EL CAPITAN DAM ON SAN DIEGO RIVER

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS

Publications of the
DIVISION OF WATER RESOURCES
EDWARD HYATT, State Engineer

BULLETIN NO. 48

SAN DIEGO COUNTY INVESTIGATION

1935

Pursuant to Chapter 278
Statutes of 1933

(SEAL)

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ACKNOWLEDGMENT

In the flood control investigation of the San Diego River and other streams in San Diego County and in the formulation of a plan for conservation and flood control of water originating in the San Diego River Basin, and a plan for flood control of the Tia Juana River between the international boundary line and the Pacific Ocean, most valuable assistance and cooperation have been received.

Many individuals, irrigation districts and other public and private agencies have furnished data and information which were particularly useful in the preparation of this report.

Valuable cooperation has been rendered by public officials of the City and the County of San Diego.

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CHAPTER 278, STATUTES OF 1933

Item 156 -- For flood control investigation of the San Diego River and other streams in San Diego County in cooperation with San Diego County and other agencies, to be expended under the authority and direction of the State Department of Public Works, twelve thousand dollars, provided that one-half of the money hereby appropriated shall not become available for expenditure unless the sum of six thousand dollars ($6,000.00) (from other than State revenues) shall have been paid and deposited in trust with the State Treasurer on or before July 5, 1933, and the balance thereof until a like sum of six thousand dollars ($6,000.00) shall have been paid and deposited in trust with the State Treasurer on or before January 1, 1934, to match the sum herein appropriated for expenditure for the same purpose as that for which this appropriation is made. No money hereby appropriated shall become available for expenditure until at least the sum of six thousand dollars ($6,000.00) shall have been paid in trust with the State Treasurer by San Diego County --------------------$12,000.00

FOREWORD

This bulletin has been prepared by the Division of Water Resources of the State Department of Public Works in cooperation with the County of San Diego and the City of San Diego.

This report presents detailed data and information on the water supplies and agricultural lands of San Diego County; the present status of irrigation and domestic and municipal water supply developments; the utilization of water supplies from surface and underground sources; the irrigable lands and water requirements and the domestic and municipal water requirements of the metropolitan area; the flood flows of the principal streams and probable frequency of occurrence; and presents a plan for the complete development of the water resources of the San Diego River Basin and flood control of the San Diego River in the Mission Bay area.

CHAPTER I

INTRODUCTION, SUMMARY AND CONCLUSIONS

San Diego County occupies the most southwesterly corner of continental United States being bounded on the south by the international boundary line between United States and Mexico and by the Pacific Ocean on the west. Orange and Riverside counties adjoin the county on the north and Imperial county lies to the east. The county approaches a rectangle in shape having a width north and south of about 60 miles and a length east and west of about 70 miles. The topography of the larger part of the county is mountainous. The Peninsula Range crosses the county running in a southeasterly direction with approximately two-thirds of the area of the county lying west of the divide. The range is rugged with several peaks over 6,500 feet in elevation. Its easterly slope is precipitous and drains into the Great Basin of the Colorado River.

Seven principal streams of the county drain the westerly slope of the range and discharge into the Pacific Ocean. They are, from north to south, Santa Margarita, San Luis Rey, San Dieguito, San Diego, Sweetwater, Otay and Tia Juana rivers. Broad gently sloping mesas border the coast line south of the Santa Margarita River and merge into the rough westerly slope of the Peninsula Range about 15 miles from the coast line.

San Diego County has an area of 4,221 square miles of which 1300 square miles were included in ranches and farms, and 226 square miles or 144,600 acres were classified as crop land in 1930. Agriculture is one of the principal industries of the county and the United States Census reported the value in 1930 of land, buildings, equipment and live stock utilized in the industry to be about $92,000,000. Approximately 285,000 acres of good agricultural lands lie

on the Pacific slope. Conditions are suitable for the production of a large variety of crops including many semi-tropical fruits and winter vegetables among which are avocados, oranges and lemons, celery, tomatoes and Irish potatoes. Dairying and the raising of beef cattle and poultry also are important industries. The value of crops and live stock products in 1929 were reported by the U. S. Census to be $13,500,000.

The most important manufacturing industry in San Diego County is the canning of fishery products. The excellent harbor and the proximity to Mexican waters from which tuna and tunalike fish are obtained places San Diego in an important position in the fish canning industry of the State. In 1929 the value of canned products of the sea was $5,557,000 or about 19 per cent of the total for the State. Sixteen different commercial minerals were produced in 1930 valued at $1,303,047. Considerable activity has recently been shown in the old gold mining district around Julian.

Practically all the electric energy used in San Diego County is generated in the county. The power plants in the county have an installed capacity of 91,000 kilovolt amperes for steam electric and 1,100 kilovolt amperes for hydroelectric generation and in 1933 produced a total of about 180,000,000 kilowatt hours of which 174,000,000 kilowatt hours were generated by the steam plants.

The country is well served by transportation facilities. Two transcontinental railroad systems have lines terminating in San Diego. The Atchison, Topeka and Santa Fe Railway traverses the coast section with branch lines running inland to Fallbrook and Escondido and gives rail transportation to the east via Los Angeles. The San Diego and Arizona Railway extends east along the south boundary of the county, part of its route lying in Mexico, and connects with the Southern Pacific main lines at Yuma, Arizona. It has a branch line running inland to La Mesa, El Cajon and Lakeside. Paved highways extend throughout most

of the developed areas and excellent dirt roads serve the balance of the county.

San Diego is the most southerly port on the Pacific Coast of the United States, and the first as well as the last port of call for vessels operating through the Panama Canal in intercoastal and foreign trade. San Diego Harbor, one of the few natural, deep water harbors on the Pacific Coast, is landlocked, and easily accessible for all types of vessels in all kinds of weather conditions. The needs of the port are well met by the important steamship lines which offer frequent and regular sailings to the Atlantic, Gulf and Pacific ports and to the principal ports of Europe.

The commerce during 1929 amounted to 958,100 short tons with a value of $47,500,000. Of this tonnage, 52,414 consisted of imports and exports while domestic coastwise shipments, both intercoastal and from Pacific Coast ports amounted to 905,686 short tons. The principal coastwise receipts consisted of petroleum products and lumber and logs, while the principal shipments comprised fish, fruit and vegetables, soap and soap powder and cotton. The principal imports were fish, sand, stone and cement, steel and paper. The principal exports were cotton, feed consisting largely of cottonseed meal and cake, clay and petroleum products and sugar. The port of San Diego is admirably situated to be of service in the development of the lower section of the State and affords an advantageous outlet for agricultural products of the Imperial Valley.

Because of the strategic location of San Diego's excellent harbor, the United States Navy Department has developed an important naval operating base at this port. The Destroyer Base, the Naval Training School, the large air station on North Island, and the Marine Corps Base are some of the naval establishments in this vicinity. A mooring mast for dirigibles has been constructed at Camp Kearney on Linda Vista Mesa. The United States Army maintains a large air force at Rockwell Field which is also located on North Island and coast defense works at Fort Rosecrans on the Military Reservation on

Point Loma. More than $40,000,000 have been invested in this vicinity by the War and Navy Departments.

San Diego County is fortunate in the many advantages which nature has given it as a recreational and residential area. The equable climate along the coast, warm in the winter and comparatively cool in summer, attracts thousands of vacationists each year, many of whom remain or later return to become permanent residents. Extending as it does from the Pacific Ocean across the mountains to the desert of the Imperial Valley in an airline distance of less than 80 miles, the county contains a varied scenery which may be found few other places. The many state parks comprise large areas for the use of the public. In Borrego Desert Park, Cuyamaca Rancho Park containing one of the highest peaks in the county, Mission Bay Park, and Silver Strand Beach, the state has provided vacation areas of outstanding interest . Cleveland National Forest embraces a great deal of the higher mountain region and the United States Forest Service has developed many areas for summer camps and homes. Many of the ocean beaches are owned by the municipalities adjoining them and are open to the public at all times. Several yacht harbors on San Diego Bay provide safe anchorage for small boats and pleasure craft . Tuna, yellow tail, marlin and other fish found in the adjacent waters of the Pacific have made San Diego famous for its sport fishing.

In addition to the advantages provided by nature the various communities of the county have provided many social advantages. The San Diego Zoo and the museum in Balboa Park are outstanding among their kind. Many schools, both public and private, are available. There are twelve public high schools, six of which are in the urban area surrounding San Diego Bay. The San Diego State Teacher's College provides four-year courses of advanced study.

The 1930 population of San Diego County was 209,659 or 3.7 per cent of the population of the entire State. More than 80 per cent of the population

live in the eight incorporated cities. The largest city, San Diego, had a population of 147,995 in 1930 and the metropolitan area which centers in that city and includes National City, Coronado, Chula Vista, La Mesa, and El Cajon had a population of 168,153. Oceanside and Escondido in the northern part of the county have populations of about 3500 each. The population of San Diego County increased 97,411 in the decade 1920 to 1930 or 87 per cent as compared to a 65 per cent increase for the entire State. The population of the metropolitan area increased 91 per cent during the same period.

Water Problems in San Diego County.

San Diego County's water problems arise from the extreme inequalities in seasonal and cyclic distribution of its water resources and from the limited supplies naturally available as related to its present and future needs. The water problems involve the conservation and utilization of its water resources and the control of floods. The wide range of run-off varying from almost no run-off in some years to several hundred per cent of normal in exceptional flood years necessitates the construction and utilization of large surface storage reservoirs and the utilization of available underground basins to secure under complete development the regulation necessary to provide dependable water supplies.

With the lack of sufficient water resources to meet the ultimate demands in the county and with the source of supplies available for importation far from the center of use, it is essential that the most complete development practicable be made of the local water resources for conservation and utilization for domestic, municipal and irrigation purposes. Flood control and use of water for power, recreation and all other purposes must be made secondary to its use for all consumptive purposes.

The increase in use for irrigation and the rapid increase in domestic

and municipal requirements during the past twenty years have resulted in the construction of large storage works on all but one of the major streams tributary to the county. The combined safe yields of the existing water supply systems in the county are about equal to the present demands, although in some of the existing systems the safe yields are being exceeded. Due to the large cyclic storage required for adequate regulation of stream flow, the future requirements must be anticipated sufficiently far in advance to allow time for construction of physical works and the storage of run-off of the wet years. The future increase in irrigation development and population is dependent upon adequate and reliable water supplies being available, for if they are not available the growth cannot occur.

The problem of flood control, while secondary to conservation, is important in the stream valleys where excellent agricultural lands are subject to inundation, erosion and the deposition of debris, and where important lines of communication are subject to interruption by flood flows. The flood control problems may be partially solved by the construction of storage reservoirs necessary for conservation, but complete solution when warranted by economic considerations will require separate works such as leveed channels, bank protection, or flood control features in conjunction with conservation reservoirs.

Previous Investigations.

The first State investigation of the water resources of San Diego County was made and published by the State Engineer, William Ham. Hall in 1888*. Insufficient funds, however, prevented the making of a comprehensive investigation.

*"Irrigation in California, Southern California, San Diego; San Bernardino; and Los Angeles", Part II of Irrigation Report of the State Engineer of California, William Ham. Hall, 1888.

In 1900, the United States Department of Agriculture, Office of Experiment Stations, made an investigation* of irrigation conditions and recommended certain changes in the water laws of the State. The Sweetwater River was included in this study. The State made an investigation in 1911 through a special board known as the "California Conservation Commission", which issued a report** on its findings. In 1912, the United States Department of Agriculture made an investigation and issued a bulletin*** dealing with the irrigation resources and their development.

A Federal report**** prepared in cooperation with the State Department of Engineering and the City of San Diego was published in 1919 on the geology and ground waters of the western part of San Diego County.

In 1921, the studies known as "The California Water Resources Investigations" were initiated under legislative authority in Chapter 889, Statutes of 1921. Further investigations were authorized in 1925 by legislative enactment. These investigations were carried out under the direction of the State Engineer. A report***** containing a complete inventory of all water within the state's boundaries, an estimate of the gross agricultural area, and

*Bulletin No. 100, "Irrigation Investigation in California, "U. S. Department of Agriculture, Office of Experiment Stations, 1901.

**Report of the Conservation Commission of the State of California, 1912.

***Bulletin No. 254, "Irrigation Resources of California and their Utilization." U. S. Department of Agriculture, Office of Experiment Stations, 1913.

****U. S. Geological Survey Water-Supply Paper 446, "Geology and Ground Waters of the Western Part of San Diego County, California" by Arthur J. Ellis and Charles H. Lee, 1919.

*****Bulletin No. 4, "Water Resources Of California," a report to the Legislature of 1923, also the following appendices: Bulletin No. 5, "Flow in California Streams", and Bulletin No. 6, "Irrigation Requirements of California Lands", Division of Engineering and Irrigation, State Department of Public Works, 1923.

of the average amount of water that should be applied for irrigation, and a general preliminary comprehensive plan for "converting the waters of California to their greatest service in this generation and for all posterity," was filed with the 1923 Legislature. An estimate of the seasonal run-off from mountain and foothill drainage areas of the principal streams in San Diego County was included in a report published in 1930.* A State investigation was made and a report** published in 1933 on the value and cost of water for irrigation.

Scope of Present Investigation.

The present investigation authorized by Chapter 278, Statutes of 1933, has been confined to the determination of the water supplies naturally tributary to San Diego County and the ultimate water requirements of the county, to the formulation of a plan for conservation of water for domestic, municipal and irrigation uses and control of floods in the San Diego River Basin, and the formulation of a plan for control of floods of the Tia Juana River between the international boundary line and the Pacific Ocean.

Water supply studies were made to estimate the run-offs of the various stream basins for the 46-year period 1887 to 1933. The estimates for the entire period were based on stream flow measurements which began in the season of 1887-1888. Estimates of run-off for the San Diego River Basin were also made beginning with the season of 1883-1884, for the four seasons 1883-84 to 1886-87,

*Bulletin No. 25, "Report to Legislature of 1931 on State Water Plan." Division of Water Resources, State Department of Public Works, 1930.

**Bulletin No. 43, "Value and Cost of Water for Irrigation in Coastal Plain of Southern California," prepared under cooperative agreement between the College of Agriculture, University of California and the Division of Water Resources, State Department of Public Works, 1933.

inclusive, from records of precipitation. Seasonal estimates of full natural run-offs were made for all the principal stream basins, and mean seasonal estimates were made of full natural run-offs of minor stream basins. The full natural run-offs of the San Diego River Basin were determined at the dam sites of potential reservoirs and used to determine the required reservoir capacities and to estimate the annual safe yields obtainable from coordinate operation of potential surface reservoirs with existing developments.

A crop and irrigated land survey was undertaken in cooperation with the County of San Diego and the State Emergency Relief Administration to determine the location and areas of the different kinds of crops grown, both irrigated and unirrigated, and the sources of water supply for the irrigated lands. The survey has not been completed and only the data secured in San Diego, Sweetwater, Otay and Tia Juana river basins are included in this report.

Topographic surveys were made of the Mission Bay area and Mission Valley on the San Diego River and of the Tia Juana River Valley from the international boundary to the Pacific Ocean. A geologic study was made to estimate the capacity of Mission Valley and upper San Diego River Valley underground reservoirs. Valuations were obtained of reservoir and channel rights of way. Geologic studies were made of all dam sites considered in the San Diego River Basin. From the geologic data secured, estimates were made of the depth of excavation necessary to obtain satisfactory foundations for the dams. Data were obtained on unit costs of materials and labor and on the probable length of time required for construction. With these data and the estimated quantities involved in the different parts of the construction, estimates were made of the costs of dams, reservoirs and leveed channels.

Data were obtained on the costs of operation, maintenance and depreciation of the different features of the physical works and with these data and estimated interest and amortization charges, estimates were made of annual

costs and of unit costs of safe yields obtainable from surface storage reservoirs.

Estimates were made of the maximum flood flows which might occur at certain intervals of time at various points on the principal streams and the effects of conservation and flood control reservoirs in reducing the sizes of these flows in the San Diego River Basin. Leveed channels were designed for reclamation of flooded areas in Mission Valley, for improvement and relocation of the San Diego River in the Mission Bay area and for the reclamation of flooded areas in the Tia Juana River Valley. Data were obtained on the value of lands subject to inundation in Mission Valley and Tia Juana River Valley, and the economic feasibility of reclamation of those areas was studied.

SUMMARY

In the following chapters of this report, there are presented in detail the basic studies and investigations of water resources and water requirements, existing development, and probable frequency and size of flood flows; plans of development and operation for conservation of waters of the San Diego River Basin and for flood control of the San Diego River in Mission Valley and Mission Bay area; and for flood control in the Tia Juana River Valley. These are briefly summarized in the remaining portion of this chapter.

Water Supply

The precipitation on the Pacific slope of San Diego County is extremely variable both geographically and seasonally. The mean seasonal precipitation varies from about ten inches per season along the coast to about forty inches per season on the higher mountain peaks. From season to season the precipitation may vary from a minimum of about 40 per cent to a maximum of approximately 200 per cent of the mean seasonal rainfall. It occurs chiefly in the form of rain.

Although there is usually some snowfall at the higher elevations every year, it usually melts away rapidly without any marked effect in changing the run-off from what it would have been had the precipitation occurred in the form of rain. On the average, over seventy per cent of the total seasonal precipitation may be expected to occur in the four winter months from December to March, inclusive, and only about five per cent in the four summer months from June to September, inclusive, when the irrigation demand is at its peak. Available precipitation records which have not been published by the United States Weather Bureau are given in Appendix B.

The Pacific slope of San Diego County is drained by many independent streams having basins ranging from a few to over 500 square miles in extent. For the purposes of this report these basins have been grouped into seven principal and four minor divisions. The group of principal basins comprises the Santa Margarita, San Luis Rey, San Dieguito, San Diego, Sweetwater, Otay, and Tia Juana river basins. Of these the Santa Margarita River on the north and the Tia Juana River on the south drain large areas outside of San Diego County. The minor basins are made up by grouping the smaller stream basins of the areas between the northern boundary of the county and Santa Margarita River, between San Luis Rey River and Escondido Creek, between San Dieguito River and Tecolate Valley, and between Switzer Canyon and Otay River. In practically all of these basins potential reservoir sites may be found, many of which are low enough on the streams to conserve the greater part of the run-off of the basins.

The following tabulation shows the mean seasonal full natural run-off for the 46-year period from 1887 to 1933, from the portions of the several drainage basins above and below the lowest potential reservoir site in each basin.

MEAN SEASONAL FULL NATURAL RUN-OFFS OF SAN DIEGO COUNTY STREAMS

1887 - 1933

Stream or stream group	Above lowest potential reservoir		Below lowest potential reservoir		Totals	
	Area of basin, in square miles	Run-off, in acre-feet	Area of basin, in square miles	Run-off, in acre-feet	Area of basin, in square miles	Run-off, in acre-feet
Principal Basins						
Santa Margarita River	710	24,050	33	2,190	743	26,240
San Luis Rey River	518	55,210	47	3,370	565	58,580
San Dieguito River	303	39,340	24	1,600	327	40,940
San Diego River	376	47,560	59	3,900	435	51,460
Sweetwater River	181	17,540	--	---	181	17,540
Otay River	99	7,650	--	---	99	7,650
Tia Juana River	*417	41,010	*44	3,530	*461	44,540
Totals, principal basins	2,604	232,360	207	14,590	2,811	246,950
Minor Basins						
San Mateo Creek to Aliso Creek	144	12,200	97	6,100	241	18,300
Loma Alto Creek to Escondido Creek	126	9,300	89	5,100	215	14,400
San Dieguito River to Tecolate Valley	70	5,500	108	6,300	178	11,800
Switzer Canyon to Otay River	12	800	153	9,800	165	10,600
Totals, minor basins	352	27,800	447	27,300	799	55,100
Grand totals	2,956	260,160	654	41,890	3,610	302,050

*Includes area within the United States only

This tabulation shows that of the 302,050 acre-feet of mean seasonal run-off for the entire Pacific slope of San Diego County, 232,360 acre-feet, or about 77 per cent, are subject to control at the lowest potential reservoirs of the principal basins and that an additional 27,800 acre-feet, or about 9 per cent, are tributary to potential reservoirs in the minor basins. A large part of the remaining 14 per cent is tributary to underground reservoirs in the stream channels near the ocean and is at least partially conservable.

The run-off of San Diego County is extremely erratic in occurrence. All the streams become practically dry in the summer time and the total seasonal run-off of the county may vary from less than 5 per cent to over 710 per cent of the long time mean in any one season. Long periods in which the seasonal run-off will average well above the long time mean may be followed by equally long periods in which the seasonal run-offs will average well below the long time mean, while shorter periods of extremely dry years have been known to occur. In the following tabulation the mean run-offs during several such periods at selected stations on the seven principal streams are shown. It may be noted that the run-off during the 19-year period 1914-1933 averaged 131 per cent of the mean for the 46-year period 1887-1933, the mean for the 19-year period 1895-1914 averaged about 57 per cent of the same 46-year mean and that the mean for the 9-year period 1895-1904 was only 19 per cent of the long time mean.

MEAN SEASONAL FULL NATURAL RUN-OFFS OF
SAN DIEGO COUNTY STREAMS FOR SELECTED PERIODS

Stream	Area of drainage basin, in square miles	Seasonal full natural run-off, in acre-feet (Season, October 1 to September 30)			
		Mean for 46-year period 1887-1933	Mean for 19-year period 1914-1933	Mean for 19-year period 1895-1914	Mean for 9-year period 1895-1904
Santa Margarita River above Ysidora	743	26,240	31,930	16,560	5,430
San Luis Rey River above Oceanside	565	58,580	71,780	37,370	14,910
San Dieguito River above Hodges Dam	303	39,340	50,680	22,300	7,520
San Diego River above Mission Gorge	377	47,560	65,260	25,940	7,110
Sweetwater River above Sweetwater Dam	181	17,540	25,720	6,860	1,030
Otay River above Lower Otay Dam	99	7,650	10,400	3,330	620
Cottonwood Creek above Barrett Dam	249	25,710	34,920	13,430	5,100
Totals	2,517	222,620	290,690	125,790	41,720
Totals in per cent of 46-year mean, 1887-1933		100	131	57	19

Present Irrigation and Urban Development and Water Supply Utilization.

While irrigation development in San Diego County was begun by the Franciscan Fathers in connection with the San Diego, San Luis Rey and Pala missions in the early part of the nineteenth century, the real growth began following the construction of the first railroad into San Diego, when the Sweetwater and Cuyamaca water supply systems were constructed in 1888. Since that time the development has steadily increased until nearly 49,000 acres were irrigated in 1932. An increase of about 95 per cent of the area irrigated in 1919 has occurred since that time. Apprxoximately 70 per cent of the total water utilized for all purposes in 1933 was used for irrigation. Irrigation water supplies are furnished by irrigation districts, mutual water companies, municipalities, U. S. Government, public utility companies, individuals and private companies.

The urban growth has been rapid and in the metropolitan area centering in the City of San Diego, the population has doubled each decade since 1900. The equable climate along the coast, with slight seasonal and daily range of temperature, together with the much greater ranges of temperature that may be found inland at the higher elevations, has been one of the major factors in attracting large numbers of people from other parts of the United States, and is responsible to a large degree for the extremely rapid growth in population.

Major water supply projects have been constructed on all the principal streams tributary to San Diego County with the exception of the Santa Margarita River. About one-third of the water utilized in 1933 was secured by pumping from underground reservoirs and two-thirds by diversion and surface storage. The total capital investment in water supply works was valued at $33,627,000 in 1933, of which $21,365,000 was the valuation of the City of

San Diego's water system. The estimated safe yield for all existing water supply development in the county including El Capitan Reservoir recently constructed by the City of San Diego amounts to 79,000 acre-feet annually.

Water Requirements.

While the uses of water in San Diego County are varied, the consumptive uses for irrigation, domestic and municipal purposes predominate. As the urban population is proportionately large the use of water for domestic and municipal purposes amounts to about 30 per cent of the total consumptive use in the county.

The local water resources are limited and deficient in amount to meet the ultimate water requirements of the county. The estimated maximum safe yield from Pacific slope basins of the county without consideration of cost or economic feasibility amounts to about 160,000 acre-feet annually. The ultimate water requirements for all irrigable lands in the county amount to approximately 312,000 acre-feet annually and are shown in the following table.

ULTIMATE SEASONAL WATER REQUIREMENTS
FOR IRRIGABLE LANDS IN SAN DIEGO COUNTY

Soil area	Total net irrigable area, in acres	Gross allowance, at average rate of 1.30 acre-feet per acre	Net allowance, at average rate of 1.25 acre-feet per acre
Capistrano	43,200	56,200	54,000
Oceanside	129,800	168,600	162,300
El Cajon	57,200	74,400	71,500
Highland valleys	10,000	13,000	12,500
Totals	240,200	312,200	300,300

The items "gross and net allowance" are defined as follows:
"Gross allowance" designates the amount of water diverted at the source of supply.
"Net allowance" designates the amount of water actually delivered to the area served.

As the future growth of the metropolitan population will probably occupy lands of low soil rating not classed as irrigable, the ultimate annual water requirement for the entire county will amount to 312,000 acre-feet plus the requirement for municipal purposes in the metropolitan area.

In 1933, approximately one-half of the ultimate development and utilization of the local water resources had occurred. As the unit use per acre for irrigation and domestic use is about the same, the local supplies will meet the water requirements of a total area of irrigated and urban land of approximately 125,000 acres. Should the irrigation development and use continue to increase at the same average rate that it has during the past forty years, or since the first major water supply developments were made, until 1965, resulting in an irrigated area of about 75,000 acres, only sufficient local water supplies can be developed to meet this irrigation use and in addition meet municipal and domestic demands sufficient to support an urban population of not more than 500,000.

Flood Control.

Although the valleys through which the streams of San Diego County reach the ocean are relatively small, they comprise a large area of good agricultural soils. During major floods, such as that of January 1916 which destroyed agricultural lands valued at $1,500,000, the valley areas are subject to destruction by either erosion or the deposition of sand and other debris. At the present time permanent improvements are being made within the flood planes of many of the major streams and, in urban areas, residential districts have encroached on many of the minor channels.

From the available data on flood occurrences since the advent of the white race in 1769 it seems probable that floods comparable to that of 1916 may be expected to occur about once in from 30 to 40 years on the average.

Analyses of the frequency of occurrence of floods on the major streams of San Diego County under present conditions of water development indicate crest flows as shown in the following tabulation. As potential conservation reservoirs are built these values will decrease. This decrease will be most marked on the smaller floods, while those which may be expected at long intervals will not, as a rule, be greatly reduced.

PROBABLE SIZE AND FREQUENCY OF CREST FLOOD FLOWS
FROM DRAINAGE BASINS IN SAN DIEGO COUNTY

Drainage basin	Area, in square miles	Average elevation, in feet	Crest flow, in second feet, occurring once in 25 years	50 years	100 years	250 years
Santa Margarita River at Ysidora	743	2,302	30,500	44,600	62,800	85,700
San Luis Rey River at Oceanside	(1) 359	(1) 1,442	(1) 28,600	(1) 41,800	(1) 58,000	(1) 80,500
San Dieguito River at Hodges Dam	303	1,965	45,900	64,600	88,400	119,000
San Diego River at San Diego	435	1,843	(2) 26,000	(2) 46,600	(2) 71,600	(2) 99,200
Sweetwater River at Sweetwater Dam	181	2,393	19,100	29,600	42,400	61,100
Tia Juana River near Nestor	1,658	unknown	40,000	80,000	121,000	173,000

(1) Excluding area of drainage basin above Henshaw Dam.
(2) The regulating effect of El Capitan Reservoir has been included in these values.

Although the intensity of the precipitation increases to a marked degree with altitude and distance from the coast, the geologic nature of soils is such that the coastal areas composed of water borne materials underlain by hardpan may be expected to yield practically as large flood flows per square mile as the higher mountain soils of a sandy nature underlain by deep beds of disintegrated granite.

Flood control may be obtained either by systems of levees, by storing flows in excess of channel capacities in reservoirs, or by combining these two methods. The hydrographic characteristics of the San Diego County floods, caused almost entirely by rainfall and coming from relatively small drainage basins, are such that control by reservoirs is particularly favorable. The value of water in San Diego County for domestic and agricultural purposes, however, is such that conservation must be given a first claim to the available reservoir space. In many cases relatively small increases in the heights of the dams will provide adequate reservoir space for flood control purposes.

At the present time very little has been done to control the floods in San Diego County except for the regulation afforded by conservation reservoirs. A small levee has been built for the purpose of preventing the overflow of the Tia Juana River into San Diego Bay; the Federal Government has constructed a dyke from Old Town to Point Loma, turning the San Diego River into Mission Bay; some bank protection has been built by individual owners; and some channel straightening and brushing has been done in connection with unemployment relief projects.

The areas of agricultural lands subject to flooding are so small in relation to the lengths of the stream channels that control of the floods through the construction of levees will be extremely expensive. The maintenance of cleared channels together with some revetment work, however, would reduce the tendency of the channels to wander and might result in the erosion of the channel and increased channel capacity adequate for the smaller floods. Further protection against the smaller floods will come with full conservation development and, where economically feasible, space may be provided in the upper parts of the conservation reservoirs or leveed channels constructed for protection against the larger floods. Until such time, it must be borne in mind that practically the entire valley floors of the major stream basins are

subject to overflow and that permanent improvements in these areas will be subject to serious damage during major floods.

Tia Juana Valley - In the Tia Juana River Valley between the international boundary and the Pacific Ocean, some 4,670 acres are subject to overflow in time of flood. Of this area, 700 acres are now in river channel and will be required for that purpose in the future, 960 acres are marsh lands which are not of any great agricultural value at the present time, and 1150 acres are class 3 soils lying in the path of probable floods. Of the remaining 1,860 acres of class 1 soils subject to overflow, only about 980 acres are in serious danger of erosion or debris deposition. It has been estimated that an adequate system of levees for the protection of these lands would cost slightly over $1,000,000. These levees would give full protection to some 3,000 acres of agricultural lands, only about 2,100 of which are in serious danger of destruction. Such protection would enable the farmers to live on their lands and permit the development of an urban center in the Tia Juana Valley. Since large areas suitable for residential purposes are situated adjacent to the valley above the flooded area, and the cost per acre for reclaiming the area in jeopardy would be large, it is not believed that so large an expenditure could be justified at the present time.

Plan for Conservation and Flood Control on San Diego River.

The plan presented herein comprehends the most economic development, conservation, utilization and control of the water resources of the San Diego River for all consumptive purposes, and flood control, in coordination with existing developments. The plan is based primarily upon conservation and utilization of water for domestic, municipal and irrigation purposes and is for the complete development of the San Diego River Basin without consideration of the possibility of storing water imported from other watersheds in reservoirs

constructed within the basin.

As the Supreme Court of the State of California has confirmed the paramount right of the City of San Diego to the waters of the San Diego River, and as the construction of additional storage works will present no different legal problems than may arise from the recently constructed El Capitan Reservoir, no allowance has been made and no costs included in the estimates for water rights or litigation arising therefrom.

The plan presented for the complete development of the San Diego River Basin includes the construction of two additional reservoirs, San Vicente reservoir on San Vicente Creek to regulate and conserve the run-off of that creek and waters diverted by gravity from the El Capitan reservoir, and Mission Gorge No. 2 reservoir to regulate and conserve the run-off originating below San Vicente and El Capitan dam sites, and an improvement and relocation of the San Diego River from Presidio Hill, Old Town, to Mission Bay.

Conservation Reservoirs - The San Vicente reservoir site is located in San Vicente Creek Canyon which has a comparatively flat gradient and steep sides. The reservoir site is an excellent one for cyclic storage, having only about 80% of the surface area of El Capitan Reservoir for the same capacity, with correspondingly greater efficiency in preventing evaporation losses. It is located at an elevation sufficiently lower than El Capitan Reservoir to allow transfer of water by gravity from the latter reservoir at many stages of the two reservoirs. The storage capacity of 174,500 acre-feet, which would be provided by a dam 263 feet in height, has been selected as that giving the maximum additional safe yield with transfer of water from El Capitan Reservoir. The reservoir site has greater capacity than that selected and additional storage at a relatively low cost may be secured for imported water when such storage becomes desirable. Under the method of operation selected, this reservoir would be reserved for long time cyclic storage and water would be withdrawn

only after the other reservoirs were empty.

The San Vicente dam site on San Vicente Creek is located about a half mile above Foster. It is underlain by an old metamorphosed series of rocks, mostly granitic in character and, while additional explorations should be made before the final location of a dam at this site is chosen, the foundation appears satisfactory for a gravity concrete dam of the height selected.

The Mission Gorge No. 2 dam site is located on the San Diego River near the head of Mission Gorge and the reservoir site covers the lower end of the upper San Diego River Valley. The reservoir would be comparatively shallow with a large surface exposure which would result in large evaporation losses if used for cyclic storage. For this reason, a comparatively small capacity has been selected for this site and a method of operation used whereby the water stored in this reservoir would be drawn on first and the reservoir emptied as rapidly as possible. This method of operation allows the use of a smaller reservoir as it would be empty at the beginning of the majority of run-off seasons. A storage capacity of 29,200 acre-feet, created by a gravity concrete dam 109 feet in height, has been selected as that required to regulate and conserve the run-off not regulated by the San Vicente and El Capitan reservoirs. About two thirds of the lands in the reservoir site are of low soil rating and the underground basin within the site is very shallow and has little storage capacity.

The Mission Gorge No. 2 dam site lies in an area of granite. Hard and massive bed rock is exposed in the stream bed and while considerable talus covers the lower portion of the left abutment, and deep weathering has occurred on the right abutment, it is believed that excavation and stripping to a reasonable depth will expose rock over the entire site suitable for satisfactory foundation for a masonry dam. Although a number of test pits have been dug in the abutments, and a number of holes drilled in the bottom of the

canyon, further explorations should be made before a final location for any dam at this site is selected.

Before a reservoir site was selected on the lower reaches of the San Diego River, studies were made of both Mission Gorge No. 2 and Mission Gorge No. 3 sites. Mission Gorge No. 3 dam site is located about 2.3 miles downstream from the line between the Ex Mission San Diego and El Cajon grants and a short distance above the lower end of Mission Gorge. Investigation showed that a loose wedge of rock existed in the lower portion of the right abutment of the site which has been commonly accepted for Mission Gorge No. 3 dam, located just downstream from the sign "Mission-Gorge Dam Site No. 3" painted on the rocks on the right bank of the river. As the large amount of excavation necessary to remove this loose wedge of rock would greatly increase the costs of dams at this site, the canyon was studied for other sites for several thousand feet upstream and for some distance downstream. The best site appeared to be one located about 300 feet downstream from the previously mentioned sign and 200 feet below the original site.

The determination of the relative merits of the different reservoir sites considered has been made from comparisons of additional safe yields obtainable and comparisons of capital, annual and unit costs. The capital cost estimates are based upon present costs of labor and material as determined from construction costs of similar structures, and upon costs of rights of way estimated from valuations made by Tax Factors, Incorporated, in 1929, except for the San Vicente site where actual costs of lands were used. Dams of gravity concrete type, straight in plan, were selected for use at all sites considered. Other types of dams could be used at each of the three sites and final construction plans may show that the use of another type of dam will result in reducing the cost. While rights of way costs used are considered a fair

value of their present worth, conditions possibly may arise whereby these values would be changed. All factors involved must be evaluated finally at the time actual construction is contemplated. However, a very material change in these factors would have to occur before the economic advantages of the sites selected would be altered. The following tabulation shows the capital and annual costs of the San Vicente and Mission Gorge reservoirs, the additional safe yields obtainable with those reservoirs operated coordinately with the existing Cuyamaca and El Capitan reservoirs, and the unit costs of additional safe yield, for several sizes of reservoir at each of the three sites.

COMPARISON OF COSTS OF RESERVOIRS

Reservoir	Storage capacity in acre-foot	Height of dam, in feet	Additional safe yield, in acre-feet	Cost of reservoir: Capital	Cost of reservoir: Annual	Capital cost of storage, per acre-foot	Unit Cost of additional safe yield, per acre-foot
San Vicente	100,800	209	8,800	$3,912,000	$252,900	$38.80	$28.70
	130,000	234	11,700	4,904,000	317,600	37.70	27.10
	158,400	256	14,500	5,814,000	377,100	36.70	26.00
	174,500	268	16,200	6,519,000	423,100	37.40	26.10
Mission Gorge No. 2	29,200	109	2,700	2,143,000	137,800	73.40	51.00
	57,600	122	4,300	2,960,000	187,900	51.40	43.70
	86,800	131	5,800	3,435,000	217,200	39.60	37.40
Mission Gorge No. 3 with dams at lower site	29,200	231	3,200	3,666,000	237,100	125.50	74.10
	57,900	252	5,000	4,870,000	313,800	84.10	62.80
	87,600	263	6,700	5,808,000	373,100	66.30	55.70

Mission Gorge No 3 reservoir would give a somewhat greater yield than the No. 2 reservoir due to greater average water depth and less evaporation loss for all sizes considered. However, the much greater heights of dam for Mission Gorge No. 3 site increase the costs to such a degree that the resultant unit costs of additional safe yield are materially greater for Mission Gorge No. 3 reservoir than for the No. 2 reservoir. Also the greater surface area of the Mission Gorge No. 2 reservoir allows greater flood control regulation with less increase in dam height. Therefore, the Mission Gorge No. 2 reservoir has been selected as more economic than Mission Gorge No. 3 reservoir for the lowest reservoir on the San Diego River.

As previously stated, the plan for the complete development of the water resources of the San Diego River Basin includes the construction of both the San Vicente and Mission Gorge No. 2 reservoirs. Under the method of operation adopted, San Vicente, Mission Gorge No. 2 and the existing Cuyamaca and El Capitan reservoirs would be operated coordinately. Water from El Capitan Reservoir would be diverted by gravity to San Vicente reservoir. The inflow into Cuyamaca Reservoir would be stored in that reservoir until May 1st and then released as rapidly as possible to El Capitan Reservoir if storage was available, or as fast as storage became available. An irrigation draft of 5,000 acre-feet per season was drawn from El Capitan Reservoir, or from San Vicente when El Capitan was empty. Water for other uses was drawn from Mission Gorge No. 2 and El Capitan, in order, until each was empty and then from San Vicente reservoir. This method of draft would reduce evaporation losses to a minimum by retaining water longest in the reservoirs with the smallest evaporation losses. This method of operation would give a total safe yield from the San Diego River Basin of 32,500 acre-feet per year or 29.0 millions of gallons per day, or an additional safe yield for San Vicente and Mission

Gorge No. 2 reservoirs of 18,500 acre-feet per year or 16.5 millions of gallons per day. If Mission Gorge No. 3 reservoir with a capacity of 29,200 acre-feet were used in this coordinated operation instead of Mission Gorge No. 2 reservoir, the additional safe yield would be increased only 300 acre-feet per year and, as just shown, the unit cost of water would be greatly increased.

In estimating the costs of additional safe yield from the San Diego River Basin, it has been assumed that when additional or complete development is made, the agency making the development will determine where the water will be utilized and will provide the necessary transmission and distribution facilities for utilization for consumptive purposes. Therefore, only costs of storage and development have been included in the estimates shown. It has been assumed that the transfer of water from El Capitan Reservoir to San Vicente Reservoir will be made through the transmission pipe lines. These transmission lines will be interconnected at Lakeside and all transfer of water may be made when these pipe lines are being only partially utilized for transmission purposes. The costs of the additional conservation developments estimated on the foregoing described bases are given in the following table.

COST OF ADDITIONAL CONSERVATION DEVELOPMENT OF SAN DIEGO RIVER

San Vicente Reservoir	174,500 acre-feet
Mission Gorge No. 2 Reservoir	29,200 acre-feet
Additional storage capacity	203,700 acre-feet

Reservoir	Additional safe yield: Acre feet per year	Additional safe yield: Millions of gallons per day	Cost of reservoirs: Capital	Cost of reservoirs: Annual	Cost of additional safe yield: Capital per acre-foot per year	Cost of additional safe yield: Unit per acre-foot	Cost of additional safe yield: Unit per million gallons
San Vicente	(1) 16,200	(1) 14.5	$6,519,000	$423,100	(1) $402.40	(1) $26.10	(1) $82.20
Mission Gorge No.2	(1) 2,700	(1) 2.4	2,143,000	137,800	(1) 793.70	(1) 51.00	(1) 156.70
Totals for coordinate operation with existing reservoirs	18,500	16.5	$8,662,000	$560,900	$468.20	$30.30	$93.00

(1) Additional safe yields and costs with each reservoir operated coordinately with existing development.

Flood Control - The operation of Cuyamaca, El Capitan, San Vicente and Mission Gorge No. 2 reservoirs for conservation would reduce the flood flows which occur about once in 25 years on the average sufficiently to prevent any contribution to the crest flows of floods in Mission Valley originating in the drainage area below Mission Gorge No. 2 dam site. Such operation would reduce the probable once-in-50-year flood flow at Old Town from 46,600 second-feet to 34,600 second-feet, the probable once-in-100-year flood flow from 71,600 second-feet at Old Town to 55,000 second-feet, and the probable once-in-250-year flood flow from 99,200 second-feet at Old Town to 79,000 second-feet. This would prevent serious flooding and damage to Mission Valley lands except by floods occurring less frequently than once in 50 years on the average. However, this condition might create a sense of false security in that area and result in a

possible loss of life and a large property damage should the valley be built up with residences. A reduction in the probable once-in-100-year flood flow at Old Town from 55,000 to 52,600 second-feet may be accomplished under conditions of complete conservation development at almost no additional cost by the inclusion of flood control features in Mission Gorge No. 2 reservoir. A greater degree of flood control may be secured with additional flood control regulation at Mission Gorge No. 2 reservoir at greater cost.

Under present conditions, as well as with complete development, the larger flood flows mentioned would flood practically all of the valley floor lands in Mission Valley. To protect these lands a leveed channel would be required. Such a channel running from the mouth of Alvarado Canyon to Presidio Hill, Old Town, has been estimated to cost approximately $2,000,000. As the value of the lands subject to inundation has been estimated from the 1933 assessed valuations to be but $404,000, it does not appear that protection from flood flows in Mission Valley is justified at present and will not be justified until such time as the lands which would be protected increase several times in value.

The flood channel designed for the San Diego River from Presidio Hill to Mission Bay would be a part of a plan for the reclamation and development of the State Park lands bordering on the south shore of Mission Bay, and the adjoining lowlands. The design of a plan for the complete reclamation and development of these lands was not within the province of this investigation.

The flood regulation of the San Diego River through the Mission Bay area when complete conservation development of the stream basin has been made, may be accomplished at minimum cost by the inclusion of flood control features in Mission Gorge No. 2 reservoir, controlling the probable once-in-100-year flood at Old Town to 52,600 second feet, and the construction of a

flood channel from Presidio Hill to Mission Bay with a capacity of 52,600 second-feet. If no flood control features are incorporated in Mission Gorge No. 2 reservoir, and all reservoirs operated for conservation, the cost would be but slightly higher, as shown by the following table.

The flood control channel as designed would carry the 52,600 second-feet of the probable once-in-100-year flood flow with complete conservation development and flood control features incorporated in Mission Gorge No. 2 reservoir, with a minimum 4-foot freeboard on the levees. It would carry the flow of 71,600 second-feet which may occur once in 100 years on the average under the existing development with a minimum freeboard of 2.4 feet. The flow of 99,200 second-feet, which may occur once in 250 years on the average under present conditions, would pass down the channel with a minimum freeboard of about one-half foot remaining on the levees. This freeboard could be increased to at least 1.5 feet, however, at little if any additional expense by slightly decreasing the width of crown of the levees and adding the material to the top.

COSTS OF FLOOD PROTECTION IN MISSION BAY AREA

With and without flood control features at Mission Gorge No. 2 reservoir and with San Diego River channel improvement and relocation from Presidio Hill to Mission Bay.

Capacity of channel with minimum 4-foot free-board on levees, in second-feet	Costs					
	Flood control features of Mission Gorge No. 2 reservoir		Channel improvement and relocation		Total	
	Capital	Annual	Capital	Annual	Capital	Annual
52,600	$1,000	$300.00	$1,341,000	$101,800	$1,342,000	$102,100
55,000	0	0	(1) 1,355,000	(1) 102,900	(1) 1,355,000	(1) $102,900

(1) Values interpolated from Table 50 and Plate XXIX, Chapter VI.

Conclusions.

The principal conclusions of this investigation may be summarized as follows:

1. The water supply of the stream basins tributary to San Diego County, excluding the watershed of the Tia Juana River in Mexico, which can be conserved and utilized under the fullest practicable development, is insufficient in amount to meet the ultimate water requirements for all consumptive uses in the county.

2. Because the water supplies naturally tributary to San Diego County are deficient in amount to meet the ultimate water requirements, it is essential that, in the formulation of plans for complete development of the water resources, such plans must be based primarily upon conservation and utilization of water for domestic, municipal or irrigation purposes. All other possible uses must be necessarily incidental and secondary.

3. The total mean seasonal run-off from stream basins tributary to San Diego County excluding the Tia Juana River watershed in Mexico, is 302,000 acre-feet from which a maximum annual safe yield of approximately 160,000 acre-feet may be obtained through the utilization of existing and potential reservoirs and underground basins. This amount will supply a net area of 125,000 acres with either a municipal or an irrigation supply. Should the irrigation development and use continue to increase at the same average rate that it has during the past forty years, or since the first major water supply developments were made, until 1965, resulting in an irrigated area of about 75,000 acres, only sufficient local water supplies can be developed to meet this irrigation use and in addition meet

municipal and domestic demands sufficient to support an urban population of not more than 500,000.

4. All present developments in the county of water supplies from both surface reservoirs, including El Capitan Reservoir, and underground basins have an estimated annual safe yield of 79,000 acre-feet or approximately one-half of the total annual safe yield that may be obtained from complete development. Taking the county as a whole, the present annual safe yield of 79,000 acre-feet is approximately equal to the present use for all consumptive purposes.

5. In order to be assured of an adequate and dependable water supply, future water requirements must be anticipated far enough in advance to permit the construction of surface storage reservoirs to conserve the run-off of the infrequent wet years. It has been estimated that under complete conservation development of the San Diego River, the full safe yield may not be secured until eight years on the average after the storage reservoirs have been completed and put into operation.

6. The relationship between annual rainfall and run-off varies so greatly in different years that the use of precipitation records for any one season for the estimation of run-off for that season gives unreliable results. The most reliable method of estimating available water supplies is through the use of dependable stream flow measurements. Stream flow records should be secured at additional points on San Diego County streams and more complete records obtained at many of the existing stream measurement stations.

7. The most economic plan for the complete conservation of the water resources of the San Diego River Basin comprises the construction of two additional reservoirs, San Vicente and Mission Gorge No. 2 reservoirs with 174,500 acre-feet and 29,200 acre-feet capacity, respectively. The capital costs of the reservoirs with these capacities have been estimated to be $6,519,000 for San Vicente reservoir and $2,143,000 for Mission Gorge No. 2 reservoir, or a total capital cost of $8,662,000.

8. The operation of San Vicente and Mission Gorge No. 2 reservoirs with 174,500 and 29,200 acre-feet capacity, respectively, in coordination with existing development, will result in a total annual safe yield from the San Diego River Basin of 32,500 acre-feet or an additional annual safe yield of 18,500 acre-feet (16.5 millions of gallons per day).

9. The San Vicente and Mission Gorge No. 2 reservoirs operated for conservation only would decrease the probable once-in-250-year flood flow from 99,200 second-feet to 79,000 second-feet at San Diego (Old Town), the probable once-in-100-year flood flow from 71,600 second-feet to 55,000 second-feet, the probable once-in-50-year flood flow from 46,600 second-feet to 34,600 second-feet, and the once-in-25-year flood flow would be decreased so that there would be no contribution to the crest flow in Mission Valley area from the basin above Mission Gorge.

10. The channel improvement and relocation of the San Diego River from Presidio Hill to Mission Bay, which would be a part of the reclamation and development of the Mission Bay State Park and the adjoining

lands, may be accomplished at a minimum capital cost of approximately $1,340,000, when complete conservation development is made in the San Diego River Basin, by incorporating flood control features in Mission Gorge No. 2 reservoir, and at slightly greater cost if Mission Gorge No. 2 reservoir is constructed for conservation only. The channel capacity required with or without the flood control features in Mission Gorge No. 2 reservoir will be 52,600 second-feet or 55,000 second-feet, respectively.

11. The protection of Mission Valley lands subject to inundation from flood flows occurring once in 100 years on the average is not justified until such time as the value of the lands to be protected increases materially.

12. The protection of Tia Juana River Valley lands subject to inundation is not economically justified with the existing farm land values.

CHAPTER II

WATER SUPPLY

An inventory has been made of the water supply of the Pacific slope basins of San Diego County for the 46-year period 1887 to 1933. The full natural run-off has been determined by months for the San Diego River and by seasons for the other principal streams. On the minor streams, where few if any actual records were available, only the average seasonal run-off for the period has been calculated.

Description of Basins.

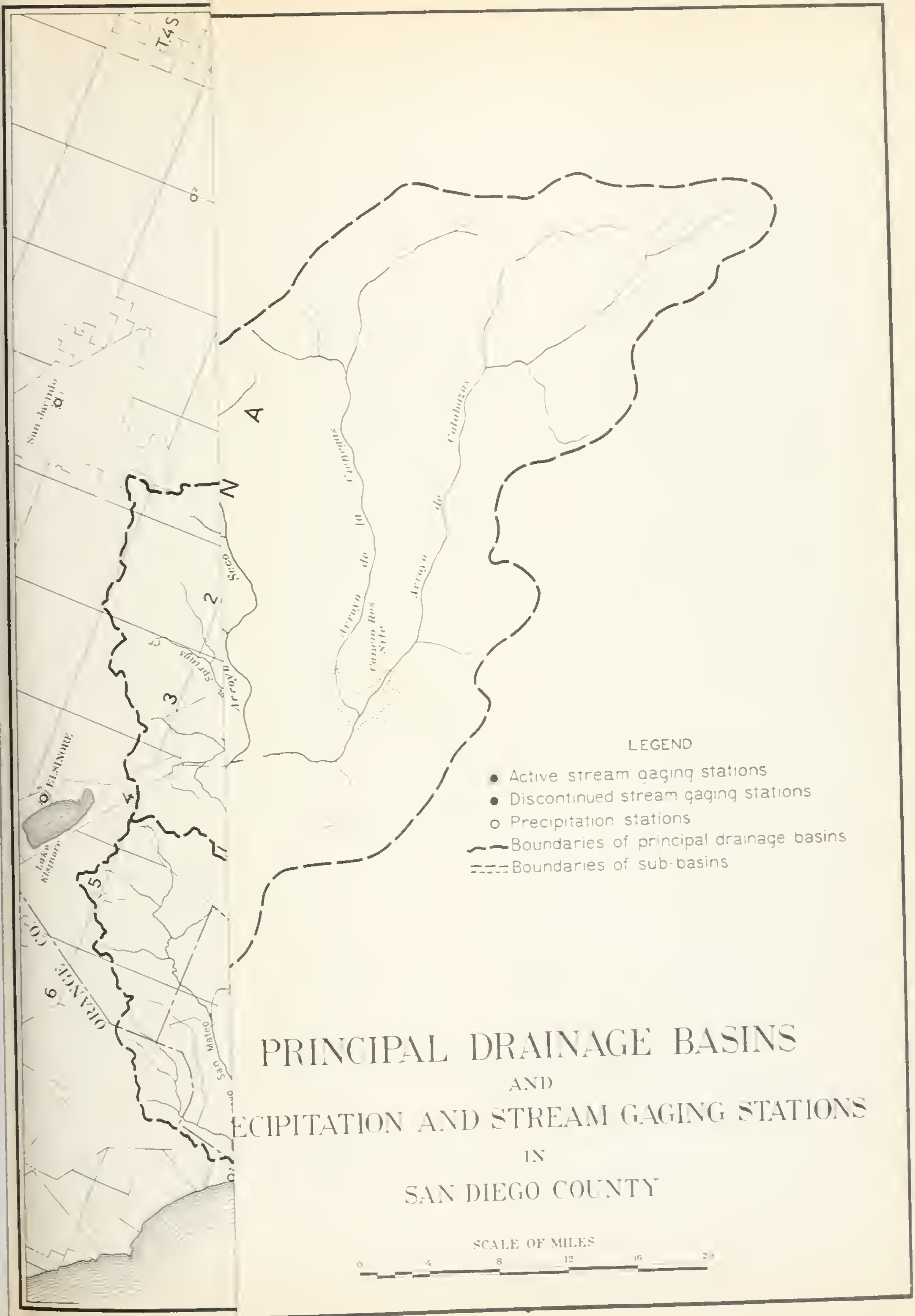
The topography of San Diego County is characterized by a broad mountain region which on the east descends steeply into broken mountains and desert valleys along the edge of the Great Basin, and on the west has a gradual slope that flattens into a coastal belt of broad, smooth-topped terraces or mesas.

The main mountain chain, known as the Peninsula Range, extends southward to form the backbone of the Lower California peninsula, while to the north it broadens and merges with the San Jacinto Range on the east and the Santa Ana Range on the west, with the region between occupied by mountains and valleys irregularly dispersed. The topography of the mountain region is complex, and is dissected by valleys and canyons into more or less isolated mountains, such as the Aqua Tibia mountains, the Palomar mountains, and the San Ysidro mountains at the head of San Luis Rey River, the Volcan mountains at the head of Santa Ysabel Creek, the Cuyamaca mountains at the head of San Diego and Sweetwater rivers, and the Laguna mountains at the head of Cottonwood Creek.

North from La Jolla, the coastal belt terminates in a line of sea cliffs which run almost unbroken between the flat, marshy valleys at the mouths of the several streams. South from La Jolla the coast line is characterized by peninsulas, bays, sandy beaches and tidal flats. The terraces or mesas of this belt range in height from 20 to 1200 feet above sea level and extend from the international boundary to the San Luis Rey River, north of which the steep, rounded San Onofre Hills replace them.

The principal streams in San Diego County rise near the divide and flow in general in a southwesterly direction to the Pacific Ocean. In the mountain region they have cut deep, narrow canyons which occasionally widen into highland valleys. Across the coastal belt the streams have eroded much broader valleys. The major valleys consist of more or less distinct parts, being narrow where the streams have cut through resistant rocks, and wider through the softer formations. The minor streams are less deeply entrenched and have for the most part cut only narrow canyons. In addition to the major stream valleys, there are many broad valleys or basins scattered from the coastal belt to the top of the divide. Characteristic of these basins are El Cajon, Escondido, Santa Maria and Warner valleys. Of the entire land area of San Diego County 2973 square miles or 70 per cent lie on the Pacific slope and 1248 square miles or 30 per cent on the eastern slope.

The principal streams whose drainage basins lie entirely or partly in San Diego County are the Santa Margarita, San Luis Rey, San Dieguito, San Diego, Sweetwater, Otay and Tia Juana rivers. The drainage basins of these streams are shown on Plate I, "Principal Drainage Basins and Precipitation and Stream Gaging Stations in San Diego County," together with the boundaries of sub-basins and precipitation and stream gaging stations. North of the Santa Margarita River, there are several minor streams from San Mateo Creek on the north to Aliso Canyon on the south whose basins lie partly in San Diego County. South of the



PRINCIPAL DRAINAGE BASINS
AND
ECIPITATION AND STREAM GAGING STATIONS
IN
SAN DIEGO COUNTY
SCALE OF MILES
0
4
8
12
16
LEGEND
Active stream gaging stations
Discontinued stream gaging stations
Precipitation stations
Boundaries of principal drainage basins
Boundaries of sub-basins
T.4S
San Jacinto
ELSINORE
Lake Elsinore
ORANGE CO.
A
N
Arroyo Seco
Arroyo de la Ciénegas
Arroyo de Calabazas
Cañada Res Site
Springs
San Mateo
1
2
3
4
5
6

PRINCIPAL DRAINAGE BASINS
AND
PRECIPITATION AND STREAM GAGING STATIONS
IN
SAN DIEGO COUNTY

Santa Margarita River, there are many minor streams draining the seaward slope of the most westerly ridge of the Peninsula Range whose basins lie between those of the principal streams. The more important of these minor basins are those of Vista, San Marcos, and Escondido creeks, Los Penasquitos, Rose and Las Chollas canyons.

The Santa Margarita River is formed by the junction of Temecula and Murrieta creeks near the town of Temecula. From this point the stream flows about 27 miles in a southwesterly direction to enter the Pacific Ocean 3 miles northwest of Oceanside. The headwaters of Temecula Creek originate in the mountains northeasterly from Oak Grove Valley. From this valley Temecula Creek flows northwesterly 23 miles to its junction with Murrieta Creek. There are several small valleys in its drainage basin but the country is mainly rough and broken. Some of its tributaries drain the north slope of Palomar Mountain which rises to an elevation of over 6,000 feet above sea level. Murrieta Creek has a broad flat drainage basin and contributes very little water to the Santa Margarita River except in seasons of exceptionally heavy rainfall. It rises near the divide between the Santa Margarita River basin and that of Lake Elsinore to the north and flows in a southeasterly direction about 10 miles to join Temecula Creek. The eastern tributaries of Murrieta Creek drain a broad, flat plain broken only by isolated hills, although Tucalota Creek rises on the slopes of Red Mountain at an elevation of over 4,500 feet above sea level. The watershed of the Santa Margarita River above the gaging station at Ysidora has an area of 743 square miles of which about 195 square miles are in San Diego County and about 548 square miles are in Riverside County.

The San Luis Rey River rises at the upper end of the Warner Valley and flows southwesterly across the valley into the Henshaw Reservoir. Several smaller tributaries flow into the reservoir. Below the Henshaw Dam, the river has cut a steep, narrow canyon which skirts the foot of Palomar Mountain.

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The San Luis Rey River rises at the upper end of the Warner Valley and flows southwesterly across the valley into the Henshaw Reservoir. Several smaller tributaries flow into the reservoir. Below the Henshaw Dam, the river has cut a steep, narrow canyon which skirts the foot of Palomar Mountain.

After emerging from the canyon near Rincon, it traverses a series of valleys of varying widths until it flows into the ocean at the city of Oceanside. Moosa and Keyes canyons are the principal tributary basins below the canyon. The highest elevations in the basin are on Palomar and Hot Springs mountains, both of which rise to elevations of over 6,000 feet above sea level. The watershed above Oceanside has an area of 565 square miles, all but 1.5 square miles being in San Diego County. The drainage basin is about 56 miles long and has an average width of 10 miles.

Escondido Creek rises on the slopes of Las Lomas Muertas, a small range to the northeastward of Escondido, at an elevation of about 2,300 feet. The drainage basin is a minor one and does not reach the crest of the divide. After crossing the wide valley around the City of Escondido, the stream flows through a canyon south of Mt. Whitney, crosses the coastal belt and enters the Pacific Ocean about 3 miles south of the town of Encinitas. The watershed above the San Elijo dam site has an area of 57 square miles.

The San Dieguito River, known as Santa Ysabel Creek from its source on the west slope of Volcan Mountain to the San Pasqual Valley, flows southwesterly and enters the Pacific Ocean about a mile north of Del Mar. Its drainage basin lies entirely in San Diego County, south of and adjacent to the San Luis Rey River and Escondido Creek basins. The principal tributaries are Black Canyon, Temescal, Santa Maria and Guejito creeks. The upper drainage basin of Santa Ysabel Creek is very steep and rugged, reaching elevations of over 5,000 feet in the Volcan mountains. Below San Pasqual Valley, the San Dieguito River flows through a narrow canyon in which Hodges Dam is constructed. Below the canyon, the San Dieguito River flows to the ocean through a valley cut in the coastal terrace. The watershed above the former gaging station near Del Mar has an area of 327 square miles and is about 38 miles long with an average width of about 9 miles.

The San Diego River rises near Julian and flows in a southwesterly direction to discharge into the Pacific Ocean through Mission Bay. Cedar and Boulder creeks join the main river a short distance above the Diverting Dam. Boulder Creek makes a precipitous descent from the Cuyamaca Reservoir which lies at an elevation of 4,600 feet above sea level. Above this reservoir, the highest elevations in the basin are reached on the slopes of Cuyamaca Peak, which rises to an elevation of over 6,500 feet above sea level.

The South Fork of the San Diego River enters the river from the east about six miles below the Diverting Dam and Chocolate Creek enters the river from the south about eight miles below the Diverting Dam. Just below the mouth of Chocolate Creek, the city of San Diego has recently completed the El Capitan Dam. About two miles below El Capitan Dam, the San Diego River emerges from a canyon into the upper San Diego River Valley which it traverses for about twelve miles to Mission Gorge. Los Coches and Forester creeks enter the San Diego River from the south and San Vicente Creek from the north in the valley. Forester Creek in reaching the San Diego River traverses the broad El Cajon Valley. San Vicente Creek emerges from a narrow canyon into a branch valley about three miles above its junction with the San Diego River.

In the Mission Gorge, the San Diego River has cut through an igneous dike similar to that on the San Dieguito River at Hodges Dam. This gorge derives its name from the Mission Dam built by the Franciscan Fathers in the early part of the nineteenth century. This dam is still standing with the exception of a short section at the left abutment. Between the Mission Gorge and its mouth in Mission Bay, the San Diego River traverses the Mission Valley, which it has cut in the coastal mesa. The watershed above Old Town has an area of 435 square miles. Its length is about 42 miles and its average width about 10 miles.

The Sweetwater River rises on the southeastern slopes of Cuyamaca

Mountain, flows south and then southwesterly, and discharges into San Diego Bay south of National City. The topography of this basin is not as rough as that of the San Diego River Basin although the mountains and foothills extend to within three or four miles of the shore line of San Diego Bay. Near the edge of the foothills, the Sweetwater Dam has been constructed forming the Sweetwater Reservoir. Above this reservoir is a valley which extends eight miles eastward. Below the Sweetwater Dam, the river runs through the Sweetwater Valley which it has cut in the coastal terrace. The watershed above the Sweetwater Dam has an area of 181 square miles with a length of about 36 miles and an average width of five miles.

The Otay River drains a basin on the lower western slope, lying between the Sweetwater River basin on the north and that of the Tia Juana River on the east and south. The principal tributaries are Dulzura, Jamul and Proctor Valley creeks. Upper Otay Reservoir is located on Proctor Valley Creek. From the Lower Otay Reservoir, situated on the edge of the foothills, the Otay River runs westward through a valley cut in the Otay Mesa and discharges into the extreme southern end of San Diego Bay. Although well known because of Upper and Lower Otay reservoirs, the basin of the Otay River should perhaps be classed as one of the minor rather than one of the principal drainage basins of San Diego County as this basin does not reach the crest of the range but drains only the seaward slope of the most westerly of the ridges. The highest elevations in this watershed are reached at Lyons Peak and Otay Mountain which both reach elevations of over 3,500 feet above sea level. The watershed above Lower Otay Reservoir is nearly half as wide as it is long and has an area of 99 square miles. Its length is about 15 miles and its average width is 7 miles.

The Tia Juana River proper, comprising that part of the main stream below Rodriguez Dam, is about seventeen miles long and flows in a northwesterly direction, entering United States from Mexico near the town of San Ysidro and

emptying into the Pacific Ocean about two miles north of the international boundary line. Cottonwood Creek, the principal tributary draining practically all of that part of the basin lying in the United States, rises on the slopes of Laguna Mountain which reaches an elevation of over 6,000 feet above sea level. It flows in a general southwesterly direction and joins the main stream in Mexico about four miles above the international boundary line. The drainage basin of Cottonwood Creek is rough, although there are several small valleys at elevations of over 3,000 feet. Its principal tributaries are Pine Valley Creek and the Rio de Tecate. Pine Valley Creek rises on the west slope of Laguna Mountain and its watershed is entirely within the United States. The Rio de Tecate basin lies on both sides of the international boundary. The principal tributary of Rio de Tecate is Campo Creek whose watershed is almost entirely within the United States. Cottonwood and Campo Creeks are the most southerly streams in San Diego County.

The watershed of the Rio Las Palmas, the main stream above Rodriguez Dam, is entirely within Mexico except for an area of about eleven square miles between Campo and Jacumba. Its tributaries, the Arroyo de Calabazas and the Arroyo de la Cienega, join to form the main stream in the Cancio reservoir site. These tributaries drain the extreme southeastern part of the watershed. The Arroyo Seco enters from the east near the head of the large valley known as Valle de las Palmas. Arroyo Matanuco joins the Tia Juana River a few hundred feet below Rodriguez Dam.

The Tia Juana River flows through a wide, flat valley after entering the United States, with a low terrace to the north. In times of extreme flood it has discharged part of its waters through a low saddle near Nestor into San Diego Bay. The drainage basin of the Tia Juana River is about 76 miles long and has an average width of 22 miles. The area of the watershed above the bridge near Nestor in San Diego County is 1,658 square miles, of

TABLE 1

AREAS AND ELEVATIONS OF DRAINAGE BASINS IN SAN DIEGO COUNTY

Stream basin	Elevation in feet: Maximum	Minimum	Average	Drainage area in square miles: Sub-basin	Cumulative total
Santa Margarita River Basin					
Temecula Creek above Nigger Canyon	6,823	1,350	3,462		321
Temecula Creek between Nigger Canyon and Murrieta Creek	4,500	950	1,516	45	
Temecula Creek above Murrieta Creek	6,823	950	3,224		366
Murrieta Creek above Temecula Creek	4,600	950	1,714	227	
Santa Margarita River above Railroad Canyon	6,823	950	2,644		593
Santa Margarita River between Railroad Canyon and Fallbrook	2,400	300	1,183	52	
Santa Margarita River above Fallbrook	6,823	300	2,527		645
Santa Margarita River between Fallbrook and Deluz	3,187	100	1,058	65	
Santa Margarita River above Deluz	6,823	100	2,393		710
Santa Margarita River between Deluz and Ysidora	1,000	0	311	33	
Santa Margarita River above Ysidora	6,823	0	2,302		745
San Luis Rey River Basin					
San Luis Rey River above Henshaw Dam	6,400	2,700	3,886		206
San Luis Rey River between Henshaw Dam and Escondido Ditch Intake	5,600	1,800	3,291	32	
San Luis Rey River above Escondido Ditch Intake	6,400	1,800	3,807		238
San Luis Rey River between Escondido Ditch Intake and Sickler's Mill near Pala	5,628	550	2,345	81	
San Luis Rey River above Sickler's Mill near Pala	6,400	550	3,436		319
San Luis Rey River between Sickler's Mill near Pala and Monserate Mountain	4,700	260	1,329	58	
San Luis Rey River above Monserate Mountain	6,400	260	3,112		377
San Luis Rey River between Monserate Mountain and Bonsall	1,900	150	916	85	
San Luis Rey River above Bonsall	6,400	150	2,708		462
San Luis Rey River between Bonsall and near Bonsall	2,300	150	924	56	
San Luis Rey River above near Bonsall	6,400	150	2,514		518
San Luis Rey River between near Bonsall and near Oceanside	800	25	352	44	
San Luis Rey River above near Oceanside	6,400	25	2,344		562
San Luis Rey River between near Oceanside and at Oceanside	310	0	100	3	
San Luis Rey River above Oceanside	6,400	0	2,334		565
Escondido Creek Basin					
Escondido Creek above Wohlford Dam	2,300	1,450	1,819		8
Escondido Creek between Wohlford Dam and San Elijo dam site	2,300	300	998	49	
Escondido Creek above San Elijo dam site	2,300	300	1,158		57
San Dieguito River Basin					
Santa Ysabel Creek above Santa Ysabel	5,570	2,950	4,317		18
Santa Ysabel Creek between Santa Ysabel and Sutherland dam site	4,800	1,900	3,071	41	
Santa Ysabel Creek, above Sutherland dam site	5,570	1,900	3,366		54
Black Canyon Creek above stream-gaging station	4,500	2,000	3,290	15	
Temescal Creek above Santa Ysabel Creek	4,100	1,000	2,349	32	
Santa Ysabel Creek between Sutherland and Pamo dam sites, excluding Black Canyon and Temescal Creeks	3,300	900	1,802	10	
Santa Ysabel Creek above Pamo dam site	5,570	900	2,915		111
Santa Ysabel Creek between Pamo dam site and head of San Pasqual Valley	2,300	600	1,464	17	
Santa Ysabel Creek above head of San Pasqual Valley	5,570	500	2,721		128
Santa Maria Creek above Santa Maria dam site	3,280	1,300	1,845	60	
Guejito Creek above San Dieguito River	4,100	400	2,035	28	
San Dieguito River between head of San Pasqual Valley and Bernardo excluding Santa Maria Creek and Guejito Creek	2,890	300	1,059	54	
San Dieguito River above Bernardo	5,570	300	2,123		270
San Dieguito River between Bernardo and Hodges Dam	1,350	200	660	33	
San Dieguito River above Hodges Dam	5,570	200	1,965		303
San Dieguito River between Hodges Dam and Del Mar stream-gaging station	1,575	25	508	24	
San Dieguito River above Del Mar stream gaging station	5,570	23	1,859		327
San Diego River Basin					
Boulder Creek above Cuyamaca Dam	6,200	4,500	4,833		12
Boulder Creek between Cuyamaca Dam and San Diego River	6,515	900	3,474	22	
Boulder Creek above San Diego River	6,515	900	3,963		34
San Diego River above Diverting Dam excluding Boulder Creek	6,028	800	3,285	69	
San Diego River above Diverting Dam	6,515	800	3,507		103
South Fork of San Diego River above stream gaging station	6,515	750	2,886	45	
San Diego River between Diverting Dam and El Capitan Dam excluding South Fork	4,224	600	1,716	42	
San Diego River above El Capitan Dam	6,515	600	2,962		190
San Diego River between El Capitan Dam and Lakeside	3,680	400	1,218	16	
San Diego River above Lakeside	6,515	400	2,825		206
San Vicente Creek above dam site near Foster	3,680	500	1,611	75	
San Diego River between Lakeside and Old Mission Dam excluding San Vicente Creek	2,200	275	751	95	
San Diego River above Old Mission Dam	6,515	275	2,057		376
San Diego River between Old Mission Dam and Loop Dam	1,590	200	699	5	
San Diego River above Loop Dam	6,515	200	2,040		381
Alvarado Canyon above Murrey Dam	1,590	500	695	(3.6)	
San Diego River between Loop Dam and Old Town including Alvarado Canyon	1,590	0	440	54	
San Diego River above Old Town	6,515	0	1,843		435
Sweetwater River Basin					
Sweetwater River above Descanso	6,515	3,300	4,386		44
Sweetwater River between Descanso and Dehesa	4,224	900	2,489	67	
Sweetwater River above Dehesa	6,515	900	3,247		111
Sweetwater River between Dehesa and Sweetwater Dam	2,800	150	1,019	70	
Sweetwater River above Sweetwater Dam	6,515	150	2,393		181
Otay River Basin					
Proctor Valley above Upper Otay Dam	2,573	550	1,039	12	
Otay River above Lower Otay Dam excluding Proctor Valley	3,755	500	1,506	87	
Otay River above Lower Otay Dam	3,755	300	1,447		99
Tia Juana River Basin					
Cottonwood Creek above Morena Dam	6,200	2,900	4,168		114
Pine Valley Creek above Cottonwood Creek	6,321	1,550	4,019	100	
Cottonwood Creek, between Morena and Barrett dams excluding Pine Valley Creek	4,200	1,500	2,628	35	
Cottonwood Creek, between Morena and Barrett dams including Pine Valley Creek	6,321	1,500	3,671		(135)
Cottonwood Creek, above Barrett Dam	6,321	1,500	3,887		249
Campo Creek and Rio del Tecate in United States	4,400	1,700	3,120	96	
Cottonwood Creek between Barrett Dam and Marron damsite No. 1	3,890	500	2,086	72	
Cottonwood Creek above Marron damsite No. 1 in United States	6,321	500	3,548		417
Rio del Tecate in Mexico*	--	300	2,469	69	
Cottonwood Creek above Marron damsite No. 1*	--	500	3,395		486
Tia Juana River above Rodriguez Dam - in United States	3,900	3,400	3,636	11	
- in Mexico*				927	
Tia Juana River above Rodriguez Dam*					(938)
Tia Juana River between Rodriguez Dam - Marron damsite No. 1 and Nestor Bridge - in United States	3,572	25	948	33	
- in Mexico*		50		201	
Tia Juana River between Rodriguez Dam - Marron damsite No. 1 and Nestor Bridge*					(234)
Tia Juana River above Nestor Bridge - in United States	6,321	25	3,362	(401)	
- in Mexico*		50		(1197)	
Tia Juana River, above Nestor Bridge*		25			1,658

*Areas of drainage basins in Mexico are based on data given in report of the American Section of the International Water Commission, United States and Mexico, 71st Congress, 2nd Session, House Document No. 359.

which 461 square miles are in the United States.

The area in square miles and the maximum, minimum and average elevations of the drainage basins and sub-basins of the principal streams in San Diego County are shown in Table 1.

Precipitation.

Many records of the occurrence and amount of precipitation at different points in San Diego County for varying periods of record are available. The locations and elevations of the precipitation gaging stations together with the period of record available are listed in Table 2, and the locations are shown on Plate I. About 20 per cent of these records kept by the United States Weather Bureau or cooperative agents and published in Weather Bureau bulletins are not given in this report. The other records, kept by local civic agencies, public utilities, private corporations and individuals, hitherto unpublished, or published in bulletins now out of print, are given in monthly and seasonal form, together with the authority compiling the data in Appendix "B". Although the United States Weather Bureau publishes a table of precipitation at San Diego beginning in 1850 and active at the present time, the early years of this table are a compilation of records kept at various points in the vicinity of San Diego and the published data is not a continuous record of one gage in an unchanged location. Six other records were commenced in the decade 1870-1880 but altho several of these cover periods of over 30 years and are active at the present time none of them are unbroken. Seven records were begun in the decade 1880-1890, two of which, Sweetwater Dam, 1888, and Cuyamaca Dam, 1887, are unbroken and active today. Of the 138 records listed in Table 2, 18 are over 30 years, 33 are over 20 years and 69 are over 10 years in length. 51 are known to be active at the present time.

The characteristics of the precipitation of the Pacific slope of San Diego County are illustrated by the data shown in Table 3. In this table

TABLE 2

PRECIPITATION STATIONS IN OR NEAR SAN DIEGO COUNTY

Index number on Plate I	Station	Location (S.B.B.& M.) Section	Township south	Range	Elevation in feet, U.S.G.S. datum	Period of record	Record available to July 1, 1933, in years
1	San Jacinto	35	4	1 W	1550	•1896 - 1933#	40.3
2	Idyllwild	12	5	2 E	5250	•1901 - 1912#	11.0
3	Hemet Lake	9	6	3 E	4350	1896 - 1931	35.0
4	Coahuila	31	7	3 E	3800	•1911 - 1919#	7.4
5	Elsinore	7	6	4 W	1300	•1877 - 1933#	35.7
6	Deluz	29	8	4 W	450	1902 - 1933	31.0
7	San Clemente	3	9	7 W	100	•1930 - 1933	3.5
8	Oceanside #1	26	11	5 W	30	1892 - 1909	17.0
8	Oceanside #2	26	11	5 W	67	•1909 - 1919	10.0
						1919 - 1926	7.0
8	Oceanside #3	26	11	5 W	60	1927 - 1933	6.5
9	Oceanside #4	19	11	4 W	280	1926 - 1933	7.0
10	San Luis Rey	5	11	4 W	60	1901 - 1916	15.5
11	Gopher Canyon	6	11	3 W	300	1916••	0.1
12	Canfield Ranch	21	10	3 W	250	1916••	0.1
13	Fallbrook #1	24	9	4 W	700	•1876 - 1904	27.8
14	Fallbrook #2	21	9	3 W	750	1909 - 1933	24.0
15	Red Mountain Ranch	16	9	3 W	640	1924 - 1933	[illegible].6
16	Aguanga	26	8	1 E	1956	•1908 - 1933#	24.6
17	Oak Grove	17	9	2 E	2751	•1910 - 1916#	3.2
18	Dead Mans Hole	1	10	2 E	3200	1911 - 192[illegible]	12.9
19	[illegible] Mountain	4	9	3 E	4200	1911 - 1915	3.8
20	Hot Springs Mountain	8	10	4 E	6200	1912 - 1915	2.8
21	Eagles Nest	20	10	4 E	4500	1911 - 1916	4.6
22	Warner Springs	23	10	3 E	3165	•1906 - 1933	27.0
23	San Felipe	30	11	4 E	3600	1911 - 1924#	11.6
24	Warner Ranch [illegible]	4	11	3 E	2804	1911 - 1916#	4.2
25	Puerta la Cruz	30	10	3 E	2772	1911 - 1917#	5.8
26	Rincon of Warner Ranch	15	10	2 E	2975	1913 - 1916	3.5
27	Warner [illegible] Road	6	11	3 E	2905	1911 - 1922#	10.5
28	Matagual	22	11	3 E	3200	1911 - 1916	4.9
29	Volcan Mountain	2	12	3 E	4800	1911 - 1924	12.5
30	Santa Ysabel-Warner Divide	33	11	3 E	3200	1913 - 1916	3.3
31	Monkey Hill	12	11	2 E	2810	1911 - 1915	4.0
32	Dunrone	14	11	2 E	2725	1911 - 1922	10.8
33	Henshaw Dam	10	11	2 E	2702	1911 - 1933	22.0
34	Mendenhall Valley	11	10	1 E	4500	1911 - 1916	4.6
35	Nellie	9	10	1 E	5000	•1901 - 1923#	17.5
						1902 - 1904#	0.8
36	Amago	26	10	1 E	2715	•1912 - 1933	21.3
37	Mesa Grande (Angels)	21	11	2 E	3450	1912 - 1916#	4.0
38	Mesa Grande	3	12	2 E	3350	•1908 - 1922#	13.9
						1905 - 1908	3.0
39	Santa Ysabel Ranch	20	12	3 E	3000	1900 - 1916#	14.5
40	Santa Ysabel Store	21	12	3 E	2983	1911 - 1916	3.8
41	Witch Creek	31	12	3 E	2800	1909 - 1916	6.9
42	Sutherland Dam Site	21	12	2 E	1900	1914 - 1931#	7.6
43	Rose Glen	32	12	2 E	2300	1911 - 1916	4.1
44	Pamo Dam	23	12	1 E	975	1914 - 1923#	8.8
45	Pamo	11	12	1 E	1050	1911 - 1913	2.4
46	Escondido Ditch Head	33	10	1 E	1986	1896 - 1933#	28.5
47	Valley Center #1	7	11	1 W	1400	1872 - 1903	31.0
48	Valley Center #2	13	11	2 W	1360	1912 - 1924#	11.8
49	Wohlford Lake	5	12	1 W	1450	1926 - 1933	6.9
50	Rockwood Ranch	35	12	1 W	430	1893 - 1915	22.0
51	Ramona (Verlaque)	15	13	1 E	1440	1896 - 1916	20.0
52	Ramona (Sentinel)	15	13	1 E	1440	1911 - 1931	19.7
53	Ramona ([illegible])	16	13	1 E	1440	•1927 - 1933	5.2
54	Santa Maria Dam Site	11	13	1 W	1400	1914 - 1916	2.3
55	Escondido #1	10	12	2 W	750	•1894 - 1933#	37.5
56	Escondido #2	22	12	2 W	660	•1918 - 1933	15.0
56	Escondido #3	22	12	2 W	660	1887 - 1897	10.0
56	Escondido #4	22	12	2 W	660	1927 - 1933	6.5
57	Twin Oaks	25	11	3 W	700	1875 - 1887	12.0
58	Bernardo Bridge	10	13	2 W	370	1923 - 1933#	8.2
59	Carroll Dam Site	8	13	2 W	250	1914 - 1916#	1.8
60	Hodges Dam	18	13	2 W	350	1919 - 1933	14.4
61	San Dieguito Dam	16	13	3 W	240	1924 - 1933#	6.4
62	Santa Fe Ranch	34	13	3 W	55	1912 - 1915	3.5
63	Poway	14	14	2 W	460	•1878 - 1909#	26.4
64	Miramar	6	15	2 W	660	1901 - 1933#	27.0
65	Scripps Institution	13	15	4 W	50	1924 - 1933	9.0
66	La Jolla	27	15	4 W	100	1927 - 1933	6.5
67	Point Loma	1	17	4 W	302	•1904 - 1933	29.5
68	Coronado	15	17	3 W	50	1927 - 1933	6.5
69	San Diego	11	17	3 W	87	•1850 - 1933(1)	83.0
70	Chula Vista	20	18	2 W	9	•1918 - 1933	14.8
71	Otay	15	18	2 W	90	1908 - 1915	7.0
72	Bonita No. 1	36	17	2 W	110	1899 - 1915	16.0
						•1915 - 1933	18.0
72	Bonita No. 2	25	17	2 W	60	1914 - 1921#	4.7
73	Sweetwater Dam	17	17	1 W	310	1888 - 1933	45.0
74	Chollas Heights	34	16	2 W	370	1914 - 1933	19.5
75	Murray Dam	13	16	2 W	500	1913 - 1933	20.5
76	La Mesa	19	16	1 W	550	1927 - 1933	6.5
77	La Presa	9	17	1 W	300	1914 - 1916	2.3
78	Lower Otay Dam	7	18	1 E	500	1906 - 1933	27.5
79	Harvey Ranch	4	18	1 E	514	1914 - 1921#	3.5
80	Upper Otay Dam	36	17	1 W	550	1916 - 1933#	11.9
81	Grossmont	16	16	1 W	640	1899 - 1933#	33.5
82	El Cajon #1	11	16	1 W	482	1882 - 1896	14.0
82	El Cajon #2	11	16	1 W	480	1927 - 1933	6.5
83	El Cajon #3	18	16	1 E	560	•1875 - 1933#	34.5
84	El Cajon Valley	24	16	1 W	670	1901 - 1933#	31.4
85	Jamul	4	17	1 E	1040	1903 - 1920#	9.1
86	Jamul Ranch	14	17	1 E	800	1912 - 1917#	4.5
87	Los Padres Ranch	16	16	1 E	490	1901 - 1915#	13.0
88	Dehesa	14	16	1 E	580	1914 - 1916	1.9
89	Lakeside	18	15	1 E	500	1909 - 1915	6.0
90	Los Coches	28	15	1 E	710	1900 - 1933	32.3
91	Chocolate Creek	8	15	2 E	760	1899 - 1933	34.3
92	Camp Denny	11	16	2 E	1450	1929 - 1933	4.0
93	Japatul	9	16	3 E	2800	1914 - 1923	9.0
94	Willows	25	15	2 E	2300	1914 - 1933	19.3
95	Viejas	20	15	3 E	2400	1915 - 1928#	2.2
96	Diverting Dam	11	14	2 E	840	1898 - 1933	35.0
97	Boulder Creek	11	14	3 E	2990	1914 - 1917	2.2
98	Cuyamaca Dam	5	14	4 E	4677	•1887 - 1933(2)	46.0
99	Schilling	32	13	4 E	4550	1912 - 1919	5.5
100	Pine Hills Hotel	13	13	3 E	4100	1913 - 1916	2.7
101	Julian	6	13	4 E	4222	•1879 - 1933#	37.3
102	Cuyamaca, East	34	13	4 E	4600	1912 - 1919	5.9
103	Harper Ranch	19	14	5 E	4800	1914 - 1931#	13.5
104	Nobles Mine	17	15	5 E	4200	1913 - 1918#	3.5
105	Laguna Ranger Station	3	15	5 E	5475	1914 - 1916	1.1
106	Laguna	15	15	5 E	5440	1894 - 1904	10.0
107	Green Valley	33	14	4 E	4100	1916••	0.1
108	Hurlburds Ranch	13	15	3 E	3450	1889 - 1895	6.5
109	Descanso	25	15	3 E	3350	•1896 - 1916#	13.9
110	Gillette Ranch	1	16	3 E	3500	1919 - 1931	12.0
111	Descanso Ranger Station	24	15	3 E	3400	1916 - 1933#	6.9
111	Descanso Valley	24	15	3 E	3500	1915 - 1916	1.3
112	Pine Valley	26	15	4 E	3700	1898 - 1904	5.6
113	Buckman Springs	20	16	5 E	5450	1912 - 1915	2.9
114	Hooks Ranch	29	16	5 E	3200	1914 - 1921	7.7
115	La Posta	1	17	5 E	3300	1915 - 1921	6.7
116	Campo	16	18	5 E	3000	•1877 - 1933#	44.4
117	Grigsby's Ranch	8	18	5 E	2690	1913 - 1921	8.7
118	Morena Dam	14	17	4 E	3050	1896 - 1933#	31.2
119	Hauser Creek	21	17	4 E	2300	1915 - 1922#	6.0
120	Skye Valley	2	17	3 E	2550	1913 - 1920	6.1
121	Barrett Dam	22	17	3 E	1650	1894 - 1917#	16.2
						•1914 - 1933#	18.7
122	Potrero	6	18	4 E	2390	1914 - 1931	17.5
123	Tecate	24	18	3 E	1800	1914 - 1931	17.5
124	Lauterbachs Ranch	4	18	3 E	1200	1909 - 1931	21.7
125	Barrett P.O.	8	18	3 E	875	1914 - 1918	5.0
126	Wiostka Valley	26	17	2 E	2500	1914 - 1917#	3.4
127	Lyon Valley	10	17	2 E	2200	1914 - 1921#	2.6
128	Lyon Peak	10	17	2 E	3755	1914 - 1918	3.6
129	Dulzura	33	17	2 E	1075	1913 - 1927#	12.6
130	Dulzura Summit	10	18	2 E	1400	1915 - 1933#	15.2
131	Marron Valley	[illegible]	[illegible]	2 E	550	1913 - [illegible]	[illegible]

* Record published by U.S. Weather Bureau.
** Record available for January 1916 in W.S.P.426
\# Broken record.

(1) Compilation of several records by U. S. W. B.
(2) Rainfall at this gage as recorded by L.M.L.D. and S.V.I.D., differs from U.S.W.B. for some months.

the maximum, minimum and mean seasonal precipitation and the monthly distribution in per cent of seasonal for the period 1908 to 1933 are shown for nine stations in San Diego County. The stations may be located on Plate I by use of the index number shown in the table. For three stations, Warner Springs, Cuyamaca Dam and San Diego, the percentage of precipitation produced by each different storm type in the period 1928 to 1933 is given. The stations included in this table are typical of conditions from the coast to the crest of the divide and from Orange County to the Mexican border. The mean seasonal precipitation varies from a minimum of about 10 inches at the coast to a maximum of about 40 inches in the higher portions of the divide. The variations from season to season are extreme, the precipitation in maximum seasons may be well over twice and in minimum seasons may fall to approximately one-half the mean seasonal rainfall.

The storms which bring precipitation to San Diego County have been segregated into four types according to their source,- North Pacific, South Pacific, Interior and Mexican.* The North Pacific storms include all those which approach the Pacific Coast north of San Francisco. These storms originate off the coast of Alaska and travel in an easterly direction across the North American continent. During the winter months their storm track swings southward and from November to May southern California lies within their precipitation area. The precipitation yield from North Pacific storms, approximately 43 per cent of the seasonal total, varies less from year to year than that of the other types. The South Pacific storms include all those which approach the Pacific Coast south of San Francisco and north of the Tropic of Cancer. These storms, producing about 19 per cent of the total precipitation, are irregular in

*"Storm Types and Resultant Precipitation in the San Diego, California, Area,"- Dean Blake, Monthly Weather Review, Volume 61, August 1933.

TABLE 3

CHARACTERISTICS OF PRECIPITATION AT NINE STATIONS IN SAN DIEGO COUNTY

Based on period of record 1908-1933

	Deluz	Aguanga*	Warner Springs	Escondido	Grossmont	Cuyamaca	Lower Otay Dam	Campo	San Diego	Mean
Index Number on Plate I	6	16	22	55	81	98	78	116	69	
Elevation in feet, U.S.G.S. datum	450	1986	3165	750	640	4677	500	3000	87	
SEASONAL PRECIPITATION										
Maximum season	1921-22	1921-22	1921-22	1921-22	1914-15	1926-27	1926-27	1921-22	1921-22	
Depth in inches	40.57	24.17	38.23	28.89	26.01	64.00	21.85	33.41	18.65	
Minimum season	1918-19	1924-25	1924-25	1912-13	1912-13	1927-28	1917-18	1920-21	1923-24	
Depth in inches	9.28	7.13	8.32	10.31	7.78	21.43	7.91	10.17	5.66	
Mean depth in inches	18.16	13.53	17.81	17.14	15.23	38.80	12.65	19.70	10.26	
PERCENTAGE OF PRECIPITATION PRODUCED BY EACH STORM TYPE IN PERIOD 1928-1933**:										
North Pacific			36			46			47	43
South Pacific			20			17			20	19
Interior			32			29			29	30
Mexican			12			8			4	8
MAXIMUM MONTHLY PRECIPITATION										
Month and year	Jan. 1916	Jan. 1916	Jan. 1916	Jan. 1916	Dec. 1921	Jan. 1916	Jan. 1916	Jan. 1916	Dec. 1921	
Depth in inches	29.25	17.85	18.92	19.55	12.42	37.50	9.91	20.44	9.26	
Per cent of mean seasonal	161	132	106	114	82	97	78	104	90	
MEAN MONTHLY DISTRIBUTION IN PER CENT OF MEAN SEASONAL TOTAL:										
July	0.0	1.6	3.3	0.2	0.3	1.3	0.1	4.6	0.1	1.3
August	0.2	3.6	4.5	0.6	0.5	1.9	0.6	2.6	0.5	1.7
September	0.9	2.0	2.5	0.8	1.4	1.6	0.6	1.3	1.1	1.4
October	4.1	5.7	4.7	4.9	5.0	5.1	5.7	4.1	5.9	5.0
November	6.3	5.5	5.8	6.8	7.1	6.4	7.5	6.6	7.1	6.6
December	16.1	13.4	16.8	16.7	17.1	16.3	17.2	14.7	18.2	16.3
January	27.8	22.1	18.9	21.9	19.8	19.2	19.8	20.1	22.1	21.3
February	22.2	20.0	18.2	20.6	19.6	19.1	19.3	19.0	18.7	19.6
March	13.1	14.5	13.2	13.7	14.5	14.9	15.5	14.3	14.5	14.2
April	6.5	8.0	7.6	9.0	9.8	9.3	9.1	8.6	8.4	8.5
May	2.3	3.1	4.1	4.4	4.5	4.3	4.1	3.7	3.1	3.7
June	0.5	0.5	0.4	0.4	0.4	0.6	0.5	0.4	0.3	0.4

*Located in Riverside County, approximately one mile north of San Diego County Line.

**"Storm Types and Resultant Precipitation in the San Diego, California, Area," Dean Blake, Monthly Weather Review, Volume 61, August 1933.

occurrence and vary widely in production from season to season. They may occur at any time from November to March and often bring warm and heavy rains. The Interior storms, erratic in movement, may occur at any time of the year, but are most frequent during the spring months. They produce about 30 per cent of the seasonal total. The Mexican storms occur only in the fall months from August to November. They are extremely erratic in movement. Altho they seldom cross the mountains to the coast, they often cause heavy rains of the cloudburst type and account for an appreciable portion of the seasonal precipitation in the mountain areas. The cloudburst of August 12, 1891, at Campo, in which 11.50 inches of rain are said to have fallen in 80 minutes, is an extreme example of this type of storm. Fortunately falls of this intensity are rare.

The monthly distributions shown in Table 3 indicate that the heaviest precipitation may be expected in January and February and that over 70 per cent of the seasonal total may be expected to occur during the four months from December to March inclusive. In exceptional seasons the fall in one month may be well in excess of the mean seasonal precipitation.

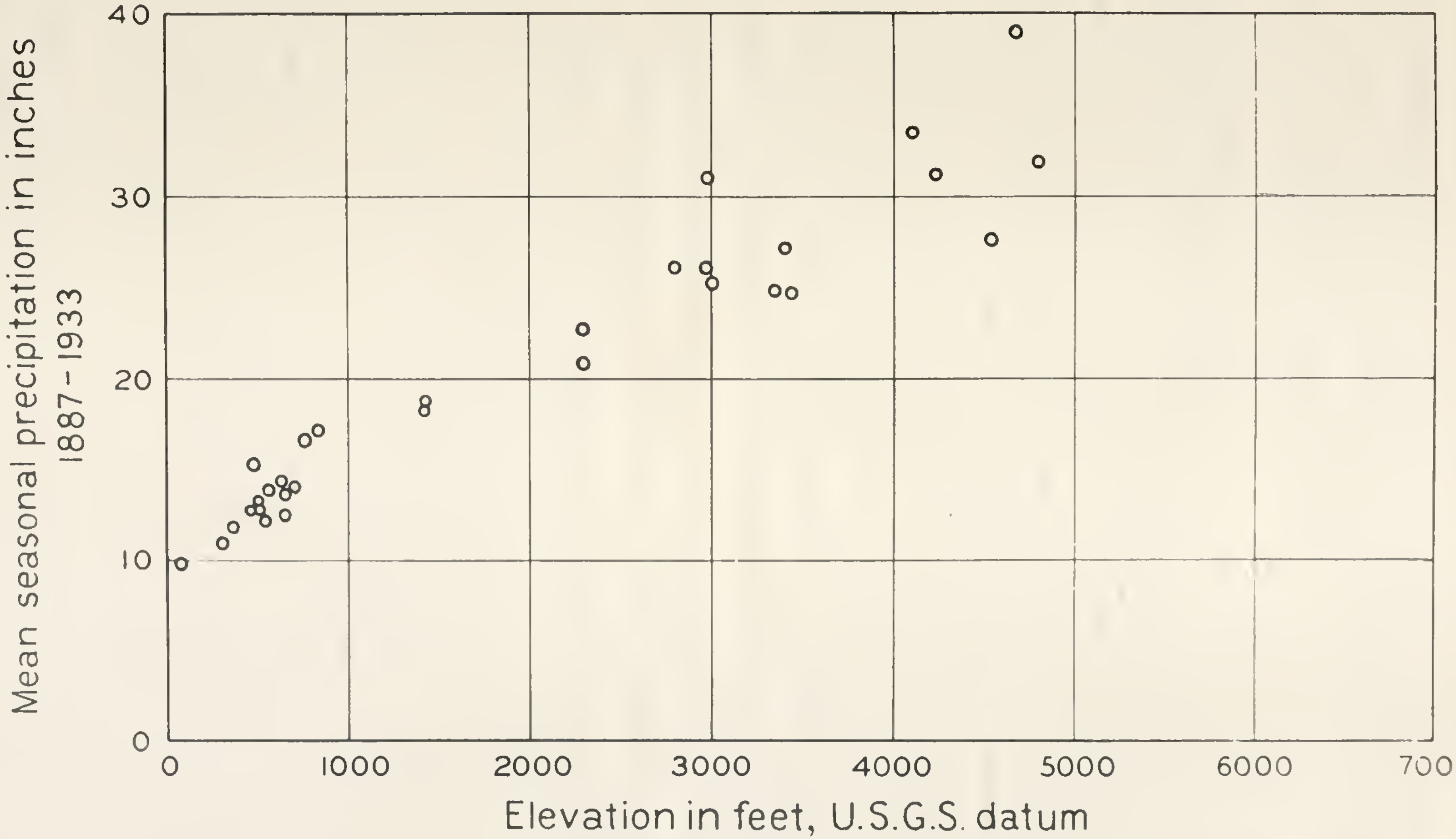
The precipitation usually occurs in the form of rainfall but there are some snows practically every year in the higher mountain areas. At Warner Springs, elevation 3,165, about 4 per cent and at Cuyamaca, elevation 4,677, about 10 per cent of the total precipitation may be expected to occur in the form of snow. This snow seldom remains on the ground for more than a few days and unless carried off by a warm rain usually disappears without any marked effect on the flow of the streams.

The variation of mean seasonal precipitation from the coast to the crest of the divide is shown graphically on Plate II, "Variation of Precipitation with Elevation in San Diego River Drainage Basin." The data on which this analysis is based are given in Table 4 and include the available records of precipitation at points in or near to the San Diego River Basin. It will

TABLE 4

VARIATION OF PRECIPITATION WITH ELEVATION
IN THE SAN DIEGO RIVER DRAINAGE BASIN

Precipitation station: Number on Plate I	Precipitation station: Name	46-year mean seasonal precipitation 1887-1933, in inches	Elevation, in feet, U.S.G.S. datum	Length of actual record, in years
69	San Diego	9.84	87	46
73	Sweetwater Dam	10.99	310	45
74	Chollas Heights	11.91	370	19
76	La Mesa	12.18	550	6
84	El Cajon Valley	12.40	670	31
82	El Cajon No. 2	12.81	480	6
82	El Cajon No. 1	12.82	480	9
75	Murray Dam	12.83	500	20
89	Lakeside	13.18	500	6
64	Miramar	13.56	660	27
90	Los Coches	13.97	710	32
83	El Cajon No. 3	13.99	560	34
81	Grossmont	14.34	640	33
87	Los Padres Ranch	15.33	490	13
91	Chocolate	16.57	760	34
96	Diverting Dam	17.08	840	34
52	Ramona (Sentinel)	18.21	1440	20
51	Ramona (Verlaque)	18.78	1440	20
94	Willows	20.69	2300	19
43	Rose Glen	22.65	2300	5
108	Hurlburds Ranch	24.58	3450	6
109	Descanso	24.98	3350	12
39	Santa Ysabel Ranch	25.19	3000	14
41	Witch Creek	26.02	2800	7
40	Santa Ysabel Store	26.06	2983	5
111	Descanso Ranger Station	27.07	3400	3
99	Schilling	27.51	4550	6
97	Boulder Creek	30.91	2990	3
101	Julian	31.31	4222	32
29	Volcan Mountain	31.94	4800	12
100	Pine Hills Hotel	33.55	4100	3
98	Cuyamaca Dam	38.98	4677	46



VARIATION OF PRECIPITATION WITH ELEVATION
IN
SAN DIEGO RIVER DRAINAGE BASIN

be noted that although the data establish a very definite trend of increasing precipitation with elevation, the actual precipitation at any given elevation may vary by as much as 20 per cent from a mean value. These variations are probably the result of local topographic features such as protecting ridges or peaks which cause eddies in the wind directions.

Relation of Run-off and Precipitation.

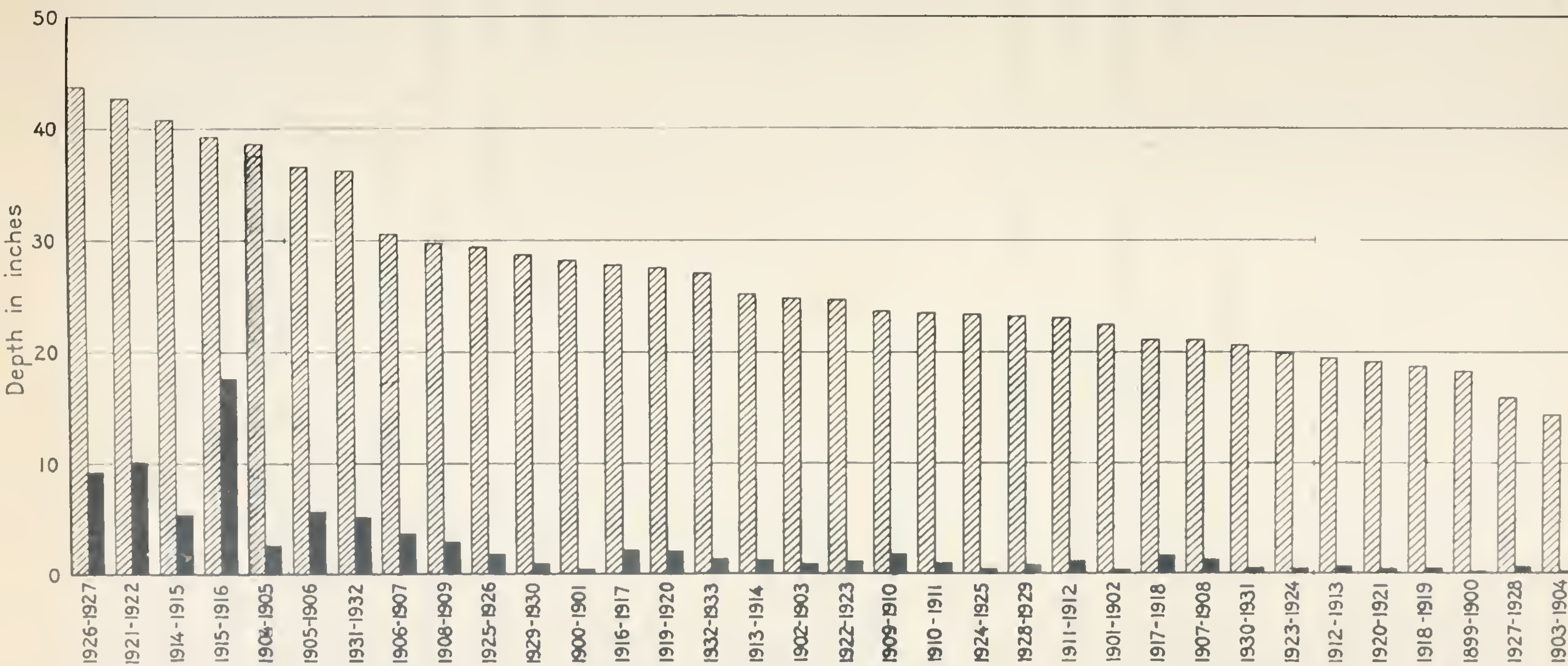
The full natural run-off of the San Diego River at Mission Gorge and the average of the recorded precipitation at Grossmont and Cuyamaca for each year since 1899 arranged in the order of magnitude of the precipitation are listed in Table 5 and are shown graphically on Plate III, "Average Precipitation at Cuyamaca and Grossmont in Comparison with Full Natural Flow of San Diego River." Although this presentation of the data shows a definite decrease in the amount of run-off with a decrease in the amount of precipitation, it also shows that the variation in the relationship for individual years is so large that the use of the precipitation of any one season for the estimation of the run-off of that season would be unreliable without considerable modification.

The major portion of the run-off of the San Diego County streams comes from the mountain areas. The underlying rock of these mountains is granitic and easily weathered. Disintegration in places has reached depths as great as 100 feet below the surface. The soils are sandy and the absorption of rainfall is rapid and large in amount. Consequently, surface run-off occurs only when the rate of precipitation is in excess of a high percolation rate or when the large storage capacity of both surface and sub-soils has been exceeded. A small portion of the water absorbed drains out immediately after the rain ceases but a much larger part remains in the ground and is either used up in support of plant life or drains out over a period of several years through springs and other outlets. The effect of the absorptive capacity of the soils

TABLE 5

AVERAGE PRECIPITATION AT CUYAMACA AND GROSSMONT
IN COMPARISON WITH
FULL NATURAL FLOW OF SAN DIEGO RIVER

Season	Seasonal rainfall, in inches			Seasonal run-off, at Mission Gorge	
	Cuyamaca	Grossmont	Mean	Acre-feet	Inches
1926-27	64.00	23.71	43.86	185,040	9.23
1921-22	59.58	25.77	42.68	201,530	10.05
1914-15	55.79	26.01	40.90	108,250	5.40
1915-16	57.87	20.83	39.35	352,030	17.55
1904-05	57.79	19.59	38.69	50,370	2.51
1905-06	56.38	16.68	36.53	111,470	5.56
1931-32	53.58	19.36	36.47	102,140	5.09
1906-07	44.91	16.14	30.52	71,820	3.58
1908-09	45.65	13.88	29.76	58,100	2.90
1925-26	37.19	21.86	29.52	36,120	1.80
1929-30	41.37	16.28	28.82	19,160	0.96
1900-01	42.81	13.68	28.24	8,650	0.43
1916-17	39.68	16.00	27.88	40,600	2.02
1919-20	38.97	16.24	27.60	42,500	2.12
1932-33	39.87	14.39	27.13	26,900	1.34
1913-14	34.82	15.53	25.18	25,580	1.28
1902-03	36.59	13.17	24.88	15,370	0.77
1922-23	38.11	11.29	24.70	22,310	1.11
1909-10	33.44	13.94	23.69	33,670	1.68
1910-11	32.15	14.84	23.50	19,730	0.98
1924-25	36.10	10.70	23.40	8,790	0.44
1928-29	35.43	11.00	23.22	15,200	0.76
1911-12	31.88	14.18	23.03	23,270	1.16
1901-02	35.98	8.98	22.48	7,500	0.37
1917-18	29.46	12.72	21.09	30,990	1.55
1907-08	30.35	11.75	21.05	24,300	1.21
1930-31	27.05	14.09	20.57	9,770	0.49
1923-24	29.89	9.85	19.87	8,770	0.44
1912-13	31.03	7.78	19.40	10,600	0.53
1920-21	27.73	10.44	19.08	7,090	0.35
1918-19	27.94	9.66	18.80	10,830	0.54
1899-00	28.79	7.60	18.20	980	0.05
1927-28	21.43	10.31	15.87	11,900	0.59
1903-04	23.53	5.33	14.43	1,270	0.06



AVERAGE PRECIPITATION AT CUYAMACA AND GROSSMONT
IN COMPARISON WITH
FULL NATURAL FLOW OF SAN DIEGO RIVER

Seasonal precipitation July 1, to June 30
Seasonal run-off at Mission Gorge Oct. 1, to Sept. 30

on the run-off from rainfall is well shown by a comparison of the run-offs of the seasons of 1914-15 and 1915-16. In these two seasons, although the total seasonal precipitation was about the same, the seasonal run-off of 1915-16 was over three times as large as that of the season 1914-15. The maximum monthly precipitation in the season 1915-16, however, was over 60 per cent of the seasonal total, while in the season 1914-15 it was only about 24 per cent of the total for that season. The effect of the storage and later release of ground water is shown by a comparison of the seasonal run-offs of the two seasons 1903-04 and 1927-28. In the season of 1903-04 the total seasonal precipitation was about nine-tenths that of 1927-28. The run-off, however, was only about 10 per cent as large as that of the season 1927-28 which had been preceded by the extremely wet season of 1926-27.

Run-off.

Many stream flow records have been obtained by private and public agencies in San Diego County. The United States Geological Survey has maintained a number of stream gaging stations in the county and has published, either wholly or in part, many of the records obtained by other agencies. The oldest stream flow records in San Diego County are derived from the computed inflows into the Cuyamaca and Sweetwater reservoirs. Both these records begin in the season of 1887-88. Monthly estimates of inflow for the entire record are available for Sweetwater Reservoir. In the case of the Cuyamaca Reservoir, monthly estimates of inflow begin in the season of 1892-93. The next oldest stream flow record in the county is on the San Diego River at the Diverting Dam. Estimates of the waste over this dam and of the amounts diverted into the Cuyamaca Flume begin in January 1899. As has been previously shown, there is apparently only a very poor relation between total rainfall and run-off in this region and so although many of the stream flow records may be of doubtful

accuracy, it is believed that they give a better estimate of the run-off which actually occurred than could be obtained from estimates derived from precipitation. Beginning in 1911 and continuing, at least in part, until 1924, the Volcan Land and Water Company maintained a number of stream gaging stations on the San Dieguito and San Luis Rey rivers and on many of their tributaries. Most of the gaging stations were established at or near potential dam sites. The San Diego County Water Co., successor to the Volcan Water Company has continued the records at the Henshaw Dam and the Escondido Mutual Water Company secures records at its diversion works on the San Luis Rey River and at Wohlford Reservoir. The Cuyamaca Water Company maintained and its successor, the La Mesa, Lemon Grove and Spring Valley Irrigation District is maintaining a number of records on the San Diego River and on the flume which diverts water from that stream. The City of San Diego has maintained records at the reservoirs of its water supply system from which it has been possible to make estimates of the inflow into these reservoirs. Mr. F. E. Green, at present hydrographer for the City of San Diego, has been instrumental in securing many stream flow records and by assemblying data secured through cooperation with various agencies and the use of many independent occasional discharge measurements has made monthly estimates of the run-off at a number of points in San Diego County. The Sweetwater Water Corporation has maintained a record at the Sweetwater Reservoir from which it has computed the inflow into that reservoir.

Altogether stream flow records have been maintained at 76 different points on streams tributary to San Diego County and records were being maintained at 37 points in 1933. The United States Geological Survey has published the stream flow record wholly or in part at 63 points on the tributary streams and in 1932 published records at 12 points. The stations on the streams tributary to San Diego County at which run-off records were available in

making this investigation are shown in Table 6, and their location is shown on Plate I. The stations at which frequent records were being taken in 1933 are shown as active stations.

The greater part of the run-off from the watersheds of San Diego County comes in floods of torrential character which occur at rather infrequent intervals. The existing records indicate that these floods, producing more than normal run-off may usually be expected to occur at intervals of from five to six years although twice in the 46-years of record the five year flood has failed to exceed the normal run-off. In the 46-year period of record 1887-1933 on the Sweetwater River at the Sweetwater Dam five to six-year floods occurred in the following seasons, 1889-90, 1894-95, 1905-06, 1915-16, 1921-22, 1926-27, and 1931-32. The floods which might have been expected about 1901-02 and 1910-11 did not occur. The total inflow in the seven flood years listed above amounted to about 64 per cent of the total runoff of the 46-year period. This extreme variation in the amount of run-off during flood and dry periods shows the necessity of large storage reservoirs if conservation and utilization of an appreciable part of the local run-off is to be obtained.

Full Natural Run-off.

The full natural or unimpaired run-off of a stream above any station is the run-off as it would have occurred if unaltered by diversions, storage development or importation of water from other watersheds. It is the run-off which would have occurred under natural conditions.

In this investigation, consideration has been given only to the run-off from the western slope of the Peninsula Range, which includes, as has been previously shown, the greater part of the area of San Diego County. Almost the entire present development both urban and rural, is on the western slope and future development will probably be mainly confined to this region. The

TABLE 6

STREAM GAGING STATIONS ON STREAMS TRIBUTARY TO SAN DIEGO COUNTY

Index number on Plate I	Stream	Station name	Location (S.B.B.& M.) Section	Township South	Range	Area of Drainage basin in square miles	Period of record	Authority (1)
1	Cottonwood Creek	At Morena Dam	14	17	4 E	114	Apr.1911-Sept.1933	City of S.D.
2	Pine Valley Creek	Near Dulzura	15	17	3 E	100	Jan.1906-Dec.1907	U.S.G.S.
3	Cottonwood Creek	At Barrett Dam, (near Dulzura)	15	17	3 E		Jan.1906-Dec.1915	U.S.G.S.
		At Barrett Dam	22	17	3 E	249	Sept.1917-Sept.1933	City of S.D.
4	Dulzura Conduit	Near Dulzura	10	18	2 E		Jan.1909-Sept.1915	U.S.G.S.
							Jan.1916-Sept.1933	City of S.D.
5	Tia Juana River	Near Nestor	3	19	2 W	1,658	Jan.1915-Sept.1915	U.S.G.S.
							Oct.1922-Sept.1925	F.E.Green
							Oct.1926-Sept.1932	F.E.Green
6	Proctor Valley Creek	At Upper Otay Dam	36	17	1 W	12	Oct.1918-Sept.1933	City of S.D.
7	Otay River	At Lower Otay Dam	18	18	1 E	99	Feb.1905-Jan.1916	City of S.D.
							Oct.1917-Sept.1933	City of S.D.
8	Sweetwater River	Near Descanso	25	16	3 E	44	Nov.1905-June 1927	U.S.G.S.
9	Sweetwater River	Near Dehesa	20	16	2 E	111	Dec.1913-July 1916	U.S.G.S.
10	Sweetwater River	Sweetwater Dam	17	17	1 W	181	Oct.1887-Sept.1933	U.S.G.S. and S. W. Co.
11A	Boulder Creek	At Cuyamaca Dam	5	14	4 E	12	1887-1892	City of S.D.
							Oct.1892-Sept.1919	Longwell
							Oct.1919-Sept.1932	F.E.Green
							Jan.1915-Sept.1933	L.M.I.D.
11B	Boulder Creek	At Cuyamaca Dam, near Julian	5	14	4 E	12	Jan.1899-Dec.1911	C.H.Lee
							June 1912-Sept.1926	U.S.G.S.
							Jan.1915-Sept.1933	L.M.I.D.
12	Boulder Creek	At mouth, near Lakeside	12	14	2 E	34	Aug.1912-Jan.1916	U.S.G.S.
							Oct.1918-Sept.1926	U.S.G.S.
							Jan.1915-Jan.1916	L.M.I.D.
							Sept.1918-Sept.1933	L.M.I.D.
13A	San Diego River	At Diverting Dam, near Lakeside	11	14	2 E	103	Jan.1899-Dec.1912	L.M.I.D.
							Oct.1912-Sept.1916	U.S.G.S.
							Jan.1915-Sept.1933	L.M.I.D.
13B	L.M.I.D. Flume	At Diverting Dam, near Lakeside	11	14	2 E	-	Jan.1899-Dec.1912	L.M.I.D.
							June 1912-Sept.1924	U.S.G.S.
							Jan.1915-Sept.1933	L.M.I.D.
14A	South Fork San Diego River	Near Alpine	10	15	2 E	45	Jan.1913-Sept.1915	U.S.G.S.
							Jan.1915-Sept.1933	L.M.I.D.
14B	South Fork of L.M.I.D. Flume	Near Alpine	10	15	2 E	-	Jan.1913-Sept.1915	U.S.G.S.
							Jan.1915-Sept.1933	L.M.I.D.
15	L.M.I.D. Flume	At South Fork	3	15	2 E	-	Oct.1925-Sept.1933	L.M.I.D.
16A	San Diego River	At El Capitan Dam	8	15	2 E	190	Feb.1920-Apr.1926	L.M.I.D.
							Oct.1919-Sept.1933	F.E.Green
16B	L.M.I.D. Flume	At Chocolate	8	15	2 E	-	Jan.1915-Aug. 1915	L.M.I.D.
							Jan.1919-Sept.1933	L.M.I.D.
17A	San Diego River	At Lakeside	18	15	1 E	206	Dec.1905-Sept.1916	U.S.G.S.
17B	L.M.I.D. Flume	At Los Coches, near Lakeside	21	15	1 E	-	Jan.1907-Sept.1925	U.S.G.S.
							Jan.1915-Sept.1933	L.M.I.D.
18	San Vicente Creek	Near Foster	31	14	1 E	75	Jan.1915-Apr. 1915	U.S.G.S.
							Oct.1919-Sept.1933	F.E.Green
19A	San Diego River	At Mission Dam, near Santee	25	15	2 W	376	May 1912-Oct. 1920	U.S.G.S.
19B	San Diego River	At Loop Dam, near Santee	35	15	2 W	381	Nov.1920-Sept.1933	U.S.G.S.
19C	L.M.I.D. Flume	At Grossmont	17	16	1 W	-	Jan.1915-Sept.1933	L.M.I.D.
20A	Alvarado Creek	At Murray Dam	13	16	2 W	3.6	Jan.1915-Sept.1933	L.M.I.D.
20B	La Mesa Ditch	At Grossmont	17	16	1 W	-	Jan.1915-Sept.1933	L.M.I.D.
21A	San Diego River	At San Diego, Murray Canyon	23	16	3 W	-	Dec.1914-Sept.1915	U.S.G.S.
21B	San Diego River	At San Diego, Old Town	21	16	3 W	435	Oct.1912-Dec. 1914	U.S.G.S.
							Jan.1916	
							Oct.1929-Sept.1931	F. E. Green
22	Santa Ysabel Creek	At Santa Ysabel	16	12	3 E	13	Aug.1913-Sept.1914	U.S.G.S.
23	Santa Ysabel Creek	At Sutherland, near Mesa Grande	21	12	2 E	54	Dec.1912-Sept.1928	U.S.G.S.
							Oct.1928-Sept.1933	F.E.Green
24	Black Canyon Creek	Near Mesa Grande	17	12	2 E	15	Feb.1913-Sept.1924	U.S.G.S.
25	Temescal Creek	Near Almond	23	12	1 E	32	Feb.1913-Nov. 1915	U.S.G.S.
26	Santa Ysabel Creek	At Pamo, near Ramona	27	12	1 E	111	Feb.1912-Feb. 1923	U.S.G.S.
27	Santa Ysabel Creek	Near Escondido	31	12	1 E	128	Jan.1906-Sept.1912	U.S.G.S.
28	East San Pasqual Ditch	Near Escondido	36	12	1 W	-	June 1912-Sept.1913	U.S.G.S.
29	Guejito Creek	Near Escondido	35	12	1 W	28	Feb.1915-Sept.1915	U.S.G.S.
							Oct.1916-Sept.1917	U.S.G.S.
							Oct.1919-Sept.1924	F. E. Green
							Oct.1921-Sept.1922	V.L.& W.
30	West San Pasqual Ditch	Near Escondido	34	12	1 W	-	May 1912-Sept.1915	U.S.G.S.
31	Santa Maria Creek	Near Ramona	11	13	1 W	60	Nov.1912-May 1920	U.S.G.S.
							Oct.1919-Sept.1923	V.L.& W.
							Oct.1911-Sept.1924	F.E.Green
32	San Dieguito River	At Bernardo	11	13	2 W	270	Apr.1912-Jan. 1916	U.S.G.S.
33	San Dieguito River	At Hodges Dam, near Bernardo	18	13	2 W	303	Jan.1916-Sept.1933	U.S.G.S.
34	San Dieguito River	Near Del Mar	32	13	3 W	327	Oct.1912-Sept.1914	U.S.G.S.
35	Escondido Creek	At Wohlford Dam	5	12	1 W	8	June 1926-Sept.1933	E.M.W.
36	Escondido Creek	At San Elijo Dam Site, near San Marcos	2	13	3 W	57	Oct.1917-Sept.1918	V.L.& W.
							Oct.1921-Sept.1923	V.L.& W.
							Oct.1919-Sept.1924	F.E.Green
37	San Marcos Creek	Near San Marcos	30	12	3 W	32	Oct.1922-Sept.1923	V.L.& W.
38	San Luis Rey River	Near Warner Springs	17	10	3 E	33	Jan.1913-Nov. 1915	U.S.G.S.
39	Canada Verde Creek	Near Warner Springs	36	10	3 E	3	Feb.1913-Aug. 1915	U.S.G.S.
40	Agua Caliente Creek	Near Warner Springs	22	10	3 E	19	Feb.1913-Nov. 1915	U.S.G.S.
41	West Fork San Luis Rey River	Near Nellie	8	10	2 E	14	Nov.1920-Sept.1921	U.S.G.S.
42	West Fork San Luis Rey River	Near Warner Springs	15	10	2 E	25	Jan.1913-Nov. 1915	U.S.G.S.
43	Matagual Creek	Near Warner Springs	16	11	3 E	9	Nov.1912-June 1916	U.S.G.S.
44	Carrista Creek	Near Warner Springs	19	11	3 E	5	Jan.1913-June 1916	
45	Susanna Creek	Near Warner Springs	19	11	3 E	4	Feb.1913-June 1916	
46	San Luis Rey River	At Henshaw Dam, near Mesa Grande	10	11	2 E	206	Dec.1905-July 1906	U.S.G.S.
							Oct.1911-Sept.1933	U.S.G.S.
							Nov.1905-June 1906	Longwell
							Feb.1911-Sept.1912	Longwell
47A	San Luis Rey River	At Escondido Intake, near Nellie	33	10	1 E	238	Oct.1915-June 1916	U.S.G.S.
							Dec.1922-June 1924	U.S.G.S.
							July 1922-July 1924	V.L.& W.
							Jan.1929-Sept.1933	E.M.W.
47B	E.M.W.Co's. Canal	At Escondido Intake, near Nellie	33	10	1 E	-	Oct.1896-Sept.1901	U.S.G.S.
							Oct.1902-Sept.1922	U.S.G.S.
							Oct.1922-Oct. 1933	E.M.W.
48	Pauma Creek	Near Nellie	31	9	1 E	5	Oct.1920-Sept.1921	U.S.G.S.
49	Pauma Creek	At Pauma Indian Reservation	3	10	1 W	11	Dec.1920-Sept.1921	U.S.G.S.
50	San Luis Rey River	At Sicklers Mill, near Pala	31	9	1 W	319	Oct.1903-June 1911	U.S.G.S.
							Nov.1912-Jan. 1916	U.S.G.S.
51A	San Luis Rey River	At Pala	26	9	2 W	335	Apr.1912-June 1912	U.S.G.S.
51B	Pala Indian Reservation Canal	At Pala	26	9	2 W	-	May 1912-Dec. 1913	U.S.G.S.
52	San Luis Rey River	At Bonsall	20	10	3 W	462	Apr.1912-Jan. 1916	U.S.G.S.
53A	San Luis Rey River	Near Bonsall	31	10	3 W	518	July 1916-Sept.1918	U.S.G.S.
							July 1916-Sept.1919	Longwell
							Oct.1917-Sept.1924	V.L.& W.
53B	San Luis Rey River	Near Bonsall	1	11	4 W	519	Oct.1927-Sept.1933	F.E.Green
							Dec.1929-Sept.1933	U.S.G.S.
54	E.M.W.Co's. Canal	Near Valley Center	22	11	1 W	-	Dec.1923-Aug. 1924	V.L.& W.
							Jan.1923-Oct. 1933	E.M.W.
55A	San Luis Rey River	Near Oceanside	13	11	5 W	562	Apr.1912-Sept.1914	U.S.G.S.
							Oct.1911-Sept.1919	Longwell
							Oct.1917-Sept.1924	V.L.& W.
55B	San Luis Rey River	At Oceanside	23	11	5 W	565	Oct.1927-Sept.1933	F.E.Green
							Dec.1929-Sept.1933	U.S.G.S.
56	Temecula Creek	At Nigger Canyon	10	8	1 W	321	Oct.1920-Sept.1921	F.E.Green
							Oct.1922-Sept.1933	F.E.Green
							Jan.1923-Sept.1933	U.S.G.S.
57	Temecula Creek	Near Temecula	24	8	3 W	366	Jan.1906-Dec.1906	U.S.G.S.
58	Murrieta Creek	At Temecula	13	8	3 W	287	Oct.1920-Sept.1923	F.E.Green
							Oct.1924-Sept.1933	F.E.Green
							Oct.1930-Sept.1933	U.S.G.S.
59	Temecula Creek	At Railroad Canyon	24	8	3 W	593	Oct.1920-Sept.1933	F.E.Green
							Jan.1923-Sept.1933	U.S.G.S.
60	Santa Margarita River	Near Fallbrook	12	9	4 W	645	Nov.1924-Sept.1933	U.S.G.S.
61	Santa Margarita River	Near Deluz	32	9	4 W	710	Oct.1924-Sept.1926	U.S.G.S.
62	O'Neil Ditch	Near Ysidora	5	10	4 W	-	Oct.1924-Sept.1933	F.E.Green
							Oct.1930-Sept.1932	U.S.G.S.
63	Santa Margarita River	At Ysidora	10	11	5 W	743	Feb.1923-Sept.1933	F.E.Green
							Feb.1923-Sept.1929	U.S.G.S.
							Oct.1930-Sept.1933	U.S.G.S.

(1) Abbreviations used: City of S.D., City of San Diego; U.S.G.S., United States Geological Survey; F.E.Green, private records of F. E. Green, hydrographer for City of San Diego; Longwell, Reports by J.S. Longwell to U. S. Reclamation Service on San Diego River and on Volcan System; C. H. Lee, Report of C.H.Lee to La Mesa, Lemon Grove and Spring Valley Irrigation District; L.M.I.D., La Mesa, Lemon Grove and Spring Valley Irrigation District; V.L.& W., Volcan Land and Water Co.; E.M.W., Escondido Mutual Water Co.

greater part of the run-off also comes from the western slope but there is some run-off from the eastern slope. A portion of the run-off of the eastern slope is now utilized to support the development of areas on that slope and additional run-off may be utilized in the future to develop new areas.

In this investigation, the seasonal full natural run-offs of the principal Pacific slope streams tributary to San Diego County were estimated for the 46-year period, 1887-1933. The long records of inflow at the Cuyamaca and Sweetwater reservoirs dictated the selection of this period as the one during which the run-off of the principal streams could be estimated within reasonable limits of error.

During periods when stream flow records were available on the principal streams, these records were adjusted to obtain the full natural run-off. Adjustments were made for storage in upstream reservoirs, for diversions from the stream basin and for the consumptive use on lands irrigated by direct diversion from the stream or by pumping from underground storage basins receiving replenishment by percolation from the stream. When the depletion of underground basins indicated their use for storage for more than one season, adjustments were made for the natural use by willows from these basins. In each principal drainage basin the record of run-off which had been kept for the longest period was used as a base record. Relationships between the run-off at the base station and at other stations in the drainage basin were established by comparing the run-off at each station with that at the base station during periods of co-incidental record. The run-off records at other points in the drainage basin were than extended to cover the period of record at the base station by the use of these relationships. The gaging stations used as base stations were Santa Margarita River at Ysidora, San Luis Rey River at Henshaw Dam, San Dieguito River at Hodges Dam, San Diego River at Diverting Dam, Sweetwater River at Sweetwater Dam, Otay River at Savage (Lower Otay) Dam, and

Cottonwood Creek at Barrett Dam.

After the extension of the records to cover the period of record at the base station, the records were extended further by comparison with the run-off of neighboring streams. This was accomplished by extending the run-off of the base stations first and then the run-off at other points on the principal streams was estimated from that of the base stations. The run-offs on the Santa Margarita and San Dieguito rivers were extended by comparison with that of the San Luis Rey River. For the seasons 1895-96 to 1902-03, inclusive, the run-off of the San Luis Rey River at Henshaw Dam was estimated from the inflow into Hemet Lake, Cuyamaca and Sweetwater reservoirs. For the seasons prior to 1895-96 for the San Luis Rey River at Henshaw Dam and for the seasons prior to 1898-99 for the other principal streams, the run-off was estimated from the inflow into the Sweetwater Reservoir or from an average index of seasonal run-off determined from the inflows into the Sweetwater and Cuyamaca reservoirs. The index of run-off for any season is the inflow for that season expressed as a percentage of the normal inflow.

During the 46-year period, 1887-1933, no run-off was estimated from precipitation but prior to this period the run-offs of the San Diego River at the Diverting Dam and at other points on this stream were estimated from the precipitation at Valley Center for the four seasons from 1883-1887. It was found by comparison of the precipitation and run-off records during the period of parallel records that the run-off was more nearly comparable to the precipitation if certain corrections were made to the precipitation. Only a small part of the precipitation that falls runs off directly. The greater part penetrates into the ground, some to be evaporated afterwards from moist ground surfaces, some to be utilized by plants and some to penetrate to ground water. Of the portion which penetrates to ground water, a part is returned to the stream channels by slow percolation during the same season but some does not

reach the stream channels until the following season. Therefore, deductions were made from each storm at Valley Center to represent the amount of precipitation which penetrated the ground and did not reach the stream channels during that season and additions were made to the precipitation for each season to allow for carry-over ground water storage from the season before. These additions were based on the portion of the precipitation it was estimated penetrated to ground water during the previous season. It is believed that the application of these corrections to the precipitation at Valley Center gave a more accurate estimate of the run-off of the San Diego River than could be obtained by using the recorded precipitation.

The seasonal full natural run-offs at the more important gaging stations in the principal stream basins tributary to San Diego County, as estimated by the methods described above for the 46-year period 1887-1933, are listed in Table 7. The mean seasonal run-off for that period at each gaging station is listed in the last column of the table.

Run-off records on the minor streams tributary to San Diego County were almost entirely lacking. Therefore, only the average seasonal run-off for the 46-year period, 1887-1933, was estimated for these streams. The relation of the average seasonal run-off at various points on the principal streams of San Diego County to the average elevation of the watershed above that point was obtained and a general relation between run-off and elevation was thus determined. From this relation, the average seasonal run-offs for the various minor stream groups were estimated. The average seasonal run-offs of the principal streams at the lowest gaging station in each basin and of the minor stream groups at sea level for the 46-year period, 1887-1933, are listed in Table 8.

An inspection of the estimated seasonal run-offs listed in Table 7 shows an extremely wide variation in the discharges of different seasons.

TABLE 7

SEASONAL FULL NATURAL RUN-OFF OF PRINCIPAL STREAMS OF SAN DIEGO COUNTY

Stream	Drainage area in square miles	Run-off in Acre Feet										
		1887-88	1888-89	1889-90	1890-91	1891-92	1892-93	1893-94	1894-95	1895-96	1896-97	1897-98
SANTA MARGARITA RIVER												
at Ysidora	743	13,400	32,400	48,500	44,800	19,400	22,100	7,000	98,200	3,700	16,000	2,100
SAN LUIS REY RIVER												
at Henshaw Dam	206	15,900	35,800	52,700	48,800	22,200	25,000	9,200	104,700	5,700	18,600	4,100
between Henshaw Dam and near Bonsall	312	13,700	30,700	45,300	42,000	19,100	21,500	7,900	89,900	4,900	16,000	3,500
near Bonsall	518	29,600	66,500	98,000	90,800	41,300	46,500	17,100	194,600	10,600	34,600	7,600
between near Bonsall and Oceanside	47	1,900	4,200	6,200	5,700	2,500	2,900	1,000	12,300	700	2,200	500
at Oceanside	565	31,500	70,700	104,200	96,500	43,800	49,400	18,100	206,900	11,300	36,800	8,100
SAN DIEGUITO RIVER (SANTA YSABEL CREEK)												
at Sutherland Dam Site	54	8,400	18,900	27,800	25,800	11,700	13,200	4,800	55,300	3,000	9,800	2,200
between Sutherland Dam Site and Hodges Dam	249	9,500	25,900	42,400	38,300	14,400	16,700	4,300	105,500	2,000	11,700	1,200
at Hodges Dam	303	17,900	44,800	70,200	64,100	26,100	29,900	9,100	160,800	5,000	21,500	3,400
SAN DIEGO RIVER												
Boulder Creek at Cuyamaca Dam	12	2,930	4,380	6,430	8,520	5,200	3,360	2,230	10,730	1,210	3,470	680
between Cuyamaca Dam and Diverting Dam	91	9,700	22,300	31,600	28,900	14,100	15,500	5,500	60,500	3,100	10,800	1,500
at Diverting Dam	103	12,630	26,680	38,030	37,420	19,300	18,860	7,730	71,230	4,310	14,270	2,180
between Diverting Dam and El Capitan Dam	87	2,200	8,100	12,900	11,500	4,100	4,800	700	30,500	600	2,500	300
at El Capitan Dam	190	14,830	34,780	50,930	48,920	23,400	23,660	8,430	101,730	4,910	16,770	2,480
San Vicente Creek at San Vicente Dam Site	75	1,800	7,200	12,200	10,700	3,500	4,000	500	30,300	0	2,200	0
below El Capitan Dam and San Vicente Dam Site	112	1,700	7,600	13,700	11,800	3,400	4,100	300	35,500	0	2,000	0
at Mission Gorge	377	18,330	49,580	76,830	71,420	30,300	31,760	9,230	167,530	4,910	20,970	2,480
SWEETWATER RIVER												
at Sweetwater Dam	181	7,050	25,250	36,820	21,560	6,200	16,260	1,340	73,410	1,320	6,890	10
OTAY RIVER												
at Lower Otay Dam	99	4,200	13,400	18,000	11,700	3,700	9,200	800	30,200	800	4,200	0
COTTONWOOD CREEK												
at Morena Dam	114	6,000	13,800	19,600	17,900	8,700	9,600	3,300	36,600	1,900	6,700	900
between Morena Dam and Barrett Dam	135	7,700	17,800	25,200	23,000	11,200	12,400	4,200	47,100	2,500	8,600	1,200
at Barrett Dam	249	13,700	31,600	44,800	40,900	19,900	22,000	7,500	83,700	4,400	15,300	2,100
SEASONAL TOTALS		106,080	267,730	399,350	350,980	149,400	150,620	53,070	820,740	31,430	121,660	18,190

Stream	Run-off in Acre Feet											
	1898-99	1899-00	1900-01	1901-02	1902-03	1903-04	1904-05	1905-06	1906-07	1907-08	1908-09	1909-10
SANTA MARGARITA RIVER												
at Ysidora	1,100	800	9,100	5,000	8,300	2,800	25,300	64,100	49,100	15,100	29,700	28,000
SAN LUIS REY RIVER												
at Henshaw Dam	3,000	2,800	11,500	7,100	10,500	4,770	28,160	68,250	52,830	17,580	32,690	31,000
between Henshaw Dam and near Bonsall	2,600	2,400	9,900	6,100	9,100	4,200	24,300	59,100	45,600	15,200	28,200	26,700
near Bonsall	5,600	5,200	21,400	13,200	19,600	8,970	52,460	127,350	98,430	32,780	60,890	57,700
between near Bonsall and Oceanside	400	300	1,200	900	1,200	0	2,800	7,200	5,500	1,600	3,300	3,100
at Oceanside	6,000	5,500	22,600	14,100	20,800	8,970	55,260	134,550	103,930	34,380	64,190	60,800
SAN DIEGUITO RIVER (SANTA YSABEL CREEK)												
at Sutherland Dam Site	1,600	1,500	6,000	3,800	5,600	2,600	14,900	33,650	19,060	5,990	25,110	18,080
between Sutherland Dam Site and Hodges Dam	800	600	6,000	2,700	5,200	1,400	19,300	48,990	26,670	6,700	35,930	25,190
at Hodges Dam	2,400	2,100	12,000	6,500	10,800	4,000	34,200	82,640	45,730	12,690	61,040	43,270
SAN DIEGO RIVER												
Boulder Creek at Cuyamaca Dam	500	140	2,670	2,060	2,090	420	5,830	10,620	7,220	2,120	6,400	4,830
between Cuyamaca Dam and Diverting Dam	1,050	640	4,580	4,340	8,680	750	22,240	34,550	28,900	12,480	20,000	14,440
at Diverting Dam	1,550	780	7,250	6,400	10,770	1,170	28,070	45,170	36,120	14,600	26,400	19,270
between Diverting Dam and El Capitan Dam	300	200	1,000	800	1,800	100	7,700	36,800	13,600	4,200	19,200	7,100
at El Capitan Dam	1,850	980	8,250	7,200	12,570	1,270	35,770	81,970	49,720	18,800	45,600	26,370
San Vicente Creek at San Vicente Dam Site	0	0	200	200	1,400	0	7,100	14,000	10,600	2,800	6,100	3,600
below El Capitan Dam and San Vicente Dam Site	0	0	200	100	1,400	0	7,500	15,500	11,500	2,700	6,400	3,700
at Mission Gorge	1,850	980	8,650	7,500	15,370	1,270	50,370	111,470	71,820	24,300	58,100	33,670
SWEETWATER RIVER												
at Sweetwater Dam	240	0	820	0	0	0	13,760	35,000	30,000	4,140	16,010	9,620
OTAY RIVER												
at Lower Otay Dam	100	0	500	0	0	0	11,220	16,160	6,760	1,150	5,010	7,150
COTTONWOOD CREEK												
at Morena Dam	700	200	3,700	2,600	2,700	600	11,900	24,900	18,220	4,520	13,480	6,320
between Morena Dam and Barrett Dam	900	300	4,800	3,400	3,500	700	15,300	32,040	23,460	5,820	17,350	8,130
at Barrett Dam	1,600	500	8,500	6,000	6,200	1,300	27,200	56,940	41,680	10,340	30,830	14,450
SEASONAL TOTALS	13,290	9,880	62,170	39,100	61,470	18,340	217,310	500,860	349,020	102,100	264,880	196,960

TABLE 7, (Continued

SEASONAL FULL NATURAL RUN-OFF OF PRINCIPAL STREAMS OF SAN DIEGO COUNTY

Stream	Drainage area in square miles	Run-off in Acre Feet 1910-11	1911-12	1912-13	1913-14	1914-15	1915-16	1916-17	1917-18	1918-19	1919-20	1920-21	1921-22
SANTA MARGARITA RIVER													
at Ysidora	743	19,800	10,500	4,000	20,100	56,400	173,700	26,600	21,700	5,300	20,900	6,470	85,400
SAN LUIS REY RIVER													
at Henshaw Dam	206	22,540	12,760	5,910	22,630	60,440	182,070	29,480	24,430	7,320	23,440	5,120	101,980
between Henshaw Dam and near Bonsall	312	19,400	9,260	5,500	18,900	87,560	153,500	27,740	18,280	9,680	20,300	3,540	70,920
near Bonsall	518	41,940	22,020	11,410	41,530	148,000	335,570	57,220	42,710	17,000	43,740	8,660	172,900
between near Bonsall and Oceanside	47	2,100	1,580	0	2,200	6,400	19,700	3,560	4,740	450	2,300	0	19,690
at Oceanside	565	44,040	23,600	11,410	43,730	154,400	355,270	60,780	47,450	17,450	46,040	8,660	192,590
SAN DIEGUITO RIVER (SANTA YSABEL CREEK)													
at Sutherland Dam Site	54	11,900	8,690	4,520	10,450	31,130	95,250	13,730	7,360	4,810	12,520	3,170	47,160
between Sutherland Dam Site and Hodges Dam	249	14,800	10,830	1,260	13,930	47,570	219,300	20,330	20,730	1,440	7,310	980	74,300
at Hodges Dam	303	26,700	19,520	5,780	24,380	78,700	314,550	34,060	28,090	6,250	19,830	4,150	121,460
SAN DIEGO RIVER													
Boulder Creek at Cuyamaca Dam	12	2,460	3,390	2,740	2,380	8,990	18,010	3,730	3,330	2,600	6,410	2,230	11,960
between Cuyamaca Dam and Diverting Dam	91	8,970	11,480	5,260	13,200	41,890	112,720	18,270	8,660	5,330	24,750	3,930	71,110
at Diverting Dam	103	11,430	14,870	8,000	15,580	50,880	130,730	22,000	11,990	7,930	31,160	6,160	83,070
between Diverting Dam and El Capitan Dam	87	5,300	3,800	1,800	3,900	16,500	69,700	6,200	11,000	2,100	5,720	930	37,960
at El Capitan Dam	190	16,730	18,670	9,800	19,480	67,380	200,430	28,200	22,990	10,030	36,880	7,090	121,030
San Vicente Creek at San Vicente Dam Site	75	1,600	2,400	500	3,100	17,570	66,300	5,300	3,400	500	2,520	0	36,300
below El Capitan Dam and San Vicente Dam Site	112	1,400	2,200	300	3,000	23,300	85,300	7,100	4,600	300	3,100	0	44,200
at Mission Gorge	377	19,730	23,270	10,600	25,580	108,250	352,030	40,600	30,990	10,830	42,500	7,090	201,530
SWEETWATER RIVER													
at Sweetwater Dam	181	3,160	5,000	920	3,520	27,080	160,580	15,280	10,200	4,050	14,940	1,810	61,940
OTAY RIVER													
at Lower Otay Dam	99	1,230	4,910	1,570	2,500	10,940	54,400	8,700	2,710	2,340	9,100	410	27,440
COTTONWOOD CREEK													
at Morena Dam	114	3,090	4,140	1,750	3,680	15,010	75,270	15,730	8,970	4,100	12,070	3,140	42,140
between Morena Dam and Barrett Dam	135	3,830	5,440	1,380	4,450	21,050	96,900	20,200	7,620	5,020	19,650	2,930	54,360
at Barrett Dam	249	6,920	9,580	3,130	8,130	36,060	172,170	35,930	16,590	9,120	31,720	6,070	96,500
SEASONAL TOTALS		121,580	96,380	37,410	127,940	471,830	1582,700	221,950	157,730	55,340	185,030	34,660	786,860

Stream	1922-23	1923-24	1924-25	1925-26	1926-27	1927-28	1928-29	1929-30	1930-31	1931-32	1932-33	MEAN
SANTA MARGARITA RIVER												
at Ysidora	11,640	7,850	2,240	16,950	93,450	5,680	4,020	9,850	6,200	43,630	8,720	26,240
SAN LUIS REY RIVER												
at Henshaw Dam	13,730	6,520	4,570	19,430	85,850	8,240	12,230	17,500	6,950	48,590	11,990	29,270
between Henshaw Dam and near Bonsall	18,240	9,650	3,900	16,700	74,300	8,900	8,320	12,610	4,240	53,290	10,600	25,940
near Bonsall	31,970	16,170	8,470	36,130	160,150	17,140	20,550	30,110	11,190	101,880	22,590	55,210
between near Bonsall and Oceanside	300	2,560	0	1,800	9,100	240	880	1,760	0	7,300	840	3,370
at Oceanside	32,270	18,730	8,470	37,930	169,250	17,380	21,430	31,870	11,190	109,180	23,430	58,580
SAN DIEGUITO RIVER (SANTA YSABEL CREEK)												
at Sutherland Dam Site	9,560	2,740	3,470	15,310	49,550	3,620	4,890	8,040	3,090	31,280	7,600	15,410
between Sutherland Dam Site and Hodges Dam	7,570	2,840	220	20,690	109,600	6,260	4,960	9,110	2,840	41,550	11,110	23,930
at Hodges Dam	17,130	5,580	3,690	36,000	159,150	9,880	9,850	17,150	5,930	72,830	18,710	39,340
SAN DIEGO RIVER												
Boulder Creek at Cuyamaca Dam	3,460	2,300	1,610	3,850	12,410	2,350	3,140	3,180	1,560	7,640	3,970	4,520
between Cuyamaca Dam and Diverting Dam	11,720	3,850	5,340	14,650	59,860	4,740	5,780	7,030	2,660	39,650	11,950	18,450
at Diverting Dam	15,180	6,150	6,950	18,500	72,270	7,090	8,920	10,210	4,220	47,290	15,920	22,970
between Diverting Dam and El Capitan Dam	6,240	2,580	1,760	6,010	45,500	4,530	5,070	6,310	1,350	18,640	4,760	9,540
at El Capitan Dam	21,420	8,730	8,710	24,510	117,770	11,620	13,990	16,520	5,570	65,930	20,680	32,510
San Vicente Creek at San Vicente Dam Site	390	40	80	5,510	32,670	280	510	1,440	500	16,710	1,820	6,910
below El Capitan Dam and San Vicente Dam Site	500	0	0	6,100	34,600	0	700	1,200	3,700	19,500	4,400	8,140
at Mission Gorge	22,310	8,770	8,790	36,120	185,040	11,900	15,200	19,160	9,770	102,140	26,900	47,560
SWEETWATER RIVER												
at Sweetwater Dam	9,110	2,820	1,140	14,420	120,140	2,890	2,970	4,610	810	26,970	6,930	17,540
OTAY RIVER												
at Lower Otay Dam	3,940	1,750	720	2,700	42,720	190	460	3,550	2,380	20,370	2,780	7,650
COTTONWOOD CREEK												
at Morena Dam	10,700	4,130	2,070	3,570	65,550	6,730	2,660	3,130	1,890	13,930	3,680	11,350
between Morena Dam and Barrett Dam	9,300	5,560	3,830	7,060	70,410	3,820	8,800	4,990	1,580	20,290	5,620	14,360
at Barrett Dam	20,000	9,690	5,900	10,630	135,960	10,550	11,460	8,120	3,470	34,220	9,300	25,710
SEASONAL TOTALS	116,400	55,190	30,950	154,750	905,710	58,470	65,390	94,310	39,750	409,340	96,770	222,620

TABLE 8

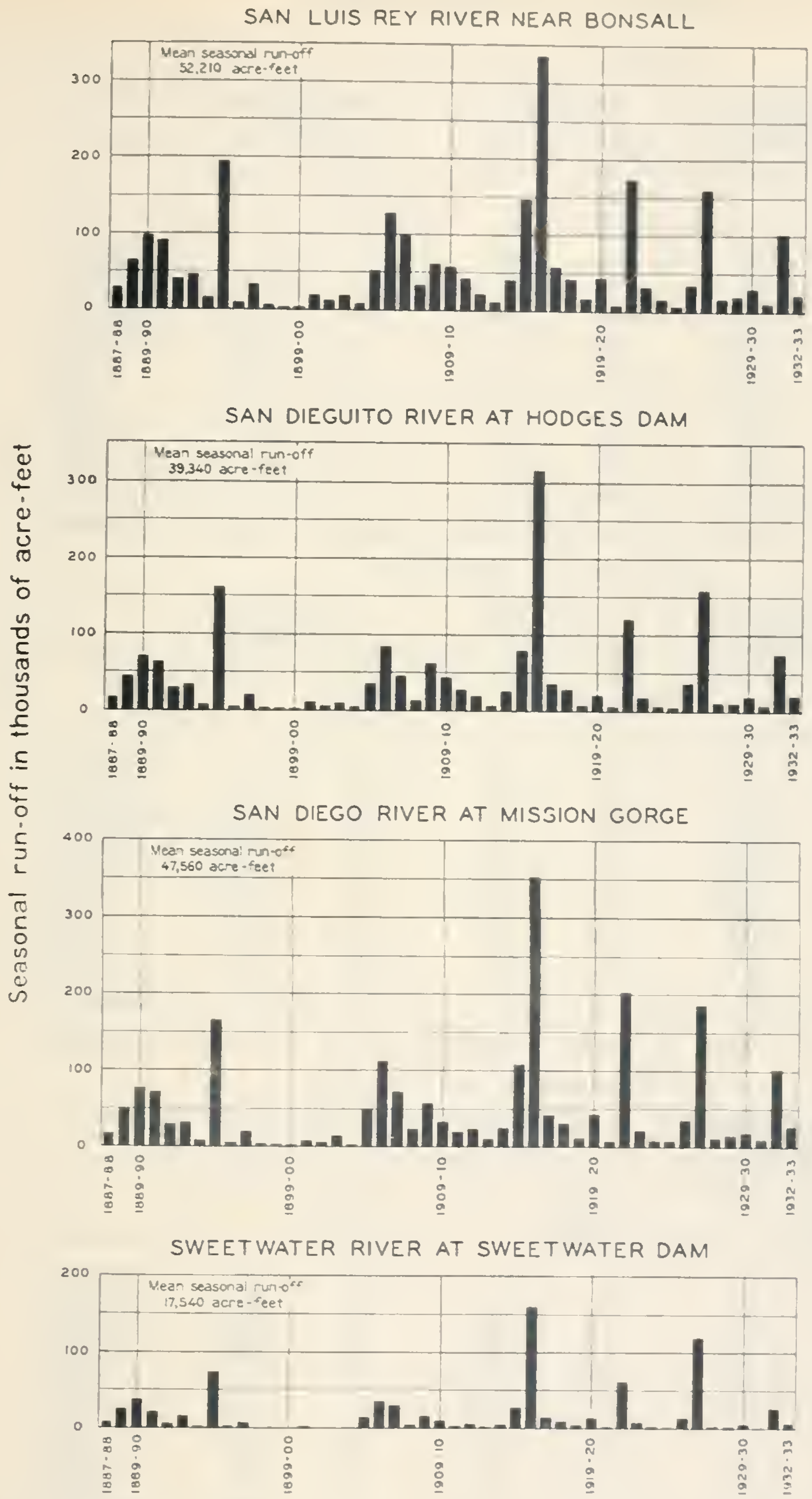
AVERAGE SEASONAL FULL NATURAL RUN-OFF
OF STREAMS TRIBUTARY TO SAN DIEGO COUNTY

Stream or stream group	Lower limit of drainage basin	Drainage area, in square miles	Average seasonal run-off for 46-year period, 1887-1933: In acre-feet	Average seasonal run-off for 46-year period, 1887-1933: In per cent of total
PRINCIPAL STREAMS				
Santa Margarita River	Ysidora	743	26,240	8.7
San Luis Rey River	Oceanside	565	58,580	19.4
San Dieguito River	Gage near Del Mar	327	40,940	13.6
San Diego River	Old Town	435	51,460	17.0
Sweetwater River	Sweetwater Dam	181	17,540	5.8
Otay River	Lower Otay Dam	99	7,650	2.5
Tia Juana River*	Bridge near Nestor	461	44,540	14.8
MINOR BASINS				
San Mateo to Aliso Creek	Pacific Ocean	241	18,300	6.1
Loma Alto to Escondido Creek	Pacific Ocean	215	14,400	4.7
San Dieguito River below Del Mar to Tecolate Valley	Pacific Ocean	178	11,800	3.9
Switzer Canyon to Otay River below Lower Otay	Pacific Ocean	165	10,600	3.5
Totals		3,610	302,050	100.0

*From drainage area in United States.

This variation is graphically illustrated on Plate IV, "Seasonal Run-off of Four Major San Diego County Streams," on which the seasonal run-offs of the San Luis Rey River near Bonsall, the San Dieguito River at Hodges Dam, the San Diego River at Mission Gorge and the Sweetwater River at Sweetwater Dam, as listed in Table 7, have been plotted in chronological order. The variation in seasonal run-offs is most marked on the Sweetwater River in which there was no flow during the dry seasons of 1899-1900, 1901-1902, 1902-1903 and 1903-1904 and in which during the wet season of 1915-1916 there was a total flow of 160,580 acre-feet or about 916 per cent of 17,540 acre-feet, the average seasonal run-off for the 46-year period 1887-1933. The run-off of the Santa Margarita River is estimated to have been 800 acre-feet during the season of 1899-1900, and in the season 1915-1916 to have been 173,700 acre-feet, about 662 per cent of the seasonal average of 26,240 acre-feet. Although the San Dieguito and the San Diego Rivers did not become entirely dry, the minimum flows of 2100 acre-feet in 1899-1900 on the San Dieguito River and 980 acre-feet on the San Diego River are almost negligible when compared with the flows during the season 1915-16 of 314,550 acre-feet, 800 per cent of the seasonal normal of 39,340 acre-feet on the San Dieguito River and 352,030 acre-feet or 740 per cent of the average seasonal flow of 47,560 acre-feet on the San Diego River.

The monthly distribution of run-off also is extremely variable. In most seasons the greater part of the total run-off occurs in only two or three winter months and in the summer the main stream channels are practically dry. These conditions are illustrated by the data presented in Table 9. In this table are shown the recorded monthly flows both in acre-feet and in percentage of the seasonal total of the San Luis Rey River at Henshaw Dam, the San Dieguito River at Hodges Dam, and the San Diego River at the Diverting Dam, for the seasons of maximum and minimum total run-offs and for the seasons in which



SEASONAL RUN-OFF

OF

FOUR MAJOR SAN DIEGO COUNTY STREAMS

TABLE 9

MONTHLY DISTRIBUTION OF RUN-OFF IN TYPICAL SEASONS OF RECORD
ON THREE MAJOR STREAMS IN SAN DIEGO COUNTY

SAN LUIS REY RIVER AT HENSHAW DAM

Month	Maximum season 1915-16		Average season 1916-17		Minimum season 1920-21	
	In acre-feet	In per-cent of seasonal total	In acre-feet	In per-cent of seasonal total	In acre-feet	In per-cent of seasonal total
October	124	0.1	885	3.0	132	2.6
November	262	0.1	708	2.4	153	3.0
December	756	0.4	2,560	8.7	304	5.9
January	141,000	77.4	4,850	16.4	966	18.9
February	21,300	11.7	8,000	27.1	678	13.2
March	11,100	6.1	4,020	13.6	1,340	26.1
April	4,090	2.3	5,310	18.0	291	5.7
May	2,030	1.1	2,110	7.2	873	17.0
June	708	0.4	552	1.9	133	2.6
July	188	0.1	112	0.4	93	1.8
August	355	0.2	136	0.5	86	1.7
September	155	0.1	240	0.8	76	1.5
Totals	182,068	100.0	29,483	100.0	5,125	100.0

SAN DIEGUITO RIVER AT HODGES DAM

Month	Maximum season 1915-16		Average season 1925-26		Minimum season 1924-25	
	In acre-feet	In per-cent of seasonal total	In acre-feet	In per-cent of seasonal total	In acre-feet	In per-cent of seasonal total
October	169	0.1	163	0.4	6	0.2
November	360	0.1	179	0.5	71	1.9
December	750	0.2	201	0.6	615	16.7
January	257,000	81.7	167	0.5	316	8.6
February	24,892	7.9	2,550	7.1	265	7.2
March	16,438	5.2	408	1.1	386	10.5
April	7,042	2.2	30,320	84.2	1,281	34.7
May	3,918	1.3	1,482	4.1	400	10.8
June	1,844	0.6	361	1.0	336	9.1
July	980	0.3	74	0.2	11	0.3
August	646	0.2	95	0.3	0	0.
September	512	0.2	3	0.	0	0.
Totals	314,551	100.0	36,003	100.0	3,687	100.0

SAN DIEGO RIVER AT DIVERTING DAM

Month	Maximum season 1915-16		Average season 1916-17		Minimum season 1899-1900	
	In acre-feet	In per-cent of seasonal total	In acre-feet	In per-cent of seasonal total	In acre-feet	In per-cent of seasonal total
October	281	0.2	630	2.9	0	0.
November	240	0.2	461	2.1	4	0.5
December	847	0.6	982	4.5	1	0.1
January	97,075	74.3	3,764	17.1	204	26.4
February	13,981	10.7	4,684	21.3	41	5.3
March	10,116	7.7	3,647	16.6	59	7.6
April	4,719	3.6	3,531	16.0	206	26.6
May	1,730	1.3	2,646	12.0	259	33.5
June	762	0.6	1,001	4.6	0	0.
July	553	0.4	317	1.4	0	0.
August	205	0.2	200	0.9	0	0.
September	223	0.2	137	0.6	0	0.
Totals	130,732	100.0	22,000	100.0	774	100.0

the total run-off most closely approached the average seasonal run-off for the 46-year period 1887-1933 on the three streams. An inspection of this table shows that in the season of 1915-1916 the maximum for all three streams approximately three-fourths of the total seasonal flow occurred in one month, that in one season of average run-off, 1916-1917, approximately 70 per cent of the seasonal total occurred in four consecutive months and in another 1925-26, 84 per cent occurred in one month. In the seasons of minimum flow 1899-1900, 1920-1921, and 1924-1925 the maximum monthly flow ranged from 26 to 35 per cent and at least 60 per cent of the seasonal total occurred in three months.

The daily distribution of flow is even more variable. In the summer time the daily flow falls to practically zero on all the major streams but in flood periods more than the average seasonal flow may pass in one day. This is shown in Table 10, in which are listed the maximum mean daily flows recorded at the more important gaging stations of San Diego County. When compared with the mean seasonal flows for theee stations listed in Table 7, it will be seen that in every case the maximum mean daily flow of record is larger than the average seasonal run-off. When compared with the seasonal run-off for the season in which the flood occurred, it will be seen that the maximum mean daily flows in all cases are over 20 per cent of the total seasonal flow.

TABLE 10

MAXIMUM MEAN DAILY FLOWS IN
PRINCIPAL STREAMS TRIBUTARY TO SAN DIEGO COUNTY

Stream	Gaging Station	Maximum Flow	
		Second-feet	Date
Santa Margarita River	Near Fallbrook	21,900 (1)	Feb.16,1927
San Luis Rey River	At Henshaw Dam	28,100	Jan.27,1916
San Luis Rey River	At Oceanside	95,600	Jan.27,1916
Santa Ysabel Creek	At Sutherland	10,800	Jan.27,1916
San Dieguito River	At Hodges Dam	37,200	Jan.27,1916
San Diego River	At Diverting Dam	12,000	Feb.16,1927
San Diego River	At San Diego	38,000	Jan.27,1916
Sweetwater River	At Sweetwater Dam	18,100	Feb.16,1927
Cottonwood Creek	At Morena Dam	8,600	Jan.27,1916
Cottonwood Creek	At Barrett Dam	(1) (2) 18,900	Feb.16,1927

(1) No record in 1916

(2) Includes computed natural flow from area above Morena Dam

CHAPTER III

WATER SUPPLY DEVELOPMENT AND UTILIZATION IN SAN DIEGO COUNTY

The climate of San Diego County is extremely mild and equable along the coast, changing to greater variation with the higher elevation of the mountains to the eastward, and to a desert climate east of the crest of the divide. The climate is one of the major factors in the development of the county, being favorable not only for living conditions but also for the production of a wide range of crops, including a variety of semi-tropical fruits, and of winter-grown vegetables. The rainfall occurs during the wet or winter season with practically no rains falling between May 31st and October 1st. The amount of rainfall increases gradually from the coastal plain to the mountains. In general, it is insufficient to mature crops without irrigation.

The first development of a water supply in San Diego County began early in the nineteenth century when the Mission Fathers constructed a masonry dam and a tile lined masonry conduit to divert and transport the waters of the San Diego River about six miles from the upper end of Mission Gorge to the valley lands in the vicinity of the San Diego Mission. The quality of this construction is evidenced by the fact that practically the entire dam and many portions of the conduit are still standing. Modern developments may be said to have begun with the completion of the California Southern Railway (now the Atchison, Topeka and Santa Fe Railway) in 1885 and the resulting real estate boom. But few ditches were constructed previous to this time and the area irrigated was in small and scattered tracts.

A grant of 10,000 acres of the best lands of Rancho de la Nacion and other lands had been made to the railroad. This led to the construction of Sweetwater Reservoir in 1887, providing a municipal supply for National City and an irrigation supply for the adjoining agricultural lands. About the same time the San Diego Flume Company constructed Cuyamaca Reservoir, the Diverting Dam on the San Diego River and the wooden flume about 36 miles in length from the Diverting Dam to the vicinity of La Mesa. This system brought domestic water to the city of San Diego and an irrigation supply to the El Cajon Valley and adjacent agricultural areas.

The Escondido Irrigation District, formed under the Wright Act in 1887 and predecessor of the Escondido Mutual Water Company built the Escondido diversion works on the San Luis Rey River, the conduit and Bear Valley (Wohlford) Reservoir, bringing an irrigation supply to the Escondido Valley in 1895. The Southern California Mountain Water Company, incorporated in 1895, took over the properties of the Mount Tecarte Land and Water Company on Cottonwood Creek, and the Otay Water Company on the Otay River starting the construction of the Upper and Lower Otay and Morena Dams, about 1896. The first two projects were completed but the construction of Morena Dam was stopped after building to only 30 feet above the stream bed. In 1909 the Dulzura conduit for diversion of water from Cottonwood Creek to the Otay basin was completed, and work on the Morena Dam was again started and carried through to completion in 1912. This system was purchased by the City of San Diego in 1913. Since then the Lower Otay Dam which failed in the flood of 1916 has been replaced, Barrett Reservoir was built in 1922 and the capacity of the Morena Reservoir has been increased three times.

Further major developments occurred in 1918, when the Santa Fe Land Improvement Company built the Hodges Dam and Reservoir on the San Dieguito River for the purpose of supplying irrigation and domestic service

to the coastal belt north of San Diego. The City of San Diego acquired this development under a lease option to purchase contract in 1925. In 1922 the San Diego County Water Company built the Henshaw Reservoir on the San Luis Rey River, which provides an irrigation supply for the Vista Irrigation District and a supplementary supply for the Escondido Mutual Water Company. The City of San Diego has recently completed the El Capitan Dam and Reservoir and the 1934-35 run-off of the San Diego River is being stored.

These major developments have been augmented throughout the entire county by many wells and pumping plants. Since 1910 a number of irrigation districts and mutual water companies have been organized. These have, for the most part, either taken over the privately owned systems previously supplying the area or have purchased their water wholesale from other agencies. At the present time the only major privately owned systems retailing water in the county are the Sweetwater Water Corporation and the Coronado Water Company, both of which are under the same management.

Agencies Furnishing Water Service.

Accurate segregation of the water supply between irrigation and domestic uses in San Diego County is difficult. Many of the farms are small and much of the irrigated area is semi-residential in character. Many of the water service agencies make no distinction between irrigation and domestic use in their sales, and of those that do, only a few have tabulated the data. Practically all of the irrigation agencies serve appreciable urban areas and three, Lakeside, Ramona and San Ysidro irrigation districts are primarily for domestic supplies. The Coronado Water Company, and the City of San Diego, however, have very few irrigation services. The areas served by the organized agencies except Indian Reservations are shown on

Plate V, "Water Service Areas of Organized Agencies in San Diego County." A short history and description of each agency is given in the following pages.

Irrigation Districts - The Fallbrook Irrigation District, comprising a gross area of 9,915 acres of the Fallbrook Plain in the vicinity of the town of Fallbrook, was formed in 1925 and represents a second effort to develop an irrigation district in this area. The first district was formed under the original Wright Act in 1891, with an area of 12,000 acres. After considerable litigation, the original district was dissolved. The present district up to date has neither secured a water supply nor worked out a final plan for the project. About 1,500 acres within the district boundaries were irrigated in 1933 through private pumping plants. No capital investment has been made in irrigation works.

The La Mesa, Lemon Grove and Spring Valley Irrigation District was formed in 1913, and embraced the lands around the towns from which it takes it name. The district, however, after voting bonds, failed to negotiate successfully the purchase of the system of the Cuyamaca Water Company, or to construct other irrigation works, and remained inactive from 1915 to 1924. All of the original bond issue except $56,000 used for purchase of lands were withdrawn from sale and burned in 1923. In 1925, the district again voted bonds and purchased the Cuyamaca system for $1,226,529.92. The gross area of the district in 1933 was 19,019 acres, of which about 2,600 acres were irrigated. The district also furnishes irrigation water to some small areas outside the district, municipal and domestic supplies to the cities of La Mesa and El Cajon and the adjacent unincorporated areas, and from Murray Reservoir at the lower end of the flume and ditch has served an auxiliary supply to the municipal system of the City of San Diego.


WATER SERVICE AREAS
OF
ORGANIZED AGENCIES
IN
San Diego County
Scale of miles
0 5 10 15
Incorporated cities
Mutual water companies
Irrigation districts
Public utilities
RIVERSIDE CO.
ORANGE CO.
IMPERIAL CO.
MEXICO
PACIFIC OCEAN
R.1 W.
R.1 E.
T.9 S.
T.18 S
Fallbrook
FALLBROOK IRR. DIST.
FALLBROOK PUBLIC UTILITY DISTRICT
PAUMA VALLEY MUT. WATER CO.
VISTA IRR. DIST.
Vista
OCEANSIDE
CARLSBAD MUT. WAT. CO.
SAN DIEGUITO IRR. DIST.
ESCONDIDO MUT. WATER CO.
ESCONDIDO
SANTA FE IRR. DIST.
Encinitas
Del Mar
RAMONA I.D.
Ramona
Hodges Res.
Wohlford Res
Henshaw Res
Julian
Cuyamaca Res
El Capitan Res.
LAKESIDE I.D.
LAKESIDE FARMS MUTUAL WATER CO.
Lakeside
RIVERVIEW FARMS MUT. WATER CO.
La Jolla
El Cajon
Murray Res
SAN DIEGO
La Mesa
LA MESA, LEMON GROVE AND SPRING VALLEY I.D.
Sweetwater Res
SWEETWATER WATER CORP.
Upper Otay Res
Lower Otay Res.
Chula Vista
National City
Coronado
SAN DIEGO BAY
CORONADO WATER CO.
San Ysidro
SAN YSIDRO IRR. DIST.
Descanso
Barrett Res
Morena Res
Campo
Jacumba
Great Basin
Pacific Slope Basins
DIVIDE
SANTA MARGARITA R.
SAN LUIS REY RIVER
SAN DIEGUITO
Escondido
Santa Maria Cr.
San Vicente
Boulder Cr
SAN DIEGO RIVER
SWEETWATER
OTAY RIVER
Tia Juana R.
Cottonwood
San Felipe
Vallecito Wash
Carriso Canyon
Wash

Following a State Supreme Court decision confirming the City of San Diego's paramount right to the waters of the San Diego River, an agreement was made between the district and the City of San Diego whereby the district is allowed to divert up to a maximum of 27 second-feet at the Diverting Dam, in addition to the water conserved by Cuyamaca Reservoir. An exchange of storage facilities allows the district the use of 10,000 acre-feet of storage capacity in El Capitan Reservoir with additional temporary storage during summer months, while the City of San Diego is given the use of 5,000 acre-feet storage in Murray Reservoir, and title to several parcels of land.

The present works, described in some detail in Chapter VI, consist of Cuyamaca Reservoir of 11,595 acre-feet capacity, the Diverting Dam, the La Mesa flume and ditch, South Fork feeder flume, Grossmont, Eucalyptus, Mt. Helix and Murray reservoirs, the El Monte wells and pumps including booster pumps and the distribution system. The capital investment on December 31, 1933, was $2,385,031. The income from water tolls on 3488 acre-feet in 1933 amounted to $147,817 or $42.38 per acre-foot.

On January 6, 1934, the district was granted a loan of $600,000 from the Public Works Administration for the replacement of the existing wooden flumes with a concrete pipe line from El Monte tunnel to Eucalyptus Reservoir. Of this amount, $132,000 is a direct grant. A loan to the district of $1,347,768.40 was authorized on November 24, 1933, by the Reconstruction Finance Corporation to provide for the refunding of all bonded indebtedness, and unpaid interest coupons falling due prior to January 1, 1934, at sixty cents on the dollar. The July 1, 1932 interest, a portion of which has been paid in full by the district, was paid in full, the district contributing 40% of the amount with the remaining 60% provided in the loan.

The refinancing of the old bond issues and the reconstruction of the flume will materially reduce interest and operating charges.

The Lakeside Irrigation District, organized in 1924, comprises a gross area of 320 acres consisting of residential lots and small tracts in and adjoining the town of Lakeside. Although organized as an irrigation district, its operation is primarily for domestic use. In 1933, 23 acre-feet were used inside the district, all for domestic purposes, 33 acre-feet were delivered for the irrigation of 22 acres of orchard outside of the district. The capital investment less depreciation amounted to $28,117,57 on December 31, 1933, and includes the right to 4 miners inches continuous flow from the La Mesa Flume, 6 acres of river bed land, a well with deep-well turbine pump, a booster pump and storage tank, and a steel pipe distribution system. An assessment of $5,663 was levied in 1933. The total income of the district from assessment and water tolls was $6,320 and from other sources $2,454.

The Ramona Irrigation District, organized in 1925, comprises a gross area of 660 acres, including the town of Ramona. The district serves Ramona with domestic water and 20 acres were reported irrigated in 1933. The physical works include 12 wells along Santa Maria Creek with pumps, storage tanks and a pipe distribution system. The capital investment in works to December 31, 1927, including legal services and interest, amounted to $95,946.81. No additions of any consequence have been made since that date. Water tolls collected in 1933 amounted to $5,308 for a total delivery of 200 acre-feet, an average rate of $26.54 per acre-foot. $5,037 of assessments also were paid in 1933.

The San Dieguito Irrigation District, organized in 1922, is located on the coastal plain about 25 miles north of San Diego. The district covers a gross area of 4,000 acres, which includes the towns of Encinitas and Cardiff. About 1,570 acres were irrigated in 1933. The source of water

supply is Hodges Reservoir and the San Dieguito River. The water is purchased from the City of San Diego, which has a lease-option to purchase contract on the Hodges system. The water is conveyed from Hodges Reservoir through Carroll conduit for about 4 miles to San Dieguito Reservoir, a small regulating reservoir, where delivery is made through the pipe line and distribution system of the district. Three booster pumps lift water to lands above gravity distribution. The total investment less depreciation on December 31, 1933 was $311,596. In 1933, $29,129 was collected for water and a total of 1,950 acre-feet of water delivered for irrigation and domestic use at an average charge of $14.94 per acre-foot. $84,057 of assessments were paid in 1933.

The Santa Fe Irrigation District, organized in 1923, is located on the coastal plain directly north of the San Dieguito River about 20 miles from San Diego and has a gross area of 10,106 acres. In 1933, 2,630 acres were irrigated. The Santa Fe District, like the San Dieguito District, obtains its water supply from Hodges Reservoir through the Carroll conduit and San Dieguito Reservoir. The physical works comprise a distribution system of pipe lines, with a number of small distributing reservoirs and booster pumping plants to reach the area above gravity distribution. The total investment in works to December 31, 1933 was $722,054.62. In 1933 a total of 2,980 acre-feet of water was delivered and water tolls were collected to the amount of $80,212, or at the average rate of $26.92 per acre-foot. An assessment was levied of $131,850.

The San Ysidro Irrigation District was organized in 1911. It is located on the right bank of the Tia Juana River, just north of the international boundary line, and has a gross area of 532 acres, including the town of San Ysidro. The district is mainly residential. Only 100 acres were irrigated in 1933. The present system of the district embraces 5 wells, located in the water bearing lands in the Tia Juana River channel,

a 625,000 gallon concrete reservoir and a pipe distribution system. The capital investment less depreciation to August 1933 was reported as $63,076. In 1932 the district delivered 368 acre-feet of water and collected water tolls to the amount of $9,684, or at the average rate of $26.32 per acre-foot and collected $2,862 in assessments.

The Vista Irrigation District, organized in 1923, is located around the town of Vista, about 10 miles inland from Oceanside, and had a gross area of 18,338 acres, of which 6,766 acres were irrigated in 1933. The water supply for the district is obtained from the Henshaw Reservoir on the San Luis Rey River by purchase from the San Diego County Water Company. The water is released from the reservoir, flows down the San Luis Rey River channel and through the Escondido ditch to Wohlford Reservoir. After passing through the Escondido Mutual Water Company's power plant, the water is delivered to the district's main supply conduit. The physical works of the district include the main supply conduit from Bear Valley Power plant, the Pechstein Reservoir of 200 acre-feet capacity, 7 circular concrete equalizing reservoirs, and a steel and concrete pipe distribution system. The capital investment on December 31, 1933, was $1,686,722. In 1933, the district collected water tolls to the amount of $104,883 and delivered 5,700 acre-feet at an average charge of $18.40 per acre-foot. The district also collected $78,112 from taxes.

Mutual Water Companies - The Carlsbad Mutual Water Company, organized in October, 1914, serves a gross area of about 11,000 acres extending from the boundary of the Santa Margarita y las Flores Rancho, approximately half a mile north of the San Luis Rey River, south to Aqua Hedionda Creek including the unincorporated community of Carlsbad and more than half of the area of the incorporated City of Oceanside. In 1933 a net area of 2,000 acres, of which only 300 acres were within the corporate limits of the City of Oceanside,

were served by this company. The present works consist of three wells in the San Luis Rey River Valley, four distributing reservoirs and a pipe distribution system, together with the necessary pumping plants. The capital investment as of December 31, 1933, was $250,000 with the water rights carried on the books at a nominal value of $1.00. 1,927 acre-feet of water were supplied in 1933 for a net charge of $29,929 or $15.53 per acre-foot, which carried the operating expenses. The charges for depreciation and improvement were met by an assessment of $8,000.

The Escondido Mutual Water Company serves water and electricity to a gross area of 13,230 acres in Escondido Valley. The active development of the Escondido Valley began during the boom of 1885-88. In 1887 the settlers formed the Escondido Irrigation District under the Wright Act. At this time the district did not contemplate the development of a water supply but hoped to purchase water wholesale from some private organization. A bond issue of $450,000 was voted, $300,000 to be paid for water at the edge of the district, and $150,000 for a distributing system. The plan, however, failed and nothing was done. In 1893 the district decided to develop its own supply from the San Luis Rey River at an estimated cost of about $175,000. The bond issue, therefore, was reduced to $250,000. This, however, proved inadequate and a further issue of $100,000 was made before the system was completed in 1895. During the period of litigation over the constitutionality of the Wright Act, many of the property owners refused to pay their assessments and in 1899 trustees for the bond holders took over the system. In 1904 the bondholders agreed to relinquish the system for $225,000 cash payable in one year. The property owners organized the Escondido Mutual Water Company and in 1905 raised the necessary money by a voluntary assessment of $43.00 per $100.00 assessed valuation, bought the bonds and dissolved the district.

The system as originally constructed comprised an intake tunnel for diversions from the San Luis Rey River, a conduit to Wohlford Reservoir, known as the Escondido ditch, the reservoir and a ditch and pipe distribution system. The diversion tunnel was located near the west line of Section 33, T. 10 S., R.1 E. and was 356 feet long heading on the left bank of the river 3 feet below low water level. The transmission conduit had a capacity of 28 second feet and consisted of 12.7 miles of open ditch, 2.7 miles of timber flume and a 450 foot tunnel discharging into a creek tributary to Wohlford reservoir. The reservoir having a capacity of 2,619 acre-feet was formed by a rock fill dam on Bear Valley Creek in Sec. 5. T. 12 S.R. 1 W., 76 feet high, having a crest length of 380 feet, and top width of 10 feet. The downstream slope of the dam was $1\frac{1}{4}$ to 1 for the lower portion, and 1 to 1 for the upper, while the water slope was $\frac{1}{2}$ to 1 and covered with a timber facing. The facing extended three feet above the dam crest. The spillway channel around the right end of the dam was 25 feet wide and 6 feet below the crest of the dam. The distribution system consisted of a small pickup wier about half a mile below the dam, 16 miles of pipe line and 15.5 miles of open ditches and flume. The dam was topped during the flood of 1916 but did not fail. However, settlement occurred which strained the plank facing, causing large leakage and necessitating repairs. The spillway was enlarged also. In 1924 the dam was raised to a height of 100 feet by placing a hydraulic fill blanket on the upstream face and a siphon spillway with its crest five feet below the top of the dam constructed. This increased the reservoir capacity to 7,225 acre-feet. In 1932 the spillway capacity was enlarged by the construction of a side channel spillway 80 feet long. About 1925 the capacity of the Escondido ditch was increased to 70 second-feet and lined with concrete. A concrete diversion dam has since been constructed at the intake on the San Luis Rey River. Two power houses have

been constructed, one at Rincon with an installed capacity of 300 kilovolt amperes to utilize the water released for the Rincon Indian Reservation and the other at Bear Valley below Wohlford Reservoir with an installed capacity of 800 kilovolt apmeres utilizing the head between the reservoir water surface and the intake of the distribution system. The distribution system now comprises 65 miles of pipe lines with no open ditches. The capital investment on February 28, 1934 amounted to $997,000 of which $814,000 was for water services and $183,000 for power.

The gross area served, as stated, is 13,230 acres of which 7,223 acres were irrigated in 1931. In the year ending February 28, 1934, 7,042 acre-feet of water were sold for irrigation at a rate of $2.52 per acre-foot plus a service charge of $0.75 for each irrigation and $0.25 for each requested change in head. In addition to its irrigation service, the Escondido Mutual Water Company wholesales water to the City of Escondido for municipal uses, 421 acre-feet having been delivered for this purpose in 1933, and acts as a transportation agency, deliverying water from Lake Henshaw through the Escondido ditch and Bear Valley power house to the Vista Irrigation District canal.

The Lakeside Farms Mutual Water Company was organized in 1910 to serve a gross area of 966 acres north of the San Diego River in the vicinity of Lakeside. 451 acres were irrigated in 1933. The existing works consist of two wells and pumps drawing from the San Diego River gravels, two booster pumps and a reservoir. The capital investment on December 31, 1933, was estimated to be about $25,000. The water rates in 1933 were 4 cents per 1,000 gallons under 100,000 gallons per month and 3 cents per 1,000 gallons over 100,000 gallons per month, with a minimum charge of $3.00 per month per meter. Low areas not requiring the use of the booster pumps were served at a rate of 35 cents per hour for the use of the low

lift pump. In 1933 the receipts from water tolls were $2,989 and $1,538 from assessment.

The Pauma Valley Mutual Water Company was organized in 1914 to serve a gross area of 496 acres in the San Luis Rey Valley about 5 miles east of Pala. 403 acres were served in 1933. The existing works consist of a diversion weir on Pauma Creek, 3 miles of 14" pipe with boxes and gates for distribution and one well and pump. The company has a water right of about 190 miner's inches on Pauma Creek, subject to the prior right of 30 miner's inches of the Pauma Indian Reservation. The well and pump were installed to supplement the gravity supply during late summer and fall months. The capital investment on December 31, 1933, was $18,700. Water tolls are $3.00 per acre for all the water available. The users pay pumping charges estimated at 25 cents per hour for well water. In 1933 about 190 inches for 8 months and 10 inches for 4 months were available.

The Riverview Farms Mutual Water Company was organized in 1916 to serve a gross area of 1,290 acres south of the San Diego River in the vicinity of Lakeside. 144 acres were irrigated in 1933. The present works consist of two wells and pumps drawing from the San Diego River gravels, booster pumps, four small regulating reservoirs and distribution system. The capital investment on December 31, 1933 was estimated to be about $50,000. In 1933, 166 acre-feet of water were sold for a total of $4,919 an average rate of $29.63 per acre-foot. Assessments and miscellaneous items increased the income of the company by $2,185.

Incorporated Cities - The City of San Diego now owns and operates its entire water supply system serving water from the drainage basins of Cottonwood, Otay, San Diego and San Dieguito rivers. The first successful organized effort to provide a water supply for this city began with the incorporation of the San Diego Water Company in 1873. This company had drilled a well

near the southeast corner of the park and commenced deliveries before March 1874. In 1875, however, the supply became inadequate and the company began pumping from the wells in the gravels of Mission Valley. In 1889 the San Diego Flume Company brought in the water from the San Diego River and Cuyamaca Reservoir and in 1894 the San Diego Water Company and the San Diego Flume Company were consolidated. In 1901 the City purchased the Mission Valley wells and the distribution system within the city limits. The supply was obtained from the Mission Valley wells and the San Diego Flume Company until 1906 when the city began the purchase of water from the Southern California Mountain Water Company, supplied from the Lower Otay Reservoir. In 1913 the city purchased the system of the Southern California Mountain Water Company and since that time both the storage and distribution of water have been in municipal control. The system at that time consisted of a low dam at Morena Reservoir, the Dulzura Conduit, the Upper and Lower Otay reservoirs and transmission pipe line to the city. The system has since been enlarged by increasing the capacity of Morena Reservoir, by the construction of Barrett Reservoir, by the replacing of Lower Otay Dam destroyed by the flood of 1916, by the purchase of Hodges Reservoir and other properties on the San Dieguito River, by the development of the upper San Diego River underground basin and the construction of El Capitan Reservoir.

Morena Reservoir now has a capacity of 65,800 acre-feet when water is stored to the top of the spillway gates. The reservoir is formed by Morena Dam located on Cottonwood Creek in Section 14, T. 17 S., R.4 E. The dam is a rock-fill structure 179 feet high with a crest length of 550 feet. The down stream face has a 1 1/3 to 1 slope while the upstream face has a 0.9 to 1 slope with a rubble and reinforced concrete facing. The side channel spillway located at the right end of the dam is 312 feet long and the flow may be partially controlled by gates. Water released from Morena Reservoir flows

down the natural stream channel of Cottonwood Creek to Barrett Reservoir. Barrett Dam which forms this reservoir is located on Cottonwood Creek in Section 22,T. 17 S., R.3 E. It was constructed in 1922 and is a gravity concrete structure, arched in plan, 160 feet high with a crest length of 750 feet. The over-pour spillway is 387 feet long and 18 feet deep. It is partially controlled by gates, and the reservoir capacity when water is stored to the top of the gates is 42,900 acre-feet. Water released from Barrett Reservoir is conveyed by the Dulzura Conduit for a distance of 13.5 miles, discharges into Dulzura Creek and flows down the natural stream channel into Lower Otay Reservoir. The conduit is concrete lined and has a capacity of 60 second feet.

The Savage Dam formerly called the Lower Otay Dam was officially renamed by Resolution No. 61,881, adopted by the Council of the City of San Diego on July 9, 1934. It forms the Lower Otay Reservoir and is located in Section 18, T. 18 S., R. 1. E., and Section 13, T. 18 S., R. 1 W. on the Otay River. The present dam is a gravity concrete structure, arched in plan, 151.5 feet high, with a crest length of 700 feet and was built in 1919. Two spillways having a combined net length of 448.5 feet are partially controlled by gates. The reservoir has a storage capacity of 56,321 acre-feet when water is stored to the top of the gates. The water released from Lower Otay Reservoir passes through a filtration and chlorination plant and is delivered to the various city regulating reservoirs through transmission pipe lines. The Upper Otay Dam, which forms the Upper Otay Reservoir, is located on Proctor Valley Creek in the Otay (Dominguez) Rancho in what would be Section 36, T. 17.S., R. 1 W., if the section lines were extended into the grant. The dam is a concrete arch 79.5 feet high with a crest length of 350 feet. The reservoir capacity below the spillway lip is 2,793 acre-feet. The spillway is an overpour type 22 feet long. Water is released directly

into Lower Otay Reservoir.

Hodges Reservoir has a storage capacity of 37,699 acre-feet and is formed by a multiple arch concrete dam located in Section 18, T.13 S., R. 2 W. The dam is 130 feet high above stream-bed and has a crest length of 729 feet. An overflow spillway 341 feet long with its lip 15 feet below the crest of the dam is located at the right end of the dam. Water is released from this reservoir and carried through the Carroll conduit to San Dieguito Reservoir where it is distributed to the Santa Fe and San Dieguito irrigation districts, to Del Mar Water, Light and Power Company and to the City of San Diego. The San Dieguito Reservoir is located in the San Dieguito Rancho, in Escondido Creek drainage basin in what would be Section 16, T. 13 S. R., 3 W. if the section lines were extended into the grant. The reservoir is formed by a multiple arch dam and has a storage capacity of 1,128 acre-feet. The Hodges system, and other properties on the San Dieguito River were acquired in 1925 by the city on a lease-option to purchase contract. Under existing contracts the city is obligated to furnish a total of 10,500 acre-feet annually from Hodges Reservoir to the Santa Fe and San Dieguito irrigation districts and the Del Mar Water, Light and Power Company.

In 1925 the city began construction of Sutherland dam and reservoir on the main stream of the San Dieguito River, which is known as Santa Ysabel Creek above Hodges Reservoir, but abandoned the project before completion. The dam site is located in Section 21, T. 12 S., R. 2 E.

The El Capitan Dam and Reservoir on the San Diego River have been recently completed and placed in operation. The dam is located in Section 7, T 15 S., R. 2 E. A somewhat detailed description of it is given in Chapter VI. The reservoir will have a storage capacity of 116,900 acre-feet. Data descriptive of the dams and reservoirs mentioned above and the regulating reservoirs of the distribution system of the City of San Diego are presented

TABLE 11
RESERVOIRS OF THE CITY OF SAN DIEGO

Reservoir	Location	Height of spillway above stream bed, in feet	Type of dam	Elevation of spillway lip, in feet U.S.G.S. datum	Flooded area at spillway lip, in acres	Storage capacity, in acre-feet
Storage						
Morena	Cottonwood Creek	167	Rockfill	3,045	1,627	65,800
Barrett	Cottonwood Creek	142	Gravity Curved	1,615	862	42,900
Upper Otay	Proctor Valley Creek	72	Constant radius arch	550	139	2,800
Lower Otay	Otay River	140	Gravity curved	491	1,266	56,300
El Capitan	San Diego River	197	Hydraulic & rockfill	750	1,580	106,900(1)
Hodges	San Dieguito River	115	Multiple arch	315	1,317	37,700
Total storage capacity						312,400
Regulating						
Murray (1)	Tributary of Alvarado Canyon	107	Multiple arch	540	200	5,000(1)
San Dieguito	Tributary of Escondido Creek	41	Multiple arch	249	--	1,128
Chollas	Tributary of Chollas Creek	43	Earth	428	--	278
Concrete lined basins and steel tanks						84
Total regulating capacity						6,490
Combined storage capacity of system						318,890

(1) The total storage capacity of El Capitan Reservoir is 116,872 acre-feet. Through an agreement between the City of San Diego and the La Mesa, Lemon Grove and Spring Valley Irrigation District an exchange of storage has been made by which the irrigation district may utilize 10,000 acre-feet of space in El Capitan Reservoir and the City of San Diego utilize 5,000 acre-feet of space in Murray Reservoir which is owned by the irrigation district, the total storage capacity of which is 5,880 acre-feet.

in Table 11.

Throughout its operation the municipal system of the City of San Diego has had a connection with the San Diego River system built by the San Diego Flume Company and now owned by the La Mesa, Lemon Grove and Spring Valley Irrigation District and in many years additional water has been purchased from this system. The wells in Mission Valley and underground supplies developed about 1927 in the San Diego River beds at Riverview and near Lakeside have also been maintained and are drawn upon from time to time for additional supplies.

The annual safe yield of the surface storage system of the City of San Diego after El Capitan Reservoir has been filled has been estimated to be 31,660 acre-feet. No estimates of the probable safe yield from the Mission Valley, Riverview and Lakeside plants are available. The gravel beds in the upper San Diego River Valley are also drawn on by the La Mesa, Lemon Grove and Spring Valley and the Lakeside irrigation districts, the Riverview and Lakeside mutual water companies, and numerous private pumping plants. The annual drafts within the city limits on this system since 1897 are shown graphically on Plate VI, "Growth of Population and Consumption of Water in Corporate Limits of San Diego" and listed in Table 12 together with the population of the city as given by the United States Census for the years 1900, 1910, 1920, and 1930 and the per capita use in these years. The sudden drop in per capita use after 1929 is probably the result of the depression and it is believed that recovery will bring a return to a per capita use approximating that of earlier years.

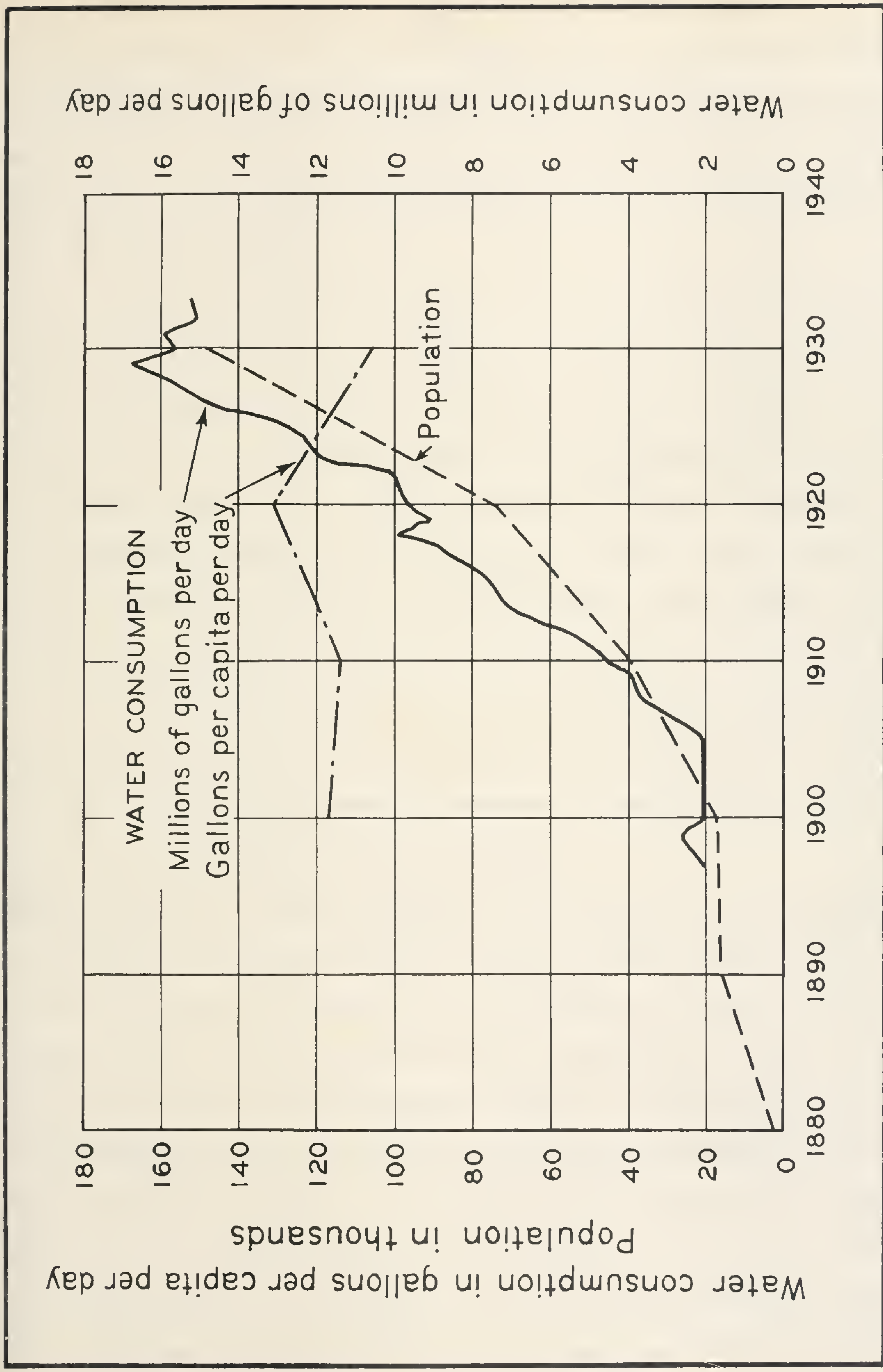
In addition to the municipal draft of 5,536 million gallons or 17,010 acre-feet in 1933, the city system also delivered 5,050 acre-feet to the San Dieguito and Santa Fe irrigation districts and the Del Mar Water, Light and Power Company under the contracts taken over when the Hodges system

TABLE 12

GROWTH OF POPULATION AND CONSUMPTION OF WATER
IN
CORPORATE LIMITS OF CITY OF SAN DIEGO

Year	Population	Water consumption		
		Annual total, in millions of gallons	Average per day, in millions of gallons	Average per capita per day, in gallons
1897		744	2.039	
1898		862	2.362	
1899		931	2.550	
1900	17,700	758	2,077	117
1901		750	2.055	
1902		761	2.085	
1903		733	2.008	
1904		771	2.106	
1905		761	2.085	
1906		944	2.586	
1907		1,222	3.348	
1908		1,386	3.787	
1909		1,413	3.871	
1910	39,578	1,653	4.529	114
1911		1,821	4.989	
1912		2,095	5.724	
1913		2,504	6.860	
1914		2,641	7.236	
1915		2,768	7.584	
1916		2,958	8.082	
1917		3,151	8.633	
1918		3,623	9.926	
1919		3,318	9.090	
1920	74,361	3,560	9.727	131
1921		3,591	9.838	
1922		3,662	10.033	
1923		4,340	11.890	
1924		4,482	12.246	
1925		4,670	12.795	
1926		5,229	14.326	
1927		5,486	15.030	
1928		5,771	15.768	
1929		6,115	16.753	
1930	147,995	5,714	15.655	106
1931		5,804	15.901	
1932		5,513	15.063	
1933		5,536	15.167	

PLATE VI



GROWTH OF POPULATION AND CONSUMPTION OF WATER
IN
CORPORATE LIMITS OF SAN DIEGO

was acquired, 1,000 acre-feet to Coronado Water Company, and about 40 acre-feet to miscellaneous users along the city pipe lines. The total draft on the city's system,therefore, was 23,100 acre-feet in 1933. The capital investment, less depreciation, in the operative portion of this system on June 30, 1933, was $18,491,570. The investment in uncompleted projects, Sutherland and El Capitan, at that time was $2,873,156.

The City of Oceanside includes an area of 8.64 square miles within its corporate limits, and had a population of 3,508 in 1930. It operates a municipally-owned water system consisting of four wells and pumps in the San Luis Rey River bed, two booster pumps, a five million gallon reservoir and a distribution system. The capital investment in 1933 was estimated to be about $380,000. The system including lands and water rights, however, was valued at $600,000. The draft in 1933 amounted to 926 acre-feet, of which about 25 per cent was for irrigation and industrial uses.

The City of Escondido owns and operates its own municipal water system and now purchases its water wholesale from the Escondido Mutual Water Company. The capital investment on December 31, 1933, amounted to $104,000 and the total draft in 1933 was 421 acre-feet.

Public Utilities and Private Companies - The Sweetwater Water Corporation serves a gross area of 14,000 acres lying below the 165-foot contour on the eastern shore of San Diego Bay between the south boundary of the City of San Diego and the Otay River, including the urban areas of National City, Chula Vista and Otay City. In 1933, 3,111 acres were irrigated. The physical works consist of the Sweetwater Dam and Reservoir, wells and pumps in the Sweetwater Valley and a pipe distribution system. The Sweetwater Dam is located on the Sweetwater River near the easterly line of Rancho La Nacion. It was built in 1886-1888 to a height of 70 feet, creating a reservoir of 18,635 acre-feet capacity. In 1895 the dam was raised 5 feet and the storage was increased to 20,720 acre-

feet. In 1911 the dam was raised again and the storage increased to 35,164 acre-feet. At the present time due to silting the capacity has been reduced to 29,065 acre-feet. The present dam is a thick concrete arch 95 feet high and 420 feet long on the crest. The spillways consist of siphons and an overflow structure. There is also an auxiliary earth dam 32 feet high and 1,140 feet long 8 feet wide on top with an upstream slope of 2:1 and a down stream slope of 3:1. The capital investment, less depreciation, on December 31, 1933 was reported to be $2,525,651. The present water rates are $0.30 per 100 cubic feet for less than 1000 cubic feet; $0.18 for the next 1000 cubic feet; for all over 2000 cubic feet, $0.06 for irrigation and $0.18 for all other purposes. Minimum charges range from $1.50 per month for a five-eighths inch meter to $14.40 per month for a four-inch meter.

The Coronado Water Company serves the City of Coronado, the Otay Valley, and the area between San Diego Bay and the Tia Juana River Basin, including the unincorporated communities of Palm City and Imperial Beach. The physical works consist of wells in the Otay River basin, pumps and a reservoir near Palm City, a transmission line from a connection with the City of San Diego's system near Otay, an eight-inch submarine pipe line connecting with the City of San Diego mains and the distribution system. On December 31, 1933, the capital investment, less depreciation, was $586,118. The Coronado Water Company, incorporated in 1886, drew its supply from the City of San Diego mains until 1889 when the wells in the Otay Basin were sunk. From that time until 1908 the whole supply was furnished by the Otay wells. From 1908 to 1916 the supply came from the Lower Otay Reservoir but the wells were maintained as an emergency supply. When the floods of 1916 destroyed the Lower Otay Dam and the pumping plants, service was maintained through the submarine connection with the City of San Diego. Although the pumping plants in the Otay Valley were rebuilt, the new Lower Otay Dam built in 1918 cut off former

lines of seepage and since 1924 only about 22 percent of the supply has come from the Otay wells. The rest has been purchased from the City of San Diego. The use, practically all domestic, amounted to about 1,240 acre-feet in 1933.

The Fallbrook Public Utility District, a public owned agency organized about 1924 for the purpose of supplying water in the town of Fallbrook and vicinity, serves a gross area of 754 acres. The original plant consisted of wells in the vicinity of Fallbrook, pumps and a distributing system. The wells, however, were abandoned because of deficient yield in 1933 and a new well was sunk in the sands of the Santa Margarita River. The present physical works consist of the new well, a pumping plant and booster pumps, a reservoir in Fallbrook and a distributing system. About 45 acre-feet of water were pumped in 1933. The capital investment, less depreciation, on December 31, 1933 was $56,313.

The San Diego County Water Company owns and operates the Henshaw Reservoir located on the San Luis Rey River, at the lower end of Warner Valley, The company is a private corporation and does not function as a public utility. The reservoir has a capacity below the spillway lip of 203,581 acre-feet and is formed by the Henshaw Dam which is located in Section 10, T. 11 S., R. 2 E. The drainage basin of the San Luis Rey River above the dam site has an area of 206 square miles. The dam is an earth-fill structure with the spillway lip 107 feet above the stream bed. The crest length is about 1,950 feet. The downstream face has a slope of 2:1 and the upstream face a slope of 2 $\frac{1}{4}$:1 and is protected by a concrete facing. The overflow spillway located at the right end of the dam has a capacity of 37,500 second-feet. The water developed by this project is wholesaled and at present the principal purchasers are the Vista Irrigation District and the Escondido Mutual Water Company. In 1933 Vista Irrigation District purchased 6,424 acre-feet of water at $17.50 per acre-foot. The water is released from the reservoir and runs down the natural channel of the San Luis

Rey River to the Escondido ditch through which it is diverted to Wohlford Reservoir and delivered to the main canal of the Vista Irrigation District and to the distribution system of the Escondido Mutual Water Company at the tail race of the Bear Valley Power house. The approximate cost of Henshaw Dam is reported to be $2,000,000.

The Del Mar Water, Power and Light Company, a private corporation, serves domestic water secured from Hodges Reservoir to the residential development in the town of Del Mar and vicinity. Its supply is purchased from the City of San Diego and in 1933 the amount used was about 123 acre-feet.

U. S. Indian Reservations - The La Jolla Indian Reservation is located on the steep south slope of Palomar Mountain and the bench lands bordering the canyon of the San Luis Rey River and comprises a total area of 8,329 acres. The irrigation system consists of a small diversion dam on Potrero Creek, which is a tributary of the San Luis Rey River, about 1000 feet of 8" pipe, a small reservoir and a pipe distributing system. It is primarily for domestic purposes and for watering small gardens. The net irrigable area is 50 acres, all of which were irrigated in 1932. The total capital investment is estimated to be $15,000.

The Pala Indian Reservation is located at the old mission San Antonio de Pala. The reservation comprises a total area of 18,780 acres, patented and withdrawn, in the San Luis Rey River Basin. The mission lands were watered by a ditch diverting from the San Luis Rey River, which was probably built in the first or second decade of the nineteenth century. This ditch is incorporated in the present system, which therefore may be said to be one of the oldest active irrigation systems in the State of California. The present system consists of an intake on the San Luis Rey River, the northside and southside laterals and distributing systems, two wells and pumps, a small reservoir, and a pipe distributing system for domestic water for use in the town of Pala.

The capital investment less depreciation was about $29,000 in 1931. The system serves a gross area of 630 acres, 587 acres being classed as irrigable, of which 400 acres were irrigated in 1933.

The Pauma Indian Reservation now comprises three tracts of land, of 225, 12.5 and 12.5 acres respectively, lying wholly within the boundaries of the Pauma Grant. It is situated in the San Luis Rey River Valley about 6 miles upstream from the town of Pala. The irrigation project is virtually identical with the tract of 225 acres and has the right to the first 30 miner's inches of water in Pauma Creek. This water is diverted and carried through the Pauma Valley Mutual Water Company's pipe line to a connection with the reservation system. The works of the reservation project comprise a diversion weir, a cobble and cement lined reservoir, and a distribution system consisting of about two miles of cement and steel pipe. The capital investment less depreciation was estimated to be $4,500 in April 1933. The net irrigable area is 222 acres of which 57 acres were irrigated in 1932.

The Rincon Indian Reservation is located in the San Luis Rey River Basin, about 10 miles above the town of Pala, and comprises a gross area of 2,314 acres, of which 720 acres are classed as irrigable. The reservation has a right to the first six second-feet of the full natural flow of the San Luis Rey River at the Escondido ditch diversion. This flow is diverted by the Escondido Mutual Water Company and delivered to the distribution system of the reservation at the tail race of the Rincon power house. Agreements with Escondido Mutual Water Company and Wm. G. Henshaw also provide for furnishing power from the Rincon or Bear Valley power plants for pumping and guarantee maintaining the water levels in gravels from which the pumping supplies are secured to certain elevations. The reservation maintains three pumping plants in the San Luis Rey River Valley to augment the supply during periods of deficient flow. 220 acres were irrigated in 1932. No information has been

obtained regarding the capital investment.

Other Indian reservation projects from the San Luis Rey River to the Mexican border are small, combined they serve a net irrigable area of 68 acres, of which 56 were irrigated in 1932. The total capital investment amounts to about $9,200.

Individual Private Development.

Almost all of the water development in San Diego County by individual enterprise consists of utilization of the ground waters by means of wells and pumps. A few ditches have been constructed for direct diversion of surface waters but in general there are no perennial streams except in the higher elevations, and a reliable surface water supply is dependent upon comparatively large surface storage. One of the few private diversions is the O'Neill ditch which diverts water from the Santa Margarita River at the upper end of the Santa Margarita Valley into the O'Neill Reservoir. This reservoir has a capacity of 690 acre-feet and was constructed in 1883. The water supply from this system is used for irrigation on valley lands near the Santa Margarita Home Ranch.

There are 14 minor dams owned by individuals and private companies in San Diego County, having a combined storage capacity of 890 acre-feet, and represent a capital expenditure of about $160,000. Most of the reservoirs formed by these dams provide regulation for the irrigation and domestic supply of private estates and small real estate developments. However, a few of them are for recreational use. A tabulation of existing surface storage reservoirs in San Diego County is shown in Table 13.

The larger part of the water supply for irrigation of the valley floors is provided through private pumping plants, while most of the supplies for the upland benches or terraces are furnished by organized agencies.

TABLE 13

EXISTING SURFACE STORAGE RESERVOIRS IN SAN DIEGO COUNTY

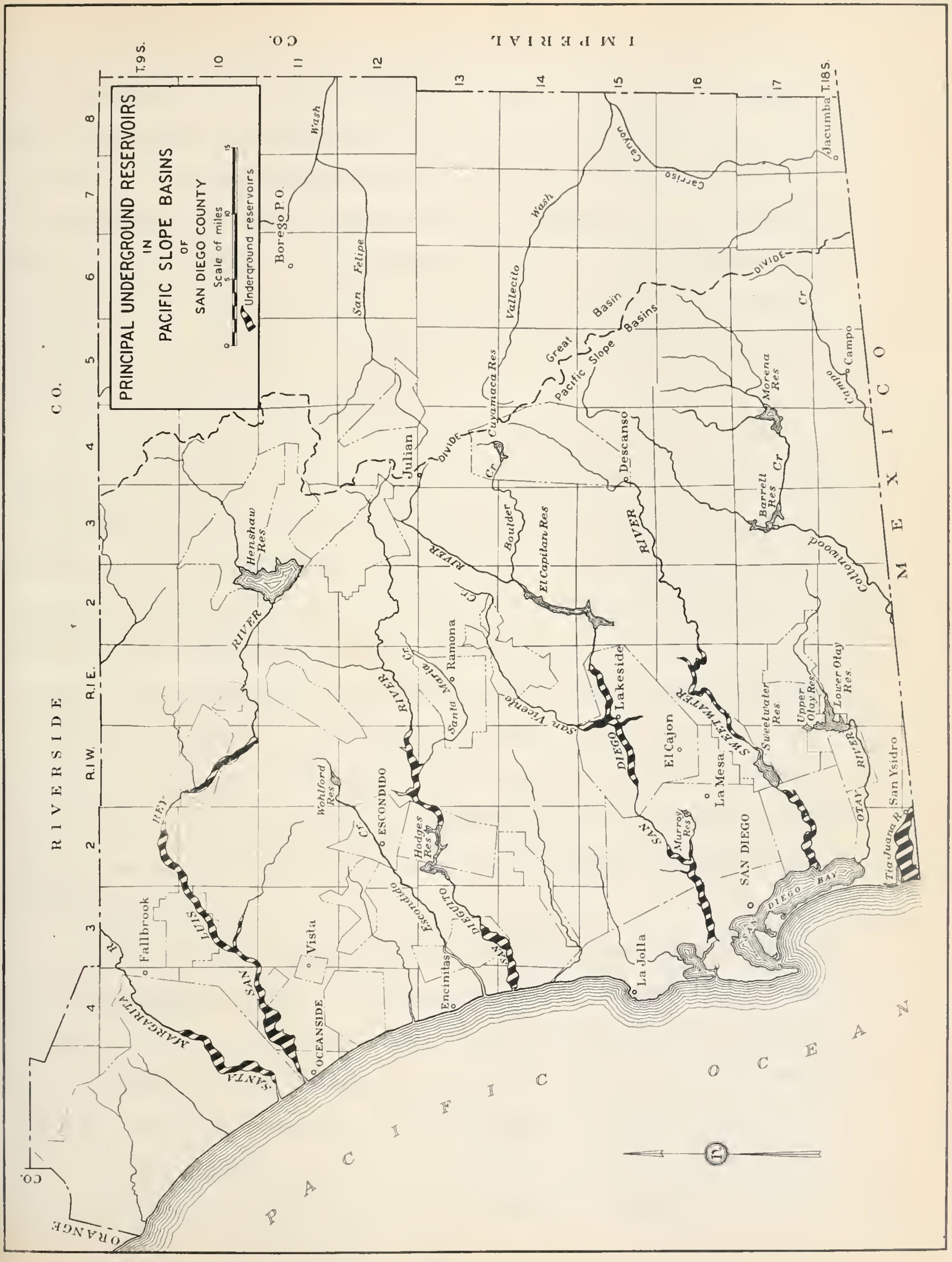
Stream basin and reservoir	Location of dam S. B. B. & M. Section	Township	Range	Type of dam	Height of spillway crest above stream bed, in feet	Reservoir capacity, in acre-feet	Totals
Santa Margarita							
O'Neill	8	10 S.	4 W.	Earth	12	690	
Total							690
San Luis Rey							
Eagles Nest	20	10 S.	4 E.	2 vertical arches	29	3	
Henshaw	10	11 S.	2 E.	Earth	107	203,581	
Total							203,584
Aqua Hedionda							
Pechstein	27	11 S.	3 W.	Earth	59	200	
Total							200
Escondido							
Wohlford	5	12 S.	1 W.	Hydraulic Fill	95	7,225	
San Dieguito	16	13 S.	3 W.	Multiple arch	41	1,128	
Total							8,353
San Dieguito							
Hodges	18	13 S.	2 W.	Multiple arch	115	37,699	
Upper 4 S.	32	13 S.	2 W.	Gravity curved	28	200	
Lower 4 S.	32	13 S.	2 W.	Gravity curved	21	60	
Green	36	12 S.	2 W.	Earth	33	10	
Fairbanks	34	13 S.	3 W.	Gravity	32	100	
Total							38,069
San Diego							
Cuyamaca	5	14 S.	4 E.	Earth	35	11,595	
Pine Hills	13	13 S.	3 E.	Earth	12	16	
El Capitan	7	15 S.	2 E.	Hydraulic & rock fill	197	116,872	
Eucalyptus	17	16 S.	1 W.	Earth	26	26	
Murray Hill	16	16 S.	1 W.	Earth	35	127	
Murray	13	16 S.	2 W.	Multiple arch	107	5,885	
Lily Pond	16	16 S.	1 W.	Earth	17	10	
Miles	17	16 S.	1 W.	Earth	16	10	
Total							134,541
Las Chollas Valley							
Lemon Grove	30	16 S.	1 W.	Earth	25	6	
Chollas	35	16 S.	2 W.	Earth	43	278	
Crouch	3	17 S.	2 W.	Earth	45	40	
Total							324
Sweetwater							
Monte Vista Ranch	31	16 S.	1 E.	Earth	50	10	
Helix	21	16 S.	1 W.	Earth	42	190	
Sweetwater	17	17 S.	1 W.	Thick arch	95	29,065	
Stilling Pool	17	17 S.	1 W.	Slab and buttress	16	5	
Keen Valley	24	17 S.	2 W.	Earth	24	50	
Total							29,320
Otay							
Upper Otay	36	17 S.	1 W.	Arch	72	2,793	
Lower Otay	18	18 S.	1 E.	Gravity curved	140	56,321	
Total							59,114
Cottonwood							
Morena	14	17 S.	4 E.	Rock fill	167	65,800	
Corte Madera	16	16 S.	4 E.	Earth	10	50	
Henry Jr.	2	17 S.	3 E.	Arch	30	196	
Mary Joe	2	17 S.	3 E.	Arch	28	135	
Barrett	22	17 S.	3 E.	Gravity curved	142	42,899	
Total							109,080
Total storage Pacific slope, San Diego County							583,275

It is estimated that 18,650 acres were irrigated in 1932 from private plants.

Utilization of Underground Basins.

The utilization of underground storage basins has been an important factor in the water supply development in San Diego County. All major stream valleys have underground basins, which while not comparable in extent or storage volume with underground reservoirs as may be found in other parts of the State such as the upper San Joaquin Valley, the south coastal basin of Southern California or Ventura County, nevertheless, are of sufficient capacity to be of great value. The location of the principal underground basins and their extent are shown on Plate VII, "Principal Underground Reservoirs in Pacific Slope Basins of San Diego County." Other smaller and less important underground basins occur in the minor stream valleys of the coastal belt and the highland area. Ground water supplies are also obtained in relatively small quantities from the weathered material or decomposed granite in the highland area, and from the tertiary and older sedimentary formations. The principal underground reservoirs have been developed by private individuals for the irrigation of the bottom lands of the major valleys and by many organized agencies for domestic and municipal use and for irrigation of permanent and annual crops on bench or mesa lands adjoining the valleys. Many scattered developments have also been made utilizing the ground water from the minor valleys and from the weathered materials in the highland areas. Approximately one third of the total quantity of water used in San Diego County is secured from underground sources. A detailed study of the geology and ground waters of the western part of San Diego County was made in 1915 by the United States Geological Survey and the results published in Water-Supply Paper 446.*

*U.S.G.S. Water-Supply Paper 446, "Geology and Ground Waters of the Western Part of San Diego County, California", 1919.


PRINCIPAL UNDERGROUND RESERVOIRS
IN
PACIFIC SLOPE BASINS
OF
SAN DIEGO COUNTY
Scale of miles
0 5 10 15
Underground reservoirs
RIVERSIDE CO.
IMPERIAL CO.
ORANGE CO.
MEXICO
PACIFIC OCEAN
Great Basin
Pacific Slope Basins
DIVIDE
Borego P.O.
San Felipe
Wash
Vallecito
Carriso Canyon
Jacumba
Campo
Morena Res
Barrell Res
Cottonwood
Cuyamaca Res
Julian
Henshaw Res.
SAN LUIS REY RIVER
SANTA MARGARITA
Fallbrook
Vista
OCEANSIDE
Encinitas
ESCONDIDO
Wohlford Res
Hodges Res
SAN DIEGUITO
Santa Maria
Ramona
Boulder Cr
El Capitan Res
San Vicente
Lakeside
SAN DIEGO RIVER
El Cajon
La Mesa
Murray Res
Descanso
SWEETWATER
Sweetwater Res.
Upper Otay Res.
Lower Otay Res.
OTAY RIVER
San Ysidro
Tia Juana R.
SAN DIEGO
SAN DIEGO BAY
La Jolla
T. 9 S.
T. 18 S.
R. 1 W.
R. 1 E.

In Water-Supply Paper 446, no studies were made of the underground basin of the San Luis Rey River which lies between the mouth of the gorge near Rincon and Pala Mountain near the town of Pala. This area and the side fills of the streams tributary on the right or north bank in this section of river were classified as Pala Conglomerates on the geological map in W.S.P. 446. A reconnaissance of this basin made during the present investigation indicates that a storage capacity of approximately 11,000 acre-feet may be available in the main fill and approximately 16,000 acre-feet in the side fill on the north side of the valley.

Detailed studies were made during the present investigation of the Mission Valley and upper San Diego River Valley underground basins to determine the storage capacities of these basins as additional information has become available since the publication of W.S.P. 446 on the specific yield of alluvial sediments, and further information regarding the underground conditions in these basins has been secured from the logs of wells drilled since that time. The storage capacities as found by these studies were somewhat larger than those estimated in W.S.P. 446. The estimated utilizable storage capacity of the upper San Diego River Valley from the Old Mission Dam to Cape Horn including the San Vicente Valley from Lakeside to Foster was found to be 24,200 acre-feet and for Mission Valley between Old Town and the lower end of Mission Gorge, 10,500 acre-feet.

While no detailed studies were made during the present investigations of the underground basins on the other major streams, a review of the storage capacities given in W.S.P. 446, based on comparisons with the results for Mission Valley and upper San Diego River Valley, indicates that, were the basins studied in the light of the more recent information available, and the fact that a material advance has been made since 1915 in the design of deep well pumping equipment, the utilizable storage capacities of several of the basins

would be found to be somewhat greater than that given in W.S.P. 446 and the combined storage capacity of the basins may be as much as 185,000 acre-feet.

The extremely unequal distribution of run-off has been shown in Chapter II. Large storage reservoirs will be required to accomplish the seasonal and cyclic regulations necessary to meet irrigation or municipal demands. The expense of surface storage works is great, and after water has been stored the losses by evaporation from the surface of the reservoirs may amount to a large part of the waters originally stored. The underground reservoirs therefore afford natural storage space utilizable in practically the same manner as surface reservoirs and with advantages in saving evaporation losses if properly operated, and in maintaining a high standard of potability. They are of especial value for reserve supplies in periods of drought, which must necessarily be held over from the previous wet cycle.

While their total storage capacity is a comparatively small amount of that necessary to fully develop and conserve the local run-off, the basins are available and at present only partially developed. Their additional development and use should be considered and more accurate data secured as to their capacities and rate of replenishment, when planning future water development of magnitude.

No effort has been made in any of the underground basins of the county to augment their natural replenishment, and little accurate data have been secured on the rate of replenishment. With increasing use of these basins and with the construction of additional surface storage, artificial spreading grounds may be required or coordinate operations with surface storage reservoirs may be essential to secure the maximum use of these basins.

At the present time the underground basins of the Santa Margarita River are being utilized for irrigation in the Temecula Valley,for domestic use by the town of Fallbrook and for irrigation in the lower Santa Margarita

Valley. In the San Luis Rey River Basin, use of underground water is being made by the Rincon and Pala Indian reservations, by the Pauma Mutual Water Company, by the Carlsbad Mutual Water Company, by the City of Oceanside and by many private individuals. About 1,500 acres are being irrigated by private wells and pumps within the Fallbrook Irrigation District and secure their water supply from the residuum or decomposed granite of the Fallbrook Plain.

In the San Dieguito River Basin, the Ramona Irrigation District secures its water supply from the basin of Santa Maria Creek, as does some private development. Private pumps and wells are operated in the San Pasqual Valley and in the San Dieguito Valley below Lake Hodges. Other private development has been made in the Bear Valley and Valley Center area and in Escondido Valley. In the San Diego River Basin, the La Mesa, Lemon Grove and Spring Valley Irrigation District has a number of wells and pumps together with a booster pump at El Monte, which are used as an auxilliary supply to its San Diego River system. The Lakeside Irrigation District and the Lakeside Farms and Riverview Farms mutual water companies secure their water supplies from the upper San Diego Basin in the vicinity of the town of Lakeside. The City of San Diego operates two pumping plants in this same basin, known as the Lakeside and Riverview Plants. In Mission Valley the City of San Diego operates wells and pumps located near the city boundary. In Mission Valley and the upper San Diego River Valley, many private plants also secure their supplies from these basins. In the southerly portion of the El Cajon Valley, an extensive development has been made utilizing water secured from the residuum or decomposed granite, which underlies that area.

In the Sweetwater River Basin the Sweetwater Water Company has developed wells and pumps in the lower underground basin below the Sweetwater Dam. In the upper Sweetwater underground basin the development has been entirely by private individuals. In the Otay Basin below Otay Reservoir, the Coronado

Water Company has wells and pumps and receives part of the supply used in Coronado from this source. Some private lands are irrigated from wells. The San Ysidro Irrigation District secures its supply from Tia Juana River underground basin, from a well field south of the town of San Ysidro. Development has been made by individuals for the irrigation of lands in the Tia Juana Valley. In addition to these developments of underground waters, many small tracts scattered throughout the county have developed reliable supplies in minor valleys from the decomposed granite.

The 1929 United States Census reports 311 pumping plants having a combined engine or motor capacity of 2,634 horse power and combined pump discharge capacity of 73,430 gallons per minute for the San Diego River drainage basin. The 1929 census did not report any other drainage basins separately in San Diego County, but gave for the entire county 996 pumping plants having a combined capacity of 9,013 horse power and a combined capacity of 223,812 gallonsper minute.

Growth and Location of Irrigated Lands.

Previous to the completion of the Sweetwater and Cuyamaca water systems, irrigation was confined to the small and scattered areas in the various stream basins with small ditches diverting the natural run-off when available. Wm. Ham. Hall, State Engineer, reported about 1,700 acres under irrigation from surface diversion in 1888 within the present boundaries of San Diego County, including 308 acres receiving water from the newly completed Sweetwater system. He reported about 1,100 acres in the San Jacinto River Valley now located in Riverside County.

The United States Census reports 10,193 acres as irrigated in 1889 for the county, which at that time included part of Riverside and all of Imperial County. During the following twenty years the irrigated area increased

gradually to about 25,000 acres, with little or no increase during the decade from 1909 to 1919. With the construction of the Hodges and Henshaw reservoirs and the formation of the Santa Fe, San Dieguito and Vista irrigation districts, the irrigated area increased rapidly and in 1932 48,725 acres were reported under irrigation. These data are given in Table 14.

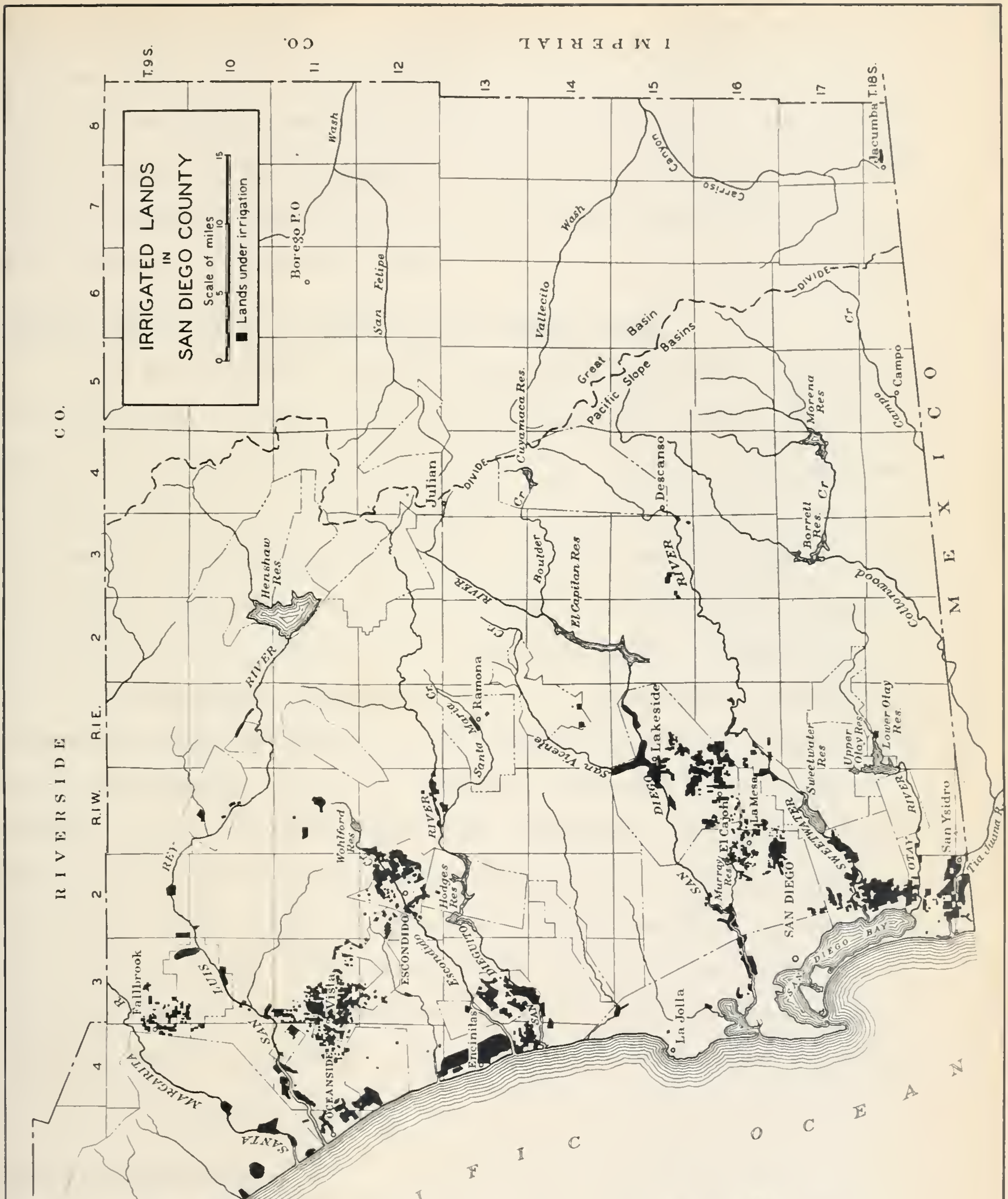
TABLE 14
GROWTH OF IRRIGATED AREAS IN SAN DIEGO COUNTY

Year of census	Census agency	Area irrigated, in acres
1889	United States	10,193 (1)
1899	United States	16,022
1909	United States	24,994
1912	California Water Conservation Commission	19,880
1919	United States	24,996
1926	Division of Water Resources	46,346
1929	United States	42,510
1932	Division of Water Resources (2)	48,725

(1) Includes some lands now in Riverside County.

(2) Bulletin No. 43 "Value and Cost of Water for Irrigation in Coastal Plain of Southern California", 1933.

The extent and location of the lands under irrigation in San Diego County are shown on Plate VIII, "Irrigated Lands in San Diego County". The information shown on this plate was secured by a field survey made in 1926 by the Division of Water Resources and supplemented by more recent data secured from irrigation districts, water companies and other sources. While irrigation may have been abandoned on some of the tracts shown and others placed under irrigation, the map portrays the general locations of the irrigated areas and


IRRIGATED LANDS
IN
SAN DIEGO COUNTY
Scale of miles
0 5 10 15
Lands under irrigation
RIVERSIDE CO.
IMPERIAL CO.
ORANGE CO.
MEXICO
PACIFIC OCEAN
T.9S.
T.18S.
R.1W.
R.1E.
Fallbrook
Vista
Oceanside
Escondido
Encinitas
La Jolla
San Diego
San Diego Bay
El Cajon
La Mesa
Lakeside
Ramona
Julian
Descanso
Campo
Jacumba
San Ysidro
Borego P.O.
Henshaw Res.
Wohlford Res.
Hodges Res.
Cuyamaca Res.
El Capitan Res.
Murray Res.
Sweetwater Res.
Upper Otay Res.
Lower Otay Res.
Morena Res.
Borrell Res.
Santa Margarita
San Luis Rey River
San Dieguito River
San Diego River
Sweetwater River
Otay River
Tia Juana R.
Santa Maria Cr.
San Vicente Cr.
Boulder Cr.
Cottonwood Cr.
Campo Cr.
Escondido Cr.
San Felipe
Vallecito Wash
Carrizo Canyon
Great Basin
Pacific Slope Basins
Divide

their relation to the total area of San Diego County. A cooperative crop and irrigated land survey is at present being conducted by the Division of Water Resources, the County of San Diego and the State Emergency Relief Administration, but has only been partially completed (January 1935). Preliminary data of this survey have been tabulated for the Tia Juana, Otay, Sweetwater and San Diego River basins and are presented in Table 15.

Present Area and Value of Irrigated and Unirrigated Crops.

A wide diversity of crops are grown in San Diego County. The large area of practically frost free land along the coast, in the foothills and the warm bench lands of the interior valleys allow the production of many varieties of semi-tropical fruits and winter vegetables. Avocados, oranges and lemons are the most important fruits produced, while celery, tomatoes, and Irish potatoes are important vegetable crops grown. Cauliflower, string beans, sweet potatoes, bell peppers, peas and summer squash are also grown and marketed during the winter and early spring. Apples are grown in the mountain district at altitudes ranging from twenty-five hundred to five thousand feet. A large acreage of grapes are grown in the valleys and foothills. Alfalfa and silage crops are produced in the river valleys and are used for dairy feed. On the mesas along the coast, beans are an important field crop and in many cases grown without irrigation. A large acreage of wheat, barley and oats are grown, a great deal of which is cut for hay. It is estimated that in 1930 the value of land, buildings, equipment and live stock utilized in the agricultural industry in the county was about $92,000,000. The area and value of crops grown for 1929, 1931 and 1932 are shown in Table 16.

Growth of Urban Areas.

San Diego was the first land sighted and visited in what is now California by Don Juan Rodriquez Cabrillo just half a century after the discovery

TABLE 15

CLASSIFICATION OF CROPS IN SAN DIEGO COUNTY BY STREAM BASINS, 1934

Stream Basin	Area of irrigated crops, in acres								
	Citrus	Avocados	Deciduous, olive and mixed orchards	Vines	Truck crops	Field crops	Alfalfa	Unclassified crops	Total irrigated crops
Tia Juana River									
Above Marron Valley	5	0	5	1	1	21	11	0	44
Tia Juana Valley	33	4	0	1	795	223	331	45	1,432
Totals	38	4	5	2	796	244	342	45	1,476
Otay River									
Above Lower Otay Dam	0	0	43	24	2	0	0	0	69
Below Lower Otay Dam	0	0	0	0	40	0	0	0	40
Totals	0	0	43	24	42	0	0	0	109
Sweetwater River									
Above Sweetwater Dam	87	23	116	60	76	61	54	64	541
Below Sweetwater Dam	1,978	113	310	1	1,006	105	115	145	3,773
Totals	2,065	136	426	61	1,082	166	169	209	4,314
San Diego River									
Above El Capitan Dam	47	0	0	0	6	0	0	0	53
La Mesa Irrigation District	1,591	903	165	358	537	190	0	6	3,750
El Capitan to Mission Gorge	624	278	173	1,285	826	490	261	59	3,996
Below Mission Gorge	0	3	4	0	436	194	170	0	807
Totals	2,262	1,184	342	1,643	1,805	874	431	65	8,606
Combined totals	4,365	1,324	816	1,730	3,725	1,284	942	319	14,505

(Continued)

TABLE 15 (Continued)

CLASSIFICATION OF CROPS IN SAN DIEGO COUNTY BY STREAM BASINS, 1934

Stream Basin	Area of irrigated crops, in acres								
	Citrus	Avocados	Deciduous, olive and mixed orchards	Vines	Truck crops	Field crops	Alfalfa	Unclassified	Total irrigated crops
Telegraph Canyon	0	0	0	0	0	0	0	0	0
Las Chollas Canyon	6	9	7	0	11	10	0	0	43
McGonigle Canyon to Rose Canyon	105	0	192	310	208	389	6	0	1,210
San Dieguito River									
Santa Maria Valley	94	0	66	74	59	43	32	8	376
Ramona Irrigation District	10	0	6	4	1	0	2	0	23
Above Lake Hodges	91	4	92	292	78	537	381	0	1,475
Santa Fe Irrigation District	1,592	675	61	0	670	14	0	56	3,068
San Dieguito Irrigation District	4	1,020	28	0	377	5	0	110	1,544
City of San Diego (Torrey Pines)	0	8	36	3	338	0	2	0	387
Below Lake Hodges	58	0	0	0	0	0	0	0	58
Totals	1,849	1,707	289	373	1,523	599	417	174	6,931
Loma Alto Creek to Escondido Creek	545	72	354	1,120	864	388	92	0	3,435
Combined totals	2,505	1,788	842	1,803	2,606	1,386	515	174	11,619

Data on pages 96b, 96c, 97b and 97c were received and inserted after this report had been mimeographed.

TABLE 15 (Continued)

CLASSIFICATION OF CROPS IN SAN DIEGO COUNTY BY STREAM BASINS, 1934

Stream Basin	Area of irrigated crops, in acres.								
	Citrus	Avocados	Deciduous, olive and mixed orchards	Vines	Truck crops	Field crops	Alfalfa	Un-classi-fied crops	Total irrigated crops
San Luis Rey River									
Escondido Mutual Water Co.	4,139	155	161	440	92	119	27	0	5,133
Vista Irrigation District	2,176	3,687	193	243	883	116		63	7,361
Rincon Indian Reservation	0	0	16	0	81	32	27	0	156
Pauma Indian Reservation	10	0	66	0	0	0	3	0	79
Pauma Valley Mutual Water Co.	119	4	339	0	12	0	0	0	474
Above Monserate Mountain	217	3	142	12	267	0	42	0	683
Fallbrook Irrigation District	825	274	88	1	288	0	0	0	1,476
Above Bonsall	439	19	556	53	109	1,548	57	0	2,781
Carlsbad Mutual Water Co.	101	879	55	0	613	21	3	44	1,716
City of Oceanside	9	58	0	0	108			37	212
Above Oceanside	270	28	41	0	890	0	270	0	1,499
Totals	8,305	5,107	1,657	749	3,343	1,836	429	144	21,570
Santa Margarita River									
Above Temecula	156	29	22	0	0	0	0	0	207
Fallbrook Irrigation District	260	35	43	0	30	0	0	0	368
Above Deluz	21	1	3	0	477	6	0	0	508
O'Neill Ditch	0	0	0	0	110	0	300	0	410
Totals	437	65	68	0	617	6	300	0	1,493
Arroyo San Mateo to Aliso Canyon	0	0	0	0	2,468	0	0	466	2,934
Combined Totals	8,742	5,172	1,725	749	6,428	1,842	729	610	25,997

TABLE 15 (Continued)

CLASSIFICATION OF CROPS IN SAN DIEGO COUNTY BY STREAM BASINS, 1934.

Stream Basin	Area of unirrigated crops, in acres									Total cropped area, in acres
	Citrus	Deciduous: olive and mixed orchards	Vines	Truck crops	Field crops	Pasture	Improved or fallow	Eucalyptus	Total unirrigated crops	
Tia Juana River										
Above Marron Valley	0	6	4	0	262	591	418	0	1,281	1,325
Tia Juana Valley	0	0	0	0	80	347	2,849	0	3,276	4,708
Totals	0	6	4	0	342	938	3,267	0	4,557	6,033
Otay River										
Above Lower Otay Dam	0	77	0	0	1,493	30	4,797	5	6,402	6,471
Below Otay Dam	0	0	0	0	0	0	3,639	0	3,639	3,679
Totals	0	77	0	0	1,493	30	8,436	5	10,041	10,150
Sweetwater River										
Above Sweetwater Dam	52	177	50	18	1,815	1,352	2,169	0	5,633	6,174
Below Sweetwater Dam	0	0	4	0	457	96	4,533	6	5,096	8,869
Totals	52	177	54	18	2,272	1,448	6,702	6	10,729	15,043
San Diego River										
Above El Capitan Dam	0	220	36	0	95	109	249	0	709	762
La Mesa Irrigation District	0	0	0	0	0	0	0	0	0	3,750
El Capitan to Mission Gorge	0	26	78	0	1,608	170	1,770	75	3,727	7,723
Below Mission Gorge	0	9	0	5	267	180	438	0	899	1,706
Totals	0	255	114	5	1,970	459	2,457	75	5,335	13,941
Combined totals	52	515	172	23	6,077	2,875	20,862	86	30,662	45,167

CLASSIFICATION OF CROPS IN SAN DIEGO COUNTY BY STREAM BASINS, 1934

Stream Basin	Area of unirrigated crops, in acres.									Total cropped area, in acres
	Citrus	Deciduous, olive and mixed orchards	Vires	Truck crops	Field crops	Pasture	Improved or fallow	Eucalyptus	Total unirrigated crops	
Telegraph Canyon	0	0	0	0	554	0	1,195	0	1,749	1,749
Las Chollas					151	0	57	0	208	251
McGonigle Canyon to Rose Canyon	0	79	38	0	3,590	778	1,794	23	6,302	7,512
San Dieguito River										
Santa Maria Valley	3	87	138	3	1,666	1,897	2,843	0	6,637	7,013
Ramona Irrigation District	0	0	0	0	0	0	0	0	0	23
Above Lake Hodges	0	84	599	0	9,161	602	1,987	128	12,561	14,036
Santa Fe Irrigation District	0	0	0	0	0	0	0	0	0	3,068
San Dieguito Irrigation District	0	0	0	0	0	0	0	0	0	1,544
City of San Diego (Torrey Pines)	0	0	0	0	0	0	0	0	0	387
Below Lake Hodges	0	2	0	0	586	415	637	763	2,405	2,461
Totals	3	173	737	3	11,413	2,914	5,467	891	21,601	28,532
Loma Alto Creek to Escondido Creek	0	675	0	0	18,197	3,633	6,044	1,140	29,689	33,124
Combined totals	3	927	775	3	33,905	7,325	14,557	2,054	59,549	71,168

Data on pages 96b, 96c, 97b and 97c were received and inserted after this report had been mimeographed.

TABLE 15 (Continued)

CLASSIFICATION OF CROPS IN SAN DIEGO COUNTY BY STREAM BASINS, 1934

Stream Basin	Area of unirrigated crops, in acres									Total cropped area, in acres
	Cutrus	Deciduous, olive and mixed orchards	Vines	Truck Crops	Field Crops	Pasture	Improved or fallow	Eucalyptus	Total unirrigated crops	
San Luis Rey River										
Escondido Mutual Water Co.	0	0	0	0	0	0	0	0	0	5,133
Vista Irrigation District	0	0	0	0	0	0	0	0	0	7,361
Rincon Indian Reservation	0	3	4	0	150	0	141	0	298	454
Pauma Indian Reservation	0	0	8	0	4	0	0	0	12	91
Pauma Valley Mutual Water Co.	0	0	0	0	0	0	0	0	0	474
Above Monserate Mountain	0	97	23	0	1,052	183	865	12	2,232	2,915
Fallbrook Irrigation District	0	0	0	0	0	0	0	0	0	1,476
Above Bonsall	0	1,034	672	5	6,908	972	5,175	87	14,853	17,634
Carlsbad Mutual Water Co.	0	0	0	0	0	0	0	0	0	1,716
City of Oceanside	0	0	0	0	0	0	0	0	0	212
Above Oceanside		75	5	0	2,724	1,149	2,069	17	6,039	7,538
Totals	0	1,209	712	5	10,838	2,304	8,250	116	23,434	45,004
Santa Margarita River										
Above Temecula	0	23	0	0	174	20	181	0	398	605
Fallbrook Irrigation District	0	0	0	0	0	0	0	0	0	368
Above Deluz	0	236	74	10	2,756	610	1,959	9	5,654	6,162
O'Niell Ditch	0	0	0	0	0	0	0	0	0	410
Totals	0	259	74	10	2,930	630	2,140	9	6,052	7,545
Arroyo San Mateo to Aliso Canyon	0	0	0	0	3,687	5,012	0	0	8,699	11,633
Combined totals	0	1,468	786	15	17,455	7,947	10,390	125	38,186	64,183
COMBINED TOTALS FOR SAN DIEGO CO.	55	2,910	1,733	41	57,437	18,147	45,809	2,265	128,397	180,518

TABLE 16

AREA AND VALUE OF CROPS IN SAN DIEGO COUNTY

Crop	(1) 1929		(2) 1931		(2) 1932	
	Area, in acres	Value	Area, in acres	Value	Area, in acres	Value
Cereals	18,594	$ 173,624)				
Other grains and seeds	6,114	335,536)	83,170	$1,635,170	116,750	$2,196,926
Hay and forage		978,108)				
Vegetables	8,316	1,666,349	10,730	4,206,658	10,400	2,289,522
Fruits and nuts	22,290	5,460,191	(4)33,270	4,292,625	(5) 35,861	3,059,898
Miscellaneous field crops	396	2,387	1,950	1,594,000	2,575	1,606,000
Nurseries and Greenhouses	(3)	807,652				
Totals	98,911	$9,423,847	129,120	$11,728,453	165,586	$9,152,346

(1) From U. S. Census.
(2) From Agricultural Commissioner of San Diego County.
(3) Areas included in crop classifications.
(4) Includes 12,328 acres of non-bearing trees.
(5) Includes 10,463 acres of non-bearing trees.

of America by Columbus. The bay was visited and named San Diego by Viscaino in 1602. The first settlement in California was made at San Diego in 1769 on the south bank of the San Diego River when the first mission in California was dedicated by Father Junipero Serra. A fort to furnish protection for the settlement was constructed by Spanish soldiers on Presidio Hill. The mission at San Luis Rey was founded in 1798 with a station established at Pala in 1815. From 1821 to 1846 the territory was under the Mexican flag.

San Diego County was founded in 1850, just after California became part of the United States and the City of San Diego incorporated in the same year. The increase in population and growth of the city was slow from this time until 1885 when the Atchinson, Topeka and Santa Fe Railway was completed. The boom years of 1886 to 1889 followed with the population of San Diego increasing from about 2,600 in 1880 to nearly 40,000 at the peak of the boom. While many of the inhabitants left with the collapse of the boom, the population in 1890 was over 16,000 an increase of six-fold in that decade. The increase in urban population was slight in the next ten years but since 1900 it has more than doubled in each ten year period so that the 1930 census returns show a total urban population in the county of 174,032. Since the United States Bureau of Census defines urban population as that residing in cities of 2,500 or more, the 1,050 population of the incorporated city of El Cajon has not been included in the total.

There are eight incorporated cities in San Diego County; Chula Vista, Coronado, El Cajon, Escondido, La Mesa, National City, Oceanside and San Diego. These cities cover an area of 127 square miles and had a total assessed valuation in 1933 of $115,613,000 or 68.7% of the total valuation of the county. The area, population, year of incorporation, assessed value in 1933 and population per acre for these incorporated cities are shown in Table 17.

TABLE 17

POPULATION AND ASSESSED VALUATION OF
INCORPORATED CITIES IN
SAN DIEGO COUNTY.

City	Area, in square miles	Population, U.S. Census 1930	Year incorporated	Assessed valuation, 1933	Population, per acre
Chula Vista	5.4	3,869	1911	$2,749,554	1.12
Coronado	1.6	5,425	1890	5,410,770	5.30
El Cajon	1.1	1,050	1913	439,850	1.49
Escondido	2.9	3,421	1888	1,313,467	1.84
La Mesa	3.2	2,513	1912	1,530,895	1.23
National City	4.6	7,301	1887	2,534,095	2.48
Oceanside	8.6	3,508	1888	2,449,927	0.64
San Diego	100.0	147,995	1850	99,184,445	2.31

Summary of Present Utilization.

Major water supply projects have been constructed on all the principal streams tributary to San Diego County with the exception of the Santa Margarita River. The total capital investment in all water supply projects in 1933 was valued at $33,627,000. Ten surface storage reservoirs having a capacity of 5,000 acre-feet or more have been constructed as well as a number of smaller ones. An area of more than 186,000 acres is included within the service areas of organized agencies, and a total area of approximately 48,000 acres were irrigated in 1933.

Approximately one-third of the 75,510 acre-feet of water used in San Diego County in 1933 for consumptive purposes was secured from underground sources, while about two-thirds was supplied from natural run-off or surface reservoirs. About thirty percent of the water was used for domestic and municipal purposes and about seventy per cent was utilized for irrigation.

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	IG-III	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

IG-III [illegible]

[illegible]

The largest water supply system is that of the City of San Diego which represented an investment of $21,365,000 on June 30, 1933. The system in addition to supplying the needs of the City of San Diego furnishes water for irrigation and domestic use outside the city limits and in 1933 supplied a total of 23,100 acre-feet. A summary of the data showing the present water supply development of San Diego County is presented in Table 18.

An estimate of the safe yield of the existing water supply development in San Diego County including both surface and underground supplies has been made and is shown in Table 19. The safe yield has been estimated on the basis of a full supply with no deficiencies. While it may not be considered necessary to limit the extent of the water supply for irrigation purposes to a one hundred percent supply throughout the most severe drought of record, it is probable that any supply not meeting these conditions will result in a much higher deficiency than planned in the last years of such a drought, due to the inability of the operating management of a system to reserve sufficient supplies to meet the demand after shortages begin to occur. For example should a drought period occur, it will be difficult to restrict the use of water while it is available in a reservoir, as it is reasonable to expect that the succeeding winter will produce run-off in sufficient quantity to relieve the emergency. The total safe yield of existing developments in the county including the recently completed El Capitan Reservoir amounts to approximately 79,000 acre-feet.

TABLE 18

PRESENT WATER SUPPLY DEVELOPMENT IN SAN DIEGO COUNTY

Agency	Gross water service area, in acres	Capital investment in water supply works, 1933	Area irrigated in 1933, in acres	Population served in 1933	Water supplied in 1933: Irrigation, in acre-feet	Domestic, in acre-feet	Total, in acre-feet
Irrigation districts	62,900	$3,826,000	13,900	15,600	13,520	1,940	15,460
Mutual water companies	27,000	1,053,000	10,300	3,800	10,130	--	10,130
Incorporated cities	71,400	21,729,000	600	167,000	720	17,930	18,650
Public utilities	23,300	3,168,000	3,200	24,700	3,980	2,450	6,430
Indian reservations	1,700	57,000	600	1,000	840	--	840
Private companies and individuals	24,200	3,794,000	19,300	14,200	23,300	800	24,100
Totals	210,500	$33,627,000	47,900	226,300	52,490	23,120	75,610

TABLE 19

ESTIMATED SAFE YIELD OF EXISTING WATER SUPPLY DEVELOPMENTS IN SAN DIEGO COUNTY.

Stream basin	Estimated safe yield, in acre-feet.
Santa Margarita River	1,600
San Luis Rey River	28,100
San Dieguito River	10,100
San Diego River	19,600
Sweetwater River	2,800
Otay River	4,200
Tia Juana River	12,600
Total	79,000

CHAPTER IV

WATER REQUIREMENTS

In San Diego County the uses of water include domestic, municipal, irrigation, power development and recreational, of which domestic, municipal and irrigation are of first importance. The use of water for power development and recreation is incidental to its use for either municipal or irrigation purposes. As San Diego County has a large urban population, the use of water for domestic and municipal purposes is large, and amounts to about 30 per cent of the total use of the county.

Irrigation water requirement is the amount of water in addition to rainfall that is required to bring a crop to maturity. This amount varies with the crop to be supplied and the point at which the water is measured. As related to the point of measurement, it is designated by the terms "gross allowance" and "net allowance". These items are defined as follows:

> "Gross allowance" designates the amount of water diverted at the source of supply.
>
> "Net allowance" designates the amount of water actually delivered to the area served.

The irrigation water requirements of California lands were studied several years ago and the results of the investigation published in a previous report.* Additional cooperative studies for certain crops have been carried on in San Diego County by the Division of Irrigation Investigations and Practice of the University of California and the results published.**

*Bulletin No. 6, "Irrigation Requirements of California Lands," Division of Engineering and Irrigation, 1923.

**Bulletin 489, "Irrigation Water Requirement Studies of Citrus and Avocado Trees in San Diego County, California, 1926 and 1927," University of California Experiment Station, 1930.

The investigations also covered the monthly distribution as well as the total seasonal amounts of water required. As the available water supply in San Diego County is limited and comparatively costly, efficient irrigation practices are used with a correspondingly low use of water. The average net allowance has been found to be 1.25 acre-feet per acre. It may be assumed from existing practice in the county that for all future developments of magnitude, conveyance and distribution conduits will be either lined conduits or pipe lines in order to minimize losses. Therefore, an average gross allowance of 1.30 acre-feet per acre has been assumed as the amount of water necessary to divert at the source of supply in order to deliver an average net allowance of 1.25 acre-feet per acre to the area served. The monthly distribution used in studies of San Diego River has been modified slightly from that shown in Bulletin 6 in accordance with monthly demands in that basin, and is shown in Chapter VI.

For domestic and municipal use, it has been shown in Chapter III that the City of San Diego's consumption of water per capita per day, has averaged about 115 gallons for the period of record 1900-1933. The average value of 115 gallons includes unmetered uses within the city limits and distribution system losses. This average value has been lowered by the falling off in per capita consumption in 1930. This may be due to the economic effect of the depression. In estimating future requirements a value of 120 gallons per capita per day has been used as the gross allowance of water to be diverted at the source of supply.

Estimated Maximum Safe Yield of Pacific Slope Basins in San Diego County.

In order to determine the adequacy of the local water resources to meet future water requirements, an estimate of the maximum safe yield that can be developed from the run-off of the stream basins of the Pacific slope tributary to San Diego County has been made. While in this investigation it has been possible to make a detailed study of the complete development of the

San Diego River basin only, by use of the relations between run-off, storage capacity and safe yield established on this stream, from the analyses of the safe yield of existing reservoirs in the county, and from available information on potential reservoir sites, an approximate estimate may be made of the amount of the mean annual run-off which may be conserved and regulated to furnish a reliable water supply, and of the storage capacity required to accomplish this.

In Chapter II, Table 8, an estimate of 302,050 acre-feet for the 46-year period 1887 to 1933, is given for the average full natural run-off of the Pacific slope basins tributary to the county. Of this amount 246,950 acre-feet originate in the principal stream basins above the lowest gaging stations while 55,100 acre-feet is the mean seasonal run-off of the minor basins.

San Diego County is especially fortunate in having a number of potential dam and reservoir sites for surface storage well distributed in all of the principal stream basins and in many of the minor basins. In Table 20, a list of potential surface reservoir sites is shown. Other sites may exist. While data is not available on all of these sites, many of them have been investigated by various agencies and sufficient information is at hand to show that the storage capacity required to regulate fully the run-off, may be secured. In this investigation, geologic examinations were made only of the dam sites of San Vicente, Mission Gorge No. 2 and Mission Gorge No. 3 reservoirs in the San Diego River basin. Therefore, the suitability of the dam sites of the other reservoirs shown in Table 20 is unknown, and geologic studies and explorations of them must be made before it can be definitely determined that satisfactory foundations exist at these sites. There are also undergound basins which may be utilized, and in many of the highland areas a sufficient depth of residuum or decomposed granite exists to afford some underground storage.

TABLE 20

POTENTIAL SURFACE STORAGE RESERVOIRS IN PRINCIPAL STREAM BASINS OF SAN DIEGO COUNTY

Stream basin and reservoir	Location of dam site (S.B.B.&M.) Section	Township	Range	Area of drainage basin, in square miles	Storage needed for complete conservation, in acre-feet	Existing capacity of major storage reservoirs, in acre-feet	Additional storage capacity needed, in acre-feet
SANTA MARGARITA RIVER					168,400		168,400
Nigger Canyon	10	8 S.	1 W.	321			
Railroad Canyon	24	6 S.	3 W.	593			
Fallbrook	12	9 S.	4 W.	645			
Deluz	32	9 S.	4 W.	710			
SAN LUIS REY RIVER					386,500	203,600	182,900
Monserate	6	10 S.	2 W.	377			
Bonsall	31	10 S.	3 W.	518			
Moosa Canyon	36	10 S.	3 W.				
SAN DIEGUITO RIVER					275,400	37,700	237,700
Sutherland	21	12 S.	2 E.	54			
Pamo	27	12 S.	1 E.	111			
Roden	31	12 S.	1 E.	128			
Santa Maria	11	13 S.	1 W.	60			
Hodges (1)	18	13 S.	2 W.	303			
SAN DIEGO RIVER					332,200	128,500(3)	203,700
Fletcher	2	14 S.	2 E.	68			
South Fork	1	15 S.	2 E.				
San Vicente	31	14 S.	1 E.	75			
Mission Gorge #2	25	15 S.	2 W.	380			
Mission Gorge #3	3	16 S.	2 W.	384			
SWEETWATER RIVER					122,800	29,100	93,700
Descanso	25	15 S.	3 E.	44			
Loveland	17	16 S.	2 E.				
OTAY CREEK					53,600	59,100(4)	---
TIA JUANA RIVER					287,100	108,700	178,400
Morena (1)	14	17 S.	4 E.	114			
Barrett (1)	22	17 S.	3 E.	249			
Marron	33	18 S.	2 E.	417(2)			

(1) Existing reservoir capacity may be increased by raising height of dam. (2) Area in United States. (3) Murray Reservoir 5885 acre-feet, considered as a regulating reservoir. (4) Water imported from Cottonwood drainage basin through Dulzura Conduit.

In the San Diego River Basin, as shown in Chapter VI, it has been found that 332,200 acre-feet of surface storage would give the maximum safe yield possible from the basin, which amount is 698 per cent of the average full natural run-off of the basin above the lowest surface reservoir site for the 46-year period 1887-1933. The capacity of the existing Henshaw Reservoir is 696 per cent of the average full natural run-off, 1887-1933, of that part of the San Luis Rey River Basin tributary to it. Analyses of Cottonwood Creek and San Dieguito River indicate that approximately this same relative amount of storage will completely regulate those streams. Therefore, 700 per cent of the average seasonal full natural run-off has been assumed as an approximate value of the storage capacity necessary to regulate fully the stream flow of San Diego County rivers. While this value will vary somewhat depending on the characteristics of the run-off of individual streams and with the efficiency of the particular surface reservoirs chosen, it is believed that it is a sufficiently close approximation to show the relation between the ultimate storage capacity required and the existing storage development on the streams in San Diego County. These values are shown in the sixth and seventh columns of Table 20, while in the eighth column the amount of additional storage required for complete conservation of the local water resources is given.

In the detailed studies of the San Diego River Basin it was found that with the adopted storage capacity a safe yield of 32,500 acre-feet could be obtained from the basin. This is 68 per cent of the average full natural run-off of the basin at Mission Gorge, the lowest reservoir site. This is a somewhat larger percentage than may be expected on the other streams due to the marked efficiency of the San Vicente reservoir site in saving evaporation losses. Analyses of several of the potential sites on the streams indicate that an average value of 60 per cent of the mean seasonal run-off may be possible of conservation with a storage capacity of 700 per cent or

seven times the mean seasonal run-off.

In the minor stream basins which drain only the lower slopes, less productive of run-off, and with more erratic stream flow characteristics, it is probable that even with coordinate operation with reservoirs on the principal streams a smaller amount of the run-off can be conserved and a value of 50 per cent of the mean seasonal run-off has been used.

The farthest downstream potential reservoir sites are located some distance inland from the Pacific Ocean. The run-off of those parts of the basins reaching the streams below these sites may be conserved through the use of underground storage, except such run-off as may drain either directly into the ocean or into the salt marshes at the mouths of the streams. Accordingly the estimated mean annual run-off as shown in Chapter II, has been divided into that originating above and below the lowest potential reservoir sites.

Table 21 has been compiled under these assumptions, the second column showing the area in square miles of the drainage basin above the lowest potential surface storage site, and the third column showing the mean seasonal run-off in acre-feet of the basin at that point. The fourth column shows the estimated total storage capacity required to regulate the run-off to secure the maximum safe yield and the fifth column the maximum safe yield that may be expected to be conserved. In the sixth, seventh and eighth columns the area of drainage basins in square miles below the farthest downstream potential surface storage site, the mean seasonal run-off in acre-feet for these areas and the safe yield from these run-offs that may be expected to be conserved through the use of underground basins naturally available are shown. For the principal streams the estimate of safe yield for the areas below the farthest downstream storage sites has been taken as twenty per cent of the mean seasonal run-off and for the minor basins ten

TABLE 21

ESTIMATED MAXIMUM SAFE YIELD FROM PACIFIC SLOPE BASINS TRIBUTARY TO SAN DIEGO COUNTY

Basin	By surface storage				By underground storage of run-off from tributary areas below surface storage sites			Total safe yield, in acre-feet per year
	Area of drainage basin, in square miles	Mean seasonal run-off, in acre-feet	Storage required, in acre-feet	Safe yield, in acre-feet per year	Area of drainage basin, in square miles	Mean seasonal run-off, in acre-feet	Safe yield, in acre-feet per year	
Principal Basins								
Santa Margarita River above Ysidora	710	24,050	168,400(2)	14,300(5)	33	2,190	440(9)	14,870
San Luis Rey River above Oceanside	518	55,210	386,500(2)	33,130(5)	47	3,370	670(9)	33,800
San Dieguito River above Del Mar	303	39,340	275,400(2)	23,600(5)	24	1,600	320(9)	23,920
San Diego River above Old Town	376	47,560	332,200(3)	32,500(3)	59	3,900	780(9)	33,280
Sweetwater River above Sweetwater Dam	181	17,540	122,800(2)	10,520(5)	-- (8)	--(8)	--(8)	10,520
Otay River above Lower Otay Dam	99	7,650	59,100(4)	3,860(6)	-- (8)	--(8)	--(8)	3,860
Tia Juana River above bridge near Nestor	417(1)	41,010(1)	287,100(2)	24,610(5)	44 (1)	3,530(1)	710(9)	25,320
Minor Basins								
San Mateo Creek to Aliso Creek	144	12,200	85,400(2)	6,100(7)	97	6,100	470(10)	6,570
Loma Alta Creek to Escondido Creek	126	9,300	65,100(2)	4,650(7)	89	5,100	350(10)	5,000
San Dieguito River to Tecolate Valley	70	5,500	38,500(2)	2,750(7)	108	6,300	490(10)	3,240
Switzer Canyon to Otay River	12	800	5,600(2)	400(7)	153	9,800	790(10)	1,190
Totals		259,760	1,826,100	156,550		42,290	5,020	161,570

(1) Run-off from area in United States only. (2) 700 per cent of mean seasonal run-off. (3) From analysis by months. (4) Existing storage. (5) 60 per cent of mean seasonal run-off. (6) From analysis by seasons. (7) 50 per cent of mean seasonal run-off. (8) Included in minor basins. (9) 20 per cent of mean seasonal run-off. (10) 10 per cent of conservable run-off.

per cent of the mean seasonal run-off not draining directly into salt marshes or the ocean.

In the tenth column, the estimated total safe yields for the various stream basins are shown and the total for the entire county amounts to approximately 160,000 acre-feet. No consideration has been taken of the economic feasibility or the cost of the physical works required to accomplish this degree of conservation. The total of 160,000 acre-feet is an approximate value which will be modified somewhat by detailed investigations of the separate stream basins. However, it is considered to be of sufficient accuracy to compare with the future water requirements and to show that the water supplies naturally tributary to San Diego County are deficient in amount to meet the future water requirements.

Agricultural Lands

Geology.- Practically the entire agricultural development of San Diego County lies on the Pacific slope. Geologically this area is divisible into two parts, the highland area made up of crystalline rocks, and the coastal plain made up of sedimentary rocks. The geology of this region has been described in Water-Supply Paper 446* as follows,

> "The area discussed in this report is divisible geologically into two provinces, one, comprising a region of crystalline rocks that extends from the eastern boundary of the area westward to the coastal section, practically coextensive with the highland area, and the other a region of sedimentary rocks that lies between the region of crystalline rocks and the ocean and is practically coextensive with the San Diego coastal belt. The boundary between these two provinces is a sinuous line roughly parallel to the coast at an average distance of about 15 miles inland. Throughout most of its length, and especially in the southern part of the area, where the edge of the crystalline rocks is marked by a range of mountains, the boundary is sharply defined by the abutment of the flat-lying sediments against steep walls of igneous rocks;

*Water-Supply Paper 446, "Geology and Ground Waters of the Western Part of San Diego County, California", United States Geological Survey, 1919.

but in most places, particularly in the northern part of the area, the sedimentary rocks overlap on the crystallines in such a way that the establishment of a boundary line between the two is more or less arbitrary. There are a few outlying masses of crystalline rocks in the sedimentary area and scattered deposits of unaltered sediments occur in the crystalline area. Slates, quartzites, and schists of sedimentary origin are present in the crystalline area, but are so intimately associated with the granites and felsites that they are regarded as elements of the crystalline complex."

Soils. Detailed soil surveys were made in 1929 and 1930 of the western part of San Diego County by the United States Department of Agriculture and the University of California Agricultural Experiment Station, which supplant a reconnoissance survey made by the same agencies in 1915. The detailed surveys are very complete and are mapped on a scale of one mile to the inch, showing occurrences of soils in areas as small as ten acres. A description of the classification and an evaluation of the soils has been summarized in Bulletin 552,* University of California Agricultural Experiment Station as follows;

"Grouping and Descriptions. Climatic factors such as precipitation, temperature, humidity, etc., have a marked effect on the soils of any region. The western part of San Diego County receives from 8 to 20 inches of rain, most of which falls during the winter months. The lowest amount is received along the coast and increases eastward. Winters are warm with little frost on the coastal plain, while the summer heat is considerably tempered by cool breezes from the ocean and occasional high fogs which intercept the sun's energy and reduce the heat and evaporation. Under these conditions vegetation grows freely during winter when the soils are covered with grass and herbage, but by midsummer these have dried up and the soil is dry and often bare. Under these climatic influences the rainfall does not penetrate deeply into the soil, most of it being used by the growing vegetation during the rainy season. The soils usually are leached only through the surface horizons, are low in organic matter, and prevailingly grayish brown, although there is a rather wide range in color.

"Differences in parent material, degree of weathering, method of formation, and lime content have all contributed their share to

*Bulletin 552, "The Classification and Evaluation of the Soils of Western San Diego County," University of California Agricultural Experiment Station, 1933.

the diversity of soils encountered. The soils of the highland area generally occur on rolling to mountainous topography where the composition of the parent material has considerable influence on the character of the resulting soils. These soils usually exhibit a youthful or only slightly weathered profile. Coarse crystalline rocks such as granite give sandy loam soil, while the denser rocks produce finer-textured heavier soils. Bedrock is usually encountered at a shallow depth under such conditions.

"The soils of the stream valleys consist of outwash from the upland region; they exhibit young or immature profiles and have a wide range in color and in lime and alkali content.

"The coastal plain soils have light to medium-textured surface horizons and heavy clay subsoils. Of these the Olivenhain, Tierra, and Las Flores series have a typical solonetz subsoil (horizon B), with the columnar structure and alkaline reaction in this horizon, while the Redding series have heavy-textured subsoils of distinctly acid reaction without the solonetz structure.

"In any system of soil classification a broader or more comprehensive idea can be had of the soils of a district if they can be grouped together on the basis of common characteristics, especially when these are correlated with common agricultural values. In the San Diego Reconnoissance Survey the soils are placed in three broad groups defined as (1) residual soils derived through the disintegration or weathering in place of consolidated rocks, (2) soils derived through the weathering and modification of old unconsolidated waterlaid deposits, and (3) recent alluvial soils.* In the detailed surveys of the Capistrano, Oceanside, and El Cajon areas, this scheme has been further elaborated to include four main groups of soils, namely: group I, primary or residual soils derived through the weathering in place of consolidated rocks with the development of soils having young or immature profiles and which usually have the bedrock or parent material occurring less than 6 feet from the surface; group II, unweathered secondary soils from alluvial material occurring in river valleys and on alluvial fans, without definite horizon development and more than 6 feet in depth; group III, slightly to moderately weathered secondary soils from alluvial or coastal plain materials having permeable subsoils and substratum to depths of 6 or more feet; group IV, weathered secondary soils from old alluvial or coastal plain materials having dense or relatively impermeable heavy clay subsoils or hardpan horizons formed as the natural result of soil weathering processes."

*Holmes, L. C. and R. L. Pendleton. Reconnoissance soil survey of the San Diego Region. Field Operations of the Bureau of Soils, 1915, 77p.

Soil Classification. An evaluation of the soil types has been made in Bulletin 552, from which the following description is quoted:

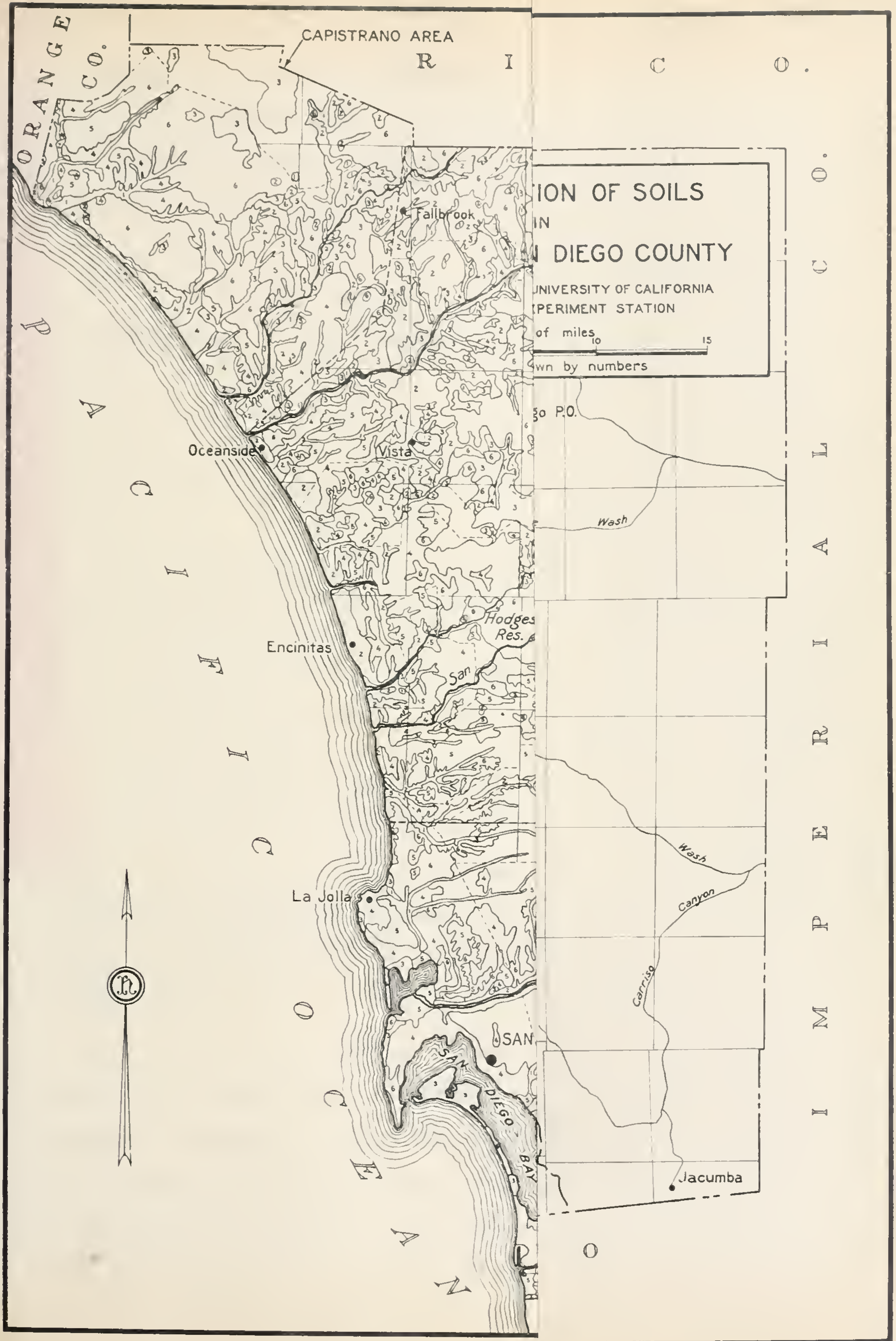
"Evaluation of the Soils.* * *, all the soil types of the El Cajon, Oceanside, and Capistrano areas have been arranged in a comparative rating on the basis of the degree to which they present conditions considered favorable for the growth of plants. Soils presenting the most favorable general conditions are given a rating of 100 per cent, and the other soils are rated in comparison. This soil rating, or index of soil value,* is based on the soil factor alone and does not include the effect of local climate, availability of water for irrigation, the locations, or other site factors that enter into land appraisals. In arriving at the 'index' or rating on the individual soil type, inherent soil characteristics are considered, such as the depth, texture, and density of the surface soil and subsoil, reactions, alkali content, and drainage conditions. The rating covers the entire area of each soil type as occurring in these surveys, and in applying it to an individual body of the soil on a farm, the index rating may have to be raised or lowered slightly because of local abnormal conditions.

"On the basis of this rating, the soils have been placed in six grades * * *, there being a range of about 20 index points within each grade except the last. This gives a considerable range in the index rating of the soils within each grade. Figures 17, 18, and 19 show the distribution of these grades in the areas. The soils of grade 1 are scattered irregularly throughout the region in small valleys. There is a narrow belt of soils of grade 2 along the coast bordering the broad band of grades 4 and 5 soils which occupy the mesa-like areas of old marine terraces along the coastal plain. Irregular-shaped bodies of the soils of grades 2 and 3 occupy the upland area between the mesas and the mountains, interspersed with large areas of grade 6 material. The last is nonagricultural because of its stony character and mountainous topography."

These groupings of soil grading were mapped and shown in Figures 17, 18, and 19 of Bulletin 552. The three areas in San Diego County shown on these plates have been combined into one map on Plate IX, "Classification of Soils in Western San Diego County".

The acreage of the various grades of soils are summarized in Table 22. These areas are gross acreages and include all waste land such as

*Storie, R. Earl. An index for rating the agricultural value of soils. Bulletin 556. University of California Agricultural Experiment Station.


CAPISTRANO AREA
ORANGE CO.
R I C O.
RIVERSIDE CO.
IMPERIAL CO.
PACIFIC OCEAN
ION OF SOILS
IN
N DIEGO COUNTY
UNIVERSITY OF CALIFORNIA
PERIMENT STATION
of miles 10 15
wn by numbers
Fallbrook
Oceanside
Vista
go P.O.
Wash
Hodges Res.
San
Encinitas
La Jolla
SAN
SAN DIEGO BAY
Wash
Canyon
Carriso
Jacumba


CLASSIFICATION OF SOILS IN WESTERN SAN DIEGO COUNTY
FROM BULLETIN 552, UNIVERSITY OF CALIFORNIA AGRICULTURE EXPERIMENT STATION
Scale of miles
0 5 10 15
Soil grades shown by numbers
RIVERSIDE CO.
ORANGE CO.
IMPERIAL CO.
PACIFIC OCEAN
MEXICO
CAPISTRANO AREA
OCEANSIDE AREA
EL CAJON AREA
Fallbrook
Oceanside
Vista
Escondido
Encinitas
La Jolla
SAN DIEGO
La Mesa
El Cajon
Lakeside
Ramona
Julian
Descanso
Borego P.O.
Campo
Jacumba
San Ysidro
San Luis Rey River
Henshaw Res.
Wohlford Res.
Hodges Res.
San Dieguito River
Santa Maria Cr.
San Vicente Cr.
San Diego River
El Capitan Res.
Boulder River
Cuyamaca Res.
Murray Res.
Sweetwater Res.
Sweetwater
Upper Otay Res.
Lower Otay Res.
Barrett Res.
Cottonwood Cr.
Morena Res.
Campo Cr.
San Felipe Wash
Vallecito Wash
Carriso Canyon
PACIFIC SLOPE
GREAT BASIN
BASINS DIVIDE
DIVIDE
San Diego Bay

roads, farmsteads, stream channels and natural drains, etc. Based on the experience in other irrigated areas, it is estimated that not over 90 per cent of the gross area of grade 1 soils will require water, 85 per cent for grade 2, and 80 per cent for grade 3.

TABLE 22

CLASSIFICATION OF LANDS OF WESTERN SAN DIEGO COUNTY

Soil area	Gross area, in acres						
	Soil grade						Total all grades
	1	2	3	4	5	6	
Capistrano	11,960	17,718	21,734	31,721	16,218	77,640	176,991
Oceanside	26,624	70,813	56,981	59,038	42,944	112,960	369,360
El Cajon	18,895	9,820	39,838	117,761	97,920	120,896	405,130
Totals	57,479	98,351	118,553	208,520	157,082	311,496	951,481

Note:- Areas of grades 1, 2 and 3 lands and "Total all grades" are from Bulletin No. 46, Division of Water Resources. Areas of grades 4, 5 and 6 are compiled from United States Department of Agriculture, Bureau of Chemistry and Soils, Bulletins No. 11 and No. 19, Series 1929, and No. 15, Series 1930, using comparative ratings shown in Bulletin 552, University of California, College of Agriculture.

The area covered by the recent detailed soil surveys includes practically all of the agricultural lands except those located in some of the highlands or mountain valleys. However, these valleys were included in the reconnoissance soil survey of 1915, which gives an excellent guide to the general soil conditions. These lands are at higher elevations and for the most part have more abundant rainfall with correspondingly

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less need for irrigation. Certain crops are successfully grown without irrigation, although, the climate of these higher elevations does not permit growing as wide a variety of crops as on the coastal plain. The areas of good soils lie in comparatively small tracts and will probably not warrant any extensive irrigation development. Only a very small area of these lands has been developed at the present time. It has been estimated that a net area of 10,000 acrea of irrigable lands lie in these mountain valleys.

While some grade 4 lands in the county have been developed successfully, it is considered that their character does not justify any extensive development for water for irrigation purposes. Municipal development will cover some of both grade 4 and grade 5 soils, but the total amount of water used primarily for irrigation on these soils will not be large. In view of the relatively large area of better soils in comparison with the available water resources, no allowance has been made for the use of water on grades 4 and 5 soils for irrigation.

The areas of net irrigable lands are shown in Table 23 together with the ultimate water requirements for irrigation use.

Future Development of Irrigable Lands - Many factors favorable to the increased use through irrigation of the large undeveloped area of excellent soils remaining in San Diego County exist. The area of practically frost land offers the opportunity for increased production of many semi-tropical fruits. The increasing urban population affords a growing local market for all types of agricultural products. The long growing season, year round in many localities, makes it possible to produce many varieties of vegetables that may be marketed during the winter and early spring when crops are either dormant or just being planted in many other parts of the country. There is a large area of good soils within the water service areas of existing organized agencies which may be developed.

TABLE 23

NET AREA AND ULTIMATE SEASONAL WATER REQUIREMENTS
FOR IRRIGABLE LANDS IN SAN DIEGO COUNTY

Soil area	Net irrigable area, in acres				Average gross allowance, in acre-feet per acre	Seasonal water requirements, in acre-feet
	Soil grade			Total		
	1	2	3			
Capistrano	10,764	15,060	17,387	43,211	1.30	56,174
Oceanside	27,962	60,191	45,585	129,738	1.30	168,659
El Cajon	17,006	8,347	31,870	57,223	1.30	74,390
Highland valleys	-----	-----	-----	10,000*	1.30	13,000
Totals	51,732	83,598	94,842	240,172	---	312,223

*Estimated from "Reconnoissance Soil Survey of the San Diego Region, California," United States Department of Agriculture, 1915.

Other factors which may retard development are also present. The scarcity of additional water supplies that may be cheaply developed, will tend to prevent a rapid increase in irrigated lands. The City of San Diego has acquired water supplies from Cottonwood Creek, Otay River, San Diego River, and San Dieguito River for municipal use and the future development of these sources may be, for the most part, for this purpose rather than for irrigation.

The irrigation development has progressed at a rather uniform rate since 1888 when the first large water supply works were constructed. The growth has been shown in Chapter III, Table 14 and is shown graphically on the upper diagram of Plate X, "Water Requirements of San Diego County with Assumed Rates of Future Growth." While little if any increase in area occurred during the decade between 1910 and 1920, the formation of several irrigation districts in the decade between 1920 and 1930 and the resulting development

brought the growth up to the average rate for the twenty years, 1890 to 1910. After consideration of the various factors involved, the average rate of growth from 1890 to 1930 has been projected forward from 1930 to 1980, and the values obtained are believed to be reasonable estimates for the purpose of setting forth future irrigation water requirements. The average rate of growth from 1890 to 1930 has been approximately 9,000 acres per decade. Projecting this rate of growth into the future gives an area of 54,000 acres for 1940; 63,000 acres for 1950; 72,000 acres for 1960; 81,000 acres for 1970; and 90,000 acres for 1980.

Population of Urban Areas.

Urban population as defined by the United States Bureau of Census, is in general that residing in cities or other incorporated places having 2,500 inhabitants or more. For use in connection with the 1930 census, the definition of urban territory has been slightly modified and extended, but this change does not affect San Diego County. Under this definition, seven of the eight incorporated cities in San Diego County are classified as urban areas.

The cities of Oceanside and Escondido and the towns along the coast are situated where their future growth will probably occur on lands classified as irrigable. At present the average use of water within the developed portion of the City of San Diego is about 1.06 acre-feet per acre, and for the City of Coronado, about 0.98 acre-feet per acre, while in the City of Oceanside with more irrigated land within the developed area the use is somewhat larger. With future growth the density of the population and use of water will increase due to the building up of the vacant areas, and the irrigation average net allowance of 1.25 acre feet per acre will probably be reached. For this reason, the future water requirements of Oceanside,

Escondido and other residential areas in the northern part of the county, whose future growth will be for the most part on irrigable lands, may be considered as included in the future irrigation water requirements of the county.

In the metropolitan area of San Diego and environs almost the entire urban development has been made on soils which have been classified as grades 4 and 5. The growth in population in this metropolitan area has been much greater than that of other parts of the county, as is shown in the last line of Table 24 which tabulates the growth of population of incorporated cities in the metropolitan area, and gives the percentage of the inhabitants of the county living in these cities. The City of El Cajon has been included in this table as its water supply is secured from the same source as the City of La Mesa, although it is not classed as urban by the census definition.

Future Growth of Population- The region surrounding the metropolitan area consists for the most part of grades 4 and 5 soils, which while of low rating for agricultural purposes, because of their location, topography, climate and other advantageous factors are of high value for residential and other urban purposes. Due to the concentration of population in the metropolitan area and the types of soil therein, the estimate of future water requirements for this area has been made on the basis of future growth in population rather than on area of land.

It should be understood that the estimates of future growth of population and of irrigated lands have been made for the purpose of showing that the ultimate development of San Diego County is definitely limited unless the local water supply of the county is augmented by importation of water from other sources. The rates of future growth of population and of irrigation development are dependent upon many factors, some of which are known and their effect estimated with reasonable precision, while many others

TABLE 24

GROWTH IN POPULATION OF INCORPORATED CITIES

IN METROPOLITAN AREA

City	1860	1870	1880	1890	1900	1910	1920	1930
San Diego	731	2,300	2,637	16,159	17,700	39,578	74,361	147,995
National City			248	1,353	1,086	1,733	3,116	7,301
Coronado					935	1,477	3,289	5,425
Chula Vista							1,718	3,869
La Mesa							1,004	2,513
El Cajon							469	1,050
East San Diego							4,148	
Totals	731	2,300	2,885	17,512	19,721	42,788	88,105	168,153
San Diego County	4,324	4,951	8,618	34,987	35,090	61,665	112,248	209,659
Per cent of county population in metropolitan area	16.9	46.5	33.5	50.1	56.2	69.4	78.5	80.2

are unknown or difficult to evaluate accurately. Consequently, these estimates are not presented as a prophesy or prediction of what the future growth in population may be, but to show that, without consideration of cost or economic feasibility, if the irrigation development and utilization of water continues until about 1965 at the same rate of increase as it has since 1890, only sufficient local water supplies can be developed for municipal and domestic purposes to support a population of less than 500,000 in the metropolitan area. Increase of irrigation development at a greater rate than that estimated

would further limit the population growth, as might the factors of cost and economic feasibility of the complete development of the local water resources.

In estimating the future growth of population, the past growth of many larger cities in the United States has been considered. However, due to large movement of population from the rural areas to the cities in recent years and a reversal of this movement during the present period of economic depression, it is thought that a more reasonable basis of estimate may be secured by using an estimate of the future growth of population of the State, which has been made in a previous report* and covered the period from 1930 to 1970. In that report a detailed analysis of the factors entering into the population growth of the State of California has been made and from that study four estimates of future population are given showing limits of future growth. Those estimates have been designated as "Extreme lower limit", "Reasonable lower limit", "Reasonable upper limit", and "Extreme upper limit", giving for 1970 - 11,100,000, - 16,900,000 - 20,300,000, and 26,300,000 for the respective estimates. In estimating the future growth in population in the metropolitan area of San Diego, the estimate designated as "Reasonable lower limit", has been adopted as a base, and estimates made for the County of San Diego, and the metropolitan area. These estimates are given in Table 25 and the estimate for the metropolitan area shown graphically on the upper diagram of Plate X.

As may be noted in the third column in Table 25 the percentage of population of the State living in San Diego County has increased since 1900 from 2.4 per cent in that year to 3.7 per cent in 1930. This trend has been disregarded and the 1930 ratio of 3.7 per cent used in estimating the future growth. The percentage of inhabitants of the county living in the

*Bulletin No. 35, "Permissible Economic Rate of Irrigation Development in California", Division of Water Resources, 1930.

TABLE 25

ESTIMATED PAST AND FUTURE IRRIGATION AND
METROPOLITAN AREA WATER REQUIREMENTS OF SAN DIEGO COUNTY

Year	Past and estimated future population				Annual municipal requirements of metropolitan area, in acre-feet.	Past and estimated future net area of irrigated lands, in acres	Annual gross allowance, in acre-feet	Total annual water requirements,	
	State of California	County in per cent of State	San Diego County	Metropolitan area				In acre-feet	In millions of gallons per day
1880	864,694	1.0	8,618	2,885	400	----	----	400	0.4
1890	1,213,398	2.9	34,987	17,512	2,400	9,000	11,700	14,100	12.6
1900	1,485,053	2.4	35,090	19,721	2,700	17,000	22,100	24,800	22.1
1910	2,377,549	2.6	61,665	42,798	5,800	23,000	29,900	35,700	31.9
1920	3,426,861	3.3	112,248	88,105	11,800	28,000	36,400	48,200	43.0
1930	5,677,251	3.7	209,659	168,153	22,600	44,000	57,200	79,800	71.2
1940	8,520,000	3.7	315,000	252,000	33,900	54,000	70,200	104,100	92.9
1950	11,630,000	3.7	430,000	344,000	46,200	63,000	81,900	128,100	114.4
1960	14,520,000	3.7	537,000	430,000	57,800	72,000	93,600	151,400	135.2
1970	16,900,000	3.7	625,000	500,000	67,200	81,000	105,300	172,500	154.0
1980	18,600,000	3.7	688,000	550,000	73,900	90,000	117,000	190,900	170.4

Note: The data presented in this table are for the purpose of showing that the ultimate water requirements for irrigation and municipal use exceed 160,000 acre-feet, the estimated safe yield of the local water resources of the county. It is not presented as a prediction of the future growth of irrigated lands or population.

metropolitan area, as shown in Table 24, has increased from 16.9 per cent in 1860 to 80.2 per cent in 1930. This trend also has been disregarded and the future population of the metropolitan area assumed to be 80 per cent of the county. These factors of 3.7 per cent of the State and 80 per cent of the county have been applied directly to the "Reasonable lower limit" estimate of Bulletin No. 35 in the fifth column of Table 25 and give an estimated metropolitan population of 252,000 in 1940, 344,000 in 1950 - 430,000 in 1960 - 500,000 in 1970 and 550,000 in 1980. The estimate for the State for the year 1980 has been secured by an extension of 1940 to 1970 estimates of Bulletin No. 35.

Estimated Future Water Requirements.

The estimates of growth of future irrigation development and of population in the metropolitan area have been made as a basis for determining future water requirements. A comparison is made between the future water requirements and the local water supplies which are possible of development in order to show that there is a large deficiency in local supplies and that if San Diego County is to continue to develop its resources and to increase its population, it must secure and import water from other sources.

As has been shown in Table 23 the ultimate water requirements for all irrigable lands in San Diego County amount to about 310,000 acre-feet. The favorable living conditions and many other favorable factors afford the opportunity for continued growth in urban population with resultant large water requirements. With a maximum safe yield of approximately 160,000 acre-feet possible of development from the local drainage basins, the ultimate deficiency of local water supplies amounts to 150,000 acre-feet without consideration of the municipal requirements of the metropolitan area.

Looking into the immediate future, however, the water requirements

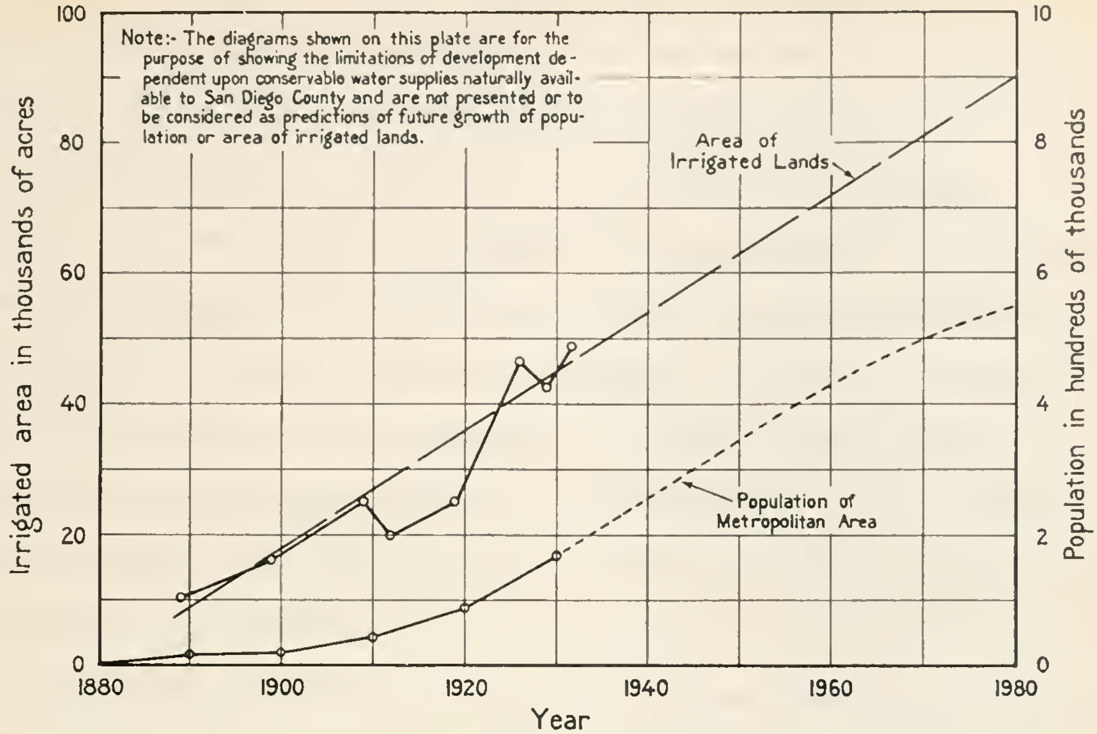
have been computed on the basis of the estimated growth in irrigation development using an average gross allowance of 1.30 acre-feet per acre and of the estimated growth in population of the metropolitan area using 120 gallons per capita per day for municipal purposes in this area.

With these unit values, and with the estimated future areas of irrigated lands and estimated future population of the metropolitan area the future water requirements have been determined and are shown in columns six and eight of Table 25 and the combined totals shown in acre-feet in column ten and in millions of gallons per day in column eleven for each ten years from 1940 to 1980. The values in acre-feet are also shown graphically on Plate X.

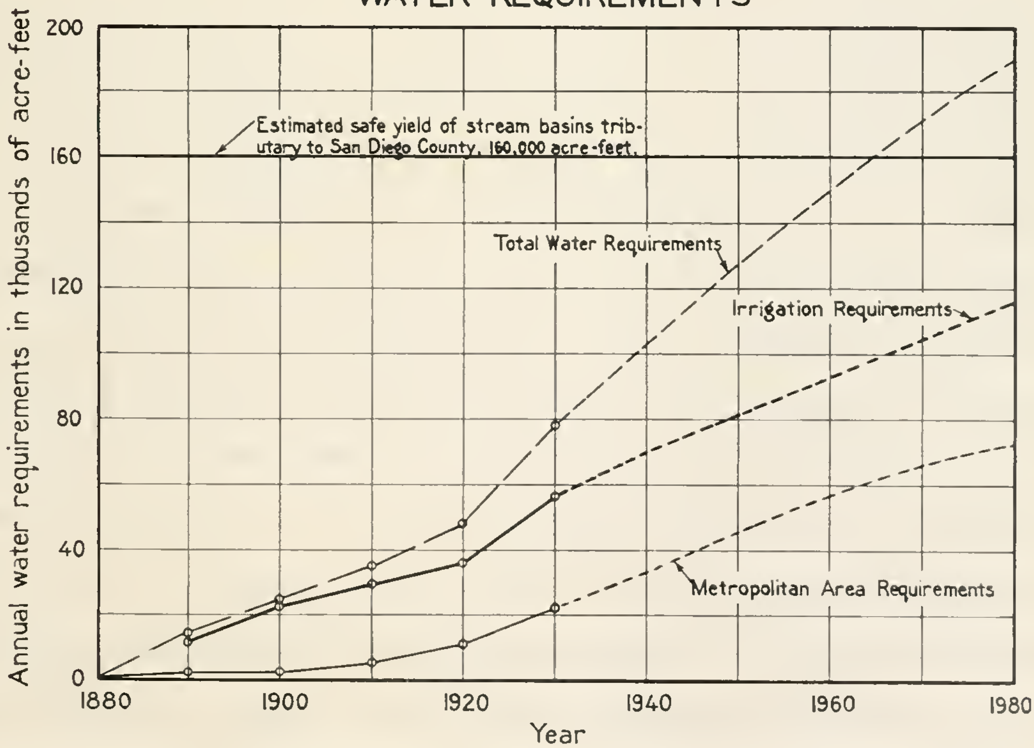
As the maximum annual safe yield from the Pacific slope basins of San Diego County has been estimated to be 160,000 acre-feet, it will be seen that to meet the future water requirements, full development of the local water resources must be accomplished by some time in the decade 1960 to 1970, if the growth of irrigation development and population is to proceed at the estimated rates, or earlier if these rates are exceeded. This may also be presented without consideration of the future rate of growth. In 1933, almost one half of the ultimate development and utilization of the local water resources has occurred. The limit of growth possible without importations of water is approximately twice the present development if the 1933 ratio of irrigation and population is maintained, or as approximately the same amount of water is required per acre for either irrigation or domestic use, the complete development of the local water resources will furnish a supply sufficient for a total area of about 125,000 acres.

As has been shown in Chapter II large seasonal and cyclic varriations occur in the run-off of San Diego County streams. To regulate run-off having such wide fluctuations and secure a dependable water supply therefrom,

NET IRRIGATED LANDS AND POPULATION



WATER REQUIREMENTS



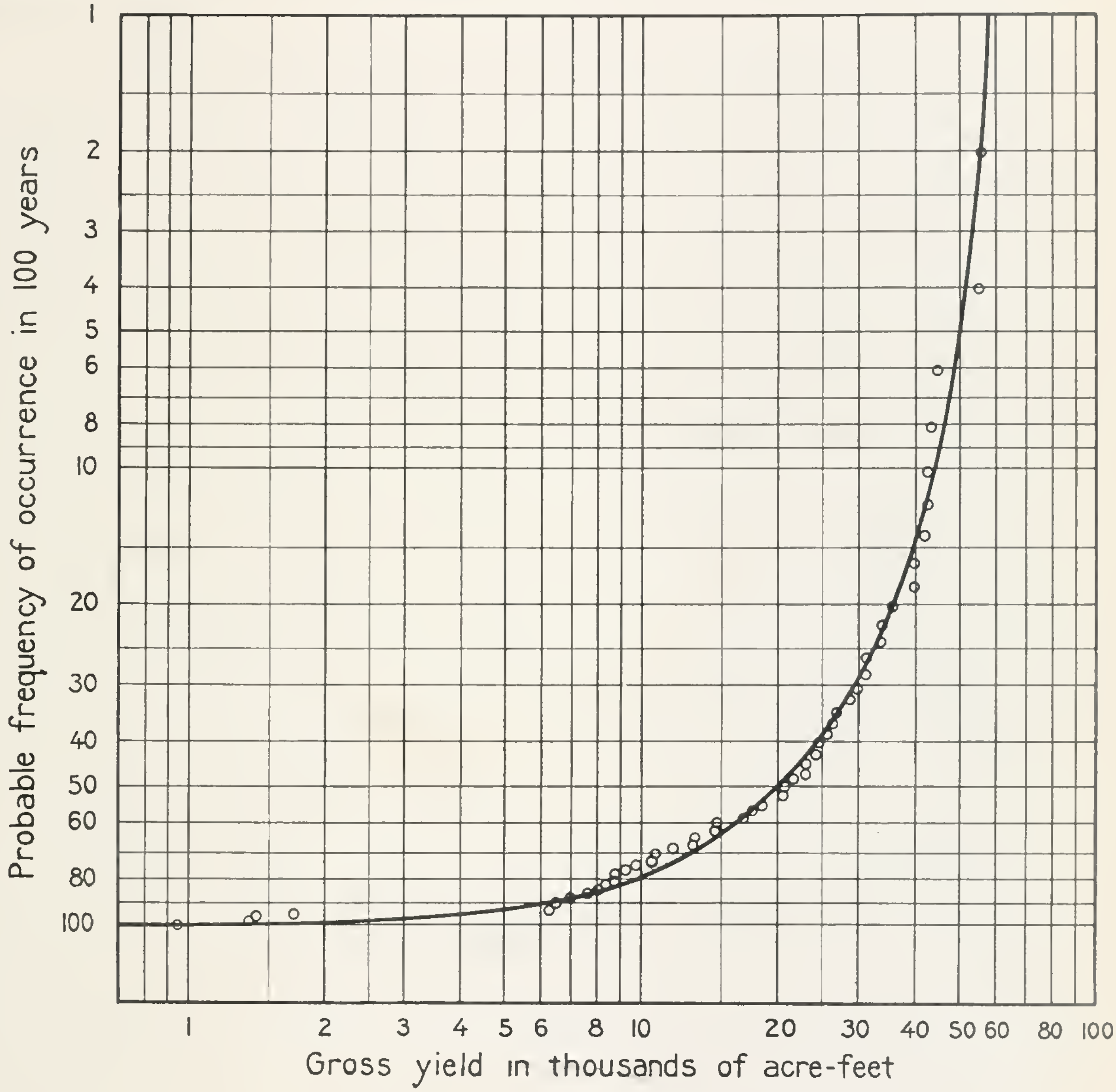
WATER REQUIREMENTS OF SAN DIEGO COUNTY

WITH

ASSUMED RATE OF FUTURE GROWTH

reservoirs are required of relatively large storage capacity. These must be constructed sufficiently far in advance of the time the water will be needed to store the waters of the wet years for use in the years of low flow. This is well illustrated by the extreme length and severity of the drought of 1897 to 1904. To have maintained a dependable supply throughout this period under complete development of the streams would have required the construction of reservoirs in time to begin storing water in the season of 1883-84 or twelve years previous to the beginning of the drought. While this is the longest and most severe drought of record in San Diego County, the rainfall records which began in 1850 indicate previous droughts of shorter length but of approximately equal severity.

A study has been made to estimate the average length of time that will elapse after the construction of surface storage for full development of the San Diego River before the estimated safe yield may be obtained and the data presented on Plate XI, "Probable Frequency of Gross Yield of San Diego River." Assuming the same surface storage reservoir capacity, 332,200 acre-feet, as shown in Chapter VI for the full development of the San Diego River to have been put in operation in each year of the 50-year period 1883 - 1933, the gross yield for that year would be the total amount of water including both draft and evaporation that could be secured in all subsequent years of the period of record. It was assumed in this study that all reservoirs would be empty when placed in operation, that three dry seasons would follow the 1932-1933 season, and that all reservoirs would be empty in 1936. The annual gross yield of the San Diego River at Mission Gorge for each year of the 50-year period 1883 to 1933 was obtained from a mass diagram based on storage capacity and flow into reservoirs shown in Table 34, Chapter VI, 1894 to 1933 and similar values for the period 1883-1894 obtained by modifying values of run-off shown in Table A-1, Appendix "A". These gross yields have been arranged in order of magnitude and their



PROBABLE FREQUENCY OF GROSS YIELD
OF
SAN DIEGO RIVER

frequency of occurrence in 100 years determined using the method described in Chapter V under "Mean Daily Flood Flows." They have been plotted on double logarithmic paper on Plate XI and a smooth curve interpreting the trend drawn through the points.

In Chapter VI, Table 34, the estimated annual safe yield of the San Diego River for full development has been shown to be 32,500 acre-feet and the average seasonal evaporation from reservoirs during the period 1894-1933 to be 9,400 acre-feet. Assuming that this average value of evaporation would obtain over the 50-year period 1883-1933, the annual gross yield necessary to produce a annual safe yield of 32,500 acre-feet would be 41,900 acre-feet. Entering the diagram with this value, it is found that this gross yield may be expected to occur 12.3 times in 100 years on the average, or approximately every eight years. Therefore, it would appear that the full safe yield of the complete development may not be secured until eight years on the average after the storage reservoirs have been completed and put into operation. For partial development the full safe yield may be expected to be secured in a shorter time on the average.

As other streams in the county have similar characteristics, similar studies on them would probably show about the same average period. These erratic characteristics of stream flow require that the future needs must be anticipated many years ahead, adequate development made and sufficient water carried in storage to meet these needs, if a serious water shortage with resultant large economic loss and retardation of the natural growth of the county is to be prevented at some future date.

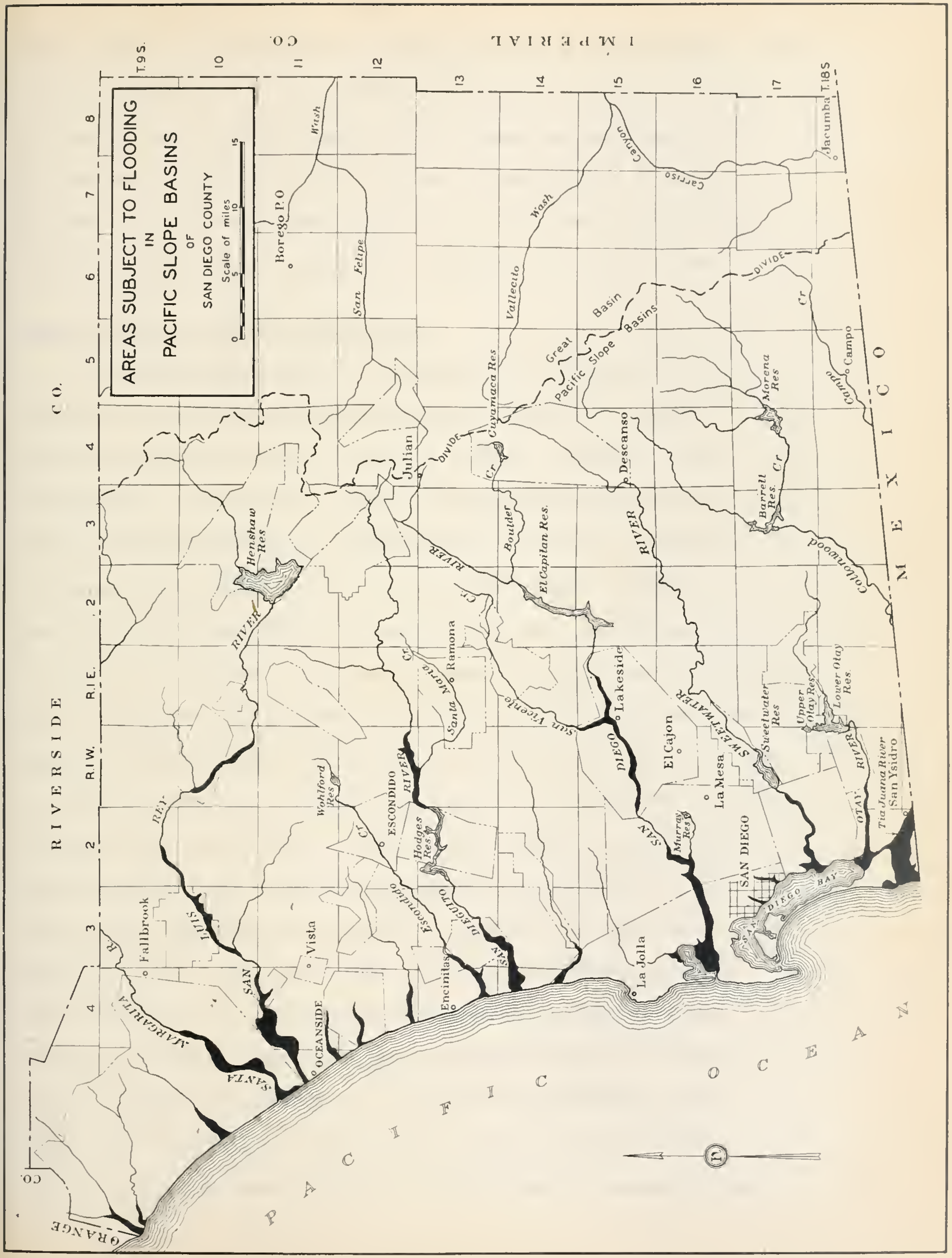
CHAPTER V

FLOOD CONTROL

The major and minor streams of San Diego County are for the most part deeply entrenched in the terraces of the coastal belt. The valleys vary in width from a few hundred feet to nearly two miles. Their floors are flat transversely with fairly steep stream bed gradients, and are bordered by steep slopes or bluffs several hundred feet high. With the exception of the delta of the San Diego River between Mission and San Diego bays, the debris cones are small. The existing stream channels are shallow with poorly defined banks and are capable of carrying only the smaller floods. In times of major floods, practically the entire valley floors are under water. Although the areas subject to damage by floods comprise but a small portion of the total area of San Diego County, they do include a large acreage of good agricultural soils, which are well adapted to raising of field crops, vegetables and dairying. The areas subject to flooding are shown on Plate XII, "Areas Subject to Flooding in San Diego County."

The flood of 1916 caused a great amount of damage in the river valleys and to lines of communication in and crossing these valleys. It has been estimated* that the total damage from this flood in San Diego County amounted to more than $4,000,000, of which $1,500,000 was estimated as the value of the agricultural lands destroyed. From the experience of this flood, many lines of communication have been revised as to location and greater channel capacity has been constructed under bridges. Until recently few residences have been reconstructed in

*United States Geological Survey, Water-Supply Paper 426- "Southern California Floods of January, 1916," by H. D. McGlashan and F. C. Ebert.


AREAS SUBJECT TO FLOODING
IN
PACIFIC SLOPE BASINS
OF
SAN DIEGO COUNTY
Scale of miles
0 5 10 15
RIVERSIDE CO.
IMPERIAL CO.
ORANGE CO.
MEXICO
PACIFIC OCEAN
Pacific Slope Basins
Great Basin
DIVIDE
Fallbrook
Vista
OCEANSIDE
Encinitas
ESCONDIDO
La Jolla
SAN DIEGO
La Mesa
El Cajon
Lakeside
Ramona
Julian
Descanso
Campo
Jacumba
San Ysidro
Borego P.O.
Henshaw Res
Wohlford Res
Hodges Res
Murray Res
El Capitan Res.
Cuyamaca Res
Sweetwater Res
Upper Otay Res
Lower Otay Res.
Morena Res
Barrett Res.
SANTA MARGARITA
SAN LUIS REY RIVER
SAN DIEGUITO
SAN DIEGO RIVER
SWEETWATER RIVER
OTAY RIVER
Tia Juana River
SAN DIEGO BAY
Escondido Cr.
Santa Maria Cr.
San Vicente
Boulder Cr.
Cottonwood Cr.
Campo Cr.
Vallecito Wash
San Felipe Wash
Carrizo Canyon
T.9S.
T.18S
R.1W.
R.1E.

valley floors in areas below the flood plane and very few permanent crops have been planted. At the present time, however, residences are again encroaching on the flood plane in the Tia Juana and San Diego River valleys and in some of the other valleys permanent crops are being planted. In the urban areas, many of the minor stream channels have been encroached on and are liable to inundation in a major flood.

History of Floods in San Diego County.

Although the history of San Diego County begins with the founding of the Mission San Diego de Alcala in 1769, no records of stream flow were kept and but little is known of the flows in the streams prior to the period of water development which began about 1887 when the Sweetwater and Cuyamaca reservoirs were built. The only data available prior to this time consist of the old Mission records of crop production and notes of stream flow and channel conditions in the diaries of the Mission Fathers and other early travelers and in later years the testimony of early settlers. These have been analysed by H. B. Lynch in a report to the Metropolitan Water District of Southern California entitled, "Rainfall and Stream Run-off in Southern California since 1769." He states that a study of these early records indicates that floods occurred in the following years: 1770, 1771, 1772, 1776, 1780, 1811, 1815, 1817, 1825, 1834, 1840, 1842, 1850, 1852, 1853, 1860, 1862, 1867, 1868, 1874, 1876 and 1884. Of these floods, that of 1825 caused the change in the course of the Santa Ana River from its old outlet in Alamitos Bay to its present outlet near Newport andof the San Diego River from Mission to San Diego Bay. The flood of 1862, however, is said to have been the largest on the San Diego River at San Diego within the memory of any

of the inhabitants then living. Since 1888 there have been many minor floods in San Diego County but only two major floods, those of January 1916 and February 1927. Although these two floods were of about the same size in many of the mountain areas, that of January 1916 seems to have been generally larger in the foothill areas and at the mouths of the streams.

The Mission dam and the conduit leading to the San Diego Mission were probably built some time in the period 1813-15 and were probably maintained in efficient condition until about 1833 when the missions were secularized and the mission organization was destroyed. In 1845 the San Diego Mission had been abandoned and many of the mission buildings had already collapsed. The buttress on the left end of the dam indicates that at some time in the period 1813-1833, possibly in 1825, the left abutment of the dam may have been washed out and replaced by a wall to the nearest exposed rock somewhat downstream from the main axis of the dam. Observers about 1870 state that at this time the left abutment had again been destroyed. Photographs of the dam taken prior to the flood of 1916 show that at that time it was heavily overgrown with willows, most of which were torn out by this flood which also destroyed additional portions of the left abutment of the dam and many sections of the conduit which had survived until that time. The flood of 1862 is said to have been higher than that of 1916, in the vicinity of Foster and Lakeside, and to have flooded houses at Old Town, San Diego. On the San Luis Rey River, however, the flood of 1916 which destroyed an old mission ditch which had survived the flood of 1862 is said to have been higher than that flood. In comparing these two floods, it should be noted that minor floods are said to have occurred with reasonable

regularity prior to 1862 and that, at that time the stream channels were probably in a fairly clean condition, whereas in 1916, with the exception of one moderate flood in 1906, there had been no flood of appreciable size since 1895, and that the stream channels, therefore, were probably heavily overgrown with trees and brush as is witnessed by the overgrown condition of the San Diego Mission Dam in 1916.

From the available data, it seems probable that in the 165 years since the first settlement was established in 1769 there have been at least four major floods, those of 1862, 1916, 1825 and 1927, with a possible fifth having occurred in 1780. It would seem, therefore, that major floods of a destructive magnitude may be expected to occur about once in from 30 to 40 years on the average.

Characteristics of Flood Occurrence.

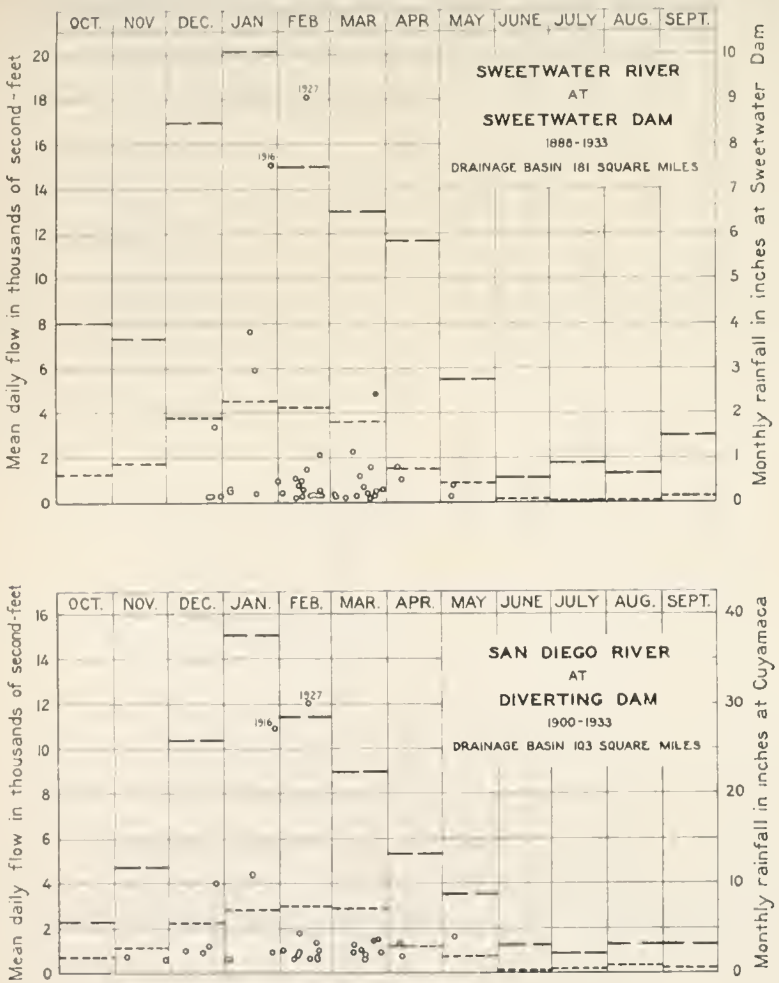
A discussion of the general types and characteristics of the storms which bring precipitation to San Diego County has been given in Chapter II. In this discussion it was pointed out that even in the higher areas only a small percentage of the precipitation occurred as snow and that this snowfall had but little effect on the stream run-off. There are no records extant which indicate that any flows of appreciable magnitude have resulted from the melting of snow without coincident rainfall. Floods in San Diego County are the result of, and occur coincidently with excessive precipitation in the form of rain.

Time of Occurrence of Flood Flows - On Plate XIII, "Time of Occurrence of Floods on Two Streams In San Diego County," the maximum mean daily flood flows of the 45 largest floods of record in the period 1888-1933 on the Sweetwater River at the Sweetwater Dam and of the 33 largest floods of record in the period 1900-1933 on the San Diego River at Diverting Dam have been plotted against the date

of their occurrence together with the mean and maximum monthly rainfalls at the Sweetwater and Cuyamaca Dams respectively. An inspection of these graphs indicates the extreme seasonal occurrence of rainfall floods in San Diego County. No floods have occurred prior to the first of November or after the middle of May and no floods of appreciable magnitude have occurred prior to the 15th of December or after the 1st of April. The mean monthly rainfalls during the months from December to March are at least twice the mean for any other month of the year and the maximum monthly rainfalls for the months of December, January and February are at least twice as large as those for any other month excepting March and April.

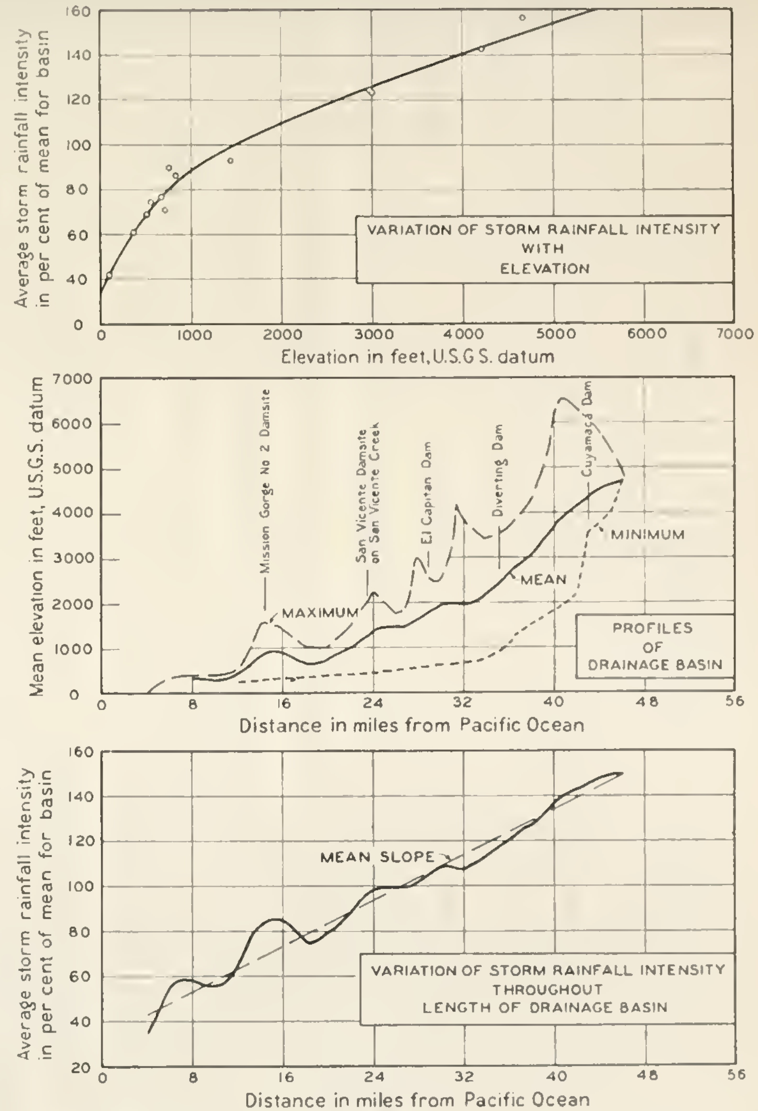
The graphs also illustrate the wide variation in the sizes of the floods which may be expected to occur. It will be noted that the large majority of the floods are relatively small and unimportant but that twice, in the 45 years of record, floods have occurred which were far larger than any of the others. On the Sweetwater River the smaller of the two major floods was 1.9 times as large as the largest of the minor floods and on the San Diego River 2.5 times as large. The first of these floods occurred in 1916, about thirty years after stream flow records were first kept in San Diego County and 54 years after the last traditional major flood. The second of the recorded major floods occurred in 1927, only eleven years later.

Variation of Intensities of Flood Flows - The Pacific slope drainage basins of the Peninsula Range in San Diego County rise from sea level to elevations of from 4000 to 6000 feet in an air line distance of from 40 to 60 miles. The intensities of storm rainfall vary considerably in the various parts of the drainage basins. Records of the daily rainfall at most of the precipitation stations shown on Plate I and listed



TIME OF OCCURRENCE OF FLOODS
ON
TWO STREAMS IN SAN DIEGO COUNTY

° Mean daily flow
------ Mean monthly rainfall.
— — Maximum monthly rainfall



VARIATION OF STORM RAINFALL INTENSITY
IN
SAN DIEGO RIVER DRAINAGE BASIN
BASED ON TEN TWO-DAY PERIODS
1914-1917

in Table 2 are available for periods of from one to over 50 years in length.

A detailed analysis of the variations in the storm intensities of precipitation has been made for the San Diego River Basin. This analysis has been based on the records of daily rainfall at thirteen stations in or close to the San Diego River drainage basin. Since the records at some of the stations were taken in the morning and at others in the evening, two-day rainfalls were used in the analyses. Thus, the storm rainfall intensities compared represent the rainfall during the same thirty-six hour period at all stations with the addition of the rainfall during a period of from 6 to 12 hours, either before or after the coincident period at individual stations. Since the period of record at three of the stations used only covered the seasons 1914-1917, this period of record has been used in the analyses. The analyses, based on the ten largest two-day rainfalls during the period of record, are shown on Plate XIV, "Variation in Storm Rainfall Intensities in San Diego River Drainage Basin based on Ten Two-day Periods 1914-1917." The upper graph on this plate indicates the variation of storm intensity expressed in percentage of the mean intensity of the drainage basin, with elevation. These data are also given in tabular form in Table 26. The middle graph shows the profiles of the drainage basin from sea level to the divide. The lower graph shows the profile of storm intensity from sea level to the divide. It will be noted that the increase in the intensity of the storm rainfall is quite uniform from the coast to the divide in the San Diego River drainage basin. Since flood flows in San Diego County are the result of intense storms, it would be logical to expect that the intensities of flood flows would vary with the intensities of storm rainfall.

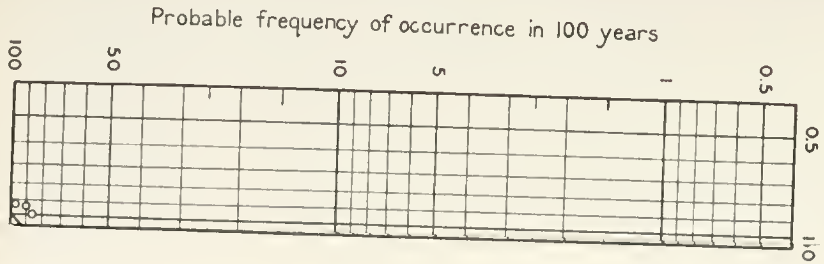
TABLE 26

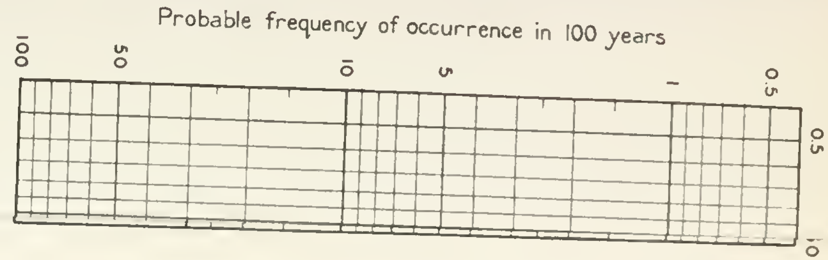
VARIATION OF INTENSITY OF STORM RAINFALL WITH ELEVATION IN THE SAN DIEGO RIVER DRAINAGE BASIN

Precipitation station			2-day storm rainfall	
Number on Plate I	Name	Elevation, in feet U.S.G.S. datum	Mean of 10 storms 1914-1917, in inches	Mean intensity, in per cent of mean of basin
69	San Diego	87	1.46	42.1
74	Chollas Heights	370	2.09	60.2
75	Murray Dam	500	2.42	69.7
90	Los Coches	710	2.45	70.6
83	El Cajon #3	560	2.60	74.9
84	El Cajon Valley	670	2.64	76.1
96	Diverting Dam	840	3.00	86.5
91	Chocolate	760	3.12	89.9
52	Ramona (Sentinel)	1440	3.23	93.1
97	Boulder Creek	2990	4.30	123.9
40	Santa Ysabel Store	2983	4.32	124.5
101	Julian	4222	4.96	142.9
98	Cuyamaca Dam	4677	5.42	156.2
	Averages for drainage basin of San Diego River above Old Town	1843	3.47(1)	100.0

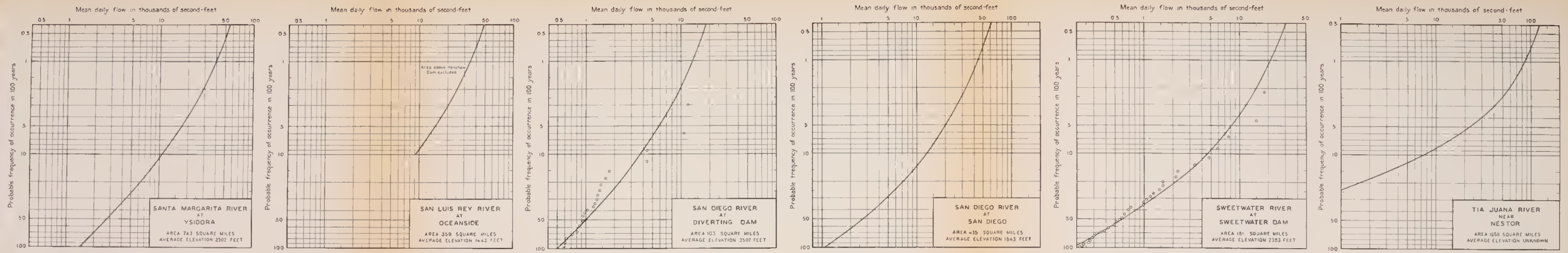
(1) Weighted by areas between 500 foot contours.

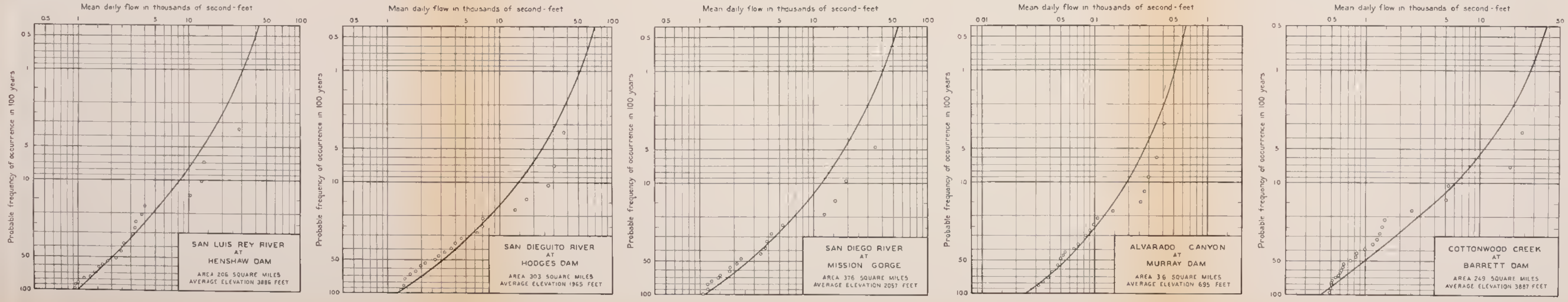
Frequency analyses of mean daily flood flows have been made at three points in the San Diego River drainage basin, the Diverting Dam, the Mission Gorge and at Murray Dam. These are presented in Plate XV, "Probable Frequency of Flood Flows from Drainage Basins in San Diego County." The analysis of flows at the Diverting Dam indicates a probable once-in-100-years mean daily flood of 13,500 second-feet or of 131 second-feet per square mile of drainage basin. The analysis of the flows at the Mission Gorge indicates a once-in-100-years mean daily flood of 40,300 second-feet at that point. The mean daily flood from the area between the Diverting Dam and Mission Gorge therefore would be about 26,800 second-feet





Probable frequency of occurrence in 100 years





PROBABLE FREQUENCY OF FLOOD FLOWS FROM DRAINAGE BASINS IN SAN DIEGO COUNTY or 98 second-feet per square mile. Based on these figures, floods from the area above the Diverting Dam would be about 1.34 times as intense as those from the area between the Diverting Dam and the Mission Gorge.

The average elevation of the area above the Diverting Dam is 3507 feet; of the area between the Diverting Dam and the Mission Gorge, 1514 feet. Applied to the upper graph, Plate XIV, these average elevations indicate storm rainfall intensities of about 133.5 and 100.5 per cent of the mean for the total basin respectively. Based on rainfall intensities, therefore, floods from the area above the Diverting Dam would be about 1.33 times as intense as floods from the area between the Diverting Dam and the Mission Gorge. This figure is in substantial agreement with the ratio indicated by the flood flow analyses. Consequently, it would seem that flood flows in the San Diego River Basin above the Mission Gorge might be expected to vary directly with theintensity of the storm rainfall.

The third record of flood run-off in the San Diego River Basin which has been analyzed is that of Alvarado Canyon at Murray Dam, a portion of the San Diego River drainage basin below the Mission Gorge. This analysis indicates a once-in-100-year mean daily flood flow of 505 second-feet or about 140 second-feet per square mile from a drainage basin of 3.6 square miles at an average elevation of 695 feet above sea level. This is a higher rate of mean daily flood flow than that indicated for the area above the Diverting Dam at an average elevation of 3507 feet. It is believed that this difference is caused by the different geological character of the two areas.* The Pacific slope of San Diego County may be divided into two

*The discussion of the geological character of San Diego County has been based on the report of A. J. Ellis in Water Supply Paper 446 of the U. S. Geological Survey "Geology and Ground Waters of the Western Part of San Diego County California."

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*The discussion of the geological character of San Diego County has been based on the report of A. J. Ellis in Water Supply Paper 446 of the U. S. Geological Survey "Geology and Ground Waters of the Western Part of San Diego County California."

geological areas, the highland area of crystalline rocks, and the coastal belt of sedimentary rock. The boundary between these two areas lies roughly about 15 miles from and parallel to the coast. There are, however, intrusions of crystalline rocks in the sedimentary area and deposits of unaltered sediment in the crystalline area. In the San Diego River drainage basin the first crystalline outcrops occur in the dyke which forms the Mission Gorge and the backbone of the divide which separates the Alvarado Canyon drainage basin from the drainage basin above the Mission Gorge. It is, however, for the most part overlain by the remnants of the Poway Mesa. In the U. S. Department of Agriculture, "Soil Survey of the El Cajon Area," most of the San Diego River drainage basin below Mission Gorge is classified as "Redding gravelly sand loam" and described as follows: "The limiting factors ... are ... shallowness and poor subdrainage ... has a 5 to 14 inch surface soil ... subsoil is red clay ... very compact ... underlain at a depth ranging from 14 to 30 inches by a hardpan like substratum of ... cemented material."

The highland area of crystalline rock is largely made up of easily weathered granites. Disintegration in some places has taken place to depths as great as 100 feet below the surface. The soils are sandy and porous.

The above discussions of the geology and soils of the San Diego River drainage basin indicate that the granitic areas of the mountainous regions above the Mission Gorge with deep, sandy soils and disintegrated granites would absorb a much larger amount of rain before producing any flood run-off than the shallow soils underlain by hardpan which are found in that portion of the San Diego River drainage basin below the Mission Gorge. It is believed that this change in the geologic character of the drainage basin presents an adequate explanation of the higher intensities of run-off found in the lower portions of the San Diego River drainage basin.

The soils of the coastal belt from the San Diego River to the Mexican border are similar in profile to those in the San Diego River Basin and it is probable that the flood flows at Murray Dam might be used successfully in estimating flood flows from the coastal areas south of the San Diego River drainage basin. North of Los Penasquitos Creek, however, the soil types change and are much more varied. Many of the soils are more sandy in character and the subsoils are more pervious to water. Consequently, the flood flows from these areas would probably be somewhat lower than those recorded at Murray Dam. However, from the apparent sizes of the smaller stream channels and a study of the few records of flow available, it is believed that the flood flows from these areas would probably be at least as large, if not larger, than those from the lower granitic areas.

Size and Frequency of Flood Flows.

The probable sizes and frequencies with which flood flows may be expected to occur from each of the major drainage basins of the Pacific slope of San Diego County have been determined through analyses of all the available data on flood flows on streams in and adjacent to San Diego County. Analyses of the probable mean daily flood flows have been made for each drainage basin for which adequate records of flood run-off were available and also for each of the major streams of San Diego County at a point near the coast. Probable hydrographs of flow have been determined for those streams on which the effect of reservoirs in flood control has been considered and the probable crest flows have been estimated for the remaining streams.

The data available for these analyses consisted chiefly of the records of flood flow obtained by the United States Geological Survey and of records of reservoir stages obtained by the City of San Diego, the

La Mesa, Lemon Grove and Spring Valley Irrigation District, the Sweetwater Water Co., and the San Diego County Water Co. on the reservoirs operated by these agencies.

Because of the difficulty of making current meter measurements in times of high flood flow and of the shifty nature of the stream channels, most of the flood estimates of the Geological Survey are based on the application of the Kutter formula to channel cross-sections and slope measurements made after the floods had subsided or on observed surface velocities only. The capacity curves used for the several reservoirs when applied to small increments of storage are inaccurate and the discharge ratings of the various spillways often with gates partially closed or blocked by debris are only approximate.

The longest record of flood flows is that based on the Sweetwater Reservoir record which has been kept during the 45-year period 1888-1933. Most of the records cover periods of only slightly more than 20 years or less. These are relatively short periods when used to determine the probable flows which may be expected at average intervals of from 100 to 250 years.

Since the data, therefore, are not exact and longer periods of record would be desirable, the probable frequencies for the major floods of record as indicated by the analyses have been compared with the testimony of long-time residents of the county. They are believed to be as reliable as the nature of the basic data permits at the present time.

Mean Daily Flood Flows - The probable sizes and frequencies with which mean daily flood flows may be expected to occur have been determined by the method of frequency analysis in general use by the Division of Water Resources. In this method the maximum mean daily flood flow of each flood of record is listed in a decreasing order of magnitude. Its number in the list thus gives the frequency with which a mean daily flood of that size or larger

occurred in the period of record. The probable number of times each flow would have occurred had the period of record been 100 years is then obtained by multiplying its number in order of magnitude in the period of record by the ratio of 100 years to the period of record. The corresponding values of mean daily flow in second-feet and frequency in 100 years are then plotted to a double logarithmic scale and a smooth curve interpreting the trend of the plotted points is drawn.

Frequency curves of mean daily flood flows on Cottonwood Creek at Barrett Dam, Sweetwater River at Sweetwater Dam, San Diego River at Diverting Dam and at Mission Gorge, Alvarado Canyon at Murray Dam, San Dieguito River at Hodges Dam, and San Luis Rey River at Henshaw Dam are shown on Plate XV. The other frequency curves shown on this plate were developed from these by the use of comparative factors based on shorter periods of stream flow record, the rainfall-elevation analyses previously discussed, and the physical characteristics of the drainage basins. The probable mean daily flood flows at selected frequencies as indicated by these curves are listed in Table 27.

Flood Hydrographs - Although records of flow have been kept for many years, the torrential nature of the stream flow and the large amount of debris carried by the floods have made both the maintenance of automatic recorders and the measurement of high flood flows extremely difficult. Consequently there are only a few hydrographs of flood flows in San Diego County available, and these, computed from records of reservoir operation or from observed gage heights and rating curves extended by means of estimates of flow based on surface velocities or Kutter's formula, may be considered only approximate. The available hydrographs of flow expressed in terms of the maximum mean 24-hour flow are shown on Plate XVI, "Hydrographs of Floods in Streams of San Diego County." The mean hydrographs at each gaging station and for the whole county are also shown on this plate.

TABLE 27

PROBABLE SIZE AND FREQUENCY OF MEAN DAILY FLOOD FLOWS
FROM DRAINAGE BASINS IN SAN DIEGO COUNTY

Drainage basin			Probable maximum mean daily flow, in second-feet, occurring once in:			
Location	Area, in square miles	Average elevation, in feet, U.S.G.S. datum	25 years	50 years	100 years	250 years
Santa Margarita River at Ysidora	743	2,302	19,700	28,300	40,500	55,300
San Luis Rey River at Henshaw Dam	206	3,886	15,300	22,400	31,000	43,000
San Luis Rey River at Oceanside	(1) 359	(1)1,442	(1)17,000	(1)24,900	(1)34,500	(1)47,900
San Dieguito River at Hodges Dam	303	1,965	27,000	38,000	52,000	70,000
San Diego River at Diverting Dam	103	3,507	6,780	9,900	13,500	18,700
San Diego River at Mission Gorge	376	2,057	21,000	30,200	40,300	55,500
San Diego River at San Diego	435	1,843	22,900	33,100	44,600	61,100
Alvarado Canyon at Murray Dam	3.6	695	303	405	505	635
Sweetwater River at Sweetwater Dam	181	2,393	9,700	15,000	21,500	31,000
Cottonwood Creek at Barrett Dam	249	3,887	12,900	20,000	27,700	38,100
Tia Juana River near Nestor	1,658	unknown	28,600	57,100	86,400	123,600

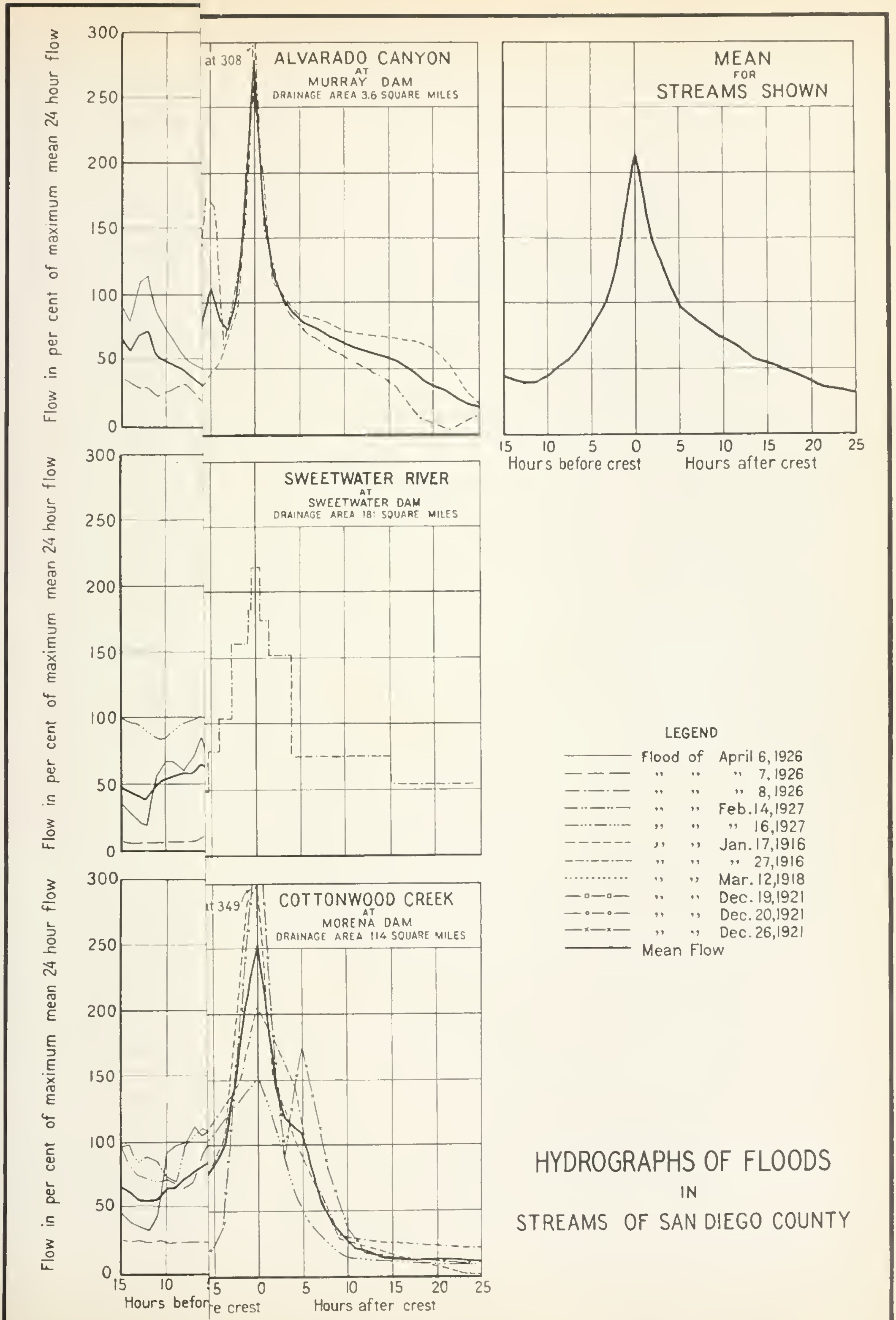
(1) Excluding area of drainage basin above Henshaw Dam.

TABLE 28

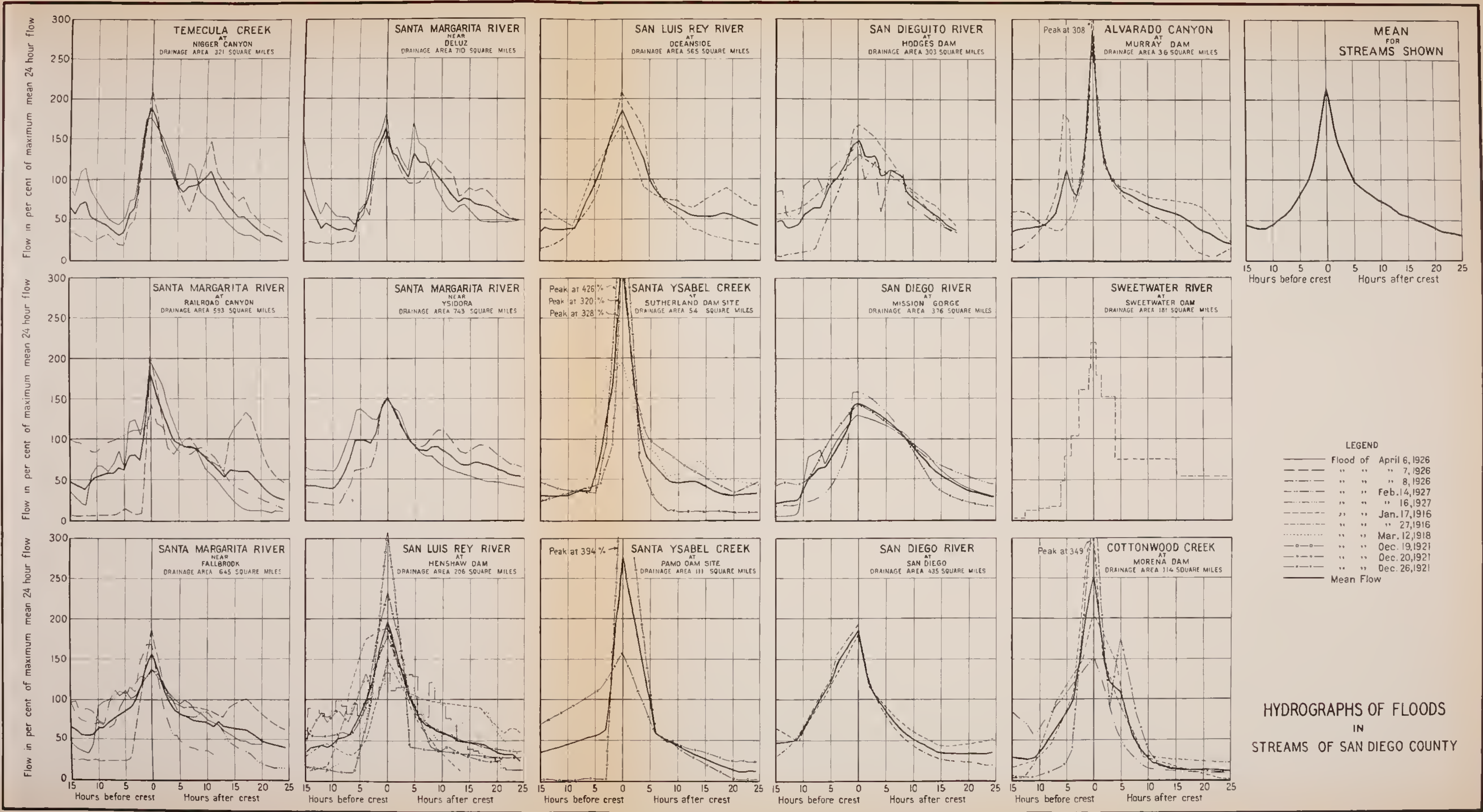
VARIATIONS IN CREST-MEAN-DAILY-FLOW RATIOS WITH THE AREAS OF DRAINAGE BASINS AND IN DIFFERENT FLOODS

Drainage basin	Area of drainage basin, in square miles	Crest-mean-daily-flow ratio (1) of flood peak occurring on Jan.17 1916	Jan.27 1916	Mar.12 1918	Dec.19 1921	Dec.20 1921	Dec.26 1921	Apr.6 1926	Apr.7 1926	Feb.14 1927	Feb.16 1927	Average
Alvarado Canyon at Murray Dam	3.6	2.66	3.08									2.87
Santa Ysabel Creek at Sutherland dam site	54			1.95		3.38	4.26					3.20
Cottonwood Creek at Morena Dam	114		2.04	2.97			3.49				1.53	2.51
Santa Ysabel Creek at Pamo dam site	111					3.94	1.58					2.76
Sweetwater River at Sweetwater Dam	181		2.19									2.19
San Luis Rey River at Henshaw Dam	206	1.50	1.88	1.90	1.79	3.08	2.33				1.33	1.97
San Dieguito River at Hodges Dam	303	1.31	1.67								1.45	1.48
Temecula Creek at Nigger Canyon	321							1.75	2.07			1.91
San Diego River at Mission Gorge	376						1.42	1.29			1.58	1.43
San Diego River at San Diego	435	1.82	1.94									1.88
San Luis Rey River at Oceanside	565	1.68	2.08									1.88
Santa Margarita River at Railroad Canyon	593							1.97	2.03		1.43	1.81
Santa Margarita River at Fallbrook	645							1.37	1.86	1.67	1.36	1.56
Santa Margarita River near Deluz	710							1.79	1.54			1.66
Santa Margarita River at Ysidora	743							1.49	1.52			1.50
Average		1.79	2.13	2.27	1.79	3.47	2.62	1.61	1.80	1.67	1.45	

(1) Mean daily flow equals 1.00.



HYDROGRAPHS OF FLOODS IN STREAMS OF SAN DIEGO COUNTY



HYDROGRAPHS OF FLOODS IN STREAMS OF SAN DIEGO COUNTY

The crest flow of each flood shown on Plate XVI expressed as a ratio of the mean daily flow has been listed in Table 28 in the order of magnitude of the drainage basins. In the last column of Table 28 are listed the average crest-mean daily flow ratios for each drainage basin and in the last line are listed the average crest-mean daily flow ratios for each storm. It will be noted that although the averages by drainage basins indicate a considerable reduction in the crest-mean daily flow ratio with an increase in the size of the drainage basin that the crest-mean daily flow ratios of the smaller drainage basins are based on a different group of storms than the ratios for larger drainage basins; that the mean ratios for the floods of record on the smaller drainage basins are considerably higher than those for the floods of record on the larger drainage basins; and that in the floods of January 27, 1916, and February 17, 1927, the two largest floods of record, with hydrographs available for both large and small drainage basins, the indicated decrease in the crest-mean daily flow ratio between drainage basins from 100 to 700 square miles in extent is but slight. An analysis attempting to factor out the effects of the variations of individual floods was made. However, the inaccuracies of the data, previously discussed, were so great that a satisfactory solution could not be obtained. For these reasons the flood hydrographs which have been used in this report have been based on combinations of recorded flood hydrographs of streams in or adjacent to the drainage basins considered, selected arbitrarily after consideration of all the factors involved.

The probable sizes and frequencies of occurrence of the crest flows of each of the major drainage basins in San Diego County are listed in Table 29.

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The probable sizes and frequencies of occurrence of the crest flows of each of the major drainage basins in San Diego County are listed in Table 29.

TABLE 29

PROBABLE SIZE AND FREQUENCY OF CREST FLOOD FLOWS
FROM DRAINAGE BASINS IN SAN DIEGO COUNTY

Drainage basin	Area, in square miles	Average elevation, in feet	Crest-mean: daily flow: ratio	Crest flow, in second feet, occurring once in			
				25 years	50 years	100 years	250 years
Santa Margarita River at Ysidora	743	2,302	1.55	30,500	44,600	62,800	85,700
San Luis Rey River at Oceanside	(1)359	(1)1,442	(1)1.68	(1)28,600	(1)41,800	(1)58,000	(1)80,500
San Dieguito River at Hodges Dam	303	1,965	1.70	45,900	64,600	88,400	119,000
San Diego River at San Diego	435	1,843	(2)1.56	(2)26,000	(2)46,600	(2)71,600	(2)99,200
Sweetwater River at Sweetwater Dam	181	2,393	1.97	19,100	29,600	42,400	61,100
Tia Juana River near Nestor	1,658	unknown	1.40	40,000	80,000	121,000	173,000

(1) Excluding area of drainage basin above Henshaw Dam.

(2) The regulating effect of El Capitan Reservoir has been included in this value. The crest-mean daily flow ratio is based on the modified mean-daily flow of theonce-in-250-year flood and not on the value listed in Table 27.

Effect of Conservation Reservoirs- The crest flood flows listed in Table 29 are based on analyses of the natural flows in the streams of San Diego County. The construction of conservation reservoirs will change the characteristics of these flows to some extent. In the operation of conservation reservoirs the reservoirs are filled as soon as is possible each year. After the reservoirs are filled the flow of the stream is passed through the spillways of the dams. In passing through the spillways the crest flows are reduced somewhat by the temporary storage required to build up the necessary head over the spillways. It has been estimated that the construction of the El Capitan Reservoir on the San Diego River will reduce the crest flow of the once-in-250-year flood at Old Town about 21 per cent. The construction of the San Vicente and Mission Gorge reservoirs to capacities of 174,500 acre-feet and 29,200 acre-feet respectively as discussed in Chapter VI would increase this reduction to 37 per cent. The effect of full conservation development would be greater on the lesser flood flows. Analyses, of full conservation operation discussed in Chapter VI, indicate that there would be flow past the Mission Gorge Reservoir only about once every three years on the average; that there would be no contribution to the crest flow of the once-in-25-year flood at Old Town from the area above the Mission Gorge; that reservoirs would probably have filled prior to the occurrence of floods with expectancies at intervals greater than once in 50 years and that the only effect of the upstream storage on such floods would be the regulative effect of their passage through the spillways. The result of this conservation development, therefore, would be that for periods of over 25 years in length the crest flood flows at San Diego would be only the comparatively small flows from the 59 square miles of drainage basin below the Mission Gorge but that once every fifty years or so a flood would occur from the 435 square miles of the San Diego River drainage basin. Such a regimen might very easily

result in a false sense of security and lead to a major flood disaster at some time in the future.

Methods of Flood Control.

Many of the stream channels are at present grown up with willows and other brush and trees which impede the flow of smaller floods and may cause a major flood to cut new channels. The removal of these obstructions and the straightening of normal channels would increase the velocities of flow and reduce the tendency to deposit debris. The channel straightening would probably necessitate some bank protection at vulnerable spots. It is probable that by means of channel cleaning and straightening with some bank protection, the natural channel capacities of most of the streams would be increased sufficiently to handle floods which might be expected to occur at average intervals of about 25 years with comparatively little damage to adjacent lands.

Additional flood control and protection of lands subject to over flow may be accomplished by the construction of levees to confine the flow to selected channels. However, the heavy gradient of most of the stream channels causes high velocities on large flows, which require costly protection for the water slope of the levees to prevent erosion and to insure their safety. Adequate drainage must also be provided for side streams and run-off from the areas behind the levees.

Flood control by means of channel clearing, bank protection and levees only, contemplates the necessity of providing channel capacities adequate to handle the natural crest flood flows of the streams. In San Diego County, however, although the crest flood flows are high, they are relatively short in duration. The average flood hydrograph, shown on Plate XVI, indicates a crest flood flow 2.16 times as large as the corresponding mean

daily flow. Flood periods, the product of excessive rainfall, seldom last more than three days. Consequently, it is possible through the storage of excess flow in a relatively small amount of reservoir space to reduce materially the size of the flows which may be expected to occur in the lower stream channels. In the average flood hydrograph shown on Plate XVI with a crest flow 2.16 times the mean daily, only 10% of the total flow occurs at a rate in excess of 1.25 times the mean daily, 17% at a rate in excess of the mean daily, 30% at a rate in excess of 0.75 times the mean daily and 50% of the total occurs at a rate in excess of 50% of the mean daily flow. Thus, with available reservoir space of only a little over 17% of the mean daily flow it would be possible to reduce the crest flood flow of a flood with these characteristics to only one-half its natural size; or, with available reservoir space equal to about 50% of the mean daily flow it would be possible to reduce the crest flow to about one-fourth its natural size. It is obvious that the reduction in size of crest flows by control of the discharge from a reservoir reduces the menace of flood flows to the downstream valley lands.

In addition to the above described methods of flood control by channel improvements or by use of reservoir storage space, a combination of the two affords a third solution. The most economic method may be determined for any specific area by a study of comparative costs of reservoir storage space and channel improvement by levees.

Utilization of Conservation Reservoirs for Flood Control- In San Diego County the limited quantities naturally available and the value of water are such that all of the most economic reservoir sites may eventually be needed for conservation purposes. If any reservoir space, therefore, is to be provided for flood control it will probably have to be in connection with a conservation reservoir. In the Sacramento and San Joaquin valleys it has been found possible to combine the use of reservoir space for both conservation

and flood control purposes.

In those areas where, as in San Diego County, the major floods were found to occur only in the winter months as the direct result of rainfall, a previous investigation found that rules of reservoir operation could be established which would permit the joint use of reservoir space for both conservation and flood control purposes. These rules were based on the time of year and on the amount of seasonal precipitation to date. They are described fully in the report* on the control of floods by reservoirs. Briefly, they consisted in establishing the limiting dates of the flood season and in reserving space for flood control purposes whenever the total rainfall to date during the flood season reached a set percentage of the normal rainfall to date. With such rules in force it was found that floods might be controlled and that any empty space in the reservoir at the end of the flood season could be filled by the run-off of the late spring and early summer.

The maximum mean daily flood flows of the San Diego River at Mission Gorge have been listed in Table 30 with the total rainfall at Cuyamaca prior to the fifth day before the flood expressed in the percentage of normal to that date, or the rainfall index. The rainfall indices for the floods of January 1895 and February 1891 have been included because of historical evidence that these floods were above normal in intensity. Inspection of this table indicates that major floods on the San Diego River may be expected to occur only when the precipitation to date is equal to or above the normal precipitation. It has been previously shown that major floods may not be expected to occur after April 1st. A logical rule for flood control operation on the San Diego River, therefore, would be as follows: -maintain

* Bulletin No. 14, "The Control of Floods by Reservoirs," Division of Engineering and Irrigation, 1928.

reservoir space for flood control whenever the rainfall index is 100 or over prior to April 1st; after this date close the flood control ports and allow the reservoir to fill.

The use of conservation space for flood control purposes without impairment of the conservation value on the San Diego River, therefore, is dependent on the possibility of filling the space reserved for flood control with the flow subsequent to April 1st. The estimated full natural flows at Mission Gorge for all years in which the rainfall index at Cuyamaca was 100 or more on April 1st are listed in Table 31. It has been pointed out above that with a mean hydrograph as shown on Plate XVI, the crest flow could be reduced 50 per cent with storage of only 17 per cent of the mean daily flow. This percentage, applied to the estimated mean daily flood flows at the Mission Gorge as listed in Table 27 would require 13,600 acre-feet of reservoir space for control of the 1-in-100-year flood and 18,700 acre-feet for control of the once-in-250-year flood to 50 per cent of the crest flow. An inspection of the data presented in Table 31 shows that in ten of the seventeen years in which space would have been required for flood control prior to April 1st it would have been impossible to fill even the space required for control of the 1-in-100-year flood after April 1st for conservation. Furthermore, in 1897, the last flood year prior to the dry period which ended in 1905, the run-off subsequent to April 1st was only 900 acre-feet. Consequently, it is believed that the use of conservation space for flood control purposes is impracticable in San Diego County.

However, many of the reservoir sites on San Diego County streams have potential storage capacities in excess of the conservation requirements. It is, therefore, possible to provide reservoir space for flood regulation in reservoirs built primarily for conservation uses by increasing the height of the dam and the total capacity of the reservoir. In a reservoir built for

TABLE 30

RELATION OF MAJOR FLOOD FLOWS TO PRIOR PRECIPITATION
FOR
SAN DIEGO RIVER BASIN ABOVE MISSION GORGE

Date of flood	Mean daily flow, in second feet	Total precipitation at Cuyamaca from July 1st to date	
		Date	In percent of normal total to date
Feb. 23, 1891	---	Feb. 18, 1891	123
Jan. 17, 1895	---	Jan. 12, 1895	129
Mar. 25, 1906	6,300*	Mar. 20, 1906	109
Jan. 17, 1916	12,500	Jan. 12, 1916	102
Jan. 27, 1916	35,000	Jan. 22, 1916	197
Mar. 12, 1918	5,400	Mar. 7, 1918	51
Dec. 26, 1921	15,400	Dec. 21, 1921	210
Feb. 16, 1927	19,400	Feb. 11, 1927	107

* Estimated from record at Lakeside.

TABLE 31

FULL NATURAL RUN-OFF OF SAN DIEGO RIVER AT MISSION GORGE
SUBSEQUENT TO APRIL 1st
IN SEASONS IN WHICH THE RAINFALL INDEX WAS ABOVE 100

Season	Rainfall index at Cuyamaca on April 1st	Full natural flow at Mission Gorge subsequent to April 1st, in acre-feet
1888-89	138	12,600
1889-90	194	900
1890-91	162	7,300
1892-93	124	4,000
1894-95	160	7,500
1896-97	113	900
1900-01	111	1,800
1904-05	138	15,900
1905-06	145	31,800
1906-07	122	22,100
1908-09	133	12,300
1914-15	118	42,300
1915-16	166	21,900
1919-20	102	12,200
1921-22	164	31,400
1926-27	174	22,700
1931-32	149	7,300

both flood control and conservation purposes, the lower portion of the reservoir space provided would be dedicated to conservation uses and the upper portion of the space provided would be used for flood control purposes. Any outlets through the dam would be so controlled that when the water surface in the reservoir was below the conservation level there would be no wasteful discharge. Flood outlets and spillways would be designed to automatically control the flood discharge to predetermined flows.

Since the area over which the flood control storage would take place would be large, an increase of only a few feet in the height required for conservation dams should provide adequate space for a considerable reduction of flow on most streams.

Status of Flood Protection in San Diego County.

Comparatively few permanent flood control works have been constructed on the streams of San Diego County. On several of the streams short stretches of bank protection works have been installed. On the San Diego River, the Federal Government in 1877 constructed a dyke running from Presidio Hill in Old Town to the high ground of Point Loma, for the purpose of permanently diverting the San Diego River into Mission Bay.

According to William E. Smythe,* the river emptied into False or Mission Bay when the Mission and Presidio were established in the latter part of the 18th century, but in 1821 or 1825 cut through into San Diego Bay and continued to flow there with only one slight interruption until the completion of the government dyke. The river carries large quantities of silt and sand when in flood and was steadily shoaling the harbor of San Diego Bay. The dyke was constructed under a Federal appropriation of $80,000 and has been raised and strengthened twice since its construction, the first time soon after the 1916 flood and the second time in 1933.

*History of San Diego, 1542-1908," by William E. Smythe, 1908.

On the Santa Margarita River some bank protection work and a levee have been constructed by the owners of the Santa Margarita Ranch near the head of the upper basin in the vicinity of O'Neill Lake. The County of San Diego in cooperation with landowners has constructed a small amount of tetrahedron bank protection along the San Luis Rey River about two miles upstream from San Luis Rey Mission to protect the adjoining farm lands and prevent the river from changing its channel.

On the San Diego River near Santee, a wire and rock mattress bank protection has been constructed on the left bank by the County of San Diego to prevent the stream from eroding the lands of the county farm.

On the Tia Juana River, the County of San Diego in cooperation with local property owners has constructed a levee approximately one-half mile in length to prevent the flood flows of the Tia Juana River from crossing the low saddle near Nestor and flowing into San Diego Bay.

Channel cleaning and straightening has been done on some of the streams of the county during the past year. In 1933 the channel of the Tia Juana River was cleared of brush and plowed from the international boundary downstream for a distance of nearly four miles by the State Division of Forestry and County of San Diego. In the winter of 1933-34 the channel of the Santa Ysabel Creek in the San Pasqual Valley was cleared of brush and trees as a C.W.A. project under the County of San Diego. The San Luis Rey River channel near Bonsall is being cleared under an SERA project and bank protection is being constructed at points where the destruction of improved farm lands is threatened.

Future Flood Control Works.- In considering the problem of flood control for San Diego County streams, it has been shown that the lands subject to overflow are a very small part of the total area of the county. From an inspection of Plate XII, it can be readily seen that most of these areas are comparatively

long and narrow. This means that each mile of channel protection would reclaim but a small acreage of land. From the experience of the 1916 flood, which caused great damage to these valley lands and destroyed many improvements, few residences have been built below the flood plane and most of the agricultural lands have been used only for annual crops since that time.

It may also be pointed out that while the major floods may cut away valuable lands or destroy others by depositing coarse sand on them, in other parts of these valleys silt is deposited and these areas improved in quality. In Water-Supply Paper No. 446,* Arthur J. Ellis states: "Within very recent geologic time the land has stood considerably higher than at present, and there are indications that along most of the coast sinking is now in progress. This sinking, possibly now in progress, is shown by the partly drowned and consequently marshy valleys of all streams that reach the ocean in this part of the country." This sinking of the land in relation to sea level would reduce the stream gradients and account for the deep alluvial fills of the lower valleys.

The gradual building up of the valley floors may be indicated by the testimony of landowners in the overflowed areas, who report fences in the river bottoms being partially buried by sand and silt and the silting of one to three feet in depth in brush areas by major floods. Minor floods also deposit silt in brush areas along the stream channel. This may result in a cycle of alternately eroding good agricultural lands and in silting up other sandy brush-covered areas with large loss to the individual landowner but with a net loss to the community of the cost of improvements. It also may result in the tendency of the stream to shift its channel location because of the building up of a ridge adjacent to the channel through deposition of debris in

*W.S.P. No. 446, "Geology and Ground Waters of the Western Part of San Diego County, California," by Arthur J. Ellis and Charles H. Lee, 1919.

brush covered areas.

The infrequency with which the major floods occur allows the stream channels to become grown up with brush and trees during the long intervals of comparatively low flows, and tends to force the large flows away from the old channels and into new ones. The maintaining of cleared channels would reduce this tendency of the stream channels to wander and might result in erosion of the channel bottoms with resulting higher banks and greater channel capacities.

The volume of major floods flows is so great in these streams, and due to the steep gradients of the stream beds, of such high velocity that the water face and toe of levees built of riverbed materials must be adequately protected to prevent erosion and failure of the levees. This greatly increases the cost of a levee system. The narrow width of the valleys in comparison with the length of levees necessary to protect them will result in a high cost per acre of land protected.

With full water development of the streams the additional storage, as has been shown for the San Diego River, will materially reduce the crest flows of the minor floods and result in protection from floods of from once in twenty-five years to possibly somewhat longer frequency. In general, this protection is very probably as great as could be economically justified with the present values of agricultural lands.

However, as has been stated earlier in this chapter, this might result in a false sense of security, and encourage the construction of permanent improvements or residences below the flood plane. Until adequate flood control works are constructed, it should be borne in mind that the valley floors are subject to inundation and that any permanent improvements in these areas are liable to damage from major floods.

It has been previously shown that flood control may also be accomplished through use of storage capacity above a conservation reservoir

through design of dam and spillway for that purpose. Consequently, it is believed that in the future construction of conservation reservoirs, especially those located on the lower reaches of the streams, a careful study should be made of the possibility of adding flood control features and of the resulting benefits to the lower valleys through the additional flood protection that may be accomplished in this manner.

It is also believed that proper maintenance of clear channels with bank protection at the more critical points may be accomplished at relatively small costs, and will materially reduce the damage liable to occur in major floods.

Protection of Tia Juana River Valley.

In the Tia Juana River Valley between the international boundary line and the Pacific Ocean, a total of some 4670 acres are subject to overflow in time of flood. Of this area 960 acres are marsh land with but little present value and little future agricultural value until the deposition of debris shall have raised their elevations several feet. About 700 acres are river wash in the main channel of the river and have no present agricultural value whatever. Under any system of flood control approximately all of this latter area will always be needed for river channel. There are about 1,150 acres of class 3 soils, at present largely covered with brush or utilized as pasture which lie along the sides of the main channel and are now subject to frequent flooding. These soils are largely classed as "Cajon fine sand" and described as follows: "The surface soil.... consists of .... fine sand or very fine sand .... The material below the surface soil is of the same character but may be variable in texture. Normally some calcium carbonate occurs in both the surface soil and subsoil, although the amount may be very slight in some of the more recently deposited soil. This soil represents

very recently deposited soil material or material that is being deposited during unusual floods. The humus content is low and the soil holds very little moisture. ...alfalfa and truck crops are grown." The remaining 1860 acres are class 1 soils predominately classed as Foster very fine sandy loam - gray phase. They are described as follows: " ... extremely high in mica, very floury and easy to till. Some calcium carbonate may occur in the surface soil but a greater amount is in the subsoil. The soil has a fairly high water holding capacity and is easy to irrigate ... highly desirable for alfalfa and truck crops." About 900 acres of this area although subject to flooding are so located that there is very little probability of their erosion or of the deposition of coarse sand or debris by floods. The rest of the class 1 soils and all of the class 3 soils, about 2110 acres of agricultural land in all, are in more or less danger of erosion or debris deposition whenever unusual floods occur.

The estimates of probable crest flows in Table 29 show that a flow of 40,000 second-feet may be expected to occur about once in 25 years on the average and one of 80,000 second-feet about once in 50 years and a flow of 121,000 second-feet might be expected about once in 100 years on the average. The average slope of the valley floor from San Ysidro to the ocean is about 10 feet to the mile.

Since the flood of 1916 the valley floor has been practically uninhabited. However, at the present time, residences are encroaching on the flood plane particularly in those areas which were not seriously flooded in 1927. If the valley floor is to be made safe for residential purposes these areas should be protected against floods of at least 1-in-100-year expectancy. A topographic map of the entire valley floor from the international boundary to the ocean was made during this investigation, and studies were made for reclaiming this area. A leveed channel 900 feet wide between the toes of the

levees and with levees about 11 feet high would provide such protection. It is estimated that such a channel would cost slightly over $1,000,000.00. It would provide protection to some 3000 acres of agricultural land, enabling the farmers to live on their farms or the development of the area as an urban center. There is, however, no particular need of this area for urban purposes, nor with large suitable residential areas within a few miles is it necessary for the farmers to live below the flood plane.

It is estimated from the County Assessor's valuations that the actual present value of land and improvements subject to flooding is approximately $500,000, and that the area subject to possible erosion or debris deposition has an actual present value of about $160,000. Consequently the large expenditure necessary to reclaim these lands is not economically justified until the land values greatly increase.

CHAPTER VI

CONSERVATION AND FLOOD CONTROL WORKS ON SAN DIEGO RIVER

The plan presented herein comprehends the most economic development, conservation, utilization and control of the water resources of the San Diego River for all consumptive purposes, and flood control, in coordination with existing developments.

The very existence of a permanent civilization rests upon a dependable and adequate water supply. As the water supplies naturally tributary to San Diego County are deficient in amount to meet the ultimate demands for complete development of the county, it is essential that in the formulation of a plan for complete development of the water resources of the San Diego River or other streams in this county, the plan must be based primarily upon conservation and utilization of water for domestic, municipal or irrigation purposes. All other possible uses of the works of the plan, such as flood control, power or recreation must be necessarily incidental and secondary.

In determining the best plan for the development of the San Diego River, no consideration has been given to the possibility of storing water imported from other watersheds in reservoirs constructed within the San Diego River Basin. Should such importations be made, provisions for storage of that water will modify the physical works as set forth in this chapter, and the operation thereof.

A decision of the Supreme Court of the State of California has confirmed the paramount right of the City of San Diego to the waters of the San Diego River. The construction of additional storage works on this river

will present no different legal problems than may arise from the construction and operation of El Capitan Reservoir. Therefore in estimating the cost of physical works for the full development of the water resources of the San Diego River, no allowance has been made and no costs included for water rights or litigation arising therefrom.

Although other types of dams may be used and were considered for some of the dam sites in the San Diego River Basin, gravity concrete dams, straight in plan, have been used at all sites for estimating capital and annual costs, and unit costs of storage and of safe yield. While all sites considered are suitable for certain other types of dams and the substitution of a different type of dam for use at all sites may result in reducing the estimates of cost, the comparative merits of the different sites will not appreciably change. The economic factors involved in the determination of the best layout of physical works are not primarily dependent upon the particular type of dam selected for comparison of the several sites and of various heights for any particular site.

Existing Development

The most important existing works of development in the San Diego River Basin are the Cuyamaca Reservoir, Diverting Dam, conveyance and feeder flumes, La Mesa ditch, and Eucalyptus, Grossmont and Murray reservoirs, all of which belong to the La Mesa, Lemon Grove and Spring Valley Irrigation District; the El Capitan Reservoir recently completed by the City of San Diego for its water supply; and the government dyke near Old Town.

The Cuyamaca Reservoir is located on the headwaters of Boulder Creek at an elevation of about 4600 feet above sea level. It is formed by an earth fill dam 665 feet long and 40 feet high with spillways at both ends, and has a capacity of 11,600 acre-feet. A more detailed description of the reservoir is

given later in this chapter under "Conservation Reservoirs". Water is stored in the reservoir for diversion to the irrigation district through its flume.

The Diverting Dam for the irrigation district's flume is located on the main San Diego River a short distance below the mouth of Boulder Creek. It is a masonry dam 510 feet long with a maximum height of about 30 feet above a stream bed elevation of 770 feet. The two spillway sections, which are in the crest of the dam, have a total length of 220 feet and their crests are about 6.5 feet below the average elevations of the tops of the abutments of the dam. The side slopes of the dam are approximately 0.1:1 upstream and 0.3:1 downstream and the crest is about 3 feet thick. There is one 30-inch square sluiceway near the bottom of the dam at the center of the channel and a 24-inch square sluiceway below the flume outlets. There are two 24-inch by 36-inch outlets for the discharge into the flume.

The flume is of wooden construction for most of its length and is set on a bench along the mountain side. Its bottom is about ten feet below the spillway crests at the Diverting Dam. It follows the left side of the river canyon from the Diverting Dam to the El Monte Tunnel, about two miles east of Lakeside, and then turns to the south and follows around the El Cajon Valley to its terminus at the Eucalyptus Reservoir near the town of La Mesa. At several points, including the South Fork and Chocolate Creek crossings, the original flume has been replaced by concrete or steel pipe syphons and in other places by semi-circular metal flume. Also, at several points, the conduit passes through points of rock and under divides or ridges in tunnel. At the present time the irrigation district is replacing the old flume from El Monte Tunnel to its terminus with reinforced centrifugal concrete pipe. The feeder conduit from the South Fork empties into the main flume just below the South Fork syphon. It is constructed partly of semi-circular metal flume

and partly of 20-inch steel pipe. After the El Capitan Reservoir has been filled, the entire flume and feeder system above the El Monte pumping plant, near Lakeside, will be abandoned, as part of it will be submerged by the water in the reservoir.

After that time, all water will be conveyed from the reservoir through a pipe line to be constructed jointly by the irrigation district and the City of San Diego to the El Monte pumping plant which will lift the district's water into the flume.

Just above the outlet of the flume into Eucalyptus Reservoir, the La Mesa ditch takes out and carries water to the Murray Reservoir, a distance of about three miles. The ditch is an unlined earth section for most of its length but there is a 36-inch wood stave pipe for about 1250 feet near the upper end.

The Eucalyptus and Grossmont reservoirs are small regulating reservoirs but the Murray Reservoir has a capacity of almost 6,000 acre-feet. This latter reservoir is located on a branch of Alvarado Canyon, a tributary of the San Diego River below Mission Gorge, and about 3½ miles above the canyon's mouth. It is formed by a concrete multiple arch dam with 27 arches, each with a 30-foot span. The maximum height of the dam is about 110 feet. The spillway is of the syphon type and is located in the right end of the dam.

The El Capitan reservoir is located on the main river and runs short distances up the South Fork and Chocolate Creek. Its storage capacity is 116,900 acre-feet. The dam is a combination earth fill-rock embankment structure with its crest at elevation 770 feet, U. S. Geological Survey datum. It is about 1200 feet long, 217 feet high above stream bed, and 1240 feet thick at the base. The spillway is of the side channel type and is located around the right end of the dam. A somewhat detailed description of the dam and reservoir

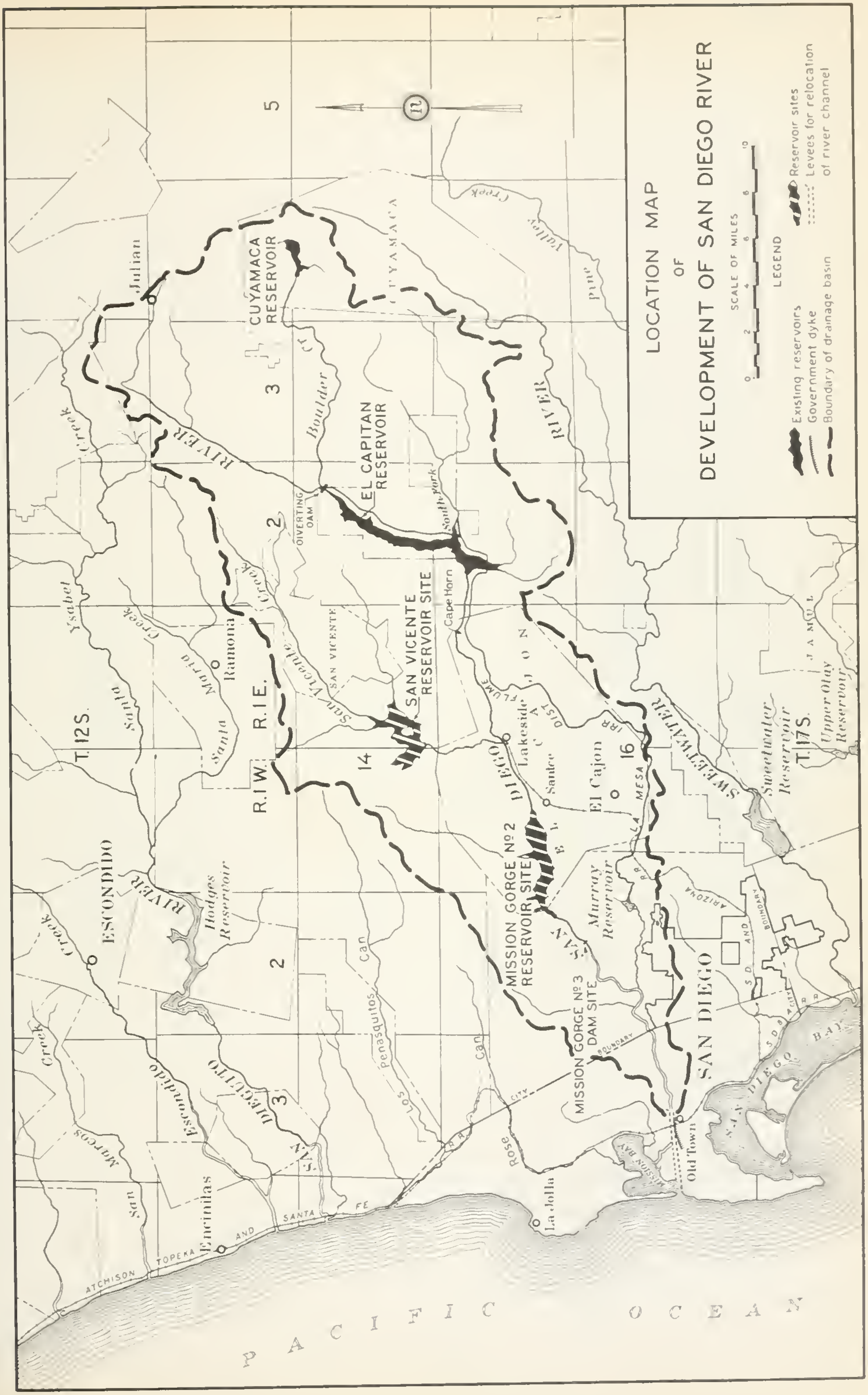
is given later in this chapter under "Conservation Reservoirs".

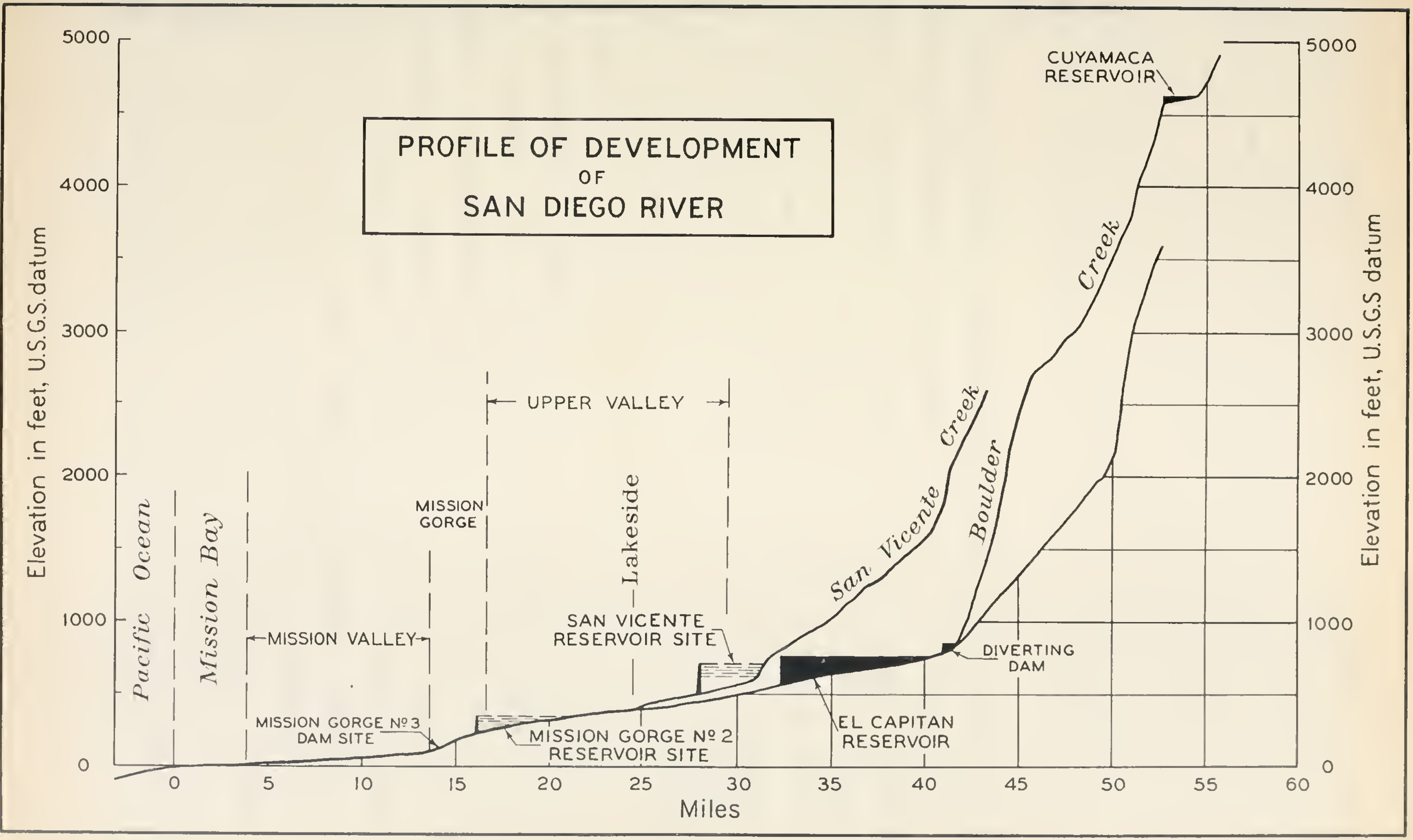
The Government Dyke, near the lower end of the San Diego River, runs from the south end of the Morena Boulevard Bridge at Old Town westerly to high ground near the intersection of Ingraham Street and Point Loma Boulevard. It was originally constructed by the United States government in 1877 for the purpose of diverting the flow of the river, which entered San Diego Bay, into Mission Bay. The government's interest in this change was the protection of the navigable San Diego Bay from filling by debris brought down by the river. To insure more adequately the permanent diversion of the river and to protect lands south of the dyke and extensive improvements on these lands, the government raised the dyke in 1917 to an elevation three feet above the high water line of the flood of 1916. The dyke was again raised and strengthened, by having the cross-section increased and some rock revetment placed on the water side slope, in 1933.

The principal foregoing described existing works on the San Diego River are shown on Plate XVII, "Location Map of Development of San Diego River". A profile of the development of the river is shown on Plate XVIII, "Profile of Development on San Diego River". The map on Plate XVII shows the relative sizes and locations of the works, and the profile on Plate XVIII shows their relative elevations. On both the map and profile, the existing works are shown in solid black.

Complete Development for Conservation and Flood Control.

In the further development of the San Diego River, it is desirable to construct works which will conserve run-off from the stream now wasting into the ocean, and to protect lands adjacent to the river from damage from flood overflow. It is believed that the best method of conserving the wasted water will be to construct additional reservoirs on the main stream and San Vicente


LOCATION MAP
OF
DEVELOPMENT OF SAN DIEGO RIVER
SCALE OF MILES
0 2 4 6 8 10
LEGEND
Existing reservoirs
Government dyke
Boundary of drainage basin
Reservoir sites
Levees for relocation of river channel
CUYAMACA RESERVOIR
EL CAPITAN RESERVOIR
SAN VICENTE RESERVOIR SITE
MISSION GORGE No 2 RESERVOIR SITE
MISSION GORGE No 3 DAM SITE
DIVERTING DAM
Julian
Ramona
Lakeside
Santee
El Cajon
La Mesa
Cape Horn
ESCONDIDO
Encinitas
La Jolla
Old Town
SAN DIEGO
SAN DIEGO BAY
MISSION BAY
Hodges Reservoir
Murray Reservoir
Sweetwater Reservoir
Upper Otay Reservoir
SAN DIEGUITO
SAN DIEGO RIVER
SWEETWATER RIVER
Boulder Cr
South Fork
San Vicente Creek
Santa Maria Creek
Santa Ysabel Creek
Escondido Creek
San Marcos
Los Penasquitos Can
Rose Can
Pine Valley Creek
CUYAMACA
EL CAJON
T. 12 S.
T. 17 S.
R. 1 W.
R. 1 E.
ATCHISON TOPEKA AND SANTA FE
CITY BOUNDARY
PACIFIC OCEAN


PROFILE OF DEVELOPMENT
OF
SAN DIEGO RIVER
Elevation in feet, U.S.G.S. datum
Elevation in feet, U.S.G.S datum
5000
4000
3000
2000
1000
0
Miles
0
5
10
15
20
25
30
35
40
45
50
55
60
Pacific Ocean
Mission Bay
MISSION VALLEY
MISSION GORGE No 3
DAM SITE
MISSION GORGE
UPPER VALLEY
MISSION GORGE No 2
RESERVOIR SITE
Lakeside
SAN VICENTE
RESERVOIR SITE
EL CAPITAN
RESERVOIR
San Vicente Creek
Boulder Creek
DIVERTING
DAM
CUYAMACA
RESERVOIR

Creek to store water during periods when there is more runoff than can be used, and to hold it for release during periods of low runoff. This will result in the holding of some water in storage for several years in order to equalize the supply in wet and dry periods. The protection of the lands adjacent to the river channel from flood overflow may be accomplished either by the construction of levees to confine flood flow to a channel reserved for this purpose, by reducing the flood flow by storage in reservoirs, or by a combination of both methods.

Sites for additional reservoirs in the San Diego River Basin are shown on Plate XVII by areas shaded with black and white bars. They are the San Vicente site on San Vicente Creek and the Mission Gorge No. 2 site on the main river. The relations of the elevations of these two reservoirs to each other and to the existing reservoirs on the stream are shown by the profile on Plate XVIII. As an alternate to the Mission Gorge No. 2 dam, one could be built at a site about 1-3/4 miles further down stream at what is known as the Mission Gorge No. 3 site, shown on both the map and profile. A discussion and comparison of these two sites is given in a following portion of this chapter.

The Mission Gorge sites No. 2 and No. 3 are the local designations of two dam and reservoir sites located in Mission Gorge of the San Diego River. Dam site No. 2 is located near the upper end of the gorge, while dam site No. 3 is located near the lower end. The flow lines of all sizes of reservoirs considered for both sites extend above Mission Gorge into the upper San Diego River Valley. The old Mission Dam constructed by the Spanish missionaries in the early part of the nineteenth century, practically all of which is still standing, is located at the extreme upper end of the gorge about one quarter of a mile east of the boundary line between Ex Mission San Diego and El Cajon grants. The term Mission Gorge No. 1 dam has apparently been reserved for the

original dam, the first constructed in California after the coming of the white race.

Although the El Capitan, San Vicente and Mission Gorge reservoirs could be used for flood control, or for flood control and conservation combined, it has been found that unless space for flood control is provided in addition to that required for conservation, the value for the latter purpose is decreased. It is believed that the greatest benefit from the reservoirs will come from their use for conservation as their primary function and this policy has been adopted in the studies for required reservoir capacity in this investigation. It is shown hereinafter that additional storage space for flood control could be provided in the Mission Gorge No. 2 reservoir without interference with its value for conservation.

The flood control works on the river which have been investigated are the reservoirs and leveed channels in the Mission Bay area and Mission Valley. A considerable degree of reduction in flood flow would result from the use of the reservoirs for conservation alone and further reduction could be accomplished by the use of the Mission Gorge No. 2 reservoir for this purpose, as one of its functions, in addition to its use primarily for conservation. The reductions in flood flow due to reservoir operation would greatly benefit the lands in Mission Valley and the Mission Bay area but for the full protection of these areas, leveed channels are required. The channel designed for the Mission Bay area would be 650 feet to 1000 feet wide and extend westerly from Presidio Hill at Old Town to Mission Bay at its outlet. The location of this channel is shown on Plate XVII. The channel through Mission Valley would be about 600 feet wide and six miles long from Old Town to Alvarado Canyon.

Conservation Reservoirs

The general method of estimating the run-offs from the San Diego River Basin is described in Chapter II. Somewhat detailed descriptions of the methods of estimating the run-offs at several points in the basin, at the dam sites on the main river and San Vicente Creek, and from the areas lying between these dam sites, and a table giving the estimated monthly run-offs at the dam sites and from the intermediate areas are given in Appendix A to this report. Run-offs so estimated were used in the studies to determine the probable yields of each reservoir and combination of reservoirs in the San Diego River Basin. Since the yield of the entire stream was to be estimated, the full natural run-off was used for the studies. As stated in Chapter II and Appendix A, run-offs for the four seasons 1883-1887 were estimated from rainfall records and those for the seasons 1887-1898 from Cuyamaca and Sweetwater reservoir operation records. After 1898, the run-offs were estimated from stream flow records taken at different points in the basin by the water companies and the U. S. Geological Survey.

Next to the water supply, probably the most important item in a study of the conservation and utilization of the water available from the San Diego River Basin is the evaporation from the reservoirs which is relatively large in amount. Data on this subject were obtained from all sources available and are summarized in Table 32 which shows the mean seasonal gross depths of evaporation from pans located at a number of dams in San Diego County. Data in this table indicate that the depth of evaporation increases as the distance from the coast increases and also, to some extent, with increase in elevation. This is probably due to the fact that the Pacific Ocean has a moderating effect on the climate along the coast by decreasing summer temperatures and increasing the humidity. As the distance from the coast increases, summer temperatures become

TABLE 32

MEAN SEASONAL GROSS EVAPORATION FROM PANS IN SAN DIEGO COUNTY

Location of Pan	Mean seasonal gross evaporation, in inches	Period of record	Elevation, in feet U.S.G.S. datum	Distance from coast, in miles	Authority	Remarks
Lower Otay Dam	54.56	1920-33	500	13	City of San Diego	3'x3'x18" Floating Pan
Upper Otay Dam	56.18	1916-23	600	13	City of San Diego	3'x3'x18" Floating Pan
Sweetwater Dam	56.64	1889-93	200	9	J. B. Lippincott	Floating Pan size unknown
		1916-21			J. F. Covert	3'x3'x18" Floating Pan
Murray Dam	61.67	1912-20	500	13	La Mesa, Lemon Grove	3'x3'x18" Floating Pan
		1920-28			and Spring Valley	3'x3'x18" Pan in ground
					Irrigation District	
Hodges Dam	58.29	1919-33	400	10	City of San Diego	3'x3'x18" Floating Pan
Barrett Dam	65.82	1922-33	1600	29	City of San Diego	3'x3'x18" Floating Pan
Morena Dam	67.23	1915-19	3000	36	City of San Diego	4.63'x7.31' Floating Pan
		1919-33				3'x3'x18" Floating Pan
Cuyamaca Dam	72.75	1912-20	4600	42	La Mesa, Lemon Grove	3'x3'x18" Floating Pan
		1921-33			and Spring Valley	3'x3'x18" Pan in ground
					Irrigation District	

greater, the humidity decreases, and apparently the rate of evaporation increases. Reservoirs near the crest of the mountain range, such as Morena and Cuyamaca, are more exposed to the dry hot winds from the desert which also tend to increase the rate of evaporation.

In estimating the evaporation losses from the reservoirs in the yield studies of the San Diego River Basin, consideration was given to the location and elevation of each reservoir. From the data given in Table 32, and with the foregoing consideration, it was estimated that the mean seasonal gross evaporation from the El Capitan and San Vicente reservoirs would be 63 inches and that from the Mission Gorge reservoirs would be 60 inches. In studying the Cuyamaca reservoir, the actual measured depths of evaporation were used during the periods of record shown in Table 32 and for other seasons a depth of 72 inches was used. The gross depth of evaporation was distributed among the months of the season by the percentages determined from the average monthly amounts during the periods of pan records. The distribution for Cuyamaca was determined from its own records. The distribution for El Capitan, San Vicente and the Mission Gorge reservoirs was assumed the same as that obtained from evaporation pan records for Murray Reservoir. The monthly gross depths of evaporation from the El Capitan, San Vicente and Mission Gorge reservoirs, and from the Cuyamaca Reservoir for the period prior to pan records and during the period of missing records, are given in Table 33. The net monthly depth of evaporation from each reservoir was estimated by deducting from the gross depth of evaporation, the estimated depth of rainfall on the reservoir during the month. These net depths for the period 1894-1933 are given in Table A-2 in Appendix A. The total monthly evaporation loss from each reservoir was obtained by multiplying the mean water surface during the month by the estimated net depth of evaporation for that month. The losses so estimated for one method of operating the reservoirs are given in Table A-4 in Appendix A.

Yield of San Diego River With Surface Reservoirs - The longest period between 1883 and 1933 in which the run-off of the San Diego River was below normal was the nine consecutive seasons 1895-96 to 1903-04, inclusive. In these seasons, the average seasonal run-off was only about 15 per cent of the average seasonal for the period 1887-1933. In the season 1894-95 just preceding this dry period, however, the run-off was about 3.5 times the normal. In all studies of yield of the river, therefore, the seasons 1895-96 to 1903-04, inclusive, are considered the critical period which determines the "safe yield" of the stream. The "safe yield" of the entire stream, of any individual reservoir, or of any combination of reservoirs, therefore, as hereinafter estimated, is the seasonal draft which could have been obtained, without deficiency, in the period 1883-1933, and which probably could be obtained in all future seasons.

In making the studies of the safe yield of the San Diego River Basin, it was assumed that 5,000 acre-feet of water would be used every season for irrigation and that the yield above this amount would be used for municipal supply. The monthly distribution of each of these supplies is shown in Table 33. Furthermore, in making the studies, it was assumed that the reservoirs would be empty at the beginning of the season 1883-84. Also, due to the fact that estimates of run-offs from 1883-84 to 1897-98 were made from rainfall records and from Cuyamaca and Sweetwater reservoir records, and that there may be some error in their amounts, a minimum of 20 per cent of the total estimated run-off into the reservoirs used in each study during the period 1887 to 1895 was allowed to waste. This allowance was made so that even if the estimates of run-off were high, there would be reasonable certainty that all of the reservoirs would be full at the beginning of the critical period starting in 1895.

In one study of the yield from the coordinated operation of the Cuyamaca and El Capitan reservoirs, the reservoirs were operated in accordance

TABLE 33

DRAFTS AND EVAPORATION FROM RESERVOIRS

Month	Drafts on reservoirs			Gross evaporation from reservoirs					
	Irrigation supply		Municipal supply	Cuyamaca Reservoir		El Capitan and San Vicente Reservoirs		Mission Gorge Reservoirs	
	Amount, in acre-feet	Per cent of annual total	Per cent of annual total	Depth, in inches	Per cent of annual total	Depth, in inches	Per cent of annual total	Depth, in inches	Per cent of annual total
January	70	1.4	6.2	2.77	3.85	2.20	3.49	2.09	3.49
February	50	1.0	5.6	3.63	5.04	3.05	4.85	2.91	4.85
March	140	2.8	7.0	4.59	6.38	4.50	7.15	4.29	7.15
April	390	7.8	7.7	4.67	6.49	4.93	7.83	4.70	7.83
May	440	8.8	9.4	6.68	9.28	6.17	9.79	5.88	9.79
June	540	10.8	10.2	8.58	11.92	7.38	11.71	7.02	11.71
July	690	13.8	11.3	9.80	13.61	8.83	14.01	8.41	14.01
August	740	14.8	11.0	9.37	13.01	8.04	12.76	7.66	12.76
September	690	13.8	9.6	8.09	11.23	6.65	10.56	6.33	10.56
October	540	10.8	8.5	6.53	9.07	5.10	8.09	4.85	8.09
November	490	9.8	7.3	4.41	6.12	3.80	6.03	3.62	6.03
December	220	4.4	6.2	2.88	4.00	2.35	3.73	2.24	3.73
Total	5,000	100.0	100.0	72.00	100.00	63.00	100.00	60.00	100.00

with an agreement entered into by the City of San Diego and the La Mesa, Lemon Grove, and Spring Valley Irrigation District, and releases for municipal and irrigation supply were made in accordance with this agreement. In this study, the district was allotted all of the water originating above Cuyamaca Reservoir and all flows up to a total of 27 second-feet of the waters originating below Cuyamaca Reservoir and above the Diverting Dam on the San Diego River and in the South Fork above the diversion of the district's flume. The City of San Diego was allotted all of the water originating below the South Fork and the remainder of all other waters originating below the Cuyamaca Reservoir, after the deduction of the 27 second-feet allotted to the district.

Of the storage in the El Capitan Reservoir, 10,000 acre-feet was allotted to the district and 106,872 acre-feet to the City of San Diego. The evaporation losses from the El Capitan Reservoir were divided among the two parties in proportion to the amount of water each had in storage at the beginning of each month.

Cuyamaca Reservoir was operated for the benefit of the district. The inflow into the reservoir was stored in the reservoir until the first of May and then released to El Capitan Reservoir until, if possible, the 10,000 acre-feet of storage allotted to the district was reached. The agreement between the City of San Diego and the district permits the district to store water in El Capitan Reservoir in excess of 10,000 acre-feet temporarily between May 1 and October 31 of any season. The temporary storage was not utilized in this study because it was found that the use of such temporary storage resulted in a portion of the waters of the San Diego River allotted to the district being lost to the City of San Diego in the event of a wet season following the season during which the temporary storage had been utilized. If the district had 10,000 acre-feet in storage in El Capitan Reservoir on May 1, the water in

Cuyamaca Reservoir was retained there until the next season. In this and succeeding studies, all releases from Cuyamaca Reservoir were assumed to be subject to losses of 5 per cent. While under present methods of operation the losses from releases from Cuyamaca Reservoir are much greater, it was felt that the method of release proposed in these studies would result in much smaller losses.

The attempted draft for the district of 5,000 acre-feet per season resulted in a deficiency of 2,148 acre-feet in 1900 and a deficiency of 2026 acre-feet in the winter of 1904-05 or a total deficiency during the critical period 1895-1905 of 4,174 acre-feet. The supplementary supply which may be obtained from underground basins below El Capitan Reservoir was not considered in this study. The draft of 9,000 acre-feet per season for the City of San Diego was obtained throughout the critical period and 2,330 acre-feet remained in storage in El Capitan Reservoir on February 1, 1905.

In order to determine whether a safe yield of 14,000 acre-feet per year could be obtained from the coordinated operation of the Cuyamaca and El Capitan reservoirs, another study was made in which there was no division of water, draft or storage space between the City of San Diego and the La Mesa, Lemon Grove and Spring Valley Irrigation District. This study was made on a seasonal basis over the critical period 1895 to 1905. In it, inflow to Cuyamaca Reservoir was stored in that reservoir until May 1st of each season, and then released as rapidly as possible to El Capitan Reservoir, if storage was available or as soon as storage became available. This resulted in a more efficient operation of Cuyamaca Reservoir through the reduction of evaporation losses, and a draft of 14,000 acre-feet per season, without deficiency, was obtained, with 2,469 acre-feet remaining in storage in El Capitan Reservoir on February 1st, 1905. This draft is that shown in the first line of Table 35 and is

believed to be the safe yield of the basin under present conditions, that is, with Cuyamaca and El Capitan reservoirs in operation.

Studies were also made to estimate the safe yields of the Cuyamaca and El Capitan reservoirs operated coordinately with the San Vicente, Mission Gorge No. 2, or Mission Gorge No. 3 reservoirs, respectively. The studies were made with four capacities of San Vicente reservoir, three capacities of Mission Gorge No. 2 reservoir, and three capacities of Mission Gorge No. 3 reservoir. In all of these studies, the Cuyamaca and El Capitan reservoirs were operated as described in the last foregoing paragraph. A seasonal draft of 5,000 acre-feet for irrigation was furnished at all times. When San Vicente reservoir was included with Cuyamaca and El Capitan reservoir in the study, the irrigation draft was obtained from the two latter reservoirs as long as possible and then from San Vicente. When Mission Gorge reservoir was used with Cuyamaca and El Capitan reservoirs, all of the irrigation draft was taken from the latter reservoirs. The order in which water was drawn from the reservoirs for other uses with San Vicente in operation was Cuyamaca, El Capitan and San Vicente. With either Mission Gorge reservoir in operation, the order was Cuyamaca, Mission Gorge and El Capitan. This method of operation reduced evaporation losses to a minimum by retaining the water longest in the reservoirs with the smallest evaporation losses, thereby increasing the total safe yield. The safe yields so estimated are given in Table 35 in sections 2, 3 and 4, respectively. The table also gives the additional safe yields due to the operation of the San Vicente, Mission Gorge No. 2, or Mission Gorge No. 3 reservoir, respectively, with the Cuyamaca and El Capitan reservoirs. This additional yield is the difference between the total yield and the 14,000 acre-feet from Cuyamaca and El Capitan reservoirs operated as previously described.

Estimates of the safe yield of the San Diego River Basin above Mission Gorge were made by utilizing sufficient reservoir space to conserve practically all of the run-off from above that point. In these studies, as previously stated, about 20 per cent of the total run-off during the period 1887 to 1895 was allowed to waste so as to be reasonably sure that all reservoirs would have been full at the beginning of the critical period 1895 to 1905. With this assumption, it was found that 130,000 acre-feet of storage in San Vicente reservoir was the maximum that could be utilized to control that stream and that 57,600 acre-feet at Mission Gorge, in addition to the storage in Cuyamaca and El Capitan reservoirs as now constructed was all that could be utilized on the main river. It would be possible of course to store less water in San Vicente reservoir and more in the Mission Gorge reservoir, holding the total to about 188,000 acre-feet. It was found, however, that this would result in a decreased yield due to increased evaporation losses. The San Vicente reservoir site lies in a comparatively narrow canyon, whereas the greater part of the Mission Gorge site is of the valley type. For equal capacities, therefore, the San Vicente reservoir would have smaller surface areas and correspondingly smaller evaporation losses. Also, on account of the character of reservoir sites, the evaporation losses from the San Vicente reservoir would be less than from the El Capitan reservoir.

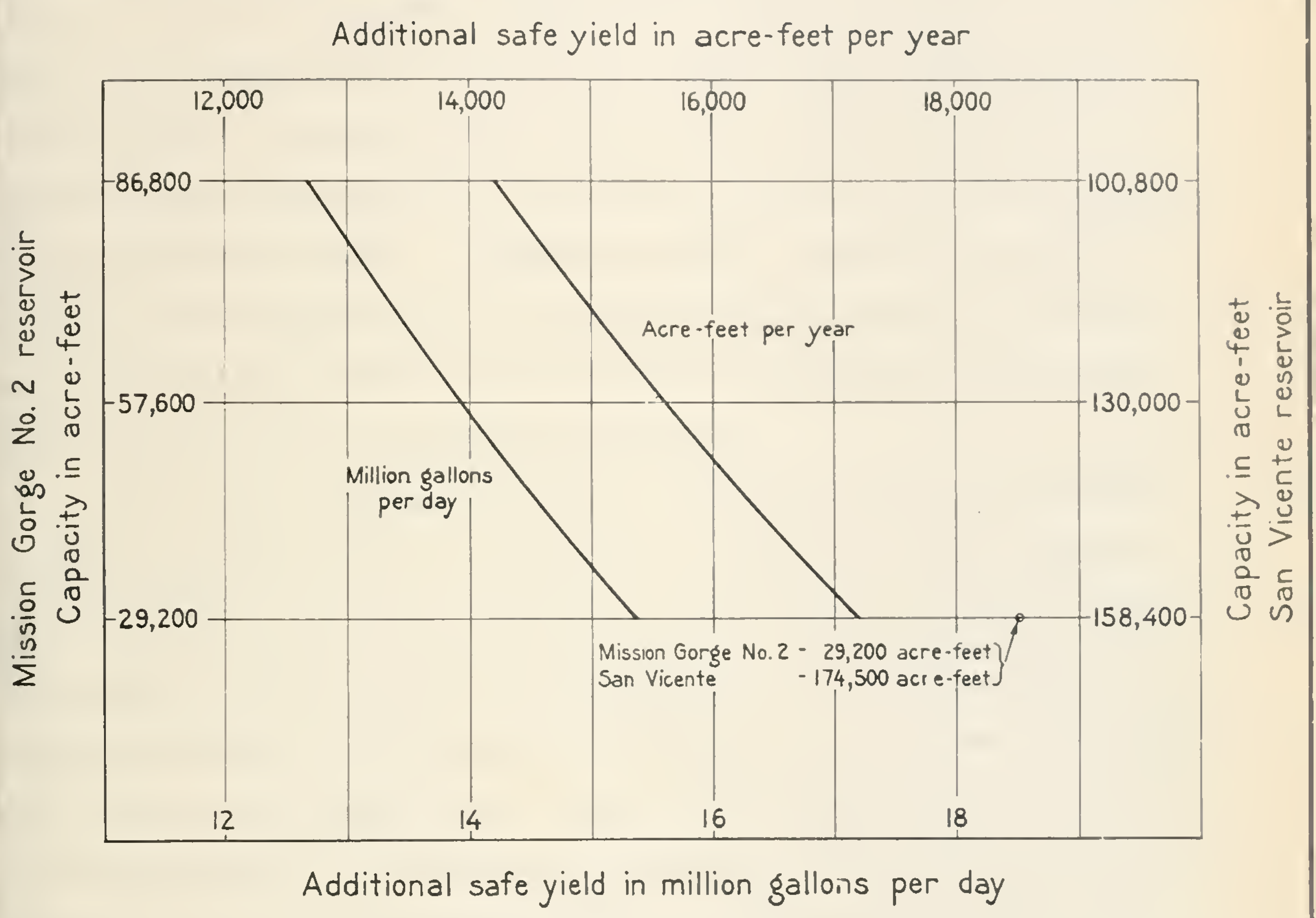
In the studies of the coordinated operation of the Cuyamaca, El Capitan, San Vicente and Mission Gorge reservoirs the assumptions as to draft were much the same as for the operation of either San Vicente or Mission Gorge reservoir, alone, with Cuyamaca and El Capitan reservoirs. The inflow to Cuyamaca Reservoir was stored in that reservoir until May 1st of each season and then released as rapidly as possible to refill El Capitan Reservoir or, if no space was available in that reservoir, as fast as storage became available. A seasonal

draft of 5,000 acre-feet for irrigation was furnished at all times. Water for this supply was obtained from El Capitan Reservoir as long as water was available from it and then from San Vicente reservoir. No water for this purpose was drawn from Mission Gorge reservoir. Additional drafts for municipal supply were drawn from Mission Gorge and El Capitan reservoirs, in order, until each was empty, and then the draft was taken from San Vicente reservoir. This method of draft, for the reasons previously given, would reduce evaporation losses to a minimum by retaining water longest in the reservoirs with the smallest evaporation losses.

Since it was found that decreasing the storage capacity of San Vicente reservoir to less than 130,000 acre-feet and increasing the capacity of Mission Gorge reservoir to more than 57,600 acre-feet, keeping the total of the combined storage capacities at about 188,000 acre-feet, would result in a decreased yield, studies were made to determine the effect of increasing the size of San Vicente reservoir to more than 130,000 acre-feet and decreasing the size of Mission Gorge reservoir. In these studies, Mission Gorge No. 2 reservoir was used. The method of operation was that described in the last preceding paragraph. The use of San Vicente Reservoir to store water in excess of 130,000 acre-feet would be possible through the transfer of water to it from El Capitan Reservoir, thereby preventing it from spilling past that reservoir to Mission Gorge reservoir. The transfer could be made without expenditure for additional works by using the pipe lines from these reservoirs which would be installed to transport the municipal supply. These lines could be connected near Lakeside and the transfer accomplished by gravity flow when there was sufficient difference in head between the water surfaces in the reservoirs. The transfer would be made at such times as the full municipal supply draft was being taken from Mission Gorgo reservoir or when the pipe lines were not operating to full

capacity for this supply. The estimated safe yields which could be obtained from the coordinated operation of Cuyamaca, El Capitan, San Vicente and Mission Gorge No. 2 reservoirs are shown in Section 5 of Table 35. This table also shows the increase in yield which could be obtained by increasing the capacity of San Vicente reservoir and decreasing that of Mission Gorge No. 2 reservoir. This effect is also shown graphically by the curves on Plate XIX, "Additional Safe Yields from San Vicente and Mission Gorge No. 2 Reservoirs Operated Coordinately with Cuyamaca and El Capitan Reservoirs."

The yields shown in the first three lines of Section 5 of Table 35 are those with a combined total capacity of San Vicente and Mission Gorge No. 2 reservoirs of 187,600 acre-feet. It was found from the studies for estimating these yields, however, that with a capacity of 29,200 acre-feet in Mission Gorge No. 2 reservoir, the minimum capacity which is required to control the run-off from the area between Mission Gorge and the El Capitan and San Vicente dam sites, and 158,400 acre-feet capacity in San Vicente reservoir, the spill from Mission Gorge No. 2 reservoir during the period 1887 to 1895 would have been more than 20 per cent of the total run-off of the basin above that reservoir in the same period. This increase in spill was caused by the decrease in evaporation losses through the storage of more water in San Vicente reservoir and less in Mission Gorge No. 2 reservoir. This indicated that more water could be stored in San Vicente reservoir, and the studies show that with a capacity of 174,500 acre-feet in this reservoir and 29,200 acre-feet in Mission Gorge No. 2 reservoir, the spill past the latter reservoir in the period 1887 to 1895 would have been about 20 per cent of the run-off. The yield with these two capacities is therefore comparable with that with 130,000 acre-feet in San Vicente reservoir and 57,600 acre-feet in Mission Gorge No. 2 reservoir. A detail study of the yield of the San Diego River using the Cuyamaca and El Capitan reservoirs,



ADDITIONAL SAFE YIELDS
FROM
SAN VICENTE AND MISSION GORGE Nº 2 RESERVOIRS OPERATED COORDINATELY
WITH
CUYAMACA AND EL CAPITAN RESERVOIRS

174,500 acre-feet in San Vicente reservoir and 29,200 acre-feet in Mission Gorge No. 2 reservoir, for the period 1894, the year preceding the beginning of the critical period, through the season 1932-33 is given in Appendix A of this report. A summary of the study is given in Table 34, and a graphical presentation of the summary is shown on Plate XX, "Combined Operation of Reservoirs on San Diego River". The yields are also shown in the last line of Section 5 of Table 35. As shown by Table 35, the increase in capacity of San Vicente reservoir from 130,000 acre-feet to 174,500 acre-feet to care for the transfer of water to it from the San Diego River for storage, would result in an increase in the safe yield of 2,900 acre-feet per year, or 9.8 per cent of the total yield and 18.6 per cent of the additional yield.

In order to determine the effect on the yield of the San Diego River of using the Mission Gorge No. 3 reservoir site instead of Mission Gorge No. 2 site, a study the same as that described in the foregoing paragraph, and shown in Appendix A, was made, using the No. 3 site instead of the No. 2 site. The capacity of the No. 3 site was taken at 29,200 acre-feet, the same as that for the No. 2 site in the other study. The safe yields estimated from this study are shown in Section 6 of Table 35. A comparison of these yields with those given in the last line of Section 5 of the same table shows that the use of Mission Gorge No. 3 site instead of Mission Gorge No. 2 site would increase the yield 300 acre-feet per year, or about one per cent.

A summary of the safe yields estimated by all of the foregoing described studies is given in Table 35.

In the foregoing studies, no account has been taken of the effect of reduction of reservoir capacity by the deposition of silt or debris brought down by the water. From information obtained from constructed reservoirs in San Diego County, it is estimated that the amount of material deposited in the

TABLE 34

SUMMARY OF STUDY TO ESTIMATE SAFE YIELD OF SAN DIEGO RIVER
WITH COORDINATED OPERATION OF
CUYAMACA, EL CAPITAN, SAN VICENTE AND MISSION GORGE NO. 2 RESERVOIRS

Cuyamaca Reservoir	11,600 acre-feet
El Capitan Reservoir	116,900 acre-feet
San Vicente Reservoir	174,500 acre-feet
Mission Gorge No. 2 Reservoir	29,200 acre-feet
Total Storage Capacity	332,200 acre-feet

Season	(1)Flow into reservoirs, in acre-feet	Water in storage October 1st, in acre-feet	Evaporation from reservoirs, in acre-feet	Draft from reservoirs, in acre-feet	Flow over spillway at Mission Gorge No. 2, in acre-feet
1894-95	166,978	236,593	14,949	32,500	54,393
1895-96	4,894	301,729	13,760	32,500	0
1896-97	20,833	260,363	9,293	32,500	0
1897-98	2,433	239,403	10,375	32,500	0
1898-99	1,849	198,961	8,487	32,500	0
1899-00	945	159,823	5,971	32,500	0
1900-01	8,564	122,297	4,319	32,500	0
1901-02	7,456	94,042	4,264	32,500	0
1902-03	15,257	64,734	3,842	32,500	0
1903-04	1,290	43,649	2,757	32,500	0
1904-05	50,015	9,682	2,784	32,500	0
1905-06	110,934	(2) 23,888	5,856	32,500	0
1906-07	71,448	96,466	7,711	32,500	0
1907-08	24,234	127,703	7,396	32,500	0
1908-09	57,739	112,041	7,226	32,500	0
1909-10	33,481	130,054	7,771	32,500	0
1910-11	19,602	123,264	7,340	32,500	0
1911-12	23,069	103,026	5,682	32,500	0
1912-13	10,472	87,913	4,825	32,500	0
1913-14	25,496	61,060	4,238	32,500	0
1914-15	107,827	49,818	6,473	32,500	0
1915-16	351,231	118,672	13,875	32,500	145,160
1916-17	40,413	278,359	15,745	32,500	653
1917-18	30,826	269,874	14,633	32,500	0
1918-19	10,655	253,567	11,046	32,500	0
1919-20	42,209	220,676	10,324	32,500	0
1920-21	6,985	220,061	10,725	32,500	0
1921-22	200,998	183,821	14,872	32,500	40,077
1922-23	22,098	297,370	16,070	32,500	0
1923-24	8,659	270,898	12,459	32,500	0
1924-25	8,704	234,598	10,488	32,500	0
1925-26	35,873	200,314	8,392	32,500	0
1926-27	184,421	195,295	13,691	32,500	25,045
1927-28	11,798	308,480	14,743	32,500	0
1928-29	15,030	273,035	11,485	32,500	0
1929-30	19,036	244,080	9,897	32,500	0
1930-31	9,704	220,719	9,452	32,500	0
1931-32	101,724	138,471	11,437	32,500	0
1932-33	26,674	246,258	10,867	32,500	0
Averages	48,509	----	9,372	32,500	6,804

(1) Flow into reservoirs consists of flow into Cuyamaca, El Capitan, San Vicente and Mission Gorge No. 2 reservoirs less transmission losses between Cuyamaca and El Capitan reservoirs.

(2) On Feb. 1, 1905, San Vicente Reservoir had 525 acre-feet of water in storage. This quantity was disregarded and the reservoir assumed to be empty at that time.

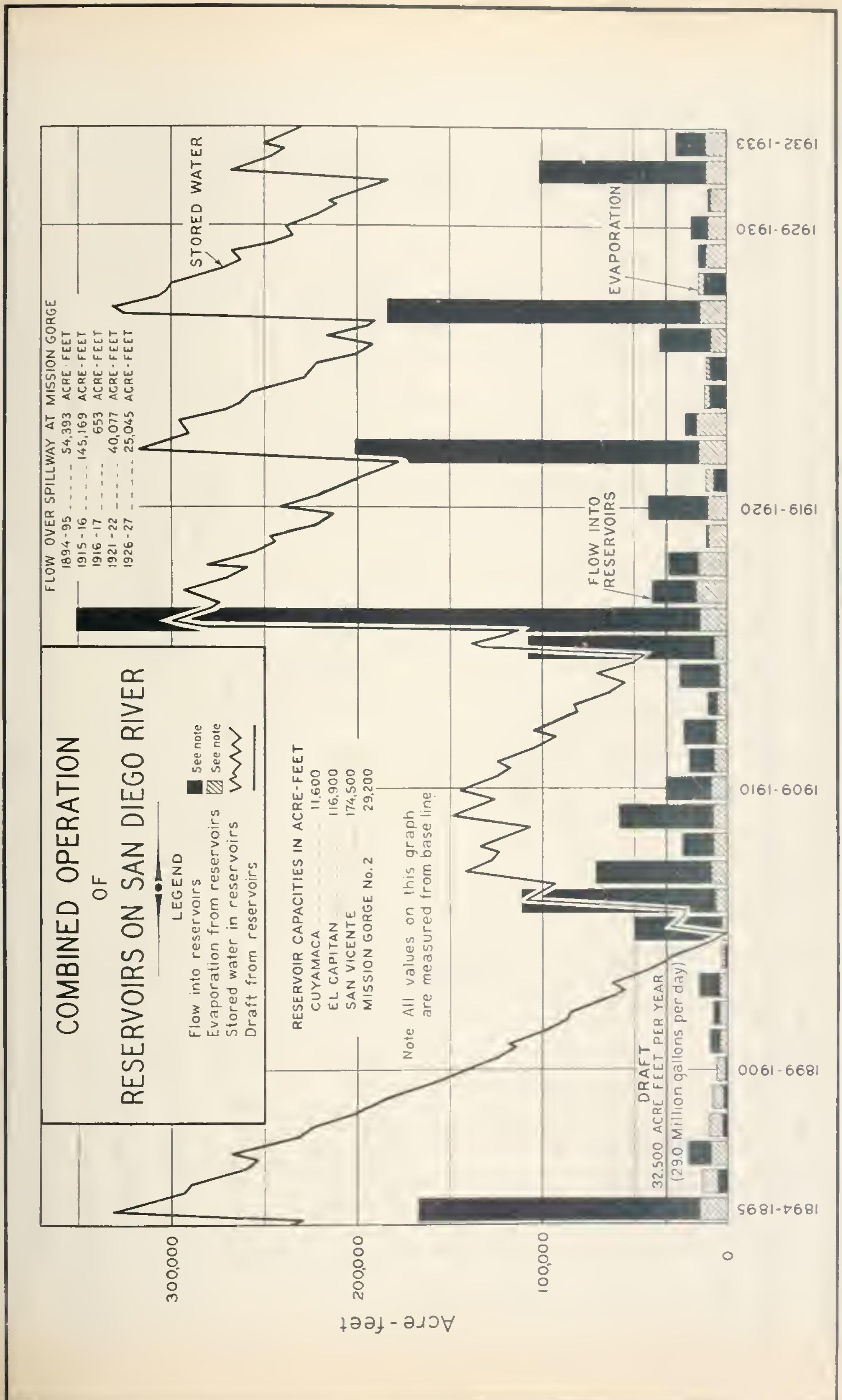

COMBINED OPERATION
OF
RESERVOIRS ON SAN DIEGO RIVER
LEGEND
Flow into reservoirs — See note
Evaporation from reservoirs — See note
Stored water in reservoirs
Draft from reservoirs
RESERVOIR CAPACITIES IN ACRE-FEET
CUYAMACA 11,600
EL CAPITAN 116,900
SAN VICENTE 174,500
MISSION GORGE No. 2 29,200
Note All values on this graph are measured from base line.
FLOW OVER SPILLWAY AT MISSION GORGE
1894-95 54,393 ACRE-FEET
1915-16 145,169 ACRE-FEET
1916-17 653 ACRE-FEET
1921-22 40,077 ACRE-FEET
1926-27 25,045 ACRE-FEET
STORED WATER
FLOW INTO RESERVOIRS
EVAPORATION
DRAFT
32,500 ACRE-FEET PER YEAR
(29.0 Million gallons per day)
Acre-feet
300,000
200,000
100,000
0
1894-1895
1899-1900
1909-1910
1919-1920
1929-1930
1932-1933

TABLE 35

SAFE YIELDS OF SAN DIEGO RIVER
WITH
ADDITIONAL RESERVOIRS OPERATING COORDINATELY WITH CUYAMACA AND EL CAPITAN RESERVOIRS

Cuyamaca Reservoir, 11,600 acre-feet — El Capitan, 116,900 acre-feet

Section	Storage capacities of additional reservoirs, in acre-feet			Safe Yields			
				Total		Additional over present (1)	
	San Vicente Reservoir	Mission Gorge No. 2 Reservoir	Mission Gorge No. 3 Reservoir	Acre-feet per year	Millions of gallons per day	Acre-feet per year	Millions of gallons per day
1	0	0	0	14,000(1)	12.50	0	0
2	100,800	0	0	22,800	20.36	8,800	7.86
	130,000	0	0	25,700	22.95	11,700	10.45
	158,400	0	0	28,500	25.44	14,500	12.94
	174,500(2)	0	0	30,200(2)	26.96	16,200(2)	14.46
3	0	29,200	0	16,700	14.91	2,700	2.41
	0	57,600	0	18,300	16.34	4,300	3.84
	0	86,800	0	19,800	17.68	5,800	5.18
4	0	0	29.200	17,200	15.36	3,200	2.86
	0	0	57,900	19,000	16.96	5,000	4.46
	0	0	87,600	20,700	18.48	6,700	5.98
5	100,800	86,800	0	28,200	25.18	14,200	12.68
	130,000	57,600	0	29,600	26.43	15,600	13.93
	158,400	29,200	0	31,200	27.86	17,200	15.36
	174,500	29,200	0	32,500	29.02	18,500	16.52
6	174,500	0	29,200	32,800	29.28	18,800	16.78

(1) Present yield is considered as that with Cuyamaca and El Capitan reservoirs operated coordinately to give the maximum utilization of water.

(2) With 174,500 acre-foot San Vicente Reservoir, the spill between 1887 and 1895 would have been only about 16 per cent of the run-off into the reservoirs instead of a minimum of 20 per cent obtained with all of the other combinations of reservoirs and their yields shown in this table.

El Capitan, San Vicente and Mission Gorge reservoirs might amount to about 340 acre-feet per year on the average. Most of this material would probably be caught in the El Capitan and San Vicente reservoirs but some silt or debris would be picked up by spill from these reservoirs and by run-off originating below them and carried into Mission Gorge reservoir. Since it would be possible to transfer water from El Capitan reservoir to San Vicente reservoir for storage, any fill which may occur in the former reservoir may be considered as occurring in the latter. It may be seen from the last two lines of Section 5 of Table 35 that a decrease in the capacity of the San Vicente reservoir would result in a decrease in the safe yield of the four reservoirs operated coordinately. Decrease in the capacity of Mission Gorge reservoir would have the same effect. Therefore, to maintain the safe yields shown in Table 35 over a long period of years, the San Vicente reservoir should be constructed originally to a capacity sufficiently greater than those shown in Table 35 to store the amount of material which would reach it and the El Capitan reservoir in the same period of years, and the Mission Gorge reservoir should be given sufficient additional capacity to store the material which would reach it.

Use of Underground Reservoirs for Seasonal and Cyclic Storage - In the foregoing described studies, the ultimate conservation development of San Diego River waters contemplates the use of a 29,200 acre-foot reservoir with a dam in Mission Gorge to store the spill from the upstream reservoirs and the run-off from the areas below El Capitan and San Vicente reservoirs. There are in the upper San Diego River Valley and Mission Valley, however, underground basins of considerable capacity which, if properly charged and drained, might be used in place of the Mission Gorge reservoir for the storage of a part of the run-off of the river and tributary streams. The substitution of the underground reservoirs, if possible, would have several advantages. The chief of

these would be, of course, the saving of the cost of the Mission Gorge dam and reservoir lands. Another saving would be in surface reservoir evaporation losses if the underground basin were so operated as to keep the water level below the roots of the brush and trees to prevent loss by surface evaporation and by transpiration.

A study of these underground basins has recently been made by J. C. Kimble and the utilizable storage capacity of the upper San Diego River Basin was estimated as 24,200 acre-feet and that of Mission Valley basin as 10,500 acre-feet. The upper San Diego River Valley basin extends from the Old Mission Dam to Cape Horn and includes the San Vicente sub-basin. However, the greatest depth of fill and more than sixty per cent of the total capacity in this upper basin occurs above Lakeside. Between Mission Dam and Sycamore Canyon the shallow fill does not permit of an appreciable amount of storage.

While the entire drainage basin area of 111 square miles above Mission Gorge and below San Vicente and El Capitan dam sites, as well as the local side drainage below Mission Gorge, is tributary to the Mission Valley underground basin, only about one half of the 111 square miles is tributary to the upper underground basin, and that portion above Lakeside, having an estimated storage capacity of 15,440 acre-feet, has but 28 square miles of drainage basin tributary to it. With the completion of El Capitan Reservoir and the construction of San Vicente reservoir, the basin would be dependent upon the run-off from these 28 square miles and the infrequent spills from the reservoirs for recharging.

While the Mission Valley basin is located at the lower end of the San Diego River drainage basin, the comparatively small capacity of this basin would be insufficient to conserve the run-off tributary to it if no reservoir were constructed at Mission Gorge. The spills from the upstream reservoirs

would occur during large storms at a time when the local run-off would probably be of greater magnitude than the absorptive capacities of the underground basins. The flood flows of the San Diego River are in general extremely flashy and of comparatively short duration, which would result in large surface outflows during the major floods and result in water wasting into the ocean.

At present both basins are being utilized for irrigation supplies and by the City of San Diego for municipal supplies. The La Mesa, Lemon Grove and Spring Valley Irrigation District has wells and a pumping plant in the upper basin at El Monte for the exportation of water. The present installed capacity of pumping equipment in wells in the upper basin is probably greater than the safe yield from the underground basin after the construction of El Capitan and San Vicente reservoirs.

The quality of water for domestic use in parts of the Mission Valley basin is inferior to that from the upper basin, but it is probable that if greater use were made of this basin by the exportation of water, the replenishment with surface waters would improve the quality.

In view of the location of the upper underground basin with respect to the drainage basin tributary to Mission Gorge reservoir, the high rate of absorption necessary to store the flashy flood flows, the inability of the underground basins to catch any appreciable amount of the spill from the upstream reservoirs, and the fact that only a very small part of the upper underground basin area would be flooded by a Mission Gorge reservoir of 29,200 acre-feet capacity, no safe yield studies or cost estimates have been made in this investigation of these underground basins, and they are not considered adequate to replace the Mission Gorge surface storage.

Any yield from the Mission Valley underground basin derived from the local run-off and spills from the Mission Gorge reservoir will be over and above

the safe yields shown for complete development by surface storage. Any yield derived from the upper San Diego River underground basin will lower the safe yield shown for complete development by surface storage but the aggregate sum of that secured from the underground basin and surface reservoirs will not be less than the safe yield shown, and may be slightly greater.

Cuyamaca Reservoir - The Cuyamaca Reservoir is located on the headwaters of Boulder Creek, a tributary of the main San Diego River, in the Cuyamaca Grant on what would be the line between Twps. 13 and 14 S., R. 4 E., S.B.B. and M. if this line were extended into the grant. Its location is shown on Plate XVII. The reservoir was constructed in 1887 and is now the property of the La Mesa, Lemon Grove and Spring Valley Irrigation District.

Data on the elevations of water surfaces and the areas of the reservoir, depths of water, and capacities of the reservoir at these elevations, as obtained from the irrigation district, are given in Table 36.

TABLE 36

AREAS AND CAPACITIES OF CUYAMACA RESERVOIR

Depth of water at dam, in feet	Water surface elevation of reservoir, in feet, U.S.G.S. datum	Area of water surface, in acres	Capacity of reservoir, in acre-feet
10	4603	9	15
15	4608	150	350
20	4613	354	1540
25	4618	574	3790
30	4623	776	7120
35.4	4628.4 (1)	978	11,600 (2)

(1) Crest of spillway.
(2) Maximum storage capacity.

The dam for the reservoir is of the earth fill type with a maximum height of 40 feet and a crest length of 665 feet. The top of the dam has a width of ten feet and the approximate slopes of the faces are 1.7:1 upstream and $1\frac{1}{2}$:1 downstream. The upstream face is protected by a layer of rock rip rap. There are spillway channels at both ends of the dam. The channel at the left end is 47 feet wide and 5 feet deep below the crest of the dam. The channel at the right end is about 84 feet wide and 4.5 feet deep. Both channels have concrete sills but are not concrete lined throughout. The combined capacity of the channels is 3,800 second-feet.

The outlet from the reservoir is a 3 foot by 4 foot masonry conduit under the central portion of the dam. Water enters this conduit through a circular brick outlet tower having an inside diameter of five feet, in which there are two 3 foot by $4\frac{1}{2}$ foot wooden regulating gates 16 feet apart with the lower gate at the elevation of the conduit.

El Capitan Reservoir - The El Capitan Reservoir site is located in Secs. 14, 15, 21, 22, 27, 28 and 33, T. 14 S., R. 2 E., and Secs. 3, 4, 7, 8, 9, 10, 16 and 17, T. 15 S., R. 2 E., S.B.B. and M. The dam site for the reservoir is located in the $E\frac{1}{2}$ of the $NE\frac{1}{4}$ of Section 7, T. 15 S., R. 2 E., about 7 miles easterly from Lakeside. The dam has recently been completed and the reservoir is storing the run-off of the 1934-1935 season. The reservoir is the property of the City of San Diego and is to be used by the city and the La Mesa, Lemon Grove and Spring Valley Irrigation District. Data on the elevations of water surfaces and the areas of the reservoir, depths of water, and capacities of the reservoir at these elevations, as obtained from the City of San Diego, are given in Table 37.

TABLE 37

AREAS AND CAPACITIES OF EL CAPITAN RESERVOIR

Depth of water at dam, in feet	Water surface elevation of reservoir, in feet, U.S.G.S. datum	Area of water surface, in acres	Capacity of reservoir, in acre-feet
40	593	101	1,500
60	613	219	4,700
80	633	352	10,400
100	653	519	19,100
120	673	708	31,400
140	693	883	47,300
160	713	1,096	67,100
180	733	1,359	91,600
197	750 (1)	1,580	116,900 (3)
200	753	1,613	121,300
217	770 (2)	1,855	150,800

(1) Crest of spillway.
(2) Top of dam.
(3) Maximum storage capacity.

The El Capitan dam is a combination earth fill-rock embankment structure, with most of the earth placed by the hydraulic method. The top of the dam is at elevation 770 feet, U. S. Geological Survey datum, at which elevation the crest has a width of 26 feet and a length of about 1200 feet. The foundation is approximately 25 feet below the original stream bed level and the maximum height of the dam is about 242 feet above foundation. On the upstream face of the dam, the slopes gradually change from 3:1 at the bottom to 2:1 at the top. On the downstream side, the slopes change from 3:1 at the bottom to 1-3/4:1 at the top. The maximum thickness of the dam at the base is about 1240 feet. The upstream and downstream toe sections of the dam across the stream bed are composed of rock dumped in place to form retaining dams for the hydraulic fill in the center. These fills extend to elevations of about 650 feet upstream and 620 feet downstream. Above these elevations, the rock

which forms the faces of the dam was also used during construction to retain the hydraulic fill. The central portion of the dam below elevation 718 feet is a hydraulically placed earth fill with a puddle core of fine impervious material approximately under the crest of the dam. Between elevations 718 and 753 feet, the earth section was constructed by compacting the material by rolling on the upstream and downstream sides and puddling the material in the core. Between elevation 753 feet and the crest of the dam, all of the earth section was compacted by rolling. Under the puddle core, there is a concrete cutoff wall keyed into bed rock and extending about 20 feet into the earth fill.

The spillway is of the side channel type and is located around the right end of the dam. The channel is mostly in rock or decomposed granite excavation and is concrete lined. It extends 1550 feet from a point about 500 feet upstream from the center line of the dam to a point about 400 feet below the downstream toe, from which point an unlined cut will carry the water to the natural channel of the river. The channel is 30 feet wide at the upstream end of the spillway crest, 215 feet wide opposite the downstream end of the crest, and 150 feet wide at the outlet end. The spillway crest is 510 feet long and is of the ogee overflow type, without gates or flashboards. Its top is at elevation 750 feet or 20 feet below the top of the dam. The estimated capacity of the spillway with a depth of water of 12 feet on the crest is 70,000 second-feet.

Diversion of the stream flow during construction was made through a 25-foot diameter concrete lined tunnel under the left abutment of the dam. An additional concrete lining has been placed in this tunnel which will be used for the outlets from the reservoir. Two 42-inch and two 36-inch pipes have been laid through a concrete tunnel plug near the upstream end of the tunnel and will connect with the delivery line leading from the reservoir. Water will

enter these pipes from a circular concrete tower, with an inside diameter of 12 feet and a height of 210 feet, located alongside the diversion tunnel about 56 feet from the inlet portal and about in line with the upstream toe of the dam. Flow into the tower is controlled by six 30-inch saucer valves in cast iron elbows and one 30-inch square slide gate, all manually-operated from the top of the tower. The saucer valve inlets are located at 25-foot differences in elevation above the lowest one at elevation 610 feet. The 30-inch square slide gate is at elevation 569 feet and is in an inlet from the side of the tunnel.

The reservoir lands lie along the main San Diego River, its South Fork, and Chocolate Creek. They are relatively flat next to these streams but extend up the steep slopes at the sides of the canyons. All of the lands have been or will be cleared of vegetation.

San Vicente Reservoir - The San Vicente reservoir site is located on San Vicente Creek in Sections 17, 19, 20, 28, 29, 30 and 31, T. 14 S., R. 1 E., and Sections 25 and 36, T. 14 S., R. 1 W., S.B.B. and M. The dam site is in the SW$\frac{1}{4}$ of the NW$\frac{1}{4}$ of Sec. 31. The location of the reservoir site is shown on Plate XVII.

A topographic survey of the reservoir site to elevation 650 feet U. S. Geological Survey datum, was made by the City of San Diego in 1923, and a map was drawn from this survey at a scale of one inch equals 500 feet, with a contour interval of 10 feet. The water surface areas of the reservoir as obtained from the City of San Diego, and the capacities of the reservoir computed from them are given in Table 38.

TABLE 38

AREAS AND CAPACITIES OF SAN VICENTE RESERVOIR

Depth of water at dam, in feet	Water surface elevation of reservoir, in feet, U.S.G.S. datum	Area of water surface, in acres (1)	Capacity of reservoir, in acre-feet
84	540	400	11,300
104	560	562	21,000
124	580	690	33,500
144	600	820	48,600
164	620	936	66,300
184	640	992	85,600
204	660	1,114	106,300
224	680	1,238	129,900
244	700	1,320	155,500
264	720	1,414	182,900
274	730	1,462	197,200

(1) From City of San Diego.

A survey of the dam site was also made by the City of San Diego in 1923. A topographic map drawn from this survey on a scale of one inch equals 100 feet with a contour interval of 10 feet was used in laying out and estimating the costs of dams at this site.

The geology of the dam site has been studied recently, in connection with the preparation of this report, by Chester Marliave. In this study, he was aided by information obtained from six holes, with an aggregate depth of 221 feet, drilled in the stream channel, and from a tunnel excavated into the right abutment and another excavated into the left abutment. All of this exploratory work was done about 1926 by the City of San Diego. Further explorations of the dam site by tunnels and drilling should be made before the final location for any dam at this site is selected. Sufficient funds for such explorations are included in the items for engineering and contingencies in the following cost estimates for the dam. A description of the geology of the site,

as taken from Chester Marliave's report is as follows:

"The San Vicente dam site is underlain by an old metamorphosed series of rocks which is often spoken of as the crystalline complex. This term rightfully suggests a complex mixture of rocks of considerable age which under the heat and pressure of mountain making movements, has fused these original rocks and recrystallized them into a hard massive conglomeration in which much of the original segregation is lacking. However, the structure of the original formations often carried through into the metamorphosed rock and at the San Vicente dam site there is a splendid example of it. The Peninsular Range of which this area is a part is composed for the most part of igneous rocks of which granite predominates.

"Some geologists who have studied the region in the southern part of the State believe that there is a possible fault running up the side of San Vicente Canyon and crossing into the hills about a half mile west of the proposed dam site. The location of this fault has been projected northwesterly and southeasterly from the dam site for about 15 miles in each direction. Observation of the topographic evidence along the eastern slope of the canyon wall between the mouth of the canyon and Foster shows no evidence that the fault has been active in historic time. At any rate, the fault does not pass through the dam site and therefore is not of serious concern.

"The rocks at the dam site are mostly granitic in character. They are hard, quite massive, have the usual fractured structure and are well exposed over most of the abutments as well as in the canyon bottom and on the higher slopes of the mountains. Interfused with the granite were some sediments in the form of sands, clay shales and possibly some volcanic ash. These sediments have for the most part been metamorphosed to hard silicified rocks but the original color and texture has been carried through the process and appears

outstanding in certain exposures from the granite.

"Faulting is not evident at the dam site. Some of the cross-fracturing has resulted in differential movement wherein these cracks are filled with crushed material but their extent is not great. Several of them were followed for over fifty feet in the draw upstream from the axis of the dam. These fractures should tighten up a short distance from the surface.

"The structure of the rocks at the dam site has a general direction running up and down the canyon with an easterly dip between 60 and 80 degrees. This structure pertains to the sedimentary rocks which occupy the stream bed and the easterly or left half of the dam site. A peculiar feature is that the adjoining granite seems to have a fracture system somewhat similar to that of the metamorphosed sediments, as well as several others. Because the granite and the sediments are fused together, it is difficult to draw a contact between them and often hard to distinguish the origin of the rock itself. Above the highway on the left side of the dam site, the sedimentary rocks can be seen outcropping with an overhang. This is due to the structure of the rocks which dip steeply into the hill with some of the weaker members weathering away more readily than the more competent members.

"The channel section of the dam site has a width of about 100 feet. This area represents the present sandy portion of the stream against which the talus slopes terminate, rising up gradually till the rock outcrops on the hill sides are encountered. Six holes were drilled in the stream channel about 1926 by the City of San Diego. According to the drill records, the sand in the channel is comparatively shallow, having a maximum depth of 15 feet. The logs of these drill holes indicate that granite was encountered, but the rock encountered is probably metamorphosed sediments. In either case, the rock is a satisfactory foundation for any type of dam. On the right hand side of the

sandy portion of the channel there is a width of about 25 feet of loose rock before the bedrock is encountered on the right abutment. On the left side of the sandy portion of the channel section there is about 200 feet average width before rock exposures are encountered on the left abutment. The concrete highway runs along this side and below the highway fill is the fill of the old county road. The fill material from these two roads has obscured the bedrock that might otherwise appear along the bottom of the slope in the channel section.

"The rock on the right abutment of the dam site, as disclosed by surface outcrops, is granite as far as can be ascertained. A tunnel which had previously been run into the hillside, at an elevation about 12 feet above the stream bed, passes through a belt of sediments for 45 feet and then encounters granite. The projection of the steep vertical contact between these two rocks was traced out on the surface, and it checked up with the surface outcrops as closely as could be expected. This contact seems to represent the western edge of the belt of sediments that underlie the dam site. Most of the surface exposures of this sedimentary rock are very hard, much like the granite, but in the tunnel some shale beds were encountered which were not quite so hard but of satisfactory character for dam foundation.

"In examining the right abutment, a small fissure in the hillside was discovered which was thought to be a fault of recent activity, because of the open trench which it exhibited continuously up the hill over the right end of the dam site. Upon investigation, the fissure or open fracture, which was several feet wide and as much as 10 feet deep in places, was found to be composed of a fine grained dike about two feet in width. This dark dike looks much like a sandstone or black shale bed but as near as could be ascertained, the rock on both sides of it is primarily a granite. The softness of this dike caused it to weather more easily than the granite, thus forming the trench-

like opening over the hillside.

"The rocks that come within the confines of the left abutment are the metamorphosed sediments. A tunnel which had previously been run into the hill a short distance in elevation above the highway encounters sandstone rocks all of the way. These rocks are bluish in color and more or less fused into a crystalline rock like quartzite. A well exposed section of similar bedrock was found in the ravine on the downstream side of this abutment where the recent rains had washed the detrital material from the surface exposing the structure of the sediments. This exposed section was traced up the hillside beyond the crest elevation of the highest dam considered for this site, where the sedimentary rocks finally gave way to granites. The granite which lies at these higher elevations seems to have encroached over upon the sediments in this area. The condition of the contact could not be obtained at this location but a few hundred feet upstream from the probable left end of the dam, the contact between the granite and the sediments was clearly observed and was found to be tightly healed together. In following down a ravine just upstream from the left end of the dam site, the sedimentary rocks were observed to be hard, tight and of satisfactory quality almost as far down as the road where they disappeared under the alluvium."

A gravity concrete or rock fill type of dam could be built at this site and both types have been considered and studied. As has been previously shown in the description of yield from the San Diego River Basin, the San Vicente reservoir would be the last one drawn upon and water might remain in storage for a long period of years. It is, therefore, essential to reduce leakage losses from the reservoir to a minimum or the amounts of water so lost might decrease the safe yield of all the reservoirs a material amount. It is believed that seepage and leakage losses can be made much smaller with a gravity concrete dam

than with a rock fill dam and for this reason the former type was selected for this site. Costs with these types were found to be approximately the same.

Estimates have been made of the costs of reservoirs with gravity concrete dams 209, 234, 256 and 268 feet in height. In making these estimates, all of the dams were located with the upstream face in the same position in the canyon. The dams would have a vertical upstream face and a downstream slope of 0.807:1 starting from the upstream crest line of the non-overflow portions of the dam. The crests of the portions not occupied by the spillway would be 10 feet wide with an approximately vertical face from the downstream crest line to an intersection with the sloping downstream face of the dam. For all heights of dam, the spillway would be placed in the crest of the dam over the stream channel. It would be 300 feet in length and its crest would be 10 feet below the tops of the non-overflow sections of the dam. With this length and depth of spillway, the estimated crest flow from a flood which may occur once in 1000 years on the average would pass over the dam without overtopping the non-overflow portions. Walls down the face of the dam from each end of the spillway crest would guide the water from it over a curved concrete bucket 145 feet in length, across the lowest part of the channel, at the toe of the dam. No gates or flashboards would be placed in the spillway and the normal maximum water surface would therefore be at the elevation of the spillway crest.

The outlets from the reservoir would consist of 30-inch steel pipes embedded in the concrete of the dam at elevation 480 feet, or about 24 feet above the stream bed level. Two pipes would extend entirely through the dam and connect with the delivery line leading from the reservoir. Flow through each pipe would be controlled by a slide valve located in a chamber inside of the dam near the upstream face. Access to this chamber would be from the drainage and inspection gallery which would run through the dam. A third

30-inch pipe to be used for a sluiceway would extend through the dam from the upstream face and discharge into the spillway channel just above the bucket. Flow through it would also be controlled by a slide valve located in the same chamber as the other valves. Water would enter the pipes through a semicircular concrete tower 20 feet in outside diameter extending from the foundation line to the top of the dam. This tower would be located just to the left of the left end of the spillway section of the dam . Water would enter the tower through five 30-inch circular slide gates operated from a gate house at the top of the tower. One of these gates would be opposite the inlet of the discharge pipes and the others would be placed at the one-fifth points between that point and the level of the spillway crest. Each gate would be protected by a semicircular trash rack which could be lifted above the water level with a hoist in the gate house.

It is estimated from the data obtained from the drill holes in the stream bed, the tunnels into the abutments, and the geological report by Chester Marliave, that the removal of about 15 feet of overburden and decomposed rock on the abutments and 15 feet of sand and gravel in the stream bed would expose firm rock for the dam foundation. In order to decrease the possibility of seepage under the dam, a concrete cut-off wall at the upstream toe of the dam would extend 15 feet into the solid rock, and below this wall the foundation rock would be sealed by pressure grouting.

It is believed that there is sufficient sand for the concrete available in the vicinity of the dam and that the local rock could be crushed for the large aggregate and part of the medium size aggregate. To make the concrete more workable, however, it is estimated that about a third of a cubic yard of gravel per cubic yard of concrete would have to be hauled from the lower end of Mission Gorge or some other gravel deposit. All other materials and equip-

ment would probably be hauled by truck about 3.5 miles from the railroad at Lakeside.

The reservoir lands are now practically all owned by the City of San Diego but their cost has been included in all estimates of the costs of the reservoirs. Some of these lands are already clear but others would have to be cleared of brush and some trees. The only improvement of any importance is the secondary State Highway from Lakeside to Ramona which runs through practically the entire length of the reservoir and this highway would have to be relocated. A possible relocation to the west of the reservoir would require about 10 miles of new road.

As previously stated, estimates of cost were made for reservoirs created by four different heights of dam. A somewhat detailed estimate of the capital and annual costs for one of these reservoirs, that with a 268-foot dam, is given in Table 39. The layout and cross sections of this dam are shown on Plate XXI, "San Vicente Dam on San Vicente Creek, a Tributary of San Diego River."

The estimated total capital and annual costs for the reservoirs with all heights of gravity concrete dams studied are given in Table 40. In making these estimates, the same items and unit costs as those given in Table 39 were used. The layouts for all dams studied were similar to that shown on Plate XXI.

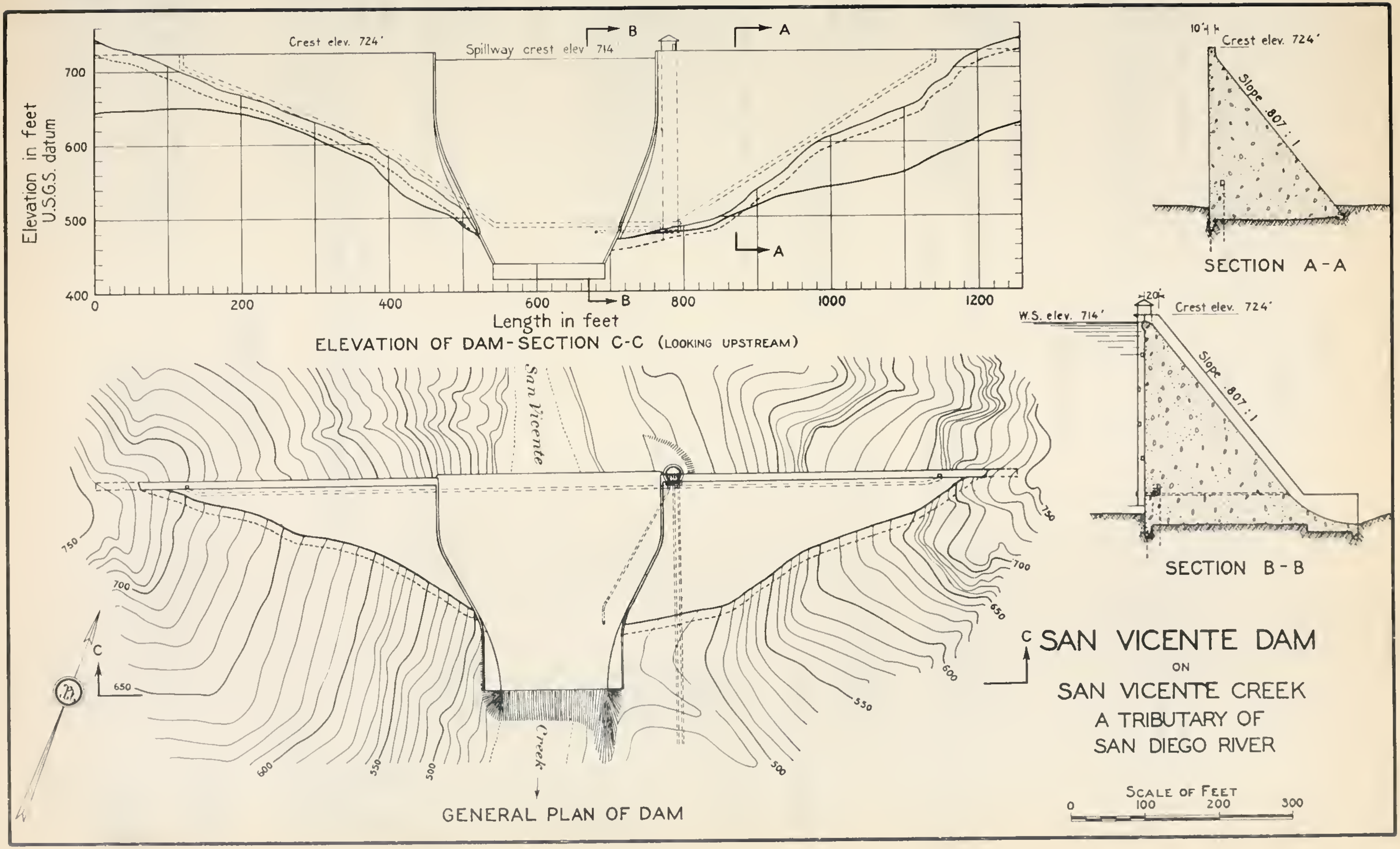

Elevation in feet
U.S.G.S. datum
Crest elev. 724'
Spillway crest elev 714'
Length in feet
ELEVATION OF DAM-SECTION C-C (LOOKING UPSTREAM)
Crest elev. 724'
Slope .807 : 1
SECTION A-A
W.S. elev. 714'
Crest elev. 724'
Slope .807 : 1
SECTION B-B
San Vicente
Creek
GENERAL PLAN OF DAM
SAN VICENTE DAM
ON
SAN VICENTE CREEK
A TRIBUTARY OF
SAN DIEGO RIVER
SCALE OF FEET

TABLE 39

COST OF SAN VICENTE RESERVOIR

Operated for Conservation Purposes

Crest of dam, elevation 724 feet, U.S.G.S. datum.	Capacity of reservoir to spillway lip, 174,500 acre-feet.
Crest of spillway, elevation 714 feet.	Capacity of spillway,
Height of dam, 268 feet.	26,000 second-feet.

CAPITAL COST

Dam (Including spillway)					
Excavation					
Gravel (Including unwatering)	17,190	cu.yds. at	$1.50	$25,790	
Rock - Stripping	86,750	cu.yds. at	2.50	216,870	
- Cutoff wall trenches	5,550	cu.yds. at	4.00	22,200	$264,860
Concrete					
Mass	586,830	cu.yds. at	6.60	$3,873,080	
Reinforced - Spillway walls	1,230	cu.yds. at	19.25	23,680	
- Gate towers and house	400	cu.yds. at	19.25	7,700	3,904,460
Grouting, drainage and seals	1,250	ft. of dam	at 90.00	112,500	112,500
Outlets					
Steel pipe - 30 inch	450	ft.	at 7.20	3,240	
Trash racks and guides	22,500	lbs.	at 0.10	2,250	
Slide valves in pipe - 30 inch	3	at	1500.	4,500	
Slide valves in tower - 30 inch	5	at	1100.	5,500	
Trash rack hoist	1	at	250.	250	15,740
Backfill	8,440	cu.yds. at	0.50	4,220	4,220
Reservoir					
Land				225,000	
Relocation of highway	10	mi. at	$36,000	360,000	
Clearing reservoir lands	1,450	ac. at	20.00	29,000	614,000
Subtotal					4,915,780
Administration and engineering	10% of subtotal				491,580
Contingencies on construction items	15% of $4,690,780				703,620
Interest during construction	5% rate				408,210
Total capital cost					$6,519,190

ANNUAL COST

Interest	5 per cent per annum	325,960
Depreciation on dam only	0.35 per cent per annum	20,080
Amortization - Sinking fund	40-year-4 per cent-Semi annual payments	67,280
Operation and maintenance	0.15 per cent per annum	9,780
Total annual cost		$423,100

TABLE 40

COSTS OF SAN VICENTE RESERVOIRS

Operated for Conservation Purposes

Elevation of crest of dam, in feet, U.S.G.S.datum	Height of dam, in feet	Elevation of water surface, in feet	Storage capacity of reservoir, In acre-feet	Storage capacity of reservoir, In millions of gallons	Cost of reservoir Capital	Cost of reservoir Annual
665	209	655	100,800	32,850	$3,912,000	$252,900
690	234	680	130,000	42,360	4,904,000	317,600
712	256	702	158,400	51,620	5,814,000	377,100
724	268	714	174,500	56,860	6,519,000	423,100

Mission Gorge No. 2 Reservoir - The Mission Gorge No. 2 reservoir site is located on the main San Diego River in the upper San Diego River Valley. It lies almost entirely within the El Cajon Rancho or Grant. The dam site is located in the upper end of Mission Gorge in Ex Mission San Diego Grant about one-half mile downstream from the line between this grant and the El Cajon Rancho, and the reservoir site extends to a point in the vicinity of Santee. The location of the reservoir site is shown on Plate XVII.

A topographic survey of the reservoir site to the 330-foot contour, U. S. Geological Survey datum, was made by the La Mesa, Lemon Grove and Spring Valley Irrigation District some years ago, and the 360 and 400-foot contours were surveyed by the City of San Diego in 1921, 1922 and 1930. The water surface areas of the reservoir as obtained from the City of San Diego, and the capacities of the reservoir computed from them are given in Table 41.

TABLE 41

AREAS AND CAPACITIES OF MISSION GORGE NO. 2 RESERVOIR

Depth of water at dam, in feet	Water surface elevation of reservoir, in feet, U.S.G.S.datum	Area of water surface, in acres	Capacity of reservoir, in acre-feet
46	290	81	1,000
56	300	210	2,400
66	310	425	5,600
76	320	754	11,500
86	330	1,179	21,100
92	336	1,550	29,200
96	340	1,794	36,000
106	350	2,520	57,500
116	360	3,320	86,800
126	370	4,200	124,400

A map of the dam site on a scale of one inch equals 100 feet with a contour interval of 10 feet, obtained from the City of San Diego, was used in laying out and estimating the costs of dams at this site.

The geology of the dam site has been studied recently, in connection with the preparation of this report, by Chester Marliave. In this study, he was aided by information obtained from the City of San Diego on eight holes, with an aggregate depth of about 300 feet, drilled into the stream bed and bottom of the canyon and ten test pits dug on the abutments. Further exploration of the dam site by tunnels and drilling should be made before the final location for any dam at this site is selected. Sufficient funds for such exploration are included in the items for engineering and contingencies in the following cost estimates for the reservoirs. A description of the geology of the site, as taken from Chester Marliave's report, is as follows:

"The Mission Gorge No. 2 dam site lies near the western edge of the Peninsular Range. This range is for the most part composed of old crystalline

rocks in which metamorphism has taken place to a considerable extent. The rocks of the granitic type predominate but included in those igneous intrusive types are some contemporaneous sediments which, due to heat and pressure and age, have become fused into the igneous rocks presenting a mass of which the original constituents have partly lost their identity.

"The general structure of the granitic mountains is considerably crushed which had aided weathering and decomposition of the surface of the mountain mass. Faulting has been responsible for much of this crushed condition because it has divided the region into blocks which have moved differentially thereby subjecting the rocks to distortion.

"Seismic activity is prevalent in the southern portion of the State but most of the active faults lie off the coast or else some distance to the east of the area under consideration. Some of the geologists who have studied this area believe that a major fault runs down the canyon of the San Diego River and have so delineated its location upon maps. This cannot be checked in the region under consideration and it is believed that the evidence is to the contrary. A fault is also noted upon some of the maps of this region as passing in a northwesterly direction across the river about a half mile upstream from the proposed dam site. This fault has not been investigated as its probability and activity are doubtful and of little concern to the consideration of a dam at the suggested location.

"The Mission Gorge No. 2 dam site lies in an area of granite about 4 miles by 2 miles surrounded by various other formations. This granitic rock is a portion of the crystalline complex while most of the surrounding rocks are recent sedimentary formations that overlie the granite. The San Diego River is at the present time in the process of cutting its course through this granitic area. Commencing about 2 miles below the mouth of Sycamore Canyon, the river

enters a gorge and continues in this narrow canyon for about $3\frac{1}{2}$ miles where it emerges upon the mesa lands that front the range and continues for about 7 miles to the ocean. The downstream half of this gorge is a volcanic series which, like the granite, has withstood erosion more than the adjacent stretches of the river. Because the river in passing through this gorge is now in the process of degradation the canyon is deep and narrow and there is little channel material strewn along the bottom.

"The channel section at the dam site under consideration is about 200 feet wide at the stream bed, but the actual low water sandy portion of the bed is only about 75 feet wide. The present channel of the river is against the right side of the canyon and the 125 feet of river bottom against the left side of the canyon is the portion that is now inundated only at flood stages. This left portion of the channel section has a rising slope and is covered to a considerable extent with boulders and gravel. Along the lower slope of the right abutment the bedrock is exposed all along the edge of the channel section. The estimated average depth of stripping and excavation to reach solid footings for a dam in this section is between zero and 15 feet.

"On the left abutment of the dam site, there are quite extensive granite outcrops some distance above the stream bed. There is considerable talus near the lower portion of the hill slope just above the county road which passes along the toe of slope on this side of the river. That this talus is not thick is indicated by the presence of bed rock just below the road fill. Just above the road there has been one small land slide about 300 feet downstream from the probable axis of the dam. With the exception of this, there is little evidence concerning the structural conditions of the bed rock on this side of the canyon. As nearly as can be ascertained from surface indications, a total of about 20 to 35 feet of stripping and excavation, normal to the surface, will probably be necessary on this abutment in order to obtain

satisfactory foundation for a masonry dam.

"The right side of the canyon exhibits more of the structural conditions of the rock than the left side. Here there is little vegetation and no trees are found. Several systems of fracturing or jointing occur along the lower slope of the canyon and are well exposed adjacent to the stream channel. In two of these localities, there has evidently been some crushing or movement along the joints for the open fracutures are filled with crushed material and run-up the hillsides where they disappear under the talus on the hill. Five shallow test pits were dug on this side of the canyon some time ago. Theso test pits merely indicate the depth of loose overburden whereas the most important conditions to be explored are the extent of the open fractures which might extend deeply into the hill and necessitate the removal of large masses of seemingly sound rock. The hillside on the right abutment is quite even and rounded showing deep decay and weathering of the rock. The change in prominence of the fracture systems indicates that there has been crushing throughout the mass. The prominence of the various systems of fracturing generally changes abruptly at the open fractures, which indicates possible movement along these fracture planes. This condition, however, is local and does not affect the integrity of the abutment as a whole.

"It is believed that none of the fractures extend deeply into the hill and, on this assumption, it is estimated that excavation and stripping to a depth of about 35 feet, normal to the surface, on this abutment will expose rock suitable for the foundation for a masonry dam.

"The dam site presents no natural facility for a spillway removed from the dam. The abutments are high and steep on both sides. The rock in the channel section, however, is hard and massive and would readily stand overpour with a little protection."

Since the canyon walls at the dam site are relatively steep and the conditions for the construction of a spillway around a rock fill dam are not good, the only type of dam considered was the gravity concrete, with the spillway in the crest of the dam.

Estimates have been made of the costs of reservoirs with dams 109, 122, and 131 feet in height from stream bed to top of non-overflow abutments. In making these estimates, the downstream toe of the dam was kept in the same position and the upstream face was moved to correspond to the height of dam. Each dam would have a vertical upstream face and a downstream slope of 0.807:1 starting from the upstream crest line of the non-overflow portions of the dam. The crests of the portions not occupied by the spillway would be 10 feet wide with an approximately vertical face from the downstream crest line to an intersection with the sloping downstream face of the dam. For all heights of dam, the spillway would be 510 feet in length and would occupy the greater part of the length of the dam. The depths below the tops of the non-overflow sections of the dam would be 17, 16 and 15 feet for the 109, 122, 131-foot dams, respectively. With spillways of these lengths and depths, the estimated crest flow from a flood which might occur once in 1000 years on the average would psss over the dam without overtopping the non-overflow portions. The central 300 feet of the spillway would lie over the stream channel, and along the downstream toe of the dam below this section there would be a concrete bucket with a cut-off wall at its toe. Water from the 100 and 110 foot sections of spillway at each end of the 300-foot central portion would be collected in a concrete lined channel along the toe of the dam and discharged into the stream channel over the bucket section. The channels would have a 5-foot bottom and ½:1 slopes on the sides away from the dam. No gates or flashboards would be placed in the spillway and the normal maximum water surface would therefore be at the elevation of the spillway crest,

The outlets from the reservoir would consist of 30-inch steel pipes embedded in the concrete of the dam and in tunnels under the base of the dam and the spillway channel. These pipes would be at elevation 250 feet, or about six feet above the stream bed level. Two pipes would connect with the delivery line leading from the reservoir. Flow through each pipe would be controlled by a slide valve located in a chamber inside of the dam a short distance from its upstream face. Access to this chamber would be from the drainage and inspection gallery running through the dam. Just upstream from the valve in one of the service outlet pipes, a 30-inch branch line would take out of the side of the pipe for a sluiceway. This sluiceway pipe would run straight through the dam and discharge onto the spillway bucket. Flow through the sluiceway would be controlled by a slide valve located in the same chamber as the other valves. Water would enter the pipes from a semicircular concrete tower 12 feet in outside diameter extending from the foundation line to the top of a pier located on the spillway crest and about 200 feet from its left end. At the top of this pier, which would be at the same level as the non-overflow abutments of the dam, there would be a circular gate house half of which would be an extension of the tower. Water would enter the tower through three 30-inch circular slide gates operated from the gate house. One of these gates would be opposite the outlet pipes and the other two at the one-third points between the lowest gate and the level of the crest of the spillway. Each gate would be protected by a semicircular trash rack which could be lifted above the water level with a hoist in the gate house.

It has been estimated by Chester Marliave, as stated in his foregoing report, that the removal of 20 to 35 feet of loose and decomposed material on the left abutment, normal to the surface, and 35 feet on the right abutment, will expose rock suitable for the foundation of a masonry dam. He also estimates

that the removal of zero to 15 feet of material in the stream bed will expose sound rock. However, in order to decrease the possibility of seepage under the dam, a concrete cut-off wall would be constructed 15 feet into the solid rock at the upstream toe of the dam and below this wall the foundation rock would be sealed by pressure grouting.

In estimating the cost of the concrete for the dam, it has been assumed that the aggregates would be hauled by truck from the lower end of Mission Gorge, a distance of about three miles. The cement and all other materials and equipment would probably be hauled by truck from the railroad at Santee, a distance of about five miles.

Most of the lands in the reservoir site are in private ownership. The City of San Diego, however, owns the dam site and all of the reservoir land lying between it and the El Cajon Rancho boundary line and two tracts in the El Cajon Rancho near the lower end of the reservoir site with an aggregate area of about 425 acres. The County of San Diego also owns the County Farm near Santee which would be partially or wholly flooded by all of the reservoirs studied. In the estimate of cost of each reservoir, the estimated cost of all lands lying below the level of the top of the dam was included although some of the land would be flooded only at long intervals of time and then for only a short period. The estimated cost of these lands has been based upon the 1929 appraised values as determined by Tax Factors, Incorporated. With the 109-foot dam, very few buildings would lie in the flooded area, but with the two higher dams, some provision would have to be made to protect the buildings on the County Farm and in Santee or they would have to be removed. Allowance for the cost of such protection or removal has been made in the cost estimates. Allowance is also made in each cost estimate for the removal of all brush and trees within the flooded area of the reservoir.

The county road from Santee through Mission Gorge and the water supply

TABLE 42

COST OF MISSION GORGE NO. 2 RESERVOIR

Operated for Conservation Purposes

Crest of dam, elevation 353 feet, U.S.G.S. datum.
Crest of spillway, elevation 336 feet.
Height of dam, 109 feet.

Capacity of reservoir to spillway lip, 29,200 acre-feet.
Capacity of spillway, 116,500 second-feet.

CAPITAL COST

Dam (Including spillway)				
Excavation				
Common	14,160 cu.yds.	at $1.50	$21,240	
Rock - Stripping	30,130 cu.yds.	at 2.50	75,320	
- Cutoff wall trenches	3,920 cu.yds.	at 4.00	15,680	
- Outlet tunnel	90 cu.yds.	at 10.00	900	$113,140
Concrete				
Mass - In dam	85,950 cu.yds.	at 6.60	567,270	
- Outlet tunnel backfill	70 cu.yds.	at 14.00	980	
Reinforced - Spillway walls	330 cu.yds.	at 19.00	6,270	
- Spillway lining	1,010 cu.yds.	at 16.25	16,410	
- Gate tower and house	100 cu.yds.	at 19.00	1,900	
- Gate house pier	140 cu.yds.	at 15.00	2,100	594,930
Grouting, drainage and seals	640 ft. of dam	at 90.00	57,600	57,600
Outlets				
Steel pipe - 30 inch	460 ft.	at 7.20	3,310	
Trash racks and guides	6,400 lbs.	at 0.10	640	
Slide valves in pipes-30 inch	3	at 1500.	4,500	
Slide valves in tower-30 inch	3	at 1100.	3,300	
Trash rack hoist	1	at 250.	250	12,000
Backfill	4,100 cu.yds.	at 0.50	2,050	2,050
Reservoir				
Land and improvements			600,000	
Relocation of roads	5.0 miles	at $20,000	100,000	
Relocation of pipe line	5.2 miles	at $45,000	234,000	
Clearing land	500 acres	at $20.00	10,000	944,000
Subtotal				1,723,720
Administration and engineering	10% of subtotal			172,370
Contingencies on construction items	15% of $1,123,720			168,560
Interest during construction	5% rate			78,040
Total capital cost				2,142,700

ANNUAL COST

Interest	5 per cent per annum	107,140
Depreciation on dam only	0.35 per cent per annum	3,540
Amortization - Sinking Fund	40 year -4 per cent-Semi-annual payments	22,120
Operation andmaintenance		5,000
Total annual cost		$137,800

pipe line of the City of San Diego which follows this road would be partially submerged by water in the reservoir and would have to be relocated. It is estimated that 5 to 6.5 miles of relocated road and 5.2 to 7.5 miles of relocated pipe line would be required with the 109 to 131-foot dams considered.

As previously stated, estimates of cost were made for reservoirs created by three heights of dam. A somewhat detailed estimate of the capital and annual costs for one of these reservoirs that with a 109 foot dam, is given in Table 42. No layout for a dam for a reservoir to be used for conservation purposes only is shown in this report but the layout for a 108-foot dam for conservation and flood control is shown on Plate XXVIII, "Mission Gorge No. 2 Dam on San Diego River with Flood Control Features." If the four drum gates and four of the gate piers were removed from this dam and the spillway crest were carried through at elevation 336 feet, the layout would be practically the same as for the 109-foot dam for conservation only.

The estimated total capital and annual costs for the conservation reservoirs with all of the heights of gravity concrete dams studied are given in Table 43. In making these estimates, the same items and unit costs as those given in Table 42 were used.

TABLE 43.

COSTS OF MISSION GORGE NO. 2 RESERVOIRS
Operated for Conservation Purposes

Elevation of crest of dam, in feet, U.S.G.S. datum	Height of dam, in feet	Elevation of water surface, in feet	Storage capacity of reservoir, In acre-feet	Storage capacity of reservoir, In million of gallons	Cost of reservoir, Capital	Cost of reservoir, Annual
353	109	336	29,200	9,520	$2,143,000	$157,800
366	122	350	57,600	13,770	2,960,000	187,900
375	131	360	86,800	28,280	3,475,000	217,200

Mission Gorge No. 3 Reservoir - The Mission Gorge No. 3 reservoir site is

located on the main San Diego River in Mission Gorge and the upper San Diego River Valley. The dam site is located in Mission Gorge about 2.3 miles downstream from the line between the Ex Mission San Diego and El Cajon grants, and the reservoir extends through these two grants to a point in the vicinity of Santee. The location of the dam site is shown on Plate XVII.

A topographic survey of the reservoir site to the 330 foot contour, U. S. Geological Survey datum, was made by the La Mesa, Lemon Grove and Spring Valley Irrigation District some years ago and the 360 and 400-foot contours above the Mission Gorge No. 2 dam site surveyed by the City of San Diego in 1921, 1922 and 1930. The water surface areas of the reservoir as obtained by using these surveys, and the capacities of the reservoir computed from them are given in Table 44.

The first dam site studied for the Mission Gorge No. 3 reservoir is the one which has commonly been accepted for the dam and is just downstream from the sign "Mission Gorge dam site No. 3" painted on the rock on the right bank of the river. The geology of the dam site has been studied and reported upon by Chester Marliave. In this study, he was aided to some extent by information obtained from explorations of the site made by other parties some time ago. These explorations consisted of the drilling of three holes in the stream bed with an aggregate depth of 87 feet, and the excavation of five test pits into the slopes with an aggregate depth of about 78 feet. A description of the geology of the site, as taken from Chester Marliave's report, is as follows:

"The Mission Gorge No. 3 dam site lies at the western edge of the Peninsular Range where the mountains give way to the mesa lands which flank the western front for many miles up and down the coast separating the ocean from the mountains for an average width of about eight miles. The western portion of the mountains is for the most part composed of a crystalline complex of

TABLE 44

AREAS AND CAPACITIES OF MISSION GORGE NO. 3 RESERVOIR

Depth of water at dam, in feet	Water surface elevation of reservoir, in feet, U.S.G.S. datum	Area of water surface, in acres	Capacity of reservoir, in acre-feet
20	120	11	120
40	140	23	450
60	160	44	1,060
80	180	62	2,120
100	200	76	3,530
120	220	103	5,310
140	240	131	7,690
160	260	166	10,640
180	280	228	14,620
200	300	360	20,430
210	310	574	25,100
220	320	913	32,540
230	330	1,424	44,230
240	340	2,140	62,050
250	350	2,960	87,550
260	360	3,770	121,200

various types of igneous rocks of Tertiary age both of volcanic and plutonic origin which have been metamorphosed to a considerable extent. In this portion, the valley of the San Diego River narrows into a narrow gorge where the stream is at present in the process of degradation, cutting its way through the "V" shaped constriction for about three miles leaving little detrital material in the floor of the canyon. The upstream half of this gorge is composed of granite while the lower portion is composed of old metamorphic sediments and volcanics, of Jurassic age. Below the gorge the river cuts through the mesa lands which are basically made up of unconsolidated conglomerates of late Tertiary age veneered with terrace material and alluvium.

"Faulting may have played an important part in determining some of the courses of the drainage systems of this region. There are numerous mesa and table lands in San Diego County and some geologists have checkered the county into blocks which are supposed to be bounded in many instances by faults. It is believed that there is little proof of the existence of many of these faults, especially in the area under consideration. No active faults are known to exist in this vicinity, although the region is subject to seismic disturbances from movements along the distantly removed active faults.

"The dam site lies wholly within an area known as 'Black Mountain Volcanics.' This formation was once quite extensive over the western portion of the range but its occurrence is now quite isolated. The surface exposure of this volcanic area through which the river runs near the dam site extends for about $\frac{1}{4}$-mile each side of the channel and for about 1- 3/4 miles along its course. The dam site lies near the western or downstream end of this exposed formation.

"The rocks at the dam site are of both sedimentary and volcanic origin but they are highly metamorphosed and the tuffaceous material as well as the sediments is compacted, hardened, and fused so that it is difficult to classify

much of it.

"The general structure of the rock in the vicinity of the dam site has a strike almost at right angles to the stream channel and with an average dip of about 10 degrees downstream. Some of the bedding or flow structure is a little steeper due to local displacement or to contact between the various types of rock. The general attitude of the rocks in the canyon is clearly visible in the field. It was possible to identify some of the beds on opposite sides of the stream channel where they seemed to cross the canyon without evidence of dislocation.

"Faulting does not seem to be of major magnitude at the dam site although there is considerable evidence of displacement just upstream from the right abutment. Downstream from the site the evidence of continuous beds crossing the stream is quite conclusive of the non-existence of a fault running down the canyon. Local movement has evidently taken place along some of the planes of fracture for many of them are quite open and some contain considerable brecciated material.

"The fracture systems are the most pronounced topographic features of the rocks at the dam site. Although the bedding of the rocks in this portion of the canyon has a uniform gentle downstream attitude, there are several systems of fracturing or jointing that show that the rocks have been compressed and crushed. The fracture systems required considerable study at the dam site . The most conspicuous exposures due to fracturing are the high vertical faces near the lower portion of the right abutment on which the sign 'Mission Gorge Dam site No. 3' has been painted. From a point in the stream bed just above the upstream end of the face on which the sign is painted, a sheer zone runs diagonally up the slope and in a downstream direction. It is composed of many vertical fractures many of which are quite open near the surface. This zone of fracturing has probably caused displacement of the horizontal bedding which

terminates at the upstream end of the large block with the sign painted upon it. The horizontal crack, or possible bedding plane, hits these vertical fracture planes nearly at right angles. There is probably another horizontal crack below the river bed at the bottom of this block.

"The structure on the lower left abutment is not so pronounced as that on the right side of the channel for there is no high bluff nor is there any shear zone comparable to that on the opposite side of the river.

"The channel section at the dam site is about 100 feet wide. It is estimated that the channel fill material averages between 20 and 25 feet deep, although it is thought that there is probably a deep narrow depression continuous with one of the vertical fracture faces of the right abutment. A drill hole put down several years ago struck bedrock at 21 feet below the river bed, but its location is clearly to the left of the deepest portion of the channel. The island whose downstream end is just upstream from the axis of the dam site is a portion of the bedrock and is separated from the left side of the canyon by a narrow shallow channel. Two holes which were drilled into the island and on the left side of this small channel, respectively, were put down in outcropping bedrock and yield little information that is not evident upon the surface.

"Rock outcrops along the lower portion of the left abutment are quite hard and fresh, but blocky. The upper two-thirds of this abutment is covered to a considerable depth with soil and disintegrated rock. Near the lower portion of the abutment adjacent to the channel is a vertical igneous dike about 9 feet thick. Just upstream from the lower end of the island this dike terminates and becomes dispersed into the horizontal bedding of the sedimentary rocks.

"On the right abutment of the dam, as previously noted, there are two pronounced vertical fracture faces adjacent to the channel section with a third zone of vertical attitude. The latter system cuts into the right abutment and continues up to about elevation 300 feet. Besides these three major fracture

systems, there is another fracture system somewhat parallel to the hill slope. One of these faces of rock forms the slope of the rock wall downstream from the right abutment. All of these fracture systems are undercut by a horizontal crack.

"It is thus evident that the lower portion of the right abutment is a loose wedge of rock of considerable extent which would have to be removed before satisfactory footings for a concrete dam could be obtained. This removal would involve a large yardage which is of vital economic consideration to the construction of a dam at this site.

"Spillway conditions are favorable at this site for an overpour section. The rock, where fresh, is insoluble and capable of standing heavy overpour except where it is badly fractured. It is probable that weaker portions of the downstream toe of the dam would have to be protected by a concrete apron or by gunite, especially where the fractures are open, to prevent mechanical dislogement from impact falling into the cracks."

Several types of dams were considered for this site. The rock-fill type was rejected because the canyon walls at the site are relatively steep, making conditions for the construction of a spillway around the dam unsatisfactory, and because there is likely to be some leakage from the reservoir with this type of dam. The concrete arch type dam was also considered, but with heights of 230 to 260 feet, which would be necessary to obtain the desired storage capacity, it was not deemed advisable to spill water over the dam, and the difficulties and added cost of constructing a side-channel spillway around the dam presented themselves. In view of these conditions and in order to determine the merits of this site as compared with San Vicente and Mission Gorge No. 2 sites, the gravity concrete dam, straight in plan and having the spillway in the crest of the dam, was selected for estimating costs.

It has been estimated by Chester Marliave, as stated in his foregoing

report, that the rock in the lower portion of the right abutment for the dam is a loose wedge of considerable extent which would have to be removed before satisfactory foundation for a concrete dam could be obtained. Estimates have been made of the extent of this loose block of rock, and also of the depths of overburden and decomposed rock over other portions of the dam site, which it would be necessary to remove to obtain a firm rock foundation for the dam. The depths of loose rock in the wedge section are estimated to be from 40 to 130 feet, vertically, and about 35 feet, normal to the surface, on other portions of the right abutment. The depths of overburden and loose rock on the left abutment are estimated to be from 10 to 35 feet. In the channel section, it is estimated that zero to 25 feet of channel fill material and about 10 feet of fractured rock would have to be removed under the base of the dam.

Although it was apparent that the large amounts of excavation would greatly increase the costs of dams at this site, estimates of cost were made for reservoirs having capacities of 29,200, 57,900 and 87,600 acre-feet. However, after it was discovered that the large block of loose rock existed in the right abutment of the proposed dam site, attention was given to finding a more satisfactory dam site in the same vicinity. The canyon was studied upstream for several thousand feet and for some distance downstream. The best site appeared to be one which is about 200 feet downstream from the first site studied and 300 feet downstream from the sign painted on the rock on the right side of the stream. This site will be called the "Lower Mission Gorge No. 3 dam site." At it there is a fairly steep cliff about 100 feet high on the right side of the canyon. The geology of this site was also briefly studied by Chester Marliave and no serious shear zones or fractures were discovered. The type of rock is the same as at the site covered by the foregoing geological report. While making his geological examination of the dam site, Chester Marliave also estimated the amounts of stripping required to obtain a sound rock

foundation for a masonry dam. He estimates that 5 to 15 feet of overburden and zero to 15 feet of decomposed and fractured rock, normal to the surface, would have to be removed from the abutments, and 10 to 25 feet of loose material and 5 to 10 feet of fractured rock would have to be removed in the stream channel.

The shape of the canyon at this lower site is in general the same as that at the upper site and for the reasons given in describing the upper site, the type of dam selected for the lower site was gravity concrete, straight in plan, with the spillway in the crest of the dam. Estimates were made of the costs of reservoirs having capacities of 29,200, 57,900, and 87,600 acre-feet.

The heights of dams for these reservoirs would be 231, 252, and 263 feet from stream bed to top of non-overflow abutments, respectively. The costs for reservoirs of these capacities with dams at the lower site were estimated to be 15.9, 15.0 and 13.9 per cent, respectively, lower than costs for reservoirs of the same capacities with dams at the upper site.

In making the estimates of cost of the dams, the downstream toe of the dam was kept in the same position and the upstream face was moved to correspond to the height of dam. Each dam would have a vertical upstream face and a downstream slope of 0.807:1 starting from the upstream crest line of the non-overflow portions of the dam. The crests of the portions not occupied by the spillway would be 10 feet wide with an approximately vertical face from the downstream crest line to an intersection with the sloping downstream face of the dam. For all heights of dam, the spillway would be 650 feet long and would occupy the greater part of the length of the dam. The depths of spillway crests below the tops of the non-overflow sections of the dam would be 15, 14 and 13 feet for the 231, 252, and 263-foot dams, respectively. With spillways of these lengths and depths, the estimated crest flow from a flood which might occur once in 1000 years on the average would pass over the dam without overtopping the non-overflow portions. Along the downstream toe of the dam below

the 150-foot portion of the spillway over the stream channel there would be a concrete bucket with a cut-off wall at its toe. Water from the 250 feet of spillway to the right of this 150-foot section and the 250 feet to its left would be collected in concrete lined channels along the toe of the dam and discharged into the stream channel over the bucket section. The channels would have bottom widths of five feet at the ends of the spillway and 50 feet, normal to the crest of the dam, at distances of 50 feet from the edges of the bucket section. From these latter points, the channels would warp into the sides of the bucket. The channels would have $\frac{1}{2}$:1 side slopes on the sides away from the dam. No gates or flash-boards would be placed in the spillway and the normal maximum water surface would therefore be at the elevation of the spillway crest.

The outlets from the reservoir would consist of two 30-inch steel pipes embedded in the concrete of the dam and in tunnels under the base of the dam and the spillway channel. These pipes would be at elevation 110 feet, or about ten feet above the stream bed level, and would connect with the delivery line leading from the reservoir. A third 30-inch pipe, to be used for a sluiceway, would run straight through the dam and discharge onto the spillway bucket. Flow through each pipe would be controlled by a slide valve located in a chamber inside of the dam near its upstream face. Access to this chamber would be from the drainage and inspection gallery running through the dam. Water would enter the pipes from a semicircular concrete tower, 20 feet in outside diameter, extending from the foundation line to the top of a pier located on the spillway crest about 300 feet from its left end. At the top of this pier, which would be at the same level as the non-overflow abutments of the dam, there would be a circular gate house half of which would be an extension of the tower. Water would enter the tower through five 30-inch circular slide gates operated from the gate house. One of these gates would be opposite the outlet pipes and the other four at the one-fifth points between the lowest gate and the level

of the crest of the spillway. Each gate would be protected by a semicircular trash rack which could be lifted above the water level with a hoist in the gate house.

In estimating the cost of the concrete for the dam, it has been assumed that the aggregates would be hauled by truck from the lower end of Mission Gorge, a distance of about one mile. The cement and other materials and the equipment could be hauled by truck from the railroad at Santee, or from San Diego.

Most of the lands in the reservoir site are in private ownerships. The City of San Diego, however, owns a tract of land just west of the El Cajon Rancho boundary line and two tracts in the Rancho near the lower end of the upper San Diego River Valley and the County of San Diego owns the County Farm near Santee, which would be flooded by the reservoirs with the two greatest heights of dam studied. In the estimate of the cost of each reservoir, the estimated cost of all lands lying below the level of the top of the dam was included, although some of the land would be flooded only at long intervals of time and then for only a short period. The estimated cost of these lands has been based upon the 1929 appraised values determined by Tax Factors, Incorporated. With the 231 and 252-foot dams, very few buildings would lie in the flooded area, but with the 263-foot dam, some provision would have to be made to protect the buildings on the County Farm and in Santee or they would have to be removed. Allowance for the cost of such protection or removal has been made in the cost estimates. Allowance is also made in each cost estimate for the removal of all brush and trees within the flooded area of the reservoir.

The county road from Santee through Mission Gorge, and the water supply pipe line of the City of San Diego which follows this road, would be partially submerged by water in the reservoir and would have to be relocated. It is estimated that five to six miles of relocated road and 5.2 to 8.2 miles

TABLE 45

COST OF MISSION GORGE NO. 3 RESERVOIR WITH DAM AT LOWER SITE

Operated for Conservation Purposes

Crest of dam, elevation 331 feet, U.S.G.S. datum.
Crest of spillway, elevation 316 feet.
Height of dam, 231 feet.

Capacity of reservoir to spillway lip, 29,200 acre-feet.
Capacity of spillway, 131,000 second-feet.

CAPITAL COST

Dam (Including spillway)				
Excavation				
Common	46,200 cu.yds.	at $1.50	$ 69,300	
Rock - stripping	93,500 cu.yds.	at 2.50	233,750	
- Cutoff wall trenches	4,100 cu.yds.	at 4.00	16,400	
- Outlet tunnel	450 cu.yds.	at 10.00	4,500	$323,950
Concrete				
Mass - In dam	279,900 cu.yds.	at 6.20	1,735,380	
- Outlet tunnel backfill	370 cu.yds.	at 13.75	5,090	
Reinforced - Spillway walls	230 cu.yds.	at 18.75	4,310	
- Spillway lining	6,270 cu.yds.	at 16.00	100,320	
- Gate tower and house	370 cu.yds.	at 18.75	6,940	
- Gate house pier	200 cu.yds.	at 14.75	3,250	1,855,290
Grouting, drainage and seals	900 lin.ft. of dam	at 90.00	81,000	81,000
Outlets				
Steel pipe - 30 inch	800 ft.	at 7.20	5,760	
Trash racks and guides	19,500 lbs.	at 0.10	1,950	
Slide valves in pipes- 30 inch	3	at 1500	4,500	
Slide valves in tower- 30 inch	5	at 1100	5,500	
Trash rack hoist	1	at 250	250	17,960
Backfill	8,250 cu.yds.	at 0.50	4,130	4,130
Reservoir				
Land and improvements			180,000	
Relocation of roads	5.0 miles	at 20,000	100,000	
Relocation of pipe line	5.2 miles	at 45,000	234,000	
Clearing land	800 acres	at 20.00	16,000	530,000
Subtotal				2,812,330
Administration and engineering	10% of subtotal			281,230
Contingencies on construction items	15% of $2,632,330			394,850
Interest during construction	5% rate			177,210
Total capital cost				$3,665,620

ANNUAL COST

Interest	5 per cent per annum	183,280
Depreciation on dam only	0.35 per cent per annum	10,500
Amortization - sinking fund	40 year - 4 per cent-Semi-annual payments	37,830
Operation and maintenance	0.15 per cent per annum	5,500
Total annual cost		$237,110

of relocated pipe line would be required with the 231 to 263-foot dams considered.

As previously stated, estimates of cost were made for reservoirs created by three heights of dam. A somewhat detailed estimate of the capital and annual costs for one of these reservoirs, that with a 231-foot dam, is given in Table 45.

The estimated total capital and annual costs for the reservoirs with all of the heights of gravity concrete dams studied are given in Table 46. In making these estimates, the same items and unit costs as those given in Table 45 were used.

TABLE 46

COSTS OF MISSION GORGE NO. 3 RESERVOIRS
WITH DAMS AT LOWER SITE

Operated for Conservation Purposes

Elevation of crest of dam, in feet U.S.G.S. datum	Height of dam in feet	Elevation of water surface, in feet	Storage capacity of reservoir: In acre-feet	Storage capacity of reservoir: In millions of gallons	Cost of reservoir: Capital	Cost of reservoir: Annual
331	231	316	29,200	9,520	$3,666,000	$237,100
352	252	338	57,900	18,870	4,870,000	313,800
363	263	350	87,600	28,540	5,808,000	373,100

Comparison of Reservoir - In the selection of additional reservoirs to be constructed in the San Diego River Basin for the conservation of its run-off, consideration must be given to the additional safe yield which would be obtained, the capital investment which must be made, and the cost per acre-foot or per million gallons of this additional yield. Comparisons of the San Vicente, Mission Gorge No. 2 and Mission Gorge No. 3 reservoirs have therefore been made on the bases of yield, unit cost of storage, and unit cost of additional safe yield. Comparisons have also been made, on the same bases, of different sizes of reservoirs at each site.

The comparisons that have been made are based primarily upon the cost estimates for the different reservoirs considered and upon the additional safe yields obtained from these reservoirs. As has been stated, the costs of rights of way for Mission No. 2 and Mission No. 3 reservoirs are based upon the appraised values of lands and improvements estimated in 1929 for the County of San Diego by Tax Factors, Incorporated. The rights of way costs for San Vicente reservoir are based upon the prices paid by the City of San Diego for practically the entire area of lands required for reservoirs at this site for all sizes considered. The costs of labor, materials, hauling and other items used in the estimates are based upon construction costs of similar structures, modified somewhat by existing local conditions. If in the future economic conditions should materially change and resultant large changes occur in labor, materials and rights of way costs, the unit costs of additional safe yields as shown will have to be modified in accordance with these changed conditions. However, the estimated costs of the different reservoir sites considered are such that a very material change in these costs would have to occur before the relative merits of the different sites considered would appreciably change. A change in labor and material costs would have little affect on the relative costs as it would affect all sites. A change in the right of way values would affect the costs of Mission No. 2 and Mission No. 3 sites and if sufficiently large would affect the relative merits of the sites. As the dam site and practically the entire reservoir site for all sizes considered of San Vicente is owned by the City of San Diego, the costs of San Vicente reservoir would not be materially changed by a change in the value of the privately owned lands.

In estimating the cost of yield from each reservoir at each of the three sites, it was assumed that the reservoir would be operated coordinately with the Cuyamaca and El Capitan reservoirs to obtain the maximum possible safe yield. The yields are those given in sections 2,3 and 4 of Table 35.

The total capital and annual costs for each reservoir have been given in Tables 40, 43, and 46. These yields and costs are brought together in Table 47 which shows the capital cost of storage and additional safe yield, and the unit cost of this yield per acre-foot and per million gallons, for each reservoir.

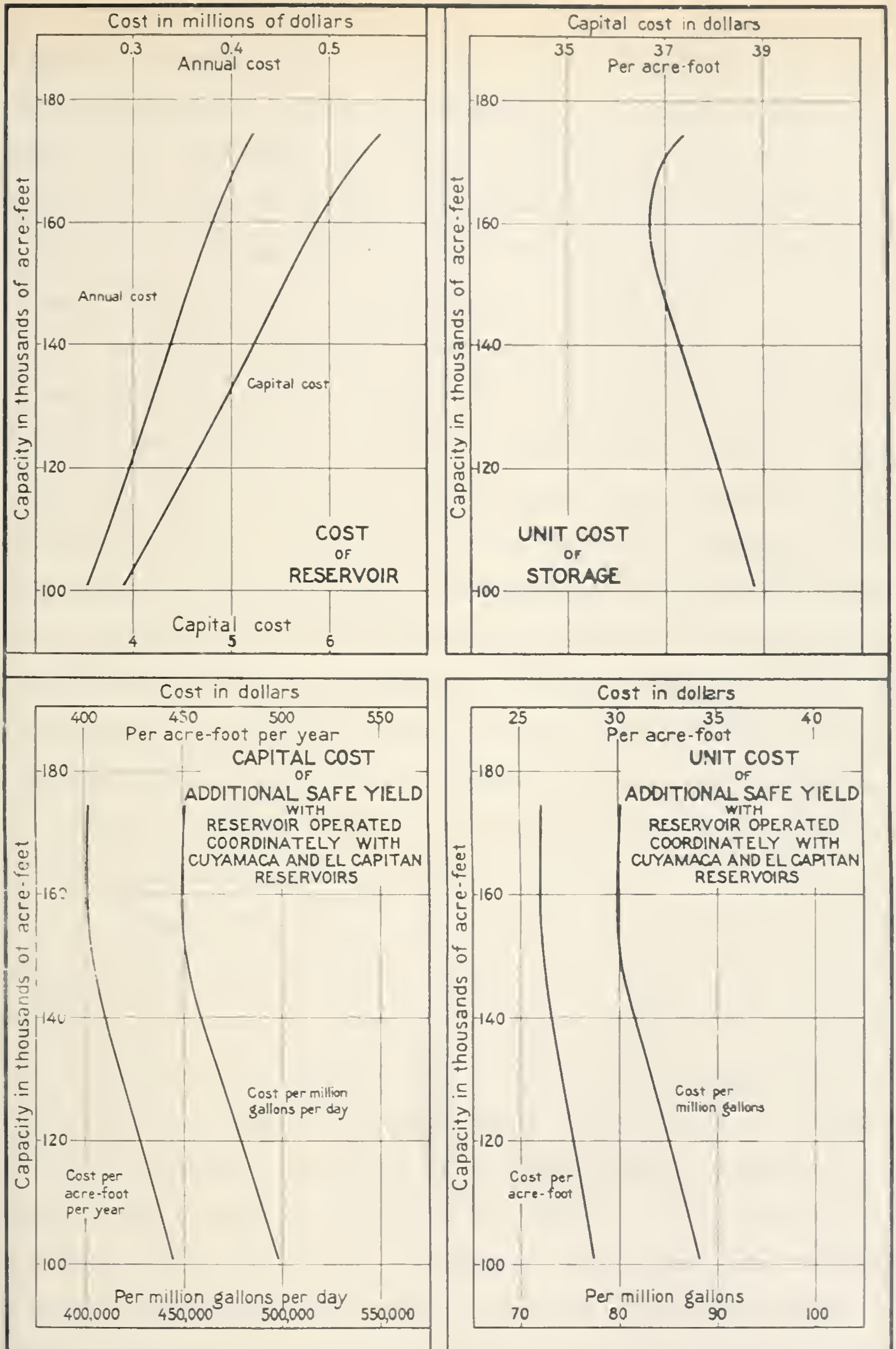
The data on costs for the San Vicente reservoir given in the first section of Table 47 are also shown graphically on Plate XXII, "Cost of Reservoir Capacity and Safe Yield from San Vicente Reservoir." The curves on the plate are drawn through four points obtained from the computations for the four capacities of reservoir investigated, and their shapes might be somewhat altered if data for more sizes of reservoirs were used. It is believed, however, that they give a good indication of the trend of costs and that those for costs of additional safe yield would be only slightly changed if more data were available for their construction. The curves indicate that the cheapest additional yield could be obtained with a reservoir capacity somewhere in the vicinity of the 158,400 acre-foot capacity for which one of the estimates was made. The table and curves also show, however, that with the capacity of the reservoir increased to 174,500 acre-feet, the maximum utilizable capacity for San Diego River water, the additional safe yield would be increased 1,700 acre-feet per year and the cost per acre-foot of the additional safe yield would be increased from $26.00 to $26.10, or only about 0.4 of one per cent.

The data on costs for the Mission Gorge No. 2 reservoir given in the second section of Table 47 are also shown graphically on Plate XXIII, "Cost of Reservoir Capacity and Safe Yield from Mission Gorge No. 2 Reservoir." In constructing the curves on this plate, only data from the computations for the three sizes of reservoir investigated were available and, in this case also, the shapes of the curves might have been somewhat altered if data for more sizes of reservoir had been used. The curves for capital and unit cost of additional

TABLE 47

COMPARISON OF CONSERVATION RESERVOIRS

Reservoir	Storage capacity, In acre-feet	Storage capacity, In millions of gallons	Additional safe yield, Acre-feet per year	Additional safe yield, Millions of gallons per day	Cost of reservoir, Capital	Cost of reservoir, Annual	Capital Cost of storage, Per acre-foot	Capital Cost of additional safe yield, Per acre-foot per year	Capital Cost of additional safe yield, Per million gallons per day	Unit cost of additional safe yield, Per acre-foot	Unit cost of additional safe yield, Per million gallons	Unit cost of additional safe yield, Per acre-foot increase
San Vicente	100,800	32,850	8,800	7.86	$3,912,000	$252,900	$38.80	$444.50	$498,000	$28.70	$88.20	
												$22.30
	130,000	42,360	11,700	10.45	4,904,000	317,600	37.70	419.10	469,000	27.10	83.30	
												21.30
	158,400	51,620	14,500	12.94	5,814,000	377,100	36.70	401.00	449,000	26.00	79.80	
												27.10
	174,500	56,860	16,200	14.46	6,519,000	423,100	37.40	402.40	451,000	26.10	80.20	
Mission Gorge No. 2	29,200	9,520	2,700	2.41	2,143,000	137,800	73.40	793.70	889,000	51.00	156.70	
												31.30
	57,600	18,770	4,300	3.84	2,960,000	187,900	51.40	688.40	771,000	43.70	134.10	
												19.50
	86,800	28,280	5,800	5.18	3,435,000	217,200	39.60	592.20	663,000	37.40	114.90	
Mission Gorge No. 3 with dams at lower site	29,200	9,520	3,200	2.86	3,666,000	237,100	125.50	1145.60	1,282,000	74.10	227.10	
												42.60
	57,900	18,870	5,000	4.46	4,870,000	313,800	84.10	974.00	1,092,000	62.80	192.80	
												34.90
	87,600	28,540	6,700	5.98	5,808,000	373,100	66.30	866.90	971,000	55.70	170.90	



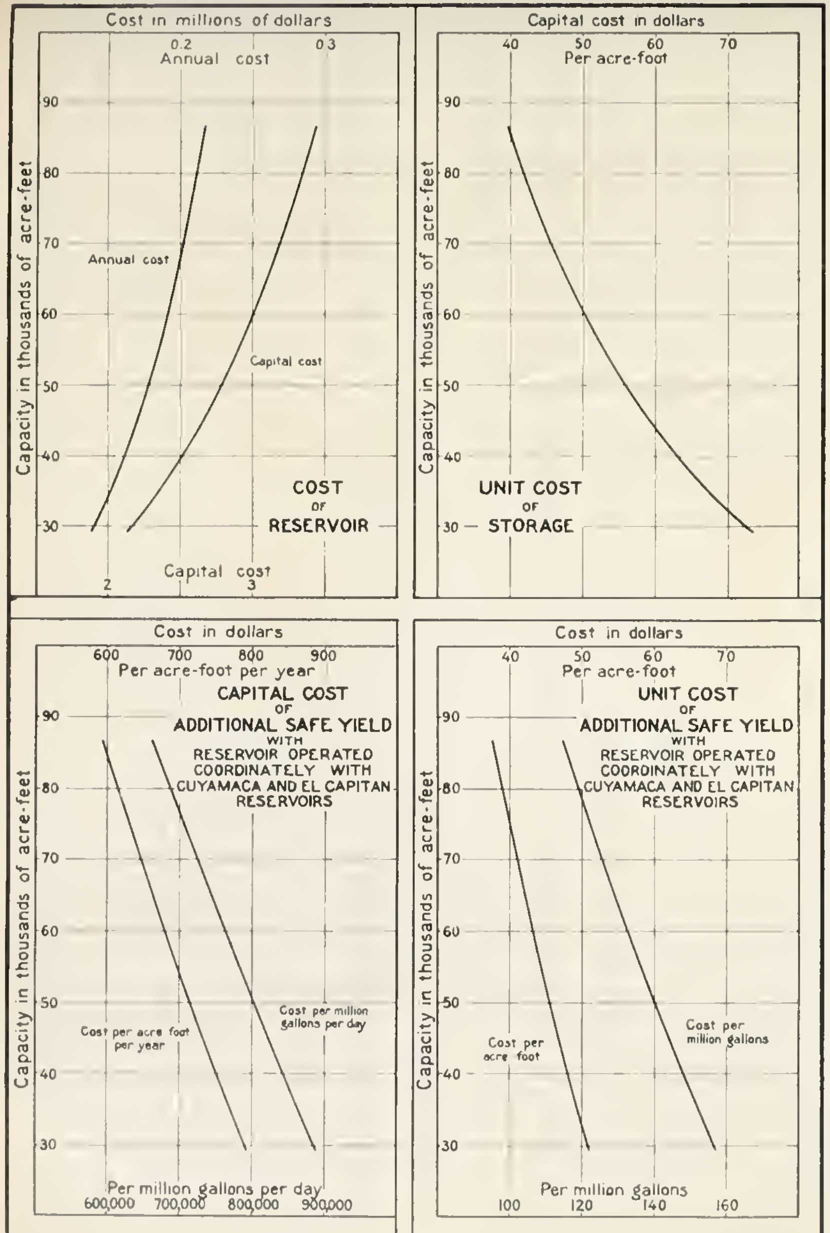
COST OF RESERVOIR CAPACITY AND SAFE YIELD FROM SAN VICENTE RESERVOIR

safe yield, however, are very flat and it is not believed that if data for points intermediate to those used were available, the shapes of these curves would be materially changed. The data in Table 47 and the curves on Plate XXIII indicate that between the limits of reservoir capacity studied, the unit cost of storage and the costs of safe yield decrease with increase in reservoir capacity, and at approximately a uniform rate.

No curves to compare the unit costs of storage and capital costs of additional safe yield for different sizes of reservoirs at the Mission Gorge No. 3 site have been drawn. Curves which compare the capital costs of reservoirs of different capacities and the unit costs of additional safe yields from these reservoirs, however, are shown on Plate XXIV, "Comparative Costs of Reservoirs on San Diego River." The remarks in the foregoing paragraph relative to the shape of the curves for the Mission Gorge No. 2 reservoir also apply to the curves for this reservoir on Plate XXIV. The data in Table 47 and the curves on Plate XXIV indicate that for the Mission Gorge No. 3 reservoir between the limits of reservoir capacity studied, as for the Mission Gorge No. 2 reservoir, the unit costs of storage and the costs of additional safe yield decrease with increase in reservoir capacity.

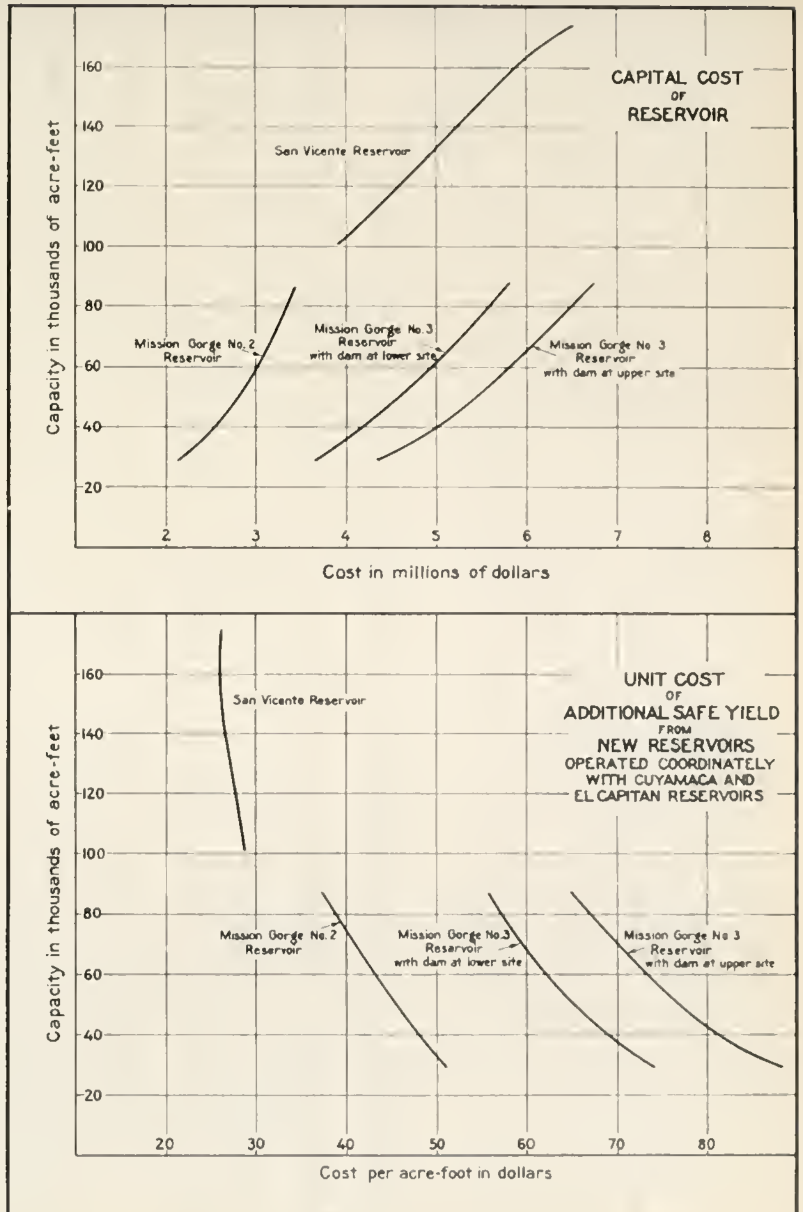
Comparisons of the additional safe yields, total capital and annual costs, capital cost per acre-foot of storage, and capital and unit costs of additional safe yields, for reservoirs of several capacities at the San Vicente, Mission Gorge No. 2, and Mission Gorge No. 3 sites, when each reservoir is operated coordinately with the Cuyamaca and El Capitan reservoirs, are given in Table 47. Graphical comparisons of the total capital costs and costs per acre-foot of additional safe yield for reservoirs at the three sites are shown by Plate XXIV. The table shows that for equal capacities of reservoirs at the Mission Gorge No. 2 and Mission Gorge No. 3 sites, the additional safe yields with the latter reservoir are somewhat greater than with the former.

PLATE XXIII



COST OF RESERVOIR CAPACITY AND SAFE YIELD FROM MISSION GORGE Nº 2 RESERVOIR

PLATE XXIV



COMPARATIVE COSTS OF RESERVOIRS ON SAN DIEGO RIVER

Both the table and plate, however, show that the capital cost and unit cost of additional safe yield for reservoirs at the Mission Gorge No. 3 site are much greater than for reservoirs at the Mission Gorge No. 2 site, for either equal capacities or yields. The Mission Gorge No. 2 site, therefore, is more economic than the Mission Gorge No. 3 site for the lowest reservoir on the San Diego River.

Costs and yields for reservoirs at the San Vicente site were not estimated for as small capacities as at either of the Mission Gorge sites, since the San Vicente site is too good to be used permanently for a small reservoir. If it should prove desirable to develop only a part of its capacity at first, the dam could be built in such a manner that it could later be raised to full height. Comparison of cost of additional safe yield from such a partial development, with the cost of an equal yield from Mission Gorge No. 2 reservoir, has not been made. The data in Table 47 and the curves on Plate XXIV, however, show the comparison of the capital costs and the unit costs of additional yields for different sizes of reservoirs at the San Vicente site to the same costs for the Mission Gorge reservoirs. The curves for unit cost of additional safe yield on Plate XXIV indicate that for capacities of San Vicente reservoir equal to those for Mission Gorge No. 2 reservoir, the cost per acre-foot would be considerably less for San Vicente reservoir than for Mission Gorge No. 2 reservoir.

The foregoing comparisons of the San Vicente, Mission Gorge No. 2, and Mission Gorge No. 3 reservoirs are based on each being operated separately, but coordinately, with the Cuyamaca and El Capitan reservoirs. For the full development of the water resources of the San Diego River Basin, however, both the San Vicente reservoir and either the Mission Gorge No. 2 or Mission Gorge No. 3 reservoir would be operated coordinately with the Cuyamaca and El Capitan reservoirs. It is therefore important to determine the best division

of storage between the San Vicente and Mission Gorge reservoirs to furnish the additional yield at the lowest cost. Studies were made for four combinations of capacities for the Mission Gorge No. 2 and San Vicente reservoirs, up to and including 174,500 acre-feet in the latter reservoir, the maximum utilizable capacity of this reservoir for the conservation of San Diego River Basin water alone. These capacities are given in the first three columns of Table 48. The additional safe yields given in the fourth and fifth columns of the same table are those shown in Table 35, and the methods by which they were obtained have been previously described. The combined capital and annual costs of the two reservoirs, and the capital and unit costs of the additional safe yields from their coordinated operation are also shown in Table 48. A graphical comparison of the unit costs of additional safe yields with the different combinations of capacities is shown by the curves on Plate XXV, "Unit Cost of Additional Safe Yield from San Vicente and Mission Gorge No. 2 Reservoirs Operated Coordinately with Cuyamaca and El Capitan Reservoirs." The curves show that the costs decrease as the capacities of San Vicente reservoir increase and those of Mission Gorge No. 2 reservoir decrease. The limiting minimum capacity at the Mission Gorge site, however, is 29,200 acre-feet, which is the storage space required to control the run-off from below the San Vicente and El Capitan reservoirs. As previously shown, the safe yield from the basin can be increased 1,300 acre-feet per year by increasing the capacity of San Vicente reservoir from 158,400 acre-feet to 174,500 acre-feet, while maintaining the capacity of the Mission Gorge No. 2 reservoir at 29,200 acre-feet. With this increase in capacity, the cost per acre-foot of additional safe yield would increase from $29.90 to $30.30, or only about 1.3 per cent.

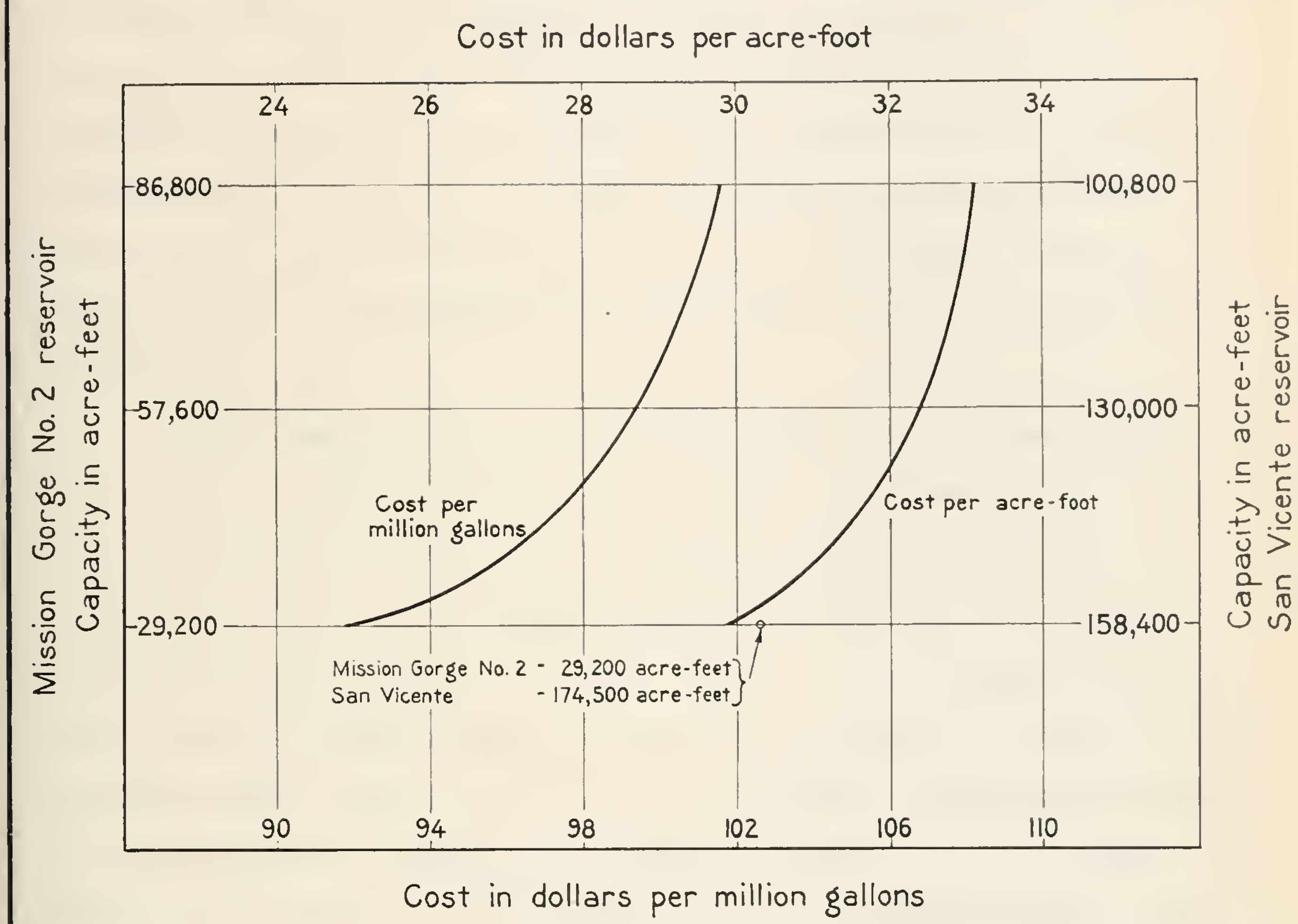
As a further comparison of the Mission Gorge No. 2 and Mission Gorge No. 3 reservoir sites, costs of additional safe yield were estimated using

TABLE 48

COSTS OF ADDITIONAL SAFE YIELDS
FROM SAN VICENTE AND MISSION GORGE RESERVOIRS OPERATED COORDINATELY

With Cuyamaca and El Capitan Reservoirs

Capacity of reservoirs, in acre-feet			Additional safe yield,		Cost of reservoirs		Cost of additional safe yield			
							Capital		Unit	
San Vicente Reservoir	Mission Gorge No.2 Reservoir	Both Reservoirs	Acre-feet per year	Millions of gallons per day	Capital	Annual	Per acre-foot per year	Per million gallons per day	Per acre-foot	Per million gallons
100,800	86,800	187,600	14,200	12.68	$7,347,000	$470,100	$517.40	$579,000	$33.10	$101.60
130,000	57,600	187,600	15,600	13.93	7,864,000	505,500	504.10	565,000	32.40	99.40
158,400	29,200	187,600	17,200	15.36	7,957,000	514,900	462.60	518,000	29.90	91.80
174,500	29,200	203,700	18,500	16.52	8,662,000	560,900	468.20	524,000	30.30	93.00
	Mission Gorge No.3 Reservoir with dam at lower site									
174,500	29,200	203,700	18,800	16.78	10,185,000	660,200	541.80	607,000	35.10	107.80



UNIT COST OF ADDITIONAL SAFE YIELDS
FROM
SAN VICENTE AND MISSION GORGE Nº 2 RESERVOIRS OPERATED COORDINATELY
WITH
CUYAMACA AND EL CAPITAN RESERVOIRS

San Vicente reservoir with a capacity of 174,500 acre-feet, and Mission Gorge No. 3 reservoir with a capacity of 29,200 acre-feet instead of Mission Gorge No. 2 reservoir with the same capacity. The costs obtained with this study are shown in the last line of Table 48. Comparison of the costs with those in the next line above in the table for the same combination of capacities using Mission Gorge No. 2 reservoir, shows that if Mission Gorge No. 3 reservoir with the dam at the lower site were used, the cost of additional safe yield would be about 16 per cent more than if the No. 2 site were used. This confirms the former conclusion that the Mission Gorge No. 2 site is more economic than the No. 3 site.

The foregoing studies indicate that the best water storage capacities for San Vicente and Mission Gorge No. 2 reservoirs are 174,500 acre-feet and 29,200 acre-feet respectively. It has been pointed out, however, that if the estimated yields are to be maintained over a long period of time additional space will be required in both reservoirs to care for the storage of silt and debris carried into these reservoirs and El Capitan Reservoir. The effect of the addition of this space will be to increase the cost of the reservoirs without increasing the safe yield, and to increase the unit costs of safe yield somewhat over those shown in the foregoing tables. In determining the ultimate capacities and method of operation of reservoirs in the San Diego River Basin, the possible storage of water imported from other watersheds should be considered and the capacities and methods of operation modified to meet these storage requirements. Additional storage space may be provided in San Vicente Reservoir at relatively low cost.

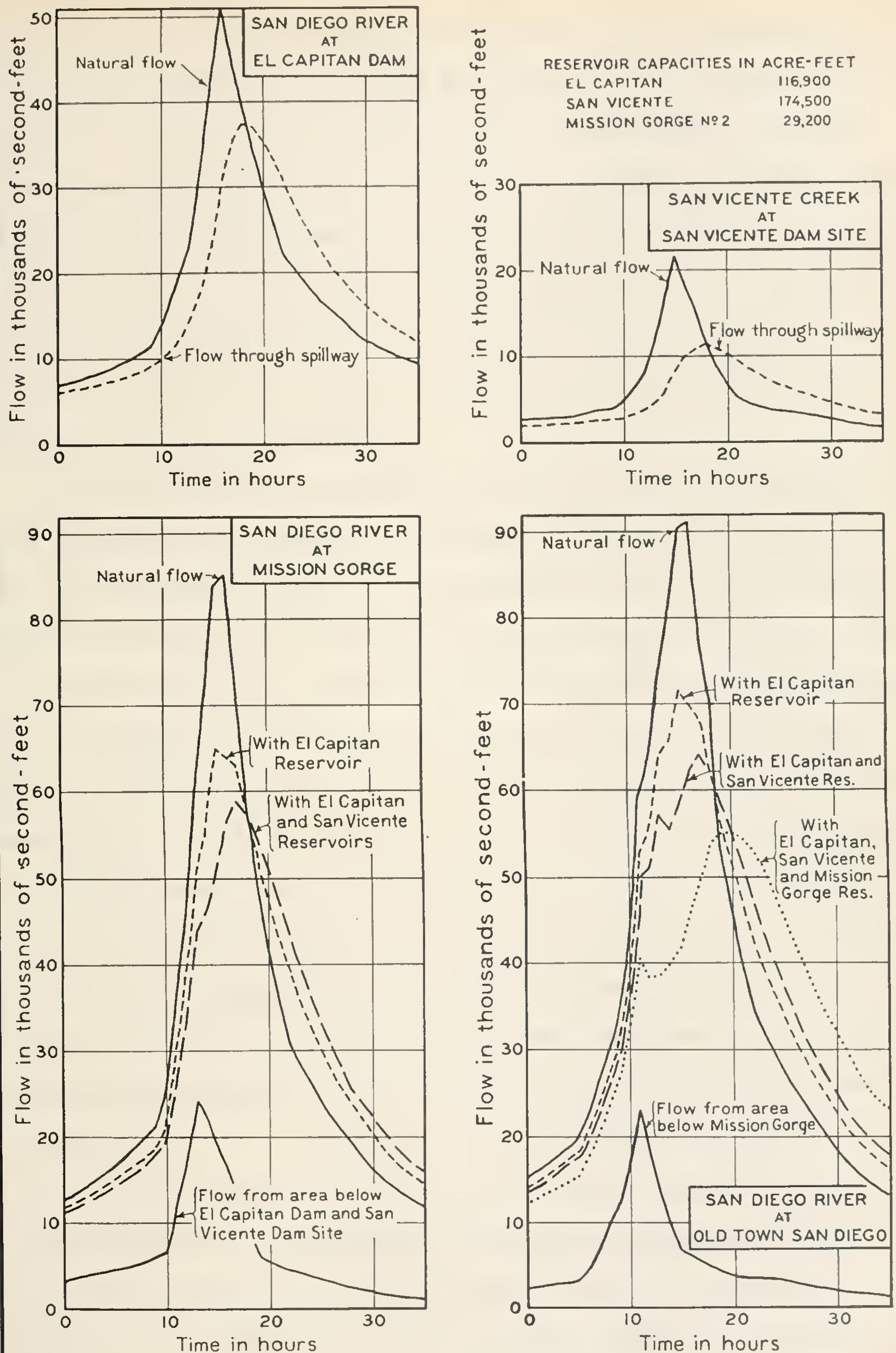
Flood Control Works

The methods of estimating the probable sizes, frequency of occurrence and characteristics of flood flows in the San Diego River Basin have been discussed in Chapter V, and the probable flows which may be expected to occur at

the Diverting Dam, Mission Gorge, and San Diego have been listed in Tables 27 and 29 in that chapter. In Chapter V, the general effect of conservation reservoirs on the San Diego River in reducing flood flows below Mission Gorge, the effect on the conservation values of reservoirs on the river from their joint use for conservation and flood control, and the effect of reservoir space utilized primarily for controlling floods are also discussed.

The reservoirs which would have an appreciable effect in reducing flood flows in the San Diego River are El Capitan, San Vicente and Mission Gorge. The San Diego River drainage basin, therefore, has been divided into four subbasins for the purpose of estimating the effect of these reservoirs on the flows at Mission Gorge and San Diego. These are the two basins directly tributary to the El Capitan and San Vicente reservoirs, the portion of the San Diego River Basin tributary to the river below the El Capitan and San Vicente reservoirs and above Mission Gorge, and the portion of the San Diego River Basin tributary to the river below Mission Gorge. The probable flood flows originating in each basin have been estimated and average hydrographs of flow have been selected for each basin by the methods described in Chapter V. The hydrographs of the probable once-in-100-year floods at the outlet end of each sub-basin and from each sub-basin are shown on Plate XXVI, "Hydrographs of Probable Once-in-100-year Flood in the San Diego River Drainage Basin." The hydrographs of floods of other frequencies are similar to these in shape.

In Water-Supply Paper 426 of the United States Geological Survey, it is stated that the crest flow of the 1916 flood passed Lakeside between 2:00 and 4:00 P.M. and San Diego about 7:00 P.M. In combining the flows of the separate sub-basins to obtain the probable total flows at Mission Gorge and San Diego, it was assumed that the crest flow from the area between the San Vicente and El Capitan dam sites and Mission Gorge would reach San Diego two hours after the crest flow from the area below Mission Gorge; that the



HYDROGRAPHS OF PROBABLE ONCE-IN-100-YEAR FLOOD
IN THE
SAN DIEGO RIVER DRAINAGE BASIN

crest flow from the area above the San Vicente dam site would reach San Diego four hours after the crest flow from the area below Mission Gorge; and that the crest flow from the area above the El Capitan dam site would reach San Diego five hours after the crest flow from the area below Mission Gorge. The probable hydrographs of the once-in-100-year flood flows at Mission Gorge and San Diego obtained by combining the separate hydrographs of flow from the sub-basins under these assumptions are also shown on Plate XXVI. The hydrographs represent the probable flows under the conditions which have existed since the construction of the Cuyamaca Reservoir.

The lands subject to inundation by floods from the San Diego River are shown on Plate XII in Chapter V. As shown on this map, the lands are divided into two separate areas, one in the Mission Bay and Mission Valley section of the basin and the other in the upper San Diego River Valley. The lower area includes all of the lands lying between Mission Bay, the Government Dyke, and the Atlantic Street State Highway and the relatively flat lands along the river through Mission Valley from Atlantic Street to the lower end of Mission Gorge. Between the lower area and the upper area lies Mission Gorge which is a narrow canyon in which the flood flows are confined to the river channel. Above Mission Gorge, the flood flows again spread out over the relatively flat lands of the upper valley. The area subject to flooding is the lower lands along the main river from Mission Dam to Cape Horn, about five miles above Lakeside and along San Vicente Creek as far upstream as Foster or the San Vicente dam site.

The lands along the San Diego River subject to inundation by flood waters may be protected by constructing levees along the channel, leaving sufficient width between them to carry the flood waters, by reducing the flood flows by storing flows in excess of the channel capacity in reservoirs, or by a combination of these two methods. If the leveed channel method is

used, it will also be necessary to clear the channel of all vegetation and to maintain this condition, and to protect the levees and banks from scour.

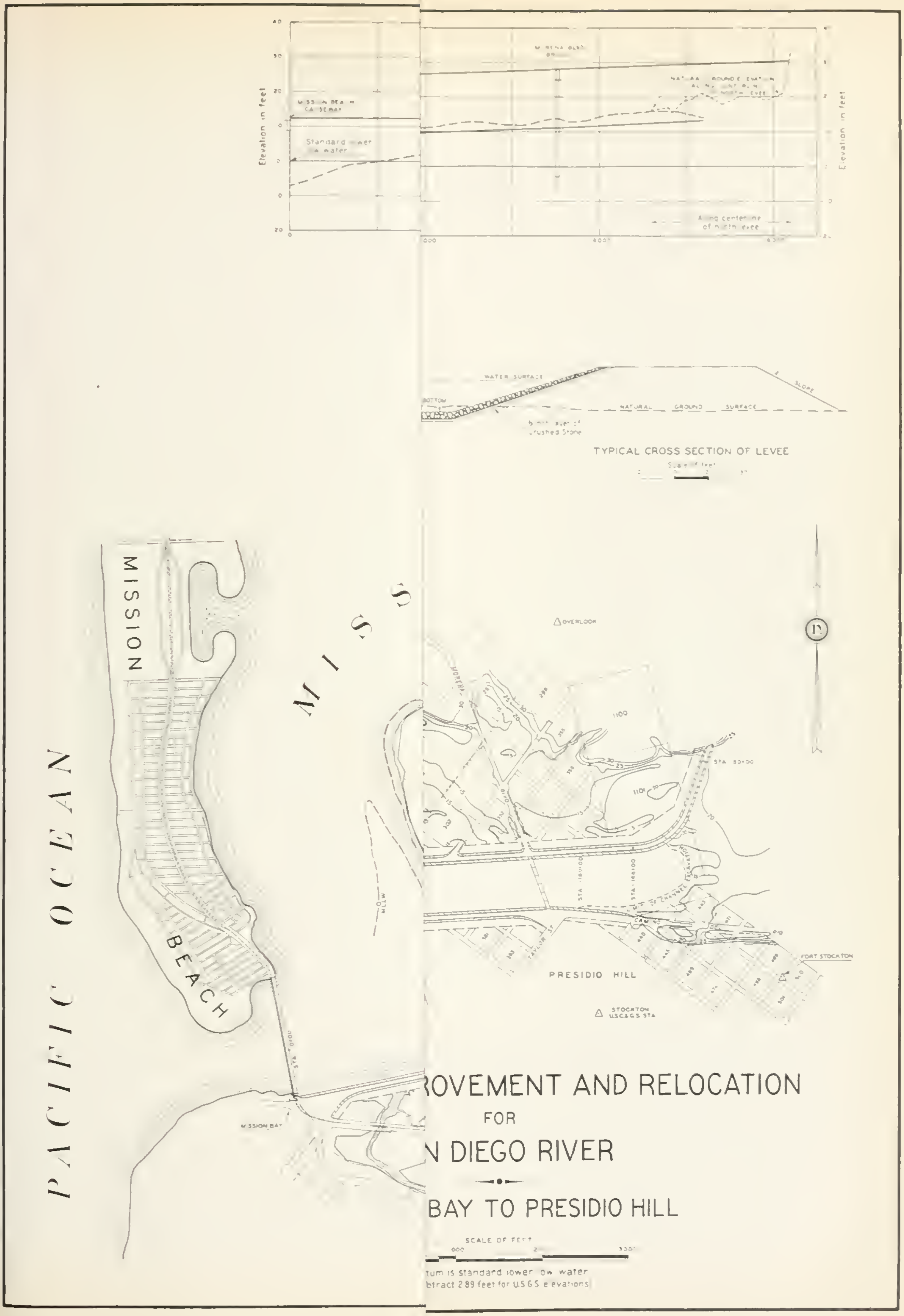
In the upper San Diego River Valley, no levee protection is contemplated. A portion of the area subject to inundation lies within the Mission Gorge reservoir site and would be purchased and used for reservoir purposes. The remaining area would receive a considerable degree of protection through the reduction of flood flows by the operation of the El Capitan and San Vicente reservoirs for conservation purposes, as hereinafter described. Further protection of such lands as would not be required for a channel could be accomplished by the construction of levees. The cost and economic feasibility of constructing such levees, however, have not been studied in this investigation.

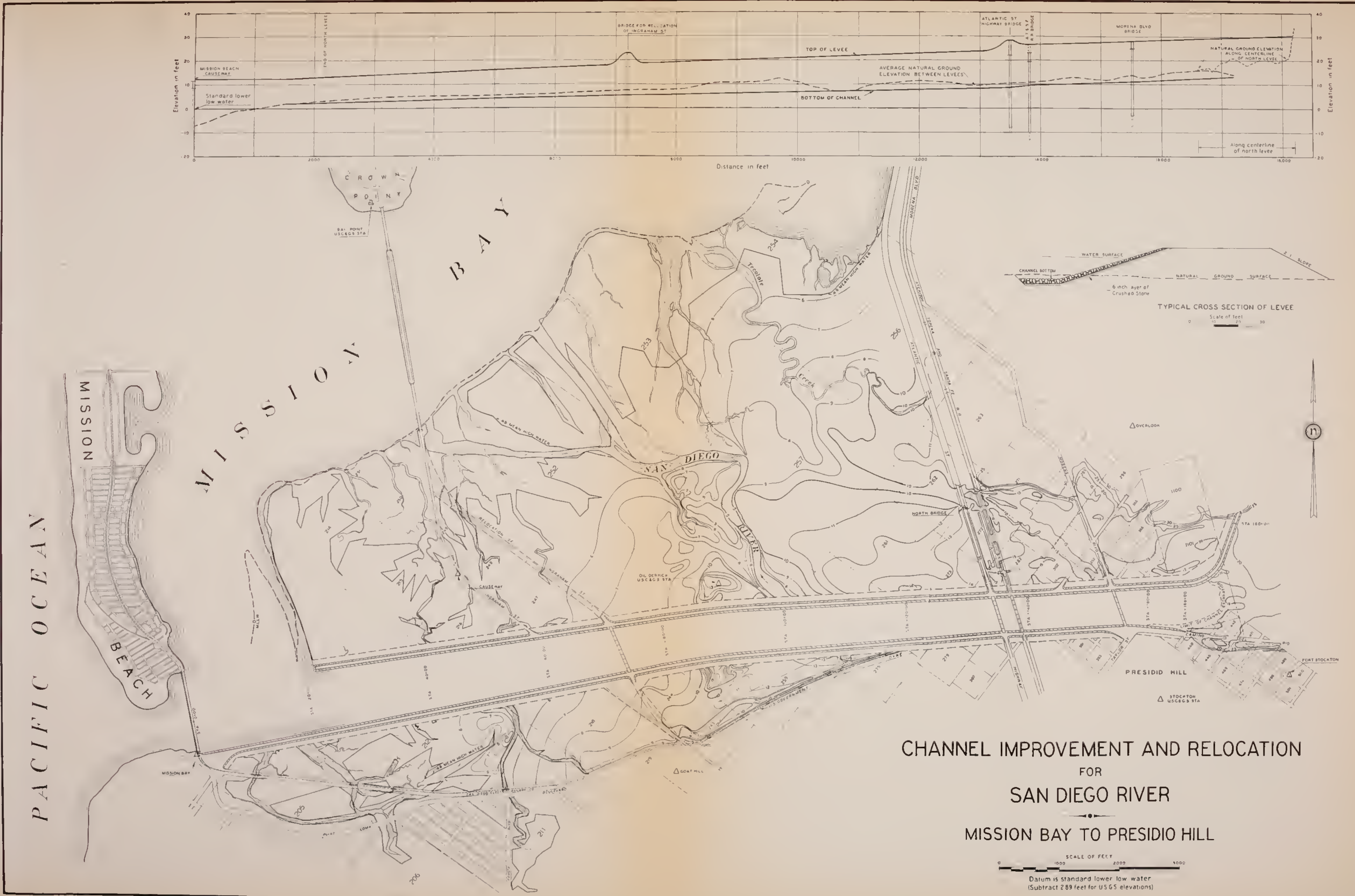
In the Mission Valley area, a very considerable degree of reduction in flood flows would be afforded by the operation of the present and proposed reservoirs for conservation purposes only, as discussed in Chapter V. A further reduction could be afforded by the construction and operation of the Mission Gorge No. 2 reservoir for flood control in addition to conservation. The El Capitan reservoir, which has recently been put into operation will have a marked effect on the flood regimen of the stream. The probable hydrograph of the once-in-100-year flood as it passes through the spillway of the El Capitan Dam, and the probable hydrographs of total flow at Mission Gorge and San Diego during the once-in-100-year flood with El Capitan Reservoir in operation are also shown on Plate XXVI. These hydrographs represent the probable flows during a once-in-100 year flood under the conditions which will obtain in the San Diego River drainage basin in the future. Probable hydrographs indicating the effects of the conservation operation of the reservoirs on San Vicente Creek and at Mission Gorge on the once-in-100-year flows at Mission Gorge and San Diego are also shown on Plate XXVI.

It has shown in Chapter V that with the El Capitan, San Vicente and Mission Gorge reservoirs all constructed and operated for conservation only, there would be flow past the Mission Gorge reservoir only about once every three years on the average and that floods which occur about once in 25 years on the average would be reduced so that there would be no contribution to the crest flow in the Mission Valley area from the basin above Mission Gorge. It is also pointed out in that chapter that the effect on a flood which would occur in Mission Valley once in 50 years on the average would be but little more than that due to its passage through the spillways. Protection of Mission Valley from the larger floods, therefore, must be accomplished by the operation of Mission Gorge No. 2 reservoir for flood control, by the construction of levees, or by combining these two methods.

Channel Improvement and Relocation in Mission Bay Area - The lands adjacent to Mission Bay subject to overflow from the San Diego River are shown on Plate XXVII, "Channel Improvement and Relocation for San Diego River - Mission Bay to Presidio Hill." These lands lie mostly west of the Atlantic Street State Highway and north of the Government Dyke and Point Loma Boulevard and consist for the most part of tidal marsh or low grade soils. A small area of good soil lies east of Atlantic Street State Highway and north of the San Diego River channel. Few residences have been built on these lands. All of the area lying below the mean high water line including Mission Bay belongs to the State of California and is under the supervision of the State Division of Parks. The remainder of the land if reclaimed could be used for residential or recreational purposes but has very little value for agriculture.

Since the Mission Bay area if reclaimed might be used to a large extent for residences, it must be protected against floods which occur at long average intervals of time. It may be seen from Table 51 that under


Elevation in feet
Standard lower low water
Along centerline of north levee
WATER SURFACE
BOTTOM
NATURAL GROUND SURFACE
SLOPE
TYPICAL CROSS SECTION OF LEVEE
OVERLOOK
PACIFIC OCEAN
MISSION
BEACH
MISS
MISSION BAY
PRESIDIO HILL
STOCKTON USC&GS STA
FORT STOCKTON
ROVEMENT AND RELOCATION
FOR
N DIEGO RIVER
BAY TO PRESIDIO HILL
SCALE OF FEET


CHANNEL IMPROVEMENT AND RELOCATION
FOR
SAN DIEGO RIVER
MISSION BAY TO PRESIDIO HILL
SCALE OF FEET
Datum is standard lower low water
(Subtract 2.89 feet for U.S.G.S. elevations)
Elevation in feet
Distance in feet
MISSION BEACH CAUSEWAY
Standard lower low water
TOP OF LEVEE
AVERAGE NATURAL GROUND ELEVATION BETWEEN LEVEES
BOTTOM OF CHANNEL
MORENA BLVD BRIDGE
NATURAL GROUND ELEVATION ALONG CENTERLINE OF NORTH LEVEE
Along centerline of north levee
WATER SURFACE
CHANNEL BOTTOM
NATURAL GROUND SURFACE
TYPICAL CROSS SECTION OF LEVEE
PACIFIC OCEAN
MISSION BEACH
MISSION BAY
CROWN POINT
SAN DIEGO RIVER
MORENA BLVD.
PRESIDIO HILL
FORT STOCKTON
OVERLOOK
NORTH BRIDGE

present conditions the flow into this area may be 26,000 second-feet once in 25 years on the average, 71-600 second-feet once in 100 years, and 99,200 second feet once in 250 years. Any of these flows would cause flooding. If the San Vicente and Mission Gorge No. 2 reservoirs were constructed and operated with the Cuyamaca and El Capitan reservoirs for conservation only, these amounts would be reduced to 13,800 second-feet, 55,000 second-feet, and 79,000 second-feet, respectively. Even if the Mission Gorge No. 2 reservoir were constructed and operated for both conservation and flood control, it is hereinafter shown that the probable minimum controlled flow would be 36,000 second feet, occurring once in 100 years on the average, and 50,600 second-feet, occurring once in 250 years. It may be seen, therefore, that to protect this area against even small floods would require a leveed channel to carry the flood flows, either unregulated or regulated by reservoirs.

Since the capacity of the leveed channel would depend largely upon the time of its construction with respect to the construction of the upstream reservoirs, the degree of protection desired, the use of Mission Gorge No. 2 reservoir for flood control as one of its functions, and the lowest combined cost of the leveed channel and flood control features of the Mission Gorge No. 2 reservoir, channel costs were estimated for capacities varying from 36,000 second-feet to 105,000 second-feet, as shown in Table 50. For all capacities, the channel was designed for the same location and for practically the same widths. The location and widths of channel are shown on Plate XXVII.

If there were no levees along the river through Mission Valley, the leveed channel would start at a point about 2,000 feet east of Morena Boulevard, at which point the north levee would tie in to high ground, and would approximately follow the present main channel of the river to a point about 3,500 feet west of the Atlantic Street Bridge. From this point, a new channel would be constructed westerly directly toward the outlet of Mission Bay. The

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south levee of the channel would be an enlargement of the Government Dyke from its easterly end at Morena Boulevard to a point about 1000 feet west of Atlantic Street and from this point west would be an entirely new levee. The north levee of the channel would be new for its entire length.

In presenting a plan for channel improvement and relocation of the San Diego River in the Mission Bay area the design of a suitable plan for development and reclamation of the State Park lands bordering on the south shore of Mission Bay was not within the scope of this investigation. Therefore, the north levee has only been carried to a point on the shore of Mission Bay where a connection can be made with the works required for development of these State Park lands.

As previously stated, the channel was maintained at practically the same widths for all capacities. To increase the capacity, the grade of the bottom was lowered and that of the tops of the levees was raised. The freeboard west of Atlantic Street on the tops of levees above the estimated flow line for the design capacity was made about four feet and a somewhat greater amount east of that point. A profile of the channel showing the grades of the bottom of channel and tops of levees, for a design capacity of 52,600 second-feet, is shown at the top of Plate XXVII.

There is also shown on Plate XXVII a typical cross-section of the levees. The section was made relatively heavy to provide additional safety for the lands protected. The top width of about 45 feet would provide space for the construction of a road on the crown. Such a road would be of great value in maintaining the levee and in furnishing accessibility to points of weakness at times of flood. To protect the levee from scour and undermining, a rip-rap facing of heavy rock laid on crushed stone would be placed on the waterside face from the top of the levee to the bottom of the channel and along the bottom of the channel for a distance of about 17 feet from the toe

of the side slope.

One of the principal items of expense in the construction of the channel would be for changes in the highway and railroad crossings. The present San Diego River channel is crossed by the Morena Boulevard and Atlantic Street highway bridges and by the Atchison, Topeka and Santa Fe Railroad bridge. The location of the new channel west of the present San Diego River channel is crossed by the Ingraham Street or Causeway highway. All of these crossings would require some expenditures for alterations, or protection, the amounts varying with the capacities of the channel.

The most expensive crossing would be at Ingraham Street since an entire new bridge would be required for this highway. The intersection of Ingraham Street with the line of the new channel is at such an acute angle that an alternate location for the highway appears desirable for both improved flowage conditions and economy in construction. The location of the present highway and the proposed relocation are shown on Plate XXVII. The reconstruction of the highway would require, in addition to the new bridge, about 5000 feet of new fill with a pavement similar to that of the present street on its crown. The bridge would be 800 feet in length and its cost has been estimated for a design similar to that of the present San Diego River Bridge on the Atlantic Street State Highway. The cost of the Ingraham Street alternate would be approximately the same for all channel capacities.

No changes would be required in the Atlantic Street crossing for any channel capacity for which estimates were made except the one for 105,000 second-feet. For this channel capacity, it would be necessary to raise the present bridge about three feet. This can be accomplished by jacking up the present spans and raising the piers.

The Santa Fe Railroad crossing would require some raising of the present plate girder spans, and the replacement of the wood trestle at

the north end of the present bridge, and some extension with additional plate girders, for all capacities of channel for which estimates were made. There would be three new 80-foot spans for all capacities of channel. The amounts and costs of raising the present spans and the approaches to the bridge would increase approximately in proportion to the increase in channel capacity but the cost of the new spans would be approximately the same for all capacities.

Above the Santa Fe Railroad bridge, the channel has been estimated for a somewhat greater width for a capacity of 105,000 second-feet than for capacities of 71,000 second-feet and under. This would necessitate a longer bridge at Morena Boulevard for the 105,000 second-foot capacity than for the smaller capacities for which estimates were made. The present bridge consists of four 101.5-foot steel truss spans. Three additional spans the same as those in the present bridge would be required for the 105,000 second-foot capacity channel and two additional 101.5-foot spans and one 50-foot plate girder span would be required for the narrower channel. No raising of the present bridge would be necessary except for the 105,000 second-foot capacity channel.

All of the piers under the present bridges are constructed of concrete and rest on piling foundations. The bottoms of the concrete piers would be from 9 to 20 feet below the bottom of the new channel and the piles would extend 25 to 50 feet lower. To protect both the existing and new piers from undermining from channel cutting, heavy riprap protection around the base of each pier has been provided for in estimating the costs of the channels.

Detailed estimates of capital and annual costs were made for channels with six capacities. A somewhat detailed estimate for one of these channels, that having a capacity of 52,600 second-feet, is given in Table 49. This

TABLE 49

COST OF CHANNEL IMPROVEMENT AND RELOCATION FOR SAN DIEGO RIVER

Mission Bay to Presidio Hill

Capacity of channel (4 foot freeboard), 52,600 second-feet

Channel and levees					
Excavation placed in levees	917,000	cu.yds. at	$0.18	$165,100	
Overhaul	728,000	sta.yds.at	0.01	7,300	
Borrow for levees	80,000	cu.yds. at	0.15	12,000	
Levee protection - Crushed rock	37,600	cu.yds. at	2.50	94,000	
- Rip-rap	116,000	cu.yds. at	2.50	290,000	$568,400
Road crossings					
Ingraham Street Alternate					
Road - Fill	80,000	cu.yds. at	0.15	12,000	
- Paving	200,000	sq.ft. at	0.20	40,000	
Bridge - Excavation	5,000	cu.yds. at	1.00	5,000	
- Wood piling	35,000	lin.ft. at	0.60	21,000	
- Concrete - Pier footings	1,100	cu.yds. at	14.00	15,400	
- Piers	1,340	cu.yds. at	15.00	20,100	
- Deck	1,500	cu.yds. at	14.00	21,000	
- Rail	60	cu.yds. at	40.00	2,400	
- Steel - Structural	615	tons at	120.00	73,800	
- Reinforcing	150	tons at	100.00	15,000	
- Cast	20	tons at	200.00	4,000	
- Traffic stripe	2,400	lin.ft. at	0.25	600	
- Curb stripe	1,600	lin.ft. at	1.00	1,600	
- Pier protection - rip-rap	1,200	cu.yds. at	2.50	3,000	234,900
Atlantic Street					
Bridge - Pier protection - rip-rap	1,200	cu.yds. at	2.50	3,000	3,000
Morena Boulevard					
Extending bridge - Excavation	2,800	cu.yds. at	1.00	2,800	
- Wood piling	5,000	lin.ft. at	0.60	3,000	
- Concrete-Piers and buttresses	1,120	cu.yds. at	15.00	16,800	
- Deck	200	cu.yds. at	15.00	3,000	
- Steel - Structural	150	tons at	140.00	21,000	
- Reinforcing	14	tons at	100.00	1,400	
Bridge pier protection - rip-rap	800	cu.yds. at	2.50	2,000	50,000

TABLE 49 (Continued)

Road crossings, (continued)					
Santa Fe Railroad crossing					
Roadbed - Earth fill	8,000 cu.yds.	at	0.25	2,000	
- Ballast	2,000 cu.yds.	at	2.00	4,000	
- Raising track	1,800 lin.ft.	at	1.00	1,800	
Raising present bridge					
- Lifting girders-Jacking				4,000	
- Raising piers-Concrete	60 cu.yds.	at	20.00	1,200	
Extending bridge - Excavation	2,500 cu.yds.	at	1.00	2,500	
- Wood piling	7,500 lin.ft.	at	0.60	4,500	
- Concrete					
-Pier footings	400 cu.yds.	at	14.00	5,600	
-Piers	670 cu.yds.	at	15.00	10,100	
- Steel					
-Plate girders	150 tons	at	120.00	18,000	
-Floor beams	90 tons	at	100.00	9,000	
-Reinforcing	4 tons	at	100.00	400	
- Timber					
-Deck	40 M.B.M.	at	75.00	3,000	
Bridge pier protection - Rip-rap	1,600 cu.yds.	at	2.50	4,000	$70,100
Right of way	350 acres	at	300.00	105,000	105,000
Sub-total					1,031,400
Administration, engineering and contingencies - 25%					257,800
Interest during construction - 5% rate					52,200
Total cost					1,341,400

ANNUAL COST

Interest	5 per cent per annum	67,100
Depreciation on channel and levees	0.64 per cent per annum	4,700
Amortization - sinking fund	40 year -4 per cent-semi-annual payments	13,800
Maintenance		
Levees and channel	2 per cent per annum	14,800
Right of way	1 per cent per annum	1,400
Total annual cost		$101,800

table shows the quantities of work required and the unit and total costs for each item. At the bottom of the table there is an estimate of the annual cost of the channel showing the items of expense, the bases for estimating the costs, and the cost of each item.

The estimated capital and annual costs for the channels with the six capacities studied are given in Table 50. In estimating the costs shown in this table, the items of cost and unit prices were practically the same as in the detail estimate shown in Table 49. A comparison of the capital and annual costs of the channels is shown graphically on Plate XXIX, "Cost of Flood Protection in Mission Bay Area", near the end of this chapter.

TABLE 50

COSTS OF CHANNEL IMPROVEMENT AND RELOCATION FOR SAN DIEGO RIVER

MISSION BAY TO PRESIDIO HILL

Capacity of channel with 4-foot free-board on levees, in second-feet	Costs	
	Capital	Annual
36,000	$1,254,000	$94,300
42,700	1,286,000	97,100
50,000	1,326,000	100,400
52,600	1,341,000	101,800
71,000	1,452,000	110,800
105,000	1,735,000	133,000

Reservoir Control of Floods - It has been shown in Chapter V that the use of conservation space in the reservoirs on the San Diego River for flood control is not advisable, as some water which should be conserved might be lost by such operation. It would be possible, however, to construct the Mission Gorge No. 2 reservoir to be operated for flood control as one of its functions by so constructing the dam that flood flows could be stored in reserve space above that provided for conservation purposes.

It has also been determined by a number of studies of the operation of the conservation reservoirs, that with these reservoirs operated for conservation alone there would be a material effect in reducing flood flows in the San Diego River below the reservoirs, especially those flows which would occur during the smaller floods. The results of these studies are shown in Table 51. The first column of the table shows the average frequency of occurrence of the flood investigated. The second column shows the amounts of flow in the river at San Diego which would originate below Mission Gorge, or below the lowest reservoir which would effect reductions in flood flow. The third

TABLE 51

EFFECT OF CONSERVATION RESERVOIRS ON SAN DIEGO RIVER
IN REDUCING FLOOD FLOWS

Capacities of Conservation Reservoirs

Cuyamaca,	11,600 acre-feet	San Vicente	174,500 acre-feet
El Capitan,	116,900 acre-feet	Mission Gorge No. 2,	29,200 acre-feet

Probable frequency with which flow would occur, on the average	Probable flow at San Diego, in second-feet					
	Originating in basin below Mission Gorge	With following reservoirs in operation				
		Cuyamaca	Cuyamaca, El Capitan	Cuyamaca, El Capitan, San Vicente	Cuyamaca El Capitan, Mission Gorge No. 2	Cuyamaca, El Capitan, San Vicente, Mission Gorge No. 2
Once in 25 years	13,800	46,400	26,000	20,500	---	13,800
Once in 50 years	18,400	67,200	46,600	40,900	---	34,600
Once in 100 years	22,900	91,000	71,600	64,100	59,400	55,000
Once in 250 years	28,900	125,100	99,200	91.200	84,100	79,000

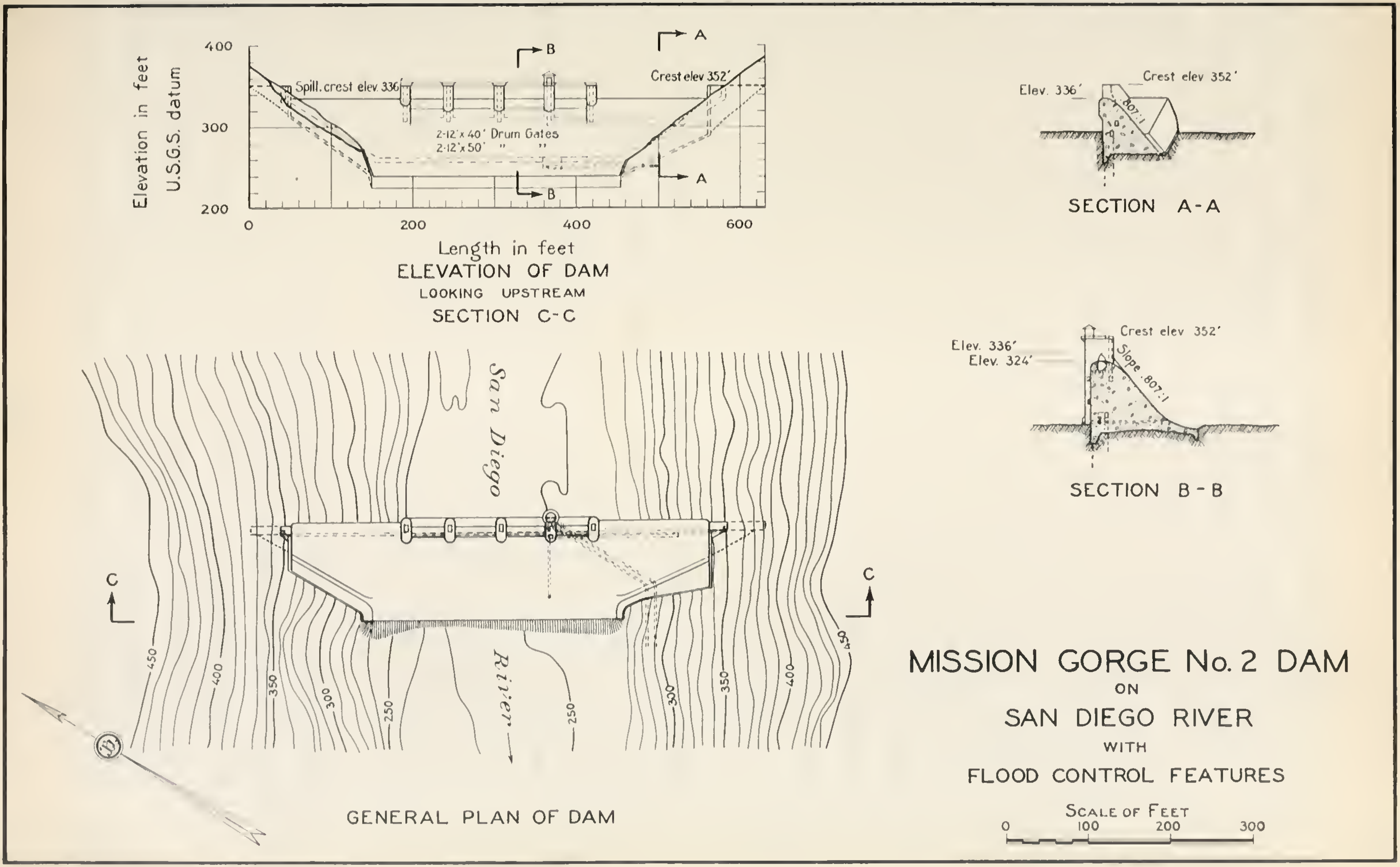
column shows the flow at San Diego if Cuyamaca Reservoir were the only reservoir on the river, which is the condition which existed before the El Capitan Reservoir was completed and in operation. The fourth column shows the flows with the El Capitan Reservoir in operation in addition to Cuyamaca Reservoir. These are the flows which may be expected to occur until additional storage is developed in the river basin. The fifth, sixth and seventh columns show the flows with San Vicente reservoir alone, Mission Gorge No. 2 reservoir alone, and San Vicente and Mission Gorge No. 2 reservoirs together, respectively, operated coordinately with Cuyamaca and El Capitan reservoirs. Differences between the figures in the fourth, fifth, sixth, and seventh columns from those in the third column show the reductions in flood flows due to the operation of the reservoirs for conservation purposes only.

As has been previously stated, Mission Gorge No. 2 reservoir could be constructed to be operated for flood control as one of its functions without interference with its value for conservation. Studies have been made to determine the height and type of dam required, and the cost of reservoir, for three controlled flows at San Diego. These flows are 36,000 second-feet, 42,700 second-feet and 52,600 second-feet, occurring once in 100 years on the average. In all cases, the capacity of the conservation portion of the reservoir was maintained at 29,200 acre-feet.

The combined conservation and flood control dam would be of the same general type, and located in the same position, as the conservation dams previously described. The principal difference would be in the lengths and depths of the spillway sections and in the use of steel drum gates in the spillways to control the flows. Statements previously made with reference to the geology of the site, amounts of excavation required to obtain a sound foundation, sealing of the foundation, outlets and sluiceway, and the availability of materials for construction, in describing the conservation dam, also apply to the

construction of the dams for conservation and flood control combined, and will not be repeated.

The total length of the spillway and flood control gate sections of the dams for all of the controlled flows studied would be within a few feet of the same length as the spillways of the conservation dams. The spillway channels, therefore, would be the same as for the conservation dams. For the dam required for a controlled flow of 36,000 second-feet, there would be two steel drum gates 12 feet high and 30 feet long, located in the center of the dam. The gates would be separated by a concrete pier 12 feet thick and there would be similar piers at the ends of the gates. Two of these piers would contain the operating mechanism for the gates. The sills of these gates would be at elevation 324 feet and the tops at elevation 336 feet. On both sides of this gate section there would be overflow spillway sections, without gates, 195 feet in length, with the crests at elevation 351 feet. The top of the dam on the abutments would be at elevation 364 feet. For a controlled flow of 42,700 second-feet, there would be three gates 12 feet high and 40 feet long, separated by 12-foot thick concrete piers, with the sills at elevation 324 feet, and two overflow spillway sections, without gates, 165 feet long with the crests at elevation 345 feet. The crest of the dam on the abutments would be at elevation 358 feet. For a controlled flow of 52,600 second-feet, there would be two gates 12 feet high and 40 feet long and two gates 12 feet high and 50 feet long, separated by 12-foot thick concrete piers, with the sills at elevation 324 feet, and two overflow spillway sections, without gates, 135 feet long with the crests at elevation 336 feet. The crest of the dam on the abutments would be at elevation 352 feet. The dam last described is shown on Plate XXVIII, "Mission Gorge No. 2 Dam on San Diego River with Flood Control Features." With all of the dams just described, a flood which might occur once in 1000 years on the average would pass the dam without overtopping the abutments.



MISSION GORGE No. 2 DAM
ON
SAN DIEGO RIVER
WITH
FLOOD CONTROL FEATURES

The principal items of cost for the flood control features of the Mission Gorge No. 2 reservoir are the purchase of additional reservoir lands and the relocations of roads and the water supply pipe line. The crest of the dam for 29,200 acre-feet capacity for conservation only would be at elevation 353 feet. The additional heights for flood control are shown by the crest elevations in the foregoing paragraph. For the 52,600 second-foot controlled flow, the crest of dam would be one foot lower than the crest for conservation alone, due to the additional capacity of the spillway. For this control, the cost of the reservoir would be practically the same as for conservation alone, as hereinafter shown. For the 42,700 second-foot control, it is estimated that 73 per cent of the cost of the flood control features would be attributable to the purchase of land and the relocation of improvements. For the 36,000 second-foot control, the cost of these items would be 77 per cent of the cost of flood control features.

In order to illustrate the method of estimating the cost of the Mission Gorge No. 2 reservoir for combined conservation and flood control, a somewhat detailed estimate is given in Table 52 for the reservoir required to obtain a controlled flow of 52,600 second-feet. This table shows the quantities of work required and the unit and total costs for each item. At the bottom of the table there is an estimate of the annual cost of the reservoir showing the items of expense, the basis for estimating the costs, and the cost of each item.

The estimated capital and annual costs for the reservoirs required to obtain the three controlled flows previously stated are given in Table 53. These costs were estimated in the same manner as shown by the estimate in Table 52. The items of cost and the unit prices were the same in all of the estimates. In addition to the costs, the table shows a summary of the flood control and spillway features of the dams and the maximum controlled flows

TABLE 52

COST OF MISSION GORGE NO. 2 RESERVOIR
WITH FLOOD CONTROL FEATURES

Capacity reserved for conservation, 29,200 acre-feet.

Crest of dam, elevation 352 feet, U.S.G.S. datum.
Uncontrolled spillway - Length 270 feet, crest elevation 336 feet.
Steel drum gate section-2 gates, 40 feet long, gate sill elevation 324 feet, 12 feet high.
-2 gates, 50 feet long, gate sill elevation 324 feet, 12 feet high.
Controlled flow at San Diego, occurring once in 100 years, 52,600 second-feet, reservoir water surface elevation 343 feet.
Controlled flow at San Diego, occurring once in 250 years, 71,200 second-feet, reservoir water surface elevation 347 feet.
Flow past dam, occurring once in 1000 years, 109,000 second-feet, reservoir water surface elevation 352 feet.
Maximum capacity of spillway, 109,000 second-feet.

CAPITAL COST

Dam (Including spillway)				
Excavation				
Common	14,000 cu.yds.	at $1.50	$21,000	
Rock - Stripping	29,900 cu.yds.	at 2.50	74,750	
- Cutoff wall trenches	3,910 cu.yds.	at 4.00	15,640	
- Outlet tunnel	90 cu.yds.	at 10.00	900	$112,290
Concrete				
Mass - In dam	84,200 cu.yds.	at 6.60	555,720	
- Outlet tunnel backfill	70 cu.yds.	at 14.00	980	
Reinforced - Spillway walls	320 cu.yds.	at 19.00	6,080	
- Spillway piers	1,500 cu.yds.	at 15.00	22,500	
- Spillway lining	1,010 cu.yds.	at 16.25	16,410	
- Gate tower and house	100 cu.yds.	at 19.00	1,900	603,590
Grouting, drainage and seals	640 lin.ft. of dam	at 90.00	57,600	57,600
Backfill	3,980 cu.yds.	at 0.50	1,990	1,990
Spillway gates - Steel drum gates	261,000 lbs.	at 0.10	26,100	
- Operating mechanism	4 sets	at 1300.00	5,200	31,300
Outlets				
Steel pipe - 30 inch	460 ft.	at 7.20	3,310	
Trash racks and guides	6,400 lbs.	at 0.10	640	
Slide valves in pipes-30 inch	3	at 1500.	4,500	
Slide valves in tower-30 inch	3	at 1100.	3,300	
Trash rack hoist	1	at 250.	250	
Foot bridges between piers	180 ft.	at 10.00	1,800	13,800

TABLE 52 (Continued)

Reservoir			
Land and improvements		$550,000	
Relocation of roads	5.0 mi. at $20,000	100,000	
Relocation of pipe line	5.2 mi. at 45,000	234,000	
Clearing land	500 ac. at 20.00	10,000	$ 894,000
Subtotal			1,714,570
Administration and engineering	10% of subtotal		171,460
Contingencies on construction items	15% of $1,164,570		174,690
Interest during construction	5% rate		83,460
Total capital cost			$2,144,180

ANNUAL COST

Interest	5 per cent per annum	$ 107,210
Depreciation on dam only	0.35 per cent per annum	3,740
Amortization - Sinking fund	40 year - 4 per cent - Semi-annual payments	22,130
Operation and maintenance		5,000
Total annual cost		$ 138,080

at San Diego which might occur once in 100 years and once in 250 years on the average. The last two columns of the table show the capital and annual costs of the flood control features only of each reservoir. These costs are also shown graphically on Plate XXIX. In obtaining these costs, the capital and annual costs of the conservation reservoir with a storage capacity of 29,200 acre-feet were subtracted from the capital and annual costs, respectively, shown in the ninth and tenth columns of the table.

Although it is assumed in estimating the costs of the Mission Gorge No. 2 reservoir for conservation and flood control combined that the reservoir would have the same value for conservation that it would have if constructed for this purpose alone, this is not exactly true. This is due to the fact that there would be no opening in the dam constructed for conservation alone below the storage level for 29,200 acre-feet at elevation 336 feet except the outlet pipes, whereas the sills of the steel drum gates required with flood control operation would be at elevation 324 feet. With these drum gates, there would always be a possibility that their failure to close would cause the loss of some of the water in the conservation portion of the reservoir. Also, with drum gates, there would be some leakage when water is against the gates and, to prevent the loss of this water, it would have to be collected below the gates and pumped back into the reservoir. This would cause some additional expense. Furthermore, since drum gates must depend upon mechanical operation, either automatic or manually controlled, neither of which can be perfect, and also since the drum gates can be prevented from opening in the manner necessary for proper flood regulation, their use for flood control cannot be absolutely depended upon.

To overcome the foregoing objections from both conservation and flood control points of view, it would be possible to construct a dam for combined conservation and flood control use with no openings in the crest below elevation

336 feet and with no movable gates. This is possible through the use of open ports in the dam, with their sills at elevation 336 feet, and overflow spillways without gates. In order to compare the cost of a reservoir having such a dam with that for one which would give the same regulated flow by using drum gates in the dam, an estimate was made for a reservoir with a dam having open ports and spillway capacity to control flood flows to a maximum of 42,900 second-feet at San Diego, occurring once in 100 years on the average. The dam would have twenty 8 foot by 8 foot openings in the central portion of the dam, separated by concrete piers 8 feet thick. The sills of the openings would be at elevation 336 feet and the tops at elevation 344 feet. Directly above these openings, there would be an overflow spillway 318 feet in length, with its crest at elevation 355 feet. At both ends of this spillway, and separated from it by five foot thick concrete piers, there would be spillways 40 feet long with crests at elevation 345 feet. There would also be two spillways, each 41 feet long, adjacent to the 40-foot spillways and separated from them by five-foot thick concrete piers, with crests at elevation 355 feet. This gives an over-all length of spillway and port section of 500 feet, the same as for the spillways for the conservation dams. The tops of the abutment sections would be at elevation 363 feet, at which height a flood occurring once in 1000 years on the average would pass the dam without the abutments being overtopped. The other features of the dam would be practically the same as for the dam for conservation alone. Data and costs for this reservoir are given in the last lines of Table 53.

Comparative data and costs for reservoirs with 29,200 acre-feet of space for conservation and with features for controlling floods to a maximum flow of 42,700 second-feet at San Diego occurring once in 100 years on the average, either by means of open ports or drum gates, may be obtained from Table 53. It will be seen that for the reservoir with open ports in the dam

TABLE 53

COSTS OF MISSION GORGE NO. 2 RESERVOIRS
WITH FLOOD CONTROL FEATURES

Capacity reserved for conservation, 29,200 acre-feet

Elevation of crest of dam, in feet U.S.G.S. datum	Flood control and spillway section: Flood control section 12 foot drum gates: Number of gates	Length of gate, in feet	Elevation of sill, in feet	Uncontrolled spillway section: Length, in feet	Elevation of crest, in feet	Maximum controlled flow at San Diego in second-feet (1): Occurring once in 100 years on the average	Occurring once in 250 years on the average	Cost of reservoir: Capital	Annual	Cost of flood control features: Capital	Annual
352	2	40	324	270	336	52,600	71,200	$2,144,000	$138,100	$ 1,000	$ 300
	2	50	324								
358	3	40	324	330	345	42,700	58,100	2,554,000	163,100	411,000	25,300
364	2	30	324	390	351	36,000	50,600	2,915,000	185,200	772,000	47,400
363	20-8'x8' openings without gates		336	80	345	42,900	59,800	2,836,000	180,300	693,000	42,500
				400	355						

(1) With conservation reservoirs of following capacities in operation

Cuyamaca	11,600 acre-feet
El Capitan	116,900 acre-feet
San Vicente	174,500 acre-feet

the flow line would be 5 feet higher, the capital cost of the reservoir and flood control features $282,000 greater, and the annual costs of these features $17,200 greater, than for the reservoir with drum gates for flood control.

It has been shown in Table 51 that with the Cuyamaca, El Capitan, San Vicente and Mission Gorge No. 2 reservoirs all operated coordinately for conservation only, the maximum flow which would probably occur at San Diego once in 100 years on the average would be 55,000 second-feet. The foregoing data show that with the same conservation reservoirs but with Mission Gorge No. 2 reservoir also operated for flood control, this flow could be reduced to 52,600 second-feet, 42,700 second-feet, 36,000 second-feet, or to some lesser amount, by utilizing sufficient reserve storage space for flood control in the Mission Gorge No. 2 reservoir in addition to the 29,200 acre-feet for conservation purposes. The reduction of the flows through Mission Valley would give protection to the lands in that area and would decrease the cost of levee protection for the lands, if such type of protection were desirable.

Protection of Mission Bay Area by Combined Flood Control by Reservoirs and Improvement and Relocation of San Diego River Channel - If it is assumed that no levees would be built in Mission Valley, that a leveed channel would be built through the Mission Bay area, and that Mission Gorge No. 2 reservoir would be built with flood control features, the costs of flood protection in the Mission Bay area with several controlled flows at San Diego, which controlled flows would also be the capacities of the leveed channels, are given in Table 54. These combined costs are also shown graphically on Plate XXIX.

TABLE 54

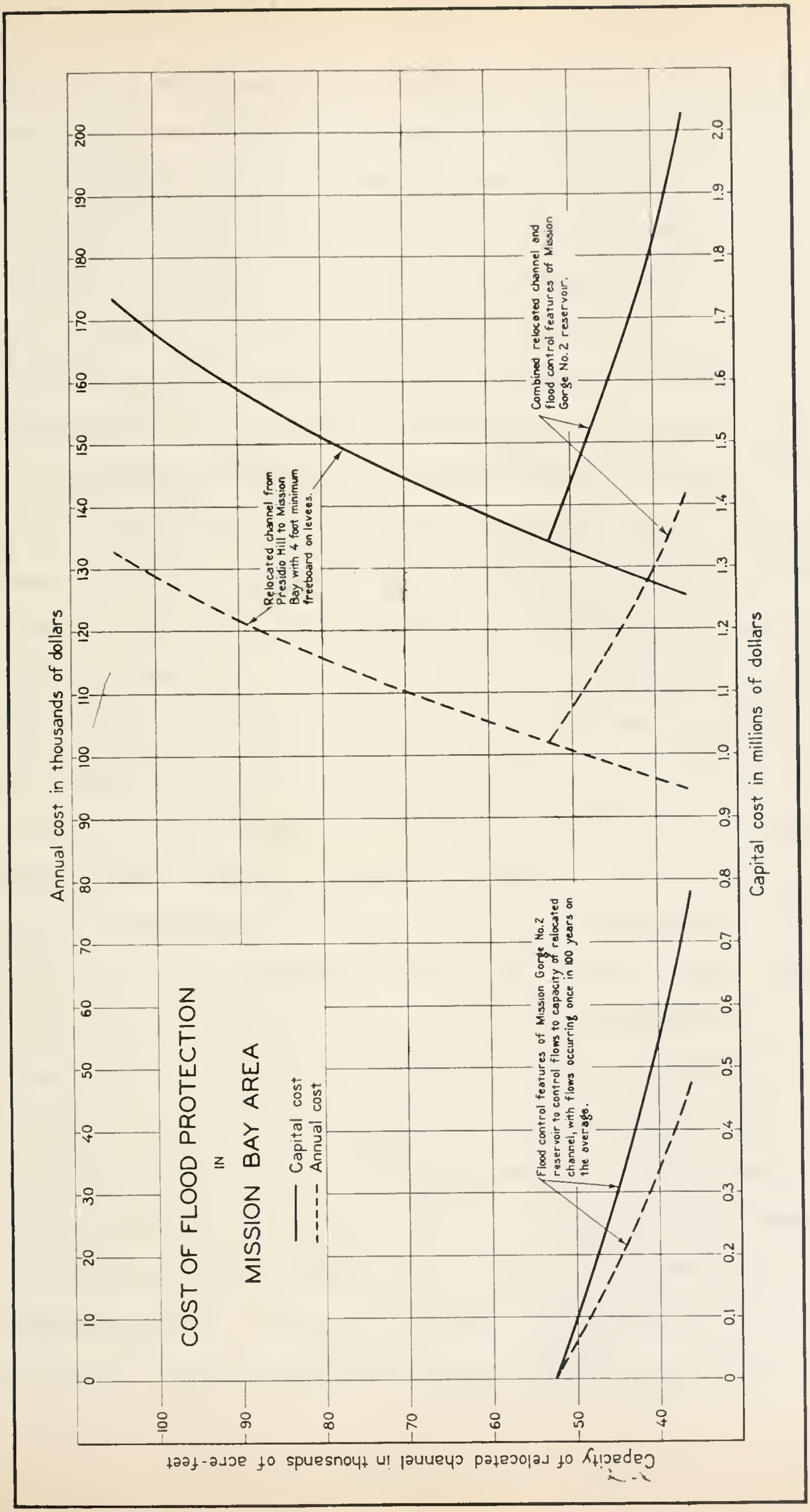
COSTS OF FLOOD PROTECTION IN MISSION BAY AREA

With Flood Control Features at Mission Gorge No. 2 Reservoir and San Diego River Channel Improvement and Relocation from Presidio Hill to Mission Bay

Capacity of channel with minimum 4-foot freeboard on levees, in second-feet	Costs					
	Flood control features of Mission Gorge No. 2 reservoir		Channel improvement and relocation		Total	
	Capital	Annual	Capital	Annual	Capital	Annual
36,000	$772,000	$47,400	$1,254,000	$94,300	$2,026,000	$141,700
42,700	411,000	25,300	1,286,000	97,100	1,697,000	122,400
52,600	1,000	300	1,341,000	101,800	1,342,000	102,100
42,900	693,000(1)	42,500(1)	1,286,000	97,100	1,979,000 (1)	139,600 (1)

(1) With open ports for flood control, instead of drum gates, in Mission Gorge No. 2 dam.

In the discussion of the improved and relocated channel for the San Diego River through the Mission Bay area, it was stated that the capacity of this channel would depend largely upon the time of its construction with respect to the time of construction of the upstream reservoirs, the degree of protection desired, the use of Mission Gorge No. 2 reservoir for flood control as one of its functions, and the lowest combined cost of the leveed channel and the flood control features of the Mission Gorge No. 2 reservoir. If it is assumed that Cuyamaca, El Capitan, San Vicente, and Mission Gorge No. 2 reservoirs were constructed to the capacities shown in the heading of Table 51 and operated for conservation purposes, that Mission Gorge No. 2 reservoir would also be enlarged and operated for flood control, and that none of the costs of flood control by reservoirs would be charged against Mission Valley, the last two columns in Table 54 and the lower right hand curves on Plate XXIX show the cost of flood protection in the Mission Bay area. The curves indicate that the minimum cost


COST OF FLOOD PROTECTION
IN
MISSION BAY AREA
Capital cost
Annual cost
Annual cost in thousands of dollars
Capital cost in millions of dollars
Capacity of relocated channel in thousands of acre-feet
Relocated channel from Presidio Hill to Mission Bay with 4 foot minimum freeboard on levees.
Combined relocated channel and flood control features of Mission Gorge No. 2 reservoir.
Flood control features of Mission Gorge No. 2 reservoir to control flows to capacity of relocated channel, with flows occurring once in 100 years on the average.

of protection would be obtained with a controlled flow of about 52,600 second-feet at San Diego occurring once in 100 years on the average, and a leveed channel of this capacity with a minimum free board of four feet on the levees. A channel of this capacity would carry the flood of 71,200 second-feet which might occur once in 250 years on the average with the same reservoirs in operation, with a minimum of 2.4 feet of the freeboard on the levees remaining.

Although the flood control features in the Mission Gorge No. 2 reservoir for a controlled flow of 52,600 second-feet occurring once in 100 years on the average cost practically nothing, this controlled flow is only 2,400 second-feet less than if the reservoir were operated for conservation only. In both cases, the Cuyamaca, El Capitan, and San Vicente reservoirs would also be in operation for conservation. Since there are disadvantages to operating the reservoir for flood control, as previously pointed out, it would be possible to obtain the same degree of protection in the Mission Bay area by increasing the capacity of the leveed channel to 55,000 second-feet. In this case, the capital cost of flood control to this area would be about $15,000 greater than if Mission Gorge No. 2 reservoir were operated for flood control as one of its functions.

If it is assumed that the lands in the Mission Bay area will be reclaimed before any more reservoirs are built on the San Diego River, the flows against which protection should be provided are those with Cuyamaca and El Capitan reservoirs in operation for conservation, shown in the fourth column of Table 51. The selection of the capacity of the leveed channel would then depend upon the immediate degree of protection desired. If full immediate protection against a flood which might occur once in 100 years on the average is desired, the channel should be designed for a capacity of 71,600 second-feet with a minimum freeboard of 4 feet on the levees. If, however, advantage is to be taken of future flood control benefits from the construction of the San

Vicente and Mission Gorge No. 2 reservoirs, the channel capacity would be made 52,600 second-feet, or 55,000 second-feet. If the channel is constructed for a capacity of 52,600 second-feet with a minimum 4-foot freeboard on the levees, the flow of 71,600 second-feet which may occur once in 100 years on the average under present conditions would be carried by the channel with a minimum free-board of 2.4 feet remaining on the levees. The flow of 99,200 second-feet which may occur once in 250 years on the average under present conditions would pass down the channel with a minimum freeboard of about one-half foot remaining on the levees. This freeboard could be increased to at least 1.5 feet, however, at no, or a very small expense, by slightly decreasing the width of crown of the levees and adding the material to the top.

Protection of Mission Valley - The lands in Mission Valley subject to overflow comprise practically all of the relatively flat lands adjacent to the San Diego River from Morena Boulevard to the lower end of Mission Gorge. Most of the lands, except those occupied by the river channel, are used for agriculture and there are only a few residences and buildings within the area which may be flooded. Above the mouth of Alvarado Canyon, the valley narrows considerably and any leveed channel through this area, sufficiently large to carry the flood flows, would occupy too large a portion of the flooded lands to justify its construction. Therefore, no flood protection except that obtained from upstream reservoir operation is proposed in this latter area.

Flood flow studies of the San Diego River show that the crest flows from the side canyons which enter lower Mission Valley precede the crests from the upper river by several hours and therefore have very little effect in increasing the amounts of the crest flows through the valley. Crest flows, for which channel capacity through the valley below Alvarado Canyon would be provided, would, therefore, remain practically constant from immediately below the

mouth of this canyon to Mission Bay. These flows under present conditions and with the proposed reservoirs constructed and operated for conservation are shown in Table 51.

It may be seen from Table 51 that under present conditions the flows through lower Mission Valley would be 26,000, 46,600, 71,600, and 99,200 second-feet once in 25, 50, 100, and 250 years on the average, respectively. The table also shows that with Cuyamaca, El Capitan, San Vicente and Mission Gorge No. 2 reservoirs operated for conservation, the flows would be 13,800, 34,600, 55,000 and 79,000 second-feet, once in 25, 50, 100 and 250 years on the average respectively. The smallest of these flows would cause some flooding adjacent to the channel and larger ones would flood practically all of the valley lands. To protect these lands, therefore, a leveed channel through the valley would be required. The size and capacity of this channel would depend upon the time of its construction with respect to the construction of the upstream reservoirs and the degree of protection desired. In this study, only one size of channel was investigated.

In estimating the cost of the leveed channel through Mission Valley, it was assumed that the cost of lengthening the Morena Boulevard Bridge was charged to the improved and relocated channel through the Mission Bay area and that the north levee of the latter channel was constructed to high ground about 2000 feet upstream from the Morena Boulevard. The north levee of the Mission Valley channel was tied in to the north levee of the Mission Bay area channel about 1000 feet east of Morena Boulevard. The south levee was started 1000 feet east of the south end of the Morena Bridge and carried along the Camino del Rio, to form an embankment for that road, for about 2000 feet. The channel was laid out to follow in general the low water course of the river. The south levee was terminated at high ground near the south end of the San Diego River bridge on

the Murphy Canyon Road. The north levee was terminated at high ground near the San Diego Mission. Levees were extended up both sides of the Murphy Canyon channel to the county road, to divert the flow from that canyon into the flood channel. The north levee of the flood channel was carried up the west side of the Murray Canyon channel to the county road and the road fill was raised to divert the flow from the canyon into the flood channel. On the east side of Murray Canyon, the ground is high enough to serve for the north levee of the flood channel for several hundred feet.

The channel was designed for a carrying capacity of 72,000 second-feet, which is approximately the estimated flow once in 100 years on the average under present conditions, with a three-foot freeboard on the levees. The bottom width would be 550 feet and the slopes of the sides of the channel cut and the water sides of the levees would be 3 to 1. The sides of the channel would be protected from scour and undermining by a rock and rip-rap protection the same as that shown on the cross section of Plate XXVII. The levees would have top widths of 20 feet and land side slopes of 2 to 1.

With a channel of the foregoing dimensions, the flood of 79,000 second-feet which might occur once in 250 years on the average with the Cuyamaca, El Capitan, San Vicente and Mission Gorge No. 2 reservoirs operated for conservation only could be carried in the channel with a freeboard of 2½ feet on the levees remaining. The flood of 55,000 second-feet which might occur once in 100 years on the average with the same reservoirs in operation could be carried with a freeboard of about 5 feet on the levees.

Mission Valley is crossed by two main highways, and new bridges would have to be constructed on both of these across the flood channel. In making the cost estimate, it was assumed that these bridges would be of the same type as the present Atlantic Street State Highway bridge but only three-fourths as wide.

A somewhat detailed estimate of the cost of the foregoing described channel is given in Table 55. This table shows the quantities of work required and the unit and total costs for each item.

It is estimated from the County Assessor's valuations that the actual value of the lands and improvements, subject to inundation in Mission Valley downstream from Alvarado Canyon is $529,000. The value of the land required for the channel is estimated to be $125,000. The present value of the land which would be protected is therefore only $404,000 as compared to $2,034,000 which it would cost to give the protection. It, therefore, does not appear that protection in Mission Valley is justified at present and that it would not be justified until such time as the protected land would increase almost six times in value, due to the protection or some other cause, or until the average annual damages would exceed the annual cost of the protection works.

TABLE 55

COST OF FLOOD CONTROL CHANNEL FOR SAN DIEGO RIVER THROUGH MISSION VALLEY

Alvarado Canyon to Morena Boulevard

Capacity of channel (3-foot freeboard), 72,000 second-feet.

Channel and levees				
Excavation and levee fill	1,459,000 cu.yds.	at $0.18	262,620	
Levee protection - Crushed rock	78,500 cu.yds.	at 2.50	196,250	
- Rip-rap	249,000 cu.yds.	at 2.50	622,500	
- Crown paving	22,800 cu.yds.	at 2.50	57,000	1,138,370
Road crossings				
Murray Canyon crossing				
Earth fill	19,800 cu.yds.	at 0.20	3,960	
Protection - Crushed rock	900 cu.yds.	at 2.50	2,250	
- Rip-rap	2,900 cu.yds.	at 2.50	7,250	
Paving	20,000 sq. ft.	at 0.20	4,000	17,460
6th St. Extension				
Bridge	665 lin.ft.	at 170.00	113,050	
Approaches - Fill	11,000 cu.yds.	at 0.20	2,200	
- Paving	17,500 sq.ft.	at .20	3,500	118,750
Murphy Canyon Road				
Bridge	640 lin.ft.	at 170.00	108,800	
Approaches - Cut and fill	7,500 cu.yds.	at 0.20	1,500	
- Paving	18,800 sq.ft.	at 0.20	3,760	114,060
Right of way				
Land	340 acres	at 275.00	93,500	
	210 "	at 150.00	31,500	
Clearing	250 "	at 20.00	5,000	
Fencing	12 miles	at 800.00	9,600	
Culverts and levees			20,000	159,600
Subtotal				1,548,240
Administrative, engineering and contingencies		25%		387,060
Interest during construction	5% rate			98,300
Total cost				$2,033,600

APPENDIX A

RESERVOIR OPERATION ON SAN DIEGO RIVER

The total safe yields and additional safe yields that may be obtained from the operation of certain reservoirs, or combinations of reservoirs, in the San Diego River Basin are given in Table 35 in Chapter VI of this report. A separate study was necessary to determine each of the safe yields shown in that table. To give the details of each of these studies in this report would require a large amount of space. As an illustration of the method used, however, one detailed study is given in this appendix. This study is for the coordinated operation of the following reservoirs with approximately the capacities given: Cuyamaca, 11,600 acre-feet; El Capitan, 116,900 acre-feet; San Vicente, 174,500 acre-feet; and Mission Gorge No. 2, 29,200 acre-feet. The study was made for the period October, 1894, to October, 1933. The estimated monthly runoffs into the various reservoirs are given in Table A-1. The computations for the net depth of evaporation from the water surfaces of the reservoirs are shown in Table A-2. The monthly distribution of draft is shown in Table A-3 and the details of the yield study are given in Table A-4.

Water Supply of San Diego River.

The general methods of estimating the water supply or run-offs from San Diego County streams are given in Chapter II. The run-offs at several points in the San Diego River Basin, which were necessary for estimating inflow to the possible reservoirs, were estimated as follows:

The run-off of the San Diego River above the Diverting Dam, excluding the inflow into Cuyamaca Reservoir, was used as a base for estimating the

run-offs at other points in the basin. Seasonal run-offs at these other points during periods of record, expressed in acre-feet per square mile, were plotted against the run-offs at the Diverting Dam for the same seasons, curves of relationship were developed, and seasonal run-offs at the other points in the basin during periods of missing records were estimated from these curves by using the seasonal run-offs of the San Diego River at the Diverting Dam, less the flow into Cuyamaca Reservoir, as indices.

Estimates of the seasonal inflow into Cuyamaca Reservoir covering the period from 1887 to 1892 were obtained from a report by the late H. N. Savage, Hydraulic Engineer, City of San Diego. Monthly estimates of the inflow from 1892 to 1919 were obtained from a report by John S. Longwell for the United States Bureau of Reclamation, and from 1919 to 1932 they were obtained from data compiled by F. E. Green. The monthly inflow for the season 1932-33 was estimated from records obtained by the La Mesa, Lemon Grove and Spring Valley Irrigation District. From 1883 to 1887, the run-offs at the Cuyamaca Dam site were estimated from the run-offs of the San Diego River at the Diverting Dam.

The run-offs of the San Diego River at the Diverting Dam were estimated excluding the inflows into Cuyamaca Reservoir. In all run-off and yield studies, when the run-off of the San Diego River at the Diverting Dam is mentioned, it is understood that the inflow into Cuyamaca Reservoir is not included unless it is definitely shown that the run-off is the total full natural flow at the Dam. Records of diversions from the San Diego River at the Diverting Dam and of waste over the dam are available from 1898 to 1933. During a portion of this period, records were available from both the La Mesa, Lemon Grove and Spring Valley Irrigation District and from the U. S. Geological Survey. In general, the records from the district were used as they covered the greater part of the period. To obtain the natural flow of the San Diego River at the

Diverting Dam, it was necessary to add the water over the dam to the diversions into the irrigation district's flume and to deduct that portion of the release from Cuyamaca Reservoir which reached the Diverting Dam. For the period prior to 1913, estimates made by C. H. Lee of the amounts of the Cuyamaca Reservoir releases which reached the Diverting Dam were used. For the period from 1913 to 1933, an independent estimate of the losses from the Cuyamaca Reservoir releases was made. During the greater part of this period, a record of run-off at the mouth of Boulder Creek was available. Deducting this run-off from that at the Diverting Dam gave the run-off from the San Diego River above Boulder Creek. These figures indicated the periods during which there probably was no flow from Boulder Creek below Cuyamaca Reservoir. Fortunately, there were no releases from Cuyamaca Reservoir during periods of high run-off, and therefore the uncertainty of the amounts of loss from these releases was not introduced.

For the period from 1887 to 1898, the seasonal run-offs of the San Diego River at the Diverting Dam were estimated from average indices of seasonal run-off as determined from the inflows into Cuyamaca and Sweetwater reservoirs.

For the period from 1883 to 1887, the seasonal run-offs at the Diverting Dam were estimated from rainfall. Rainfall records covering this period are available at two stations, San Diego and Valley Center. Since Valley Center is at a higher elevation, its rainfall is believed to be more representative of rainfall conditions on the watershed above the Diverting Dam and its records were selected for estimating the run-off at the dam. Parallel records of rainfall at Valley Center and run-off at the Diverting Dam are available from 1911 to 1924. In setting up a relation between the two, the depth of seasonal run-off above the Diverting Dam, in inches, was first plotted against the seasonal rainfall, in inches, at Valley Center. Second,deductions

of 1, 1½ and 2 inches, respectively, were made from each storm's rainfall at Valley Center, and the net seasonal rainfalls at Valley Center thus obtained were plotted against the run-offs at the Diverting Dam. Third, the foregoing net seasonal rainfalls at Valley Center were corrected by adding to each a percentage of the difference between the preceding season's gross and net rainfalls, to allow for seasonal carry over from ground water in the run-off at the Diverting Dam, and these corrected net seasonal rainfalls were then plotted against the run-offs. Curves were then drawn showing the trends of each of the foregoing sets of plotted points and the accuracy of each relationship was determined by measuring the average departures of the plotted points from the curve showing the trend. It was determined that a curve drawn by plotting corrected seasonal rainfall at Valley Center obtained by deducting two inches from each storm rainfall and adding percentages of the difference between gross and net rainfalls of the preceding season varying uniformly from 0 for a 10 inch difference to twenty percent for a 20-inch difference, against the run-off at the Diverting Dam gave the best relationships. Such a curve was used for estimating the seasonal run-offs at the Diverting Dam from 1883 to 1887.

Run-off records of the South Fork of the San Diego River near its mouth are available from 1912 to 1933. However, there are many periods of missing record, usually during times of high run-off. The full natural run-offs of the South Fork during periods of record were obtained by adding the diversions by the La Mesa, Lemon Grove and Spring Valley Irrigation District to the waste. Both the monthly and seasonal full natural run-offs of the South Fork were plotted against the corresponding run-offs of the San Diego River at the Diverting Dam. A poor relationship was shown by these points, probably due to inaccuracies in the South Fork run-off record. However, it was necessary to establish a relationship from which run-offs in periods of

missing record and prior to the period of record could be estimated. The seasonal run-offs of the South Fork, reduced to acre-feet per square mile, were therefore plotted against those of the San Diego River at the Diverting Dam and a curve was drawn to show the trend of those points. By using the run-offs at the Diverting Dam as indices, the run-offs of the South Fork during seasons of missing record were estimated from this curve.

Estimates of the run-off of the San Diego River at the El Capitan dam site for the period February 1920 to September 1933 have been made by F. E. Green from measurements at that point and at other points on the river, and from records of flow at other points on the river taken by other agencies. These were used for this period. By deducting the waste at the Diverting Dam, and that from the South Fork, from the estimated run-off at El Capitan dam site, the inflow from the intermediate area between the South Fork, the Diverting dam and El Capitan dam site was obtained. The full natural run-off of the San Diego River at El Capitan dam site was obtained by adding the computed inflow from the intermediate area between it and the South Fork and the Diverting Dam to the full natural run-off at the Diverting Dam and to that of the South Fork. The seasonal full natural run-offs at the El Capitan dam site and those from the intermediate area, expressed in acre-feet per square mile, were plotted against the corresponding seasonal full natural run-offs at the Diverting Dam, and curves averaging those points were drawn and adjusted so that the sum of the run-offs from above the Diverting Dam, from the South Fork, and from the intermediate area would equal the total run-off above El Capitan Dam site. For the period from 1913 to 1920, the run-off from the intermediate area was estimated from the run-off at the Diverting Dam and added to this latter run-off and that from the South Fork to obtain the total run-off at El Capitan dam site. For the period from 1883 to 1912, the run-offs

at El Capitan dam site were estimated from those at Diverting Dam, the run-offs from the area between the Diverting Dam and El Capitan dam site were obtained by subtracting the run-offs at the Diverting Dam from those at El Capitan dam site. From 1905 to 1915, the U. S. Geological Survey obtained records of the run-off of the San Diego River at Lakeside, a short distance below El Capitan dam site. During this period, the inflow from between the Diverting Dam and Lakeside was computed from the run-off records and this in turn was divided into two parts, that coming in above and that coming in below El Capitan dam site. If this division indicated too much inflow from the small area between El Capitan dam site and Lakeside, the estimated inflow above El Capitan dam site was increased so that the inflows above and below El Capitan dam site were in proportion to the drainage areas. A negative inflow between El Capitan dam site and Lakeside indicated absorption in the gravels.

Estimates and measurements of the run-off of San Vicente Creek at the dam site near Foster, for the period from 1919 to 1933 and the greater part of 1914-15 season, made by various agencies, were used for these periods. The seasonal run-offs for these periods, expressed in acre-feet per square mile, were plotted against the corresponding run-offs above the Diverting Dam on San Diego River and a curve was drawn averaging the plotted points. For the periods of 1883 to 1914 and 1915 to 1919, the seasonal run-offs from San Vicente Creek were taken from this curve by using the run-off at the Diverting Dam for each season as the index for that from San Vicente Creek.

No records of the run-off from the area below El Capitan and San Vicente dam sites and above Mission Gorge are available, but the seasonal run-offs were estimated in the following manner. The seasonal run-offs for each of the seasons from 1914-15 to 1916-17 and from 1919-20 to 1932-33 from above Cuyamaca

Reservoir, above the Diverting Dam, above El Capitan dam site, above San Vicente dam site, and the inflow into Murray Reservoir, all expressed in acre-feet per square mile, were plotted against the average elevations of their watersheds, curves were drawn averaging the plotted points for each season and the curves were extended downward to zero elevation. By entering these curves with the average elevation of its watershed as an index, the seasonal runoffs for the area between El Capitan and San Vicente dam sites and Mission Gorge were obtained for the seasons represented by the curves. These seasonal run-offs were then plotted against the corresponding ones from above the Diverting Dam and a curve was drawn averaging the plotted points. For the period from 1883 to 1914 and for the season 1917-18, the seasonal run-offs from the area between El Capitan and San Vicente dam sites and Mission Gorge were obtained from this curve by using the run-offs from above the Diverting Dam as indices. The seasonal run-offs from this area were tested and in some cases adjusted by the following procedure. The valley of the San Diego River below the El Capitan and San Vicente dam sites and above Mission Gorge was treated as an underground reservoir and studies of its operation were made in the same manner as for a surface reservoir. The run-offs at El Capitan dam site, at San Vicente dam site, and from the area between these sites and Mission Gorge were treated as inflows, and the run-offs at Mission Gorge as outflows. In addition, there were uses from this underground reservoir caused by pumping by the City of San Diego and the La Mesa, Lemon Grove and Spring Valley Irrigation District, pumping for the irrigation of valley lands, and natural use by willows. Records of the amounts pumped by the city and by the district are available and were used. A field reconnaissance in 1934 indicated that 2400 acres of valley lands were irrigated. A seasonal use of 2,700 acre-feet for these lands was used. The area of willows was estimated to be 1,000 acres and the use as 2.64 acre-feet per acre per season. For the period after September 1928, the use by

willows was discontinued as heavy pumping during the late dry season had lowered the water table and killed the large trees. A monthly study of the operation of the underground basin was made covering the periods from July 1907 to September 1915 and from June 1916 to September 1933. During these periods, records of the outflow at Mission Gorge were available after 1912. Prior to 1912, they were estimated from the inflow into the Sweetwater Reservoir. During the periods covered by the study of the underground reservoir, the study indicated no large outflows in excess of those measured or estimated at Mission Gorge, showing that the run-offs and uses as estimated were probably correct.

The seasonal full natural run-offs at Cuyamaca, the Diverting Dam, El Capitan and Mission Gorge as estimated by the foregoing described methods are given in Table 7 in Chapter II. The monthly full natural run-offs at each of the reservoir dam sites and from the areas lying between these dam sites are given in Table A-1.

Evaporation from Water Surfaces of Reservoirs in the San Diego River Basin.

The methods of estimating the rates of evaporation and the annual and monthly gross and net evaporation losses from the Cuyamaca, El Capitan, San Vicente and Mission Gorge reservoirs have been discussed in Chapter Vl. The estimated gross evaporations for each month of the year at each of the above reservoirs are listed in Table 33 of that chapter. In the discussion of methods used it was stated that the net monthly depth of evaporation was obtained by deducting the depth of the rainfall on the reservoir surface during the month from the gross depth of evaporation estimated for that month. Since the rainfall in any one month varies from year to year the net evaporation for that month will also vary from year to year. In months

of exceptionally heavy rainfall the net evaporation may even become negative indicating an increase in the storage due to rainfall on the reservoir surface. The estimated net depths of evaporation for each month during the period of the yield study from the surfaces of Cuyamaca, El Capitan, San Vicente and Mission Gorge reservoirs are given in Table A-2.

The evaporation in any month in acre-feet at the various reservoirs was obtained from the average areas of the reservoirs during that month multiplied by the corresponding net depth of evaporation.

Net Safe Yield of San Diego River through Coordinated Operation of Cuyamaca, El Capitan, San Vicente and Mission Gorge No. 2 Reservoirs.

Table A-4 presents a portion of a detailed study of the coordinated operation of the Cuyamaca, El Capitan, San Vicente and Mission Gorge 2 reservoirs to obtain the maximum net safe yield from the San Diego River drainage basin above Mission Gorge. A summary of this study has been presented in Table 34 of Chapter VI of this report. The reasons for selection of the reservoir capacities used and a brief description of the methods used has also been given in Chapter VI. The entire study covered the 50-year period from 1883 to 1933. However, only that portion included in the period 1894-1933 has been included in this table. As was explained in Chapter VI, the estimates of run-off in the earlier years of the period 1883-1933 were based on rainfall and cannot be considered as reliable as the estimate of the later years. For this reason the analyses assumed a required spill of about 20 per cent of the run-off for the period 1883-1895 and the analyses were made using run-off groupings from December 1st to April 30th, May 1st to May 31st, and from June 1st to November 30th rather than monthly run-offs during this period. It will be noted that in the detailed yield analysis the monthly run-offs used are given to the nearest acre-foot.

For this reason they do not correspond exactly to the run-offs presented in Table A-1, which were rounded to the nearest ten and adjusted to correspond to the seasonal run-offs presented in Table 7 of Chapter II, which were rounded to the nearest ten for seasonal estimates which were based on actual records and to the nearest hundred for seasonal estimates based on comparative curves.

In the net safe yield studies of coordinate reservoir operation shown in Table A-4, the inflow into Cuyamaca Reservoir was stored in that reservoir until May 1st of each season and then released as rapidly as possible to El Capitan Reservoir if storage was available, or as fast as storage became available. An irrigation draft of 5,000 acre-feet was furnished at all times. This draft was obtained from El Capitan Reservoir as long as the water was available in it and then from San Vicente Reservoir. No water was drawn from Mission Gorge reservoir for this purpose. Additional drafts for other uses were drawn from Mission Gorge and El Capitan reservoirs, in order, until each was empty, and then the draft was taken from San Vicente reservoir. This method of draft would reduce evaporation losses to a minimum by retaining water longest in the reservoir with smallest evaporation losses, and results in a greater safe yield than any other method of operation. The monthly distribution of the seasonal drafts used is shown in Table A-3.

TABLE A-1

MONTHLY FULL NATURAL RUN-OFFS FROM SAN DIEGO RIVER BASIN IN ACRE-FEET.

Season and Month	At Cuyamaca Dam	Between Cuyamaca Dam and Diverting Dam	At Diverting Dam Including Cuyamaca run-off	Between Diverting Dam and El Capitan Dam	At El Capitan Dam	At San Vicente dam site	Between San Vicente and El Capitan dam sites and Mission Gorge	At Mission Gorge
1883-84								
October	0	0	0	0	0	0	0	0
November	0	0	0	0	0	0	0	0
December	800	5,210	6,010	3,500	9,510	3,220	4,350	17,080
January	870	5,650	6,520	3,800	10,320	3,500	4,720	18,540
February	12,750	82,880	95,630	55,700	151,330	51,300	69,230	271,860
March	6,320	41,070	47,390	27,600	74,990	25,420	34,310	134,720
April	1,010	6,550	7,560	4,400	11,960	4,050	5,470	21,480
May	590	3,870	4,460	2,600	7,060	2,400	3,230	12,690
June	280	1,780	2,060	1,200	3,260	1,110	1,490	5,860
July	140	890	1,030	600	1,630	550	750	2,930
August	90	600	690	400	1,090	370	500	1,960
September	50	300	350	200	550	180	250	980
Totals	22,900	148,800	171,700	100,000	271,700	92,100	124,300	488,100
1884-85								
October	60	300	360	140	500	130	160	790
November	50	250	300	130	430	120	130	680
December	4,670	23,370	28,040	10,350	38,390	10,360	11,920	60,670
January	1,540	7,690	9,230	3,430	12,660	3,420	3,930	20,010
February	770	3,840	4,610	1,680	6,290	1,700	1,950	9,940
March	300	1,540	1,840	660	2,500	670	780	3,950
April	1,260	6,300	7,560	2,800	10,360	2,800	3,220	16,380
May	40	160	200	90	290	80	90	460
June	10	40	50	20	70	20	20	110
July	0	0	0	0	0	0	0	0
August	0	0	0	0	0	0	0	0
September	0	0	0	0	0	0	0	0
Totals	8,700	43,490	52,190	19,300	71,490	19,300	22,200	112,990
1885-86								
October	0	0	0	0	0	0	0	0
November	490	2,560	3,050	1,230	4,280	1,220	1,410	6,910
December	90	450	540	230	770	220	260	1,250
January	5,240	27,670	32,910	12,990	45,900	13,110	15,140	74,150
February	170	900	1,070	390	1,460	420	480	2,360
March	3,220	17,010	20,230	8,000	28,230	8,060	9,310	45,600
April	320	1,710	2,030	800	2,830	810	930	4,570
May	150	780	930	370	1,300	370	430	2,100
June	60	310	370	150	520	150	170	840
July	30	160	190	70	260	70	80	410
August	20	100	120	50	170	50	60	280
September	10	50	60	20	80	20	30	130
Totals	9,800	51,700	61,500	24,300	85,800	24,500	28,300	138,600
1886-87								
October	10	40	50	20	70	10	20	100
November	1,110	5,210	6,320	2,180	8,500	2,150	2,420	13,070
December	210	980	1,190	410	1,600	400	450	2,450
January	50	260	310	110	420	100	120	640
February	4,420	20,740	25,160	8,650	33,810	8,540	9,620	51,970
March	520	2,420	2,940	1,010	3,950	1,000	1,130	6,080
April	1,030	4,850	5,880	2,020	7,900	2,000	2,250	12,150
May	260	1,230	1,490	510	2,000	510	570	3,080
June	100	470	570	190	760	190	220	1,17[illegible]
July	0	0	0	0	0	0	0	0
August	0	0	0	0	0	0	0	0
September	0	0	0	0	0	0	0	0
Totals	7,710	36,200	43,910	15,100	59,010	14,900	16,800	90,710
1887-88								
October	0	0	0	0	0	0	0	0
November	0	0	0	0	0	0	0	0
December	490	1,620	2,110	360	2,470	290	290	3,050
January	730	2,420	3,150	540	3,690	450	420	4,560
February	620	2,080	2,700	490	3,190	390	360	3,940
March	950	3,140	4,090	720	4,810	590	550	5,950
April	80	260	340	50	390	50	50	490
May	60	180	240	40	280	30	30	340
June	0	0	0	0	0	0	0	0
July	0	0	0	0	0	0	0	0
August	0	0	0	0	0	0	0	0
September	0	0	0	0	0	0	0	0
Totals	2,930	9,700	12,630	2,200	14,830	1,800	1,700	18,330
1888-89								
October	0	0	0	0	0	0	0	0
November	20	110	130	40	170	40	40	250
December	380	1,940	2,320	700	3,020	620	660	4,300
January	350	1,720	2,070	630	2,700	580	590	3,870
February	380	1,920	2,300	700	3,000	610	650	4,260
March	2,140	10,930	13,070	3,980	17,050	3,520	3,730	24,300
April	780	3,970	4,750	1,450	6,200	1,280	1,350	8,830
May	220	1,130	1,350	400	1,750	360	370	2,480
June	110	580	690	200	890	190	210	1,290
July	0	0	0	0	0	0	0	0
August	0	0	0	0	0	0	0	0
September	0	0	0	0	0	0	0	0
Totals	4,380	22,300	26,680	8,100	34,780	7,200	7,600	49,580
1889-90								
October	30	160	190	70	260	60	80	400
November	40	200	240	80	320	60	90	470
December	3,490	17,160	20,650	6,990	27,640	6,640	7,420	41,700
January	1,390	6,850	8,240	2,800	11,040	2,650	2,970	16,660
February	1,050	5,150	6,200	2,100	8,300	2,000	2,230	12,530
March	350	1,700	2,050	690	2,740	650	740	4,130
April	70	350	420	150	570	120	150	840
May	10	30	40	20	60	20	20	100
June	0	0	0	0	0	0	0	0
July	0	0	0	0	0	0	0	0
August	0	0	0	0	0	0	0	0
September	0	0	0	0	0	0	0	0
Totals	6,430	31,600	38,030	12,900	50,930	12,200	13,700	76,830
1890-91								
October	0	0	0	0	0	0	0	0
November	0	0	0	0	0	0	0	0
December	0	0	0	0	0	0	0	0
January	190	660	850	260	1,110	250	290	1,650
February	5,940	20,140	26,080	8,020	34,100	7,450	8,200	49,750
March	1,520	5,140	6,660	2,050	8,710	1,900	2,100	12,710
April	580	1,970	2,550	780	3,330	730	800	4,860
May	290	990	1,280	390	1,670	370	410	2,450
June	0	0	0	0	0	0	0	0
July	0	0	0	0	0	0	0	0
August	0	0	0	0	0	0	0	0
September	0	0	0	0	0	0	0	0
Totals	8,520	28,900	37,420	11,500	48,920	10,700	11,800	71,420
1891-92								
October	0	0	0	0	0	0	0	0
November	0	0	0	0	0	0	0	0
December	0	0	0	0	0	0	0	0
January	0	0	0	0	0	0	0	0
February	1,750	4,750	6,500	1,380	7,880	1,180	1,150	10,210
March	850	2,320	3,170	680	3,850	580	550	4,980
April	1,320	3,580	4,900	1,040	5,940	890	860	7,690
May	1,280	3,450	4,730	1,000	5,730	850	840	7,420
June	0	0	0	0	0	0	0	0
July	0	0	0	0	0	0	0	0
August	0	0	0	0	0	0	0	0
September	0	0	0	0	0	0	0	0
Totals	5,200	14,100	19,300	4,100	23,400	3,500	3,400	30,300
1892-93								
October	0	0	0	0	0	0	0	0
November	0	0	0	0	0	0	0	0
December	70	140	210	60	270	40	40	350
January	330	770	1,100	260	1,360	200	200	1,760
February	210	720	930	230	1,160	190	190	1,540
March	2,460	11,850	14,310	3,620	17,930	3,060	3,150	24,140
April	240	1,800	2,040	560	2,600	460	470	3,530
May	50	220	270	70	340	50	50	440
June	0	0	0	0	0	0	0	0
July	0	0	0	0	0	0	0	0
August	0	0	0	0	0	0	0	0
September	0	0	0	0	0	0	0	0
Totals	3,360	15,500	18,860	4,800	23,660	4,000	4,100	31,760

TABLE A-1. (Continued)

MONTHLY FULL NATURAL RUN-OFFS FROM SAN DIEGO RIVER BASIN IN ACRE-FEET.

Season and Month	At Cuyamaca Dam	Between Cuyamaca Dam and Diverting Dam	At Diverting Dam Including Cuyamaca run-off	Between Diverting Dam and El Capitan Dam	At El Capitan Dam	At San Vicente dam site	Between San Vicente and El Capitan dam sites and Mission Gorge	At Mission Gorge
1893-94								
October	0	0	0	0	0	0	0	0
November	220	1,170	1,390	140	1,530	100	70	1,700
December	0	1,590	1,590	200	1,790	140	90	2,020
January	620	190	810	30	840	10	10	860
February	610	1,760	2,370	230	2,600	160	100	2,860
March	710	790	1,500	100	1,600	90	30	1,720
April	0	0	0	0	0	0	0	0
May	0	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0	0
July	10	0	10	0	10	0	0	10
August	60	0	60	0	60	0	0	60
September	0	0	0	0	0	0	0	0
Totals	2,230	5,500	7,730	700	8,430	500	300	9,230
1894-95								
October	0	0	0	0	0	0	0	0
November	0	0	0	0	0	0	0	0
December	940	2,600	3,540	1,320	4,860	1,300	1,520	7,680
January	7,750	44,050	51,800	22,190	73,990	22,070	25,830	121,890
February	910	6,840	7,750	3,440	11,190	3,420	4,000	18,610
March	730	4,290	5,020	2,170	7,190	2,150	2,520	11,860
April	360	2,060	2,420	1,040	3,460	1,020	1,250	5,730
May	0	410	410	220	630	210	240	1,080
June	40	250	290	120	410	130	140	680
July	0	0	0	0	0	0	0	0
August	0	0	0	0	0	0	0	0
September	0	0	0	0	0	0	0	0
Totals	10,730	60,500	71,230	30,500	101,730	30,300	35,500	167,530
1895-96								
October	0	0	0	0	0	0	0	0
November	0	0	0	0	0	0	0	0
December	200	260	460	50	510	0	0	510
January	580	1,070	1,650	210	1,860	0	0	1,860
February	80	410	490	70	560	0	0	560
March	270	1,270	1,540	250	1,790	0	0	1,790
April	80	90	170	20	190	0	0	190
May	0	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0	0
July	0	0	0	0	0	0	0	0
August	0	0	0	0	0	0	0	0
September	0	0	0	0	0	0	0	0
Totals	1,210	3,100	4,310	600	4,910	0	0	4,910
1896-97								
October	0	0	0	0	0	0	0	0
November	10	0	10	0	10	0	0	10
December	60	80	140	20	160	0	0	160
January	460	900	1,360	210	1,570	210	180	1,960
February	760	3,280	4,040	770	4,810	730	670	6,210
March	2,090	5,880	7,970	1,370	9,340	1,260	1,150	11,750
April	90	560	650	120	770	0	0	770
May	0	100	100	10	110	0	0	110
June	0	0	0	0	0	0	0	0
July	0	0	0	0	0	0	0	0
August	0	0	0	0	0	0	0	0
September	0	0	0	0	0	0	0	0
Totals	3,470	10,800	14,270	2,500	16,770	2,200	2,000	20,970
1897-98								
October	0	0	0	0	0	0	0	0
November	0	0	0	0	0	0	0	0
December	70	160	230	30	260	0	0	260
January	150	340	490	70	560	0	0	560
February	300	670	970	130	1,100	0	0	1,100
March	160	330	490	70	560	0	0	560
April	0	0	0	0	0	0	0	0
May	0	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0	0
July	0	0	0	0	0	0	0	0
August	0	0	0	0	0	0	0	0
September	0	0	0	0	0	0	0	0
Totals	680	1,500	2,180	300	2,480	0	0	2,480
1898-99								
October	0	0	0	0	0	0	0	0
November	0	0	0	0	0	0	0	0
December	10	0	10	0	10	0	0	10
January	180	0	180	0	180	0	0	180
February	130	90	220	60	280	0	0	280
March	180	480	660	120	780	0	0	780
April	0	310	310	80	390	0	0	390
May	0	110	110	30	140	0	0	140
June	0	60	60	10	70	0	0	70
July	0	0	0	0	0	0	0	0
August	0	0	0	0	0	0	0	0
September	0	0	0	0	0	0	0	0
Totals	500	1,050	1,550	300	1,850	0	0	1,850
1899-00								
October	0	0	0	0	0	0	0	0
November	0	0	0	0	0	0	0	0
December	0	0	0	0	0	0	0	0
January	90	110	200	60	260	0	0	260
February	10	30	40	50	90	0	0	90
March	10	60	70	50	120	0	0	120
April	30	180	210	20	230	0	0	230
May	0	260	260	20	280	0	0	280
June	0	0	0	0	0	0	0	0
July	0	0	0	0	0	0	0	0
August	0	0	0	0	0	0	0	0
September	0	0	0	0	0	0	0	0
Totals	140	640	780	200	980	0	0	980
1900-01								
October	0	0	0	0	0	0	0	0
November	120	30	150	10	160	0	0	160
December	10	10	20	10	30	0	0	30
January	160	180	340	40	380	0	0	380
February	2,080	2,430	4,510	500	5,010	200	200	5,410
March	70	690	760	130	890	0	0	890
April	100	390	490	80	570	0	0	570
May	30	380	410	120	530	0	0	530
June	0	130	130	80	210	0	0	210
July	70	110	180	20	200	0	0	200
August	0	230	230	10	240	0	0	240
September	30	0	30	0	30	0	0	30
Totals	2,670	4,580	7,250	1,000	8,250	200	200	8,650
1901-02								
October	0	0	0	0	0	0	0	0
November	0	0	0	0	0	0	0	0
December	0	0	0	0	0	0	0	0
January	30	20	50	10	60	0	0	60
February	490	260	750	50	800	100	50	950
March	1,270	2,720	3,990	500	4,490	100	50	4,640
April	180	840	1,020	150	1,170	0	0	1,170
May	0	270	270	50	320	0	0	320
June	90	140	230	30	260	0	0	260
July	0	80	80	10	90	0	0	90
August	0	10	10	0	10	0	0	10
September	0	0	0	0	0	0	0	0
Totals	2,060	4,340	6,400	800	7,200	200	100	7,500
1902-03								
October	0	0	0	0	0	0	0	0
November	30	0	30	0	30	0	0	30
December	70	10	80	10	90	0	0	90
January	40	60	100	10	110	0	0	110
February	680	1,370	2,050	280	2,330	740	740	3,810
March	340	2,690	3,030	550	3,580	340	330	4,250
April	890	3,570	4,460	740	5,200	320	330	5,850
May	10	680	690	140	830	0	0	830
June	20	170	190	30	220	0	0	220
July	10	80	90	20	110	0	0	110
August	0	50	50	20	70	0	0	70
September	0	0	0	0	0	0	0	0
Totals	2,090	8,680	10,770	1,800	12,570	1,400	1,400	15,370

TABLE A-1, (Continued)

MONTHLY FULL NATURAL RUN-OFFS FROM SAN DIEGO RIVER BASIN IN ACRE-FEET.

Season and Month	At Cuyamaca Dam	Between Cuyamaca Dam and Diverting Dam	At Diverting Dam Including Cuyamaca run-off	Between Diverting Dam and El Capitan Dam	At El Capitan Dam	At San Vicente dam site	Between San Vicente and El Capitan dam sites and Mission Gorge	At Mission Gorge
1903-04								
October	0	0	0	0	0	0	0	0
November	0	0	0	0	0	0	0	0
December	0	0	0	0	0	0	0	0
January	0	0	0	0	0	0	0	0
February	50	0	50	0	50	0	0	50
March	370	530	900	70	970	0	0	970
April	0	180	180	20	200	0	0	200
May	0	40	40	10	50	0	0	50
June	0	0	0	0	0	0	0	0
July	0	0	0	0	0	0	0	0
August	0	0	0	0	0	0	0	0
September	0	0	0	0	0	0	0	0
Totals	420	750	1,170	100	1,270	0	0	1,270
1904-05								
October	0	0	0	0	0	0	0	0
November	0	0	0	0	0	0	0	0
December	0	0	0	0	0	0	0	0
January	190	70	260	30	290	0	0	290
February	1,590	4,090	5,680	1,410	7,090	1,320	1,400	9,810
March	1,840	10,970	12,810	3,780	16,590	3,770	3,990	24,350
April	1,280	2,660	3,940	920	4,860	890	930	6,680
May	510	2,990	3,500	1,050	4,550	760	810	6,120
June	110	970	1,080	330	1,410	280	290	1,980
July	130	200	330	70	400	80	80	560
August	70	90	160	30	190	0	0	190
September	110	200	310	80	390	0	0	390
Totals	5,830	22,240	28,070	7,700	35,770	7,100	7,500	50,370
1905-06								
October	0	210	210	90	300	0	0	300
November	920	3,040	3,960	1,250	5,210	0	0	5,210
December	330	230	560	100	660	0	0	660
January	890	870	1,760	350	2,110	0	0	2,110
February	970	2,620	3,590	1,080	4,670	500	550	5,720
March	5,550	18,110	23,660	20,670	44,330	10,110	11,230	65,670
April	790	4,590	5,380	9,760	15,140	2,740	3,020	20,900
May	470	1,630	2,100	2,160	4,260	570	620	5,450
June	350	1,380	1,730	570	2,300	80	80	2,460
July	110	730	840	300	1,140	0	0	1,140
August	240	700	940	290	1,230	0	0	1,230
September	0	440	440	180	620	0	0	620
Totals	10,620	34,550	45,170	36,800	81,970	14,000	15,500	111,470
1906-07								
October	0	360	360	140	500	0	0	500
November	0	400	400	150	550	0	0	550
December	720	1,390	2,110	530	2,640	240	260	3,140
January	1,750	6,530	8,280	4,200	12,480	2,950	3,220	18,650
February	890	2,960	3,850	1,760	5,610	1,490	1,620	8,720
March	1,770	5,960	7,730	3,340	11,070	3,390	3,660	18,120
April	1,380	5,500	6,880	1,280	8,160	2,080	2,250	12,490
May	400	2,270	2,670	860	3,530	330	360	4,220
June	230	2,220	2,450	840	3,290	120	130	3,540
July	50	550	600	210	810	0	0	810
August	30	420	450	160	610	0	0	610
September	0	340	340	130	470	0	0	470
Totals	7,220	28,900	36,120	13,600	49,720	10,600	11,500	71,820
1907-08								
October	70	720	790	180	970	0	0	970
November	90	720	810	180	990	0	0	990
December	30	1,280	1,310	330	1,640	0	0	1,640
January	260	1,040	1,300	340	1,640	460	460	2,560
February	870	3,500	4,370	1,100	5,470	1,520	1,460	8,450
March	450	1,750	2,200	1,180	3,380	720	690	4,790
April	200	1,210	1,410	310	1,720	100	90	1,910
May	10	910	920	250	1,170	0	0	1,170
June	0	480	480	120	600	0	0	600
July	0	360	360	90	450	0	0	450
August	20	290	310	70	380	0	0	380
September	120	220	340	50	390	0	0	390
Totals	2,120	12,480	14,600	4,200	18,800	2,800	2,700	24,300
1908-09								
October	60	290	350	100	450	0	0	450
November	0	320	320	110	430	0	0	430
December	140	250	390	90	480	0	0	480
January	1,580	3,040	4,620	5,480	10,100	950	1,000	12,050
February	2,370	7,530	9,900	6,860	16,760	2,260	2,360	21,380
March	1,100	3,620	4,720	3,440	8,160	1,370	1,440	10,970
April	350	2,450	2,800	1,940	4,740	1,290	1,360	7,390
May	0	1,830	1,830	630	2,460	220	230	2,910
June	200	460	660	350	1,010	10	10	1,030
July	210	100	310	110	420	0	0	420
August	170	10	180	40	220	0	0	220
September	220	100	320	50	370	0	0	370
Totals	6,400	20,000	26,400	19,200	45,600	6,100	6,400	58,100
1909-10								
October	130	70	200	20	220	0	0	220
November	210	320	530	90	620	0	0	620
December	490	1,960	2,450	550	3,000	490	510	4,000
January	1,970	5,910	7,880	3,210	11,090	2,090	2,160	15,340
February	390	1,420	1,810	1,360	3,170	590	600	4,360
March	620	1,970	2,590	900	3,490	280	280	4,050
April	270	1,640	1,910	670	2,580	150	150	2,880
May	0	630	630	170	800	0	0	800
June	0	200	200	40	240	0	0	240
July	250	40	290	10	300	0	0	300
August	250	190	440	50	490	0	0	490
September	250	90	340	30	370	0	0	370
Totals	4,830	14,440	19,270	7,100	26,370	3,600	3,700	33,670
1910-11								
October	150	150	300	40	340	0	0	340
November	70	200	270	50	320	0	0	320
December	0	310	310	70	380	0	0	380
January	300	880	1,180	210	1,390	120	100	1,610
February	1,000	3,140	4,140	1,650	5,790	560	500	6,850
March	740	2,110	2,850	2,320	5,170	690	600	6,460
April	80	1,290	1,370	550	1,920	230	200	2,350
May	0	510	510	270	780	0	0	780
June	0	150	150	130	280	0	0	280
July	120	10	130	0	130	0	0	130
August	0	100	100	0	100	0	0	100
September	0	120	120	10	130	0	0	130
Totals	2,460	8,970	11,430	5,300	16,730	1,600	1,400	19,730
1911-12								
October	0	0	0	10	10	0	0	10
November	0	0	0	0	0	0	0	0
December	0	10	10	0	10	0	0	10
January	40	80	120	20	140	0	0	140
February	0	100	100	30	130	0	0	130
March	1,770	3,810	5,580	980	6,560	60	30	6,650
April	1,100	4,840	5,940	1,930	7,870	1,900	1,810	11,580
May	230	1,890	2,120	610	2,730	430	360	3,520
June	0	420	420	130	550	10	0	560
July	130	200	330	50	380	0	0	380
August	110	100	210	30	240	0	0	240
September	10	30	40	10	50	0	0	50
Totals	3,390	11,480	14,870	3,800	18,670	2,400	2,200	23,270
1912-13								
October	130	110	240	0	240	0	0	240
November	20	110	130	0	130	0	0	130
December	20	150	170	10	180	0	0	180
January	220	430	650	40	690	130	80	900
February	290	1,230	1,520	320	1,840	270	170	2,280
March	1,350	2,050	3,400	840	4,240	100	50	4,390
April	180	880	1,060	460	1,520	0	0	1,520
May	0	230	230	40	270	0	0	270
June	180	70	250	10	260	0	0	260
July	110	0	110	0	110	0	0	110
August	170	0	170	0	170	0	0	170
September	70	0	70	80	150	0	0	150
Totals	2,740	5,260	8,000	1,800	9,800	500	300	10,600

TABLE A-1. (Continued)

MONTHLY FULL NATURAL RUN-OFFS FROM SAN DIEGO RIVER BASIN IN ACRE-FEET.

Season and Month	At Cuyamaca Dam	Between Cuyamaca Dam and Diverting Dam	At Diverting Dam Including Cuyamaca run-off	Between Diverting Dam and El Capitan Dam	At El Capitan Dam	At San Vicente dam site	Between San Vicente and El Capitan dam sites and Mission Gorge	At Mission Gorge
1913-14								
October	0	0	0	0	0	0	0	0
November	70	120	190	30	220	0	0	220
December	50	150	200	20	220	0	0	220
January	750	3,060	3,810	770	4,580	650	630	5,860
February	930	6,210	7,140	2,100	9,240	2,040	1,970	13,250
March	170	1,560	1,730	370	2,100	380	370	2,850
April	200	1,030	1,230	300	1,530	30	30	1,590
May	20	880	900	270	1,170	0	0	1,170
June	50	190	240	40	280	0	0	280
July	30	0	30	0	30	0	0	30
August	80	0	80	0	80	0	0	80
September	30	0	30	0	30	0	0	30
Totals	2,380	13,200	15,580	3,900	19,480	3,100	3,000	25,580
1914-15								
October	0	50	50	10	60	0	0	60
November	0	110	110	20	130	0	0	130
December	170	220	390	40	430	0	0	430
January	1,410	2,760	4,170	1,050	5,220	1,410	3,770	10,400
February	3,110	12,260	15,370	5,140	20,510	8,280	10,010	38,800
March	960	5,940	6,900	2,880	9,780	2,890	3,480	16,150
April	610	3,810	4,420	1,420	5,840	1,520	1,840	9,200
May	2,380	14,130	16,510	4,830	21,340	3,330	4,030	28,700
June	150	1,960	2,110	870	2,980	140	170	3,290
July	0	460	460	190	650	0	0	650
August	200	130	330	40	370	0	0	370
September	0	60	60	10	70	0	0	70
Totals	8,990	41,890	50,880	16,500	67,380	17,570	23,300	108,250
1915-16								
October	230	50	280	10	290	0	0	290
November	90	150	240	70	310	0	0	310
December	270	580	850	350	1,200	0	0	1,200
January	13,260	83,820	97,080	51,830	148,910	50,860	65,380	265,150
February	1,650	12,330	13,980	4,980	18,960	7,100	9,130	35,190
March	1,680	8,430	10,110	5,510	15,620	5,420	6,980	28,020
April	480	4,240	4,720	2,770	7,490	1,990	2,580	12,060
May	10	1,720	1,730	1,900	3,630	730	940	5,300
June	70	700	770	1,010	1,780	170	240	2,190
July	180	370	550	500	1,050	30	50	1,130
August	10	190	200	460	660	0	0	660
September	80	140	220	310	530	0	0	530
Totals	18,010	112,720	130,730	69,700	200,430	66,300	85,300	352,030
1916-17								
October	0	630	630	560	1,190	0	0	1,190
November	0	460	460	340	800	0	0	800
December	210	780	990	560	1,550	440	590	2,580
January	940	2,830	3,770	740	4,510	1,940	2,590	9,040
February	980	3,700	4,680	1,000	5,680	1,680	2,240	9,600
March	410	3,230	3,640	790	4,430	490	670	5,590
April	470	3,060	3,530	880	4,410	740	1,000	6,150
May	180	2,460	2,640	670	3,310	10	10	3,330
June	160	840	1,000	320	1,320	0	0	1,320
July	120	190	310	180	490	0	0	490
August	130	70	200	100	300	0	0	300
September	130	20	150	60	210	0	0	210
Totals	3,730	18,270	22,000	6,200	28,200	5,300	7,100	40,600
1917-18								
October	120	50	170	60	230	0	0	230
November	30	140	170	90	260	0	0	260
December	50	240	290	110	400	0	0	400
January	60	260	320	140	460	0	0	460
February	340	640	980	220	1,200	0	0	1,200
March	2,320	5,740	8,060	8,170	16,230	3,300	4,460	23,990
April	60	900	960	1,110	2,070	100	140	2,310
May	10	400	410	850	1,260	0	0	1,260
June	150	130	280	110	390	0	0	390
July	0	30	30	40	70	0	0	70
August	130	60	190	40	230	0	0	230
September	60	70	130	60	190	0	0	190
Totals	3,330	8,660	11,990	11,000	22,990	3,400	4,600	30,990
1918-19								
October	280	90	370	130	500	0	0	500
November	70	240	310	110	420	0	0	420
December	130	400	530	150	680	0	0	680
January	0	160	160	100	260	0	0	260
February	720	980	1,700	390	2,090	120	80	2,290
March	870	2,200	3,070	740	3,810	280	150	4,240
April	110	830	940	320	1,260	100	70	1,430
May	0	320	320	150	470	0	0	470
June	100	90	190	10	200	0	0	200
July	60	0	60	0	60	0	0	60
August	260	0	260	0	260	0	0	260
September	0	20	20	0	20	0	0	20
Totals	2,600	5,330	7,930	2,100	10,030	500	300	10,830
1919-20								
October	0	60	60	0	60	0	0	60
November	50	130	180	70	250	0	0	250
December	860	290	1,150	150	1,300	0	0	1,300
January	360	370	730	60	790	0	0	790
February	1,070	3,750	4,820	1,390	6,210	0	0	6,210
March	2,370	13,860	16,230	920	17,150	2,060	2,540	21,750
April	900	4,220	5,120	2,460	7,580	450	550	8,580
May	230	1,460	1,690	510	2,200	10	10	2,220
June	70	480	550	140	690	0	0	690
July	360	130	490	20	510	0	0	510
August	140	0	140	0	140	0	0	140
September	0	0	0	0	0	0	0	0
Totals	6,410	24,750	31,160	5,720	36,880	2,520	3,100	42,500
1920-21								
October	0	60	60	0	60	0	0	60
November	0	110	110	20	130	0	0	130
December	370	200	570	20	590	0	0	590
January	270	490	760	80	840	0	0	840
February	630	550	1,180	360	1,540	0	0	1,540
March	490	1,160	1,650	10	1,660	0	0	1,660
April	180	280	460	110	570	0	0	570
May	60	870	930	280	1,210	0	0	1,210
June	0	130	130	20	150	0	0	150
July	0	60	60	30	90	0	0	90
August	90	20	110	0	110	0	0	110
September	140	0	140	0	140	0	0	140
Totals	2,230	3,930	6,160	930	7,090	0	0	7,090
1921-22								
October	60	30	90	0	90	0	0	90
November	20	10	30	0	30	0	0	30
December	3,820	17,110	20,930	7,910	28,840	10,820	21,950	61,610
January	1,320	8,280	9,600	6,270	15,870	6,410	5,610	27,890
February	2,760	16,290	19,050	7,760	26,810	8,010	7,020	41,840
March	1,960	14,880	16,840	7,670	24,510	7,520	6,590	38,620
April	680	8,080	8,760	4,240	13,000	2,660	2,340	18,000
May	340	4,250	4,590	2,170	6,760	790	690	8,240
June	0	1,530	1,530	1,220	2,750	90	0	2,840
July	250	440	690	450	1,140	0	0	1,140
August	350	160	510	170	680	0	0	680
September	400	50	450	100	550	0	0	550
Totals	11,960	41,110	83,070	37,960	121,030	36,300	44,200	201,530
1922-23								
October	0	130	130	140	270	10	0	280
November	40	360	400	210	610	20	0	630
December	560	1,270	1,830	1,150	2,980	70	10	3,060
January	70	880	950	850	1,800	40	0	1,840
February	540	3,230	3,770	1,140	4,910	20	190	5,120
March	490	2,700	3,190	1,020	4,210	130	150	4,490
April	420	2,040	2,460	1,220	3,680	90	150	3,920
May	170	830	1,000	330	1,330	10	0	1,340
June	230	250	480	140	620	0	0	620
July	460	0	460	30	490	0	0	490
August	360	10	370	0	370	0	0	370
September	120	20	140	10	150	0	0	150
Totals	3,460	11,720	15,180	6,240	21,420	390	500	22,310

TABLE A-1, (Continued)

MONTHLY FULL NATURAL RUN-OFFS FROM SAN DIEGO RIVER BASIN IN ACRE-FEET.

Season and Month	At Cuyamaca Dam	Between Cuyamaca Dam and Diverting Dam	At Diverting Dam Including Cuyamaca run-off	Between Diverting Dam and El Capitan Dam	At El Capitan Dam	At San Vicente dam site	Between San Vicente and El Capitan dam sites and Mission Gorge	At Mission Gorge
1923-24								
October	90	30	120	20	140	0	0	140
November	220	120	340	60	400	0	0	400
December	100	250	350	150	500	10	0	510
January	130	300	430	320	750	0	0	750
February	140	140	280	200	480	0	0	480
March	480	1,310	1,790	740	2,530	20	0	2,550
April	360	1,440	1,800	850	2,650	10	0	2,660
May	0	220	220	200	420	0	0	420
June	130	30	160	20	180	0	0	180
July	290	10	300	0	300	0	0	300
August	180	0	180	10	190	0	0	190
September	180	0	180	10	190	0	0	190
Totals	2,300	3,850	6,150	2,580	8,730	40	0	8,770
1924-25								
October	100	0	100	10	110	0	0	110
November	120	40	160	20	180	0	0	180
December	380	460	840	230	1,070	10	0	1,080
January	20	190	210	110	320	0	0	320
February	60	370	430	120	550	0	0	550
March	170	660	830	100	930	10	0	940
April	460	2,550	3,010	680	3,690	50	0	3,740
May	170	690	860	470	1,330	10	0	1,340
June	40	380	420	20	440	0	0	440
July	50	0	50	0	50	0	0	50
August	0	0	0	0	0	0	0	0
September	40	0	40	0	40	0	0	40
Totals	1,610	5,340	6,950	1,760	8,710	80	0	8,790
1925-26								
October	420	180	600	20	620	0	0	620
November	170	140	310	20	330	0	0	330
December	110	330	440	30	470	0	0	470
January	30	210	240	20	260	0	0	260
February	660	710	1,370	370	1,740	100	0	1,840
March	140	480	620	170	790	10	0	800
April	1,940	11,260	13,200	5,050	18,250	5,330	6,100	29,680
May	80	1,190	1,270	260	1,530	60	0	1,590
June	10	140	150	50	200	10	0	210
July	90	0	90	10	100	0	0	100
August	150	10	160	0	160	0	0	160
September	50	0	50	10	60	0	0	60
Totals	3,850	14,650	18,500	6,010	24,510	5,510	6,100	36,120
1926-27								
October	80	0	80	10	90	0	0	90
November	60	10	70	10	80	0	0	80
December	1,660	2,420	4,080	1,260	5,340	10	10	5,360
January	410	1,460	1,870	210	2,080	0	0	2,080
February	8,020	38,540	46,560	27,990	74,550	25,530	26,900	126,980
March	820	9,140	9,960	7,760	17,720	4,860	5,150	27,730
April	470	4,190	4,660	4,770	9,430	1,660	1,760	12,850
May	270	2,530	2,800	1,880	4,680	520	550	5,750
June	220	700	920	1,250	2,170	90	230	2,490
July	150	460	610	230	840	0	0	840
August	220	240	460	60	520	0	0	520
September	30	170	200	70	270	0	0	270
Totals	12,410	59,860	72,270	45,500	117,770	32,670	34,600	185,040
1927-28								
October	220	220	440	110	550	0	0	550
November	60	220	280	620	900	0	0	900
December	180	960	1,140	250	1,390	10	0	1,400
January	250	550	800	820	1,620	10	0	1,630
February	330	970	1,300	980	2,280	120	0	2,400
March	220	700	920	1,110	2,030	140	0	2,170
April	160	600	760	360	1,120	0	0	1,120
May	110	300	410	200	610	0	0	610
June	10	80	90	50	140	0	0	140
July	340	90	430	10	440	0	0	440
August	230	30	260	10	270	0	0	270
September	240	20	260	10	270	0	0	270
Totals	2,350	4,740	7,090	4,530	11,620	280	0	11,900
1928-29								
October	200	0	200	20	220	0	0	220
November	100	40	140	20	160	0	0	160
December	100	80	180	140	320	0	0	320
January	130	440	570	390	960	0	0	960
February	730	1,370	2,100	710	2,810	50	10	2,870
March	840	1,580	2,420	1,770	4,190	160	70	4,420
April	480	1,580	2,060	1,680	3,740	300	210	4,250
May	130	490	620	290	910	0	410	1,320
June	120	140	260	30	290	0	0	290
July	80	0	80	10	90	0	0	90
August	90	0	90	10	100	0	0	100
September	140	60	200	0	200	0	0	200
Totals	3,140	5,780	8,920	5,070	13,990	510	700	15,200
1929-30								
October	20	0	20	10	30	0	0	30
November	80	0	80	0	80	0	0	80
December	90	0	90	10	100	0	0	100
January	520	780	1,300	1,260	2,560	20	20	2,600
February	420	610	1,030	270	1,300	0	0	1,300
March	950	2,060	3,010	1,720	4,730	490	400	5,620
April	190	760	950	630	1,580	30	30	1,640
May	620	2,220	2,840	2,290	5,130	900	750	6,780
June	120	420	540	90	630	0	0	630
July	70	120	190	10	200	0	0	200
August	30	30	60	10	70	0	0	70
September	70	30	100	10	110	0	0	110
Totals	3,180	7,030	10,210	6,310	16,520	1,440	1,200	19,160
1930-31								
October	150	20	170	10	180	0	0	180
November	270	70	340	20	360	0	20	380
December	50	50	100	20	120	0	20	140
January	100	240	340	80	420	0	40	460
February	470	1,210	1,680	800	2,480	460	3,370	6,310
March	100	400	500	140	640	0	30	670
April	100	390	490	230	720	30	140	890
May	80	210	290	40	330	10	80	420
June	10	60	70	10	80	0	0	80
July	90	10	100	0	100	0	0	100
August	70	0	70	0	70	0	0	70
September	70	0	70	0	70	0	0	70
Totals	1,560	2,660	4,220	1,350	5,570	500	3,700	9,770
1931-32								
October	10	0	10	10	20	0	0	20
November	100	140	240	0	240	0	0	240
December	1,260	1,240	2,500	760	3,260	590	670	4,520
January	750	1,630	2,380	720	3,100	360	470	3,930
February	3,840	25,600	29,440	11,510	40,950	13,770	16,050	70,770
March	770	7,950	8,720	3,140	11,860	1,630	1,900	15,390
April	260	1,420	1,680	1,350	3,030	310	350	3,690
May	110	890	1,000	760	1,760	50	60	1,870
June	160	310	470	300	770	0	0	770
July	130	150	280	70	350	0	0	350
August	100	190	290	10	300	0	0	300
September	150	130	280	10	290	0	0	290
Totals	7,640	39,650	47,290	18,640	65,930	16,710	19,500	102,140
1932-33								
October	220	170	390	80	470	10	20	500
November	190	60	250	20	270	0	0	270
December	320	640	960	330	1,290	10	30	1,330
January	760	2,640	3,400	1,460	4,860	1,220	2,960	9,040
February	550	2,580	3,130	1,240	4,370	460	1,120	5,950
March	470	1,240	1,710	330	2,040	10	40	2,090
April	460	1,110	1,570	580	2,150	70	140	2,360
May	600	2,600	3,200	590	3,790	40	90	3,920
June	0	630	630	100	730	0	0	730
July	240	130	370	10	380	0	0	380
August	90	70	160	10	170	0	0	170
September	70	80	150	10	160	0	0	160
Totals	3,970	11,950	15,920	4,760	20,680	1,820	4,400	26,900

TABLE 4-2

LOSS IN EVAPORATION FROM RESERVOIRS ON SAN DIEGO RIVER

SAN VICENTE RESERVOIR AND EL CAPITAN RESERVOIR

Month	Gross depth of evaporation in inches	1894-1895 Rainfall on (1) reservoir in inches	1894-1895 Net depth of evaporation in inches	1895-1896 Rainfall on reservoir in inches	1895-1896 Net depth of evaporation in inches	1896-1897 Rainfall on reservoir in inches	1896-1897 Net depth of evaporation in inches
October	5.10	0	6.10	0	6.10	2.77	2.32
November	3.80	0	3.80	1.80	2.00	1.14	2.66
December	2.35	6.04	-3.69	0.56	1.79	3.31	-0.96
January	2.20	12.29	-10.09	2.81	-0.61	4.87	-2.67
February	3.05	1.08	1.97	0.14	2.91	6.60	-3.65
March	4.50	2.19	2.31	4.59	-0.09	3.44	1.06
April	4.93	0.74	4.19	0.86	4.07	0	4.93
May	6.17	0.62	6.55	0.20	5.97	0.19	5.98
June	7.38	0	7.38	0	7.38	0	7.38
July	8.83	0	8.83	0.14	8.69	0	8.83
August	8.04	0	8.04	0	8.04	0	8.04
September	6.65	0	6.65	0	6.65	0	6.65
Totals	63.00	22.96	40.04	11.10	51.90	22.32	40.68

Month	Gross depth	1897-1898 Rainfall	1897-1898 Net depth	1898-1899 Rainfall	1898-1899 Net depth	1899-1900 Rainfall	1899-1900 Net depth
October	5.10	1.94	3.16	0	5.10	0	5.10
November	3.80	0	3.80	0	3.80	0	3.80
December	2.35	1.06	1.29	1.66	0.69	1.00	1.35
January	2.20	2.51	-0.31	3.84	- 1.64	2.99	-0.79
February	3.05	0.77	2.28	1.37	1.68	0	3.05
March	4.50	1.72	2.78	1.93	2.57	0.96	3.54
April	4.93	0.51	4.42	0.24	4.69	2.06	2.87
May	6.17	1.65	4.52	0	6.17	1.65	4.52
June	7.38	0	7.38	0.95	6.43	0	7.38
July	8.83	0	8.83	0	8.83	0	8.83
August	8.04	0	8.04	0	8.04	0	8.04
September	6.65	0	6.65	0	6.65	0	6.65
Totals	63.00	10.16	52.84	9.99	53.01	8.66	54.34

Month	Gross depth	1900-1901 Rainfall	1900-1901 Net depth	1901-1902 Rainfall	1901-1902 Net depth	1902-1903 Rainfall	1902-1903 Net depth
October	5.10	0.15	4.95	0	5.10	0.35	4.75
November	3.80	4.08	-0.28	0.40	3.40	1.95	1.85
December	2.35	0	2.35	0.05	2.30	2.21	0.14
January	2.20	2.88	-0.68	3.19	-0.99	1.78	0.42
February	3.05	8.08	-5.03	2.26	0.79	4.08	-1.03
March	4.50	1.20	3.30	4.33	0.17	2.03	2.47
April	4.93	0.60	4.33	0.85	4.08	1.45	3.48
May	6.17	0.63	5.54	0.06	6.11	0.06	6.11
June	7.38	0	7.38	0	7.38	0	7.38
July	8.83	0	8.83	0.36	8.47	0	8.83
August	8.04	0	8.04	0	8.04	0	8.04
September	6.65	0	6.65	0	6.65	0.14	6.51
Totals	63.00	17.62	45.38	11.50	51.50	14.05	48.95

Month	Gross depth	1903-1904 Rainfall	1903-1904 Net depth	1904-1905 Rainfall	1904-1905 Net depth	1905-1906 Rainfall	1905-1906 Net depth
October	5.10	0.17	4.93	0.52	4.58	0.07	5.03
November	3.80	0	3.80	0	3.80	3.38	0.42
December	2.35	0	2.35	2.04	0.31	1.15	1.20
January	2.20	0.30	1.90	4.07	-1.87	1.96	0.24
February	3.05	2.87	0.18	9.61	-6.56	4.43	-1.38
March	4.50	3.65	0.85	5.76	-1.26	8.68	-4.18
April	4.93	0.40	4.53	0.44	4.49	1.59	3.34
May	6.17	0.24	5.93	1.32	4.85	1.30	4.87
June	7.38	0	7.38	0	7.38	0.05	7.33
July	8.83	0	8.83	0	8.83	0	8.83
August	8.04	0	8.04	0	8.04	0.25	7.79
September	6.65	0	6.65	0.81	5.84	0.49	6.16
Totals	63.00	7.63	55.37	24.57	38.43	23.35	39.65

Month	Gross depth	1906-1907 Rainfall	1906-1907 Net depth	1907-1908 Rainfall	1907-1908 Net depth	1908-1909 Rainfall	1908-1909 Net depth
October	5.10	0.05	5.05	1.92	3.18	1.20	3.90
November	3.80	1.96	1.84	1.18	2.62	0.80	3.00
December	2.35	5.98	-3.63	0.71	1.64	0.69	1.66
January	2.20	5.39	-3.19	4.16	-1.96	8.17	-5.97
February	3.05	1.53	1.52	4.73	-1.68	4.42	-1.37
March	4.50	3.41	1.09	2.11	2.39	3.36	1.14
April	4.93	0.62	4.31	1.38	3.55	0.22	4.71
May	6.17	0.23	5.94	0.47	5.70	0.05	6.12
June	7.38	0.43	6.95	0	7.38	0	7.38
July	8.83	0	8.83	0	8.83	0	8.83
August	8.04	0	8.04	0.67	7.37	0.89	7.15
September	6.65	0	6.65	0.64	6.01	0	6.65
Totals	63.00	19.60	43.40	17.97	45.03	19.80	43.20

Month	Gross depth	1909-1910 Rainfall	1909-1910 Net depth	1910-1911 Rainfall	1910-1911 Net depth	1911-1912 Rainfall	1911-1912 Net depth
October	5.10	0	5.10	0.80	4.30	0.30	4.80
November	3.80	3.55	0.25	1.37	2.43	0.10	3.70
December	2.35	6.56	-4.21	0.66	1.69	1.84	0.51
January	2.20	2.79	-0.59	4.38	-2.18	0.53	1.67
February	3.05	0.87	2.18	4.20	-1.15	0	3.05
March	4.50	2.48	2.02	1.37	3.13	9.75	-5.25
April	4.93	0.33	4.60	1.29	3.64	3.10	1.83
May	6.17	0	6.17	0	6.17	1.67	4.50
June	7.38	0	7.38	0	7.38	0.50	6.88
July	8.83	0.31	8.52	0	8.83	0.04	8.79
August	8.04	0	8.04	0	8.04	0.63	7.41
September	6.65	0.28	6.37	0.12	6.53	0	6.65
Totals	63.00	17.17	45.83	14.19	48.81	18.46	44.54

Month	Gross depth of evaporation in inches	1912-1913 Rainfall on reservoir in inches	1912-1913 Net depth of evaporation in inches	1913-1914 Rainfall on reservoir in inches	1913-1914 Net depth of evaporation in inches	1914-1915 Rainfall on reservoir in inches	1914-1915 Net depth of evaporation in inches
October	5.10	1.05	4.05	0.04	5.06	1.09	4.01
November	3.80	0.80	3.00	3.13	0.67	1.22	2.58
December	2.35	0	2.35	1.86	0.49	3.07	-0.72
January	2.20	2.38	-0.18	5.50	- 3.30	6.51	-4.31
February	3.05	5.03	-1.98	5.22	- 2.17	7.56	-4.51
March	4.50	1.43	3.07	0.97	3.53	1.45	3.05
April	4.93	0.49	4.44	2.47	2.46	3.89	1.04
May	6.17	0.36	5.81	0.20	5.97	2.20	3.97
June	7.38	0.22	7.16	0.17	7.21	0	7.38
July	0.83	0.05	8.78	0	8.83	0	8.83
August	8.04	0.12	7.92	0	8.04	1.37	6.67
September	6.65	0	6.65	0.06	6.59	0	6.65
Totals	63.00	11.93	51.07	19.62	[illegible]	28.36	34.64

Month	Gross depth	1915-1916 Rainfall	1915-1916 Net depth	1916-1917 Rainfall	1916-1917 Net depth	1917-1918 Rainfall	1917-1918 Net depth
October	5.10	0	6.10	1.82	3.28	0	5.10
November	3.80	0.99	2.81	0.05	3.76	0.48	3.32
December	2.35	3.64	-1.29	3.17	-0.82	0	2.35
January	2.20	19.81	-17.61	5.03	-2.83	2.63	-0.43
February	3.05	1.90	1.15	4.36	-1.30	3.08	-0.03
March	4.50	2.33	2.17	0.72	3.78	7.22	-2.72
April	4.93	0.32	4.61	2.55	2.38	0	4.93
May	6.17	0.22	5.95	1.36	4.81	0.03	6.14
June	7.38	0	7.38	0	7.38	0.03	7.35
July	8.83	0.19	8.64	0	8.83	0.10	8.73
August	8.04	0.01	8.03	0	8.04	0.70	7.34
September	6.65	0.29	6.36	0	6.65	0	6.65
Totals	63.00	29.70	33.30	19.05	43.95	14.27	48.73

Month	Gross depth	1918-1919 Rainfall	1918-1919 Net depth	1919-1920 Rainfall	1919-1920 Net depth	1920-1921 Rainfall	1920-1921 Net depth
October	5.10	1.07	4.03	1.18	3.92	0.61	4.49
November	3.80	2.11	1.69	1.43	2.37	0.09	3.71
December	2.35	2.13	0.22	1.42	0.93	1.09	1.26
January	2.20	0.19	2.01	0.68	1.52	2.18	0.02
February	3.05	4.27	-1.22	4.75	-1.70	1.10	1.95
March	4.50	3.12	1.38	6.15	-1.65	1.29	3.21
April	4.93	1.05	3.88	0.64	4.29	0.15	4.78
May	6.17	0.07	6.10	0.13	6.04	3.21	2.96
June	7.38	0	7.38	0	7.38	0	7.38
July	8.83	0	8.83	0	8.83	0	8.83
August	8.04	0	8.04	0	8.04	0.04	8.00
September	6.65	0.45	6.20	0.02	6.63	0.28	6.37
Totals	63.00	14.46	48.54	16.40	46.60	10.04	52.96

Month	Gross depth	1921-1922 Rainfall	1921-1922 Net depth	1922-1923 Rainfall	1922-1923 Net depth	1923-1924 Rainfall	1923-1924 Net depth
October	5.10	1.54	3.56	0.55	4.55	0.38	4.72
November	3.80	0.26	3.54	1.44	2.36	0.43	3.37
December	2.35	9.44	-7.09	3.12	-0.77	2.09	0.26
January	2.20	4.63	-2.43	1.91	0.29	0.60	1.60
February	3.05	3.49	-0.44	1.55	1.50	0	3.05
March	4.50	3.28	1.22	1.39	3.11	4.12	0.38
April	4.93	1.25	3.68	2.12	2.81	2.44	2.49
May	6.17	0.53	5.64	0	6.17	0	6.17
June	7.38	0	7.38	0.12	7.26	0	7.38
July	8.83	0.04	8.79	0	8.83	0	8.83
August	8.04	0.02	8.02	0	8.04	0	8.04
September	6.65	0	6.65	0.13	6.52	0	6.65
Totals	63.00	24.48	38.52	12.33	50.67	10.08	52.94

Month	Gross depth	1924-1925 Rainfall	1924-1925 Net depth	1925-1926 Rainfall	1925-1926 Net depth	1926-1927 Rainfall	1926-1927 Net depth
October	5.10	0.51	4.59	4.63	0.47	0.44	4.66
November	3.80	0.71	3.09	1.27	2.53	1.14	2.66
December	2.35	2.98	-0.63	1.64	0.71	4.64	-2.29
January	2.20	0.40	1.80	1.45	0.75	0.92	1.28
February	3.05	0.95	2.10	2.66	0.39	14.32	-11.27
March	4.50	1.54	2.96	0.54	3.96	3.72	0.78
April	4.93	3.32	1.61	7.85	-2.92	1.67	3.26
May	6.17	0	6.17	0.06	6.11	0	6.17
June	7.38	1.02	6.36	0	7.38	0.12	7.26
July	8.83	0	8.83	0	8.83	0	8.83
August	8.04	0	8.04	0	8.04	0	8.04
September	6.65	0	6.65	0	6.65	0	6.65
Totals	63.00	11.43	51.57	20.10	42.90	26.97	36.03

Month	Gross depth	1927-1928 Rainfall	1927-1928 Net depth	1928-1929 Rainfall	1928-1929 Net depth	1929-1930 Rainfall	1929-1930 Net depth
October	5.10	2.72	2.38	0.35	4.75	0	5.10
November	3.80	1.20	2.60	1.58	2.22	0	3.80
December	2.35	3.87	-1.52	2.21	0.14	0	2.35
January	2.20	0.77	1.43	2.39	-0.19	5.91	-3.71
February	3.05	1.83	1.22	3.09	-0.04	1.31	1.74
March	4.50	0.96	3.54	2.56	1.94	4.02	0.48
April	4.93	0.14	4.79	1.51	3.42	0.46	4.47
May	6.17	0.47	5.70	0	6.17	4.33	1.34
June	7.38	0	7.38	0	7.38	0	7.38
July	8.83	0	8.83	0	8.83	0	8.83
August	8.04	0	8.04	0	8.04	0	8.04
September	6.65	0	6.65	0.16	6.49	0	6.65
Totals	63.00	11.96	51.04	13.85	49.15	16.03	46.97

Month	Gross depth	1930-1931 Rainfall	1930-1931 Net depth	1931-1932 Rainfall	1931-1932 Net depth	1932-1933 Rainfall	1932-1933 Net depth
October	5.10	0.38	4.72	0.43	4.67	1.13	[illegible]
November	3.80	2.06	1.74	2.95	0.85	0	3.80
December	2.35	0	2.35	4.36	-2.01	3.86	-1.51
January	2.20	2.55	-0.35	1.68	0.52	4.61	-2.41
February	3.05	4.71	-1.66	6.60	-3.55	0.13	2.92
March	4.50	0.04	4.46	0.12	4.38	0.24	4.26
April	4.93	2.64	2.29	0.39	4.54	2.71	2.22
May	6.17	0.92	5.25	0	6.17	1.22	4.95
June	7.38	0	7.38	0.07	7.31	0.03	7.35
July	8.83	0	8.83	0	8.83	0	8.83
August	8.04	0.15	7.89	0	8.04	0	8.04
September	6.65	0	6.65	0	6.65	0	6.65
Totals	63.00	13.45	49.55	11.60	51.40	13.96	49.04

(1) October 1894 - September 1899, 93 per cent of rainfall at Valley Center.
October 1899 - September 1933, rainfall at Chocolate

LOSS IN EVAPORATION FROM RESERVOIRS ON SAN DIEGO RIVER

MISSION GORGE NO. 2 RESERVOIR

Month	Gross depth of evaporation in inches	Rainfall on(1) reservoir in inches	Net depth of evaporation in inches	Rainfall on reservoir in inches	Net depth of evaporation in inches	Rainfall on reservoir in inches	Net depth of evaporation in inches
		1894-1895		1895-1896		1896-1897	
October	4.85	0	4.85	0	4.85	1.37	3.48
November	3.62	0	3.62	0	3.62	1.39	2.23
December	2.24	2.12	0.12	3.16	-0.92	3.09	-0.85
January	2.09	11.32	-9.23	1.80	0.29	4.44	-2.35
February	2.91	1.06	1.85	0.02	2.89	3.86	-0.95
March	4.29	1.62	2.67	4.10	0.19	2.17	2.12
April	4.70	0.17	4.53	0.35	4.35	0.02	4.68
May	5.88	0.18	5.70	0.04	5.84	0.17	5.71
June	7.02	0	7.02	0.01	7.01	0	7.02
July	8.41	0	8.41	0	8.41	0.01	8.40
August	7.66	0	7.66	0.18	7.48	0	7.66
September	6.33	0	6.33	0	6.33	0	6.33
Totals	60.00	16.47	43.53	9.66	50.34	16.52	43.48
		1897-1898		1898-1899		1899-1900	
October	4.85	1.50	3.35	0	4.85	0.67	4.18
November	3.62	0.03	3.59	0.21	3.41	1.39	2.23
December	2.24	0.45	1.79	1.23	1.01	0.87	1.37
January	2.09	2.42	-0.33	2.15	-0.06	1.33	0.76
February	2.91	0.09	2.82	0.55	2.36	0.11	2.80
March	4.29	1.29	3.00	1.15	5.14	0.71	3.58
April	4.70	0.31	4.39	0.08	4.62	1.30	3.40
May	5.88	0.94	4.94	0.04	5.84	1.48	4.40
June	7.02	0.03	6.99	0.52	6.50	0.19	6.83
July	8.41	0	8.41	0	8.41	0	8.41
August	7.66	0	7.66	0	7.66	0	7.66
September	6.33	0.10	6.23	0	6.33	0	6.33
Totals	60.00	7.16	52.84	5.93	54.07	8.05	51.95
		1900-1901		1901-1902		1902-1903	
October	4.85	0.40	4.45	0.32	4.53	0.20	4.65
November	3.62	2.61	1.01	0.28	3.34	1.73	1.89
December	2.24	0	2.24	0.43	1.81	2.21	0.03
January	2.09	1.89	0.20	2.28	-0.19	0.84	1.25
February	2.91	2.66	0.25	2.49	0.42	2.97	-0.06
March	4.29	2.57	1.72	2.81	1.48	1.33	2.96
April	4.70	0.69	4.01	0.33	4.57	1.29	3.41
May	5.88	0.67	5.21	0.04	5.84	0.14	5.74
June	7.02	0.11	6.91	0	7.02	0	7.02
July	8.41	0.10	8.31	0.75	7.66	0	8.41
August	7.66	0.11	7.55	0	7.66	0	7.66
September	6.33	0	6.33	0	6.33	0	6.33
Totals	60.00	11.81	48.19	9.73	50.27	10.71	49.29
		1903-1904		1904-1905		1905-1906	
October	4.85	0.20	4.65	0.27	4.58	0.25	4.60
November	3.62	0	3.62	0	3.62	4.89	-1.27
December	2.24	0.10	2.14	2.73	-0.49	0.55	1.69
January	2.09	0.17	1.92	2.67	-0.58	1.20	0.89
February	2.91	2.19	0.72	9.22	-6.31	2.13	0.78
March	4.29	2.66	1.63	4.23	0.06	6.56	-2.27
April	4.70	0.10	4.60	0.36	4.34	1.65	3.04
May	5.88	0.29	5.59	1.02	4.86	0.73	5.15
June	7.02	0	7.02	0	7.02	0.04	6.98
July	8.41	0	8.41	0.03	8.38	0	8.41
August	7.66	0	7.66	0.01	7.65	0.13	7.53
September	6.33	0	6.33	0.57	5.76	0.30	6.03
Totals	60.00	5.71	54.29	21.11	38.89	18.44	41.56
		1906-1907		1907-1908		1908-1909	
October	4.85	0	4.85	2.10	2.75	0.69	4.26
November	3.62	1.52	2.10	0.62	3.00	0.84	2.78
December	2.24	4.14	-1.90	0.57	1.67	1.19	1.05
January	2.09	4.35	-2.26	4.58	-2.49	5.31	-3.22
February	2.91	0.85	2.06	3.39	-0.48	2.83	0.08
March	4.29	3.06	1.23	1.34	2.95	3.37	0.92
April	4.70	0.44	4.26	0.69	4.01	0	4.70
May	5.88	0.20	5.68	0.23	5.65	0	5.88
June	7.02	0.25	6.77	0	7.02	0	7.02
July	8.41	0	8.41	0.16	8.25	0	8.41
August	7.66	0	7.66	0.89	6.77	0.15	7.51
September	6.33	0	6.33	0.32	6.01	0	6.33
Totals	60.00	14.81	45.19	14.89	45.11	14.28	45.72
		1909-1910		1910-1911		1911-1912	
October	4.85	0	4.85	0.94	3.91	0.28	4.57
November	3.62	2.87	0.75	0.88	2.74	0	3.62
December	2.24	4.75	-2.51	0.33	1.91	1.59	0.65
January	2.09	2.72	-0.63	4.74	-2.65	0.50	1.59
February	2.91	0.35	2.56	4.00	-1.09	0	2.91
March	4.29	2.21	2.08	1.30	2.99	7.80	-3.51
April	4.70	0.24	4.46	1.07	3.63	2.42	2.28
May	5.88	0	5.88	0	5.88	1.29	4.59
June	7.02	0	7.02	0	7.02	0.70	6.32
July	8.41	0.34	8.07	0.06	8.35	0	8.41
August	7.66	0	7.66	0	7.66	0.32	7.34
September	6.33	0.15	6.18	0.46	5.87	0	6.33
Totals	60.00	13.53	46.37	13.78	46.22	14.90	45.10

1. October 1894 - December 1895, rainfall at El Cajon City published in U.S.G.S. Water Supply Paper 446; January 1896 - December 1898, rainfall at U. S. Weather Bureau Station in San Diego multiplied by 1.417; January 1899 - September 1933, rainfall at El Cajon published by U. S. Weather Bureau.

Month	Gross depth of evaporation in inches	Rainfall on reservoir in inches	Net depth of evaporation in inches	Rainfall on reservoir in inches	Net depth of evaporation in inches	Rainfall on reservoir in inches	Net depth of evaporation in inches
		1912-1913		1913-1914		1914-1915	
October	4.85	0.77	4.08	0.02	4.83	1.09	3.76
November	3.62	0.76	2.86	2.83	0.79	1.35	2.27
December	2.24	0.05	2.19	1.03	1.21	2.85	-0.61
January	2.09	1.50	0.59	4.56	-2.47	6.49	-4.40
February	2.91	3.10	-0.19	4.00	-1.09	4.22	-1.31
March	4.29	1.09	3.20	0.60	3.69	1.33	2.96
April	4.70	0.19	4.51	1.25	3.45	2.86	1.84
May	5.88	0.16	5.72	0.27	5.61	1.42	4.46
June	7.02	0.10	6.92	0.16	6.86	0	7.02
July	8.41	0.20	8.21	0	8.41	0	8.41
August	7.66	0.23	7.43	0	7.66	0	7.66
September	6.33	0	6.33	0.10	6.23	0	6.33
Totals	60.00	8.15	51.85	14.82	45.18	21.61	38.39
		1915-1916		1916-1917		1917-1918	
October	4.85	0	4.85	1.57	3.28	0.04	4.81
November	3.62	1.26	2.36	0	3.62	0.21	3.41
December	2.24	3.47	-1.23	2.11	0.13	0	2.24
January	2.09	16.68	-14.59	4.41	-2.32	1.44	0.65
February	2.91	1.57	1.34	2.25	0.66	2.29	0.62
March	4.29	1.27	3.02	0.38	3.91	6.58	-2.29
April	4.70	0.15	4.55	1.39	3.31	0	4.70
May	5.88	0.12	5.76	0.67	5.21	0.06	5.82
June	7.02	0	7.02	0	7.02	0	7.02
July	8.41	0.30	8.11	0	8.41	0.08	8.33
August	7.66	0.10	7.56	0	7.66	0.19	7.47
September	6.33	0.22	6.11	0	6.33	0.04	6.29
Totals	60.00	25.14	34.86	12.78	47.22	10.93	49.07
		1918-1919		1919-1920		1920-1921	
October	4.85	0.82	4.03	0.75	4.10	0.74	4.11
November	3.62	1.83	1.79	1.26	2.36	0.29	3.33
December	2.24	2.66	-0.42	0.87	1.37	0.69	1.55
January	2.09	0.33	1.76	0.70	1.39	2.62	-0.53
February	2.91	2.88	0.03	4.47	-1.56	0.84	2.07
March	4.29	2.27	2.02	4.90	-0.61	1.27	3.02
April	4.70	1.20	3.50	0.79	3.91	0.18	4.52
May	5.88	0.14	5.74	0.48	5.40	3.69	2.19
June	7.02	0	7.02	0	7.02	0	7.02
July	8.41	0	8.41	0	8.41	0	8.41
August	7.66	0.10	7.56	0	7.66	0.07	7.59
September	6.33	0.30	6.03	0.07	6.26	0.96	5.37
Totals	60.00	12.53	47.47	14.29	45.71	11.35	48.65
		1921-1922		1922-1923		1923-1924	
October	4.85	1.38	3.47	0.30	4.55	0.43	4.42
November	3.62	0.54	3.08	1.38	2.24	0.43	3.19
December	2.24	11.68	-9.44	2.60	-0.36	1.79	0.45
January	2.09	4.64	-2.55	1.75	0.34	0.75	1.34
February	2.91	3.09	-0.18	1.87	1.04	0	2.91
March	4.29	2.42	1.87	1.36	2.93	4.50	-0.21
April	4.70	0.55	4.15	1.66	3.04	1.60	3.10
May	5.88	0.53	5.33	0	5.88	0	5.88
June	7.02	0	7.02	0	7.02	0	7.02
July	8.41	0.04	8.57	0.04	8.37	0	8.41
August	7.66	0.01	7.65	0.05	7.61	0.03	7.63
September	6.33	0.05	6.28	0.09	6.24	0	6.33
Totals	60.00	24.93	35.07	11.10	48.90	9.53	50.47
		1924-1925		1925-1926		1926-1927	
October	4.85	0.22	4.63	5.02	-0.17	0.31	4.54
November	3.62	0.68	2.94	1.38	2.24	0.56	3.06
December	2.24	2.40	-0.16	1.75	0.49	4.41	-2.17
January	2.09	0.24	1.85	0.75	1.34	0.45	1.64
February	2.91	0.57	2.34	2.90	0.01	12.78	-9.87
March	4.29	2.28	2.01	0.57	3.72	2.74	1.55
April	4.70	2.29	2.41	6.98	-2.28	1.42	3.28
May	5.88	0.01	5.87	0.12	5.76	0.59	5.29
June	7.02	0.75	6.27	0	7.02	0.14	6.88
July	8.41	0.01	8.40	0.12	8.29	0	8.41
August	7.66	0	7.66	0.11	7.55	0	7.65
September	6.33	0	6.33	0	6.33	0	6.33
Totals	60.00	9.45	50.55	19.70	40.30	23.40	36.60
		1927-1928		1928-1929		1929-1930	
October	4.85	3.08	1.77	0.95	3.90	0	4.85
November	3.62	0.24	3.38	0.86	2.76	0	3.62
December	2.24	3.11	-0.87	2.75	-0.51	0	2.24
January	2.09	0.41	1.68	1.92	0.17	4.65	-2.56
February	2.91	1.82	1.09	1.84	1.07	0.80	2.11
March	4.29	0.88	3.41	1.89	2.40	3.83	0.46
April	4.70	0.04	4.66	1.21	3.49	0.62	4.08
May	5.88	0.59	5.29	0	5.88	3.69	2.19
June	7.02	0.04	6.98	0.02	7.00	0	7.02
July	8.41	0	8.41	0	8.41	0.04	8.37
August	7.66	0	7.66	0	7.66	0	7.66
September	6.33	0	6.33	0.55	5.78	0	6.33
Totals	60.00	10.21	49.79	11.99	48.01	13.63	45.37
		1930-1931		1931-1932		1932-1933	
October	4.85	0.47	4.38	0.33	4.52	1.30	3.55
November	3.62	2.22	1.40	2.54	1.08	0	3.62
December	2.24	0	2.24	5.43	-3.19	4.41	-2.17
January	2.09	2.76	-0.67	1.31	0.78	5.21	-3.12
February	2.91	4.57	-1.66	7.68	-4.77	0.04	2.87
March	4.29	0.02	4.27	0.44	3.85	0.12	4.17
April	4.70	1.78	2.92	0.59	4.11	1.88	2.82
May	5.88	0.62	5.26	0.01	5.87	0.95	4.93
June	7.02	0	7.02	0.16	6.86	0.07	6.95
July	8.41	0.02	8.39	0	8.41	0	8.41
August	7.66	0.37	7.29	0	7.66	0	7.66
September	6.33	0	6.33	0	6.33	0	6.33
Totals	60.00	12.83	47.17	18.49	41.51	13.98	46.02

TABLE A-2. (Continued)

LOSS IN EVAPORATION FROM RESERVOIRS ON SAN DIEGO RIVER

CUYAMACA RESERVOIR

Month	Gross depth of evaporation in inches	1894-1895 Rainfall (1) on reservoir in inches	1894-1895 Net depth of evaporation in inches	1895-1896 Rainfall on reservoir in inches	1895-1896 Net depth of evaporation in inches	1896-1897 Rainfall on reservoir in inches	1896-1897 Net depth of evaporation in inches
October	6.53	0	6.53	0.82	5.71	3.94	2.59
November	4.41	0	4.41	5.53	-1.12	2.76	1.65
December	2.88	10.24	-7.36	1.33	1.55	2.99	-0.11
January	2.77	24.27	-21.50	4.62	-1.85	5.05	-2.28
February	3.63	3.68	-0.05	0.16	3.47	7.32	-3.69
March	4.59	4.79	-0.20	5.62	-1.03	7.65	-3.06
April	4.67	0.88	3.79	1.42	3.25	0.17	4.50
May	6.68	0.93	5.75	0.74	5.94	0.30	6.38
June	8.58	0	8.58	0	8.58	0	8.58
July	9.90	0	9.80	1.03	8.77	0	9.80
August	9.37	0	9.37	0.70	8.67	0	9.37
September	8.09	0.02	8.07	0.85	7.24	0.31	7.78
Totals	72.00	44.81	27.19	22.82	49.18	36.49	41.51

Month	Gross depth	1897-1898 Rainfall	1897-1898 Net depth	1898-1899 Rainfall	1898-1899 Net depth	1899-1900 Rainfall	1899-1900 Net depth
October	6.53	3.78	2.75	0	6.53	3.61	2.92
November	4.41	0.86	3.55	0.70	3.71	3.63	0.78
December	2.88	2.34	0.54	1.71	1.17	1.99	0.89
January	2.77	4.95	-2.18	5.70	-2.93	2.90	-0.13
February	3.63	1.58	2.05	1.84	1.79	0.21	3.42
March	4.59	3.71	0.88	5.79	-1.20	2.01	2.58
April	4.67	0.99	3.68	0.78	3.89	5.35	-0.68
May	6.68	4.77	1.91	0.38	30	3.22	3.46
June	8.58	0	8.58	2.37	6.21	0.08	8.50
July	9.90	0	9.80	0.03	9.77	0.22	9.58
August	9.37	1.06	8.31	0	9.37	0	9.37
September	8.09	0	8.09	0	8.09	0.74	7.35
Totals	72.00	24.04	47.96	19.30	52.70	23.96	48.04

Month	Gross depth	1900-1901 Rainfall	1900-1901 Net depth	1901-1902 Rainfall	1901-1902 Net depth	1902-1903 Rainfall	1902-1903 Net depth
October	6.53	0.59	5.94	1.55	4.98	0.81	5.72
November	4.41	9.57	-5.16	1.18	3.23	4.07	0.34
December	2.88	0.03	2.85	0.42	2.46	2.93	-0.05
January	2.77	6.54	-3.77	6.54	-3.77	3.17	-0.40
February	3.63	10.61	-6.98	6.00	-2.37	5.04	-1.41
March	4.59	1.86	2.73	11.06	-6.47	4.91	-0.32
April	4.67	0.99	3.68	1.67	3.00	6.57	-1.90
May	6.68	3.10	3.58	0.11	6.57	0.55	6.13
June	8.58	0	8.58	0.14	8.44	0	8.58
July	9.80	0	9.80	1.23	8.57	0	9.80
August	9.37	0.06	9.31	0	9.37	0.22	9.15
September	8.09	0.06	8.03	0	8.09	1.02	7.07
Totals	72.00	33.41	38.59	29.90	42.10	29.29	42.71

Month	Gross depth	1903-1904 Rainfall	1903-1904 Net depth	1904-1905 Rainfall	1904-1905 Net depth	1905-1906 Rainfall	1905-1906 Net depth
October	6.53	0.42	6.11	0.94	5.59	0.12	6.41
November	4.41	0.03	4.38	0	4.41	8.12	-3.71
December	2.88	0.13	2.75	2.36	0.52	2.22	0.66
January	2.77	0.62	2.15	7.90	-5.13	4.35	-1.58
February	3.63	3.14	0.49	12.73	-9.10	5.92	-2.29
March	4.59	10.20	-5.61	12.50	-7.91	17.93	-13.34
April	4.67	2.11	2.56	2.83	1.84	2.83	1.84
May	6.68	0.92	5.76	5.69	0.99	2.69	3.99
June	8.58	0	8.58	0	8.58	0.12	8.46
July	9.80	0.16	9.64	0	9.80	0.08	9.72
August	9.37	1.00	8.37	0	9.37	2.40	6.97
September	8.09	0.12	7.97	0.81	7.28	0.72	7.37
Totals	72.00	18.85	53.15	45.76	26.24	47.50	24.50

Month	Gross depth	1906-1907 Rainfall	1906-1907 Net depth	1907-1908 Rainfall	1907-1908 Net depth	1908-1909 Rainfall	1908-1909 Net depth
October	6.53	0.64	5.89	2.72	3.81	1.64	4.89
November	4.41	2.94	1.47	1.05	3.36	0.99	3.42
December	2.88	7.30	-4.42	1.44	1.44	0.56	2.32
January	2.77	7.58	-4.81	5.33	-2.56	12.13	-9.36
February	3.63	2.58	1.05	7.44	-3.81	10.00	-6.37
March	4.59	9.11	-4.52	2.60	1.99	7.08	-2.49
April	4.67	1.37	3.30	2.22	2.45	0.17	4.50
May	6.68	0.51	6.17	1.48	5.20	0	6.68
June	8.58	0.70	7.88	0	8.58	0	8.58
July	9.80	0	9.80	0	9.80	0.13	9.67
August	9.37	0	9.37	2.29	7.08	1.04	8.33
September	8.09	0	8.09	1.46	6.63	0.24	7.85
Totals	72.00	32.73	39.27	28.03	43.97	34.18	37.82

Month	Gross depth	1909-1910 Rainfall	1909-1910 Net depth	1910-1911 Rainfall	1910-1911 Net depth	1911-1912 Rainfall	1911-1912 Net depth
October	6.53	0.05	6.48	1.49	5.04	0.54	5.99
November	4.41	4.86	-0.45	2.10	2.31	0.23	4.18
December	2.88	9.41	-6.53	0.90	1.98	1.88	1.00
January	2.77	5.06	-2.29	8.15	-5.38	1.04	1.73
February	3.63	1.08	2.55	6.61	-2.98	0	3.63
March	4.59	4.15	0.44	3.51	1.08	15.89	-11.30
April	4.67	0.74	3.93	1.43	3.24	3.50	1.17
May	6.68	0	6.68	0	6.68	1.35	5.33
June	8.58	0	8.58	0	8.58	0.33	8.25
July	9.80	1.20	8.60	0.51	9.29	0.67	9.13
August	9.37	0.07	9.30	0	9.37	0.51	8.86
September	8.09	0.26	7.83	0.23	7.86	0.01	8.08
Totals	72.00	26.88	45.12	24.93	47.07	25.95	46.05

Month	1912-1913 Gross depth of evaporation in inches	1912-1913 Rainfall on reservoir in inches	1912-1913 Net depth of evaporation in inches	1913-1914 Gross depth of evaporation in inches	1913-1914 Rainfall on reservoir in inches	1913-1914 Net depth of evaporation in inches
October	6.53	4.42	2.11	6.86	0.27	6.59
November	4.41	1.93	2.48	5.63	3.89	1.74
December	2.88	0.06	2.82	2.85	2.66	0.19
January	2.77	4.30	-1.53	3.28	7.80	-4.52
February	3.63	9.50	-5.87	5.46	5.55	-0.09
March	4.59	1.70	2.89	7.20	1.88	5.32
April	4.67	0.74	3.93	5.60	3.04	2.56
May	6.68	0.41	6.27	7.33	0.03	7.30
June	9.25	0.57	8.68	8.99	0.41	8.58
July	8.18	0.42	7.76	9.90	0.03	9.87
August	7.94	1.90	6.04	10.76	1.06	9.70
September	9.68	0.02	9.66	7.53	0.16	7.37
Totals	71.21	25.97	45.24	81.59	26.78	54.81

Month	1914-1915 Gross depth	1914-1915 Rainfall	1914-1915 Net depth	1915-1916 Gross depth	1915-1916 Rainfall	1915-1916 Net depth
October	6.08	1.30	4.78	8.30	0	8.30
November	3.28	0.94	2.34	3.99	2.35	1.64
December	3.94	3.65	-2.71	4.88	5.66	-0.78
January	3.47	9.18	-5.71	0.68	30.00	-29.32
February	3.97	9.86	-5.89	4.65	2.80	1.85
March	4.56	2.94	1.62	6.26	3.61	2.65
April	3.75	5.93	-2.18	6.57	0.59	5.98
May	4.52	6.58	-2.06	7.21	0.51	6.70
June	9.66	0	9.66	8.25	0	8.25
July	8.74	0	8.74	10.05	1.70	8.35
August	10.30	0.36	9.94	8.68	1.67	7.01
September	7.16	0.41	6.75	6.11	1.08	5.03
Totals	69.43	44.15	25.28	75.63	49.97	25.66

Month	1916-1917 Gross depth	1916-1917 Rainfall	1916-1917 Net depth	1917-1918 Gross depth	1917-1918 Rainfall	1917-1918 Net depth
October	3.15	4.10	-0.95	6.53	0.02	6.51
November	3.82	0.10	3.72	4.41	0.99	3.42
December	2.40	4.21	-1.81	2.88	0	2.88
January	2.75	5.87	-3.12	2.57	3.37	-0.80
February	2.01	6.35	-4.34	3.61	4.49	-0.88
March	2.94	1.40	1.54	3.00	12.56	-9.56
April	2.88	4.09	-1.21	5.24	0	5.24
May	4.88	1.17	3.71	5.85	0.36	5.49
June	6.58	0	6.58	6.20	0.47	5.73
July	6.91	0.94	5.97	9.02	0.09	8.93
August	8.54	0	8.54	7.11	0.35	6.76
September	7.12	0.37	6.75	6.65	0.03	6.62
Totals	53.98	28.60	25.38	63.07	22.73	40.34

Month	1918-1919 Gross depth	1918-1919 Rainfall	1918-1919 Net depth	1919-1920 Gross depth	1919-1920 Rainfall	1919-1920 Net depth
October	6.24	0.88	5.36	8.75	1.65	7.10
November	2.45	4.34	-1.89	7.34	1.59	5.75
December	2.38	3.76	-1.38	2.88	3.25	-0.37
January	2.07	0.54	1.53	2.77	2.62	0.15
February	2.60	5.86	-3.26	3.63	8.07	-4.44
March	2.98	5.10	-2.12	4.59	8.22	-3.63
April	4.55	1.13	3.42	4.67	3.09	1.58
May	5.76	0.27	5.49	6.68	0.24	6.44
June	9.38	0	9.38	8.58	0.04	8.54
July	8.29	1.00	7.29	9.80	0.06	9.74
August	7.97	0.80	7.17	9.37	0.68	8.69
September	7.99	0.40	7.59	8.09	0.14	7.95
Totals	62.66	24.08	38.58	77.15	29.85	47.30

Month	1920-1921 Gross depth	1920-1921 Rainfall	1920-1921 Net depth	1921-1922 Gross depth	1921-1922 Rainfall	1921-1922 Net depth
October	6.53	3.15	3.38	7.27	1.48	5.79
November	4.41	0.76	3.65	3.24	0.77	2.47
December	2.88	2.48	0.40	2.88	20.78	-17.90
January	2.77	3.46	-0.69	2.77	6.83	-4.06
February	3.63	2.01	1.62	3.63	7.19	-3.56
March	4.59	2.83	1.76	4.59	5.78	0.81
April	4.67	0.88	3.79	4.67	2.00	2.67
May	6.68	5.73	0.95	5.17	1.06	4.11
June	8.58	0	8.58	7.28	0	7.28
July	9.40	1.45	7.95	10.51	0.46	10.05
August	10.11	0.06	10.05	10.14	1.22	8.92
September	9.74	2.26	7.48	8.98	0.20	8.78
Totals	75.99	25.07	48.92	71.13	45.77	25.36

Month	1922-1923 Gross depth	1922-1923 Rainfall	1922-1923 Net depth	1923-1924 Gross depth	1923-1924 Rainfall	1923-1924 Net depth
October	6.41	1.08	5.33	7.04	1.42	5.62
November	4.23	4.50	-0.27	4.18	1.20	2.98
December	1.83	6.68	-4.85	3.77	4.23	-0.46
January	3.19	4.80	-1.61	4.87	1.46	3.41
February	2.65	4.78	-2.13	5.56	0.04	5.52
March	5.26	2.59	2.67	4.59	11.07	-6.48
April	4.69	4.18	0.51	4.13	3.31	0.82
May	7.70	0	7.70	8.74	0	8.74
June	9.64	0	9.64	10.04	0	10.04
July	11.50	0.38	11.12	12.98	0	12.98
August	12.40	0	12.40	11.02	0	11.02
September	6.46	0.80	5.66	8.32	0	8.32
Totals	75.96	29.79	46.17	85.24	22.73	52.51

TABLE A-2, (Continued)

LOSS IN EVAPORATION FROM RESERVOIRS ON SAN DIEGO RIVER
CUYAMACA RESERVOIR

Month	1924-1925			1925-1926		
	Gross depth of evaporation in inches	Rainfall on reservoir in inches	Net depth of evaporation in inches	Gross depth of evaporation in inches	Rainfall on reservoir in inches	Net depth of evaporation in inches
October	6.87	0.92	5.95	6.33	4.61	1.98
November	4.75	1.96	2.79	4.41	1.86	6.55
December	6.88	6.17	-3.29	2.88	1.99	0.89
January	2.77	0.97	1.80	4.70	3.47	1.23
February	3.63	1.78	1.85	5.84	5.05	0.79
March	4.59	5.17	-0.58	4.39	1.61	2.78
April	4.67	9.07	-4.40	4.67	10.69	-6.02
May	6.68	0.43	6.25	6.01	0.47	5.54
June	8.58	2.41	6.17	8.80	0	8.80
July	9.20	0	9.20	10.46	0	10.46
August	8.00	0	8.00	9.60	0.14	9.46
September	9.04	0	9.06	8.74	0	6.74
Totals	71.65	28.88	42.80	77.03	29.89	47.14
	1926-1927			1927-1928		
October	6.02	0.05	5.97	6.33	3.16	3.17
November	4.63	3.16	1.47	3.41	0.12	3.29
December	1.63	13.21	-11.58	2.14	4.91	-2.77
January	2.31	1.45	0.86	3.82	1.41	2.41
February	2.01	22.86	-20.85	4.92	4.06	0.84
March	4.91	6.58	-1.67	3.87	1.64	2.23
April	4.02	1.86	2.16	6.16	0.14	6.00
May	7.83	1.90	5.93	7.59	1.21	6.58
June	8.28	0	8.28	10.44	0	10.44
July	10.20	0	10.20	11.33	0	11.33
August	9.22	0	9.22	11.00	0	11.00
September	8.38	0.48	7.90	9.56	0	9.56
Totals	69.46	51.33	17.91	80.57	16.67	63.90
	1928-1929			1929-1930		
October	5.91	0.79	5.12	6.90	0	6.90
November	4.12	2.18	1.94	3.24	0	3.24
December	3.54	5.85	-2.31	4.48	0	4.48
January	2.33	6.07	-3.74	1.63	13.45	-11.82
February	4.31	5.06	-0.75	5.12	2.42	2.70
March	5.29	5.74	-0.45	3.38	5.18	-1.80
April	4.65	2.65	2.00	6.48	0.96	5.52
May	9.78	0	9.78	6.05	7.04	-0.99
June	9.56	0	9.56	9.04	0	9.04
July	11.06	0.45	10.61	9.78	0	9.78
August	8.59	1.03	7.56	9.29	1.22	8.07
September	7.29	2.57	4.72	8.91	0	8.91
Totals	76.43	32.39	44.04	76.30	30.27	46.03
	1930-1931			1931-1932		
October	6.94	0.71	6.23	5.73	1.32	4.41
November	3.68	4.51	1.17	4.19	3.93	0.26
December	2.90	0	2.90	0.19	11.09	-10.90
January	3.85	2.71	1.14	1.80	3.74	-1.94
February	2.34	5.19	-2.85	1.14	17.78	-16.64
March	5.97	0.34	5.63	3.44	0.45	4.99
April	5.62	4.69	0.93	6.13	2.17	3.96
May	8.60	2.21	6.39	7.40	0	7.40
June	8.40	0.06	8.34	8.68	0	8.68
July	10.78	0.54	10.24	11.04	0	11.04
August	9.17	0.17	9.00	11.98	0	11.98
September	7.69	1.67	5.92	9.98	0	9.98
Totals	77.84	22.80	55.04	73.70	40.48	33.22
	1932-1933					
October	7.04	4.41	2.63			
November	5.56	0	5.56			
December	3.49	9.72	-6.23			
January	2.95	9.19	-6.24			
February	3.48	0.09	3.39			
March	6.18	0.32	5.86			
April	5.66	5.33	0.33			
May	8.50	2.70	5.80			
June	8.82	0.13	8.69			
July	11.08	0.37	10.71			
August	9.96	0.10	9.86			
September	9.44	0	9.44			
Totals	82.16	32.36	49.80			

1) 80 per cent of rainfall at Cuyamaca.

TABLE A-3

MONTHLY DRAFTS ON RESERVOIRS

32,500 Acre-feet Total Seasonal Draft

Cuyamaca Reservoir	11,600 acre-feet
El Capitan Reservoir	116,900 acre-feet
San Vicente Reservoir	174,500 acre-feet
Mission Gorge No. 2 Reservoir	29,200 acre-feet
Total Storage Capacity	332,200 acre-feet

Month	Irrigation supply		Municipal supply		Combined totals	
	In acre-feet	In per cent of annual total	In acre-feet	In per cent of annual total	In acre-feet	In per cent of annual total
January	70	1.4	1,705	6.2	1,775	5.6
February	50	1.0	1,540	5.6	1,590	4.9
March	140	2.8	1,925	7.0	2,065	6.3
April	390	7.8	2,118	7.7	2,508	7.7
May	440	8.8	2,585	9.4	3,025	9.3
June	540	10.8	2,805	10.2	3,345	10.3
July	690	13.8	3,107	11.3	3,797	11.7
August	740	14.8	3,025	11.0	3,765	11.6
September	690	13.8	2,640	9.6	3,330	10.2
October	540	10.8	2,337	8.5	2,877	8.8
November	490	9.8	2,008	7.3	2,498	7.7
December	220	4.4	1,705	6.2	1,925	5.9
Totals	5,000	100.0	27,500	100.0	32,500	100.0

TABLE A-4

COORDINATED OPERATION OF CUYAMACA, EL CAPITAN, SAN VICENTE AND MISSION GORGE NO. 2 RESERVOIRS ON SAN DIEGO RIVER

1894-1933.

CUYAMACA RESERVOIR
Height of dam: 40 feet
Capacity: 11,595 acre-feet

EL CAPITAN RESERVOIR
Height of dam: 217 feet
Capacity: 116,872 acre-feet

SAN VICENTE RESERVOIR
Height of dam: 268 feet
Capacity: 174,458 acre-feet

MISSION GORGE NO. 2 RESERVOIR
Height of dam: 109 feet
Capacity: 29,223 acre-feet

Municipal draft - 27,500 acre-feet per year, or an average of 24.5 million gallons per day.
Irrigation draft - 5,000 acre-feet per year, or an average of 4.5 million gallons per day.
Total draft - 32,500 acre-feet per year, or an average of 29.0 million gallons per day.

Year and month	CUYAMACA RESERVOIR: Flow into reservoir in acre-feet	Stage of reservoir in acre-feet	Net loss from evaporation in acre-feet	Flow to El Capitan Reservoir in (1) acre-feet	Flow over spillway in acre-feet	EL CAPITAN RESERVOIR: Flow into reservoir in (2) acre-feet	Stage of reservoir in acre-feet	Net loss from evaporation in acre-feet	Draft in (3) acre-feet	Flow over spillway in acre-feet
1894-95										
October	0	0	0	0		0	72,001	482	2,877	0
November	0	0	0	0		0	68,642	348	2,498	0
December	935	0	-88	0		3,911	65,796	-340	400	0
January	7,761	1,023	-965	0		66,217	69,647	-1,138	1,775	18,355
February	909	9,749	-4	0		10,278	116,872	259	1,590	8,429
March	723	10,662	-16	0		6,458	116,872	305	2,065	4,088
April	359	11,401	307	0		3,093	116,872	551	2,508	34
May	0	11,453	427	3,184		3,662	116,872	732	3,025	0
June	45	7,842	497	3,521		3,709	116,777	970	3,345	0
July	0	3,869	326	3,543		3,366	116,171	1,155	3,366	0
August	0	0	0	0		0	115,016	1,043	740	0
September	0	0	0	0		0	113,733	[illegible]	690	0
Totals	10,732		484	10,248		100,694		5,222	24,879	30,906
1895-96										
October	0	0	0	0	0	0	111,688	651	540	0
November	0	0	0	0	0	0	110,497	254	490	0
December	201	0	7	0	0	314	109,753	238	220	0
January	581	194	-27	0	0	1286	109,621	-78	70	0
February	75	802	71	0	0	493	110,915	372	50	0
March	276	806	-23	0	0	1533	110,986	-12	140	0
April	74	1105	79	0	0	112	112,391	522	390	0
May	0	1100	72	1088	0	977	111,591	764	440	0
June	0	0	0	0	0	0	111,364	938	1033	0
July	0	0	0	0	0	0	109,393	1083	3797	0
August	0	0	0	0	0	0	104,513	974	3765	0
September	0	0	0	0	0	0	99,774	783	3330	0
Totals	1207		179	1088	0	4715		6477	14,265	0
1896-97										
October	1	0	1	0	0	0	95,661	268	2,877	0
November	10	0	0	0	0	0	92,516	300	2,498	0
December	54	10	0	0	0	107	89,718	-106	1,925	0
January	467	64	-23	0	0	1121	88,006	-293	1,590	0
February	766	554	-82	0	0	4059	87,830	-396	915	0
March	2079	1402	-113	0	0	7249	91,370	122	911	0
April	90	3594	208	0	0	694	97,586	576	2,508	0
May	0	3476	201	3875	0	3231	95,196	691	3,025	0
June	0	0	0	0	0	0	94,711	840	3,345	0
July	0	0	0	0	0	0	90,526	974	3,797	0
August	0	0	0	0	0	0	85,753	856	3,765	0
September	0	0	0	0	0	0	81,134	683	3,330	0
Totals	3467		192	3275	0	16,461		4,515	30,486	0
1897-98										
October	0	0	0	0	0	0	77,121	314	2877	0
November	0	0	0	0	0	0	73,930	368	2498	0
December	63	0	1	0	0	166	71,064	121	1925	0
January	152	62	-15	0	0	397	69,184	-29	1775	0
February	305	229	26	0	0	797	67,835	209	1590	0
March	161	508	15	0	0	420	66,833	251	2065	0
April	0	654	64	0	0	0	64,937	389	2508	0
May	0	590	22	568	0	540	62,040	388	3025	0
June	0	0	0	0	0	0	59,167	610	3345	0
July	0	0	0	0	0	0	55,212	696	3797	0
August	0	0	0	0	0	0	50,719	601	3765	0
September	0	0	0	0	0	0	46,353	473	3330	0
Totals	681		113	568	0	2320		4391	32,500	0

Year and month	SAN VICENTE RESERVOIR: Flow into reservoir in (4) acre-feet	Stage of reservoir in acre-feet	Net loss from evaporation in acre-feet	Draft in acre-feet	Flow over spillway in acre-feet	MISSION GORGE NO. 2 RESERVOIR: Flow into reservoir in (5) acre-feet	Stage of reservoir in acre-feet	Net loss from evaporation in acre-feet	Draft in acre-feet	Flow over spillway in acre-feet
1894-95										
October	0	164,592	574	0	0	0	0	0	0	0
November	0	164,018	428	0	0	0	0	0	0	0
December	1,304	163,590	-416	0	0	1,525	0	0	1,525	0
January	22,080	165,310	-1153	0	14,083	58,264	0	-587	0	29,628
February	3,427	174,458	227	0	3,200	15,637	29,223	235	0	15,402
March	2,153	174,458	268	0	1,885	8,492	29,223	339	0	8,153
April	1,031	174,458	484	0	547	1,787	29,223	577	0	1,210
May	212	174,458	641	0	0	248	29,223	720	0	0
June	121	174,029	852	0	0	142	28,751	871	0	0
July	0	173,298	1016	0	0	0	28,022	1012	431	0
August	0	172,282	923	0	0	0	26,579	849	3025	0
September	0	171,359	762	0	0	0	22,705	621	2640	0
Totals	30,328		4606	0	19,717	86,095		4637	7,621	54,393
1895-96										
October	0	170,597	573	0	0	0	19,444	423	2337	0
November	0	170,024	225	0	0	0	16,684	283	2008	0
December	0	169,799	200	0	0	0	14,393	-66	1705	0
January	0	169,599	-69	0	0	0	12,754	19	1706	0
February	0	169,668	329	0	0	0	11,030	163	1540	0
March	0	169,339	-11	0	0	0	9,325	9	1925	0
April	0	169,350	455	0	0	0	7,391	168	2118	0
May	0	168,895	668	0	0	0	5,105	147	2585	0
June	0	168,227	824	0	0	0	2,575	61	2312	0
July	0	167,403	967	0	0	0	0	0	0	0
August	0	166,436	890	0	0	0	0	0	0	0
September	0	165,546	844	0	0	0	0	0	0	0
Totals	0		5895	0	0	0		1209	18,235	0
1896-97										
October	0	164,702	263	0	0	0	0	0	0	0
November	0	164,439	300	0	0	0	0	0	0	0
December	0	164,139	-108	0	0	0	0	0	0	0
January	199	164,247	-300	0	0	0	185	0	186	0
February	726	164,746	403	0	0	675	0	0	675	0
March	1241	165,875	120	0	0	1154	0	0	1154	0
April	0	166,996	560	0	0	0	0	0	0	0
May	0	166,436	675	0	0	0	0	0	0	0
June	0	165,761	833	0	0	0	0	0	0	0
July	0	164,928	996	0	0	0	0	0	0	0
August	0	163,932	905	0	0	0	0	0	0	0
September	0	163,027	745	0	0	0	0	0	0	0
Totals	2166		4586	0	0	2014		0	2014	0
1897-98										
October	0	162,282	353	0	0	0	0	0	0	0
November	0	161,929	425	0	0	0	0	0	0	0
December	0	161,504	144	0	0	0	0	0	0	0
January	0	161,360	-35	0	0	0	0	0	0	0
February	0	161,395	255	0	0	0	0	0	0	0
March	0	161,140	310	0	0	0	0	0	0	0
April	0	160,830	491	0	0	0	0	0	0	0
May	0	160,339	504	0	0	0	0	0	0	0
June	0	159,835	619	0	0	0	0	0	0	0
July	0	159,016	978	0	0	0	0	0	0	0
August	0	158,038	894	0	0	0	0	0	0	0
September	0	157,144	733	0	0	0	0	0	0	0
Totals	0		5871	0	0	0		0	0	0

(1) Transmission losses in natural water course between Cuyamaca and El Capitan reservoirs are estimated to be 5 per cent of the water released or spilled from Cuyamaca Reservoir.
(2) Flow into El Capitan Reservoir includes 95 per cent of the flow and spill from Cuyamaca Reservoir in addition to natural run-off.
(3) Draft in acre-feet from El Capitan Reservoir includes water transferred to San Vicente Reservoir.
(4) Flow in San Vicente Reservoir includes water transferred from El Capitan Reservoir in addition to natural run-off.
(5) Flow into Mission Gorge No. 2 Reservoir includes spill from El Capitan and San Vicente reservoirs in addition to natural run-off.

TABLE A-4. (Continued) COORDINATED OPERATION OF CUYAMACA, EL CAPITAN, SAN VICENTE AND MISSION GORGE NO. 2 RESERVOIRS ON SAN DIEGO RIVER, 1894-1933.

Year and month	CUYAMACA RESERVOIR: Flow into reservoir in acre-feet	Stage of reservoir in acre-feet	Net loss from evaporation in acre-feet	Flow to El Capitan Reservoir in (1) acre-feet	Flow over spillway in acre-feet	EL CAPITAN RESERVOIR: Flow into reservoir in (2) acre-feet	Stage of reservoir in acre-feet	Net loss from evaporation in acre-feet	Draft in (3) acre-feet	Flow over spillway in acre-feet	SAN VICENTE RESERVOIR: Flow into reservoir in (4) acre-feet	State of reservoir in acre-feet	Net loss from evaporation in acre-feet	Draft in acre-feet	Flow over spillway in acre-feet	MISSION GORGE NO. 2 RESERVOIR: Flow into reservoir in (5) acre-feet	Stage of reservoir in acre-feet	Net loss from evaporation in acre-feet	Draft in acre-feet	Flow over spillway in acre-feet	Year and month
1898-99																					1898-99
October	0	0	0	0	0	0	42,550	348	2877	0	0	156,411	562	0	0	0	0	0	0	0	October
November	0	0	0	0	0	0	39,325	249	2498	0	0	155,849	418	0	0	0	0	0	0	0	November
December	9	0	0	0	0	0	36,578	44	1925	0	0	155,431	77	0	0	0	0	0	0	0	December
January	179	9	-14	0	0	0	34,609	-101	1775	0	0	155,354	-181	0	0	0	0	0	0	0	January
February	150	202	19	0	0	150	32,955	100	1890	0	0	155,535	185	0	0	0	0	0	0	0	February
March	186	315	-17	0	0	602	31,395	149	2065	0	0	155,350	283	0	0	0	0	0	0	0	March
April	0	516	60	0	0	400	29,785	261	2508	0	0	155,067	514	0	0	0	0	0	0	0	April
May	0	456	65	395	0	514	27,414	324	3025	0	0	154,553	686	0	0	0	0	0	0	0	May
June	0	0	0	0	0	72	24,579	312	3345	0	0	153,867	705	0	0	0	0	0	0	0	June
July	0	0	0	0	0	0	20,994	382	3797	0	0	153,164	963	0	0	0	0	0	0	0	July
August	0	0	0	0	0	0	16,815	297	3765	0	0	152,201	875	0	0	0	0	0	0	0	August
September	0	0	0	0	0	0	12.753	203	3330	0	0	151,326	[illegible]	0	0	0	0	0	0	0	September
Totals	504		111	393		1738		2563	32,500	0	0		5808	0	0	0		0	0	0	Totals
1899-1900																					1899-1900
October	0	0	0	0	0	0	9220	125	2877	0	0	150,603	554	0	0	0	0	0	0	0	October
November	4	0	0	0	0	0	6218	71	2498	0	0	150,049	415	0	0	0	0	0	0	0	November
December	1	4	0	0	0	0	5649	17	1925	0	0	149,636	146	0	0	0	0	0	0	0	December
January	88	5	0	0	0	179	1707	-4	1775	0	0	149,490	-86	0	0	0	0	0	0	0	January
February	8	95	18	0	0	72	115	2	185	0	0	149,576	330	1405	0	0	0	0	0	0	February
March	8	83	13	0	0	87	0	0	87	0	0	147,841	381	1978	0	0	0	0	0	0	March
April	30	78	-4	0	0	197	0	0	197	0	0	145,488	307	2311	0	0	0	0	0	0	April
May	0	112	13	99	0	370	0	0	370	0	0	142,864	480	2655	0	0	0	0	0	0	May
June	0	0	0	0	0	0	0	0	0	0	0	139,729	776	3345	0	0	0	0	0	0	June
July	0	0	0	0	0	0	0	0	0	0	0	135,608	919	3797	0	0	0	0	0	0	July
August	0	0	0	0	0	0	0	0	0	0	0	130,892	826	3765	0	0	0	0	0	0	August
September	0	0	0	0	0	0	0	0	0	0	0	126,301	674	3330	0	0	0	0	0	0	September
Totals	159		40	99	0	905		211	9914	0	0		5720	22,586	0	0		0	0	0	Totals
1900-01																					1900-01
October	0	0	0	0	0	0	0	0	0	0	0	122,297	495	2877	0	0	0	0	0	0	October
November	123	0	-19	0	0	40	0	0	40	0	0	118,925	-27	2458	0	0	0	0	0	0	November
December	5	142	21	0	0	16	0	0	16	0	0	116,494	230	1909	0	0	0	0	0	0	December
January	162	124	-56	0	0	221	0	0	221	0	0	114,355	-66	1554	0	0	0	0	0	0	January
February	2065	522	1178	0	0	2958	0	-22	1366	0	224	112,867	-486	0	0	224	0	0	224	0	February
March	74	2585	106	0	0	829	1594	19	2065	0	0	113,577	320	0	0	0	0	0	0	0	March
April	103	2553	142	0	0	464	339	6	797	0	0	115,287	417	1711	0	0	0	0	0	0	April
May	25	2514	94	2445	0	2819	0	0	2819	0	0	111,129	529	208	0	0	0	0	0	0	May
June	0	0	0	0	0	211	0	0	211	0	0	110,394	694	5134	0	0	0	0	0	0	June
July	69	0	0	69	0	198	0	0	198	0	0	106,566	808	3599	0	0	0	0	0	0	July
August	0	0	0	0	0	226	0	0	226	0	0	102,159	707	3539	0	0	0	0	0	0	August
September	20	0	0	20	0	24	0	0	24	0	0	97,915	565	3306	0	0	0	0	0	0	September
Totals	2669		150	2539	0	7988		5	7983	0	224		4186	24,293	0	224		0	224	0	Totals
1901-02																					1901-02
October	0	0	0	0	0	0	0	0	0	0	0	94,042	437	2877	0	0	0	0	0	0	October
November	1	0	0	0	0	0	0	0	0	0	0	90,738	283	2498	0	0	0	0	0	0	November
December	1	1	0	0	0	0	0	0	0	0	0	87,957	191	1925	0	0	0	0	0	0	December
January	34	2	-5	0	0	-34	0	0	34	0	0	85,481	-81	1751	0	0	0	0	0	0	January
February	488	41	-25	0	0	316	0	0	316	0	105	84,171	65	1221	0	53	0	0	53	0	February
March	1262	552	-141	0	0	5225	0	1	2006	0	119	82,990	14	0	0	59	0	0	59	0	March
April	178	1975	102	0	0	1001	1218	15	2204	0	0	85,095	335	304	0	0	0	0	0	0	April
May	0	2051	156	1895	0	2121	0	0	2121	0	0	82,456	501	904	0	0	0	0	0	0	May
June	94	0	0	94	0	259	0	0	259	0	0	81,051	602	3086	0	0	0	0	0	0	June
July	0	0	0	0	0	98	0	0	98	0	0	77,363	684	3699	0	0	0	0	0	0	July
August	0	0	0	0	0	7	0	0	7	0	0	72,980	639	3758	0	0	0	0	0	0	August
September	0	0	0	0	0	0	0	0	0	0	0	68,585	519	3330	0	0	0	0	0	0	September
Totals	2058		69	1989	0	7051		16	7035	0	224		4179	25,353	0	112		0	112	0	Totals
1902-03																					1902-03
October	0	0	0	0	0	0	0	0	0	0	0	64,734	364	2877	0	0	0	0	0	0	October
November	30	5	0	0	0	0	0	0	0	0	0	61,493	159	2498	0	0	0	0	0	0	November
December	70	35	0	0	0	19	0	0	19	0	0	58,856	11	1906	0	0	0	0	0	0	December
January	35	103	-5	0	0	77	0	0	77	0	0	56,939	31	1698	0	0	0	0	0	0	January
February	680	141	-20	0	0	1656	0	-3	877	0	753	55,210	-75	0	0	713	0	0	713	0	February
March	341	641	-8	0	0	5254	782	21	1745	0	338	56,036	181	0	0	320	0	0	320	0	March
April	894	1190	-57	0	0	4319	2270	51	2198	0	578	56,195	255	0	0	310	0	0	310	0	April
May	10	2141	148	2003	0	2713	4340	104	3025	0	0	56,268	448	0	0	0	0	0	0	0	May
June	21	0	0	21	0	223	5924	79	3345	0	0	55,820	538	0	0	0	0	0	0	0	June
July	4	0	0	4	0	105	723	21	807	0	0	55,282	632	2990	0	0	0	0	0	0	July
August	0	0	0	0	0	68	0	0	68	0	0	51,660	534	5697	0	0	0	0	0	0	August
September	1	0	0	1	0	1	0	0	1	0	0	47,409	431	3329	0	0	0	0	0	0	September
Totals	2089		60	2029	0	12,435		273	12,162	0	1419		3509	18,995	0	1343		0	1343	0	Totals

(1), (2), (3), (4), (5). See notes at bottom of first page of this table.

TABLE A-4. (Continued) COORDINATED OPERATION OF CUYAMACA, EL CAPITAN, SAN VICENTE AND MISSION GORGE NO. 2 RESERVOIRS OF SAN DIEGO RIVER, 1894-1933.

Year and month	CUYAMACA RESERVOIR: Flow into reservoir in acre-feet	Stage of reservoir in acre-feet	Net loss from evaporation in acre-feet	Flow to El Capitan Reservoir in (1) acre-feet	Flow over spillway in acre-feet	EL CAPITAN RESERVOIR: Flow into reservoir in (2) acre-feet	Stage of reservoir in acre-feet	Net loss from evaporation in acre-feet	Draft in (3) acre-feet	Flow over spillway in acre-feet
1903-04										
October	0	0	0	0	0	0	0	0	0	0
November	8	0	0	0	0	0	0	0	0	0
December	0	8	0	0	0	0	0	0	0	0
January	4	2	0		0	0	0	0	0	0
February	48	6	1	0	0	0	0	0	0	0
March	363	53	-52	0	0	622	0	0	622	0
April	0	468	37	0	0	220	0	0	220	0
May	0	431	56	375	0	404	0	0	404	0
June	0	0	0	0	0	0	0	0	0	0
July	0	0	0	0	0	0	0	0	0	0
August	2	0	0	2	0	0	0	0	2	0
September	0	0	0	0	0	0	0	0	0	0
Totals	419		42	377	0	1248		0	1248	0
1904-05										
October	2	0	0	2	0	2	0	0	2	0
November	0	0	0	0	0	0	0	0	0	0
December	1	0	0	0	0	0	0	0	0	0
January	192	1	-25	0	0	98	0	0	98	0
February	1592	218	-198	0	0	5503	0	65	197	0
March	1834	2008	-331	0	0	14,742	5371	-37	3797	0
April	1283	4173	97	0	0	5576	16353	176	3797	0
May	511	5339	39	5831	0	9564	13956	215	1405	0
June	106	0	0	106	0	1400	23902	359	5051	0
July	128	0	0	128	0	1394	21892	396	3712	0
August	71	0	0	71	0	191	18178	316	3763	0
September	111	0	0	111	0	370	14288	196	3330	0
Totals	5831		-418	6249	0	55,840		1556	23,152	0
1905-06										
October	0	0	0	0	0	298	11,132	143	2877	0
November	909	0	-42	0	0	4296	8,410	12	2498	0
December	331	951	16	0	0	332	10,196	34	1925	0
January	896	1266	-40	0	0	1217	8,569	6	1775	0
February	973	2211	-92	0	0	3696	8,005	-38	1032	0
March	5551	3276	-792	0	0	38,779	10,707	-214	3797	0
April	793	9619	139	0	0	14,358	46,903	257	3797	0
May	469	10,273	221	10,521	0	13,793	56,207	419	3797	0
June	348	0		348	0	2,278	65,784	664	3797	0
July	115	0		115	0	1,133	63,611	766	3797	0
August	238	0		238	0	1,210	60,181	659	2190	0
September	0	0		0	0	620	58,542	508	3330	0
Totals	10,625		-599	11,222	0	82,010		3206	34,612	0
1906-07										
October	0	0	0	0	0	499	55,324	402	2877	0
November	0	0	0	0	0	549	52,544	142	2498	0
December	722	0	-44	0	0	1919	50,453	-276	1663	0
January	1743	766	-143	0	0	10,721	50,987	-254	3797	0
February	893	2652	45	0	0	4,725	58,165	128	3797	0
March	739	3502	-234	0	0	9,278	58,965	93	3797	0
April	1378	5493	198	0	0	6,791	64,361	388	3797	0
May	404	6673	277	6,602	0	9,587	66,957	557	3797	0
June	235	0		235	0	3,274	72,190	671	2197	0
July	48	0		48	0	806	72,596	838	3797	0
August	32	0		32	C	604	68,767	733	3763	0
September	0	0		0	0	465	64,873	584	3330	0
Totals	7,216		99	7,117	0	49,218		4004	39,112	0
1907-08										
October	59	0	0	59	0	964	61,424	272	2877	0
November	95	0	9	0	0	901	59,239	219	2498	0
December	87	86	8	0	0	1610	57,423	136	1925	0
January	263	106	-22	0	0	1386	56,978	-162	1325	0
February	874	390	-72	0	0	4603	57,198	-142	139	0
March	447	1336	68	0	0	2940	61,801	208	1376	0
April	199	1725	78	0	0	1517	63,157	310	2412	0
May	13	1846	116	1743	0	2802	61,952	493	3025	0
June	0	0	0	0	0	597	61,236	623	3345	0
July	0	0	0	0	0	449	57,863	719	3797	0
August	24	0	0	24	0	383	53,796	572	3765	0
September	117	0	0	117	0	382	49,842	447	3330	0
Totals	2118		175	1943	0	18,534		3697	29,814	0

SAN VICENTE RESERVOIR: Flow into reservoir in (4) acre-feet	Stage of reservoir in acre-feet	Net loss from evaporation in acre-feet	Draft in acre-feet	Flow over spillway in acre-feet	MISSION GORGE NO. 2 RESERVOIR: Flow into reservoir in (5) acre-feet	Stage of reservoir in acre-feet	Net loss from evaporation in acre-feet	Draft in acre-feet	Flow over spillway in acre-feet	Year and month
										1903-04
0	43,649	315	2877	0	0	0	0	0	0	October
0	40,457	235	2498	0	0	0	0	0	0	November
0	37,724	142	1925	0	0	0	0	0	0	December
0	35,657	111	1775	0	0	0	0	0	0	January
0	33,771	10	1590	0	0	0	0	0	0	February
0	32,171	48	1445	0	0	0	0	0	0	March
0	30,680	245	2288	0	0	0	0	0	0	April
0	28,147	307	2621	0	0	0	0	0	0	May
0	25,219	361	3345	0	0	0	0	C	0	June
0	21,513	398	3797	0	0	0	0	0	0	July
0	17,318	321	3763	0	0	0	0	0	0	August
0	13,234	222	3330	0	0	0	0		0	September
0		2715	31,252	0	0		0	0	0	Totals
										1904-05
0	9,682	119	2875	0	0	0	0	0	0	October
0	6,688	69	2498	0	0	0	0	0	0	November
0	4,121	3	1923	0	0	0	0	0	0	December
0	2,193	-9	1677	0	0	0	0	0	0	January
1318	*525	-16	0	0	1393	0	0	1393	0	February
7433	1334	-21	0	0	3989	0	1	1925	0	March
4286	8788	144	0	0	988	2063	45	2118	0	April
764	12,930	180	0	0	808	828	14	1622	0	May
279	13,514	277	0	0	294	0	0	294	0	June
80	13,516	330	0	0	85	0	0	85	0	July
0	13,268	297	0	0	0	0	0	0	0	August
0	12,969	213	0	0	0	0	0	0	0	September
14,160		1586	8976	0	7497		60	7437	0	Totals
										1905-06
0	12,756	181	0	0	0	0	0	0	0	October
0	12,675	15	0	0	0	0	0	0	0	November
0	12,560	43	0	0	0	0	0	0	0	December
0	12,517	0	0	0	0	0	0	0	0	January
501	12,508	-80	0	0	558	0	0	558	0	February
13,771	13,069	-186	0	0	11,258	0	-61	1925	0	March
6,130	27,016	182	0	0	3,031	9394	168	2118	0	April
3,920	32,964	285	0	0	631	10,139	268	2585	0	May
3,325	36,699	447	0	0	76	7,917	276	2906	0	June
3,107	39,477	556	0	0	0	4,912	185	3107	0	July
0	42,028	496	0	0	0	1,620	48	1575	0	August
0	41,532	390	0	0	0	0	0	0	0	September
30,754		2368	0	0	15,554		881	14,673	0	Totals
										1906-07
0	41,148	319	0	0	0	0	0	0		October
0	40,823	116	0	0	0	0	0	0		November
241	40,707	-229	0	0	263	0	0	263		December
6689	41,177	-208	0	0	3218	0	-13	1706		January
5239	48,074	106	0	0	1621	1526	34	1540		February
7045	53,207	79	0	0	3681	1583	21	1925		March
5484	60,173	330	0	0	2258	3318	99	2118		April
3687	65,327	464	0	0	359	3359	67	2585		May
117	68,550	647	0	0	127	1046	25	1148		June
0	68,120	693	0	0	0	0	0	0		July
0	67,427	629	0	0	0	0	0	0		August
0	66,798	519	0	0	0	0	0	0		September
28,502		3365	0	0	11,526		843	11,263		Totals
										1907-08
0	66,279	248	0	0	0	0	0	0	0	October
0	66,031	204	0	0	0	0	0	0	0	November
0	66,827	128	0	0	0	0	0	0	0	December
476	65,699	-153	0	0	450	0	0	450	0	January
1533	66,337	-131	0	0	1451	0	0	1451	0	February
728	67,991	186	0	0	689	0	0	689	0	March
103	68,531	280	0	0	96	0	0	96	0	April
0	68,353	448	0	0	0	0	0	0	0	May
0	67,905	579	0	0	0	0	0	0	0	June
0	67,326	691	0	0	0	0	0	0	0	July
0	66,635	674	0	0	0	0	0	0	0	August
0	66,061	467	0	0	0	0	0	0	0	September
2839		3584	0	0	2686		0	2686	0	Totals

(1), (2), (3), (4), (5). See notes at bottom of first page of this table.

* San Vicente Reservoir assumed to be empty February 1, 1906.

TABLE A-4. (Continued) COORDINATED OPERATION OF CUYAMACA, EL CAPITAN, SAN VICENTE AND MISSION GORGE NO. 2 RESERVOIRS ON SAN DIEGO RIVER, 1894-1933.

	CUYAMACA RESERVOIR					EL CAPITAN RESERVOIR					SAN VICENTE RESERVOIR					MISSION GORGE NO. 2 RESERVOIR					
Year and month	Flow into reservoir in acre-feet	Stage of reservoir in acre-feet	Net loss from evaporation in acre-feet	Flow to El Capitan Reservoir in (1) acre-feet	Flow over spillway in acre-feet	Flow into reservoir in (2) acre-feet	Stage of reservoir in acre-feet	Net loss from evaporation in acre-feet	Draft in (3) acre-feet	Flow over spillway in acre-feet	Flow into reservoir in (4) acre-feet	Stage of reservoir in acre-feet	Net loss from evaporation in acre-feet	Draft in acre-feet	Flow over spillway in acre-feet	Flow into reservoir in (5) acre-feet	Stage of reservoir in acre-feet	Net loss from evaporation in acre-feet	Draft in acre-feet	Flow over spillway in acre-feet	Year and month
1908-09																					1908-09
October	55	0	0	55	0	446	46,447	280	2877	0	0	65,694	303	0	0	0	0	0	0	0	October
November	0	0	0	0	0	428	43,736	208	2498	0	0	65,291	232	0	0	0	0	0	0	0	November
December	145	0	9	0	0	337	41,458	112	1925	0	0	65,059	128	0	0	0	0	0	0	0	December
January	1581	136	-189	0	0	8533	59,758	-422	774	0	950	64,931	-464	0	0	1001	0	0	1001	0	January
February	2373	1906	-270	0	0	14,405	47,939	-108	3797	0	5976	66,345	-108	0	0	2350	0	0	1540	0	February
March	1102	4549	-138	0	0	7,069	58,653	97	3797	0	5017	72,429	92	0	0	1433	810	3	1925	0	March
April	352	5789	266	0	0	4,406	61,828	415	850	0	1278	77,334	384	0	0	1347	315	4	1658	0	April
May	0	5875	279	5596	0	7,771	64,969	360	2792	0	221	78,248	498	0	0	233	0	0	233	0	May
June	196	0	0	196	0	988	69,388	680	3331	0	13	77,971	600	0	0	14	0	0	14	0	June
July	216	0	0	216	0	409	66,365	785	3797	0	0	77,384	718	0	0	0	0	0	0	0	July
August	165	0	0	165	0	211	62,192	610	5765	0	0	76,666	580	0	0	0	0	0	0	0	August
September	212	0	0	212	0	352	58,028	544	3330	0	0	76,086	538	0	0	0	0	0	0	0	September
Totals	6397		-43	6440	0	45,353		3761	35,533	0	13,455		5501	0	0	6378		7	6371	0	Totals
1909-10																					1909-10
October	134	0	0	134	0	212	54,506	405	2877	0	0	75,548	412	0	0	0	0	0	0	0	October
November	207	0	-25	0	0	420	51,439	19	2498	0	0	75,136	20	0	0	0	0	0	0	0	November
December	483	230	-99	0	0	2518	49,342	-320	1419	0	491	75,116	-341	0	0	506	0	0	506	0	December
January	1963	812	-70	0	0	9123	50,761	-47	3797	0	5823	75,948	-48	0	0	2160	0	-1	1705	0	January
February	386	2845	107	0	0	2792	56,134	181	538	0	384	81,819	179	0	0	601	436	3	1054	0	February
March	622	3184	20	0	0	2879	58,209	169	1785	0	272	82,224	165	0	0	280	0	0	280	0	March
April	276	3726	188	0	0	2518	59,134	387	2362	0	145	82,331	377	0	0	146	0	0	146	0	April
May	0	3814	221	3592	0	4222	58,703	580	3025	0	0	82,097	506	0	0	0	0	0	0	0	May
June	0	0	0	0	0	242	59,580	616	3345	0	0	81,591	605	0	0	0	0	0	0	0	June
July	253	0	0	253	0	294	55,661	680	3797	0	0	80,986	697	0	0	0	0	0	0	0	July
August	256	0	0	256	0	479	51,478	608	3765	0	0	80,289	657	0	0	0	0	0	0	0	August
September	249	0	0	249	0	350	47,584	461	3330	0	0	79,632	580	0	0	0	0	0	0	0	September
Totals	4829		344	4485	0	25,858		3876	32,536	0	7313		3749	0	0	5893		2	5691	0	Totals
1910-11																					1910-11
October	155	0	0	155	0	329	44,152	299	2,877	0	0	79,112	350	0	0	0	0	0	0	0	October
November	75	0	8	0	0	240	41,308	184	2,498	0	0	78,762	198	0	0	0	0	0	0	0	November
December	0	69	8	0	0	578	38,883	111	1,925	0	0	78,564	158	0	0	0	0	0	0	0	December
January	308	61	-48	0	0	1092	57,225	-141	1,661	0	123	78,426	-178	0	0	114	0	0	114	0	January
February	1005	411	-63	0	0	4791	56,797	-76	1,078	0	558	78,727	-94	0	0	618	0	0	512	0	February
March	788	1479	35	0	0	4435	40,858	216	1,438	0	676	79,373	256	0	0	627	0	0	627	0	March
April	73	2172	114	0	0	1825	43,367	254	2,306	0	218	79,793	297	0	0	202	0	0	202	0	April
May	0	2151	161	1970	0	2650	42,652	427	3,028	0	6	79,714	503	0	0	0	0	0	0	0	May
June	0	0	0	0	0	277	41,830	497	5,346	0	0	79,211	602	0	0	0	0	0	0	0	June
July	120	0	0	120	0	128	38,265	563	3,797	0	0	78,609	719	0	0	0	0	0	0	0	July
August	0	0	0	0	0	101	34,033	478	5,785	0	0	77,890	654	0	0	0	0	0	0	0	August
September	0	0	0	0	0	119	29,891	360	5,380	0	0	77,336	530	0	0	0	0	0	0	0	September
Totals	2458		215	2245	0	16,565		3152	31,045	0	1369		5975	0	0	1455		0	1433	0	Totals
1911-12																					1911-12
October	0	0	0	0	0	6	26,320	245	2877	0	0	76,706	389	0	0	0	0	0	0	0	October
November	0	0	0	0	0	0	23,204	175	2498	0	0	76,317	300	0	0	0	0	0	0	0	November
December	0	0	0	0	0	15	20,531	22	1925	0	0	76,017	41	0	0	0	0	0	0	0	December
January	37	0	2	0	0	99	18,099	69	1775	0	0	75,976	135	0	0	0	0	0	0	0	January
February	0	35	9	0	0	188	16,854	119	1590	0	0	75,841	247	0	0	0	0	0	0	0	February
March	1759	26	-202	0	0	4790	15,273	-212	2034	0	52	75,594	-423	0	0	31	0	0	31	0	March
April	1106	1987	45	0	0	6771	18,841	88	684	0	1898	76,071	149	0	0	1824	0	0	1824	0	April
May	236	3047	155	3128	0	5469	24,243	234	2635	0	411	77,880	367	0	0	392	0	0	392	0	May
June	0	0	0	0	0	526	26,845	355	3342	0	4	77,864	569	0	0	5	0	0	5	0	June
July	131	0	0	131	0	570	23,674	416	3797	0	0	77,306	715	0	0	0	0	0	0	0	July
August	107	0	0	107	0	228	19,832	310	5765	0	0	76,594	601	0	0	0	0	0	0	0	August
September	13	0	0	13	0	43	15,985	240	3330	0	0	75,993	538	0	0	0	0	0	0	0	September
Totals	3388		9	3379	0	18,445		2057	30,250	0	2363		3616	0	0	2250		0	2250	0	Totals
1912-13																					1912-13
October	134	0	0	134	0	233	12,458	124	3,877	0	0	75,485	327	0	0	0	0	0	0	0	October
November	22	0	2	0	0	109	9,690	78	2,498	0	0	75,128	343	0	0	0	0	0	0	0	November
December	17	20	5	0	0	161	7,223	51	1,928	0	0	74,886	198	0	0	0	0	0	0	0	December
January	217	32	-10	0	0	477	5,408	-3	1,887	0	118	74,694	-15	0	0	88	0	0	88	0	January
February	291	259	-84	0	0	1551	4,201	-34	1,407	0	244	74,827	-150	0	0	183	0	0	183	0	February
March	1338	634	73	0	0	2888	4,579	57	2,000	0	86	75,231	248	0	0	65	0	0	65	0	March
April	179	1917	131	0	0	1341	5,210	60	2,508	0	0	75,069	359	0	0	0	0	0	0	0	April
May	0	1965	144	1821	0	1997	3,963	87	3,025	0	0	74,710	469	0	0	0	0	0	0	0	May
June	177	0	0	177	0	253	2,848	60	3,041	0	0	74,241	576	304	0	0	0	0	0	0	June
July	109	0	0	109	0	104	0	0	104	0	0	73,361	699	3693	0	0	0	0	0	0	July
August	168	0	0	168	0	160	0	0	160	0	0	68,969	618	3605	0	0	0	0	0	0	August
September	73	0	0	73	0	153	0	0	153	0	0	64,746	509	3177	0	0	0	0	0	0	September
Totals	2745		261	2484	0	9427		500	21,385	0	448		4064	10,779	0	336		0	336	0	Totals

(1), (2), (3), (4), (5). See notes at bottom of first page of this table.

TABLE A-4. (Continued) COORDINATED OPERATION OF CUYAMACA, EL CAPITAN, SAN VICENTE AND MISSION GORGE NO. 2 RESERVOIRS ON SAN DIEGO RIVER, 1894-1933.

Year and month	CUYAMACA RESERVOIR					EL CAPITAN RESERVOIR					SAN VICENTE RESERVOIR					MISSION GORGE NO. 2 RESERVOIR					Year and month
	Flow into reservoir in acre-feet	Stage of reservoir in acre-feet	Net loss from evaporation in acre-feet	Flow to El Capitan Reservoir in (1) in acre-feet	Flow over spillway in acre-feet	Flow into reservoir in (2) in acre-feet	Stage of reservoir in acre-feet	Net loss from evaporation in acre-feet	Draft to (3) in acre-feet	Flow over spillway in acre-feet	Flow into reservoir in (4) in acre-feet	Stage of reservoir in acre-feet	Net loss from evaporation in acre-feet	Draft in acre-feet	Flow over spillway in acre-feet	Flow into reservoir in (5) in acre-feet	Stage of reservoir in acre-feet	Net loss from evaporation in acre-feet	Draft in acre-feet	Flow over spillway in acre-feet	
1913-14																					1913-14
October	0	0	0	0	0	0	0	0	0	0	0	61,060	380	2877	0	0	0	0	0	0	October
November	68	0	4	0	0	145	0	0	145	0	0	57,803	49	2363	0	0	0	0	0	0	November
December	40	64	1	0	0	166	0	0	166	0	0	55,401	36	1759	0	0	0	0	0	0	December
January	747	108	-63	0	0	3834	0	-21	1138	0	637	53,606	-237	0	0	637	0	0	637	0	January
February	934	920	-8	0	0	8298	2717	-47	60	0	2050	54,500	-158	0	0	1980	0	-1	1540	0	February
March	171	1856	173	0	0	1925	11,012	109	1256	0	394	56,708	260	0	0	373	441	5	809	0	March
April	200	1854	84	0	0	1329	11,678	76	2477	0	36	56,842	181	0	0	31	0	0	31	0	April
May	22	1970	172	1820	0	2875	10,349	173	3025	0	0	56,697	439	0	0	0	0	0	0	0	May
June	44	0	0	44	0	266	10,086	186	3345	0	0	56,258	528	0	0	0	0	0	0	0	June
July	33	0	0	33	0	31	6,761	160	3797	0	0	55,730	644	0	0	0	0	0	0	0	July
August	82	0	0	82	0	78	2,835	66	2847	0	0	55,066	580	918	0	0	0	0	0	0	August
September	25	0	0	25	0	24	0	0	24	0	0	53,588	464	3306	0	0	0	0	0	0	September
Totals	2371		367	2004	0	18,971		701	18,270	0	3137		3166	11,213	0	3021		4	3017	0	Totals
1914-15																					1914-15
October	0	0	0	0	0	51	0	0	51	0	0	49,818	273	2826	0	0	0	0	0	0	October
November	0	0	0	0	0	138	0	0	138	0	0	46,719	171	2366	0	0	0	0	0	0	November
December	168	0	-12	0	0	260	0	0	260	0	0	44,182	-47	1665	0	0	0	0	0	0	December
January	1410	178	-113	0	0	3824	0	-35	70	0	1416	42,564	-280	0	0	3779	0	-34	1705	0	January
February	3111	1701	-253	0	0	17,408	3,789	-142	50	0	8280	44,260	-308	0	0	10,080	2108	-49	1540	0	February
March	966	3085	-92	0	0	8,819	21,289	158	140	0	2890	52,848	220	0	0	3,497	10,637	184	1925	0	March
April	612	5939	-133	0	0	5,226	29,810	61	3,797	0	4927	55,318	78	0	0	1,839	12,025	118	2118	0	April
May	2569	6684	-65	9118	0	27,637	31,178	276	3,797	0	6687	60,367	303	0	0	4,029	11,628	293	2585	0	May
June	154	0	0	154	0	2,974	54,742	587	3,797	0	3392	66,749	580	0	0	163	12,779	432	2805	0	June
July	0	0	C	0	0	652	53,532	682	3,797	0	3107	69,561	701	0	0	0	9,705	395	3107	0	July
August	806	0	0	206	0	355	49,505	493	3,797	0	3057	71,967	534	0	0	0	8,203	228	3025	0	August
September	0	0	0	0	0	75	45,370	476	690	0	0	74,490	536	0	0	0	2,950	71	2640	0	September
Totals	8994		-484	9478	0	67,413		2556	20,378	0	33,756		2763	6857	0	23,327		1638	21,450	0	Totals
1915-16																					1915-16
October	230	0	0	230	0	283	44,479	337	2641	0	0	73954	410	0	0	0	239	3	236	0	October
November	92	0	6	0	0	218	41,764	190	2498	0	0	73544	225	0	0	0	0	0	0	0	November
December	269	87	-7	0	0	927	39,294	-86	1925	0	0	73,319	-104	0	0	0	0	0	0	0	December
January	13,255	365	-1385	0	3418	138,902	38,382	-1738	1775	60,375	30,860	73,423	-1606	0	0	125,752	0	-928	0	97,457	January
February	1,651	11,595	151	0	1500	18,746	116,872	132	3797	14,797	10,847	125,888	119	0	0	23,924	29,223	171	1540	22,213	February
March	1,679	11,595	216	0	1465	15,344	116,872	286	2065	12,993	3,427	136,616	229	0	0	19,970	29,223	385	0	19,583	March
April	477	11,093	487	0	0	7,016	116,872	607	2508	3,901	2,000	141,814	491	0	0	6,472	29,223	579	0	5,893	April
May	8	11,586	539	0	0	3,620	116,872	784	2836	0	734	143,323	636	0	0	943	29,223	733	189	21	May
June	66	11,054	606	2,742	0	4,316	116,872	971	3345	0	178	143,421	788	0	0	229	29,223	894	0	0	June
July	179	7,772	475	3,996	0	4,672	116,872	1137	3797	0	35	142,813	918	0	0	44	28,568	997	0	0	July
August	12	3,482	221	3,273	0	3,754	116,610	1064	3109	0	0	141,930	852	0	0	0	27,613	897	656	0	August
September	82	0	0	82	0	526	116,201	832	690	0	0	141,078	674	0	0	0	26,062	672	2640	0	September
Totals	18,009		1305	10,323	6381	198,324		4546	30,986	92,066	70,081		3631	0	0	177,334		4393	3261	143,169	Totals
1916-17																					1916-17
October	0	0	0	0	0	1,188	115,206	426	540	0	0	140,404	347	0	0	0	22,750	325	2337	0	October
November	0	0	0	0	0	798	115,425	489	490	0	0	140,057	396	0	0	0	20,068	327	2008	0	November
December	211	0	-9	0	0	1,336	116,244	-107	280	0	437	139,661	-86	0	0	581	17,753	11	1705	0	December
January	929	220	-55	0	0	3,076	116,467	-378	1,867	1,675	2035	140,184	-301	0	0	4258	16,618	-203	0	0	January
February	981	1204	-136	0	0	4,709	116,872	-171	1,590	3,290	1681	142,520	-138	0	0	5524	21,081	70	0	0	February
March	413	2321	39	0	0	4,030	116,872	498	2,065	1,467	490	144,339	406	0	0	2118	26,535	471	0	0	March
April	474	2673	-51	0	0	3,941	116,872	313	2,508	1,120	744	144,424	250	0	0	2109	28,182	415	0	653	April
May	180	3200	155	549	0	3,659	116,872	634	3,025	0	9	144,913	515	0	0	12	29,223	656	0	0	May
June	161	2676	179	2658	0	3,689	116,872	972	2,717	0	0	144,407	789	0	0	0	28,379	858	628	0	June
July	126	0	0	126	0	500	116,872	1168	690	0	0	143,818	942	0	0	0	27,093	945	3107	0	July
August	134	0	0	134	0	298	115,524	1047	740	0	0	142,676	856	0	0	0	23,041	753	3025	0	August
September	122	0	0	122	0	194	114,036	869	690	0	0	141,820	706	0	0	0	19,263	543	2640	0	September
Totals	3,731		142	3,589	0	27,917		5,748	17,142	7,652	5396		4686	0	0	14,602		5169	13,450	653	Totals
1917-18																					1917-18
October	116	0	0	116	0	219	112,680	655	540	0	0	141,114	541	0	0	0	16,080	362	2337	0	October
November	29	0	3	0	0	239	111,704	425	490	0	0	140,573	352	0	0	0	13,361	225	2008	0	November
December	60	26	9	0	0	353	111,028	300	280	0	0	140,221	249	0	0	0	11,148	129	1705	0	December
January	58	67	-6	0	0	401	110,861	-65	70	0	0	139,972	-46	0	0	0	9,314	32	1705	0	January
February	342	130	-10	0	0	864	111,847	-3	50	0	0	140,018	-3	0	0	0	7,377	26	1540	0	February
March	2326	482	-279	0	0	13,908	112,064	-354	2065	7389	3300	140,021	-290	0	0	11,849	6,011	-143	0	0	March
April	65	3087	222	0	0	2,008	116,872	649	1359	0	100	143,611	526	0	0	140	18,003	398	1149	0	April
May	8	2928	189	2724	0	3,834	116,872	809	3025	0	0	143,185	665	0	0	0	16,396	472	0	0	May
June	146	85	18	211	0	439	116,872	964	540	0	0	142,530	782	0	0	0	16,124	321	2805	0	June
July	0	0	0	0	0	64	115,807	1157	690	0	0	141,748	927	0	0	0	12,798	504	3107	0	July
August	132	0	0	132	0	224	114,044	949	740	0	0	140,821	778	0	0	0	9,187	335	3025	0	August
September	63	0	0	63	0	186	112,579	852	690	0	0	140,043	703	0	0	0	5,827	183	2640	0	September
Totals	3,333		87	3,246	0	22,739		6,328	10,479	7,389	3400		3174	0	0	11,989		3044	22,021	0	Totals

(1), (2), (3), (4), (5). See notes at bottom of first page of this table.

TABLE A-4. (Continued) COORDINATED OPERATION OF CUYAMACA, EL CAPITAN, SAN VICENTE AND MISSION GORGE NO. 2 RESERVOIRS ON SAN DIEGO RIVER, 1894-1933.

Year and month	CUYAMACA RESERVOIR: Flow into reservoir in acre-feet	Stage of reservoir in acre-feet	Net loss from evaporation in acre-feet	Flow to El Capitan Reservoir in (1) acre-feet	Flow over spillway in acre-feet	EL CAPITAN RESERVOIR: Flow into reservoir in (2) acre-feet	Stage of reservoir in acre-feet	Net loss from evaporation in acre-feet	Draft in (3) acre-feet	Flow over spillway in acre-feet	SAN VICENTE RESERVOIR: Flow into reservoir in (4) acre-feet	Stage of reservoir in acre-feet	Net loss from evaporation in acre-feet	Draft in acre-feet	Flow over spillway in acre-feet	MISSION GORGE NO. 2 RESERVOIR: Flow into reservoir in (5) acre-feet	Stage of reservoir in acre-feet	Est loss from evaporation in acre-feet	Draft in acre-feet	Flow over spillway in acre-feet	Year and month
1918-19																					1918-19
October	284	0	0	284	0	486	111,223	514	540	0	0	139,340	426	0	0	0	3004	51	2337	0	October
November	70	0	-4	0	0	330	110,655	214	1,885	0	0	138,914	178	0	0	0	616	3	613	0	November
December	128	74	-10	0	0	549	109,906	27	1,925	0	0	138,736	23	0	0	0	0	0	0	0	December
January	0	212	14	0	0	258	107,503	251	1,776	0	0	138,713	212	0	0	0	0	0	0	0	January
February	724	198	-52	0	0	1,362	105,736	-152	1,508	0	109	138,501	-129	0	0	82	0	0	82	0	February
March	868	974	-39	0	0	2,933	105,741	171	1,880	0	246	138,739	145	0	0	185	0	0	185	0	March
April	108	1901	113	0	0	1,134	106,623	480	2,439	0	93	138,840	408	0	0	69	0	0	69	0	April
May	0	1896	124	1,772	0	2,153	104,838	747	3,025	0	0	138,325	642	0	0	0	0	0	0	0	May
June	97	0	0	97	0	192	103,219	889	3,345	0	0	137,883	775	0	0	0	0	0	0	0	June
July	61	0	0	61	0	68	99,177	1,034	3,797	0	0	137,108	926	0	0	0	0	0	0	0	July
August	258	0	0	258	0	245	94,404	913	3,766	0	0	136,188	841	0	0	0	0	0	0	0	August
September	0	0	0	0	0	23	89,971	683	3,330	0	0	135,341	648	0	0	0	0	0	0	0	September
Totals	2,598			2,472	0	9,745		5,771	29,214	0	448		5095	0	0	336		54	3286	0	Totals
1919-20																					1919-20
October	0	0	0	0	0	63	85,983	421	2877	0	0	134,693	409	0	0	0	0	0	0	0	October
November	44	0	8	0	0	197	82,748	249	2498	0	0	134,284	247	0	0	0	0	0	0	0	November
December	863	36	-5	0	0	439	80,198	93	1925	0	0	134,037	96	0	0	0	0	0	0	0	December
January	358	904	3	0	0	428	78,817	155	1775	0	0	133,941	159	0	0	0	0	0	0	0	January
February	1071	1259	-145	0	0	3137	77,115	-175	1590	0	0	133,782	-177	0	0	0	0	0	0	0	February
March	2369	2473	-168	0	0	14,781	80,837	-183	140	0	2055	133,959	-173	0	0	2558	0	-1	1925	0	March
April	900	5010	90	0	0	6,683	95,681	507	1318	0	453	136,187	450	0	0	564	634	8	1190	0	April
May	236	5820	287	5789	0	7,460	100,521	732	5014	0	9	136,190	631	0	0	11	0	0	11	0	May
June	73	0	0	73	0	687	104,235	896	3345	0	1	135,568	771	0	0	0	0	0	0	0	June
July	356	0	0	356	0	491	100,681	1046	3797	0	0	134,798	921	0	0	0	0	0	0	0	July
August	142	0	0	142	0	138	96,329	925	3765	0	0	133,877	836	0	0	0	0	0	0	0	August
September	0	0	0	0	0	0	91,777	739	3330	0	0	133,041	688	0	0	0	0	0	0	0	September
Totals	6,412		52	6,360	0	30,506		3,407	29,374	0	2518		4858	0	0	3133		7	3126	0	Totals
1920-21																					1920-21
October	0	0	0	0	0	64	87,708	488	2,877	0	0	132,353	466	0	0	0	0	0	0	0	October
November	0	0	0	0	0	135	84,407	393	2,498	0	0	131,887	384	0	0	0	0	0	0	0	November
December	369	0	2	0	0	212	81,649	131	1,925	0	0	131,563	131	0	0	0	0	0	0	0	December
January	271	367	-10	0	0	667	79,805	2	1,775	0	0	131,372	2	0	0	0	0	0	0	0	January
February	627	648	-36	0	0	984	78,596	198	1,590	0	0	131,370	201	0	0	0	0	0	0	0	February
March	492	1,259	50	0	0	0	77,731	325	2,065	0	0	131,169	333	0	0	0	0	0	0	0	March
April	177	1,681	118	0	0	400	76,486	472	2,508	0	0	130,836	493	0	0	0	0	0	0	0	April
May	58	1,740	20	1778	0	2840	75,905	290	3,085	0	0	130,343	306	0	0	0	0	0	0	0	May
June	0	0	0	0	0	132	73,430	706	3,345	0	0	130,037	760	0	0	0	0	0	0	0	June
July	0	0	0	0	0	90	69,531	809	3,797	0	0	129,277	909	0	0	0	0	0	0	0	July
August	89	0	0	89	0	107	65,015	701	3,765	0	0	128,568	821	0	0	0	0	0	0	0	August
September	143	0	0	143	0	136	60,656	336	3,330	0	0	127,547	652	0	0	0	0	0	0	0	September
Totals	2,226		216	2,010	0	6,769		5,051	32,500	0	0		5458	0	0	0	0	0	0	0	Totals
1921-22																					1921-22
October	66	0	0	36	0	64	56,926	889	2877	0	0	126,893	364	0	0	0	0	0	0	0	October
November	20	0	2	0	0	12	53,844	276	2498	0	0	126,531	362	0	0	0	0	0	0	0	November
December	3818	18	-463	0	0	25,028	51,082	-627	220	0	10,820	126,169	-735	0	0	21,950	0	-456	1705	0	December
January	1320	4299	-223	0	0	14,548	76,517	-258	70	0	6,403	137,724	-257	0	0	5,610	20,701	-265	1705	0	January
February	2751	5842	-232	0	0	24,051	91,253	-54	50	0	8,013	144,384	-48	0	0	7,021	24,871	-22	1540	1151	February
March	1956	8825	61	0	0	22,565	115,308	160	2065	18,776	7,821	152,445	135	0	0	25,366	29,223	238	0	25,128	March
April	686	10,720	211	0	0	12,318	116,872	485	2508	9,325	2,664	159,831	411	0	0	11,659	29,223	528	0	11,131	April
May	344	11,195	328	0	0	8,421	116,878	743	3025	2,653	793	162,084	631	0	0	3,348	29,223	681	0	2,667	May
June	0	11,211	654	1,653	0	4,317	118,872	972	3345	0	79	162,246	825	0	0	0	29,223	882	0	0	June
July	251	9,004	626	3,997	0	4,680	116,872	1155	3797	0	3	161,500	980	0	0	0	28,341	1023	0	0	July
August	355	4,632	318	3,963	0	4,086	116,600	1051	3765	0	3	160,523	892	0	0	0	27,318	909	0	0	August
September	399	706	112	993	0	1,092	115,870	869	943	0	3	159,634	738	0	0	0	26,409	701	2387	0	September
Totals	11,956		1,294	10,662	0	119,202		5,061	25,163	30,754	36,302		4298	0	0	74,954		4219	7337	40,077	Totals
1922-23																					1922-23
October	0	0	0	0	0	276	115,150	592	540	0	8	158,899	504	0	0	0	23,321	460	2337	0	October
November	38	0	0	0	0	572	114,294	307	490	0	15	158,403	262	0	0	0	20,524	207	2008	0	November
December	563	58	-50	0	0	2417	114,069	-100	220	0	62	158,156	-65	0	0	11	18,309	-31	1705	0	December
January	72	651	-30	0	0	1726	116,366	58	1182	0	27	158,303	32	0	0	0	16,646	27	593	0	January
February	541	753	-50	0	0	4370	116,872	198	1590	2582	80	158,298	166	0	0	2,753	16,026	69	0	0	February
March	488	1344	78	0	0	3725	116,872	409	2065	1251	116	158,212	344	0	0	1,396	18,690	268	0	0	March
April	421	1754	17	0	0	3250	116,872	370	2508	372	79	157,984	311	0	0	493	19,818	285	0	0	April
May	169	2158	187	2140	0	5190	116,872	812	2378	0	7	157,752	682	0	C	0	20,026	542	647	0	May
June	233	0	0	235	0	616	116,872	953	540	0	0	157,077	801	0	0	0	18,837	589	2805	0	June
July	458	0	0	458	0	472	115,995	1153	690	0	0	156,276	973	0	0	0	15,443	594	3107	0	July
August	359	0	0	359	0	351	114,624	1042	740	0	0	155,303	884	0	0	0	11,742	428	3025	0	August
September	121	0	0	121	0	139	113,193	838	690	0	0	154,419	715	0	0	0	8,289	259	2640	0	September
Totals	3,465		132	3,313	0	21,104		6,612	13,633	4,805	394		5589	0	0	4,653		3717	18,667	0	Totals

(1), (2), (3), (4), (5). See notes at bottom of first page of this table.

TABLE A-4, (Continued) COORDINATED OPERATION OF CUYAMACA, EL CAPITAN, SAN VICENTE AND MISSION GORGE NO. 2 RESERVOIRS ON SAN DIEGO RIVER, 1894-1933.

Year and month	CUYAMACA RESERVOIR					EL CAPITAN RESERVOIR					SAN VICENTE RESERVOIR					MISSION GORGE NO. 2 RESERVOIR					Year and month
	Flow into reservoir in acre-feet	Stage of reservoir in acre-feet	Net loss from evaporation in acre-feet	Flow to El Capitan Reservoir in (1) acre-feet	Flow over spillway in acre-feet	Flow into reservoir in (2) acre-feet	Stage of reservoir in acre-feet	Net loss from evaporation in acre-feet	Draft in (3) acre-feet	Flow over spillway in acre-feet	Flow into reservoir in (4) acre-feet	Stage of reservoir in acre-feet	Net loss from evaporation in acre-feet	Draft in acre-feet	Flow over spillway in acre-feet	Flow into reservoir in (5) acre-feet	Stage of reservoir in acre-feet	Net loss from evaporation in acre-feet	Draft in acre-feet	Flow over spillway in acre-feet	
1923-24																					1923-24
October	91	0	0	91	0	140	111,804	602	540	0	0	153,704	516	0	0	0	5390	122	2337	0	October
November	218	0	14	0	0	181	110,802	429	490	0	0	153,188	369	0	0	0	2931	43	2008	0	November
December	100	204	-5	0	0	399	110,064	33	1046	0	6	152,819	29	0	0	0	880	1	879	0	December
January	130	309	43	0	0	615	109,384	201	1775	0	3	152,796	174	0	0	0	0	0	0	0	January
February	137	396	78	0	0	339	108,023	380	1590	0	1	152,625	333	0	0	0	0	0	0	0	February
March	473	455	-126	0	0	2041	106,392	48	2065	0	20	152,293	42	0	0	0	0	0	0	0	March
April	356	1054	21	0	0	2295	106,320	310	2508	0	9	152,271	273	0	0	0	0	0	0	0	April
May	0	1389	163	1226	0	1597	105,797	759	3025	0	0	152,007	673	0	0	0	0	0	0	0	May
June	133	0	0	133	0	171	103,610	891	3345	0	0	151,334	803	0	0	0	0	0	0	0	June
July	295	0	0	295	0	292	99,545	1038	3797	0	0	150,531	959	0	0	0	0	0	0	0	July
August	183	0	0	183	0	183	95,002	917	3765	0	0	149,572	871	0	0	0	0	0	0	0	August
September	179	0	0	179	0	179	90,503	736	3330	0	0	148,701	719	0	0	0	0	0	0	0	September
Totals	2295		188	2107	0	8432		6344	27,276	0	39		5761	0	0	0		166	5224	0	Totals
1924-25																					1924-25
October	100	0	0	100	0	110	86,616	494	2,877	0	0	147,982	495	0	0	0	0	0	0	0	October
November	133	0	10	0	0	54	83,355	325	2,498	0	0	147,487	334	0	0	0	0	0	0	0	November
December	366	123	-36	0	0	690	80,586	-65	1,925	0	10	147,153	-67	0	0	0	0	0	0	0	December
January	25	525	29	0	0	302	79,416	184	1,775	0	2	147,230	194	0	0	0	0	0	0	0	January
February	63	519	30	0	0	486	77,739	212	1,590	0	4	147,038	226	0	0	0	0	0	0	0	February
March	170	552	-10	0	0	760	74,443	295	2,065	0	10	146,816	319	0	0	0	0	0	0	0	March
April	463	732	-101	0	0	3217	74,843	159	2,508	0	40	146,507	173	0	0	0	0	0	0	0	April
May	170	1296	112	1354	0	2443	75,393	610	3,025	0	10	146,374	663	0	0	0	0	0	0	0	May
June	27	0	0	27	0	435	74,201	615	3,345	0	0	145,721	682	0	0	0	0	0	0	0	June
July	52	0	0	52	0	53	70,676	818	3,797	0	0	145,039	945	0	0	0	0	0	0	0	July
August	0	0	0	0	0	3	66,114	711	3,765	0	0	144,094	859	0	0	0	0	0	0	0	August
September	39	0	0	39	0	41	61,641	564	3,330	0	0	143,235	709	0	0	0	0	0	0	0	September
Totals	1606		34	1572	0	8594		4922	32,500	0	76		5532	0	0	0		0	0	0	Totals
1925-26																					1925-26
October	422	0	0	422	0	599	57,788	38	2877	0	0	142,526	50	0	0	0	0	0	0	0	October
November	167	0	10	0	0	166	55,472	202	2498	0	0	142,476	270	0	0	0	0	0	0	0	November
December	106	157	8	0	0	352	52,938	55	1925	0	0	142,206	75	0	0	0	0	0	0	0	December
January	26	255	13	0	0	232	51,310	57	1775	0	0	142,131	79	0	0	0	0	0	0	0	January
February	663	268	13	0	0	1082	49,710	30	1590	0	100	142,052	42	0	0	0	0	0	0	0	February
March	140	918	63	0	0	643	49,172	295	2065	0	10	142,110	421	0	0	0	0	0	0	0	March
April	1948	995	-201	0	0	16,308	47,455	-236	390	0	5327	141,699	-312	0	0	6043	0	-31	2118	0	April
May	86	3144	165	3065	0	4,371	63,609	548	440	0	59	147,338	658	0	0	0	3956	104	2585	0	May
June	9	0	0	9	0	198	66,992	665	2110	0	10	146,739	794	0	0	0	1267	32	1235	0	June
July	90	0	0	90	0	91	64,415	768	3797	0	0	145,955	948	0	0	0	0	0	0	0	July
August	145	0	0	145	0	155	59,941	669	3765	0	0	145,007	861	0	0	0	0	0	0	0	August
September	52	0	0	52	0	56	55,662	529	3330	0	0	144,146	710	0	0	0	0	0	0	0	September
Totals	3854		71	3783	0	24,253		3620	26,568	0	5506		4596	0	0	6043		105	5938	0	Totals
1926-27																					1926-27
October	80	0	0	80	0	91	51,859	355	2,877	0	0	143,436	497	0	0	0	0	0	0	0	October
November	68	0	3	0	0	15	48,718	196	2,498	0	0	142,939	284	0	0	0	0	0	0	0	November
December	1665	63	-218	0	0	3,675	46,039	-168	1,914	0	10	142,655	-244	0	0	11	0	0	11	0	December
January	407	1948	30	0	0	1,673	47,968	95	1,771	0	4	142,909	137	0	0	4	0	0	4	0	January
February	8015	2325	-1232	0	0	66,538	47,775	-1153	50	0	25,525	142,776	-1243	0	0	26,890	0	-568	1540	0	February
March	826	11,572	-136	0	938	17,794	115,416	102	2,065	14,171	4,867	169,544	90	0	0	19,322	25,918	188	0	15,829	March
April	463	11,595	176	0	287	9,841	116,872	430	2,508	6,303	1,654	174,321	377	0	1140	9,194	29,223	417	0	8,777	April
May	274	11,595	483	0	0	4,409	116,872	814	3,025	570	512	174,458	713	0	0	1,112	29,223	673	0	439	May
June	217	11,386	625	2480	0	4,301	116,872	956	3,343	0	94	174,257	838	0	0	225	29,223	867	0	0	June
July	145	8,498	608	3997	0	4,479	116,872	1161	3,797	0	3	173,513	1017	0	0	3	28,561	1035	0	0	July
August	220	4,038	243	3963	0	4,058	116,393	1053	3,763	0	0	172,499	924	0	0	0	27,549	915	0	0	August
September	35	52	14	73	0	305	115,633	866	690	0	0	171,575	762	0	0	0	26,634	709	2640	0	September
Totals	12,415		596	10,393	1226	116,579		4707	28,305	21,044	32,669		4152	0	1140	56,761		4236	4195	25,045	Totals
1927-28																					1927-28
October	228	0	0	228	0	530	114,382	308	540	0	4	170,813	272	0	0	0	23,285	179	2337	0	October
November	58	0	6	0	0	847	114,084	338	490	0	4	170,545	298	0	0	0	20,769	314	2008	0	November
December	183	32	-20	0	0	1210	114,103	-198	220	0	8	170,251	-174	0	0	0	18,447	-74	1705	0	December
January	250	255	29	0	0	1372	113,291	187	70	0	21	170,433	163	0	0	0	16,816	134	1705	0	January
February	329	476	14	0	0	1943	116,406	161	1316	0	117	170,291	140	0	0	0	14,977	82	274	0	February
March	217	791	48	0	0	1807	116,872	466	1341	0	125	170,268	405	0	0	0	14,621	249	724	0	March
April	158	960	137	0	0	962	116,872	630	390	0	0	169,988	447	0	0	0	13,648	310	2118	0	April
May	111	981	99	993	0	1442	116,814	750	943	0	0	169,541	650	0	0	0	11,220	299	2082	0	May
June	8	0	0	8	0	137	116,563	966	540	0	0	168,891	840	0	0	0	8,839	306	2805	0	June
July	342	0	0	342	0	427	115,194	1148	690	0	0	168,051	1003	0	0	0	5,728	226	3107	0	July
August	227	0	0	227	0	254	113,783	1033	1437	0	0	167,048	911	0	0	0	2,395	67	2328	0	August
September	237	0	0	237	0	255	111,565	841	3330	0	0	166,137	751	0	0	0	0	0	0	0	September
Totals	2348		313	2035	0	11,206		6632	11,307	0	279		5706	0	0	0		2092	21,193	0	Totals

(1), (2), (3), (4), (5). See notes at bottom of first page of this table.

TABLE A-4. (Continued) COORDINATED OPERATION OF CUYAMACA, EL CAPITAN, SAN VICENTE AND MISSION GORGE NO. 2 RESERVOIRS ON SAN DIEGO RIVER, 1894-1933.

	CUYAMACA RESERVOIR					EL CAPITAN RESERVOIR					SAN VICENTE RESERVOIR					MISSION GORGE NO. 2 RESERVOIR					
Year end month	Flow into reservoir in acre-feet	Stage of reservoir in acre-feet	Net loss from evaporation in acre-feet	Flow to El Capitan Reservoir in (1) acre-feet	Flow over spillway in acre-feet	Flow into reservoir in (2) acre-feet	Stage of reservoir in acre-feet	Net loss from evaporation in acre-feet	Draft in (3) acre-feet	Flow over spillway in acre-feet	Flow into reservoir in (4) acre-feet	Stage of reservoir in acre-feet	Net loss from evaporation in acre-feet	Draft in acre-feet	Flow over spillway in acre-feet	Flow into reservoir in (5) acre-feet	Stage of reservoir in acre-feet	Net loss from evaporation in acre-feet	Draft in acre-feet	Flow over spillway in acre-feet	Year and month
1928-29																					1928-29
October	197	0	0	197	0	209	107,649	589	2,877	0	0	165,386	556	0	0	0	0	0	0	0	October
November	101	0	6	0	0	39	104,392	270	2,498	0	0	164,850	250	0	0	0	0	0	0	0	November
December	102	95	-18	0	0	225	101,883	17	1,925	0	0	164,600	16	0	0	0	0	0	0	0	December
January	126	215	-43	0	0	838	99,964	-23	1,778	0	5	164,584	-22	0	0	0	0	0	0	0	January
February	733	384	-14	0	0	2077	99,044	-4	1,583	0	50	164,611	-4	0	0	7	0	0	7	0	February
March	847	1131	-13	0	0	3347	99,542	833	1,992	0	153	164,865	219	0	0	66	0	0	56	0	March
April	481	1991	71	0	0	3237	100,657	411	2,306	0	298	164,599	325	0	0	203	0	0	203	0	April
May	127	2401	251	2277	0	2944	101,198	748	2,630	0	0	164,512	694	0	0	395	0	0	395	0	May
June	123	0	0	123	0	294	100,770	876	5,340	0	0	163,818	829	0	0	0	0	0	0	0	June
July	81	0	0	81	0	86	96,843	1019	3,797	0	0	162,989	989	0	0	0	0	0	0	0	July
August	88	0	0	88	0	90	92,113	898	3,765	0	0	162,000	898	0	0	0	0	0	0	0	August
September	136	0	0	136	0	195	87,540	703	5,330	0	0	161,102	724	0	0	0	0	0	0	0	September
Totals	3,142		240	2,908	0	13,613		5,731	31,829	0	506		5514	0	0	671		0	671	0	Totals
1929-30																					1929-30
October	22	0	0	22	0	25	83,708	537	2877	0	0	160,578	568	0	0	0	0	0	0	0	October
November	83	0	12	0	0	1	80,313	390	2498	0	0	159,810	423	0	0	0	0	0	0	0	November
December	84	71	26	0	0	16	77,436	236	1925	0	0	159,387	261	0	0	0	0	0	0	0	December
January	523	129	-164	0	0	2040	78,281	-369	1750	0	18	159,126	-412	0	0	15	0	0	15	0	January
February	418	816	68	0	0	886	76,950	175	1690	0	2	159,556	195	0	0	0	0	0	0	0	February
March	947	1178	-55	0	0	3780	78,065	48	1658	0	482	159,368	53	0	0	413	0	0	415	0	March
April	189	2174	196	0	0	1390	77,133	445	2481	0	38	159,798	496	0	0	27	0	0	27	0	April
May	616	2167	-24	28 07	0	7177	75,597	187	2250	0	904	159,330	204	0	0	775	0	0	775	0	May
June	122	0	0	122	0	630	80,557	755	3344	0	5	160,050	821	0	0	1	0	0	1	0	June
July	74	0	0	74	0	201	76,868	871	5797	0	0	159,211	980	0	0	0	0	0	0	0	July
August	31	0	0	31	0	63	73,401	759	5766	0	0	158,231	890	0	0	0	0	0	0	0	August
September	69	0	0	69	0	103	67,940	501	3330	0	0	157,341	734	0	0	0	0	0	0	0	September
Totals	3178		53	3125	0	16,318		4633	31,289	0	1440		5211	0	0	1231		0	1231	0	Totals
1930-31																					1930-31
October	150	0	0	150	0	173	64,112	412	2877	0	0	156,807	520	0	0	0	0	0	0	0	October
November	270	0	0	0	0	95	60,996	148	2483	0	1	156,087	195	0	0	15	0	0	15	0	November
December	53	264	32	0	0	69	58,458	195	1911	0	0	155,896	259	0	0	14	0	0	14	0	December
January	103	285	14	0	0	324	56,421	-28	1738	0	5	155,657	-38	0	0	57	0	0	57	0	January
February	470	374	-50	0	0	2012	55,035	-135	50	0	460	166,680	-163	0	0	3370	0	-11	1840	0	February
March	105	894	122	0	0	521	57,138	369	216	0	8	156,323	492	0	0	37	1841	29	1849	0	March
April	104	877	21	0	0	629	57,068	187	2369	0	19	165,836	252	0	0	139	0	0	139	0	April
May	02	960	84	958	0	1157	55,141	418	2944	0	11	165,603	677	0	0	81	0	0	81	0	May
June	7	0	0	7	0	72	52,936	568	3345	0	1	155,037	811	0	0	0	0	0	0	0	June
July	87	0	0	87	0	98	49,095	647	5797	0	1	154,227	968	0	0	0	0	0	0	0	July
August	72	0	0	72	0	71	44,749	548	3766	0	0	153,260	863	0	0	0	0	0	0	0	August
September	57	0	0	57	0	39	40,507	459	3330	0	1	152,398	725	0	0	0	0	0	0	0	September
Totals	1560		229	1331	0	5278		3768	28,825	0	504		5437	0	0	3693		18	3675	0	Totals
1931-32																					1931-32
October	9	0	0	9	0	15	36,797	294	2877	0	0	151,674	508	0	0	0	0	0	0	0	October
November	102	0	1	0	0	143	33,641	51	2498	0	0	151,166	93	0	0	0	0	0	0	0	November
December	1264	101	-193	0	0	1994	31,235	-119	1259	0	589	151,075	-218	0	0	686	0	0	686	0	December
January	755	1560	-65	0	0	2347	32,109	31	1360	0	356	151,880	56	0	0	418	0	0	415	0	January
February	3841	2380	-847	0	0	37,119	35,065	-276	50	0	15,776	152,180	-595	0	0	16,048	0	-179	1540	0	February
March	773	7068	327	0	0	11,093	70,410	436	140	0	1,632	166,351	497	0	0	1,901	14,687	287	1925	0	March
April	286	7514	263	0	0	2,761	80,927	477	390	0	309	167,486	515	0	0	360	14,576	287	2118	0	April
May	116	7517	352	7281	0	8,569	82,821	678	440	0	60	167,280	699	0	0	58	12,331	353	2585	0	May
June	147	0	0	147	0	761	90,278	817	540	0	5	166,631	827	0	0	5	9,451	521	2805	0	June
July	112	0	0	112	0	330	89,682	981	690	0	0	165,807	997	0	0	0	6,328	254	3107	0	July
August	101	0	0	101	0	287	88,341	863	881	0	0	164,810	906	0	0	0	2,967	83	2884	0	August
September	156	0	0	156	0	285	86,864	716	3330	0	0	163,904	747	0	0	0	0	0	0	0	September
Totals	7642		- 164	7806	0	65,702		4963	14,435	0	16,718		5238	0	0	19,471		1406	18,063	0	Totals
1932-33																					1932-33
October	227	0	0	227	0	448	83,101	415	2858	0	8	163,157	441	0	0	19	0	0	19	0	October
November	189	0	23	0	0	84	80,278	390	2498	0	0	162,724	426	0	0	0	0	0	0	0	November
December	518	166	-77	0	0	966	77,474	-153	1892	0	14	162,298	-169	0	0	33	0	0	33	0	December
January	759	561	-141	0	0	4111	76,701	-247	70	0	1228	162,481	-271	0	0	2948	0	-14	1705	0	January
February	538	1461	104	0	0	3825	80,989	308	50	0	465	163,980	388	0	0	1111	1,257	21	1540	0	February
March	470	1895	200	0	0	1562	84,456	457	1240	0	12	164,115	479	0	0	29	807	11	825	0	March
April	457	2165	13	0	0	1693	84,321	237	2378	0	54	165,648	249	0	0	130	0	0	130	0	April
May	601	2609	155	3055	0	6096	83,399	533	2951	0	39	163,453	556	0	0	94	0	0	94	0	May
June	0	0	0	0	0	740	86,051	788	3346	0	0	162,936	824	0	0	0	0	0	0	0	June
July	244	0	0	244	0	575	82,638	917	3797	0	0	162,112	987	0	0	0	0	0	0	0	July
August	91	0	0	91	0	159	78,297	804	3765	0	0	161,125	896	0	0	0	0	0	0	0	August
September	72	0	0	72	0	158	73,887	639	3330	0	0	160,229	740	0	0	0	0	0	0	0	September
October		0					70,076					159,489					0				October
Totals	[illegible]		277	3589	0	20,215		5086	28,134	0	1818		5486	0	0	4364		18	4346	0	Totals

(1), (2), (3), (4), (5). See notes at bottom of first page of this table.

APPENDIX B

MONTHLY PRECIPITATION AT MISCELLANEOUS STATIONS IN SAN DIEGO COUNTY

In the discussion of precipitation presented in Chapter II it was pointed out that only about twenty per cent of the available records of precipitation in San Diego County had been compiled and published by the United States Weather Bureau. For this reason it is believed that a compilation of the available unpublished records of precipitation will be of value at the present time, and it is presented in this appendix. Since the publications of the United States Weather Bureau are in general circulation and easily obtainable in most cities the records of precipitation which have been published by the Weather Bureau are not included herein. They may be found in the "Climatic Summary of the United States - Section 18, Southern California and Owens Valley" published by the United States Department of Agriculture Weather Bureau, from the establishment of stations to 1930 and since that date in the "Annual Summaries of Climatological Data, California Section" published by the same agency. The data contained in the following tables were obtained from various civic agencies, private corporations and citizens of San Diego County and environs. The limitations of time and expense precluded as extensive a search for precipitation data as might have been desirable and it is possible that additional stations exist which are not included herein and that some of the records shown as inactive at the present time are still active. Many of these records prior to 1915 were published in Water-Supply Paper 446 "Geology and Ground Waters of the Western Part of San Diego County", of the United States Geological Survey but since this paper is now out of print they are republished at this time.

The various precipitation gaging stations, the index number on Plate I and the period of years for which records were available at each station are listed in Table B-1 which is an alphabetical rearrangement of the data presented in Table II.

The monthly and seasonal rainfalls at all stations for which records have not been published by the United States Weather Bureau are given in Table B-2. The name of the observer or the authority from whom the record was obtained, the index number on Plate I and the location to the nearest section of each station are given at the head of each individual table of precipitation.

TABLE B-1

PRECIPITATION STATIONS IN OR NEAR SAN DIEGO COUNTY

Station	Index number on Plate I	Location (S.B.B.& M.) Section	Township south	Range	Elevation in feet, U.S.G.S. datum	Period of record	Record available to July 1, 1933, in years
Aguanga	16	26	8	1 E	1986	*1908 - 1933ϕ	24.6
Amago	36	26	10	1 E	2715	*1912 - 1933	21.3
Barrett Dam	121	22	17	3 E	1650	1894 - 1917ϕ	16.2
Barrett Dam	121	22	17	3 E	1650	*1914 - 1933ϕ	18.7
Barrett P. O.	125	8	18	3 E	875	1914 - 1918	5.0
Bernardo Bridge	58	10	13	2 W	370	1923 - 1933ϕ	8.2
Bonita #1	72	36	17	2 W	110	1899 - 1915	16.0
Bonita #1	72	36	17	2 W	110	*1915 - 1933	18.0
Bonita #2	72	25	17	2 W	60	1914 - 1921ϕ	4.7
Boulder Creek	97	11	14	3 E	2990	1914 - 1917	2.2
Buckman Springs	113	20	16	5 E	5450	1912 - 1915	2.9
Camp Denny	92	11	16	2 E	1450	1929 - 1933	4.0
Campo	116	16	18	5 E	3000	*1877 - 1933ϕ	44.4
Canfield Ranch	12	21	10	3 W	250	**1916	0.1
Carroll Damsite	59	8	13	2 W	250	1914 - 1916ϕ	1.8
Chihuahua Mountain	19	34	9	3 E	4200	1911 - 1915	3.8
Chocolate Creek	91	8	15	2 E	760	1899 - 1933	34.3
Chollas Heights	74	34	16	2 W	370	1914 - 1933	19.5
Chula Vista	70	20	18	2 W	9	*1918 - 1933	14.8
Coahuilla	4	31	7	3 E	3800	*1911 - 1919ϕ	7.4
Coronado	68	15	17	3 W	50	1927 - 1933	6.5
Cuyamaca Dam	98	5	14	4 E	4677	*1887 - 1933(2)	46.0
Cuyamaca, East	102	34	13	4 E	4600	1912 - 1919	5.9
Damroos	32	14	11	2 E	2725	1911 - 1922	10.8
Deadmans Hole	18	1	10	2 E	3200	1911 - 1924	12.9
Dehesa	88	14	16	1 E	580	1914 - 1916	1.9
Deluz	6	29	8	4 W	450	1902 - 1933	31.0
Descanso	109	25	15	3 E	3350	*1896 - 1916ϕ	13.9
Descanso Ranger Station	111	24	15	3 E	3400	1916 - 1933ϕ	6.9
Descanso Valley	111	24	15	3 E	3500	1915 - 1916	1.3
Diverting Dam	96	11	14	2 E	840	1898 - 1933	35.0
Dulzura	129	33	17	2 E	1075	1913 - 1927ϕ	12.6
Dulzura Summit	130	10	18	2 E	1400	1915 - 1933ϕ	15.2
Eagles Nest	21	20	10	4 E	4500	1911 - 1916	4.6
El Cajon #1	82	11	16	1 W	482	1882 - 1896	14.0
El Cajon #2	82	11	16	1 W	480	1927 - 1933	6.5
El Cajon #3	83	18	16	1 E	560	*1875 - 1933ϕ	34.5
El Cajon Valley	84	24	16	1 W	670	1901 - 1933ϕ	31.4
Elsinore	5	7	6	4 W	1300	*1887 - 1933ϕ	35.7
Escondido #1	55	10	12	2 W	750	*1894 - 1933ϕ	37.5
Escondido #2	56	22	12	2 W	660	*1918 - 1933	15.0
Escondido #3	56	22	12	2 W	660	1887 - 1897	10.0
Escondido #4	56	22	12	2 W	660	1927 - 1933	6.5
Escondido Ditch Head	46	33	10	1 E	1986	1896 - 1933ϕ	28.5
Fallbrook #1	13	24	9	4 W	700	*1876 - 1904ϕ	27.8
Fallbrook #2	14	21	9	3 W	730	1909 - 1933	24.0
Gillette Ranch	110	1	16	3 E	3500	1919 - 1931	12.0
Gopher Canyon	11	5	11	3 W	300	**1916	0.1
Green Valley	107	33	14	4 E	4100	**1916	0.1
Grigsbys Ranch	117	8	18	5 E	2690	1913 - 1921	8.7
Grossmont	81	16	16	1 W	640	1899 - 1933ϕ	33.8
Harper Ranch	103	19	14	5 E	4800	1914 - 1931ϕ	13.8
Harvey Ranch	79	4	18	1 E	514	1914 - 1921ϕ	3.5
Hauser Creek	119	21	17	4 E	2300	1915 - 1922ϕ	6.0
Hemet Lake	3	9	6	3 E	4350	1896 - 1931	35.0
Henshaw Dam	33	10	11	2 E	2702	1911 - 1933	22.0
Hodges Dam	60	18	13	2 W	350	1919 - 1933	14.4
Hooke Ranch	114	29	16	5 E	3200	1914 - 1921	7.7
Hot Springs Mountain	20	8	10	4 E	6200	1912 - 1915	2.8
Hurlburds Ranch	108	13	15	3 E	3450	1889 - 1895	6.5
Idyllwild	2	12	5	2 E	5250	*1901 - 1912ϕ	11.0
Jamul	85	4	17	1 E	1040	1903 - 1920ϕ	9.1
Jamul Ranch	86	14	17	1 E	800	1912 - 1917ϕ	4.5
Japatul	93	9	16	3 E	2800	1914 - 1923	9.0
Julian	101	6	13	4 E	4222	*1879 - 1933ϕ	37.3
Laguna	106	15	15	5 E	5440	1894 - 1904	10.0
Laguna Ranger Station	105	3	15	5 E	5475	1914 - 1916	1.1
La Jolla	66	23	15	4 W	100	1927 - 1933	6.5
Lakeside	89	18	15	1 E	500	1909 - 1915	6.0
La Mesa	76	19	16	1 W	550	1927 - 1933	6.5
La Posta	115	1	17	5 E	3300	1915 - 1921	6.7
La Presa	77	9	17	1 W	300	1914 - 1916	2.3
Lauterbachs Ranch	124	4	18	3 E	1200	1909 - 1931	21.7
Los Coches	90	28	15	1 E	710	1900 - 1933	32.3
Los Padres Ranch	87	16	16	1 E	490	1901 - 1915ϕ	13.0
Lower Otay Dam	78	7	18	1 E	500	1906 - 1933	27.5
Lyon Peak	128	10	17	2 E	3755	1914 - 1918	3.6
Lyon Valley	127	10	17	2 E	2200	1914 - 1921ϕ	2.6
Merron Valley	131	28	18	2 E	550	1913 - 1921	8.1
Matagual	28	22	11	3 E	3200	1911 - 1916	4.9
Mendenhall Valley	34	11	10	1 E	4500	1911 - 1916	4.6
Mesa Grande (Angelo)	37	21	11	2 E	3450	1912 - 1916ϕ	4.0
Mesa Grande	38	3	12	2 E	3350	*1908 - 1922	13.9
Mesa Grande	38	3	12	2 E	3350	1905 - 1908	3.0
Miramar	64	5	15	2 W	660	1901 - 1933ϕ	27.0
Monkey Hill	31	12	11	2 E	2810	1911 - 1915	4.0
Morena Dam	118	14	17	4 E	3050	1896 - 1933ϕ	31.2
Murray Dam	75	13	16	2 W	500	1913 - 1933	20.5
Nellie	35	9	10	1 E	5000	*1901 - 1923ϕ	17.5
Nellie	35	9	10	1 E	5000	1902 - 1904ϕ	0.8
Nobles Mine	104	17	15	5 E	4200	1913 - 1918ϕ	3.5
Oak Grove	17	17	9	2 E	2751	*1910 - 1919ϕ	8.2
Oceanside #1	8	26	11	5 W	30	1892 - 1909	17.0
Oceanside #2	8	26	11	5 W	67	*1909 - 1919	10.0
Oceanside #2	8	26	11	5 W	67	1919 - 1926	7.0
Oceanside #3	8	26	11	5 W	60	1927 - 1933	6.5
Oceanside #4	9	19	11	4 W	280	1926 - 1933	7.0
Otay	71	15	18	2 W	90	1908 - 1915	7.0
Pamo	45	11	12	1 E	1050	1911 - 1913	2.4
Pamo Camp	44	25	12	1 E	975	1914 - 1923ϕ	8.8
Pine Hills Hotel	100	13	13	3 E	4100	1913 - 1916	2.7
Pine Valley	112	26	15	4 E	3700	1898 - 1904	5.6
Point Loma	67	1	17	4 W	302	*1904 - 1933	29.5
Potrero	122	6	18	4 E	2390	1914 - 1931	17.8
Poway	63	14	14	2 W	460	*1878 - 1909ϕ	26.4
Puerta La Cruz	25	30	10	3 E	2772	1911 - 1917ϕ	5.8
Ramona (Greene)	53	16	13	1 E	1440	*1927 - 1933	5.2
Ramona (Sentinel)	52	15	13	1 E	1440	1911 - 1931	19.7
Ramona (Verlaque)	51	15	13	1 E	1440	1896 - 1916	20.0
Red Mountain Ranch	15	16	9	3 W	940	1924 - 1933	8.6
Rincon of Warner Ranch	26	15	10	2 E	2975	1913 - 1916	3.5
Rockwood Ranch	50	35	12	1 W	430	1893 - 1915	22.0
Rosa Olmo	43	32	12	2 E	2300	1911 - 1916	4.1
San Clemente	7	3	9	7 W	100	*1930 - 1933	3.5
San Diego	69	11	17	3 W	87	*1850 - 1933(1)	83.0
San Dieguito Dam	61	16	13	3 W	250	1924 - 1933ϕ	6.4
San Felipe	23	30	11	4 E	3600	1911 - 1924ϕ	11.6
San Jacinto	1	35	4	1 E	1550	*1886 - 1933ϕ	40.3
San Luis Rey	10	5	11	4 W	60	1901 - 1916	15.5
Santa Fe Ranch	62	32	13	3 W	55	1912 - 1915	3.5
Santa Maria Damsite	54	11	13	1 E	1400	1914 - 1916	2.3
Santa Ysabel Ranch	39	20	12	3 E	3000	1900 - 1916ϕ	14.5
Santa Ysabel Store	40	21	12	3 E	2983	1911 - 1916	3.8
Santa Ysabel-Warner Divide	30	33	11	3 E	3200	1913 - 1916	3.3
Schilling	99	32	13	4 E	4550	1912 - 1919	5.8
Scripps Institution	65	13	15	4 W	50	1924 - 1933	9.0
Skye Valley	120	2	17	3 E	2550	1913 - 1920	6.1
Sutherland Damsite	42	21	12	2 E	1900	1914 - 1933ϕ	7.6
Sweetwater Dam	73	17	17	1 W	310	1888 - 1933	45
Tecate	123	24	18	3 E	1800	1914 - 1931	17.8
Twin Oaks	57	25	11	3 W	700	1875 - 1887	12.0
Upper Otay Dam	80	36	17	1 W	550	1916 - 1933ϕ	11.9
Valley Center #1	47	7	11	1 W	1400	1872 - 1903	31.0
Valley Center #2	48	13	11	2 W	1360	1912 - 1924ϕ	11.8
Viejas	95	20	15	3 E	2400	1915 - 1928ϕ	2.8
Volcan Mountain	29	2	12	3 E	4800	1911 - 1924	12.5
Warner Ranch House	24	4	11	3 E	2598	1911 - 1916ϕ	4.2
Warner Summer Road	27	6	11	3 E	2805	1911 - 1922ϕ	10.5
Warner Springs	22	23	10	3 E	3165	*1906 - 1933	27.0
Willows	94	25	15	2 E	2300	1914 - 1933	19.3
Winetka Valley	126	26	17	2 E	2500	1914 - 1919ϕ	3.4
Witch Creek	41	31	12	3 E	2800	1909 - 1916	6.9
Wohlford Lake	49	5	12	1 W	1450	1926 - 1933	6.9

* Record published by U. S. Weather Bureau

** Record for January 1916 published by U. S. Geological Survey in W. S. P. 426.

ϕ Broken Record.

(1) Compilation of several independent records by U. S. Weather Bureau.

(2) Rainfall at this gage as recorded by La Mesa, Lemon Grove and Spring Valley Irrigation District differs from records of U. S. Weather Bureau, for some isolated months.

TABLE B-2, MONTHLY PRECIPITATION AT MISCELLANEOUS STATIONS IN SAN DIEGO COUNTY.

Precipitation Station: Hemet Lake
Location: Section 9, T. 6 S., R. 3 E., S.B.B.&M.
Elevation: 4360 feet
Authority: Lake Hemet Water Co.
Index No. 2
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1896-97				1.70	1.00	1.56	6.40	6.30	4.20	0.10	0.10	0	(21.35)
1897-98	0.20	0.90	0.80	2.20	0.20	1.10	3.80	0.90	1.70	0.30	1.40	0	13.30
1898-99	1.80	1.30	0	0	0.10	1.60	3.00	1.20	1.80	0.80	0.10	0.50	11.60
1899-00	0	0	0	2.00	2.90	1.60	1.50	0	0.70	3.00	1.50	0	13.20
1900-01	1.00	0.10	0.10	0.50	4.30	0	2.60	8.40	0.70	0.30	1.70	0	19.70
1901-02	0.30	1.09	0	0.77	0.36	0.06	4.35	3.06	4.75	0.93	0.13	0.84	16.22
1902-03	0.12	0	0	0.13	2.25	1.65	1.38	5.20	5.60	3.10	0	0	19.35
1903-04	0	0	0	0	0	0	0.10	2.15	4.61	0.66	0.10	0	7.61
1904-05	0.82	3.60	0.90	0.30	0	0.90	5.00	5.90	6.60	0.80	2.50	0.25	88.57
1905-06	0	0	0.26	0	6.18	2.18	3.60	2.53	6.20	1.80	0.80	0	25.34
1906-07	2.40	0.60	0	0.10	1.45	8.12	7.68	1.30	6.50	0	0.60	2.00	29.65
1907-08	0	0	0	5.02	0.73	1.56	4.55	4.06	1.65	0.90	0.67	0	19.16
1908-09	0.53	3.60	1.97	0.74	0.30	0.53	9.86	5.95	3.28	0.21	0	0	87.11
1909-10	0.21	2.69	1.00	0	2.92	4.78	5.94	0.19	2.16	0.20	0	0	19.98
1910-11	0.84	0.90	0.32	1.10	8.23	0.16	6.90	4.99	3.12	0.61	0	0	21.17
1911-12	0.18	0	0.85	0.23	0.08	1.37	0.73	0	9.30	4.02	1.08	0.03	17.68
1912-13	0.64	0.20	0	2.68	1.30	0.03	2.59	3.71	1.64	0.99	0.18	0.12	14.10
1913-14	0.70	1.72	0.44	0	2.69	2.78	5.92	6.06	0.69	3.38	0	0	24.38
1914-15	1.56	0.17	0.30	1.40	0.63	2.92	5.35	7.74	1.13	3.44	2.53	0	27.27
1915-16	0	0	0.22	0	1.24	4.49	16.17	1.33	1.64	0	0.30	0	25.44
1916-17	0.55	0.64	0.82	1.90	0.14	2.80	2.85	3.94	0.47	2.10	1.13	0	17.34
1917-18	1.43	0.47	0	0.12	0.48	0	1.79	2.56	8.88	0.21	0.44	0.25	16.37
1918-19	0.93	1.00	0.80	1.42	2.43	1.98	0.07	3.73	3.30	0.32	0	0	15.78
1919-20	0.98	0.61	1.11	1.00	8.87	1.38	1.40	5.61	7.68	1.89	0.06	0	23.83
1920-21	0	0.22	0	1.88	0.25	1.32	4.98	0.76	3.47	0.26	3.43	0	16.23
1921-22	0.84	8.96	0	2.44	0.87	13.74	5.97	3.20	2.25	0.10	1.34	0	34.21
1922-23	0.78	0.77	0.80	0.73	1.52	3.33	3.03	2.91	1.38	4.86	0	0	20.10
1923-24	0.35	0.16	1.41	0.60	1.26	2.16	0.08	0	5.60	2.39	0	0	14.20
1924-25	0	0	0	0.16	0.56	3.85	0.44	0.60	2.06	4.32	0.12	2.03	14.13
1925-26	0.43	1.29	0	4.67	0.91	1.30	0.10	4.74	0.70	10.37	0.78	0	25.18
1926-27	0.95	0.67	0	0	2.07	9.25	0.86	13.41	2.08	0.71	0.83	0.11	30.86
1927-28	0	0.33	0	0.99	1.90	3.77	0.75	2.46	3.01	0	1.30	0	13.53
1928-29	0	0	0	0.78	1.08	2.47	1.78	1.89	2.10	2.37	0	0.07	12.54
1929-30	3.12	2.47	2.86	0	0	0	8.68	1.39	3.77	1.64	4.35	0	28.27
1930-31	0.25	0.47	0	0.60	2.90	0	1.37	3.07	0.84	2.03	0.63	0.14	11.99
1931-32	0.04	1.70	1.10										

Precipitation Station: Delus
Location: Section 29, T. 8 S., R. 4 W., S.B.B.&M.
Elevation: 450 feet
Authority: R. J. Wilmot, Delus
Index No. 6
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1902-03	0	0	0	1.76	3.00	3.75	2.25	3.50	7.00	3.50	0.06	0	23.81
1903-04	0	0	0	0	0	0	1.18	1.50	5.85	0.50	0	0	8.37
1904-05	0	0	0	0.20	0	1.25	6.25	10.25	2.00	0	0.75	0	19.75
1905-06	0	0	0	0	5.00	0.13	4.00	2.00	13.50	0.80	0.50	0	25.73
1906-07	0	0	0.18	0	2.75	6.75	9.50	2.00	4.60	0.13	0.06	0	25.80
1907-08	0	0	0	3.00	1.00	1.36	6.75	4.50	1.37	0.50	0.50	0	18.98
1908-09	0	0	0.50	0.50	1.26	1.80	12.25	5.25	2.12	0	0	0.13	23.80
1909-10	0	0	0	0	1.75	6.63	4.70	0.06	3.50	0.25	0	0.01	15.92
1910-11	0.08	0	0	0.25	0.36	0.06	6.12	4.00	1.18	0.25	0.01	0	12.39
1911-12	0	0	0.12	0.12	0.12	0.69	0.20	0	8.50	1.37	0.85	0	11.48
1912-13	0	0	0	0.87	0.54	0.26	5.25	6.13	0.63	0.07	0.13	0.50	11.39
1913-14	0	0	0	0	3.75	2.50	9.36	9.00	0.75	0.73	0.15	0.07	26.30
1914-15	0	0	0	0.37	1.10	3.00	9.75	3.25	0.75	1.50	1.00	0	22.72
1915-16	0	0	0.25	0	0.75	3.76	29.50	2.00	1.00	0	0	0	37.00
1916-17	0	0	0.50	0.90	0.26	1.50	3.50	5.25	0.13	2.14	0.27	0	14.44
1917-18	0	0	0	0	0.60	0	3.00	4.25	7.12	0.01	0.01	0	14.89
1918-19	0	0.75	0	1.12	1.28	1.00	1.30	1.32	2.06	0.85	0	0	9.28
1919-20	0	0	0.50	1.37	0.53	1.81	0.60	6.00	8.88	0.83	0.13	0	19.45
1920-21	0	0	0	2.00	1.00	0.38	4.85	0.60	2.00	0	4.25	0	15.08
1921-22	0.07	0	1.30	0.08	0	20.00	8.00	6.75	3.40	0.88	1.04	0	40.67
1922-23	0	0	0	0.50	2.38	4.38	2.62	1.60	0	1.50	0	0	13.98
1923-24	0	0	0	0.25	1.00	1.63	1.25	0	4.30	1.75	0	0	10.18
1924-25	0	0	0	0.13	0.81	3.62	0.31	0.40	1.93	2.50	0	1.25	10.93
1925-26	0	0	0	2.50	0	0	1.50	6.88	0	7.00	0	0	17.88
1926-27	0	0	0.12	0.13	2.50	3.13	2.00	21.00	3.37	0.94	0.06	0	33.25
1927-28	0	0	0	6.75	2.06	4.08	0.60	1.81	2.18	0.06	0	0.12	14.58
1928-29	0	0	0	0.62	1.00	3.75	2.50	2.62	2.34	1.61	0	0	14.66
1929-30	0	0	0.50	0	0	0	9.25	1.00	4.30	2.50	2.37	0	20.12
1930-31	0	0	0	0.32	1.98	0	1.95	5.50	0	2.75	0.50	0	13.08
1931-32	0	0.12	0	1.13	3.25	7.87	1.10	7.13	0	0.48	0	0	21.08
1932-33	0	0	0	1.30	0	1.31	7.25	0.12	0	0.43	0.18	0	10.79

Precipitation Station: Oceanside #1.
Location: Section 26, T. 11 S., R. 5 W., S.B.B.&M.
Elevation: 30 feet
Authority: J. A. Tulip
Index No. 8
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1892-93	0	0	0	0.27	1.85	3.07	1.33	1.92	2.41	2.25	0	0	13.10
1893-94	0	0	0.58	0.55	0.86	2.29	1.14	0	1.54	0	0	0	6.95
1894-95	0	0	0.43	0	0	3.98	8.10	0	0.95	0.82	0.53	0	14.33
1895-96	0	0	0	0	1.85	0	2.92	0	2.35	0	0	0	7.12
1896-97	0	0	0	1.05	1.14	1.98	4.70	4.66	2.55	0	0	0	16.06
1897-98	0	0	0	2.19	0	0	2.84	.37	1.05	0.46	0	0	6.91
1898-99	0	0	0	0	0	0.78	2.73	0.30	0.90	0.07	0.21	0	4.99
1899-00	0	0	0	0.74	1.74	1.65	2.69	0.10	0.55	1.07	1.29	0	9.61
1900-01	0	0	0	0.33	2.16	0	3.08	3.43	0.20	0	0	0	9.20
1901-02	0	0	0	0.29	0.84	0.18	3.92	0	3.00	0.53	0	0	8.76
1902-03	0.14	0	0	0.27	1.85	3.97	1.33	1.92	2.41	2.25	0	0	14.14
1903-04	0	0	0	0	0	0.15	0.19	1.39	2.45	0.19	0.15	0	4.52
1904-05	0	0	0	1.60	0	1.72	2.92	6.16	2.58	0.20	1.21	0	16.29
1905-06	0	0	0	0	3.51	0	2.60	1.53	6.62	0.73	0.46	0	15.45
1906-07	0	0	0	0	1.47	3.27	3.54	0	2.78	0.27	0	0	11.33
1907-08	0	.0	0	1.39	0	1.13	3.21	2.17	0.89	0.62	0	0	9.41
1908-09	0	1.10	0	0	0.78	0.72	3.41	2.23	2.28	0	0.05	0	10.57

Precipitation Station: Oceanside #2
Location: Section 25, T. 11 S., R. 5 W., S.B.B.&M.
Elevation: 67 feet
Authority: S. D. Brodie
Index No. 8
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1911-12		1909-19 (See U. S. Weather Bureau publications)											
1912-13													
1919-20	0	0.07	0.60	0.67	0.53	1.46	0.39	1.70	2.90	0.50	0.33	0	9.27
1920-21	0	0	0	1.13	0.67	0.54	2.32	0.86	2.68	0	2.30	0.14	10.64
1921-22	0	0.19	1.29	0.48	0.08	8.56	3.71	2.69	1.47	0.33	0.28	0	19.06
1922-23	0	0	0	0	0.44	2.06	2.22	1.85	0.53	1.74	0	0	9.04
1923-24	0	0	0	0.16	0.42	0.65	0.38	3.36	1.09	0	0	0	6.06
1924-25	0	0	0	0.83	0.26	1.64	0.08	0.26	1.28	1.45	0.42	0.27	6.19
1925-26	0	0	0	2.51	0.51	0.82	1.37	1.67	0.89	4.47	0	0	12.44

Precipitation Station: Oceanside #3
Location: Section 26, T. 11 S., R. 5 W., S.B.B.&M.
Elevation: 60 feet
Authority: San Diego Consolidated Gas & Electric Co.
Index No. 8
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1926-27							0.84	7.07	2.83	0.72	0	0.28	(11.74)
1927-28	0	0	0	0.96	3.25	4.28	0.74	0.89	1.07	0	0	0	11.19
1928-29	0	0	0	0.45	0.85	1.22	0.86	1.40	1.99	0.77	0	0	7.54
1929-30	0	0	0.21	0	0	0	5.33	1.23	2.86	0.22	3.92	0	13.77
1930-31	0	0	0.03	0.66	1.78	0	2.50	4.40	0	1.25	.62	0	11.22
1931-32	0	0	0.62	0.02	0.65	3.36	5.24	1.21	5.50	0.22	0.64	0	17.37
1932-33	0	0	0	1.88	0	2.83	5.84	0	0	0.73	0.29	0.05	11.66
1933-34	0	0	0	0.22	0.40	2.18	1.19	2.42	0.80	0	0		

Precipitation Station: Oceanside #4
Location: Section 19, T. 11 S., R. 4 W., S.B.B.&M.
Elevation: 280 feet
Authority: City of Oceanside
Index No. 9
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1926-27	0	0	0	0.03	1.25	2.94	0.48	7.71	2.47	0.51	0.15	0.43	13.97
1927-28	0.03	0.02	0.72	3.09	3.59	0.64	1.10	1.85	0.18	0.31	0	0	10.88
1928-29	0	0	0	0.27	0.91	2.43	0.78	1.48	1.91	0.87	0	0	8.62
1929-30	0	0	0.15	0	0	0	4.73	0.98	2.13	0.31	3.52	0	11.84
1930-31	0	0	0	0.39	1.58	0	2.32	3.81	0	1.82	0.67	0	10.26
1931-32	0	0.56	0.01	0.54	2.63	6.35	1.94	3.69	0.12	0.54	0.02	0	13.40
1932-33	0	0	0	1.82	0	2.29	6.25	0.01	0.18	0.67	0.57	0.05	11.86
1933-34	0	0	0	0.20	0.56	2.56	1.32	2.58	1.19	0	0.06	----	

TABLE B-2, (Continued) MONTHLY PRECIPITATION AT MISCELLANEOUS STATIONS IN SAN DIEGO COUNTY

Precipitation Station: San Luis Rey — Elevation: 60 feet — Index No. 10
Location: Section 5, T. 11 S., R. 4 W., S.B.B.&M. — Authority: B. F. Libby — Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1900-01							2.67	3.86	0.95				
1901-02				0.58	0.69	0.06	1.64	3.20	3.13	0.20	0.32		9.74
1902-03	0.20	0.04		0.15	1.25	3.91	1.60	2.27	3.70	1.58			14.88
1903-04					0.07		0.45	2.70	2.73	0.38	0.17		6.51
1904-05			0.03	1.45	0.06	1.95	3.37	7.75	3.96	0.07	1.17		19.80
1905-06			0.25	0.10	4.59	0.37	2.63	2.97	9.30	1.18	1.41	0.06	23.26
1906-07					1.35	4.43	4.53	0.78	3.31	0.48		0.08	13.10
1907-08	0.02			1.79	0.02	0.91	3.20	2.60	0.92	0.93	0.24		10.63
1908-09		1.33	0.35	0.47	0.91	0.82	6.37	2.84	3.90	0.07	0.16	0.06	17.30
1909-10					2.98	4.34	1.78	0.13	1.43	0.31			10.99
1910-11	0.13			0.05	0.09	0.37	4.51	3.39	1.70	0.93			11.19
1911-12	0.07		0.05	0.15	0.03	0.90	0.60	0.04	6.64	2.40	1.09		11.97
1912-13		0.22		0.90	0.69	0.63	0.98	2.64	0.60	0.25	0.00	0.13	6.87
1913-14	0.03		0.03	0.10	2.10	1.74	7.06	3.24	0.97	0.57	1.17	0.33	17.33
1914-15				1.43	1.47	3.28	6.66	0.20	0.74	2.25	0.88		21.91
1915-16		0.32			0.49	3.33	13.13	1.38	1.25				20.10
1916-17			0.53	1.34									

Precipitation Station: Fallbrook #2 — Elevation: 730 feet — Index No. 14
Location: Section 21, T. 9 S., R. 3 W., S.B.B.&M. — Authority: H. E. White — Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1909-10	0	0	0	0	3.89	7.97	3.66	0.37	2.18	0.28	0	0	18.29
1910-11	0	0	0	0.73	1.27	0.43	6.20	5.40	2.43	1.10	0.10	0	17.70
1911-12	0	0	0	0.35	0.85	1.32	0.43	0	9.39	3.62	1.17	0	16.66
1912-13	0	0	0	1.01	1.24	0	2.64	4.15	0.72	0.43	0.26	0.24	10.89
1913-14	0.10	0	0	0	2.72	1.82	9.61	6.45	1.25	1.42	0.05	0.46	23.68
1914-15	0.08	0	0	0.77	0.82	3.59	9.48	8.90	0.64	3.82	1.73	0.05	29.90
1915-16	0	0.10	0.10	0	0.58	4.60	20.31*	2.12	1.87	0.07	0.13	0	29.78*
1916-17	0	0.16	0.43	1.94	0.66	3.05	4.78	4.01	0.65	2.75	0.96	0	19.26
1917-18	0	0	0	0.10	0.47	0	2.84	3.50	9.60	0.13	0.29	0	16.93
1918-19	0.52	0.10	0.16	0.60	1.82	1.50	0.30	3.29	2.48	0.54	0.24	0	11.74
1919-20	0.10	0	0.25	1.30	1.62	1.72	0.69	4.73	7.16	1.28	0.36	0	19.10
1920-21	0	0	0	1.42	1.29	1.60	4.17	1.17	3.01	0.20	3.96	0.07	16.78
1921-22	0.27	0.57	2.29	0.43	0.10	14.95	5.98	5.24	3.24	0.68	1.01	0	34.66
1922-23	0	0	0	0.31	2.16	4.66	3.16	1.97	0.88	1.91	0.08	0	16.07
1923-24	0	0	0.10	0.77	0.05	2.61	0.81	0	4.66	2.38	0	0	11.52
1924-25	0	0	0	0.65	1.06	3.80	0.29	1.05	2.21	1.90	0.06	0.78	11.59
1925-26	0	0	0	3.29	1.23	1.66	1.39	4.89	0.20	9.20	0.00	0.03	21.96
1926-27	0	0	0	0.18	2.23	3.61	0.82	17.25	3.34	0.64	0.39	0.04	28.33
1927-28	0	0	0	4.22	0.25	4.04	0.57	1.00	2.08	0.13	0.30	0.10	12.43
1928-29	0	0	0	0.26	0.93	3.61	2.35	1.04	1.71	1.40	0	0	12.80
1929-30	0	0	1.22	0	0	0	7.83	1.09	6.30	2.18	1.88	0.06	19.59
1930-31	0	0	0	0.77	3.00	0	3.01	6.05	0.06	2.85	0.78	0.10	16.64
1931-32	0	0.40	0.05	0.74	3.18	6.64	2.33	9.62	0.60	0.81	0	0.16	24.29
1932-33	0	0	0	2.03	0	3.16	6.09	0.13	0.14	1.07	0.53	0	15.17
1933-34	0	0	0	0.36	0.36	6.72	1.58	2.87	1.07	0.05	0		

* Gage overflowed. True value should be larger.

Precipitation Station: Red Mountain Ranch — Elevation: 940 feet — Index No. 13
Location: Section 16, T. 9 S., R. 3 W., S.B.B.&M. — Authority: J. W. Kingsbury — Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1924-25						2.34	0.21	0.84	1.93	1.56	0.12	0.55	(7.56)
1925-26	0.01	0	0	2.86	1.01	1.31	0.04	4.41	0.16	8.04	0.05	0	18.06
1926-27	0	0	0	0.13	1.60	3.11	0.77	13.20	2.79	0.56	0.44	0.04	22.89
1927-28	0	0	0	4.26	0.24	3.61	0.39	0.94	1.87	0.12	0.29	0.05	11.97
1928-29	0	0	0	0.65	0.64	3.47	2.64	1.86	1.55	1.21	0	0	12.42
1929-30	0	0.02	1.57	0	0	0	7.37	0.91	4.87	1.96	1.89	0	18.69
1930-31	0	0	0.08	0.79	2.87	0	2.66	5.23	0.07	2.29	0.72	0.20	15.55
1931-32	0	0.37	0.05	0.92	2.91	5.81	3.08	8.17	0.19	0.76	0	0.16	22.36
1932-33	0	0	0	1.74	0	2.96	5.24	0.14	0.11	1.05	0.48	0.03	11.75
1933-34	0	0	0	0.32	0.38	4.68	2.62	2.82	0.93	0.05	0	---	

Precipitation Station: Deadman's Hole — Elevation: 3200 feet — Index No. 18
Location: Section 1, T. 10 S., R. 2 E., S.B.B.&M. — Authority: San Diego County Water Co. — Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1911-12		0	0.65	0.20	0	1.20	0.21	0.05	9.81	3.48	1.54	0.17	17.31*
1912-13	0.15	0.58	0	1.73	0.61	0	1.50	3.77	1.18	0.50	0.10	0.07	12.19
1913-14	0.33	2.13	0.04	0.05	2.46	1.09	7.42	6.79	1.76	1.59	0.06	0.09	23.81
1914-15	0.06	0.04	0.05	0.57	0.94	4.43	9.64	8.26	2.44	4.28	1.62	0.10	32.45
1915-16	0	0.25	0.13	0	0.75	2.54	27.96	1.34	1.69	0.17	0.08	0	34.92
1916-17	0.22	0.02	0.12	1.57	0.12	7.09	4.91	3.02	0.76	2.52	0.56	0	21.40
1917-18	1.51	0.04	0.75	0	0.45	0	2.30	3.10	10.34	0	0.51	0.67	19.67
1918-19	0.20	0.41	0.10	1.20	1.71	2.27	0.40	2.78	4.30	0.33	0.35	0	14.07
1919-20	1.10	0.23	1.05	0.97	2.40	0.97	1.25	7.77	8.30	0.32	0.20	0	24.63
1920-21	1.00	0.86	0	1.36	0.62	0.71	3.60	1.00	2.10	0.32	1.76	0	12.72
1921-22	1.00	1.20	0.75	1.10	0.25	17.97	6.34	4.97	3.30	0.55	1.05	0.35	38.93
1922-23	1.60	0.65	0.08	0.80	1.06	3.09	2.15	2.75	1.40	1.14	0	0	15.02
1923-24	0.80	0	1.17	1.60	1.11	1.96	0.15	0	5.70	2.62	0	0	13.13

* Partial Season

Precipitation Station: Chihuahua Mountain — Elevation: 4200 feet — Index No. 19
Location: Section 34, T. 9 S., R. 3 E., S.B.B.&M. — Authority: San Diego County Water Co. — Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1911-12				0.16	0	0.73	0.04	0	10.16	2.02	1.25	0.35	15.10*
1912-13	0	0.65	0	2.22	0.67	0	2.26	5.01	1.30	0.32	0.30	0.21	13.53
1913-14	1.06	5.16	0	0.05	2.68	1.39	6.73	6.75	1.52	2.35	0.50	0	26.02
1914-15	0	0	0			4.02	9.36	5.28	2.06	4.00	1.27	0.03	26.84*
1915-16	0.27	0.84											

* Partial Season

Precipitation Station: Hot Springs Mountain — Elevation: 6200 feet — Index No. 20
Location: Section 6, T. 10 S., R. 4 E., S.B.B.&M. — Authority: San Diego County Water Co. — Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
(1911-12													
(1912-13						0	3.27	4.26	0.56				
1913-14	2.00	3.04	0.20	0.06	3.46	1.06	3.53	3.70	0.77	0.90	0	0	18.80
1914-15	0.02	0.10	0.65	0.95	1.20	2.79	3.70	4.04	0.43	4.08	2.21	0	20.18
1915-16	0	0.68	1.35	0									

Precipitation Station: Eagles Nest — Elevation: 4500 feet — Index No. 21
Location: Section 20, T. 10 S., R. 4 E., S.B.B.&M. — Authority: San Diego County Water Co. — Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1911-12						1.22	0.34	0	5.14	2.34	0.81	0	9.95*
1912-13	0.51	0.28	0	3.99	1.10	0	1.35	3.34	0.35	0.15	0.09	0.17	11.32
1913-14	0.41	2.62	0	0	1.12	1.09	4.43	3.19	1.79	2.26	0	0.04	17.17
1914-15	0.16	0	0	1.35	1.56	5.85	9.28	6.80	0.50	4.02	2.72	0.03	32.37
1915-16	0.08	0.74	0.32	0	1.25	3.60	20.40	1.11	2.80	0.30	0.29	0	30.89

* Partial Season

Precipitation Station: San Felipe — Elevation: 3600 feet — Index No. 23
Location: Section 30, T. 11 S., R. 4 E., S.B.B.&M. — Authority: San Diego County Water Co. — Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1911-12				0.10	0.06	1.65	0.30	0	14.50	2.32	1.85	0.23	20.92*
1912-13	0.80	0.35	0	2.60	0.33	0.06	2.34	6.00	1.80	0.63	0.24	0.20	15.66
1913-14	0.60	1.75	0	0.25	2.33	1.32	8.05	7.80	1.90	2.30	0	0.22	26.42
1914-15	0.60	0	0.11	0.40	1.30	2.14	9.15	8.40	3.20	4.75	2.26	0	32.21
1915-16	0	2.60	M	0	0.70	3.38	25.40	2.04	1.18	0.10	0.01	0	33.28*

CONTINUED

TABLE B-2, (Continued) MONTHLY PRECIPITATION AT MISCELLANEOUS STATIONS IN SAN DIEGO COUNTY

Precipitation Station: San Felipe --Continued
Location: Section 30, T. 11 S., R. 4 E., S.B.B.&M.
Elevation: 3600 feet
Authority: San Diego County Water Co.
Index No. 23
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1916-17	0	0.20	0.40	1.07	0.09	3.10	4.00	2.14	0.20	1.69	0.35	0	14.32
1917-18	0.72	0	0.00	0	0.26	0	0.76	3.26	9.77	0	0.65	1.07	16.36
1918-19	0	0.14	M	0.13	1.48	2.31	1.76	1.08	2.19	0.36	0.14	0	10.08*
1919-20	2.03	1.97	0.36	M	3.30	M	1.66	6.41	11.29	0.70	0.19	M	27.60*
1920-21	0.67	M	0	1.60	0.54	2.03	4.26	1.63	2.31	0.73	4.00	M	17.96*
1921-22							3.70	3.16	2.42	0.61	1.19	0	---
1922-23	2.31	2.16	0.10	1.06	1.48	3.88	2.51	2.12	1.90	1.67	0	0.08	19.36
1923-24	0.10	0.16	1.40	1.04	0.09	2.19	0.80	0	4.68	2.71	0		13.25

* Partial season

Precipitation Station: Werner Ranch House
Location: Section 4, T. 11 S., R. 3 E., S.B.B.&M.
Elevation: 2894 feet
Authority: San Diego County Water Co.
Index No. 24
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1911-12				0.18	0	0.63	0.38	0	7.62	2.99	1.29	0	13.18*
1912-13	M	0.62	0	1.86	0.62	0	2.60	3.09	0.57	0.75	0.13	0.11	11.14*
1913-14	0.31	2.30	0	0	1.54	0.66	7.64	4.73	1.16	1.50	0	M	20.22*
1914-15	0.81	0	0	0.63	1.30	2.69	6.02	6.54	2.09	4.04	4.76	0	29.78
1915-16	0	M	M	0	M	3.03	24.16	1.20	1.49	M	M	0	29.88*

* Partial Season

Precipitation Station: Puerta la Cruz
Location: Section 30, T. 10 S., R. 3 E., S.B.B.& M.
Elevation: 2772 feet
Authority: San Diego County Water Co.
Index No. 25
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1911-12	M	0	0.25	0.15	0.12	0.98	0.23	0	7.62	2.66	1.08	0.27	13.70*
1912-13	0.20	0.53	0	2.11	0.50	0.02	2.42	3.97	1.17	0.40	0.06	0.15	11.53
1913-14	0.41	1.47	0	0.12	1.48	0.76	6.42	6.26	1.20	2.21	0	0.81	19.62
1914-15	0.50	0	0	0.63	0.98	4.14	7.62	7.03	0.40	5.43	1.12	0.07	28.08
1915-16	0	0.61	0.03	0	0.92	2.40	23.88	1.02	1.40	0.09	0.18	0	30.61
1916-17	0.30	0.60	0	1.16	0.11	2.94	3.30	2.66	0.40	2.64	M	M	14.30*

* Partial Season

Precipitation Station: Rincon of Werner Ranch
Location: Section 15, T. 10 S., R. 2 E., S.B.B.&M.
Elevation: 2975 feet
Authority: San Diego County Water Co.
Index No. 26
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1912-13								7.92	2.09	0.49	0.18	0.32	
1913-14	0.26	0.90	0	0.40	2.74	1.71	8.78	8.24	2.00	1.98	0	0.22	27.20
1914-15	0.53	0	0	0.94	1.00	4.91	11.69	12.98	1.69	7.54	1.29	0.14	42.71
1915-16	0	0.31	0.07	0	1.17	4.08	33.83	1.83	3.61	0.12	0.21	0	45.18
1916-17	0.28												

Precipitation Station: Werner Summer Road
Location: Section 5, T. 11 S., R. 3 E., S.B.B.&M.
Elevation: 2805 feet
Authority: San Diego County Water Co.
Index No. 27
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1911-12	M	0	0.36	0.14	0.07	0.83	0.48	0	8.40	2.80	1.43	0.20	14.78*
1912-13	0.50	0.42	0	2.04	0.79	0.30	2.46	3.97	0.79	0.36	0.08	0.16	11.93
1913-14	0.34	1.44	0.02	0.06	1.79	0.69	6.77	6.18	1.27	1.41	0	0.14	19.31
1914-15	0.93	0	0	0.66	1.47	2.67	0.01	7.28	0.50	4.77	1.31	0.06	27.98
1915-16	0	0.44	0	0	0.67	2.60	27.16	0.66	1.20	0.09	0.16	0	33.00
1916-17	0.21	0.09	0	1.36	0.06	3.67	3.24	2.26	0.59	2.34	M	M	13.73*
1917-18	M	M	0.93	0	0.22	0	1.93	2.51	8.66	0.02	0.83	1.22	16.04*
1918-19	0	0.48	0	1.00	1.87	2.22	0.56	2.78	3.12	0.36	0.13	0	12.15
1919-20	0.37	0.37	0.18	1.23	2.30	0.09	0.78	7.03	6.99	0.99	0.28	0	21.56
1920-21	0.07	0.99	0.05	1.37	0.39	0.68	3.36	0.69	1.82	0.58	3.37	0	13.51
1921-22	0.36	1.74	1.44	0.24	0.24	16.16	2.03	6.11	2.59	1.10	0.69		32.71

* Partial season

Precipitation Station: Mataguai
Location: Section 22, T. 11 S., R. 3 E., S.B.B.&M.
Elevation: 3200 feet
Authority: San Diego County Water Co.
Index No. 28
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1911-12	M	0	0.40	0.29	0.03	1.24	0.21	0	11.19	3.54	1.50	0.33	18.72*
1912-13	0.30	0.44	0	2.60	0.89	0.25	3.24	6.16	1.58	0.63	M	0.14	16.43*
1913-14	0.27	1.96	0	0.10	2.56	0.98	6.14	6.17	1.50	2.48	0	0.82	24.74
1914-15	0	0	0	0.69	1.24	5.08	9.62	9.76	0.62	6.16	1.66	0	35.12
1915-16	0	1.38	0.04	0	1.27	1.86	27.56	0.16	1.73	0.10	0.16	0	34.23

* Partial Season

Precipitation Station: Volcan Mountain
Location: Section 2, T. 12 S., R. 3 E., S.B.B.&M.
Elevation: 4800 feet
Authority: San Diego County Water Co.
Index No. 29
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1911-12						2.06	1.46	0	17.18	7.66	2.30	M	30.63*
1912-13	0.50	1.06	0.20	4.54	2.01	0.69	4.60	12.35	3.60	1.25	0.76	0.71	32.32
1913-14	0.90	1.76	0	0.11	4.65	3.33	9.19	7.31	1.54	2.43	0.60	0.93	32.77
1914-15	0	0	0.10	1.72	1.70	7.21	6.67	9.40	6.25	7.10	4.66	0.90	47.71
1915-16	0	2.00	0.22	0	1.23	6.59	39.87	1.66	3.94	0.46	0.68	0	56.51
1916-17	0	0	0.50	3.62	0.41	6.36	8.84	7.13	1.00	4.20	2.24	0	33.32
1917-18	0.43	0	0.11	0	0.96	0	2.77	6.18	11.45	0.12	1.70	0.76	23.48
1918-19	0.19	0.15	0	1.06	3.09	2.23	0.16	5.57	6.10	1.22	0.47	0	20.23
1919-20	0.50	0.60	1.07	1.00	3.20	0.60	0.90	7.10	7.92	1.16	0.10	0	24.33
1920-21	0.10	2.01	0	2.92	0.40	2.93	4.92	2.15	2.60	1.10	3.97	0	23.30
1921-22	1.02	1.05	1.05	2.49	0.36	21.61	11.07	3.48	4.56	1.42	1.12	0	49.27
1922-23	1.76	0.41	0	1.10	3.72	7.31	4.34	3.00	2.85	4.91	0	0.11	29.50
1923-24	0.11	0.18	0.15	1.30	0.07	4.35	0.30	0	7.05	4.14	0	0	17.65

* Partial Season

Precipitation Station: Santa Ysabel-Werner Divide
Location: Section 33, T. 11 S., R. 3 E., S.B.B.&M.
Elevation: 3200 feet
Authority: San Diego County Water Co.
Index No. 30
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1912-13							-	6.76	3.06	0.99	0.54	0.46	
1913-14	0.26	1.31	0	0.32	3.51	2.37	9.38	6.53	1.73	3.36	0	0.62	29.73
1914-15	0.05	0	0	1.54	1.28	6.36	13.17	10.21	1.10	9.34	2.24	0.06	44.38
1915-16	0	0.87	0.10	0	1.45	4.39	42.51	2.96	M	0.25	0.45	0	52.96

* Partial Season

Precipitation Station: Monkey Hill
Location: Section 12, T. 11 S., R. 2 E., S.B.B.&M.
Elevation: 2610 feet
Authority: San Diego County Water Co.
Index No. 31
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1911-12		0	0.30	0.14	0	0.69	0.29	0	6.03	2.19	1.37	0.18	11.18*
1912-13	0.45	M	0	1.92	0.60	0	1.50	3.86	0.30	0.33	0.06	0.17	9.23*
1913-14	0.46	1.64	0.06	0.06	1.37	1.03	6.21	3.96	1.28	1.06	0	0.09	16.45
1914-15	0.36	0	0	0.69	1.21	3.33	7.21	6.06	0.45	3.16	0.74	0.04	23.34
1915-16	0	0.31	0	0									

* Partial Season

Precipitation Station: Damrons
Location: Section 14, T. 11 S., R. 2 E., S.B.B.&M.
Elevation: 2725 feet
Authority: San Diego County Water Co.
Index No. 32
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1911-12		0	0.16	0.20	0.07	1.61	0.67	0	16.06	4.94	1.47	0.30	25.70*
1912-13	0.05	0.87	0	2.20	2.52	0.02	3.76	9.12	3.62	1.14	0.44	0.32	23.44
1913-14	0.34	3.19	0.34	0.06	4.11	2.01	11.51	7.94	2.06	2.71	0.12	0.54	34.97
1914-15	0.44	0	0	0.25	1.32	6.33	11.14	13.89	0.93	6.60	3.40	0.09	44.39
1915-16	0	1.23	0.06	0	1.33	4.93	34.67	2.62	2.40	0.26	0.41	0	50.30
1916-17	0.12	0.06	0	2.92	0.23	6.43	6.47	6.37	1.13	4.66	1.81	0	29.41
1917-18	0.14	M	0.62	0	0.94	0	3.18	6.23	14.20	0.22	1.13	1.12	26.76*

CONTINUED

Precipitation Station: Damrone -- continued
Location: Section 14, T. 11 S., R. 2 E., S.B.B.&M.
Elevation: 2725 feet
Authority: San Diego County Water Co.
Index No. [illegible]
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1918-19	0	0.56	0	1.28	3.34	3.35	1.37	6.06	5.98	0.81	0.21	0	23.16
1919-20	0.73	0.92	0.42	2.49	3.21	1.72	1.49	10.64	12.69	1.97	0.21	0	36.52
1920-21	0.34	0.56	0	2.65	0.92	1.98	5.16	2.03	3.29	1.06	5.86	0	23.85
1921-22	0.16	1.72	2.31	0.47	0.35	21.68	4.07	12.30	5.56	1.90	1.70	M	52.22*

* Partial Season

Precipitation Station: Henshaw Dam
Location: Section 10, T. 11 S., R. 2 E., S.B.B.&M.
Elevation: 2702 feet
Authority: San Diego County Water Co.
Index No. 33
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1911-12	0.87	0	0.39	0.37	0.13	1.98	0.71	0.05	13.60	4.68	1.34	0.19	26.31
1912-13	0.15	0.68	0	2.77	1.49	0.08	3.79	7.67	1.58	0.83	0.30	0.24	19.58
1913-14	0.47	0.88	0.13	0.23	3.64	1.70	10.71	8.05	3.10	2.54	0.09	0.21	31.77
1914-15	2.04	0	0.06	0.76	1.13	5.07	11.15	11.22	2.30	6.67	3.23	0.07	43.70
1915-16	0	0.49	0.06	0	1.06	4.31	33.93	1.34	2.21	0.24	0.50	0	44.14
1916-17	0.15	0.18	0.16	2.46	0.10	4.82	5.90	5.20	1.06	4.85	1.45	0	26.33
1917-18	0.44	0	0.05	0	0.80	0	2.76	3.78	14.99	0.07	0.97	0.73	24.59
1918-19	0	0.41	0	1.03	2.72	3.07	1.15	4.70	3.25	0.73	0.18	0	19.21
1919-20	0.42	0.12	0.25	1.87	2.98	1.70	1.01	9.57	10.42	1.31	0.18	0	29.83
1920-21	0.07	0.74	0.03	2.12	0.88	1.35	5.22	1.59	3.39	0.83	5.61	0	21.91
1921-22	0.37	1.02	2.39	0.67	0.29	23.22	7.89	7.19	4.60	2.03	1.41	0	51.08
1922-23	0.30	0	0.03	1.02	2.22	3.85	3.79	3.02	2.06	2.22	0.03	0.07	20.63
1923-24	0.38	0	1.12	0.93	1.27	3.27	1.31	0	8.63	2.78	0	0	19.69
1924-25	0	0	0.14	0.64	0.62	7.07	0.45	1.28	3.39	3.81	0.23	1.38	21.01
1925-26	0	0	0	6.14	1.80	1.32	0.39	8.39	0.87	14.04	0.09	0	32.44
1926-27	0	0.10	0	0.10	2.82	7.40	1.03	27.17	5.03	1.39	1.50	0.11	46.65
1927-28	0	0	0	1.24	2.48	6.47	0.78	3.55	2.18	0.21	1.23	0	18.14
1928-29	0	0	0	0.65	2.67	5.52	4.54	3.84	5.65	3.63	0	0	28.32
1929-30	0	1.05	0.39	0	0	0	13.14	2.76	6.93	0.98	7.96	0	33.21
1930-31	0	0	0	0.74	4.28	0	2.77	6.88	0.21	5.11	1.54	0	21.51
1931-32	0	0.76	0.12	2.20	3.27	11.18	3.35	18.91	0.50	2.47	0.25	0.05	45.06
1932-33	0	0	0	2.44	0	7.82	7.27	0.29	0.10	3.06	2.00	0.08	23.06

Precipitation Station: Mendenhall Valley
Location: Section 11, T. 10 S., R. 1 E., S.B.B.&M.
Elevation: 4500 feet
Authority: San Diego County Water Co.
Index No. 34
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1911-12				0.54	M	2.25	0.39	0.10	19.18	5.41	1.30	M	29.38*
1912-13	0.70	0.83	0	2.72	0.98	0.47	3.93	11.01	2.10	1.01	0.50	0.33	24.60
1913-14	0.27	0.75	0.30	0	5.66	3.10	12.37	9.17	3.10	1.98	0.80	0.30	37.40
1914-15	0.25	0	0	1.28	1.41	6.44	15.42	6.50	1.08	9.04	2.43	0.15	42.00
1915-16	0	0.60	0	0	2.00	7.15	28.32	2.80	3.94	0.32	0.49	0	45.62

* Partial Season

Precipitation Station: Nellie
Location: Section 9, T. 10 S., R. 1 E., S.B.B.&M.
Elevation: 5000 feet
Authority: T. O. Bailey
Index No. 35
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1902-03			0.22	0.85	5.32	5.26							
1903-04	0	0	-	0.78	0.01	0							

Note:- These values fill in missing records in the United States Weather Bureau tabulations.

Precipitation Station: Mesa Grande (Angeles)
Location: Section 21, T. 11 S., R. 2 E., S.B.B.&M.
Elevation: 3450 feet
Authority: San Diego County Water Co.
Index No. 37
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1911-12							1.30	0.07	15.88	5.30	2.03		
1912-13	0.30	0.91	M	3.33	1.56	0	9.81	8.57	3.65	1.57	0.78	0.67	31.15
1913-14	0.26	1.10	0	0	5.45	2.89	12.47	7.50	2.70	3.48	0.16	0.88	36.89
1914-15	0	0	0	1.64	1.50	4.98	9.44	11.88	M	4.13	M	M	33.57*
1915-16	M	0.25	0.17	1.80	0	5.94	33.60	2.45	2.81	0.47	0.72	0	48.21*

* Partial Season

Precipitation Station: Mesa Grande
Location: Section 3, T. 12 S., R. 2 E., S.B.B.&M.
Elevation: 3350 feet
Authority: E. H. Davis
Index No. 38
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1905-06													47.03
1906-07													33.66
1907-08													27.67

Additional Record published by U. S. Weather Bureau.

Precipitation Station: Santa Ysabel Ranch
Location: Section 20, T. 12 S., R. 3 E., S.B.B.&M.
Elevation: 3000 feet
Authority: S. Roto –
San Diego County Water Co.
Index No. 39
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1900-01													21.45
1901-02													18.55
1902-03													20.75
1903-04													11.00
1904-05													31.00
1905-06													42.00
1906-07													24.70
1907-08													24.00
1908-09													25.25
1909-10													22.85
1911-12		0	0.60	0.45	M	1.85	1.10	0.10	12.25	4.05	1.85	0.32	22.57*
1912-13	2.50	0.50	0	3.50	1.75	0.05	2.95	2.57	3.20	1.25	0.55	0.50	19.32
1913-14	0.38	0.75	0	0	3.47	2.44	8.25	6.00	1.40	3.29	0	0.90	26.88
1914-15	0	0	0.05	1.74	1.05	4.41	10.70	9.00	3.45	7.00	1.80	0	39.80
1915-16	0	M	M	0	2.50	5.45	30.40	M	2.50	0.11	M	0	40.96*

* Partial Season

Precipitation Station: Santa Ysabel Store
Location: Section 21, T. 12 S., R. 3 E., S.B.B.&M.
Elevation: 2983 feet
Authority: San Diego County Water Co.
Index No. 40
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1911-12						2.05	1.15	0	13.97	4.12	2.00	0.35	23.64*
1912-13	0	0.60	0	3.70									
1913-14	0.69	0.78	0	0	3.06	2.03	8.48	6.25	1.51	2.55	0	M	25.33*
1914-15	1.20	0	0	1.59	1.28	3.70	8.63	10.38	2.68	5.43	5.98	0	40.87
1915-16	0	0	0	0	2.22	4.73	29.41	2.19	3.29	0.08	0.54	0	42.46

* Partial Season

Precipitation Station: Witch Creek — Elevation: 2600 feet — Index No. 41
Location: Section 21, T. 12 S., R. 3 E., S.B.B.&M. — Authority: 1909-15 J. Woods; 1916-16 San Diego Co. Water Co. — Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1909-10													27.40
1910-11													23.55
1911-12	M	0	0.64	0.65	0.35	2.00	1.40	0.	14.20	4.96	1.40	0.30	25.89*
1912-13	0.15	0.60	0	4.00	1.60	0	3.50	6.06	2.55	0.75	0.56	0.50	20.26
1913-14	0.30	0.40	0	0	3.90	2.40	0.80	6.25	1.45	3.10	0	0.70	27.30
1914-15	0	0	0.10	1.30	0.90	6.40	9.75	10.30	2.30	6.00	4.36	0	40.40
1915-16	0	0.50	0	0	1.40	2.65	29.30	1.00	3.25	0.35	0.40	0	39.66

* Partial Season

Precipitation Station: Sutherland Damsite — Elevation: 1900 feet — Index No. 42
Location: Section 21, T. 12 S., R. 2 E., S.B.B.&M. — Authority: 1914-22 San Diego Co. Water Co.; 1930-31 City of San Diego — Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1913-14							8.48	5.54	1.54	3.92	0.70	0.45	
1914-15	0	0	0	1.34	1.86	3.96	9.58	5.78	3.27	6.23	5.35	0	37.37
1915-16	0	0.11	.07	0	M	1.96	M	M	4.76	0.65	M	M	
1916-17	0.23	0.02	0.29	3.26	M	M	6.24	6.01	0.60	3.01	1.81	0	21.72*
1917-18	0.02	M	0	0	M	0	2.79	4.00	9.97	0.14	1.10	0.16	18.26*
1918-19	0	0.10	0.12	1.51	1.48	M	1.24	4.42	5.02	0.93	1.03	M	15.93*
1919-20	M	M	M	1.95	M	M	9.95	7.33	8.92	1.91	0.48	M	21.42*
1920-21	M	1.07	0.10	1.60	0.49	8.22	3.87	2.87	3.06	0.26	M	M	16.14*
1921-22	M	"	M	1.07	0.45	17.97	6.72	6.21	4.77	2.08	1.65	M	40.92*
1930-31	0	0	0.08	1.35	3.60	0	2.73	6.01	0.40	3.03	1.50	0.13	18.77

* Partial Season

Precipitation Station: Ross Glen — Elevation: 2300 feet — Index No. 43
Location: Section 32, T. 12 S., R. 2 E., S.B.B.&M. — Authority: San Diego County Water Co. — Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1911-12						2.15	1.17	0.02	9.96	4.20	2.50	0.55	20.63*
1912-13	M	0.50	0	2.55	1.45	0.05	2.57	4.71	2.51	.03	0.50	0.50	16.17*
1913-14	0.25	0.72	0	1.60	3.27	2.09	7.18	4.65	1.33	2.76	0.46	0.80	24.93
1914-15	0	0	0	1.27	1.06	3.08	7.57	8.01	1.55	5.32	2.86	0	30.71
1915-16	0	0.90	0	0	1.53	5.01	24.62						

* Partial Season

Precipitation Station: Pamo Camp — Elevation: 975 feet — Index No. 44
Location: Section 22, T. 12 S., R. 1 E., S.B.B.&M. — Authority: San Diego County Water Co. — Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1913-14							4.50	4.33	1.14	1.37	0.63	.24	
1914-15	0	0	0.02	.90	1.65	2.73	7.45	6.34	1.65	3.13	4.31	0	28.18
1915-16	0	1.20	0.04	0	0.96	4.08	24.47	1.29	1.47	0.21	0.17	0	33.89
1916-17	0.14	0.25	0.14	1.80	0.16	2.69	4.10	2.88	0.43	1.59	0.76	0	14.84
1917-18	0	0	0	0	0.30	0	2.17	2.44	5.27	0.06	1.11	0.07	12.42
1918-19	0	0.02	0	1.05	1.60	3.05	0.16	3.77	4.16	0.63	0.32	0	14.06
1919-20	0.36	0.07	0.41	1.41	1.35	1.89	0.88	4.91	5.51	1.25	0.19	0	17.63
1920-21	[illegible]		0	0.87	0.31	1.37	3.02	1.60	1.89	0.24	3.35		12.55*
1921-22	0.14	0.41	2.29	0.50	0.54	15.31	5.73	4.26	3.46	1.24	1.01		34.89*
1922-23				0.63	1.55	3.38	2.85	2.09	0.90*				11.40*

* Partial Season

Precipitation Station: Fargo — Elevation: 1050 feet — Index No. 45
Location: Section 11, T. 12 S., R. 1 E., S.B.B.&M. — Authority: San Diego County Water Co. — Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1911-12		0	0.46	0.32	0.11	1.37	0.70	0	9.21	3.67	1.97	0.14	17.95*
1912-13	0.04	0.20	0.09	2.08	1.25	0.10	2.14	4.71	1.79	0.95	0.22	0.16	13.73
1913-14	0.26	0	0.06	0.35	3.21	1.47							

* Partial Season

Precipitation Station: Escondido Ditch Head — Elevation: 1986 feet — Index No. 46
Location: Section 32, T. 10 S., R. 1 E., S.B.B.&M. — Authority: Escondido Mutual Water Co. — Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1896-97				2.75	1.17	8.10	7.35	7.02	4.50	0	0		24.89
1897-98				1.60	1.85	1.25	3.80	0.70	2.42	0.10			11.72
1898-99					0.26	1.45	1.35	1.60	2.92	0.40	0	1.35	9.53
1899-00						a 4.55	2.60	0.03	1.30	2.72	1.92		13.12
1900-01					4.97	0	3.70	7.05	1.55	0.25			17.52
1901-02													
1902-03					3.19	3.40	2.10	3.60	4.40	5.15	0		21.84
1903-04													
1904-05					1.25			1.80	9.55	1.40	4.25		
1905-06					6.45		2.30	3.93	21.15				
1906-07				0.10	2.76	3.05	7.00	1.70	6.00	1.15	0.35		22.10
1907-08				5.46	0.91	1.50	6.65	5.45	2.30	1.25	0.75		24.27
1908-09		1.00	0.36	0.35	0.00	1.48	11.10	4.25	4.22	0.13	0.17		24.05
1909-10					4.85	8.83	4.05	0.45	5.15	0.50			23.83
1910-11				0.70	1.63	0.33	5.02	6.97	4.48	1.43	0.03		20.59
1911-12				0.07	0.25	2.00	0.60		12.80	3.80	2.25		21.77
1912-13	0.28					0	2.90	6.78	0.55	1.02	0.55	0.41	12.43
1913-14	0.25	0	0	0	0	2.10	10.70	10.20	2.70	2.45	0.28	0.40	29.08
1914-15	0	0	0	0	0	6.78	8.85	10.40	2.52	5.28	3.44	0.08	37.30
1915-16									1.85		0.34		
1916-17	0.17						3.90	3.90	0.78	6.10	2.10		
1917-18		0.80					4.00	2.75	10.20		1.13		
1918-19		1.30				9.50	0.60	5.91	4.92	1.15	1.00		24.38
1919-20	0.65			1.10	2.80	2.38	1.17	8.95	7.71				24.76
1920-21								0.20	2.90	0.60	5.60		
1921-22													
1922-23					3.25	4.05	3.95	2.05	2.40	3.01	0.30		19.01
1923-24													
1924-25						9.12	0.37	1.75	3.50	3.76	1.87	3.10	23.46
1925-26				6.26		1.25	3.00	9.65	1.75	14.15			35.05
1926-27					6.95	6.65	1.00	16.75	3.95	1.50	1.25	0.25	34.30
1927-28				2.00	2.20	4.70	1.20	3.00	1.95	0.20	0.75		16.00
1928-29													
1929-30		0.09	1.27	0	0	0	9.30	1.50	5.85	0.52	8.40	0	26.93
1930-31	0	0	0	1.15	3.46	0	2.96	4.60	0.30	5.78	1.15	0	19.39
1931-32	0	0.72	0				4.56	14.55	1.38	2.65	0.90	0.67	25.41
1932-33	0	0	0			6.96	8.29	0.37	0.39	4.27	1.96	0.04	22.28

a) Total to date.
Record kept by Ditch tender read with measuring stick graduated to tenths only.
Record should be used carefully as there is no assurance that blank months did not have a slight rainfall.

Precipitation Station: Valley Center No. 1 — Elevation: 1400 feet — Index No. 47
Location: Section 7, T. 11 S., R. 1 W., S.B.B.&M. — Authority: S. 7. Antes — Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1872-73						3.70	0.47	7.32	0.00	0.13			11.65
1873-74		2.45			1.68	9.18	8.38	11.05	3.09	1.02	1.02		37.80
1874-75					3.10	1.00	7.63	0.52	0.73	0.20	0.12	0	13.30
1875-76					4.00	0.65	7.32	3.83	3.72	0.44	.04		20.00
1876-77							2.43	1.15	2.94	0.01	1.45		8.80
1877-78				0.40	0.93	3.66	3.71	8.00	2.53	5.80	0.83	0.45	26.31
1878-79							4.62	1.80	0.30	1.74			8.46
1879-80					6.25	7.12	1.90	2.48	2.75	4.05			24.55
1880-81				1.30	0.87	7.35	1.23	0.47	3.37	1.22	0.22		16.03
1881-82				1.17	0.25	0.35	2.48	6.32	2.20	1.34			14.11
1882-83					1.16		0.85	3.31	2.82	1.79	2.02		11.94

CONT'D

Precipitation Station: Valley Center No. 1 -- Continued
Location: Section 7, T. 11 S., R. 1 W., S.B.B.&M.
Elevation: 1400 feet
Authority: S. Y. Antes
Index No. 47
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1883-84				1.85		4.22	3.00	18.50	14.20	5.61	2.52	0.61	50.51
1884-85				0.40	0.08	7.09	0.68	0.31	0.39	3.92	0.51		13.38
1885-86					3.26	0.59	11.11	2.20	6.68	3.51			30.35
1886-87					3.07	0.23	0.15	7.28	0.18	2.47	0.35		13.71
1887-88					2.00	4.95	10.21	0.39	4.58	0.57			22.80
1888-89				0.95	3.51	6.91	2.80	2.37	9.52	0.84	0.40		26.70
1889-90				2.68	0.40	12.30	5.67	5.48	1.64	0.36	0.87		30.40
1890-91			0.50	0.18	0.52	5.38	0.97	14.17	0.94	2.00	1.86		26.56
1891-92	0.05		0.18			2.95	0.80	7.84	3.80	0.67	2.00		18.27
1892-93					2.32	1.18	3.36	2.02	10.57	0.95			20.60
1893-94				0.35	1.62	2.21	0.97	2.65	1.45	0.13	0.49	0.05	9.90
1894-95						6.50	13.22	1.16	2.35	0.80	0.67		24.70
1895-96					1.93	0.60	3.02	0.15	4.94	0.93	0.22		11.79
1896-97	0.15			2.98	1.22	3.56	5.24	7.10	3.70		0.20		24.15
1897-98				2.09		1.14	2.70	0.83	1.85	0.55	1.77		10.93
1898-99						1.79	4.13	1.47	2.07	0.26		1.08	10.74
1899-00				1.10	2.52				0.87	1.63	1.76		7.88
1900-01					4.90	1.80	1.84	8.02	0.55	1.67			18.78
1901-02				0.72	0.36		4.49	3.65	1.73				10.95
1902-03					3.15	5.24	1.58	4.43	3.02	6.12			21.54

Precipitation Station: Valley Center No. 2
Location: Section 13, T. 11 S., R. 2 W., S.B.B.&M.
Elevation: 1360 feet
Authority: San Diego County Water Co.
Index No. 48
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1911-12								0	6.50	5.00	1.20		
1912-13							1.90	3.82	0.88	0.66	0.25	0.25	
1913-14	0.18	0	0.01	0.05	2.40	1.18	7.08	6.22	1.64	1.48	0.27	0.30	20.81
1914-15	0	0	0	1.25	1.73	5.15	8.17	6.41	1.61	4.12	1.45	0	27.87
1915-16	0	0.28	0.04	0	0.89	4.12	22.05	1.01	1.08	[illegible]	0.10	0	29.81
1916-17	0.02	0.31	0	2.50	0.04	2.65	5.96	3.73	0.81	2.76	0.80	0	17.58
1917-18	0.74	0	0	0	0.45	0	3.04	3.28	8.90	0	2.29	0	18.70
1918-19	0	0.19	0	0.98	2.05	2.08	0.58	5.98	5.49	0.92	0.48	0	14.69
1919-20	0.29	0	0.36	1.10	1.44	1.51	0.58	5.22	5.99	1.07	0.34	0.05	17.93
1920-21	0	0	0	1.05	0.27	0.85	3.50	1.10	1.74	0.19	5.22	0	11.82
1921-22	0.28	0.43	1.21	0.98	0.32	15.51	5.68	4.96	5.25	0.83	0.81	0	32.36
1922-23	0.12	0	0	0.72	1.48	5.40	2.25	1.68	1.19	0.79	0	0.18	11.76
1923-24	0	0	0.18	1.27	1.00	2.44	0.89	0	6.25	2.02	0.04	0	14.06

Precipitation Station: Wohlford Lake
Location: Section 5, T. 12 S., R. 1 W., S.B.B.&M.
Elevation: 1450 feet
Authority: Escondido Mutual Water Co.
Index No. 49
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1926-27	0	0	0	0	2.22	5.81	0.99	16.66	3.42	0.97	1.45	0.14	31.66
1927-28	0	0	0	1.55	2.65	5.64	0.77	2.75	1.15	0.10	0.60	0	15.01
1928-29	0	0.02	0	0.59	1.68	4.78	2.98	2.90	2.61	2.53	0	0	17.95
1929-30	0	0.22	0.80	0	0	0	7.80	1.35	5.56	0.82	7.03	0	21.56
1930-31	0.05	0	0	0.86	8.34	0	M	7.23	0.14	5.40	0.99	0	15.23*
1931-32	0	0.45	0	1.55	4.21	7.64	2.22	10.75	0.35	1.01	0.11	0.32	28.59
1932-33	0	0	0	2.04	0	4.69	6.66	0.24	0.38	2.74	1.37	0	17.98

* Partial Season

Precipitation Station: Rockwood Ranch
Location: Section 35, T. 12 S., R. 1 W., S.B.B.&M.
Elevation: 430 feet
Authority: L. D. Rockwood
Index No. 50
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1893-94	0	0	0	0.62	0.62	2.50	0.75	0.62	1.00	0	0	0	6.11
1894-95	0	0	0	0	0	3.88	10.25	1.00	0.12	0	0	0	15.25
1895-96	0	0	0	0	2.00	0.50	3.25	0	4.50	0	0	0	10.25
1896-97	0	0	0	1.25	0.75	2.00	3.75	4.50	2.00	0	0	0	14.25
1897-98	0	0	0	0.62	0	0	1.75	0.25	1.75	0	1.00	0	6.57
1898-99	0	0	0	0.50	0.	1.00	2.25	1.00	2.12	0	0	0	6.87

CONTINUED

Precipitation Station: Rockwood Ranch -- Continued
Location: Section 35, T. 12 S., R. 1 W., S.B.B.&M.
Elevation: 430 feet
Authority: L. D. Rockwood
Index No. 50
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1899-00	0	0	0	0.95	1.68	1.24	5.25	0	0.41	1.16	1.05	0	11.74
1900-01	0	0	0	0.15	3.06	0	1.68	5.22	0	0	1.90	0	11.94
1901-02	0	0	0	0.80	0.40	0	1.99	a) 2.64	4.02	0.50	0	0	a) 9.75
1902-03	0	0	0	0.25	2.27	1.89	0.82	5.45	2.79	3.53	0	0	14.98
1903-04	0	0	0	0	0	0	0.10	1.28	3.18	0.53	0.21	0	5.32
1904-05	0	0	0	0.60	0	1.58	3.05	6.60	6.46	0.86	0.90	0	19.94
1905-06	0	0	0	0	2.18	0.40	2.14	2.42	8.27	1.60	1.09	0	18.10
1906-07	0	0	0	0	1.26	4.38	4.77	1.30	3.17	0.25	0	0	15.13
1907-08	0	0	0	2.33	0.62	0.63	2.92	3.46	1.18	0.75	0.22	0	12.11
1908-09	0	1.60	0	0	0.60	0.78	6.12	3.72	2.00	0	0	0	14.72
1909-10	0	1.60	0	0	3.45	6.88	0.90	0.30	1.46	0	0	0	14.49
1910-11	0	[illegible]	0	0.97	1.41	0.35	4.55	4.88	1.83	0.71	0	0	14.68
1911-12	0	0	0.30	0.30	0.32	1.67	0.65	0	7.56	3.25	1.28	0	15.54
1912-13	0	0.78	0	1.16	0	0.28	1.75	3.71	1.11	0.67	0	0	9.46
1913-14	0	0	0	0	2.29	1.12	3.57	3.63	1.86	1.45	0	0	15.50
1914-15	0	0	0	1.20	1.16	8.32	6.92	3.19	1.21	4.37	2.12	0	24.69

a) Storm of February 2 not included.

Precipitation Station: Ramona (Verlaque)
Location: Section 15, T. 13 S., R. 1 E., S.B.B.&M.
Elevation: 1440 feet
Authority: R. L. Verlaque
Index No. 51
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1896-97	0	0	0	1.93	1.37	1.90	4.93	6.93	2.68	0	0	0	18.96
1897-98	0	0	0	1.55	0	0.94	5.25	0.25	1.95	0	1.35	0	9.51
1898-99	0	0	0	0	0.75	1.10	2.80	1.05	1.35	0	0	1.00	8.05
1899-00	0	0	0	0.75	1.50	1.25	4.05	0.15	0.85	1.80	1.90	0	13.05
1900-01	0	0	0	0	3.55	0	2.15	6.10	0.50	0	1.42	0	13.72
1901-02	0	0	0	0.40	0.37	0.10	2.35	2.85	3.50	0.80	0	0	10.35
1902-03	0.26	0	0	0.20	2.50	8.25	1.45	5.60	2.31	3.70	0.35	0	16.61
1903-04	0	0	0.15	0.55	0	0	0.32	2.26	4.25	0.63	0.35	0	8.31
1904-05	0	0	0	0.65	0	2.30	4.70	9.82	7.98	1.13	2.18	0	28.66
1905-06	0	0	0.52	0.20	5.50	1.13	2.50	4.17	11.80	2.10	1.13	0	28.65
1906-07	0	0.25	0.30	0.30	2.25	5.42	6.75	1.28	5.49	0.33	0.32	0.25	24.24
1907-08	0	0	0	3.69	0.45	1.10	3.04	3.94	1.92	0.77	0.47	0	17.50
1908-09	0	0	0.30	0.45	0.65	1.30	7.45	4.85	5.05	0	0	0	18.05
1909-10	0	1.10	0	0	5.85	7.50	3.25	0.65	2.07	0.45	0	0	18.57
1910-11	0	0	0	1.06	1.56	0.40	5.25	5.60	1.75	1.35	0	0	16.95
1911-12	a) 0.20	0	0.45	0.26	0	1.75	0.76	0	9.80	4.02	1.85	0.20	19.50
1912-13	0	0.33	0	1.55	0.80	0	2.50	4.79	1.40	0.30	0.37	0.30	11.84
1913-14	0.20	0	0	0.55	2.60	1.50	7.85	4.76	0.75	a) 2.02	0.30	0	20.52
1914-15	0	0	0	1.15	1.45	5.10	8.65	6.95	0.97	4.36	2.65	0	29.80
1915-16	0	2.85	0	0	1.50	4.18	21.95	1.00	1.60	0.15	0.15	0	35.18
1916-17	0.85												

(a) Estimated

Precipitation Station: Ramona (Sentinel)
Location: Section 15, T. 13 S., R. 1 E., S.B.B.&M.
Elevation: 1440 feet
Authority: 1911-1924-Ramona Sentinel
1924-1931-City of San Diego
Index No. 52
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1911-12					0	1.52	0.67	0	8.02	3.75	3.03	0	17.59*
1912-13	0	0.40	0	1.55	0.32	0	1.85	4.50	0.37	M	M	M	8.79*
1913-14	M	0	0.16	0.50	2.85	1.20	6.55	3.87	0.60	[illegible]	0.62	0	18.16*
1914-15	0	0	0	1.01	1.34	3.15	6.78	6.39	1.30	4.97	1.89	0	26.83
1915-16	0	2.91	0.10	0	1.20	5.81	21.59	1.50	1.60	0.15	0.15	0	33.09
1916-17	0.85	0.70	0	2.06	0.30	5.90	3.35	2.51	0.56	1.64	0.56	0	18.55
1917-18	0	0	0	0	0.57	0	1.78	2.90	7.61	0	0.55	0	13.89
1918-19	0	0	0	0.55	1.38	2.50	0.70	3.15	4.15	1.00	0.40	0	14.01
1919-20	0	0.10	0.28	0.70	1.35	1.55	1.45	5.20	5.60	0.80	0.25	0	17.28
1920-21	0	0	0	1.20	0.25	1.40	2.75	0.95	2.15	0.35	3.25	0	12.30
1921-22	0.05	0.05	1.60	1.15	1.06	14.45	3.35	4.45	3.40	1.10	0.95	0	33.60
1922-23	0.10	0	0	0.45	1.70	5.25	3.85	1.20	2.50	2.10	0	0.25	15.00
1923-24	0	0	0.10	1.40	1.05	1.70	0.15	0	6.30	1.95	0	0	12.65
1924-25	0	0	0	0.45	1.10	4.52	0.30	0.60	2.54	5.20	0	0.85	13.66
1925-26	0	0	0	3.97	1.50	1.10	1.50	2.80	0.60	10.85	0.20	0	24.52
1926-27	0	0	0	0.10	1.25	5.75	0.50	18.75	4.10	1.05	1.03	0.30	32.85

CONTINUED

Precipitation Station: Ramona (Sentinel)--Continued
Location: Section 15, T. 13 S., R. 1 E., S.B.B.&M.
Elevation: 1440 feet
Authority: 1911-1924-Ramona Sentinel
1924-1931-City of San Diego
Index No. 52
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1927-28	0.40	0	0	2.56	0.15	6.00	0.95	3.00	1.45	0.30	0.65	0	14.45
1928-29	0	0	0	0.40	1.13	2.70	8.62	2.05	2.70	1.80	0	0	13.40
1929-30	0	0	0.80	0	0	0	7.25	1.67	5.28	1.67	4.26	0	20.91
1930-31	0	0	0	0.90	2.90	0	2.30	6.85	0.25	3.05	1.20	0	17.45
1931-32	0	0.75	0.05	0.95									

* Partial Season

Precipitation Station: Santa Maria Damsite
Location: Section 11, T. 13 S., R. 1 W., S.B.B.&M.
Elevation: 1400 feet
Authority: San Diego County Water Co.
Index No. 54
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1913-14							5.83	4.05	0.93	2.21	0.70	0.38	
1914-15	0	0	0	1.09	1.15	4.01	3.76	5.85	2.10	8.65	2.81	0	28.42
1915-16	0	1.20	0.02	0	1.31	4.41	a) 3.75			0.13	0.12	0	

a) To January 10 only.

Precipitation Station: Escondido #3
Location: Section 22, T. 12 S., R. 2 W., S.B.B.&M.
Elevation: 660 feet
Authority: Escondido Land & Town Co.
Index No. 56
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1887-88	0	0	0	0.25	2.45	3.60	3.45	1.90	3.70	0.50	0	0	15.85
1888-89	0	0	0	0.62	3.08	5.70	1.75	1.07	5.75	0.50	0	0	18.47
1889-90	0	0	1.00	3.25	1.25	4.55	3.98	4.11	1.75	0.60	0.50	0	20.89
1890-91	0	0	0	0.75	0.50	3.00	0.10	8.57	0.78	1.25	0	0	14.95
1891-92	0	0	0	0	0.50	1.25	1.76	2.50	3.03	0.40	2.17	0	11.60
1892-93	0	0	0	0.01	2.60	1.50	2.20	3.00	8.63	0.42	0	0	18.56
1893-94	0	0	0	0.65	0.65	2.55	0.80	0.50	0.75	0	0	0	5.90
1894-95	0	0	0	0.10	0	4.51	10.26	1.25	1.35	0.75	0.35	0	18.57
1895-96	0	0	0	0.25	1.42	0.25	2.42	0	3.48	0.10	0	0	7.92
1896-97	0	0	0	2.30	1.05	1.85	3.95	4.75	1.60	0	0	0	15.50

Precipitation Station: Escondido #4
Location: Section 22, T. 12 S., R. 2 W., S.B.B.&M.
Elevation: 660 feet
Authority: San Diego Consolidated Gas and Electric Co.
Index No. 56
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1926-27							0.70	11.82	4.17	0.81	0.52	0	
1927-28	0	0	0	0.97	2.44	4.81	0.65	2.98	0.82	0	0	0	12.67
1928-29	0	0	0	0.16	1.17	2.33	2.32	1.96	1.87	1.90	0	0	11.71
1929-30	0	0	0.37	0	0	0	6.99	1.16	2.83	0.23	6.50	0	17.08
1930-31	0	0	0	0.29	2.35	0	2.94	4.79	0.07	2.15	0.55	0.19	13.33
1931-32	0	0.33	0	0.95	3.13	5.98	1.47	9.39	0.23	0.99	0.06	0.09	22.62
1932-33	0	0	0	2.20	0	5.14	5.49	0.16	0.13	2.06	0.96	0	16.14
1933-34	0	0	0.02	0.53	0	4.19	2.67	1.76	0.11	0	0	--	

Precipitation Station: Twin Oaks
Location: Section 25, T. 11 S., R. 3 W., S.B.B.&M.
Elevation: 700 feet
Authority: Major C. F. Merriam
Index No. 57
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1875-76	0	0	2.50	0	3.61	0.42	6.04	4.03	3.12	0.38	0.81	0	20.81
1876-77	0	0	0	0.05	0.16	0.07	3.80	2.87	1.00	0.42	0	0	8.57
1877-78	0	0	0.05	0.09	0.78	4.03	3.95	7.90	2.49	5.66	1.40	0.47	26.80
1878-79	0	0	0	0.28	0.35	0.98	3.26	1.34	0.41	1.59	0.18	0.33	8.72
1879-80	0	0	0	0.45	3.50	4.38	1.50	2.10	2.65	5.00	0.25	0	19.83
1880-81	0	0.10	0	0.75	0.75	4.05	0.91	0.70	2.75	0.66	0	0	10.67
1881-82	0	0	0.10	1.20	0.25	0.60	3.80	2.87	1.00	0.30	0.20	0	10.32
1882-83	0	0	0.08	0.68	0.84	0.20	1.03	1.40	1.30	0.87	1.30	0	7.70

CONTINUED

Precipitation Station: Twin Oaks--continued
Location: Section 25, T. 11 S., R. 3 W., S.B.B.&M.
Elevation: 700 feet
Authority: Major C. F. Merriam
Index No. 57
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1883-84	0	0	0	1.45	0	3.58	2.22	9.83	8.68	3.26	2.00	1.05	32.07
1884-85	0	0	0	0.30	0.48	4.96	0.45	0.60	0	2.61	0	0	9.40
1885-86	0	0	0	0	4.68	0.75	7.33	0.80	4.71	2.60	0	0	20.87
1886-87	0	0	0	0.20	2.72	0.20	0.12	4.73	0	1.85	0.70	0	10.52

Precipitation Station: Bernardo Bridge
Location: Section 10, T. 13 S., R. 2 W., S.B.B.&M.
Elevation: 370 feet
Authority: City of San Diego
Index No. 58
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1923-24				0.66	0.44	2.25	0.66	0.05	4.17	1.64			9.85*
1924-25													
1925-26						1.05	1.46	3.42	0.31	6.63	0.05	0	12.90*
1926-27	0	0	0	0.12	1.13	5.05	0.50	9.00	3.59	0.98	0.66	0	21.01
1927-28	0.02	0	0	1.68	0.20	4.64	0.99	0.96	1.65	0.37	0.95	0.12	11.58
1928-29	0	0	0	0	1.34	3.83	2.22	1.77	1.89	1.85	0	0	12.90
1929-30	0	0	0.58	0	0	0	6.39	1.19	3.33	2.34	2.56	0	16.39
1930-31	0	0	0	0.20	1.97	0	3.04	6.27	0.16	2.30	1.59	0	15.53
1931-32	0	0.16	0	1.14	2.71	5.55	2.70	8.20	0.59	0.88	0.43	0.09	22.45
1932-33	0	0	0	2.24	0	5.26	5.64	0.10	0.20	2.18	0.68	0.08	16.38
1933-34	0	0.10											

* Partial Season

Precipitation Station: Carrol Damsite
Location: Section 8, T. 13 S., R. 2 W., S.B.B.&M.
Elevation: 250 feet
Authority: San Diego County Water Co.
Index No. 59
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1914-15						5.72	7.88	4.71	2.05	3.31	2.08	0	25.75*
1915-16	0	0.03	0.02	0.04	0.80	4.03	14.91	1.27	1.94	M	0.21	0	23.25*
1916-17	0	0	0										

* Partial Season

Precipitation Station: Hodges Dam
Location: Section 18, T. 13 S., R. 2 W., S.B.B.&M.
Elevation: 350 feet
Authority: City of San Diego
Index No. 60
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1918-19								0.90	3.26	0.75	0.36	0.05	
1919-20	0.44	0.17	0.28	0.88	0.60	1.10	0.58	2.73	3.43	1.16	0.32	0.19	11.88
1920-21	0	0	0	0.80	0.54	1.23	2.92	1.33	1.10	0.03	2.64	0	10.59
1921-22	0.02	0.15	1.69	0.49	0.20	12.08	5.11	3.62	2.50	0.50	0.38	0.08	26.82
1922-23	0.02	0	0	0.26	0.84	1.86	2.31	2.25	1.50	1.85	0	0.16	11.05
1923-24	0	0	0.14	0.54	0.24	1.41	0.84	0	4.30	1.44	0	0	8.91
1924-25	0	0.05	0.02	0.56	1.03	4.59	0.48	0.96	1.76	2.37	0.04	0.50	12.36
1925-26	0	0	0	4.95	0.76	1.35	2.12	4.47	0.53	6.11	0.06	0	20.35
1926-27	0	0	0	0.45	1.34	5.21	0.88	9.37	3.59	0.77	0.70	0.23	22.54
1927-28	0	0	0	2.42	0.16	4.38	0.58	2.41	1.60	0.32	0.81	0.11	12.79
1928-29	0	0	0	0.45	1.20	3.38	2.17	1.51	1.60	1.56	0.03	0.20	12.10
1929-30	0	0	0.61	0	0	0	5.63	1.28	3.35	1.79	2.29	0	14.95
1930-31	0	0.05	0	0.31	1.93	0	2.57	6.04	0.08	2.49	1.17	0	14.64
1931-32	0	0.35	0.03	0.85	3.20	6.13	2.42	6.27	0.34	0.61	0.12	0.19	20.51
1932-33	0	0	0	1.94	0	5.11	5.47	0.12	0.28	1.78	0.63	0.07	15.40

Precipitation Station: San Dieguito Dam
Location: Section 16, T. 13 S., R. 3 W., S.B.B.&M.
Elevation: 250 feet
Authority: City of San Diego
Index No. 61
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1924-25			0.05	0	0.56	2.44	0.20	0.37	1.19	1.57	0.03	0.13	6.54*
1925-26	0	0	0	4.34	0.71								
1926-27							0.82	8.37	1.69	0.74	0.37	0.23	
1927-28	0	0	M	2.16	0.15	4.55	0.41	1.75	1.56	0.35	0.95	0.03	11.91*
1928-29	0	0	0	0.45	1.11	2.98	1.72	1.26	1.50	1.24	0	0	10.[illegible]

CONTINUED

TABLE B-2, (Continued) MONTHLY PRECIPITATION AT MISCELLANEOUS STATIONS IN SAN DIEGO COUNTY

Precipitation Station: San Dieguito Dam --Continued
Location: Section 16, T. 13 S., R. 3 W., S.B.B.&M.
Elevation: 200 feet
Authority: City of San Diego
Index No. 61
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1929-30	0	0	0.45	0	0	0							
1930-31		0.03					2.21	4.22	M	1.50	0.99	0.03	
1931-32	0	0.53	0.02	0.71	3.59	5.35	1.54	6.49	0.45	0.75	M	M	19.43*
1932-33	0	0	0	2.12	M	4.44	5.04	0.21	0.15	1.25	0.58	0.09	13.88*
1933-34	0	0.13											

* Partial Season

Precipitation Station: Santa Fe Ranch
Location: Section 32, T. 13 S., R. 3 W., S.B.B.&M.
Elevation: 55 feet
Authority: M. H. Crawford
Index No. 62
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1911-12							0	0	5.39	2.81	1.10	0	9.30*
1912-13	0.15	0	0	0	0.90	0	1.50	2.17	0.56	0	0	0	5.28
1913-14	0	0	0	0	1.80	0.60	4.19	3.48	0	0.48	0	0	10.55
1914-15	0	0	0	0.40	1.13	1.80	5.27	4.52	1.27	1.77	0.19	0	16.35

* Partial Season

Precipitation Station: Miramar
Location: Section 5, T. 15 S., R. 2 W., S.B.B.&M.
Elevation: 660 feet
Authority: (O.A.Riley - 1901-1915
(S.G.Erro - 1920-1934
Index No. 64
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1901-02	0	0	0	0.45	0.60	0	1.85	1.45	3.20	0.60	0.20	0	8.35
1902-03	0	0	0	0.45	3.05	2.85	1.30	3.20	1.60	1.30	0	0	13.75
1903-04	0	0	0	0.20	0	0.15	0.30	2.50	3.13	0.25	0.25	0	6.78
1904-05	0.80	0	0	0.30	0	2.45	3.55	6.95	2.60	0.45	0.90	0	18.00
1905-06	0	0	0.20	0.16	4.40	0.65	1.80	3.35	7.45	0.95	1.10	0.10	20.15
1906-07	0	0	0.25	0	1.05	5.25	3.85	0.80	2.35	0.10	0.30	0.28	14.23
1907-08	0	0	0	0.20	1.65	0.55	3.60	2.70	1.00	0.50	0.25	0	10.45
1908-09	0	0.50	0.35	0.35	1.05	0.75	4.67	3.17	2.32	0.	0.30	0	13.46
1909-10	0	0	0	0	3.45	5.90	3.50	0.46	2.05	0.30	0	0	15.65
1910-11	1.00	0	0	1.10	6.85	0.30	4.45	5.10	1.65	1.20	0	0.17	16.82
1911-12	0	0	0.10	0.22	0	1.50	0.97	0	5.90	3.15	1.20	0.20	13.24
1912-13	0	0.45	0	1.15	0.55	0.05	1.50	3.45	1.15	0.40	0.30	0.05	9.05
1913-14	0.05	0	0.15	0	2.15	1.20	5.36	3.45	1.00	1.05	0.30	0.35	15.05
1914-15	0	0	0	1.25	1.55	3.60	8.95	5.15	1.10	1.04	1.50	0	24.14
1920-21	0	0	0	0	0.16	0.78	2.89	1.14	1.03	0.49	2.91	0	9.40
1921-22	0	0	1.45	0.83	0.99	11.15	5.12	3.21	2.56	0.70	0	0	26.01
1922-23	0	0	0	0	1.82	2.57	3.43	0.89	1.20	1.83	0	0	11.74
1923-24	0	0	0	0	0.64	1.38	1.06	0	5.22	0	0	0	8.30
1924-25	0	0	0	0.60	0	1.24	0	1.55	1.08	2.73	0	0	7.20
1925-26	0	0	0	4.60	1.10	0.85	0	4.24	0	7.22	0	0	17.91
1926-27	0	0	0.50	0	0	4.01	0	7.90	0	0	0	0	12.41
1927-28	0	0	0	0	3.10	2.15	2.10	0.90	0	0	0	0	8.25
1928-29	0	0	0	0	1.46	5.52	2.25	1.51	1.78	1.30	0	0	11.82
1929-30	0	0	0	0	0	0	6.80	0.95	3.25	1.79	2.37	0	14.16
1930-31	0	0.44	0	0	1.55	0	3.13	5.84	0	5.04	0.75	0	14.75
1931-32	0	0	0	0.33	3.28	4.91	1.60	7.14	0	0.65	0	0	17.91
1932-33	0	0	0	2.93	0	4.24	6.49	0	0	1.66	0.55	0	15.87
1933-34	0	0	0	0	0	2.62	0.40	2.75	0.43	0	0	0.11	6.31

Precipitation Station: Scripps Pier
Location: Section 15, T. 15 S., R. 4 W., S.B.B.&M.
Elevation: 50 feet
Authority: Scripps Biological Institute
Index No. 65
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1924-25	0	0	0	0.34	0.37	1.16	0.09	0.30	1.28	1.96	0	0.21	5.71
1925-26	0	0	0	4.85	1.00	1.10	0.35	1.79	0.15	3.75	0	0	12.99
1926-27	0	0	0	0.41	0.47	3.94	0.46	6.38	2.11	0.48	0.16	0.04	14.44
1927-28	0	0	0.01	0.53	1.40	2.90	0.27	1.55	0.58	0.08	0.32	0.07	7.71
1928-29	0	0	0	0.10	0.98	2.48	1.15	0.64	0.44	0.82	0.05	0	6.66
1929-30	0	0	0.25	0	0	0	4.48	1.01	2.82	1.11	1.58	0.06	11.31

CONTINUED

Precipitation Station: Scripps Pier (Continued)
Location: Section 13, T. 15 S., R. 4 W., S.B.B.&M.
Elevation: 50 feet
Authority: Scripps Biological Institute
Index No. 65
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1930-31	0	0	0	0.16	1.58	0	2.97	3.57	0.04	2.03	0.72	0	11.07
1931-32	0	0.41	0.02	0.03	2.29	3.98	1.10	4.94	0.11	0.46	0.04	0.08	13.46
1932-33	0.03	0	0	2.24	0.14	2.37	4.26	0	0.05	1.25	0.40	0.16	10.90
1933-34	0	0.09	0	0.19	0.25	1.02	0.25						

Precipitation Station: La Jolla
Location: Section 23, T. 15 S., R. 4 W., S.B.B.&M.
Elevation: 100 feet
Authority: San Diego Consolidated G.&E. Co.
Index No. 66
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1926-27							0.36	7.00	2.73	0.49	0	0.52	11.10*
1927-28	0	0	0	0.45	1.83	3.34	0.35	1.63	0.50	0	0	0	8.10
1928-29	0	0	0	0.16	1.02	1.65	1.20	1.09	0.75	0.96	0.04	0	6.87
1929-30	0	0	0.26	0	0	0	3.70	0.82	2.97	0.20	2.53	0	10.48
1930-31	0	0	0	0.11	1.34	0	3.11	2.45	0	1.98	0.62	0.13	9.94
1931-32	0	0.25	0	0.06	2.54	3.88	1.10	5.86	0.08	0.21	0.03	0	14.01
1932-33	0	0	0	1.61	0	2.12	4.56	0	0.05	1.15	0.51	0.23	10.23
1933-34	0	0	0	0.17	0.21	1.47	0.62	1.50	0.11	0			

* Partial Season

Precipitation Station: Coronado
Location: Section 15, T. 17 S., R. 5 W., S.B.B.&M.
Elevation: 50 feet
Authority: San Diego Consolidated G.&E. Co.
Index No. 68
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1926-27							0.28	6.25	2.30	0.23	0.47	0.13	(9.66)*
1927-28	0	0	0	0.55	1.10	4.00	0.41	0.86	0.50	0	0	0.01	7.43
1928-29	0	0	0	0.05	0.60	1.28	0.96	1.08	1.22	0.65	0	0	5.84
1929-30	0	0	0.28	0	0	0	4.07	0.76	3.01	0.15	2.89	0	11.16
1930-31	0	0	0	0.20	0.72	0	4.17	4.32	0	1.48	0.50	0	11.39
1931-32	0	0.07	0	0.03	1.74	5.23	0.86	5.50	0.16	0.24	0.03	0	11.88
1932-33	0	0	0	1.03	0	2.60	4.41	0	0.10	1.58	0.43	0.07	10.22
1933-34	0	0	0	0.11	0.05	1.08	0.34	1.91	0.57	0	0	--	

* Partial Season

Precipitation Station: Otay
Location: Section 15, T. 18 S., R. 2 W., S.B.B.&M.
Elevation: 90 feet
Authority: G. O. Downes
Index No. 71
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1908-09	0	0	0	0.43	1.08	0.39	2.72	2.31	4.64	0.09	0	0	11.66
1909-10	0	0	0.02	3.79	5.40	2.54	0.50	1.44	0.49	0	0	0	14.18
1910-11	0	0	0	1.51	0.70	0.37	2.76	5.10	0.66	0.44	0	0	9.54
1911-12	0.07	0	0.22	0.25	0.19	1.20	0.49	0	5.17	1.93	0.12	0.19	9.81
1912-13	0.20	0.28	0	0.43	0.56	0	1.50	2.64	0.48	0.13	0.10	0.12	6.44
1913-14	0.04	0	0	0	1.96	0.92	3.47	2.07	0.70	0.36	0.18	0	9.70
1914-15	0	0	0.07	1.76	1.22	2.53	5.24	3.11	0.68	1.32	0.45	0	16.18

Precipitation Station: Bonita #1
Location: Section 36, T. 17 S., R. 2 W., S.B.B.&M.
Elevation: 110 feet
Authority: (O. A. Norton - 1899-1914
(R. M. Allen - 1914-1915
Index No. 72
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1899-00	0	0	0	0.56	1.21	0.79	0.45	0.05	0.47	0.99	1.45	0	5.77
1900-01	0	0	0	0.28	1.36	0	1.53	3.65	0.44	0	0.74	0	8.00
1901-02	0	0	0	0.37	0	0.11	1.94	1.57	2.61	0.32	0	0	6.72
1902-03	1.15	0	0	0.04	1.30	2.97	0.91	2.28	1.17	1.12	0	0	10.94
1903-04	0	0	0	0.14	0	0.12	0.12	1.98	2.05	0.21	0.27	0	4.89
1904-05	0	0	0	0.26	0	2.16	1.80	6.64	2.93	0.26	0.92	0	14.97
1905-06	0	0	0.69	0.30	4.12	0.58	1.12	2.32	5.69	1.77	8.79	0.07	17.45
1906-07	0	0	0	0	1.39	4.20	4.12	0.97	2.01	0.16	0	0	12.85
1907-08	0	0	0	1.79	0	0.37	3.50	2.96	1.14	0.42	0.16	0	10.34

CONTINUED

Precipitation Station: Bonita #1 (Continued) Elevation: 110 feet Index No. 72
Location: Section 36, T. 17 S., R. 2 W., S.B.B.&M. Authority: (O. A. Norton - 1899-1914 (R. M. Allen - 1914-1915 Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1908-09	0	0.72	0.08	0.20	1.00	0.56	3.73	2.21	3.55	0	0	0	12.15
1909-10	0	0	0	0	2.66	3.69	2.19	0.38	1.22	0.46	0	0	10.60
1910-11	0	0	0	0.87	0.84	0.20	2.97	3.47	0.76	0.50	0	0	9.61
1911-12	0	0	0.25	0.64	0	1.61	0.81	0	5.17	2.28	0.96	0.32	12.04
1912-13	0	0.15	0	0.75	0.38	0	1.88	2.78	0.64	0.17	0	0.12	6.87
1913-14	0	0	0	0	2.06	0.75	4.30	2.21	0.78	0.77	0.08	0	10.95
1914-15	0	0	0.08	1.06	0.81	2.24	4.64	3.32	0.95	1.73	0.71	0	15.54

See U. S. Weather Bureau Publications for continuation of record.

Precipitation Station: Bonita #8 Elevation: 60 feet Index No. 72
Location: Section 25, T. 17 S., R. 2 W., S.B.B.&M. Authority: (J. M. Vonlede (City of San Diego Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1913-14							3.28	1.88	0.68	0.75	0.11	0.01	
1914-15	0	0	0.10	0.80	0.78	2.35	4.37	2.62	0.95	1.52	0.67	0.01	13.97
1915-16	0	0	0	0	1.51	2.81	7.89	0.96	0.92				13.89*
1916-17													
1917-18							1.93	1.50	4.33	0	0.08	0.06	7.90*
1918-19	0	0.11	0.11	0.53	1.91		0.24	1.94	2.04	0.34	0.18		7.40*
1919-20							0.65	3.66	3.46	0.46	0.40		
1920-21				0.48	0.20	0.74	2.71	0.68	1.36	0.01	2.32		8.70*

Precipitation Station: Sweetwater Dam Elevation: 310 feet Index No. 75
Location: Section 17, T. 17 S., R. 1 W., S.B.B.&M. Authority: Sweetwater Water Co. Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1888-89	0	0	0.48	0.36	2.81	3.22	1.56	1.86	2.84	0.36	0.21	0.33	14.02
1889-90	0.01	0.09	0	2.60	0.10	8.05	2.26	2.73	0.74	0.13	0.41	0	17.12
1890-91	0	0.07	0.87	0	0.93	2.43	0.62	5.29	0.25	1.27	0.83	0.09	12.63
1891-92	0	0.03	0.04	0.02	0.13	1.75	1.57	3.47	1.20	0.28	1.46	0	9.95
1892-93	0	0.02	0	0.16	0.68	1.48	1.01	1.17	6.50	0.27	0.20	0	11.48
1893-94	0.16	0	0	0.33	0.84	2.08	0.36	0.71	1.69	0.04-	0.15	0	6.36
1894-95	0	0	0	0.04	0	3.03	10.06	1.09	1.18	0.79	0	0	16.19
1895-96	0	0	0.02	0.45	1.45	0.43	1.70	0	2.52	0.65	0.05	0	7.27
1896-97	0.06	0.11	0.04	0.69	1.14	1.69	5.11	2.95	2.27	0	0.06	0	12.07
1897-98	0	0	0	1.30	0.06	0.45	2.23	0.13	1.30	0.39	0.79	0	7.05
1898-99	0	0	0	0	0.07	0.76	2.40	0.70	0.89	0.23	0.11	0.38	5.74
1899-00	0	0	0	0.41	1.66	0.77	0.57	0	0.37	1.06	1.66	0	6.50
1900-01	0	0	0	0.28	1.63	0	1.76	4.22	0.04	0.11	0.74	0	9.24
1901-02	0	0	0.03	0.43	0.19	0	1.96	1.60	2.39	0.49	0	0	7.09
1902-03	0.90	0	0	0.11	1.29	2.80	0.77	2.41	1.28	0.89	0	0	10.45
1903-04	0	0	0	0.25	0	0.12	0.11	1.85	2.30	0.14	0.34	0	5.11
1904-05	0	0	0	0.34	0	2.15	3.02	6.02	3.47	0.36	1.05	0	15.40
1905-06	0.19	0	0.30	0.24	3.69	0.43	0.99	2.66	5.46	1.67	0.85	0	16.68
1906-07	0	0	0.25	0.03	1.20	4.37	3.67	0.56	2.35	0.18	0.08	0.39	13.08
1907-08	0	0	0	1.85	0.08	0.31	3.10	3.21	1.06	0.66	0.25	0	10.51
1908-09	0	0.67	0.56	0.48	0.82	0.70	4.06	2.07	2.73	0	0	0	12.09
1909-10	0.01	0	0	0	2.54	4.00	1.85	0.24	1.24	0.41	0	0	10.29
1910-11	0	0	0	1.05	0.74	0.20	2.86	3.54	2.07	0.80	0.01	0	11.27
1911-12	0.19	0	0.35	0.43	0.02	1.54	0.77	0	4.80	2.29	0.54	0.44	11.39
1912-13	0.02	0.24	0	0.83	0.48	0.04	1.52	3.02	0.65	0.13	0.12	0.13	7.17
1913-14	0.14	0.15	0	0	2.59	1.06	3.59	1.90	0.36	0.86	0.08	0	10.78
1914-15	0	0	0	1.05	0.86	2.21	4.91	3.62	0.33	1.15	0.28	0	14.41
1915-16	0	0	0	0	0.73	2.60	8.97	1.17	0.94	0.05	0.08	0	14.54
1916-17	0.05	0.04	0.22	1.27	0	1.60	4.36	2.60	0.61	1.34	0.49	0	12.58
1917-18	0	0	0	0.18	0.09	0	1.65	1.68	5.29	0	0	0	8.89
1918-19	0	0	0	0.55	2.40	1.66	0.75	1.95	1.59	0.52	0	0	9.42
1919-20	0	0	0.42	0.70	0.78	0.87	0.62	3.19	3.54	0.68	0.31	0	11.01
1920-21	0	0	0	0.38	0.46	0.75	2.50	0.22	1.38	0	2.78	0	8.67
1921-22	0	0.28	1.44	0.32	0.28	8.49	3.75	2.36	1.45	0.40	0.46	0	19.23
1922-23	0	0	0	0.13	0.97	2.39	1.91	2.00	1.10	1.01	0	0	9.51
1923-24	0	0	0	0.92	0.91	1.64	0.27	0	3.43	1.18	0	0	8.35
1924-25	0	0	0	0.26	0.90	1.86	0.10	0.48	2.01	2.05	0	0.45	8.09
1925-26	0	0	0	4.00	1.29	0.96	1.63	2.12	0.16	5.86	0	0	16.01
1926-27	0	0	0	0.21	0.44	4.28	0.03	7.48	2.41	0.47	0.30	0.17	15.79
1927-28	0	0	0	2.46	0.12	3.49	0.60	0.98	0.59	0.14	0.87	0.05	9.40

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Precipitation Station: Sweetwater Dam (Continued) Elevation: 310 feet Index No. 75
Location: Section 17, T. 17 S., R. 1 W., S.B.B.&M. Authority: Sweetwater Water Co. Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1928-29	0	0	0	0.70	1.34	2.19	1.36	1.60	1.37	1.24	0	0.01	9.81
1929-30	0	0	0.52	0	0	0.20	4.14	0.72	2.69	1.08	2.36	0	11.71
1930-31	0	0.06	0	0.38	1.59	0	3.25	4.19	0.04	1.53	0.58	0	11.42
1931-32	0	0.14	0	0.29	2.15	3.42	0.94	5.63	0.39	0.30	0	0.05	13.51
1932-33	0	0	0	0.96	0.	2.78	3.96	0.03	0.16	1.27	0.94	0.11	10.21
1933-34	0	0	0	0.16	0.12	1.03							

Precipitation Station: Chollas Heights Elevation: 570 feet Index No. 74
Location: Section 34, T. 16 S., R. 2 W., S.B.B.&M. Authority: City of San Diego Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1913-14							3.48	2.51	0.61	1.05	0.17	0.16	
1914-15	0	0	0	1.47	1.11	3.22	6.45	4.71	0.74	1.74	0.86	0.01	19.31
1915-16	0	0	0	0	1.31	2.81	11.11	0.97	0.81	0.13	0	0	17.16
1916-17	0.07	0.04	0.19	1.94	0.03	1.35	4.77	2.34	0.42	1.84	0.68	0	13.67
1917-18	0	0	0	0.10	0.10	0	1.80	1.86	6.00	0	0.04	0.05	9.95
1918-19	0	0.32	0.06	0.58	1.94	2.06	0.42	2.52	1.88	0.26	0.25	0	10.19
1919-20	0	0	0.26	1.15	0.76	0.51	0.69	3.53	3.17	0.66	0.30	0	11.03
1920-21	0	0	0.07	0.44	0.39	0.74	2.42	0.61	1.36	0.18	2.56	0	8.71
1921-22	0	0.12	0.51	2.06	0.81	9.68	5.98	2.79	1.56	0.33	0.44	0	21.58
1922-23	0	0	0	0.08	0.92	2.59	1.85	1.51	0.98	1.38	0	0.02	9.33
1923-24	0.01	0.08	0.17	0.59	0.37	6.00	0.53	0	3.04	1.65	0	0	8.24
1924-25	0	0.01	0	0.33	0.70	1.94	0.18	0.48	1.76	2.01	0.04	0.50	7.97
1925-26	0	0	0	4.02	1.07	1.71	0.41	3.41	0.41	6.68	0	0.09	17.80
1926-27	0	0	0	0.32	0.70	3.83	0.40	8.87	2.83	0.75	0.26	0.02	17.98
1927-28	0	0	0	2.80	0.02	3.15	0.60	0.96	0.78	0.13	0.77	0.	9.11
1928-29	0	0.02	0.02	0.11	1.11	2.87	1.60	1.31	1.76	0.71	0	0	9.51
1929-30	0	0	0.41	0	0	0	4.38	0.84	2.83	1.40	1.75	0	11.61
1930-31	0	0	0	0.09	1.69	0	3.64	6.34	0.09	2.23	0.47	0	14.55
1931-32	0	0.12	0	0.07	6.28	4.53	1.13	6.38	0.33	0.45	0	0	15.49
1932-33	0	0	0	1.32	0	3.09	4.78	0.06	0.16	1.46	0.88	0.09	11.84

Precipitation Station: Murray Dam Elevation: 500 feet Index No. 75
Location: Section 15, T. 16 S., R. 2 W., S.B.B.&M. Authority: LaMesa, Lemon Grove and Spring Valley Irrigation District Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1912-13							1.43	2.61	1.04	0.80	0.30	0.09	5.67*
1913-14	0.12	0	0	0	2.99	1.01	4.15	5.12	0.61	1.34	0.30	0.19	15.81
1914-15	0	0	0	1.55	1.17	2.67	6.50	6.14	1.24	2.63	1.12	0	22.02
1915-16	0	0.01	0.08	0	1.17	3.41	13.98	1.54	1.17	0.11	0.10	0	21.51
1916-17	0.21	0	0.36	2.11	0.10	1.98	4.91	2.58	0.47	2.05	0.45	0	15.22
1917-18	0	0	0	0.02	0.17	0	2.42	2.13	2.30	0	0.13	0	7.17
1918-19	0	0.17	0.09	0.51	2.41	1.22	0.35	1.91	1.87	0.39	0.17	0	9.09
1919-20	0	0	0.68	0.82	0.96	1.05	0.63	3.89	4.78	0.51	0.42	0	13.96
1920-21	0	0	0	0.49	0.30	0.66	2.89	0.51	1.54	0.10	2.80	0	9.29
1921-22	0	0.09	1.71	0.86	0.49	10.52	3.20	2.96	2.15	0.44	0.52	0	22.94
1922-23	0.03	0	0	0.15	1.30	2.48	2.14	2.18	1.21	1.82	0	0.07	11.38
1923-24	0	0.15	0.20	0.61	0.22	1.70	0.91	0	2.70	1.25	0	0	7.74
1924-25	0	0.09	0	0.41	0.66	1.92	0.25	0.63	2.05	2.25	0.03	0.61	8.86
1925-26	0	0	0	4.09	0.98	1.56	1.66	2.60	0.45	7.88	0	0	19.12
1926-27	0	0.04	0	0.45	0.65	3.81	0.21	9.75	2.72	1.70	0.38	0	19.71
1927-28	0	0	0	2.38	0.94	4.67	0.58	0.95	0.79	0.09	0.47	0.08	10.95
1928-29	0	0	0	0.10	0.99	2.60	1.68	1.49	1.66	0.72	0	0	9.16
1929-30	0	0	0.41	0	0	0	4.42	0.93	3.41	0.25	3.32	0	12.74
1930-31	0	0	0	0.17	1.56	0	2.85	5.91	0.05	1.90	0.47	0	12.91
1931-32	0	0.27	0.06	0.45	2.64	3.95	0.91	6.81	0.48	0.46	0	0	15.99
1932-33	0	0	0	1.68	0	3.33	4.69	0.09	0.09	1.40	0.66	0.08	12.14
1933-34	0	0.02											

* Partial Season

Precipitation Station: La Mesa
Location: Section 19, T. 18 S., R. 1 W., S.B.B.&M.
Elevation: 550 feet
Authority: San Diego Cons. G.&E. Co.
Index No. 76
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1926-27							0.24	10.01	2.03	1.13	0.24	0.08	
1927-28	0	0	0	1.77	1.22	3.25	0.58	1.07	0.34	0	0	0	9.43
1928-29	0	0	0	0.30	0.75	1.55	1.27	1.30	1.43	1.23	0	0.05	7.88
1929-30	0	0	0.44	0	0	0	4.83	0.48	3.02	0.40	3.80	0	12.94
1930-31	0	0	0	0.42	2.04	0	3.32	4.51	0	1.88	0.89	0	12.28
1931-32	0	0.18	0	0.20	2.58	4.35	1.40	7.16	0.50	0.39	0	0.08	16.84
1932-33	0	0	0	1.36	0	3.43	4.58	0.11	0	1.67	1.24	0	12.39
1933-34	0	0	0	0.08	0.22	1.68	0.49	2.35	1.00	0			

Precipitation Station: La Presa
Location: Section 9, T. 17 S., R. 1 W., S.B.B.&M.
Elevation: 300 feet
Authority: City of San Diego
Index No. 77
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1914-15	0	0	0	1.01	0.88	2.67	3.11	3.73	0.78	2.02	3.93	0	17.13
1915-16	0	0.05	0.02	0	1.29	2.88	9.67	0.96	1.39	0.04	0.09	0	16.39
1916-17	0.08	0.01	0.25	1.43									

Precipitation Station: Lower Otay Dam
Location: Section 7, T. 18 S., R. 1 E., S.B.B.&M.
Elevation: 500 feet
Authority: City of San Diego
Index No. 78
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1905-06							0.74	3.39	3.12	2.75	0.72	0	
1906-07	0	0.08	0	0.02	1.31	3.31	4.54	0.74	2.85	0.35	0.09	0.22	13.51
1907-08	0	0	0	0.78	0	0.35	4.35	2.52	2.00	0.73	0.06	0	10.78
1908-09	0	1.20	0.14	0.35	0.80	0	3.94	2.39	2.20	0	0	0	11.02
1909-10	0	0	0	0	1.50	4.74	1.85	0.05	1.36	0.62	0	0	10.22
1910-11	0	0	0	1.34	1.39	0.33	3.13	3.59	1.21	0.64	0	0	11.63
1911-12	0.03	0	0.16	0.24	0.06	1.19	0.79	0	7.29	2.49	1.13	0.29	13.67
1912-13	0.01	0.20	0	1.26	1.97	0.16	1.51	3.89	0.67	0.18	0.04	0.23	10.09
1913-14	0.10	0.05	0	0.01	2.17	1.63	2.98	2.17	0.88	0.78	0.15	0	10.89
1914-15	0	0	0	0.80	0.83	2.58	4.28	3.97	0.87	1.79	1.00	0	15.92
1915-16	0	0.18	0	0	0.78	2.68	9.91	0.98	1.36	0.27	0.19	0	16.28
1916-17	0	0	0	0	0	1.47	4.37	2.44	0.69	1.63	0.42	0	11.02
1917-18	0	0	0.01	0.08	0.19	0	1.13	1.88	4.42	0	0.20	0	7.91
1918-19	0	0.08	0	0.94	1.27	1.88	0.36	2.91	1.93	0.51	0.19	0	10.07
1919-20	0.02	0	0.29	0.29	1.26	1.13	0.72	3.76	3.57	0.87	0.59	0	12.30
1920-21	0	0	0	0.63	0.22	0.55	2.14	0.91	1.79	0.12	3.03	0.01	9.40
1921-22	0	0	0.35	2.47	0.51	8.44	3.84	2.93	2.02	0.48	0.35	0	21.39
1922-23	0	0	0	0.11	1.56	2.96	2.90	2.59	0.69	1.28	0	0.10	12.19
1923-24	0	0	0.18	0.58	1.00	2.68	0.58	0	4.27	2.05	0.03	0	11.35
1924-25	0	0	0	0.61	0.75	2.39	0.13	0.70	1.83	2.81	0.16	0.37	9.78
1925-26	0.10	0	0	3.72	1.71	1.20	0.31	3.66	0.68	4.40	0.12	0.09	15.99
1926-27	0	0.01	0	0.40	0.30	5.43	0.56	9.06	4.09	0.82	0.98	0.20	21.85
1927-28	0	0	0	2.56	0.14	3.69	0.39	0.82	0.86	0.28	0.28	0	8.98
1928-29	0	0	0	0.52	0.64	2.31	1.82	1.56	1.61	0.75	0	0	9.41
1929-30	0	0	0.85	0	0	0	4.16	0.62	3.99	1.90	2.80	0	14.12
1930-31	0.01	0.01	0	0.36	1.63	0	4.20	4.72	0.06	1.80	0.64	0	13.33
1931-32	0	0.28	0	0.02	3.42	3.64	2.19	3.42	0.30	0.65	0	0.08	16.00
1932-33	0	0	0	0.62	0	3.19	4.43	0.14	0.29	1.98	0.81	0.06	11.52

Precipitation Station: Harvey Ranch
Location: Section 4, T. 18 S., R. 1 E., S.B.B.&M.
Elevation: 514 feet
Authority: City of San Diego
Index No. 79
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1913-14							3.77	2.74	0.72	0.98	0.15	0	
1914-15	0	0	0.03	0.84	1.00	2.62	4.01	3.66	0.94				
1916-17													
1917-18							1.45	2.10	5.37	0.01	0.12	0.02	
1918-19	0	0.24	0	1.67	2.07	2.05	0.27	3.79	2.40	0.96	0.15	0	13.60
1919-20	0.03	0	0.54	0.81				3.17	3.14				
1920-21							3.30	1.18	1.55a				

a. Partial Month

Precipitation Station: Upper Otay Dam
Location: Section 36, T. 17 S., R. 1 W., S.B.B.&M.
Elevation: 550 feet
Authority: City of San Diego
Index No. 80
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1916-17		0				1.53	4.30	2.74	.49	1.31	0.33	0	
1917-18	0	0	0	0.03	0.17	0	1.37	1.81	4.72		0.25	.01	8.36
1918-19		.09	0.01	0.73	1.54	1.90	0.69	3.75	1.88	0.80	0.10	0	11.49
1919-20	0.02	0.06	0.50	1.19	1.19	1.14	1.21	3.73	4.45	.69	0.43	0	14.61
1920-21	0	0.01	0.29	0.55	0.21	.73	2.71	.73	1.34	.10	3.01	0	9.68
1921-22	0	0	0	1.76									
1922-23													
1923-24							0.36	0					
1924-25													
1925-26					1.42	1.30	0.20	3.28	.44	4.49	.02	0	11.15*
1926-27	0	0	0	M	M	3.71	0.79	12.15	3.90	0.73	0	0	23.28*
1927-28	0	0	0	1.49	0.09	4.46	0.36	.92	.77	0.23	0.47	0	0.99
1928-29	0	0	0	0.61	1.21	2.50	2.46	1.70	2.19	"	0	0	10.67*
1929-30	0	0	M	0	0	0	3.37	0.65	3.91	0.40	4.81	0	15.14*
1930-31	-	0	0	0.37	2.48	0	4.06	4.70	0.15	1.98	-	0	13.74*
1931-32	0	0	0	-M	3.29	4.37	.78	5.53	0.19	0.78	0	0.05	14.99*
1932-33	0	0	0	0.80	0	3.28	4.82	0.08	0.14	1.98	1.50	0.07	12.07
1933-34	0	0	0										

* Partial Season

Precipitation Station: Grossmont
Location: Section 16, T. 18 S., R. 1 W., S.B.B.&M.
Elevation: 640 feet
Authority: LaMesa, Lemon Grove and Spring Valley Irrigation District
Index No. 81
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1899-00	0	0	0	0.62	1.35	0.81	1.28	0	0.70	1.39	1.45	0	7.60
1900-01	0	0	0.01	0.31	2.76	0	2.90	6.06	0.70	0.75	0.19	0	13.68
1901-02	0	0	0	0.39	0.37	0.27	2.44	2.90	2.24	0.20	0.17	0	8.98
1902-03	0.96	0	0	0.20	2.17	2.70	1.07	2.77	1.83	1.53	0.04	0	13.17
1903-04	0	0	0.03	0.04	0	0.10	0.18	1.83	3.00	0.12	0.23	0	5.53
1904-05	0	0	0	0.23	0	3.21	2.69	7.76	4.05	0.42	1.23	0	19.59
1905-06	0	0	0.35	0.12	3.08	0.65	1.35	2.08	6.64	1.78	0.63	0	16.68
1906-07	0	0	0.42	0	1.35	4.91	4.40	0.96	3.24	0.31	0.20	0.35	16.14
1907-08	0	0	0	1.07	0.40	0.66	3.57	3.46	1.35	0.82	0.42	0	11.75
1908-09	0	0.90	0.41	0.07	0.11	0.73	3.47	2.99	3.10	0.05	0.05	0	13.88
1909-10	0	0.18	0	0.02	3.06	5.83	2.38	0.22	1.80	0.45	0	0	15.94
1910-11	0.47	0	0	0.99	1.10	0.25	4.57	4.72	1.41	1.27	0	0.06	14.84
1911-12	0.27	0	0.10	0.24	0.05	1.53	0.74	0	7.58	2.66	0.59	0.42	14.18
1912-13	0	0.24	0	0.44	0.46	0	1.70	3.21	1.12	0.21	0.29	0.11	7.78
1913-14	0.20	0	0	0	3.79	1.07	4.30	3.72	0.53	1.61	0.20	0.11	15.58
1914-15	0	0	0.03	1.28	1.08	3.36	7.34	6.53	1.86	2.94	1.61	0	26.01
1915-16	0	0.08	0	0	1.24	4.48	11.26	2.47	1.14	0	0.16	0	20.83
1916-17	0.19	0.02	0.29	1.98	0.04	2.23	3.27	3.09	0.48	2.03	0.47	0	16.09
1917-18	0	0	0	0	0.10	0	2.05	2.63	7.84	0	0.10	0	12.72
1918-19	0	0.04	0	0.67	2.23	1.62	0.27	1.93	2.29	0.46	0.15	0	9.66
1919-20	0	0	0.27	1.15	1.03	1.29	0.87	4.48	5.72	1.06	0.37	0	16.24
1920-21	0	0	0.12	0.79	0.30	0.82	3.28	0.66	1.26	0.21	2.98	0	10.44
1921-22	0	0	1.62	0.91	0.30	12.42	3.69	3.42	2.45	0.33	0.53	0	25.77
1922-23	0	0	0	0.23	1.31	2.81	1.85	1.48	1.50	1.88	0	0.03	11.29
1923-24	0	0	0.26	0.45	0.18	2.15	1.07	0	3.58	2.16	0	0	9.85
1924-25	0	0.09	0	0.41	0.85	2.62	0.30	0.79	2.07	2.82	0	0.75	10.70
1925-26	0	0	0	5.46	1.16	1.58	1.57	2.34	0.99	8.77	0	0	21.86
1926-27	0	0	0	0.40	0.58	4.84	0.22	11.22	2.59	2.02	1.70	0.14	23.71
1927-28	0	0	1.51	0	1.13	3.82	0.87	1.53	0.76	0	0.67	0	10.31
1928-29	0	0	0	1.03	1.16	2.74	-a-	-a-	0.97	0.89	0	0	6.78*
1929-30	0	0	0.60	0	0	0	3.44	0.95	3.77	0.84	5.28	0	16.28
1930-31	0	0	0	0.36	2.34	0	2.62	3.28	0.05	2.53	0.91	0	14.09
1931-32	0	0.24	0	0.48	3.58	5.06	0.94	8.54	0.30	0.42	0	0	19.36
1932-33	0	0	0	1.82	0	3.95	5.12	0.07	0.10	2.36	0.91	0.08	14.39

* Partial Season

Precipitation Station: El Cajon #1 | Elevation: 482 feet | Index No. 82
Location: Section 11, T. 16 S., R. 1 W., S.B.B.& M. | Authority: T. J. Cox | Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1882-83	0	0	0.09	0.20	0.49	0.29	0.83	1.71	1.09	1.10	1.04	0	6.84
1883-84	0	0	0	1.67	0.10	8.64	1.89	9.66	7.05	3.58	2.63	0.40	29.65
1884-85	0	0	0	0.24	0.13	6.48	0.54	0.58	0.75	1.88	0.28	0	10.88
1885-86	0	0	0	0.08	1.67	0.47	7.29	2.90	2.11	2.26	0	0	16.78
1886-87	0	0	0	0.13	1.91	0.20	0	4.47	0.15	1.97	0.13	0	8.97
1887-88	0	0	0	0	2.33	3.07	3.62	1.30	4.17	0.36	0	0	14.85
1888-89	0	0	0.35	0.65	2.16	4.16	1.54	2.40	4.44	0.33	0.28	0	16.31
1889-90	0	0.18	0	3.77	0.18	8.54	2.38	2.89	0.68	0.05	0.21	0	18.88
1890-91	0	0	0.91	0.05	0.80	2.56	0.60	6.14	0.89	1.35	1.01	0	14.29
1891-92	0	0	0	0	0.11	2.05	1.34	3.19	2.04	0.26	1.89	0	10.87
1892-93	0	0	0	0.35	1.02	1.10	1.26	1.39	7.96	0.32	0.08	0	13.48
1893-94	0	0	0	0.31	0.97	2.12	0.59	0.84	1.79	0	0.22	0.15	6.99
1894-95	0	0	0	0	0	3.16	11.32	1.06	1.62	0.17	0.18	0	17.61
1895-96	0	0	0	0.68	1.58	0.28	1.79	0.04	3.27	0.40	0.13	0	8.17

Precipitation Station: El Cajon #B | Elevation: 480 feet | Index No. 82
Location: Section 11, T. 16 S., R. 1 W., S.B.B.&M. | Authority: San Diego Cons. G.&E. Co. | Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1926-27							0.58	11.66	2.55	1.34	0.21	0	(16.34)*
1927-28	0	0	0	1.38	0.86	3.65	0.53	1.32	0.33	0	0	0	8.26
1928-29	0	0	0	0.48	1.00	1.21	1.82	1.69	1.49	0.61	0	0	8.30
1929-30	0	0	0.33	0	0	0	4.45	0.67	3.36	0.21	3.88	0	12.90
1930-31	0	0	0	0.44	1.87	0	2.88	5.81	0.02	1.70	0.89	0	13.61
1931-32	0	0.12	0	0.30	2.61	5.14	1.22	8.17	0.31	0.44	0	0.02	18.33
1932-33	0	0	0	1.64	0	3.77	4.91	0.07	0.14	2.08	0.94	0.07	13.62
1933-34	0	0.04	0	0.09	0.43	1.96	0.65	2.31	0.70	0			

* Partial Season

Precipitation Station: El Cajon Valley | Elevation: 670 feet | Index No. 84
Location: Section 24, T. 16 S., R. 1 W., S.B.B.&M. | Authority: LaMese, Lemon Grove and Spring Valley Irrigation District | Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1901-02						0.45	2.11	2.21	2.45	0.37	0.08	0	7.67*
1902-03	0.68	0	0	0.23	1.74	2.45	0.35	3.02	1.20	1.46	0.05	0	11.17
1903-04	0	0	0.01	0.17	0	0	0.18	1.91	2.21	0.15	0.33	0	4.96
1904-05	0	0	0	0.32	0	2.13	2.18	3.67	4.07	0.22	0.97	0	15.56
1905-06	0	0	0.40	0	3.92	0.46	0.83	1.76	5.08	1.72	0.39	0	14.56
1906-07	0	0	0.19	0	0.95	2.73	4.24	0.65	2.67	0.32	0.06	0.23	12.04
1907-08	0	0	0	1.75	0.96	0.17	3.93	2.95	1.20	0.58	0.19	0	11.83
1908-09	0	0.71	0.21	0.89	0.82	1.67	3.14	2.30	3.06	0	0.06	0	12.88
1909-10	0	0.09	0	0	2.81	4.17	1.95	0.20	1.69	0.16	0	0	11.07
1910-11	0.22	0	0.10	1.81	0.86	0.27	3.59	2.99	0.90	0.61	0	0	11.35
1911-12	0	0	0.62	0.18	0.05	1.27	0.27	0	0	1.97	1.03	0.72	6.01
1912-13	0	0.25	0	0.86	0.41	0	1.42	2.78	1.12	0.15	0.25	0.13	7.37
1913-14	0.15	0.14	0.02	0.02	3.01	0.62	4.73	3.60	0.59	1.26	0.31	0.09	14.74
1914-15	0	0	0.09	1.21	1.14	3.15	5.58	5.28	1.08	2.35	1.25	0	21.09
1915-16	0	0.01	0	0	1.08	3.35	16.48	1.54	2.10	0.18	0	0	24.74
1916-17	0.13	0.06	0.45	1.38	0.02	2.21	4.48	3.40	0.44	1.19	0.75	0	14.61
1917-18	0	0	0	0	M	0	1.24	2.46	5.05	0	0.05	0	8.81*
1918-19	0	0	0	0.39	1.91	M	0.28	3.30	2.16	0.97	0.07	0	9.08*
1919-20	0	0	0.44	0.96	1.03	0.90	0.81	4.25	4.98	0.72	0.15	0	14.24
1920-21	0	0	0.20	0.78	0.28	0.79	2.30	0.81	1.25	0.10	3.29	0	9.80
1921-22	0	0.17	1.67	0.84	0.22	9.98	4.40	3.08	2.42	0.47	0.55	0	23.80
1922-23	0.08	0	0	0.35	1.24	2.87	1.40	1.37	1.75	1.92	0	0.06	11.04
1923-24	0.15	0.05	0.20	0.25	0.18	1.78	0.88	0	4.44	2.01	0	0	9.94
1924-25	0	0	0	0.16	0.81	2.64	0.37	0.80	2.09	2.61	0	0.79	10.47
1925-26	0	0	0	3.13	1.17	1.03	1.32	1.76	0.88	7.03	0.05	0	18.37
1926-27	0	0	0	0.35	0.60	5.13	0.24	10.60	2.28	1.01	0.50	0.23	20.94
1927-28	0	0	0	3.38	0.88	4.26	0.44	1.71	0.69	0	0.61	0	10.87
1928-29	0	0	0	0.89	0.95	2.88	2.35	1.83	1.92	1.19	0	0	12.01
1929-30	0	0	0.94	0	0	0	5.33	0.72	3.25	0.26	4.65	0	15.15
1930-31	0	0	0	0.39	2.32	0	2.63	4.23	0.04	1.67	0.38	0	11.84
1931-32	0	0.41	0	0.42	2.67	5.47	1.04	7.71	0.40	0.58	0	0.17	18.87
1932-33	0	0	0	1.46	0	4.24	4.79	0.07	0.12	2.04	1.12	0.07	13.91

* Partial Year

Precipitation Station: Jamul | Elevation: 1040 feet | Index No. 85
Location: Section 4, T. 17 S., R. 1 E., S.B.B.&M. | Authority: City of San Diego | Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1903-04						0.15	0.22	1.83	3.97	0.53	0.49	0	7.19*
1904-05	0	0.28	0	0.56	0	1.90	3.47	9.58	4.27	0.65	1.30	0	21.91
1905-06	0	0.30	0.32	0	4.70	0.44	1.47	2.82	9.29	2.82	1.25	0.05	23.46
1906-07	0	0	0.47	0	1.77	6.19	3.46	0.87	3.08	0	0.22	0.40	16.46
1907-08	0	0	0										
1912-13	M	0.44	M	1.07	1.06	M	2.20	1.54	1.42	0.27	0.27	M	6.27*
1913-14	M	M	M	M	2.44	1.54	5.43	3.62	1.08	1.09	0.17	0	15.39
1914-15	0	0	0.11	0.81	1.16	3.13	6.57	4.85	1.49	2.70	1.66	0	22.47
1915-16	0	0	0	0	0.48	M	17.76	1.01	1.82	M	0	0	21.07*
1916-17	0	0	0.60	1.26	0	2.38	4.93						
1917-18							1.69	2.21	7.15	0	0	0	
1918-19	0	0	0	1.80	2.26	2.58							
1919-20				0.85	1.43	1.17	1.22	2.93	5.24				12.86*

* Partial Season

Precipitation Station: Jamul Ranch | Elevation: 800 feet | Index No. 86
Location: Section 14, T. 17 S., R. 1 E., S.B.B.&M. | Authority: City of San Diego | Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1911-12							0.60	0	10.34	2.83	1.15	0	
1912-13	0	0	0	0.90	0.80	0	M	4.96	1.44	0.19	0.18	0	8.47*
1913-14					2.53	1.22	4.69	3.54	0.90	1.15	0.20	0	14.23*
1914-15	0	0	0	0.87	0.92	2.37	6.67	4.18	2.48	2.68	1.90	0	22.07
1915-16	0	0.13	0	0	1.04	3.76	21.13	1.41	1.36	0.11	0.06	0	29.20
1916-17	0.49							3.35	0.58	1.85			

* Partial Year

Precipitation Station: Los Padres Ranch | Elevation: 490 feet | Index No. 87
Location: Section 16, T. 16 S., R. 1 E., S.B.B.&M. | Authority: 1901-1911 U.S.G.S. W.S.P.446; 1912-1915 M.O.Allen | Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1901-02	0	0	0.20	0.30	0.50	0.40	3.10	2.60	3.30	0.30	0	0	10.70
1902-03	0.70	0	0	0.90	1.25	2.40	0.76	3.50	1.06	1.30	0	0	12.05
1903-04	0	0	0.30	0	0.35	2.50	0.10	2.33	3.22	0.28	0.23	0	9.28
1904-05	0	0	0.40	0	0	2.83	3.27	9.62	5.05	0.58	0.66	0	22.43
1905-06	0	0	0.20	0.45	4.85	0.70	1.32	2.93	7.73	2.16	1.19	0	21.51
1906-07	0	0	0.36	0	2.26	0.27	3.12	1.50	3.73	0.39	0.30	0	18.92
1907-08	0	0.46	0	1.67	0.87	0	5.05	3.71	1.77	1.09	0.98	0	15.50
1908-09	0	1.28	0.49	0.76	0.82	1.82	5.33	3.58	6.55	0	0	0	19.83
1909-10	0	0	0.36	0	3.49	5.02	3.63	0.57	2.57	0.33	0	0	15.97
1910-11	0	0	0.34	0.81	1.46	0.40	4.02	3.05	1.39	1.02	1.02	0	15.71
1911-12													
1912-13	0	0	0.70	0	0.70	0	1.60	4.02	1.00	0	0	0	8.02
1913-14	0	0	0	0	2.30	1.06	4.70	3.97	0.70	1.05	0.17	0	14.16
1914-15	0	0	0	1.06	1.42	2.76	6.05	5.66	1.08	1.94	2.30	0	22.27

Precipitation Station: Dehesa | Elevation: 580 feet | Index No. 88
Location: Section 14, T. 16 S., R. 1 E., S.B.B.&M. | Authority: City of San Diego | Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1913-14										2.05	0.14	0.17	
1914-15	0	0	0.09	0.98	1.69	2.66	5.84	5.62	1.38	1.97	5.36	0	25.59
1915-16	0	0.41	0	0	0.83	3.61	19.36	0					

Precipitation Station: Lakeside — Elevation: 500 feet — Index No. 89
Location: Section 18, T. 15 S., R. 1 E., S.B.B.&M. — Authority: San Diego & Southeastern Ry. — Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1909-10	0	0	0	0	3.06	3.96	3.76	0.35	1.72	0.10	0	0	12[illegible]
1910-11	0	0	0	0.75	1.00	0.43	3.56	4.95	1.38	0.77	0	0	12.84
1911-12	0	0	0.50	0.16	0	1.72	0.50	0	6.77	3.22	0.85	0.70	14.41
1912-13	0	0.22	0	0.62	0	0	1.87	3.37	0.98	0.43	0.20	0.04	7.73
1913-14	0	0.04	0	0	2.62	1.06	4.46	3.02	0.54	1.24	0.19	0.02	13.19
1914-15	0	0	0.03	1.03	1.60	3.04	5.82	3.98	1.12	2.17	1.82	0	20.61

Precipitation Station: Los Coches — Elevation: 710 feet — Index No. 90
Location: Section 28, T. 15 S., R. 1 E., S.B.B.&M. — Authority: LaMesa, Lemon Grove and Spring Valley Irrigation District — Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1900-01						9.34				0.50	0.47	0	(10.31)*
1901-02	0.02	0	0	0.22	0.32	0.08	2.35	2.03	3.44	0.49	0.06	0	9.01
1902-03	0.61	0	0	0.40	1.73	2.38	1.13	3.20	1.96	1.21	0.05	0	12.67
1903-04	0	0	0.13	0.19	0	0.12	0.25	2.35	2.53	0.20	0.75	0	6.52
1904-05	0	0	0	0.51	0	1.98	2.52	9.77	4.70	0.46	1.03	0	20.97
1905-06	0	0	0.93	0.25	4.08	0.60	1.23	1.98	6.36	1.56	0.83	0.01	17.85
1906-07	0	0.04	0.35	0.05	2.09	5.78	4.58	0.93	2.69	0.16	0.16	0.12	16.95
1907-08	0	0	0	1.44	0.56	0.48	3.98	3.44	1.48	0.68	0.19	0	12.25
1908-09	0	0.52	0.65	0.53	0.65	1.38	4.01	2.77	2.50	0.06	0.03	0	13.10
1909-10	0	0.27	0	0.03	3.17	4.78	2.25	0.43	2.15	0.10	0	0	13.18
1910-11	0.10	0	0.03	0.68	0.99	[illegible].43	4.18	3.71	1.19	0.65	0	0	11.96
1911-12	0.10	0	0.08	0.28	0.06	1.44	0.47	0	6.94	2.62	1.20	0.54	13.63
1912-13	0	0.38	0	0.74	0.58	0	1.37	3.47	0.87	0.22	0.26	0.22	8.31
1913-14	0.10	0.22	0.01	0.04	2.80	0.89	4.80	4.10	0.74	1.32	0.16	0.12	15.30
1914-15	0	0	0.09	1.03	1.60	2.96	6.43	5.91	1.38	2.62	1.34	0	23.36
1915-16	0	0.07	0	0	0.73	3.34	14.36	1.61	1.83	0.29	0.10	0	22.33
1916-17	0.22	0.08	0.28	1.61	0.03	2.15	4.73	3.21	0.39	1.96	0.81	0	15.49
1917-18	0	0	0	0.04	0.33	0	1.48	3.35	7.27	0	0.10	0	12.57
1918-19	0.07	1.40	0	1.00	1.58	2.45	0.24	2.96	2.57	0.64	0.20	0	13.11
1919-20	0	0	0.61	1.25	1.16	1.17	0.87	4.21	4.71	0.66	0.41	0	15.06
1920-21	0	0	0.10	0.77	0.23	0.75	2.47	0.87	1.37	0.06	3.07	0	9.69
1921-22	0	0	1.65	0.87	0.25	10.62	4.93	3.46	2.49	0.63	0.44	0	25.34
1922-23	0.05	0	0	0.31	1.39	2.43	1.66	1.17	1.20	1.37	0	0.10	9.68
1923-24	0	0	0.16	0.40	0.19	1.87	0.82	0	4.62	1.90	0	0	9.95
1924-25	0	0	0	0.32	0.56	2.44	0.25	0.76	1.82	2.81	0	0.69	9.65
1925-26	0	0	0	4.64	1.56	1.55	1.01	2.48	0.50	7.33	0.13	0	19.20
1926-27	0	0	0	0.42	0.50	4.18	0.35	10.97	2.70	1.31	0.30	0	20.73
1927-28	0	0	0	3.03	0.93	3.37	0.47	1.43	0.81	0	0.36	0	10.40
1928-29	0	0	0	0.55	1.03	2.65	1.91	1.75	1.21	1.17	0	0	10.27
1929-30	0	0	0.48	0	0	0	3.52	1.93	4.20	0.40	5.70	0	18.25
1930-31	0	0	0	0.58	1.83	0	2.24	5.07	0.03	1.73	0.66	0	12.14
1931-32	0	0.50	0	0.30	2.55	4.36	1.20	7.15	0.18	0.60	0	0.12	16.96
1932-33	0	0	0	1.52	0	4.23	5.15	0.09	0.12	1.79	0.99	0.06	13.93

Precipitation Station: Chocolate Creek — Elevation: 760 feet — Index No. 91
Location: Section 8, T. 15 S., R. 2 E., S.B.B.&M. — Authority: LaMesa, Lemon Grove and Spring Valley Irrigation District — Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1898-99									1.70	0.16	0	0.53	
1899-00	0	0	0	0	2.45°	1.00	2.99	0	0.96	2.06	1.65	0	11.11
1900-01	0	0	0	0.15	4.08	0	2.88	8.08	1.20	0.60	0.63	0	17.62
1901-02	0	0	0	0	0.40	0.05	3.19	2.26	4.33	0.85	0.06	0	11.14
1902-03	0.36	0	0	0.35	1.95	2.21	1.78	4.08	2.03	1.45	0.06	0	14.27
1903-04	0	0	0.14	0.17	0	0	0.30	2.87	3.65	0.40	0.24	0	7.77
1904-05	0	0	0	0.52	0	2.04	4.07	9.61	3.76	0.44	1.32	0	23.76
1905-06	0	0	0.81	0.07	3.38	1.15	1.96	4.43	8.68	1.59	1.30	0.05	25.42
1906-07	0	0.26	0.49	0.06	1.96	3.98	5.30	1.33	3.41	0.62	0.23	0.43	20.34
1907-08	0	0	0	1.92	1.18	0.71	4.16	4.73	2.11	1.38	0.47	0	16.66
1908-09	0	0.67	0.64	1.20	0.80	0.69	8.17	4.42	3.36	0.28	0.05	0	20.28
1909-10	0	0.89	0	0	3.55	6.56	2.79	0.87	2.48	0.33	0	0	17.47
1911-12	0	0	0.12	0.30	0.10	1.84	0.53	0-	9.75	3.10	1.67	0.50	17.91
1912-13	0.04	0.63	0	1.03	0.80	0	2.38	5.03	1.43	0.49	0.56	0.22	12.43

CONTINUED

° Since July 1st.

Precipitation Station: Chocolate Creek (Continued) — Elevation: 760 feet — Index No. 91
Location: Section 8, T. 15 S., R. 2 E., S.B.B.&M. — Authority: LaMesa, Lemon Grove and Spring Valley Irrigation District — Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1913-14	0.05	0.12	0	0.04	3.13	1.86	5.50	5.22	0.97	2.47	0.20	0.17	19.73
1914-15	0	0	0.06	1.09	1.22	3.07	6.51	7.56	1.45	3.89	2.20	0	27.05
1915-16	0	1.37	0	0	0.99	3.64	19.81	1.90	2.33	0.32	0.22	0	30.58
1916-17	0.19	0.01	0.29	1.82	0.05	3.17	5.03	4.35	0.72	2.55	1.36	0	19.54
1917-18	0	0	0	0	0.48	0	2.63	3.08	7.22	0	0.03	0.03	13.47
1918-19	0.10	0.70	0	1.07	2.11	2.13	0.19	4.27	3.12	1.05	0.07	0	14.81
1919-20	0	0	0.45	1.18	1.43	1.42	0.68	4.75	5.15	0.64	0.13	0	15.83
1920-21	0	0	0.02	0.61	0.09	1.09	2.18	1.10	1.29	0.15	3.21	0	9.74
1921-22	0	0.04	0.28	1.54	0.26	9.44	4.63	3.49	3.28	1.25	0.53	0	24.74
1922-23	0.04	0.02	0	0.55	1.44	3.12	1.91	1.55	1.39	2.12	0	0.12	12.26
1923-24	0	0	0.13	0.38	0.43	2.09	0.60	0	4.12	2.44	0	0	10.19
1924-25	0	0	0	0.51	0.71	2.98	0.40	0.95	1.54	3.32	0	1.02	11.43
1925-26	0	0	0	4.63	1.27	1.64	1.45	2.66	0.34	7.85	0.06	0	20.10
1926-27	0	0	0	0.44	1.14	4.64	0.92	14.32	3.72	1.67	0	0.12	26.97
1927-28	0	0	0	2.72	1.20	3.87	0.77	1.83	0.96	0.14	0.47	0	11.96
1928-29	0	0	0	0.35	1.58	2.21	2.39	3.09	2.56	1.51	0	0	13.69
1929-30	0	0	0.16	0	0	0	5.91	1.31	4.02	0.46	4.33	0	16.19
1930-31	0	0	0	0.38	2.06	0	2.55	4.71	0.04	2.64	0.92	0	13.30
1931-32	0	0.15	0	0.43	2.95	4.36	1.68	6.60	0.12	0.39	0	0.07	16.75
1932-33	0	0	0	1.16	0	3.86	4.61	0.13	0.24	2.71	1.22	0.03	13.95

Precipitation Station: Camp Denny — Elevation: 1450 feet — Index No. 92
Location: Section 11, T. 16 S., R. 2 E., S.B.B.&M. — Authority: Sweetwater Water Co. — Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1929-30	0	0	0	0	0	0	6.39	1.18	4.03	0.90	4.02	0	16.52
1930-31	0.15	0.07	0.02	0.38	2.39	0	3.00	4.00	0.15	2.34	1.50	0	14.00
1931-32	0.12	0.26	0	0.74	3.34	5.98	2.37	7.77	0.46	1.01	0	0.20	22.25
1932-33	0	0	0	1.38	0.83	3.99	6.13	0.33	0.31	2.78	0.95	0	16.70
1933-34	0	0	0.01	0.11	0.27	2.20							

Precipitation Station: Japatul — Elevation: 2800 feet — Index No. 93
Location: Section 9, T. 16 S., R. 3 E., S.B.B.&M. — Authority: R. J. Krause, City of San Diego — Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1913-14										1.17	0.54	0.17	
1914-15	0.16	0	0.11	0.79	1.08	3.95	8.06	6.33	2.02	3.24	3.14	0	28.88
1915-16	0	0.14	0.14	0	1.43	3.49	23.95	1.37	2.86	0.53	0.17	0	34.08
1916-17	0.58	0.13	1.06	1.49	0.03	3.74	M	M	.66	3.05	0.64	0	
1917-18	0.03	0	0	0.06	0.40	0	1.91	3.07	8.12	0.03	0.11	0.16	13.89
1918-19	0.76	0.30	0.01	1.45	2.62	2.31	0.17	5.39	3.15	1.20	0.63	0	17.97
1919-20	0.57	0.12	0.71	0.91	3.07	1.31	1.42	6.81	6.43	0.97	0.51	0	22.83
1920-21	0	0.23	0.31	1.38	0.21	1.26	3.04	1.15	1.68	0.48	4.37	0.01	14.12
1921-22	0.78	0.09	0.39	2.84	0.39	13.93	6.40	3.65	3.71	1.86	0.88	0	34.92
1922-23	0.05	0.08	0.15	0.48	2.14	3.41	3.07	2.62	1.81	2.34	0.05	M	16.40*

* Partial Season

Precipitation Station: Willows — Elevation: 2300 feet — Index No. 94
Location: Section 25, T. 15 S., R. 2 E., S.B.B.&M. — Authority: J. F. Jordan — Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1913-14									0.97	1.98	0.16	0.21	
1914-15	0	0	0.06	1.33	1.16	3.43	7.06	7.33	1.50	3.42	3.52	0	28.91
1915-16	0	0.60	0	0	1.37	4.10	27.18	1.10	3.69	0.43	0.21	0	38.58
1916-17	1.25	0	0.30	1.98	0.10	3.23	6.53	4.07	0.87	2.52	1.48	0	22.33
1917-18	0.24	0	0	0.14	0.72	0	2.40	2.43	8.97	0	0.22	0.18	15.30
1918-19	0.15	0.71	0	3.08	1.99	3.16	0.36	5.73	3.15	0.70	0.98	0	20.01
1919-20	0.36	0.19	0.25	2.50	5.88	1.80	1.69	8.48	7.73	1.35	0.40	0	28.63
1920-21	0	0	0	1.99	0.22	1.38	3.06	1.92	2.69	0.68	4.10	0	16.04
1921-22	0	0	1.30	1.17	0.40	13.61	6.09	3.34	2.96	1.80	0.61	0	31.88
1922-23	0	0	0	0.88	1.54	6.30	2.69	2.36	2.30	2.44	0	0.42	18.93
1923-24	0	0	0	0	2.13	3.24	1.17	0.07	7.36	3.23	0	0	17.40
1924-25	0	0	0	0.[illegible]	0	4.54	1.99	1.44	3.26	3.64	0.32	0	17.72

CONTINUED

Precipitation Station: Willows (continued) — Elevation: 2300 feet — Index No. 94
Location: Section 25, T. 15 S., R. 2 E., S.B.B.&M. — Authority: J. F. Jordan — Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1925-26	0	0	0	4.52	1.65	1.83	0.56	4.45	1.44	11.81	0.46	0	26.62
1926-27	0	0.22	0	0.02	1.49	3.59	1.12	16.71	5.38	4.31	1.21	0.80	34.85
1927-28	0	0	0	2.40	0.37	5.17	0.78	3.13	0.95	0.20	0	0	13.00
1928-29	0	0	0	0.68	1.86	3.49	2.48	2.81	3.71	1.78	0	0	16.81
1929-30	0	1.08	0.50	0	0	0	7.42	1.33	4.54	0.49	0	0	15.36
1930-31	0	0	0	0.75	3.20	0	2.98	6.19	0	2.23	1.72	0.08	17.15
1931-32	1.90	0.62	0	0.73	3.64	7.86	2.62	10.09	0.67	1.07	0	0.40	29.60
1932-33	0	0	0	1.18	0	6.78	6.82	0	0	3.69	1.40	0	18.87

Precipitation Station: Viejas — Elevation: 2400 feet — Index No. 95
Location: Section 20, T. 15 S., R. 3 E., S.B.B.&M. — Authority: City of San Diego — Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1914-15								8.09	0.84	4.01	2.93	0	
1915-16	0	0	0	0	1.37	4.10							
1926-27		0.20		0.17	1.05	4.10	0.63	17.13	1.57				
1927-28				2.26	0.17	4.12	0.61	1.89	1.20	0.11	0.84		

Precipitation Station: Diverting Dam — Elevation: 840 feet — Index No. 96
Location: Section 11, T. 14 S., R. 2 E., S.B.B.&M. — Authority: LaMesa, Lemon Grove and Spring Valley I.D. — Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1898-99							4.07°	0.78	1.61	0.09	0.01	0.53*	7.09*
1899-00	0	0	0	0.80	1.65	0.90	3.95	0.00	0.37	1.62	1.18	0	10.52
1900-01	0	0	0	0.07	4.33	0	2.72	6.69	1.28	0.44	1.03	0	16.56
1901-02	0	0.03	0	0.25	0.37	0	2.70	2.26	4.22	0.78	0.02	0	10.63
1902-03	0.40	0	0	0.35	2.24	2.11	1.21	4.37	3.20	2.25	0.08	0	16.21
1903-04	0	0	0.19	0.11	0	0	0.27	2.25	3.76	0.30	0.23	0	7.09
1904-05	0	0	0	0.25	0	1.30	2.97	10.06	6.55	0.95	2.38	0	24.46
1905-06	0	0	0.38	0	3.43	0.98	1.66	4.10	11.97	1.75	1.32	0	25.59
1906-07	0.11	0.95	0.66	0.64	2.20	7.10	6.01	1.71	4.07	0.40	0.19	0.34	24.38
1907-08	0	0	0	2.74	0.26	0.50	4.06	3.99	1.84	0.99	0.65	0	15.05
1908-09	0	0.58	0.57	0.35	0.62	0.93	6.71	4.50	3.06	0.06	0	0	16.38
1909-10	0.52	0.68	0	0	2.82	5.93	3.41	0.51	2.68	0.30	0	0	16.85
1910-11	0.11	0	0.28	1.10	1.62	0.75	5.27	4.09	1.47	1.10	0	0	15.79
1911-12	0	0	0	0.30	0.10	1.13	0.44	0	9.53	3.29	1.84	0.53	17.16
1912-13	0.03	0.36	0	1.05	0.61	0	2.36	3.91	1.40	0.19	0.19	0.08	10.18
1913-14	0.11	0.11	0.11	0.04	2.99	1.11	5.69	4.11	0.81	2.32	0.34	0.20	17.94
1914-15	0.02	0	0	1.30	1.09	3.34	6.62	6.35	1.65	2.86	2.30	0	25.53
1915-16	0	0	0	0	1.10	3.21	16.65	0	0	0.30	0.14	0	21.30
1916-17	0.44	0.15	0.31	1.67	0.06	2.49	4.62	2.55	0.73	2.72	0.46	0	16.20
1917-18	0	0	0	0	0.56	0	2.40	2.68	8.17	0	0.15	0.01	13.87
1918-19	0	0	0	1.63	2.33	2.21	0.18	5.54	3.73	0.92	0.47	0	17.01
1919-20	0.13	0	0.98	1.04	2.11	1.23	0.86	5.38	5.79	0.63	0.09	0	18.24
1920-21	0	0	0.04	1.42	0.07	0.90	2.63	1.05	2.05	0.18	3.79	0	12.13
1921-22	0.22	0.06	0.25	2.27	0.34	14.47	5.82	3.93	3.87	0.69	1.02	0	32.94
1922-23	0.02	0	0	0.36	0.90	4.24	2.12	1.75	1.68	1.04	0	0.05	12.16
1923-24	0	0	0.31	0.69	0.85	2.03	0.68	0	6.78	1.61	0	0	11.95
1924-25	0	0	0	0.73	0.78	2.92	0.46	0.95	2.41	3.54	0.05	0.51	12.35
1925-26	0	0	0	4.81	1.41	1.16	1.53	2.37	0.37	8.00	0.05	0	19.70
1926-27	0	0.10	0	0.30	1.02	6.18	0.88	17.70	3.38	1.44	0.80	0.29	32.09
1927-28	0	0	0	2.21	1.10	4.45	0.70	1.69	1.68	0.13	0.34	0	12.30
1928-29	0	0	0	0.54	0.92	2.75	2.62	2.52	2.82	2.08	0	0	14.25
1929-30	0	0.16	0.51	0	0	0	7.14	1.42	4.40	0.50	4.46	0	18.59
1930-31	0	0	0	0.67	2.50	0	1.97	5.75	0.12	2.56	1.06	M	14.63*
1931-32	0	0.34	0.12	0.62	2.70	6.29	1.76	8.68	0.32	0.60	0	0.05	21.48
1932-33	0	0	0	2.70	0	5.24	5.64	0.08	0.09	2.91	1.44	0.05	18.15

* Partial Season
° Total since July 1st.

Precipitation Station: Boulder Creek — Elevation: 2990 feet — Index No. 97
Location: Section 11, T. 14 S., R. 3 E., S.B.B.&M. — Authority: San Diego County Water Co. — Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1914-15						12.77	[illegible]	10.29	2.80	6.44	4.89	0	46.23*
1915-16	0	0.08					31.51	2.36	3.83	0.69	0.45	0	38.92*
1916-17		0.29	0.37	3.05	0.05	4.09	7.29	4.63	1.58	4.74	1.98	0	28.07*

* Partial Season

Precipitation Station: Schilling — Elevation: 4550 feet — Index No. 99
Location: Section 32, T. 13 S., R. 4 E., S.B.B.&M. — Authority: San Diego County Water Co. — Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1912-13						0.04	1.06	5.61	M	1.05	0.51	0.29	
1913-14	0.86	1.35	0.60	0.14	5.66	2.46	8.08	5.94	1.68	2.70	0.17	0.46	30.10
1914-15	0	0.20	0.08	0.83	1.41	5.35	11.09	9.83	0.96	4.94	3.90	0	38.59
1915-16	M	M	0.76	0	1.25	5.12	33.00	1.89	4.40	0.10	0.25	M	46.77*
1916-17	0.50	0.40	M	3.67	M	2.76	7.56	6.60	1.25	3.80	0.30	0.07	26.91*
1917-18	1.50	0.22	0.73	0	1.05	M	3.35	4.48	12.65	0	0.21	1.00	25.19*
1918-19	1.10	0.83	1.20	0.65	3.25	3.30	0.27	6.58	3.97	M	M	M	21.09*

* Partial Season

Precipitation Station: Pine Hills Hotel — Elevation: 4100 feet — Index No. 100
Location: Section 13, T. 13 S., R. 3 E., S.B.B.&M. — Authority: San Diego County Water Co. — Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1913-14	M	1.45	M	0.10	7.80	2.75	10.20	7.65	2.10	4.00	0	0.50	36.55*
1914-15	0.67	0	0.30	1.85	1.20	5.96	11.05	13.0	2.88	6.20	M	0	43.11*
1915-16	0	1.24	0.12	0	2.54	6.64	33.74	3.07	3.74	0.85	[illegible]	M	52.60*

* Partial Season

Precipitation Station: Cuyamaca East — Elevation: 4600 feet — Index No. 102
Location: Section 34, T. 15 S., R. 4 E., S.B.B.&M. — Authority: San Diego County Water Co. — Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1912-13	0.84					0.04	2.52	6.20	1.86	1.03	0.22	0.13	
1913-14	0.72	0.21	2.10	0.22	3.18	1.75	4.86	5.16	1.05	0.77	0.50	0.10	20.62
1914-15	0	0.46	0.43	0.46	1.38	3.53	8.74	6.81	1.01	3.22	2.44	0	28.48
1915-16	M	M	0.10	0	1.15	3.39	25.30	1.42	2.69	M	0.17	M	34.22*
1916-17	1.31	0.80	0.29	1.95	0.01	2.33	4.12	6.05	1.27	2.53	0.57	0.02	21.25
1917-18	2.50	M	0.39	0	0.43	M	2.75	4.22	9.59	0	0.20	1.30	21.41*
1918-19	0.13	1.48	0.40	0.81	2.40	2.48	0.15	4.98	2.19	M	M	M	15.00*

* Partial Season

Precipitation Station: Harper Ranch — Elevation: 4600 — Index No. 103
Location: Section 19, T. 14 S., R. 5 E., S.B.B.&M. — Authority: E. A. Harper, City of San Diego — Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1914-15						3.32	8.41	5.79	1.99	3.19	3.09	0.19	
1915-16	0	1.47	0.31	0	1.05	3.23	24.20	1.70	3.80	0.12	0.40	0	36.28
1916-17	0.57	1.44	0.18	1.86	0.03	3.90	M	M	0.62	2.29	M	0	
1917-18	2.57	0.02	0.73	0.01	0.28	0	2.88	2.97	11.05	0.01	0.33	0.16	20.41
1918-19	0.54	1.62	0.22	1.03	2.73	2.62	0.13	3.66	2.45	0.64	0.43	0	16.29
1919-20	3.30	0.05	0.27	1.89	3.19	1.29	2.63	7.11	6.76	1.11	0.24	0	27.84
1920-21	0.61	0.56	1.48	2.21	0.21	1.26	3.33	1.46	2.51	0.63	3.01	0.01	17.28
1921-22	0.72	0.54	1.11	1.92	0.47	16.68	5.34	1.55					
1924-25						6.90	0.52	0.80	2.57	3.83	0.28	0.40	
1925-26	1.15	0	0	4.84	2.07	2.17	5.29	3.13	0.86	10.39	0	0	27.90
1926-27	0	0.20	0	0	1.90	12.28	1.49	26.11	0	1.10	0	0	43.08
1927-28	0	0	0	0	0	13.28	[illegible]	1.77	2.40	0.22	1.10	0	19.59

CONTINUED

Precipitation Station: Harper Ranch (Continued) Elevation: 4800 Index No. 103
Location: Section 19, T. 14 S., R. 6 E., S.B.B.&M. Authority: E. A. Harper, City of San Diego Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1928-29	0	0	0	0.65	1.60	2.75	4.97	2.03	4.44	2.17	0.03	0	18.64
1929-30	0	1.88	6.41	0	0	0	6.64	1.76	3.42	0	5.51	0	25.62
1930-31	0	0.50	0	0.33	4.64	0	2.16	6.24	0.17	2.66	1.33	0.45	18.68
1931-32	0.15	0.67	0.44										

Precipitation Station: Nobles' Mine Elevation: 4200 feet Index No. 104
Location: Section 17, T. 15 S., R. 5 E., S.B.B.&M. Authority: City of San Diego Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1912-13							3.70	5.60	1.95	0.60	0.30	0.17	
1913-14	0.45	0.74	0.33	0.21	2.29	1.60	5.73	4.15	1.31	2.28	0.30	0.15	19.64
1914-15	0.45	0.30	0.68	0.97	0.98								
1915-16													
1916-17						4.60	6.65	4.41	1.10	3.12	1.53	0	21.41*
1917-18	2.47	0	0.15	0.01	0.61	0	2.71	2.37	8.49	0.05	0.32	0.39	17.57

* Partial Season

Precipitation Station: Laguna Ranger Station Elevation: 5475 feet Index No. 105
Location: Section 3, T. 15 S., R. 5 E., S.B.B.&M. Authority: City of San Diego Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1914-15						5.75	12.32	6.84	0.36	8.27	0.45	0	
1915-16	0	1.45	0	0	1.45		6.21*						

* Partial Month

Precipitation Station: Laguna Elevation: 5440 feet Index No. 106
Location: Section 15, T. 15 S., R. 5 E., S.B.B.&M. Authority: Arch Campbell Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1894-95	1.15	2.83	0	0	0	9.97	17.44	8.87	2.70	0	0.45	0	37.41
1895-96	0	0	0	M	6.40	#	3.55	#	5.60	1.55	0.23	0	17.35*
1896-97	1.50	3.83	0	3.35	2.48	2.74	3.60	1.08	0	0	0	0	18.58
1897-98	0	0	0.05	2.60	0	1.80	#	#	8.10	#	4.44	0	16.87
1898-99	0	0	0	0	M	M	#	#	#	16.00	0	0	16.00*
1899-00	0	0	0	1.85	2.70	1.65	3.30	0.37	1.00	5.80	2.19	0.30	17.16
1900-01	0	0	0.20	0.40	6.20	0	5.80	8.60	0.95	0.71	2.09	0	24.75
1901-02	0.42	1.25	0	1.42	0.54	0.38	0.40	0.55	8.15	1.05	0.11	0.21	12.85
1902-03	2.32	0	0	0.48	3.23	2.95	#	2.00	M	3.20	0.54	0.15	14.87*
1903-04	0	0.45	1.08	0	0	0.05	0.55	M	6.00	2.00	0.50	0	10.63*
1904-05	1.67	6.95	0.21	0.57	0								

* Partial Season
\# Included in following measurement

Precipitation Station: Hurlburd Ranch Elevation: 3450 feet Index No. 108
Location: Section 13, T. 15 S., R. 3 E., S.B.B.&M. Authority: B. R. Hurlburd Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1889-90													31.30a
1890-91													30.25a
1891-92													20.60a
1892-93	0	0	0	0	1.50	2.00	3.01	2.64	14.07	0.50	0	0	23.72
1893-94	0.75	0	0.25	1.25	5.15	4.38	2.16	3.40	3.63	1.15	0.50	0.38	20.98
1894-95	0.12	0.15	0	0	0	7.62	19.52	2.78	3.15	0.64	0.63	0	34.55
1895-96	0	0	0	0.37	4.37	1.00							

a. Season September to September

Precipitation Station: Gillette Ranch (1) Elevation: 3500 feet Index No. 110
Location: Section 1, T. 16 S., R. 3 E., S.B.B.&M. Authority: C. O. Griffin Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1919-20	0	0	0	0	1.00	2.27	2.19	7.78	9.24	1.84	0.81	0	25.13
1920-21	0	0	0	2.46	0	2.16	4.61	2.85	3.49	1.04	5.01	0	21.61
1921-22	0	0	0	3.55	.47	16.57	7.30	4.41	4.15	2.07	1.32	0	39.84
1922-23	0	0	0	1.06	2.77	8.28	3.95	2.31	2.36	4.88	0	0	23.61
1923-24	0	0	0	1.85	0	3.49	1.17	0	7.63	3.17	0	0	17.31
1924-25	0	0	0	.85	1.55	6.19	.67	1.97	3.57	5.14	.30	1.75	21.99
1925-26	0	0	0	4.65	2.17	1.49	.82	4.79	1.07	11.57	0	0	26.56
1926-27	0	0	0	1.05	1.51	7.65	1.62	19.85	6.08	1.45	0	0	39.21
1927-28	0	0	0	2.81	.25	6.32	1.27	2.95	1.76	.82	.80	0	16.98
1928-29	0	0	0	.52	1.99	4.23	3.61	4.06	4.61	1.95	0	0	20.97
1929-30	0	0	.70	0	0	0	9.13	2.18	5.38	.40	5.78	0	23.57
1930-31	0	0	0	.65	4.02	0	3.54	6.09	0	3.28	1.36	0	18.94

(1) Located approximately 1 mile south of U.S.W.B. gage called Descanso and located at Ellis Ranch, Sec. 25, T. 15 S., R. 3 E.

Precipitation Station: Descanso Valley Elevation: 3600 feet Index No. 111
Location: Section 19, T. 15 S., R. 4 E., S.B.B.&M. Authority: O. O. Bremner, City of San Diego Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1913-14										1.09	0.33	0.29	
1914-15	0.82	0	0.11	1.56	0.75	4.82	9.03	9.83	2.04	5.32	5.33	0	40.31

Precipitation Station: Descanso Ranger Station Elevation: 3400 feet Index No. 111
Location: Section 24, T. 15 S., R. 3 E., S.B.B.&M. Authority: U. S. Forest Service Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1915-16							30.67	2.08	4.37	0.64	0.34	0	
1916-17	0.68	1.67	1.37	1.77	0				1.22	5.00	2.47	0	
1917-18	0.37	0.30	0.04	0.02	M	0	2.63	3.18	11.66	0	0.45	2.45	21.06*
1918-19	1.38	0.20	0	1.58	3.55	3.91	0.44	6.67	4.04	1.70	1.10	0	24.57
1919-20	0.45	0	0.30										
1929-30							11.05	2.86	5.75	1.24	6.79	8	
1930-31	0	0	0.05	1.05	3.37	0	3.73	8.14	0.34	3.44	1.35	0	23.45
1931-32	1.05	0.19	0	1.58	4.79	9.36	3.53	12.63	0.78	2.09	0.41	0.78	36.96
1932-33	0	0	0	1.98	0	7.90	8.88	0.41	0.36	5.42	2.76	0.19	27.[illegible]
1933-34	0.06	0	0.10	0.18	0.85	4.36	2.13	5.86	1.04	0.20	0.01		

* Partial Season

Precipitation Station: Pine Valley Elevation: 3700 feet Index No. 112
Location: Section 27, T. 15 S., R. 4 E., S.B.B.&M. Authority: City of San Diego Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1898-99												2.00	11.81
1899-00	M	M	M	2.37	3.00	0.87	2.50	0.75	1.16	3.85	2.25	0	16.75*
1900-01	0	0	M	0.50	8.40	M	3.05	10.40	1.15	0.55	1.35	0	25.40*
1901-02	0	0	0	1.13	0.22	0.35	6.36	5.40	5.50	1.20	0.10	0	20.98
1902-03	0.60	0	0	0.27	3.45	2.67	1.50	6.43	2.25	4.42	0.48	0	25.09
1903-04	0	0	0.12	0.38	0	0	0.70	2.80	7.10	1.25	1.00	0	13.35

* Partial Season

Precipitation Station: Buckman Springs Elevation: 3430 feet Index No. 113
Location: Section 20, T. 16 S., R. 5 E., S.B.B.&M. Authority: City of San Diego Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1912-13					0.53	0.46	2.94	5.59	0.96	0.13	0.07	0.04	
1913-14	0.34	1.45	0.17	0.14	M	1.51	M	M	1.05	1.73	0.[illegible]	0.03	
1914-15	0.70	0	0.68	0.91	0.68	5.06	8.76	6.63	1.67	2.53	2.93	0	30.47
1915-16	0	0.26	0	0	1.23	3.67							

Precipitation Station: Hook's Ranch
Location: Section 29, T. 16 S., R. 5 E., S.B.B.&M.
Elevation: 3200 feet
Authority: City of San Diego
Index No. 114
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1913-14											0	0	
1914-15	0	0	0	0.07	0.63	4.17	7.84	5.93	2.40	3.09	3.45	0	28.38
1915-16	0	0	0.27	0	1.22	3.48	23.79	0.77	4.64	0.25	0.16	0	36.58
1916-17	1.00	0.60	0.30	1.23	0.06	3.59	6.25	3.75	1.70	3.25	1.13	0	22.86
1917-18	0.85	0.30	0.60	0.20	0.30	0	2.02	3.03	10.51	0.11	0.17	0.10	18.19
1918-19	1.50	2.35	0	1.61	2.50	3.35	0.04	5.59	3.47	1.31	0.17	0	21.89
1919-20	1.40	0.10	0.42	1.40	4.69	1.47	1.92	8.70	7.15	1.25	0.50	0	29.00
1920-21	0.20	2.53	0.65	1.80	0.25	1.22	3.97	1.35	2.06	0.83	3.41	0	18.29
1921-22	0.95	1.80	0.26	1.45	0.40	15.37							

Precipitation Station: La Posta
Location: Section 1, T. 17 S., R. 5 E., S.B.B.&M.
Elevation: 3300 feet
Authority: City of San Diego
Index No. 115
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1914-15							7.75	6.06	2.03	2.37	2.78		
1915-16	M	M	0	M	0.95	3.06	23.09	1.34	3.35	0.08	0.21	0	32.06*
1916-17	0.76	0	0.88	0.95	0	2.46	4.55	3.64	0.81	2.77	0.97	0	17.79
1917-18	1.00	0	0.02	0	0.41	0	1.98	2.96	10.22	0.05	0.07	0.34	17.05
1918-19	2.32	3.84	0.39	1.40	1.62	3.07	1.01	4.61	3.84	0.64	0.12	0	22.86
1919-20	0.17	0.69	M	1.18	3.50	1.12	1.40	5.40	6.09	0.88	1.13	0	23.56*
1920-21	0.27	1.48	0.46	1.93	0.15	0.84	3.58	1.10	1.62	0.76	2.70	0	14.87
1921-22	1.75	0.38	0.24	2.17	0.25	14.66							

* Partial Season

Precipitation Station: Origeby's Ranch
Location: Section 8, T. 18 S., R. 5 E., S.B.B.&M.
Elevation: 2690 feet
Authority: A. B. Origeby, City of San Diego
Index No. 117

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1912-13								5.50	2.32	0.40	0	0.24	
1913-14	0.35	2.42	M	M	2.20	1.38	5.49	4.33	1.02	2.23	0.64	0	20.08*
1914-15	1.32	0	0.05	0.81	0.86	4.36	7.31	6.15	2.16	2.28	3.28	0	28.58
1915-16	0.81	0	0	0	1.23	3.94	23.15	0.69	3.76	0.24	0.11	0	33.95
1916-17	1.18	0	0.19	0.92	0	2.99	3.51	M	0.93	2.93	0.73	0	15.38*
1917-18	0.47	0	0.76	0.03	0.42	0	1.94	3.20	7.15	0.05	0.23	1.09	15.34
1918-19	0	3.20	0.60	0.45	2.35	2.88	0.16	6.48	3.82	1.11	0.05	0	21.10
1919-20	0.42	0	0.17	1.14	4.02	0.99	2.14	7.39	7.27	0.96	0.73	0	25.23
1920-21	0	1.67	0.25	1.25	0.13	0.87	3.26	0.78	2.31	0.54	3.47	0	14.53
1921-22	2.27	0.79	0.28	2.84	0.51	13.02							

* Partial Season

Precipitation Station: Morena Dam
Location: Section 14, T. 17 S., R. 4 E., S.B.B.&M.
Elevation: 3050 feet
Authority: City of San Diego
Index No. 118
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1896-97	0	1.51	0.09	1.51	1.83	2.42	4.40	4.81	3.66	1.13	1.12	0	22.48
1897-98	0	0	0.20	1.93	0.20	1.42	5.42	0.33	3.64	0.90	2.14	0	16.18
1898-99	0.02	2.47	0	0	0.33	0.77	3.73	1.90	2.58	0.24	0.28	1.15	13.47
1899-00	0	0	0.05	1.05	2.49	1.38	2.25	9.38	1.58	0.62	1.83	0	20.63
1905-06										0.86	1.66	0	
1906-07	1.04	1.34	0.51	0.12	2.51	7.39	6.44	1.59	4.71	0.84	0.39	0.88	27.76
1907-08	0	0	0	2.64	0.41	0.61	5.61	4.98	1.90	1.18	0.92	0	18.25
1908-09	0	0.86	1.31	1.29	1.31	1.20	10.90	5.55	4.22	0.17	0	0	26.81
1909-10	0.06	1.64	0	0	3.99	5.64	5.69	0.98	2.78	0.38	0	0	21.16
1910-11	0.97	0	0.47	1.36	1.91	0.46	4.33	6.39	2.04	1.59	0	0	19.52
1911-12	0.96	0	0.06	0.71	0.14	1.75	1.09	0.06	12.07	3.59	1.25	0.14	21.82
1912-13	0.43	0.30	0	1.19	1.18	0.48	3.11	4.86	2.71	0.59	0.28	0.31	15.44
1913-14	0.43	1.64	0.26	0	2.40	2.00	5.54	4.76	1.02	1.94	0.41	0.27	20.67
1914-15	0	0	0.10	1.38	0.61	4.26	8.00	5.78	2.34	4.08	4.13	0	30.68
1915-16	0	0.05	0.06	0	1.13	3.87	28.01	1.10	5.47	0.14	0.15	0	39.98
1916-17	1.12	0.17	1.04	3.31	0.03	3.35	6.48	3.62	1.00	3.27	1.08	0	24.47
1917-18	0.52	0	0.74	0.03	0.49	0	2.29	2.72	10.80	0.08	0.23	0.58	18.48
1918-19	0	2.09	0	1.54	1.83	3.17	0.15	5.17	3.10	1.70	0.45	0	19.20
1919-20	0.62	0.05	0.36	1.42	4.38	1.71	2.55	8.31	7.36	1.14	0.50	0	28.40

CONTINUED

Precipitation Station: Morena Dam (Continued)
Location: Section 14, T. 17 S., R. 4 E., S.B.B.&M.
Elevation: 3050 feet
Authority: City of San Diego
Index No. 118
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1920-21	0.11	0	0.31	1.64	0.70	1.72	3.99	1.01	2.08	0.56	3.65	0	13.77
1921-22	2.67	0.47	0.43	3.07	0.35	15.37	6.06	4.66	3.57	1.59	0.73	0	39.04
1922-23	0.73	0.91	0	1.01	1.53	6.08	3.58	2.47	2.21	2.57	0.06	0.17	21.32
1923-24	2.33	0	0.69	0.52	1.11	3.32	0.85	0	5.64	2.36	0	0	16.82
1924-25	0.55	0	0.01	0.42	1.16	5.17	0.50	1.52	2.68	4.19	0.23	2.23	18.66
1925-26	0	0	0	4.71	2.42	1.75	0.80	5.92	0.61	9.94	0.12	0	26.27
1926-27	0	0.40	0	0.23	1.65	4.96	1.69	19.69	4.35	1.34	1.31	0.27	35.89
1927-28	0.25	1.35	0	1.80	1.23	6.41	0.40	2.30	1.28	0.23	0.59	0	13.84
1928-29	0	0	0	0.22	1.14	3.78	3.33	3.28	3.16	1.79	0	0	17.00
1929-30	0	1.59	0.56	0	0	0	8.70	1.67	4.07	0.67	4.91	0	22.17
1930-31	0.17	0.88	0.05	0.61	2.91	0.40	3.45	5.14	0.26	2.18	0.71	0.04	16.80
1931-32	0.18	0.14	0.26	0.93	3.70	7.16	2.36	11.17	0.48	1.28	0.02	0.38	28.26
1932-33	0	0	0	0.66	0	5.73	6.54	0.27	0.29	3.24	1.52	0.14	18.39
1933-34	0.03	0.05											

Precipitation Station: Heuser Creek
Location: Section 21, T. 17 S., R. 4 E., S.B.B.&M.
Elevation: 2300 feet
Authority: City of San Diego
Index No. 119
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1914-15											1.69	0	
1915-16	0	0	0.01	0			19.52		3.24	0.60	0.03		
1916-17	0.25	0	0.61						0.90	2.62	0.30	0	
1917-18	0.08	0	0.61	0		0	0.96	2.74	8.95	0.02	0.10	2.95	16.41*
1918-19	0.55	0.56	0	0.13	0	3.13	0.18	5.15	3.35	1.11	0.15	0	14.31
1919-20	0.60	1.02					1.62	5.24					8.43*
1920-21	0.05	0.18	0.35	1.41	0.13	0.83	2.49	0.91	1.50	0.50	3.38	0	11.73
1921-22	2.12	2.60	0.44	2.40	0	14.31	5.38	3.96	0.34	1.36	0.39	0	33.30
1922-23	0	0	0	0	0								

* Partial Season

Precipitation Station: Skye Valley
Location: Section 2, T. 17 S., R. 3 E., S.B.B.&M.
Elevation: 2550 feet
Authority: C. F. Korte
Index No. 120
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1912-13								3.33	1.55	M	0.21	0.10	
1913-14	1.00	0.40	1.10	0.06	1.95	1.35	5.72	4.92	1.05	1.69	0.21	0	19.45
1914-15	0.10	0	0.08	0.65	1.26	3.33	5.04	6.16	1.80	5.55	M	M	24.17*
1915-16					1.21	3.75	24.32	1.10	3.31				
1916-17	0.55	0.52	0.25	0.89	0	2.98	4.60	3.32	0.93	3.15	1.19	0	18.38
1917-18	0.01	0	0	0.10	0.37	0	2.06	2.32	8.75	0.03	0	0.27	13.91
1918-19	0.81	0.70	0	1.91	0.45	3.15	0	4.11	5.49	M	M	0	14.62*
1919-20	0	0.57	0.37	0.97	2.41	0.90	0.45	6.20					

* Partial Season

Precipitation Station: Barrett Dam
Location: Section 22, T. 17 S., R. 3 E., S.B.B.&M.
Elevation: 1650 feet
Authority: City of San Diego
Index No. 121
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1894-95						3.93	19.24	2.00	1.43	0.51	0.39	0	29.50*
1895-96	0	0	0.04	0.63	3.00	0.56	2.04	0.16	4.41	1.04	0.15	0	12.03
1896-97	0	0.32	0	1.41	2.27	2.11	4.70	4.37	2.87	0.31	0.11	0	18.47
1897-98	0	0.15	0.17	1.78	0.10	1.42	3.54	0.25	2.53	0.46	1.06	0	11.48
1898-99	0	0.45	0.15	0	0.25	2.15	3.22	2.20	1.63	0.22	0.16	0.80	11.23
1899-00	0	0	0	0.55	1.60	1.50	1.60	0.15	0.84	2.45	1.70	0	10.39
1905-06													
1906-07	M	M	M	M	M	6.21	4.98	1.66	3.04	0.45	0.19	0.28	16.81*
1907-08	0	0	0	1.33	0.24	0.62	4.94	4.50	1.51	0.68	0.47	0	14.29
1908-09	0	0.99	0.12	1.38	0.95	1.34	6.88	4.71	3.83	0.04	0	0	20.18
1909-10	0	1.07	0	0	3.10	4.91	4.39	0.76	2.13	0.28	0	0	16.64
1910-11	0.53	0	0.53	1.03	1.10	0.53	3.01	5.34	1.54	0.69	0	0	14.32
1911-12	0.68	0	0.06	0.34	0.08	1.70	0.48	0.01	10.93	3.30	1.23	0.08	18.91
1912-13	[illegible]	0.11	0	0.81	0.62	0.05	2.44	5.04	1.91	0.35	0.18	0.21	11.77

* Partial Season

CONTINUED

Precipitation Station: Barrett Dam (Continued) Elevation: 1600 feet Index No. 121
Location: Section 22, T. 17 S., R. 3 E., S.B.B.&M. Authority: City of San Diego Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1913-14	0.26	0.03	0.75	0	1.80	1.17	4.28	4.37	0.78	1.72	0.38	0.11	16.25
1914-15	0.30	0	0.08	0.83	1.20	3.29	6.89	6.51	2.27	2.93	2.50	0	26.80
1915-16	0	0.27	0	0	0.80	3.84	21.81	0.65	3.20	0.27	0.19	0	31.11
1916-17	0.16	0.52	0.09	1.21	0.02	3.16	5.61	2.94	1.05	2.60	1.03	0	18.39
			Continued in United States Weather Bureau publications.										

Precipitation Station: Potrero Elevation: 2390 feet Index No. 122
Location: Section 6, T. 18 S., R. 4 E., S.B.B.&M. Authority: City of San Diego Plate I.
C. Nelson

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1913-14							7.12	4.75	0.96	1.93	0.34	0.11	
1914-15	0	0	0.16	0.87	0.90	3.78	7.23	6.65	2.05	2.58	3.03	0	27.35
1915-16	0	0.27	0	0	1.52	3.91	24.70	0.93	3.38	0.35	0.18	0	35.24
1916-17	0.43	0.57	0.09	1.16	0	4.42	5.79	M	1.10	3.34	0.91	0	
1917-18	0.01	0	0	0	0.43	0	1.93	3.11	9.05	0.07	0.19	0.52	15.31
1918-19	0.06	0.07	0	1.42	2.45	3.75	0.31	6.34	3.51	1.50	0.18	0	19.69
1919-20	0.92	0.26	0.75	0.95	3.71	1.00	0.60	7.35	6.59	1.03	0.38	0	23.54
1920-21	0	0.02	0.19	1.05	0.22	1.24	3.54	1.02	1.69	0.44	3.83	0	13.24
1921-22	1.57	0.79	0.50	2.65	0.44	12.92	5.85	4.22	3.18	1.31	0.74	0	34.17
1922-23	0	0	0	0.90	1.91	3.89	2.50	3.08	2.10	2.21	0	0.13	16.78
1923-24	0.02	0	0.48	0.39	1.36	3.24	0.89	0	5.45	2.50	0	0	14.33
1924-25	0	0	0	0.54	1.02	4.41	0.65	1.11	2.80	3.95	0.17	1.27	15.92
1925-26	0	0	0	4.12	1.83	1.13	0.84	4.63	0.91	8.14	0.45	0	22.05
1926-27	0	0.35	0	0.26	0.85	4.13	1.02	17.61	5.11	1.23	1.44	0	32.00
1927-28	0.54	0	0	1.47	1.64	5.28	0.87	1.73	0.74	0.23	0.50	0	13.00
1928-29	0	0	0	0.34	1.13	3.19	3.04	3.11	2.90	1.02	0	0	15.53
1929-30	0	0	0.17	0	0	0	6.84	1.47	3.84	0.45	5.98	0	18.75
1930-31	1.63	0	0	0.12	2.50	0	3.11	5.80	0.28	2.63	0.41	0.14	16.62
1931-32	0	0.07	0.06										

Precipitation Station: Tecate Elevation: 1800 feet Index No. 123
Location: Section 24, T. 18 S., R. 3 E., S.B.B.&M. Authority: City of San Diego Plate I.
(Thing Bros. Obs.)

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1913-14							6.72	3.81	0.66	2.13	0.57	0	
1914-15	0	0	0.37	0.63	0.62	3.80	6.41	5.04	1.50	2.62	2.74	0	23.73
1915-16	0	2.50	0	0	1.74	3.80	22.26	0.72	3.13	0.02	0.30	0	34.47
1916-17	1.75	0.93	0	1.05	0	2.57	5.58	2.95	0.85	2.05	0.65	0	18.38
1917-18	0	0.57	0	0.10	0.20	0	1.79	2.20	4.88	0	0.03	0.15	9.92
1918-19	0.20	0.31	0	1.47	2.28	3.33	0.32	5.58	3.03	1.04	0.17	0	17.71
1919-20	0.11	0.14	0.19	0.80	3.66	0.82	1.61	5.24	5.87	0.06	M	0	19.30*
1920-21	0	0	0.19	1.27	0.14	1.10	3.05	0.53	1.34	0.65	2.80	0	11.07
1921-22	1.47	0.17	1.15	1.34	0.58	10.71	5.06	3.31	2.72	1.67	0.64	0	28.82
1922-23	0.25	0	0	0.46	1.80	2.92	2.53	2.28	1.33	1.15	0	0	12.71
1923-24	0	0	0	0	2.79	1.29	0.84	0	4.52	1.88	0	0	11.32
1924-25	0	0	0	0.34	0.87	2.64	0.55	1.30	2.47	3.71	0	0.58	12.36
1925-26	0.60	0	0	3.67	1.80	0.19	2.42	2.03	0.48	6.80	0.20	0	18.19
1926-27	0	0.57	0	0	0.35	2.74	0.92	14.02	3.86	1.00	0.78	0.16	24.40
1927-28	0.70	0	0.02	2.61	0.07	4.89	0.64	1.61	0.79	0.18	0.30	0	11.81
1928-29	0	0	0	0.24	1.00	2.87	2.35	1.15	2.52	1.50	0	0	11.63
1929-30	0	0	0.05	0	0	0	5.73	0.95	3.67	0.31	2.19	0	12.90
1930-31	1.00	0	0	0.52	2.18	0	2.70	6.11	0.15	2.32	0.68	0	16.46
1931-32	0.15	0.05	0										

* Partial season

Precipitation Station: Lauterbach Ranch Elevation: 1200 feet Index No. 124
Location: Section 4, T. 18 S., R. 3 E., S.B.B.&M. Authority: City of San Diego Plate I.
F. R. Lauterbach

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1909-10					3.11	5.01	5.09	0.80	2.40	0.35	0	0	16.76*
1910-11	0.05	0	0.45	1.08	0.98	0.26	4.34	4.47	1.29	0.55	0	0	[illegible]
1911-12	0.87	0	0.11	0.17	0.04	1.72	0.75	0	10.84	3.75	1.28	0.04	19.57
1912-13	0.03	0.08	0	0.90	0.66	0	2.57	5.14	2.27	0.27	0.10	0.11	12.33
1913-14	0.20	0.21	0.06	0.18	1.24	1.43	6.03	4.61	0.67	1.34	0.28	0.05	16.50
1914-15	0.03	0	0.04	0.46	0.66	3.69	7.96	6.11	2.37	2.21	3.11	0	26.64
1915-16	0	2.04	0.02	0	0.87	3.45	22.60	0.56	3.09	0.07	0.21	0	33.11
1916-17	0.26	0.47	0.06	1.19	0	2.83	5.45	3.23	0.80	2.76	0.61	0	17.68
1917-18	0	0	0	0	0.22	0	2.01	2.85	7.81	0.02	0.13	0.02	13.06
1918-19	0	0.22	0	1.26	1.67	3.44	0.20	5.68	3.20	1.00	0.11	0	16.78
1919-20	0.40	0	0.13	0.51	2.81	0.90	1.36	5.89	5.67	1.12	0.60	0	19.39
1920-21	0	0	0.24	0.75	0.12	0.98	2.93	0.83	1.74	0.34	3.27	0	11.20
1921-22	0.30	0.27	0.35	1.87	0.42	12.14	5.58	3.54	3.15	1.03	0.51	0	29.16
1922-23	0.02	0	0.06	0.87	1.53	3.60	2.15	2.79	1.92	1.60	0	0.05	14.77
1923-24	0.27	0	0.18	0.55	0.91	2.35	1.24	0	4.98	2.51	0	0	12.79
1924-25	0	0.02	0	0.41	0.93	3.72	0.67	[illegible]	1.61	3.15	0.09	0.62	12.28
1925-26	0	0	0	4.04	1.73	1.44	0.32	3.95	0.58	7.67	0.32	0	20.05
1926-27	0	0.13	0	0.24	0.77	3.82	1.02	17.41	4.58	1.19	1.27	0	30.43
1927-28	0.05	0	0	1.65	1.30	5.46	0.67	1.35	0.65	0.15	0.30	0	11.58
1928-29	0	0	0	0.35	1.06	3.00	2.85	2.38	2.67	1.45	0	0	13.76
1929-30	0	0	0.19	0	0	0	6.64	1.10	3.49	0.57	4.82	0	16.81
1930-31	0.05	1.02	0	0.45	2.39	0	2.99	6.98	0.26	1.66	0.67	0	16.47

* Partial season

Precipitation Station: Barret P.O. Elevation: 875 feet Index No. 125
Location: Section 8, T. 18 S., R. 3 E., S.B.B.&M. Authority: City of San Diego Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1913-14							5.50	4.02	0.67	1.29	0.31	0	
1914-15	0.17	0	0	0.60	0.79	3.29	6.28	5.05	1.84	1.98	2.65	0	22.65
1915-16	0	0.96	0	0	1.07	3.66	22.23	1.55	2.95	0.27	0.20	0	32.69
1916-17	0.26	0.37	0.05	1.19	0	0.09	4.48	2.37	0.97	2.45	0.46	0	12.70
1917-18	0	0.05	0	0	0.34	0	1.56	2.39	7.63	0	0.19	0	12.16
1918-19	0	0	0	1.28	2.12	2.68							

Precipitation Station: Winatka Valley Elevation: 2500 feet Index No. 126
Location: Section 26, T. 17 S., R. 2 E., S.B.B.&M. Authority: City of San Diego Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1913-14							6.73	5.00	1.55	2.06	0.25	0.	
1914-15	0	0	0	1.60	1.17	3.09	7.86	7.40	2.52	4.71	M	M	28.33*
1915-16	1.96	M	M	M	1.18	4.20	22.38	1.38	3.41	0.18	0.60	0	35.23*
1916-17	0	0	0	0	0.62	0							
1917-18							2.23						
1918-19	0	0	0	2.91	2.30	4.06	0.28	M	3.99	1.64			

* Partial

Precipitation Station: Lyon Valley Elevation: 2200 feet Index No. 127
Location: Section 10, T. 17 S., R. 2 E., S.B.B.&M. Authority: City of San Diego Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1913-14							6.72	4.56	1.39	2.27	0.21	0.25	
1914-15	0	0	0.10	1.33	1.45	4.36	7.95	9.14	2.66	6.13	3.49	0	36.61
1915-16	0	0.87	0	0	1.51	-	24.97	2.17					
1918-19										1.38			
1919-20								5.58	7.52	1.42			
1920-21							5.66	1.17					

TABLE B-2, (Continued) MONTHLY PRECIPITATION AT MISCELLANEOUS STATIONS IN SAN DIEGO COUNTY

Precipitation Station: Lyon Peak
Location: Section 10, T. 17 S., R.2 E., S.B.B.&M.

Elevation: 375. feet
Authority: City of San Diego

Index No. 128
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1913-14							5.45	4.23	1.49	2.22	0.34	0.27	
1914-15	0	0	0.10	1.58	1.61	3.55	5.35	7.00	1.32	6.00	2.51	0	30.02
1915-16	0	0.98	0	0	1.32			1.18	3.18	0.16	0.27	0	
1916-17	0.16	0.10	0.34	1.84	0				1.48	3.00	0.94	0	
1917-18	0	0	0	0	0.7?	0							

Precipitation Station: Dulzure
Location: Section 33, T. 17 S., R. 2 E., S.B.B.&M.

Elevation: 1075 feet
Authority: City of San Diego

Index No. 129
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1913-14					1.64	1.13	5.41	4.47	0.83	1.67	0	0	16.15*
1914-15	0	0	0	1.35	0.90	2.22	7.65	5.68	2.02	3.33	0.88	0	24.03
1915-16	0	0.66	0	0	0.85	2.30	20.61	0.67	1.61	0.08			26.75*
1916-17	0	0.30	0.24						0.75	2.50	0.44	0	
1917-18	0	0	0	0.00	0.34	0	1.30	2.51	5.91	0.12	0.26	0.01	11.61
1918-19	0.08	0.08	0	2.33	1.73	3.08	0.80	3.44	5.32	0	0.34	0	17.38
1919-20	0.07	0	0.29	0.70	2.50	0.78	1.37	5.21	6.83	0.15	0.51	0	17.18
1920-21	0	0	0	0	0	0.61	2.70	0.95	1.68	0.32	1.41	0	7.67
1921-22	0	0	0										26.24
1922-23	0												12.96
1923-24	0	0	0.15	0.33	0.05	2.70	1.26	0	5.07	2.43	0	0	12.70
1924-25	0	0	0	0.29	0.00	3.09	0.98	0.73	1.04	3.00	0.07	0.85	11.65
1925-26	0.05	0	0	4.07	1.80	1.62	0.28	4.18	0.66	7.54	0	0	20.10
1926-27	0	0	0			3.77	0.29						

* Partial Season

Precipitation Station: Dulzure Summit
Location: Section 10, T. 18 S., R. 2 E., S.B.B.&M.

Elevation: 1400 feet
Authority: City of San Diego

Index No. 130
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1915-16	0	0.06	0.01	M	1.13	3.48	26.75	1.27	1.97	0.17	0.13	0	35.77*
1916-17	0.47	0.18	0.20	1.26	0.02	2.81	4.71	M	0.84	2.73	0.71	0	13.93*
1917-18	0	0.04	0	0.05	0.38	0	1.66	2.64	7.66	0.04	0.27	0.01	12.65
1918-19	0	0.16	0	2.12	2.00	3.52	0.19	4.26	2.98	1.12	0.50	0	16.83
1919-20	0.16	0.06	0.32	M	2.45	0.69	1.53	5.19	4.89	0.71	0.44	0	16.14*
1920-21	0	0	0.26	0.87	0.13	0.47	2.81	0.63	1.04	0.33	3.75	0	11.19
1921-22	0	0	0.42	2.31	0.60	12.04	4.59	3.32	0.18	0.39	0	0	23.85
1922-23	0	0	0	0.38	1.50	3.43	2.86	2.47	1.37	1.17	0	0.08	13.23
1923-24	0	0	0.21	0.33	1.57	2.65	1.26	0	5.12	2.65	0	0	13.79
1924-25	0	0	0	0.29	0.80	3.09	0.98	0.73	1.84	3.00	0.07	0.85	11.65
1925-26	0.05	0	0	4.07	1.80	1.52	0.2?	4.18	0.66	7.54	0	0	20.10
1926-27	0	0	0	0.13	0.80	4.04	0.81					0.20	
1927-28	0.04	0	0	1.07	1.08	3.54							
1928-29		0					2.55	1.86	2.55	1.50	0	0	
1929-30	0	0	0.18	0	0	0	3.91	0.06	4.06	0.36	3.43	0	16.90
1930-31	0	0.40	0	0	1.99	0	2.92	6.62	0.23	1.90	0.74	0.01	15.10
1931-32	0.02	0.11	0	0.59	2.67	7.65	M	M	0.44	0.47	0	0.17	
1932-33	0	0	0	0.74	M	3.87	6.21	0.18	0.10	0.78	1.47	0.09	13.44*

* Partial Season

Precipitation Station: Marron Valley
Location: Section 28, T. 18 S., R. 2 E., S.B.B.&M.

Elevation: 550 feet
Authority: City of San Diego
A. L. Donohoe, Obs.

Index No. 131
Plate I.

Season	July	August	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Seasonal Total
1913-14	Gage installed 11-29-13					1.73	4.28	3.20	0.58	1.51	0.22	0	11.48*
1914-15	0	0	0	0.82	0.64	2.61	5.51	3.42	1.40	2.99	1.41	0	18.80
1915-16	0	0.06	0	0	1.34	3.20	17.63	0.90	1.75	0.23	0.23	0	25.34
1916-17	0.10	0	0.10	1.14	0	1.76	5.29	2.93	0.79	1.74	0.80	0	14.54
1917-18	0	0	0	0.02	0.23	0	1.93	2.67	6.01	0	0.14	0	11.00
1918-19	0.03	0.02	0	2.15	1.26	2.74	0.23	4.35	2.22	0.63	0.23	0	14.06
1919-20	0.02	0	0.17	0.39	1.08	1.10	1.49	5.32	5.00	1.00	0.38	0	16.85
1920-21	0	0	0.26	0.22	0.01	1.35	2.97	1.02	1.13	0.60	2.74	1.55	11.85
1921-22	0	0	0.32	1.56	0.67	9.29							

* Partial Season