor intensity, and long-term storability after harvest.

Comments at the meeting indicated an element of uncertainty by a number of farmers as to whether they would participate in an agricultural water purchase plan. The farmers were clear in stating that participation would have to be voluntary and accompanied by assurances their water rights would not be impaired.

Some of the concerns and/or sentiments expressed by the potential participants were:

° Farmers and land are geared to rice production.

° Nothing makes the economic return that rice does.

° Too disruptive to local economy.

° Unfair to county community to not grow rice.

° Not interested in anything but rice production.

° Rice allotments would have to be lifted in order for growers to accumulate a rice surplus to meet dry-year foreign market demands.

° Realize the water could be a lot cheaper for State to obtain on a horse-trading basis than any project now on the drawing board could produce.

° Water law is too fragile; Southern California has the votes and will probably get our water one way or another.

Socioeconomic Study by SRI International

In recognition of the need to identify and measure socioeconomic impacts of the AWPP on a community, the Department contracted with SRI International to make an analysis of a geographically limited rice belt area in the northern Sacramento Valley. The Department instructed SRI International to look at the impacts of purchasing a 123 000 dam^3 (100,000 ac-ft) block of water from the Joint Water District Board in a dry year where their existing water supply would already be reduced by 40-50 percent of normal.

The findings of the study were reported[1/] as follows: Analysis of the AWPP in the representative case (100,000 ac-ft) has shown total income and employment effects to be small. Specifically, the regional economy would suffer a loss of $2.8 million, or less than 0.3 percent of personal income (in 1978 dollars). However, in particular business sectors, such as crop services and farming supplies, some hardship may occur. A ceiling level of compensation required for these sectors is $3.7 million, which equals the total decrease in sales to these sectors. This amount represents less than 10 percent of the regional economic activity in the three county regions (Butte, Sutter and Yuba) but would be nearly 30 percent in the Joint Water District subregion. The isolated hardship that could occur in this subregion would be confined to certain operators in specific sectors -- for instance, the aerial operators located closest to participating rice farmers. If the benefits of the alternative use of the water were substantial, these impacts could very probably be mitigated through compensatory payments.

1/ SRI International, "Local Socioeconomic Impacts of the Agricultural Water Purchase Plan", January 1981.

Environmental Considerations

Potential environmental impacts associated with an agricultural water purchase plan were identified as affecting fish and wildlife biota. However, the study focused on the consequences of reducing rice land operations. Further study may be required, should other crop-types be considered in subsequent plans.

Waterfowl

A rice culture habitat is critical to the maintenance of waterfowl populations of the Pacific Flyway, a resource of international concern. Millions of waterfowl, as well as a large number of other birds, use the rice-growing lands of the Sacramento Valley as wintering habitat. Rice fields contribute waste that feeds more than half these birds. In addition, an estimated 65,000 resident teal and mallards nest in rice fields during the growing season. Most wild mallards harvested in California are hatched in these areas.

During a dry year, reduction of rice lands in Sacramento Valley by an agricultural water purchase plan would further reduce the amount of wintering waterfowl habitat already in short supply because of drought. Resident populations would be reduced through loss of nesting habitat, and wintering populations would be stressed by reduction of available feeding area.

A secondary impact associated with waterfowl habitat reduction would be the rise in disease-caused deaths. Although some disease occurs every year, the heavier concentration of wintering waterfowl on remaining wetlands during dry years could be expected to increase the incidence and magnitude of losses from avian cholera and waterfowl botulism.

Larger-than-normal numbers of wintering waterfowl in the Sacramento Valley caused by a shortage of wetlands to the south, along with a reduction in the area of available rice lands and an increase in the area of vulnerable crops, could result in serious waterfowl depredation problems.

Most recreational waterfowl hunting in Sacramento Valley takes place on harvested rice lands. In addition to organized hunting clubs, most rice land in the study area is available for waterfowl hunting through access granted by farmers. Many growers charge access fees which provide additional income that is economically significant. Reduction in rice planting will cause a proportional loss in opportunities for recreational waterfowl hunting which supplies hunting season income to farmers.

Pheasant

Pheasant hunting is important in the study area and has economic value to local farmers. An agricultural water purchase plan that results in idled rice lands where volunteer vegetation is allowed to remain would have a significant beneficial effect on the pheasants of Sacramento Valley.

Endangered Species

No threat to any endangered species is known to exist within the study area where the water would be purchased. Depending on the areas of ultimate use, any AWPP would affect endangered species only if the availability of water would encourage conversion of wildlands.

Fisheries

Any substantial reduction of available water would obviously affect fisheries and invertebrate resources in the rice-growing counties. However, based on present information on the manner in which a water purchase plan would be operated, there is no method to determine exactly what these losses would be. If the duration of the plan were short, which is likely, recovery of resources and use would be fairly rapid.

Additional losses could occur indirectly from deterioration of water quality.

Agricultural water (specifically, return water) is characteristically high in pesticides and total dissolved solids, and has a high level of specific conductance; it is often low in dissolved oxygen.

Present Status

In recent months, DWR Northern District staff members have met with local water agencies and continued their efforts to advance the AWPP concept. The Department and the Sacramento River Contractors Association have discussed purchasing "pool water" during drought periods. "Pool water" is surplus water that becomes available when certain contractors overestimate their actual needs during preseason negotiations. The surplus water is then made available (pooled) for use by other association members. The Sacramento River Water Contractors Association, however, does not appear to be interested in dealing with the Department because of the Association's close ties to USBR.

In meetings with Joint Water District Board officials (Western Canal, Biggs--West Gridley, Richvale, and Sutter Extension), the Board seemed most troubled with the potential loss to the local economy and associated effects on the region of a significant one- or two-year reduction in rice production. Thus, the Board's concern, which had been suggested in DWR's study as a problem requiring further evaluation, reinforced the need to identify and measure monetary impacts of the AWPP on a community and beyond. In recognition of this need, DWR contracted with SRI International to undertake the socioeconomic impact analysis of the AWPP, as previously described in this chapter.
The Department is continuing to discuss the AWPP with the Joint Water District with the hope that some type of implementation agreement may be reached as a contingency for future need.

APPENDIX A

DEFERRED SURFACE AND GROUND WATER STORAGE PLANS

DEFERRED SURFACE AND GROUND WATER STORAGE PLANS

This appendix contains information derived from DWR reconnaissance studies conducted during 1977-80 on the following plans of water development:

Surface Water (offstream storage) Plans

- Glenn Reservoir--River Diversion
- Colusa Reservoir--River Diversion
- Lake Berryessa Enlargement
- Corral Hollow Reservoir
- Los Banos Grandes Reservoir

Ground Water Storage Basins

- Antelope Valley
- Las Posas
- San Gabriel
- Santa Clara River Valley
- Upper Coachella Valley
- White Wolf

Surface water projects are described in terms of locations, storage and conveyance facilities (tentative sizes), water supply and yield, energy requirements for pumping, energy recovery, capital cost, unit cost of yield per acre-foot, and environmental and social considerations. Ground water storage projects are described in terms of characteristics, recharge facilities, findings, and environmental and social considerations.

The foregoing surface and ground water storage plans are not included in planning feasibility studies currently being conducted by DWR under the SWP Future Supply Program. Very limited reconnaissance studies are continuing on Colusa and Los Banos Grandes Reservoirs as alternative water sources, should Thomes-Newville and/or Los Vaqueros Reservoirs be deemed infeasible.

Reasons for Deferment

DWR does not recommend the foregoing surface and ground water storage plans for feasibility level investigations at this time for the following reasons:

Deferred Surface Water Storage Plans

Glenn Reservoir--River Diversion Plan

- The Department completed an engineering report covering the Glenn Reservoir--River Diversion Plan in November 1980. The report concludes that the plan is feasible from an operational and engineering viewpoint, but the smaller Thomes-Newville development (described in Chapter IV) would better meet expected future water demands. The Glenn Reservoir--River Diversion Plan would have greater environmental impact and much higher requirements for capital cost than Thomes-Newville. It would also have much higher energy requirements during reservoir filling operations. Accordingly, the Department is concentrating its further Sacramento Valley planning efforts on the Thomes-Newville development. Additional planning on the Glenn Reservoir--River Diversion Plan has been deferred (except as needed to help evaluate alternatives during the upcoming feasibility studies of enlarging Lake Shasta).

Colusa Reservoir--River Diversion Plan

- The Colusa Reservoir plan to augment the SWP conflicts with the U. S. Bureau of Reclamation (USBR) proposal to construct and operate a smaller reservoir at the same vicinity. Sites Reservoir would occupy the southern half of the site for Colusa Reservoir. Under USBR plans, Sites Reservoir would be operated in conjunction with the West Sacramento Canal Unit of the Central Valley Project (an extension of the Tehama-Colusa Canal) to provide supplemental water supplies to Yolo and Solano Counties.

° Because of its additional auxiliary dams and embankment requirements, the unit cost of storage in Colusa Reservoir is about twice the unit cost of storage in the smaller Sites Reservoir.

Lake Berryessa Enlargement

° Fish. The plan requires a large-capacity diversion system from the lower Sacramento River to fill the enlarged lake. This system could have a serious impact on migratory fish, if the diversion is not properly screened and if suitable flows are not allowed to remain in the river. In addition, an existing trout fishery on Putah Creek below Monticello Dam would be partially inundated by the enlarged lake.

° Wildlife. The enlarged lake would inundate habitat which supports about 3,000 deer.

° Energy. The plan as presently formulated would require a net consumption of energy in the range of 250 to 300 million kWh/yr.

° Cultural Aspects. At the larger sizes under consideration, the reservoir would inundate the Pope Valley Region of Napa County, which is believed exceedingly rich in cultural and archaeological resources.

° Earthquakes. While there is no evidence indicating that a safe dam could not be designed and constructed at the enlarged Lake Berryessa site, this region is an area of seismic activity, and faulting, with numerous shocks of low magnitude, has occurred in the vicinity since 1900. The most significant historic earthquake was the "Winters-Vacaville Earthquake" of April 1892, estimated to have a magnitude of 7.0, which produced widespread damage throughout much of Solano, Yolo and Napa counties.[1/]

° Relocations. Up to 1,000 permanent residents and 3,000 to 4,000 temporary residents would require relocation, and the planned aqueduct system would cause severance damage in Yolo County.

° Alternative Plan. Preliminary studies indicate that enlargement of Lake Shasta is probably a better plan for a joint State-Federal facility.

Corral Hollow Reservoir

° Cost. The first cost of storage at this offstream reservoir site is about \$650 per dam^3 (\$800 per ac-ft), which is excessive compared to alternative sites south of the Delta, such as Los Vaqueros or Los Banos Grandes. The unit cost of new yield is also excessive.

° Environmental Impact. The Corral Hollow Reservoir site has important plant, animal, paleontological and historical characteristics. The diversity of plant and animal communities and the age of the fossil specimens give the site unique characteristics that would be adversely affected by a major reservoir.

° Lawrence Livermore Installation. A major installation, owned by the United States Government and leased to the Lawrence Livermore Laboratory, exists in the reservoir site and would require costly relocation.

1/ Refer to DWR Preliminary Report, "West Sacramento Valley Fault and Seismicity Study", July 1978.

Los Banos Grandes Reservoir

- Reservoir Filling Problem. Operation studies of SWP facilities indicate that Los Banos Grandes Reservoir would be very slow to fill and refill, due to limited availability of aqueduct conveyance capacity, particularly after SWP water demands approach full entitlements. The conveyance problem could be improved in the future, however, by enlarging the North San Joaquin Division of the California Aqueduct. Because of the impending aqueduct conveyance constraint and reservoir evaporation losses, the reservoir could provide only a small amount of yield on a continuous basis. Its main purpose would be to provide carryover storage to protect against a long-term drought.

Deferred Ground Water Storage Plans

Antelope Valley Basin

- Direct storage is not feasible because of poor infiltration rates.

- Only a small amount of indirect storage can be implemented because of the low municipal and industrial demand for ground water.

- There is no control over pumping.

Las Posas Basin

- No conveyance facilities are available for delivering untreated SWP water, and no spreading grounds are available for direct storage.

- Indirect storage may require delivery of treated SWP water for agricultural use.

- There is no control over pumping.

San Gabriel Basin

- Limited ground water basin storage space is available.

- Storage of large amounts of SWP water could cause waterlogging of sand and gravel pits.

- Modifications of court judgment and approval of MWD and Watermaster are required.

Santa Clara River Valley Basins

- No conveyance facilities are available for delivering SWP water for direct or indirect storage.

- There are no extraction or distribution facilities for recapturing SWP water.

- There is no control over pumping.

Upper Coachella Valley

- Construction of an aqueduct is necessary to supply SWP water to Upper Coachella Valley.

- Metropolitan Water District of Southern California has an exchange program currently operating with Coachella Valley Water District and Desert Water Agency where Colorado River water is exchanged for SWP entitlement water.

White Wolf Basin

- Infiltration rates are relatively low, and suitable land for recharge sites is limited.

- Depth to ground water ranges from 135 m (400 ft) to 305 m (1,000 ft).

- Construction of spreading and recapture facilities would be required.

- There is no control over pumping.

Glenn Reservoir--River Diversion Plan

The Glenn Reservoir--River Diversion Plan (Figure A-1) would include a large reservoir in western Glenn and Tehama Counties for offstream storage of surplus water pumped from the Sacramento River. Glenn Reservoir would be a combination of Newville Reservoir on North Fork Stony Creek and Rancheria Reservoir, which would be formed by a dam on the main stem of Stony Creek. The two reservoir compartments would merge at water surface elevations greater than 283 m (930 ft). Glenn Reservoir would have enormous storage potential; its maximum capacity (as limited by topography and geologic conditions) would be approximately 11 000 000 dam^3 (9,000,000 ac-ft). This would exceed the combined capacity of the two largest reservoirs in California (Shasta and Oroville).

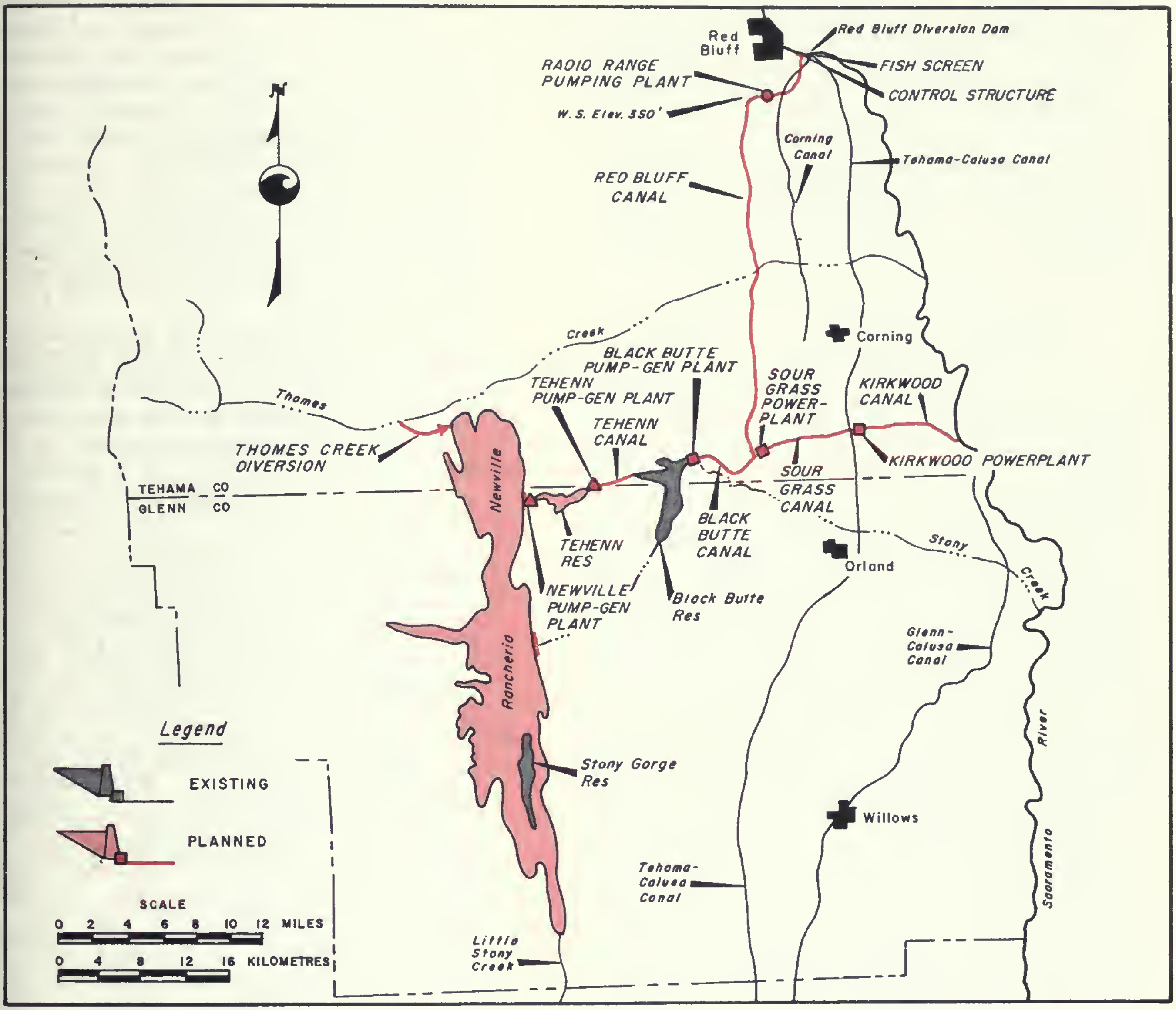
The natural runoff reaching Glenn Reservoir would justify development of only a small fraction of its storage potential. Glenn Reservoir was conceived in the early 1960s as a potential storage component of various plans to divert water from the North Coast rivers to the Sacramento Valley. When the California Wild and Scenic Rivers Act was passed in 1972, the Department terminated studies of North Coast developments and began investigating use of Glenn Reservoir for offstream storage of water from within the Sacramento River basin. These studies led to the plan described herein, which would be entirely independent of any water imports from North Coast basins.

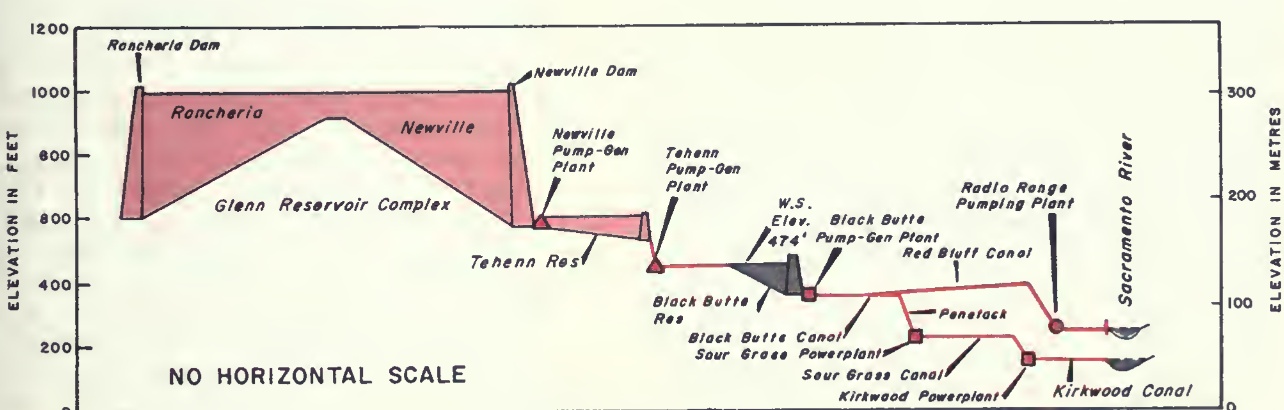
The Glenn Reservoir--River Diversion Plan outlined in this section would be constructed in one stage. Earlier planning studies considered construction of Glenn Reservoir as an expansion of a Thomes-Newville development (see Chapter IV), but it was found that provisions for later expansion would add excessive cost to the initial facilities. The Department has selected the Thomes-Newville development for further study; additional analysis of a Glenn Reservoir--River Diversion Plan is proposed only as part of the consideration of alternatives to an enlarged Shasta Reservoir.

The formulation of a Glenn Reservoir--River Diversion Plan is influenced by the pattern of water supply demands it

	Newville Compartment	Rancheria Compartment	Total Glenn Reservoir
Normal pool elevation			
Metres	306	306	306
Feet	1,004	1,004	1,004
Reservoir gross storage			
Cubic dekametres	6 440 000	4 310 000	10 750 000
Acre-feet	5,220,000	3,490,000	8,710,000
Reservoir area			
Hectares	7 100	14 500	21 600
Acres	17,500	35,900	53,400
Height of main dam			
Metres	129	132	--
Feet	424	434	--
Type of Dam	Earth and rock or earth and gravel embankment		

Figure A-1 GLENN RESERVOIR--RIVER DIVERSION PLAN





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would be required to meet, which would depend on the other facilities assumed to be added to the SWP system. The following discussion describes a sample formulation that allows for prior construction of a Cottonwood Creek Project and assumes a typical demand pattern wherein average annual yield is about half the critical dry-period yield. Formulation for other demand patterns would result in different sizes of the various facilities of the plan.

Storage Facilities

The two main dams that would form Glenn Reservoir would be located about 10 km (6 mi) upstream from the existing Black Butte Reservoir.

In addition to the main dams, 13 saddle dams would be required around the Newville compartment rim and one in the Rancheria compartment rim. The largest saddle dam would be 53 m (174 ft) high; all of the others would rise less than 23 m (75 ft) above original ground.

The Newville compartment of Glenn Reservoir would inundate a sparsely populated area that is used primarily for cattle grazing. The site of the Rancheria compartment is also used primarily for cattle grazing but is more developed. The Rancheria compartment would inundate Stony Gorge Reservoir, a 61 900-dam^3 (50,200-ac-ft) federal facility serving the Orland Project, plus the community of Elk Creek, a lumber mill, and the 40-ha (100-ac) Grindstone Indian Rancheria.

Conveyance Facilities

A number of alternative conveyance alignments have been examined in conjunction with the Glenn Reservoir-River Diversion Plan. Those shown in Figure A-1 were selected as most compatible with the single-stage construction plan covered by this section. The conveyance facilities may be grouped into the following four categories:

Thomes-Creek Diversion Facilities. These facilities would be similar to those employed for a Thomes-Newville development, but the point of diversion would have to be farther up Thomes Creek because of the higher elevation of the Newville compartment. The concrete diversion dam on Thomes Creek would be about 27 m (90 ft) high. From there, a concrete-lined conveyance channel would carry up to 280 m^3/s (10,000 ft^3/s) to Glenn Reservoir. The channel would be about 4 000 m (13,100 ft) long.

Red Bluff--Black Butte Reservoir Conveyance Facilities. These facilities would convey up to 340 m^3/s (12,000 ft^3/s) of surplus winter and spring runoff from the Sacramento River at Lake Red Bluff to Black Butte Reservoir. A total of 46 km (29 mi) of concrete-lined canal and two pumping plants would be included. Intake facilities at Lake Red Bluff would include trashracks, fish screens, and a settling basin to reduce the sediment load entering the canal. The Radio Range Pumping Plant, located near the point of diversion, would lift the water about 30 m (100 ft) to the Red Bluff Canal. The canal would tie into the Black Butte Canal, which would connect to a pumping-generating plant near the toe of Black Butte Dam. This plant would lift the water about 41 m (134 ft) into Black Butte Reservoir. The reservoir would be maintained near its spillway crest elevation of 144 m (474 ft) since its flood control storage capability would no longer be needed.

Black Butte Reservoir--Glenn Reservoir Conveyance Facilities. Water could be conveyed between Black Butte and Glenn Reservoirs via either the main stem or North Fork Stony Creek. Both routes were studied, and, for a development to be constructed in a single stage, the North Fork alignment shown in Figure A-1 was found significantly less costly. Tehenn Reservoir would be constructed on North Fork Stony Creek to serve as a conveyance link between Black Butte and Newville Reservoirs. The Tehenn Canal would be formed by deepening the natural channel of North Fork Stony Creek upstream from Black Butte Reservoir to Tehenn Dam. Tehenn Dam would be an earthfill structure, rising 34 m (112 ft) above original streambed level. Pumping facilities near the toe of Tehenn Dam would lift water about 42 m (136 ft) from the Tehenn Canal to Tehenn Reservoir; reversible pumping-generating units would be employed to produce hydroelectric power when water was being released through Tehenn Reservoir. A second pumping-generating plant at the toe of Newville Dam would make the final lift of up to 120 m (394 ft) into Glenn Reservoir. For the example formulation being described, both the Tehenn and Newville Pumping-Generating Plants would have a pumping capacity of 340 m^3/s (12,000 ft^3/s) and a generating capacity of 142 m^3/s (5,000 ft^3/s).

Release Facilities to Sacramento River. All releases from Glenn Reservoir would pass back through the Newville and Tehenn Pumping-Generating Plants to Black Butte Reservoir. From there, approximately one-fourth of the water would be released to Stony Creek, either to satisfy downstream rights or as spills. The remaining release would be discharged through the Black Butte Pumping-Generating Plant to the Black Butte Canal and then to the Sacramento River in a separate conveyance system (Sour Grass and Kirkwood Canals, as shown in Figure A-1). The separate conveyance system to the river would facilitate power generation with the water released from Glenn Reservoir, prevent bank erosion on Stony Creek, and prevent possible detrimental impacts on the ground water basin adjacent to lower Stony Creek. The conveyance system to the river would have a capacity of about 142 m^3/s (5,000 ft^3/s); it would include two generating plants and about 16 km (10 mi) of concrete-lined canal. The generating plants would develop a combined total head of 55-59 m (180-195 ft), depending on the level of flow in the river. A river outlet structure and fish barrier would be installed at the point of discharge to the river.

Water Supply

The total surplus water available from the natural runoff of Stony Creek for storage in Glenn Reservoir would average about 250 000 dam^3 (203,000 ac-ft) per year. An additional annual average of 100 000 dam^3 (136,000 ac-ft) of surplus water could be diverted to storage from Thomes Creek with the 280 m^3/s (10,000 ft^3/s) diversion capacity chosen for this example. These amounts of surplus local flow would justify only a relatively small amount of reservoir storage (as in the Thomes-Newville development); a full-scale Glenn Reservoir would depend primarily on surplus water pumped from the Sacramento River. The average flow of the Sacramento River at Red Bluff was 10 300 000 dam^3 (8,360,000 ac-ft) per year over the 1922-71 period. Of that total, an annual average of about 3 000 000 dam^3 (2,400,000 ac-ft) was surplus to all environmental needs or downstream rights (with SWP/CVP facilities operating at maximum entitlement levels) and thus was potentially available for storage. However, this surplus flow occurred irregularly during various winter and spring months, often during flood periods; only a portion of the total surplus flows could be captured with pumping facilities of practical capacity. Studies of daily flow records during the historic surplus flow periods (with adjustments to reflect existing developments and the proposed Cottonwood Creek Project) show that an average of about 1 550 000 dam^3 (1,260,000 ac-ft) could be diverted with the 340 m^3/s (12,000 ft^3/s) pumping capacity selected for this example. However, a Glenn Reservoir--River Diversion Plan would actually divert less than the available amount of water because pumping would be curtailed whenever the reservoir was full. A 50-year operation study of the plan showed that the annual diversions from the Sacramento River would average about 640 000 dam^3 (520,000 ac-ft).

New Water Yield

Glenn Reservoir would be operated to meet the needs of the State Water Project, which are larger in dry years than in wetter years. A Glenn Reservoir Plan could be formulated to meet a wide variety of demand patterns, depending on what other features are added to the SWP system in the future and how they are operated. For this example, the Glenn Reservoir--River Diversion Plan was assumed to meet a constant percentage of the demands currently projected. Under that operating mode, the plan would add approximately 1 490 000 dam^3 (1,210,000 ac-ft) of firm yield per year at the Delta.

Energy

The Glenn Reservoir--River Diversion Plan would include four pumping installations to lift surplus Sacramento River water to the reservoir. The maximum static pumping head for the example would be 229 m (751 ft). All reservoir releases (except for a minor amount of flood spills) would pass through a series of five hydroelectric power plants on the way to the Sacramento River. Because releases would reach the river far downstream from the point of diversion, the total generating head would exceed the total pumping head by about 27 m (90 ft).

Due to natural inflow and the water diverted from Thomes Creek, long-term average reservoir releases would exceed Sacramento River diversions by about 71 percent. Consequently, the plan would eventually be a net energy producer. However, a heavy energy deficit would be incurred during initial filling of the reservoir. Based on average hydrologic conditions, the initial filling period would last about seven years. Average energy consumption and production for the example would be:

	Average Annual Amount in kilowatthours
Initial filling period	
Energy required for pumping	1 081 000 000
Energy generated	329 000 000
Net energy consumption	752 000 000
Long-term average operation	
Energy generated	538 000 000
Energy required for pumping	460 000 000
Net generation	78 000 000

The cumulative net energy deficit during the 7-year initial filling period would be about 5 300 000 000 kilowatthours. With the relatively small net generation under long-term average operating conditions, some 68 years would be required to offset the energy used during initial filling.

Cost

Preliminary cost estimates for the previously described Glenn Reservoir--River Diversion Facilities (at January 1981 prices, including contingencies and engineering costs) are:

	Cost in $1,000
Storage Facilities	
Newville Dam and Reservoir	$ 444,000
Rancheria Dam and Reservoir	545,000
Land and Right-of-Way	82,000
Subtotal (storage)	$1,071,000
Conveyance Facilities	
Thomes Creek Diversion Facilities	$ 53,000
Red Bluff-Black Butte Reservoir	485,000
Black Butte Reservoir--Glenn Reservoir	595,000
Release Facilities to Sacramento River	156,000
Land and Right-of-Way	10,000
Subtotal (conveyance)	$1,299,000
Total First Cost	$2,370,000

The incremental project yield from the Glenn Reservoir--River Diversion Plan would have an average unit cost of approximately $190 per dam^3 ($230 per ac-ft).

Environmental and Social Considerations

The Glenn Reservoir--River Diversion Plan would have major social and environmental impacts related to (1) the inundation of large areas of land inhabited by about 730 permanent residents and (2) by the diversion and release of large quantities of water.

Glenn Reservoir would inundate 21 600 ha (53,400 ac) of foothill lands (primarily woodland, grassland, and chaparral) that are used principally for cattle grazing. Although the overall wildlife habitat value of these lands is classified as moderate, particular areas may be important for certain wildlife species. For example, the Department of Fish and Game has expressed concern over the potential loss of wintering deer habitat. About 80 ha (200 ac) of riparian habitat would be inundated, and diversions and reservoir releases could also affect riparian habitat along Thomes and Stony Creeks. Riparian habitat supports a diverse community of plants and animals and is becoming scarce, as human activities such as land clearing and water control become more widespread.

A large new diversion near Red Bluff would require adequate fish screening to prevent Sacramento River fish from being diverted into the system. As currently envisioned, the diversion facilities near Red Bluff would have about one-half of the capacity of the diversion and screening works the Department plans for the Peripheral Canal. Salmon and steelhead are of special concern. Releases from the reservoir would cause changes in flow, water quality, and water temperature in the Sacramento River. These changes could adversely affect anadromous fish.

Glenn Reservoir would also have significant adverse social impacts relating to required relocations. The Grindstone Rancherio Indian Reservation, a wood products mill, and a town of over 400 residents are located in the Rancheria compartment area. Approximately 90 Indians would require relocation from the 40-ha (100-ac) Rancheria, as well as their dance house, which has important religious significance.

Diversions to Glenn Reservoir from the Sacramento River during flood periods would affect seepage and bank erosion problems downstream. An investigation is under way to determine the effects of large releases of stored water on seepage and bank erosion in the downstream levees and channels.

Colusa Reservoir--River Diversion Plan

The Colusa Reservoir site is located on the west side of the Sacramento Valley in Colusa and Glenn counties, as indicated in Figure A-2. At the maximum size under study, Colusa Reservoir would have a length of 32 km (20 mi), surface area of 11 500 ha (28,500 ac), and capacity of 3 710 000 dam^3 (3,010,000 ac-ft).

The plan is a modification and enlargement of the U. S. Bureau of Reclamation (USBR) Sites Reservoir proposal.[1/] Under the original USBR plan, Sites Reservoir, at a capacity of 1 500 000 dam^3 (1,215,000 ac-ft), would be filled during winter and spring seasons with water pumped from the Tehama-Colusa Canal, an existing feature of the Central Valley Project. The proposed West Sacramento Canal would be an extension of the Tehama-Colusa Canal into Yolo County and would use water stored in Sites Reservoir to meet peak seasonal demands in the Central Valley Project service area. Sites Reservoir would be formed by dams constructed on Stone Corral and Funks Creeks. The much larger Colusa Reservoir under DWR study would require con-

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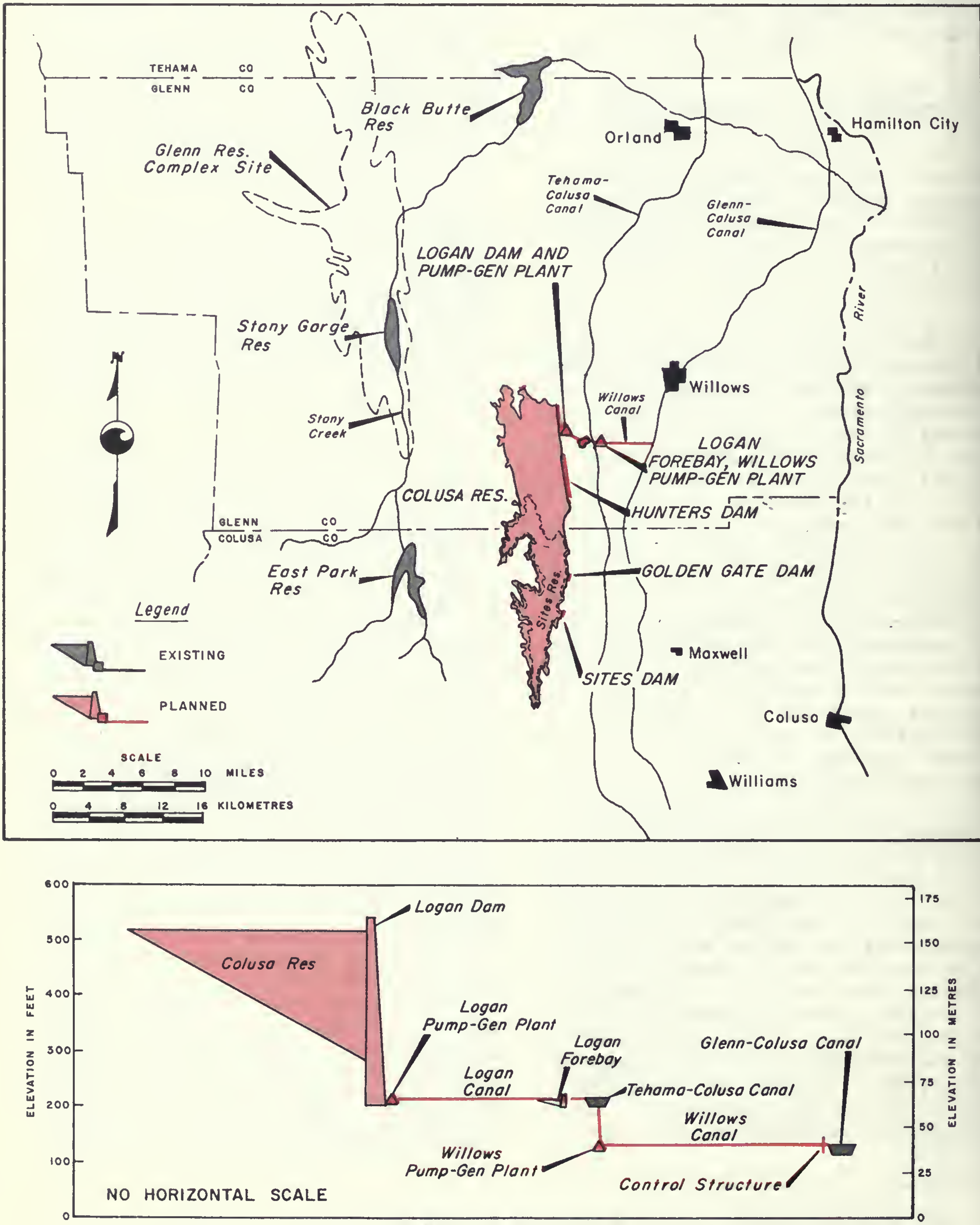
1/ USBR proposed Feasibility Report, "West Sacramento Canal Unit,Central Valley Project", December 1964.

Figure A-2 COLUSA RESERVOIR-RIVER DIVERSION PLAN



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struction of higher dams at those sites, and would also require considerably larger dams on Hunters and Logan Creeks.

The Colusa Reservoir--River Diversion plan would utilize the winter and spring surplus capacity of both the Tehama-Colusa Canal and the existing Glenn-Colusa Irrigation District Canal to fill Colusa Reservoir. The filling system would not require a new canal from the Sacramento River, provided that suitable agreements could be reached with USBR and Glenn-Colusa Irrigation District. A pump connection for filling and release purposes would be required between Colusa Reservoir and those two canals. Releases from Colusa Reservoir to augment the Delta water supply would be made to Tehama-Colusa and Glenn-Colusa Canals in exchange for water normally diverted from the Sacramento River by those canals. The Tehama-Colusa Canal and Glenn-Colusa Canal each have a capacity of about 60 m^3/s (2 100 ft^3/s) at the location of the planned pump connection to Colusa Reservoir.

Studies of Colusa Reservoir to date have indicated that the incremental cost of storage is excessive in comparison to storage costs of Sites Reservoir. The higher cost is due to the major embankments required at Hunters and Logan Dams to obtain storage in the northern end of Colusa Reservoir. Therefore, this plan is not proposed for a full feasibility analysis. Hunters and Logan Dams would not be required for the smaller USBR Sites Reservoir; however, Colusa Reservoir may be reconsidered in future plans. The cost and water supply information developed in the study is described in the following text.

Storage and Conveyance Facilities

Colusa Reservoir would be formed by a series of embankment type dams along a ridge of the Coast Range foothills. Major dams are required at Logan, Hunters, Funks, and Stone Corral Creeks. Numerous small dams and extensions of the ridge are also required.

Land within the reservoir boundaries is typically dry, undulating foothill terrain used principally for dry farming and grazing. Sites, the only town in the reservoir area, is a small rural community of a few houses, a small store and a cemetery. Total population in the reservoir area is less than 100.

Facilities for filling Colusa Reservoir from the Tehama-Colusa and Glenn-Colusa canals would consist of:

Logan Forebay. This reservoir would require a low earth dam on Logan Creek adjacent to the west side of the Tehama-Colusa Canal. It would regulate water imported from Tehama-Colusa and Glenn-Colusa Canals and water released back to those canals from Colusa Reservoir. Logan Forebay would have a maximum water surface elevation of 64.6 m (212 ft) and capacity of 493 dam^3 (400 ac-ft).

Connecting Canals. The Willows Canal would connect the Glenn-Colusa Canal to the Willows pumping-generating plant below Logan Forebay. It would have a design capacity of 57 m^3/s (2,000 ft^3/s) and a length of 6.8 km (4.2 mi). The Logan Canal, with a capacity of 113 m^3/s (4,000 ft^3s), would extend 2.7 km (1.7 mi) from Logan Forebay to the Logan pumping-generating plant located at the base of Colusa Reservoir's Logan Dam.

Pumping-Generating Plants. The Willows pumping-generating plant would operate at a maximum head of about 25 m (83 ft), with a pump capacity requirement of 17 megawatts and generating capacity of 12 megawatts. With Colusa Reservoir sized at the maximum planned capacity of 3 700 000 dam^3 (3,000,000 ac-ft), Logan pumping-generating plant would operate at a maximum head of 94 m (308 ft), with a pumping capacity of 86 megawatts and a generating capacity of 32 megawatts.

Water Supply

Inflow to Colusa Reservoir would be derived from Sacramento River surplus flows but would be limited by the capacity of the foregoing import conveyance facilities. Historical runoff data indicate that surplus flows occur at the diversion points in random amounts, predominantly between the first of November and the end of April of most years. The potential supply to Colusa Reservoir would average approximately 660 000 dam^3 (540,000 ac-ft) per year, if both Tehama-Colusa and Glenn-Colusa canals could be used. The average supply during a critical drought (with the severity of the 1928-34 drought period) would be reduced, however, to about 111 000 dam^3 (90,000 ac-ft) per year.

Water Yield

Relationships between reservoir capacity and water yield accomplishments of the Colusa Reservoir river diversion facilities are indicated below.

The yield values represent average increments that would be added to the State Water Project-Central Valley Project systems under long-term runoff conditions and under a critical drought period.

Reservoir Capacity					
Total		Active		Firm Annual Yield	
1 000 dam^3	(1,000 ac-ft)	1 000 dam^3	(1,000 ac-ft)	1 000 dam^3	(1,000 ac-ft)
3 710	(3,010)	3 640	(2,950)	562	(456)
3 430	(2,780)	3 350	(2,720)	528	(428)
2 870	(2,330)	2 800	(2,270)	449	(364)

Energy

Average long-term energy consumption and generation at the two Colusa Reservoir pumping-generating plants, after initial filling of the reservoir, would be in the following order of magnitude.

Energy consumed while pumping into the reservoir = 100 million kWh/yr.

Energy generated during releases from the reservoir = 50 million kWh/yr.

The energy quantities are based upon long-term operation of a 3.7-million-dam^3 (3-million-ac-ft) Colusa Reservoir.

Cost of Facilities

Costs of Colusa Reservoir and pump connection (conveyance) facilities are shown on the next page at January 1981 prices for two reservoir sizes. The following costs include an allowance for contingencies and costs of design and construction supervision.

Unit Cost of Water

The annual unit cost of dry period yield from Colusa Reservoir is estimated to be \$145 per dam^3 (\$180 per ac-ft), based upon the total reservoir capacity. Under comparable cost and yield criteria, the dependable yield from Sites Reservoir would cost about \$85 per dam^3 (\$105 per ac-ft). The cost of the increment of new yield developed in Colusa Reservoir from the storage above Sites Reservoir is estimated to be about \$230 per dam^3 (\$285 per ac-ft).

Environmental and Social Considerations

Preliminary inspections indicate that Colusa Reservoir would be favorably located from environmental and social viewpoints, in comparison with other new reservoirs. The area, used principally for dry farming and grazing, is thinly populated, with no rare or endangered species identified to date. The plan described for this report would maximize use of the diversion capacity of two

	First Cost in $1,000	
	Normal Water Surface Elevation 146 m (480 ft) 2 470 000 dam^3 (2,000,000 ac-ft)	Normal Water Surface Elevation 158 m (520 ft) 3 710 000 dam^3 (3,010,000 ac-ft)
Colusa Reservoir		
Reservoir clearing and facilities	$ 50,000	$ 50,000
Right-of-Way Cost	13,000	17,000
Sites Dam	25,000	31,000
Golden Gate Dam	46,000	53,000
Hunters Dam*	175,000	318,000
Logan Dam*	135,000	148,000
Outlet works and spillway	18,000	23,000
First Cost of Storage	$462,000	$640,000
Conveyance Facilities		
Lower Canal 57 m^3/s (2,000 ft^3/s)	17,000	$ 17,000
Willows Pump-Generating Plant	26,000	26,000
Upper Canal 113 m^3/s (4,000 ft^3/s)	15,000	15,000
Logan Forebay	1,000	1,000
Logan Pump-Generating Plant	45,000	52,000
Transmission	7,000	7,000
First Cost of Conveyance	$111,000	$118,000
Total First Cost	$573,000	$758,000

* Not required under the federal plan for Sites Reservoir.

existing canals and would require no additional diversion facilities at the Sacramento River.

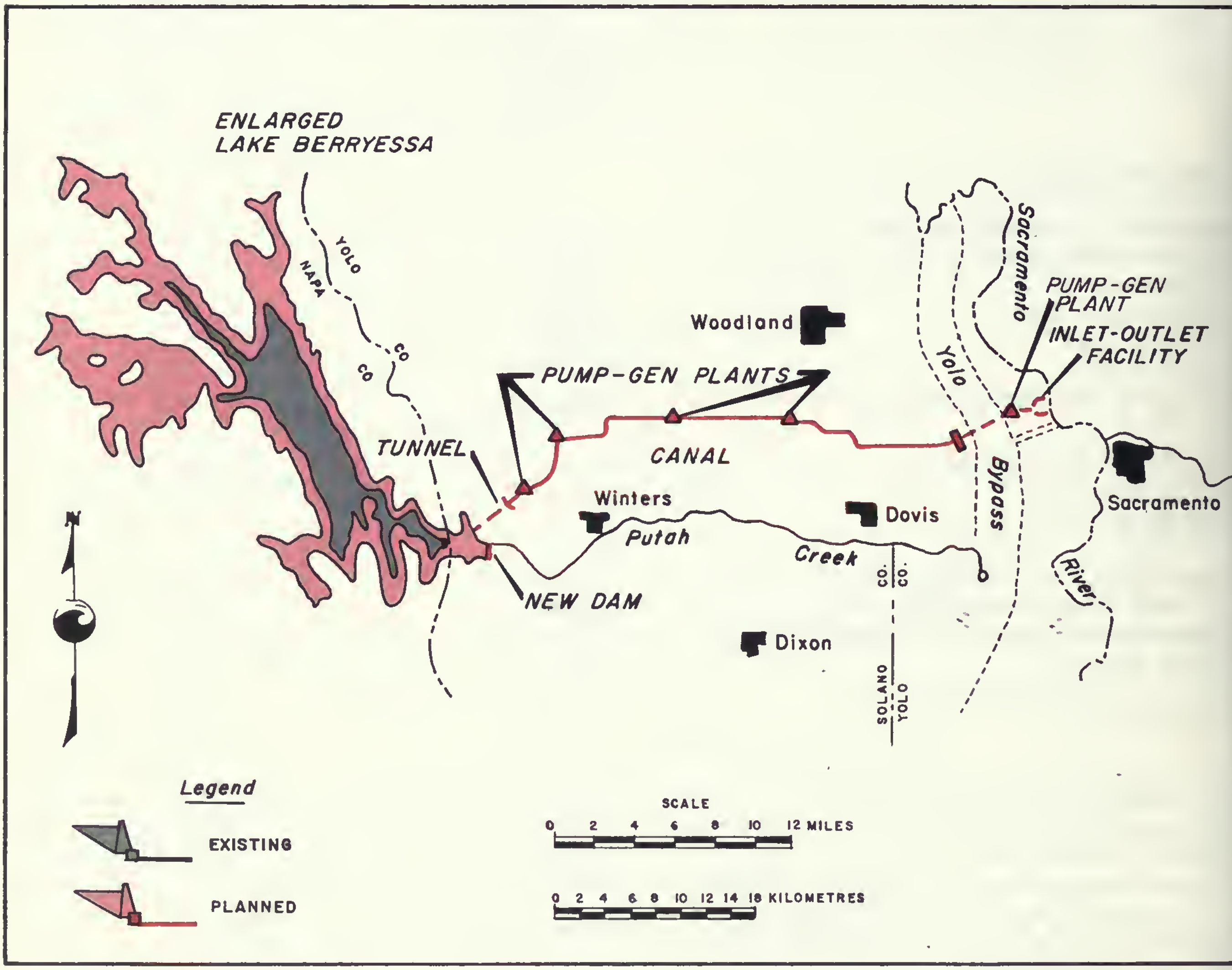
Operation of Colusa Reservoir would result in reduction of high-stage winter flows and a general increase in late spring or summer flows in the Sacramento River and the Delta. Water quality in the river may also be altered during the summer, perhaps beneficially by dilution from agricultural return waters.

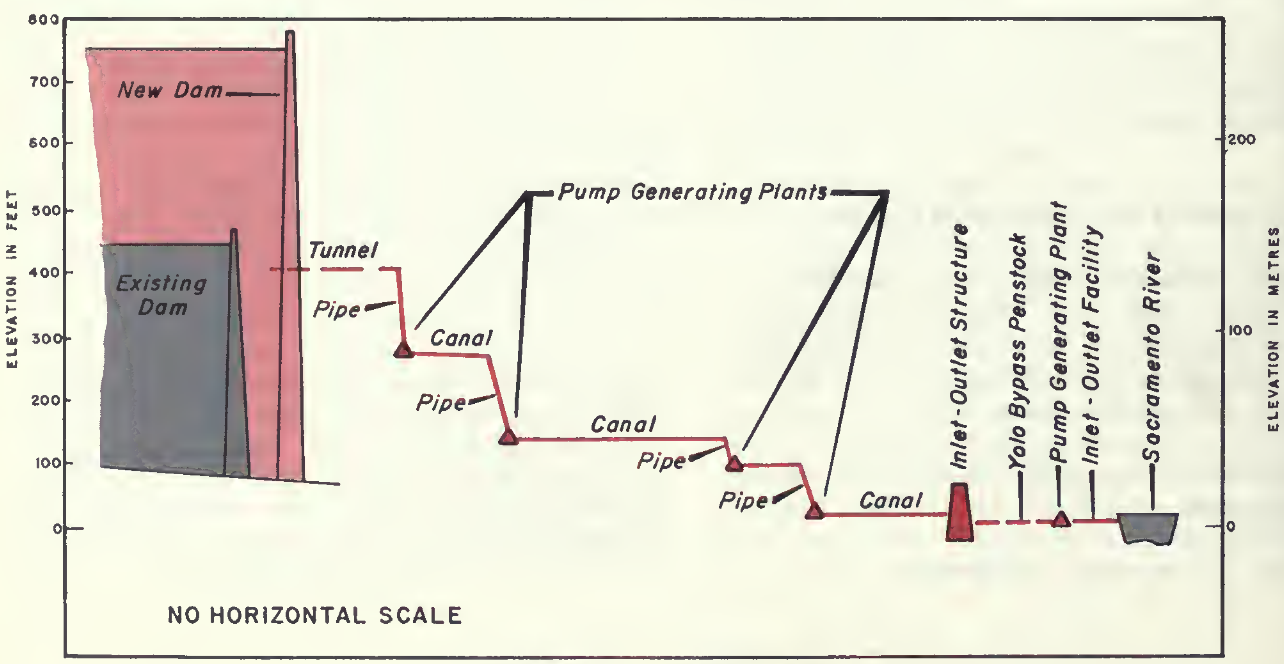
A minor amount of wildlife habitat would be inundated.

Lake Berryessa Enlargement Plan

Lake Berryessa was constructed by the U. S. Bureau of Reclamation (USBR) in 1957 to develop a water supply for the federal Solano Project service area in Solano County. The reservoir (Figure A-3) is formed by Monticello Dam, a thin concrete arch dam with a height of 82.6 m (271 ft) located on Putah Creek at the junction of Napa, Solano, and Yolo Counties. At its spillway elevation of 134 m (440 ft), Lake Berryessa has the capacity to hold 1 974 000 dam^3 (1,600,000 ac-ft), an amount more than ample to control the runoff of Putah Creek, which averages 442 000 dam^3

Figure A-3 LAKE BERRYESSA ENLARGEMENT PLAN





SCHEMATIC PROFILE

(358,000 ac-ft) per year. The site has the potential to develop a much larger reservoir at reasonable cost, if its storable inflow could be sufficiently increased to make the larger size feasible.

A preliminary study has been made of a plan to enlarge Lake Berryessa to a much greater capacity and to construct facilities for conveyance of unregulated surplus flows from the Sacramento River to the reservoir. A new higher dam would be constructed downstream of the existing dam. In addition to serving the Solano Project service area, enlarged Lake Berryessa would also provide supplemental supplies to the Delta for use in the State Water Project and Central Valley Project.

Storage Facilities

The existing Monticello Dam is located in a gap in the eastern boundary of the Coast Range. Alternative sites for the new dam under consideration are located about 1.6 km (1 mi) and about 3.2 km (2 mi) downstream of the existing dam. Raising the existing dam, or constructing upstream of the existing dam, is not proposed due to the necessary lowering or emptying of the existing reservoir during construction, which would disrupt normal operation of the existing Solano Project. A decision has not been made as to which of the two lower sites is superior, although the estimates of dam material quantities and costs prepared for this report were based upon the damsite which is farthest downstream. In terms of embankment requirements per unit of storage space, both of the two lower sites are superior to any of the known remaining damsites in the State. Physical details on enlarged Lake Berryessa are presented below at three sizes for comparison.

	Size A	Size B	Size C
Spillway elevation in metres	183	206	229
(feet)	(600)	(675)	(750)
Total capacity in cubic dekametres	7 400 000	11 300 000	16 400 000
(acre-feet)	(6 000,000)	(9,200,000)	(13,300,000)
Reservoir area in hectares	14,200	20,200	25,500
(acres)	(35,000)	(50,000)	(63,000)
Dam height in metres	143	166	189
(feet)	(470)	(545)	(620)
Dam volume in cubic metres	21 100 000	31 300 000	47 600 000
(cubic yards)	(27,600,000)	(41,000,000)	(62,300,000)

Lake Berryessa has a water surface area of 8 380 ha (20,700 ac), with an irregular strip of land bordering the lake controlled by USBR and used for recreation. Within that strip are seven privately operated recreation resorts (for boating, fishing, swimming and camping), all of which would require relocation if the lake were enlarged.

Topography of the potential enlarged reservoir area varies from level, farmable land in Pope Valley to rolling hills and steep mountain land. A large portion of the land has no water and is used for grazing. Five subdivisions are situated within the enlarged new reservoir limits; however, many of the lots were purchased on speculation and are not improved. Approximately 1,800 mobile homes are also stationed within the enlarged reservoir area, more than 1,500 of which are located on federally owned recreation land leased to private concerns. About 1,000 persons live year-round in the enlarged reservoir area. Some of the area is also used at the present time as habitat for some 3,000 deer.

In 1978, DWR performed a preliminary investigation of faults and seismicity for the enlarged Lake Berryessa.1/ It found that (1) four major faults have been mapped in the vicinity of the present Lake Berryessa, (2) a maximum credible earthquake of magnitude 7.0 can be expected within 9.7 km (6 mi) of the enlarged Berryessa damsite, (3) filling of the existing reservoir appears to have increased local seismicity for the first couple of years, and (4) no large faults have been mapped which pass through or near the proposed dam foundation.

Conveyance Facilities

Under the preliminary plans chosen for study, a conveyance system extending from the Sacramento River to the enlarged Lake Berryessa would be 51.5 km (32 mi) long and require a static pump lift of more than 213 m (700 ft). The system would be designed for two-way flow and would have the following major components:

Fish Screen. Extensive fish screening facilities would be constructed on the west bank of the Sacramento River just upstream (north) of the Sacramento Weir. The facilities would be designed to operate when water is diverted from the river and when water is released to the river. Converging intake channels would extend from the Sacramento River to the first pumping-generating plant, a distance of about 3 km (2 mi).

Pumping-Generating Plants. A total of five pumping-generating plants would be required in the conveyance system. The first plant would be located adjacent to the eastern levee of the Yolo Bypass, and the last plant would pump through a tunnel into enlarged Lake Berryessa.

Yolo Penstocks. Underground pipelines would be constructed across the Yolo Flood Bypass, a distance of 3.4 km (2.1 mi). Penstocks for the four other pumping-generating plants located west of the Yolo Bypass would have a total length of 1.0 km (0.6 mi).

Canal. A concrete-lined canal with a total length of 40.2 km (25 mi) would be constructed in four reaches from the Yolo Bypass to the Berryessa Tunnel. The canal alignment would require structures for crossing several creeks, sloughs, irrigation ditches, State highways, county roads, and farm access roads.

Berryessa Tunnel. This tunnel would connect the canal with the enlarged Berryessa Reservoir. It would have an invert elevation of 130 m (400 ft) and a length of 3.7 km (2.3 mi).

Alternative Alignment. As a possible alternative, Sacramento River water could be diverted to an enlarged Lake Berryessa from the vicinity of the Peripheral Canal intake near Hood. If necessary, the intake and fish screens for the Berryessa diversion could be located on the east bank of the river to reduce the potential impact on fish.

With an east bank diversion, a very large inverted siphon would be needed to cross under the river. From the diversion point near Hood, a canal would extend northwest, crossing the Sacramento River Deep Water Ship Channel via another inverted siphon. Other major crossings would be required south of Dixon for Interstate Highway 80 and the Southern Pacific Railroad. The canal would enter a series of interconnected small foothill reservoirs south of Winters. A mile-long tunnel would pass

1/ Preliminary Report, "West Sacramento Valley Fault and Seismicity Study", July 1978.

through the hills to Pleasant Valley Creek. Another 6.4 to 8.0 km (4 to 5 mi) of canal would reach the main pumping plant near the new Monticello Dam. This alternative conveyance system would be about 3 km (2 mi) longer than the more northern route, but it would require a tunnel only about half as long. Total pumping head would be nearly the same with either diversion route,

Water Supply

Operation studies of the base State Water Project/Central Valley Project systems under future operating conditions indicate that surplus flows would occur in Sacramento River at the Sacramento Weir in 46 years out of 50. The average annual amount would be about 7 400 000 dam^3 (6,000,000 ac-ft). The average during the critically dry period of May 1928-December 1934 was 210 000 dam^3 (170,000 ac-ft) per year. Not all the surplus water would be divertible, however, due to the peaking nature of Sacramento River flow in winter and spring seasons. The average annual divertible supply to the enlarged Lake Berryessa with a 283 m^3/s (10,000 ft^3/s) conveyance system would be in the range of 1.8 to 2.5 million dam^3 (1.5 to 2 million ac-ft) per year.

Water Yield. Estimates of additional annual yield for the enlarged Lake Berryessa and conveyance facilities are indicated in the following tabulation. These values do not include yield from the existing reservoir.

Enlarged Lake Berryessa

Capacity			Additional Firm Annual Yield	
1 000 dam^3 (1,000 ac-ft)		m /s^3 (ft^3/s)	1 000 dam^3 (1,000 ac-ft)	
Gross Storage*	New Active Storage	Import System	Average (1922-71)	Dry Period (1928-34)
13 900 (11,300)	11 700 (9,500)	340 (12,000)	1 132 (918)	1 887 (1,530)
14 900 (12,100)	12 700 (10,300)	340 (12,000)	1 018 (825)	2 035 (1,650)
16 000 (13,000)	13 800 (11,200)	340 (12,000)	888 (720)	2 220 (1,800)

* Includes existing reservoir.

Energy

The Lake Berryessa enlargement plan as presented in this report includes aqueduct and pumping-generation facilities for transferring water from the Sacramento River to the enlarged lake and transferring water back to the river through the same facilities (see Figure A-3). However, it does not include a powerplant below the new dam to generate energy when the natural runoff of Putah Creek is released to serve the existing Solano Project demands. While such a powerplant may be feasible, its costs and energy accomplishments were not derived for this reconnaissance investigation and are not included here.

The long-term average amount of water pumped annually from Sacramento River to enlarged Lake Berryessa would exceed the amount released back to the river through pumping-generating plants by approximtely 185 000 dam^3 (150,000 ac-ft) per year due to reservoir evaporation loss. Net energy consumption would range from 250 million to 300 million kilowatthours per year, depending upon the selected size of the facilities.

Costs of Facilities

Costs of storage and conveyance facilities at 1978 prices for the enlarged reservoir are presented in an office report, "SWP Future Supply Program, Enlarged Berryessa Reservoir, Reconnaissance Study", published by the Department's Division of Design and Construction in July 1978. Costs were estimated for alternative spillway crest elevations of 183, 206, and 229 m (660, 675, and 750 ft) and for the conveyance facilities with alternative import capacities of 142, 283, and 566 m^3/s (5,000, 10,000, and 20,000 ft^3/s). Cost of right-of-way acquisition for reservoir elevation 229 m (750 ft) is shown in an office report, "Acquisition Cost Estimate ... Lake Berryessa", prepared by the Department's Division of Land and Right of Way in June 1978. Costs derived from those reports, adjusted to January 1981 prices, are shown in the following tabulations.

Costs of Enlarged Lake Berryessa Storage Facilities
In $1,000,000 at sizes indicated

	Total Reservoir Capacity		
	7 400 000 dam^3 (6,000,000 ac-ft) a/	11 300 000 dam^3 (9,200,000 ac-ft) b/	16 400 000 dam^3 (13,300,000 ac-ft) c/
Dam embankment	$ 205	$ 275	$ 384
Outlets works and spillway	18	20	23
Clearing and road construction	43	55	67
Subtotal	266	350	474
Engineering and contingencies	93	122	166
Subtotal-construction cost	359	472	640
Right of way acquisition and relocations d/	100	134	163
Total First Cost	$ 459	$ 606	$ 803

a/ Spillway elevation 183 m (600 ft) at top of gates.
b/ Spillway elevation 206 m (675 ft) at top of gates.
c/ Spillway elevation 229 m (750 ft) at top of gates.
d/ Cost of areas for reservoir, recreation areas, roads, and relocation of public utilities and cemetery.

Costs of Enlarged Lake Berryessa Conveyance Facilities
In $1,000,000 at sizes indicated

Conveyance Facilities for Res. Elev. 229 m (750 ft)*	142 m^3/s (5,000 ft^3/s)	283 m^3/s (10,000 ft^3/s	566 m^3/s (20,000 ft^3/s
Fish Screen Facilities	$ 20	$ 37	$ 68
Yolo Penstocks	29	54	111
Pumping-Generating Plants (5)	204	410	815
Canal (4 Reaches)	60	81	127
Berryessa Tunnel	128	145	184
Transmission and Substation	9	9	9
Control System	1	1	1
Subtotal	$ 451	$ 737	$ 1,315
Engineering and Contingencies	158	258	460
Subtotal-Construction	$ 609	$ 995	$ 1,775
Right of Way Acquisition	13	13	15
Total First Cost	$ 622	$1,008	$ 1,790
Conveyance Facilities for Res. Elev. 206 m (675 ft)*			
Construction	$ 600	$ 979	$ 1,745
Right of Way Acquisition	13	13	15
Total First Cost	$ 613	$ 992	$ 1,760
Conveyance Facilities for Res. Elev. 183 m (600 ft)*			
Construction	$ 592	$ 958	$ 1,705
Right of Way Acquisition	13	13	15
Total First Cost	$ 605	$ 971	$ 1,720

* Elevation at top of spillway gates.

The difference in conveyance system costs shown for different reservoir elevations is due to the difference in cost of the variable head pumping-generating plant located at the east end of the Berryessa Tunnel.

Total first costs of combined storage and conveyance facilities at various sizes for the enlarged Berryessa Reservoir plan are summarized in the following tabulation:

14—75071

	First Costs in \$1,000,000		
	Capacity of Conveyance System		
	142^3/s (5,000 ft^3/s)	283 m^3/s (10,000 ft^3/s)	556 m^3/s (20,000 ft^3/s)
Reservoir 16 400 000 dam^3 (13,300,000 ac-ft)	\$ 803	\$ 803	\$ 803
Conveyance System	622	1,008	1,790
Total First Cost	\$ 1,425	\$ 1,811	\$ 2,593
Reservoir 11 300 300 dam^3 (9,200,000 ac-ft)	\$ 606	\$ 606	\$ 606
Conveyance System	613	992	1,760
Total First Cost	\$ 1,219	\$ 1,598	\$ 2,366
Reservoir 7 400 000 dam^3 (6,000,000 ac-ft)	\$ 459	\$ 459	\$ 459
Conveyance System	605	971	1,720
Total First Cost	\$ 1,064	\$ 1,430	\$ 2,179

Unit Cost of Water

In the reconnaissance studies, the unit cost of new dry-period yield from the enlarged Lake Berryessa was estimated to be about \$100 per dam^3 (\$125 per ac-ft).

Environmental and Social Considerations

A major environmental investigation would be required if this plan for storing Sacramento River surplus flows in enlarged Lake Berryessa were proposed for advanced study. The anticipated environmental issues which appear to be most important are briefly described below.

Fish. Diverting an additional several thousand cubic feet per second from the lower Sacramento River to fill enlarged Lake Berryessa would have quite an impact on Sacramento River migratory fish, and there is concern regarding that potential impact.

The cold-water fishery on Putah Creek below the existing Monticello Dam would be partially eliminated, if the planned new dam were located one or two miles downstream of the existing dam. Enlargement would also affect fish population in the existing reservoir.

Wildlife. The California Department of Fish and Game has concluded that enlargement of Lake Berryessa would have an adverse impact on deer and other wildlife due to inundation of diverse and productive habitat.

Rare and Endangered Species. It is not known whether any rare or endangered species would be affected by the new facilities. Four plant species listed on the Federal Endangered or Threatened Plant List occur in the general vicinity, but their exact locations in relation to the boundaries of this project have not been determined.

Relocations. There are about 1,000 permanent residents in the enlarged reservoir area. In addition, there are some 3,000 to 4,000 residents living in approximately 1,800 mobile homes located mainly on the federally owned recreation lands along the existing lake. Concern exists for severance damage which would result in southern Yolo County from construction of the large aqueduct from the Sacramento River as described here.

Corral Hollow Offstream Storage Plan

Corral Hollow Reservoir (Figure A-4) is considered as a possible offstream storage facility in southwestern San Joaquin County. The main dam site is located 4 km (2.5 mi) west of the California Aqueduct and about 29 km (18 mi) south of Clifton Court Forebay. The reservoir would be operated conjunctively with the California Aqueduct to store and regulate Delta surplus flows and thereby increase the dependable yield of the State Water Project. Since Corral Hollow Reservoir site is also near the Hetch Hetchy Aqueduct, it would also have the potential to serve that Bay area system.

The preliminary investigation conducted to date has revealed two problems associated with the plan: (1) excessive cost of storage and (2) concern for environmental impact.

Water Yield

Under median water supply conditions, Corral Hollow Reservoir would have an annual water supply from future unregulated Delta flows of about 200 000 dam^3 (160,000 ac-ft) per year. It would add about 200 000 dam^3 (160,000 ac-ft) per year to the State Water Project/Central Valley Project facilities during a seven-year critical drought period.

Cost of Facilities

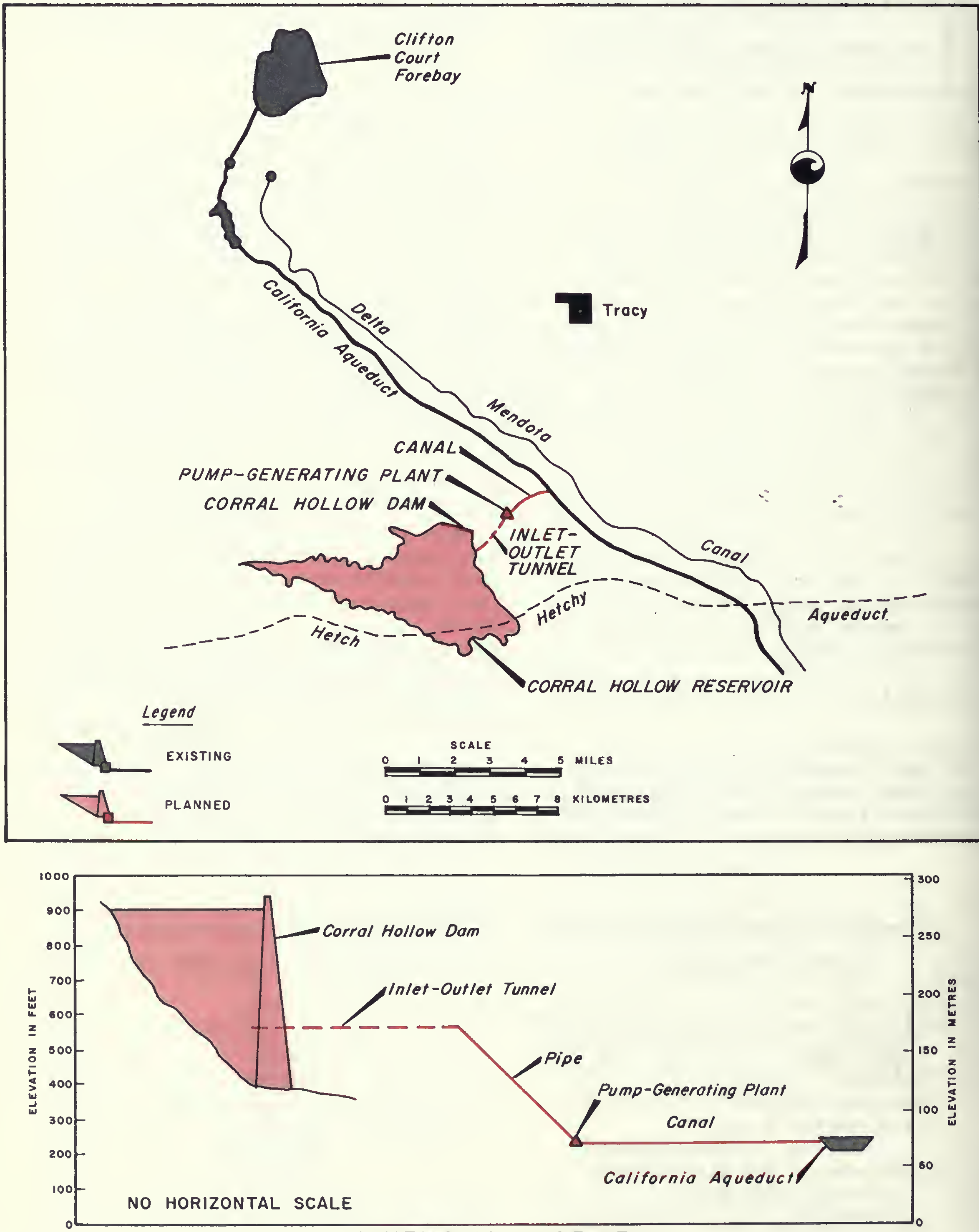
A design and cost study was made for Corral Hollow Dam at the considered maximum feasible size for the dam site. At that size, Corral Hollow Reservoir would have a normal pool elevation of 274 m (900 ft) and a storage capacity of 1 360 000 dam^3 (1,100,000 ac-ft). The dam would be an earth and rockfill embankment with a crest elevation of 280 m (920 ft), a height of 180 m (590 ft), and a volume of 65 400 000 m^3 (85,600,000 yd^3). Six saddle dams with a total embankment of 3 370 000 m^3 (4,410,000 yd^3) would also be required.

Corral Hollow Reservoir would have a surface area of 2 600 ha (6,400 ac) at an elevation 274 m (900 ft). The land that would be required is a thinly populated grassland area with low economic value. However, a major installation in the reservoir area, owned by the United States Government and leased to Lawrence Livermore Laboratory, would be costly to relocate.

Costs of the Corral Hollow storage and conveyance facilities at January 1981 prices are shown in the following tabulations:

Storage Facilities	First Cost in $1,000
Main Dam	$605,000
Reservoir Clearing and Facilities	17,000
Saddle Dams	42,000
Spillway	12,000
Emergency Release Facilities	3,000
Inlet-Outlet Works	47,000
Subtotal - Construction	$726,000
Right-of-way and Relocations	96,000
Total First Cost	$822,000

Figure A-4 CORRAL HOLLOW OFFSTREAM STORAGE PLAN



SCHEMATIC PROFILE

Conveyance Facilities	First Cost in $1,000	
Capacity (Alternative Sizes)	85 m^3/s (3,000 ft^3/s)	170 m^3/s (6,000 ft^3/s)
Channel Works	$ 21,000	$ 24,000
Pumping-Generating Plant	76,000	153,000
Right-of-Way	1,000	1,000
Total First Cost	$ 98,000	$178,000

Environmental and Social Considerations

The area that would be inundated by Corral Hollow Reservoir has a permanent population of fewer than 50 residents. It is presently used for animal grazing and motorcycle hill climbing events, and a large portion is set aside as a testing area for the Lawrence Livermore Laboratory.

Inundation of the Corral Hollow site would present several adverse environmental and social impacts. The Corral Hollow site has important plant, animal, paleontological and historical characteristics. The diversity of plant and animal communities and the age of the fossil specimens give the site unique characteristics that would be adversely affected by the presence of a major reservoir. Because of its unique features, this area has been designated one of the natural areas of California by the Natural Areas Coordinating Council, a group of concerned citizens.

Vegetation types in the reservoir area include desert and semidesert species, nine of which reach their northern distributional limits at Corral Hollow. The area is particularly noted for its rich assemblage of reptile and amphibian species, three of which are reaching critical numbers in parts of their range, although not as yet protected. The area has large nesting colonies of the cliff swallow and the white-throated swift. It is also the source of marine invertebrate fossils and the oldest fossil plants in the San Francisco Bay area.

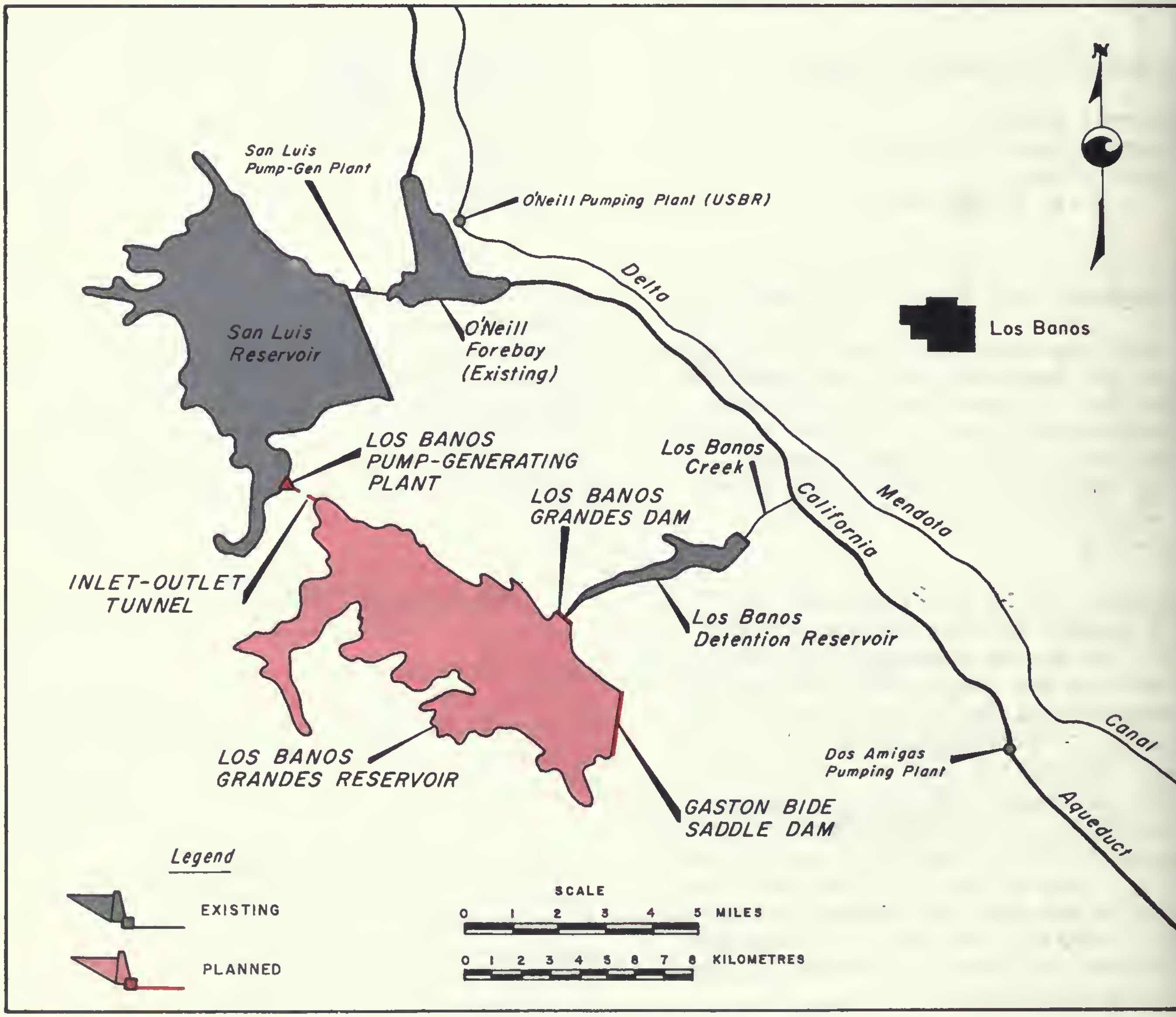
Corral Hollow has some historical background. A monument marking the site where Juan Bautista de Anza camped in April 1776, an abandoned coal mine called Tesla, an old brick and pottery plant called Pottery, and an abandoned town named Carnegie, which once had 2,000 inhabitants, would be inundated.

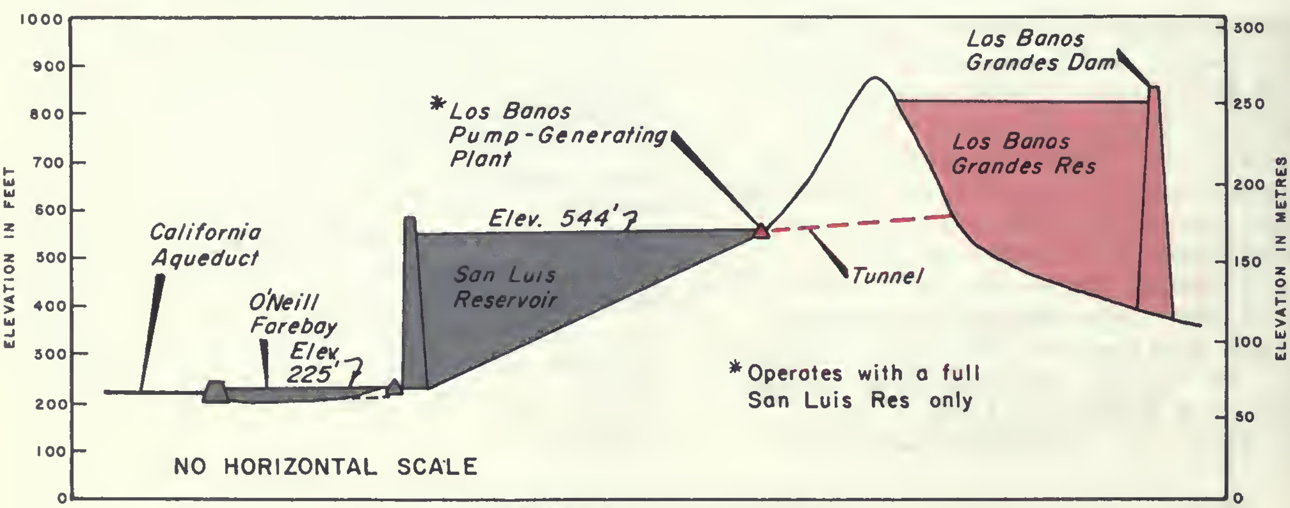
Los Banos Grandes Offstream Storage Plan

Los Banos Grandes offstream storage facilities (Figure A-5) would be located in western Merced County about 1.6 km (1 mi) south of the existing San Luis Reservoir.

Los Banos Grandes Reservoir would be operated in conjunction with San Luis Reservoir for additional storage and regulation of intermittent Delta flows and thereby add dependable yield to the State Water Project and the Central Valley Project. Available water supply would be very limited, however, as it would be restricted to periods of simultaneous occurrence of (1) surplus flows in the Delta and (2) availability of surplus aqueduct capacity in the North San Joaquin Division of the California Aqueduct. Filling and refilling Los Banos Grandes Reservoir may require extensive periods of time; therefore, its main purpose, and operating mode, would be to provide long-term carryover storage for use during severe droughts when other sources of supply are critically depleted.

Figure A-5 LOS BANOS GRANDES OFFSTREAM STORAGE PLAN





SCHEMATIC PROFILE

Storage Facilities

Los Banos Grandes Reservoir would be formed by a main dam on Los Banos Creek upstream from the existing Los Banos Creek Detention Dam, with saddle dams on both the north and south ends of the reservoir. The Gaston Bide saddle dam on the south end would be a major structure, having less height but greater length and volume than the main dam. As presently contemplated, Los Banos Grandes Reservoir would have a maximum water surface elevation of 244 m (800 ft) and storage capacity of 2 710 000 dam^3 (2,200,000 ac-ft). When filled, the area of the reservoir would be 5 670 ha (14,000 ac).

The earth and rockfill embankment type dams under study would have a total volume of about 41 200 000 m^3 (54,000,000 yd^3), of which 17 700 000 m^3 (23,200,000 yd^3) would be in the main dam, 22 400 000 m^3 (29,300,000 yd^3) would be in the Gaston Bide Dam, and 1 100 000 m^3 (1,500,000 yd^3) would be in additional saddle dams.

The Ortigalita Fault, which may be considered active, is located about 4 000 m (13,000 ft) northwest of the main damsite. This fault is currently considered a prime factor in limiting the size of the reservoir and in the location of a connecting tunnel to San Luis Reservoir.

Topography of the Los Banos Grandes Reservoir area is gently rolling dry pasture and steep hillside pasture, with Los Banos Creek located in the north central portion of the site. Los Banos Creek flows only part of the year, but it provides some stock water during wet seasons. Pasture and water supplies are seasonal only. Sheep and cattle grazing is customary from midfall to midspring, if there is sufficient rainfall. Improvements in the reservoir area consist primarily of scattered small dwellings, feed barns, sheds, and corrals.

Approximately 15 ownership parcels are located partially within the planned reservoir take line. Access to those ownerships consists of graded county roads and private farm roads. One major utility--a 500 kW power transmission line across the northern reservoir area--would require relocation.

Total land area required for the reservoir area, a buffer zone, and construction of facilities would be 7 200 ha (17,800 ac). Total easement area required for access roads to remaining parcels and utility relocation would be 100 ha (246 ac).

Conveyance Facilities

Surplus Delta water supplies would be transported to San Luis Reservoir through existing facilities of the State Water Project. Water transfer from San Luis Reservoir, at normal water surface elevation of 166 m (544 ft), to Los Banos Grandes Reservoir would require the facilities described below.

Los Banos Pumping-Generating Plant. This plant would be capable of lifting water at a rate of 170 m^3/s (6,000 ft^3/s) from a full San Luis Reservoir to Los Banos Grandes Reservoir at its maximum elevation of 244 m (800 ft). The plant would have an input capacity requirement of about 160 000 kW when pumping and a generating capacity of 100 000 kW when releasing water.

Los Banos Inlet-Outlet Tunnel and Channel. This tunnel would have a diameter of 6.4 m (21 ft) and a length of 2 600 m (8,500 ft). The channel to be excavated at the surface of San Luis Reservoir to facilitate pumping would be 2 200 m (7,200 ft) in length. Conveyance capacity of the tunnel and channel would be 170 m^3/s (6,000 ft^3/s).

Alternative Plan. In an alternative conveyance plan, water would be transferred from O'Neill Forebay to Los Banos Grandes Reservoir via Los Banos Creek.

Two pumping-generating plants would be required: one to lift water from O'Neill Forebay at elevation 68.6 m (225 ft) to Los Banos Creek Detention Reservoir at elevation 108 m (354 ft); and the second to lift water from the Detention Reservoir to Los Banos Grandes Reservoir. At a pumping capacity of 170 m^3/s (6,000 ft^3/s), the two plants would require input capacity of 90 000 kW and 280 000 kW, respectively. Some modification to the existing spillway at Los Banos Creek Detention Dam would be required.

Water Supply

Operation studies of the "base" State Water Project-Central Valley Project facilities indicate that surplus flows--those that exceed project requirements and requirements for filling San Luis Reservoir--will occur periodically at the Delta. Some of this water could be delivered for storage in Los Banos Grandes Reservoir via the North San Joaquin Division of the California Aqueduct, which has a total conveyance capacity of 283 m^3/s (10,000 ft^3/s). The quantities of deliverable surplus water, however, will decrease as demands build up for SWP and CVP entitlement water. Annual deliveries of surplus water to Los Banos Grandes Reservoir under median water supply conditions in year 2000 would amount to about 200 000 dam^3 (160,000 ac-ft).

Water Yield. Because of its long-range water supply limitations, Los Banos Grandes Reservoir would be operated primarily to provide an emergency water supply in critical drought periods. Its operation, except for higher evaporation losses, would be very similar to proposals for yield increases through conjunctive use of ground water basin storage with the California Aqueduct.

After allowing for reservoir evaporation losses, which average about 74 000 dam^3 (60,000 ac-ft) per year, the incremental project yield of Los Banos Grandes Reservoir is estimated to be:

Dry Period (1928-34)	- 308 000 dam^3/yr (250,000 ac-ft/yr)
Long-term average	- 135 000 dam^3/yr (110,000 ac-ft/yr)

Energy

Quantities of additional energy needed for pumping from O'Neill Forebay to Los Banos Grandes Reservoir and additional energy generated with releases back to O'Neill Forebay are:

	Average Annual Amount (in kilowatthours)
Pump Energy Required	102 000 000
Energy Generated During Release	47 000 000
Net Energy Requirement	55 000 000

Cost of Facilities

First costs of Los Banos Grandes offstream storage facilities are estimated at 1981 price levels and include contingencies and engineering costs. The conveyance system costs are for facilities which would transfer water from a full San Luis Reservoir to a full Los Banos Grandes Reservoir at 170 m^3/s (6,000 ft^3/s).

Los Banos Grandes Dam and Reservoir	$441,000,000
Pumping-Generating Plant (conveyance)	169,000,000
Tunnel and Outlet Channel (conveyance)	123,000,000
TOTAL	$733,000,000

The conveyance costs ($292,000,000) via San Luis Reservoir are less than costs of the alternative Los Banos Creek conveyance route facilities at equivalent capacity. First costs, at 1981 prices, of Los Banos Creek conveyance route facilities at 170 m^3/s (6,000 ft^3/s) capacity are compared in the following tabulation:

Diversion and Intake Channels	$ 8,500,000
Spillway modification at Los Banos Creek Detention Dam	2,500,000
Lower Pumping-Generating Plant	118,000,000
Upper Pumping-Generating Plant	227,000,000
TOTAL	$356,000,000

Environmental and Social Considerations

Adverse impacts related to this project appear to be mainly associated with loss of wildlife and riparian habitat. Los Banos Grandes Reservoir would inundate about 5 700 ha (14,000 ac) of grazing land. Only three or four families reside permanently in the reservoir areas.

Vegetation consists mostly of grassland in Los Banos Valley, with scattered oaks and brush on the hills to the west and southwest. Within the area proposed for inundation, Los Banos Creek is bordered by mature riparian habitat composed mainly of sycamore trees. Loss of riparian trees is of concern because of the scarcity of this type of habitat in this region of the State.

Wildlife game species affected by the project include deer, wild pig, quail, and dove. Los Banos Valley is potentially within the range of the San Joaquin kit fox and the blunt-nosed leopard lizard, both State and federally protected endangered species. The California red-legged frog, known to occur along Los Banos Creek, may be approaching critical numbers, although it is not yet protected.

Archaeological resources, although unknown, may be extensive along the creek. A large Indian burial site was uncovered downstream from the proposed dam site, prior to construction of Los Banos Detention Reservoir.

Antelope Valley Ground Water Basin

Antelope Valley is an arid region in the westernmost Mojave Desert, 64 km (40 mi) north of downtown Los Angeles. The study area lies in Los Angeles and Kern counties (Figure A-6). Approximately 2 600 km^2 (1,000 mi^2) of relatively flat land and 3 100 km^2 (1,200 mi^2) of mountain and foothill land are included in the study area. The area is bounded on the north by Rosamond Dry Lake and Rogers Dry Lake and on the east by a chain of granite buttes.

Antelope Valley is essentially a closed ground water basin. Seven subbasins are located within the study area. In most of them, the upper aquifer is the principal supplier of water to the valley. Total storage capacity of the basin, from 7 m (20 ft) below ground surface to the base of water-bearing deposits, is 84 million dam^3 (68 million ac-ft). The total volume of ground water currently stored in the basin is an estimated 68 million dam^3 (55 million ac-ft). The remaining available storage, therefore, is about 16 million dam^3 (13 million ac-ft).

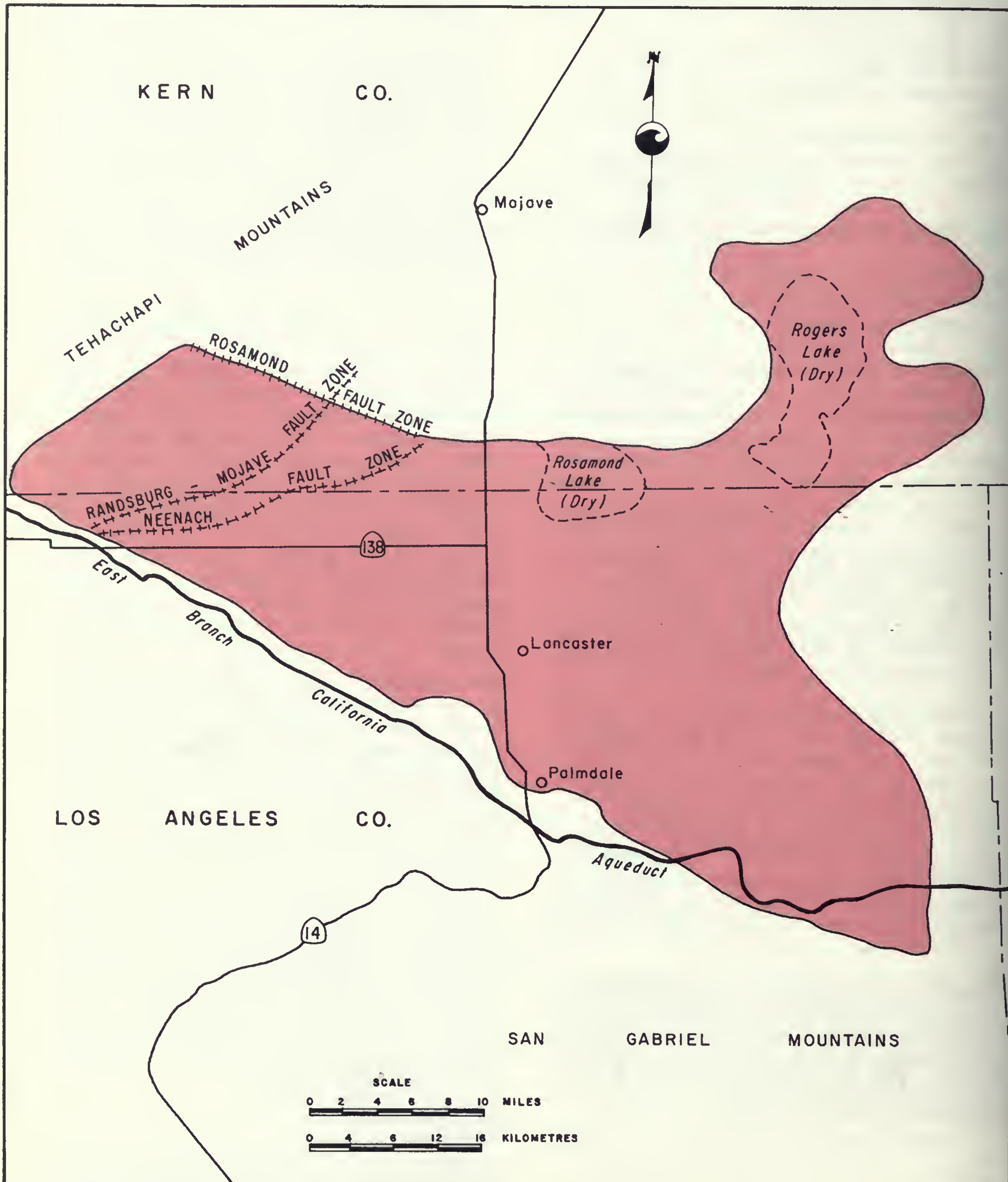
The estimated annual natural recharge is 50 000 dam^3 (40,000 ac-ft), which is less than the average annual pumpage for the past many years. Consequently, ground water levels have decreased more than 91 m (200 ft) in the vicinity of Lancaster, causing the land surface to subside. Several wells were lost when their casings collapsed as a result.

Ground water quality in Antelope Valley is generally excellent. Small pockets of inferior quality water do occur on the margins of the basins and in scattered shallow wells. SWP water is supplied to the study area by Antelope Valley-East Kern Water Agency, Littlerock Creek Irrigation District, and Palmdale Water District.

Findings

The direct storage method (direct recharge of imported surplus SWP water) appears impractical for ground water

Figure A-6 ANTELOPE VALLEY GROUND WATER BASIN



storage in Antelope Valley. A review of potential recharge sites in Antelope Valley indicates that they do not meet the necessary conditions for this method. The five requisites to implementing an indirect plan do exist in the subarea encompassing Lancaster and West Palmdale.

Operational and cost data follow:

- 62 000 dam^3 (50,000 ac-ft) of SWP water could be stored by the indirect method, using existing facilities.

- During a dry period similar to 1928-1934, 8 600 dam^3 (7,000 ac-ft) of incremental project yield could be derived per year.

Environmental and Social Considerations

The indirect storage method would slightly reduce the present rate of ground water level decline in the Lancaster Subbasin of Antelope Valley and would not require new construction. This would reduce the energy required for pumping and would limit the movement of poor quality water into the more important portions of the subbasin.

Las Posas Ground Water Basin

Las Posas Basin is situated in southwestern Ventura County (Figure A-7). The basin, which underlies the Calleguas Creek stream system, is an east-west trending structure in which water-bearing deposits dip toward the Oxnard Plain. It is bounded on the west by the Oxnard Plain Basin, on the north by South Mountain, on the east by Oak Ridge Mountain, and on the southwest by Las Posas Hills and Pleasant Valley Basin. The basin occupies a surface area of about 194 km^2 (75 mi^2).

Most of the basin consists of alluvial deposits, mostly of sand and gravels, with minor amounts of silt or clay. The deposits yield extensive quantities of water. They reach a depth of 61 m (200 ft) near the Moorpark area.

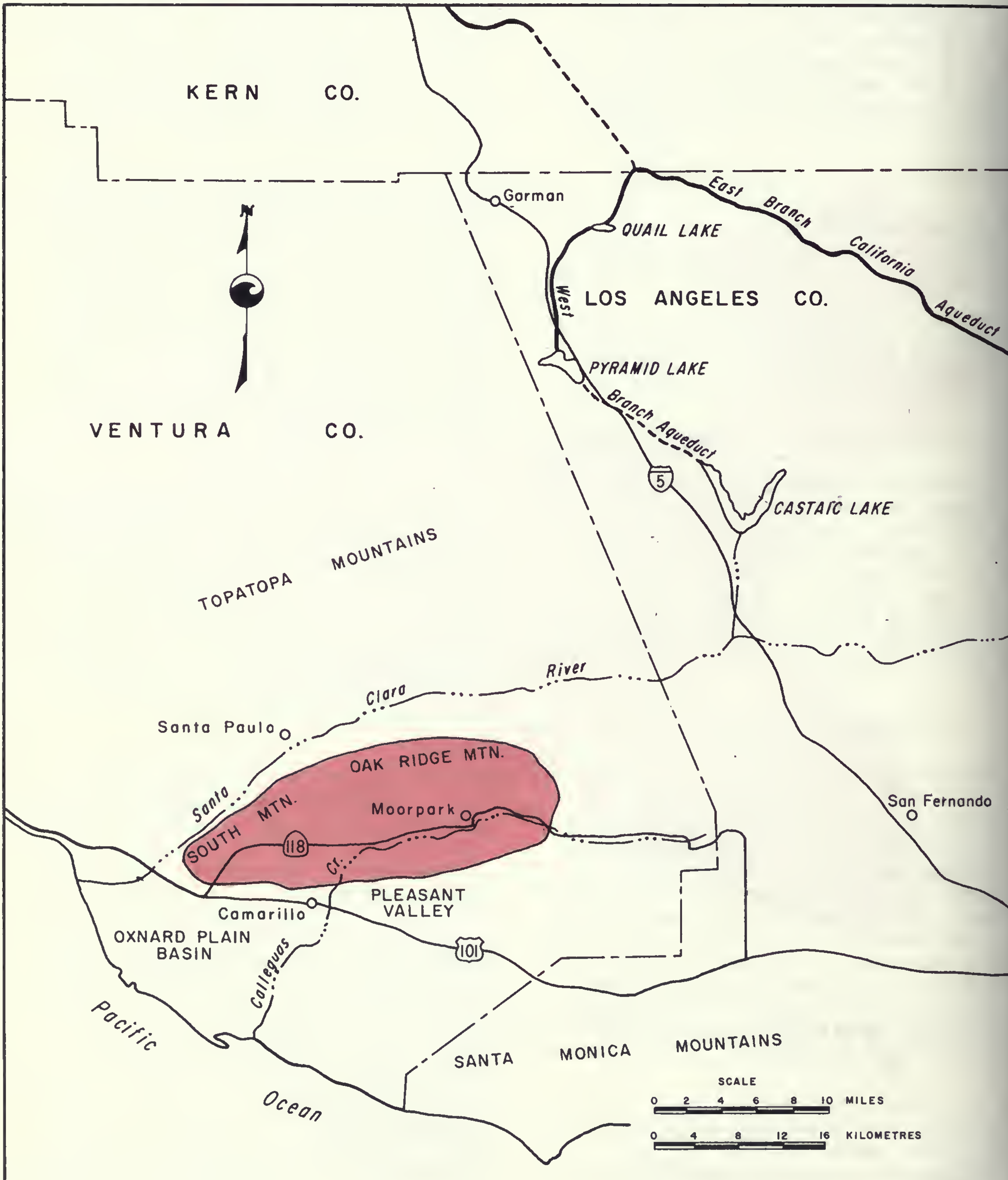
The Fox Canyon aquifer zone is the most important source of ground water in Las Posas Basin. It consists of approximately 30 to 180 m (100 to 600 ft) of continuous sand and gravel, with minor silt and clay lenses and interbeds. The zone covers almost the entire basin.

The quality of ground water in Las Posas Basin is generally good for domestic and most agricultural uses. Ground water in the eastern portion is of generally better quality than that in the western portion. A large quantity of good quality native water is stored in the deep aquifers of the central portion of the basin. However, high mineral content from certain wells is suspected to result from percolation of agricultural return flows and/or pumping of perched water.

The total storage capacity of the basin is approximately 5.2 million dam^3 (4.3 million ac-ft). The usable storage capacity is estimated to be between 1.2 million and 2.1 million dam^3 (950,000 and 1,700,000 ac-ft). Limited information suggests that adequate storage space may be available for the conservation of SWP water.

Natural recharge is estimated to be about 13 000 dam^3 (10,800 ac-ft) per year, whereas annual extractions (as of 1970) average around 23 000 dam^3 (18,700 ac-ft). Because of this, water levels have been declining by 1.2 to 1.5 m (4 to 5 ft) per year. To help alleviate this problem, the Calleguas Municipal Water District (CMWD) supplements the area's water supply with SWP water imported from The Metropolitan Water District of Southern California (MWD). It is estimated that by the early 1980s the demand for water within the CMWD service area will exceed the available supply. Therefore, an additional supply of water must be developed to prevent further ground water overdraft. Despite the overdraft condition, the basin has not been adjudicated.

Figure A-7 LAS POSAS GROUND WATER BASIN



Findings

Before a ground water storage program could be implemented, MWD might have to increase its treatment capacity to make certain the additional SWP water could be conveyed to the basin. Because no spreading grounds have been developed in the basin, the direct storage method is probably not feasible. Although recharge could be implemented in several areas, it has not been determined whether the sites are available for purchase and development by the State. No facility is available to convey untreated SWP water to the basin. This restricts the potential for direct recharge and for using SWP water for indirect recharge in agricultural areas. The cost of pipeline construction appears to outweigh the benefits.

Operational and cost data follow:

- On the basis of a theoretical storage and recapture schedule, 123 000 dam^3 (100,000 ac-ft) of SWP water could be stored by the indirect method.
- Annual yield from such storage amount would equal 18 500 dam^3 (15,000 ac-ft) average during a critical 7-year dry period.

Environmental and Social Considerations

An increase in ground water levels would help alleviate pumping depressions. This in turn would benefit ground water quality. This storage program would require restrictions in pumping by local well owners, an action which could adversely affect agricultural pumpers.

San Gabriel Ground Water Basin

The San Gabriel Basin (Figure A-8) is situated in the eastern part of Los Angeles County, approximately 40 km (25 mi) from the Pacific Ocean and northwest of Chino Basin and immediately southeast of Raymond Basin. The basin covers 518 km^2 (200 mi^2). The San Gabriel River, the only significant stream channel, originates in the San Gabriel Mountains to the north and traverses the entire valley.

Storage capacity was estimated to be 9.5 million dam^3 (7.7 million ac-ft) in 1965. Records show that between 1944, when the water level was the highest, and 1965, when it reached the lowest point in 40 years, storage decreased by 1.1 million dam^3 (900,000 ac-ft). A long-term annual safe yield has not been determined, but based on 1977 steady-state conditions, approximately 185 000 dam^3 (150,000 ac-ft) of ground water could be used annually. The basin is being operated under a 1972 Los Angeles County Superior Court Judgment, with administration by a court-appointed Watermaster.

Ground water quality is generally within the limits set by regulating agencies for drinking water standards. Except for a few wells with high fluoride or nitrate concentrations, the water is of good mineral quality.

SWP water is delivered to the area by San Gabriel Valley Municipal Water District and by MWD to Upper San Gabriel Valley Municipal Water District.

Recharge Facilities

In addition to the San Gabriel River channel, which functions as a natural recharge facility, 14 spreading areas totaling 422 ha (1,070 ac) are available within the basin. Recapture and conveyance facilities exist for implementing a direct method of storage.

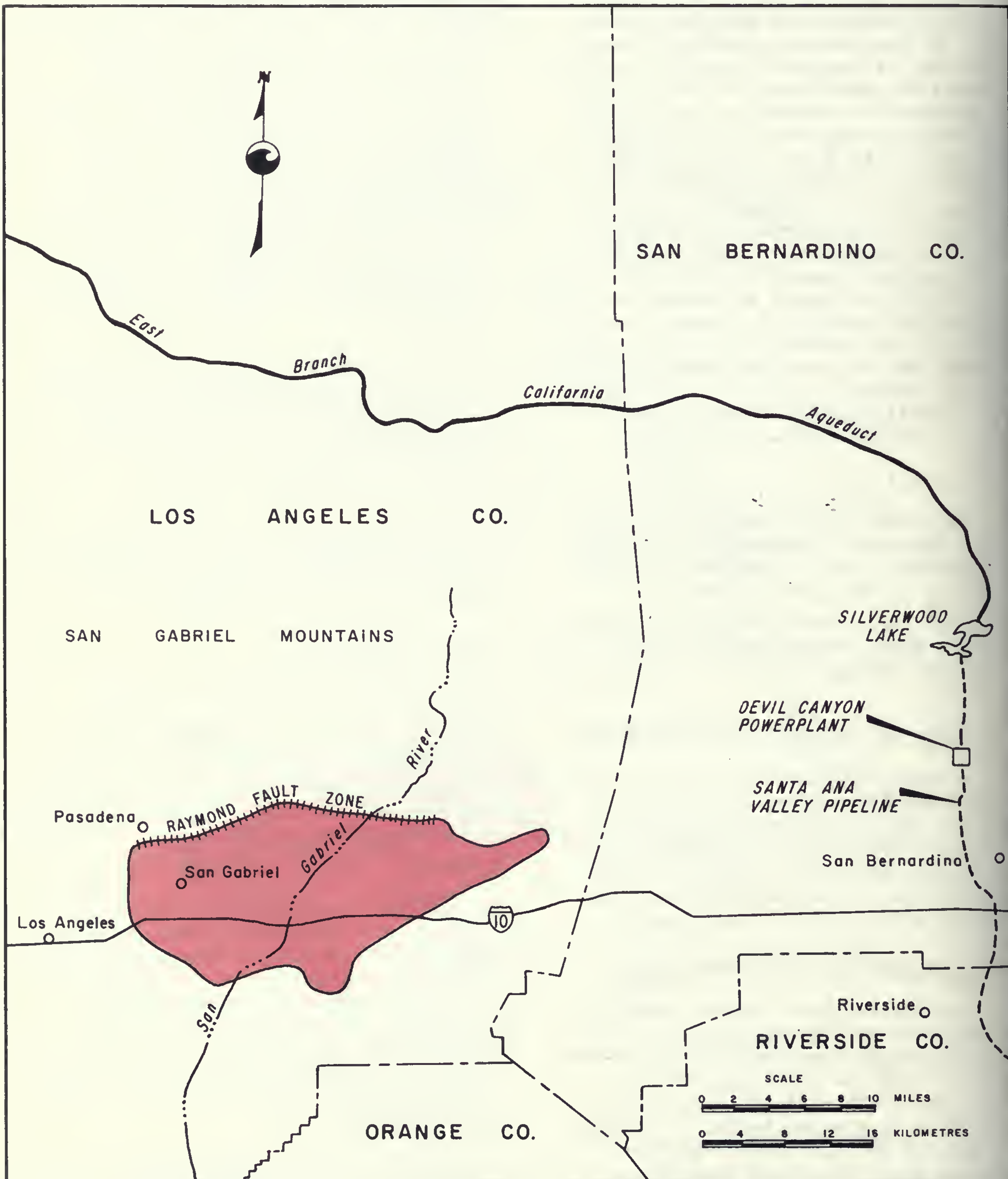
Findings

San Gabriel Basin has the existing facilities to accomplish a direct recharge program. The amount of water that could be stored is based on the availability of aqueduct capacity at Devil Canyon Powerplant and the amount of excess flow at the Delta. The amount of storage available for use is dependent on space reserved for local agencies future water supply operation plans.

Operational and cost data follow:

- Storage of 148 000 dam^3 (120,000 ac-ft) of SWP water could possibly be accomplished.

Figure A-8 SAN GABRIEL GROUND WATER BASIN



° The average annual dry-period yield would be about 21 000 dam^3 (17,000 ac-ft).

Environmental and Social Considerations

Sand and gravel pits could be subject to waterlogging, should water levels rise too high. No construction would be necessary to implement a ground water recharge plan.

Santa Clara River Valley Ground Water Basins

The Santa Clara River Valley extends from Los Angeles County west into Ventura County (Figure A-9). It comprises about 650 km^2 (250 mi^2). Ground water is found in nine basins that can be distinguished from one another by hydrologic or geologic factors.

The ground water basins underlying Ventura County have particular economic importance because they constitute the principal source of water in that area. SWP water is delivered by the Metropolitan Water District to Calleguas Municipal Water District serving this area. Total ground water in storage is estimated to be 33 million dam^3 (27 million ac-ft).

Natural runoff in Santa Clara River Valley is intermittent, depending largely on rainfall. The flow contributes significantly to ground water recharge and ground water quality control. While a series of wet years or a single very wet year can refill the basins upstream from Oxnard Plain Basin, Oxnard Plain Basin is in continuous, long-term overdraft. This condition has caused subsurface compaction and sea-water intrusion, two factors that have reduced the availability of fresh-water storage space.

The State Water Resources Control Board has the authority under Water Code Section 2100 to seek Superior Court approval for adjudication of water rights, if such action would prevent destruction of or irreparable injury to the quality of ground water. Responding to a request from the Environmental Coalition of Ventura County concerned with Oxnard Plain overdraft, the Board initiated a study of the sea-water intrusion problem. The study resulted in a Board resolution recognizing the threat of irreparable damage to ground water in the Oxnard Plain. At the present time, local water agencies are undertaking a concerted effort to develop and distribute more local water supplies so as to reduce ground water pumping at the locations contributing to sea-water intrusion. If successful, the Board will refrain from taking any steps toward seeking adjudication of Oxnard ground water rights. Ground water rights have not been adjudicated in other basins of Santa Clara River Valley.

Recharge Facilities

Three spreading areas exist within Santa Clara River Valley. Together their annual recharge capability is 226 000 dam^3 (183,000 ac-ft). With present average operations, there would be excess capacity to receive additional SWP water for direct recharge. However, additional extraction wells and distribution pipelines would be required.

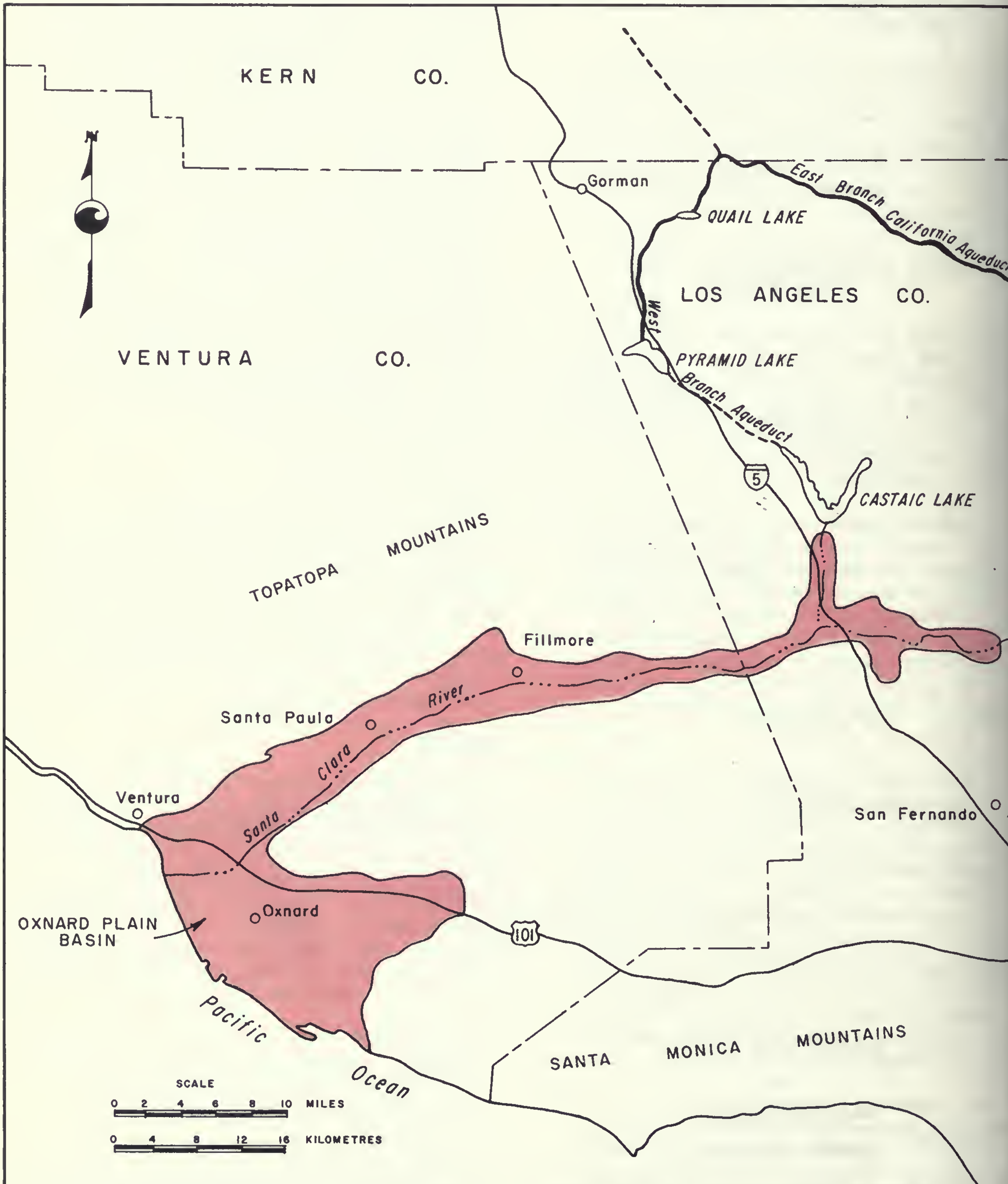
Findings

Five different storage capacities were investigated for a direct storage plan. They varied from 215 000 to 373 000 dam^3 (174,000 to 302,000 ac-ft). The lower storage value could be obtained with existing spreading areas; however, storage of greater amounts would require additional spreading-area capacity. Additional operational and cost data for the extremes of the storage range follow:

° At the maximum storage of 373 000 dam^3 (302,000 ac-ft), the basin would provide an average annual dry-period yield of 50 600 dam^3 (41,000 ac-ft).

° At the minimum storage of 215 000 dam^3 (174,000 ac-ft), the basin would provide an average annual dry-period yield of 29 000 dam^3 (23,500 ac-ft).

Figure A-9 SANTA CLARA RIVER VALLEY GROUND WATER BASINS



Environmental and Social Considerations

The increase in available water could enhance the wildlife habitat and the existing fishery at the Saticoy Spreading Grounds. Higher water levels occurring when water is in storage could prevent or retard movement of the poorer quality water into the main basin.

Upper Coachella Valley Ground Water Basin

The Coachella Valley (Figure A-10) is a 1 790-km^2 (690-mi) valley in the Colorado Desert about 161 km (100 mi) southeast of Los Angeles, lying primarily in Riverside County. The valley extends southeast from the east end of San Gorgonio Pass along a structural depression known as the Salton Trough. It is bordered on the north and northeast by the San Bernardino and Little San Bernardino Mountains, on the southwest by the San Jacinto and Santa Rosa Mountains, and on the southeast by the Salton Sea. The valley is drained by the Whitewater River system, which flows southeast into the Salton Sea.

The upper Coachella Valley, wherein the study area lies, refers to that part of the valley north and west of the Coachella Branch of the All American Canal. Thus, the southern boundary of this area is an arbitrary line from Point Happy northeast to the Little San Bernardino Mountains. South of this line, irrigation by imported Colorado River water is causing ground water levels to rise. North of this boundary, the major source of water is pumped ground water, and water levels are declining.

The Desert Water Agency and Coachella Valley Water District, under an agreement reached on July 1, 1976, manage ground water resources in the study area. Under the agreement, they monitor pumping, provide replenishment to the aquifer, and share the cost of supplemental water. The rights to water in the ground water basin have not been adjudicated.

Comparison of water levels between 1936 and 1973 shows that water levels declined more than 30 m (100 ft) in parts of the Palm Springs area and more than 21 m (70 ft) in parts of the Palm Desert area during the 37-year period. In recent years, the decline has averaged 1.5 m (5 ft) annually in the Palm Springs area. The net change in storage between 1945 and 1967 was about 740 000 dam^3 (600,000 ac-ft). The estimated average annual decrease in storage was 40 700 dam^3 (33,000 ac-ft) for 1953-67, and this annual figure was increasing as consumptive use increased. A conservative estimate is that an additional 419 000 dam^3 (340,000 ac-ft) of net storage depletion has occurred between 1967 and 1978. It therefore seems reasonable that 1 110 000 dam^3 (900,000 ac-ft) of water could be stored in the upper Coachella Valley without water levels rising above those that existed in 1945.

The quality of ground water in most of the upper Coachella Valley is suitable for beneficial use.

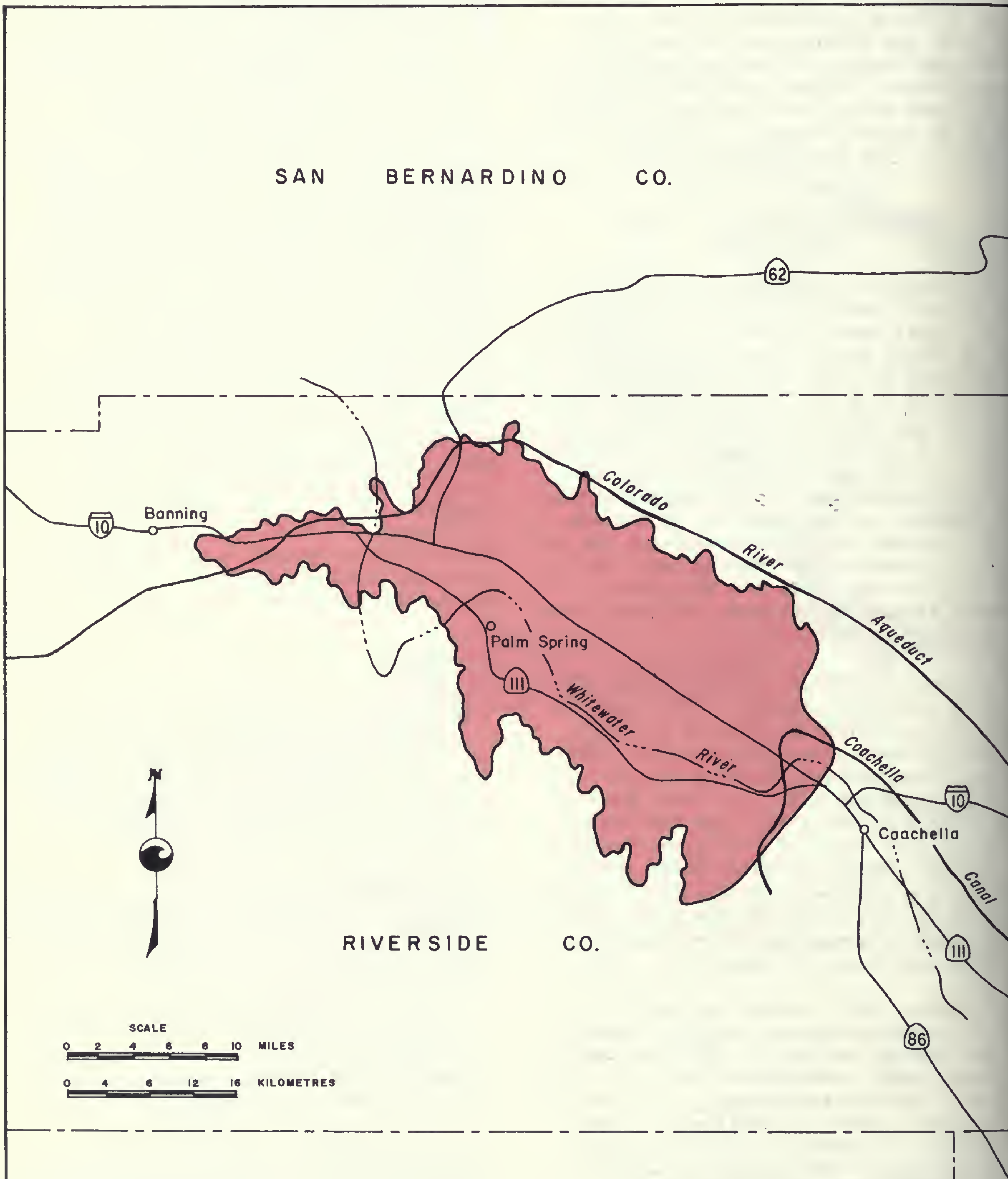
Findings

- Ground water extractions comprise 90-95 percent of the water used in the Upper Coachella Valley. Ground water is replenished with local water and imported Colorado River water. There are no facilities for treating imported water.

- The management of ground water resources is administered by the Desert Water Agency and the Coachella Valley Water District under an agreement reached on July 1, 1976. Under this agreement, the agencies monitor water pumping, provide ground water replenishment and divide the cost of supplemental water. The ground water basin has not been adjudicated.

- The Whitewater River subbasin of the upper Coachella Valley could reasonably store more than 1 110 000 dam^3 (900,000 ac-ft) of SWP water without

Figure A-10 UPPER COACHELLA VALLEY GROUND WATER BASIN



water levels rising above those that existed in 1945.

- Construction of an aqueduct along the pass route or the desert route is necessary to supply SWP water to the upper Coachella Valley.

Environmental and Social Considerations

The proposed ground water storage program would use the same ground water basin currently being used by the Desert Water Agency and the Coachella Valley Water District. Local distribution by these two agencies is accomplished by local pumping. Therefore, very little change in the environment could be expected during operation of the program.

White Wolf Ground Water Basin

The White Wolf Basin is located at the southern end of San Joaquin Valley (Figure A-11). The basin is separated from the main part of the valley by White Wolf Fault. Depth to water ranges from more than 135 m (450 ft) near White Wolf Fault to 305 m (1,000 ft) on the south side of the basin along the California Aqueduct. Consequently, most water wells in the basin are very deep, varying from 245 to 430 m (800 to 1,400 ft). Water levels and other data indicate the wells enter a single, unconfined body of ground water. An estimated 3.1 million dam^3 (2.5 million ac-ft) of ground water is currently in storage. The available storage space is about 1.9 million dam^3 (1.5 million ac-ft).

The ground water basin is recharged both by stream runoff and imported water. Very little replenishment results from subsurface inflow or precipitation on the valley floor. Since the 1940s, water levels have dropped about 75 m (250 ft). The depletions have been reduced from 38 000 dam^3 (31,000 ac-ft) per year in 1967 to an average of 2 500 dam^3 (2,000 ac-ft) per year (based on the period from 1973 to 1976).

Ground water quality varies, but most ground water is suitable for irrigation of crops. Ground water supplies in the main part of the basin have a total dissolved solids (TDS) concentration ranging from 500 to 800 milligrams per litre (mg/l). Ground water on the west side has a TDS concentration greater than 1 000 mg/l. The Wheeler Ridge-Maricopa Water Storage District, which overlies the ground water basin, receives SWP water from the Kern County Water Agency.

Water rights have not been adjudicated; therefore, agreements between the State and local pumpers/agencies would be needed to guarantee that stored SWP water could be recaptured at a later date.

Findings

Both the direct and indirect recharge methods could be considered as potential ways to store SWP water. At present, White Wolf Basin has no spreading areas, but three areas were found to have potential. Together the three areas could spread about 12 400 dam^3 (10,000 ac-ft) per month. Existing distribution and recapture facilities are inadequate and would require additional development to implement either a direct or indirect plan.

Operational and cost data follows:

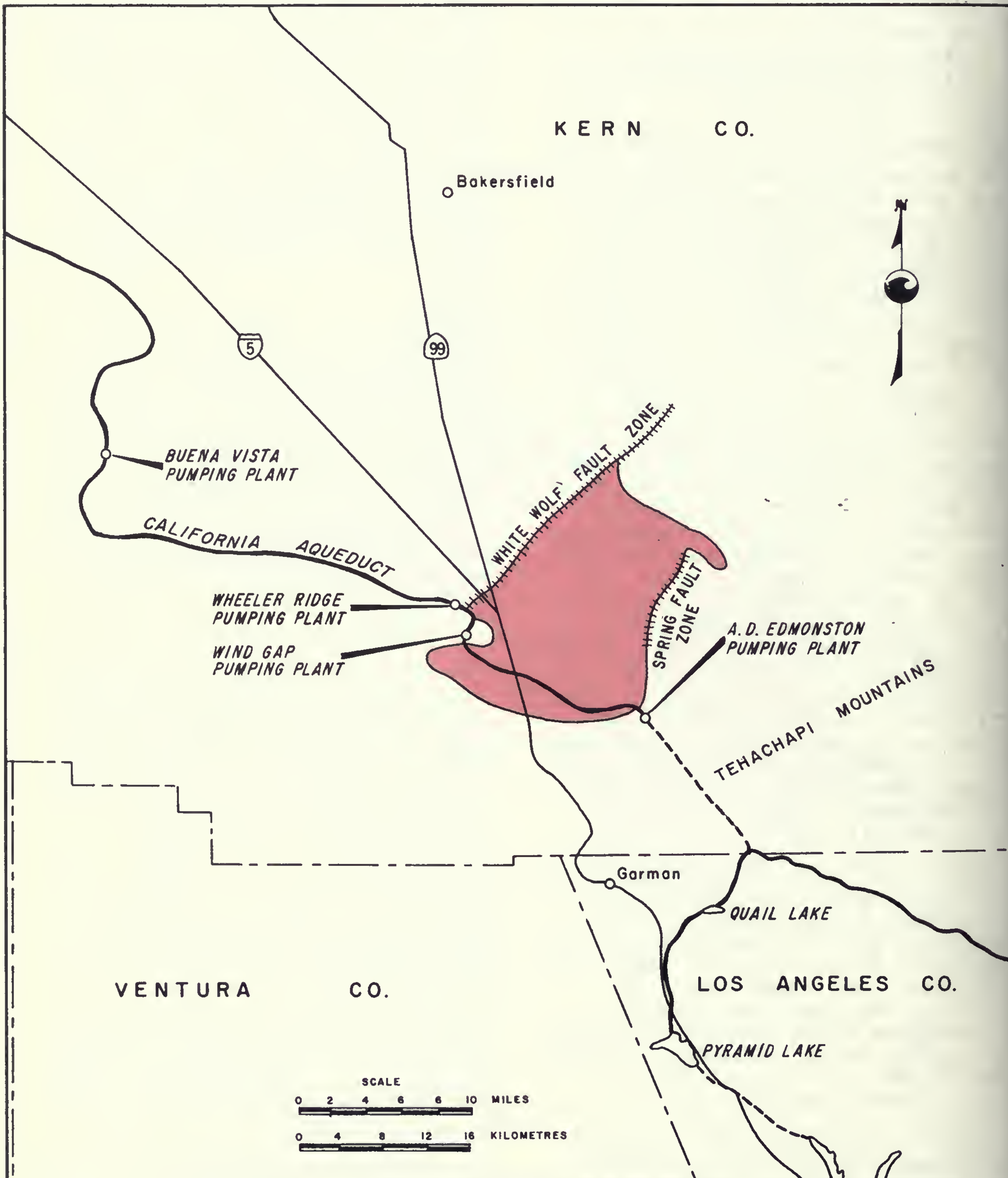
- The basin has the capacity to store approximately 220 000 dam^3 (178,000 ac-ft) of SWP water, if construction of new conveyance, recharge, and recapture facilities were accomplished.
- The average annual dry-period yield would be about 29 600 dam^3 (24,000 ac-ft).

Environmental and Social Considerations

In San Joaquin Valley, a White Wolf ground water storage program could disturb the habitat of the endangered blunt-nosed leopard lizard and the rare San Joaquin kit fox. One rare plant species, the Cotton eriogonum, and one endangered plant species, the Lost Hills saltbrush, occur in Kern County. The potential effects of the storage program on these plant species are unknown.

The construction of distribution and recapture facilities would be necessary in this basin. Potential impacts of this construction were not investigated.

Figure A-11 WHITE WOLF GROUND WATER BASIN



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APPENDIX B

STATE SENATE BILL 200

AND

ASSEMBLY CONSTITUTIONAL AMENDMENT 90

Senate Bill No. 200

CHAPTER 632

An act to amend Section 11460 of, to add Sections 11108, 11109, 11110, 11456, 11457, 11458, and 11915.2 to, to add Article 9.4 (commencing with Section 11255) to Chapter 2 of Part 3 of Division 6 of, the Water Code, relating to water.

[Approved by Governor July 18, 1980. Filed with Secretary of State July 20, 1980.]

LEGISLATIVE COUNSEL'S DIGEST

SB 200, Ayala. Water facilities.

(1) Existing law provides for the design, construction, operation, and maintenance of specified water development facilities by the state. Such facilities include, among others, the facilities specified or authorized as additional facilities in the state Central Valley Project, and specified facilities in the Sacramento-San Joaquin Delta including facilities for transfer of water across the delta, flood and salinity control, and related functions.

This bill would designate as additional facilities of the Central Valley Project, subject to specified conditions, a specified peripheral canal to be built in specified stages, relocation of the intake to the Contra Costa Canal, the Los Vaqueros Unit as described, specified south delta water quality improvement facilities, Suisun Marsh protection facilities as specified, specified facilities for utilizing ground water storage space in specified locations, the Glenn Reservoir-River Diversion Unit as specified, the Colusa Reservoir-River Diversion Unit as specified subject to specified conditions, waste water reclamation programs as specified, water conservation programs as specified, the Mid-Valley Canal as specified, the Western Delta Overland Water Facilities as specified, and facilities to provide for the transportation of water to San Joaquin, San Francisco, San Mateo, Alameda, and Contra Costa Counties as specified.

The bill would provide that construction of the peripheral canal or the Mid-Valley Canal are conditioned upon the Department of Water Resources and the Department of Fish and Game entering into a permanent agreement for the protection of fish and wildlife, as specified. The bill would prohibit the transportation of water for the federal Central Valley Project through state project facilities, including the peripheral canal, with specified exceptions, until the enactment of federal legislation or the Secretary of the Interior entering into a permanent contract with the department which requires operation of the federal Central Valley Project in coordination with the State Water Resources Development System and in compliance with water quality standards and permit and

license conditions adopted by the State Water Resources Control Board, as specified, and in conformity with a permanent agreement between the United States and the state for the protection and enhancement of fish and wildlife, as specified, and until federal agreement to the transportation of water of the federal Central Valley Project through the peripheral canal. The bill would require the department to enter into contracts with specified delta agencies as prescribed and would require differences between the state and such delta agencies, if contracts have not been executed by the effective date of the bill, to be resolved by arbitration in accordance with specified provisions.

The bill would provide that authorizations of the Los Vaqueros, ground water storage, Glenn Reservoir-River Diversion, Colusa Reservoir-River Diversion, and Mid Valley Canal units are conditioned upon completion of specified favorable feasibility reports.

(2) Under existing federal law, before federal authorization of a project and if nonfederal public bodies indicate their intent in writing to administer project land and water areas for recreation and fish and wildlife enhancement, as specified, and to bear not less than one-half the separable costs of the project allocated to such purposes and all of the costs of operation, maintenance, and replacement, the federal project may take into account such benefits in determining the economic benefits of the project, allocate such costs as specified and provide that not over one-half of such separable costs and all joint costs of the project allocated to such enhancement purposes shall be borne by the United States and be nonreimbursable.

The bill would authorize the Secretary of the Resources Agency to make such indication in writing for any federal multiple-purpose water project land and water areas of the Mid-Valley Canal Unit.

(3) Existing law prohibits the Department of Water Resources from depriving a watershed or area wherein water originates, as specified, of the prior right to the water required therein, as specified.

This bill would also require the project to be operated in compliance with water quality standards set forth as conditions in permits or licenses and in water quality control plans, as specified or as established by contract. The bill would require specified state agencies to take all necessary actions to assure that the federal Central Valley Project is operated in compliance with such standards.

The bill would require the costs of benefits in the delta as a result of a project operation, in excess of any detriments caused by the project, to be repaid, to the extent properly allocable, to the department by the beneficiaries and not by the contractors of the project who do not receive those benefits.

The bill would require the department to make an allocation of specified costs to the project to compensate for historic upstream

depletion and diversions, and would specify that public agencies which have contracted for water supplies shall not be responsible for such allocated costs.

(4) The bill would also authorize the Department of Fish and Game, to administer, as specified, a comprehensive study to determine the interrelationship between delta outflow, including flushing flows, and fish and wildlife resources in the San Francisco Bay System westerly of the delta and waste discharges into the San Francisco Bay System. The bill would require the Department of Water Resources to study the possible interconnection between the State Water Resources Development System and water supply systems serving the Counties of Alameda, Contra Costa, San Francisco, San Joaquin, and San Mateo. The bill would also authorize the department to participate in an investigation of the need to enlarge Shasta Dam and Reservoir or other existing federal reservoirs.

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

SECTION 1. Section 11108 is added to the Water Code, to read:

11108. "Delta" means the Sacramento-San Joaquin Delta as described in Section 12220.

SEC. 2. Section 11109 is added to the Water Code, to read:

11109. "Suisun Marsh" means the area defined in Section 29101 of the Public Resources Code.

SEC. 3. Section 11110 is added to the Water Code, to read:

11110. "Historical level" means the average annual abundance from 1922 through 1967 of the adult populations of fish and wildlife estimated to have lived in or been dependent on any area, as determined by the Department of Fish and Game.

SEC. 4. Article 9.4 (commencing with Section 11255) is added to Chapter 2 of Part 3 of Division 6 of the Water Code, to read:

Article 9.4. Additional Facilities and Programs

11255. The project includes the units authorized in this section, subject to the conditions specified in Sections 11256 and 11257, and in compliance with the California Environmental Quality Act (commencing with Section 21000 of the Public Resources Code) and which may be constructed, operated, and financed as joint-use facilities with the United States:

(a) A peripheral canal unit, around the eastern and southern rim of the delta. This unit shall be designed, constructed, and operated to meet the provisions of this part in the most effective manner, and shall consist of canals, pumping plants, intake and outlet structures, siphons and fish screens. The department shall design and construct the unit so as to optimize its usefulness for the protection of the resources of the delta and the augmentation of water supplies. The

department may provide for joint use or delivery of water from the unit with local agencies or with the United States upon the execution of agreements with local agencies or with the United States concerning operation, financing, and sharing of benefits of the unit. This unit shall be constructed in three stages, with the work on the first and second stages proceeding concurrently. Stage one shall consist of construction of the facility from the town of Hood to Shima Tract on the northwest outskirt of Stockton. Stage two shall consist of preconsolidation from the San Joaquin River to Clifton Court Forebay of the California Aqueduct. Stage three shall consist of the completion of the facilities from Shima Tract to Clifton Court Forebay. When stage one is completed, it shall be operated for a period of two years to establish adequate fish screen and operational criteria. Thereafter, stage three shall be constructed when the Director of Water Resources and the Director of Fish and Game both determine from the results of the trial period that the fish screen and operational criteria will adequately protect fish populations. The state water facilities referred to in paragraph (3) of subdivision (d) of Section 12934 are defined to include this unit.

(b) Relocation of the intake to the Contra Costa Canal to divert water from the state water facilities, subject to the terms of a contract between the department and beneficiaries.

(c) The Los Vaqueros unit, to be located in eastern Contra Costa County about eight miles west of the Clifton Court Forebay. Other offstream storage reservoirs may be located south or west of the delta, as determined by the Director of Water Resources, to be served by existing project facilities.

(d) South delta water quality improvement facilities, consisting of pumping plants, discharge canals, flow control structures, and channelization of sloughs to provide improved circulation, distribution, and quality of water in the southeastern delta and to meet the needs of the south delta area, to be completed no later than the facility described in subdivision (a) of this section. Such facilities may include a turnout from the California Aqueduct to the Westley Wasteway of the federal Delta-Mendota Canal or other facilities to deliver water to the San Joaquin River or in lieu thereof the director may agree with the Bureau of Reclamation to exchange equivalent water between the Delta-Mendota Canal and the California Aqueduct. The portion of the facilities not integrally connected with the facility described in subdivision (a) of this section, or its operation, shall be constructed only if a contract between an appropriate agency representing the beneficiaries and the department is executed.

(e) As mitigation for the past, present, and future adverse impacts of reduced delta outflows on the wildlife resources of the Suisun Marsh, the department shall construct, maintain, and operate or contract with the Suisun Resources Conservation District for the construction, maintenance, or operation of the Suisun Marsh overall protection facilities in accordance with a plan to be developed by the department in cooperation with the Suisun Resources Conservation District and the Department of Fish and Game. The facilities shall be completed no later than stage one of the facilities described in subdivision (a) of this section.

(f) Facilities for utilizing ground water storage space determined by the director to be feasible for the purpose of providing yield for the State Water Resources Development System based upon estimates by the department that ground water storage can yield 400,000 acre-feet annually, in conjunction with existing and future surface water supplies, by the recharge and extraction of ground water and including the capitalized cost of delivering water for filling or refilling ground water storage space, in one or more of the following locations within the service area of the State Water Resources Development System:

(1) The south San Francisco Bay area in the Counties of Santa Clara and Alameda, served by the South Bay Aqueduct.

(2) San Joaquin Valley, served by the California Aqueduct.

(3) Southern California, served by the California Aqueduct, including enlargement of the Devil Canyon Power Plant and the Mojave Division (East Branch) from the proposed Cottonwood Power Plant to Silverwood Lake.

None of the facilities described in this subdivision shall be constructed or operated within the boundaries of an agency that has contracted for water from the State Water Resources Development System without a contract with such agency.

(g) Glenn Reservoir-River Diversion Unit on the west side of the Sacramento Valley in the vicinity of Stony Creek and Thomes Creek watersheds. This unit may be constructed in stages.

(h) If the Glenn Reservoir-River Diversion Unit authorized in subdivision (g) is not feasible, as determined by the Director of Water Resources, the Colusa Reservoir-River Diversion Unit on the west side of the Sacramento Valley in the western portion of the Counties of Glenn and Colusa. This unit may be constructed in stages. The Sites Reservoir portion of the unit may be developed at any time hereafter by the federal government as a facility of the federal Central Valley Project to serve the Tehama-Colusa Canal and any extension thereof into Yolo and Solano Counties.

(i) Waste water reclamation programs to provide yield for the State Water Resources Development System, provided such facilities are economically competitive with alternative new water supply sources. None of the facilities described in this subdivision shall be constructed or operated within the boundaries of any agency that has contracted for water from the State Water Resources Development System without a contract with such agency.

(j) Water conservation programs within the boundaries of agencies that have contracted for water from the State Water Resources Development System, provided, that the implementation

of such programs is contingent upon contracts between such agencies and the Department of Water Resources. Based on estimates of the department, waste water reclamation and water conservation in urban areas served by the State Water Resources Development System are projected to total 700,000 acre-feet annually by year 2000.

(k) The Mid-Valley Canal Unit, which shall be constructed primarily for the purpose of alleviating the ground water overdraft and providing water supplies for the state and federal water fowl management areas in the canal service area; provided, that the water delivered through its facilities shall be water developed by facilities other than those of the project, and provided further, that such water shall be transported through the facilities described in subdivision (a) of this section and, provided further, that the full cost of the unit incurred by the state and allocated to agricultural, municipal, and industrial contractors shall be repaid by them.

The Secretary of the Resources Agency is authorized to indicate in writing the state's intent to agree to administer any federal multiple-purpose water project land and water areas of the Mid-Valley Canal Unit for recreation and fish and wildlife enhancement as provided in Public Law 89-72 if constructed by the United States.

(*l*) Western Delta Overland Water Facilities, to supply water to agricultural areas on Sherman Island, Jersey Island, Hotchkiss Tract, and adjacent areas.

(m) (1) Facilities to provide for the transportation of water to termini to serve the Counties of San Joaquin, San Francisco, and San Mateo.

(2) Facilities to provide for the transportation of a supplemental water supply to areas in Alameda and Contra Costa Counties not served through the Contra Costa Canal or the South Bay Aqueduct, provided that the water to be delivered shall be water developed by facilities of the federal Central Valley Project.

11256. (a) Construction of the facilities described in subdivision (a) or (k) of Section 11255 shall commence only if the department enters into a permanent agreement with the Department of Fish and Game for the protection and enhancement of fish and wildlife which shall provide for the following:

(1) The restoration and maintenance of adult populations of fish and wildlife at historical levels in the delta and the Suisun Marsh and the San Francisco Bay system westerly of the delta. Maintenance at historical levels shall consider natural fluctuations in annual water supply and populations of fish and wildlife. The agreement shall include those limitations on exports and diversions to storage which are necessary to restoring and maintaining historical levels of fish and wildlife.

To the extent practicable, fresh water needed to restore and maintain fish and wildlife in the San Franciso Bay System westerly

of the delta shall be provided from unregulated flows, and

(2) The realization of the potential of the project for increasing these resources above the levels in paragraph (1) consistent with the contracts for water delivery and with other purposes of the projects.

(b) The department shall immediately proceed with activities prerequisite to the construction of the facilities provided for in subdivision (a) of Section 11255 and shall complete the design and commence construction as soon as possible.

11257. The authorizations contained in subdivisions (c), (f), (g), (h), and (k) of Section 11255 are conditional upon the completion of engineering, economic, environmental, and financial feasibility reports found favorable by the Director of Water Resources.

Each financial feasibility report shall contain:

(a) An initial allocation of project costs to project purposes.

(b) The proposed method of financing.

(c) An estimate of the method of repayment.

(d) A designation of the water and power contractors that are proposed to repay the allocated reimbursable water development costs, including interest if any, on upstream storage, conveyance, operations, maintenance, and replacement.

(e) An estimate of the impact upon retail water prices in the various service areas of the project.

11258. The environmental impact report on the peripheral canal shall include a discussion of the sources of the mineral, nutrient, and biological components of the Sacramento River and shall evaluate the possible impacts to such components resulting from the operation of the proposed peripheral canal.

If the department determines that there will be significant adverse mineral, nutrient, or biological effects caused by the operation of the peripheral canal, the department shall:

(a) Evaluate mitigation measures in the environmental impact report.

(b) Propose cost allocation principles for the mitigation.

(c) Prepare trial cost allocation.

To the extent practicable, the department shall mitigate adverse impacts upon mineral, nutrient, or biological effects caused by the operation of the canal.

SEC. 5. Section 11456 is added to the Water Code, to read:

11456. The department shall enter into permanent and enforceable contracts, with the delta agencies specified in this section, for the purpose of recognizing the right of users to make use of the waters of the delta and establishing criteria for the minimum quality of water which shall prevail within the delta before water may be exported therefrom, such quality to be adequate to permit the preservation of present delta agricultural, domestic, and environmental uses, all as provided in Part 4.5 (commencing with Section 12200) of this division. Such contracts shall provide for reasonable payment to be made for any benefits which may be

received through the water supply or quality provided in such contracts in excess of that which would have been available in absence of the operations by the State Water Resources Development System and by the federal Central Valley Project, and offset by any detriments caused thereby. If contracts have not been executed by the effective date of this section, differences between the state and such agencies shall be resolved by arbitration upon the written request of either party to the proposed contract identifying the issues upon which arbitration shall be held, which arbitration shall be conducted in accordance with Title 9 (commencing with Section 1280) of Part 3 of the Code of Civil Procedure. The agencies with which such contracts shall be entered into are the following:

(a) North Delta Water Agency.

(b) Central Delta Water Agency.

(c) South Delta Water Agency.

(d) East Contra Costa Irrigation District.

(e) Byron-Bethany Irrigation District.

(f) Contra Costa County Water Agency.

(g) Contra Costa County Water District.

(h) Suisun Resource Conservation District.

When binding determinations have been made involving two-thirds of the total acreage within the delta and Suisun Marsh located within the foregoing agencies, the department or the remaining agencies may withdraw from the arbitration proceedings. The provisions of this section shall not supersede any requirement for elections to approve such contracts, reached by negotiation or arbitration, as may be required by the act authorizing creation of the agency.

SEC. 6. Section 11457 is added to the Water Code, to read:

11457. The costs of providing any benefits received by agricultural, municipal, and industrial water users in the delta as a result of project operations, in excess of any detriments caused thereby, shall, to the extent properly allocable be repayable to the department by the beneficiaries. The costs of providing such benefits shall not be reimbursable by any State Water Resources Development System water service contractor who does not receive those benefits.

SEC. 7. Section 11458 is added to the Water Code, to read:

11458. (a) Except as provided for in subdivision (b) of this section, the department shall not transport water for the federal Central Valley Project through project facilities, including the peripheral canal, until the following events occur:

(1) The Congress of the United States enacts legislation or the Secretary of the Interior enters into a permanent contract with the department which requires operation of the federal Central Valley Project:

(A) In full coordination with the State Water Resources Development System and in compliance with water quality standards adopted pursuant to Section 13170 and as set forth as conditions in permits and licenses as provided for in Part 2 (commencing with Section 1200) of Division 2; provided, that actions of the State Water Resources Control Board in establishing water quality standards and conditions in permits and licenses shall be a combined action meeting all the applicable requirements of Part 2 (commencing with Section 1200) of Division 2.

(B) In conformity with a permanent agreement between the United States and the state for the protection and enhancement of fish and wildlife which shall provide for the following:

(i) The restoration and maintenance of adult populations of fish and wildlife at historical levels in the delta and the Suisun Marsh and the San Francisco Bay System westerly of the delta. Maintenance at historical levels shall consider natural fluctuations in annual water supply and populations of fish and wildlife. The agreement shall include those limitations on exports and diversions to storage which are necessary to assist in restoring and maintaining historical levels of fish and wildlife.

To the extent practicable, fresh water needed to restore and maintain fish and wildlife in the San Francisco Bay System westerly of the delta shall be provided from unregulated flows: and

(ii) The realization of the potential of the project for increasing these resources above the levels in paragraph (i), consistent with the contracts for water delivery and with other purposes of the projects.

(2) The federal government agrees to the transportation of water of the federal Central Valley Project through the facilities described in subdivision (a) of Section 11255.

(b) The department may transport water for the federal Central Valley Project through project facilities: (1) under contracts between the department and the United States existing on the effective date of this section, (2) and in accordance with the requirements of any decision of the State Water Resources Control Board, and (3) for the San Felipe Unit of the federal Central Valley Project in implementation of the principles of the agreement between the department and the Santa Clara Valley Water District as follows: if operation of the federal Central Valley Project to meet delta water quality standards requires proportionate reduction in deliveries of water to the San Felipe Unit, such reductions will be made.

SEC. 8. Section 11460 of the Water Code is amended to read:

11460. (a) In the construction and operation by the department of any project under the provisions of this part a watershed or area wherein water originates, or an area immediately adjacent thereto which can conveniently be supplied with water therefrom, shall not be deprived by the department directly or indirectly of the prior right to all of the water reasonably required to adequately supply the beneficial needs of the watershed, area, or any of the inhabitants or property owners therein.

(b) The project shall be operated in compliance with water quality standards set forth as conditions in permits or licenses as provided for in Part 2 (commencing with Section 1200) of Division 2 and in water quality control plans as provided for in Section 13170 or as established by contract, including rectifying failure of the United States to operate the federal Central Valley Project in accordance with such standards; provided that actions of the State Water Resources Control Board in establishing water quality standards and conditions in permits and licenses shall be a combined action meeting all the applicable requirements of Part 2 (commencing with Section 1200) of Division 2.

(c) The department, the Attorney General, and other state agencies shall take all necessary actions, including initiating or participating in judicial, administrative, and legislative proceedings, to assure that the federal Central Valley Project is operated in compliance with standards established by the State Water Resources Control Board as specified in subparagraph (A) of paragraph (1) of subdivision (a) of Section 11458.

SEC. 9. Section 11915.2 is added to the Water Code, to read:

11915.2. The department shall make an allocation of the costs to the project which provide water for water quality, fish and wildlife, and recreation in the delta, Suisun Marsh, or San Francisco Bay, to compensate for historic upstream depletions and diversions which have reduced the amount of water naturally available in the delta, Suisun Marsh, and San Francisco Bay. Public agencies that have contracted for water supplies from the project shall not be responsible for such allocated costs.

SEC. 10. (a) The Department of Fish and Game is authorized to administer a comprehensive study to determine the interrelationship between delta outflow, including flushing flows, and fish and wildlife resources in the San Francisco Bay System westerly of the delta and waste discharges into the San Francisco Bay System. The State Water Resources Control Board shall be responsible for the portions of the study relating to waste discharges. Such study and the work plan for it shall be reviewed by a committee composed of representatives of the San Francisco Bay Conservation and Development Commission, the State Water Resources Control Board, and the Department of Water Resources. The Department of Fish and Game shall report progress on such study annually to the Legislature. Such report shall include recommendations for coordination with any other ongoing related study and for adjustment in funding and the report shall include independent statements of review from each agency on the review committee.

(b) The primary purpose of the study is to provide data to aid the State Water Resources Control Board in its consideration of the need to set standards to protect San Francisco Bay to assure that planning for future projects will not appreciably reduce unregulated delta outflows before the State Water Resources Control Board

determines the need for water quality standards to protect the San Francisco Bay System westerly of the delta.

(c) The study need not be completed before the final environmental impact report on the peripheral canal authorized by subdivision (a) of Section 11255 of the Water Code is adopted.

(d) Nothing in this section shall affect the obligation of the Department of Water Resources under the California Environmental Quality Act (Division 13 (commencing with Section 21000) of the Public Resources Code).

SEC. 11. The Department of Water Resources shall study the possible interconnection between the State Water Resources Development System and water supply systems serving the Counties of Alameda, Contra Costa, San Francisco, San Joaquin, and San Mateo.

SEC. 12. The Department of Water Resources may participate in an investigation of the need to enlarge Shasta Dam and Reservoir or other existing federal reservoirs for joint use of the State Water Resources Development System and the federal Central Valley Project, if a contract therefor is executed between the Secretary of the Interior and the Department of Water Resources. The study shall be subject to the provisions of Section 11257 of the Water Code.

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RESOLUTION CHAPTER 49

Assembly Constitutional Amendment No. 90—A resolution to propose to the people of the State of California an amendment to the Constitution of the state, by adding Article X A, relating to water.

[Filed with Secretary of State June 26, 1980]

LEGISLATIVE COUNSEL'S DIGEST

ACA 90, Kapiloff. Water resources development.

The California Water Resources Development Bond Act, which was approved by the voters in 1960, provided for the issuance of $1,750,000,000 in general obligation bonds to help finance the immediate construction of specified water facilities, as part of a State Water Resources Development System, including a multiple-purpose dam and reservoir on the Feather River in the vicinity of Oroville and an aqueduct system for the transportation of water to various parts of the state. Existing law provides for the design, construction, operation, and maintenance of additional water development facilities by the state as part of the State Water Resources Development System.

This measure would provide that no statute amending or repealing, or adding to, specified provisions enacted by SB 200 of the 1979–80 Regular Session of the Legislature relating to the protection of fish and wildlife resources in the Sacramento-San Joaquin Delta, Suisun Marsh, and San Francisco Bay system westerly of the delta, the protection of existing water rights in the delta, and compliance with water quality standards and water quality control plans by the State Water Resources Development System shall become effective unless approved by the electors in the same manner as initiative statutes are approved, except that the Legislature may amend such provisions by ⅔ vote if the statute does not in any manner reduce the protection of the delta or fish and wildlife. The measure would make related findings.

The measure would specify that no water shall be available for appropriation by storage in, or by direct diversion from, any of the components of the California Wild and Scenic Rivers System, as such system exists on January 1, 1981, where such appropriation is for export of water into another major hydrologic basin of the state as defined in Department of Water Resources Bulletin 160-74, unless such export is expressly authorized by an initiative statute approved by the electors or a ⅔ vote of the Legislature prior to such appropriation.

The measure would provide that no statute amending, or adding to, or repealing specified provisions of the Water Code relating to protection of the Sacramento-San Joaquin Delta shall become

effective unless approved by the electors in the same manner as initiative statutes are approved, except that the Legislature may amend such provisions by a ⅔ vote if the statute does not in any manner reduce the protection of the delta or fish and wildlife.

The measure would prohibit any public agency from utilizing eminent domain proceedings to acquire water rights, which are held for uses within the Sacramento-San Joaquin Delta, or any contract rights for water or water quality maintenance in the delta, for the purpose of exporting such water from the delta.

The measure would, with respect to specified actions or proceedings arising under SB 200 of the 1979–80 Regular Session or actions which would have the effect of attacking, reviewing, preventing, or substantially delaying construction of the peripheral canal, require venue in any superior court action to be in Sacramento County, provide for Sacramento County to be reimbursed for actual costs imposed by such requirements, require such actions to be brought within specified periods, require such actions to be given preference over other civil actions and proceedings and for the hearing to be commenced within a specified period, prescribe a remedy for certain of such actions, and would require the Supreme Court, in accordance with prescribed requirements, to transfer to itself before a decision in the court of appeal of any appeal or petition for extraordinary relief from any such action, unless the Supreme Court determines that the action is unlikely to substantially affect specified matters.

The measure would require state agencies to exercise their authorized powers in a manner consistent with the protections provided by the measure.

The measure would have no force or effect unless SB 200 of the 1979–80 Regular Session is chaptered and takes effect.

Resolved by the Assembly, the Senate concurring, That the Legislature of the State of California at its 1979–80 Regular Session commencing on the fourth day of December, 1978, two-thirds of the members elected to each of the two houses of the Legislature voting therefor, hereby proposes to the people of the State of California that the Constitution of the state be amended, by adding Article X A thereto, to read:

Article X A

Water Resources Development

SECTION 1. The people of the State hereby provide the following guarantees and protections in this article for water rights, water quality, and fish and wildlife resources.

SEC. 2. No statute amending or repealing, or adding to, the provisions of the statute enacted by Senate Bill No. 200 of the 1979–80

Regular Session of the Legislature which specify (1) the manner in which the State will protect fish and wildlife resources in the Sacramento-San Joaquin Delta, Suisun Marsh, and San Francisco Bay system westerly of the delta; (2) the manner in which the State will protect existing water rights in the Sacramento-San Joaquin Delta; and (3) the manner in which the State will operate the State Water Resources Development System to comply with water quality standards and water quality control plans, shall become effective unless approved by the electors in the same manner as statutes amending initiative statutes are approved; except that the Legislature may, by statute passed in each house by roll call vote entered in the journal, two-thirds of the membership concurring, amend or repeal, or add to, these provisions if the statute does not in any manner reduce the protection of the delta or fish and wildlife.

SEC. 3. No water shall be available for appropriation by storage in, or by direct diversion from, any of the components of the California Wild and Scenic Rivers System, as such system exists on January 1, 1981, where such appropriation is for export of water into another major hydrologic basin of the state, as defined in the Department of Water Resources Bulletin 160-74, unless such export is expressly authorized prior to such appropriation by: (a) an initiative statute approved by the electors, or (b) the Legislature, by statute passed in each house by roll call vote entered in the journal, two-thirds of the membership concurring.

SEC. 4. No statute amending or repealing, or adding to, the provisions of Part 4.5 (commencing with Section 12200) of Division 6 of the Water Code (the Delta Protection Act) shall become effective unless approved by the electors in the same manner as statutes amending initiative statutes are approved; except that the Legislature may, by statute passed in each house by roll call vote entered in the journal, two-thirds of the membership concurring, amend or repeal, or add to, these provisions if the statute does not in any manner reduce the protection of the delta or fish and wildlife.

SEC. 5. No public agency may utilize eminent domain proceedings to acquire water rights, which are held for uses within the Sacramento-San Joaquin Delta as defined in Section 12220 of the Water Code, or any contract rights for water or water quality maintenance in the Delta for the purpose of exporting such water from the Delta. This provision shall not be construed to prohibit the utilization of eminent domain proceedings for the purpose of acquiring land or any other rights necessary for the construction of water facilities, including, but not limited to, facilities authorized in Chapter 8 (commencing with Section 12930) of Part 6 of Division 6 of the Water Code.

SEC. 6. (a) The venue of any of the following actions or proceedings brought in a superior court shall be Sacramento County:

(1) An action or proceeding to attack, review, set aside, void, or annul any provision of the statute enacted by Senate Bill No. 200 of

the 1979–80 Regular Session of the Legislature.

(2) An action or proceeding to attack, review, set aside, void, or annul the determination made by the Director of Water Resources and the Director of Fish and Game pursuant to subdivision (a) of Section 11255 of the Water Code.

(3) An action or proceeding which would have the effect of attacking, reviewing, preventing, or substantially delaying the construction, operation, or maintenance of the peripheral canal unit described in subdivision (a) of Section 11255 of the Water Code.

(4) An action or proceeding to require the State Water Resources Development System to comply with subdivision (b) of Section 11460 of the Water Code.

(5) An action or proceeding to require the Department of Water Resources or its successor agency to comply with the permanent agreement specified in subdivision (a) of Section 11256 of the Water Code.

(6) An action or proceeding to require the Department of Water Resources or its successor agency to comply with the provisions of the contracts entered into pursuant to Section 11456 of the Water Code.

(b) An action or proceeding described in paragraph (1) of subdivision (a) shall be commenced within one year after the effective date of the statute enacted by Senate Bill No. 200 of the 1979–80 Regular Session of the Legislature. Any other action or proceeding described in subdivision (a) shall be commenced within one year after the cause of action arises unless a shorter period is otherwise provided by statute.

(c) The superior court or a court of appeals shall give preference to the actions or proceedings described in this section over all civil actions or proceedings pending in the court. The superior court shall commence hearing any such action or proceeding within six months after the commencement of the action or proceeding, provided that any such hearing may be delayed by joint stipulation of the parties or at the discretion of the court for good cause shown. The provisions of this section shall supersede any provisions of law requiring courts to give preference to other civil actions or proceedings. The provisions of this subdivision may be enforced by mandamus.

(d) The Supreme Court shall, upon the request of any party, transfer to itself, before a decision in the court of appeal, any appeal or petition for extraordinary relief from an action or proceeding described in this section, unless the Supreme Court determines that the action or proceeding is unlikely to substantially affect (1) the construction, operation, or maintenance of the peripheral canal unit described in subdivision (a) of Section 11255 of the Water Code, (2) compliance with subdivision (b) of Section 11460 of the Water Code, (3) compliance with the permanent agreement specified in Section 11256 of the Water Code, or (4) compliance with the provisions of the contracts entered into pursuant to Section 11456 of the Water Code. The request for transfer shall receive preference on the Supreme Court's calendar. If the action or proceeding is transferred to the Supreme Court, the Supreme Court shall commence to hear the matter within six months of the transfer unless the parties by joint stipulation request additional time or the court, for good cause shown, grants additional time.

(e) The remedy prescribed by the court for an action or proceeding described in paragraph (4), (5), or (6) of subdivision (a) shall include, but need not be limited to, compliance with subdivision (b) of Section 11460 of the Water Code, the permanent agreement specified in Section 11256 of the Water Code, or the provisions of the contracts entered into pursuant to Section 11456 of the Water Code.

(f) The Board of Supervisors of the County of Sacramento may apply to the State Board of Control for actual costs imposed by the requirements of this section upon the county, and the State Board of Control shall pay such actual costs.

(g) Notwithstanding the provisions of this section, nothing in this Article shall be construed as prohibiting the Supreme Court from exercising the transfer authority contained in Article VI, Section 12 of the Constitution.

SEC. 7. State agencies shall exercise their authorized powers in a manner consistent with the protections provided by this article.

SEC. 8. This article shall have no force or effect unless Senate Bill No. 200 of the 1979–80 Regular Session of the Legislature is enacted and takes effect.

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APPENDIX C

GUIDELINES ON FUNDING LOCAL WATER SUPPLY PROJECTS FOR INCLUSION IN THE STATE WATER PROJECT

GUIDELINES ON FUNDING LOCAL WATER SUPPLY PROJECTS FOR INCLUSION IN THE STATE WATER PROJECT

I. INTRODUCTION

This report is designed to serve as a guide for local agencies, the Water Service Contractors, and the Department in regarding construction of local water supply projects as a part of the State Water Project (SWP).

Environmental, energy, and cost considerations have made it necessary for the Department to investigate new sources of water for the State Water Resources Development System (which includes the SWP) as alternatives or additions to those water supply sources previously considered in planning for future development of the SWP. "Local water supply projects" would become units of the SWP and include dams, reservoirs, reclamation projects, and ground water storage projects. Several ground water basins in Southern California are currently being studied.

The Department is currently studying additional storage projects to provide substantial amounts of project yield. However, smaller local projects should also be considered to provide project yield and decrease project energy requirements by minimizing the need for transporting water over long distances to the service areas.

A. Local water supply projects as units of SWP

The Department has the authority to add units to the SWP which are consistent with, and which may be constructed, maintained, and operated as a part of and in furtherance of, the objectives of the SWP (Water Code Section 11290). A local water supply project may be constructed to provide project yield. Water from a local water supply project may be furnished to a project contractor either directly or by water exchange. A local water supply project will be designated a unit of the SWP, if it is feasible on an engineering and financial basis, economically justified, environmentally sound, and competitive with other water supply alternatives.

Local water supply units of the SWP may be financed by Central Valley Project revenue bonds. The costs of designated water supply projects are to be included in the Delta Water Charge.

Local agencies within the SWP service areas are encouraged to develop and to propose projects to the Department. The Department will study those local water supply projects which respective agencies request that we undertake separately or together, and those projects which DWR feels should be investigated for possible units of SWP, but which local agencies are unable or unwilling to undertake. The Department will analyze proposed projects for technical, economic, and financial feasibility. If added to the SWP, a project will be operated as a part of the SWP, although the joint operation with a local agency may be possible.

B. SWP Contractor Role

The Department is committed to providing water supplies as provided in State Water Project contracts.

In the implementation of the SWP, the Department has discretion to determine the most economical and environmentally appropriate measures to provide water supplies for the SWP.

The SWP contractors collectively are the beneficiaries of new dependable supplies provided by "local water supply projects" designated units of the SWP, whether they are (1) facilities to increase the water supplies available for delivery through existing facilities of the SWP; or (2) facilities located within the service areas of the SWP contractors which provide supplies in those service area(s), in lieu of deliveries from other conservation or transportation facilities of the SWP.

II. PROJECT YIELD

A. The local project must provide a yield to the SWP service area within the annual 4.23 million acre-feet Project yield.

The "minimum project yield" as set forth in Article 1-K of the Standard Provisions for Water Supply Contract establishes 4.23 million acre-feet as the dependable annual supply of water to be made available from the SWP (subject to deficiencies in times of drought), and contracted for SWP contractors. This yield is to be produced by a combination of initial project conservation facilities and additional project conservation facilities that may include certain "local water supply projects" designated units of the SWP.

The "minimum project yield" establishes a limit on the number of such projects. The annual entitlements of each water contractor are contained in Table A of the water supply contracts. When the combined yield of the initial project conservation facilities and the additional project conservation facilities is equivalent to the "minimum project yield", the SWP will be considered complete, and no further additions will be authorized, except to provide water to replace additional depletions upstream from and within the Delta. Project yield developed in SWP service areas will result in reduced diversions from the Sacramento-San Joaquin Delta.

B. The water supply developed by a local water supply project must be new, dependable, and of adequate quantity and quality to serve the intended beneficial uses.

"New" water is that portion of stream flows, return flows, ground water, and treated waste water not now being recovered for any beneficial use. The water supply developed by the project must increase the amount of water available to meet beneficial uses in the SWP service area. This can be determined by an analysis of water supply, uses, and disposal, with and without the project.

If the project is to be relied on as a primary source of supply, then the dependable life of the new water supply projects must be at least 30 years (particularly for water reclamation projects), and preferably as long as the terms of the water contracts (particularly for surface water storage projects).

Projects as small as 100 acre-feet per year (particularly water reclamation projects) may be considered, as long as the unit cost of their development and the contract- administration costs compare favorably with other potential increments of supply to the SWP. However, priority will be given to those projects that develop 1,000 acre-feet per year or more.

The local water supply project is to fulfill a demand that otherwise would be met by SWP, either directly or by exchange.

The quality of any new or exchanged water must be suitable for the intended beneficial uses to be served by the local water supply project.

III. FINANCING AND REPAYMENT

The Department has determined that eligible local projects added to the SWP may be financed by sale of Central Valley Project revenue bonds. Additional financing could be obtained for eligible waste water reclamation projects under the Clean Water Grant Program. In some cases, local participation in financing the construction of a selected project may be required.

Water supply contracts provide for payment of two charges: (1) Delta Water

Charge (Article 22), and (2) A Transportation Charge (Article 23). Repayment of reimbursable costs of local water supply projects will comply with the water supply contracts and will include these two charges.

The following section presents a discussion of eligible projects, construction costs to be included in Delta Water Charge, Transportation Costs, and waste water reclamation project financing.

A. Eligible Projects

A "local water supply project", including a water reclamation project or a ground water storage project, may be constructed, maintained, and operated as an authorized water conservation facility in furtherance of the objectives of the SWP. Projects will be designated units of the SWP on a case-by-case basis.

Projects may be constructed and operated (1) by SWP, (2) as a joint SWP-Federal project, or (3) as a joint State-local agency project.

Before a local agency could construct and operate an eligible joint project with SWP financing, a contract will be required.

In requesting Department consideration of a local water supply project, the local agency must submit a formal request, accompanied by a report containing the results of a short conceptual study of the engineering, economic, and environmental feasibility of the project.

Once it has been determined that a project meets these guidelines, the Department may undertake a detailed feasibility investigation of those local water supply projects that appear to be feasible.

B. Costs to construct the water conservation facilities of a local project will become a part of the Delta Water Charge.

The reimbursable costs of construction, operation, maintenance, and replacement of the conservation facilities of eligible local water supply projects shall be included in the Delta Water Charge. This may require an amendment of the water supply contracts.

C. Transportation costs are to be considered separately for each project.

The reimbursable cost of construction, operation, maintenance, and replacement of the transportation facilities of local water supply projects designated units of the SWP shall be included in the Transportation Charge and are to be paid by each contractor entitled to delivery of water from the project. An amendment to each affected contract will be required. Transportation Charges are to be considered separately for each eligible water supply project.

Local transportation facilities which are parts of local water supply projects designated as units of the SWP may be constructed in lieu of currently planned project transportation facilities of the SWP, but they are to be repaid by the local SWP contractors under their transportation charge.

D. Waste Water Reclamation Projects could be included under SWRCB's 201 Clean Water Grant Program for funding.

Local agencies and State agencies, including the Department of Water Resources (DWR), can qualify for a grant for waste water reclamation projects included within the State Water Resources Control Board's (SWRCB's) Clean Water Grant Program. The SWRCB can fund waste water reclamation projects that provide water quality enhancement and that also (1) provide new sources of water, (2) replace an existing water supply so that it can be used for a higher use, or (3) prevent the discharge of suitable quality waste water to saline water. Under this concept, local agencies and DWR could be eligible for a 75-percent grant from U. S. Environmental Protection Agency and 12-1/2 percent from SWRCB's Clean Water Bond Fund. Also, DWR can supply the required 12-1/2 percent of local funding for a project to be constructed and operated by the local agency under a SWP contract defining joint operation, providing these funds are reimbursed under the Delta Water Charge.

IV. FEASIBILITY

The DWR will make feasibility studies of local water supply projects designated as units of the SWP.

A. Local projects must be feasible on an engineering and financial basis, economically justified, and environmentally sound.

A proposed project is engineeringly feasible when it can be designed, constructed, and operated to accomplish the purposes for which it is planned, and when it is planned in accordance with accepted engineering principles and concepts. In this respect, sound hydrologic studies, as well as information on water quality and the adequacy of the source, are basic to determination of engineering feasibility.

A proposed project is economically justified if it is competitive with alternative sources, considering the total economic and environmental costs.

A proposed project is financially feasible if sufficient funds can be made available to complete the project, and if sufficient annual revenues can be obtained to repay the reimbursable costs, operate the project, and provide for replacement.

A project is environmentally sound if it (1) has been designed to enhance the environment, if possible, and (2) contains measures to mitigate any unavoidable adverse effects on the environment.

B. Environmental and institutional constraints must be evaluated.

In determining the feasibility of local water supply projects, environmental considerations will be evaluated for soundness. Evaluation of health requirements, problems, and criteria will be incorporated in the feasibility analysis.

Evaluations of energy use in a local water supply project will be based on the total system of which the local project is a part. It should include an analysis of the energy required to store, pump, treat, and transport water to the point of use.

V. SUMMARY

The following is a summary of the guidelines on funding water reclamation, ground water storage, and other local water supply projects for inclusion in the SWP:

1. SWP contractors must be involved.

2. The local project must provide a water supply within the annual 4.23 million acre-feet Project yield.

3. The water supply developed by the project must be new, dependable, and of adequate quantity and quality to serve the intended beneficial uses.

4. Costs to construct water conservation facilities of a local project will become a part of the Delta Water Charge.

5. Transportation costs are to be considered separately for each project.

6. Waste Water Reclamation Projects could be included under SWRCB's Clean Water Grant Program for funding.

7. Local projects must be feasible on an engineering and financial basis, economically justified, and environmentally sound.

APPENDIX D

GOVERNOR'S EXECUTIVE ORDER B-68-80

Executive Department
State of California

EXECUTIVE ORDER B-68-80

WHEREAS, California's water resources are the lifeblood of our economy and way of life; and

WHEREAS, Article X, Section 2 of the California Constitution states that the conservation of the State's 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; and

WHEREAS, wise stewardship of our natural resources is an obligation of all regions of the State, and this obligation has been heightened by the continued development of the State Water Resources Development System.

NOW, THEREFORE, I, Edmund G. Brown Jr., Govenor of the State of California, by virtue of the power and authority vested in me by the Constitution and statues of the State of California, do hereby issue this order, to become effective immediately:

1. The Department of Water Resources is hereby directed to prepare a plan of water conservation, reclamation, and management for the State Water Project to be submitted to the State Water Resources Control Board, such plan to recommend actions that could be undertaken by the State and its water service contractors to reduce the demand for water, to reclaim urban and agricultural waste water, to store water underground in order to provide for dry years, and to provide for consideration of pricing changes, water exchanges, and other methods for reducing the demand for new water facilities.

2. The Department of Water Resources is hereby directed to implement as quickly as possible a program of recycling agricultural drainage and other brackish water to increase the supplies available in the State Water Project with the objective of desalting 400,000 acre-feet by the year 2000, and thereby deferring the need for additional Northern California surface supplies.

Executive Department
State of California

3. The State Water Resources Control Board is hereby urged to require water conservation plans in the exercise of its water rights authority. The Board is also urged to implement water reclamation and conservation programs as a condition of federal and state grants.

IN WITNESS WHEREOF, I have hereunto set my hand and caused the Great Seal of the State of California to be affixed this 18th day of July, 1980.

Governor of California

ATTEST:

Secretary of State

by
Deputy Secretary of State

ACKNOWLEDGEMENTS FOR PHOTOGRAPHS

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