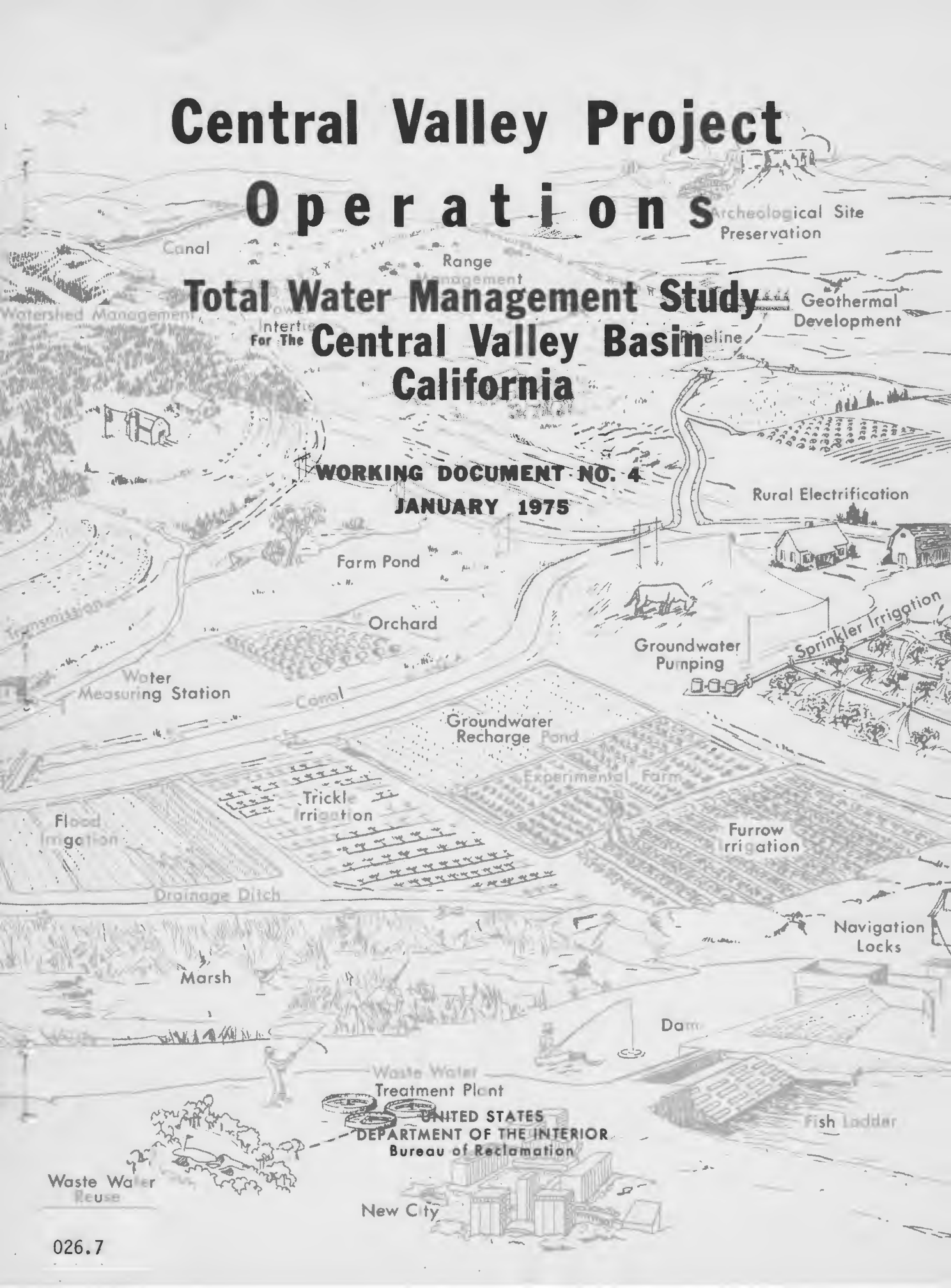
Central Valley Project Operations

Total Water Management Study For The Central Valley Basin California

WORKING DOCUMENT NO. 4

JANUARY 1975



UNITED STATES
DEPARTMENT OF THE INTERIOR
Bureau of Reclamation

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TOTAL WATER MANAGEMENT STUDY
FOR THE
CENTRAL VALLEY BASIN, CALIFORNIA

CENTRAL VALLEY PROJECT
OPERATIONS

WORKING DOCUMENT NO. 4

January 1975

Bureau of Reclamation
Mid-Pacific Region

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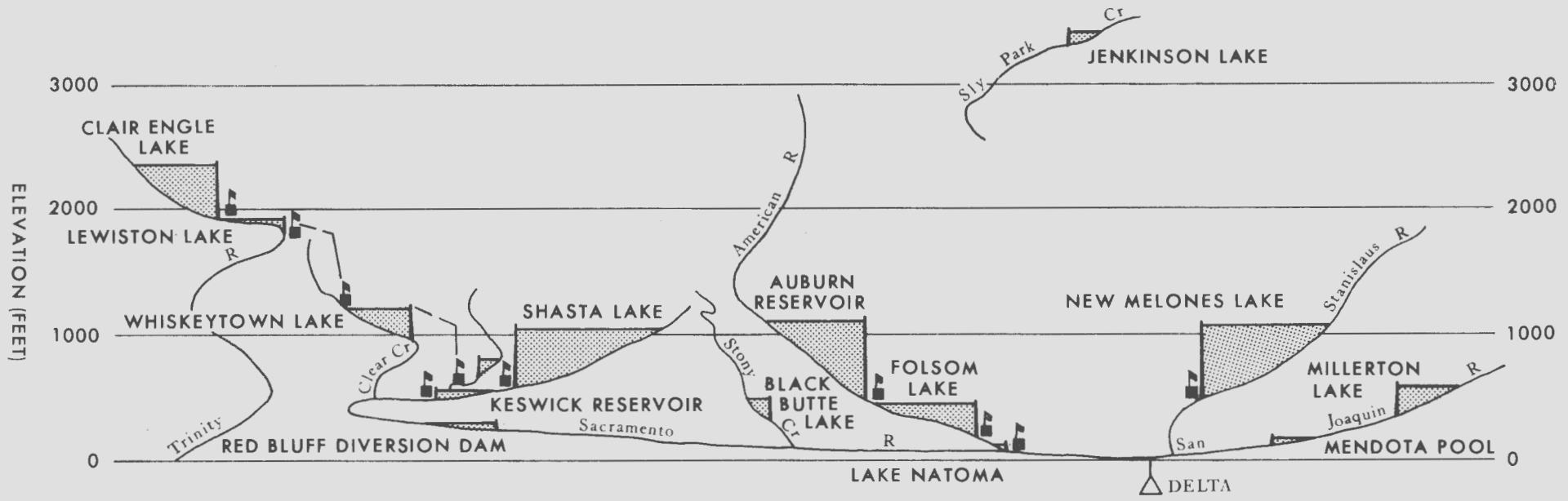

POWERPLANT

SCHEMATIC PROFILE

CENTRAL VALLEY PROJECT RESERVOIRS

INTRODUCTION

The Central Valley Basin extends from the Cascade Range which forms the northern boundary of the Sacramento Valley to the semiarid plains of the Kern River in the Tulare Basin to the south.

The main valley floor of the Central Valley Basin, comprising one-third of the basin area, is a gently sloping alluvial plain. The Sacramento River drains the northern portion of the basin, and the San Joaquin River provides the principal drainage outlet for the southern portion, with the Tulare Basin having only interior drainage. The two rivers flow toward each other, join in the Sacramento-San Joaquin Delta, and have a common outlet to the ocean through San Francisco Bay.

Water supply and water requirements are not in balance throughout the basin. The total runoff of the Sacramento Valley far exceeds its ultimate water requirements, while the total runoff of the San Joaquin Valley is inadequate to satisfy its total water requirements. Rainfall is less in the south and water requirements are greater due to larger irrigable areas, greater population, and more industry.

PURPOSE AND SCOPE

This document describes the Central Valley Project (CVP) facilities, both completed and under construction. In addition, it also describes how these facilities are used to accomplish the various purposes for which the Central Valley Project has been and is being constructed.

Included in the document are descriptions of the Central Valley Project for two different levels of development. The first level, identified as "present," consists of the existing project facilities used to meet the present operational objectives. The second level, identified as "authorized," consists of the existing project facilities and those additional units or divisions of the Central Valley Project which are authorized but not yet completed. In the second level, the project is operated in a manner demonstrating the full utilization of the Federal Project as presently envisioned.

The facilities authorized but not yet completed include the Sacramento Canals (Tehama-Colusa Canal), Auburn-Folsom South, Folsom-Malby, and Foresthill Divide Units, the San Felipe Division and the Corps of Engineers' New Melones, Marysville, Hidden, and Buchanan Projects.

The accomplishments as presented herein are measured in terms of water supply, water quality, flood control, minimum flow requirements for fishery and navigation, hydroelectric power, and recreation.

Introduction

As the Total Water Management Study progresses, the impact of the potential changes in needs and objectives that may be satisfied by the operation of the Central Valley Project can be measured against the base project accomplishments presented herein.

AUTHORITY

Funds were appropriated by Congress to initiate a Total Water Management Study for the Central Valley Basin during fiscal year 1974. The Bureau of Reclamation, Mid-Pacific Region, is conducting the study as part of its General Investigations program in coordination with local, State, and other Federal interests.

PREVIOUS STUDIES

The Bureau of Reclamation report entitled, "An Appraisal of Total Water Management in the Central Valley Basin," was released in August 1972. The report identified studies of various alternatives which might (1) increase the water supply, (2) reduce the water use, or (3) improve the means of satisfying the objectives of other water related activities. The report spelled out the philosophical and planning concept of the Total Water Management Study; this document is a basic element of the study.

HISTORY OF THE PROJECT

The history of the Central Valley Project, a plan to store and use the surplus water that had previously passed unused to the ocean, is in part a history of the valley itself and of its people. The influx of settlers into the valley began in 1849 with the discovery of gold at Sutter's Mill near Sacramento and continued during the Westward expansion of the following decades. Initially attracted by the promise of wealth, many 49'ers later abandoned their diggings and began to irrigate farms in the valley. Droughts or floods, however, often ruined the grain crops needed to feed the increasing population.

In the 1850's after California had become a State, the first legislature recognized the importance of water in the State's development and established the office of Surveyor General to study the problems of navigation, drainage and irrigation. Over the years as more settlers moved into the valley to farm, the State authorized the incorporation of canal companies and irrigation districts and funds for engineering plans. Individual farmers, irrigation districts, and power companies dug wells, built levees, dams, canals, and irrigation systems in their struggle to conserve and use the water.

Despite these efforts, however, by the early years of the 20th century, a way to store and regulate the water supply had not yet been found. Alternating periods of flood and drought caused severe loss of grain and livestock. After a series of very dry years, the ground water in the San Joaquin Valley was seriously depleted; many farmers and ranchers had given up and left the land. Salt water from the San Francisco Bay had also begun encroaching upon the cropland in the Delta. It was apparent that individual and local planning was insufficient to solve problems which affected the valley and State as a whole.

An effort at developing a comprehensive plan for the Central Valley had been made several years before. In 1873, in response to a severe drought in the Central Valley, Congress authorized the Alexander Commission to study the Sacramento and San Joaquin Rivers. In his report, Alexander, a colonel in the Army Corps of Engineers, outlined a system of irrigation-water supply works, stressing the necessity of coordinated planning, and suggested Federal assistance.

Such Federal assistance to Western irrigation planning was authorized by Congress with the adoption of the Reclamation Act of 1902, creating the Reclamation Service, later the Bureau of Reclamation. During the next 30 years the Service and the State of California cooperated in surveys of the Central Valley.

The Marshall Plan, published in 1920, made a significant contribution to comprehensive State water planning. Essentially the basis for the present-day Central Valley Project, this plan proposed a large-scale public works project to supply water for the Sacramento and San Joaquin Valleys. In 1933 the State legislature approved the Central Valley Project Act providing for the construction of Shasta Dam and powerplant on the Sacramento River; Friant Dam and powerplant on the San Joaquin River; a transmission line and other works between the Shasta damsite and Antioch; and the Contra Costa, Madera, and Friant-Kern Canals. The depression of the 1930's, however, made State financing of such a plan impossible, so the State appealed to the Federal government for help. In 1937 Congress appropriated funds and authorized construction and operation of the Central Valley Project by the Bureau of Reclamation. Construction began on October 19, 1937, on the Contra Costa Canal. Shasta Dam, the key to the project, was begun in 1938. Its construction marked the turning point in the people's long struggle to control their water supply.

Construction of the initial features of the project coincided with World War II. Prior to the war, water planners in the Central Valley had been primarily concerned with developing irrigation supplies. During and after the war, the valley experienced a rapid urban,

agricultural, and industrial growth which increased the demands for water and power above what the initial features could provide. Different kinds of water uses--municipal and industrial, and recreation--became important. Responding to this growth, Congress authorized the American River Division in 1949, which provided for the construction of Folsom and Nimbus Dams, reservoirs and powerplants. This American River Act converted a limited, single-purpose authorization of a flood control reservoir into a substantially enlarged multiple-purpose project integrated into the Central Valley Project.

As they were needed, additional features were authorized: the Sacramento Canals Unit in 1950; the Trinity River Division, including Trinity Dam and Powerplant, Lewiston Dam, Whiskeytown Dam, Judge Francis Carr Powerhouse, and Spring Creek Powerplant in 1955; the San Luis Unit in 1960; the Auburn-Folsom South Unit in 1965; and the San Felipe Division in 1967. The San Luis Unit is unique in that it is the first joint venture by a State and the Bureau.

The main multiple functions of the Central Valley Project are to provide a dependable, ample, year-round supply of water for irrigation in the Central Valley, and for municipal and industrial uses. But the facilities which store and deliver this water provide many additional benefits, including power, flood control, navigation, fish and wildlife enhancement, recreation, water quality control, and environmental protection and preservation.

To coordinate operation, project powerplants are tied together by a 230-kV transmission system which also interconnects with lines of other power utilities in the area. This system is further interconnected with the Pacific Northwest-Pacific Southwest (PNW-PSW) Intertie which interconnects the hydroelectric projects in the Columbia River Basin, the California power systems including the Central Valley Project, and the Colorado River Basin systems. The Central Valley Project's portion of the PNW-PSW Intertie consists of a 500-kV transmission line from the Oregon border to Round Mountain Substation and a 230-kV transmission line from Round Mountain to Cottonwood Substation.

Total estimated construction cost of authorized features of the project, including those now under construction, is $2,540,193,439, with 90 percent reimbursable to the United States. Total costs to the end of 1973 were more than $1,536,000,000.

In 1973 the project delivered 6 million acre-feet of water. Most of this was used for agriculture, municipal and industrial, and

fish and wildlife purposes, with 2,464,320 acre-feet used for water-right purposes. Project powerplants produced nearly 6-1/2 billion kilowatt-hours of energy for project pumping and for commercial sale.

A total of 22 recreational areas are now provided at various project sites. These areas are used for camping, fishing, picnicking, swimming, boating, water skiing, hiking, and sightseeing, with attendance during 1973 estimated at 6-3/4 million visitor-days.

Conceived and built in response to the needs of the people of the State of California for food, flood protection, and jobs, the Central Valley Project has helped stabilize and enhance the economic and social development of the valley and the State. Irrigation from the project has turned both semiarid and marshlands into fertile fields. Fruits, nuts, grains, vegetables, sugar beets, alfalfa, rice-- a few of the crops grown--help to supply the increasing agricultural demands of the State, the Nation, and the world.

PRESENT PROJECT

PHYSICAL FEATURES

The operational objectives of the Central Valley Project are the delivery of water pursuant to contractual obligations, maintenance of water quality standards as water supply conditions permit, reservation of reservoir storage for flood control, and satisfaction of minimum flow and storage requirements for fishery, recreation, navigation, generation of hydroelectric power, and provision for drainage of agricultural lands where authorized.

Some of the present operational objectives in terms of quantity are different from those reflected in the "as authorized" project described later.

The physical features of the Central Valley Project shown on map 214-208-5133 include dams and reservoirs, pumping plants, canals, and generating facilities. Statistics for these facilities are presented in tables 1, 2, 3, and 4, respectively, pages 25-27. Since the Federal Central Valley Project and the California State Water Project (SWP) share the use of several facilities, the joint facilities are also shown on the tables.

A schematic profile of the major CVP reservoirs appears on page iv.

Project service facilities are authorized, designed, and constructed to meet the project water needs of a service area 40 to 50 years in the future. During the interim, from completion of the project until water use in that area reaches full design capacity of the project, surplus water will be available for other purposes in other areas.

WATER SUPPLY

In an extensive multiple-purpose water resource system, proper utilization of the available water resource can be achieved only through careful budgeting of the anticipated water supply to meet anticipated water demand. The hydropower production is a byproduct of the water system; the ability to satisfy project needs and contractual power requirements is directly dependent on water supply and the release pattern selected to meet the water demands.

Operating plans are prepared on the basis of median forecasted inflow data and corresponding system demand data. These plans are also evaluated on the basis that upper- or lower-quartile water supply conditions may occur in order that a plan of action is

developed that will best utilize the water supply without jeopardizing the project's operational capability.

The three water supply conditions used in making the evaluations are:

1. Upper-quartile year--25 percent probability that the runoff will exceed this value.

2. Median year--50 percent probability that the runoff will exceed this value, and 50 percent probability that the runoff will be less.

3. Lower-quartile year--25 percent probability that the runoff will be less than this value.

The median, upper-, and lower-quartile monthly runoff data are derived from past historical records of runoff to CVP reservoirs and other control points which are ranked in ascending order by month. An example of this type of ranking for inflow to Shasta Lake is presented in table 5, p. 28, which shows the monthly median, upper- and lower-quartile values. Inflow to Shasta Lake tabulated chronologically is presented in table 6, p. 29.

The operating plans are updated periodically as the current year hydrologic conditions become better defined. The determination of seasonal quantities for the current year of expected runoff to Shasta, Clair Engle, Folsom, and Millerton Lakes is derived from multiple correlations, using the following independent variables from the respective watersheds: (a) antecedent inflow or inflow to date, (b) antecedent precipitation or precipitation to date, (c) water content in snow (from snow survey data), and (d) projected precipitation. Quantities are estimated for the February-July through April-July and the total water year time frames. For Folsom and Millerton Lakes, the results are derived in terms of full natural flows. These natural flows are adjusted for the existing upstream development. The adjustments for the natural flow above Millerton Lake are made pursuant to storage levels stipulated in the contract with Southern California Edison.

In the development of runoff forecasts, recognition is given to the considerable amount of uncontrolled runoff which occurs to the Sacramento River below Keswick Dam, the San Joaquin River between Friant Dam and Vernalis, and the Mokelumne, Cosumnes, and Calaveras Rivers along the periphery of the Sacramento-San Joaquin Delta.

The historical records of flow for the Sacramento River at Sacramento and the San Joaquin River near Vernalis have been ranked in ascending order by month for use in projecting estimates of inflow to the Sacramento-San Joaquin Delta. In use, these records are adjusted to reflect the significant development that has taken place in recent years in the San Joaquin River and Sacramento River Basins. Examples of this type of development are Don Pedro Dam, New Hogan Dam, New Bullards Bar Dam, and the Oroville-Thermalito complex of the State Water Project.

The projected inflows to Whiskeytown Lake are derived from Clear Creek historical runoff records. No attempt is made to forecast inflows from snow survey data.

Periodic inflow projections for Black Butte Reservoir are made using past historical records which recognize the effect of two upstream Orland Project reservoirs, East Park and Stony Gorge.

No attempt is made to estimate the negligible runoff into San Luis Reservoir from its tributary watershed. Inflows to San Luis Reservoir are projected only from the estimated total quantities to be pumped by the State and Bureau. Total inflows to O'Neill Forebay are based on the projected pumping of State water from the California Aqueduct and the Bureau of Reclamation water from the Delta-Mendota Canal via the O'Neill Pumping Plant. These estimates are adjusted for releases of water from San Luis Reservoir for power generation by either or both agencies.

WATER DEMANDS

In order to provide the greatest utilization of the available CVP water resources, operational forecasts for the project are based on the concept of basinwide integration. Under this concept, operation is dependent upon the total water supply regardless of source. The major objective in planning CVP operations is to make the optimum utilization of the total water supply to meet the project water demands.

Most of the water users that obtain their water deliveries from or via the CVP facilities are located on the Sacramento and San Joaquin Valley floors. The principal interests currently being provided a water supply are:

1. Exchange contractors and other users located downstream from CVP facilities with entitlements to use water.

2. Irrigation, municipal and industrial users adjacent to the Sacramento River.

3. Users located with the Sacramento-San Joaquin Delta.

4. Irrigation, municipal, and industrial users supplied water from the Delta-Mendota, San Luis, Friant-Kern, Madera, Tehama-Colusa, Corning, and Contra Costa Canals.

5. Waterfowl conservation and recreation users delivered water from various CVP facilities.

The main source of CVP project water to satisfy CVP demands is Shasta Reservoir. Shasta releases to the Sacramento River are augmented by a cross-basin transfer of Trinity River water to Keswick Reservoir 11 miles downstream from Shasta Dam. No actual water demand schedules are furnished by water users obtaining their water from the Sacramento River, including the Tehama-Colusa and Corning Canals. Estimates of these uses are made based upon previous historical occurrences. The operation of the project facilities reflects these estimates in assuring that sufficient flows are maintained at the navigation control point and that the inflow to the Sacramento-San Joaquin Delta is adequate to meet the internal Delta and export needs with sufficient Delta outflow to protect the region from salinity intrusion. When required, upon 24 hours' notice, releases from Folsom Lake can supplement the total demand for water in the Delta region.

Exports from the Delta to the Delta-Mendota Canal are primarily intended to meet the demands of water users taking water from Mendota Pool during the peak irrigation demand months of June through August. This was made possible through the water exchange agreement with the Mendota Pool water users, who, prior to construction of the Delta-Mendota Canal, took their water from the San Joaquin River. The San Joaquin River water is now stored in Millerton Lake and released to the water users receiving their supply via the Friant-Kern and Madera Canals. As the irrigation season demands diminish, the Delta-Mendota Canal conveys water to the Federal-State O'Neill Forebay, San Luis Reservoir, and San Luis Canal to meet Federal water demands. If the total demand for water exceeds the Tracy Pumping Plant's pumping capability, Federal water stored in San Luis Reservoir is released to meet the San Luis demands.

Deliveries from Millerton Lake to the Friant-Kern and Madera Canals are available either as class 1 or class 2 water. Class 1 water is a firm supply which is expected to be available to meet water demands each year, except in very dry years. Class 2 water is the intermittent supply of project water in excess of class 1 water and is available during most years in varying amounts. Initial schedules are submitted by the water service districts having long-term contracts prior to March 1 of each year, taking into account both

classes of water. Adjustments can be made in the schedules within the capabilities of the project facilities during any month of the year. The Bureau provides the districts with forecasts of the water supply available from Millerton Lake. If the forecasts indicate the scheduled demands can be met, any excess supply may be marketed under short-term or temporary contracts. However, when the available water supply is not adequate to meet the total scheduled quantity, class 2 schedules are eliminated, if necessary, before class 1 schedules are modified.

Water deliveries from Millerton Lake to the Friant-Kern and Madera Canals are provided in the following order of priority, depending on the available water supply.

1. Long-term water service contracts.

2. Temporary contracts with districts having long-term contracts.

3. Short-term (5-year) contracts for agricultural water service.

4. Temporary contracts with others.

ELECTRIC POWER

The existing CVP power facilities consist of seven powerplants and two pumping-generating plants with an installed capacity (nameplate) of 1,334,000 kW. Most of the powerplants are located just downstream from the CVP storage reservoirs and are operated in conjunction with the water demands made on these reservoirs. Since Reclamation policy requires that CVP reservoirs be operated with major emphasis on meeting water demands associated with the other multipurpose functions, the generation of electric power is for the most part a byproduct. Although the generation of electric power is not the primary operational objective, it is an essential project benefit, and in the day-to-day project operation for scheduling water deliveries, every effort is made to maximize power generation.

Power generated at CVP powerplants is directly related to the demands for project water. Recognizing that these water demands would be seasonal (with much larger releases being made during the summer months), CVP powerplants were designed to generate peaking power. Since peaking power alone cannot satisfy the power requirements of CVP power customers, and since peaking power is more efficiently used when integrated with baseload power, the Bureau entered into a support contract, No. 14-06-200-2948A (Contract

2948A), with the Pacific Gas and Electric Company (PG&E). Contract 2948A provides for the delivery of peaking power from CVP powerplants into the PG&E system and PG&E, in return, delivers power as required, to CVP customers.

The electric power generated by CVP powerplants is dedicated first to meeting the power requirements of the project facilities (project use). The power remaining after meeting project use, is used to provide commercial power to various preference customers, (military installations, irrigation districts, municipalities, and various Federal and State Government installations) in northern California. A detailed discussion of the project use power requirements and the amount of CVP power available for commercial sale follows.

Project Use

Project use is the term applied to the power (energy and capacity) required for project pumping and the auxiliary equipment at the various operating facilities (station use). The amount of power required for project pumping is estimated based on historical records and projected water deliveries that are pumped by project pumps enroute to the service area. The actual amount of power used is recorded by the watthour meters at the various project pumping plants. These pumping plants which receive project use power are listed in table 7, p. 30. The power required for station use is estimated based on historical records and the actual amount of power used is metered.

Commercial Power

The energy and capacity that are available from CVP hydroelectric powerplants for commercial sale are described in the following paragraphs.

Energy. Electric energy is generated as water is released from CVP reservoirs through the various powerplants. Under most operating conditions the amount of electric energy that is generated during any specified period can be forecasted and controlled by the amount of water that is released from CVP reservoirs. The forecast of energy generation varies from day to day, month to month, and year to year, depending on the inflow to the reservoirs, rainfall, and the releases required by project water demands. The energy generation quantity that is used to measure CVP power accomplishments is estimated, based on the electric energy generated, or which would have been generated over an extended period. The current estimate for CVP average generation, about 4.6 billion kilowatthours, is based on water supply conditions that occurred during the period 1921 through 1970.

Dependable capacity. The CVP dependable capacity is the portion of the electric system's installed capacity (kilowatts) that can be relied on to meet preference customer loads under adverse hydrologic conditions. The criteria for determining the dependable capacity are set forth in the firming contract with PG&E. These criteria which are applied in a water and power operation study (Reclamation Study), are as follows:

1. Water conditions (conditions of water availability) are based on the hydrological period that existed in the Central Valley Basin from May 1930 through 1934, as modified to reflect current and future levels of development.

2. Project use power requirements are determined based on the amount of pumping that would be accomplished during the 1930 through 1934 period. Project energy and capacity are further divided into onpeak and offpeak requirements. The Reclamation Study requires that all onpeak project use energy and capacity be met from CVP generation on a concurrent basis. The offpeak requirements, which are usually the largest part of the project use because the project's water conveyance facilities are designed for maximum offpeak operation, can be met at any time during the year. This treatment of the offpeak project use requirements is provided in Contract 2948A which establishes an Annual Energy Exchange Account. The annual energy account provides the opportunity during any month to (a) credit to the account when CVP generation is in excess of needs and to (b) borrow from the account if CVP generation is insufficient to meet the total need, including both offpeak and onpeak needs. However, Contract 2948A requires that every effort should be made to balance out this account to zero by the end of each calendar year.

3. After onpeak project use requirements are met, the remaining CVP generation is used to support dependable capacity. The contract also sets the minimum energy required (kilowatthours per kilowatt) each month to support each kilowatt for dependable capacity. The kilowatthours per kilowatt requirements, which are the minimum time in hours that each plant must be operated per month to support dependable capacity, are:

Present Project

Month	Shasta or Folsom	Keswick or Nimbus	Each Trinity River Division Powerplant	
			Dry year	Other years
	(kilowatthours per kilowatt)			
January	96	138	128	128
February	112	160	112	112
March	112	160	112	112
April	112	160	112	112
May	112	160	112	112
June	160	240	244	160
July	320	360	575	376
August	360	400	553	440
September	280	320	368	368
October	144	200	232	232
November	112	120	136	136
December	80	80	96	96

Source: Table 2, Contract 2948A.

In addition to individual plant requirements, the system generation (all plants) must satisfy these requirements:

1. For months January through June--820 kilowatthours per kilowatt, meeting only onpeak project use energy.

2. For months July through December--1960 kilowatthours per kilowatt, meeting only onpeak project use energy.

3. For the year January through December--2780 kilowatthours per kilowatt, meeting all project use energy.

The present dependable capacity is 925,000 kilowatts. This is the capacity (kilowatts) available for commercial sale to CVP preference customers.

The criteria described above are used in the Reclamation Study to determine the dependable capacity under adverse hydrologic conditions and do not apply in total to normal project operation. Under normal operating conditions, the CVP hydroelectric plants are operated to meet the dependable capacity, which was derived based on Reclamation Study, on a system basis. The system basis allows for more operational flexibility, in that the minimum energy

requirements are met by the system instead of individual plants. The minimum energy requirements for operating purposes are:

Month	Dry year	Other years
	(kilowatthours per kilowatt)	
January	109	109
February	112	112
March	112	112
April	112	112
May	112	112
June	190	160
July	415	341
August	433	390
September	317	317
October	180	180
November	122	122
December	87	87

Source: Table 1, Contract 2948A.

Although the operating criteria for meeting the minimum energy requirements are more flexible on a per month per plant basis, the two 6-month and the annual requirements must still be met.

WATER QUALITY

The Central Valley Project, as built, has not been authorized by Congress to meet specific instream water quality objectives at any location within the basin. However, the Bureau is always striving to provide the best water quality to water users along the Delta-Mendota Canal, Mendota Pool, and the Contra Costa Canal.

In making water deliveries from the Delta-Mendota Canal and Mendota Pool, under exchange contract with the contracting entities, the Bureau is obligated to provide water of a quality that does not exceed the following mean total dissolved solids:

Period	Maximum limits (ppm)
Daily	800
Monthly	600
Annual	450
5-year	400

Under contracts with irrigation districts, the districts are not obligated to accept and pay for any water which contains in excess of 300 parts per million of chlorides. However, if the water is used, it is paid for at prevailing contract rates.

For water supplied to the Contra Costa Canal Intake, the revised contract with the Contra Costa County Water District calls for the best water quality possible within the operations capability of the Central Valley Project.

In addition to operating to meet the contractual water quality objectives, the Central Valley Project is being operated to satisfy Federally approved water quality criteria in the Sacramento-San Joaquin Delta within the capability of the project, after first meeting contractual obligations for water use. These Delta objectives, adopted by the California State Water Resources Control Board and approved as Federal criteria by the Environmental Protection Agency, are part of the State's Water Quality Control Policies, June 1967, Resolution 68-17 and Resolution 73-16. Table 8 summarizes these water quality objectives.

Meeting the Delta water quality criteria periodically requires the release of stored water from Central Valley Project reservoirs. These releases will continue to be made only if doing so does not infringe upon the project's ability to meet its contractual water and power commitments. A guarantee that these standards will be met would require either Congressional legislation providing specifically that the Central Valley Project will be operated to meet specific criteria in the Delta, or contracts with Delta beneficiaries wherein they agree to pay for the benefits derived from CVP water delivered to the Delta.

FLOOD CONTROL

Responsibility for operation of Federal reservoir projects is defined in various project authorizations. Under the 1944 Flood Control Act, the Secretary of the Army has the responsibility of prescribing regulations for storage reserved for flood control, at all reservoirs constructed wholly or in part with Federal funds provided on the basis of flood control.

Regulations for operation of Bureau of Reclamation CVP reservoirs for the control of floods are established by cooperative agreement between the Bureau of Reclamation and Corps of Engineers. Flood control regulations for the operation of Shasta, Friant, and Folsom Dams and Reservoirs were published in the Federal Registers dated January 3, 1953, December 10, 1955, and June 20, 1956, respectively.

Present Project

A memorandum of agreement dated December 29, 1958, between the Department of the Army and the Department of the Interior on "Division of Responsibilities in the Central Valley Basin, California," establishes principles, procedures, and designations of responsibility applicable to the conduct of water development programs of the Corps of Engineers and the Bureau of Reclamation. This memorandum provides for flood control operation under Corps' regulations.

Major CVP Reservoirs

The pertinent parameters of the respective flood control criteria for the existing CVP reservoirs are:

	Shasta	Folsom	Millerton
Operation period	October-April	October-May	October-July
Maximum storage reservation (acre-feet)	1,300,000	400,000	85,000 to 170,000
Minimum storage reservation (acre-feet)	500,000	200,000	85,000
Maximum release (ft^3/s)	79,000 (below Keswick)	115,000 (below Nimbus)	8,000
Allowable release change rate			
Increasing rate	15,000 ft^3/s in 2 hrs.	10,000 ft^3/s in 2 hrs.	--
Decreasing rate	3,000-6,000 ft^3/s in 3 hrs.	5,000-11,000 ft^3/s in 3 hrs.	--
Determination of permissible storage	30 days antecedent inflow	60 days antecedent precipitation	15 days antecedent precipitation or snowmelt parameters.[a]

[a] Credit provided also for upstream storage space available.

The operation period is the part of the year during which a portion of the reservoir storage capacity is reserved for the temporary storage of floodwaters. The maximum and minimum storage reservations establish the range of storage capacity that may be reserved during the operation period depending upon the hydrologic conditions in the watershed.

Permissible storage is the maximum reservoir storage permitted after reserving the necessary storage capacity for temporary storage of floodwater. The maximum release is equal to the capacity of the downstream channel, and the flood control criteria is developed so that during normal flood control operations, outflow may be controlled to this rate of release. The allowable release change rate is the maximum amount the rate of release can be increased or decreased in a specified period of time.

Whiskeytown Lake

Although Whiskeytown Lake is not operated specifically to meet defined flood control criteria, storage space of about 40,000 acre-feet is maintained during the winter months to help prevent flood releases to Clear Creek if large storms should occur in the Whiskeytown drainage basin. The drawdown or evacuation period normally extends from November 15 through March or early April, depending on hydrologic conditions. A smaller drawdown is programmed from September 20 to November 15, primarily to enhance the spawning of kokanee salmon within the lake.

Black Butte Reservoir

Black Butte Reservoir, while a feature of the Central Valley Project, is operated by the Corps of Engineers. The flood control criteria are:

Operation period	September-June 15
Maximum storage reservation	150,000 acre-feet
Minimum storage reservation	75,000 acre-feet
Maximum release	15,000 ft^3/s
Allowable release change rate	2,000 ft^3/s in 2 hours
Determination of permissible storage	59 days antecedent basin mean precipitation multiplied by 0.97 and adjusted for current day's precipitation. Credit allowed for upstream storage space available in East Park and Stony Gorge Reservoirs.

Other

In addition to the flood control criteria previously summarized, releases from Shasta Lake and Millerton Lake are limited while attempting to maintain these flows at downstream locations:

Location	Flow (ft^3/s)
Sacramento River	
At Bend Bridge	100,000
At Ord Ferry	130,000
San Joaquin River	
Friant Dam to Chowchilla Bypass	8,000
Chowchilla Bypass	5,500
Chowchilla Bypass to Mendota Pool	2,500
Below Mendota Pool	4,500

At times it is physically impossible to keep the flow at these points from exceeding the amounts shown, due to substantial unregulated tributary inflow originating below the respective facilities, and flood control releases necessary in order to maintain space in the reservoirs.

FISH AND WILDLIFE

The project facilities are operated to maintain normal minimum releases for protection of fish life below the regulating reservoirs. These reservoirs are:

Reservoir	Period	Release (ft^3/s)
Keswick[a]	September-November	3,900
	December-February	2,600
	March-August	2,300
Lewiston (to Trinity River)	October 15-November 14	250
	September 1-October 14 and November 15-November 30	200
	December-August	150
Whiskeytown (to Clear Creek)	November-December	100
	January-October	50
Nimbus[a]	September 15-December 31	500
	January 1-September 14	250
Millerton[b]	January-December	35

[a] Smaller releases than those shown are permissible during critical years.
[b] State Trout Hatchery at Friant.

In order to enhance the salmon spawning, operations below Keswick and Nimbus are geared to maintain constant or increasing releases from October 15 through December 15.

The flows of Spring Creek are toxic due to high concentrations of copper and zinc. The Spring Creek Debris Dam is operated to control these flows in order that they may be safely diluted with Shasta Lake and Spring Creek Powerplant releases to Keswick Reservoir. If the flows of Spring Creek are not adequately diluted, fish kills in the Sacramento River downstream from Keswick Dam may result.

By agreement with the California Department of Fish and Game for enhancing the spawning of kokanee salmon in Whiskeytown Reservoir, storage levels are controlled after Labor Day and through the winter months.

Black Butte Reservoir is maintained at a constant level during a period of each spring to protect crappie during their spawning season.

Releases are made to fish hatcheries below Lewiston, Nimbus, and Friant Dams, as well as through the fishtrap at Keswick Dam. These releases are included as a part of the total scheduled releases below these dams.

The normal releases for fish life to the Feather River below the Oroville complex are 1,700 cubic feet per second from October through March, and 1,000 cubic feet per second from April through September.

An agreement with the Department of Fish and Game protects the salmon fishery on the Lower San Joaquin River near the city of Stockton in the fall. It provides for the Bureau to augment flows in the river up to 60,000 acre-feet as may be necessary to dilute a pollution block which impedes the salmon and steelhead from reaching spawning areas. If such augmentation is required, releases are made through wasteways from the Delta-Mendota Canal to the San Joaquin River.

The Sly Park Unit facilities are operated by the El Dorado Irrigation District. A release of 1 cubic foot per second or the natural flow of Sly Park Creek, whichever is less, is made from Jenkinson Lake. A flow of 2 cubic feet per second or the natural flow of Camp Creek, whichever is less, is allowed to bypass the Camp Creek Diversion Dam.

The Tehama-Colusa fish facilities are in a complex centered primarily around the Red Bluff Diversion Dam and the first 3.5 miles of the Tehama-Colusa Canal. Water is diverted at the Red Bluff Diversion Dam from the Sacramento River for use in the dual-use spawning channel of the Tehama-Colusa Canal, and the single-purpose spawning and access channel from Coyote Creek to the canal.

RECREATION

Initially recreation was not specifically authorized as an intended purpose of the Central Valley Project. After construction of the initial features of the project, however, the excellent recreational opportunities that became available required development in order to fully reach their maximum potential. Recognition of this need was reflected in the passage of the legislation authorizing the San Luis Unit (P.L. 86-488) and Auburn-Folsom South Unit (P.L. 89-76), which provided for the financial participation of the Federal government in the development of recreation facilities

in the units on a cost-sharing basis. P.L. 89-72, passed in 1965, authorized Federal participation on a cost-sharing basis with non-Federal agencies in the development of recreational facilities around already existing and authorized project features. The Federal share is limited to $100,000 and the recreational facilities are to be developed, operated, and maintained by the non-Federal agencies.

The major reservoirs are operated to obtain the highest possible water level during the late spring or early summer months of each year. This period of highest water levels generally coincides with the beginning of the primary recreation season, and therefore proves of value to most recreational interests. The maximum reservoir water stages reached will vary, depending on the available runoff, early season downstream water demands, and storage carried over from the previous year.

Minimum pools are maintained at most reservoirs even in years of very short water supply. Thus, extensive recreational use can be contemplated at the various storage facilities throughout the year.

Specific operational practices or objectives aimed at meeting recreational interests are:

At Whiskeytown Lake an essentially full reservoir is maintained from late April through the Labor Day weekend.

At Lewiston Lake a maximum reservoir fluctuation of only 2 feet is maintained throughout the entire year at the near full storage level.

In addition to releases made to maintain the Trinity River fishery flows, water is released from Lewiston Lake to the Trinity River during the last weekend in July to accommodate raft races sponsored by the Lewiston Chamber of Commerce.

Storage is maintained at Red Bluff Diversion Reservoir at all times of the year except during periods of flood operation on the Sacramento River. During the summer months, reservoir levels are held at a full stage and normally 1 foot below the full stage during the winter months.

Sufficient storage is provided in Black Butte Reservoir during the summer, at least until the Labor Day weekend, to permit continued operations of the boat ramps during years in which water supply conditions permit such operation.

At Folsom Lake storage is maintained at a sufficient stage during years in which water supply conditions permit to allow for the continual use throughout the year of the marina located in Browns Ravine.

Storage in San Luis Reservoir is maintained above 350,000 acre-feet between Memorial Day and Labor Day.

Recreation facilities at the Central Valley Project reservoirs and canals are maintained by local, State, or other Federal agencies.

NAVIGATION

The maintenance of flows for navigation in the main channel of the Sacramento River is an authorized objective of the Central Valley Project. In most years a minimum flow of 5,000 cubic feet per second (6-foot-depth) is maintained in the Sacramento River, usually as measured between Colusa and Knights Landing. In dry years, reductions in the minimum flow are allowed, depending on the available water supply. Water necessary to satisfy the navigation requirements may be released from Shasta or Clair Engle Lakes.

Navigation projects within the Sacramento-San Joaquin Delta are: the Sacramento River Deepwater Ship Channel, and the San Joaquin River Main Channel (which includes the Stockton Deepwater Ship Channel).

Table 1. Central Valley Project reservoirs

CVP reservoirs	Total storage	Minimum power pool[a] (acre-feet)	Dead storage[b]
Shasta	4,552,000	502,000	116,000
Clair Engle	2,448,000	313,000	10,000
Whiskeytown	241,000	27,500	0
Lewiston	14,700	10,500	0
Keswick	23,800	16,300	3,800
Spring Creek	5,900	-	0
Red Bluff	3,900	-	0
Contra Loma	2,100	-	0
Folsom	1,010,000	89,800	0
Lake Natoma	9,300	2,300	1,800
Jenkinson	41,000	-	500
Black Butte (USCE)	160,000	-	0
Millerton	520,500	-	17,400
Joint reservoirs (CVP-SWP)			
San Luis			
Total	2,039,000	79,200	79,200
Federal share	971,000	37,700	37,700
O'Neill Forebay			
Total	56,400	35,600	35,600
Federal share	26,900	17,000	17,000
Los Banos	34,600	-	8,300
Little Panoche	13,200	-	300

a The minimum power pool is the reservoir storage associated with the minimum head at which the powerplant may be operated without damage to the equipment.

b Dead storage is the reservoir capacity below the lowest outlet level of a reservoir and is not susceptible to gravity release.

Table 2. Central Valley Project pumping plants

Plant	Capacity: Cubic feet per second	Capacity: Installed kilowatts[a]
Central Valley Project		
Corning	500	3,240
Tracy	4,600	90,000
Contra Costa	350	1,640
O'Neill	4,200	24,000
Joint (CVP-SWP)		
San Luis		
Total	11,000	376,000
Federal share (47.62%)	5,100	179,000
Dos Amigos		
Total	13,200	180,000
Federal share (45.80%)	6,000	82,000

a Installed kilowatts are the nameplate electrical capacity required to permit pumping of water at the cubic foot per second rate shown.

Table 3. Central Valley Project canals

CVP Canals	Initial capacity (cubic feet per second)
Folsom South	3,500
Delta-Mendota	4,600
Contra Costa	350
Friant-Kern	4,500
Madera	1,300
Tehama-Colusa	2,530
Corning	500
Joint Facilities	
San Luis	
Total	13,000
Federal	6,000

Table 4. Central Valley Project generating facilities

CVP Facilities	Units	Installed capacity per unit (kilowatts)	Total installed capacity (kilowatts)	Maximum plant capability[a] (kilowatts)
Trinity	2	52,778	105,556	128,000
Lewiston	1	350	350	-
Carr	2	70,722	141,444	150,000
Spring Creek	2	75,000	150,000	190,000
Shasta				
Main	5	83,662	418,310	487,000
Station service	2	2,000	4,000	
Keswick	3	25,000	75,000	90,000
Folsom	3	66,240	198,720	210,000
Nimbus	2	6,750	13,500	16,000
O'Neill	6	6,400	25,200	21,000

	Joint (CVP-SWP)	Units	Installed capacity per unit (kilowatts)	Total installed capacity (kilowatts)	Federal share (47.62%) (kilowatts)
10.	San Luis	8			
	150 RPM		53,000	424,000	201,900
	120 RPM		34,000	272,000	129,500

a The maximum plant capability is presently the maximum capacity in kilowatts obtained from each powerplant through actual operation and is used in daily operation whenever possible under hydraulic and safe operating limits.

Table 5. Monthly ascending rank of inflow to Shasta Lake

INFLOW TO SHASTA LAKE BY WATERYEARS FOR THE PERIOD 1922 - 1973. DRAINAGE AREA 6665 SQUARE MILES.

YEAR	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	ANNUAL TOTAL	
	161.0	165.0	177.0	179.0	220.0	228.0	208.0	182.0	167.0	161.0	153.0	149.0	2150.0	
	163.0	171.0	190.0	218.0	266.0	330.0	236.0	194.0	173.0	163.0	157.0	153.0	2414.0	
	165.0	175.0	190.0	222.0	271.0	356.0	325.0	252.0	186.0	169.0	163.0	155.0	2629.0	
	171.0	177.0	206.0	224.0	272.0	365.0	342.0	260.0	192.0	177.0	165.0	157.0	2708.0	
	173.0	178.0	212.0	233.0	298.0	376.0	364.0	270.0	204.0	180.0	167.0	159.0	2814.0	
	180.0	179.0	216.0	242.0	309.0	379.0	404.0	272.0	214.0	184.0	168.0	160.0	2907.0	
	181.0	188.0	237.0	270.0	315.0	401.0	407.0	300.0	232.0	188.0	170.0	163.0	3052.0	
	184.0	189.0	238.0	272.0	329.0	444.0	422.0	319.0	238.0	188.0	173.0	164.0	3160.0	
	185.0	204.0	246.0	284.0	331.0	456.0	432.0	321.0	240.0	190.0	177.0	167.0	3233.0	
	191.0	206.0	246.0	299.0	355.0	511.0	440.0	343.0	248.0	195.0	177.0	169.0	3380.0	
	191.0	224.0	251.0	310.0	371.0	516.0	444.0	353.0	248.0	196.0	178.0	173.0	3455.0	
	196.0	235.0	258.0	312.0	371.0	525.0	449.0	355.0	251.0	197.0	178.0	177.0	3504.0	
Lower quartile	198.0	236.0	262.0	323.0	423.0	531.0	471.0	365.0	263.0	201.0	179.0	178.0	3630.0	L.Q.
	202.0	238.0	267.0	327.0	437.0	556.0	474.0	369.0	264.0	202.0	186.0	179.0	3701.0	
	206.0	238.0	289.0	339.0	478.0	562.0	488.0	375.0	264.0	205.0	187.0	186.0	3817.0	
	208.0	240.0	292.0	347.0	490.0	597.0	501.0	395.0	269.0	207.0	187.0	187.0	3920.0	
	212.0	246.0	298.0	386.0	497.0	600.0	503.0	395.0	270.0	208.0	192.0	187.0	3994.0	
	213.0	250.0	306.0	390.0	507.0	604.0	503.0	398.0	271.0	209.0	196.0	188.0	4035.0	
	214.0	251.0	318.0	393.0	542.0	604.0	511.0	408.0	271.0	212.0	198.0	188.0	4110.0	
	215.0	252.0	325.0	395.0	557.0	609.0	522.0	417.0	277.0	217.0	199.0	189.0	4174.0	
	220.0	253.0	332.0	402.0	558.0	652.0	553.0	422.0	278.0	219.0	200.0	189.0	4278.0	
	221.0	260.0	333.0	404.0	559.0	657.0	574.0	424.0	282.0	220.0	204.0	194.0	4332.0	
	222.0	260.0	342.0	414.0	577.0	659.0	584.0	448.0	284.0	220.0	205.0	196.0	4411.0	
	223.0	262.0	342.0	466.0	583.0	663.0	594.0	450.0	287.0	223.0	205.0	197.0	4495.0	
	227.0	264.0	345.0	477.0	604.0	663.0	595.0	453.0	287.0	223.0	206.0	199.0	4543.0	
Median	227.0	270.0	349.0	480.0	637.0	686.0	612.0	462.0	287.0	224.0	206.0	200.0	4640.0	MED.
	229.0	279.0	350.0	486.0	721.0	698.0	615.0	465.0	292.0	227.0	207.0	200.0	4769.0	
	229.0	286.0	372.0	548.0	750.0	716.0	616.0	472.0	295.0	229.0	208.0	202.0	4923.0	
	230.0	293.0	397.0	587.0	840.0	718.0	629.0	478.0	302.0	233.0	208.0	203.0	5118.0	
	230.0	295.0	439.0	595.0	855.0	746.0	701.0	480.0	305.0	234.0	208.0	206.0	5294.0	
	233.0	303.0	497.0	695.0	862.0	803.0	712.0	485.0	317.0	236.0	212.0	206.0	5561.0	
	237.0	304.0	502.0	719.0	864.0	813.0	735.0	489.0	320.0	236.0	212.0	207.0	5638.0	
	238.0	313.0	509.0	731.0	868.0	854.0	741.0	499.0	324.0	238.0	213.0	214.0	5742.0	
	241.0	319.0	530.0	738.0	874.0	866.0	772.0	502.0	325.0	244.0	223.0	216.0	5850.0	
	247.0	321.0	532.0	742.0	908.0	871.0	790.0	507.0	333.0	247.0	227.0	218.0	5943.0	
	247.0	322.0	634.0	748.0	914.0	873.0	811.0	551.0	335.0	251.0	228.0	220.0	6134.0	
	249.0	333.0	634.0	777.0	983.0	889.0	834.0	554.0	344.0	253.0	229.0	223.0	6302.0	
	254.0	350.0	639.0	805.0	1037.0	891.0	882.0	582.0	344.0	256.0	231.0	223.0	6494.0	
	257.0	377.0	640.0	888.0	1038.0	899.0	893.0	623.0	347.0	257.0	232.0	227.0	6678.0	
Upper quartile	264.0	378.0	671.0	901.0	1055.0	923.0	938.0	665.0	354.0	258.0	232.0	228.0	6867.0	U.Q.
	265.0	388.0	700.0	952.0	1062.0	948.0	998.0	697.0	375.0	263.0	233.0	228.0	7109.0	
	266.0	393.0	902.0	952.0	1140.0	959.0	1002.0	705.0	384.0	267.0	234.0	229.0	7433.0	
	272.0	439.0	938.0	1004.0	1209.0	963.0	1031.0	712.0	399.0	279.0	234.0	229.0	7709.0	
	279.0	450.0	954.0	1028.0	1229.0	980.0	1036.0	730.0	405.0	279.0	235.0	233.0	7838.0	
	280.0	474.0	987.0	1029.0	1253.0	1002.0	1090.0	752.0	466.0	294.0	239.0	233.0	8099.0	
	282.0	488.0	1053.0	1112.0	1263.0	1005.0	1132.0	781.0	468.0	296.0	247.0	235.0	8362.0	
	286.0	500.0	1061.0	1340.0	1308.0	1048.0	1211.0	800.0	476.0	299.0	248.0	237.0	8814.0	
	288.0	540.0	1069.0	1411.0	1360.0	1141.0	1225.0	801.0	492.0	301.0	252.0	241.0	9121.0	
	290.0	594.0	1109.0	1426.0	1531.0	1206.0	1299.0	814.0	511.0	301.0	254.0	256.0	9591.0	
	394.0	631.0	1324.0	1677.0	1535.0	1319.0	1301.0	827.0	523.0	303.0	263.0	257.0	10354.0	
	529.0	654.0	1612.0	1758.0	1675.0	1377.0	1395.0	932.0	531.0	319.0	264.0	261.0	11307.0	
	659.0	720.0	1870.0	2925.0	2480.0	1886.0	1632.0	984.0	538.0	345.0	281.0	262.0	14582.0	
TOTALS	12624.0	16555.0	27992.0	35182.0	40771.0	38924.0	36979.0	26089.0	16552.0	12123.0	10830.0	10497.0	285118.0	
MEAN	242.8	318.4	538.3	676.6	784.1	748.5	711.1	501.7	318.3	233.1	208.3	201.9	5483.0	
PERCENT	4.4	5.8	9.8	12.3	14.3	13.7	13.0	9.2	5.8	4.3	3.8	3.7	100.1	

Table 6. Chronological list of inflow to Shasta Lake

INFLOW TO SHASTA LAKE BY WATERYEARS FOR THE PERIOD 1922 - 1973. DRAINAGE AREA 6665 SQUARE MILES.

YEAR	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	ANNUAL TOTAL
1921-22	230.0	235.0	332.0	299.0	542.0	604.0	772.0	623.0	335.0	238.0	212.0	200.0	4622.0
1922-23	230.0	252.0	333.0	395.0	309.0	330.0	584.0	353.0	264.0	212.0	192.0	194.0	3648.0
1923-24	220.0	204.0	216.0	224.0	331.0	228.0	208.0	182.0	167.0	169.0	167.0	163.0	2479.0
1924-25	202.0	321.0	292.0	310.0	1308.0	525.0	811.0	448.0	287.0	197.0	178.0	186.0	5065.0
1925-26	227.0	246.0	251.0	242.0	868.0	401.0	522.0	270.0	192.0	177.0	168.0	164.0	3728.0
1926-27	196.0	631.0	671.0	695.0	1360.0	854.0	1031.0	551.0	347.0	244.0	207.0	200.0	6987.0
1927-28	208.0	450.0	342.0	466.0	637.0	980.0	790.0	395.0	248.0	220.0	196.0	188.0	5120.0
1928-29	198.0	238.0	258.0	270.0	371.0	379.0	407.0	321.0	232.0	188.0	177.0	169.0	3208.0
1929-30	180.0	177.0	700.0	393.0	557.0	686.0	422.0	319.0	214.0	188.0	177.0	177.0	4190.0
1930-31	184.0	188.0	190.0	272.0	266.0	365.0	236.0	194.0	173.0	161.0	157.0	153.0	2539.0
1931-32	173.0	175.0	397.0	347.0	315.0	657.0	432.0	462.0	238.0	180.0	163.0	155.0	3694.0
1932-33	161.0	179.0	190.0	222.0	220.0	803.0	488.0	424.0	278.0	184.0	165.0	157.0	3471.0
1933-34	171.0	171.0	325.0	480.0	490.0	456.0	325.0	252.0	186.0	163.0	153.0	149.0	3321.0
1934-35	163.0	303.0	238.0	486.0	507.0	600.0	1211.0	582.0	277.0	205.0	178.0	167.0	4917.0
1935-36	181.0	178.0	712.0	805.0	1062.0	562.0	503.0	343.0	295.0	202.0	170.0	160.0	4673.0
1936-37	165.0	165.0	177.0	179.0	272.0	866.0	882.0	554.0	324.0	209.0	173.0	159.0	4125.0
1937-38	185.0	720.0	1109.0	587.0	1531.0	1886.0	1299.0	984.0	476.0	301.0	247.0	223.0	9548.0
1938-39	264.0	270.0	349.0	327.0	298.0	604.0	342.0	260.0	204.0	190.0	179.0	178.0	3465.0
1939-40	191.0	189.0	342.0	1004.0	1675.0	1377.0	938.0	417.0	271.0	223.0	204.0	199.0	7030.0
1940-41	221.0	250.0	1069.0	1411.0	1263.0	1206.0	1225.0	781.0	466.0	319.0	264.0	241.0	8716.0
1941-42	249.0	262.0	1053.0	1112.0	1535.0	556.0	893.0	697.0	468.0	303.0	254.0	237.0	7619.0
1942-43	247.0	304.0	439.0	901.0	721.0	963.0	741.0	489.0	354.0	263.0	232.0	220.0	5874.0
1943-44	229.0	251.0	246.0	284.0	478.0	516.0	404.0	355.0	292.0	233.0	208.0	189.0	3685.0
1944-45	223.0	378.0	497.0	390.0	914.0	511.0	471.0	499.0	344.0	229.0	206.0	196.0	4858.0
1945-46	282.0	474.0	1324.0	777.0	423.0	597.0	594.0	465.0	287.0	251.0	229.0	203.0	5906.0
1946-47	214.0	295.0	306.0	233.0	437.0	716.0	449.0	272.0	375.0	223.0	200.0	188.0	3908.0
1947-48	290.0	238.0	237.0	742.0	271.0	531.0	1132.0	800.0	511.0	253.0	205.0	206.0	5416.0
1948-49	215.0	240.0	267.0	218.0	371.0	1141.0	612.0	450.0	248.0	196.0	187.0	173.0	4318.0
1949-50	191.0	206.0	206.0	477.0	577.0	652.0	616.0	408.0	240.0	195.0	186.0	179.0	4133.0
1950-51	529.0	594.0	954.0	731.0	983.0	663.0	503.0	502.0	264.0	207.0	199.0	187.0	6316.0
1951-52	237.0	388.0	1061.0	748.0	1140.0	923.0	1301.0	827.0	399.0	301.0	232.0	228.0	7785.0
1952-53	238.0	236.0	639.0	1677.0	497.0	663.0	629.0	665.0	538.0	296.0	233.0	229.0	6540.0
1953-54	247.0	393.0	350.0	952.0	1055.0	959.0	1036.0	480.0	325.0	257.0	252.0	235.0	6541.0
1954-55	241.0	350.0	502.0	339.0	329.0	376.0	574.0	507.0	270.0	219.0	198.0	207.0	4112.0
1955-56	206.0	293.0	1870.0	1758.0	1209.0	889.0	735.0	730.0	384.0	279.0	248.0	233.0	8834.0
1956-57	288.0	260.0	262.0	312.0	855.0	1002.0	615.0	705.0	333.0	256.0	223.0	257.0	5368.0
1957-58	394.0	377.0	634.0	888.0	2480.0	1319.0	1395.0	801.0	523.0	345.0	281.0	261.0	9698.0
1958-59	279.0	260.0	289.0	952.0	840.0	609.0	511.0	369.0	269.0	234.0	212.0	262.0	5086.0
1959-60	233.0	224.0	246.0	402.0	874.0	873.0	474.0	453.0	320.0	224.0	208.0	202.0	4733.0
1960-61	227.0	319.0	640.0	404.0	862.0	718.0	501.0	472.0	305.0	220.0	206.0	197.0	5071.0
1961-62	222.0	333.0	532.0	323.0	1253.0	698.0	595.0	422.0	282.0	208.0	205.0	189.0	5262.0
1962-63	659.0	313.0	634.0	386.0	908.0	659.0	1632.0	752.0	344.0	267.0	231.0	218.0	7003.0
1963-64	257.0	488.0	298.0	595.0	355.0	356.0	364.0	300.0	317.0	201.0	187.0	187.0	3905.0
1964-65	212.0	322.0	1612.0	1340.0	583.0	444.0	1002.0	485.0	284.0	258.0	227.0	214.0	6983.0
1965-66	229.0	500.0	345.0	719.0	604.0	891.0	712.0	395.0	263.0	227.0	208.0	206.0	5299.0
1966-67	213.0	540.0	902.0	738.0	750.0	1005.0	998.0	932.0	531.0	299.0	263.0	233.0	7404.0
1967-68	266.0	253.0	318.0	414.0	1037.0	746.0	444.0	365.0	251.0	217.0	234.0	227.0	4772.0
1968-69	254.0	279.0	530.0	1426.0	1229.0	871.0	1090.0	814.0	405.0	279.0	235.0	256.0	7668.0
1969-70	272.0	264.0	938.0	2925.0	864.0	813.0	440.0	375.0	302.0	247.0	239.0	223.0	7902.0
1970-71	265.0	654.0	987.0	1028.0	558.0	1048.0	834.0	712.0	492.0	294.0	228.0	228.0	7328.0
1971-72	280.0	286.0	372.0	548.0	559.0	948.0	701.0	398.0	287.0	236.0	234.0	229.0	5078.0
1972-73	286.0	439.0	509.0	1029.0	1038.0	899.0	553.0	478.0	271.0	236.0	213.0	216.0	6167.0
TOTALS	12624.0	16555.0	27992.0	35182.0	40771.0	38924.0	36979.0	26089.0	16552.0	12123.0	10830.0	10497.0	285118.0
MEAN	242.8	318.4	538.3	676.6	784.1	748.5	711.1	501.7	318.3	233.1	208.3	201.9	5483.0
PERCENT	4.4	5.8	9.8	12.3	14.3	13.7	13.0	9.2	5.8	4.3	3.8	3.7	100.1

Table 7. Project use facilities

Pumps	Number of pumps	Installed capacity (kilowatts)
Corning Canal	45	7,500
Contra Costa area	9	5,400
Folsom area	3	1,400
Folsom South area	5	2,500
San Felipe area	14	5,700
San Luis Pumping-Generating	47.62% of 8	179,000[a]
San Luis Canal	147	96,400
Shasta area	15	5,800
Tehama-Colusa Canal	62	9,400
Tracy	6	90,000
Pleasant Valley	9	29,200
Dos Amigos	45.80% of 6	82,000[a]
O'Neill Pumping-Generating	6	24,000
Total	327.55	537,300

[a] Federal share of Federal/State joint-use facilities.

Table 8. Summary of Delta salinity objectives

Use Protection		Station	Type of Year[a]	Period	Parameter[b]	Criteria Document[c] (Criteria designated by Article No.) Federally approved standards: November 19, 1965 (CVP-SWP)	State Water Quality Control Policy, 1967	SWRCB Resolution 68-17, 1968	SWRCB Resolution 73-16, 1973
Western Delta Agriculture	Without substitute (overland) supply	Jersey Point and Emmaton	N C C	Jan-Dec Jan-Jul Aug-Dec	1000 p/m Cl (10-DA) 1000 p/m Cl (10-DA) 1400 p/m Cl (10-DA)	D-1		B-1	
	With substitute (overland) supply	Three-mile Sl @ Sac and San Joaquin R (after 1980)	N C C	Jan-Dec Jan-Jul Aug-Dec	1000 p/m Cl (10-DA) 1000 p/m Cl (10-DA) 1400 p/m Cl (10-DA)	E			
Delta Agriculture (flushing)		Jersey Point and Emmaton	N, BN	Apr-May	200 p/m Cl (10-CD)	D-2		B-2	
Interior Delta Agriculture		Terminus, Rio Vista, San Andreas Landing, and Clifton Court Ferry	N	Jan-Dec	500 p/m TDS (MA)				
			BN	Jan-Jul	500 p/m TDS (MA)	D-3b		B-3b	
				Aug-Dec	600 p/m TDS (MA)	D-4		B-4	
			D,C	Jan-Mar	500 p/m TDS (MA)				
				Apr-Dec	600 p/m TDS (MA)				
		Bifurcation of Middle & Old R	Same as above stations after initial operation of the Peripheral Canal			D-3b D-4		B-3b B-4	
		Sacramento R @ Green's Landing (Adjustment)	Whenever values exceed 150 p/m TDS (MA), max values for above stations may be increased by adding 1.5 times the excess			D-5		B-5	
		Clifton Court Ferry	All	Jan-Dec	600 p/m TDS (MA)		16a		
Eastern Delta Agriculture		Eastern Delta channels	All	Jan-Dec	700 p/m TDS (MA)		16e		
Agriculture, Municipal and Industrial		Vernalis	All	Jan-Dec	500 p/m TDS (MA)	C[e]	16d		
Contra Costa Canal Municipal and Industrial		Rock Slough @ Contra Costa Canal Intake	All	Jan-Dec	250 p/m Cl (MTC) & 100 p/m Cl (MTC) at least 65% of yr		17a		
					750 p/m TDS (MTC) & 380 p/m TDS (MTC) at least 65% of yr		16c		
Vallejo Municipal and Industrial		Cache Sl @ City of Vallejo Intake	All	Jan-Dec	250 p/m TDS (AT)		16b		
					100 p/m Cl (AT)		17b		
Western Delta Municipal and Industrial without substitute (overland) supply		Antioch	N, BN	150 days					A-1
			D	120 days					A-1
			C	100 days					A-1
Striped Bass		Antioch Water Works Intake	All	For 5 wks beginning when water temperature reaches 60°F	1000 p/m TDS (14-DA)				A-2[d]
		Prisoner's Point			350 p/m TDS (14-DA)				A-2[d]

a N=Normal; BN=Below Normal; C=Critical; D=Dry.

b p/m=parts per million; Cl=Chlorides; TDS=Total Dissolved Solids; (10-DA)=10-day average; (10-CD)=Daily average for at least 10 consecutive days; (14-DA)=14-day average; (MA)=Monthly average; (MTC)=Mean Tidal Cycle; (AT)=All Times; (DA)=Daily average.

c State Water Quality Control Policy (1967), Resolution 68-17 (1968), and Resolution 73-16 (1973) have been adopted as Federal policy. (June 20, 1973).

d May be modified for fishery experimentations.

e Provided not more than 70,000 a.f. released from New Melones Reservoir for water quality control.

HYDROLOGIC BASE

The Central Valley Project capability to satisfy its existing and anticipated water contractual commitments is estimated from reservoir operation studies, using the basic hydrology described in this part.

The operational objectives are defined in the legislation authorizing the Central Valley Project, agreements with other Federal or State agencies, water right and water service contracts, and power contracts. These objectives are:

1. Maintenance of storage for flood control at reservoirs where authorized.

2. Maintenance of Sacramento River flows to assure continued navigability.

3. Maintenance of minimum flows downstream from some CVP facilities to protect and preserve the fish and wildlife resources.

4. Maintenance of water quality to assure project ability to deliver water to project water users at quality levels equal to or better than those specified in given contracts.

5. The recognition and satisfaction of vested prior rights to the use of waters originating above CVP facilities.

6. The satisfaction of CVP water service contract commitments.

7. Maintenance of reservoir storage levels for recreational uses.

8. The generation of electric power, mostly as a result of meeting the foregoing objectives.

Prior to the CVP water rights hearings of 1959-60, CVP accomplishments were based on priority to the use of water as indicated by dates of applications, permits, and licenses. This meant that projects which were existing at the time of inclusion of CVP facilities were operated for their projected purposes, and the Central Valley Project would establish its entitlements to utilize the waters of the basin on the basis of water remaining. Other water development based on appropriations made after the establishment of the CVP entitlements would be junior to the Central Valley Project.

The State Water Rights Board Decision D-990 and the May 16, 1960, agreement between the Bureau of Reclamation and the State of

California Department of Water Resources (DWR) modified this position to the effect that D-990 provided for future appropriations of water within the Sacramento Valley and Delta with a priority over the CVP exports regardless of date of application. The May 16, 1960, agreement gave the State Water Project a priority to the flows remaining in the Delta equal to that of the Central Valley Project. The end result was that a new hydrologic base was developed so that the CVP accomplishments could be redetermined on the basis of its new status relative to other development and the State Water Project.

In development of a hydrologic base upon which to estimate the future quantities of water in the Central Valley Basin that would be available for CVP use, the Bureau of Reclamation and Department of Water Resources collaborated in the preparation of streamflow data on all water diversions or depletions due to future development in the basin. The resulting data are referred to as the Central Valley Depletion Analysis. There are a number of assumptions basic to the depletion analysis concept that were used so that the accomplishments of the Central Valley Project would be reasonably conservative and not subject to criticism because of insufficient consideration of the potential impact of D-990. They are:

1. Almost all of the irrigable land within the Central Valley Basin would be developed in order to satisfy food and fiber needs of the State and Nation at the assumed level of development.

2. The necessary water resource development, i.e., storage, imports, and conveyance, would be provided as required to satisfy the projected water requirements which are assumed to be constant from year to year.

3. The Central Valley Basin was divided into 40 hydrographic or water-producing and water-using areas, each with an identifiable outflow point or points. Either recorded or estimated historical flows are available for each of these points.

4. The hydrologic effect of the operation of all known local water storage, diversion, or detention works that are not operated on an integrated basis with facilities of the Central Valley Project was reflected in the development of the depletion analysis data. The level of use of these facilities in 2015 reflected the maximum utilization that could be expected based on design of the respective facilities. Examples of local facilities are: Orland Project, Solano Project, Yuba County Water Agency Project, Placer County Water Agency Project, New Don Pedro Dam and Reservoir, and New Exchequer Dam and Reservoir.

5. It would be necessary to develop additional storage over and above that which was identifiable as already existing or planned for construction in order to satisfy the projected water requirements. Either seasonal or long-term carryover storage would be necessary to guarantee water deliveries during the summer months or during the recurrence of a period of very dry years such as has been experienced in the past. This additional storage amounted to approximately 10,700,000 acre-feet. It was anticipated that a portion of this storage would be made available in the ground-water reservoir through the greater conjunctive use of ground water. The additional surface storage was expected to become available as a result of the development of such facilities as the proposed Sites, Paskenta-Newville, Tuscan Buttes, and Glenn Complex Reservoirs. This additional storage was refilled by recharge from the winter flows at given points in the basin.

6. An import supply from outside the Central Valley Basin, in addition to the Trinity River import, was required to fully satisfy the projected water requirements. This import supply averaged approximately 850,000 acre-feet per year, varying from a minimum of 42,000 acre-feet to 1,652,000 acre-feet. The average is based upon riverflows that would be expected during a recurrence of a period of water years similar in water production--rain and snowfall--to the period 1922 to 1954.

7. The projected consumptive use water requirements were met by utilizing rain and snowfall, water already available in the soil, direct diversion of streamflow, and releases from storage reservoirs.

8. An upstream hydrographic area's entire water requirements were assumed to be satisfied before the water requirements of the next downstream hydrographic area were satisfied.

9. Water rights were recognized on a basin-of-origin basis in the depletion analysis. This did not constitute the ignoring of prior vested water rights since the area covered by such rights was included within the projected irrigable lands.

10. The flows computed by the depletion analysis procedure were adjusted to include return flows from project and nonproject uses, existing and future uses.

11. Return flow rates for the valley floor hydrographic areas were set at 15 percent, and those of the foothill areas at 25 percent of the water applied to the land.

12. Flows remaining after computing and adjusting depletions are available to satisfy CVP and SWP requirements from the Sacramento-San Joaquin Delta.

It should be reiterated that the conditions described above would be necessary to develop lands as indicated in State projections. If the water supply development did not materialize, the land could not be developed and conversely if the projection proves too high, the additional water supply development would not be needed. In either case, the impact on the hydrology used to demonstrate CVP developed water supply would not materially change the CVP accomplishments described herein, since the incremental development and associated water supply are somewhat independent from the authorized Central Valley Project.

As the base upon which the accomplishments of the Central Valley Project are premised, flow data derived from the depletion analysis for various locations were used. These locations are:

Inflow to	Flow at
Shasta Lake	Red Bluff Diversion Dam
Folsom Lake	Navigation Control Point
Auburn Reservoir	
Clair Engle Lake	
Whiskeytown Lake	
Sacramento-San Joaquin Delta from:	
a. Sacramento Valley	
b. San Joaquin Valley	

The period of record for which depletion analysis data have been prepared is 1922 to 1966. Earlier CVP operation studies were made using the 1922 to 1954 period. The length of record can be significant in the evaluation of long-term averages for power generation, reservoir stages and surface areas, Delta outflow, and evaporation.

Within this period there occurred a sequence of severely dry years which is used for water service contracting purposes to estimate the water supply capability of the Central Valley Project in the Sacramento Basin and Sacramento-San Joaquin Delta. The critical drought period, as it is commonly identified, extends from May of 1928 to December of 1934. During this sequence of years, the reservoirs of the Central Valley Project are designed to provide the necessary carryover storage that would permit the satisfaction of the full project accomplishments with allowable shortages.

AUTHORIZED PROJECT

PHYSICAL FEATURES

The Central Valley Project has been carefully planned and developed as a series of contiguous units, each enjoying the water supply reliability and flexibility created by coordination with water and power operations of other units. As water needs have been identified and the desirability of Federal involvement determined, additional divisions or units have been authorized for inclusion in the project.

At the present time the following facilities authorized for inclusion into the Central Valley Project are at various stages of preconstruction or construction:

Auburn Dam and Powerplant
New Melones Dam and Powerplant
Marysville Dam and Powerplant
Hidden Dam
Buchanan Dam
Sugar Pine Dam
County Line Dam
San Felipe Division
San Luis Drain and Kesterson Reservoir
Folsom South Canal
Tehama-Colusa Canal (reaches 4 through 8)

WATER SUPPLY

The firm annual water supply of the Central Valley Project including Auburn has been considered to be 9,250,000 acre-feet available for the Sacramento and American River Basins and the Sacramento-San Joaquin Delta from a Central Valley Project comprised of Clair Engle, Shasta, Folsom, Auburn, Whiskeytown, and San Luis Reservoirs.

The total water supply expected to be available from the existing and authorized Federal CVP facilities is 11,407,116 acre-feet annually, including prior vested rights water. Table 10, p. 52, shows how the expanded supply was derived.

To satisfy prior vested rights downstream from or at project facilities, annual water supplies presently estimated to be available are:

	Acre-feet
Sacramento River Basin	2,450,500
American River Basin	324,000
Sacramento-San Joaquin Delta	885,622
	3,660,122

The Central Valley Project, as authorized, is expected to develop 7,746,994 acre-feet of water annually for marketing to irrigation, municipal, industrial, wildlife conservation users, and for satisfaction of conveyance losses. This annual supply will be available as follows:

Basin	Present	Authorized to be constructed (acre-feet)	Total
Trinity and Sacramento Rivers and Sacramento-San Joaquin Delta	4,456,878	190,000	4,646,878
Stony Creek	59,000	-	59,000
American River	935,000	320,800	1,255,800
Cosumnes River	23,000	-	23,000
San Joaquin River	1,504,316	258,000	1,762,316
Annual supply	6,978,194	768,800	7,746,994

The facilities authorized to be constructed and the estimated annual supply they are expected to provide are:

	Dam and reservoir		Annual supply (acre-feet)
Trinity and Sacramento Rivers, and Sacramento-San Joaquin Delta	Marysville		155,000
	New Melones		35,000
		Subtotal	190,000
American River	Auburn		318,000
	Sugar Pine		2,800
		Subtotal	320,800
San Joaquin River	New Melones		210,000
	Hidden		24,000
	Buchanan		24,000
		Subtotal	258,000
		Total	768,800

By basin the supply available with the present project, and with the authorized project facilities is:

Basin	Vested downstream rights	Supply available (including vested downstream rights) Present project (acre-feet)	Supply available (including vested downstream rights) Authorized project (acre-feet)
Sacramento Valley	2,450,000	3,864,000	3,864,000
American River	324,000	1,259,000	1,579,800
Delta	885,622	3,988,000	4,178,000
San Joaquin Valley	-	1,527,316	1,785,316
Total	3,660,122	10,638,316	11,407,116

In developing the water supply capability of the Central Valley Project, these points need to be emphasized:

1. Water supplies estimated to be available from the Sacramento and American River Basins and Sacramento-San Joaquin Delta for the Central Valley Project and the State Water Project are predicated on the existence of the proposed Peripheral Canal and facilities to serve the western Delta.

2. With the Peripheral Canal and facilities to serve the western Delta, a minimum Delta outflow of 1,800 cubic feet per second was estimated to be adequate to satisfactorily meet the water quality criteria outlined in an agreement, dated November 19, 1965, between the Sacramento River and Delta Water Association, San Joaquin Water Rights Committee, California Department of Water Resources, and the Bureau of Reclamation.

3. The CVP facilities which contribute water to the Sacramento-San Joaquin Delta are operated in coordination with the State Water Project. The SWP supply available for export from the Delta with 1,800 cubic foot per second outflow is estimated at 3,800,000 acre-feet. The present estimate of the maximum SWP contract requirements from the Delta are about 4,425,000 acre-feet per year.

4. The location of the service area in which project water is projected to be used has a direct bearing upon the supply estimated to be available. Water diverted within the basin above the Delta will produce return flows which may be diverted at downstream locations.

For example, 10 acre-feet of water diverted to a service area above the Delta for irrigation is estimated to produce 3 acre-feet of return flow available for diversion from the Delta. The total water available would be 13 acre-feet. However, if no water was diverted to a service area above the Delta for irrigation, the total water available for outflow or consumptive use would be only 10 acre-feet as there would be no reusable return flow available.

5. Not all of the water supply developed by the Central Valley Project will be available on a firm basis every year. The class 2 supply available from Millerton Lake and the supplies expected to be available from Hidden and Buchanan Reservoirs are variable from year to year, depending upon the runoff conditions of the respective basins. In addition, there is little opportunity in these two reservoirs to provide carryover storage from one year to the next, because of storage capacity limitations and flood control criteria.

CVP supplies from the other sources are expected to be available every year as carryover storage is adequate. Shortages which may be taken in these supplies during critical dry years are reflected in the expected water supply accomplishments of the project.

WATER DEMANDS

Consumptive water demands upon the Central Valley Project are those irrigation, municipal, industrial, waterfowl conservation, and wildlife refuge requirements projected to occur within the CVP service areas plus those downstream water rights which are satisfied by releases of inflow from CVP reservoirs.

Table 9 shows the CVP supply obligated by long-term contract, calendar year 1972 water use, and anticipated demand for CVP water. The quantities shown include both project and downstream water rights quantities.

The calendar year 1972 quantities include water delivered both to long-term and temporary contractors. Temporary contractors generally have either 1-year or 5-year contracts to use project water which is surplus to long-term contractor needs. These temporary contracts are usually renewable, depending upon the continued availability of unused project water.

The anticipated future demands for CVP water are a result of several types of information. They are:

1. Water quantities committed by long-term contracts.

2. Water quantities under discussion in negotiations between the Bureau and potential contractors that will lead to contracts.

3. Estimates of water required to satisfy the projected agricultural, municipal, industrial, wildlife, and waterfowl demands which resulted from studies leading to the authorization of additional divisions or units to the project.

It should be noted that in table 9:

1. Some of the demands have been limited to the estimated CVP supply or conveyance capacity available.

2. Several areas for which a demand is shown do not presently have conveyance facilities necessary to deliver the water. Further, Mid-Valley and West Sacramento Valley Canals have not been authorized.

3. In several areas which desire project water, potential water users are planning and developing their own facilities so that they may obtain water from existing CVP facilities.

Other potential requirements for CVP water are not included in table 9. These are:

1. Project water necessary to supplement the Sacramento-San Joaquin Delta consumptive use requirements.

2. Project water required to maintain Delta water quality standards that become the responsibility of the United States in addition to the current Federally approved standards.

3. Cooling water for power-generating facilities that may be located in the Central Valley Basin.

4. Water requirements of the SWP contractors which apparently cannot be satisfied by existing State supplies and may be contracted by the State.

Additional data on projected requirements for CVP water will be presented in a working document on uncontracted water which is an activity of the Total Water Management Study.

ELECTRIC POWER

The criteria for determining the electric power accomplishments associated with the Central Valley Project as authorized are, with few exceptions, the same as the present project operation. The exceptions are that project use energy will increase from 980 million kilowatthours in 1974 to about 1,650 million kilowatthours in year 2020. Average energy generation and dependable capacity will also increase with the addition of these powerplants.

Powerplant	Installed capacity (kilowatt)
New Melones	300,000
Auburn	300,000
Marysville	50,000

The average energy generation will increase from 4.6 billion kilowatthours in 1974 to about 5.9 billion in year 2020. The dependable capacity will also increase from the present level of 925,000 kilowatts to about 1,248,000 kilowatts in year 2020. In regard to the change in dependable capacity, it should be noted that:

1. The dependable capacity will decrease from the present level to about 700,000 kilowatts by 1995, if all authorized powerplants are not constructed.

2. The present firming contract with PG&E sets energy requirements applicable to each plant, with a project annual requirement of about 32 percent system load factor. Since the need for peaking capacity in northern California is growing, the assumption has been made that CVP hydroplants can be used more for peaking type operation, and can thereby increase project dependable capacity with the same amount of energy generation. This would be accomplished by eliminating the seasonal energy requirement by purchase of energy to meet offpeak pumping during critical periods, and by operation of the New Melones Powerplant at plant load factors decreasing to about 10 percent after 1990.

WATER QUALITY

The water and power accomplishments of the authorized features of the Central Valley Project are presently predicated upon the satisfaction of the Delta salinity objectives outlined in the November 19, 1965, Agreement. The controlling objective of that agreement was 1,000 parts per million for the 10 consecutive day average chloride line at Emmaton on the Sacramento River and Jersey Point on the San Joaquin River. This salinity objective may be relaxed to 1,400 parts per million for the 10 consecutive day average chloride during August through December of critical years. With Central Valley Project and State Water Project pumping from the Delta, and with the existence of the Peripheral Canal and facilities to serve the western Delta, an outflow of 1,800 cubic feet per second was expected to be adequate to maintain the average chloride objective of 1,000 parts per million for 10 consecutive days. With an outflow of 1,500 cubic feet per second, the relaxed objective of 1,400 parts per million was expected to be maintained. Table 8 shows the water quality objectives of the November 19, 1965, Agreement criteria.

The authorization of the New Melones Project, now being constructed by the Corps of Engineers and to be operated by the Bureau of Reclamation, directed the Secretary of the Army to give consideration to the advisability of including storage for the regulation of streamflow for downstream water quality control. Evaluations were made and an agreement was reached between the Bureau of Reclamation and the California Regional Water Quality Control Board, Central Valley Region, establishing these operational objectives for water quality:

> In the Stanislaus River, maintenance of the oxygen level (DO) at or above 5 milligrams per liter (mg/l).
>
> For the San Joaquin River at Vernalis below the mouth of the Stanislaus River, maintenance of the level of total dissolved solids (TDS) so as not to exceed a mean monthly concentration of 500 mg/l.

Releases of water from New Melones Reservoir to satisfy the water quality objectives are not to exceed 70,000 acre-feet in any one year.

The purpose of the San Luis Drain, authorized as a part of the San Luis Unit, is to convey drainage waters from the unit service area in order to maintain tolerable salinity and water levels in the soil profile. The drain has been constructed to Kesterson Reservoir near Gustine where the drainage waters will be disposed of by evaporation until the authorized reach from Kesterson to the Delta is completed.

FLOOD CONTROL

As the authorized reservoirs of the Central Valley Project are completed, their flood control capability will be added to the project. These additional facilities and the criteria which are expected to govern the flood control operations are presented in table 11.

With the completion of Auburn Dam, the maximum flood control storage reservation of the American River CVP facilities will increase from the present 400,000 acre-feet with only Folsom Reservoir to 650,000 acre-feet with Auburn and Folsom Reservoirs.

FISH AND WILDLIFE

The requirements to provide minimum flows downstream from the uncompleted authorized facilities of the Central Valley Project are:

Reservoir	Period	Release (ft^3/s)
Auburn	All year	75
New Melones	October 1-December 31	200
	January 1-May 31	125
	June 1-September 30	100
Marysville	October 1-February 28/29	400
	March 1-July 31	250
	August 1-September 30	70
Sugar Pine	February 1-May 31	5 or inflow
	June 1-January 31	2 or inflow
	Year round	never less than 1.5
County Line	All year	8 or natural inflow (whichever is less)

RECREATION

Recreational facilities are to be developed at the authorized, but uncompleted, additions to the Central Valley Project. These facilities will be maintained by various local, State, or Federal entities.

Minimum pools will be maintained in County Line, Hidden, Buchanan, and Sugar Pine Reservoirs for recreation and resident fishery.

The Corps of Engineers will be developing recreation facilities at New Melones Reservoir. In addition, recreational access points to the Stanislaus River downstream from the project are being

evaluated for potential development. These would provide access to the river for fishing, picnicking, rafting, kayaking, and boating.

Lands around the Auburn Reservoir will become part of the California State Park system. Many types of recreational activity are expected to be available. With Auburn Reservoir, the Bureau of Reclamation can operate Folsom Dam and Reservoir so that the average fluctuation of Folsom Lake will be reduced from 43 feet during the recreation season to 16 feet. This will enhance the recreation potential of Folsom Lake.

Since the construction of Folsom Dam and the authorization of the Auburn-Folsom South Unit, the public has placed greater emphasis on the fishery and recreational uses of the river below Nimbus Dam. In relation to these uses, there is a strong demand for additional releases over the minimum amounts established by a 1957 agreement with the State of California Department of Fish and Game. Additional impetus to this demand was engendered by the adoption by the State Water Resources Control Board of Decision 1400 affecting the water rights permits held by the United States for Auburn Dam and Reservoir. Implementation of Decision 1400 would require that flows of 1,250 cubic feet per second be maintained in the entire reach of the American River from Nimbus to its mouth from October 15 to July 14, reducing to 800 cubic feet per second from July 15 to October 14, for maintenance of fish and wildlife. In addition, implementation of Decision 1400 would require a minimum flow of 1,500 cubic feet per second for recreational purposes from May 15 through October 14. Implementation of Decision 1400 is contingent upon resolution of the litigation pending in the matter.

NAVIGATION

No additional navigation objectives are associated with the authorized additions to the Central Valley Project. The objectives discussed under "Present Project" are expected to remain the same.

Table 9. CVP supply obligated by long-term contract, calendar year 1972 water use, and anticipated demand for CVP water (unit = acre-feet)

	SACRAMENTO VALLEY	Supply under long-term contract (1972)	Use, calendar year 1972	Anticipated demand for water
1.	Clear Creek South	17,400	3,070	31,000
2.	Cow Creek South	24,000	5,745	24,000
3.	City of Redding	6,140[a]	119	6,140
4.	Feather Water District	20,000	21,130	20,000
5.	Spring Creek Conduit & others	1,625	410	1,625
6.	Toyon Pipeline	3,960	1,481	3,960
7.	Shasta area	5,000	39	5,000
8.	Sacramento River diverters	2,432,609	2,336,820	2,933,500
	Project water	(507,460)	(210,444)[b]	(378,000)
	Base supply	(1,820,149)	(1,595,662)[c]	(1,950,500)
	Bypasses and riparian	-	(500,000)	(500,000)
	Wildlife refuges	(105,000)	(30,714)	(105,000)
9.	Sacramento Canals	226,000	48,253	705,000
	Corning Canal	(44,900)	(26,931)	(108,000)
	Tehama-Colusa Canal	(172,100)	(19,217)	(400,000)
	West Sacramento Valley Canal	-	-	(148,000)
	Losses	(9,000)	(2,105)	(49,000)
10.	Stony Creek diverters	170	73	170
	Subtotal	2,736,904	2,417,140	3,730,395

a City of Redding also receives water under a Sacramento River Diverter contract - 3,150 acre-feet, project supply, 17,850 acre-feet, base supply.

b Includes 882 acre-feet of project water used by the city of Redding.

c Includes 5,006 acre-feet of base supply used by the city of Redding.

Table 9 (continued)

	AMERICAN RIVER	Supply under long-term contract (1972)	Use, calendar year 1972	Anticipated demand for water
1.	El Dorado County	37,600[a]	1,261	37,600
2.	San Juan Suburban	11,200	3,941	11,200
3.	City of Roseville	40,000	6,219	40,000
4.	North Fork, Natomas Ditch, and Folsom Prison	69,000	54,620	69,000
5.	Placer County	117,000	-	117,000
6.	Placer County Water Rights	120,000	-	120,000
7.	Malby	-	-	25,000
8.	City of Sacramento	230,000[b]	35,792	230,000
9.	Folsom South Canal	237,000	-	965,000
	SMUD	(75,000)[c]	-	(75,000)[c]
	EBMUD	(150,000)	-	(150,000)
	Irrigation	-	-	(620,000)
	M&I	-	-	(80,000)
	Losses	(12,000)[d]	-	(40,000)
10.	Foresthill Divide	2,800	-	2,800
	Subtotal	864,600	101,833	1,617,600

a The 37,000 acre-feet for the El Dorado County Hills Water District is subject to reduction in the event the entity does not pay for the contractual minimum.

b Total contractual obligation is 245,000 acre-feet (project water, 90,000 acre-feet; water rights, 155,000 acre-feet). 15,000 acre-feet is to be delivered to SMUD via the Folsom South Canal and 20,000 acre-feet are available from return flows originating below Nimbus Dam.

c Includes 15,000 acre-feet of city of Sacramento water rights water to be conveyed to SMUD's Rancho Seco facilities.

d Losses shown are those associated with the SMUD and EBMUD supplies only.

Table 9 (continued)

DELTA	Supply under long-term contract (1972)	Use, calendar year 1972	Anticipated demand for water
1. Delta-Mendota Canal	1,491,851	1,604,896	1,667,000
DMC water	(422,227)[a]	(572,610)[b]	(594,365)
Exchange contracts	(840,000)	(836,885)	(840,000)
Schedule II	(34,624)	(31,164)	(37,635)
Water rights	(6,000)	-	(6,000)
Grasslands	(50,000)	(62,156)	(50,000)
State of California	(19,000)	(24,081)	(19,000)
Losses	(120,000)	(78,000)	(120,000)
2. Contra Costa Canal	195,000	94,380	195,000
Schedule A	(86,000)	(86,000)	(86,000)
Schedule B	(39,000)	(8,380)	(39,000)
Schedule C	(70,000)	(0)	(70,000)
3. San Luis Canal	1,475,200	856,181	1,475,200
San Luis irrigation	(1,176,000)[c]	(839,714)	(1,176,000)
San Luis interim	(207,000)	(0)	(207,000)
Miscellaneous	(5,700)	(424)	(5,700)
M&I	(27,500)	(6,043)	(27,500)
Losses	(59,000)	(10,000)	(59,000)
4. San Felipe Unit	-	-	216,000
5. Cross Valley Canal	-	-	128,300
6. Mid-Valley Canal	-	-	650,000
Subtotal	3,162,051	2,555,457	4,331,500
Subtotal - Sacramento and American Rivers, Sacramento-San Joaquin Delta	6,763,555	5,074,430	9,679,495

a Includes only long-term contracts. A number of entities have enlarged their areas and are using additional water from the uncontracted supply each and every year.

b Water is delivered to various individuals and entities pursuant to amendatory and temporary contracts.

c Contracts with the Panoche, San Luis, and Westlands Water Districts totaling 396,000 acre-feet are awaiting Secretary of the Interior approval.

Table 9 (continued)

	SAN JOAQUIN VALLEY	Supply under long-term contract (1972)	Use, calendar year 1972	Anticipated demand for water
1.	Friant Division	2,271,000 [a]	896,340[b]	1,504,316
	Class I	(800,000)	(806,497)	-
	Class II	(1,402,800)[a]	(64,050)	-
	Losses	(68,200)	(25,793)	-
2.	Hidden Project	24,000	-	24,000
3.	Buchanan Project	24,000	-	24,000
4.	Sly Park Unit	23,000	20,903	23,000
5.	New Melones Project	-	-	210,000[c]
	Subtotal	2,342,000	917,243	1,785,316
	Total	9,105,555[a]	5,991,673	11,464,811

a Maximum class II water entitlements. Historically an average of approximately 47 percent of the maximum class II supply has been available.

b Inflow to Millerton Lake was approximately 60 percent of average, thus accounting for the relatively low use of water during 1972.

c Demand assumed to be within Stanislaus, Tuolumne, Calaveras, and San Joaquin Counties.

Table 10. Total CVP water supply available[a]

Facility or service area	Supply (acre-feet)
Central Valley Project[b]	9,250,000
Existing facilities	(8,932,000)
Authorized facilities (Auburn)	(318,000)
Other reservoirs	532,800
Existing facilities	82,000
Sly Park	(23,000)
Black Butte*	(59,000)
Authorized facilities	450,800
New Melones*	(245,000)
Marysville*	(155,000)
Hidden*	(24,000)
Buchanan*	(24,000)
Sugar Pine	(2,800)
Other service areas	1,624,316
Existing facilities	1,624,316
Placer County Water rights	(120,000)
Friant Division	(1,504,316)
Total	11,407,116
SUMMARY	
Existing facilities	10,638,316
Authorized facilities	768,800
TOTAL	11,407,116

* Corps of Engineers' project

a Available from existing and authorized CVP facilities plus Peripheral Canal and overland facilities to serve the Western Delta.

b Without Millerton, Sly Park, Sugar Pine or Corps of Engineers' projects listed.

Table 11. Flood control criteria for authorized facilities

	Auburn	Folsom with Auburn	New Melones	Buchanan	Hidden	Marysville
Operation period	Oct-May	Oct-May	Sep-July	Sep-May	Sep-May	Sep-May
Maximum reservation (acre-feet)	450,000[a]	325,000[a]	450,000	45,000	65,000	260,000
Minimum reservation (acre-feet)	325,000[a]	200,000[a]	450,000	29,000	37,000	160,000
Maximum release (ft^3/s)	-	115,000	b	c	d	e
Allowable release change rate						
Increasing rate (ft^3/s)		10,000 in 2 hours	-	500 in 1 hour	500 in 1 hour	10,000 in 2 hours
Decreasing rate (ft^3/s)		5,000-11,500 in 3 hours		500 in 1 hour	500 in 1 hour	10,000 in 2 hours

a Congressional authorization for the combined flood pools of Auburn and Folsom Reservoirs is 650,000 acre-feet. When the maximum reservation is being maintained in Auburn Reservoir, it will only be necessary to maintain the minimum reservation in Folsom Reservoir. When the maximum reservation is being maintained in Folsom Reservoir, the minimum reservation is to be maintained in Auburn Reservoir.

b Water shall be released so that the flows of the Stanislaus River at Riverbank are not caused to exceed 8,000 ft^3/s.

c Water shall be released so that the flows of the Chowchilla River at Madera Canal are not caused to exceed 7,000 ft^3/s.

d Water shall be released so that the flows of the Fresno River at Madera Canal are not caused to exceed 5,000 ft^3/s.

e Water shall be released, subject to the following conditions:

1. That flows in the Yuba River at the mouth do not exceed the lesser of 180,000 ft^3/s or maximum rate of inflow for the flood.

2. That releases do not cause flows in the Feather River below the mouth of the Yuba River to exceed 300,000 ft^3/s.


ATMOSPHERIC WATER RESOURCES
Transmountain Diversion
Debris Dam
Natural Area Preservation
For Pollution Control
Wildlife Refuge
MULTIPURPOSE RESERVOIR
RECREATION
Evaporation Studies
FLOOD CONTROL
Pump Storage Reservoir
Pumping Plant (Reversible Turbines)
MUNICIPAL & INDUSTRIAL WATER
POWER
Erosio Contr
Underground
Regulating Reservoir
Diversion Dam
Fish Ladder
Port Facility
Historical Area Preservation
Wasteway
Fish Hatchery
Sewage Treatment Plant
Navigation
Public Beach
Nuclear Power Plant
Undersea
Aqueduct
DESALINATION PLANT
(MUNICIPAL & INDUSTRIAL WATER)