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FLOODS OF MARCH 1938 IN SOUTHERN CALIFORNIA

BY

HAROLD C. TROXELL AND OTHERS

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FLOODS OF MARCH 1938 IN SOUTHERN CALIFORNIA

Harold C. Troxell and others

ABSTRACT

During the winter of 1937-38 California was visited by two disastrous floods, one in December 1937, in the northern part of the State, 1/ and the other in March 1938, in the southern part of the State. The present volume is a report on the flood in the southern part of the State.

A series of heavy rainstorms in the coastal area, extending from San Diego on the south to San Luis Obispo on the north and inland to parts of the Mojave Desert, produced extreme floods. These floods, which appear to have been the greatest within the last 70 years, caused the loss of 87 lives and damage estimated at $78,602,000.

The storm seems to have centered in the San Bernardino and San Gabriel Mountain areas tributary to the Los Angeles, San Gabriel, Santa Ana, and Mojave River Basins. These mountain areas are among the highest in southern California, ranging in altitude from about 1,000 to 11,485 feet above sea level. Their average precipitation for the period February 27 to March 4 was about 22.5 inches, and the greatest precipitation recorded was 32.20 inches at Kelly's Kamp, in the San Gabriel Mountains between Ontario and Cucamonga Peaks, at an altitude of 8,300 feet.

The typical drainage areas within this mountain region are small, short, rough, and steep, the average land slope ranging from about 35 to 65 percent. In much of the region, considerably more than half of the average rainfall of 22.5 inches was absorbed in the soil mantle and underlying rock and held in storage at the end of the storm period, notwithstanding the many factors conducive to rapid surface runoff.

The rates of rainfall during the storm period of March 1938 were not particularly high as compared with the rates in other storm periods in the same region. Only for periods as long as 24 hours do the maximum rates of rainfall appear to equal or exceed those of earlier storms. The maximum discharge coming at the culmination of these maximum 24-hour periods, produced in some areas a runoff of more than 1,000 second-feet per square mile. This report indicates that these high rates of flood runoff occurred at a time when antecedent rainfall had been such as to fill most of the space available for subsurface storage.

The relations between rates of rainfall and rates of runoff for the 24-hour and shorter periods of maximum rainfall as obtained for a number of areas controlled by reservoirs are included in this report. Many features incidental to these relations have also been indicated.

In a region marked by the sharp topographic and geologic contrasts that exist in southern California many factors affect rates of flood runoff. Considered from a broad viewpoint the area consists of a series of mountain ranges and intervening valleys, varying in size and altitude, that merge into the coastal plain. The mountains represent great upthrust or upfolded blocks of the earth's crust, and the valleys are depressed segments filled with debris eroded from the surrounding mountains. The surface conditions affecting rates of runoff throughout the mountain area range from steep slopes of much-fractured rock overlain by a thin soil mantle, interspersed with outcrops of practically impervious unweathered rock, to almost level surfaces covered by a porous soil mantle and underlain by thick deposits of highly permeable alluvium.

The region is geologically young, with erosion proceeding at an active rate within the mountain area. During the flood of March 1938 the streams moved down their mountain channels a great quantity of debris, much of which had accumulated since the time of previous major floods. Measured on an areal basis the debris load in parts of the region exceeded 70 acre-feet per square mile. This movement of debris from the stream channels had the effect of reducing the storage capacity of many of the mountain reservoirs as much as 78 percent.

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1 McGlashan, H. D., and Briggs, R. C., Floods of December 1937 in northern California; U. S. Geol. Survey Water-Supply Paper 843, 497 pp., 1940.

INTRODUCTION

During the period February 27 to March 4, 1938, southern California was visited by a series of heavy rainstorms, centered along the coastal slopes of the San Gabriel and San Bernardino Mountains, that produced flood discharge far in excess of any previously recorded. Although the rates of rainfall for short periods were not unusually high, the maximum rates for a 24-hour period at many of the mountain stations exceeded any within the period of record. According to reports of the Corps of Engineers, United States Army, the resulting floods claimed the lives of 87 persons and caused damage amounting to $78,602,000.

More information has been available concerning these floods than for any of the previous floods in this region because of the concern that had developed among the residents in matters pertaining to flood control and conservation of water. Records were obtained from approximately 730 precipitation stations, of which about 70 were equipped with recording gages. The flood runoff, or the maximum discharge, has been determined at about 160 places in southern California. Difficulties involved in obtaining satisfactory records of runoff in the mountain area have made it necessary to compute a part of these records on the basis of the relation of runoff to rainfall. The basic factors in this relationship were determined mainly from the records obtained during the flood period at a group of flood-control reservoirs in Los Angeles County. Much information on the movement of debris down the channels of steep mountain streams was obtained at each of these reservoirs as well as at a group of debris basins, and some of it is included in this report.

In order to compile and make available to the general public data obtained during this flood period, the President of the United States on May 23, 1938, approved the allotment of the sum of $3,779 by the Works Progress Administration to the Geological Survey, United States Department of the Interior. In June 1938, the Public Works Administration, acting in accordance with the National Industrial Recovery Act of 1938, allotted to the Geological Survey the sum of $21,000 to assist in the preparation of the present report, which embodies these data.

ADMINISTRATION AND PERSONNEL

The field and office work incident to the preparation of this report were performed by the water-resources branch of the Geological Survey under the general administrative direction first, of N. C. Grover, chief hydraulic engineer until his retirement on January 31, 1939; then of C. G. Paulsen, acting chief hydraulic engineer until October 17, 1939; and finally of G. L. Parker, chief hydraulic engineer since October 17, 1939. Mr. Paulsen has administered the work also as chief of the division of surface water.

The actual field work and collection and tabulation of the basic information on stages and discharges and the many other tasks in the preparation of the report were done by the personnel of the Los Angeles suboffice of the San Francisco district office of the division of surface water, under the direction of H. D. McGlashan, district engineer.

The activities in the Los Angeles office have been carried on under the supervision of F. C. Ebert, senior hydraulic engineer in charge, assisted by Harold C. Troxell. Mr. Troxell has been largely responsible for the special hydraulic and hydrologic studies that have contributed to the preparation of the report. The manuscript was reviewed by W. G. Hoyt, consulting engineer, of the conservation branch of the Geological Survey. The final assembling and arranging of the report was carried on under the direction of R. W. Davenport, chief of the division of water utilization. Many of the members of the Geological Survey staff have participated in the collection and preparation of the information embodied in the report, especially George E. Carroll, R. Stanley Lord, and Kenneth R. Melin, all of the Los Angeles office. H. V. Peterson, also of the Los Angeles office, prepared the section entitled "Physiographic and geologic features affecting flood runoff". Much of the tabulation and typing necessary for the report was done as project 365-03-3-34 of the Works Progress Administration, under the direction of Herbert C. Legg, administrator for southern California, and Edwin B. Scheuer, coordinator of research, surveys, and statistical projects. In carrying on this work the permanent field and office staffs were assisted by temporary employees appointed by the Secretary of the Interior under the provisions of the National Industrial Recovery Act.

ACKNOWLEDGMENTS

The Corps of Engineers, United States Army, through Maj. Theodore Wyman, Jr., district engineer, Los Angeles, Calif., made available, for use in this report, information collected by that organization on the floods of March 1938, data on historic floods, flood damage, flood runoff, and precipitation, and photographs. The Los Angeles County Flood Control District, through H. E. Hedger, chief engineer, furnished most of the

precipitation records for that county and detailed records of operation of the reservoirs and of silt deposition in the reservoirs and debris basins. The Orange County Flood Control District, through M. N. Thompson, chief engineer, furnished precipitation and runoff data for the Santa Ana River Basin. The United States Weather Bureau and the Division of Water Resources of the State of California, Department of Public Works, furnished data on precipitation. The United States Forest Service furnished data on precipitation and runoff collected in the San Dimas Experimental Forest.

Much information was obtained from other sources, including individuals, corporations, and city officials, acknowledgments of which are given as far as practicable, at appropriate places in the report.

GENERAL FEATURES OF THE STORM AND FLOOD

The rains that caused the severe floods of March 1938 in southern California began with a general light fall on February 27 and during the early hours of February 28. The later hours of February 28 were marked by generally intense and continuous precipitation. On March 1 there was a lull, followed on March 2 by the heaviest rains of the storm and on March 3 by light and intermittent rain, which continued in some places through March 4. Although the storm is generally referred to as that of February 27 to March 4, it had ceased over most of the area on March 3.

The heavy rains covered the Pacific coast area for about 250 miles north of the boundary with Mexico and extended inland 50 to 100 miles. (See fig. 1.)

The storm appears to have centered in the San Gabriel and San Bernardino Mountain areas tributary to the Santa Ana, San Gabriel, and Los Angeles Rivers. Many of the rainfall records indicated from 20 to 30 inches of rain during the period February 27 to March 4. The heaviest rainfall for this period, 32.20 inches, was observed at Kelly's Kamp, in the San Gabriel Mountains between Ontario and Cucamonga Peaks, at an altitude of 8,300 feet. The rainfall decreased sharply to the north and south of this area, the recording stations at San Diego and San Luis Obispo showing 4.26 inches and 3.67 inches, respectively. The rainfall decreased sharply also toward the Mojave Desert area; at Table Mountain (altitude, 7,500 feet), about 12 miles northwest of Kelly's Kamp, the rainfall was 10.40 inches, and at Victorville (altitude, 2,713 feet), about 30 miles northeast of Kelly's Kamp, it was 3.16 inches. These records were not typical of the headwaters of the Mojave River, for there

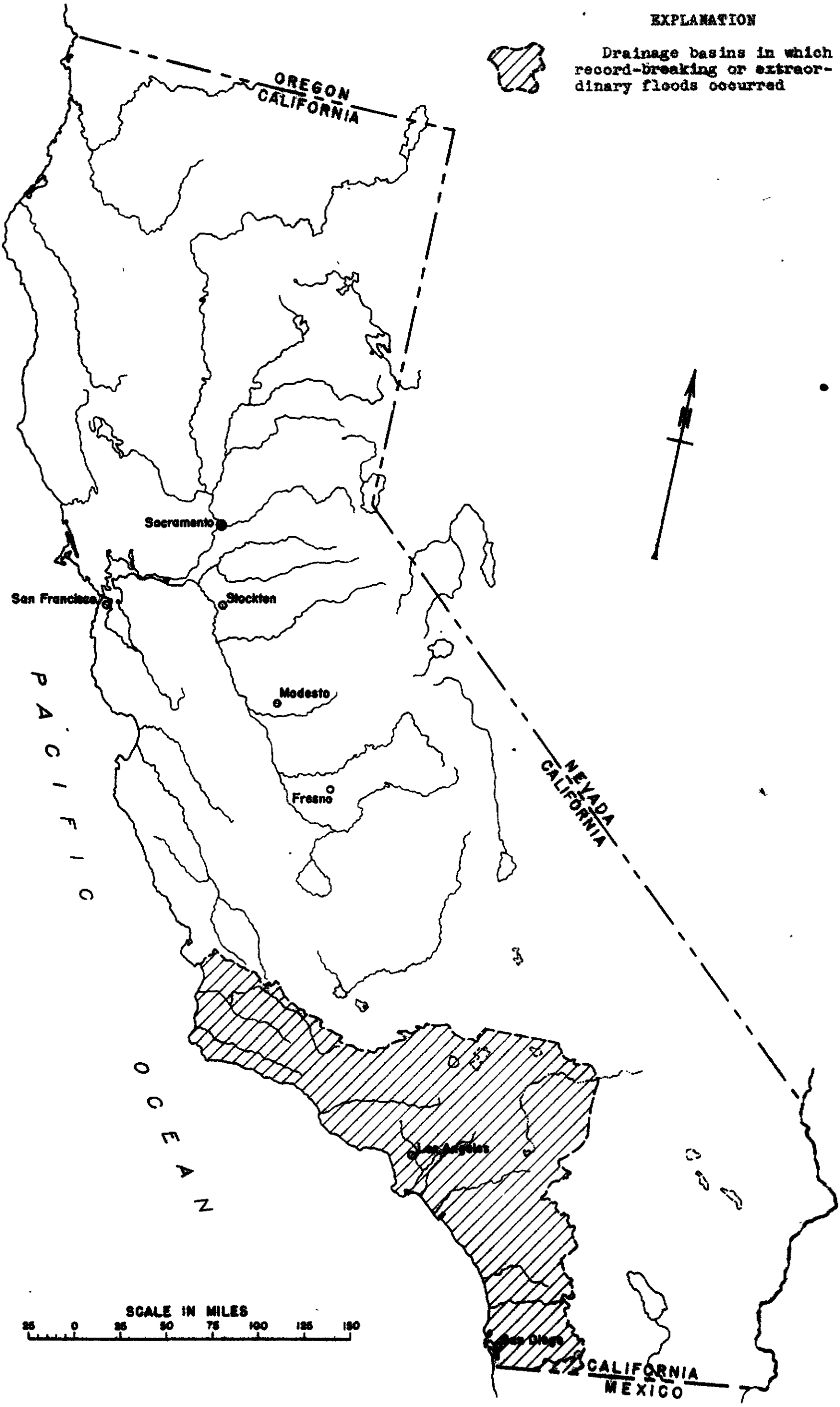

Figure 1.- Map of California showing area covered by this report.

was a rainfall of 30.49 inches at Lake Arrowhead and 28.58 inches at Sawpit Canyon.

Daingerfield [2] gives the following account of this storm and the antecedent weather conditions:

The season of 1937-38 (beginning July 1, 1937) has been marked by wide contrasts in rainfall over southern California. Los Angeles was rainless from May 31 to October 2, 1937, inclusive, a period of 125 days, followed by 67 days, or until December 8, 1937, with only two light showers, totaling 0.03 inch. The combined period of 192 days had only 0.03 inch of precipitation. This long dry period is second only to that of 1927, when no measurable rainfall occurred at Los Angeles for the 197-day period from April 13 to October 26, although traces were recorded each month. The recent drought was rather definitely ended by the rain of December 9-12, 1937, and precipitation was ample and approximately normal during the remainder of December and through January, 1938.

The closing days of January, however, were marked by intense disturbances over the Gulf of Alaska and adjacent North Pacific waters, with strong southeasterly trends near the Pacific coast of North America, which has been absent or deficient in the earlier depressions of the season. This change in storm development and movement ushered in a period of almost continuous and frequently heavy rainfall over this area of California during the first half of February, during which period the soil became well saturated with moisture.

The tendency to form disturbances near and off the Pacific coast featured the late January, February, and early March period. A storm which developed northeast of Hawaii moved slowly eastward (followed by a well-developed Pacific high) and moved inland near the Bay region on February 9. This was an exceptionally violent disturbance, attended by precipitation throughout California, heavy over the northern part of the State, and high winds and gales over most coastal districts and inland to and beyond Sacramento.

A series of North Pacific and Gulf of Alaska depressions prevailed from February 26 to March 4, 1938, extending their maximum sphere of influence hundreds of miles farther southeastward than normally over the Pacific coast area. On February 27, a rather shallow disturbance moved slowly in over the southern California coast, attended by a general light rain on the 27th and intermittently through the 28th. During the night of February 28-March 1, heavy rain occurred as the result of the passage of a cold front, which moved in from the northwest. No general rain occurred after this frontal passage until March 2, with the arrival of a more intense disturbance. This disturbance likewise developed northeast of the Hawaiian Islands, and while the center moved to the Oregon coast, the region of greatest intensity was over southern California. Warm-front action and a pronounced orographic effect produced the greatest intensities and amounts of precipitation of the entire storm period, which were directly the cause of the great flood.

The origin of the storm is briefly described in a report of the Corps of Engineers, United States Army,[3] as follows:

The storm, or rather series of storms, which caused the flood of March, 1938, originated in Siberia, circled southward over the Pacific Ocean to Midway Island, swinging eastward near Hawaii, and thence to the California coast. In their long, encircling course over the Pacific Ocean, a great amount of moisture was absorbed. Reaching southern California, the air masses swept in at high speed at almost right angles to the main mountain ranges. As the moist air was thrust upward by these obstructions, it encountered the colder upper air. The rapid condensation resulting caused excessively heavy rainfall.

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2 Daingerfield, L. H., Southern California rain and flood, February 27 to March 4, 1938: Monthly Weather Rev., vol. 66, no. 5, p. 139, 1938.

3 Santa Ana River, Calif., flood control, Hydrology of flood of March 1938, p. 2, U. S. Engineer Office, Los Angeles, August 1938 (processed).

Discussions of the more intricate features of the synoptic analysis of this storm have been prepared by Pierce, of the United States Weather Bureau;[4] Burke, of the Los Angeles County Flood Control District;[5] and the staff of the Los Angeles district office, Corps of Engineers, United States Army.[6]

The intensity of rainfall for relatively short periods, although high in much of the storm-affected area, was generally less than had been previously recorded, and only in the maximum rainfall for a 24-hour period did this storm exceed most previous storms. In the mountain area, however, the maximum 24-hour precipitation for 1938 apparently has not been exceeded during the past 30 years. The storm of March 1938 had many of the characteristics of the storm of December 31, 1933, to January 1, 1934, sometimes called the "New Year's storm of 1934", which was notable for the large amount of flood damage in the La Cañada Valley.[7]

In the storm of March 1938, the maximum rate of rainfall for a 5-minute period was 4.80 inches an hour, as recorded by a rain gage in the Rossmoyne fire area in the Verdugo Mountains near Glendale. The maximum rate for a 1-hour period was 1.99 inches at Clear Creek, in the San Gabriel Mountains.

The main streams affected by this storm were the San Diego, San Luis Rey, Santa Margarita, Santa Ana, San Gabriel, Los Angeles, Santa Clara, Ventura, Santa Ynez, and Santa Maria Rivers. (See fig. 2.) The basins of the Santa Ana, San Gabriel, and Los Angeles Rivers and parts of that of the Santa Clara River contributed the greatest flood runoff. Profiles of the Santa Ana and San Gabriel Rivers and their main tributaries are shown in figures 3 and 4.

The flood runoff from the storm of March 1938 was especially heavy in the larger streams in the mountains and in the main streams crossing the valley floor. It is believed that the peak discharges over a considerable part of the area exceeded any since those of the floods of 1861-62, which are generally accepted as the greatest previously known in the region. Of the more recent floods for which there are records of discharge, those of 1914 and 1916 rank as having the highest peaks prior to 1938.

4 Pierce, C. H., Synoptic analysis of the southern California flood of March 2, 1938: Monthly Weather Rev., vol., 66, no. 5, p. 135, 1938.

5 Burke, M. F., Flood of March 2, 1938, Los Angeles County Flood Control District, May 20, 1938 (processed).

6 Los Angeles County drainage area, Calif., Report on engineering aspects, flood of March 1938, U. S. Engineer Office, Los Angeles, August 1938 (processed).

7 Troxell, H. C., and Peterson, J. Q., Flood in La Cañada Valley, California, January 1, 1934: U. S. Geol. Survey Water-Supply Paper 796-C, pp. 53-98, 1937.

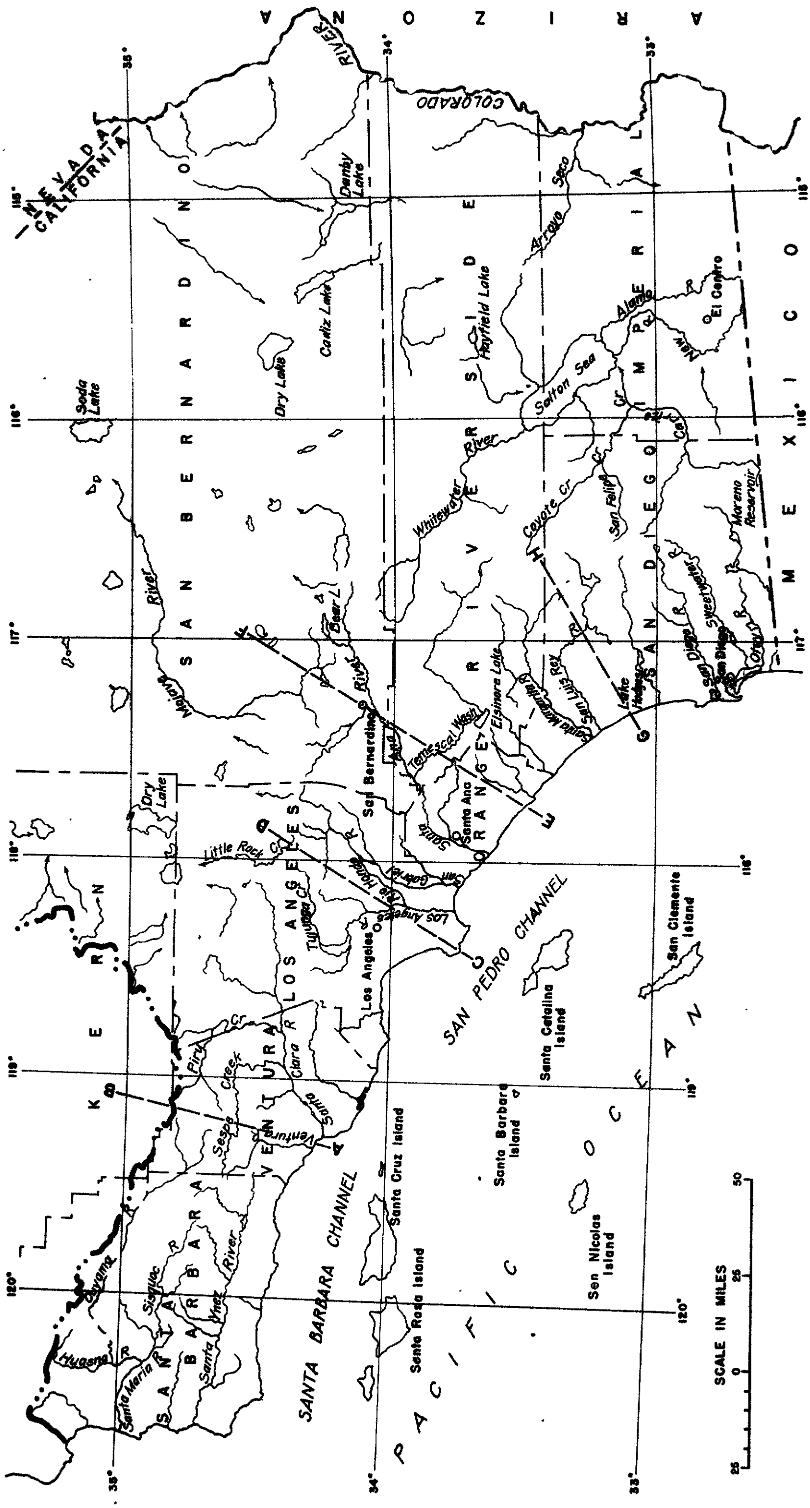

Figure 2.- Map of area covered by this report showing principal drainage systems.

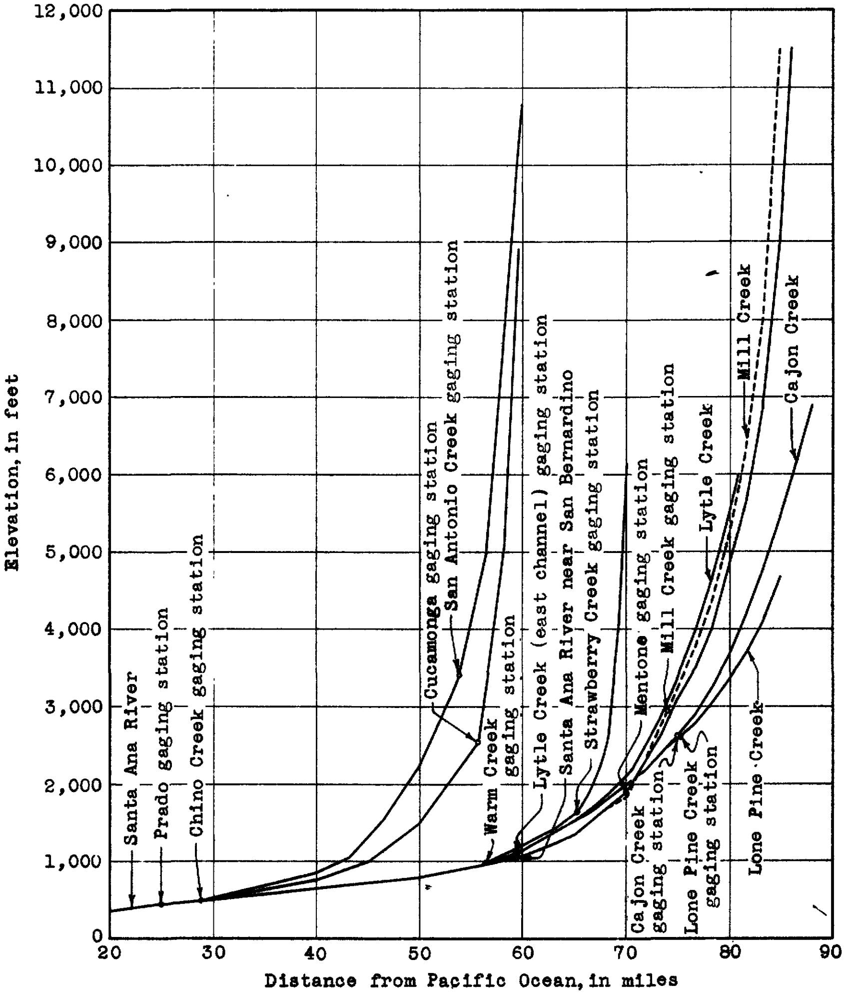

Figure 3.- Profiles of Santa Ana River and its main tributaries.

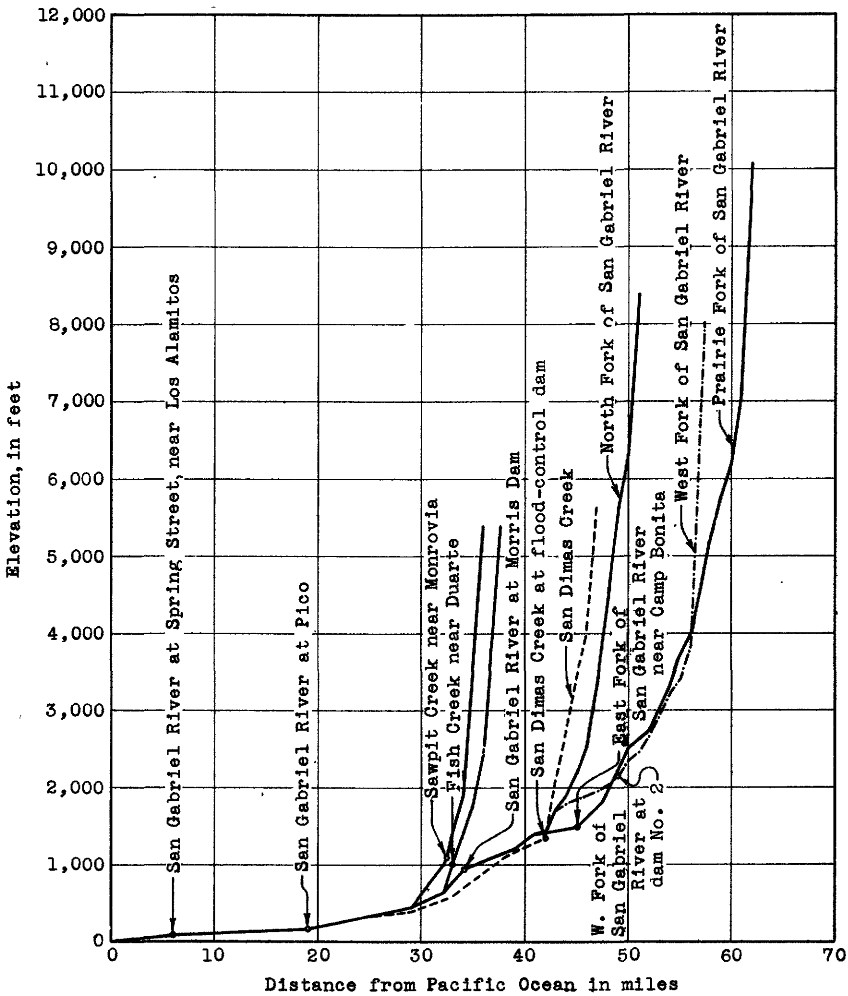

Figure 4.- Profiles of San Gabriel River and its main tributaries.

The Santa Ana, San Gabriel, and Los Angeles River systems drain the most highly developed areas of southern California: practically all the arable land from the mountains on the north to the ocean on the south is occupied by farms, orchards, and towns. When the floods were at their highest, generally during the afternoon of March 2, water and debris poured from the steep mountain canyons and spread over much of the land bordering the streams. Areas near the mountains were covered with debris and extensive tracts along the lower courses of the streams were inundated. (See pls. 1 and 2.)

During the period February 27 to March 3 the total direct flood run-off from the mountain areas, in mean depth in inches, ranged from less than 1 inch to more than 13 inches. Rates of maximum discharge ranged from 200 to 600 second-feet per square mile and were estimated to be as high as 1,000 second-feet per square mile in some places. The streams flowing in the steep, narrow canyons moved enormous quantities of debris and greatly disturbed the material in the bottom of the canyons. The damage in the canyons, however, where the population is sparse, was small in comparison with that on the outer slopes and floors of the valleys.

The area centering at Colton, where Warm and Lytle Creeks join the Santa Ana River, was extensively overflowed (see pl. 3); and parts of the cities of San Bernardino and Riverside were also submerged. Above the city of Santa Ana, where breaks occurred in the levees (see pl. 4), large areas were inundated and some of the floodwater entered an old river channel and damaged many homes and orchards. (See pls. 5 and 6.) This spreading of the floodwaters above the city of Santa Ana reduced the peak discharge at that place to about half the peak at the Orange-Riverside County line, about 18 miles upstream.

At the stream-measurement station on Santa Ana River near Mentone, a peak discharge of 52,300 second-feet occurred during the flood of March 1938, as compared with a peak discharge of 29,100 second-feet on January 27, 1916.

On the San Gabriel River the flood was the greatest of record, notwithstanding the large storage capacity of San Gabriel No. 1 and Morris Reservoirs, on the main stream, and additional regulation on tributaries. Much of the floodwater of the San Gabriel River flowed into the Rio Hondo soon after leaving the mountains and thence into the Los Angeles River near Downey. Comparatively little damage was done along the lower reaches of the San Gabriel except in an area near the ocean and along Coyote Creek.

At San Gabriel River flood-control dam No. 1, on the San Gabriel River about 3½ miles above the Geological Survey's stream-measurement station near Azusa, the partly regulated peak discharge on March 2, 1938, was about 90,000 second-feet as compared with an unregulated peak discharge of 40,000 second-feet at the gaging station near Azusa on January 18, 1916.

On the Los Angeles River the flood of March 1938 exceeded all previous floods for which records are available. Pacoima and Tujunga Creeks, Arroyo Seco, and other tributaries reached unusually high stages. The highly developed areas along the Los Angeles River and its tributaries in the city of Los Angeles sustained the greatest damage. (See pl. 7.) Large tracts in San Fernando Valley were inundated, and bridges, highways, and railroads were severely damaged. (See pl. 8.) The flow from Rio Hondo added considerable water to the Los Angeles River below Los Angeles and increased the peak flow at the city of Long Beach, although comparatively little damage was done to that city. At a point a mile upstream from the Main Street Bridge in Los Angeles, above the Arroyo Seco, the discharge of the Los Angeles River was about 67,000 second-feet, as compared to an estimated discharge of about 31,100 second-feet at the Main Street Bridge during the flood of January and February 1914.[8] During the storm of March 1938 the flood-control reservoirs on Pacoima and Tujunga Creeks and Arroyo Seco were filled to capacity and undoubtedly contributed somewhat to the regulation of the discharge.

In the Santa Clara and Ventura River Basins the flood runoff exceeded the maximum of record in many localities. The flood on Santa Clara River did considerable damage to the Southern Pacific Railroad in Soledad Canyon and to citrus groves and several highway bridges in the Santa Paula area. The maximum discharge of the Santa Clara River at Santa Paula on March 2, 1938, was about 120,000 second-feet. The maximum discharge of the Ventura River near Ventura was 39,200 second-feet, as compared with the previously recorded maximum of 23,000 second-feet on December 31, 1933.

The maximum discharge of the Santa Ynez River near Lompoc was about 50,100 second-feet on March 3, 1938, as compared with 41,800 second-feet on January 25, 1914.

8 From reports of the Board of Engineers, Flood Control, Los Angeles, p. 248, July 27, 1915.

In the Mojave River and Rock Creek Basins record-breaking floods resulted from the heavy rains that fell on the north slopes of the San Gabriel and San Bernardino Mountains. As these streams flow onto the Mojave Desert, in the Great Basin, little damage was done except to highways and the railroad in the vicinity of Victorville, Barstow, and Yermo.

In the remainder of the area covered by the storm, the maximum discharges of the streams during the flood of March 1938 were not of major proportions and have been exceeded several times during the period of record.

Flood stages are most keenly felt by occupants of a flooded area when the safety of their lives or homes is menaced. The manner in which man has challenged nature on some of the streams of southern California is conspicuous. Streams that formerly meandered freely over debris cones and valley floors are now restricted to narrow channels (see pl. 9), fixed by the ever-encroaching developments of a rapidly increasing population. It seems probable that much of the flood runoff from the mountains that formerly was absorbed by the very porous gravel cones, built to a thickness of many hundreds of feet by flood debris, now moves rapidly, through concrete storm drains, across the debris cones and the naturally absorptive valley floors. The older river channels that carry the runoff to the ocean are now taxed beyond their capacities by concentrated flows. For these reasons, it is no doubt true that storm rainfalls of no greater intensity are considerably more disastrous, in many areas, under present conditions than under former conditions. The covering of absorptive cones and valley floors with houses and streets, the construction and other surficial changes in mountain areas, and the changes in land cover due to fires and other causes may all change, within a comparatively short time, the runoff characteristics of a drainage basin, especially in an area as young geologically as southern California. The evaluation of these influences on the runoff from the March storm seems beyond the limits of conjecture.

During the floods of March 1938 houses, both large and small, were destroyed (see pl. 10), and highways, bridges, and many other public improvements were washed away or damaged. Citrus groves along the Santa Ana River were overflowed, and large losses resulted. More than 290,000 acres of land was inundated in Los Angeles, San Bernardino, Orange, Riverside, and Ventura Counties. Owing to the rapidity with which the flood waters collected in the river channels there was not sufficient time to warn many of the residents in the threatened areas. As a result, 87 lives were lost, mainly along the Santa Ana and Los Angeles Rivers, and many people were driven from their homes. The property damage caused in southern California by the floods is estimated by the Corps of Engineers, U. S. Army, at about $78,602,000.

COLLECTION OF RAINFALL AND RUNOFF RECORDS

As the floods of March 1938 in southern California were extraordinary in respect to loss of life and property damage, special effort has been made to collect and compile in this report all available information relating to meteorologic conditions that may have had a bearing on their magnitude and other characteristics. Likewise, an attempt has been made to present all available stream-flow records during the flood period, including estimates of peak discharges. Concerning the adequacy of the information obtained, the Corps of Engineers [9] summarizes the difficulties encountered by the various fact-finding agencies as follows:

> Notwithstanding the great amount of hydrological data collected, results have been disappointing in many respects, principally due to the lack of direct measurements of discharge during the peak period. The streams in this area produce floods of exceedingly short duration. The rapidly changing stages do not allow sufficient time for the collection of necessary data. Transportation is disrupted to a great extent. Water-stage recorders, in many cases, were damaged or destroyed before the peak arrived. Bridges from which discharge measurements were made during the lower stages were swept away. Current-meters were damaged or lost because of the debris and high velocity of flow. Surveys to determine fill or scour were, in many cases, rendered valueless because of the lack of data concerning the conditions of the stream bed before the flood. Information was missing in some cases as to just where the channels were at the time of the peak.

At many river-measurement stations maintained by the Geological Survey, it has been necessary to fill in incomplete records by a comparison of observations in a given basin with observations in adjacent basins; by surveys and studies of cross sections and slopes of stream channels; and by the conversion of rainfall into runoff by means of such relationships as could be determined in basins for which continuous records are available. Throughout this report an endeavor has been made to indicate clearly the source of the data and the methods used in deriving such results as are not based on actual observations or arrived at by standard methods. The publication, so far as practicable, of all the base data obtained will enable engineers to judge as to the reasonableness of the assumptions and to make independent studies of the records. Flood runoff data are included in this report for all localities indicated on plates 11, 12, and 13.

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9 Los Angeles County drainage area, Calif., Report on engineering aspects, flood of March 1938, U. S. Engineer Office, August 1938 (processed).

MOUTH OF SANTA ANA RIVER, MARCH 3, 1938.

Figures along channel represent distance in miles from Pacific Ocean. Courtesy of Fairchild Aerial Surveys, Inc.

OVERFLOW AT MOUTH OF SANTA ANA RIVER, SHOWING AREA BETWEEN SANTA ANA RIVER AND HUNTINGTON BEACH SUBMERGED ON MARCH 3, 1938.

Courtesy of Fairchild Aerial Surveys, Inc.

A.

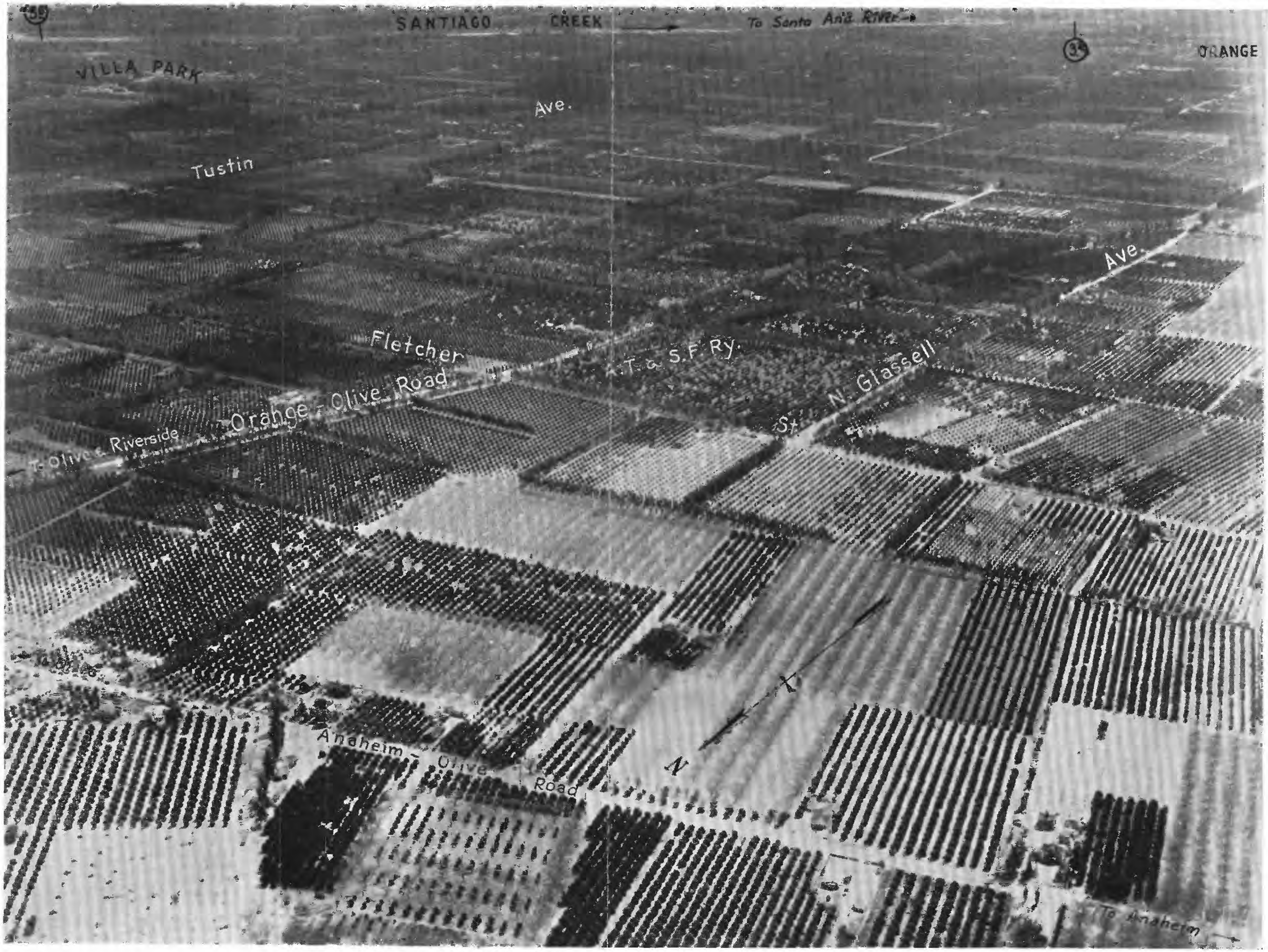
B.

DEBRIS DEPOSITS IN COLTON.

Damage caused by flood runoff of Lytle Creek.

BREAK IN LEVEE OF SANTA ANA RIVER, MARCH 3, 1938.

Figures along channel represent distance in miles from Pacific Ocean. Courtesy of Fairchild Aerial Surveys, Inc.



OVERFLOWED LAND ALONG SANTIAGO CREEK.

Flooded citrus and walnut groves near Orange and Villa Park. Courtesy of Fairchild Aeria Surveys, Inc.

A.

B.

DEBRIS DEPOSITS IN OVERFLOWED CITRUS GROVE.

A. WASH-OUT ON RAILROAD RIGHT-OF-WAY.

B. DAMAGE TO CHANNEL.

SCENES ON LOS ANGELES RIVER NEAR LOS ANGELES.

SAN FERNANDO VALLEY, MARCH 2, 1938.

Note small, meandering channel in right center. Courtesy of 115th Photo Section, California National Guard.

A. OUTLET CHANNEL FROM DUNSMUIR DEBRIS BASIN.

B. OUTLET CHANNEL FROM EAGLE-GOSS DEBRIS BASIN.

ARTIFICIAL CHANNELS ACROSS DEBRIS CONES, MARCH 2, 1938.

Note waves in the flood runoff. Courtesy of Corps of Engineers, U. S. Army.

A. DESTRUCTION BY MEANDERING STREAM.
Note composition of stream banks.

B. DEBRIS DEPOSITED BY MEANDERING STREAM.
Note that deposit is as high as fence at front of house but much lower at rear.

PROPERTY DAMAGED BY FLOOD.

Courtesy of Ralph Willis.

METEOROLOGIC AND HYDROLOGIC CONDITIONS

Precipitation records

In the arid and semiarid climate of southern California rainfall is a dominant factor in the life of the people, and the collection of data on precipitation is, therefore, of great importance and public interest. Many governmental agencies furnish data on rainfall to supplement those collected by the United States Weather Bureau. Among these agencies are the Forest Service and Soil Conservation Service of the United States Department of Agriculture; Corps of Engineers, United States Army; California State Division of Water Resources; Los Angeles County Flood Control District; Orange County Flood Control District; Ventura County Engineer; and Los Angeles City Water Department. In addition to the establishment of their own stations, these agencies have aided in furnishing gages to individuals for operation in sparsely populated areas where no precipitation records were available. Many rain gages have also been operated by private individuals and by cities and towns for their own information. Some of these records may be subject to error in interpretation, owing to faulty location of gages or topographic influence, but generally information thus collected makes a substantial contribution to the knowledge of precipitation in the area. As a result of this widespread activity and interest, southern California has a more complete coverage of precipitation stations than most other sections of the United States.

The floods of March 1938 were the direct result of rain which fell during the storm period February 27 to March 4. The daily precipitation data for this period are presented in table 1, which embodies the records at 733 standard rain-gage stations in the region covered by this report in which direct observations were made of the accumulated catch. The stations are arranged alphabetically in 22 groups corresponding to areas defined by drainage basins or other topographic features. For each station are given the location, altitude, daily rainfall, total rainfall for the storm period, name of observer or source of the record, and a note concerning time of observation if other than in the afternoon. The latitude and longitude of each station are recorded to the nearest minute, or to the nearest second if the close spacing of the gages in an area makes this desirable or if already so determined. Altitudes were obtained from topographic maps of the Geological Survey and are accurate within 10 to 100 feet, depending on the contour interval of the maps. Small amounts of rainfall observed at some stations on February 26 and March 5 were combined with amounts recorded on February 27 and March 4, respectively in order to complete the record for the entire storm.

Table 1.- Daily precipitation, in inches, at standard gages for the period February 27 to March 4, 1938
(Measured in the afternoon except as noted)

Station	Latitude	Longitude	Altitude (feet)	February 27	February 28	March 1	March 2	March 3	March 4	Total	Data furnished by
	° ' "	° ' "									
Tia Juana, Otay, and Swectwater River Basins											
Barrett Dam**	32 40 45	116 40 15	1,650	0.62	1.60	1.32	0.70	4.10	1.38	9.72	San Diego Water Department.
Bonita **	32 39 15	117 02 30	110	.52	.34	.92	.39	1.07	.23	3.47	U. S. Weather Bureau.
Camp Denny**	32 47 45	116 45 00	1,360	1.22	1.06	.67	3.80	.53	.03	7.31	California Water & Telephone Co.
Campo**	32 35 45	116 28 30	2,543	1.04	.71	.75	.48	1.91	1.42	6.31	U. S. Weather Bureau.
Chollas Heights Reservoir**	32 43 35	117 04 30	375	.55	.70	1.06	.66	1.80	.38	5.15	San Diego Water Department.
Chula Vista, Western Salt Works	32 36 15	117 05 45	9	.97	.93	.38	1.06	.07	.05	3.46	Western Salt Works.
Chula Vista, 270 Madrona Street	32 38 15	117 05 00	75	.50	.36	.84	1.40	1.07	.09	4.26	San Diego Consolidated Gas & Electric Co.
Coronado, First and D Streets	32 41 45	117 10 30	30	.68	.42	.83	.63	1.56	.07	4.19	Do.
Descanso ranger station	32 51 00	116 37 15	3,400	.46	1.42	1.45	.85	7.09	2.15	13.42	U. S. Forest Service.
Dulzura**	32 38 15	116 46 30	1,100	.69	1.32	1.25	.50	3.15	1.29	8.20	Fred R. Clark.
Dulzura Summit**	32 37 00	116 45 45	1,458	.86	.87	1.44	.63	3.15	1.35	8.30	San Diego Water Department.
Frostless Acres**	32 45 00	116 54 00	550	.65	.92	.80	.62	1.75	.56	5.30	California Water & Telephone Co.
Judson Reservoir**	32 37 00	117 03 30	235	.56	.34	.84	.37	.94	.12	3.17	Do.
Morena Dam**	32 41 00	116 33 00	3,050	.92	1.46	1.31	.60	4.11	1.43	9.83	San Diego Water Department.
National City, 916 National Avenue	32 40 30	117 06 30	50	.49	.36	.62	.46	1.23	.12	3.28	San Diego Consolidated Gas & Electric Co.
Pine Valley, Cottonwood Ranch**	32 44 30	116 29 00	3,200	2.19	.79	.82	2.05	4.23	.85	10.93	Cottonwood Ranch.
Point Loma**	32 40 10	117 14 30	302	.67	.55	.82	.85	1.45	.04	4.38	U. S. Weather Bureau.
Savage Dam**	32 36 30	116 55 45	500	.64	.47	.96	.46	1.45	.41	4.39	San Diego Water Department.
South Basin treatment plant**	32 33 00	117 05 15	25	.91	.26	.78	1.49	.29	.03	3.76	California Water & Telephone Co.
Sweetwater Lake**	32 41 30	117 00 30	310	.55	.40	.75	.43	1.13	.29	3.55	Do.
Viejas Valley **	32 51 15	116 42 00	2,400	.45	.95	1.14	.78	3.85	1.11	8.28	Do.
Willows **	32 50 00	116 43 15	2,175	.38	.85	1.30	.65	3.30	1.10	7.58	J. F. Jordan.
San Diego and San Dieguito River Basins											
Alpine	32 50	116 46	1,850	1.28	.40	1.05	1.21	2.27	.68	6.89	U. S. Weather Bureau.
Bernardo Bridge**	33 03 30	117 04 15	370	.36	1.65	1.50	.84	3.02	.74	8.11	San Diego Water Department.
Cuyamaca Dam**	32 59 15	116 35 15	4,677	.89	2.67	2.46	.94	7.65	3.05	17.66	U. S. Weather Bureau.
Del Mar**	32 58 45	117 15 30	50	.44	.58	1.02	.64	1.54	.17	4.39	San Diego Consolidated Gas & Electric Co.
Encinitas, 0.3 mile east of railroad station	33 02 30	117 17 15	150	.40	.97	1.37	.92	2.44	.44	6.54	U. S. Weather Bureau.

Escondido, 755 West Third Street	33 06 45	117 05 20	650	.44	2.25	1.75	1.15	3.20	.50	9.29	San Diego Consolidated Gas & Electric Co.
Escondido**	33 08 45	117 04 30	750	.40	2.04	1.65	.65	3.59	.56	8.89	L. E. Bagley.
El Cajon, near Main Street and Johnson Avenue **	32 47 30	116 58 30	480	.51	1.26	1.12	.68	2.60	.38	6.55	San Diego Consolidated Gas & Electric Co.
El Cajon **	32 47 30	116 55 30	560	.56	.87	1.31	.56	2.00	.88	6.18	U. S. Weather Bureau.
El Capitan Dam**	32 53 00	116 48 15	550	.35	1.38	1.31	.54	2.88	1.46	7.92	San Diego Water Department.
Grossmont, Eucalyptus Reservoir**	32 46 45	117 00 15	700	.55	1.17	1.38	.66	2.08	.64	6.48	La Mesa, Lemon Grove and Spring Valley Irrigation District.
Hodges Dam**	33 02 30	117 08 00	350	.43	1.75	1.59	.72	3.01	.38	7.88	San Diego Water Department.
Julian	33 04	116 38	4,000	1.45	.38	*	5.84	2.05	–	9.72	Franklin L. Barnes.
Julian	33 05 30	116 37 00	4,250	3.50	*	*	5.50	4.75	1.75	15.50	Fred Sawday.
La Jolla, Pearl and Cuvier Streets**	32 50 15	117 16 45	75	.65	.49	.94	.83	1.34	.16	4.41	San Diego Consolidated Gas & Electric Co.
La Mesa, Spring Street**	32 46 00	117 01 15	550	.53	1.08	1.30	.76	2.00	.32	5.99	Do.
Lake Wohlford**	33 10 15	116 59 45	1,450	.20	3.20	2.20	1.00	4.35	1.00	11.95	Escondido Mutual Water Co.
Lockwood Mesa**	32 59 00	117 15 00	200	.48	.72	1.10	.65	1.58	.15	4.68	San Diego Water Department.
Mesa Grande	33 12 30	116 47 30	3,450	*	6.60	*	*	*	10.15	16.75	C. H. Angel.
Mesa Grande, post office	33 10 45	116 46 00	3,250	3.00	1.00	2.00	4.50	4.00	1.62	16.12	Gleason Ambler.
Miramar, Scripps Ranch	32 54 00	117 06 00	660	1.80	.45	1.35	1.55	1.90	.25	7.30	S. G. Erro.
Mission Valley, near Grantville School**	32 48 30	117 05 30	100	.53	.90	.90	.66	1.46	.49	4.94	John Trusheim.
Monte pumping plant**	32 52 00	116 53 30	439	.43	1.10	1.31	.54	2.31	1.00	6.69	La Mesa, Lemon Grove and Spring Valley Irrigation District.
Murray Dam**	32 46 45	117 02 45	500	.43	.86	.83	.65	1.26	.28	4.31	Do.
Pacific Beach at mouth of Rose Canyon**	32 48 30	117 13 15	30	.54	.65	.83	.51	1.40	.46	4.39	Sanford Brown.
Ramona	33 02 30	116 51 45	1,435	*	2.20	*	5.14	1.16	–	8.50	A. C. Bisher.
Rancho Santa Fe, civic center**	33 01 45	117 10 15	200	*	1.34	1.32	.84	2.00	–	5.50	V. V. Ballard.
San Diego River diverting dam**	32 58 15	116 44 15	808	.30	1.70	1.33	.43	2.22	1.03	7.01	La Mesa, Lemon Grove and Spring Valley Irrigation District.
San Dieguito Dam**	33 02 15	117 12 00	250	.40	1.12	1.40	.69	2.02	.34	5.97	H. R. Stefanson.
Santa Ysabel, post office	33 06 30	116 40 30	2,983	*	3.02	1.63	.74	5.64	1.56	12.59	J. A. McDaniel.
Scott Ranch near Encinitas	33 03 45	117 15 15	100	1.35	.47	1.17	1.15	1.97	–	6.11	Dr. G. L. Dietrich.
Scripps Institute of Oceanography, La Jolla**	32 51 30	117 15 30	25	.51	.42	.71	.60	2.03	.03	4.30	C. W. Palmer.
State College, San Diego**	32 46 30	117 04 15	450	.57	1.25	1.04	.73	2.11	.37	6.07	U. S. Weather Bureau.
Wynola, Spencer Valley	33 05 30	116 38 30	3,750	*	2.75	*	3.00	*	9.25	15.00	J. A. Watkins.

*Included in next measurement.

**Measured in the morning.

Table 1.- Daily precipitation, in inches, at standard gages for the period February 27 to March 4, 1938--Continued
(Measured in the afternoon except as noted)

Station	Latitude ° ' "	Longitude ° ' "	Altitude (feet)	February 27	February 28	March 1	March 2	March 3	March 4	Total	Data furnished by
San Luis Rey and Santa Margarita River Basins											
Anza	33 30	116 51	2,600	0.36	0.98	0.66	2.78	0.94	0.03	5.75	Harry Bergman.
Amago	33 17 00	116 51 30	2,715	*	1.84	2.00	3.00	3.84	.25	10.93	U. S. Weather Bureau.
Carlsbad**	33 09 45	117 20 15	192	.52	1.40	1.65	1.02	1.00	.10	5.69	Carlsbad Mutual Water Co.
Deluz	33 26	117 20	400	5.63	*	2.95	5.45	2.55	.73	17.31	J. E. Brode.
"E" Reservoir	33 12 45	117 12 30	750	1.85	1.61	.80	1.44	*	.30	6.00	O. L. Simpson.
Escondido canal intake **	33 16	116 53	1,986	2.00	2.30	.61	6.50	1.38	.13	12.92	Escondido Mutual Water Co.
Fallbrook **	33 22 30	117 15 30	700	*	3.52	2.30	1.58	2.88	.40	10.68	Fallbrook Citrus Association.
Fallbrook	33 23	117 12	700	4.07	.30	2.17	4.36	.35	-	11.25	H. E. White.
Henshaw Dam**	33 14 15	117 46 00	2,702	.28	2.89	2.42	1.11	8.39	1.72	16.81	San Diego County Water Co.
Kelly Ranch near Carlsbad	33 09 00	117 18 00	50	1.55	.55	1.73	1.15	.96	.03	5.97	U. S. Weather Bureau.
Oceanside, Third and Tremont Streets**	33 11 30	117 23 00	50	.90	1.40	2.00	1.10	1.21	.05	6.66	San Diego Consolidated Gas & Electric Co.
Oceanside**	33 12 30	117 20 30	300	.62	1.79	2.17	1.00	1.13	.05	6.76	Oceanside Water Department.
Pala	33 22	117 05	400	*	1.37	1.25	4.00	.50	-	7.12	Postmaster.
Pala, 4 miles west of**	33 20 45	117 08 00	300	*	1.96	1.39	1.94	1.13	.18	6.60	R. H. Wight.
Pauba Ranch, station C**	33 28 45	117 06 00	1,000	*	1.94	2.02	2.80	2.65	.55	9.96	Vail Co.
Pechstein Reservoir**	33 11 00	117 10 45	840	1.50	1.30	.60	2.50	*	.30	6.20	Vista Irrigation District.
Red Mountain Ranch**	33 23 15	117 11 45	925	3.65	2.40	2.10	2.74	.29	-	11.18	Red Mountain Ranch.
Rincon **	33 17 15	116 57 00	1,100	.18	.04	.43	2.61	4.52	.83	8.61	Dr. Mansur.
San Clemente	33 25	117 37	135	.57	.60	1.64	2.60	1.37	.10	6.88	Orange County Flood Control District.
Santa Margarita Ranch**	33 18 30	117 20 30	80	*	2.70	1.98	.97	2.00	.26	7.91	Santa Margarita Ranch.
Santa Rosa Ranch	33 30 30	117 15 15	1,800	3.79	7.20	3.45	7.58	.48	-	22.50	Claud Murphy.
Valley Center **	33 14 30	117 00 15	1,600	.33	1.54	1.94	.90	5.49	.69	10.89	H. W. Lake.
Vista	33 15 15	117 11 30	350	1.65	.82	1.51	1.42	1.25	.11	6.76	E. D. Brink.
Vista **	33 12 00	117 14 30	330	.40	2.10	1.83	1.12	1.75	.09	7.29	E. M. Remsburg.
Warner Springs**	33 17	116 38	3,165	.21	1.21	1.36	.53	4.44	.98	8.73	C. L. McIlwaine.
Aliso and San Juan Capistrano Creek Basins											
Aliso project, Whiting Ranch	33 39 55	117 40 45	444	.63	1.12	1.89	3.21	1.56	.24	8.65	U. S. Soil Conservation Service.
El Toro Civilian Conservation Corps camp **	33 38	117 41	440	.28	1.06	1.63	1.46	2.91	.28	7.62	Do.
El Toro, 5 miles northeast of	33 39 45	117 35 15	1,000	.20	*	3.42	*	*	4.35	7.97	H. G. Astell.
El Toro, 1½ miles southwest of	33 36 30	117 42 00	375	M	M	1.48	1.47	3.19	.34	-	L. F. Moulton.
El Toro, 6 miles northeast of	33 39 45	117 34 00	1,100	.30	1.00	2.30	1.50	5.60	.25	10.95	L. Robinson.

Hare and Starr Ranch, Bell Canyon	33 38 15	117 33 45	1,150	.31	1.32	4.03	*	4.88	-	10.54	Orange County Flood Control District.
Laguna Airway station, Laguna Beach	33 32	117 46	205	.98	.61	1.44	2.32	1.06	.01	6.42	Do.
Moro Ranch, Irvine,Co.**	33 33	117 49	100	.50	1.62	1.12	1.53	2.65	-	7.42	Do.
San Juan Capistrano, ½ mile north of**	33 31	117 40	103	.30	1.13	1.77	1.43	3.03	.20	7.86	San Diego Consolidated Gas & Electric Co.
San Juan Capistrano, on Ortega Highway 1.65 miles from	33 31	117 38	150	.36	1.28	1.99	1.43	3.86	.28	9.20	Carl Hankey.
Trabuco Civilian Conservation Corps camp **	33 38 30	117 39 00	1,000	.25	1.20	2.19	1.70	3.12	.24	8.70	Orange County Flood Control District.
<u>Santa Ana, San Gabriel, and Los Angeles River Basins</u>											
San Gabriel Mountains											
Altacanyada, 5268 Linda Vista Drive	34 13 30	118 12 45	1,915	*	3.35	3.46	M	M	-	-	K. L. Williams.
Altadena, 2780 Page Drive	34 11 15	118 07 00	1,330	1.51	3.50	2.65	8.33	.62	-	16.61	C. W. Barton.
Altadena, 165 East Foothill Boulevard	34 11 45	118 08 30	1,345	1.86	2.75	2.18	8.33	.62	-	15.74	G. S. Chiesa.
Altadena, 1860 Allen Drive	34 11 30	118 06 30	1,360	1.47	3.70	2.70	8.95	.74	-	17.56	F. C. Lindvall.
Altadena, 575 Sacramento Street	34 11	118 08	1,125	1.61	2.84	2.50	8.20	.53	-	15.68	J. H. Persons.
Altadena, Ventura Street	34 11 30	118 09 30	1,179	1.53	2.48	2.34	8.52	.61	-	15.48	Los Angeles County Flood Control District.
Arroyo Seco Canyon, chlorine plant	34 12 30	118 10 00	1,150	1.37	2.75	2.70	8.63	1.07	-	16.52	Pasadena Water Department.
Arroyo Seco patrol station, 352 Michigan Avenue	34 12 00	118 11 15	1,155	1.65	2.83	3.23	8.47	1.36	-	17.54	H. J. Durand.
Arroyo Seco ranger station	34 13 20	118 10 40	1,530	1.26	2.62	2.62	8.10	1.00	-	15.60	U. S. Weather Bureau.
Bear Creek, West Fork of San Gabriel River	34 14 30	117 53 10	1,600	1.90	4.52	3.52	14.02	1.83	.09	25.88	Los Angeles County Flood Control District.
Bennett Ranch near Lytle Creek	34 10 15	117 27 15	1,750	*	5.50	2.15	4.00	5.20	.55	17.40	U. S. Weather Bureau.
Briggs Terrace, Pickens Canyon a/	34 14 15	118 13 30	2,310	1.18	3.36	3.15	8.88	1.10	.86	18.53	L. R. Bleitz.
Browns Flat	34 11	117 43	4,300	*	*	*	*	*	*	22.38	U. S. Forest Service.
Brydon Ranch, north end of Wheeler road	34 09	117 45	1,680	1.10	2.13	2.31	6.35	1.68	.05	13.62	R. S. Brydon.
Camp Baldy, San Antonio Canyon a/	34 14 15	117 39 15	4,320	1.16	3.73	3.56	11.67	3.26	.60	23.98	Los Angeles County Flood Control District.
Camp Rincon, West Fork of San Gabriel River	34 14 30	117 51 15	1,500	1.39	3.89	2.65	*	14.00	.16	22.09	R. B. Lackey.
Chilao, 1 mile north of Newcomb Ranch a/	34 20 31	117 59 30	5,585	3.42	.70	2.20	8.14	1.51	-	15.97	Los Angeles County Flood Control District.
Claremont, Indian Hill Road	34 07 30	117 43 00	1,405	.88	1.81	1.94	5.55	1.47	-	11.65	W. White.
Clear Creek, 1.6 miles above junction with Tujunga Creek a/	34 16 37	118 10 15	3,100	1.34	3.39	3.61	3.20	10.61	.22	22.37	R. H. Rogers.
Colby Ranch, Tujunga Creek	34 18 27	118 06 55	3,300	1.97	1.55	2.23	7.82	1.76	-	15.33	Los Angeles County Flood Control District.

*Included in next measurement. **Measured in the morning. M Record missing. a See table 2 for recording rain-gage record.

Table 1.- Daily precipitation, in inches, at standard gages for the period February 27 to March 4, 1938—Continued
(Measured in the afternoon except as noted)

Station	Latitude	Longitude	Altitude (feet)	February 27	February 28	March 1	March 2	March 3	March 4	Total	Data furnished by
	° ' "	° ' "									
Santa Ana, San Gabriel, and Los Angeles River Basins—Continued											
San Gabriel Mountains--Continued											
Crystal Lake, West Pine Flat	34 18 50	117 50 45	5,370	1.65	5.02	3.35	12.32	3.34	-	25.68	Roy M. Tuttle.
Crystal Lake, East Pine Flat a/	34 19 10	117 50 45	5,740	1.72	5.05	3.31	12.62	3.14	-	25.84	Do.
Cucamonga, Highland Avenue, Lewis and King Ranch	34 10	117 37	2,500	.46	2.54	2.42	7.00	1.34	0.42	14.18	Orange County Flood Control District.
Dalton flood-control dam	34 10 00	117 48 45	1,575	1.29	3.64	3.39	7.23	1.71	.21	17.47	Paul Keiser.
Dalton Creek ranger station, at junction of Volfe and Bell Canyons	34 11 00	117 48 36	1,950	*	6.18	.62	9.40	.92	.08	17.20	A. M. Troat.
Deer Park, 1.5 miles above Sawpit Dam	34 12 00	117 57 30	2,500	1.04	3.68	2.88	8.04	4.04	-	19.68	Ben Overturf.
Devils Gate flood-control dam	34 10 50	118 10 30	1,100	1.31	2.38	2.38	9.55	1.08	-	16.70	Los Angeles County Flood Control District.
Eaton debris dam	34 10 10	118 05 30	900	1.46	2.83	2.40	7.35	.63	-	14.66	U. S. Weather Bureau.
Eaton Canyon, at mouth	34 11 30	118 06 20	1,325	1.48	3.53	2.70	8.74	.70	-	17.15	Los Angeles County Flood Control District.
Echo Mountain	34 12 45	118 07 15	3,250	1.78	1.80	2.80	*	9.39	.48	16.25	Do.
Fish Canyon, at U. S. Geological Survey gaging station	34 10 15	117 55 45	1,050	1.36	1.28	4.33	7.10	1.08	.06	15.21	August Bohn.
Glendora, mouth of Englewild Canyon**	34 09 22	117 50 00	1,200	2.59	1.48	2.94	8.17	.52	.13	15.83	Mrs. J. P. Englehart.
Haines Canyon, gravel pit	34 15 45	118 16 45	2,250	1.20	2.58	2.22	7.47	.75	-	14.22	Los Angeles County Flood Control District.
Henninger Flats, Mount Wilson toll road a/	34 11 30	118 05 15	2,650	1.30	4.03	3.15	9.50	1.28	-	19.26	E. L. Lioret.
Hermann, 11332 Osborne Avenue	34 16 30	118 23 00	1,120	.68	1.20	1.48	4.45	.65	-	8.46	J. Hermann.
Hoegee's camp, West Fork of Santa Anita Creek a/	34 12 30	118 02 30	2,750	1.71	7.82	4.06	13.95	2.54	-	30.08	William Murphy.
Kelly's Kamp, 1.25 miles northeast of Ontario Peak	34 14	117 36	8,300	1.80	3.05	4.00	17.55	4.90	.90	32.20	H. S. Delker.
Kiener Ranch	34 18 30	118 24 00	1,375	.72	1.62	1.66	4.48	1.06	-	9.54	Los Angeles County Flood Control District.
Kinneloa Ranch, east side of Eaton Wash	34 10 45	118 05 00	1,400	1.54	2.07	2.04	8.70	.78	-	15.13	Do.
La Cañada, 4620 Commonwealth Avenue	34 12 45	118 12 00	1,275	1.48	2.88	2.53	8.36	.74	-	15.99	Mrs. S. T. Chisam.
La Cañada, 4874 Commonwealth Avenue	34 12	118 12	1,350	1.55	3.20	2.65	8.99	1.09	-	17.48	Toni Hall.
La Crescenta, 2908 Foothill Boulevard	34 14 30	118 14 30	1,565	1.21	3.35	3.08	10.27	.89	-	18.80	H. A. Scheuner.
La Crescenta	34 14 30	118 14 15	2,264	1.18	3.76	3.05	9.42	.94	-	18.35	U. S. Weather Bureau.
Little Cienaga, 1 mile north of Coldbrook Camp	34 18 30	117 50 00	4,650	1.55	4.17	3.35	12.76	.44	.10	22.37	Frank M. Headlee.
Little Tujunga	34 19 30	118 20 00	1,700	.83	1.42	1.62	5.04	.84	.11	9.86	F. M. McBride.

Live Oak Canyon, 4055 North San Antonio Avenue	34 07	117 44	1,255	.97	1.84	1.85	5.51	1.68	Tr.	11.85	C. S. Elder.
Live Oak Canyon near dam	34 08 00	117 44 50	1,420	1.06	2.08	2.16	6.50	1.42	-	13.22	Los Angeles County Flood Control District.
Loomis Ranch, near junction of North and Middle Forks of Alder Creek a/	34 21	118 03	4,300	1.24	.93	1.62	7.64	1.42	.17	13.02	L. G. Loomis.
Lopez Canyon at mouth**	34 17	118 24	1,173	*	1.41	2.41	1.80	2.96	.41	8.99	Los Angeles County Flood Control District.
Lower Haines Canyon near U. S. Geological Survey gaging station	34 16 15	118 16 30	2,250	1.27	2.70	2.36	7.80	.85	.02	15.00	Do.
Lytle Creek at powerhouse intake	34 14	117 29	2,800	.43	5.96	5.36	3.76	12.22	.25	27.98	State of California.
Lytle Creek ranger station**	34 15	117 29	2,770	.32	4.49	4.27	3.08	M	-	-	U. S. Forest Service.
Lytle Creek at powerhouse	34 12 15	117 27 30	2,225	1.75	4.10	2.45	9.10	2.55	.53	20.48	U. S. Weather Bureau.
Mira Monte Reservoir, at foot of Mount Wilson trail, Sierra Madre	34 10	118 03	985	.53	3.47	4.38	3.75	5.64	.19	17.96	Al Freeland.
Monrovia Canyon	34 10 00	117 59 45	975	.26	3.47	3.81	*	*	5.65	13.19	U. S. Weather Bureau.
Monrovia Falls, Monrovia Canyon a/	34 11 15	117 59 00	1,450	1.20	4.74	3.24	10.64	4.20	-	24.02	M. L. Packer.
Morris Dam, San Gabriel Canyon	34 11	117 53	1,210	1.36	3.86	3.13	8.68	1.25	.08	18.36	Pasadena Water Department.
Mountain Springs Ranch, San Dimas Canyon	34 08 50	117 46 25	1,400	1.11	1.97	2.42	5.87	.95	-	12.32	Mrs. E. B. White.
Mount Gleason a/	34 22 26	118 12 20	5,450	1.28	2.10	2.05	9.81	1.85	.45	17.54	Los Angeles County Flood Control District.
Mount Wilson a/	34 13 20	118 03 20	5,850	2.16	5.93	3.99	11.83	2.32	-	26.23	K. Pitt.
Oakwilde Resort, Arroyo Seco Canyon	34 14 45	118 11 00	2,000	1.60	3.14	1.91	*	12.50	-	19.15	J. R. Phillips.
Opid's camp, West Fork of San Gabriel River a/	34 15 15	118 05 45	4,350	1.79	4.89	3.21	14.92	2.44	.02	27.27	Mrs. John Opid.
Pacoima Canyon	34 21	118 22	2,200	.85	2.61	2.74	6.11	1.35	.20	13.86	Los Angeles County Flood Control District.
Pacoima flood-control dam a/	34 20	118 24	1,700	.88	1.94	2.01	5.38	1.27	-	11.48	R. E. Waddicar.
Padue Hills, 1.5 miles north of Base Line Road	34 08 45	117 41 50	1,768	*	3.04	2.46	4.36	4.74	.13	14.73	K. B. Forbes.
Pasadena	34 10 40	118 06 10	-	.95	3.17	4.09	3.35	6.28	.03	17.87	Los Angeles County Flood Control District.
Pickens Canyon a/	34 15 15	118 13 00	4,250	1.43	3.60	3.14	8.12	1.06	.01	17.36	Do.
Pickens debris basin	34 13 15	118 13 45	1,600	*	*	*	*	*	-	15.34	Do.
Prairie Forks, 2 miles east of Vincent Gulch	34 20	117 42	5,680	*	3.35	2.21	*	10.02	.13	15.71	Gus Wissendorff.
San Antonio guard station a/	34 10 45	117 40 28	2,450	*	6.53	.90	9.89	.09	-	17.41	U. S. Forest Service.
San Antonio Canyon, 1.25 miles southwest of Camp Baldy	34 14	117 40	4,527	1.38	3.88	4.25	13.13	2.70	.50	25.84	M. M. Smith.
San Antonio Canyon at mouth	34 10 40	117 40 35	2,500	.98	3.34	2.35	*	10.17	-	16.84	Los Angeles County Flood Control District.
Santa Anita Canyon ranger station	34 50 00	118 01 05	1,950	.47	7.12	4.01	10.64	1.36	-	23.60	U. S. Forest Service.
Santa Anita flood-control dam	34 11 04	118 01 11	1,400	1.30	4.06	2.53	6.76	.73	-	15.38	Joseph Propst.
San Dimas Experimental Forest, Bell-Volfe a/	34 10	117 48	1,880	1.56	6.38	.68	9.32	1.10	-	19.04	U. S. Forest Service.

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Table 1.- Daily precipitation, in inches, at standard gages for the period February 27 to March 4, 1938—Continued
(Measured in the afternoon except as noted)

Station	Latitude ° ′ ″	Longitude ° ′ ″	Altitude (feet)	February 27	February 28	March 1	March 2	March 3	March 4	Total	Data furnished by
Santa Ana, San Gabriel, and Los Angeles River Basins—Continued											
San Gabriel Mountains—Continued											
San Dimas Experimental Forest, Tanbark Flats a/	34 12 21	117 45 34	2,700	1.26	3.66	3.35	10.83	1.79	0.31	21.20	U. S. Forest Service.
San Dimas Experimental Forest, Bell Canyon a/	34 12	117 46	3,100	1.50	4.80	.22	5.43	M	-	-	Do.
San Dimas Experimental Forest, West Fork of San Dimae Creek	34 10	117 47	2,100	1.14	5.34	.82	8.94	1.00	-	17.24	Do.
San Dimas ranger station	34 10	117 46	1,500	1.21	2.46	2.01	7.07	1.58	-	14.33	O. L. Trout.
San Dimas flood-control dam	34 09 05	117 46 28	1,350	1.14	2.19	1.83	7.07	1.58	-	13.81	G. W. Rodger.
San Dimas, ½ mile north of Foothill Boulevard	34 07 35	117 47 50	1,110	1.15	1.92	2.25	6.50	1.20	-	13.02	A. L. Stevens.
San Gabriel flood-control dam No. 1 a/	34 12 20	117 51 20	1,251	1.49	3.85	2.82	9.90	1.69	.13	19.88	Los Angeles County Flood Control District.
San Gabriel flood-control dam No. 2 a/	34 14 45	117 58 00	2,335	1.90	4.53	3.52	13.42	1.18	-	24.55	Do.
San Gabriel River at mouth of canyon a/	34 09 48	117 54 17	800	.27	2.20	4.04	3.02	5.24	.16	14.93	Roger Dalton.
San Gabriel River, East Fork of	34 14 15	117 49 00	1,500	1.48	3.36	2.88	10.90	1.60	.03	20.25	Los Angeles County Flood Control District.
San Gabriel River, East Fork of a/	34 16 35	117 45 05	2,500	.57	2.93	2.33	8.62	1.61	-	16.06	Do.
San Gabriel River, North Fork of	34 15 15	117 51 15	1,790	*	5.36	*	8.87	M	-	-	Do.
San Gabriel River at junction of East and West Forks	34 13 30	117 50 45	1,600	1.36	3.67	3.07	12.19	1.55	-	21.84	Do.
San Gabriel River powerhouse	34 09 30	117 54 30	850	1.37	2.80	2.60	6.47	1.61	.01	14.85	Do.
Sawpit Canyon	34 11	117 58	2,000	1.03	3.64	2.85	7.96	4.00	-	19.48	M. L. Packer.
Sawpit flood-control dam	34 10 31	117 59 16	1,378	1.05	3.81	2.81	7.51	4.33	-	19.51	Do.
Sierra Madre flood-control dam	34 10 30	118 02 30	1,400	.56	3.54	4.48	8.82	.68	-	18.08	Al Freeland.
Sierra Madre, north end of Baldwin Avenue	34 10	118 03	1,110	1.63	3.98	2.36	8.80	.44	-	17.21	Arthur Carter.
Sierra Madre, 575 North Hermosa Avenue a/	34 10 15	118 03 30	1,160	1.54	3.68	2.68	7.89	.58	-	16.37	Col. H. B. Hersey.
Sierra Madre, 621 East Central Avenue	34 09 45	118 02 30	700	.40	3.07	3.55	3.16	5.55	.21	15.94	J. P. Hogan.
Sleepy Hollow Ranch a/	34 18 04	118 06 42	3,600	2.13	1.70	2.45	10.95	1.52	.06	18.81	Joe Argay.
Sturtevant Camp, upper Santa Anita Canyon	34 13 30	118 02 15	3,375	2.00	6.07	2.98	12.12	1.96	-	25.13	V. B. Hoopes.
Switzer's camp a/	34 15 15	118 09 15	3,000	1.20	2.69	2.02	12.41	1.46	-	19.78	B. B. Austin.
Tujunga flood-control dam	34 17 00	118 11 45	2,050	1.20	3.28	3.00	10.83	2.05	-	20.36	Sam Browne.
Tujunga Canyon, Southern California Edison Co.	34 18 15	118 09 30	2,600	1.05	2.60	2.15	7.88	1.49	-	15.17	J. R. Hoehn.

Tujunga	34 15 00	118 17 15	1,850	1.01	2.12	2.07	6.02	1.88	Tr.	13.10	U. S. Weather Bureau.
Upper Haines Canyon a/	34 16 18	118 15 11	3,450	1.57	3.31	2.95	10.39	1.16	.02	19.40	Los Angeles County Flood Control District.
Wolfskill Falls, Wolfskill Canyon	34 10 30	117 45 00	2,400	1.58	6.06	.62	9.72	.70	-	18.68	Lloyd E. Davis.
San Bernardino Mountains											
Arrowhead Springs Hotel	34 11 15	117 16 00	2,000	.30	2.05	1.92	4.70	2.08	-	11.05	U. S. Weather Bureau.
Bear Valley	34 14 15	116 57 00	6,875	*	4.75	*	6.25	9.00	1.74	21.74	W. L. Rideout.
Bear Valley Dam	34 14 45	116 58 30	6,800	4.96	3.39	1.54	15.06	2.00	-	26.95	U. S. Weather Bureau.
Beaumont	33 55 45	116 58 45	2,580	.63	1.28	1.76	1.01	4.08	.33	9.09	Do.
Beaumont, north of	33 59 00	116 58 15	3,040	.45	.95	1.75	.90	6.25	.46	10.76	Do.
Del Rosa ranger station a/	34 10	117 15	2,250	1.20	1.15	1.66	1.69	6.33	.12	12.20	U. S. Forest Service.
Devil Canyon experimental station a/	34 13 00	117 19 40	2,700	1.04	3.90	.04	9.37	2.55	.10	17.00	Do.
Devil Canyon, mouth of	34 12 15	117 20 00	2,000	.19	2.13	2.40	1.91	6.73	.29	13.65	San Bernardino Water Department.
Devore, Cajon Creek	34 14 00	117 24 15	2,500	.38	3.40	3.12	1.68	7.35	.25	16.18	U. S. Weather Bureau.
Forest Home, Southern California Edison Co.'s intake	34 05 30	116 56 00	5,000	2.23	2.00	2.33	9.20	6.28	.08	22.12	Do.
Mill Creek powerhouses Nos. 2 and 3	34 05 15	117 02 30	2,950	1.16	.92	1.31	3.57	3.40	.56	10.92	Do.
Newark Reservoir, San Bernardino	34 10 15	117 19 00	1,385	.23	1.93	1.93	1.65	6.02	.81	12.57	Do.
Panoramic Point, State highway maintenance station	34 13 30	117 18 10	4,000	*	4.38	1.82	8.45	2.45	.39	17.49	State of California.
Plunge Creek Divide	34 12 30	117 06 30	6,000	1.82	4.23	2.61	11.74	4.82	1.80	27.02	Do.
Redlands, Crafton Orange Growers Association	34 04	117 08	1,650	*	1.69	*	3.83	2.37	.40	8.29	Orange County Flood Control District.
Redlands, east of	34 03 30	117 06 30	2,000	.30	1.16	1.20	.68	4.12	.64	8.10	F. B. King.
Santa Ana River powerhouse No. 1, Southern California Edison Co.	34 08 30	117 03 00	3,517	1.05	1.56	1.27	3.10	M	M	M	U. S. Weather Bureau.
Santa Ana River powerhouse No. 3, Southern California Edison Co.	34 06 30	117 06 00	2,500	1.38	.84	1.03	2.90	3.26	.51	9.92	Do.
Seven Oaks	34 10 45	116 55 30	5,000	1.42	.98	2.10	8.47	4.69	.56	18.22	Do.
Squirrel Inn	34 13 45	117 15 00	5,300	2.15	5.10	3.15	10.97	4.70	.10	26.17	Do.
Yucaipa	34 02 30	117 02 15	2,850	.38	1.05	1.43	.84	5.02	.58	9.30	Orange County Flood Control District.
San Fernando Valley											
Adohr Dairy, Ventura Boulevard	34 09 56	118 31 38	815	.24	1.87	2.52	2.64	3.24	.02	10.53	E. M. Sherman.
Bell Canyon, Johnson-Woodruff Ranch	34 12 13	118 38 39	930	.75	1.26	1.52	5.41	.54	-	9.48	Paul Johnson.
Burbank Airport**	34 11	118 18	650	.07	1.26	1.92	.70	2.85	.21	7.01	U. S. Weather Bureau.
Burbank	34 10 55	118 18 24	650	1.41	1.79	2.43	6.43	.71	-	12.77	Los Angeles County Flood Control District.
Calabasas	34 09 26	118 38 21	950	.93	.96	1.70	5.07	.46	-	9.12	Tom Farmer.

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Station	Latitude	Longitude	Altitude (feet)	February 27	February 28	March 1	March 2	March 3	March 4	Total	Data furnished by
	° ' "	° ' "									
Santa Ana, San Gabriel, and Los Angeles River Basins—Continued											
San Fernando Valley—Continued											
Chatsworth, Twin Lakes Park fire station a/	34 16 38	118 36 12	1,249	0.53	1.19	2.06	6.10	0.80	-	10.68	Los Angeles County Flood Control District.
Chatsworth, south of Devonshire Street and east of Vassar Street	34 15 25	118 36 20	965	1.52	1.58	*	4.68	.76	-	8.54	E. L. Johnson.
Chatsworth patrol station	34 15	118 37	865	.53	1.19	2.06	6.10	.80	-	10.68	U. S. Weather Bureau.
Chatsworth Reservoir, east end of	34 13 36	118 37 03	865	.05	1.07	2.08	2.59	3.13	.06	8.98	R. R. Melrose.
Encinó Reservoir, 1 mile southwest of Encino	34 08 56	118 30 52	1,000	.12	1.65	2.09	1.76	2.47	.07	8.16	John H. Cowan.
Girard, Brant Ranch	34 10 16	118 35 56	892	.40	1.16	2.01	5.33	.52	.05	9.47	Thos. Franklin.
Girard, corner Ventura Boulevard and Topanga Canyon road**	34 10 06	118 36 18	892	.96	1.07	1.53	5.37	.52	.05	9.50	Albert Shaw.
Glendale	34 09	118 16	526	.55	2.78	2.50	3.35	4.87	.29	14.34	U. S. Weather Bureau.
Glendale, 448 West Pioneer Drive	34 09 21	118 15 47	526	1.35	1.80	1.85	4.28	M	-	-	A. W. Taylor.
Granada pump plant	34 16 42	118 30 59	1,130	.48	1.79	1.75	4.14	.54	-	8.70	City of Los Angeles, Bureau of Water and Power.
Griffith Park, north slope of Mount Hollywood	34 07 54	118 17 54	1,600	*	2.14	*	*	10.56	-	12.70	L. Strauss.
Griffith Park, south slope of Mount Hollywood	34 07 45	118 17 53	1,400	*	2.10	*	*	9.32	-	11.42	Do.
Griffith Park Zoo	34 08 03	118 17 20	575	1.25	1.50	4.00	5.76	3.62	.03	16.16	B. C. Gibson.
Headworks power plant, west of north entrance to Griffith Park	34 09 21	118 18 20	473	1.44	2.09	2.46	7.31	.55	-	13.85	W. A. Herring.
Lower San Fernando Reservoir	34 17 15	118 29 00	1,150	1.30	2.65	2.10	3.25	.07	-	9.37	F. Ortiz.
Miller Ranch, 14163 Van Nuys Boulevard	34 15 25	118 26 07	944	.88	1.22	1.45	4.90	.35	-	8.80	W. D. Miller.
Mulholland fire station, Franklin Canyon	34 07 48	118 24 42	1,175	1.50	2.43	2.38	7.13	.05	-	13.49	M. Huggins.
North Hollywood powerplant	34 11 55	118 23 18	732	.50	1.52	1.92	2.07	2.27	-	8.28	D. A. Reid.
North Hollywood	34 10	118 24	630	1.40	1.30	1.83	5.32	.28	-	10.13	U. S. Weather Bureau.
North Hollywood, 10834 East Blix Street	34 09 47	118 22 17	593	.32	2.26	3.05	3.25	3.47	.07	12.42	Katie Elix.
North Los Angeles, corner Parthenia and Van Alden Avenues	34 13 44	118 33 02	797	.12	1.31	1.75	2.30	3.62	.05	9.15	Jack Andrews.
Olive View Sanatorium	34 19 45	118 27 00	1,425	*	2.54	1.84	4.76	1.00	-	10.14	R. N. Loomis.
Oneoto Ranch, 13781 Payton Avenue	34 16 10	118 26 00	1,005	*	1.55	2.08	1.64	2.70	.04	8.01	L. D. Bowlas.
Roscoe, 10100 Helen Street	34 15 15	118 22 00	1,060	1.07	1.27	1.46	4.17	.70	-	8.67	Sam Chappell.
Roscoe, near mouth of La Tuna Canyon**	34 14 19	118 21 28	1,000	.15	1.71	1.91	1.37	3.33	.04	8.51	E. S. Merrill.

San Fernando, Ford Craig Ranch	34 19 12	118 24 59	1,455	.77	1.72	1.76	4.63	.55	-	9.43	V. H. Craig.
San Fernando Lemon Association packing house**	34 16 15	118 27 54	950	.03	1.31	2.64	1.86	3.03	.08	8.95	B. Henneman.
San Fernando ranger station, 12605 Osborne Avenue	34 15 21	118 24 27	955	.96	1.44	1.58	4.97	.76	.05	9.76	V. Taylor.
Sepulveda Boulevard near Chase Street	34 13 34	118 28 03	815	.39	1.22	2.33	1.71	3.17	-	8.82	R. Larson.
Sepulveda Canyon at Mulholland Drive**	34 07 18	118 29 42	1,400	.54	2.10	4.28	5.90	1.82	-	14.64	Carl M. Nave.
Sylmar, olive-packing plant	34 18 37	118 28 17	1,250	*	2.32	1.43	4.35	.68	-	8.78	W. C. Simonds.
Upper San Fernando Reservoir	34 18 49	118 29 30	1,248	*	1.22	3.21	1.97	3.62	.21	10.23	Los Angeles County Flood Control District.
Van Nuys, city warehouse, Aetna and Vesper Streets a/	34 10 48	118 27 03	695	.17	1.53	2.46	2.24	3.29	.02	9.71	Frank Carr.
Verdugo Mountains											
Brand Estate, Grandview Avenue	34 10 57	118 16 33	815	1.28	1.60	2.14	6.06	.42	-	11.50	F. W. Pomeroy.
Brand Park a/	34 11 19	118 16 21	1,250	1.33	2.08	2.54	7.02	.75	.01	13.73	Los Angeles County Flood Control District.
Glendale, 318 East Randolph Street	34 09 55	118 15 01	620	.49	1.85	2.45	7.06	.21	-	12.06	J. E. Jones.
Rossmoyne fire area, Glendale a/	34 10 50	118 14 40	1,500	1.15	2.18	2.10	7.10	.80	.06	13.39	Los Angeles County Flood Control District.
Sunset Canyon, Burbank	34 12 10	118 17 08	1,650	1.29	2.01	2.44	6.78	.73	-	13.25	Do.
Verdugo Mountain, Oakmont fire road	34 12 28	118 16 17	2,825	1.42	2.36	2.66	7.85	.86	.02	15.17	Los Angeles County Forestry Department.
San Rafael Hills											
El Mirador Ranch, west end of El Mirador Drive	34 09 56	118 10 46	1,025	1.51	2.46	2.17	7.72	.55	-	14.41	J. D. Hoffman.
El Sereno, 4566 Bedillion Street a/	34 04 54	118 11 02	553	1.34	1.69	1.94	6.43	.40	-	11.80	George P. Morgan.
Flintridge fire station, Inverness and Gleneagle Streets	34 10 57	118 11 47	1,325	1.46	2.71	2.35	7.77	.64	-	14.93	Los Angeles County Flood Control District.
Glendale, 811 North Glendale Avenue	34 09 29	118 14 25	653	1.39	1.82	1.90	6.90	.17	-	12.18	John Opid.
Highland Park, 6425 Elgin Street	34 07 06	118 10 40	680	1.70	2.25	2.01	6.48	.63	-	13.07	Robert H. Lindsay.
San Rafael Hills, 502 Lakeview Avenue	34 07	118 12	825	1.62	2.14	1.92	6.17	.60	-	12.45	Los Angeles County Flood Control District.
Sycamore Canyon, 2821 North Chevy Chase Drive	34 09 57	118 12 23	900	1.39	2.48	2.10	6.27	.61	-	12.85	F. H. Hay.
Tampico Street a/	34 05 30	118 10 30	600	1.51	1.81	1.88	5.81	.18	-	11.19	Los Angeles County Flood Control District.
San Gabriel Valley											
Arcadia	34 08 20	118 01 48	475	1.60	2.73	2.35	7.30	.57	-	14.55	Do.
Arcadia pumping plant, north of East Live Oak Avenue	34 09 32	118 02 02	611	1.22	2.96	2.86	7.67	.83	-	15.54	Scott M. Lee.
Alhambra, corner Second and Main Streets	34 05 40	118 07 43	485	*	4.02	1.88	7.11	.59	-	13.60	J. W. Clay.

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(Measured in the afternoon except as noted)

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Santa Ana, San Gabriel, and Los Angeles River Basins—Continued											
San Gabriel Valley—Continued											
Azusa, rear of city hall	34 08 04	117 54 17	607	1.33	2.25	2.30	6.72	0.84	Tr.	13.44	Paul E. Smith.
Azusa, Foothill Ranch, 2 miles west of Citrus Avenue	34 08 00	117 53 37	615	1.42	2.40	2.48	6.61	.76	-	13.67	Charles Stewart.
Azusa, Bonita Street, west of Cerritos Avenue a/	34 06 24	117 53 58	545	1.31	1.75	2.01	5.86	.91	-	11.84	E. B. Griffith.
Azusa, 325 Foothill Boulevard	34 08 02	117 54 14	602	1.40	2.22	2.35	6.72	.91	-	13.60	John Hibsch.
Baldwin Park experiment station, Scott Place	34 05 38	117 57 39	387	*	2.42	2.64	*	6.28	.01	11.35	Los Angeles County Flood Control District.
Baldwin Park, 334 North Main Street	34 05 17	117 57 35	378	1.60	1.60	1.71	5.68	.87	-	11.46	S. Howard Leach.
California Institute of Technology a/	34 08 16	118 07 38	763	1.62	2.72	2.27	7.53	.63	-	14.77	Los Angeles County Flood Control District.
Chapman Wells, Sierra Madre Avenue	34 08 48	118 04 05	635	1.60	2.79	2.30	7.51	.57	-	14.77	W. E. Comerford.
Charter Oaks, Covina Boulevard	34 06 00	117 50 02	805	1.50	1.65	1.95	6.79	1.06	-	12.95	Will G. Fields.
Covina, City Water Department, 125 East College Street	34 05 15	117 53 18	583	1.27	1.51	1.92	4.67	1.55	-	10.92	H. H. Snodgrass.
Covina, 161 Navilla Place **	34 04 55	117 53 17	527	1.98	.83	1.85	2.55	2.74	1.33	11.28	J. L. Mathews.
Covina, Puente Street, east of high school	34 04 57	117 52 28	575	1.36	1.48	1.86	5.13	1.27	-	11.10	W. O. Temple.
Covina, Cameron Avenue	34 03 39	117 52 38	630	.98	1.33	1.62	4.70	.73	-	9.36	Ben F. Thorpe.
Diamond Bar Ranch, Spadra office	34 02 15	117 48 43	675	*	1.85	1.55	4.78	.87	-	9.05	W. Collins.
El Monte, fire station	34 04 27	118 02 08	301	*	2.65	2.08	6.39	.53	-	11.65	Martin Sorensen.
Glendora, 234 North Michigan Avenue	34 08 22	117 51 54	782	1.28	2.39	2.55	6.58	.86	-	13.66	H. C. Warren.
Glendora Irrigation Co., Azusa plant	34 09 00	117 55 00	675	1.25	2.34	2.41	7.00	.96	-	13.96	Glendora Irrigation Co.
Glendora, Pennsylvania and Sierra Madre Avenues	34 08 49	117 52 04	825	1.35	2.56	2.73	6.69	1.66	-	14.99	Frank H. Brown.
Glendora Irrigation Co., Sierra Madre Avenue	34 08 51	117 52 53	865	1.37	2.40	2.61	6.71	1.86	-	14.95	H. C. Warren.
Glendora, 460 East Bennett Avenue	34 08 23	117 51 33	822	.98	2.45	2.61	6.70	.98	-	13.72	L. M. West.
Howell Ranch, 1 mile west of Walnut post office	34 00 04	117 52 21	475	*	2.28	1.86	6.00	.87	.01	11.02	C. Cullum.
Hurst Ranch, Orange and Merced Avenues, near Covina	34 03 51	117 57 00	358	1.64	1.59	1.80	5.13	1.00	-	11.16	Hurst Bros.
Lamanda Park	34 08 56	118 05 42	742	*	3.72	3.90	2.91	5.70	.14	16.37	F. G. Webber.
La Verne, at Pacific Electric Railway station	34 05 47	117 46 16	1,036	1.00	1.75	1.83	6.35	.95	-	11.88	W. O. Hathaway.
La Verne, 2152 Third Street	34 06 01	117 46 07	1,054	1.00	1.52	1.77	5.44	1.46	-	11.19	Alice C. McClellan.

Marks pasture, Puente Hills	34 01 55	118 04 57	600	1.65	1.35	2.25	6.50	.80	-	12.55	W. S. Marks.
Monrovia, on roof of city hall	34 08 57	118 00 02	600	.97	2.65	2.20	7.46	.69	-	13.97	G. H. Duell.
Monrovia, 432 North Primrose Street	34 09 32	118 00 25	675	.40	2.60	3.21	2.90	4.97	.15	14.23	Charles J. O'Conner.
Newmark, Merced Hills, Southern California Edison Co. a/	34 02 45	118 07 43	375	1.65	1.67	1.63	5.89	.60	-	11.44	County storm-drain employees.
North Whittier, Cole Ranch, Seventh Avenue	34 00 23	117 59 46	600	1.62	1.23	2.00	5.67	.54	-	11.06	Bart Priest.
North Whittier Heights, 1058 Los Robles Avenue	34 00 20	117 59 22	500	1.75	1.22	1.90	*	7.52	.14	12.53	J. A. Smith.
North Whittier Heights	34 01 15	117 58 38	312	2.44	*	1.97	2.77	4.00	-	11.18	U. S. Soil Conservation Service.
Pasadena	34 08 55	118 08 36	864	1.72	2.53	2.18	7.70	.68	-	14.81	Water Department Employees.
Pasadena, Central fire station a/	34 08 50	118 08 47	862	*	3.53	2.70	3.64	4.59	.05	14.51	Los Angeles City Department of Public Works.
Pasadena, Ohio and Euclid Streets a/	34 07 43	118 08 34	755	*	3.50	2.68	3.96	4.04	.07	14.25	Do.
Pasadena, Sunset Reservoir a/	34 09 43	118 09 17	930	1.65	2.61	2.27	*	8.08	-	14.61	H. J. Sievert.
Pasadena, Washington Street and Palm Terrace a/	34 10 08	118 08 12	1,010	1.16	3.06	2.60	7.76	1.00	.01	15.59	Do.
Potrero Heights, 3623 Delta Street	34 02 37	118 05 10	320	.32	1.61	2.98	2.45	4.28	-	11.64	J. Reifer, Jr.
Puddingstone Dam, at caretaker's house	34 05 30	117 48 24	1,030	1.09	1.64	1.68	5.45	1.15	-	11.01	F. A. Pollard.
Puente, Southern California Edison Co. substation	34 00 34	117 55 46	374	1.53	.91	1.64	4.83	1.10	-	10.01	G. C. Hoisington.
Rowland Ranch at ranch house, near Puente	33 59 37	117 56 30	466	.25	2.00	2.05	2.85	2.95	.14	10.24	D. F. Ferrero.
San Dimas, Juanita Avenue east of Walnut Avenue	34 06 38	117 47 59	1,000	1.10	1.84	2.01	3.99	3.50	.22	12.66	Mrs. George Ferguson.
San Dimas, 167 North San Dimas Avenue	34 06 31	117 48 25	963	1.16	1.65	1.91	6.17	.97	-	11.86	W. E. Mount.
San Dimas, 114 East First Street	34 06 28	117 48 22	960	1.12	1.67	1.90	6.20	1.04	-	11.93	Sam L. Trout.
San Dimas Water Co. pumping plant, Foothill Boulevard and Artesia Avenue	34 07 23	117 47 36	1,064	1.00	1.74	2.02	6.10	1.01	-	11.87	F. L. Brockham.
San Gabriel, 424 North Milton Avenue	34 06 32	118 06 19	487	*	3.07	2.60	3.30	4.25	-	13.22	George B. Gleason.
San Gabriel, 309 East Live Oak Avenue	34 06 07	118 05 45	433	1.65	2.10	1.83	6.30	1.34	-	13.22	Richard Watts.
Sierra Madre, 415 East Live Oak Street	34 09 29	118 02 36	665	1.43	3.60	2.60	7.35	.83	-	15.81	C. J. Pegler.
South Pasadena, city hall	34 06 58	118 09 05	660	1.60	2.10	2.15	6.97	.45	-	13.27	Frank H. Clough.
State Narcotic Hospital near Spadra	34 02 51	117 50 50	770	.17	1.74	2.02	2.06	3.46	.17	9.62	L. P. Graff.
Walnut Fruit Growers Association, 0.5 mile southeast of Walnut	34 00 13	117 51 11	533	*	2.29	1.89	*	6.59	-	10.77	Los Angeles County Flood Control District.
West Arcadia, 2307 Naomi Drive	34 07 25	118 03 40	490	1.32	2.23	2.38	4.58	3.49	.07	14.07	Mrs. Mamie L. Picard.
West Azusa	34 06 51	117 54 58	505	1.43	1.84	2.21	5.55	1.12	-	12.15	Los Angeles County Flood Control District.
Whittier Narrows (Paso de Bartolo)	34 00 54	118 04 25	195	1.16	1.13	1.73	4.75	.61	-	9.38	D. M. Cate.

*Included in next measurement. **Measured in morning. a See table 2 for recording rain-gage record.

Table 1.- Daily precipitation, in inches, at standard gages for the period February 27 to March 4, 1938—Continued
(Measured in the afternoon except as noted)

Station	Latitude ° ' "	Longitude ° ' "	Altitude (feet)	February 27	February 28	March 1	March 2	March 3	March 4	Total	Data furnished by
Santa Ana, San Gabriel, and Los Angeles River Basins—Continued											
Chino Valley											
Alta Loma Citrus Association, near Upland	34 07 30	117 35 30	1,325	*	2.33	1.96	4.18	3.07	-	11.54	Mr. Bridge.
Braundale Acres, east of Ontario	34 02 45	117 37 00	900	0.65	.77	1.43	1.64	3.50	0.03	8.02	Orange County Flood Control District.
Chino Ranch, American Beet Sugar Co.**	33 59 15	117 40 15	714	*	1.26	1.50	*	5.64	.21	8.61	Do.
Chino plant, American Beet Sugar Co.**	34 00 30	117 42 00	710	.42	.95	1.74	2.42	3.57	.26	9.36	Do.
Chino, Big W Ranch	34 01 15	117 41 00	750	1.05	.80	1.49	3.64	2.39	.02	9.39	Do.
Chino, Southern California Edison Co., substation	33 59 50	117 40 45	670	.95	.48	1.44	4.48	2.10	-	9.45	Southern California Edison Co.
Claremont, fire station, Second Street	34 05 47	117 42 59	1,165	.82	1.24	1.66	7.45	.65	-	11.82	George M. Williams.
Claremont, Pomona College Observatory a/	34 05 52	117 42 34	1,190	.79	1.25	1.63	5.73	.59	-	9.99	John S. Hopkins.
Cucamonga, 1 mile east of	34 06 15	117 34 20	1,150	*	*	3.02	*	7.40	.12	10.54	Orange County Flood Control District.
Etiwanda a/	34 08 15	117 31 00	1,450	*	1.73	2.45	2.50	3.87	.54	11.09	U. S. Army, Corps of Engineers.
Guasti, Guasti Wine Co.	34 04 00	117 35 15	975	*	1.08	1.85	1.97	3.00	.13	8.03	Guasti Wine Co.
Highland Avenue	34 09	117 35	1,575	.10	1.56	2.62	3.02	4.90	.18	12.38	Victor Cherbak.
Highland Avenue, 3 miles northwest of Cucamonga	34 08 45	117 36 00	1,650	.39	2.49	2.11	7.60	.61	.29	13.49	Orange County Flood Control District.
Mission Winery, near Cucamonga	34 06 25	117 34 35	1,175	.63	.92	1.53	4.05	.79	.31	8.23	Do.
Ontario, Chaffey Union High School	34 04 45	117 39 00	1,150	*	1.30	1.90	4.80	1.00	.30	9.30	Do.
Ontario, West Ontario Citrus Association	34 03 45	117 41 00	991	*	1.79	1.69	3.42	2.88	.10	9.88	West Ontario Citrus Association.
Ontario, Southern Pacific Co.	34 03 30	117 39 00	990	1.37	1.76	3.02	3.48	.93	-	10.56	Orange County Flood Control District.
Pomona, 987 North Weber Street**	34 04 03	117 46 23	838	.12	1.45	2.11	2.17	4.21	.19	10.25	J. E. Adamson.
Pomona, 2211 South Tower Avenue	34 25 57	117 44 26	778	1.18	.75	1.65	5.10	1.09	-	9.77	Milton Frater.
Pomona, Southern Pacific Co.	34 03 34	117 45 04	862	.10	1.55	1.87	2.45	3.52	.24	9.73	U. S. Weather Bureau.
Upland, 1544 North Benson Avenue	34 07 00	117 40 45	1,550	.73	1.39	1.75	5.29	1.16	-	10.32	Los Angeles County Flood Control District.
Upland, West Ninth Street and North San Antonio Avenue	34 05 45	117 39 30	1,215	*	2.17	1.96	3.99	3.17	.45	11.74	Mr. Jordan.
Upland, West Twenty-second Street near Mountain View Avenue	34 09	117 39	1,740	.10	1.42	1.98	2.45	5.09	.22	11.26	U. S. Weather Bureau.
Upland, north of	34 08	117 38	-	*	1.45	2.72	2.12	4.76	.25	11.30	Liberty Groves.
Upland, West Tenth Street near Mountain Avenue	34 06 00	117 40 45	1,275	.63	*	2.79	5.49	.65	-	9.56	Orange County Flood Control District.

Upper Santa Ana Valley											
Bloomington, Citizens Land & Water Co.	34 04	117 24	1,100	*	1.32	*	3.00	3.00	.20	7.52	Mr. Greason.
Colton, Police Department	34 04 00	117 19 30	975	1.35	.69	1.17	4.62	1.15	.07	9.05	Colton Police Department.
Colton, Southern Pacific Co.	34 04 00	117 19 30	975	.13	1.83	1.33	.88	4.68	.82	9.67	Orange County Flood Control District.
Crown Jewel Groves, ½ mile west of Redlands	34 04 30	117 12 45	1,200	*	1.76	1.03	2.00	3.28	.09	8.16	Crown Jewel Groves.
East Highlands	34 07	117 10	1,400	1.30	.88	1.20	3.14	3.54	.34	10.40	East Highlands Orange Co.
Do.	34 07 15	117 10 00	1,400	1.30	.88	1.20	3.14	3.54	.70	10.76	Gold Buckle Association.
Fontana	34 06 30	117 25 30	1,325	.68	1.11	1.30	3.62	3.30	.12	10.13	U. S. Weather Bureau.
Fontana, Fontana Farms Co.	34 06	117 26	1,175	*	1.36	1.44	1.50	5.19	–	9.49	Philip B. Hasbrouck.
Gage canal headgate**	34 05 00	117 15 30	1,050	.16	1.62	1.00	.92	3.95	.70	8.35	Gage Canal Co.
Highlands, 1 mile northeast of	34 08 00	117 11 45	1,450	2.22	1.32	1.08	6.09	.75	.30	11.76	Thomas A. Ewing.
Lytle Creek, Base Line Street**	34 07 30	117 21 00	1,172	.30	1.60	1.72	1.60	5.04	1.26	11.52	U. S. Weather Bureau.
Redlands**	34 03 00	117 10 30	1,500	.54	.91	1.07	.71	3.63	.52	7.38	D. S. C. Anderson.
Redlands	34 03 30	117 11 00	1,360	1.10	.44	1.05	1.66	3.08	.38	7.71	U. S. Weather Bureau.
Rialto	34 06 30	117 22 00	1,175	.65	.77	1.54	5.80	2.00	.13	10.89	Orange County Flood Control District.
San Bernardino, Second and D Streets	34 06 00	117 17 15	1,048	.41	1.67	1.38	1.04	4.84	.56	9.90	U. S. Weather Bureau.
San Bernardino	34 08 00	117 16 30	1,172	1.36	1.10	1.34	4.46	1.56	.23	10.05	Do.
Jurupa Basin											
Citrus experiment station, University of California a/	33 58 30	117 20 00	1,075	.21	.52	1.10	.71	2.56	.18	5.28	Do.
Mira Loma Ranch	34 01 30	117 31 10	825	*	1.00	1.46	1.60	2.52	–	6.58	Orange County Flood Control District.
Riverside	33 58	117 26	895	.12	.93	.96	.68	2.15	.42	5.26	U. S. Weather Bureau.
Riverside, San Jacinto Land Co.	33 53 30	117 26 45	975	1.29	.91	.69	2.40	.19	–	5.48	Orange County Flood Control District.
San Jacinto River Basin											
Backus Ranch	34 36	118 12	2,620	*	.86	.65	1.74	.32	–	3.57	Do.
Decker Ranch**	33 49	116 45	5,550	.50	1.74	3.00	3.10	6.73	1.32	16.39	U. S. Weather Bureau.
Elsinore**	33 40	117 20	1,272	2.18	.32	1.02	4.04	1.88	.19	9.63	Do.
Elsinore, 1½ miles east of	33 41 00	117 17 50	1,400	1.00	1.43	1.07	.93	4.41	.43	9.27	Dr. Baer.
Elsinore, west end of Lake Elsinore	33 40 45	117 24 00	1,272	1.24	1.26	1.80	*	8.73	–	13.03	Orange County Flood Control District.
Hemet**	33 45	116 57	1,700	.65	.22	1.65	.78	2.07	.13	5.50	U. S. Weather Bureau.
Idlewild	33 45	116 43	5,300	1.36	*	2.07	1.42	5.73	1.54	12.12	Do.
Lake Hemet Dam	33 39 45	116 42 45	5,000	*	.68	1.55	.82	5.38	.51	8.94	Do.
Lawrence adit	33 53	116 53	2,840	1.51	.98	.82	4.24	3.35	.25	11.15	Metropolitan Water District.
March Field, U. S. Army Air Corps	33 53 45	117 15 30	1,500	.66	.54	.84	2.42	.63	.01	5.10	U. S. Weather Bureau.

*Included in next measurement. **Measured in morning. a See table 2 for recording rain-gage record.

Table 1.- Daily precipitation, in inches, at standard gages for the period February 27 to March 4, 1938--Continued
(Measured in the afternoon except as noted)

Station	Latitude	Longitude	Altitude (feet)	February 27	February 28	March 1	March 2	March 3	March 4	Total	Data furnished by
	° ' "	° ' "									
Santa Ana, San Gabriel, and Los Angeles River Basins--Continued											
San Jacinto River Basin--Continued											
Maynard Ranch	33 54	117 02	1,960	*	2.60	*	*	4.36	-	6.96	Metropolitan Water District.
Perris**	33 45	117 11	1,466	1.00	.55	1.15	1.10	2.63	0.12	6.55	U. S. Weather Bureau.
Portero shaft	33 50	116 56	2,325	1.03	.97	.91	4.43	.88	.26	8.48	Metropolitan Water District.
Poppet Flats	33 51	115 51	3,540	*	1.80	*	*	*	6.30	8.10	Do.
San Jacinto	33 47 00	116 57 45	1,550	.85	.32	1.28	2.15	1.15	.18	5.93	U. S. Weather Bureau.
Sims Ranch	33 48	116 52	2,100	.98	.56	1.55	*	1.80	1.58	6.47	Metropolitan Water District.
Vista Grande Ranch	33 49	116 47	5,000	2.45	2.21	.68	4.38	.86	.46	11.04	Orange County Flood Control District.
Temescal Creek Basin											
Cajalco No. 1	33 50	117 27	1,290	*	1.13	.70	1.58	1.37	-	4.78	Metropolitan Water District.
Cajalco Reservoir	33 50 30	117 21 30	1,300	*	.98	.86	1.06	1.91	-	4.81	Do.
Corona	33 51 30	117 34 15	850	.15	1.35	1.35	1.05	4.30	.60	8.80	U. S. Weather Bureau.
Corona, Jamison Co.	33 51 30	117 33 00	875	1.43	1.53	1.28	2.88	.75	.10	7.97	Orange County Flood Control District.
Corona, Temescal Water Co.	33 52 30	117 34 00	700	.39	.98	1.35	1.37	3.97	.47	8.53	Do.
Corona, Foothill Lemon Co.	33 51 45	117 35 50	850	.50	1.19	1.42	1.52	4.57	.47	9.67	Do.
Corona, Foothill Lemon Co.	33 50 45	117 34 45	1,050	.50	1.42	1.45	1.46	5.31	.49	10.63	Do.
Corona, Foothill Lemon Co.	33 49 50	117 34 50	1,350	.60	1.57	1.58	1.64	6.44	.39	12.22	Do.
Corona, Foothill Lemon Co.	33 50 45	117 32 15	850	.50	1.10	1.24	1.23	3.32	.52	7.91	Do.
Orange Heights Water Co., near Norco	33 56 30	117 33 30	800	.53	.43	1.01	1.71	2.32	.37	6.37	Do.
Temescal, Temescal Water Co.	33 46	117 29	1,075	.81	1.45	2.06	1.54	8.49	.59	14.94	Do.
Santiago Creek Basin											
Limestone Ranch, Irvine Ranch Co.	33 46	117 43	1,000	.31	1.27	1.81	1.43	4.75	.11	9.68	Do.
Peters Canyon Dam, Irvine Ranch Co.	33 47 45	117 46 00	550	.31	1.30	1.23	1.35	2.18	.09	6.46	Orange County Flood Control District.
Santiago Canyon	33 44	117 39 45	1,050	-	1.40	1.86	2.70	4.44	-	10.40	Mr. Redman.
Santiago Dam, Irvine Ranch Co.	33 47 00	117 43 15	1,025	.32	1.47	1.75	1.47	4.43	.05	9.49	Orange County Flood Control District.
Silverado Canyon at head	33 45	117 34	2,000	1.30	2.70	2.08	-	7.18	-	13.26	Do.
Silverado Canyon, Holtz Ranch	33 44 45	117 38	1,500	.20	1.19	2.68	1.70	5.98	.09	11.84	Do.

Coastal plains											
Aliso, Irvine Ranch Co.	33 43	117 50	62	.30	1.00	.96	1.27	2.40	.10	6.03	U. S. Weather Bureau.
American Best Sugar Co., near Westminster	33 45 00	118 00 30	25	.32	1.43	1.55	1.60	2.05	.10	7.05	Orange County Flood Control District.
Anaheim, city water works	33 49 45	117 54 45	150	*	1.57	1.93	2.13	2.98	.02	8.63	U. S. Weather Bureau.
Anaheim, Anaheim Union Water Co.	33 49 45	117 55 00	150	*	1.63	1.85	2.06	3.00	-	8.54	Orange County Flood Control District.
Anaheim Associate Laboratories	33 50	117 56	125	*	1.60	1.65	2.24	2.72	-	8.21	Do.
Artesia, 1804 Pioneer Street	33 51 35	118 04 52	49	*	1.72	1.55	3.88	1.30	-	8.45	W. S. Russell.
Avalon	33 18	118 14	30	.49	1.62	1.22	1.45	2.18	.03	6.99	J. C. Wegmann.
Bell, fire department, 6320 Pine Street	33 58 44	118 11 25	145	1.65	1.31	1.85	4.60	.42	-	9.83	J. F. Salvail.
Bellflower, 900 East Park Avenue, at Somerset Avenue	33 52	118 08	68	1.65	.51	1.47	4.01	.41	-	8.05	R. V. Bashore.
Bel-Air, administration building a/	34 05 11	118 26 45	540	1.58	2.02	2.00	6.83	.21	-	12.64	O. F. Bell.
Bixby Ranch, Walnut Canyon	33 50	117 46	500	*	2.15	1.95	2.13	3.93	.28	10.44	Orange County Flood Control District.
Beverly Hills, city hall a/	34 04 27	118 23 57	255	1.42	2.24	1.79	6.08	.30	-	11.83	C. Valle Riestra.
Buena Park, Nelson Hardware Co.	33 51 45	117 59 45	90	1.46	1.49	2.20	2.11	.10	-	7.36	Orange County Flood Control District.
Carbon Canyon	33 58 00	117 45 45	1,150	.15	1.95	1.76	2.80	2.70	.15	9.51	J. B. Chillibolost.
Carroll Ranch, 3 miles west of Anaheim	33 50	117 58	105	.12	1.50	1.46	2.02	2.51	-	7.61	Orange County Flood Control District.
Cemetery near El Toro	33 39 00	117 40 45	700	.28	.91	1.61	1.44	3.11	.21	7.56	Do.
Clark Memorial Library, 2205 West Adams St.	34 02 00	118 18 50	203	1.25	1.74	1.64	5.30	.38	-	10.31	M. C. McCrae.
Compton, 401 South Poinsettia Avenue	33 53 36	118 12 36	67	1.63	.48	1.36	3.70	.55	.04	7.76	George H. Nye.
County Farm, 741 Old River School Road	33 56 17	118 09 22	104	1.58	.46	.54	4.01	.58	-	7.17	Clyde Morrow.
Culver City, corner Jefferson and Duquesne Streets	34 01 00	118 23 17	65	.17	1.56	2.25	5.69	.44	.14	10.25	Los Angeles County Flood Control District.
Curson Canyon	34 06 51	118 21 13	1,125	1.48	2.05	1.94	6.25	.45	-	12.17	C. G. Carlson.
Downey, fire station, Downey and Firestone Boulevards	33 56 33	118 08 10	117	1.77	.67	1.52	4.16	.64	-	8.76	T. C. Loggins.
Downey, 241 North Downey Avenue**	33 56 30	118 08 00	119	1.62	.62	1.65	4.28	.62	.04	8.83	Mrs. K. C. Weiss.
Downey, 751 Florence Avenue	33 57 30	118 08 15	128	1.65	.51	1.47	4.01	.41	-	8.05	Los Angeles County Flood Control District.
Diamond Bar Ranch, Brea Canyon road	33 58 00	117 50 40	710	.98	1.44	1.75	5.59	1.20	-	10.96	F. E. Lewis.
Dominguez Hills, near reservoir	33 51 37	118 14 01	195	1.71	.44	1.43	3.41	.74	.04	7.77	James L. Nash.
El Segundo, Standard Oil refinery	33 54 55	118 25 10	135	1.11	.65	1.23	3.16	.54	-	6.69	T. H. N. Waite.
Fullerton, airport***	33 52 15	117 58 30	92	1.09	1.74	.53	3.58	M	-	-	Orange County Flood Control District.
Fullerton	33 52	117 55	-	1.47	.85	1.39	2.21	2.60	.62	9.14	U. S. Weather Bureau.
Fullerton, evaporation station a/	33 52	117 58	90	*	*	3.22	2.52	*	2.24	7.98	Orange County Flood Control District.

*Included in next measurement.
**Measured in the morning.
***Measured at midnight.
M Record missing.
a See table 2 for recording rain-gage records.

Table 1.- Daily precipitation, in inches, at standard gages for the period February 27 to March 4, 1938—Continued
(Measured in the afternoon except as noted)

Station	Latitude	Longitude	Altitude (feet)	February		March				Total	Data furnished by
	° ′ ″	° ′ ″		27	28	1	2	3	4		
Santa Ana, San Gabriel, and Los Angeles River Basins—Continued											
Coastal plains—Continued											
Fullerton, water department	33 53 00	117 55 15	155	1.13	0.85	1.21	4.11	2.60	0.60	10.50	Orange County Flood Control District.
Fullerton, water department	33 50 45	117 55 30	200	1.47	.35	1.39	2.21	2.60	.73	8.75	Do.
Garden Grove	33 46 15	117 56 30	-	*	1.20	1.45	2.30	.85	-	5.80	Do.
Garden Grove, Allen Brothers Ranch	33 47 00	117 56 30	95	.49	1.42	1.82	2.06	2.77	.03	8.59	Do.
Garden Grove, Garden Grove Lumber Co.	33 46	117 56	90	.38	1.34	1.37	1.88	3.78	-	8.75	Do.
Gardena, Vermont and Rosecrans Boulevards	33 54 07	118 17 29	64	1.60	.45	1.70	2.05	1.60	.20	7.60	C. E. Rosecrans.
General Petroleum Corporation, 2 miles northwest of Torrance	33 51 11	118 20 26	75	1.28	.46	1.37	2.95	.55	-	6.61	Marion E. Price.
Griffith Park Nursery, North Commonwealth Avenue a/	34 07 12	118 17 11	750	1.22	1.80	1.68	6.16	.33	-	11.19	J. Kladler.
Griffith Park tunnel	34 07 24	118 18 11	1,100	*	2.03	1.83	6.71	.36	-	10.93	Louis Strauss.
Hamilton Bowl, near Signal Hill	33 47 27	118 10 07	25	1.10	.36	1.15	3.15	.42	-	6.18	Los Angeles County Flood Control District.
Hancock Park, 5801 Wilshire Boulevard a/	34 03 48	118 21 19	177	1.26	1.75	1.65	5.50	.40	-	10.56	C. G. Carlson.
Harkel road camp, Irvine Ranch	33 40 30	117 47 45	100	.12	1.18	1.19	1.06	2.45	.01	6.01	Irvine Ranch Co.
Hewes Park, Hewes Ranch	33 46 45	117 48 30	640	.16	1.56	.54	1.49	2.23	.10	6.08	Orange County Flood Control District.
Hole pumping station, Union Oil Co., near Fullerton	33 53 45	117 54 30	-	.92	1.35	1.92	2.60	3.42	.15	10.36	Do.
Holly Sugar Co., near Santa Ana	33 42 30	117 51 15	55	1.32	.94	1.33	2.02	-	-	5.61	Do.
Hollywood, 6225 Santa Monica Boulevard	34 05 28	118 19 30	305	*	2.98	1.95	5.87	.41	-	11.21	E. L. Phillips.
Hollywood, Hollywood Dam	34 07 04	118 19 55	750	2.39	2.10	2.99	3.00	-	-	10.48	City of Los Angeles.
Huntington Beach, 3½ miles north of	33 43	118 00	25	*	*	2.85	1.45	2.25	-	6.55	Orange County Flood Control District.
Huntington Beach	33 40 00	118 00 15	35	1.44	.55	1.17	2.85	.40	.04	6.45	Frank Parcel.
Huntington Beach, Union Oil pumping station	33 41 15	118 00 15	65	.11	1.97	1.32	1.41	2.21	.03	7.05	Orange County Flood Control District.
Huntington Beach, evaporation station	33 43 15	118 02 00	15	*	1.35	*	*	4.53	-	5.88	Do.
Huntington Park, city yard, Slauson and Miles Streets	33 59 02	118 13 06	175	1.60	1.23	1.66	4.54	.57	-	9.60	W. E. Ford.
Hynes, 347 South Paramount Boulevard	33 52 58	118 09 36	72	1.65	.42	1.42	3.54	.83	.03	7.89	N. B. Haydon.
Inglewood, high school	33 57 38	118 21 20	117	.81	1.55	1.52	3.28	1.45	.09	8.70	George Green.
Irvine warehouse, Irvine Ranch Co.	33 40 15	117 45 15	200	.32	.97	1.54	1.35	4.23	.07	8.48	Irvine Ranch Co.

Johnson Ranch, Irvine Ranch Co.	33 39	117 43	320	.32	1.06	1.90	1.87	3.85	-	9.00	Irvine Ranch Co.
Laguna Bell a/	33 58 38	118 08 45	140	1.72	.64	1.74	4.55	.37	-	9.02	City of Los Angeles.
La Habra, Zinn Laboratory	33 55	117 56	300	*	1.82	1.73	2.22	2.33	.12	8.22	Jack Zinn.
La Habra Citrus Association	33 55 45	117 57 00	300	*	1.82	2.00	2.25	3.02	.07	9.16	Orange County Flood Control District.
La Habra project, Goodell-Proud Ranch	33 55 57	117 56 48	300	*	2.50	1.70	6.02	*	.05	10.27	U. S. Soil Conservation Service.
La Habra project, Harts Ranch	33 57 10	117 57 26	520	1.95	2.13	2.34	3.73	-	-	10.15	Do.
La Habra project, Murphy Coyote Ranch Gage No. 1	33 55 46	117 57 45	275	1.64	*	1.77	2.20	2.81	.14	8.56	Do.
La Habra project, Murphy Coyote Ranch Gage No. 2	33 55 39	117 58 15	300	1.87	*	1.61	2.27	2.52	.11	8.38	Do.
La Habra project, Wardman Ranch	33 56 10	117 54 49	480	1.52	1.23	1.88	*	6.53	-	11.16	Do.
La Habra project, Weisel Ranch	33 57 08	117 55 30	540	1.39	1.02	1.97	5.33	.64	.06	10.41	Do.
La Mirada, Center Street	33 53 15	118 00 58	86	.18	1.27	1.62	2.11	2.00	.13	7.31	Los Angeles County Flood Control District.
Lambert Ranch, Irvine Ranch Co.	33 41 45	117 42 30	400	.30	1.12	1.65	1.35	3.65	.47	8.54	Irvine Ranch Co.
La Vida Mineral Springs	33 55 45	117 48 00	850	*	1.99	2.38	2.50	4.56	.07	11.50	Orange County Flood Control District.
Long Beach, city hall**	33 46 12	118 11 35	30	.68	.96	1.36	2.14	2.07	.01	7.22	C. Bower.
Long Beach, 22 Pacific Avenue **	30 46 05	118 11 35	30	1.05	.52	1.39	2.41	1.91	.01	7.29	W. N. Beach.
Long Beach	33 46 00	118 11 16	25	1.10	.36	1.14	3.15	.42	-	6.17	Los Angeles County Flood Control District.
Long Beach***	33 46	118 12	70	.02	1.38	1.63	.58	3.30	.47	7.38	U. S. Weather Bureau.
Long Beach**	33 45 45	118 08 30	-	.65	.88	1.37	1.79	1.91	.02	6.62	City of Long Beach.
Long Beach**	33 49 30	118 10 15	-	.77	1.03	1.35	2.50	2.40	.05	8.10	Do.
Long Beach**	33 51 45	118 10 45	-	.52	.69	1.54	2.23	2.09	.02	7.09	Do.
Long Beach**	33 46 45	118 08 30	-	.62	.84	1.43	1.92	2.20	.02	7.03	Do.
Long Beach**	33 47 15	118 11 46	13	1.18	1.30	1.37	2.10	2.35	.01	8.31	Do.
Los Angeles, Second and Hill Streets	34 03 38	118 14 48	385	*	2.37	1.88	6.17	.48	-	10.90	D. A. Lane.
Los Angeles, Eighth and Figueroa Building	34 02 55	118 15 45	260	1.30	1.57	1.65	5.89	.46	-	10.87	Los Angeles County Flood Control District.
Los Angeles, 4213 West Second Street	34 04 16	118 18 19	238	1.41	1.73	1.47	5.66	.38	-	10.65	F. M. Casey.
Los Angeles, Los Angeles Junior College**	34 05 21	118 17 34	315	1.30	1.81	1.71	4.40	2.15	-	11.37	Frank S. Trueblood.
Los Angeles, West Eightieth Street	33 58 00	118 18 29	-	1.75	2.52	3.65	1.44	.50	-	9.86	H. F. Parkinson.
Los Angeles, municipal airport	33 56	118 23	97	.30	1.15	1.71	2.03	1.96	.11	7.26	U. S. Weather Bureau.
Los Angeles, Silver Lake Reservoir	34 06 08	118 15 54	455	2.67	2.43	3.70	3.01	.11	-	11.92	City of Los Angeles.
Los Angeles, Ninety-sixth Street and Central Avenue a/	33 57 00	118 15 25	121	1.68	1.18	.74	3.42	.80	.05	7.87	Los Angeles County.
Mandeville Canyon, administration building	34 03 57	118 29 35	470	.72	2.30	2.70	6.28	.36	-	12.36	Dudley Corlett.
Moore, Mrs. A. H.	33 43 00	118 00 25	25	.90	1.25	1.25	3.00	.55	-	6.95	Orange County Flood Control District.
Montana Ranch, 3 miles southwest of Artesia	33 50 35	118 07 09	47	.24	1.44	1.65	2.26	3.24	.03	8.86	J. F. Anthony.
Montebello, 117 West Washington Avenue	34 00 44	118 05 58	205	1.30	.90	1.65	3.27	.71	-	7.83	Mrs. Zola Cotton.
Mount St. Mary's College	34 05 06	118 28 53	1,015	1.70	2.18	2.15	6.75	.34	-	13.12	Sister Gertrude Joseph.

*Included in next measurement. **Measured in the morning. ***Measured at midnight. a See table 2 for recording rain-gage records.

Table 1.- Daily precipitation, in inches, at standard gages for the period February 27 to March 4, 1938--Continued
(Measured in the afternoon except as noted)

Station	Latitude ° ' "	Longitude ° ' "	Altitude (feet)	February 27	February 28	March 1	March 2	March 3	March 4	Total	Data furnished by
Santa Ana, San Gabriel, and Los Angeles River Basins--Continued											
Coastal plains--Continued											
Murdy, J. A., ranch, south of Westminster	33 43 30	118 00 45	25	0.10	1.40	1.45	1.46	2.11	-	6.52	Orange County Flood Control District.
Navanjal pumping station, 2 miles west of Brea	33 55 40	117 51 25	575	.55	1.25	1.50	2.18	3.00	0.08	8.56	Do.
Newport Harbor, near entrance	33 36 15	117 52 45	50	.30	1.12	1.18	1.16	1.83	-	5.59	Do.
Newport Beach (Balboa)	33 36	117 54	15	.40	.95	1.39	1.23	1.98	-	5.95	U. S. Weather Bureau.
Norwalk, 1 mile southeast of	33 53 50	118 03 58	83	1.36	.52	1.58	4.22	.82	.02	8.52	C. S. Hargitt.
Old Ranch, Irvine Ranch Co.	33 39 45	117 53 50	50	.30	1.12	1.18	1.16	1.83	-	5.59	Irvine Ranch Co.
Orange, ½ mile north of	33 48 30	117 49 45	200	.40	1.45	1.90	1.95	3.00	.30	9.00	Orange County Flood Control District.
Orange	33 47	117 51	200	.43	1.46	1.61	2.16	2.81	.11	8.58	Mrs. Samuel Armour.
Orange, ½ mile south of	33 46 30	117 50 30	205	.46	1.40	1.69	1.54	2.54	.10	7.73	E. E. Campbell.
Palos Verdes, Golf Club	33 47 47	118 22 12	450	*	2.10	1.52	2.00	1.10	-	6.72	Gomer Sims.
Palos Verdes Estates, 75 Malaga Cove Plaza	33 48 00	118 23 20	300	1.80	.63	1.12	2.72	.23	-	6.50	G. B. Snelgrove.
Placentia, Placentia Mutual Orange Association	33 52 00	117 52 30	205	1.20	.87	1.96	5.15	.79	.21	10.18	Orange County Flood Control District.
Placentia, 1½ miles west of	33 52 15	117 54 00	195	.86	1.08	2.59	2.44	3.21	.29	10.47	C. S. Knowlton.
Placentia, 5½ miles east of	33 52	117 46	350	1.20	.57	1.50	3.00	2.52	.16	8.95	Albert Yorba.
Point Vicente Lighthouse	33 44 30	118 24 38	125	.78	.39	1.27	2.59	.49	-	5.52	A. Trittinger.
Puente Hills (La Habra Heights)	33 57 15	117 54 20	725	1.39	1.02	1.97	5.33	.70	.02	10.43	R. H. Marsh.
Redondo, city hall	33 50 28	118 23 22	50	*	2.02	1.25	2.49	.45	.02	6.23	City Clerk.
Rivera Pico	33 59 33	118 04 54	173	1.14	.77	1.70	4.61	.49	.29	9.00	U. M. Robinson.
Salt works 1½ miles north of Newport	33 37 30	117 53 00	40	.34	1.30	.93	1.35	1.95	.07	5.94	Orange County Flood Control District.
Santa Ana, Hill & Son, hardware	33 45	117 52	133	*	1.60	1.38	1.46	2.19	-	6.63	Do.
Santa Ana	33 46	117 51	133	1.38	.84	1.03	2.90	3.26	.08	9.49	U. S. Weather Bureau.
Santa Ana, Orange County Flood Control District office a/	33 45 00	117 52	130	.37	1.31	1.38	1.43	2.00	.02	6.51	Orange County Flood Control District.
San Joaquin Fruit Co.	33 42 30	117 45 00	197	.40	1.30	1.31	3.20	1.30	.20	7.71	Do.
Santa Monica	34 02	118 28	140	.80	1.70	1.56	4.11	.85	-	9.02	U. S. Weather Bureau.
Santa Monica, 1245 Fourth Street	34 01 06	118 29 50	100	.30	2.63	1.50	4.38	.62	-	9.43	Paul F. Knief.
San Pedro Hills, at west end	33 46 30	118 22 53	1,235	1.92	.79	1.47	3.11	.43	-	7.72	W. W. McCarrell.
San Pedro	33 43	118 17	90	.09	.85	1.53	.90	1.28	.45	5.10	U. S. Weather Bureau.
Seal Beach, powerhouse	33 44 30	118 06 45	25	1.11	1.77	.91	2.89	.36	-	7.04	Orange County Flood Control District.

Shady Ranch, Irvine Ranch Co.	33 37 30	117 48 00	300	.48	1.20	1.72	1.25	2.99	.08	7.72	Irvine Ranch Co.
Signal Hill, city hall a/	33 47 49	118 10 03	115	1.35	.50	1.14	3.34	.45	-	6.78	George I. Osborne.
National Military Home	34 03 25	118 27 17	335	1.35	2.12	1.75	*	6.10	-	11.32	L. P. Emerick.
Southern California Edison Co., 1½ miles south of Anaheim	33 48	117 54	135	.92	.82	2.05	4.44	.95	-	9.18	Orange County Flood Control District.
Stanton	33 49	118 00	55	.95	1.91	2.01	2.61	-	-	7.48	T. W. Clark.
Stewarts pumping station, Union Oil Co.	33 55 55	117 54 50	385	.11	1.45	1.77	2.22	3.23	.08	8.86	Orange County Flood Control District.
Stone Canyon Dam	34 06 25	118 27 13	725	2.78	3.31	3.68	3.68	.03	.01	13.49	City of Los Angeles.
Sunny Hills Ranch, laboratory	33 53 35	117 55 35	292	.25	1.75	1.63	2.30	2.74	.10	8.77	Orange County Flood Control District.
Sunny Hills Ranch, Lemon Mesa	33 53 10	117 57 10	225	*	1.94	1.55	1.75	2.87	.15	8.26	Do.
Sunny Hills Ranch, Red Tank	33 54 30	117 56 20	400	*	2.05	1.78	2.60	2.43	.14	9.00	Do.
Sunny Hills Ranch, Santa Fe	33 52 30	117 57 25	112	*	1.80	1.56	2.36	2.52	.28	8.52	Do.
Sunny Hills Ranch, Viejo	33 54 10	117 55 35	295	*	2.00	1.89	2.50	2.40	.10	8.89	Do.
Talbert Avenue	33 42	117 58	25	.32	1.30	1.12	1.10	1.50	.05	5.39	Bob Harper.
Telegraph Road, 0.2 mile west of San Gabriel River	33 57 10	118 05 49	141	1.50	.55	1.59	4.01	.54	-	8.19	F. C. Collins.
Torrance, Southern California Edison Co. substation, 190th Street and Western Avenue	33 51 32	118 18 33	57	1.32	.45	1.23	3.05	.21	-	6.26	B. Bunje.
Tustin	33 43	117 48	125	.32	.97	1.54	1.35	4.23	-	8.41	U. S. Weather Bureau.
Tustin, Union High School	33 44 00	117 49 30	120	*	1.50	1.06	1.34	2.12	-	6.02	Orange County Flood Control District.
Tustin, near home ranch of Irvine Ranch Co.	33 43	117 47	130	.30	1.15	1.18	1.30	2.45	.05	6.43	U. S. Weather Bureau.
Union Oil Co., near Brea	33 54	117 52	-	.70	.92	1.75	2.14	3.64	.07	9.22	Orange County Flood Control District.
University of California at Los Angeles, near Westwood	34 04	118 26	180	.27	2.49	2.66	4.60	1.51	.03	11.56	U. S. Weather Bureau.
Upper Franklin Canyon Reservoir	34 07 11	118 24 38	867	1.35	1.99	2.09	5.62	.45	-	11.50	W. H. Wood.
Venice, city hall	33 59 18	118 27 33	17	*	2.96	1.38	4.19	.51	-	9.04	A. S. Ede.
Villa Park Orchard Association	33 49 00	117 49 30	290	*	1.93	1.94	2.26	2.36	.14	9.13	Orange County Flood Control District.
Watts, 103d Street	33 56 37	118 13 45	110	*	2.35	1.60	2.48	*	1.72	8.15	M. E. Tower.
Western Avenue Reservoir	33 56 54	118 18 35	235	1.30	2.50	.81	3.76	.89	.04	9.30	City of Los Angeles.
West Los Angeles, city hall	34 02 44	118 26 57	232	*	3.50	1.77	5.21	.62	-	11.10	W. B. Scott.
Whittier, city hall	33 58 53	118 02 13	365	1.28	.67	1.65	4.50	.73	-	8.83	E. W. Honeyman.
Whittier News	33 58 50	118 02 10	350	.61	1.15	1.77	2.40	2.76	.07	8.76	Los Angeles County Flood Control District.
Whittier, east of	33 57	118 01	215	1.28	.67	1.65	4.50	.73	-	8.83	Do.
Whittier, Leffingwell Ranch	33 56 25	117 59 35	253	*	1.95	1.98	2.53	3.03	.26	9.75	J. F. Harris.
Whittier, Laurel Avenue	33 57 33	118 01 49	215	1.43	.61	1.50	4.70	.62	-	8.86	Peter E. Sharples.
Wilmington, 1251 Banning Boulevard	33 47 20	118 15 32	40	1.39	1.49	.15	3.67	.63	-	7.33	E. A. Bishop.
Yorba Linda	33 53	117 49	406	.70	.84	1.77	2.43	3.34	.13	9.21	Orange County Flood Control District.

*Included in next measurement.

a See table 2 for recording rain-gage records.

Table 1.- Daily precipitation, in inches, at standard gages for the period February 27 to March 4, 1938—Continued
(Measured in the afternoon except as noted)

Station	Latitude	Longitude	Altitude (feet)	February 27	February 28	March 1	March 2	March 3	March 4	Total	Data furnished by
	° ′ ″	° ′ ″									
Topanga, Malibu, and Calleguas Creek Basins											
Aggen Ranch, near Somis**	34 16 17	119 02 04	375	*	0.64	1.95	2.10	2.33	0.11	7.13	Ventura County Water Survey.
Bel Air Bay Club, Coast Highway	34 02 28	118 32 45	95	1.02	1.35	2.44	5.25	.28	–	10.34	Henry Jenks.
Broome Ranch, near Point Mugu	34 09 15	119 02 20	75	*	.65	1.44	1.78	1.26	–	5.13	Ventura County Water Survey.
Camarillo, American Crystal Sugar Co. Ranch**	34 12 15	119 04 15	140	.03	.85	1.83	3.15	1.48	.03	7.37	Do.
Conejo Ranch, near Newbury Park**	34 10 30	118 50 30	860	*	.84	2.05	5.31	.55	–	8.75	Do.
Crags Country Club, southwest of Calabassas	34 05 53	118 43 45	575	*	2.75	2.90	6.25	1.48	–	13.38	Joe Roldan.
Dume Canyon	34 04 58	118 49 38	1,500	.75	2.90	4.18	6.00	2.20	.03	16.06	R. L. Oakley.
Escondido patrol station, Escondido Canyon	34 03 02	118 46 25	1,025	.49	2.00	1.85	4.58	1.33	.03	10.28	H. A. Gibson.
Garrapata Canyon, 0.5 miles northeast of Topanga Canyon road	34 07 03	118 35 02	990	1.20	2.70	2.75	7.70	.13	–	14.48	R. L. Peeler.
Hueneme, lighthouse**	34 08 40	119 12 37	40	*	.65	1.62	2.70	1.80	–	6.77	Ventura County Water Survey.
Kerr Ranch, near Fairview	34 18 50	118 53 30	870	*	1.03	1.76	3.32	2.35	–	8.46	Do.
Lake Sherwood	34 08 52	118 50 10	1,030	1.02	.78	2.08	5.73	.46	–	10.07	Do.
Lechuza, patrol station on Decker road a/	34 04 50	118 52 38	1,530	.60	2.42	2.85	5.84	1.25	.08	13.04	A. L. Cesena.
Las Posas project, Agourre Ranch	34 16 04	118 58 34	382	*	.90	2.00	4.00	.74	–	7.64	U. S. Soil Conservation Service.
Las Posas project, Culbert Ranch	34 15 47	119 02 20	367	*	.82	1.75	4.62	.45	–	7.64	Do.
Las Posas project, Dietrich Ranch	34 16 17	119 03 51	475	.12	.84	1.90	4.30	.53	–	7.69	Do.
Las Posas project, Goodyear Ranch	34 16 23	119 01 20	425	*	.85	1.95	*	4.94	–	7.74	Do.
Las Posas project, Honda Ranch	34 16 50	119 02 22	508	*	.68	2.00	4.30	.44	–	7.42	Do.
Las Posas project, Jones Ranch	34 19 53	118 57 34	1,150	*	1.12	2.80	5.68	1.96	–	11.56	Do.
Las Posas project, Le Fever Ranch	34 16 17	119 02 59	450	*	2.84	2.79	1.81	–	–	7.44	Do.
Las Posas project, Mahan Ranch	34 17 36	118 58 33	621	.12	.68	2.25	2.48	2.91	.15	8.59	Do.
Las Posas project, Mullinix Ranch	34 16 51	119 00 40	456	*	.91	2.11	2.71	2.15	–	7.88	Do.
Las Posas project, Pellerino Farm	34 18 26	119 02 03	825	*	3.14	*	*	4.66	–	7.80	Do.
Las Posas project, Puerta Zuela Ranch	34 18 05	118 58 00	900	*	.30	*	*	8.13	–	8.43	Do.
Las Posas project, Stockton Ranch	34 17 42	119 03 06	620	*	.69	2.82	4.50	.55	–	8.56	Do.
Las Posas project, Thille Ranch	34 15 48	119 03 36	309	*	.72	2.20	2.20	2.50	–	7.62	Do.
Las Posas project, Waters Ranch	34 17 15	119 04 53	900	*	2.85	3.10	2.00	.77	–	8.72	Do.
Mason estate, East Fork of Arroyo Sequis	34 05 13	118 53 27	1,155	.42	1.89	2.74	5.98	.97	–	12.00	R. L. Mason.
North Simi, Union Oil Co. lease**	34 17 50	118 47 00	1,000	*	.84	1.40	2.24	1.62	.06	6.16	Ventura County Water Survey.
Oxnard	34 11 30	119 10 25	51	.70	1.89	3.30	1.66	.01	–	7.56	Do.

Santa Ynez Canyon	34 04 09	118 33 34	500	*	4.00	*	*	12.90	-	16.90	W. W. Culp.
Santa Rosa Valley, Janns Investment Co.	34 14 10	118 55 50	300	*	.73	1.52	2.05	2.63	-	6.93	Ventura County Water Survey.
Seminole Hot Springs, La Sierra Canyon	34 06 25	118 47 38	875	.63	1.82	2.58	6.25	1.02	-	12.30	V. M. Ward.
Somie, Snyder Ranch	34 15 49	118 59 57	300	*	.88	1.92	2.98	2.25	-	8.03	Ventura County Water Survey.
Tapo Mutual Water Co., near Santa Susana	34 17 45	118 43 15	1,080	*	2.48	*	*	4.33	-	6.31	Do.
Topanga Canyon, 4 miles south of Topanga Bridge a/	34 05 08	118 35 58	747	1.27	3.03	3.08	7.98	.35	.03	15.74	E. C. Roth.
Topanga Summit, on Topanga Canyon road	34 08 23	118 36 00	1,520	*	2.70	1.95	5.44	.49	.09	10.67	R. L. Scott.
West Saddle above Crater camp	34 04 28	118 41 19	890	.81	2.79	2.65	6.47	.27	-	12.99	Ralph Zeilke.
Wolf Ranch near Santa Susana	34 16 45	118 43 35	980	.34	.70	1.10	3.56	.74	-	6.44	Ventura County Water Survey.
Santa Clara and Ventura River Basins											
Acton, just east of summit, Mint Canyon road	34 31 15	118 13 30	3,250	.50	.26	.72	2.82	1.13	.04	5.47	Mrs. A. S. Hubbard.
Acton, Modie Ranch	34 25 20	118 11 52	3,100	*	1.93	1.31	6.28	1.18	.29	10.99	Los Angeles County Flood Control District.
Acton, north branch of Escondido Canyon a/	34 29 51	118 15 56	3,075	.59	.26	.89	3.05	.81	.03	5.63	H. F. Mellen.
Aliso Canyon south of Acton	34 27 40	118 09 25	2,900	1.17	.27	.91	5.63	.67	-	8.65	George J. Blum.
Borgstrom Ranch, east of Ventura	34 16 45	119 15 00	200	*	1.09	2.10	3.74	.49	-	7.42	Ventura County Water Survey.
Bouquet Canyon, Artesian Springs a/	34 34 20	118 22 05	3,650	.48	1.06	1.26	5.01	.89	-	8.70	City of Los Angeles.
Bouquet Canyon, Cherry Summit a/	34 35 20	118 23 40	2,975	.45	.89	1.24	4.60	1.04	-	8.22	Do.
Bouquet Canyon, Bouquet Canyon road near Lincoln Crest a/	34 35 00	118 18 20	3,600	.70	.95	1.09	4.55	1.00	-	8.29	Do.
Bouquet Canyon, at reservoir yard a/	34 35 10	118 21 40	3,000	.42	1.99	.12	4.61	.77	-	7.91	R. W. Mathews.
Bouquet Canyon, Spunky Summit a/	34 36	118 23	3,500	.54	.79	1.18	4.70	.74	-	7.95	City of Los Angeles.
Bouquet Canyon, East Spunky Summit a/	34 36 30	118 21 45	3,725	.57	.90	1.01	3.89	1.09	-	7.46	Do.
Camulas Ranch, near Piru**	34 24 10	118 45 20	730	.36	.97	1.44	1.89	3.95	.22	8.83	Ventura County Water Survey.
Casitas Ranch, near Casitas**	34 22 15	119 20 15	400	*	1.10	2.70	*	3.00	3.00	9.80	Do.
Del Mar Ranch, west of Saticoy**	34 16 45	119 11 37	300	.29	1.11	1.81	2.52	1.72	.67	8.12	Do.
Dry Canyon Reservoir	34 38 55	118 31 40	1,507	.05	.67	1.21	2.91	.53	-	5.37	Jim Ray.
Fillmore	34 24 15	118 54 50	530	*	1.02	1.92	2.63	3.46	.10	9.18	R. H. Stephens.
Gorman, on Ridge Route	34 48 00	118 51 00	3,830	*	1.15	.87	.71	2.05	.20	4.98	J. L. Ralphe.
Hammond Canyon, Rancho Cañada Larga	34 22 50	119 13 50	800	*	1.00	2.57	*	5.38	-	8.95	Ventura County Water Survey.
Kingston Reservoir, near Ventura	34 20 30	119 17 45	210	.05	1.14	2.50	2.26	4.94	-	10.89	Do.
Krotona Hill, near Ojai**	34 26 05	119 16 20	830	*	.74	2.45	3.00	3.74	.16	10.09	Do.
Lathrop Ranch, near Wheeler Springs**	34 33 15	119 12 30	3,210	*	1.14	2.21	8.41	.98	-	12.74	Do.
Leavens and Goodnough Ranch, near Fillmore**	34 23 30	118 50 20	550	.24	1.10	1.45	6.01	.71	.33	9.84	Do.
Limoneira Ranch packing house, near Santa Paula**	34 20 00	119 07 50	335	.20	1.10	2.12	5.09	.45	-	8.96	Do.

*Included in next measurement. **Measured in the morning. a See table 2 for recording rain-gage records.

Table 1.- Daily precipitation, in inches, at standard gages for the period February 27 to March 4, 1938—Continued
(Measured in the afternoon except as noted)

Station	Latitude ° ' "	Longitude ° ' "	Altitude (feet)	February 27	February 28	March 1	March 2	March 3	March 4	Total	Data furnished by
Santa Clara and Ventura River Basins—Con.											
Matilija Canyon, Sheldon Ranch**	34 28 45	119 17 30	950	*	1.18	2.65	8.27	0.75	-	12.85	Ventura County Water Survey.
Mint Canyon at Oak Garage	34 30 46	118 21 15	2,400	0.41	.40	1.11	3.70	.80	-	6.42	W. A. Dodrill.
Moorpark at S. P. Milling Co.	34 17 00	118 53 00	508	*	*	*	*	*	-	7.35	Ventura County Water Survey.
Munz Ranch, between Elizabeth and Hughes Lakes	34 40 00	118 25 20	3,250	1.65	1.05	.94	5.40	.90	-	9.94	Eli Munz.
Newhall, ¼ mile north of	34 23 07	118 31 54	1,267	1.05	1.40	1.85	5.22	.94	-	10.46	Milan A. Priest.
Newhall, ranger station	34 22 13	118 30 46	1,325	1.54	1.22	2.31	6.06	.86	-	11.99	U. S. Forest Service.
Newhall, at Southern Pacific Railroad station	34 22 47	118 31 36	1,270	1.00	1.43	2.08	5.38	.68	.18	10.75	A. B. Thatcher.
Oliver Young Ranch	34 22 55	118 56 50	400	.06	1.17	1.86	5.86	.58	-	9.53	Ventura County Water Survey.
Ojai Valley	34 27 15	119 13 40	800	.28	.73	1.93	7.90	.72	-	11.56	Do.
Ojai Valley	34 27 00	119 14 50	750	*	.78	1.90	2.70	3.62	.10	9.10	G. W. Mallory.
Pine Canyon patrol station, between Hughes and Elizabeth Lakes	34 40 20	118 25 40	3,400	.80	1.79	1.22	5.41	.90	.12	10.24	Los Angeles County Forestry Department.
Pine Tree Ranch, near Santa Paula**	34 22 20	119 00 55	400	*	.81	1.96	5.16	.25	.16	8.34	Ventura County Water Survey.
Piru, Piru Citrus Association	34 24 35	118 47 45	650	*	.89	1.70	2.35	3.75	.17	8.86	Do.
Piru, Newhall Ranch orchard	34 24 10	118 44 15	675	*	1.33	1.53	5.39	.93	.05	9.23	Do.
Placerita Canyon at Dulin Ranch	34 22 38	118 28 42	1,480	2.10	3.30	2.25	5.10	.35	-	13.10	John Wood.
Plush Ranch, 5 miles west of Griffin	34 45 00	119 08 00	5,400	*	1.42	*	2.00	1.32	-	4.74	Ventura County Water Survey.
Radium Hot Springs, Elizabeth Lake Canyon	34 36 15	118 33 30	2,041	.44	1.79	1.79	8.30	.80	-	13.12	Louis G. Klein.
Rancho Matilija, near Ojai**	34 25 45	119 18 45	658	*	.80	2.40	3.00	3.50	4.40	14.10	Ventura County Water Survey.
Rancho Sespe, near Fillmore**	34 23 00	118 57 45	430	*	.87	2.36	2.67	3.57	.28	9.75	Do.
Ridge Route, 11 miles south of Gorman	34 40 34	118 46 53	2,425	.73	2.16	2.16	4.03	.72	-	9.80	Los Angeles County Flood Control District.
Rouff Ranch, on Bouquet Canyon road	34 36 20	118 16 30	3,200	.78	.82	.97	4.36	.94	-	7.87	George Rouff.
San Francisquito Canyon, powerhouse 1	34 35 15	118 27 00	2,100	Tr.	.95	1.64	1.50	3.82	.31	8.22	City of Los Angeles.
San Francisquito Canyon, powerhouse 2	34 32 02	118 31 27	1,580	Tr.	.87	1.78	1.62	3.63	.18	8.08	Do.
Sandbergs, on old Ridge Route	34 44 30	118 42 45	4,200	*	1.65	1.59	3.72	.61	-	7.57	A. R. Grant.
Sand Canyon	34 22 42	118 24 28	1,900	2.10	1.95	3.10	4.85	.25	-	12.25	H. Riley.
Santa Ana Valley, near Oakview**	34 25 05	119 22 15	750	*	.85	2.24	3.26	3.48	-	9.83	V. Selby.
Santa Paula, Blanchard Investment Co.	34 21 00	119 04 30	275	*	1.12	2.13	5.71	.47	-	9.43	Ventura County Water Survey.
Santa Paula Canyon, Ferndale Ranch**	34 26 00	119 05 15	1,100	*	1.06	2.37	6.78	1.08	-	11.29	Do.

Santa Paula Canyon, Rancho la Cuesta**	34 25 00	119 05 00	900	*	1.12	2.46	2.45	5.07	.47	11.57	Do.
Saticoy Walnut Association	34 16 50	119 09 05	150	*	1.00	2.00	*	4.89	-	7.89	Do.
Saugus, Southern California Edison Co. substation	34 25 23	118 34 32	1,093	.58	.77	1.05	3.27	.55	.16	6.33	W. H. Roberts.
Saugus, State highway maintenance station	34 25 17	118 32 26	1,176	.76	.77	.76	4.30	1.76	-	8.35	Los Angeles County Flood Control District.
Soledad Canyon	34 24 47	118 26 24	1,472	.85	1.61	1.40	4.60	.40	.10	8.96	Do.
Soledad Canyon, east of Mint Canyon	34 26 15	118 17 38	2,250	.95	.56	1.24	6.00	.43	.19	9.37	James E. Nelson.
Thacher School, near Ojai**	34 27 50	119 10 55	1,360	*	1.04	2.02	1.92	6.40	.20	11.58	Ventura County Water Survey.
Timber Canyon, near Santa Paula	34 25 20	119 01 00	2,280	*	1.42	2.52	6.07	3.15	.11	13.27	Do.
Upper Ojai Valley	34 25 50	119 11 45	1,250	*	1.07	2.76	6.59	.68	.26	11.36	Do.
Upper Ojai Valley near Summit School**	34 26 07	119 08 20	1,560	*	1.10	2.60	2.30	5.10	-	11.10	Do.
Upper Sespe Creek near Choro Grande**	34 35 30	119 19 15	4,000	Tr.	1.20	1.85	2.45	4.34	-	9.84	Do.
Ventura	34 16 35	119 17 30	50	*	1.08	*	*	6.52	-	7.60	Do.
Vincent patrol station	34 29 30	118 07 45	3,250	1.00	.30	.78	3.37	.48	-	5.93	Los Angeles County Forestry Department.
Wagon Wheel Ranch, Aliso Canyon	34 25 00	118 05 30	3,920	1.07	1.18	1.47	6.63	1.05	.10	11.50	Los Angeles County Flood Control District.
Wheeler Hot Springs**	34 30 30	119 17 30	1,560	*	1.17	2.73	6.52	1.26	-	11.68	Ventura County Water Survey.
<u>San Luis Obispo Creek, and Santa Maria and Santa Ynez River Basins</u>											
Alisal Ranch, near Solvang	34 33 10	120 08 10	500	*	2.79	*	4.60	.40	-	7.79	E. Edwards.
Betteravia	34 55 00	120 31 00	100	.20	1.14	.47	1.40	.31	-	3.52	Union Sugar Co.
Buellton**	34 36 40	120 11 00	450	.20	1.36	.70	2.48	.25	.08	5.07	W. Budd.
Buellton, State highway maintenance station**	34 36 30	120 11 30	325	-	.18	1.36	.81	2.41	.19	4.95	State of California, Division of Highways.
Burchardi Dairy, near Solvang**	34 35 40	120 08 10	495	.17	1.65	*	.85	2.14	-	4.81	H. Burchardi.
Cuyama Canyon, State highway maintenance station**	35 01	120 12	1,000	-	.17	1.03	.38	2.13	.63	4.34	State of California, Division of Highways.
Cuyama, State highway maintenance station	34 57 30	119 40 30	2,100	-	.04	.79	.35	1.44	.21	2.83	Do.
Cuyama Canyon, near Pine Canyon	35 04	120 08	900	-	-	1.00	1.50	1.50	.50	4.50	Bernard Permasse.
Cuyama, ranger station	34 51 00	119 29 00	2,749	-	*	.99	1.96	.66	.15	3.76	U. S. Forest Service.
Gibraltar Dam	34 31 30	119 41 15	2,250	Tr.	.40	2.40	6.15	1.75	-	10.70	O. J. Packard.
Guadalupe	34 58 10	120 34 15	80	-	-	.21	1.30	.22	-	1.73	Puritan Ice Co.
Happy Canyon Ranch**	34 36 50	120 00 00	750	2.23	*	*	3.30	.70	-	6.23	W. A. Coons.
Huasna	35 07 15	120 23 30	200	-	1.34	-	2.23	.57	.05	4.19	Grace M. Bair.
Juncal Reservoir, Santa Ynez River**	34 29 30	119 30 50	2,300	.36	.19	2.66	6.02	1.17	-	11.20	Montecito County Water District.
Lompoc project**	34 39 50	120 19 45	500	-	.14	1.00	.65	2.06	.18	4.03	U. S. Soil Conservation Service.

*Included in next measurement. **Measured in the morning.

Table 1.- Daily precipitation, in inches, at standard gages for the period February 27 to March 4, 1938—Continued
(Measured in the afternoon except as noted)

Station	Latitude	Longitude	Altitude (feet)	February 27	February 28	March 1	March 2	March 3	March 4	Total	Data furnished by
	° ′ ″	° ′ ″									
San Luis Obispo Creek, and Santa Maria and Santa Ynez River Basins—Continued											
Lompoc project**	34 50 15	120 25 15	250	-	0.14	1.29	0.57	1.96	0.40	4.36	U. S. Soil Conservation Service.
Lompoc project**	34 40 45	120 23 40	250	-	.15	1.18	.64	1.87	.26	4.10	Do.
Lompoc project**	34 41 45	120 25 15	500	-	.14	1.33	.54	1.68	.36	4.05	Do.
Lompoc**	34 38 30	120 27 30	100	-	.20	1.45	.65	2.02	.49	4.81	State Division of Highways.
Los Alamos, State highway maintenance station	34 44 30	120 16 45	550	-	.16	1.02	.46	1.98	.2[illegible]	3.84	Do.
Maricopa	34 56 20	119 23 30	3,700	-	.20	.84	1.72	.81	.18	3.75	J. B. Hudson.
Mitchell Ranch, near Santa Ynez	34 35 00	120 05 40	5,000	0.25	1.75	1.14	2.92	.16	-	6.22	Mr. Jensen.
Nipomo, 2 miles north of***	35 02 30	120 28 30	350	-	.16	.97	.45	1.35	.43	3.36	Andrew Mehlschau.
Nojoqui County Park**	34 32 00	120 10 30	750	-	.53	3.58	3.73	2.54	.12	10.50	Mr. Smith.
Ozena	34 41 45	119 19 10	3,680	.23	1.50	.52	2.48	.60	.06	5.39	U. S. Forest Service.
Pine Canyon guard station	35 02 15	120 11 00	-	*	*	*	*	3.55	-	-	Do.
Santa Barbara	34 25 00	119 42 00	125	-	.86	2.23	3.59	.76	Tr.	7.44	U. S. Weather Bureau.
Santa Barbara, State highway maintenance station	34 24 30	119 42 00	40	.75	2.50	2.25	2.10	1.90	-	9.50	State Division of Highways.
San Julian ranch near Lompoc**	34 31 20	120 17 00	1,000	-	.71	3.31	3.45	1.95	-	9.42	Mr. Russell.
San Luis Obispo, State highway maintenance station**	35 16 45	120 40 00	250	-	.22	1.13	.65	1.13	.13	3.26	State Division of Highways.
San Marcos Pass, Painted Cave	34 29 20	119 47 00	1,250	-	.90	2.30	2.10	2.00	-	7.30	Mr. Ogram.
San Marcos Pass	34 30 00	119 49 15	2,250	-	-	4.14	4.30	3.25	.59	12.28	Mr. Marshall.
San Marcos Pass, State highway maintenance station	34 32 00	119 51 00	1,300	-	.81	3.23	3.47	4.40	.35	12.26	State Division of Highways.
Santa Maria	34 56 50	120 26 00	200	.13	1.03	.32	1.93	.26	.03	3.70	A. A. Howard.
Santa Maria, State highway maintenance station**	34 57 00	120 25 55	200	-	.12	.94	.30	1.71	.25	3.32	State Division of Highways.
Solvang**	34 38 10	120 10 45	450	-	.19	1.53	2.15	.83	.21	4.91	John Orton.
Surf**	34 40 50	120 36 00	36	-	.30	.84	.44	1.42	.30	3.30	U. S. Weather Bureau.
Suey Ranch	35 00 00	120 22 00	600	-	1.05	.23	1.03	1.71	.40	4.42	Newhall Land and Farming Co.
Union Oil substation, 4 miles north of Nipomo**	35 08 30	120 33 00	300	*	*	*	.54	1.70	.38	2.62	Union Oil Co.
Washington Grove Park	34 54	120 27	-	*	1.50	1.00	2.13	.40	-	5.03	George H. Wilson.

Great Basin											
Mojave River Basin											
Aldrich Ranch, Pallett Creek, 2.5 miles northwest of Devils Punch Bowl	34 26 10	117 53 07	4,050	1.78	.72	1.40	4.62	.54	-	9.06	A. P. Aldrich.
Bennit Ranch	34 19	117 25	4,000	*	5.50	*	*	8.00	1.78	15.28	U. S. Forest Service.
Big Pines Park, Apple Tree Flat	34 23 24	117 43 00	5,900	2.73	2.68	2.45	9.16	3.09	.59	20.70	Ralph Price.
Big Pines Park	34 22 45	117 41 28	6,860	2.00	2.59	1.68	6.80	4.48	.30	17.85	Leslie E. MacDonald.
Big Pines, south edge of Jackson Lake	34 23 30	117 43 40	6,075	2.54	2.08	2.29	9.46	3.20	.20	19.77	Ralph Price.
Big Pines, Sawmill Flat	34 22 24	117 41 00	6,750	1.98	2.22	1.72	6.58	4.81	.20	17.51	Leslie E. MacDonald.
Calivalli Farms, on Victorville road 1 mile north of Palmdale	34 32 08	117 58 00	2,835	.82	.30	.68	1.93	.37	Tr.	4.10	George Jacoby.
Fairmont Reservoir	34 42	118 25	3,036	*	1.65	1.83	1.15	4.00	.49	9.12	U. S. Weather Bureau.
Lake Arrowhead	34 15	117 11	5,000	.35	9.40	2.33	17.91	*	.50	30.49	Do.
Lake Tweedy near Neenach	34 44	118 34	3,905	1.17	1.87	.58	4.78	.25	.10	8.75	Do.
Lancaster, Union High School	34 41 58	118 07 48	2,350	*	.80	.45	.43	2.73	.16	4.57	R. E. Lofinck.
Little Rock Creek, 1.5 miles below dam	34 30 18	118 01 40	2,900	1.22	.43	1.06	1.70	2.50	.05	6.96	Gene Breslin.
Little Rock, at Juniper Hills	34 29 52	117 56 45	3,150	*	1.62	.77	1.65	1.30	Tr.	5.34	J. N. Booth.
Llano	34 29 47	117 49 02	3,300	1.27	.47	.58	1.75	.45	.04	4.56	Los Angeles County Flood Control District.
Munz Ranch, 14 miles west of Lancaster	34 42 50	118 21 15	2,600	.65	2.10	1.61	3.57	.46	-	8.39	Eric Munz.
Palmdale	34 34 51	118 06 52	2,648	*	1.41	.57	.76	2.39	.14	5.57	U. S. Weather Bureau.
Sawpit Canyon	34 16 45	117 20 30	3,350	*	*	11.24	*	*	17.34	28.53	U. S. Forest Service.
Sawmill Mountain Ranch, 8.9 miles northwest of Lake Hughes	34 43 15	118 35 00	3,700	.68	1.51	1.29	6.16	1.26	.12	11.02	Clarence Scates.
Table Mountain	34 22 53	117 41 05	7,500	1.80	1.40	.88	4.59	1.71	.02	10.40	A. F. Moore.
Trona	35 45 30	117 22 00	1,656	.45	.55	1.27	.37	-	-	2.64	American Potash Chemical Corporation.
Valyermo	34 26 50	117 51 30	3,740	1.00	.98	1.17	3.28	.32	.12	6.87	L. F. Noble.
Victorville	34 30	117 21	2,713	.21	.73	.68	.17	1.10	.27	3.16	A. S. Amaral.
Salton Sea Basin											
Banning	33 55	116 53	2,330	*	1.65	1.27	2.24	2.70	.25	8.11	U. S. Weather Bureau.
Blythe	33 35	114 38	268	.28	.23	.30	*	.16	-	.97	Do.
Cabazon shaft	33 54	116 48	1,770	.37	1.37	1.41	.71	5.86	1.22	10.94	Metropolitan Water District.
Hurley Flat	33 52	116 47	3,600	.29	2.00	1.80	.74	6.26	1.24	12.33	Do.
Imperial	32 50	115 36	-65	.77	.22	.28	.05	.13	Tr.	1.45	M. J. Dowd.
Indio	33 43	116 12	-20	.53	.16	*	.64	.01	-	1.34	U. S. Weather Bureau.
Palm Springs	33 50	116 34	584	.49	.10	.70	.58	4.00	.09	5.96	Do.
Poppet Flats	33 51	116 51	3,600	*	1.80	*	*	*	6.30	8.10	Metropolitan Water District.
Raywood Flat	34 03	116 49	7,200	.50	4.00	3.50	1.35	13.50	.88	24.23	U. S. Weather Bureau.
Snow Creek	33 53	116 41	1,300	*	1.50	*	*	*	11.00	12.50	Do.
San Gorgonio powerhouse	34 02 20	116 53 30	4,500	2.50	3.50	1.50	12.15	.75	.25	20.65	Nevada-California Co.

*Included in next measurement.　　** Measured in the morning.　　***Measured at midnight.

Table 2.- Daily precipitation, in inches, at recording gages for the period February 27 to March 4, 1938

Station	Latitude	Longitude	Altitude (feet)	February 27	February 28	March 1	March 2	March 3	March 4	Total	Data furnished by
	° ' "	° ' "									
Tia Juana, Otay, and Sweetwater River Basins											
San Diego	32 42 45	117 10 00	87	a1.06	0.31	0.71	1.56	0.53	0.09	4.26	U. S. Weather Bureau.
Santa Ana, San Gabriel, and Los Angeles River Basins											
San Gabriel Mountains											
Briggs Terrace, Pickens Canyon	34 14 15	118 13 30	2,310	1.24	6.20	.48	9.70	.41	-	18.03	Los Angeles County Flood Control District and Corps of Engineers, U. S. Army.
Camp Baldy, San Antonio Canyon	34 14 15	117 39 15	4,320	1.44	6.49	.81	M	M	M	-	Do.
Chilao, 1 mile north of Newcomb Ranch	34 20 31	117 59 30	5,585	2.09	3.90	.30	8.62	.85	-	15.76	Do.
Clear Creek, 1.6 miles above junction with Tujunga Creek	34 16 37	118 10 15	3,100	1.49	6.35	.82	12.70	.56	-	21.92	Do.
Crystal Lake, East Pine Flat	34 19 10	117 50 45	5,740	2.20	6.60	.88	13.17	1.60	-	24.45	Do.
Henninger Flats, Mount Wilson toll road	34 11 30	118 05 15	2,650	1.46	5.84	.70	8.91	.53	-	17.44	Do.
Hoegee's camp, West Fork of Santa Anita Creek	34 12 30	118 02 30	2,750	2.20	11.13	.73	14.87	.78	-	29.71	Do.
Loomis Ranch near junction of North and Middle Forks of Alder Creek	34 21	118 03 00	4,300	1.28	2.06	.44	7.96	.84	-	12.58	Do.
Monrovia Falls, Monrovia Canyon	34 11 15	117 59 00	1,450	1.49	7.60	.49	M	M	M	-	Do.
Mount Gleason	34 22 26	118 12 20	5,450	1.35	3.73	.22	9.41	1.30	-	16.01	Do.
Mount Wilson	34 13 20	118 03 20	5,850	2.81	9.19	.48	12.58	1.19	-	26.25	Do.
Opid's camp, West Fork of San Gabriel River	34 15 15	118 05 45	4,350	2.37	7.39	.53	15.70	1.24	-	27.23	Do.
Pacoima flood-control dam	34 20 00	118 24	1,700	.96	3.56	.38	M	M	M	-	Do.
Pickens Canyon	34 15 15	118 13 00	4,250	1.59	6.58	.19	8.67	.32	-	17.35	Do.
San Antonio guard station	34 10 45	117 40 28	2,450	1.43	5.10	.90	9.89	.09	-	17.41	Do.
San Dimas Experimental Forest, Bell-Volfe	34 10 00	117 48	1,880	1.52	6.27	.42	9.24	.96	-	18.41	Do.
San Dimas Experimental Forest, Tanbark Flats	34 12 21	117 45 34	2,700	1.53	6.33	.61	11.72	1.14	-	21.33	Do.
San Dimas Experimental Forest, Bell Canyon	34 12 00	117 46	3,100	1.50	4.68	.33	M	M	M	-	Do.
San Dimas Experimental Forest, Fern Canyon	34 12 15	117 41 45	4,800	.32	7.12	.74	11.42	.84	-	20.44	U. S. Forest Service.
San Gabriel flood-control dam No. 1	34 12 20	117 51 20	1,251	1.81	5.93	.40	10.28	.95	-	19.37	Los Angeles County Flood Control District and Corps of Engineers, U. S. Army.
San Gabriel flood-control dam No. 2	34 14 45	117 58 00	2,335	2.31	7.29	.60	13.55	.65	-	24.40	Do.
San Gabriel River at mouth of canyon	34 09 48	117 54 17	800	1.52	4.69	.61	7.25	.75	-	14.82	Do.
San Gabriel River, East Fork of	34 16 35	117 45 05	2,500	1.02	3.95	.56	9.30	.92	-	15.75	Do.

Sierra Madre, 575 North Hermosa Avenue	34 10 15	118 03 30	1,160	1.70	5.98	.42	M	M	M	–	Do.
Sleepy Hollow Ranch	34 18 04	118 06 42	3,600	2.04	4.11	.26	11.41	.80	–	18.62	Do.
Switzer's camp	34 15 15	118 09 15	3,000	M	M	.44	12.80	.58	–	–	Do.
Upper Haines Canyon	34 16 18	118 15 11	3,450	1.70	6.00	.67	M	M	M	–	Do.
San Bernardino Mountains											
Del Rosa ranger station	34 10	117 15	2,250	1.68	1.32	.70	6.84	1.00	–	11.54	U. S. Forest Service.
Devil Canyon experimental station	34 13 00	117 19 40	2,700	2.00	3.13	.80	M	M	M	–	U. S. Forest Service and Corps of Engineers, U. S. Army.
San Fernando Valley											
Chatsworth, Twin Lakes Park fire station	34 16 38	118 36 12	1,249	.53	3.28	.53	M	M	M	–	Do.
Van Nuys, city warehouse, Aetna and Vesper Streets	34 10 48	118 27 03	695	1.26	2.90	.30	5.27	.28	–	10.01	Do.
Verdugo Mountains											
Brand Park	34 11 19	118 16 21	1,250	1.44	4.56	.45	6.91	.62	–	13.98	Do.
Rossmoyne fire area, Glendale	34 10 50	118 14 40	1,500	1.18	4.13	.42	6.71	.58	–	13.02	Do.
San Rafael Hills											
El Sereno, 4566 Bedillion Street	34 04 54	118 11 02	553	1.44	3.68	.34	6.26	.28	–	12.00	Do.
Tampico Street	34 05 30	118 10 30	600	1.59	3.47	.35	5.59	.14	–	11.14	Do.
San Gabriel Valley											
Azusa, Bonita Street, west of Cerritos Avenue	34 06 24	117 53 58	545	1.32	3.43	.43	5.92	.67	–	11.77	Los Angeles County Flood Control District and Corps of Engineers, U. S. Army.
California Institute of Technology	34 08 16	118 07 38	763	1.74	4.64	.31	7.21	.37	–	14.27	Do.
Newmark, Merced Hills, Southern California Edison Co.	34 02 45	118 07 43	375	1.74	3.14	.41	5.69	.45	–	11.43	Do.
Pasadena, Central fire station	34 08 50	118 08 47	852	1.81	4.68	.42	6.40	.52	–	13.83	Do.
Pasadena, Ohio and Euclid Streets	34 07 43	118 08 34	755	1.39	3.66	.27	4.83	.28	–	10.43	Do.
Pasadena, Sunset Reservoir	34 09 43	118 09 17	930	1.58	4.49	.40	7.12	.41	–	14.00	Do.
Pasadena, Washington Street and Palm Terrace	34 10 08	118 08 12	1,010	1.60	4.95	.38	7.62	.44	–	14.99	Do.
Chino Valley											
Claremont, Pomona College Observatory	34 05 52	117 42 34	1,190	.86	2.72	.38	5.45	.58	–	9.99	Do.
Etiwanda	34 08 15	117 31 00	1,450	1.21	2.85	.32	5.53	.05	–	9.96	Corps of Engineers, U. S. Army.

a Includes 0.22 inch on Feb. 26.

M Record missing.

Table 2.- Daily precipitation, in inches, at recording gages for the period February 27 to March 4, 1938—Continued

Station	Latitude	Longitude	Altitude (feet)	February 27	February 28	March 1	March 2	March 3	March 4	Total	Data furnished by
	° ' "	° ' "									
Santa Ana, San Gabriel, and Los Angeles River Basins--Continued											
Jurupa Basin											
Citrus experiment station, University of California	33 58 30	117 20 00	1,075	0.52	0.68	0.61	2.75	0.51	-	5.07	University of California and Corps of Engineers, U. S. Army.
Santiago Creek Basin											
Orange Park Acres	33 48 04	117 46 08	600	b1.28	2.06	.58	3.75	.32	-	7.99	U. S. Soil Conservation Service.
Santiago Dam	33 47	117 43 00	700	1.18	2.05	.46	4.38	.30	-	8.37	Corps of Engineers, U. S. Army.
Silverado ranger station	33 44 15	117 39 45	1,500	.73	2.67	.45	5.36	.45	-	9.66	Orange County Flood Control District and Corps of Engineers, U. S. Army.
Coastal plains											
Bel-Air, administration building	34 05 11	118 26 45	540	1.68	3.92	.63	6.16	.14	-	12.53	Los Angeles County Flood Control District and Corps of Engineers, U. S. Army.
Beverly Hills, city hall	34 04 27	118 23 57	255	1.50	3.83	.65	5.74	.18	-	11.90	Do.
Fullerton evaporation station	33 52	117 58	90	1.09	1.74	.53	3.68	M	M	-	Do.
Griffith Park Nursery, North Commonwealth Avenue	34 07 12	118 17 11	750	1.28	3.16	.51	5.69	.19	-	10.83	Do.
Hancock Park, 5801 Wilshire Boulevard	34 03 48	118 21 19	177	1.26	2.98	.79	5.19	.21	-	10.43	Do.
Laguna Bell	33 58 38	118 08 45	140	1.75	2.28	.43	4.20	.28	-	8.94	Do.
Los Angeles, Sixth and Main Streets	34 03	118 15 00	417	1.47	2.85	.48	5.88	.38	-	11.06	U. S. Weather Bureau.
Los Angeles, Ninety-sixth Street and Central Avenue	33 57 00	118 15 25	121	1.72	1.79	.54	3.60	.11	-	7.76	Los Angeles County Flood Control District and Corps of Engineers, U. S. Army.
Santa Ana, Orange County Flood Control District office	33 45 00	117 52 00	130	.95	1.53	.65	2.78	.16	-	6.07	Orange County Flood Control District and Corps of Engineers, U. S. Army.
Signal Hill, city hall	33 47 49	118 10 03	115	1.50	1.12	.73	2.75	.40	-	6.50	Los Angeles County Flood Control District and Corps of Engineers, U. S. Army.

Topanga, Malibu, and Calleguas Creek Basins											
Lechuza, patrol station on Decker Road	34 04 50	118 52 38	1,530	.52	4.96	.92	5.33	1.05	-	12.78	Do.
Las Posas project, McCormick Ranch	34 18	119 02	-	-	2.53	.50	3.69	.54	-	7.26	U. S. Soil Conservation Service.
Topanga Canyon, 4 miles south of Topanga Bridge	34 05 08	118 35 58	747	1.52	5.75	.69	6.71	.25	-	14.92	Los Angeles County Flood Control District and Corps of Engineers, U. S. Army.
Santa Clara and Ventura River Basins											
Acton, North Branch of Escondido Canyon	34 29 51	118 15 56	3,075	.53	1.00	.07	3.05	.57	-	5.22	Do.
Bouquet Canyon, Artesian Springs	34 34 20	118 22 05	3,650	.56	2.24	.17	5.01	.72	-	8.70	City of Los Angeles.
Bouquet Canyon, Cherry Summit	34 35 20	118 23 40	2,975	.45	2.13	.12	4.83	.69	-	8.22	Do.
Bouquet Canyon, on Bouquet Canyon road near Lincoln Crest	34 35 00	118 18 20	3,600	.91	1.77	.12	4.80	.69	-	8.29	Do.
Bouquet Canyon, at reservoir yard	34 35 10	118 21 40	3,000	.42	1.99	.12	4.61	.69	-	7.83	Do.
Bouquet Canyon, Spunky Summit	34 36 00	118 23	3,500	.56	1.93	.18	4.68	.60	-	7.95	Do.
Bouquet Canyon, East Spunky Summit	34 36 30	118 21 45	3,725	.67	1.83	.14	4.11	.73	-	7.48	Do.
San Luis Obispo Creek Basin											
San Luis Obispo	35 17	120 40	250	.05	1.35	.31	1.41	.55	-	3.67	U. S. Soil Conservation Service.

b Includes 0.03 inch on Feb. 26.

M Record missing.

The amounts of precipitation as shown for the individual days are not strictly comparable, as the observations at the various stations were not always made simultaneously. Most of the amounts given in table 1 represent the rainfall during the 24-hour period preceding the time of the daily observation. Rainfall occurring during the daylight hours, however, may be recorded under the date of occurrence if observations were made in the late afternoon, or under the date of the following day if readings were made in the early morning.

Recording rain gages are maintained near many of the standard rain gages for which data are given in table 1. The two gages are usually operated for the purpose of comparison, and frequently there is considerable difference between the catch in the two. It should be emphasized that only the records for the standard-can rain gages are presented in table 1. All recording rain-gage records are presented in table 2 in a form similar to that used in table 1. The stations in table 1 for which recording-gage data are given in table 2 are indicated by a footnote reference. As the amounts given in table 2 represent rainfall occurring from midnight to midnight, the arrangement of the records is capable of presenting several features of the storm not discernible from readings made at different times during the day at the standard gages. By reference to several precipitation stations having gages of both types (see tables 1 and 2), the difference resulting from either unequal catch or different times of reading will be readily apparent.

Preparation of isohyetal maps

Although most of the precipitation fell in two or more rather distinct storms, both storms occurred within the period February 27 to March 4, which has been treated as one storm period in the preparation of the isohyetal map. The isohyetal map for the entire storm period was developed from the records of the standard rain gages as given in table 1. The location of each rain gage and the total storm rainfall were plotted on topographic sheets. For areas where there were a large number of station records and changes in topographic aspect were pronounced, maps on a scale of 1 mile to the inch were used; such areas included the coastal slopes of the San Gabriel, San Bernardino, Santa Ana, Verdugo, and Santa Monica Mountains, and the San Rafael Hills. For the remaining areas, where there were either fewer precipitation records or greater uniformity in topographic aspect, as in the valley areas, the information was plotted on topographic maps having a scale of 4 miles to the inch. The final isohyetal map, on a scale of 4 miles to the inch, is reproduced as plates 11-13 in this report. In locating the position of the isohyetals, full use has been made of such relations as could be determined between altitude, topographic aspect, and storm precipitation. In his recent account of the storm, Daingerfield [10] states:

> The San Gabriel and San Bernardino mountains, with their east-west trend, lying directly across the pass of the moisture-laden winds, performed the functions of fixed and permanent "fronts", mechanically accomplishing the chilling of tropical maritime air and precipitating its moisture.

Under the conditions described, fairly definite relations between altitude and storm rainfall can reasonably be expected. Figure 5 presents an example of these relations. On the upper half of the figure, the storm rainfall for both the coastal and desert slopes of Mount Islip and vicinity was plotted against altitude, and graphs were drawn to show the relation between altitude and rainfall. The relative position of the rain gages with respect to topography is indicated on the lower half of this figure. Also included on the graphs, for the purpose of comparison, are records of a few gages located in the Santa Ana and San Bernardino Mountains. These graphs indicate that the storm rainfall on the coastal side of Mount Islip varied at a rate of about 3 inches per 1,000 feet of change in altitude and on the desert side at a rate of about 6 inches per 1,000 feet, although as discussed in the following section, "Local storm characteristics", the altitude-rainfall relations were not so well defined in all parts of the area as in the part represented by figure 5.

In drawing the isohyetals, an effort was made to obtain the altitude-rainfall relations throughout the storm area, but there are many purely local conditions that seem to obscure any such relation. This is especially true in the mountains, where for nearly every storm many small areas show consistently higher or lower rainfall than the surrounding areas. The Los Angeles County Flood Control District has observed many such areas within the county and has maintained standard or recording rain gages in them for a number of years. In some parts of the mountains, therefore, there is perhaps a tendency to have a disproportionate number of gages indicating special conditions as compared with the number indicating normal conditions. As rain gages in the mountains must generally be located at or near places of human habitation, it is often difficult to arrange for the collection of records in desirable but remote places.

10 Daingerfield, L. H., Southern California rain and flood, February 27 to March 4, 1938: Monthly Weather Rev., vol. 66, no. 5, p. 139, 1938.

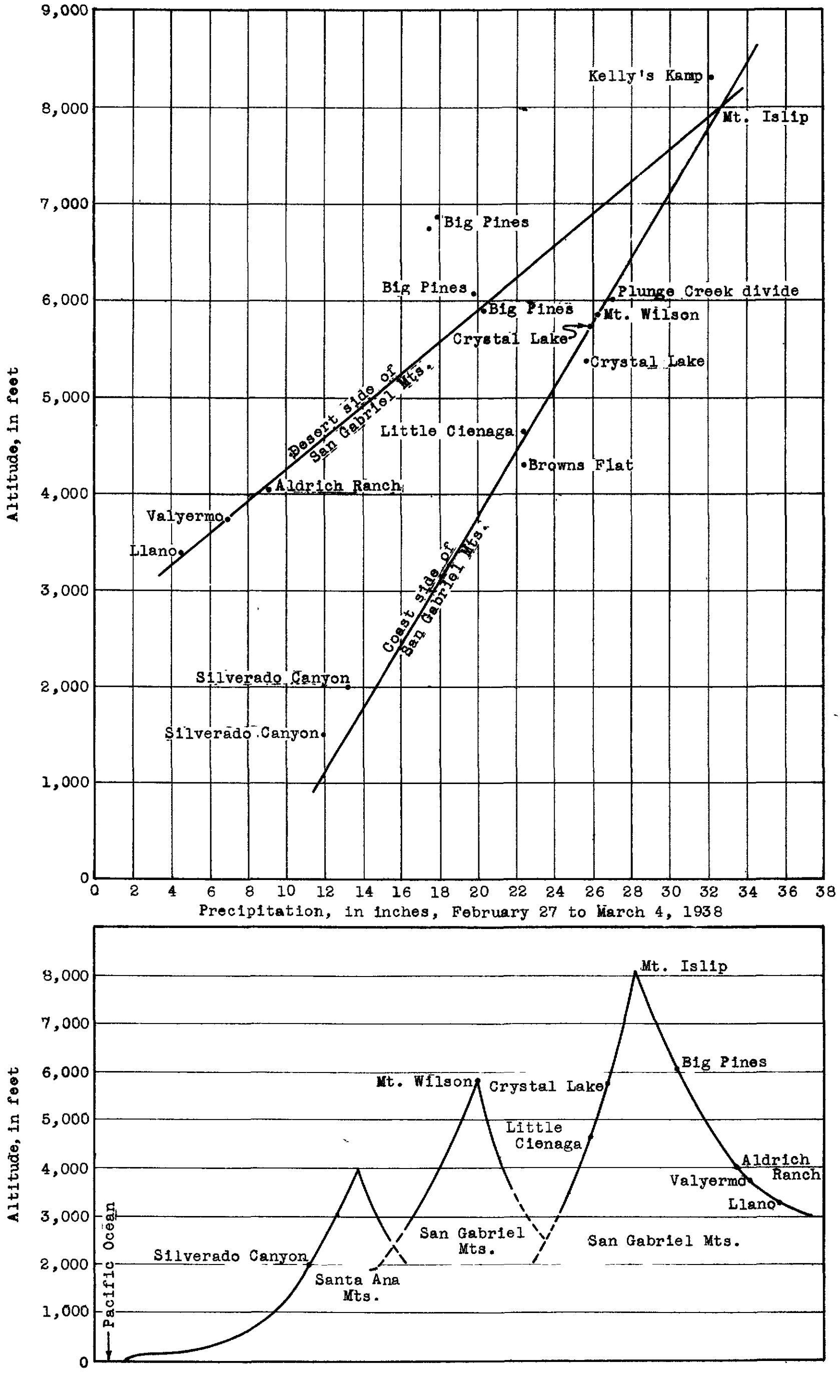


Figure 5.- Relation between altitude and precipitation in the vicinity of Mount Islip and schematic cross sections showing relative position of rain gages.

For most drainage areas in southern California, each rainfall observation for the storm period was plotted against altitude, and the relations were developed in a similar manner to those indicated on figure 5. In areas that failed to show definite relations, a series of parallel curves indicating a change in rainfall of 3 inches per 1,000 feet of difference in altitude were passed through each observation. With such an altitude-rainfall relation established, the construction of the isohyetal map was somewhat simplified. Starting with the recorded precipitation at the various stations and using the indicated altitude-rainfall relation, points for fixing the position of each isohyetal were located at right angles to the land contours above and below each rain gage. The isohyetals were, in the main, drawn parallel to ground-surface contours, with gradual or abrupt transitions according to the influence of topographic features.

In those basins where there were few precipitation stations, especially in the headwaters of the Ventura, Santa Clara, and Cuyama Rivers, the location of the isohyetals may be subject to considerable error. Likewise, the isohyetal map for much of the desert region, such as the Deep Creek and West Fork of Mojave River Basins, may not represent actual conditions. In parts of the area, the isohyetals have been shown as dashed lines to indicate that their position is uncertain.

Table 3 shows for each of 22 drainage areas listed in table 1 the number of rain gages; the approximate area in square miles; the range in altitude of the rain gages and of the drainage area; the average precipitation over the area during the storm period February 27 to March 4 obtained by planimetering the area between each isohyetal; and a statement of opinion as to the probable accuracy of the isohyetals according to the classifications well defined, fairly well defined, and poorly defined.

Local rainfall characteristics

Analysis of the precipitation records used in the preparation of the isohyetal map shows that certain areas have rainfall characteristics that appear to be related to local altitude and topography. Some of these areas and their individual characteristics are described as follows:

Some of the heaviest rainfall occurred just over the 5,000- to 6,000-foot divide of the south frontal ridge that parallels the main range of the San Gabriel Mountains. The upward movement of the moist tropical air mass, caused by the blocking of its passage eastward by these steep coastal slopes, apparently continued after the mass passed the divide and

Table 3.- Summary of information regarding distribution of standard rain-gage records for storm of February 27 to March 4, 1938, in southern California

Region	Area		Rain gages		Mean areal precipitation	
	Square miles	Range in altitude (feet above m.s.l.)	Number	Range in altitude (feet above m.s.l.)	Inches	Accuracy
Pacific slope						
Tia Juana, Otay, and Sweetwater Rivers [a]	948	0 to 6,515	22	9 to 3,400	-	-
San Diego and San Dieguito Rivers	1,089	0 to 6,515	34	25 to 4,677	9.31	Fairly well defined.
San Luis Rey and Santa Margarita Rivers	1,656	0 to 6,400	25	50 to 3,165	10.20	Do.
Aliso and San Juan Capistrano Creeks	274	0 to 5,680	11	100 to 1,150	10.67	Poorly defined.
Santa Ana, San Gabriel, and Los Angeles Rivers						
San Gabriel Mountains	556	700 to 10,080	103	700 to 8,300	22.25	Fairly well defined.
San Bernardino Mountains	300	1,480 to 11,485	21	1,385 to 6,875	23.11	Do.
San Fernando Valley	244	400 to 1,821	38	473 to 1,600	10.70	Well defined.
Verdugo Mountains	26	600 to 3,126	6	620 to 2,825	12.40	Fairly well defined.
San Rafael Hills	21	500 to 1,888	8	553 to 1,325	13.86	Do.
San Gabriel Valley	279	170 to 1,500	57	195 to 1,064	12.11	Well defined.
Chino Valley	256	500 to 2,250	25	670 to 1,740	9.59	Do.
Upper Santa Ana Valley	205	900 to 1,900	16	975 to 1,500	10.34	Do.
Jurupa Basin	160	700 to 3,000	4	825 to 1,075	6.16	Fairly well defined.
San Jacinto River	732	1,270 to 10,080	17	1,272 to 5,550	7.74	Do.
Temescal Creek	212	700 to 5,680	11	700 to 1,350	10.84	Do.
Santiago Creek	85	420 to 5,680	6	550 to 2,000	13.23	Do.
Coastal plains	1,040	0 to 2,000	151	13 to 1,235	8.48	Well defined.
Topanga, Malibu, and Calleguas Creeks	591	0 to 3,050	39	40 to 1,530	9.84	Fairly well defined.
Santa Clara and Ventura Rivers	1,970	0 to 8,800	66	50 to 5,400	11.42	Poorly defined.
San Luis Obispo Creek and Santa Maria and Santa Ynez Rivers	1,861	0 to 6,828	40	36 to 5,000	7.69	Do.
Great Basin						
Mojave River	-	-	22	1,656 to 7,500	-	Do.
Salton Sea	-	-	11	65 to 7,200	-	De.

a Data refer to area in United States only.

resulted in the condensation and excessive precipitation of its moisture on the northern slopes of these ridges. The very heavy precipitation at such stations as Opid's camp, Arrowhead Lake, and Hoegee's camp may be explained in part by such topographic influences.

The effect of local conditions and of differences in exposure of the gages is illustrated by rainfall records in the vicinity of Julian, where three gages within a radius of 3 miles and with a difference in altitude of less than 500 feet showed a variation in rainfall of 5.8 inches. So wide a divergence suggests that the isohyetals may only roughly represent actual conditions.

An example of the effect of mountain ranges on rainfall is indicated by the records from the rain gages in the San Luis Rey River Basin. Two gages at Mesa Grande, at an altitude of more than 3,000 feet and on the coastal slope of the range, indicated a rainfall in excess of 16 inches. The gage at Henshaw Dam, in the San Luis Rey River gap between the ranges, showed similar precipitation. At Warner Springs (altitude, 3,165 feet), less than 10 miles east of the coastal range, there was only 8.73 inches of rainfall.

The low precipitation in the area around Riverside and in parts of the San Jacinto River Basin may be ascribed to the influence of the Santa Ana Mountains on the incoming maritime air mass, an influence similar to that indicated for the mountains near Warner Springs.

The abrupt changes in topography and altitude in the San Gabriel Mountains, whose runoff is tributary to the Santa Ana, San Gabriel, and Los Angeles Rivers, introduce great difficulty in the development of isohyetals. Rainfall data for this area, however, are more complete than for any other mountainous section of southern California.

The altitude-rainfall relations for the vicinity of Mount Islip are shown on figure 5. Similar conditions were assumed to apply in all places where the individual observations checked this curve reasonably well. For example, the total rainfall on the divide at the head of Pickens Canyon, at an altitude of 4,250 feet, was 17.36 inches, but 2½ miles north, at Tujunga flood-control dam, at an altitude of 2,050 feet - or 2,200 feet lower - the total was 20.36 inches. The rainfall recorded at the Tujunga flood-control dam is considerably greater than the amount normally to be expected for this altitude. (See fig. 5.) This unusually heavy rainfall may result from the effect of the steep mountain canyon on the upward movement of the warm, moisture-laden maritime air masses, which apparently continue their upward course for some distance over the ridge. The accompanying chilling process would thus produce excessive precipitation for a short distance beyond. Likewise, at Opid's camp, (altitude, 4,350 feet), 3 miles northwest of Mount Wilson, the rainfall was 27.27 inches, as compared with 26.23 inches at Mount Wilson (altitude, 5,850 feet). Actually there was a zone of heavy rainfall north of the frontal ridge and paralleling the mountain range that extends for a distance of about 20 miles from Tujunga flood-control dam to the junction of the East and West Forks of the San Gabriel River.

With the exception of the rainfall of 32.20 inches at Kelly's Kamp (altitude, 8,300 feet), the heaviest precipitation in the southern California area was 30.08 inches at Hoegee's camp (altitude, 2,750 feet), which is located on the east side of a north-south mountain spur formed by Mount Wilson and Mount Harvard in the West Fork of Santa Anita Creek. Inasmuch as the tropical air mass seemed to move eastward, this short spur extending across the path of the storm may have produced a condition similar to that already described.

Similar characteristics were observed for this eame group of stations during the 2-day storm period of December 31, 1933, to January 1, 1934, known locally as the "New Year's storm of 1934", when 19.20 inches of rain fell at Hoegee's camp. This exceeds by 1.10 inches the rainfall for the maximum 2-day period in the storm of February 27 to March 4, 1938. At Opid's camp, the rainfall of 17.21 inches during the "New Year's storm of 1934" was 0.12 inch less than that during the maximum 2-day period for the 1938 storm. A similar comparison of these two storms at the Clear Creek station and at Tujunga flood-control dam shows an excess of only about 3 inches for the 1938 storm. At Mount Wilson, the rainfall of 14.69 inches for the 1934 storm was but 1.13 inches less than that for the maximum 2-day period during the 1938 storm.

A group of rain gages, including those at Mount Gleason (altitude, 5,450 feet), Chilao (altitude, 5,585 feet), and Loomis Ranch (altitude, 4,300 feet), are located about 10 miles directly north of this area of extremely heavy rainfall, to the west of Mount Islip and somewhat nearer the ocean. They indicate that considerably less rain fell in this area than in areas of comparable altitude on the frontal range. Mount Gleason had a rainfall of 17.54 inches at an altitude of 5,450 feet, as compared with 25.0 inches for that altitude as indicated by the Mount Islip altitude-rainfall relations. The greater rainfall at Mount Islip may be explained, in part, by its greater height and by the fact that it is approached on the coastal side by two straight north-south canyons, the canyons of Bear Creek and North Fork of San Gabriel River, which are more than 7 miles long. The prevailing winds are mainly from the south and are believed to have caused free movement of the moisture-laden air mass up these canyons, with heaviest rainfall at the head of the canyons as a result of the more rapid upward movement of air currents there. Loomis Ranch showed the least rainfall of the stations in this group, a fact which may be attributed to its lower altitude. During the 1934 storm, also, Loomis Ranch had a lower rainfall than the nearby stations.

Each station in these several groups showed characteristics during the 1938 storm similar to those it showed in the 1934 storm, indicating that as a result of local topographic conditions certain localities have a tendency toward predominantly lighter or heavier rainfall as considered in relation to each other. There are undoubtedly other localities throughout the southern California mountains that possess similar characteristics but because of insufficient rainfall records have not as yet been identified.

In the San Bernardino Mountains, also, are found local conditions that are likely to affect the rainfall of surrounding areas. The rainfall shown by the Plunge Creek gage (altitude, 6,000 feet) is almost identical in amount with that to be expected from the normal altitude-rainfall relation indicated on figure 5. Many of the San Bernardino Mountain stations, however, show considerably less rainfall than that indicated on figure 5 for their respective altitudes.

As indicated in the analysis of the observations from stations similarly situated in the San Gabriel Mountains, records from stations affected by local conditions are representative of relatively small areas that may receive comparatively light or heavy rainfall with a considerable degree of regularity. Because of the scarcity of gages elsewhere, such observations are of necessity assumed to be representative of many more areas than those to which they actually apply.

Isohyetals in Bear Valley and parts of Cajon Pass are not so reliable as in the remainder of the San Bernardino area, mainly because of lack of precipitation data.

Rainfall at the base of the Verdugo Mountains, between San Fernando and La Cañada Valleys, also showed considerable variation, caused probably by the local topography. A poorly defined altitude-rainfall relation indicated that the rainfall varied from 8.5 inches for the 1,000-foot altitude, in the western part, to 13 inches for the same altitude in the eastern part. An isohyetal map of the New Year's storm of 1934, prepared by the Los Angeles County Flood Control District, shows characteristics of distribution very similar to those of the 1938 storm.

The effect of local topography is strikingly illustrated in figures 6 and 7 which show four topographic cross sections of the southern California coastal plain, with the recorded rainfall for the 1938 storm plotted directly above them. One cross section is of an area in Ventura County, and the others of areas that cross the basins of Los Angeles, San Gabriel, Santa Ana, San Luis Rey Rivers and Temecula Creek. In none of the areas represented by the sections shown does the highest rainfall appear to have occurred at the point of highest altitude.

San Dimas Experimental Forest

The San Dimas Experimental Forest, located in the Sierra Madre Mountains northeast of Glendora, covers 17,000 acres and includes the entire drainage basins of San Dimas and Dalton Canyons above the flood-control dams maintained by the Los Angeles County Flood Control District. The investigation being conducted by the United States Forest Service in this area involves a determination of the relation of the chaparral vegetation to the yield of usable water from mountain drainage basins and of the extent to which this vegetation reduces flood runoff and erosion. Exact measurements of precipitation and runoff are necessary for the solution of these important problems. The entire area has been divided into two major basins, which, in turn, are subdivided into 10 component areas of 1 to 14 square miles each.

Rainfall is measured at the end of each storm at about 300 gages spaced half a mile apart along a system of trails built on the contours at altitudes of 2,100, 3,100, 4,100, and 5,100 feet. In addition, records of rainfall intensity are obtained from 15 recording rain gages distributed throughout the area in situations as nearly equal as possible both as to altitude and area.

Through the cooperation of Dr. E. I. Kotok, Director of the California Forest and Range Experimental Station, J. D. Sinclair, silviculturist in charge of the San Dimas Experimental Forest, and members of their staffs, an isohyetal map for the storm period February 27 to March 4 in the San Dimas Experimental Forest was drawn. (See fig. 8.) On this map is a random cross-section line through the area, showing rainfall and altitude. The extent to which local influences may obscure the relation between altitude and rainfall is clearly evident from this map. An altitude-rainfall relation developed under these conditions is limited in

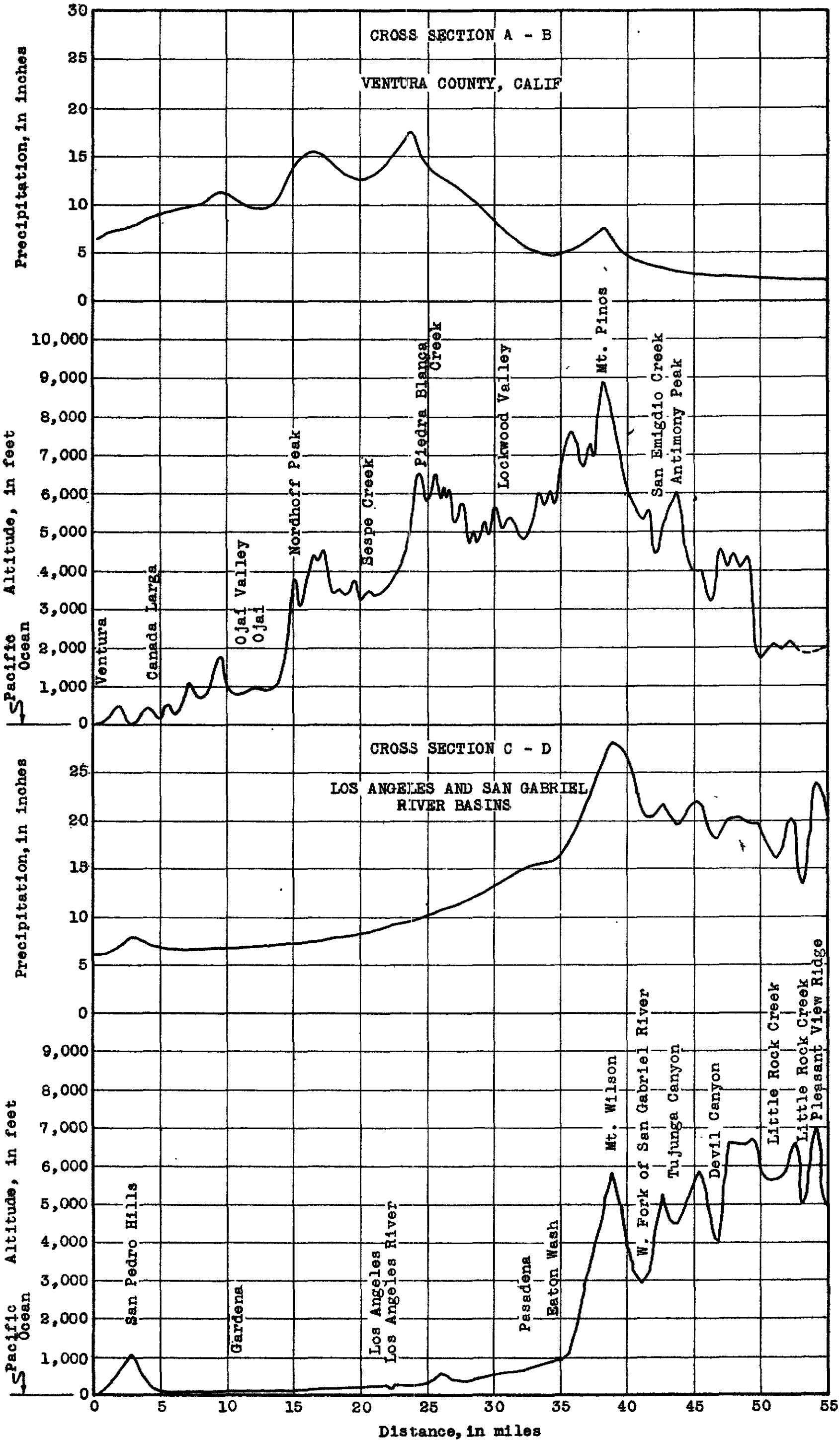


Figure 6.- Cross sections showing altitude and precipitation in Ventura County and in Los Angeles and San Gabriel River Basins.

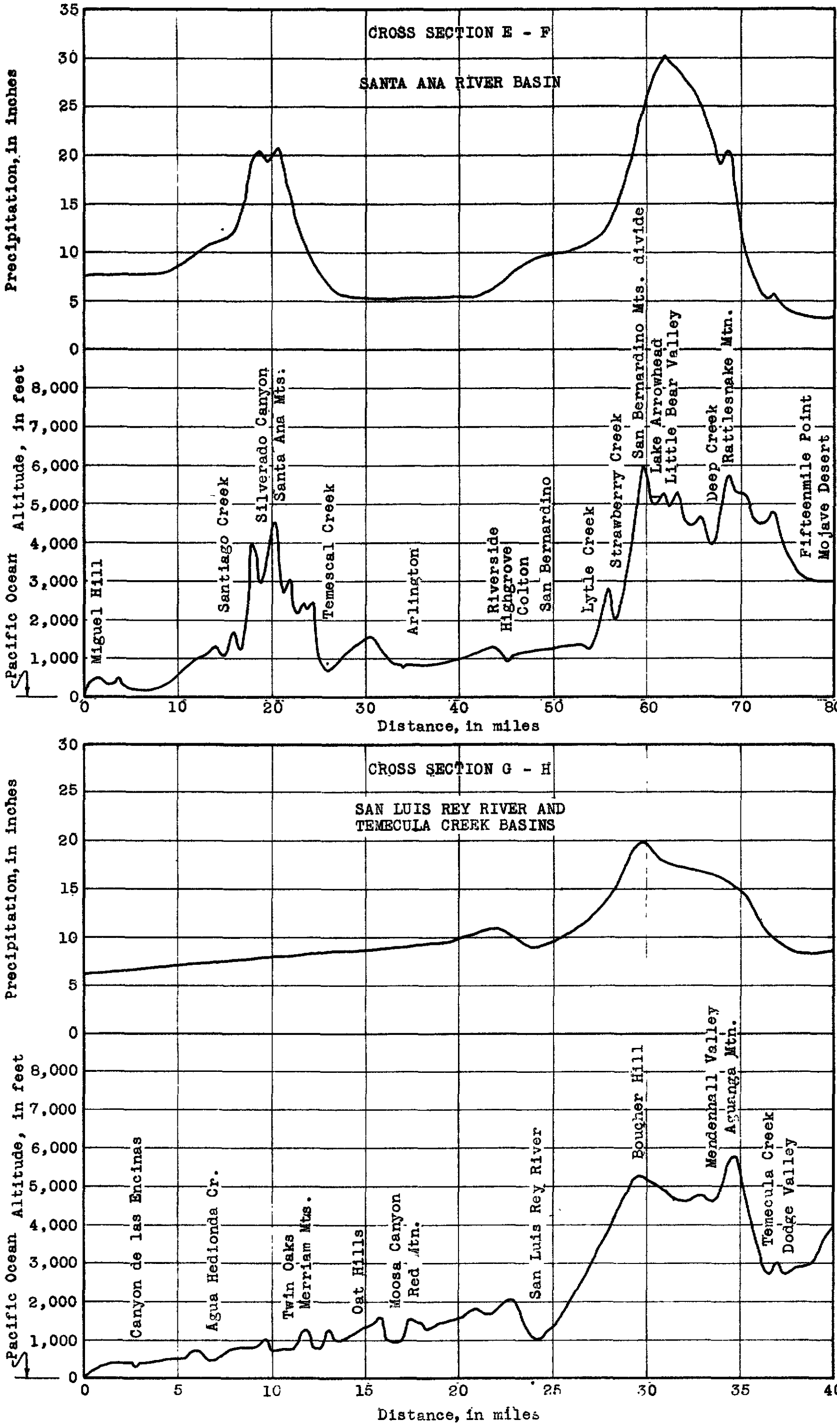


Figure 7.- Cross sections showing altitude and precipitation in basins of Santa Ana and San Luis Rey Rivers and Temecula Creek.

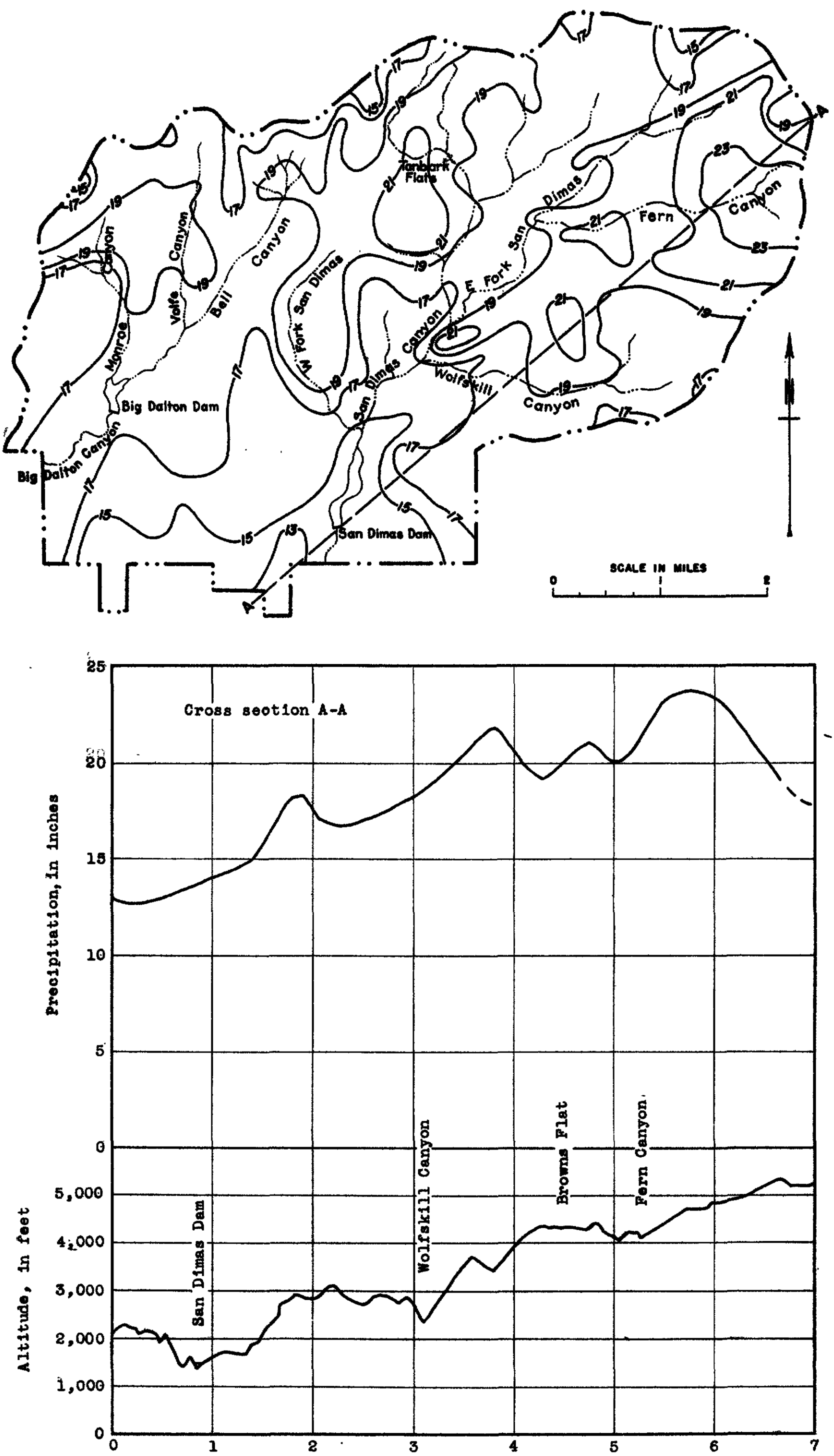


Figure 8.- Isohyetal map and cross sections showing altitude and precipitation in San Dimas Experimental Forest.

its application, and isohyetals based strictly on such a relationship, especially in areas where the data are meager, should be used with caution.

Chronologic distribution

The precipitation of the storm of February 27 to March 4, 1938, was marked by four phases. The first phase occurred on February 27 and 28. From the morning of February 27 to the early hours of the morning of February 28 the rain was light and intermittent. During the remainder of February 28 the precipitation was generally continuous and intense. Many of the precipitation stations, especially those near the coast, reported maximum intensities of short duration during this phase. In the second phase, on March 1, no appreciable precipitation occurred from 1 a.m. to 10 or 11 p.m. This lull was followed by the third phase, on March 2, when the rainfall was extremely heavy. At stations in the headwater areas of many streams, especially the Los Angeles, San Gabriel, and Santa Ana Rivers, the maximum 24-hour rainfall was the greatest on record. Some stations recorded maximum rates during the morning of March 2 and others recorded them during the afternoon. The data obtained during the storm were not so complete for areas north and south of these basins, but available observations indicate that the storm there was less severe than in the intermediate areas. Following the intense rain of March 2, the storm entered its fourth and closing phase on March 3, when light and intermittent rains continued generally until late afternoon. During the period March 4-10 there was either no rainfall at any station or too little to be significant.

The four phases of the storm are readily visualized by noting the mass curves of accumulated rainfall at several representative stations, as shown in figure 9. (Mass curves of accumulated precipitation for typical groups of stations are shown in fig. 13.) The periods of maximum intensity are also clearly indicated in figure 10, which shows the hourly precipitation at representative stations. The general eastward movement of the center of the storm is indicated by comparing the mass curves for the Topanga and Sleepy Hollow stations in figure 9. During the period of intense precipitation on February 28 the Topanga station showed considerably more accumulated rainfall than the Sleepy Hollow station, 32 miles to the northeast. This excess continued until shortly after noon on March 2, when the precipitation in the Topanga area began to slacken, but that in the Sleepy Hollow area did not slacken until several hours later. The

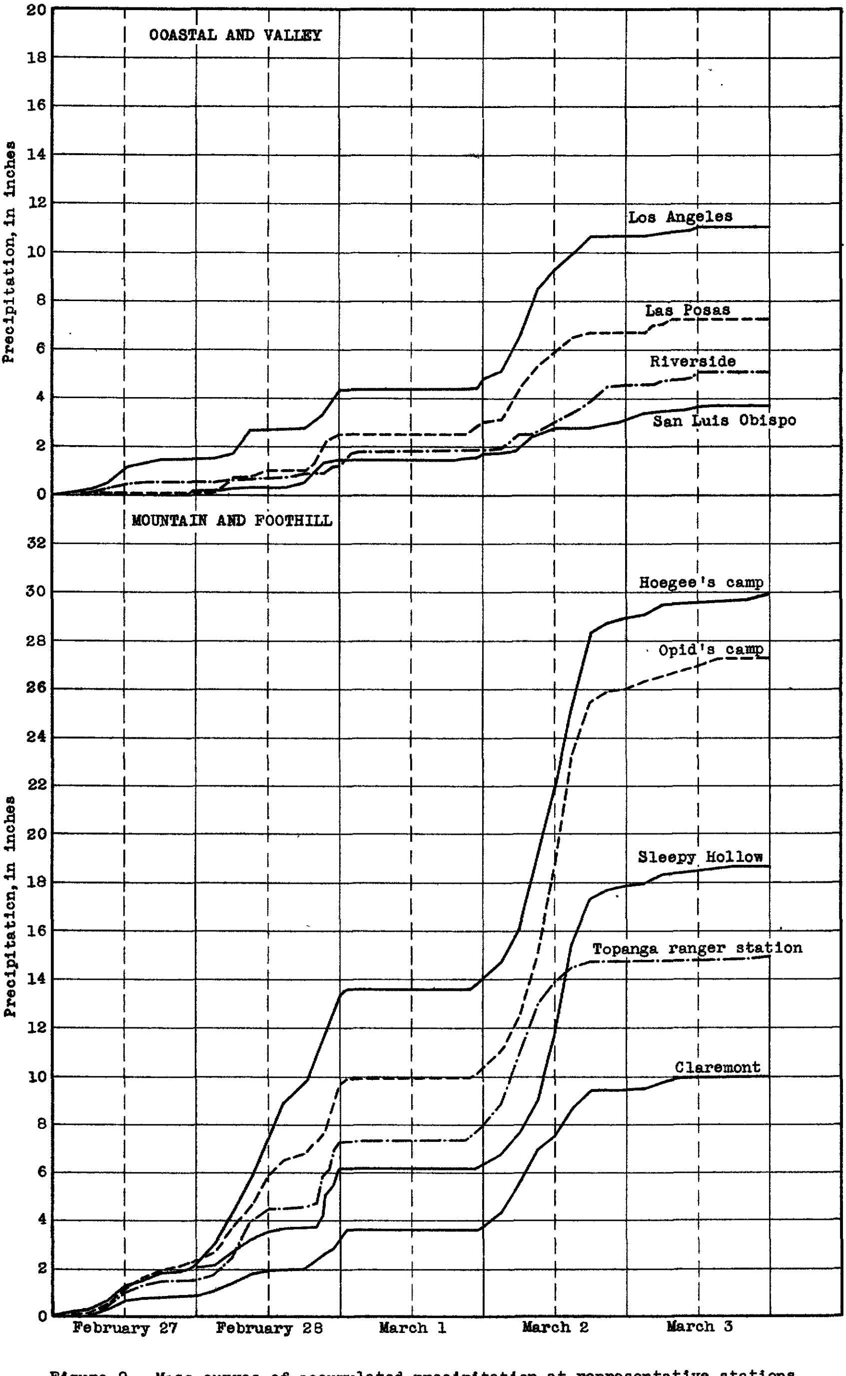


Figure 9.- Mass curves of accumulated precipitation at representative stations, February 27 to March 3, 1938.

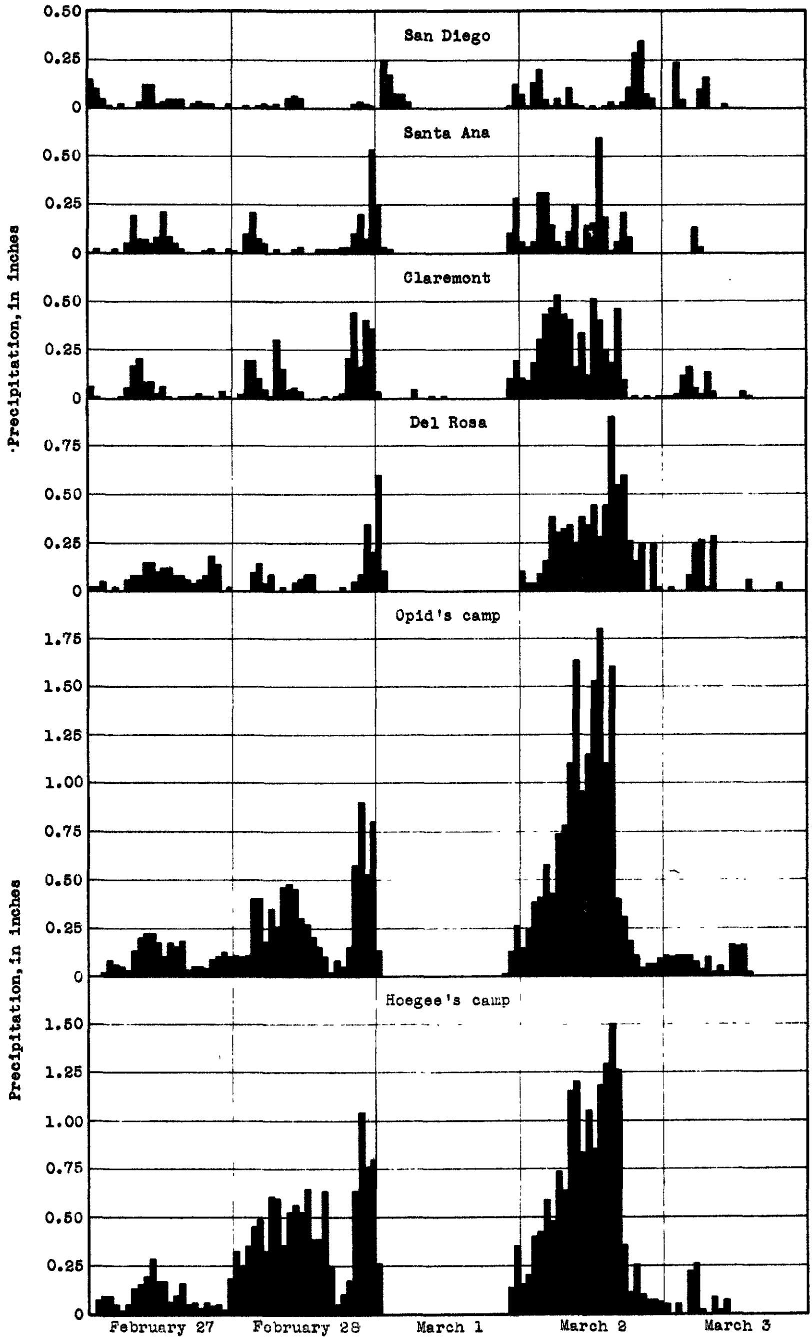


Figure 10.- Hourly precipitation at representative stations, February 27 to March 3, 1938.

extremely heavy 12-hour rainfall, especially in the mountains, is graphically indicated by the mass curves of precipitation at Hoegee's camp and Opid's camp. The mass curve for the San Luis Obispo station indicates that this station was outside the area of heavy precipitation. Table 4, which gives the percentage of the total storm rainfall occurring at representative stations during each day of the storm, presents also data on the periods of rainfall and indicates the variations in the storm characteristics of the affected region. The average of 58 records from recording gages in the Los Angeles, San Gabriel, and Santa Ana areas, included in this table, shows that about 52 percent of the total rainfall fell on March 2, which was the day of maximum rainfall during the storm.

Table 4.- Percentage of total storm precipitation on indicated days at 10 representative recording stations in Los Angeles and adjacent counties for the period February 27 to March 3, 1938

Station	February		March			Total (inches)
	27	28	1	2	3	
Hoegee's camp, West Fork of Santa Anita Creek	7.4	37.5	2.4	50.1	2.6	29.71
Opid's camp, West Fork of San Gabriel River	8.7	27.1	2.0	57.6	4.6	27.23
Sleepy Hollow Ranch	11.0	22.0	1.4	61.3	4.3	18.62
Topanga Canyon, 4 miles south of Topanga Bridge	10.2	38.5	4.6	45.0	1.7	14.92
Del Rosa ranger station	14.5	11.5	6.0	59.3	8.7	11.54
Los Angeles, Sixth and Main Streets	13.3	25.8	4.3	53.2	3.4	11.06
Claremont, Pomona College Observatory	8.6	27.2	3.8	54.5	5.9	9.99
Santa Ana, Orange County Flood Control District office	15.7	25.2	10.7	45.8	2.6	6.07
San Diego	21.3	7.8	18.0	39.5	13.4	3.95
San Luis Obispo	1.4	36.8	8.4	38.4	15.0	3.67
Average of 63 recording gages	9.8	29.7	3.6	52.0	4.9	

Rainfall intensities

Among the first recording rain gages to be established outside the Los Angeles metropolitan area were those located in the San Gabriel Mountains. Prior to 1916 the United States Forest Service, the United States Weather Bureau, and the County of Los Angeles, entered into a cooperative agreement that provided for the establishment and operation of certain recording rainfall stations in the mountain areas. These stations were located at Mount Wilson, Sister Elsie Peak, Haines Canyon (upper station), and Alder Creek (Loomis Ranch). The gages at Haines Canyon and Sister Elsie Peak which were some distance from human habitation, were inspected weekly by employees of the United States Forest Service. This duty was later assumed by the Geological Survey and more recently by the Los Angeles County Flood Control District.

The hydrologic division of the Los Angeles County Flood Control District was created in 1927, and Walter J. Wood, the present chief hydraulic engineer, and Finley B. Laverty and F. H. Hays, former chief hydraulic engineers, were largely responsible for establishing the large number of recording rain-gage stations now in operation in Los Angeles County. As a result of the combined activities of the various agencies previously referred to, more than 60 recording rain gages were in operation during the storm of February 27 to March 4, 1938, in an area covering about 7,000 square miles and including both mountains and valleys.

In order to facilitate a more detailed analysis of the rainfall records, the hourly records of rainfall at the automatic recording gages are assembled in table 5. The stations are the same as those for which the daily precipitation is given in table 2.

Tables 6 and 7 present data deduced from the original records on the intensity of the precipitation during the storm period February 27 to March 4, 1938, and its duration at different rates of intensity. Table 6 shows the number of hours in the storm period during which the intensity exceeded the given rates, which range from 0.2 of an inch to 1.4 inches per hour, and also the total amount of precipitation that fell at rates in excess of the indicated rates. Table 7 shows the maximum rates of precipitation, in inches per hour, for specified periods, ranging from 5 minutes to 120 hours, within the storm period. In table 7 the specified periods are continuous, but in table 6 they may be either continuous or discontinuous. The basic data for tables 6 and 7 were furnished, in the main, by the Corps of Engineers, United States Army, and the Los Angeles County Flood Control District.

In some localities, especially on the coastal plain, the maximum rates of precipitation for the short periods occurred on February 28, or outside the maximum 24-hour period of the storm, which corresponded in general to the calendar day March 2. Generally, at the stations given in table 5, each maximum period of 3 hours or longer occurred within the next longer maximum period.

The recording-gage records in the foothill and mountain areas have been analyzed, and five groups, A to E, inclusive, have been selected that seem to be more or less distinct in the total amount of rainfall, the relation between duration and average intensity, and the time of occurrence.

Table 5.-- Precipitation, in inches, for period ending at indicated time, February and March, 1938

Station	Day	A.M.												P.M.												Total
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	
Tia Juana, Otay, and Sweetwater River Basins																										
San Diego	Feb. 26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.01	0.01	0.07	0.13	0.22
	27	0.14	0.09	0.04	0.01	-	0.02	-	-	0.03	0.12	0.12	0.01	0.03	0.04	0.04	0.04	-	0.02	0.03	0.02	.02	-	-	.02	.84
	28	-	-	.01	-	0.01	.02	0.01	0.02	-	.05	.06	.05	-	-	-	-	-	-	-	-	.02	.03	.02	.01	.31
	Mar. 1	-	.24	.17	.07	.07	.03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.01	.12	.71
	2	.07	.01	.11	.19	.04	.01	.05	.01	.10	.02	.01	-	.01	-	.01	.03	0.01	.03	.11	.28	.34	.07	.05	-	1.56
	3	-	-	.23	.04	-	-	.09	.15	-	-	.02	-	-	-	-	-	-	-	-	-	-	-	-	-	.53
	4	-	.05	-	-	.02	-	-	-	-	-	.02	-	-	-	-	-	-	-	-	-	-	-	-	-	.09
																										4.26
Santa Ana, San Gabriel, and Los Angeles River Basins																										
San Gabriel Mountains																										
Briggs Terrace, Pickens Canyon	Feb. 27	-	-	.04	.07	.03	-	.02	.12	.15	.16	.16	.11	.05	.04	.03	.06	.02	.04	-	.03	.02	.03	.01	.05	1.24
	28	.06	.10	.16	.36	.16	.19	.37	.22	.35	.37	.26	.17	.11	.11	.03	.03	.05	.05	.06	.14	.44	1.03	.50	.88	6.20
	Mar. 1	.03	-	-	.01	.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.02	.08	.33	.48
	2	.14	.06	.26	.36	.39	.33	.53	.56	.82	.97	.45	.70	.90	1.06	.94	.59	.27	.10	.06	.10	.01	.03	.07	-	9.70
	3	-	.05	.01	.04	.09	.18	-	.01	-	-	-	-	.03	-	-	-	-	-	-	-	-	-	-	-	.41
																										18.03
Camp Baldy, San Antonio Canyon	Feb. 27	.07	.07	-	.03	.03	.02	.02	.02	.12	.22	.14	.06	.09	.05	.15	.05	.05	.02	.03	.04	.06	.04	.03	.03	1.44
	28	.12	.22	.16	.25	.30	.25	.22	.26	.34	.20	.23	.20	.21	.20	.17	.12	.03	.02	.18	.11	.27	.70	.83	.90	6.49
	Mar. 1	.63	.03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.15	.81
	2	.22	.07	.16	.26	.33	.38	.52	.35	.73	.97	1.00	1.00	1.47	1.53	1.78	M	M	M	M	M	M	M	M	M	-
Chilao, 1 mile north of Newcomb Ranch	Feb. 27	-	-	.04	.07	.05	.03	.06	.12	.23	.20	.20	.21	.18	.20	.15	.06	.06	.07	.02	.03	.02	.03	.05	.01	2.09
	28	.04	.05	.10	.20	.30	.12	.20	.18	.17	.18	.12	.10	.04	.05	.03	.02	.01	.01	.08	.16	.29	.60	.31	.54	3.90
	Mar. 1	.10	-	.01	.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.02	.04	.12	.30
	2	.14	.20	.19	.11	.18	.30	.47	.43	.42	.61	.52	.45	.82	.68	1.00	1.00	.61	.20	.10	.05	.02	.02	.06	.04	8.62
	3	.03	.03	.12	.03	.09	.01	.05	.07	.08	.02	.03	.04	.06	.03	.05	.01	-	.05	-	.01	.01	.04	-	-	.85
																										15.76
Clear Creek, 1.6 miles above junction with Tujunga Creek	Feb. 27	-	-	-	-	*.10	*.10	*.10	.10	*.10	*.10	*.10	*.10	*.10	*.10	*.10	*.10	.14	.10	-	-	.02	.03	-	-	1.49
	28	.05	.06	.14	.15	.47	.15	.23	.25	.30	.17	.28	.32	.22	.12	.06	.15	.14	.15	.04	.03	.27	.90	.70	1.00	6.35
	Mar. 1	.47	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.10	.25	.82
	2	.22	.08	.15	.35	.36	.39	.41	.10	.31	1.58	1.40	1.15	1.40	1.25	1.13	1.05	.53	.22	.20	.15	.05	.10	.05	.07	12.70
	3	-	.04	.04	-	.10	.15	-	.02	.02	.01	.01	.05	.04	.01	-	-	-	-	.02	.05	-	-	-	-	.56
																										21.92

*Estimated

M Record missing.

Table 5.- Precipitation, in inches, for period ending at indicated time, February and March, 1938—Continued

Station	Day	A.M.												P.M.												Total
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	
Santa Ana, San Gabriel, and Los Angeles River Basins—Continued																										
San Gabriel Mountains—Continued																										
Crystal Lake, East Pine Flat	Feb. 27	-	0.02	0.09	0.07	0.07	-	0.06	0.14	0.10	0.13	0.21	0.14	0.15	0.11	0.11	0.15	0.11	0.09	0.06	0.04	0.06	0.09	0.09	0.11	2.20
	28	0.09	.19	.17	.30	.37	0.24	.71	.46	.18	.37	.42	.30	.20	.10	.16	.05	-	.04	.02	.12	.32	.73	.46	.60	6.60
	Mar. 1	.63	.07	-	-	-	-	-	-	.02	.01	.02	-	-	-	-	-	-	-	-	-	-	-	.01	.12	.88
	2	.25	.12	.20	.23	.34	.45	.35	.73	.79	.86	1.00	.93	1.57	1.50	1.55	.95	-	.26	.20	.17	.32	.07	.18	.15	13.17
	3	.10	.08	.14	.06	.25	.17	.10	.04	.04	.02	-	.01	.07	-	.22	.07	.01	.07	.02	-	.08	.05	-	-	1.60
																										24.45
Henninger Flats, Mount Wilson toll road	Feb. 27	-	-	.08	.07	.05	-	.04	.13	.12	.18	.19	.15	.12	.06	.05	.06	.05	.05	.03	.01	-	.01	-	.01	1.46
	28	.10	.08	.12	.23	.40	.18	.43	.49	.18	.35	.24	.42	.22	.12	.03	.04	.09	.01	.04	.12	.50	.58	.05	.82	5.84
	Mar. 1	.28	.16	-	-	.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.04	.21	.70
	2	.18	.02	.16	.25	.35	.37	.42	.40	.88	.98	.49	.66	.65	.50	.94	.87	.33	.26	.04	.06	.01	.05	.04	-	8.91
	3	-	-	.04	-	.18	.18	.01	-	.04	-	.04	.02	.01	.01	-	-	-	-	-	-	-	-	-	-	.53
																										17.44
Hoegee's camp, West Fork of Santa Anita Creek	Feb. 27	-	.07	.09	.09	.05	.02	.05	.13	.15	.19	.28	.14	.14	.06	.09	.16	.05	.06	.03	.06	.04	.05	.02	.18	2.20
	28	.32	.25	.34	.45	.48	.32	.60	.59	.35	.52	.56	.52	.64	.38	.38	.63	.25	.05	.10	.17	.63	1.04	.76	.80	11.13
	Mar. 1	.26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.13	.34	.73
	2	.15	.21	.37	.42	.58	.47	.73	.63	1.15	1.19	.83	1.05	.85	1.18	1.29	1.50	1.26	.35	.11	.25	.10	.07	.07	.06	14.87
	3	.05	-	.06	-	.22	.26	.02	-	.08	.02	.07	-	-	-	-	-	-	-	-	-	-	-	-	-	.78
																										29.71
Loomis Ranch, near junction of North and Middle Forks of Alder Creek	Feb. 27	-	-	.03	.03	.05	.01	.03	.08	.15	.15	.17	.15	.12	.11	.07	.05	.03	.05	-	-	-	-	-	-	1.28
	28	-	-	.05	.06	.14	.07	.10	.20	.10	.06	.01	.01	-	-	-	-	-	-	-	.04	.16	.44	.27	.35	2.06
	Mar. 1	.26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.01	.03	.14	.44
	2	.06	-	.03	.16	.30	.30	.29	.28	.34	.49	.64	.49	.80	.75	1.06	.99	.57	.24	.08	.01	.01	.04	.03	-	7.96
	3	.01	.01	.07	.02	.06	.18	.11	.06	.02	.02	-	.07	.03	.02	.01	.03	.02	.02	-	.02	.01	.01	.02	.02	.84
																										12.58
Monrovia Falls, Monrovia Canyon	Feb. 27	-	.04	.09	.05	.04	.02	.06	.14	.10	.14	.20	.10	.05	.04	.07	.03	.03	.08	-	.02	.03	.01	-	.15	1.49
	28	.20	.13	.18	.33	.32	.23	.39	.51	.34	.30	.30	.45	.04	.31	.14	.31	.06	.05	.05	.22	.65	.65	.41	1.03	7.60
	Mar. 1	.14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.08	.27	.49
	2	.22	.16	.25	.31	.39	.48	.78	.36	.96	.78	.63	.50	.82	.68	M	M	M	M	M	M	M	M	M	M	-
Mount Gleason	Feb. 27	-	-	-	-	-	-	-	.02	.10	.29	.16	.13	.13	.12	.15	.08	.03	.04	.02	.02	-	.01	-	.05	1.35
	28	.01	.04	.01	.04	.24	.30	.12	.19	.14	.16	.12	.41	.05	.10	.01	.01	.01	.02	.02	.07	.24	.59	.28	.55	3.73
	Mar. 1	.05	-	-	-	.01	-	-	-	-	-	-	-	.01	-	-	-	-	-	-	-	-	-	-	.15	.22
	2	.18	.13	.24	.33	.36	.35	.59	.21	.64	.61	.50	.69	.91	.67	.80	.93	.46	.26	.16	.15	.17	.03	.02	.02	9.41
	3	-	-	.05	.05	.01	.12	.23	.02	.02	.03	.05	.02	.05	.01	.02	-	.07	.15	.33	.07	-	-	-	-	1.30
																										16.01

Mount Wilson	Feb. 27	-	.05	.11	.14	.06	-	.09	.12	.18	.27	.27	.23	.25	.06	.23	.14	.13	.12	.07	.06	.07	.08	.02	.06	2.81
	28	.17	.17	.12	.41	.49	.19	.49	.35	.30	.45	.30	.50	.55	.55	.37	.28	.17	.23	.14	.21	.55	1.14	.63	.43	9.19
	Mar. 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.18	.30	.48
	2	.09	.21	.35	.02	.87	.51	.62	.60	1.02	1.05	.55	1.05	1.15	.93	1.10	1.10	.68	.20	.04	.13	.10	.05	.11	.05	12.58
	3	.04	1	.02	.04	.30	.10	.05	-	.05	.05	.05	.05	.09	-	.16	-	-	-	-	-	-	-	.15	-	1.19
																										26.25
Opid's camp, West Fork of San Gabriel River	Feb. 27	-	-	.02	.08	.06	.04	.03	.13	.20	.22	.22	.17	.11	.17	.16	.18	.03	.05	.05	.04	.09	.10	.12	.10	2.37
	28	.11	.10	.11	.40	.40	.18	.35	.26	.46	.47	.45	.30	.27	.20	.15	.10	.02	.08	.05	.15	.57	.89	.52	.80	7.39
	Mar. 1	.13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.01	.13	.26	.53
	2	.14	.24	.38	.40	.57	.42	.73	.77	1.10	1.63	.95	1.14	1.53	1.80	1.10	1.61	.39	.30	.18	.10	.04	.05	.05	.08	15.70
	3	.10	.09	.10	.10	.10	.07	.03	.09	.01	.04	.02	.16	.15	.16	.01	-	-	-	-	-	-	-	-	.01	1.24
																										27.23
Pacoima flood-control dam	Feb. 27	-	-	-	-	-	-	-	.07	.09	.20	.09	.09	.05	.05	.12	.09	.04	-	-	.01	-	.01	.02	.03	.96
	28	.03	.03	.08	.33	.12	.13	.13	.09	.19	.26	.11	.17	.12	.05	-	-	.03	.02	.01	.07	.35	.36	.36	.52	3.56
	Mar. 1	.01	-	-	-	-	-	-	-	-	-	.02	-	-	-	-	-	-	-	-	-	-	.03	.12	.20	.38
	2	.12	.06	.16	.31	.40	.10	.23	.11	.55	.55	.20	.30	.41	.40	M	M	M	M	M	M	M	M	M	M	-
Pickens Canyon	Feb. 27	-	-	.06	.09	-	-	.08	.12	.18	.17	.17	.13	.09	.09	.08	.08	.04	.07	-	.02	.02	.02	.01	.07	1.59
	28	.08	.10	.12	.13	.20	.22	.39	.45	.31	.35	.31	.22	.19	.16	.08	.08	.13	.12	.10	.20	.47	.93	.56	.68	6.58
	Mar. 1	.03	.02	.01	.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.12	.19
	2	.30	.17	.07	.25	.38	.47	.44	.22	.34	1.00	.85	.33	.70	.77	.70	.45	.50	.28	.10	.07	.15	.03	.03	.07	8.67
	3	.02	-	.04	.02	.05	.09	.10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.32
																										17.35
San Antonio guard station	Feb. 27	.02	.01	.02	.02	.02	.02	.02	.06	.20	.13	.07	.08	.04	.14	.04	.04	.01	.04	.01	.01	.04	.10	.08	.21	1.43
	28	.05	.24	.29	.24	.21	.25	.33	.19	.22	.19	-	.23	.13	.15	.04	.03	.03	-	.03	.18	.13	.46	.67	.81	5.10
	Mar. 1	.67	.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.18	.90
	2	.22	.15	.14	.20	.28	.37	.50	.46	.50	1.05	.73	.56	.71	1.10	.85	.75	.45	.56	.14	.01	.10	.01	.03	.02	9.89
	3	.01	.07	.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.09
																										17.41
San Dimas Experimental Forest, Bell-Wolfe	Feb. 27	-	.04	.09	.02	-	.02	.05	.06	.22	.26	.18	.09	.05	.04	.06	.04	.03	.02	.03	.07	.02	.04	.01	.08	1.52
	28	.20	.27	.16	.24	.22	.21	.19	.68	.25	.24	.08	.16	.05	.11	.01	.01	.05	.14	.02	.16	.52	.55	.90	.85	6.27
	Mar. 1	.20	.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.21	.42
	2	.21	.15	.19	.24	.54	.48	.50	.48	.90	.70	.41	.44	.60	.70	.77	.66	.62	.27	.10	.03	.04	.05	.10	.06	9.24
	3	.05	.02	.04	.05	.09	.41	.01	-	.05	-	-	-	-	-	-	-	.07	.17	-	-	-	-	-	-	.96
																										18.41
San Dimas Experimental Forest, Tanbark Flats	Feb. 27	-	.04	.06	.02	-	.01	.04	.06	.24	.27	.18	.08	.05	.05	.10	.07	.04	-	-	.01	.02	.09	.06	.04	1.53
	28	.17	.26	.21	.19	.31	.27	.24	.45	.29	.30	.10	.17	.18	.10	.05	.03	.03	.02	.05	.13	.25	.62	.70	1.21	6.33
	Mar. 1	.43	.02	.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.15	.61
	2	.23	.15	.17	.22	.31	.52	.50	.30	.90	1.05	.75	.60	.63	1.14	1.40	1.18	.75	.39	.17	.08	.10	.04	.07	.07	11.72
	3	.03	.06	.05	.03	.12	.43	.07	-	.05	.04	-	-	-	-	-	-	-	.02	.10	.09	.05	-	-	-	1.14
																										21.33
San Dimas Experimental Forest, Bell Canyon	Feb. 27	-	.03	.10	.02	.01	.01	.05	.06	.22	.25	.24	.09	.07	.03	.06	.06	.03	.01	.01	.04	.03	.03	.02	.03	1.50
	28	.14	.15	.05	.12	.15	.12	.03	.41	.19	.26	.10	.13	.10	.06	.04	.05	.02	.02	.10	.12	.28	.56	.56	.92	4.68
	Mar. 1	.10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.23	.33
	2	.15	.16	.20	.23	.33	.47	.50	.50	.64	.53	.22	.37	.30	.41	.43	M	M	M	M	M	M	M	M	M	-

M Record missing.

Table 5.- Precipitation, in inches, for period ending at indicated time, February and March, 1938—Continued

Station	Day	A.M.												P.M.												Total
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	
Santa Ana, San Gabriel, and Los Angeles River Basins—Continued																										
San Gabriel Mountains—Continued																										
San Dimas Experimental Forest, Fern Canyon	Feb. 27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.08	0.14	0.08	-	0.02	0.32
	28	0.16	0.28	0.16	0.24	0.36	0.24	0.32	0.30	0.38	0.26	0.14	0.18	0.24	0.24	0.20	0.22	0.06	-	0.22	.16	.30	.70	0.76	1.00	7.12
	Mar. 1	.52	.04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.18	.74
	2	.26	.12	.18	.30	.36	.42	.58	.34	.62	.92	.80	.56	1.10	1.24	1.26	.84	.76	0.38	.16	.02	.04	.04	.06	.06	11.42
	3	.02	.04	.06	.04	.12	.44	.12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.84
																										20.44
San Gabriel flood-control dam No. 1	Feb. 27	-	.02	.05	.04	.01	.03	.04	.08	.18	.22	.24	.12	.10	.08	.07	.06	.08	.05	.07	.04	.05	.03	.03	.12	1.81
	28	.15	.17	.15	.19	.25	.15	.25	.48	.32	.43	.10	.26	.05	.14	.12	.03	.01	.04	.09	.11	.40	.60	.52	.92	5.93
	Mar. 1	.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.20	.40
	2	.20	.21	.24	.28	.30	.45	.64	.58	1.02	.75	.42	.62	.76	.78	.93	.62	.80	.21	.17	.07	.12	.02	.03	.06	10.28
	3	.02	.05	.06	-	.32	.40	-	.01	.01	.02	.01	-	-	.05	-	-	-	-	-	-	-	-	-	-	.95
																										19.37
San Gabriel flood-control dam No. 2	Feb. 27	-	.02	.09	.07	.05	.03	.06	.18	.12	.15	.25	.19	.20	.12	.16	.11	.08	.08	.04	.05	.07	.08	.05	.06	2.31
	28	.18	.14	.13	.29	.28	.15	.40	.42	.35	.44	.39	.27	.21	.18	.10	.04	.05	.07	.16	.24	.58	.96	.58	.68	7.29
	Mar. 1	.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.10	.30	.60
	2	.17	.19	.30	.33	.46	.55	.80	.50	1.15	1.15	.63	1.07	1.48	1.45	1.00	1.08	.71	.18	.07	.14	.05	.01	.05	.03	13.55
	3	-	.05	.04	.02	.14	.16	-	-	.04	.02	.02	.02	.06	-	.08	-	-	-	-	-	-	-	-	-	.65
																										24.40
San Gabriel River at mouth of canyon	Feb. 27	-	.02	.05	.04	-	.02	.04	.10	.16	.24	.24	.12	.08	.06	.06	.03	.03	.02	.01	.03	.04	.05	.02	.06	1.52
	28	.09	.08	.14	.14	.17	.15	.15	.72	.33	.23	.05	.12	.01	-	.01	-	-	-	.06	.07	.27	.44	.59	.87	4.69
	Mar. 1	.27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.07	.27	.61
	2	.17	.18	.26	.29	.40	.43	.62	.87	.63	.35	.13	.45	.30	.45	.50	.46	.42	.14	.06	.04	.06	.02	.01	.01	7.25
	3	-	.04	-	.12	.32	.18	-	-	-	.03	-	-	-	-	-	-	.04	.02	-	-	-	-	-	-	.75
																										14.82
San Gabriel River, East Fork of	Feb. 27	-	.05	.08	.03	.02	.02	.02	.03	-	-	.12	.04	.08	.02	.08	.11	.03	.02	.01	.03	.06	.08	.04	.05	1.02
	28	.08	.07	.10	.14	.17	.17	.17	.30	.13	.22	.15	.15	.03	.05	.10	-	-	.05	.02	.09	.19	.45	.58	.54	3.95
	Mar. 1	.42	.04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.10	.56
	2	.16	.08	.15	.21	.26	.34	.43	.49	.65	.68	.65	.35	.95	.80	.90	1.00	.60	.25	.08	.17	.02	.01	.02	.05	9.30
	3	.05	.05	.05	.01	.21	.38	.05	-	-	.02	-	-	-	-	.03	-	.02	-	-	-	.05	-	-	-	.92
																										15.75
Sierra Madre, 575 North Hermosa Avenue	Feb. 27	-	.12	.13	-	.06	-	.03	.11	.16	.22	.26	.14	.08	.06	.06	.06	.01	.07	.03	-	.01	.05	.01	.03	1.70
	28	.14	.12	.15	.20	.39	.10	.32	*.40	*.40	*.40	*.43	.05	.07	.08	.07	.10	.05	-	.07	.13	.44	.74	.53	.60	5.98
	Mar. 1	.14	.01	-	-	-	-	.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.04	.18	.42
	2	.29	.09	.19	.29	.12	.44	.60	.38	1.16	.74	.45	.37	.60	M	M	M	M	M	M	M	M	M	M	M	-

Sleepy Hollow Ranch	Feb. 27	-	-	.04	.07	.02	-	.07	.10	.20	.20	.22	.23	.25	.21	.16	.10	.07	.06	-	-	.01	.01	.01	.01	2.04
	28	.01	.02	.10	.22	.21	.07	.19	.18	.16	.15	.10	.08	.04	.06	.01	-	-	-	.02	.12	.42	.83	.49	.63	4.11
	Mar. 1	.02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.06	.19	.26
	2	.09	.03	.14	.22	.43	.28	.30	.50	.67	1.10	.60	.93	1.27	1.20	1.37	1.10	.50	.17	.15	.11	.05	.05	.07	.08	11.41
	3	.06	.05	.10	-	.15	.15	-	-	.05	.01	-	.04	.06	.04	.03	.01	.03	.02	.01	-	-	-	-	-	.80
																										18.62
Switzer's camp	Feb. 27	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	-
	28	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	-	-	.03	.10	.04	.26	-
	Mar. 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.15	.29	.44
	2	.13	.08	.19	.22	.52	.30	.42	.54	1.46	1.13	1.61	.86	1.10	1.10	1.13	.97	.38	.14	.11	.18	.04	.06	.05	.08	12.80
	3	.01	.04	.10	.01	.18	.20	.02	.02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.58
Upper Haines Canyon	Feb. 27	-	-	.06	.03	.02	-	.05	.17	.24	.18	.18	.15	.11	.13	.11	.09	.06	.03	.01	.01	.01	.03	.02	.01	1.70
	28	.12	.09	.12	.40	.29	.13	.25	.15	.21	.26	.31	.17	.27	.18	.06	.06	.12	.03	.08	.13	.51	.79	.40	.87	6.00
	Mar. 1	.14	-	-	.01	.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.04	.15	.32	.67
	2	.15	.03	.21	.36	.43	.35	.40	.20	.81	.83	.68	.90	1.23	1.01	M	M	M	M	M	M	M	M	M	M	-
San Bernardino Mountains																										
Del Rosa ranger station	Feb. 27	.02	.02	.04	-	.02	-	.06	.08	.08	.14	.14	.10	.12	.12	.08	.08	.06	.04	.06	.08	.18	.14	-	.02	1.68
	28	-	-	-	.10	.14	.04	.06	-	.02	-	.04	.06	.08	.08	-	-	-	-	.02	-	.04	.08	.34	.20	1.32
	Mar. 1	.60	.10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.70
	2	.10	.04	.04	.08	.16	.38	.30	.32	.34	.24	.38	.34	.44	.28	.44	.90	.54	.60	.26	.16	.24	-	.24	.02	6.84
	3	-	.02	-	-	.08	.24	.26	.02	.28	-	-	-	-	.06	-	-	-	-	.04	-	-	-	-	-	1.00
																										11.54
Devil Canyon experimental station	Feb. 27	-	.02	.01	-	.02	.05	.08	.07	.15	.12	.08	.11	.19	.07	.03	.02	.08	.12	.13	.15	.15	.15	.02	.18	2.00
	28	.10	.04	.26	.15	.17	.08	.05	.12	.33	.20	.20	.20	.11	.06	-	-	-	-	.07	.04	.07	.45	.25	.18	3.13
	Mar. 1	.32	.42	.03	-	-	-	-	-	.01	.01	.01	-	-	-	-	-	-	-	-	-	-	-	-	-	.80
	2	-	.19	.07	.24	.19	.48	.40	.55	.30	.60	.70	.77	.63	.85	1.00	1.05	.75	.60	M	M	M	M	M	M	-
San Fernando Valley																										
Chatsworth, Twin Lakes Park fire station	Feb. 27	-	-	-	-	-	-	-	-	.01	.17	.12	.06	.01	.01	.10	.02	.01	-	-	-	-	.01	-	.01	.53
	28	.02	.01	.02	.14	.06	.10	.10	.11	.20	.28	.03	.06	-	.04	-	-	-	.06	.06	.08	.55	.50	.63	.23	3.28
	Mar. 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.04	.04	.17	.28	.53
	2	.20	.13	.26	.40	.51	.46	.22	.30	.64	.20	.24	.40	.52	M	M	M	M	M	M	M	M	M	M	M	-
Van Nuys, city warehouse, Aetna and Vesper Streets	Feb. 27	-	-	.03	.04	-	-	.05	.10	.20	.15	.10	.17	.11	.08	.06	.07	.02	-	-	.01	.01	.02	.01	.03	1.26
	28	.01	.02	.04	.14	.01	.09	.13	.14	.20	.07	.09	.04	.02	.02	.01	.03	-	.01	.03	.13	*.28	*.55	*.54	*.30	2.90
	Mar. 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.01	.09	.20	.30
	2	.08	.08	.24	.38	.39	.38	.39	.32	.44	.20	.18	.60	.49	.37	.39	.14	.11	.06	-	.03	-	-	-	-	5.27
	3	-	.01	.01	.01	.18	.04	-	-	-	-	-	-	-	.03	-	-	-	-	-	-	-	-	-	-	.28
																										10.01

*Estimated.

M Record missing.

Table 5.- Precipitation, in inches, for period ending at indicated time, February and March, 1938—Continued

Station	Day	A.M. 1	2	3	4	5	6	7	8	9	10	11	12	P.M. 1	2	3	4	5	6	7	8	9	10	11	12	Total
Santa Ana, San Gabriel, and Los Angeles River Basins—Continued																										
Verdugo Mountains																										
Brand Park	Feb. 27	-	-	0.08	0.08	-	-	0.06	0.12	0.18	0.16	0.15	0.11	0.09	0.05	0.07	0.12	0.05	0.03	-	0.03	0.01	0.02	0.01	0.02	1.44
	28	0.08	0.06	.12	.28	0.07	0.16	.27	.22	.30	.07	.15	.04	.13	.02	.04	-	.02	.02	0.05	.17	.54	.80	.55	.40	4.56
	Mar. 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.02	.13	.30	.45
	2	-	.08	.07	.26	.40	.50	.46	.46	.32	.80	.64	.17	.54	.55	.68	.39	.26	.18	.08	.01	.04	-	.01	.01	6.91
	3	.01	.01	.01	.04	.07	.25	-	.01	.01	.01	.02	-	.14	.03	.01	-	-	-	-	-	-	-	-	-	.62
																										13.98
Rossmoyne fire area, Glendale	Feb. 27	-	-	.04	.01	.02	.01	.03	.12	.16	.18	.17	.14	.08	.04	.03	.04	.02	.05	-	-	.02	-	.01	.01	1.18
	28	.05	.06	.04	.22	.16	.14	.28	.32	.33	.02	.16	.16	.11	.05	.03	.01	.03	-	.03	.09	.28	.64	.34	.58	4.13
	Mar. 1	.05	-	-	-	-	-	-	-	-	.04	.02	-	-	-	-	-	-	-	-	-	-	-	.09	.22	.42
	2	.09	.04	.16	.32	.28	.22	.38	.30	.90	.75	.13	.55	.67	.75	.55	.20	.23	.12	-	.01	.01	.03	.02	-	6.71
	3	-	-	.01	.05	-	.22	-	.06	.01	.01	-	-	.06	.16	-	-	-	-	-	-	-	-	-	-	.58
																										13.02
San Rafael Hills																										
El Sereno, 4566 Bedillion Street	Feb. 27	-	.05	.03	.07	.02	.01	.05	.21	.19	.23	.18	.14	.06	.04	.02	.04	.02	-	-	-	.02	.02	-	.04	1.44
	28	.01	.01	.05	.18	.11	.06	.24	.65	.13	.12	.07	.03	.05	.06	-	-	-	.02	.04	.09	.48	.39	.32	.57	3.68
	Mar. 1	.05	-	-	-	-	-	.03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.04	.22	.34
	2	.12	.10	.30	.28	.58	.30	.72	.74	.46	.44	.06	.42	.16	.48	.48	.30	.20	.06	.02	.04	-	-	-	-	6.26
	3	-	-	-	.06	.04	.08	-	.06	.04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.28
																										12.00
Tampico Street	Feb. 27	-	-	.05	.05	.03	.03	.04	.17	.25	.27	.19	.14	.11	.08	.04	.04	.02	-	-	-	-	.05	-	.03	1.59
	28	.08	.01	.03	.13	.06	.08	.50	.44	.20	.01	.06	.04	.01	.04	.03	-	.02	.01	.01	.19	.40	.42	.27	.43	3.47
	Mar. 1	.18	-	.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.03	.13	.35
	2	.12	-	.34	.36	.63	.29	.63	.44	.60	.40	-	.20	.21	.38	.41	.43	.13	.02	-	-	-	-	-	-	5.59
	3	.01	-	-	-	.01	.10	.02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.14
																										11.14
San Gabriel Valley																										
Azusa, Bonita Street, west of Cerritos Avenue	Feb. 27	.02	.03	.03	.02	.14	.14	.14	.14	.14	.10	.05	.14	.07	.05	.05	-	-	.01	.01	-	-	.01	.01	.02	1.32
	28	.02	.04	.07	.16	.14	.08	.08	.64	.38	.06	-	.01	-	-	-	.02	-	-	.02	.02	.24	.30	.24	.91	3.43
	Mar. 1	.21	.01	-	.01	-	-	-	.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.02	.17	.43
	2	.18	.11	.18	.28	.38	.40	.60	.75	.37	.28	.20	.17	.28	.36	.43	.33	.35	.21	.06	-	-	-	-	-	5.92
	3	-	-	.01	.02	.10	.34	.05	-	.06	.09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.67
																										11.77

California Institute of Technology	Feb. 27	-	.02	.05	.05	-	.05	.04	.12	.15	.22	.26	.19	.40	.07	-	-	.01	.02	.01	.02	-	.03	-	.03	1.74
	28	.10	.07	.05	.22	.12	.12	.32	.73	.28	.31	.08	.05	.03	.05	.03	.01	.01	-	.01	.11	.46	.63	.38	.47	4.64
	Mar. 1	.10	-	-	-	.01	.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.19	.31
	2	.16	.07	.21	.34	.46	.36	.57	.45	.91	.70	.10	.28	.45	.40	.70	.54	.35	.09	.02	.04	.02	-	-	-	7.21
	3	-	-	.01	.10	.16	.02	-	.04	.01	.03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.37
																										14.27
Newmark, Merced Hills, Southern California Edison Co.	Feb. 27	-	.03	.03	.02	-	.02	.07	.15	.28	.38	.28	.17	.10	.06	.08	.01	-	-	.02	.02	.01	-	-	.04	1.74
	28	.01	-	.09	.16	.05	.06	.04	.85	.25	-	.05	-	-	.01	.01	-	-	-	.01	.18	.34	.34	.26	.43	3.14
	Mar. 1	.07	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.10	.24	.41
	2	.09	.05	.20	.35	.58	.35	.55	.56	.41	.18	.06	.19	.45	.37	.32	.51	.30	.09	-	.08	-	-	-	-	5.69
	3	-	-	-	.02	.07	.08	-	.12	.06	.05	.05	-	-	-	-	-	-	-	-	-	-	-	-	-	.45
																										11.43
Pasadena, Central fire station	Feb. 27	-	-	.04	.06	.05	.02	.04	.15	.19	.22	.30	.15	.17	.15	.08	.10	.02	.03	-	-	-	-	-	.04	1.81
	28	.38	.07	.02	.19	.13	.12	.38	.47	.18	.05	.16	.14	.12	.05	.03	-	.03	.01	.01	.08	.67	.60	.37	.42	4.68
	Mar. 1	.10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.05	.27	.42
	2	.12	.08	.20	.37	.63	.37	.48	.31	.43	.85	.13	.57	.38	.57	.50	.15	.12	.07	-	.05	.01	-	.01	-	6.40
	3	-	-	-	.04	.11	.31	.02	.02	.02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.52
																										13.83
Pasadena, Ohio and Euclid Streets	Feb. 27	-	-	.03	.05	.04	.01	.04	.11	.15	.21	.22	.10	.18	.09	.04	.08	.02	.02	-	-	-	-	-	-	1.39
	28	.03	.03	.04	.13	.08	.12	.27	.73	.44	.04	.07	.03	.03	.04	.03	-	.03	.01	-	.14	.36	.64	.26	.11	3.66
	Mar. 1	.08	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.19	.27
	2	.10	.07	.16	.39	.36	.06	.03	.08	.01	.60	.08	.45	.25	.18	.79	.72	.38	.08	-	.04	-	-	-	-	4.83
	3	-	-	-	.03	.05	.17	.01	.02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.28
																										10.43
Pasadena, Sunset Reservoir	Feb. 27	-	.03	.08	.06	.04	.01	.04	.16	.13	.22	.21	.12	.12	.10	.04	.08	.04	.05	.01	-	-	.02	-	.02	1.58
	28	.11	.05	.03	.19	.09	.11	.44	.40	.30	.16	.22	.12	.09	.02	.02	.01	.04	.02	.01	.12	.48	.58	.26	.62	4.49
	Mar. 1	.08	-	.01	-	-	-	.01	-	.01	-	-	-	-	-	-	-	-	-	-	-	-	-	.05	.24	.40
	2	.09	.06	.17	.32	.44	.29	.47	.49	1.13	.66	.25	.39	.40	.38	.57	.53	.32	.09	.04	.03	-	-	-	-	7.12
	3	-	-	-	-	-	.10	.16	.02	.01	.02	-	.10	-	-	-	-	-	-	-	-	-	-	-	-	.41
																										14.00
Pasadena, Washington Street and Palm Terrace	Feb. 27	-	.02	.08	.05	.04	.01	.05	.14	.14	.20	.26	.15	.12	.09	.04	.07	.04	.03	.01	-	-	.02	-	.04	1.60
	28	.12	.09	.06	.24	.12	.16	.55	.24	.28	.17	.21	.19	.11	.02	.02	.01	.09	.02	.02	.13	.58	.63	.33	.56	4.95
	Mar. 1	.07	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.01	.06	.24	.38
	2	.09	.06	.19	.34	.43	.35	.46	.51	1.06	.85	.19	.49	.32	.48	.65	.68	.31	.09	.01	.05	-	-	.01	-	7.62
	3	-	-	.01	-	.01	.13	.17	.02	.02	-	.01	.07	-	-	-	-	-	-	-	-	-	-	-	-	.44
																										14.99

Table 5.- Precipitation, in inches, for period ending at indicated time, February and March, 1938—Continued

Station	Day	A.M.												P.M.												Total
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	
Santa Ana, San Gabriel, and Los Angeles River Basins—Continued																										
Chino Valley																										
Claremont, Pomona College Observatory	Feb. 27	0.06	0.01	-	-	-	0.01	0.05	0.17	0.20	0.08	0.08	0.02	0.06	0.01	-	0.01	0.01	0.01	0.02	0.01	0.01	-	0.03	0.01	0.86
	28	-	.02	0.19	0.19	0.10	.04	.01	.30	.15	.04	.05	.03	-	-	-	.01	-	.01	.02	.20	.44	0.16	.40	.36	2.72
	Mar. 1	.03	-	-	-	-	-	.04	-	-	.01	-	.01	-	-	-	-	-	-	-	-	-	-	.10	.19	.38
	2	.10	.09	.18	.30	.43	.46	.53	.43	.40	.16	.33	.12	.51	.40	0.25	.18	.46	.09	-	.01	-	.01	-	.01	5.45
	3	.01	.01	.02	.11	.16	.05	.02	.13	.03	-	-	-	-	.03	.01	-	-	-	-	-	-	-	-	-	.58
																										9.99
Etiwanda	Feb. 27	.04	.01	-	-	.02	.05	.08	.10	.14	.02	.05	.04	.09	.01	.01	.01	.02	.05	.10	.09	.13	.08	.06	.01	1.21
	28	-	-	.10	.20	.12	.05	-	.20	.14	.09	.12	.10	-	-	-	-	.02	.02	-	.05	.44	.33	.29	.58	2.85
	Mar. 1	.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.06	.21	.32
	2	.12	.15	.13	.30	.37	.43	.30	.35	.53	.62	.17	.27	.31	.40	.18	.22	.40	.14	.06	.03	.02	.02	.01	-	5.53
	3	-	-	.01	.01	.01	.02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.05
																										9.96
Jurupa Basin																										
Citrus experiment station, University of California	Feb. 27	.02	.03	.01	.01	.02	.04	.04	.05	.03	.08	.02	.05	.06	.05	-	-	.01	-	-	-	-	-	-	-	.52
	28	-	-	-	.06	.10	.03	.01	-	-	-	-	-	.01	-	-	.02	.11	.01	.01	-	-	.04	.22	.06	.68
	Mar. 1	.46	.12	.01	-	.01	-	.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.61
	2	.13	.02	.01	.07	.19	.20	.05	.01	.01	.10	.20	.17	.18	.11	.15	.14	.10	.17	.41	.16	.08	.02	.05	.02	2.75
	3	-	-	-	-	.05	.08	.17	.08	-	.02	.10	.01	-	-	-	-	-	-	-	-	-	-	-	-	.51
																										5.07
Santiago Creek Basin																										
Orange Park Acres	Feb. 26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.01	-	-	.01	-	-	.01	.03
	27	.01	.01	-	-	.01	.01	.06	.19	.18	.11	.04	.15	.20	.05	-	-	-	-	.07	.08	.05	-	-	.03	1.25
	28	.02	-	.16	.22	.07	.10	-	.02	.02	.02	.04	.04	.01	.01	.01	.01	-	-	.01	.01	.14	.54	.13	.68	2.06
	Mar. 1	.28	.03	-	.01	-	.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.02	.23	.58
	2	.11	.05	.06	.29	.46	.24	.14	.15	.18	.29	.05	.24	.20	.55	.26	.02	.08	.24	.08	.04	.02	-	-	-	3.75
	3	-	-	-	.01	.01	.16	.07	-	.04	.03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.32
																										7.99
Santiago Dam	Feb. 27	.03	-	.01	.01	.03	.10	.11	.11	.14	.12	.16	.17	.06	.02	-	-	.01	-	.02	.03	.01	-	.01	.03	1.18
	28	.01	.11	.18	.11	.12	.03	-	.01	.03	.03	.07	-	-	-	.05	-	.02	.01	-	.07	.43	.13	.33	.31	2.05
	1	.06	-	.01	.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.03	.25	.10	.46
	2	.05	.03	.34	.26	.19	.16	.21	.31	.42	.26	.22	.28	.47	.46	.04	.17	.28	.08	.01	.01	.12	.01	-	-	4.38
	3	-	-	.01	.02	.10	.09	.01	.01	.03	.02	-	.01	-	-	-	-	-	-	-	-	-	-	-	-	.30
																										8.37

Silverado ranger station	Feb. 27	.03	-	.02	.02	.03	.08	.05	.09	.03	.06	.05	.06	.01	.01	-	.01	-	.01	.02	.05	.01	-	.04	.06	.73
	28	.01	.08	.18	.12	.11	.05	.01	.01	.07	.08	.15	.02	.02	.01	.03	.02	.05	.01	.01	[illegible]	.56	.13	.18	.61	2.67
	Mar. 1	.09	.01	.01	.01	-	.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.01	.21	.10	.45
	2	.03	.05	.33	.31	.28	.19	.19	.34	.50	.26	.25	.21	.44	.59	.27	.34	.47	.13	.08	-	.06	.02	.01	.01	5.36
	3	.01	-	.02	.10	.08	.22	.02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.45
																										9.66
Coastal plains																										
Bel-Air, administration building	Feb. 27	-	-	-	.08	.06	-	-	.09	.14	.28	.14	.14	.18	.09	.08	.15	.14	.02	.01	-	.01	.01	.05	.01	1.68
	28	.03	.11	.01	.01	.23	.07	.22	.34	.26	.27	.03	.15	.03	.02	-	.15	-	.04	.04	.12	.52	.21	.64	.33	3.92
	Mar. 1	.01	-	-	.01	.02	.02	-	.04	-	-	-	-	-	-	-	-	-	-	-	-	-	.02	.19	.32	.63
	2	.26	.22	.37	.47	.68	.51	.67	.95	.33	.41	.10	.22	.15	.21	.17	.16	.20	.03	.02	-	-	-	.03	-	6.16
	3	-	-	.01	.07	.01	.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.14
																										12.53
Beverly Hills, city hall	Feb. 27	-	.02	.08	.08	-	-	.06	.13	.26	.15	.16	.13	.10	.08	.06	.09	.02	.01	-	.03	-	-	-	.04	1.50
	28	.14	.01	.05	.17	.07	.23	.67	.36	.28	.05	.05	.05	.02	.01	-	-	-	.03	.04	.06	.44	.29	.26	.55	3.83
	Mar. 1	.04	-	-	-	.01	-	.03	.02	.01	-	.01	-	-	-	-	-	-	-	-	-	-	.02	.15	.36	.65
	2	.19	.13	.31	.55	.70	.62	.90	.80	.50	.21	.03	.17	.04	.16	.05	.17	.11	.07	.01	.02	-	-	-	-	5.74
	3	-	.01	.01	.04	.04	.03	-	.01	.01	.01	-	-	-	.01	.01	-	-	-	-	-	-	-	-	-	.18
																										11.90
Fullerton evaporation station	Feb. 27	.02	.04	.01	.01	.01	.01	.04	.11	.23	.19	.04	.12	.04	.10	.01	-	-	-	-	.02	.02	.01	.01	.05	1.09
	28	-	.01	.07	.19	.09	.05	-	.03	.03	.02	.02	.03	-	-	.02	-	-	.03	.02	.05	.27	.10	.08	.63	1.74
	Mar. 1	.19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.14	.20	.53
	2	.10	.06	.07	.45	.54	.39	.19	.06	.22	.10	.02	.11	.25	.37	.13	.10	.30	.20	-	.02	-	-	-	-	3.68
	3	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	-
Griffith Park Nursery, North Commonwealth Avenue	Feb. 27	-	-	.09	.06	.02	-	.04	.10	.17	.19	.16	.14	.09	.03	.05	.04	.04	.02	-	-	-	-	.01	.03	1.28
	28	.02	.02	.02	.19	.07	.13	.23	.44	.21	.08	-	.06	.07	-	-	.04	.03	.02	.04	.14	.36	.29	.26	.44	3.16
	Mar. 1	.05	-	-	-	-	-	-	.06	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.13	.27	.51
	2	.10	.11	.29	.39	.49	.02	.94	.26	1.00	.44	.07	.32	.15	.38	.19	.20	.21	.08	.02	.03	-	-	-	-	5.69
	3	-	.01	.01	.02	.02	.09	-	.01	.02	.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.19
																										10.83
Hancock Park, 5801 Wilshire Boulevard	Feb. 27	.02	.06	.06	.01	.01	.04	.15	.18	.18	.13	.13	.08	.06	.03	.05	.03	.01	-	-	-	-	-	.03	-	1.26
	28	.04	-	.08	.14	.05	.21	.74	.20	.12	.03	.03	-	.01	.01	.02	-	.01	-	.02	.14	.51	.11	.39	.12	2.98
	Mar. 1	.02	-	-	-	-	.05	.02	.05	.04	.14	.01	.01	-	-	-	-	-	-	-	-	.03	.16	.26	-	.79
	2	.09	.12	.24	.51	.49	.43	.81	.87	.29	.29	.04	.24	.04	.16	.10	.18	.17	.08	.01	.02	-	-	.01	-	5.19
	3	-	-	-	.04	.07	.02	-	.08	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.21
																										10.43
Laguna Bell	Feb. 27	.02	.03	.05	-	-	.05	.09	.14	.34	.37	.26	.12	.18	.06	-	.01	.01	-	-	-	.01	-	-	.01	1.75
	28	-	-	.11	.15	.04	.06	-	.24	-	-	.01	-	-	-	-	-	-	-	.04	.25	.25	.23	.37	.53	2.28
	Mar. 1	.06	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.02	.15	.20	.43
	2	.07	.07	.09	.37	.58	.49	.42	.11	.26	.14	.01	.15	.19	.30	.07	.33	.46	.09	-	.01	-	-	-	-	4.20
	3	-	-	-	.03	.05	.09	-	.06	-	.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.28
																										8.94

M Record missing.

Table 5.– Precipitation, in inches, for period ending at indicated time, February and March, 1938—Continued

Station	Day	A.M. 1	2	3	4	5	6	7	8	9	10	11	12	P.M. 1	2	3	4	5	6	7	8	9	10	11	12	Total
Santa Ana, San Gabriel, and Los Angeles River Basins—Continued																										
Coastal plains—Continued																										
Los Angeles, Sixth and Main Streets	Feb. 27	0.01	0.01	0.04	0.04	0.01	0.01	0.03	0.16	0.21	0.29	0.18	0.17	0.14	0.05	0.02	0.03	0.03	–	–	0.01	–	–	0.01	0.02	1.47
	28	.01	.01	.03	.11	.03	.06	.61	.25	.07	.01	.06	.01	.03	–	–	–	–	0.01	0.03	.13	0.37	0.29	.20	.53	2.85
	Mar. 1	.08	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	.01	.15	.24	.48
	2	.10	.07	.14	.44	.68	.34	.77	.54	.59	.45	.02	.33	.08	.41	.19	.42	.20	.08	–	.03	–	–	–	–	5.88
	3	–	–	–	.06	.05	.04	.03	.09	.11	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	.38
																										11.06
Los Angeles, Ninety-sixth Street and Central Avenue	Feb. 27	.01	.01	.02	.02	.01	.03	.07	.24	.36	.30	.25	.12	.10	.06	.05	.02	.01	.01	.01	–	–	–	.01	.01	1.72
	28	.01	.01	.07	.10	.02	–	.07	.66	.09	–	–	.07	.01	.03	–	–	–	–	–	.14	.10	.10	.16	.15	1.79
	Mar. 1	.09	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	.02	.24	.19	.54
	2	.05	.05	.15	.56	.46	.18	.29	.36	.02	–	.09	.11	.06	.24	.03	.15	.18	.25	.34	.03	–	–	–	–	3.60
	3	–	–	–	–	–	.01	.04	.04	–	–	.02	–	–	–	–	–	–	–	–	–	–	–	–	–	.11
																										7.76
Santa Ana, Orange County Flood Control District office	Feb. 27	–	.02	–	–	.02	–	.05	.19	.07	.07	.05	.08	.21	.08	.04	.02	–	–	–	.01	.02	–	–	.02	.95
	28	.01	–	.10	.21	.07	.05	–	.01	–	–	.02	.03	–	–	.02	.02	.02	.02	.03	.03	.10	.20	.07	.52	1.53
	Mar. 1	.24	.03	.01	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	.10	.27	.65
	2	.06	.05	.06	.31	.31	.14	.06	.03	.11	.24	.02	.14	.15	.59	.18	.01	.06	.21	.07	–	–	–	–	–	2.78
	3	–	–	–	–	–	.13	.03	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	.16
																										6.07
Signal Hill, city hall	Feb. 27	.03	.02	.07	.02	–	.02	.06	.20	.28	.26	.20	.12	.08	.06	.03	.02	–	–	.01	.02	–	–	–	–	1.50
	28	.01	–	.03	.12	.06	.04	–	.04	–	–	–	.04	–	–	–	–	–	–	–	.10	.18	.11	.05	.34	1.12
	Mar. 1	.34	.02	–	.02	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	.20	.15	.73
	2	.07	.06	.10	.40	.37	.13	.12	.12	.46	.04	.04	.07	.27	.23	.17	–	–	.10	–	–	–	–	–	–	2.75
	3	.01	.01	.02	.02	.04	.28	.02	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	.40
																										6.50
Topanga, Malibu, and Calleguas Creek Basins																										
Leehmza, patrol station on Decker road	Feb. 27	–	–	–	.03	.02	–	.01	–	–	.09	.09	.03	.07	.15	.01	.02	–	–	–	–	–	–	–	–	.52
	28	.01	.01	.23	.25	.25	.32	.33	.48	.26	.04	.07	–	.01	–	–	–	.12	.03	.21	.59	.59	.27	.74	.15	4.96
	Mar. 1	–	–	–	.01	–	.12	.04	–	–	–	.02	–	–	–	–	–	–	–	–	.02	–	.20	.23	.28	.92
	2	.26	.09	.56	.79	.48	.50	.26	.66	.36	.05	.14	.61	.05	.19	.13	.07	.07	–	.03	.03	–	–	–	–	5.33
	3	–	–	.01	.06	.72	–	.05	.03	.02	–	–	–	.03	.12	–	.01	–	–	–	–	–	–	–	–	1.05
																										12.78
Las Posas project, McCormick Ranch	Feb. 28	–	–	.10	.19	.25	.05	.05	.05	.05	.05	.03	.03	–	–	–	.01	–	–	.15	.36	.60	.24	.28	.04	2.53
	Mar. 1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	.03	.03	.14	.15	.15	.50
	2	.11	.03	.24	.37	.36	.40	.28	.28	.23	.14	.23	.30	.09	.30	.16	.08	.05	.01	–	.01	–	.01	.01	–	3.69
	3	.01	.01	.01	.33	.09	.03	.02	.01	.01	.01	.01	–	–	–	–	–	–	–	–	–	–	–	–	–	.54
																										7.26

Topanga Canyon, 4 miles south of Topanga Bridge	Feb. 27	-	-	.07	.11	.07	-	.05	.10	.20	.21	.15	.06	.08	.13	.07	.07	.06	-	-	-	-	.01	-	.08	1.52
	28	.05	.04	.14	.32	.10	.27	.36	.36	.78	.13	.22	.13	.02	-	.01	.02	.02	.05	.05	.22	1.04	.34	.81	.27	5.75
	Mar. 1	.01	.01	-	.01	.01	-	-	-	.04	-	.01	-	-	-	-	-	-	-	-	-	.03	.11	.20	.26	.69
	2	.21	.19	.46	.59	*.64	*.65	*.65	1.10	.55	.16	.19	.50	.15	.29	.13	.14	.05	.02	-	.01	.03	-	-	-	6.71
	3	-	-	-	.04	.01	-	-	-	-	-	-	-	.05	-	-	-	-	-	-	-	-	.08	-	.07	.25
																										14.92
Santa Clara and Ventura River Basins																										
Acton, North Branch of Escondido Canyon	Feb. 27	-	-	-	-	-	-	-	.04	.07	.15	.10	.05	.06	.01	-	.04	-	-	-	-	-	-	.01	-	.53
	28	-	-	.01	.04	.06	.03	-	.02	.02	.03	-	.01	-	-	-	-	-	-	-	-	.08	.22	.09	.39	1.00
	Mar. 1	.02	-	-	.01	.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.03	.07
	2	.03	.05	.02	.08	.14	.10	.04	.02	.22	.16	.18	.26	.31	.31	.35	.31	.17	.18	.04	.06	.02	-	-	-	3.05
	3	-	.01	.01	.01	.20	.11	-	.06	.06	.02	-	.04	.04	.01	-	-	-	-	-	-	-	-	-	-	.57
																										5.22
Bouquet Canyon, Artesian Springs	Feb. 27	-	-	-	-	-	-	.01	-	-	.04	.15	.07	.06	.07	.02	.04	.02	.01	-	-	.03	.01	.02	.01	.56
	28	-	-	.01	.08	.20	.12	.10	.14	.04	.12	.08	.07	-	.01	.01	-	-	-	.02	.05	.14	.40	.25	.40	2.24
	Mar. 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.01	.01	-	-	.03	.01	.11	.17
	2	.04	.05	.19	.25	.25	.36	.17	.32	.54	.25	.25	.40	.42	.33	.60	.22	.20	.01	.10	.01	-	-	-	.05	5.01
	3	.01	.03	.06	.06	.24	.18	.14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.72
																										8.70
Bouquet Canyon, Cherry Summit	Feb. 27	-	-	-	-	-	-	-	-	-	.07	.11	.02	.09	.05	.04	.04	.03	-	-	-	-	-	-	-	.45
	28	-	.01	.03	.08	.13	.10	.14	.05	.07	.10	.12	.02	.02	.02	-	-	-	-	.06	.02	.18	.35	.27	.36	2.13
	Mar. 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.01	.01	.10	.12
	2	.06	.06	.11	.22	.29	.23	.18	.16	.45	.44	.26	.48	.52	.50	.20	.17	.15	.18	.10	.04	.02	-	-	.01	4.83
	3	-	.04	.02	.25	.17	.04	.01	.02	.10	.02	.02	-	-	-	-	-	-	-	-	-	-	-	-	-	.69
																										8.22
Bouquet Canyon, Bouquet Canyon road near Lincoln Crest	Feb. 27	-	-	-	-	-	-	-	.01	.04	.11	.21	.05	.11	.06	.02	.06	.03	.01	.01	.01	.10	.04	.02	.02	.91
	28	.01	.01	.01	.06	.10	.09	.08	.13	.02	.12	.07	.02	-	-	.01	.01	-	-	.01	.01	.03	.30	.25	.43	1.77
	Mar. 1	-	-	-	-	-	.02	-	-	.03	-	.01	-	-	-	-	-	-	-	-	-	-	-	.08	.04	.12
	2	.06	.04	.12	.17	.22	.28	.17	.04	.44	.48	.20	.32	.35	.49	.44	.45	.22	.07	.06	.06	.02	.02	.03	.05	4.80
	3	-	.02	.06	-	.18	.15	.01	.06	.02	.02	.01	.01	.01	.04	.06	.02	.03	-	-	-	-	-	-	-	.69
																										8.29
Bouquet Canyon, at reservoir yard	Feb. 27	-	-	-	-	-	-	-	-	.03	.10	.08	.05	.06	.02	.03	.02	.01	-	-	-	-	-	.01	.01	.42
	28	-	.01	.03	.14	.15	.08	.08	.04	.15	.06	.09	-	-	-	-	-	-	-	.05	.01	.12	.37	.35	.26	1.99
	Mar. 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.02	.10	.12
	2	.02	.04	.12	.20	.25	.25	.22	.38	.30	.25	.22	.59	.59	.70	.17	.15	.02	.10	.01	-	-	-	.01	.02	4.61
	3	.01	.03	.32	.19	-	-	.05	.05	-	-	-	-	-	-	.02	.02	-	-	-	-	-	-	-	-	.69
																										7.83

*Estimated.

Table 5.- Precipitation, in inches, for period ending at indicated time, February and March, 1938—Continued

Station	Day	A.M. 1	2	3	4	5	6	7	8	9	10	11	12	P.M. 1	2	3	4	5	6	7	8	9	10	11	12	Total
Santa Clara and Ventura River Basins—Con.																										
Bouquet Canyon, Spunky Summit	Feb. 27	-	-	-	-	-	-	-	-	-	0.10	0.11	0.02	0.11	0.07	0.01	0.09	0.03	-	-	-	0.02	-	-	-	.56
	28	-	0.01	0.04	0.07	0.12	0.10	0.10	0.05	0.06	.07	.11	-	-	.04	-	-	-	-	0.06	0.01	.10	0.30	0.25	0.44	1.93
	Mar. 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.02	.01	.01	-	.01	.01	.01	.11	.18
	2	0.04	.04	.20	.20	.23	.28	.15	.15	.33	.22	.21	.34	.56	.54	.47	.46	.12	.08	.02	.06	-	.01	-	-	4.68
	3	-	-	.05	.03	.18	.23	-	-	.06	.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.60
																										7.95
Bouquet Canyon, East Spunky Summit	Feb. 27	-	-	-	-	-	-	-	-	.02	.12	.09	.07	.10	.04	.07	.03	.05	-	-	.04	.01	.01	.01	.01	.67
	28	.01	-	.04	.13	.10	.07	.13	.04	.10	.08	.10	-	.01	-	.01	-	-	-	.05	.01	.20	.22	.28	.25	1.83
	Mar. 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.01	.13	.14
	2	.01	.04	.08	.23	.30	.25	.13	.08	.34	.22	.20	.23	.40	.38	.34	.35	.17	.14	.04	.08	.07	.01	.01	.01	4.11
	3	.01	.01	.03	.03	.08	.28	.07	.01	.01	.15	.01	.01	.01	.02	-	-	-	-	-	-	-	-	-	-	.73
																										7.48
San Luis Obispo Creek Basin																										
San Luis Obispo	Feb. 27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.05	.05
	28	-	.05	.03	.04	.04	.03	.02	-	-	-	.01	-	-	.01	.01	.01	-	.21	.25	.22	.31	.07	.02	.02	1.35
	Mar. 1	-	-	-	-	-	-	-	-	-	.01	-	-	-	-	-	-	-	-	-	.05	.07	.03	.05	.10	.31
	2	.01	.01	.02	.01	.02	.01	.05	.26	.30	.09	.10	.11	.06	.01	-	-	-	-	.01	.09	.06	.04	.12	.03	1.41
	3	.05	.20	.02	.02	.02	.02	.02	.01	.02	.07	.01	.01	.02	.01	.03	.02	-	-	-	-	-	-	-	-	.55
																										3.67

Table 6.- Duration and amount of precipitation in excess of indicated rates for the period February 27 to March 4, 1938

Station	Altitude in feet	Duration, in hours, at rates of precipitation, in inches per hour, in excess of indicated rates										Precipitation, in inches per hour, in excess of indicated rates									
		0.2	0.3	0.4	0.5	0.6	0.7	0.8	1.0	1.2	1.4	0.2	0.3	0.4	0.5	0.6	0.7	0.8	1.0	1.2	1.4
<u>Tia Juana, Otay, and Sweetwater River Basins</u>																					
San Diego	87	4	1	-	-	-	-	-	-	-	-	0.29	0.04	-	-	-	-	-	-	-	-
<u>Santa Ana, San Gabriel, and Los Angeles River Basins</u>																					
San Gabriel Mountains																					
Briggs Terrace, Pickens Canyon	2,310	26	22	14	11	8	7	7	2	-	-	9.04	6.63	4.77	3.48	2.50	1.70	1.00	0.09	-	-
Camp Baldy, San Antonio Canyon a/	4,320	32	20	15	15	14	12	9	3	3	3	12.85	10.34	8.55	7.05	5.63	4.30	2.35	1.78	1.18	0.58
Chilao, 1 mile north of Newcomb Ranch	5,585	19	14	13	9	5	3	3	-	-	-	5.99	4.26	2.95	1.78	1.11	.72	.42	-	-	-
Clear Creek above junction with Tujunga Creek	3,100	28	19	14	11	10	9	9	7	4	1	11.81	9.47	7.84	6.59	5.56	4.56	3.66	1.96	.83	.18
Crystal Lake, East Pine Flat	5,740	32	23	17	13	12	11	7	3	3	3	12.27	9.51	7.54	6.05	4.75	3.62	2.76	1.62	1.02	.42
Henninger Flats, Mount Wilson toll road	2,650	28	21	15	8	7	5	5	-	-	-	7.92	5.53	3.63	2.38	1.60	.99	.49	-	-	-
Hoegee's camp, West Fork of Santa Anita Creek	2,750	44	36	27	23	17	13	10	8	3	1	17.68	13.70	10.55	8.03	5.96	4.53	3.34	1.66	.45	.10
Loomis Ranch, near junction of North and Middle Forks of Alder Creek	4,300	18	11	9	6	5	4	2	1	-	-	5.26	3.62	2.63	1.81	1.24	.80	.45	.06	-	-
Monrovia Falls, Monrovia Canyon	1,450	38	29	20	16	14	10	6	1	-	-	12.06	8.69	6.33	4.49	2.98	1.77	.81	.03	-	-
Mount Gleason	5,450	26	17	13	10	7	3	2	-	-	-	6.81	4.62	3.15	1.98	1.05	.54	.24	-	-	-
Mount Wilson	5,850	40	28	24	18	12	9	9	7	-	-	13.97	10.47	7.82	5.65	4.14	3.11	2.21	.66	-	-
Opid's camp, West Fork of San Gabriel River	4,350	32	25	19	15	12	12	9	7	5	4	15.31	12.33	9.91	8.21	6.85	5.65	4.55	2.91	1.81	.97
Pacoima flood-control dam	1,700	19	15	7	5	1	-	-	-	-	-	3.81	2.02	.84	.32	.05	-	-	-	-	-
Pickens Canyon	4,250	27	21	14	8	7	4	3	-	-	-	7.47	5.08	3.37	2.19	1.43	.75	.38	-	-	-
San Antonio guard station a/	2,450	28	18	16	11	9	7	4	2	-	-	8.32	6.13	4.43	2.96	1.94	1.10	.61	.15	-	-
San Dimas Experimental Forest, Bell-Volfe	1,880	29	19	19	13	9	4	3	-	-	-	8.27	6.01	4.11	2.49	1.38	.62	.25	-	-	-
San Dimas Experimental Forest, Tanbark Flats	2,700	32	20	17	13	11	8	6	5	2	-	10.95	8.27	6.46	4.95	3.73	2.78	2.08	.98	.21	-
San Dimas Experimental Forest, Fern Canyon	4,800	34	22	16	14	11	9	6	3	2	-	10.86	8.06	5.42	4.66	3.40	2.38	1.56	.60	.10	-
San Gabriel, flood-control dam No. 1	1,251	31	21	17	13	10	7	3	1	-	-	9.02	6.46	4.52	3.04	1.84	1.06	.47	.02	-	-
San Gabriel, flood-control dam No. 2	2,335	31	23	19	15	12	10	8	6	2	2	13.10	10.26	8.09	6.37	4.96	3.85	2.94	1.38	.53	.13

a Partly estimated.

Table 6.- Duration and amount of precipitation in excess of indicated rates for the period February 27 to March 4, 1938—Continued

Station	Altitude in feet	Duration, in hours, at rates of precipitation, in inches per hour, in excess of indicated rates										Precipitation, in inches per hour, in excess of indicated rates									
		0.2	0.3	0.4	0.5	0.6	0.7	0.8	1.0	1.2	1.4	0.2	0.3	0.4	0.5	0.6	0.7	0.8	1.0	1.2	1.4
<u>Santa Ana, San Gabriel, and Los Angeles River Basins</u>—Continued																					
San Gabriel Mountains—Continued																					
San Gabriel River at mouth of canyon	800	26	17	13	6	5	3	2	-	-	-	6.02	3.75	2.25	1.30	0.71	0.36	0.14	-	-	-
San Gabriel River, East Fork of	2,500	23	17	14	10	7	4	3	-	-	-	7.06	5.11	3.54	2.35	1.43	.85	.45	-	-	-
Sierra Madre, Hermosa Avenue	1,160	27	22	13	7	3	3	1	1	-	-	7.03	4.56	2.51	1.47	.84	.54	.36	0.16	-	-
Sleepy Hollow Ranch	3,600	24	15	15	10	9	7	7	5	2	-	9.28	7.54	6.04	4.70	3.70	2.90	2.20	1.04	0.24	-
Upper Haines Canyon e/	3,450	28	20	13	12	9	8	7	3	1	-	9.17	6.89	5.15	3.92	2.86	1.98	1.19	.38	.03	-
San Bernardino Mountains																					
Del Rosa ranger station	2,250	21	12	6	4	1	1	1	-	-	-	3.76	2.02	1.12	.64	.30	.20	.10	-	-	-
Devil Canyon experiment station a/	2,700	23	18	14	11	7	5	3	1	-	-	7.65	5.50	3.85	2.60	1.55	.92	.50	.05	-	-
San Fernando Valley																					
Van Nuys, city warehouse, Aetna and Vesper Streets a/	695	15	12	5	3	-	-	-	-	-	-	3.06	1.64	.62	.19	-	-	-	-	-	-
Verdugo Mountains																					
Brand Park, 200 feet above tank	1,250	23	15	11	8	4	2	-	-	-	-	5.57	3.53	2.12	1.10	.52	.20	-	-	-	-
Rossmoyne fire area	1,500	22	13	9	8	5	3	-	-	-	-	5.03	3.28	2.23	1.39	.71	.30	-	-	-	-
San Rafael Hills																					
El Sereno, 4566 Bedillion Street	553	21	13	11	5	3	2	-	-	-	-	4.61	2.83	1.62	.76	.31	.06	-	-	-	-
Tampico Street	600	21	15	10	3	2	-	-	-	-	-	4.12	2.31	.93	.36	.06	-	-	-	-	-
San Gabriel Valley																					
Azusa, Bonita Street, west of Cerritos Avenue	545	21	13	5	4	3	2	1	-	-	-	4.08	2.34	1.33	.90	.50	.26	.11	-	-	-
California Institute of Technology	763	26	20	12	7	5	2	1	-	-	-	6.19	3.92	2.27	1.28	.67	.24	.11	-	-	-
Newmark, Merced Hills, Southern California Edison Co.	375	21	15	8	5	1	1	1	-	-	-	4.20	2.29	1.15	.55	.25	.15	.05	-	-	-
Pasadena, Central fire station	852	22	20	11	6	3	1	1	-	-	-	5.45	3.36	1.79	.89	.35	.15	.05	-	-	-
Pasadena, Ohio and Euclid Streets	755	16	11	7	5	4	3	-	-	-	-	3.87	2.56	1.57	.98	.48	.14	-	-	-	-
Pasadena, Sunset Reservoir	930	25	17	11	6	3	1	1	1	-	-	5.61	3.52	2.01	1.09	.61	.43	.33	.13	-	-
Pasadena, Washington Street and Palm Terrace	1,010	24	18	13	9	5	2	2	1	-	-	6.25	4.18	2.73	1.57	.87	.51	.31	.06	-	-

Chino Valley																					
Claremont, Pomona College Observatory	1,190	15	12	7	2	–	–	–	–	–	–	3.00	1.55	.46	.04	–	–	–	–	–	–
Etiwanda	1,450	17	11	5	3	1	–	–	–	–	–	2.95	1.46	.60	.23	.02	–	–	–	–	–
Jurupa Basin																					
Citrus experiment station, University of California	1,075	3	2	2	–	–	–	–	–	–	–	.49	.27	.07	–	–	–	–	–	–	–
Santiago Creek Basin																					
Orange Park Acres	600	13	4	3	2	–	–	–	–	–	–	1.72	.83	.49	.23	.08	–	–	–	–	–
Santiago Dam	700	15	8	4	–	–	–	–	–	–	–	1.83	.67	.18	–	–	–	–	–	–	–
Silverado ranger station	1,500	17	10	6	3	1	–	–	–	–	–	2.79	1.49	.77	.26	.01	–	–	–	–	–
Coastal plains																					
Bel-Air, administration building	540	23	13	8	6	4	1	1	–	–	–	4.32	2.64	1.65	.97	.54	.25	.15	–	–	–
Beverly Hills, city hall	255	18	12	9	7	5	2	1	–	–	–	4.69	3.16	2.13	1.29	.69	.30	.10	–	–	–
Fullerton evaporation station	90	10	5	3	1	1	–	–	–	–	–	1.65	.78	.32	.13	.03	–	–	–	–	–
Griffith Park nursery	750	18	10	6	2	2	2	2	–	–	–	3.62	2.20	1.35	.94	.74	.54	.34	–	–	–
Hancock Park, 5801 Wilshire Boulevard	177	14	8	7	5	3	3	2	–	–	–	3.48	2.35	1.56	.94	.62	.32	.08	–	–	–
Laguna Bell	140	17	11	5	1	–	–	–	–	–	–	2.64	1.21	.37	.08	–	–	–	–	–	–
Los Angeles, Sixth and Main Streets	417	18	13	10	6	3	1	–	–	–	–	4.16	2.58	1.54	.72	.26	.07	–	–	–	–
Los Angeles, Ninety-sixth Street and Central Avenue	121	13	6	3	2	1	–	–	–	–	–	1.95	.94	.48	.22	.06	–	–	–	–	–
Santa Ana, Orange County Flood Control District office	130	10	4	2	2	–	–	–	–	–	–	1.11	.53	.31	.11	–	–	–	–	–	–
Signal Hill, city hall	115	10	5	1	–	–	–	–	–	–	–	1.23	.41	.06	–	–	–	–	–	–	–
Topanga, Malibu, and Calleguas Creek Basins																					
Lechuza, patrol station on Decker Road	1,530	24	14	11	8	5	3	–	–	–	–	5.43	3.53	2.32	1.26	.52	.15	–	–	–	–
Las Posas project, McCormick Ranch	–	16	6	1	1	–	–	–	–	–	–	1.85	.62	.20	.10	–	–	–	–	–	–
Topanga Canyon, 4 miles south of Topanga Bridge	747	23	15	11	9	7	4	3	2	–	–	6.50	4.65	3.37	2.31	1.47	.99	.55	.14	–	–

a Partly estimated.

Table 6.- Duration and amount of precipitation in excess of indicated rates for the period February 27 to March 4, 1938--Continued

Station	Altitude in feet	Duration, in hours, at rates of precipitation, in inches per hour, in excess of indicated rates										Precipitation, in inches per hour, in excess of indicated rates									
		0.2	0.3	0.4	0.5	0.6	0.7	0.8	1.0	1.2	1.4	0.2	0.3	0.4	0.5	0.6	0.7	0.8	1.0	1.2	1.4
<u>Santa Clara and Ventura River Basins</u>																					
Acton, north branch of Escondido Canyon	3,075	8	5	-	-	-	-	-	-	-	-	0.77	0.17	-	-	-	-	-	-	-	-
Bouquet Canyon, Artesian Springs	3,650	16	9	3	2	-	-	-	-	-	-	2.28	1.07	0.36	0.14	-	-	-	-	-	-
Bouquet Canyon, Cherry Summit	2,975	13	7	5	1	-	-	-	-	-	-	2.02	1.00	.39	.02	-	-	-	-	-	-
Bouquet Canyon, Bouquet Canyon road near Lincoln Crest	3,600	14	8	6	-	-	-	-	-	-	-	2.08	1.00	.33	-	-	-	-	-	-	-
Bouquet Canyon, at reservoir yard	3,000	14	7	3	3	1	-	-	-	-	-	2.25	1.20	.68	.38	.10	-	-	-	-	-
Bouquet Canyon, Spunky Summit	3,500	14	7	5	2	-	-	-	-	-	-	2.06	1.04	.47	.10	-	-	-	-	-	-
Bouquet Canyon, East Spunky Summit	3,725	14	5	-	-	-	-	-	-	-	-	1.27	.31	-	-	-	-	-	-	-	-
<u>San Luis Obispo Creek Basin</u>																					
San Luis Obispo	250	6	1	-	-	-	-	-	-	-	-	.35	.01	-	-	-	-	-	-	-	-

Table 7.- Maximum rates of precipitation, in inches per hour, for shorter periods within the storm period February 27 to March 4, 1938

Station	Minutes					Hours										
	5	10	15	20	30	1	2	3	6	12	18	24	48	72	96	120
Santa Ana, San Gabriel, and Los Angeles River Basins																
San Gabriel Mountains																
Briggs Terrace, Pickens Canyon	2.28	1.80	1.60	1.50	1.28	1.06	1.00	0.97	0.84	0.69	0.51	0.43	0.27	0.23	0.18	0.15
Camp Baldy, San Antonio Canyon	2.40	2.04	1.96	1.92	1.90	1.78	1.65	1.59	1.29	*.99	*.73	*.58	*.36	*.29	*.24	*.20
Chilao, 1 mile north of Newcomb Ranch	1.32	1.32	1.24	1.23	1.20	1.00	1.00	.89	.76	.61	.46	.36	.22	.18	.16	.13
Clear Creek, 1.6 miles above junction with Tujunga Creek	3.84	3.72	3.08	2.61	2.44	1.99	1.49	1.38	1.32	.89	.67	.54	.34	.28	.23	.18
Crystal Lake, East Pine Flat	3.00	2.40	2.20	2.10	1.90	1.65	1.54	1.54	1.37	.94	.69	.55	.32	.29	.24	.20
Henninger Flats, Mount Wilson toll road	3.00	2.40	2.08	1.83	1.40	.98	.93	.78	.70	.62	.48	.38	.24	.21	.18	.14
Hoegee's camp, West Fork of Santa Anita Creek	3.60	2.76	2.16	1.89	1.82	1.50	1.40	1.35	1.19	1.01	.79	.63	.39	.37	.30	.25
Loomis Ranch, near junction of North and Middle Forks of Alder Creek	2.88	1.74	1.36	1.20	1.12	1.08	1.03	.94	.79	.58	.43	.34	.20	.14	.13	.10
Monrovia Falls, Monrovia Canyon	2.04	1.80	1.60	1.47	1.46	-	-	.97	.82	.74	.66	.58	.32	.27	.24	.20
Mount Gleason	1.80	1.44	1.28	1.20	1.02	.97	.87	.80	.75	.61	.49	.40	.23	.19	.16	.13
Mount Wilson	3.00	3.00	2.48	2.07	1.50	1.27	1.10	1.06	.98	.86	.68	.54	.33	.31	.26	.22
Opid's camp, West Fork of San Gabriel River	4.20	4.14	3.44	2.79	2.16	1.80	1.67	1.50	1.36	1.11	.84	.66	.36	.33	.27	.23
Pacoima flood-control dam	1.68	1.38	1.28	1.08	.98	.71	.55	.43	*.40	*.35	*.31	*.27	*.17	*.14	*.12	*.05
Pickens Canyon	2.40	1.80	1.60	1.50	1.40	1.00	.93	.73	.72	.56	.46	.36	.24	.21	.18	.14
San Antonio guard station	2.40	2.10	1.80	1.50	1.20	1.10	.98	.90	.84	.69	.53	.42	.27	.22	.18	.15
San Dimas Experimental Forest, Bell-Volfe	2.40	2.10	1.60	1.50	1.32	1.17	.88	.77	.63	.60	.49	.39	.26	.22	.18	.15
San Dimas Experimental Forest, Tanbark Flats	4.20	3.06	2.80	2.40	2.04	1.40	1.29	1.24	.95	.81	.62	.49	.31	.26	.22	.18
San Dimas Experimental Forest, Fern Canyon	-	1.56	1.52	-	1.36	1.35	1.26	1.20	.98	.79	.61	.48	.26	.26	.21	.17
San Gabriel flood-control dam No. 1	2.40	1.56	1.40	1.26	1.20	1.02	.88	.78	.75	.70	.55	.43	.27	.23	.18	.16
San Gabriel flood-control dam No. 2	*3.60	*2.52	*2.40	*2.07	*1.80	*1.64	*1.47	*1.33	*1.10	*.96	*.74	*.58	*.35	*.30	*.25	*.20
San Gabriel River at mouth of canyon	2.40	2.10	1.64	1.32	1.08	.87	.75	.70	.55	.47	.39	.32	.20	.18	.15	.12
San Gabriel River, East Fork of	2.16	1.62	1.44	1.35	1.30	1.00	.95	.90	.78	.65	.50	.39	.24	.19	.16	.13
Sierra Madre, 575 North Hermosa Avenue	3.12	2.40	1.84	1.50	1.32	1.16	.95	.78	.63	*.54	*.43	*.33	*.22	*.20	*.17	*.14
Sleepy Hollow Ranch	2.40	1.80	1.68	1.56	1.44	1.37	1.29	1.28	1.08	.82	.61	.48	.29	.22	.19	.15
Switzer's camp	2.76	1.86	1.84	1.50	1.26	1.13	1.12	1.11	.99	.76	.57	.46	-	-	-	.16
Upper Haines Canyon	2.64	1.92	1.56	1.47	1.36	1.23	1.12	1.04	*.93	*.73	*.57	*.44	*.28	*.24	*.20	*.16
San Bernardino Mountains																
Del Rosa ranger station	3.00	1.80	1.40	1.20	1.00	.90	.72	.68	.53	.43	.36	.28	.16	.13	.12	.10
Devil Canyon experimental station **	-	-	-	-	-	1.05	1.03	.97	.84	*.68	*.52	*.47	*.26	*.21	*.18	*.15

*Partly estimated.

**Rates for periods less than 1 hour could not be determined.

Table 7.- Maximum rates of precipitation, in inches per hour, for shorter periods within the storm period February 27 to March 4, 1938—Continued

Station	Minutes					Hours										
	5	10	15	20	30	1	2	3	6	12	18	24	48	72	96	120
Santa Ana, San Gabriel, and Los Angeles River Basins—Con.																
San Fernando Valley																
Chatsworth, Twin Lakes Park fire station	1.92	1.32	1.12	1.02	0.88	0.64	0.56	0.56	0.42	*0.39	*0.32	*0.28	*0.17	*0.15	*0.11	*0.09
Van Nuys, city warehouse, Aetna and Vesper Streets	1.68	1.32	1.24	1.08	.96	.78	.55	.49	.38	.38	.30	.23	.15	.12	.10	.08
Verdugo Mountains																
Brand Park	2.28	1.62	1.32	1.23	.98	.86	.72	.63	.56	.49	.39	.31	.20	.17	.14	.12
Rossmoyne fire area	4.80	3.12	2.48	2.10	1.66	1.29	.83	.66	.62	.48	.37	.29	.19	.16	.13	.11
San Rafael Hills																
El Sereno, 4566 Bedillion Street	4.08	2.58	1.96	1.59	1.14	.87	.73	.64	.47	.43	.35	.27	.18	.14	.12	.10
Tampico Street	2.40	2.28	1.80	1.50	1.10	.67	.54	.56	.50	.39	.32	.24	.16	.13	.11	.09
San Gabriel Valley																
Azusa, Bonita Street, west of Cerritos Avenue	3.00	2.10	1.60	1.32	1.10	.91	.68	.58	.46	.38	.32	.25	.17	.14	.12	.10
California Institute of Technology	2.76	1.50	1.28	1.17	1.16	.91	.81	.69	.57	.52	.40	.31	.20	.17	.14	.12
Newmark, Merced Hills, Southern California Edison Co.	2.88	2.34	2.04	1.77	1.34	.85	.56	.51	.47	.38	.32	.25	.16	.13	.11	.10
Pasadena, Central fire station	2.40	2.16	1.76	1.53	1.18	.85	.64	.55	.50	.47	.38	.29	.19	.16	.14	.11
Pasadena, Ohio and Euclid Streets	1.80	1.50	1.48	1.29	.96	.79	.75	.63	.46	.30	.27	.21	.14	.12	.11	.09
Pasadena, Sunset Reservoir	2.40	1.98	2.08	1.86	1.62	1.13	.89	.76	.58	.50	.40	.31	.20	.17	.14	.12
Pasadena, Washington Street and Palm Terrace	2.16	2.04	1.96	1.86	1.60	1.13	.96	.81	.56	.54	.43	.33	.21	.18	.15	.12
Chino Valley																
Claremont, Pomona College Observatory	2.16	1.62	1.32	1.05	.70	.53	.49	.47	.42	.36	.31	.24	.15	.12	.10	.08
Etiwanda	1.80	1.74	1.44	1.20	.96	.71	.58	.50	.43	.35	.30	.24	.16	.12	.10	.08
Jurupa Basin																
Citrus experiment station, University of California	1.20	.84	.88	.78	.72	.46	.29	.25	.19	.16	.14	.11	.07	.06	.05	.04
Santiago Creek Basin																
Orange Park Acres	1.44	1.20	1.12	.99	.98	.68	.48	.38	.27	.25	.20	.17	.12	.09	.08	.07
Santiago Dam	1.08	.90	.80	.78	.72	.47	.46	.40	.35	.30	.24	.20	.12	.10	.09	.07
Silverado ranger station	1.68	1.32	1.16	1.05	.90	.61	.51	.43	.39	.34	.29	.23	.12	.12	.10	.08

Coastal plains																
Bel-Air, administration building	2.28	1.92	1.76	1.50	1.12	.95	.81	.71	.60	.43	.35	.28	.18	.15	.13	.10
Beverly Hills, city hall	3.60	2.04	1.68	1.41	1.22	.90	.85	.77	.68	.45	.34	.26	.17	.14	.12	.10
Fullerton, evaporation station	2.52	1.56	1.24	1.23	.92	.63	.50	.49	.31	.24	.20	.17	.11	.08	.07	–
Griffith Park Nursery, North Commonwealth Avenue	4.56	2.88	2.72	2.04	1.48	1.00	.72	.57	.52	.40	.32	.25	.16	.13	.11	.09
Hancock Park, 5801 Wilshire Boulevard	3.12	2.04	1.60	1.38	1.14	.92	.84	.74	.58	.38	.29	.23	.15	.12	.11	.09
Laguna Bell	3.24	1.92	1.44	1.20	.86	.58	.54	.50	.37	.27	.24	.19	.13	.10	.09	.07
Los Angeles, Sixth and Main Streets	2.52	1.98	1.72	1.50	1.32	.90	.72	.63	.56	.40	.33	.26	.16	.13	.11	.09
Los Angeles, Ninety-sixth Street and Central Avenue	3.12	2.40	1.80	1.44	1.04	.66	.51	.40	.33	.21	.19	.17	.10	.08	.08	.06
Santa Ana, Orange County Flood Control District office	1.44	1.02	.88	.96	.82	.59	.38	.31	.22	.19	.16	.13	.09	.07	.06	.05
Signal Hill, city hall	1.32	1.14	.92	.78	.64	.46	.39	.30	.27	.20	.17	.13	.09	.07	.06	.05
Topanga, Malibu, and Calleguas Creek Basins																
Lschuza, patrol station on Decker road	1.80	1.44	1.32	1.17	1.16	.79	.68	.61	.54	.40	.32	.25	.18	.16	.13	.11
Las Posas project, McCormick Ranch	1.80	.90	.88	.87	.86	.67	.54	.42	.31	.27	.22	.17	.12	.09	.08	.06
Topanga Canyon, 4 miles south of Topanga Bridge	2.88	2.04	2.04	1.83	1.64	1.10	.83	.73	.70	.50	.39	.30	.21	.18	.15	.12
Santa Clara and Ventura River Basins																
Acton, north branch of Escondido Canyon	1.92	1.20	.88	.72	.61	.39	.32	.32	.28	.22	.16	.13	.08	.06	.05	.04
Bouquet Canyon, Artesian Springs**	–	–	–	–	–	.60	.47	.45	.38	.35	.31	.21	.13	.11	.09	.07
Bouquet Canyon, Cherry Summit**	–	–	–	–	–	.52	.51	.50	.44	.33	.26	.21	.13	.10	.09	.07
Bouquet Canyon, at reservoir yard**	–	–	–	–	–	.70	.65	.63	.44	.34	.25	.20	.12	.10	.08	.07
Bouquet Canyon, Bouquet Canyon road near Lincoln Crest**	–	–	–	–	–	.49	.47	.46	.38	.32	.25	.20	.12	.09	.08	.07
Bouquet Canyon, Spunky Summit**	–	–	–	–	–	.56	.55	.52	.43	.33	.26	.20	.12	.10	.08	.07
Bouquet Canyon, East Spunky Summit**	–	–	–	–	–	.40	.39	.37	.32	.27	.22	.18	.11	.09	.08	.06
San Luis Obispo Creek Basin																
San Luis Obispo	1.80	1.02	.72	.57	.44	.30	.27	.20	.15	.08	.08	.06	.05	.05	.04	.03

*Partly estimated

**Rates for periods less than 1 hour could not be determined.

Table 8 lists the stations in the several groups and gives for each the latitude and longitude, altitude, and recorded rainfall for the total storm period and for March 2, the day of heaviest rainfall. General descriptions of the different groups follow.

Group A. Stations at relatively high altitudes on the slopes of the second mountain range to the north and east of the zone of heaviest rainfall.

Group B. Stations near or just beyond the first divide and in the zone of heaviest rainfall in the San Gabriel and San Bernardino Mountains.

Group C. Stations on the coastal side of the first divide in a zone of heavy though somewhat less average precipitation than observed at the stations of group B.

Group D. Stations on the coastal side of the first divide at a somewhat lower average altitude and in a zone of somewhat less average precipitation than the stations of group C.

Group E. Stations situated along the toe of the San Gabriel Mountains, in a zone of less rainfall than the other groups.

Table 8.- Location, altitude, and storm precipitation, for certain groups of stations in Santa Ana, San Gabriel, and Los Angeles River Basins

Station and group	Latitude ° ' "	Longitude ° ' "	Altitude (feet)	Precipitation Mar. 2	Precipitation Total
Group A					
Chilao, 1 mile north of Newcomb Ranch	34 20 31	117 59 30	5,585	8.62	15.76
Loomis Ranch near junction of North and Middle Forks of Alder Creek	34 21	118 03	4,300	7.96	12.58
Mount Gleason	34 22 26	118 12 20	5,450	9.41	16.01
East Fork of San Gabriel River	34 16 35	117 45 05	2,500	9.30	15.75
Group B					
Camp Baldy, San Antonio Canyon	34 14 15	117 39 15	4,320	a10.77	a19.51
Crystal Lake, East Pine Flat	34 19 10	117 50 45	5,740	13.17	24.45
Hoegee's camp, West Fork of Santa Anita Creek	34 12 30	118 02 30	2,750	14.87	29.71
Opid's camp, West Fork of San Gabriel River	34 15 15	118 05 45	4,350	15.70	27.23
Group C					
Devil Canyon experimental station	34 13 00	117 19 40	2,700	a9.37	a15.30
Monrovia Falls, Monrovia Canyon	34 11 15	117 59 00	1,450	a7.32	a16.90
Mount Wilson	34 13 20	118 03 20	5,850	12.58	26.25
San Antonio guard station	34 10 45	117 40 28	2,450	9.89	17.41
San Dimas Experimental Forest, Tanbark Flats	34 12 21	117 45 34	2,700	11.72	21.33
Group D					
Henninger Flats, Mount Wilson toll road	34 11 30	118 05 15	2,650	8.91	17.44
Pickens Canyon	34 15 15	118 13 00	4,250	8.67	17.35
San Gabriel River at mouth of canyon	34 09 48	117 54 17	800	7.25	14.82

a Incomplete record.

Table 8.- Location, altitude, and storm precipitation, for certain groups of stations in Santa Ana, San Gabriel, and Los Angeles River Basins--Con.

Station and group	Latitude ° ' "	Longitude ° ' "	Altitude (feet)	Precipitation Mar. 2	Total
Group E					
Azusa, Bonita Street, west of Cerritos Avenue	34 06 24	117 53 58	545	5.92	11.77
California Institute of Technology	34 08 16	118 07 38	763	7.21	14.27
Claremont, Pomona College Observatory	34 05 52	117 42 34	1,190	5.45	9.99
Etiwanda	34 08 15	117 31 00	1,450	5.53	9.96
Newmark, Merced Hills, Southern California Edison Co.	34 02 45	118 07 43	375	5.69	11.43

The rainfall characteristics at the stations in these groups are believed to be representative of those of much of the area in which the greater part of the flood runoff originated. The data collected at these stations have therefore been analyzed in detail. For the three stations at which the recording rain-gage record is incomplete, the missing part was computed from additional readings made by observers and from mass curves similar to those in figure 9.

Figure 11, based on data in table 6, shows graphically for each group of stations the average number of hours of rainfall at rates in excess of those indicated, and also the percentage of the total precipitation that fell at rates in excess of those indicated. The graphs show the increase in the intensity of rainfall from the group E stations, along the toe of the mountains, to the group B stations, in the belt of heaviest precipitation near or just beyond the first divide, and a decrease from the group B stations to the group A stations, which are located farther north and some of which are high on the slopes of the secondary divide.

Figure 12 gives, for each group of stations, the average hourly rainfall throughout the storm period based on the recording-gage data, and figure 13 gives, for each group, the accumulated precipitation in the form of mass curves determined from the data given in figure 12.

All stations show two outstanding periods of intense precipitation, separated by an interval of about 20 hours on March 1, when little or no rain fell at any station. In general, little flood runoff occurred during the first major storm period, and the maximum flood runoff in all the areas was associated with the precipitation during the second major storm period, the third phase of the storm, which occurred March 2. It was the rain that fell on this day that was mainly responsible for the intense flood runoff, and the storm characteristics of this third phase have therefore been further analyzed.

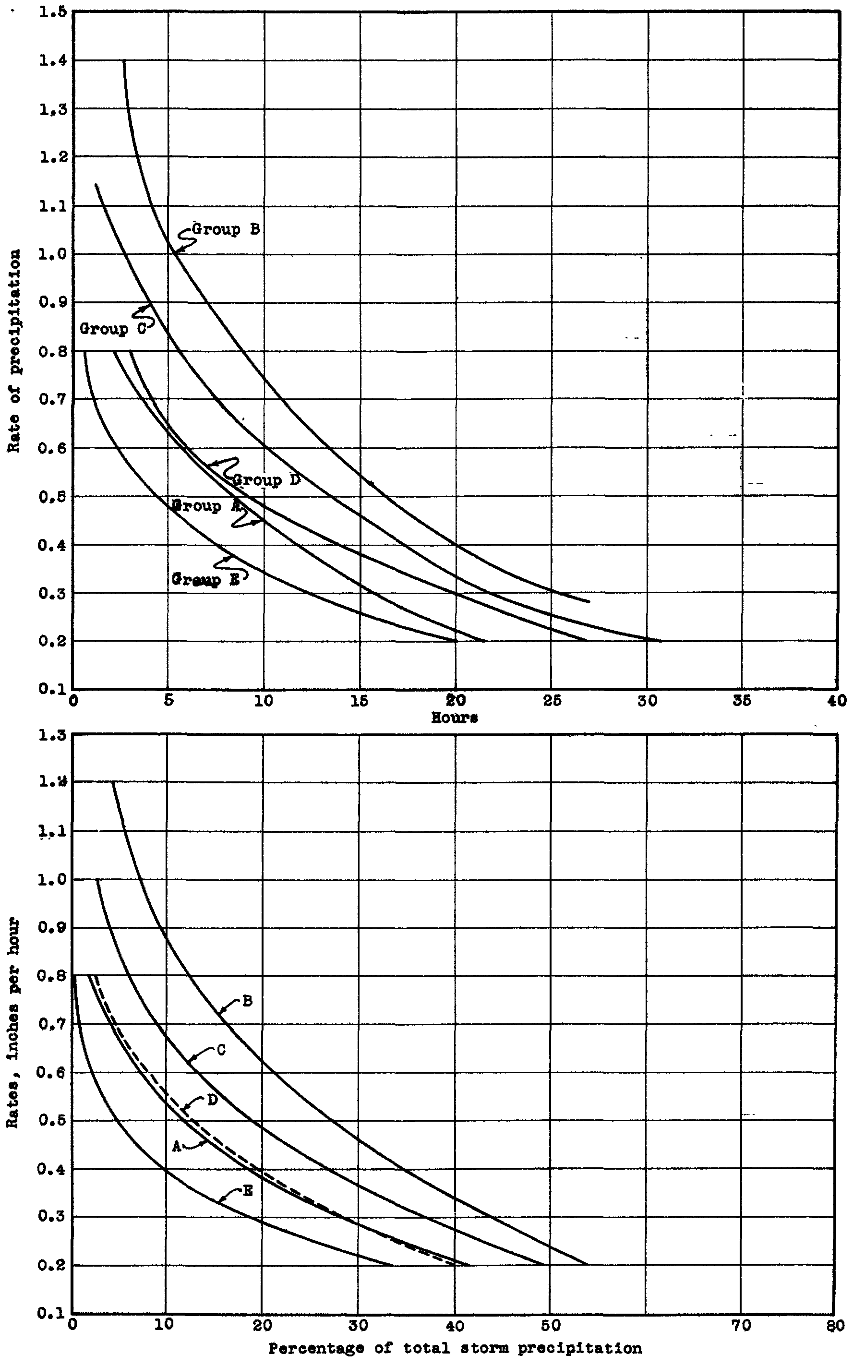


Figure 11.- Hours of precipitation and percentage of total, in excess of indicated rates, for groups of stations A to E in San Gabriel and San Bernardino Mountains and foothill areas.

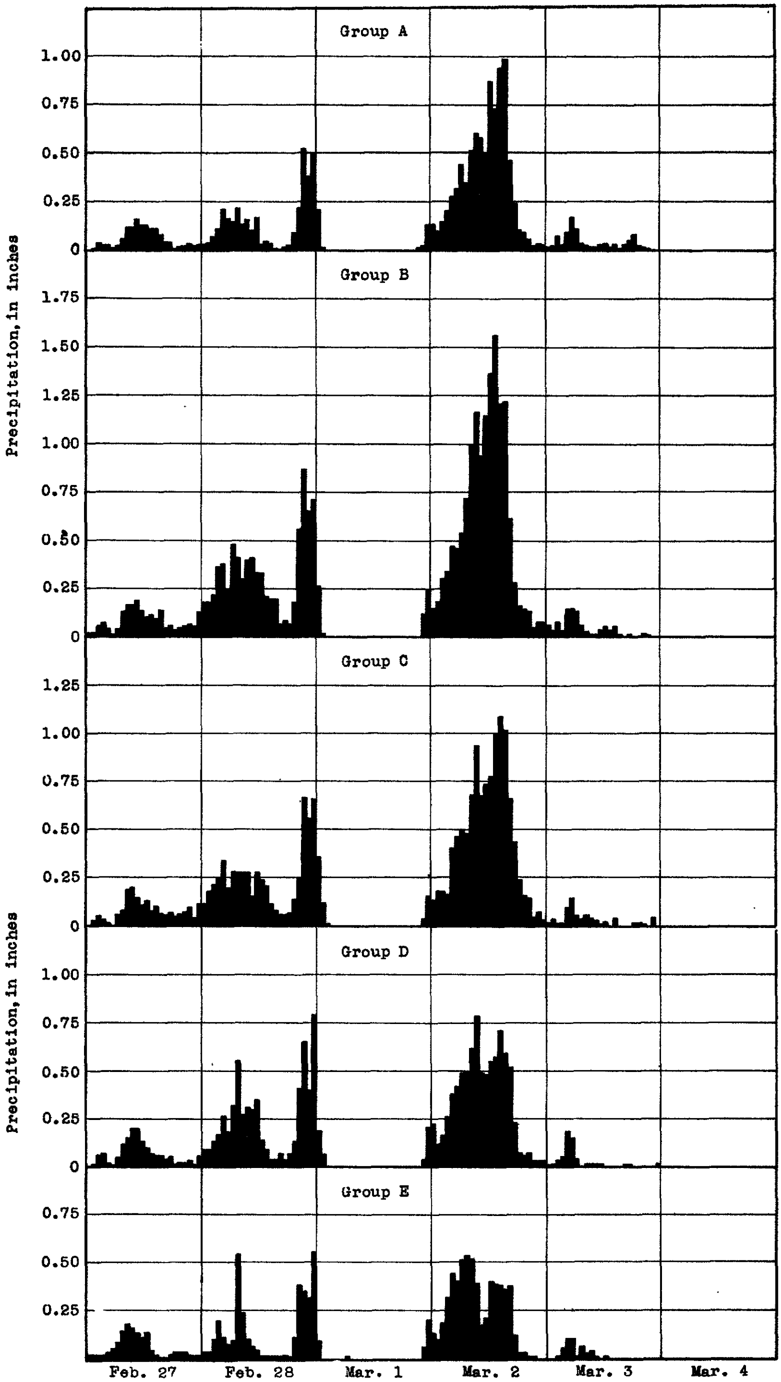


Figure 12.- Average hourly precipitation for groups of stations A to E.

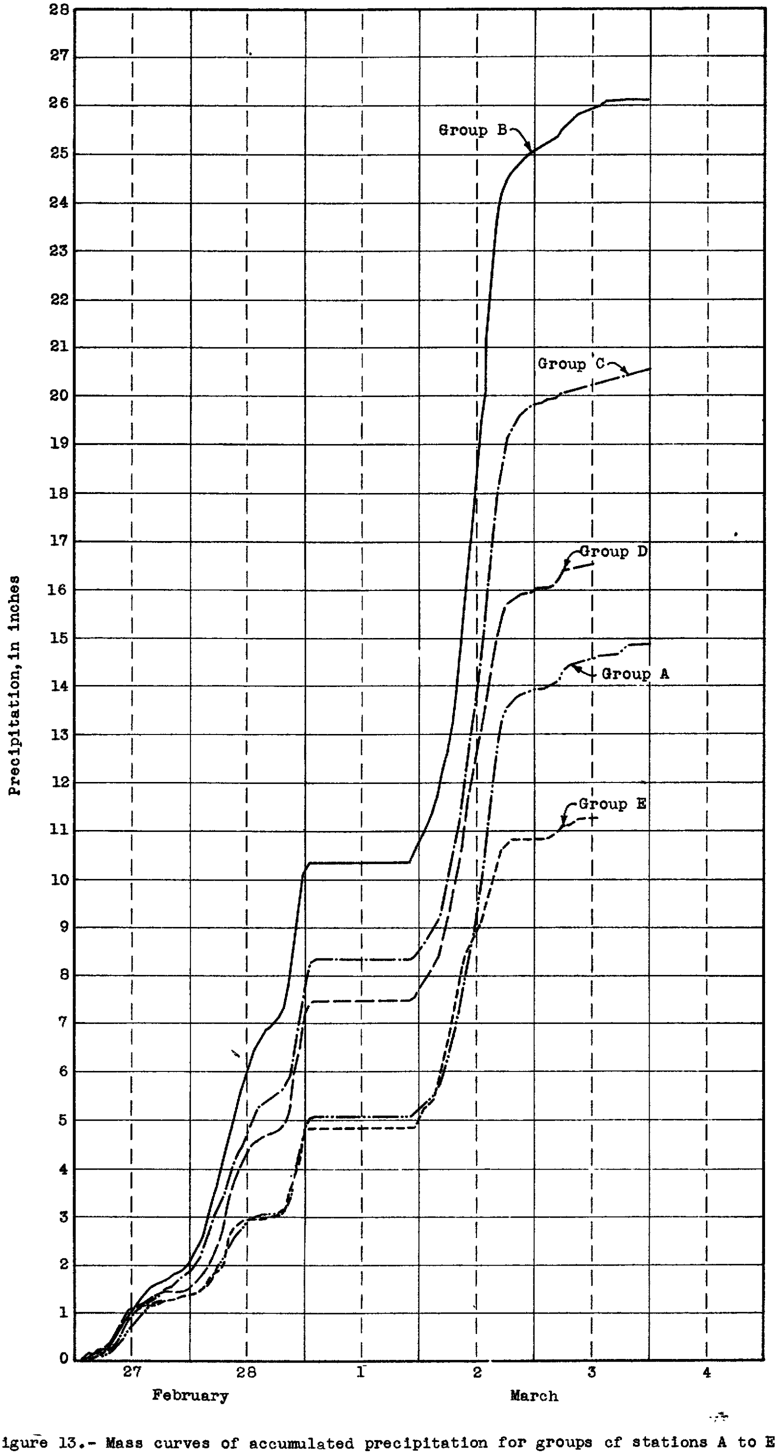


Figure 13.- Mass curves of accumulated precipitation for groups of stations A to E.

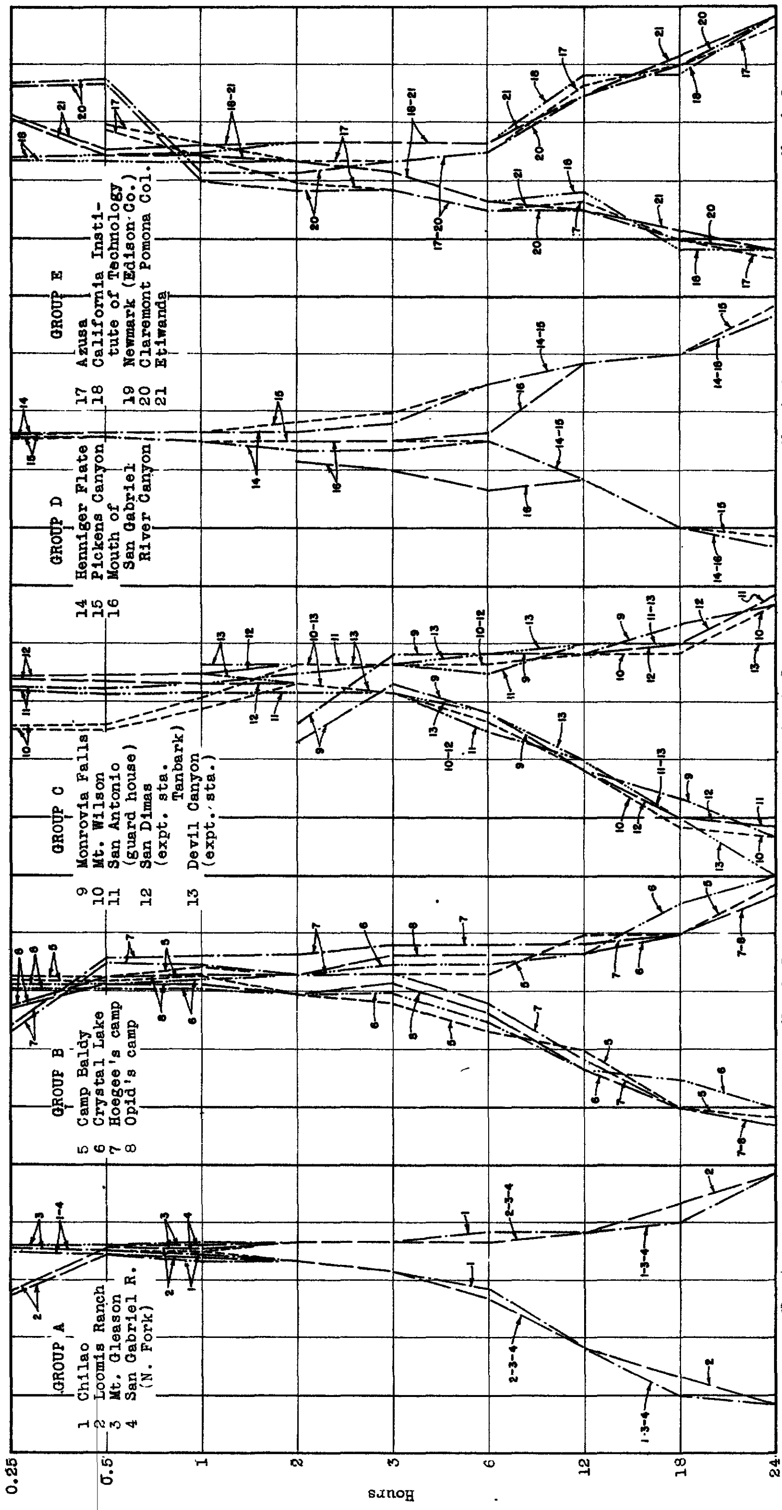


Figure 14.- Time of occurrence of maximum periods of precipitation for groups of stations A to E.

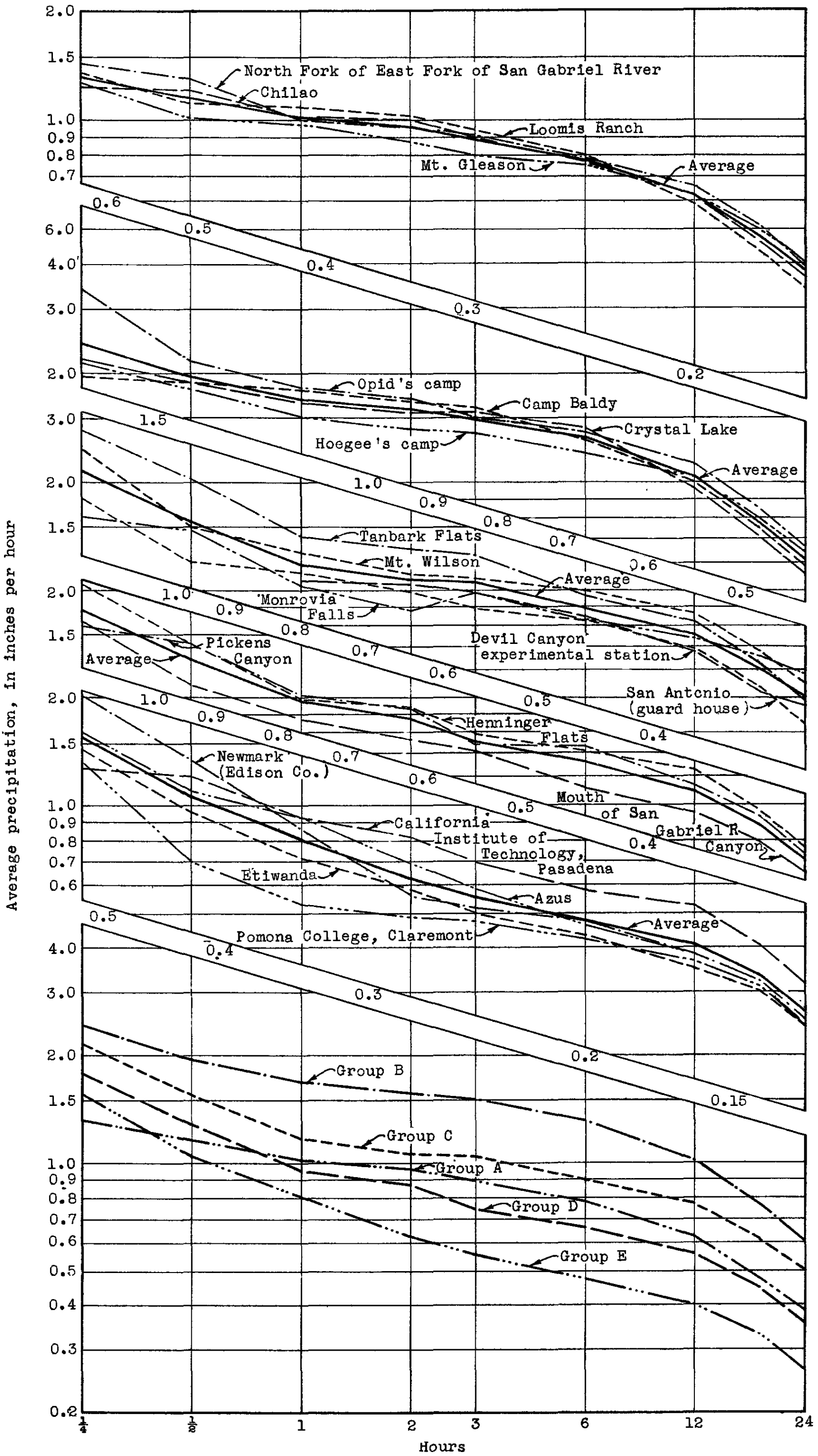


Figure 15.- Rates of precipitation for groups of stations A to E.

Figure 14 gives the time of occurrence of the maximum rate of rainfall at the stations of groups A to E, during the second major storm period, for consecutive periods of 15 minutes to 24 hours. The rates of precipitation for periods of less than 15 minutes often reflected purely local storm conditions not characteristic of any large area. It may be observed that, with the exception of group E, each maximum period usually occurred within the succeeding longer maximum period. Generally, if a shorter maximum period occurred outside the succeeding longer maximum period, the rate during the shorter maximum period was only slightly higher than the rate for corresponding periods within the longer maximum period.

Figure 15 shows the observed rates of precipitation at each station in groups A to E for periods ranging from 15 minutes to 24 hours on March 2. These rates are presented logarithmically, because on this type of projection, the tendency for lines to be parallel indicates similar characteristics of rainfall distribution. Considering the scattered locations of these stations, the close agreement for groups A and B, in the San Gabriel Mountains, is significant.

In the San Bernardino Mountains there were no recording rain gages in the area characterized by the group B type of rainfall. However, the record of the 8-inch standard rain gage at Lake Arrowhead (altitude, 5,000 feet) showed characteristics of precipitation similar to group B. On the basis of readings made at approximately 2-hour intervals, this record indicated a rate of 1.55 inches per hour for the maximum 2-hour period, 1.15 inches per hour for the maximum 6-hour period, 0.98 inch per hour for the maximum 8-hour period, and 0.88 inch per hour for the maximum 10-hour period. The station at Big Bear Lake Dam, situated to the east of this station, might also be considered in group B, as the record from its standard gage showed 1.06 inches per hour for the maximum 5-hour period and 1.00 inch per hour for the maximum 10-hour period.

At the bottom of figure 15 the average graph for each of these groups of stations is given. The precipitation represented by groups A and B is characterized by a relatively greater prevalence of rainfall at higher rates than for the other groups. The rate for the maximum 15-minute period was 3.47 times that for the maximum 24-hour period in group A and 4.08 times that in group B. The rates for the maximum 1-hour, 2-hour, 3-hour, and 6-hour periods were 2.68, 2.51, 2.29, and 2.02 times, respectively, that for the maximum 24-hour period in group A. The corresponding ratios for group B were 2.84, 2.63, 2.45, and 2.17. It was the precipitation of this type that produced the major part of the runoff on such streams as the San Gabriel River and San Antonio and Cucamonga Creeks.

The average graphs for groups C and D show storm characteristics similar to each other but different from those found for groups A and B. For periods shorter than 2 hours, the average curves for groups C and D curve upward more sharply than for groups A and B. The rate for the maximum 15-minute period for group C was 4.32 times the maximum 24-hour rate; the corresponding ratio of the maximum 15-minute and 24-hour periods for group D was 5.00. For periods of 1 hour, 2 hours, 3 hours, and 6 hours, the graph for group C indicated precipitation rates 2.34, 2.10, 2.06, and 1.78 times the maximum 24-hour rate; for group D, the corresponding ratios were 2.76, 2.44, 2.12, and 1.85. On small streams this type of precipitation would tend to produce sharp peak discharges.

The average curve for group E on figure 15 is characterized by even shorter periods of the heavier rainfall; the maximum rate for a 15-minute period was 5.96 times that for a 24-hour period. For periods of 1 hour, 2 hours, 3 hours, and 6 hours, the ratios were 3.07, 2.38, 2.11, and 1.81, respectively. The resulting runoff would tend to have even sharper peaks than any of the other groups. In many of the smaller canyons at the lower altitudes in the vicinity of Pasadena, Monrovia, and La Cañada, the characteristics of flood flow were determined from this type of rainfall.

Rainfall stations located on the coastal plain and in the Verdugo, Santa Monica, and Santa Ana Mountains all showed characteristics very similar to those indicated by group E.

The five groups of stations indicate factors that might tend to produce a heavier and more continuous flow for the higher altitudes than for the lower altitudes.

The data on intensity for the part of the storm period when the rainfall was heaviest have been correlated with observed rates of runoff at the reservoirs maintained by the Los Angeles Flood Control District and other agencies, and from the relations thus obtained many missing records have been filled in, especially for the period of major flow at a considerable number of river-measurement stations where, for reasons elsewhere explained, observations of stage and discharge were interrupted or lost during the flood period.

Comparison of rates of intensity with rates in previous storms

The records from several typical recording rain-gage stations cover a period sufficiently long to make possible a comparison between intensities of rainfall during the storm of March 1938 and several previous periods of heavy rains. Burke's report [11] contains a table listing the rainfall for selected periods of time during the March 1938 storm and maxima for previous storms at nine stations in Los Angeles County. This interesting table, somewhat modified, is included in this report as table 9. It indicates that, except at Hoegee's camp, Clear Creek station, and Camp Baldy, the rates of rainfall for periods of 30 minutes or less during the 1938 storm were lower than have previously been recorded during the relatively short time that the gages have been in operation. According to Burke the maximum rate of precipitation for a 5-minute period recorded during the 1938 storm at Opid's camp (4.20 inches an hour) has been exceeded four times during the 12 years of record. The maximum 5-minute rate of 2.52 inches an hour observed at Los Angeles during this storm has been exceeded 17 times during the 38 years of record. For longer periods up to 24 hours, the rates of rainfall observed during the 1938 storm approach the previous maximum rates, and at three of the nine locations exceed them. At Opid's camp the rate of 1.80 inches for the maximum 1-hour period recorded on March 2, 1938, has been exceeded only once in the 12-year period of record, and the rate for the maximum 24-hour period was the highest ever observed. At Los Angeles, the rate of 0.90 inch for the maximum 1-hour period during this storm has been exceeded only four times in 38 years, and the rate for the maximum 24-hour period has been exceeded only once.

Table 9 further shows that at the Los Angeles station of the United States Weather Bureau during the 38 years of record prior to March 2, 1938, the maximum 24-hour rate of precipitation occurred during the New Year's storm of 1934. In addition, at each of the other valley-floor and foothill stations--Van Nuys, Sierra Madre, Claremont, and Hancock Park--the maximum 24-hour rate occurred during the same storm. It was only in the more mountainous sections of the San Gabriel Mountains, at Opid's camp, Hoegee's camp, Clear Creek, and Camp Baldy, that the maximum 24-hour rate during the 1938 storm exceeded that for the 1934 storm and all other storms in the comparatively short periods of record at these stations.

11 Burke, M. F., Flood of March 2, 1938, Los Angeles County Flood Control District, May 20, 1938 (processed).

Table 9.- Maximum precipitation during indicated periods for period of record at selected stations

Station	Altitude (feet)	Period of record (years)	Storm period	Precipitation, in inches, for periods indicated						
				5 minutes	10 minutes	15 minutes	30 minutes	1 hour	2 hours	24 hours
Opid's camp, West Fork of San Gabriel River	4,350	12	Previous maximum	a 1.17	a 1.18	a 1.18	a 1.52	a 2.21	a 3.80	b 13.94
			March 2, 1938	.35	.69	.86	1.08	1.80	3.33	15.96
Hoegee's camp, West Fork of Santa Anita Creek	2,750	12	Previous maximum	c .41	c .47	d .58	d .90	e 1.47	e 2.48	b 14.76
			March 2, 1938	.30	.46	.54	.91	1.50	2.79	15.21
Clear Creek, 1.6 miles above junction with Tujunga Creek	3,100	10	Previous maximum	f .35	f .42	g .54	h .82	h 1.26	i 1.79	i 6.30
			March 2, 1938	.54	.62	.77	1.22	1.99	2.98	12.96
Camp Baldy, San Antonio Canyon	4,320	11	Previous maximum	f .21	f .30	i .39	i .58	i 1.04	i 1.91	i 6.96
			March 2, 1938	.20	.34	.49	.95	1.78	3.31	13.92
Van Nuys, city warehouse, Aetna and Vesper Streets	695	8	Previous maximum	j .24	j .31	j .39	k .55	j .82	j 1.27	b 6.94
			March 2, 1938	.14	.22	.31	.48	.78	1.10	5.56
Sierra Madre, 575 North Hermosa Avenue	1,160	11	Previous maximum	k .34	m .48	m .58	m .68	m .96	b 1.62	b 8.07
			March 2, 1938	.26	.40	.46	.66	1.16	1.90	8.00
Claremont, Pomona College Observatory	1,190	11	Previous maximum	m .23	h .30	m .36	m .58	b .92	b 1.47	b 7.86
			March 2, 1938	.18	.27	.33	.35	.53	.98	5.70
Hancock Park, 5801 Wilshire Boulevard	177	9	Previous maximum	m .30	m .50	m .62	m .96	m 1.41	m 1.57	b 6.83
			March 2, 1938	.26	.34	.40	.57	.92	1.68	5.63
Los Angeles, Sixth and Main Streets	417	38	Previous maximum	n .42	p .65	p .70	p 1.14	p 1.51	p 1.99	b 7.36
			March 2, 1938	.21	.33	.43	.66	.90	1.44	6.28

a April 4-5, 1926.
b Dec. 31, 1933-Jan. 1, 1934.
c April 29, 1935.
d October 18, 1936.
e April 8, 1935.
f Feb. 11, 1938.
g May 3, 1930.
h Sept. 24-25, 1935.
i Feb. 28 - Mar. 1, 1938.
j Feb. 3, 1931.
k Jan. 5, 1935.
m Oct. 17, 1934.
n Jan. 14, 1908.
p Feb. 18, 1914.

During the 38 years of record at Los Angeles the heaviest rainfall for periods ranging from 10 minutes to 2 hours occurred on February 18, 1914, and the rates for 10-minute, 15-minute, 30-minute, 1-hour, and 2-hour periods were 2.24, 1.84, 1.73, 1.67, and 1.38 times as high, respectively, as for the 1938 storm. Thus, the March 1938 rainfall at Los Angeles did not at any time exceed in intensity rate, that previously recorded.

Records of short-period rainfall intensities during previous floods are not available for the San Bernardino Mountains, and a comparison is therefore impossible. However, a comparison of the observations taken in these mountains during the 1938 storm with those taken in the San Gabriel Mountains indicates that conditions in the two ranges were in all probability similar. The following comparison is quoted from the record of storms since 1884 as compiled by the Bear Valley Mutual Water Company:

> In 1891, 32 inches of rain fell in 48 hours at Bear Valley Dam, as compared with 21.75 inches in 1916 and 18 inches in March 1938, for a similar period. The maximum 24-hour precipitation of 15.06 inches during the March 1938 storm was exceeded only by the February 22-23, 1891, storm.

In table 10, there are listed, for 25 selected stations at which records are available for periods ranging from 15 to 44 years, the maximum daily precipitation recorded prior to March 1938, the maximum for March 1938, and the number of times the latter record has been exceeded. The maximum daily rainfall for the March 1938 storm has been exceeded at 17 of the stations and, on an average, twice at each station. Many of these daily records were not obtained from recording rain gages and so are not strictly comparable with those so obtained. They seem to indicate, however, that in much of the lower part of the region, the maximum daily rainfall during the 1938 storm was not especially extreme. At the two stations of the group having the highest altitudes--Mount Wilson, 5,850 feet, and Camp Baldy, San Antonio Canyon, 4,320 feet--the maximum daily precipitation for the 1938 storm has apparently not been exceeded during periods of record of 30 and 17 years, respectively.

Storm movement

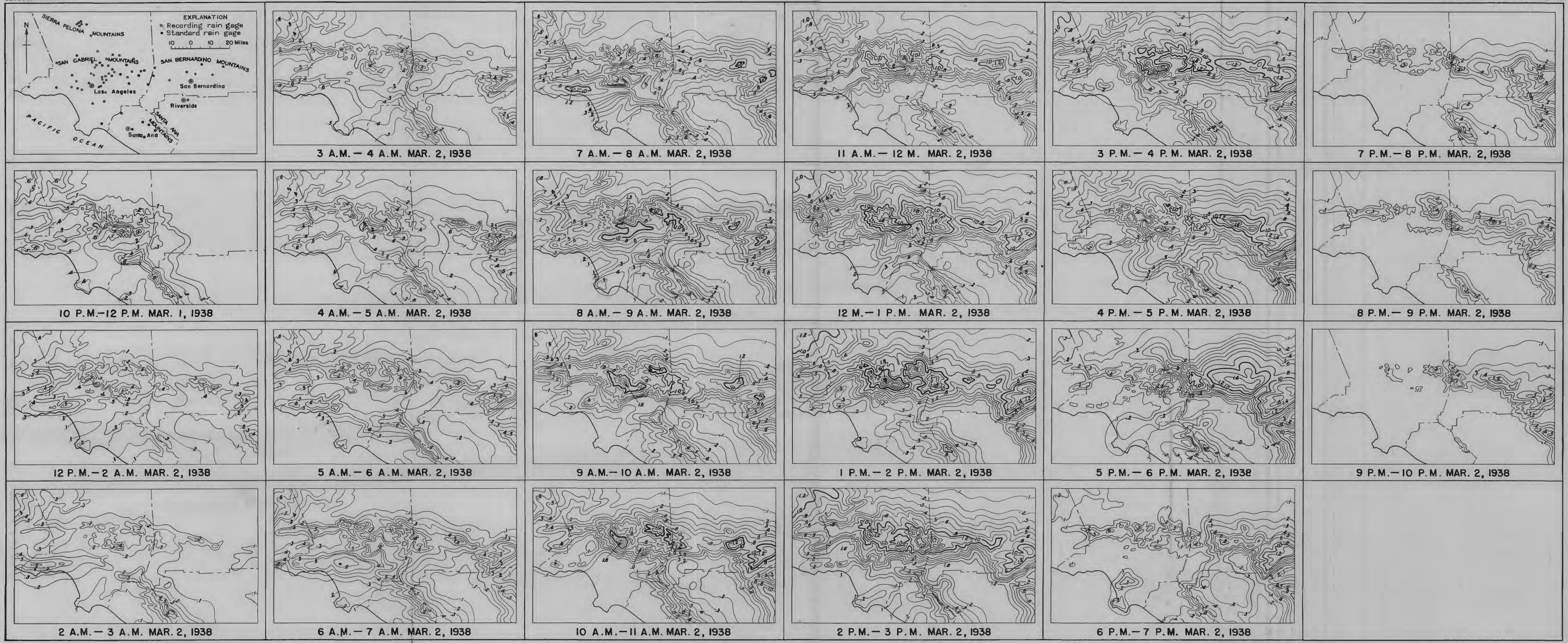
From the rainfall-runoff studies of the storm of March 1938, it appears that the flood discharge was closely related to the precipitation that fell during the second major period of the storm, the 24-hour period from about 10 p.m. March 1 to 10 p.m. March 2. For the area of heaviest precipitation, where there was a fairly complete coverage by recording rain gages, isohyetal maps (pl. 14) have been prepared indicating the

Table 10.- Maximum daily precipitation during March 1938 at selected stations compared with maximum previously recorded.

Station	Altitude	Period of record (years)	Maximum daily precipitation: Prior to March 1938 (inches)	Maximum daily precipitation: March 2 or 3 1938 (inches)	Times March 1938 maximum has been exceeded
Azusa, Bonita Street, west of Cerritos Avenue	545	44	7.18	5.86	4
Claremont, Pomona College Observatory	1,190	41	7.82	5.73	2
Newhall, at Southern Pacific Co. railroad station	1,270	39	6.02	5.38	3
Sierra Madre, north end of Baldwin Avenue	1,110	39	7.84	8.80	0
San Dimas, 167 North San Dimas Avenue	963	38	6.98	6.17	2
Acton, just east of summit, Mint Canyon Road	3,250	35	3.75	2.82	6
Mount Wilson	5,850	30	11.0	11.83	0
Girard, Brant Ranch	892	24	4.55	5.33	0
Arroyo Seco Canyon, chlorine plant	1,150	22	9.40	8.63	1
Azusa, Foothill Ranch, 2 miles west of Citrus Avenue	615	22	9.53	6.61	2
Claremont, Indian Hill Road	1,405	20	7.77	5.55	3
Santa Anita Canyon ranger station	1,950	20	8.70	10.64	0
San Dimas, 114 East First Street	960	20	5.86	6.20	0
Montana Ranch, 3 miles southwest of Artesia	47	19	4.00	3.24	2
Sylmar, olive-packing plant	1,250	19	5.26	4.35	1
Camp Baldy, San Antonio Canyon	4,320	17	10.65	11.67	0
Diamond Bar Ranch, Spadra Office	675	17	6.62	4.78	1
Glendale, 811 North Glendale Avenue	653	17	7.15	6.90	1
Pomona, 987 North Weber Street	838	16	5.60	4.21	3
Altadena, 575 Sacramento Street	1,125	16	6.91	8.20	0
Covina, Puente Street, east of high school	575	16	8.30	5.13	1
San Fernando Lemon Association packing house	950	15	7.55	3.03	3
Kinneloa Ranch, east side of Eaton Wash	1,400	15	9.20	8.70	1
Lamanda Park	742	15	11.42	5.70	1
Altadena, Ventura Street	1,179	15	5.87	8.52	0

Note.- Data based on report of Los Angeles County Flood Control District.

amount of rain that fell during each 2-hour period from 10 p.m. March 1 to 2 a.m. March 2 and each 1-hour period from 2 a.m. to 10 p.m. March 2. In parts of the mountain areas and in San Jacinto River Basin, the isohyetals have been developed from observations at standard gages, the total rainfall being distributed on the basis of records at the nearest recording gage.



PRECIPITATION IN PART OF SOUTHERN CALIFORNIA FOR INDICATED INTERVALS OF THE MAXIMUM 24-HOUR PERIOD, 10 P.M. MARCH 1 TO 10 P.M. MARCH 2, 1938

U. S. GOVERNMENT PRINTING OFFICE : 1942 O - 454720

The general eastward movement of the storm and the tendency for the heaviest rainfall to occur in the mountains is clearly indicated by the series of rainfall maps shown on plate 14. With the exception of a period from about 7 to 9 a.m. March 2, when rain fell at a rate of 1 inch an hour on the coastal plain, the area over which a rate was 1 inch or more an hour lies chiefly in the San Gabriel and San Bernardino Mountains. From about noon until 2 p.m. March 2 rain was falling at the highest intensity and over the largest area in the San Gabriel and San Bernardino Mountains. Following this period there was a general eastward movement of the storm, and by 7 p.m. the rainfall rate had dropped to 0.1 inch an hour in the central part of the area, and it was only in the extreme eastern part that the rate exceeded 1 inch an hour. By 9 p.m. the rate at all stations was reduced to less than 1 inch an hour.

Antecedent precipitation

In southern California the greater part of the annual precipitation occurs during a comparatively short rainy season that is followed by a long dry season, during which there is a gradual draining out of the ground water and a loss of moisture through evaporation and transpiration. As the rainy season progresses the absorptive capacity of the ground tends gradually to be fully utilized, and the magnitude of the runoff following any storm therefore depends to a large extent on the time of occurrence of the storm within the rainy season and the amount of antecedent precipitation. Table 11 gives, for each of eight typical stations, the total precipitation and departure from normal for the periods July 1, 1937, to January 31, 1938, and February 1-25, 1938, and the total departure from normal for the period July 1, 1937, to February 25, 1938. The selected stations are distributed over the area from San Diego on the south to San Luis Obispo on the north. The stations in the middle part of the table represent the area of heaviest rainfall during the storm of February 27 to March 4, 1938. The remaining stations are situated around the margin of the storm area.

From table 11 it is evident that the seasonal precipitation prior to February 1, 1938, was below normal except at Pattiway and Santa Maria. On the other hand, the precipitation for the first 25 days in February was so greatly above normal as to more than make up for the deficiency prior to February 1. Squirrel Inn and Mount Wilson, located near one of the storm centers, had excesses of 9.67 and 8.32 inches above normal, respectively, during the first 25 days in February, and similar trends of less

Table 11.- Precipitation and departure from normal, in inches, at typical stations, for periods from July 1, 1937, to Feb. 25, 1938

Station	Precipitation July 1, 1937 to Jan. 31, 1938		Precipitation Feb. 1-25, 1938		Departure from normal July 1, 1937 to Feb. 25, 1938
	Total	Departure	Total	Departure	
San Diego	2.13	-3.25	2.11	+0.30	-2.95
Cuyamaca	10.16	-8.35	8.39	+1.77	-6.58
Santa Ana	4.30	-2.40	4.95	+2.56	+.16
Riverside	3.01	-2.52	1.83	-.08	-2.60
San Bernardino	5.58	-2.11	4.02	+1.31	-.80
Squirrel Inn	14.84	-4.06	17.03	+9.67	+5.61
Mount Wilson	11.67	-1.92	14.02	+8.32	+6.40
San Fernando	5.41	-2.09	6.82	+3.75	+1.66
Los Angeles	5.18	-2.63	5.49	+2.75	+.12
Oxnard	5.93	-.86	3.06	+1.10	+.24
Ojai	7.40	-2.79	9.60	+5.89	+3.10
Pattiway	4.77	+.27	2.45	+.42	+.69
Santa Barbara	6.55	-3.09	7.34	+3.88	+.79
Santa Maria	8.03	+.88	6.23	+3.77	+4.65
San Luis Obispo	11.01	-.32	11.68	+7.97	+7.65

magnitude are shown for all stations except Riverside.

The effect of this generally heavy precipitation prior to the March storm was to increase the soil moisture, to lessen the capacity for storage afforded by surface detention, and in much of the mountain area to replenish, in part at least, the ground-water storage. These conditions tended to increase the direct runoff resulting from the storm of February 27 to March 4 to an amount above what it would have been if there had been less rain in the period just prior to the storm.

The influence of antecedent precipitation is discussed further in the section entitled "Rainfall, runoff, and retention".

Snow

Records of snowfall prior to and during the storm of March 1938 are few and fragmentary. At Bear Valley Dam (altitude, 6,800 feet), on the headwaters of Bear Creek, a tributary of the Santa Ana River in the San Bernardino Mountains, the following observations were made by the president and general manager of the Bear Valley Mutual Water Co.:[12]

> In this 1938 storm, we estimate that the average depth of snow at the beginning of the storm on the watershed was 18 inches. With 9 inches added at the close of the storm, the appearance of the snow cover in the valley was very much the same at the end as at the beginning. At no time did the snow lose its structure or slush down. The rain seemed to pass right through it and come running out under the snow. Temperatures early in the storm of March 2 were 36° to 38°, but about 4 a.m. on March 3 the temperature dropped to 28°, the precipitation changed to sleet and snow, and the runoff decreased immediately.

12 Pendergast, J. J., Memorandum on storms, 1884-1938.

At the Big Pines station of the Los Angeles County Flood Control District (altitude, 6,860 feet), on the desert side of the San Gabriel Mountains, in the Great Basin, 19 inches of snow was reported on the ground on February 27, 7 inches fell during the storm, and 23 inches remained on March 4. Table Mountain station (altitude, 7,500 feet), a short distance from Big Pines station, recorded 32 inches of snow on the ground on February 27, a fall of 8 inches during the storm, and 27 inches remaining March 4. At a few other stations the records are not so complete, owing to infrequent observations.

At Kelly's Kamp (altitude, 8,300 feet), in the San Antonio Creek Basin, 72 inches of snow was reported on the ground on February 28 and 60 inches on March 9, but of the 32 inches of storm precipitation, only a trace fell in the form of snow. Mount Gleason station (altitude, 5,450 feet), on the headwaters of Pacoima Creek, recorded 3 inches of snow on the ground on February 13, 2 inches on February 28, and none on March 15. At Opid's camp (altitude, 4,350 feet), in the basin of West Fork of San Gabriel River, in the San Gabriel Mountains, there was no snow on the ground on February 28, 1 inch on March 3 and half an inch on March 4. These stations represent most of the areas in southern California in which snow is an important factor in seasonal runoff.

These fragmentary observations in the San Bernardino and San Gabriel Mountains indicate the probable absence of snow at the beginning of the storm period at an altitude of about 5,000 feet or less. Above 6,000 feet there was a snow cover of considerable depth, with a maximum of more than 70 inches in some areas at an altitude of 8,000 feet and above. It appears that at the higher altitudes some snow accumulated during the storm, and that at the lower altitudes there was no material depletion in snow cover. At stations located at an altitude of more than 6,000 feet, some of the precipitation during the later part of the storm occurred as sleet and snow. In general, the snowmelt is believed to have contributed but little to the flood runoff, and in the headwater areas the flood runoff may have been less than it would otherwise have been because some of the precipitation occurred as snow, which remained on the ground after the storm. Roughly, 30 percent of the area of the basins above the stream-measurement stations in the San Gabriel and San Bernardino Mountains is above 6,000 feet, and 5 percent is above 8,000 feet.

In San Diego, Ventura, and Santa Barbara Counties the snowfall is usually light and seldom remains long on the ground. The snowfall in these counties from February 27 to March 4, 1938, was negligible.

BASIC DISCHARGE RECORDS

During a major flood it is extremely difficult, if not impossible, to obtain continuous accurate records of discharge of the streams in southern California. In determining discharge at a stream-measurement station, current-meter measurements are made to establish a rating curve that will show the discharge for any given stage at a given time. Ordinarily the rating curve can be defined by measurements for the usual range of stage, but its definition is more difficult for unusually high stages, and increasingly difficult for flood stages so high as to be of rare occurrence, when conditions for obtaining measurements are most unfavorable.

Complete definition of the rating curve to the highest peak can be obtained only by an adequate number of timely measurements and a record of channel conditions during the flood. In southern California, this ideal is difficult to attain owing to the fact that it is practically impossible to make current-meter measurements during the higher flood stages. The streams have flashy floods with excessively high velocities and usually move large quantities of debris and suspended material. Their flood crests frequently occur almost simultaneously throughout the area, and often during the night. The field engineer is further handicapped during flood periods by washed-out or obstructed routes of travel and at times by damage to bridges or cableways from which discharge measurements are made.

For many streams in both the mountain and valley areas, the continual shifting of their channels owing to scour, fill, or bank cutting make it impossible to develop a stage-discharge relation even if it is possible to obtain a large number of measurements. On the Los Angeles River at Los Angeles, 44 current-meter measurements made in the period February 28 to March 5 showed that no stage-discharge relation could be defined. For this reason many of the gage-height records in the main flood area were of little value as an indication of the magnitude of the flood runoff.

There were, however, within the flood area a number of flood-control reservoirs from the records of whose contents it was possible to compute fairly satisfactory records of runoff for the flood period. Similar records were available for certain reservoirs that are maintained for purposes other than flood control. For a small number of other streams, also, the records of discharge through the flood rise are believed to be reliable with respect to rates of flow for short periods. The aforementioned records are presented herein as "basic discharge records" and are analyzed in relation to rainfall rates and other pertinent factors in order to develop relations which are of general interest and which may be used in interpreting the often meager data obtainable at stream-measurement stations.

In measuring the outflow from these reservoirs, the ratings for the valves and spillways are based mainly on current-meter measurements, although a few are based on model ratings. The operation of the release valves in the dams made it necessary to compute the inflow and outflow from the reservoir for intervals of time between readings of the valve openings. This opening and closing of the valves necessarily affects the record of stage in the reservoir and makes difficult the accurate determination of inflow data for very short intervals of time. At some reservoirs the operation of these valves resulted in so much drawdown at the water-stage recorder that the record was not a correct index of inflow. For such periods observations made on staff gages, which are not affected by drawdown, were used as a true index of reservoir stages. During the periods of greatest discharge the staff gages were read frequently.

Shortly after the floods the flood-control reservoirs were resurveyed by the California Institute of Technology, the Los Angeles County Flood Control District, and the United States Soil Conservation Service, and new capacity tables were prepared. In determining the inflow to the reservoirs the older capacity tables were used prior to the time of the maximum discharge and the new capacity tables subsequently.

The estimated storage, which is added to or subtracted from the spillway discharge and valve release in order to determine the inflow, was based on the area of the water surface at the time of observation, the rate of change in area, and the rate of change in the altitude of the water surfaces. The surveys made after the storm period indicate that the area of the water surface for each gage height had been decreased somewhat by debris deposition, with the higher gage heights showing the least change in area. The shift of capacity tables at the time of the maximum discharge has the tendency to increase the computed inflow on the rising stages during the periods of greatest runoff and to decrease to a much slighter degree, however, the computed inflow on the falling stages.

Most of these reservoirs were practically full prior to the periods of maximum discharge, so there was little fluctuation in the area and altitude of their water surfaces during these periods. The rather small capacity of the reservoirs found in these steep, narrow canyons tends to reduce further the influence of change in storage on the inflow computations. It is under these conditions that the change in storage factors would have the minimum influence on the inflow computations.

The computed inflow to these reservoirs includes not only the water but the debris that was carried with it and deposited in the reservoirs. As incoming debris entered the upper end of a reservoir, it caused the displacement of water at a rate and in a volume equivalent to its own. The section on debris (pp. 372-376) discusses the deposition of debris in the reservoirs. Theoretically, debris movement varies with the fifth or sixth power of the velocity. Since the highest velocity is associated with the greatest discharge, it might be assumed that the greatest inflow of debris would also be associated with the greatest discharge. Available information indicates that streams tend to carry more debris on rising than on falling stages. For this reason it may be assumed that most of the inflow of debris occurred during the greater discharges.

Table 28 (p. 374) shows, in acre-feet per square mile of drainage area, the debris deposited in each of 13 reservoirs, as determined from surveys before and after the flood, and the inflow to each for the maximum 24 hours. In the aggregate, the debris inflow is computed to be between 8 and 9 percent of the maximum 24-hour inflow, with the percentages for individual reservoirs ranging generally from 5 to 15. Probably the debris was associated mostly with the rising side of the flood hydrograph and with perhaps less than half of the volume of flow in the maximum 24 hours, thus apparently increasing the content of debris considerably above the percentages indicated. The significance of this complicating factor in relation to the computed inflow and the correlation of rainfall and runoff rates must be kept in mind.

The complicating factor of debris enters into the measurement of the flood flow of all the mountain streams of southern California, as is pointed out in other places in this report. The reservoir records permitted a more reliable determination of the flow including the debris than was possible at any of the gaging stations. The records are especially valuable in furnishing information as to the volume of debris borne by the flood waters of natural streams, this being a subject on which reliable data are very meager.

The inflow and outflow for the flood-control reservoirs during the main part of the storm period and the peak discharges have been computed by the Geological Survey from data furnished by the Los Angeles County Flood Control District, but these data were not complete at the time this report was prepared. Owing to differences in interpretation of the basic data, some of the results differ by relatively small amounts from those reported by the flood-control District.[13] The records for Morris Reservoir were computed and furnished by the City of Pasadena Water Department. The records for Santiago Creek Reservoir were computed and furnished by the Corps of Engineers and the Orange County Flood Control District.

Records were furnished by the United States Forest Service for two basins in Fern Canyon, designated Watersheds Nos. 2 and 3, having drainage areas of 0.063 and 0.084 square mile, respectively. No runoff records were obtained from the Watershed No. 1 because of damage to the measuring equipment. These watersheds are small, contiguous basins lying along the eastern divide of the San Dimas Creek drainage area, within the San Dimas Experimental Forest. (See pl. 15.) They have an average altitude of about 5,000 feet and an average slope of about 65 percent. The soil mantle varies in depth from less than 1 foot to more than 2 feet, with an average of about 1 foot. At the time of the flood of March 1938, each basin had a fairly heavy and uniform chaparral cover. At the lower end of each basin is a concrete dam, founded on bedrock, above which is a concrete-lined reservoir with a capacity of 10,000 cubic feet, built to trap the erosional debris. The runoff of these basins was measured by a modified 3-foot Parshall flume and a 90° V-notch weir.

The United States Forest Service has also made available basic records on Wolfskill Creek and West Fork of San Dimas Creek, in the San Dimas Creek Basin. In addition, the United States Soil Conservation Service maintained several broadcrested-weir gaging stations on Honda Barranca in the Los Posas area, for which records are presented.

In general there are given for each reservoir a description of the station, a table of mean daily and monthly inflow to the reservoir

13 Los Angeles County Flood Control District, Biennial report on hydrologic data, seasons 1936-37 and 1937-38, June 30, 1939.

throughout the 3-month period February to April 1938, a table of hourly or bihourly inflow for the period February 27 to March 10, 1938, and corresponding tables of outflow. The presentation of the data has followed a uniform plan as far as practicable.

The station description gives, in the first paragraph, the location of the reservoir and the altitude of the stream bed at the dam. A second paragraph gives characteristics of the drainage area upstream from the dam. Each drainage area as measured on the most recent topographic maps, and its average altitude was determined by planimeter. It was then divided into small areas, ranging from 1,000 feet to 1 mile square each, and the average slope of each was estimated. The average of these estimates was taken as the average slope for the entire area. The average slope of the main stream channel was obtained by dividing the difference between the maximum and minimum altitudes of the channel by the length of the channel as scaled from the topographic maps. The next paragraph, relating to the gage-height record, gives the method of determining the stage during the flood. In a fourth paragraph is given the method of computing the discharge. This is followed by a paragraph giving the maximum discharge and the time of its occurrence. The method of estimating the maximum discharge is discussed later. The sixth and last paragraph, under the heading "Remarks", begins with a statement concerning the reliability of the record; it then gives the altitude of the spillway, the area of the reservoir at the spillway, the capacity of the reservoir before and after the floods, a statement concerning storage or diversion upstream from the reservoir, and other miscellaneous information. Similar descriptions for stations other than those at reservoirs were also furnished.

Following each description, if the records are available, is a table showing the mean daily inflow in second-feet, and the monthly inflow in acre-feet for the period February 1, 1938, to April 30, 1938. This covers the actual flood period and sufficient time before and after it to establish the relations of flood discharges to the prevalent discharges and to give a general perspective of the March flood. The table of inflow at indicated times was obtained from inflow hydrographs developed on the basis of the gage-height record from the water-stage recorder on the reservoir, supplemented by staff readings and records of valve operation. The table of outflow from each reservoir is presented immediately following the table of inflow.

FERN CANYON WATERSHEDS NOS. 1, 2, AND 3.

Vegetation unburned for past 50 years. 47 rain gages are located on contour trails at altitudes of 4,700, 4,950, and 5,200 feet on total area of 123 acres. Courtesy of U. S. Forest Service.

The outflow from the reservoirs was governed mainly by the opening and closing of valves, resulting in a steplike hydrograph. Daily discharges were computed from this steplike hydrograph, but in computing the outflow at indicated times, a smoothed hydrograph was used; the total discharge for any hour is approximately the same computed from either hydrograph.

Hydrographs of inflow into five of the flood-control reservoirs, namely, those on Tujunga Creek, West Fork of San Gabriel River, Santa Anita Creek, Eaton Creek, and Live Oak Creek, are shown on figure 16. The drainage areas of these streams represent a wide variety of basin characteristics, with that of Eaton Creek having the steepest slope and that of Live Oak Creek the gentlest. The West Fork of San Gabriel River had the greatest runoff to the square mile, however, and Live Oak Creek the least.

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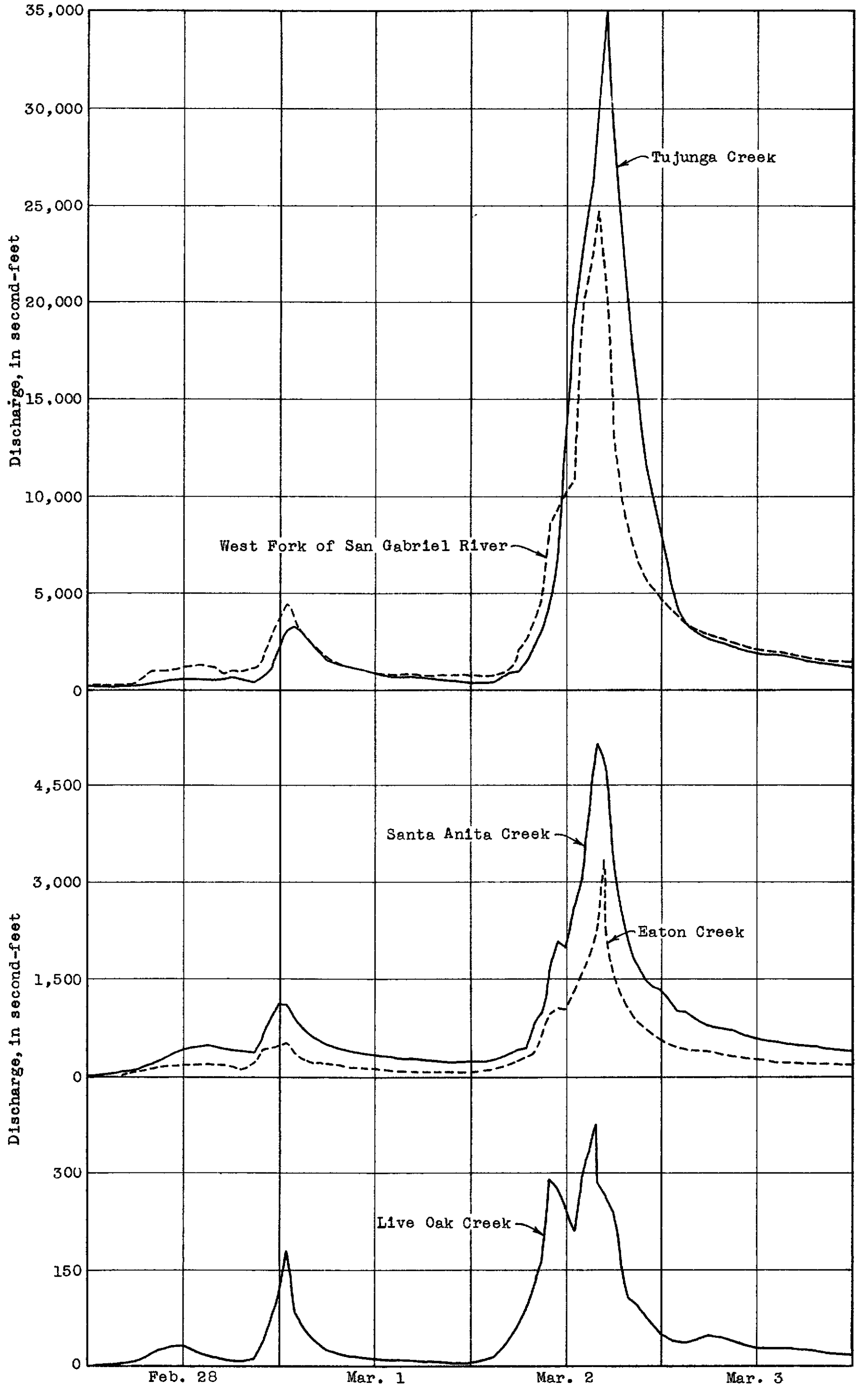

Figure 16.- Graphs of discharge into various reservoirs in southern California, March 1938.

Santa Ana River Basin

Santiago Creek at Santiago Reservoir, near Villa Park, Calif.

Location.- Water-stage recorder, lat. 33°47'00", long. 117°43'35", in Lomas de Santiago grant, 2 miles east of Orange County Park, and 5 miles east of Villa Park, Orange County. Altitude of stream bed, 680 feet.

Drainage area.- Area, 62.5 square miles. Average altitude, 2,120 feet. Maximum altitude, 5,680 feet. Average slope, 45 percent. Length of main stream channel, 13.0 miles. Average slope of main stream channel, 7.3 percent.

Gage-height record.- Water-stage recorder graph.

Discharge record.- Computed from record of stage, stage-capacity tables, and spillway rating curve.

Maxima.- 1938: Inflow, 9,850 second-feet 5 p.m. Mar. 2.
Outflow, 5,670 second-feet 9:30 p.m. Mar. 2.

Remarks.- Records good. Capacity at spillway level, 25,000 acre-feet. Reservoir operated by Irvine Co. and Serrano and Carpenter Irrigation Districts. Records furnished by Corps of Engineers, U. S. Army, and Orange County Flood Control District through M. N. Thompson, chief engineer.

Mean daily inflow, in second-feet, 1938

Feb. 28	243	Mar. 6	659
Mar. 1	586	7	575
2	4,200	8	549
3	2,430	9	529
4	1,150	10	501
5	803	11	469

Inflow Feb. 28 to Mar. 11, in acre-feet..25,180

Inflow, in second-feet, at indicated time, 1938

Hr.	Feb. 28	Mar. 1	Mar. 2	Mar. 3	Mar. 4	Mar. 5	Mar. 6	Mar. 7	Mar. 8	Mar. 9	Mar. 10
1		1,600	328	3,800							
2	90	1,700	430	3,400	1,410						
3		1,410	500	3,130							
4	92	1,000	675	3,040	1,350	885	700	593	555	530	520
5		867	920	2,980							
6	92	760	1,040	2,900	1,300						
7	92	655	1,280	2,840							
8	104	570	1,750	2,800	1,240	835	680	587	560	530	505
9		550	2,700	2,690							
10	150	512	3,060	2,600	1,190						
11		405	3,600	2,470							
N	203	342	4,130	2,330	1,130	790	660	580	555	530	500
1		321	5,300	2,220							
2	189	313	6,950	2,120	1,080						
3		308	7,800	2,060							
4	184	299	8,650	2,000	1,040	760	640	560	545	530	495
5		270	9,850	1,930							
6	190	241	9,100	1,870	1,010						
7	211	224	7,800	1,800							
8	249	211	6,900	1,710	980	740	620	555	540	530	485
9	370	211	5,950	1,650							
10	660	220	5,270	1,600	940						
11	1,050	232	4,700	1,550							
M	1,420	248	4,170	1,500	910	710	600	550	530	525	475

Mean daily outflow, in second-feet, 1938

Feb. 28	0	Mar. 6	703
Mar. 1	0	7	600
2	1,700	8	557
3	3,180	9	532
4	1,410	10	512
5	895	11	476

Outflow Feb. 28 to Mar. 11, in acre-feet. 20,960

Outflow, in second-feet, at indicated time, 1938

Hr.	Feb. 28	Mar. 1	Mar. 2	Mar. 3	Mar. 4	Mar. 5	Mar. 6	Mar. 7	Mar. 8	Mar. 9	Mar. 10
1				5,060	1,850						
2				4,770	1,800	1,030	760				
3				4,460	1,740						
4				4,180	1,700	990	745	628	560	536	520
5				3,950	1,650						
6				3,790	1,600	960	740				
7				3,650	1,540						
8				3,520	1,510	940	728	620	560	530	520
9				3,390	1,470						
10				3,270	1,440	910	710				
11				3,140	1,410						
N	0	0	0	3,020	1,380	890	705	600	560	530	512
1			0	2,900	1,340						
2			330	2,780	1,300	860	685				
3			1,070	2,670	1,260						
4			2,030	2,570	1,240	840	680	580	560	530	504
5			3,160	2,480	1,210						
6			4,270	2,390	1,190	810	670				
7			5,010	2,310	1,170						
8			5,480	2,220	1,150	810	660	574	550	530	504
9			5,630	2,120	1,120						
10			5,630	2,040	1,100	790	646				
11			5,520	1,980	1,080						
M	0	0	5,310	1,920	1,060	770	635	562	542	530	494

Supplemental record.- Mar. 2, 9:30 p.m. 5,670 sec.-ft.

San Gabriel River Basin

San Gabriel River at flood-control reservoir No. 1, near Azusa, Calif.

Location.- Staff gage, lat. 34°12'15", long. 117°51'20", in NE¼ sec. 6, T. 1 N., R. 9 W., 6 miles northeast of Azusa. Altitude of stream bed, about 1,200 feet.

Drainage area.- Area, 202 square miles. Average altitude, 4,500 feet. Maximum altitude, 10,080 feet. Average slope, 49 percent. Length of main stream channel, 24.5 miles. Average slope of main stream channel, 6.9 percent.

Gage-height record.- Staff gage read daily at 8 a.m., more frequently during storm period, and at about 4-minute intervals 3 - 7 p.m. Mar. 2.

Discharge record.- Computed from record of stage, spillway rating table, valve rating curves, valve-operation record, and changes in storage based on record of stage and stage-capacity tables; stage-capacity table based on survey of 1937 used to time of peak stage of Mar. 2 (7:30 p.m.), table based on survey of October 1938 used thereafter.

Maxima.- 1938: Inflow, 90,000 second-feet 4 p.m. Mar. 2.
Outflow, 56,700 second-feet 7:30 p.m. Mar. 2.

Remarks.- Records good. Altitude of spillway, 1,453 feet. Area at spillway level, 523 acres (Oct. 1938). Capacity at spillway level before storm of Mar. 2, 53,334 acre-feet; after storm, 47,191 acre-feet. Partial regulation at flood-control dam No. 2 on West Fork of San Gabriel River, 10 miles upstream. Outflow goes directly into Morris Reservoir. Basic data Feb. 27 to Mar. 11 and entire record for rest of February, March, and April furnished by Los Angeles County Flood Control District, through H. E. Hedger, chief engineer.

Mean daily inflow, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	215	5,290	525	11	963	1,220	667	21	253	1,260	488
2	129	31,100	763	12	903	4,190	719	22	249	1,330	476
3	510	15,700	699	13	554	3,400	593	23	236	1,280	482
4	749	7,790	688	14	448	2,550	554	24	239	1,210	505
5	420	4,570	773	15	378	2,040	516	25	240	1,190	511
6	286	3,730	747	16	329	1,470	488	26	233	1,110	436
7	228	3,390	700	17	300	1,270	474	27	419	1,070	398
8	206	3,100	632	18	294	1,220	475	28	2,850	1,050	390
9	291	3,480	648	19	312	1,170	496	29		940	405
10	367	2,080	692	20	269	1,100	506	30		854	387
								31		801	
Mean monthly inflow, in second-feet									460	3,610	561
Inflow, in acre-feet									25,530	222,100	33,390

Inflow, in second-feet, at indicated time, 1938

Hour	February 27	February 28	March 1	March 2	March 3	March 4
1	242	833	10,600	3,070	26,900	
2	238	855	9,530	3,160	24,000	9,760
3	236	865	8,960	3,300	19,200	
4	233	892	8,570	3,200	18,800	9,300
5	232	945	8,320	3,120	20,700	
6	246	1,070	8,000	3,170	19,900	8,800
7	262	1,530	6,800	7,600	18,800	
8	280	2,160	5,320	9,200	17,700	8,540
9	295	2,510	4,930	10,700	16,600	
10	310	2,900	4,700	15,500	15,900	8,320
11	330	3,200	4,420	20,200	15,100	
N	352	3,360	4,120	27,600	14,500	8,000
1	375	3,540	3,910	39,000	13,700	
2	405	3,800	3,780	57,300	13,100	7,730
3	443	3,940	3,600	69,500	12,800	
4	489	3,680	3,360	90,000	12,500	7,550
5	535	3,490	2,890	81,000	12,000	
6	575	3,330	3,040	72,000	11,700	6,900
7	612	3,300	3,460	59,500	11,400	
8	647	3,380	3,300	48,300	11,100	5,680
9	685	3,450	3,140	40,800	10,800	
10	730	3,700	3,060	35,800	10,600	5,390
11	775	6,800	3,000	31,300	10,300	
12	805	9,100	3,010	29,000	10,000	5,200
	March 5	**March 6**	**March 7**	**March 8**	**March 9**	**March 10**
2	5,020	4,270	3,610	3,180	3,950	3,280
4	4,900	4,220	3,590	3,170	3,980	3,250
6	4,810	4,150	3,550	3,160	4,000	3,220
8	4,700	4,090	3,500	3,120	4,010	3,190
10	4,610	3,570	3,400	2,710	3,990	2,370
N	4,480	2,840	3,350	2,110	3,920	1,600
2	4,320	2,810	3,320	2,420	3,330	1,280
4	4,200	3,700	3,290	2,630	2,790	1,220
6	4,310	3,760	3,260	3,260	2,200	1,100
8	4,380	3,740	3,220	3,900	2,700	1,080
10	4,360	3,690	3,210	3,980	3,250	1,140
M	4,300	3,630	3,200	3,950	3,290	1,210

Mean daily outflow, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	133	0	1,150	11	285	1,410	1,420	21	528	1,140	503
2	177	11,800	2,820	12	309	3,790	499	22	532	1,380	502
3	181	16,700	2,770	13	183	3,490	501	23	507	1,380	501
4	147	8,080	2,700	14	137	2,590	504	24	504	1,380	501
5	162	4,640	2,640	15	288	2,140	504	25	502	1,380	167
6	191	3,790	2,560	16	321	1,520	504	26	478	1,370	1
7	177	3,420	2,490	17	304	1,350	504	27	489	1,370	1
8	204	3,100	2,400	18	282	1,330	503	28	291	1,370	1
9	199	3,540	2,300	19	538	1,330	503	29		1,360	1
10	239	2,300	2,190	20	524	1,320	503	30		1,360	1
								31		932	
Mean monthly outflow, in second-feet........................									315	2,970	1,070
Outflow, in acre-feet......................................									17,480	182,600	63,760

Outflow, in second-feet, at indicated time, 1938

Hour	February 27	February 28	March 1	March 2	March 3	March 4
1					29,200	10,200
2	490	494	0	0	26,600	10,000
3					24,400	9,800
4	490	496	0	0	22,800	9,600
5					21,500	9,300
6	490	498	0	0	20,500	9,100
7					19,700	8,900
8	490	500	0	0	18,800	8,700
9					17,700	8,600
10	489	510	0	0	16,800	8,500
11					15,900	8,350
N	488	520	0	0	15,200	8,200
1		527		0	14,500	8,000
2	487	0	0	0	13,800	7,940
3				0	13,300	7,860
4	486	0	0	0	13,000	7,740
5				0	12,600	7,600
6	487	0	0	36,700	12,100	7,400
7				56,400	11,800	6,830
8	488	0	0	54,400	11,500	6,180
9				47,000	11,200	5,970
10	490	0	0	40,600	11,000	5,700
11				35,400	10,700	5,500
M	492	0	0	31,600	10,300	5,400

Outflow, in second-feet, at indicated time, 1938--Continued

Hour	March 5	March 6	March 7	March 8	March 9	March 10
2	5,180	4,310	3,620	3,190	3,960	3,250
4	5,000	4,270	3,600	3,160	3,980	3,250
6	4,850	4,220	3,550	3,160	3,980	3,250
8	4,780	4,190	3,520	3,180	3,980	3,220
10	4,680	3,960	3,440	3,020	3,980	3,050
N	4,580	3,320	3,400	2,500	3,980	2,320
2	4,420	2,960	3,360	2,470	3,820	1,820
4	4,300	3,200	3,320	3,100	3,250	1,540
6	4,270	3,640	3,280	2,920	2,860	1,340
8	4,360	3,720	3,230	3,430	2,540	1,220
10	4,360	3,760	3,210	3,820	2,930	1,180
M	4,360	3,680	3,200	3,940	3,150	1,160

Supplemental record.- Mar. 2, 7:30 p.m., 56,700 sec.-ft.

San Gabriel River at Morris Reservoir, near Azusa, Calif.

Location.- Water-stage recorder, lat. 34°10'25", long. 117°52'50", in NE¼ sec. 13, T. 1 N., R. 10 W., 3½ miles northeast of Azusa. Altitude of stream bed, about 950 feet.

Drainage area.- Area, 211 square miles. Average altitude, 4,480 feet. Maximum altitude, 10,080 feet. Average slope, 49 percent. Length of main stream channel, 27.5 miles. Average slope of main stream channel, 6.3 percent.

Gage-height record.- Water-stage recorder graph and frequent staff-gage readings.

Discharge record.- Inflow computed from outflow, records of evaporation and diversion, and changes in storage, based on record of stage and stage-capacity tables. Outflow computed from record of stage, spillway rating curve, valve rating curve, and gate and valve operation record.

Maxima.- 1938: Inflow, 66,200 second-feet 7:25 p.m. Mar. 2.
Outflow, 65,700 second-feet 7:05 p.m. Mar. 2.
1894-1937: Discharge, 40,000 second-feet Jan. 18, 1916.

Remarks.- Records good. Altitude of spillway, 1,152 feet; top of gates, 1,170 feet. Area at spillway level, 414 acres. Capacity before storm of Mar. 2, at spillway level, 31,700 acre-feet and at top of gates, 38,690 acre-feet; capacity after storm, 30,180 and 37,170 acre-feet, respectively. Inflow partially regulated by flood-control reservoir No. 1, 3 miles upstream, and flood-control reservoir No. 2, 13 miles upstream on West Fork of San Gabriel River. Records of inflow and records of outflow for Feb. 22 to Apr. 30 furnished by City of Pasadena Water Department.

Mean daily inflow, in second-feet, 1938

Feb. 17	235	Feb. 25	517
18	288	26	507
19	575	27	535
20	552	28	567
21	558	Mar. 1	230
22	558	2	13,700
23	540	3	18,600
24	524	4	7,790
		5	4,240

Inflow Feb. 17 to Mar. 5 in acre-feet...100,200

Inflow, in second-feet, at indicated time, 1938

Hour	March 2	March 3	March 4	March 5
1	200	33,600	10,500	
2	200	29,700	10,000	4,770
3	240	27,600	9,660	
4	280	24,800	9,240	4,580
5	350	21,600	9,030	
6	500	21,000	8,860	4,500
7	720	20,100	8,660	
8	1,000	18,400	8,500	4,330
9	1,350	17,200	8,260	
10	1,470	16,500	8,050	4,240
11	1,540	16,300	7,900	
N	1,700	16,500	7,750	4,120
1	2,000	16,400	7,600	
2	2,580	16,100	7,500	4,040
3	3,000	15,800	7,320	
4	3,400	15,400	7,200	3,980
5	4,100	14,900	7,060	
6	34,500	14,400	6,960	3,940
7	61,000	13,900	6,400	
8	57,800	13,300	5,850	3,910
9	51,400	13,000	5,640	
10	44,000	12,500	5,400	3,880
11	38,300	12,000	5,180	
M	35,300	11,200	5,020	3,880

Supplemental record.- Mar. 2, 7:25 p.m., 66,200 sec.-ft.

Mean daily outflow, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	3.8	205	860	11	89	1,620	1,190	21	94	700	403
2	3.3	12,730	1,330	12	92	1,950	462	22	98	580	406
3	5.5	21,660	1,280	13	89	2,690	418	23	99	1,030	409
4	7	8,620	1,640	14	89	2,700	414	24	170	1,360	343
5	6	4,520	2,410	15	88	2,380	414	25	341	1,300	96
6	5.5	3,900	2,620	16	88	1,920	383	26	308	1,300	13
7	4.2	3,840	2,500	17	88	1,140	392	27	180	1,210	12
8	25	4,460	2,320	18	88	1,760	395	28	86	1,310	9.5
9	72	4,940	2,290	19	89	1,750	397	29		1,310	9
10	85	2,670	2,010	20	92	1,420	400	30		1,310	8.5
								31		790	
Mean monthly outflow, in second-feet									88.8	3,196	861
Outflow, in acre-feet									4,930	196,500	51,240

Outflow, in second-feet, at indicated time, 1938

Hour	March 2	March 3	March 4	March 5
1	45	32,200	13,800	
2	60	28,700	12,100	5,250
3	60	28,500	11,000	
4	60	27,300	10,300	5,000
5	75	20,200	9,850	
6	105	20,800	9,500	4,830
7	165	20,500	9,200	
8	255	19,500	8,960	4,630
9	390	16,200	8,700	
10	615	16,500	8,500	4,500
11	735	17,500	8,300	
N	855	21,300	8,100	4,400
1	1,020	20,500	8,000	
2	1,290	21,000	7,800	4,360
3	1,600	20,500	7,600	
4	5,230	21,200	7,500	4,250
5	13,500	21,500	7,400	
6	20,200	19,500	7,300	4,160
7	50,400	18,300	7,050	
8	55,500	19,400	6,700	4,060
9	51,800	19,400	6,350	
10	46,200	19,300	6,100	4,020
11	39,600	18,700	5,900	
M	33,500	16,700	5,650	4,000

Supplemental records.- Mar. 2, 7:05 p.m., 65,700 sec.-ft.; 7:12 p.m., 65,400 sec.-ft.; 7:20 p.m., 51,800 sec.-ft.; 8:25 p.m., 56,300 sec.-ft.

West Fork of San Gabriel River at flood-control reservoir No.2, near Camp Rincon, Calif.

Location.- Staff gage, lat. 34°14'45", long. 117°57'50", near center sec. 19, T. 2 N., R. 10 W., 6 miles west of Camp Rincon. Altitude of stream bed, 2,140 feet.

Drainage area.- Area, 40.4 square miles. Average altitude, 4,290 feet. Maximum altitude, 8,038 feet. Average slope, 47 percent. Length of main stream channel, 8.5 miles. Average slope of main stream channel, 13 percent.

Gage-height record.- Staff gage read daily at 8 a.m.; more frequently during storm period.

Discharge record.- Computed from spillway rating curve, valve rating curves, valve operation record, record of stage, discharge measurements, and changes in storage based on record of stage and stage-capacity tables; stage-capacity table dated October 1935 used to time of peak stage of Mar. 2 (4:30 p.m.), and table corrected by silt survey made after storm used thereafter.

Maxima.- 1938: Inflow, 26,900 second-feet 4:15 p.m. Mar. 2.
Outflow, 24,200 second-feet 4:30 p.m. Mar. 2.

Remarks.- Records good. Altitude of spillway, 2,385 feet. Area at spillway level, 143 acres. Capacity at spillway level before storm of Mar. 2, 12,298 acre-feet; after storm, 10,787 acre-feet. Basic data Feb. 27 to Mar. 11 and entire record Feb. 1-26 and Mar. 12 to Apr. 30 furnished by Los Angeles County Flood Control District through H. E. Hedger, chief engineer.

Mean daily inflow, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	93	1,430	107	11	549	246	70	21	53	203	52
2	39	8,100	101	12	288	853	71	22	48	197	48
3	246	2,420	100	13	162	539	72	23	47	190	48
4	305	995	99	14	113	469	69	24	42	185	54
5	132	613	95	15	91	388	65	25	41	178	61
6	70	428	94	16	71	321	60	26	42	155	56
7	54	313	79	17	61	276	61	27	140	155	45
8	46	350	79	18	75	264	56	28	1,030	163	45
9	107	276	77	19	73	238	56	29		145	51
10	109	294	75	20	62	227	52	30		126	57
								31		111	
Mean monthly inflow, in second-feet									150	673	68.5
Inflow, in acre-feet									8,310	41,350	4,080

Inflow, in second-feet, at indicated time, 1938

Hr.	Feb. 27	Feb. 28	Mar. 1	Mar. 2	Mar. 3	Mar. 4	Mar. 5	Mar. 6	Mar. 7	Mar. 8
1	45	248	4,600	705	4,350					
2	45	244	3,350	735	3,860	1,290				282
3	45	242	2,720	780	3,430					
4	46	267	2,300	850	3,240	1,250	698	485	326	273
5	46	320	1,860	1,180	3,020					
6	46	425	1,680	1,940	2,870	1,180				287
7	46	625	1,540	2,580	2,700					
8	46	960	1,400	3,600	2,550	1,120	675	480	311	308
9	55	1,060	1,200	5,100	2,400					
10	65	1,130	1,040	8,600	2,270	1,040				375
11	77	1,170	915	9,300	2,170					
N	95	1,200	880	10,200	2,100	975	640	470	300	392
1	123	1,220	860	10,800	2,010					
2	162	1,300	843	20,000	1,930	905				410
3	204	1,580	830	21,800	1,850					
4	230	1,160	820	24,700	1,790	850	550	370	300	435
5	246	890	806	20,300	1,700					
6	260	950	798	13,000	1,650	805				455
7	284	985	787	10,000	1,590					
8	269	1,040	775	8,050	1,510	765	505	350	327	360
9	263	1,180	763	6,500	1,460					
10	259	1,940	735	5,700	1,410	733				320
11	255	2,850	695	5,200	1,370					
M	250	3,450	680	4,730	1,330	720	490	333	295	300

Supplemental record.- Mar. 2, 4:15 p.m., 26,900 sec.-ft.

Mean daily outflow, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	7.5	181	97	11	30	123	6	21	23	225	7.5
2	9	6,810	96	12	38	540	6	22	22	286	8
3	12	2,980	96	13	34	332	6	23	22	288	7.5
4	26	1,655	95	14	34	283	6.5	24	21	286	8
5	30	741	95	15	34	192	7	25	20	282	8.5
6	28	733	94	16	33	14	7	26	20	266	9
7	26	860	74	17	30	15	7	27	21	268	9
8	25	934	56	18	28	84	7	28	31	272	9
9	23	1,290	24	19	26	129	7	29		177	9
10	25	533	7	20	24	155	7	30		135	9
								31		93	
Mean monthly outflow, in second-feet									25.1	683	29.5
Outflow, in acre-feet									1,390	41,970	1,760

Outflow, in second-feet, at indicated time, 1938

Hour	February 27	February 28	March 1	March 2	March 3	March 4
1					7,050	
2	20	22	65	386	5,050	2,170
3					3,730	
4	20	22	75	387	3,460	2,150
5					3,270	
6	20	22	82	392	3,170	2,140
7				397	3,060	
8	20	23	87	403	2,860	2,120
9				411	2,710	
10	21	26	90	423	2,610	2,100
11				4,150	2,420	
N	21	29	92	6,430	2,380	2,070
1				6,840	2,320	
2	21	33	94	14,500	2,280	2,050
3			95	19,600	2,240	
4	21	37	236	22,800	2,230	2,020
5			377	23,400		654
6	21	39	378	16,700	2,230	654
7				12,300		
8	21	42	380	9,530	2,210	657
9				7,730		
10	21	45	381	6,430	2,200	658
11				6,710		
M	22	52	382	7,550	2,190	659

Outflow, in second-feet, at indicated time, 1938--Continued

Hour	March 5	March 6	March 7	March 8	March 9	March 10
2						
4	659	915	883	821	1,610	1,330
6						
8	660	905	871	813	1,510	1,290
10		25	861	18		260
N	660	25	861	18	1,420	7
2		911			646	
4	660	910	850	1,770	641	7
6	927				321	
8	924	903	840	1,720	1,420	7
10						337
M	921	895	832	1,670	1,390	335

Supplemental record.- Mar. 2, 4:30 p.m., 24,200 sec.-ft.

Sawpit Creek at flood-control reservoir near Monrovia, Calif.

Location.- Water-stage recorder, lat. 34°10'30", long. 117°59'00", near center sec. 13, T. 1 N., R. 11 W., 2 miles north of Monrovia. Altitude of stream bed, 1,228 feet.

Drainage area.- Area, 3.27 square miles. Average altitude, 2,960 feet. Maximum altitude, 5,390 feet. Average slope, 50 percent. Length of main stream channel, 3.1 miles. Average slope of main stream channel, 25 percent.

Gage-height record.- Water-stage recorder graph and frequent staff-gage readings.

Discharge record.- Computed from spillway rating curve, valve rating curves, valve operation records, record of stage, discharge measurements, and stage-capacity tables; stage-capacity table based on survey of October 1935 used to time of peak stage of Mar. 2 (6 p.m.), table corrected by silt survey made after storm used thereafter.

Maxima.- 1938: Inflow, 1,000 second-feet 4:15 p.m. Mar. 2.
Outflow, 665 second-feet 6 p.m. Mar. 2.
1932-37: Mean hourly inflow, 240 second-feet 2 - 3 a.m. Jan. 1, 1934.

Remarks.- Records fair. Altitude of spillway, 1,360 feet. Area at spillway level, 7.9 acres (after storm of Mar. 2). Capacity at spillway level before storm, 389 acre-feet; after storm, 320 acre-feet. Basic data Feb. 27 to Mar. 11 and entire record for rest of February, March, and April furnished by Los Angeles County Flood Control District, through H. E. Hedger, chief engineer.

Mean daily inflow, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	3.4	83	8	11	9.5	14	5.5	21	1.5	11	4.8
2	1.4	371	8	12	9	21	5.5	22	1.2	10	4.8
3	22	132	7.5	13	6	17	5.5	23	1.4	9.5	4.8
4	16	54	7.5	14	4.8	15	5.5	24	1.5	9	5
5	6	35	7.5	15	3.3	14	5.5	25	1.4	8.5	5
6	3.0	34	7	16	3.3	14	5	26	1.0	8.5	4.4
7	2.1	27	6.5	17	3.2	13	5	27	1.3	8.5	3.9
8	1.0	17	6	18	3.1	13	5	28	44	8.5	3.4
9	4.2	15	6	19	3.0	12	5	29		8.5	3.4
10	4.6	15	6	20	2.4	11	4.9	30		8.5	3.3
								31		8.5	
Mean monthly inflow, in second-feet									5.88	33.1	5.51
Inflow, in acre-feet									326	2,040	328

Inflow, in second-feet, at indicated time, 1938

Hr.	Feb.27	Feb.28	Mar.1	Mar.2	Mar.3	Mar.4	Mar.5	Mar.6	Mar.7	Mar.8	Mar.9	Mar.10
1	0.9	2.1	245	49	240							
2	.9	3.2	183	51	220	68						
3	.9	5.5	151	52	205							
4	.9	13	128	58	196	64	38	35	31	18	16	14
5	.9	22	110	76	185							
6	.9	31	97	99	174	60						
7	1.0	42	87	156	163							
8	1.4	60	81	180	150	57	36	36	30	17	16	14
9	2.7	73	75	260	134							
10	2.1	68	68	314	129	54						
11	1.6	63	62	320	122							
N	1.3	58	59	455	115	52	34	36	26	17	15	13
1	.8	54	57	515	106							
2	1.0	39	54	615	97	50						
3	1.3	31	50	800	93							
4	1.4	25	47	925	90	48	33	34	23	17	15	13
5	1.4	23	46	815	87							
6	1.4	22	44	680	84	46						
7	1.4	21	43	620	83							
8	1.4	19	42	575	82	44	32	32	20	16	15	13
9	1.4	32	40	470	81							
10	1.4	120	41	352	80	42						
11	1.4	156	44	300	79							
M	1.6	170	47	265	79	40	33	32	19	16	15	20

Supplemental record.- Mar. 2, 5:15 p.m., 1,000 sec.-ft.

Mean daily outflow, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	0	63	9	11	7	13	6	21	0	10	4.8
2	0	231	7.5	12	9.5	20	5.5	22	0	10	4.8
3	2.9	149	7.5	13	9.5	17	5.5	23	0	13	4.8
4	16	75	8	14	7.5	15	5.5	24	0	9	5
5	8.5	71	7	15	4.9	15	5.5	25	0	8	5
6	7	68	7	16	4.4	14	5.5	26	0	8.5	4.6
7	4.5	59	6.5	17	4.1	13	5	27	5.5	8.5	3.9
8	8	27	6	18	1.7	12	5	28	16	8.5	3.2
9	9.5	16	5.5	19	0	11	5	29		9	3.4
10	0	15	5.5	20	0	11	4.9	30		8.5	3.2
								31		8	
Mean monthly outflow, in second-feet									4.52	32.8	5.52
Outflow, in acre-feet									251	2,020	328

Outflow, in second-feet, at indicated time, 1938

Hr.	Feb.27	Feb.28	Mar.1	Mar.2	Mar.3	Mar.4	Mar.5	Mar.6	Mar.7	Mar.8	Mar.9	Mar.10
1	0		53		276							
2	0	10	58	62	251							
3	0		62		231	80						
4	0	10	63	61	216		72	69	65	44	17	15
5	0											
6	0	10	64	62	200	74						
7	0											
8	0	10	65	64	165	74	72	68	64	40	17	15
9	0											
10	0	10	65	66	145	74						
11	5	10		68								
N	10	16	65	103	130	74	71	68	62	26	16	15
1		19		105								
2	10	7	65	108	111	74						
3		13		256								
4	10	15	64	318	100	74	71	67	57	17	15	15
5				583								
6	10	20	64	665	100	73						
7				649								
8	10	20	63	618	93	73	70	66	52	17	15	15
9		20		502								
10	10	28	63	403	90	73						
11		38		333								
M	10	44	63	303	87	73	70	66	48	17	15	14

San Dimas Creek at flood-control reservoir near San Dimas, Calif.

Location.- Water-stage recorder, lat. 34°09'15", long. 117°46'15", in SE¼ sec. 24, T. 1 N., R. 9 W., 4 miles northeast of San Dimas. Altitude of stream bed, 1,350 feet.

Drainage area.- Area, 16.5 square miles. Average altitude, 3,130 feet. Maximum altitude, 5,558 feet. Average slope, 42 percent. Length of main stream channel, 6 miles. Average slope of main stream channel, 13 percent.

Gage-height record.- Water-stage recorder graph and staff-gage readings.

Discharge record.- Computed from spillway rating curve, valve rating curves, valve operation record, record of stage, and stage-capacity tables; stage-capacity table based on survey of December 1935 used to time of peak stage on Mar. 2 (5:15 p.m.), table corrected by silt survey made after storm used thereafter.

Maxima.- 1938: Inflow, 4,600 second-feet 5:10 p.m. Mar. 2.
Outflow, 4,370 second-feet 5:15 p.m. Mar. 2.
1932-37: Mean hourly inflow, 422 second-feet 3 - 4 a.m. Jan. 1, 1934.

Remarks.- Records fair. Altitude of spillway, 1,462 feet. Area at spillway level, 36 acres (after storm of Mar. 2). Capacity of spillway level before storm, 1,399 acre-feet; after storm, 1,188 acre-feet. Basic data Feb. 27 to Mar. 2 and entire record for rest of February, March, and April furnished by Los Angeles County Flood Control District, through H. E. Hedger, chief engineer.

Mean daily inflow, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	13	331	31	11	42	50	21	21	6	51	15
2	5.5	1,580	30	12	34	121	22	22	6	48	15
3	32	461	28	13	18	116	20	23	4.9	44	14
4	30	191	28	14	15	97	17	24	3.7	43	17
5	13	135	26	15	10	83	15	25	3.7	42	18
6	8	95	25	16	9	72	16	26	5	38	15
7	5.5	77	24	17	8	66	15	27	11	37	15
8	5.5	76	23	18	8	58	14	28	144	36	15
9	15	61	22	19	7.5	59	15	29		36	15
10	13	54	21	20	5.5	55	16	30		33	15
								31		32	
Mean monthly inflow, in second-feet									17.2	138	19.4
Inflow, in acre-feet									956	8,480	1,160

Inflow, in second-feet, at indicated time, 1938

Hr.	Feb.27	Feb.28	Mar.1	Mar.2	Mar.3	Mar.4	Mar.5	Mar.6	Mar.7	Mar.8	Mar.9	Mar.10
1			1,420	97								
2	5	20	1,270	108	800	247	154					
3			770	121								
4	5	34	545	139	705	219	156	102	82	74	63	58
5			430	160								
6	6	58	360	219	600	210	157					
7			300	343								
8	13	93	265	500	530	200	156	97	79	78	62	55
9			232	710								
10	16	170	218	1,220	441	192	150					
11		167	205	1,700								
N	14	171	183	1,730	363	183	138	93	77	80	61	53
1		181	167	2,090								
2	13	170	150	3,200	330	177	120					
3			140	4,100								
4	14	160	130	4,010	314	170	116	92	74	80	60	52
5			120	4,200								
6	14	149	111	3,850	298	165	114					
7		132	104	2,600								
8	12	139	98	2,300	293	161	113	88	74	73	59	50
9		159	92	1,900								
10	11	230	87	1,280	284	157	110					
11		410	86	1,010								
M	14	790	88	870	270	154	108	84	72	66	60	50

Supplemental record.- Mar. 2, 5:10 p.m., 4,600 sec.-ft.

Mean daily outflow, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	0	235	30	11	0	38	23	21	0	53	2.1
2	0	1,290	26	12	6	76	23	22	0	53	2.1
3	0	720	26	13	14	109	7.5	23	0	47	2.1
4	0	319	26	14	15	128	0	24	0	44	1.6
5	0	193	25	15	14	109	0	25	0	44	0
6	0	106	25	16	10	68	0	26	0	43	0
7	0	96	24	17	11	61	0	27	5	37	3.0
8	0	70	24	18	6.5	32	0	28	74	32	9
9	0	68	24	19	0	80	.8	29		32	12
10	0	47	23	20	0	64	2.1	30		32	12
								31		32	
Mean monthly outflow, in second-feet									5.56	140	11.8
Outflow, in acre-feet									308	8,640	700

Outflow, in second-feet at indicated time, 1938

Hr.	Feb.27	Feb.28	Mar.1	Mar.2	Mar.3	Mar.4	Mar.5	Mar.6	Mar.7	Mar.8	Mar.9	Mar.10
1			113		995							
2		18	115	250	1,090	328						
3			120		1,120							
4		18	255	248	960	325	300	105	103	69	69	68
5												
6		19	255	248	780	325						
7												
8		19	255	248	720	325	295	105	103	69	69	52
9		19										
10		110	255	250	717	323						
11				458								
N	0	110	255	785	710	320	287	105	103	69	69	36
1				798								
2	0	110	255	830	702	318	0					
3				2,370								
4		110	255	3,700	695	316	0	105	102	70	69	36
5	0			4,150								
6	18	110	255	4,200	685	314	145		102			
7				2,850								
8	18	110	252	2,630	675	311	145	105	69	70	69	36
9				2,350	330							
10	18	110	250	1,560	330	308	125					
11				1,240								
M	18	111	250	1,090	328	305	105	104	69	70	69	36

Supplemental record.- Mar. 2, 5:15 p.m., 4,370 sec.-ft.

Fern Canyon Watershed No. 2, near San Dimas, Calif.

Location.- Water-stage recorders and flume, lat. 34°11'55", long. 117°42'08", in sec. 3, T. 1 N., R. 8 W., in San Dimas Experimental Forest, about 8 miles northeast of San Dimas. Altitude, about 4,500 feet.

Drainage area.- Area, 0.063 square mile. Average altitude, 5,000 feet. Maximum altitude, 5,400 feet. Average slope, 65 percent. Length of main stream channel, 0.41 mile. Average slope of main stream channel, 42 percent.

Gage-height record.- Water-stage recorder graphs.

Discharge record.- The runoff is measured by a modified 3-foot Parshall flume and represents the inflow into a small concrete-lined reservoir of 10,000-cubic-foot capacity. A 90° V-notch weir is used in conjunction with flume for low flows. Ratings of flume and weir used throughout the period.

Maximum.- 1938: Discharge, 28.8 second-feet 4 p.m. Mar. 2.

Remarks.- Records furnished by U. S. Forest Service.

Mean daily discharge, in second-feet, 1938

Feb. 27	0.004	Mar. 5	0.221
28	2.02	6	.090
Mar. 1	1.38	7	.044
2	8.62	8	.033
3	2.52	9	.027
4	.592	10	.023

Runoff Feb. 27 to Mar. 10, in acre-feet..... 30.9

Discharge, in second-feet, at indicated time, 1938

Time	Discharge	Time	Discharge	Time	Discharge	Time	Discharge	Time	Discharge	Time	Discharge
February 27		10:35	1.22	11	0.790	12:30	15.25	6	3.50	12	0.343
9 am	0	11	.955	12 m	.700	12:45	12.2	10:50	3.35		
9:30	.004	12 m	.991	1 pm	.617	1	15.0	11:15	2.00	March 5	
10	.003	1 pm	1.18	2	.539	1:30	18.5	12 m	1.92	6 am	.264
12 m	.006	2	1.81	3	.468	1:45	16.8	2 pm	1.71	12 m	.211
1 pm	.005	2:30	2.94	4	.424	2	19.0	3	1.57	6 pm	.171
2	.008	3	3.50	6	.352	2:30	25.4	4	1.48	12	.130
4	.006	4	3.88	8	.289	2:45	20.6	5:30	1.39		
6	.007	5	3.50	10	.240	3	27.8	6	1.46	March 6	
7	.008	6	3.05	11:30	.218	3:30	18.8	6:15	1.30	6 am	.106
7:30	.018	6:30	3.27	12	.240	3:45	25.0	6:30	1.43	12 m	.088
8	.008	8	2.83			4	28.8	7	1.30	12 pm	.058
10	.010	9	3.28	March 2		4:15	26.5	8	1.18		
12	.008	10	5.90	1 am	.334	4:30	28.2	8:15	1.16	March 7	
		11	7.32	2	.289	4:50	21.6	8:30	1.18	12 m	.041
February 28		12	7.80	3	.324	5	25.6	9	1.14	12 pm	.036
1 am	.014			4	.445	5:30	22.0	10	1.04		
2	.020	March 1		5	.590	6	18.0	12	.955	March 8	
3	.027	12:15am	7.60	6	.955	6:30	15.0			12 m	.033
4	.046	1	5.58	7	1.34	7	13.4	March 4		12 pm	.030
5	.062	2	3.85	8	1.97	8	10.5	2 am	.887		
6	.159	3	3.00	9	2.83	9	8.30	4	.790	March 9	
7	.240	4	2.32	9:30	3.70	10	7.10	6	.715	12 m	.027
7:30	.225	6	1.76	10	5.18	11	5.95	8	.658	12 pm	.025
8	.515	7	1.48	11	8.20	12	5.18	10	.617		
9	.921	8	1.26	11:30	6.70			12 m	.564	March 10	
10	1.10	9	1.06	12 m	8.30	March 3		4	.480	8:55 am.	.023
10:30	1.22	10	.887	12:15pm	11.30	2 am	4.20	8	.403		

Fern Canyon Watershed No. 3, near San Dimas, Calif.

Location.- Water-stage recorders and flume, lat. 34°11'53", long. 117°42'09", in San Dimas Experimental Forest, about 8 miles northeast of San Dimas. Altitude, about 4,500 feet.

Drainage area.- Area, 0.084 square mile. Average altitude, 5,000 feet. Maximum altitude, 5,400 feet. Average slope, 65 percent. Length of main stream channel, 0.52 mile. Average slope of main stream channel, 33 percent.

Gage-height record.- Water-stage recorder graphs.

Discharge record.- The runoff is measured by a modified 3-foot Parshall flume and represents the inflow into a small concrete-lined reservoir of 10,000-cubic-foot capacity. A 90° V-notch weir is used in conjunction with flume for low flows. Ratings of flume and weir used throughout the period.

Maximum.- 1938: Discharge, 19.0 second-feet 4 and 4:15 p.m. Mar. 2.

Remarks.- Records furnished by U. S. Forest Service.

Mean daily discharge, in second-feet, 1938

Feb. 27	0.001	Mar. 5	0.152
28	.616	6	.036
Mar. 1	1.15	7	.010
2	5.10	8	.005
3	1.75	9	.003
4	.527	10	.001

Runoff, Feb. 27 to Mar. 10, in acre-feet.... 18.5

Discharge, in second-feet, at indicated time, 1938

Time	Dis-charge	Time	Dis-charge	Time	Dis-charge	Time	Dis-charge	Time	Dis-charge	Time	Dis-charge
February 27											
2 am	0	11	0.468	4	2.32	8	1.70	6:40	7.10	March 5	
3	.001	12 m	.539	6	1.55	10	4.00	7	6.35	6 am	0.207
6	0	1 pm	.672	7	1.40	11	6.15	8	4.40	12 m	.141
8	.001	2	.854	8	1.12	11:30	5.58	12	2.50	6 pm	.096
9:30	.004	3	1.030	9	.980	12 m	5.95			12	.065
12 m	.001	3:45	.921	10	.850	1 pm	8.30	March 3			
1 pm	.002	4	1.010	11	.445	1:30	10.9	12 m	1.84	March 6	
2	.001	5	.790	12 m	.362	1:50	13.4	2 pm	1.61	6 am	.046
3	.003	6	.617	1 pm	.306	2	12.2	4	1.43	12 m	.032
8	.001	6:30	.672	2	.248	2:30	16.5	5:30	1.34	6 pm	.023
10	.002	7	.590	4	.118	3	18.5	6	1.43	12	.018
12	.001	8	.515	6	.125	3:15	13.2	6:15	1.28		
		9	.590	8	.092	3:30	16.8	6:30	1.39	March 7	
February 28		9:30	.822	11	.065	3:45	15.0	7	1.26	12 m	.008
2 am	.004	10	1.700	12	.072	4	19.0	8	1.18	12 pm	.007
3:30	.004	11	2.80			4:10	17.2	12	.921		
5	.007	12	4.60	March 2		4:15	19.0			March 8	
6	.032			1 am	.080	4:30	15.0	March 4		12 m	.005
7	.072	March 1		2:30	.072	4:45	8.90	2 am	.822	12 pm	.004
8	.096	12:30am	5.75	4	.106	5	15.0	10	.539		
9	.125	1	5.18	5	.171	5:30	12.2	4 pm	.403	March 9	
10	.184	2	4.00	6	.256	6	8.30	8	.324	12 m	.003
10:30	.240	3	3.20	7	.760	6:20	6.35	12	.264	12 pm	.002
										March 10	
										10:30 am	.001

Wolfskill Creek near San Dimas, Calif.

Location.- Water-stage recorders and flume, lat. 34°10'35", long. 117°45'25", in sec. 18 T. 1 N., R. 8 W., in San Dimas Experimental Forest, about 5.5 miles northeast of San Dimas. Altitude, about 1,700 feet.

Drainage area.- Area, 2.78 square miles. Average altitude, 3,460 feet. Maximum altitude, 5,200 feet. Average slope, 49 percent. Length of main stream channel, 3.5 miles. Average slope of main stream channel, 19 percent.

Gage-height record.- Water-stage recorder graph.

Discharge record.- The runoff is measured by a 10-foot modified Parshall flume and a 2-foot San Dimas flume for lower flows. Rating of flumes used throughout the period.

Maximum.- 1938: Discharge, 830 second-feet 2:43 p.m. Mar. 2.

Remarks.- Records furnished by U. S. Forest Service.

Mean daily discharge, in second-feet, 1938

Feb. 27	1.2
28	13.5
Mar. 1	34.8

Discharge, in second-feet, at indicated time, 1938

Time	Discharge	Time	Discharge	Time	Discharge	Time	Discharge	Time	Discharge	Time	Discharge
February 27		9:50	20.2	11:30	35.5	3	3.6	10:30	225	3:00	590
8 am	0.7	10	16.5	12	66.0	4	6.6	10:40	255	3:10	741
9	1.0	11	12.5			5	14.2	10:50	270	3:20	645
10	1.4	12 m	16.2	March 1		5:30	16.8	11	289	3:30	590
12 m	1.6	12:20 pm	14.5	12:30am	130	6	21.6	11:10	340	3:40	543
4 pm	1.4	12:30	17.5	12:45	137	6:10	18.1	11:20	330	3:50	530
12	1.3	1	27.8	1	130	6:20	18.1	11:30	307	4	515
		2	17.0	2	108	6:30	20.5	11:40	304	4:10	440
February 28		2:30	27.2	3	93.0	6:40	20.5	11:50	311	4:20	505
1 am	1.5	3	22.2	3:30	84.0	6:50	18.1	12 m	300	4:30	520
1:30	1.7	3:30	18.7	4	76.0	7	18.1	12:10	300	4:40	615
2	2.0	3:45	20.0	4:30	66.0	7:10	19.7	12:20	289	4:50	365
2:30	2.1	4	18.7	5	51.7	7:20	25.7	12:30	307	5	515
3	2.5	4:30	19.4	6	42.0	7:30	27.0	12:40	307	5:10	490
3:30	2.9	4:45	20.8	8	39.2	8:10	27.0	12:50	327	5:20	520
4	3.6	6:20	18.9	9	30.2	8:20	30.2	1 pm	327	5:30	480
4:30	4.7	6:50	19.0	10	27.0	8:30	39.6	1:10	330	5:40	460
5	5.3	7	18.9	11	25.4	8:40	53.0	1:20	420	5:50	505
5:30	6.1	7:30	17.9	12 m	21.0	8:50	57.0	1:30	370	6	520
6	7.0	8	17.6	2 pm	15.5	9	76.0	1:40	430	6:10	450
6:30	7.9	8:30	17.3	4	10.5	9:10	66.0	1:50	430	6:20	430
7	8.0	8:40	17.3	6	8.5	9:20	76.0	2	460	6:30	355
7:30	8.0	8:50	17.1	8	5.6	9:30	78.0	2:10	490	6:40	355
7:45	8.6	9	17.4	10	3.3	9:40	118	2:20	543	6:50	335
8	9.9	9:30	19.6	12	1.0	9:50	106	2:30	635	7	327
8:30	11.5	10	22.0			10	127	2:40	795	7:10	240
9	13.0	10:30	24.8	March 2		10:10	165	2:43	830		
9:30	16.5	11	31.6	2 am	2.3	10:20	180	2:50	655		

West Fork of San Dimas Creek near San Dimas, Calif.

Location.- Water-stage recorders and flumes, lat. 34°10'10", long. 117°46'15", in SE¼SE¼, sec. 13, T. 1 N., R. 9 W., in San Dimas Experimental Forest, about 4.5 miles northeast of San Dimas. Altitude, about 1,600 feet.

Drainage area.- Area, 1.66 square miles. Average altitude, 2,360 feet. Maximum altitude, 3,100 feet. Average slope, 47 percent. Length of main stream channel, 2.5 miles. Average slope of main stream channel, 11.4 percent.

Gage-height record.- Water-stage recorder graph.

Discharge record.- The runoff is measured by a 10-foot modified Parshall flume and a 2-foot San Dimas flume for lower flows. Rating of flumes used throughout the period.

Maximum.- 1938: Discharge, 664 second-feet 4:05 p.m. Mar. 2.

Remarks.- Records furnished by U. S. Forest Service.

Mean daily discharge, in second-feet, 1938

Feb.	27	1.1
	28	16.3
Mar.	1	41.4

Discharge, in second-feet, at indicated time, 1938

Time	Discharge	Time	Discharge	Time	Discharge	Time	Discharge	Time	Discharge	Time	Discharge
February 27		5:30	7.3	3:20	78.5	8:20	68.5	1:20	270	4:25	355
7 am	0.5	6	7.8	4	63.8	8:40	78.5	1:30	281	4:35	378
9	.8	7	9.4	5	49.0	8:50	101	1:40	308	4:45	330
9:30	1.4	8	13.1	6:20	38.9	9	112	1:45	340	4:50	390
10	1.9	12 m	24.0	7	41.9	9:10	118	1:50	315	4:55	450
11	2.4	1	20.7	8:40	45.9	9:20	124	1:55	297	5	470
12	2.3	2	20.4	9	44.8	9:30	142	2	311	5:10	492
1 pm	1.8	3	19.0	10	34.0	9:40	152	2:10	322	5:20	415
2	1.6	4	16.9	11	29.5	9:50	164	2:20	330	5:30	350
3	1.4	5	15.4	12 m	26.5	10	184	2:25	360	5:40	300
4	1.4	6	15.0	1 pm	23.4	10:10	214	2:30	390	5:45	254
5	1.4	7	14.5	2	21.0	10:20	236	2:40	425	5:50	289
6	1.3	7:30	14.1	4	20.2	10:25	248	2:50	460	5:55	322
7	1.2	8	13.8	5	18.1	10:35	261	2:55	500	6	292
8	1.2	8:30	14.2	7	17.8	10:40	259	3	530	6:10	251
12	1.0	9	16.1	9	16.2	10:50	248	3:05	580	6:20	232
		9:30	21.2	10	14.2	11	229	3:10	610	6:30	221
February 28		10	31.5	12	14.0	11:05	195	3:15	585	6:40	215
1 am	1.6					11:10	174	3:20	558	6:50	206
1:20	1.9	March 1		March 2		11:20	164	3:30	585	7	180
1:40	2.3	12:15am	49.0	4 am	14.0	11:40	160	3:45	595	7:10	164
2	2.9	12:30	76.0	5	15.0	12 m	166	3:50	568	7:30	157
2:20	3.5	1	225	5:30	16.8	12:10pm	177	3:55	615	8	145
2:40	4.1	1:30	180	6	27.8	12:20	195	4	650	8:30	130
3	4.1	2	107	6:30	38.5	12:30	206	4:05	664	9	112
3:30	4.2	2:10	102	7	53.0	12:40	219	4:10	630	9:30	104
4	4.7	2:20	100	7:20	57.0	12:50	232	4:15	530	10	101
4:30	5.3	2:40	91.0	7:40	61.5	1	244	4:20	475		
5	6.1	3	82.5	8	63.8	1:10	259				

Dalton Creek at flood-control reservoir near Glendora, Calif.

Location.- Water-stage recorder, lat. 34°10'10", long. 117°48'30", near center sec. 15, T. 1 N., R. 9 W., 3½ miles northeast of Glendora. Altitude of stream bed, 1,565 feet.

Drainage area.- Area, 4.49 square miles. Average altitude, 2,590 feet. Maximum altitude, 3,606 feet. Average slope, 40 percent. Length of main stream channel, 3.5 miles. Average slope of main stream channel, 11 percent.

Gage-height record.- Water-stage recorder graph and frequent staff-gage readings.

Discharge record.- Computed from valve rating curves, valve operation records, record of stage, discharge measurements, and stage-capacity tables; stage-capacity table based on survey of November 1934 used to time of peak stage of Mar. 2 (8:30 p.m.), table corrected by silt survey made after storm used thereafter.

Maxima.- 1938: Inflow, 1,350 second-feet 3:15 p.m. Mar. 2.
Outflow, 739 second-feet 6 p.m. Mar. 2.
1929-37: Mean hourly inflow, 227 second-feet 3 - 4 a.m. Jan. 1, 1934.

Remarks.- Records good. Altitude of spillway, 1,706 feet. Area at spillway level, 23 acres (after storm of Mar. 2). Capacity at spillway level before storm, 1,040 acre-feet; after storm, 974 acre-feet. Basic data Feb. 27 to Mar. 10 and complete record for rest of February, March, and April furnished by Los Angeles County Flood Control District, through H. E. Hedger, chief engineer.

Mean daily inflow, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	1.6	101	5	11	8.5	15	4.5	21	1.6	9	3.3
2	.6	416	6	12	8	39	4.7	22	1.6	8.5	3.4
3	7	147	5	13	5.5	38	4.7	23	.8	7	3.4
4	5	67	5	14	3.4	33	3.9	24	1.1	8.5	3.4
5	1.9	45	5	15	2.7	27	4	25	1.2	9.5	3.5
6	1.6	37	4.5	16	2	20	4	26	.8	9.5	3.5
7	1.2	31	4.5	17	2.1	18	4	27	2.8	9.5	3.5
8	1.3	31	3.7	18	2	14	3.4	28	50	10	2.6
9	3.2	22	3.8	19	2.7	11	3.3	29		8	3.6
10	2.5	17	4.5	20	2	11	3.3	30		7	3.6
								31		7	
Mean monthly inflow, in second-feet									4.45	39.8	4.02
Inflow, in acre-feet									247	2,450	239

Inflow, in second-feet, at indicated time, 1938

Hr.	Feb.27	Feb.28	Mar.1	Mar.2	Mar.3	Mar.4	Mar.5	Mar.6	Mar.7	Mar.8	Mar.9	Mar.10
1	0	4.8	370	45	207							
2	0	7	275	47	190	80						
3	.8	9.5	235	50	180							
4	.8	11	218	60	170	75	49	39	32	31	25	18
5	.8	11	150	81	163							
6	.8	13	103	105	161	72						
7	1.0	44	95	140	195							
8	2.8	55	86	210	215	69	47	38	30	32	24	17
9	4.8	54	82	313	187							
10	6	54	75	405	172	66						
11	8.5	54	67	520	161							
N	6	57	60	550	153	63	45	37	29	32	22	17
1	4.8	64	54	570	146							
2	3.6	57	50	645	139	61						
3	2.4	49	48	1,080	130							
4	2.2	45	46	1,100	122	59	43	36	29	31	21	16
5	2.1	43	45	1,000	117							
6	2.2	41	43	780	109	56						
7	2.4	43	42	630	103							
8	2.6	46	40	520	98	54	42	36	30	29	19	16
9	2.8	55	38	430	94							
10	3.1	90	36	315	90	52						
11	3.5	170	33	245	86							
M	3.9	260	36	215	86	50	40	35	31	26	18	21

Supplemental record.- Mar. 2, 3:15 p.m., 1,350 sec.-ft.

Mean daily outflow, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	0	10	4.5	11	0	14	0	21	0	10	0
2	0	179	4.5	12	0	16	0	22	0	10	0
3	0	117	4.5	13	0	16	0	23	0	10	0
4	0	173	4.5	14	0	16	0	24	0	6.5	0
5	0	96	4.5	15	0	18	0	25	0	5	0
6	0	94	4.5	16	0	25	0	26	0	5	0
7	0	60	4.5	17	0	25	0	27	0	9	0
8	0	48	4.5	18	0	21	0	28	0	12	0
9	0	33	2.3	19	0	12	0	29		8.5	0
10	0	37	0	20	0	10	0	30		7	0
								31		6	
Mean monthly outflow, in second-feet									0	35.8	1.28
Outflow, in acre-feet									0	2,200	76

Outflow, in second-feet, at indicated time, 1938

Hr.	Feb.27	Feb.28	Mar.1	Mar.2	Mar.3	Mar.4	Mar.5	Mar.6	Mar.7	Mar.8	Mar.9	Mar.10
1					138	344						
2	0	0	0	29	138	342						
3					138	340						
4	0	0	0	29	138	337	66	108	60	59	30	43
5					83	335						
6	0	0	0	29	83	333						
7					84	330						
8	0	0	0	30	84	164	66	107	60	59	30	43
9					84	0						
10	0	0	0	30	84	0	0					
11					84	83						
N	0	0	0	31	84	166	66	105	60	59	29	42
1				32	84	149						
2	0	0	0	81	112	132	112	83		59		
3	0	0	0	131	123	66						
4	0	0	15	134	106	66	111	62	60	30	29	42
5	0	0	29	456	123	33						
6	0	0	29	739	140	66					43	42
7				460	140	66						
8	0	0	29	462	140	66	110	61	60	30	43	21
9				462	140	66						
10	0	0	29	328	140	66						17
11				327	244	66						
M	0	0	29	231	346	66	109	60	59	30	43	17

Supplemental records.- Mar. 2, 4:01 p.m., 449 sec.-ft.; 5:01 p.m., 732 sec.-ft.; and 6:01 p.m., 458 sec.-ft.

Live Oak Creek at flood-control reservoir near La Verne, Calif.

Location.- Water-stage recorder, lat. 34°07'45", long. 117°44'45", in NW¼ sec. 32, T. 1 N., R. 8 W., 2½ miles northeast of La Verne. Altitude of stream bed, 1,430 feet.

Drainage area.- Area, 2.30 square miles. Average altitude, 2,220 feet. Maximum altitude, 3,694 feet. Average slope, 36 percent. Length of main stream channel, 2.75 miles. Average slope of main stream channel, 16 percent.

Gage-height record.- Water-stage recorder graph;staff-gage observations daily at 8 a.m. and more frequently during storm periods.

Discharge record.- Computed from valve rating curve, valve operation record, record of stage, and stage-capacity tables; stage-capacity table based on survey of March 1936 used to time of peak stage of Mar. 2 (6:20 p.m.), table based on survey of May 1938 used thereafter.

Maxima.- 1938: Inflow, 373 second-feet 3:45 p.m. Mar. 2.
Outflow, 200 second-feet about 5:30 p.m. Mar. 2.
1936-37: Mean inflow, 139 second-feet between 6 and 6:30 p.m. Feb. 6, 1937.

Remarks.- Records good for March and fair for February and April. Altitude of spillway, 1,497 feet. Area at spillway level, 11.6 acrss (May 1938). Capacity at spillway level before storm of Mar. 2, 242 acre-feet, after storm, 229 acre-feet. Basic data Feb. 27 to Mar. 12 and entire record Feb. 1-26 and Mar. 13 to Apr. 30 furnished by Los Angeles County Flood Control District, through H. E. Hedger, chief engineer.

Mean daily inflow, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	0.2	28	0.8	11	4.9	3.2	0.4	21	0	1.9	0.4
2	0	148	.7	12	3.3	13	.4	22	0	1.7	.4
3	1.5	35	.7	13	1.2	11	.5	23	0	1.5	.3
4	1.2	13	.7	14	.5	6	.5	24	0	1.3	.6
5	.5	10	.7	15	.5	4.9	.5	25	0	1.2	1.2
6	.1	6	.5	16	.2	4.1	.4	26	0	1.1	.8
7	.1	4.4	.5	17	.2	3.4	.4	27	.4	1.1	.6
8	.1	3.1	.5	18	.1	2.8	.4	28	19	1.2	.5
9	.9	3.0	.4	19	.1	2.3	.4	29		1	.5
10	.6	3.3	.4	20	.1	2.1	.4	30		1.1	.4
								31		.9	
Mean monthly inflow, in second-feet									1.28	10.3	0.53
Inflow, in acre-feet									70.8	636	31.5

Inflow, in second-feet, at indicated time, 1938

Hour	February 27	February 28	March 1	March 2	March 3
1	0	0.1	177	13	46
2	0	.1	85	15	42
3	0	1.0	62	16	41
4	0	1.4	41	17	39
5	0	2.5	31	29	40
6	0	7.5	27	64	53
7	0	8.5	23	110	56
8	1.0	11	19	130	49
9	1.3	25	16	168	43
10	1.2	31	14	290	38
11	.9	37	13	278	34
N	.7	34	12	250	31
1	.6	25	11	214	30
2	.5	19	10	290	29
3	.5	16	10	335	29
4	.4	14	9.5	285	28
5	.4	12	9	269	27
6	.3	10	8	241	26
7	.3	9	7	158	25
8	.3	11	6	103	23
9	.3	14	5	92	21
10	.3	40	3.2	84	20
11	.2	72	2.6	71	19
M	.2	115	6	54	18

Supplemental record.- Mar. 2, 3:45 p.m., 373 sec.-ft.

Mean daily outflow, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	0	26	0	11	0	3.2	0	21	0	3.2	0
2	0	82	0	12	0	7.5	0	22	0	3.1	0
3	0	55	0	13	0	7.5	0	23	0	2.6	0
4	0	22	0	14	0	5.5	0	24	0	2.6	0
5	0	19	0	15	0	5.5	0	25	0	.8	0
6	0	17	0	16	0	5.5	0	26	0	0	0
7	0	15	0	17	0	5.5	0	27	0	0	0
8	0	13	0	18	0	5.0	0	28	.7	0	0
9	0	6.5	0	19	0	2.8	0	29		0	0
10	0	3.2	0	20	0	3.3	0	30		0	0
								31		0	
Mean monthly outflow, in second-feet									0.025	10.4	0
Outflow, in acre-feet									1.39	639	0

Outflow, in second-feet, at indicated time, 1938

Hr.	Feb.27	Feb.28	Mar.1	Mar.2	Mar.3	Mar.4	Mar.5	Mar.6	Mar.7	Mar.8	Mar.9	Mar.10
1			40									
2			40	25	75	25						
3												
4			40	25	75	25	19	18	16	14	12	
5												
6			40	25	75	25						
7												
8			40	25	75	25	19	18	16	14	12	
9			40	25								
10			28	50	74	25					4.5	
11			15	75		19						
N	0	0	15	75	74	19	19	17	16	13	3.2	3.2
1				75								
2			15	88	74	19						
3				150	25							
4			15	162	25	19	19	17	15	13	3.2	
5				195								
6			15	195	25	19						
7				175								
8			15	150	25	19	18	17	15	13	3.2	
9				113								
10		0	15	100	25	19						
11		10	15	88								
M	0	25	25	75	25	19	18	16	15	12	3.2	

Supplemental record.- Mar. 2, 5:30 p.m., 200 sec.-ft.

Thompson Creek at flood-control reservoir near Claremont, Calif.

Location.- Staff gage, lat. 34°08'30", long. 117°42'30", in SW¼ sec. 27, T. 1 N., R 8 W., 3 miles north of Claremont. Altitude of stream bed, 1,582 feet.

Drainage area.- Area, 3.91 square miles. Average altitude, 2,670 feet. Maximum altitude, 4,700 feet. Average slope, 36 percent. Length of main stream channel, 2.5 miles. Average slope of main stream channel, 24 percent.

Gage-height record.- Staff gage read at irregular intervals except during storm period, when several observations were made daily.

Discharge record.- Computed from valve rating curves, valve operation record, record of stage, observations of depth of flow in release flume, and stage-capacity table; stage-capacity table based on survey of November 1932 used throughout storm period.

Maxima.- 1938: Inflow, 669 second-feet 2:30 p.m. Mar. 2.
Outflow, 133 second-feet 12:30 p.m. Mar. 3.
1932-37: Mean hourly inflow, 91 second-feet between 8 and 9 a.m. Feb. 9, 1932.

Remarks.- Records good Feb. 28 to Mar. 6; major portion of inflow for periods Feb. 1-27 and Mar. 7 to Apr. 30 diverted above dam to spreading grounds. Altitude of spillway, 1,640 feet. Area at spillway level, 35 acres. Capacity at spillway level before storm of Mar. 2, 812 acre-feet; after storm, 786 acre-feet. Basic data Feb. 28 to Mar. 6 and entire record Feb. 1-27 and Mar. 7 to Apr. 30 furnished by Los Angeles County Flood Control District, through H. E. Hedger, chief engineer.

Mean daily inflow, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	0	42	0	11	1.0	3.4	0	21	0	0	0
2	0	259	0	12	5.2	14	0	22	0	0	0
3	0	101	0	13	4.8	11	0	23	0	0	0
4	0	44	0	14	0	5.5	0	24	0	0	0
5	0	25	0	15	0	1.8	0	25	0	0	0
6	0	16	0	16	.2	0	0	26	0	0	0
7	0	9	0	17	0	0	0	27	0	0	0
8	0	0	0	18	0	0	0	28	24	0	0
9	0	0	0	19	0	0	0	29		0	0
10	.1	0	0	20	0	0	0	30		0	0
								31		0	
Mean monthly inflow, in second-feet									1.26	17.2	0
Inflow, in acre-feet									70	1,050	0

Inflow, in second-feet, at indicated time, 1938

Hour	Feb.27	Feb.28	Mar. 1	Mar. 2	Mar. 3	Mar. 4	Mar. 5	Mar. 6	Mar. 7
1	0		170	13	126				
2	0	0.2	155	15	119	62			
3	0		117	17	120				
4	0	.2	75	24	153	56	29		
5	0		51	34	142				
6	0	.2	43	55	132	50			
7	0		40	98	126				
8	0	.3	37	130	120	46	26		
9	0	30	35	233	115				
10	0	39	32	375	108	43			
11	0	27	29	430	102				
N	0	23	27	398	96	39	23	16	9
1	0	22	25	380	92				
2	0	21	22	460	88	37			
3	0	20	18	535	84				
4	0	20	16	508	80	36	22		
5	0	19	15	540	77				
6	0	18	14	530	75	35			
7	0	18	14	405	74				
8	0	18	13	292	73	34	21		
9	0	19	12	236	71				
10	0	23	12	212	70	34			
11	0	35	11	173	69				
M	0	66	12	136	67	33	19		

Supplemental record.- Mar. 2, 2:30 p.m., 669 sec.-ft.

Mean daily outflow, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	0	0	1.7	11	0	25	1.3	21	0	5	1.0
2	0	16	1.7	12	0	.5	1.3	22	.1	1.2	1.0
3	0	101	1.7	13	0	3.1	1.3	23	.1	1.2	1.0
4	0	87	1.7	14	0	10	1.3	24	.1	1.7	1.0
5	0	39	1.6	15	0	10	1.3	25	.1	1.8	1.0
6	0	25	1.6	16	0	11	1.3	26	.1	1.7	1.0
7	0	17	1.6	17	0	13	1.3	27	.1	2.2	.9
8	0	12	1.6	18	0	13	1.2	28	0	2.3	.9
9	0	20	1.6	19	0	12	1.2	29		2.1	.9
10	0	23	1.6	20	0	12	1.2	30		2.0	.9
								31		2.1	
Mean monthly outflow, in second-feet									0.02	15.3	1.29
Outflow, in acre-feet									1.2	938	76.8

Outflow, in second-feet, at indicated time, 1938

Hour	March 2	March 3	March 4	March 5	March 6
1		70			
2		72	117		
3		74			
4		76	114	45	24
5		77			
6		78	111		
7		79			
8		79	107	42	26
9		80			
10		80	104		
11		80			
N		81	101	42	32
1		132			
2		131	98		
3		130	96		
4	0	129	50	36	29
5	0	128			
6	39	128	49		
7	52	127	.		
8	59	125	49	32	23
9	63	123			
10	67	121	47		
11	68	120			
M	70	119	45	28	26

Supplemental record.- Mar. 3, 12:30 p.m., 133 sec.-ft.

Los Angeles River Basin

Pacoima Creek at flood-control reservoir near San Fernando, Calif.

Location.- Water-stage recorder, lat. 34°20'00", long. 118°23'45", in NW¼NW¼ sec. 19, T. 3 N., R. 14 W., 4 miles northeast of San Fernando. Altitude of stream bed, 1,650 feet.

Drainage area.- Area, 27.8 square miles. Average altitude, 3,890 feet. Maximum altitude, 6,500 feet. Average slope, 41 percent. Length of main stream channel, 15.6 miles. Average slope of main stream channel, 5.2 percent.

Gage-height record.- Water-stage recorder graph; staff-gage readings daily at 8 a.m. and more frequently during storm period.

Discharge record.- Computed from spillway rating curve, valve rating curves, valve operation record, record of stage and stage-capacity tables; stage-capacity table based on survey of January 1936 used to time of peak stage of Mar. 3 (1 a.m.); table corrected by silt survey made after storm used thereafter.

Maxima.- 1938: Inflow, 8,450 second-feet 3:50 p.m. Mar. 2.
Outflow, 2,440 second-feet 12 p.m. Mar. 2 to 2 a.m. Mar. 3.
1914, 1927-37: 5,400 second-feet February 1914.

Remarks.- Records good. Altitude of spillway, 1,950 feet. Area at spillway level, 63 acres (after storm of Mar. 2). Capacity at spillway level before storm, 5,592 acre-feet; after storm, 5,004 acre-feet. Basic data Feb. 27 to Mar. 11 and entire record Feb. 1-26 and Mar. 12 to Apr. 30 furnished by Los Angeles County Flood Control District, through H. E. Hedger, chief engineer.

Mean daily inflow, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	14	355	60	11	198	130	36	21	27	132	28
2	14	2,430	55	12	146	310	34	22	25	119	27
3	100	1,520	53	13	84	445	36	23	24	106	26
4	113	579	47	14	61	364	35	24	21	96	31
5	55	367	45	15	49	304	34	25	21	87	39
6	32	279	44	16	42	254	33	26	21	78	28
7	24	225	42	17	38	215	32	27	26	74	24
8	20	193	39	18	35	183	31	28	116	71	23
9	24	156	39	19	35	159	29	29		66	27
10	30	140	37	20	30	146	28	30		62	28
								31		61	
Mean monthly inflow, in second-feet									50.9	313	35.7
Inflow, in acre-feet									2,830	19,250	2,120

Inflow, in second-feet, at indicated time, 1938

Hr.	Feb.27	Feb.28	Mar.1	Mar.2	Mar.3	Mar.4	Mar.5	Mar.6	Mar.7	Mar.8	Mar.9	Mar.10
1	14	37	435	261	2,480	805						
2	14	37	590	276	2,370	780						
3	14	37	690	300	2,220	748						
4	14	42	685	343	2,100	718	415	305	250	207	162	146
5	15	54	500	375	2,000	695						
6	15	51	390	407	1,880	665						
7	16	47	375	495	1,800	636						
8	17	54	364	630	1,690	620	377	293	230	200	156	142
9	18	82	350	815	1,600	608						
10	20	95	336	1,060	1,540	597						
11	24	106	371	1,190	1,500	570						
N	26	119	306	1,700	1,450	537	360	270	219	195	153	140
1	27	141	289	3,120	1,380	528						
2	28	140	275	3,840	1,320	520						
3	29	135	262	5,950	1,260	516						
4	33	131	253	7,850	1,180	508	348	260	210	190	152	138
5	36	129	250	5,730	1,140	480						
6	38	128	249	5,000	1,070	474						
7	40	130	248	4,700	1,030	469						
8	39	136	247	3,860	1,000	460	329	259	203	178	151	135
9	39	169	246	3,320	960	454						
10	38	270	244	2,950	920	448						
11	38	300	242	2,710	890	440						
M	37	412	247	2,550	860	436	314	259	204	170	148	131

Supplemental record.- Mar. 2, 3:50 p.m., 8,450 sec.-ft.

Mean daily outflow, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	0	56	50	11	0	297	74	21	33	265	27
2	0	618	50	12	18	243	87	22	33	268	25
3	0	1,740	50	13	30	296	83	23	33	249	25
4	0	676	77	14	19	301	86	24	33	144	25
5	0	416	108	15	8	240	62	25	28	106	25
6	0	330	106	16	0	304	47	26	22	120	17
7	0	293	104	17	26	302	46	27	8	91	22
8	0	316	100	18	32	297	46	28	8	76	22
9	0	310	97	19	22	292	35	29		61	22
10	0	304	95	20	33	285	30	30		57	9.5
								31		49	
Mean monthly outflow, in second-feet									13.8	303	55.1
Outflow, in acre-feet									766	18,650	3,280

Outflow, in second-feet, at indicated time, 1938

Hr.	Feb.27	Feb.28	Mar.1	Mar.2	Mar.3	Mar.4	Mar.5	Mar.6	Mar.7	Mar.8	Mar.9	Mar.10
1	20	0	25	174	2,440	958						
2	20	0	25	87	2,440	927	475		0			
3	20	0	25	0	2,370	887						
4	20	0	25	0	2,250	847	465	342	320	317	312	306
5	20	0	25	0	2,140	817						
6	20	0	25	0	2,020	787	455					
7	20	0	25	0	2,010	747						
8	20	0	25	0	2,000	726	434	332	320	317	312	305
9	20	0	25	0	1,980	706						
10	0	0	25	0	1,960	686	424					
11	0	0	25	0	1,940	666						
N	0	0	25	0	1,840	646	404	325	320	316	310	304
1	0	0	25	0	1,730							
2	0	0	25	143	1,630	606						
3	0	0	25	297	1,540							
4	0	0	50	487	1,460	576	393	321	319	315	310	303
5	0	25	75	684	1,380							
6	0	25	75	796	1,290	545						
7	0	25	75	1,480	1,240							
8	0	25	75	2,220	1,180	525	373	321	319	314	308	302
9	0	25	174	2,380	1,140							
10	0	25	174	2,410	1,080	505						
11	0	25	174	2,420	1,050							
M	0	25	174	2,440	1,020	485	353	320	318	313	307	300

Tujunga Creek at flood-control reservoir near Sunland, Calif.

Location.- Water-stage recorder, lat. 34°17'30", long. 118°11'10", in NE¼ sec. 1, T. 2 N., R. 13 W., 10 miles northeast of Sunland. Altitude of stream bed, 2,104 feet.

Drainage area.- Area, 81.4 square miles. Average altitude, 4,500 feet. Maximum altitude, 7,078 feet. Average slope, 40 percent. Length of main stream channel, 12 miles. Average slope of main stream channel, 7.8 percent.

Gage-height record.- Water-stage recorder graph except 2 - 6 p.m. Mar. 2; staff-gage readings daily at 8 a.m. and more frequently during storm period; maximum stage determined from floodmarks.

Discharge record.- Computed from record of stage, spillway rating curve, valve rating curves, valve operation record, discharge measurements, and stage-capacity tables; stage-capacity table of December 1935 used to time of peak stage (5:20 p.m. Mar. 2), table corrected by silt survey made after storm used thereafter.

Maxima.- 1938: Inflow, 35,000 second-feet 5 p.m., Mar. 2.
Outflow, 32,500 second-feet 5:20 p.m., Mar. 2.
1931-37: Mean hourly inflow, 2,430 second-feet 3 to 4 a.m., Jan. 1, 1934.

Remarks.- Records fair. Spillway discharge affected by debris Mar. 5-6. Altitude of spillway, 2,290 feet. Area at spillway level, 74.4 acres (after storm of Mar. 2). Storage capacity before storm, 6,240 acre-feet; after storm, 4,734 acre-feet. Basic data Feb. 27 to Mar. 11 and entire record for remainder of February, March, and April furnished by Los Angeles County Flood Control District, through H. E. Hedger, chief engineer.

Mean daily inflow, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	66	1,240	112	11	532	204	84	21	38	199	62
2	39	11,600	117	12	228	825	85	22	38	188	60
3	118	2,330	115	13	112	558	91	23	35	184	62
4	150	867	108	14	81	405	81	24	32	171	72
5	66	521	102	15	65	347	80	25	35	166	69
6	34	415	82	16	51	301	78	26	35	143	62
7	25	327	82	17	39	259	73	27	106	133	59
8	25	324	84	18	37	272	72	28	501	142	57
9	59	247	82	19	55	242	67	29		135	64
10	91	236	82	20	43	205	66	30		126	61
								31		117	
Mean monthly inflow, in second-feet									97.7	756	79.0
Inflow, in acre-feet									5,430	46,470	4,700

Inflow, in second-feet, at indicated time, 1938

Hr.	Feb.27	Feb.28	Mar.1	Mar.2	Mar.3	Mar.4	Mar.5	Mar.6	Mar.7	Mar.8	Mar.9	Mar.10
1	15	160	3,140	420	5,750							
2	24	179	3,330	420	4,250	1,090						
3	33	188	3,060	437	3,420							
4	40	196	2,310	655	3,000	1,030	612	431				
5	40	210	1,750	805	2,700							
6	38	240	1,430	1,000	2,600	970						
7	35	280	1,300	1,450	2,530							
8	32	318	1,220	2,200	2,400	920	574	428				
9	30	490	1,160	3,280	2,220							
10	36	580	1,020	4,300	2,150	875						
11	48	553	925	7,400	2,070							
N	57	580	882	13,000	1,990	857	497	422	327	324	247	236
1	66	600	820	18,700	1,880							
2	82	600	775	23,100	1,780	815						
3	102	585	715	25,000	1,700							
4	131	595	680	30,000	1,610	773	451	411				
5	173	620	650	35,000	1,550							
6	229	640	620	28,500	1,470	746						
7	275	515	590	23,200	1,400							
8	253	470	547	18,300	1,350	723	440	392				
9	244	440	520	14,900	1,290							
10	238	720	492	11,600	1,230	700						
11	221	1,100	469	9,550	1,190							
M	200	2,130	448	7,860	1,150	675	435	366				

Mean daily outflow, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	13	627	100	11	13	196	71	21	57	225	0
2	21	10,900	109	12	55	557	72	22	57	191	0
3	7	2,530	111	13	76	619	73	23	57	169	0
4	2.5	893	108	14	76	383	74	24	57	195	0
5	40	524	137	15	57	320	50	25	57	67	0
6	45	405	155	16	26	433	18	26	57	170	0
7	45	818	155	17	50	429	18	27	17	171	0
8	45	775	104	18	31	283	8	28	60	144	0
9	0	717	68	19	38	248	2.7	29		97	0
10	0	342	69	20	57	213	0	30		99	31
								31		97	
Mean monthly outflow, in second-feet									39.9	769	51.1
Outflow, in acre-feet									2,210	47,280	3,040

Outflow, in second-feet, at indicated time, 1938

Hr.	Feb.27	Feb.28	Mar.1	Mar.2	Mar.3	Mar.4	Mar.5	Mar.6	Mar.7	Mar.8	Mar.9	Mar.10
1	52		518	980	6,620	1,170						
2	52	0	518	975	5,200	1,130	650		375			
3	52		518	975	3,970	1,090						
4	52	0	518	970	3,150	1,050	625	400	365	1,050	655	891
5	52		560	970	2,800	1,020						
6	52	0	584	970	2,630	985	600		360			880
7	52		571	970	2,590	960						
8	26	0	571	970	2,520	930	585	400	360	1,040	646	300
9	0		530	1,120	2,410	910						
10	0	0	530	1,130	2,220	895	570		370	1,020		
11	0		520	1,560	2,130	882						
N	0	0	507	8,090	2,060	875	515	410	380	640	635	295
1			507	15,300	1,960	865						
2	0	0	507	21,400	1,870	845	470			190		205
3		80	480	23,200	1,780	820						
4	0	160	456	28,200	1,690	800	445	410	1,510	190	625	205
5			430	32,200	1,600	775						
6	0	160	712	31,400	1,520	757	431					205
7			994	25,100	1,480	742						
8	0	160	990	20,300	1,410	730	420	410	1,460	670	940	205
9			990	16,400	1,360	718						
10	0	160	985	13,100	1,310	703	413		1,100		930	0
11			985	10,600	1,260	690						
M	0	160	980	8,330	1,210	680	408	395	1,080	660	905	200

Supplemental record.- Mar. 2, 5:20 p.m., 32,500 sec.-ft.

Santa Anita Creek at flood-control reservoir near Sierra Madre, Calif.

Location.- Water-stage recorder, lat. 34°11'10", long. 118°01'10", near center of sec. 10, T. 1 N., R. 11 W., 2½ miles northeast of Sierra Madre. Altitude of stream bed, 1,100 feet.

Drainage area.- Area, 10.8 square miles. Average altitude, 3,560 feet. Maximum altitude, 5,886 feet. Average slope, 47 percent. Length of main stream channel, 4.2 miles. Average slope of main stream channel, 20 percent.

Gage-height record.- Water-stage recorder graph to about 2 p.m. Mar. 2. Frequent staff-gage readings during storm period; one reading daily at 8 a.m. at other times.

Discharge record.- Computed from record of stage, spillway discharge curves, valve rating curves, valve operation record, discharge measurements, and stage-capacity tables; stage-capacity table based on survey of February 1936 used to time of peak stage of Mar. 2 (4:20 p.m.), table based on survey of July 1938 used thereafter.

Maxima.- 1938: Inflow, 5,490 second-feet 4:10 p.m. Mar. 2.
Outflow, 5,260 second-feet 4:20 p.m. Mar. 2.
1932-37: Mean daily inflow, 323 second-feet Jan. 1, 1934.

Remarks.- Records good except those for Mar. 3 to Apr. 30, which are fair. Area at lower spillway level, 10.8 acres (July 1938). Capacity at lower spillway level before storm of Mar. 2, 1,010 acre-feet, after storm, 683 acre-feet. Altitude of spillway, 1,316 feet. Basic data Feb. 27 to Mar. 11 and entire record for rest of February, March, and April furnished by Los Angeles County Flood Control District, through H. E. Hedger, chief engineer.

Mean daily inflow, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	18	423	36	11	64	77	26	21	11	62	24
2	7.5	1,780	34	12	50	146	26	22	11	58	23
3	74	666	32	13	32	129	26	23	10	55	23
4	74	285	30	14	25	108	26	24	10	51	23
5	29	185	28	15	19	93	26	25	9	49	23
6	17	143	27	16	16	85	26	26	8.5	47	22
7	14	123	27	17	15	78	25	27	15	45	21
8	11	107	27	18	16	74	24	28	332	43	21
9	21	90	27	19	17	69	24	29		42	20
10	19	86	26	20	13	67	24	30		40	20
								31		38	
Mean monthly inflow, in second-feet									34.2	172	25.6
Inflow, in acre-feet									1,900	10,600	1,520

Inflow, in second-feet, at indicated time, 1938

Hr.	Feb.27	Feb.28	Mar.1	Mar.2	Mar.3	Mar.4	Mar.5	Mar.6	Mar.7	Mar.8	Mar.9	Mar.10
1	7	17	1,110	231	1,160							
2	7.5	21	890	240	1,090	370						
3	7.5	30	750	260	1,020							
4	8	51	650	285	930	350	212	150	131	115	95	86
5	9	96	555	370	880							
6	9.5	115	490	402	830	327						
7	11	147	457	450	770							
8	9.5	226	430	820	720	302	201	146	129	113	93	86
9	9	239	393	970	680							
10	16	258	360	1,650	655	285						
11	22	330	334	2,130	625							
N	24	405	323	2,010	590	274	187	143	125	107	90	86
1	27	505	312	2,600	560							
2	25	505	298	3,060	535	261						
3	23	479	278	4,130	516							
4	21	455	260	5,120	498	249	175	140	117	103	88	86
5	18	429	250	4,700	483							
6	15	411	239	3,500	468	240						
7	14	390	228	2,600	453							
8	17	350	222	2,000	440	234	162	138	115	98	86	83
9	21	370	218	1,700	428							
10	19	660	217	1,500	417	229						
11	17	900	220	1,390	405							
M	17	1,130	225	1,300	392	223	156	134	115	96	86	80

Supplemental record.- Mar. 2, 4:10 p.m., 5,490 sec.-ft.

Mean daily outflow, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	8	559	37	11	19	77	21	21	11	62	24
2	12	1,520	37	12	56	144	.3	22	11	59	24
3	4.7	692	36	13	55	130	1.1	23	11	55	23
4	43	292	34	14	43	109	19	24	11	51	22
5	46	188	34	15	32	93	26	25	11	57	23
6	28	146	34	16	23	85	26	26	11	42	22
7	29	124	35	17	17	79	25	27	13	46	21
8	38	107	35	18	12	74	24	28	104	42	21
9	14	90	36	19	8.5	70	24	29		40	20
10	0	86	37	20	12	67	24	30		42	21
								31		39	
Mean monthly outflow, in second-feet........................									24.4	170	26
Outflow, in acre-feet....................................									1,360	10,450	1,520

Outflow, in second-feet, at indicated time, 1938

Hr.	Feb.27	Feb.28	Mar.1	Mar.2	Mar.3	Mar.4	Mar.5	Mar.6	Mar.7	Mar.8	Mar.9	Mar.10
1			573		1,230	383						
2	10	25	580	494	1,130	370						
3					1,060	359						
4	10	25	584	484	980	346	216	155	130	115	95	86
5					930	336						
6	10	25	583	477	870	325						
7	10			367	807	318						
8	5	25	580	256	745	310	195	148	127	115	93	86
9	0	25		263	705	302						
10	0	50	575	402	665	297						
11		75		548	645	290						
N	0	75	568	570	605	280	185	144	127	105	93	86
1				983	590	269						
2	0	75	560	2,450	550	260						
3	25			3,850	530	260						
4	25	75	550	5,060	510	260	185	140	115	105	86	86
5		75		4,960	495	258						
6	25	138	541	3,320	480	254						
7		200		2,790	467	250						
8	25	200	530	1,950	453	246	160	137	115	98	86	86
9		200		1,760	440	241						
10	25	200	518	1,610	425	236						
11		467		1,520	411	231						
M	25	564	506	1,350	398	226	160	133	115	97	86	82

Supplemental record.- Mar. 2, 4:20 p.m., 5,260 sec.-ft.

Little Santa Anita Creek at flood-control reservoir near Sierra Madre, Calif.

Location.- Water-stage recorder, lat. 34°10'40", long. 118°02'40", near center of sec. 10, T. 1 N., R. 11 W., 1½ miles northeast of Sierra Madre. Altitude of stream bed, 1,110 feet.

Drainage area.- Area, 2.39 square miles. Average altitude, 3,170 feet. Maximum altitude, 5,433 feet. Average slope, 50 percent. Length of main stream channel, 3.0 miles. Average slope of main stream channel, 27 percent.

Gage-height record.- Water-stage recorder graph.

Discharge record.- Outflow obtained from record of water-stage recorder located 270 feet below the dam (operated by Los Angeles County Flood Control District). Inflow Feb. 1 - 27 and Mar. 4 to Apr. 30, taken as equal to measured outflow; inflow Feb. 27 to Mar. 3 computed from measured outflow and changes in storage, based on record of stage and stage-capacity tables. Stage capacity table based on survey of April 1932 used to 2 p.m. Mar. 2, and table based on survey made after storm used after 12 p.m. Mar. 2; capacity loss distributed during period 2 - 12 p.m. Mar. 2.

Maxima.- 1938: Inflow, 633 second-feet 4:10 p.m. Mar. 2.
Outflow, 630 second-feet 4:10 p.m. Mar. 2.

Remarks.- Records fair. Altitude of spillway, 1,172 feet. Area at spillway level, 1.04 acres (April 1938). Capacity at spillway level before storm of Mar. 2, 47.4 acre-feet, capacity after storm, 8.5 acre-feet. Basic data Feb. 28 to Mar. 3 and entire record Feb. 1 - 27 and Mar. 5 to Apr. 30 furnished by Los Angeles County Flood Control District, through H. E. Hedger, chief engineer.

Mean daily inflow, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	0.9	67	5.5	11	6.5	19	4.7	21	0.7	27	3.7
2	0	214	5	12	5.5	38	5	22	.5	16	3.0
3	6.5	118	5	13	3.3	35	5.5	23	.4	8.5	2.2
4	8.5	48	6	14	2.8	20	6	24	.3	8	3.3
5	3.9	38	6	15	2.0	30	6	25	.2	11	3.3
6	1.8	32	5.5	16	1.6	14	6	26	.2	11	3.3
7	1.1	28	5	17	1.2	12	5	27	1.5	7.5	2.8
8	.8	16	4.7	18	1.1	13	2.8	28	47	7	2.5
9	2.4	12	5	19	.9	19	1.6	29		7.5	2.8
10	1.8	16	5	20	.7	24	2.2	30		4.7	2.3
								31		4.7	
Mean monthly inflow, in second-feet									3.72	29.9	4.22
Inflow, in acre-feet									206	1,840	251

Inflow, in second-feet, at indicated time, 1938

Hour	February 27	February 28	March 1	March 2	March 3
1			133	40	
2	0.2	3.3	132	45	180
3			123	49	
4	.4	7	105	56	164
5			92	65	
6	.4	15	85	92	151
7		23	80	76	
8	.6	36	75	80	138
9		19	72	143	
10	1.7	24	66	220	126
11		38	62	236	
N	3.6	53	57	212	112
1		60	53	252	
2	2.3	73	48	370	100
3		92	44	465	
4	2.0	76	41	560	86
5		65	39	403	
6	2.2	58	36	363	79
7		54	34	318	
8	2.2	58	33	272	76
9		77	33	247	
10	1.8	103	34	230	73
11		125	35	214	
M	1.8	134	38	198	70

Supplemental record.- Mar. 2, 4:10 p.m., 633 sec.-ft.

Mean daily outflow, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	0.9	64	5.5	11	6.5	19	4.7	21	0.7	27	3.7
2	0	192	5	12	5.5	38	5	22	.5	16	3.0
3	6.5	118	5	13	3.3	35	5.5	23	.4	8.5	2.2
4	8.5	48	6	14	2.8	20	6	24	.3	8	3.3
5	3.9	38	6	15	2.0	30	6	25	.2	11	3.3
6	1.8	32	5.5	16	1.6	14	6	26	.2	11	3.3
7	1.1	28	5	17	1.2	12	5	27	1.5	7.5	2.8
8	.8	16	4.7	18	1.1	13	2.8	28	45	7	2.5
9	2.4	12	5	19	.9	19	1.6	29		7.5	2.8
10	1.8	16	5	20	.7	24	2.2	30		4.7	3.3
								31		4.7	
Mean monthly outflow, in second-feet									3.65	29.2	4.26
Outflow, in acre-feet									203	1,800	253

Outflow, in second-feet, at indicated time, 1938

Hour	February 27	February 28	March 1	March 2	March 3
1			108	49	190
2	0.2	3.3	136	43	182
3			117	41	160
4	.4	7	101	52	148
5			94	68	157
6	.4	15	88	82	162
7			80	13	162
8	.6	32	73	10	150
9			67	168	138
10	1.7	20	62	182	129
11		35	59	170	121
N	3.6	64	55	139	112
1		54	52	157	107
2	2.3	82	50	215	102
3		86	47	416	99
4	2.0	80	44	630	89
5		59	39	421	85
6	2.2	55	34	363	84
7		53	29	324	83
8	2.2	54	27	277	82
9		56	26	240	82
10	1.8	86	31	219	81
11		114	37	205	80
M	1.8	128	42	200	80

Supplemental record.- Mar. 2, 4:10 p.m., 630 sec.-ft.

Eaton Creek at flood-control reservoir near Pasadena, Calif.

Location.- Water-stage recorder, lat. 34°10'05", long. 118°05'30", in Santa Anita grant, 2 miles northeast of Pasadena, Los Angeles County. Altitude of stream bed, 840 feet.

Drainage area.- Area, 9.48 square miles. Average altitude, 3,100 feet. Maximum altitude, 6,156 feet. Average slope, 52 percent. Length of main stream channel, 6 miles. Average slope of main stream channel, 17 percent.

Gage-height record.- Water-stage recorder; staff-gage observations made daily at 8 a.m. and more frequently during storm period.

Discharge record.- Computed from spillway rating curve, valve rating curve, valve operation record, record of stage, and stage-capacity tables; stage-capacity table based on survey of November 1937 used to time of peak stage of Mar. 2 (4:45 p.m.), and table corrected by silt survey made after storm used thereafter. Inflow Feb. 1 - 26 and Mar. 28 to Apr. 30 taken from records of station "Eaton Creek near Pasadena", 1 mile upstream. Small outflows measured by weir.

Maxima.- 1938: Inflow, 3,340 second-feet 4:40 p.m. Mar. 2.
Outflow, 2,800 second-feet 4:45 p.m. Mar. 2.

Remarks.- Records good except those for Feb. 1 - 26 and Mar. 28 to Apr. 30, which are fair. Altitude of spillway, 888 feet. Area at spillway level, 39 acres (after storm of Mar. 2). Capacity at spillway level before storm of Mar. 2, 940 acre-feet, after storm, 698 acre-feet. The City of Pasadena Water Department diverts water from Eaton Creek during periods of low flow. Basic data Feb. 27 to Mar. 27 furnished by Los Angeles County Flood Control District, through H. E. Hedger, chief engineer.

Mean daily inflow, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	9	161	18	11	45	38	9	21	2.0	26	8
2	1.9	882	13	12	40	74	14	22	2.0	24	7
3	36	300	9	13	20	55	12	23	2.0	22	6
4	46	126	11	14	11	44	10	24	2.0	24	5.5
5	20	82	12	15	7.5	32	8.5	25	2.0	22	5
6	4.6	64	11	16	6	31	8	26	4.0	19	4.5
7	0	57	11	17	12	33	7	27	8	20	4.5
8	0	52	10	18	5	26	6	28	155	23	4.5
9	8.8	42	8	19	5	25	6	29		22	3.5
10	6.3	39	8.5	20	3.0	27	7.5	30		18	4.5
								31		17	
Mean monthly inflow, in second-feet									16.6	78.2	8.42
Inflow, in acre-feet									921	4,810	501

Inflow, in second-feet, at indicated time, 1938

Hr.	Feb.27	Feb.28	Mar.1	Mar.2	Mar.3	Mar.4	Mar.5	Mar.6	Mar.7	Mar.8	Mar.9	Mar.10
1	0	13	500	84	515							
2	1.5	13	386	93	466	162						
3	3	13	302	106	442							
4	3	25	263	140	430	153	91	68	59	54	45	38
5	3	53	221	182	413							
6	3	78	195	252	395	146						
7	3	102	171	296	370							
8	3.5	121	158	370	320	138	86	65	58	54	44	39
9	5.5	138	145	695	315							
10	9.5	146	133	990	295	128						
11	14	153	124	1,090	279							
N	13	170	113	1,050	263	120	81	63	57	53	42	40
1	12	211	103	1,320	256							
2	9	200	96	1,610	250	116						
3	5	190	89	1,900	242							
4	8	179	82	2,300	230	110	77	62	56	51	41	40
5	12	165	78	2,280	219							
6	13	149	73	1,610	207	106						
7	13	129	70	1,200	200							
8	13	140	69	1,050	191	102	73	60	56	49	39	39
9	13	223	68	845	186							
10	13	428	67	720	180	98						
11	13	440	70	645	173							
M	13	475	75	567	170	96	70	60	54	47	38	39

Supplemental record.- Mar. 2, 4:40 p.m., 3,340 sec.-ft.

Mean daily outflow, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	0	191	0	11	0	16	9.5	21	0	21	2.9
2	0	694	0	12	0	34	4.3	22	0	21	4.0
3	0	295	5	13	0	32	19	23	0	21	3.5
4	0	144	4.1	14	0	15	16	24	0	18	2.3
5	0	129	2.2	15	0	49	15	25	0	17	2.3
6	0	128	2.2	16	0	55	5.5	26	0	16	.9
7	0	87	11	17	0	35	4.3	27	0	17	0
8	0	58	23	18	0	45	4.0	28	6	31	0
9	0	61	23	19	0	45	3.5	29		49	0
10	0	60	23	20	0	30	2.4	30		0	0
								31		0	
Mean monthly outflow, in second-feet									.214	77.8	6.43
Outflow, in acre-feet									11.9	4,780	383

Outflow, in second-feet, at indicated time, 1938

Hr.	Feb.27	Feb.28	Mar.1	Mar.2	Mar.3	Mar.4	Mar.5	Mar.6	Mar.7	Mar.8	Mar.9	Mar.10
1	0	0	235		517	165						
2	0	0	237	166	517	165						
3					430							
4	0	0	237	165	430	165	130	127	125	58	57	108
5					430							
6	0	0	237	165	324	164						106
7				166	325							
8	0	0	235	60	325	164	129	126	124	58	57	70
9				60	325	131						
10	0	0	235	149	325	131			123		0	35
11				244	324							
N	0	0	232	452	305	131	129	134	58	58	0	35
1			231	464	202							
2			120	474	203	131					29	
3				800								
.4			120	2,330	203	131	128	131	58	58	58	35
5				2,660								
6			120	1,980	204	131					114	
7				1,250								
8			120	1,250	204	131	127	129	58	58	114	35
9		0	170	1,240								
10		59	169	1,160	204	130						
11		60		715								
M	0	146	167	607	203	130	128	127	58	58	111	35

Supplemental record.- Mar. 2, 4:45 p.m., 2,800 sec.-ft.

Calleguas Creek Basin

Honda Barranca at Berylwood Road, near Somis, Calif.

Location.- Water-stage recorder and weir control, lat. 34°17'22", long. 119°02'32", in Los Posas grant, 3½ miles northwest of Somis, Ventura County. Altitude, 562 feet.

Drainage area.- Area, 1.35 square miles. Average slope, 35 percent.

Gage-height record.- Water-stage recorder graph.

Discharge record.- Stage-discharge relation determined from broad-crested weir rating.

Maximum.- 1938: Discharge, 256 second-feet 9:05 p.m. Feb. 28.

Remarks.- Records good. Records furnished by U. S. Soil Conservation Service.

Mean daily discharge, in second-feet, 1938

Feb.	28	13
Mar.	1	.6
	2	24
	3	7.2

Runoff Feb. 28 to Mar. 3, in acre-feet ... 89

Discharge, in second-feet, at indicated time, 1938

Hour	February 28	March 1	March 2	March 3
1	0	2.4	15	13
2	0	.6	14	13
3	.2	.2	23	13
4	.9	0	70	40
5	14.5	0	35	14
6	9	0	45	14
7	5	0	25	14
8	3.1	0	15	14
9	1.9	0	30	19
10	1.1	0	26	13
11	.7	0	35	1.5
N	.4	.1	45	.6
1	.2	.1	18	.3
2	.1	.1	64	.2
3	0	.2	19	.1
4	0	.2	13	0
5	0	.2	13	0
6	.4	.3	13	0
7	2.1	.3	13	0
8	23	.4	13	0
9	200	.4	13	0
10	16	.7	13	0
11	40	2.2	13	0
M	7.6	6.4	13	0

Supplemental record.- Feb. 28, 9:05 p.m., 256 sec.-ft.

Honda Barranca at Perkins Road, near Somis, Calif.

Location.- Water-stage recorder and concrete weir control, lat. 34°16'05", long. 119°02'55", in Los Posas grant, at Perkins road, 3 miles west of Somis, Ventura County. Altitude, 349 feet.

Drainage area.- Area, 2.86 square miles. Average slope, 27 percent.

Gage-height record.- Water-stage recorder graph.

Discharge record.- Stage-discharge relation determined from broad-crested weir rating.

Maximum.- 1938: Discharge, 486 second-feet 9:20 p.m. Feb. 28.

Remarks.- Records good. Records furnished by U. S. Soil Conservation Service.

Mean daily discharge, in second-feet, 1938

Feb.	28	26
Mar.	1	1.0
	2	119
	3	19.4

Runoff Feb.28 to Mar.3, in acre-feet 328

Discharge, in second-feet, at indicated time, 1938

Hour	February 28	March 1	March 2	March 3
1	0	0	50	17
2	0	0	50	22
3	0	0	37	23
4	0	0	160	250
5	0	0	230	50
6	60	0	350	24
7	5	0	210	9
8	.7	0	110	36
9	.1	0	241	30
10	0	0	163	0
11	0	0	210	0
N	0	0	330	0
1	0	0	110	0
2	0	0	190	0
3	0	0	210	0
4	0	0	57	0
5	0	0	51	0
6	0	0	34	0
7	0	0	8	0
8	40	0	4.9	0
9	172	0	7.0	0
10	100	0	7.0	0
11	237	5.5	7.5	0
M	4	37	11	0

Supplemental record.- Feb. 28, 9:20 p.m., 486 sec.-ft.

MAXIMUM INFLOW TO RESERVOIRS

As previously explained, for several reservoirs the records of stage and outflow were used in conjunction with the capacity tables to compute rates of inflow. For those reservoirs for which the differences in contents over periods of time constitute a material factor in the determination of inflow, the results will tend to be more reliable for long than for short periods. The differences in contents for very short periods of time may be subject to considerable inaccuracy or even be indeterminable, and therefore the method is not well suited to the determination of rates of inflow at any instant or for any very short period.

During the period of maximum discharge the inflow to reservoirs was not computed for any interval of less than 15 minutes. Therefore, further study was made in order to estimate the maximum or peak rates of inflow as given in the preceding tables.

Records of instantaneous rates of discharge throughout the flood rise were determined at five stations, which are listed in table 12. These records are included, also, in the basic discharge records presented in the next preceding section. Table 12 gives, for each of these stations, the peak discharge rate (inches per hour for 1 minute), the maximum 5-, 10-, 15-, and 30-minute and 1-hour rates, and the percentage of excess of the peak rate above the maximum 5-, 10-, 15-, and 30-minute and 1-hour rates. The percentages of excess, as given in table 12, appear to have a tendency to increase as the discharge rates decrease.

Table 12.- Maximum rates of discharge for indicated periods and excess of peak discharge (duration 1 minute) over those rates in San Dimas and Calleguas Creek Basins, March 2, 1938

Stream	Drainage area (sq. mi.)	Maximum discharge (inches per hour)						Excess of peak (1 minute) over maximum discharge (percent)		
		1 min.	5 min.	10 min.	15 min.	30 min.	1 hour	15 min.	30 min.	1 hour
San Dimas Creek										
Wolfskill Creek near San Dimas	2.78	0.463	0.451	0.439	0.424	0.390	0.379	9.2	18.7	22.2
West Fork of San Dimas Creek, near San Dimas	1.66	.620	.615	.609	.602	.574	.559	3.0	8.0	10.9
Fern Canyon Watershed No. 3	.084	.350	.346	.340	.334	.324	.314	4.8	8.0	11.5
Fern Canyon Watershed No. 2	.063	.710	.703	.698	.691	.671	.651	2.7	5.8	9.1
Calleguas Creek										
Honda Barranca at Perkins Road, near Somis	2.86	.214	.211	.206	.203	.190	.166	5.4	12.6	28.9

In figure 17, the discharge rates for each of the stations are plotted against corresponding intervals of time, using logarithmic scales. For this purpose, the peak discharge is assumed to correspond to a time interval of 1 minute. The plottings have been extended to longer intervals than are given in table 12. Discharge rates have also been plotted on the figure for some of the reservoirs for which the maximum average rates of inflow are believed to be reliably determined for the shorter intervals of time.

In general, the ratios of the maximum mean discharge, for progressively shorter intervals of time, to the maximum 24-hour discharge have been found to increase with enough regularity to suggest that the trend of these ratios could be utilized in estimating the peak inflow to the reservoirs. The foregoing rather fragmentary observations as to the relation between peak rates of flow and the average rates over selected periods of time have been useful in estimating the peak inflow.

With the exception of those for the Fern Canyon stations, none of the records in table 12 cover conditions in the zones of heaviest rainfall and thus may not reflect in all particulars the conditions of flow that prevailed with runoff from higher rainfall intensities. There is the possibility that none of the records in table 12 are necessarily applicable to the behavior of flow in some of the steep channels in which higher and relatively sharper peaks may have occurred. As pointed out in the preceding section, the peak discharge was made up of debris in an unknown but perhaps substantial amount.

Table 13 shows, for each of 14 drainage basins for which basic discharge records have been presented, its area, the peak discharge (estimated for most of the streams) and maximum 24-hour discharge in second-feet per square mile, and the ratios of the peak discharge and maximum mean discharge for indicated periods to the maximum 24-hour discharge.

Figure 18 shows these ratios graphically for several of the stations represented in table 13 and also the average ratios for the 14 stations plotted against the corresponding intervals of time.

These ratios reflect generally and in a composite way the factors affecting the concentration of flow in individual streams, such as amount and rate of precipitation, direction of storm travel, size and shape of drainage basin, slope of stream channel and general slope of basin, infiltration rate and retention capacity of basin, and vegetative cover. It is to be inferred that the greater the difference in these factors in the

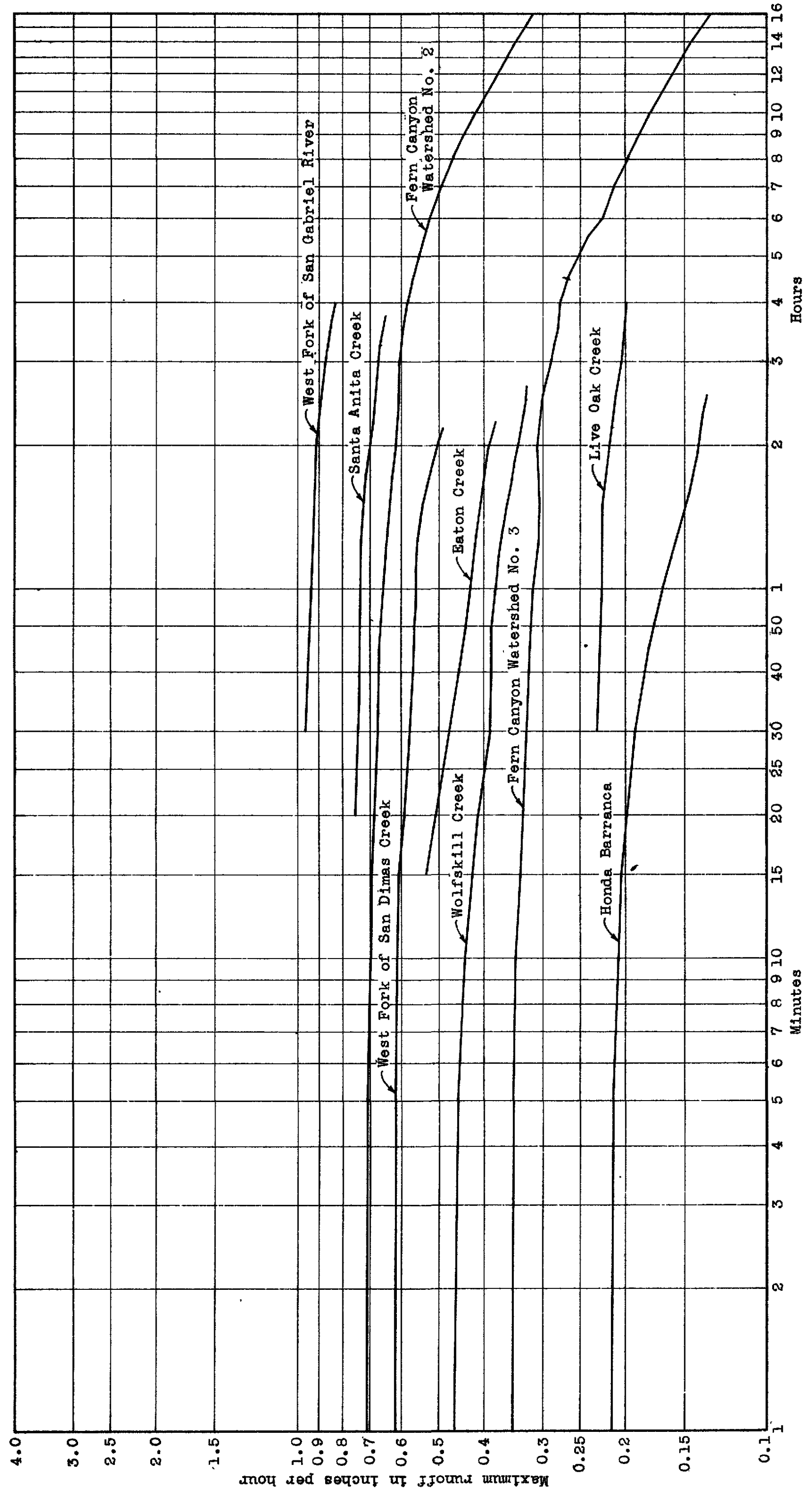

Figure 17.- Maximum rates of runoff for periods of 1 minute to 16 hours in certain areas in San Gabriel and Los Angeles River and Calleguas Creek Basins.

Table 13.- Ratio of maximum discharge for indicated periods to maximum 24-hour discharge for certain areas in Santa Ana, San Gabriel, and Los Angeles River Basins

Stream	Drainage area (sq.mi.)	Maximum discharge (sec.-ft. per sq.mi.)		Ratio of maximum mean discharge for indicated period to maximum 24-hour discharge							
		Peak	24 hour	Peak	½ hour	1 hour	2 hour	3 hour	6 hour	12 hour	18 hour
Santa Ana River Basin											
Santiago Creek, inflow to Santiago Reservoir near Villa Park	62.5	158	80.3	1.96	1.94	1.90	1.86	1.82	1.66	1.36	1.14
San Gabriel River Basin											
West Fork of San Gabriel River, inflow to flood-control reservoir near Camp Rincon	40.4	666	222	*3.00	2.82	2.73	2.68	2.56	2.09	1.53	1.22
San Dimas Creek, inflow to flood-control reservoir near San Dimas	16.5	279	106	*2.63	2.50	2.44	2.38	2.38	2.06	1.62	1.25
Dalton Creek, inflow to flood-control reservoir near Glendora	4.49	301	103	*2.92	2.86	2.57	2.43	2.34	1.92	1.49	1.20
Thompson Creek, inflow to flood-control reservoir near Claremont	3.91	172	73.9	*2.32	2.05	2.00	1.86	1.82	1.74	1.48	1.19
Sawpit Creek, inflow to flood-control reservoir near Monrovia	3.27	306	123	*2.48	2.47	2.31	2.21	2.10	1.84	1.47	1.21
Live Oak Creek, inflow to flood-control reservoir near La Verne	2.30	162	67.3	*2.41	2.21	2.17	2.08	1.96	1.83	1.57	1.24
Fern Canyon Watershed No. 3 near San Dimas	.084	226	71.0	3.18	2.94	2.85	2.80	2.62	2.14	1.48	1.19
Fern Canyon Watershed No. 2 near San Dimas	.063	457	153	2.99	2.83	2.74	2.59	2.54	2.20	1.56	1.22
Los Angeles River Basin											
Tujunga Creek, inflow to flood-control reservoir near Sunland	81.4	430	154	*2.79	2.62	2.58	2.52	2.42	2.15	1.50	1.17
Pacoima Creek, inflow to flood-control reservoir near San Fernando	27.8	304	112	*2.71	2.55	2.49	2.18	2.08	1.79	1.38	1.16
Santa Anita Creek, inflow to flood-control reservoir near Sierra Madre	10.8	508	184	*2.76	2.55	2.52	2.41	2.31	1.90	1.45	1.17
Eaton Creek, inflow to flood-control reservoir near Pasadena	9.48	352	102	*3.45	2.98	2.72	2.45	2.18	1.90	1.48	1.21
Little Santa Anita Creek, inflow to flood-control reservoir near Sierra Madre	2.39	265	104	*2.51	2.31	2.24	2.05	1.91	1.64	1.30	1.13
Average	-	-	-	2.72	2.54	2.45	2.32	2.22	1.92	1.48	1.19

*Estimated.

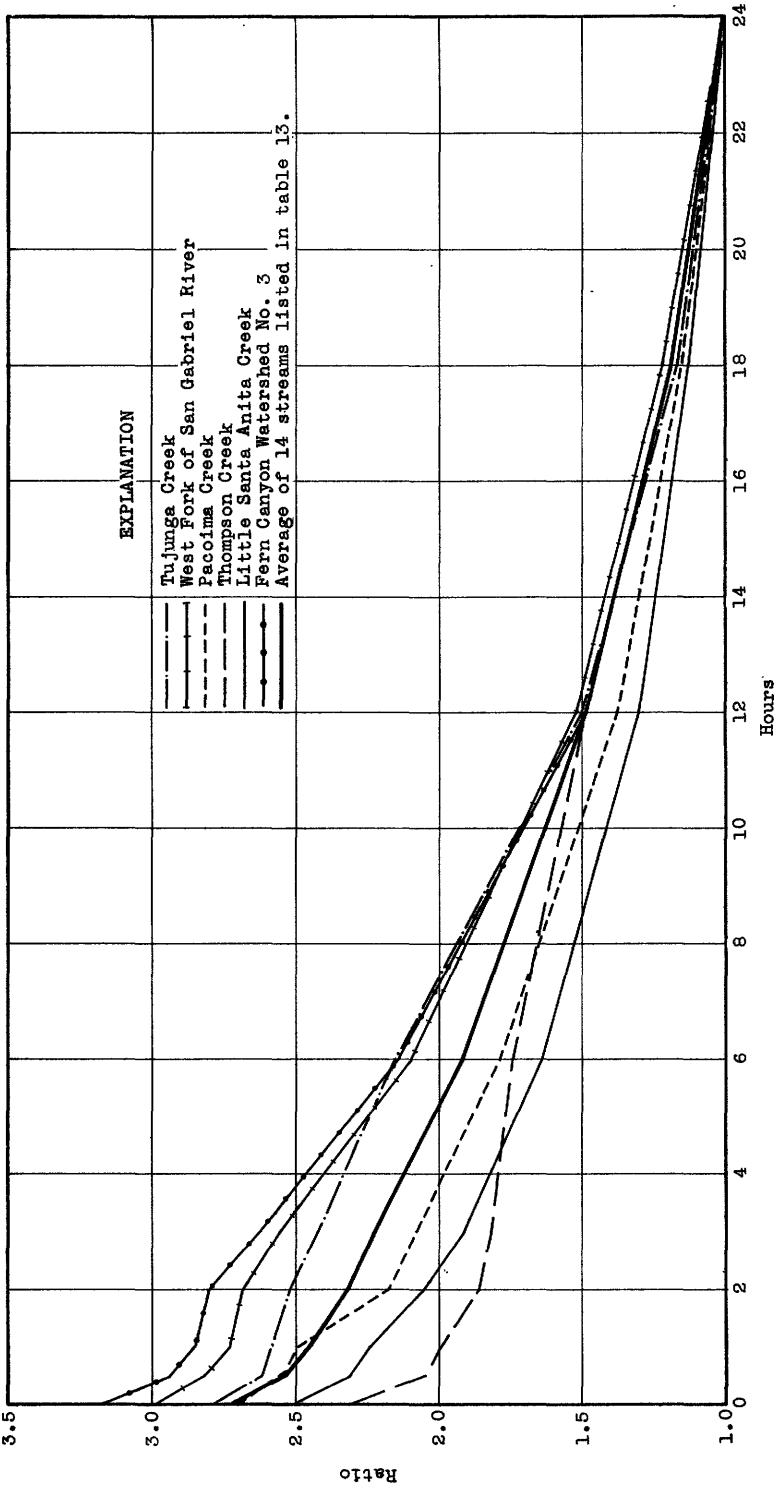

Figure 18.- Ratio of maximum discharge for indicated period to maximum 24-hour discharge in areas above certain dams in Santa Ana, San Gabriel, and Los Angeles River Basins.

several basins, the wider the variation in the magnitude of the ratios during the floods.

Although the estimates of maximum or peak inflow to the reservoirs is obtained by somewhat indirect methods into which individual judgment enters, it is believed that the margin of probable error is relatively small and that, in general, the results are acceptable for determinations of extremely high flood flows and materially more accurate than the results obtained for the floods of March 1938 at other places in this region.

STUDIES OF BASIC DISCHARGE RECORDS IN RELATION TO BASIN CHARACTERISTICS AND RAINFALL

For the region most severely affected by the storms and floods of March 1938, many rainfall records have been presented and discussed in earlier sections of this report. Also, available basic discharge records believed to be reliable, have been presented in the section immediately preceding. For most of the stream basins covered by these records there are given, in tables to be introduced hereafter, pertinent data regarding the area, channel slopes, form relations, and other characteristics that may be examined with regard to their influence on the concentration of flood runoff. (See tables 14 and 15.)

The studies of the hydrologic features relate, first, to volumes of rainfall and flood runoff expressed in depth in inches over these areas, and second, to rates of rainfall and runoff. Since the flood proper was largely associated with the heavy rain that fell on March 2, the analyses of rates of rainfall and runoff have been confined to the rates for the maximum 24-hour period. The discussion of the precipitation and runoff on an areal basis relates to the entire storm and flood period.

The analyses of the runoff data on an areal basis are primarily of interest in problems relating to the storage of water at or near the source either in reservoirs or by means of land-management or cultural practices whereby the natural retention capacity of the basins can be maintained. The analyses showing the extent to which the runoff was concentrated with respect to time, the relations between the maximum rates of rainfall and runoff, and the time interval or "lag" between the occurrence of rain and its appearance as stream flow are largely of interest in problems relating to the control and disposal of water after it has reached the stream channels. They are essential to the designing of spillways, bridge openings, bypasses, flood channels, and other engineering structures and flood-control devices.

Basin characteristics

The word "basin" is used at many places in this report to mean only the area upstream from the gaging station at which the runoff is measured. Therefore, under this usage, in the consideration of runoff it means the entire basin of a given stream only if the gaging station discussed is near the mouth of the stream.

By means of suitable maps certain drainage basins hereinafter listed were divided areally into segments or groups of segments, the upper limit of the first segment being 1 mile upstream from the reference station (lowermost point in the basin), and the upper limit of each succeeding segment or group being 1 mile upstream from that of the segment or group preceding it, or, when it is reached, the watershed line of the basin. The division of a drainage area into segments is illustrated in figure 19, which represents Tujunga Creek above the flood-control dam.

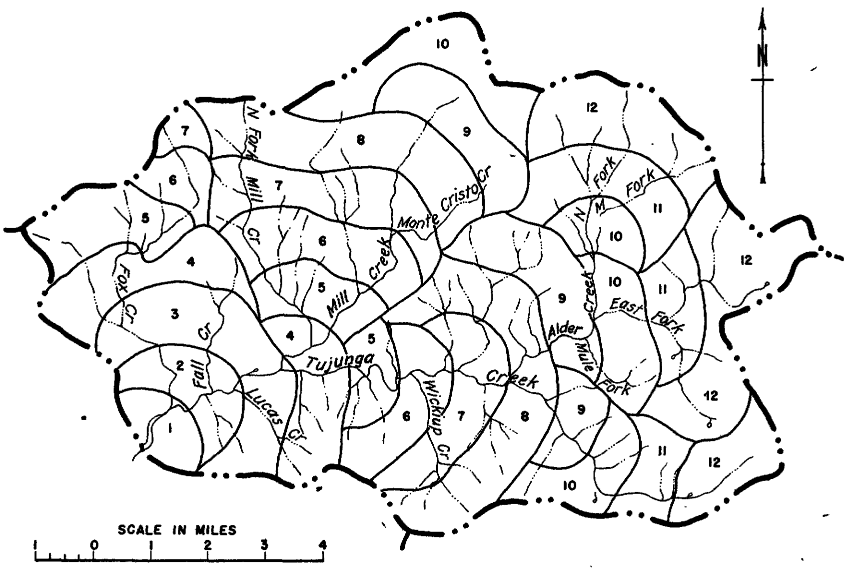

Figure 19.- Tujunga Creek Basin, showing segments used in determining maximum concentration of area.

Figure 20 shows the distribution of the segments of the drainage basins in accordance with this method of subdivision. The influence that the shape of the basin may have had on the concentration of runoff may be considered by studying this figure. For example, Pacoima Creek Basin, except for the segment 9 to 10 miles from the dam, has no segment or group of segments as shown equal in area to 10 percent of the total drainage basin. The basin of West Fork of San Gabriel River, which produced the greatest runoff to the square mile measured at the flood-control dams during the flood of March 1938, has no group of segments upstream from the dam with an area as great as 20 percent of the entire drainage basin.

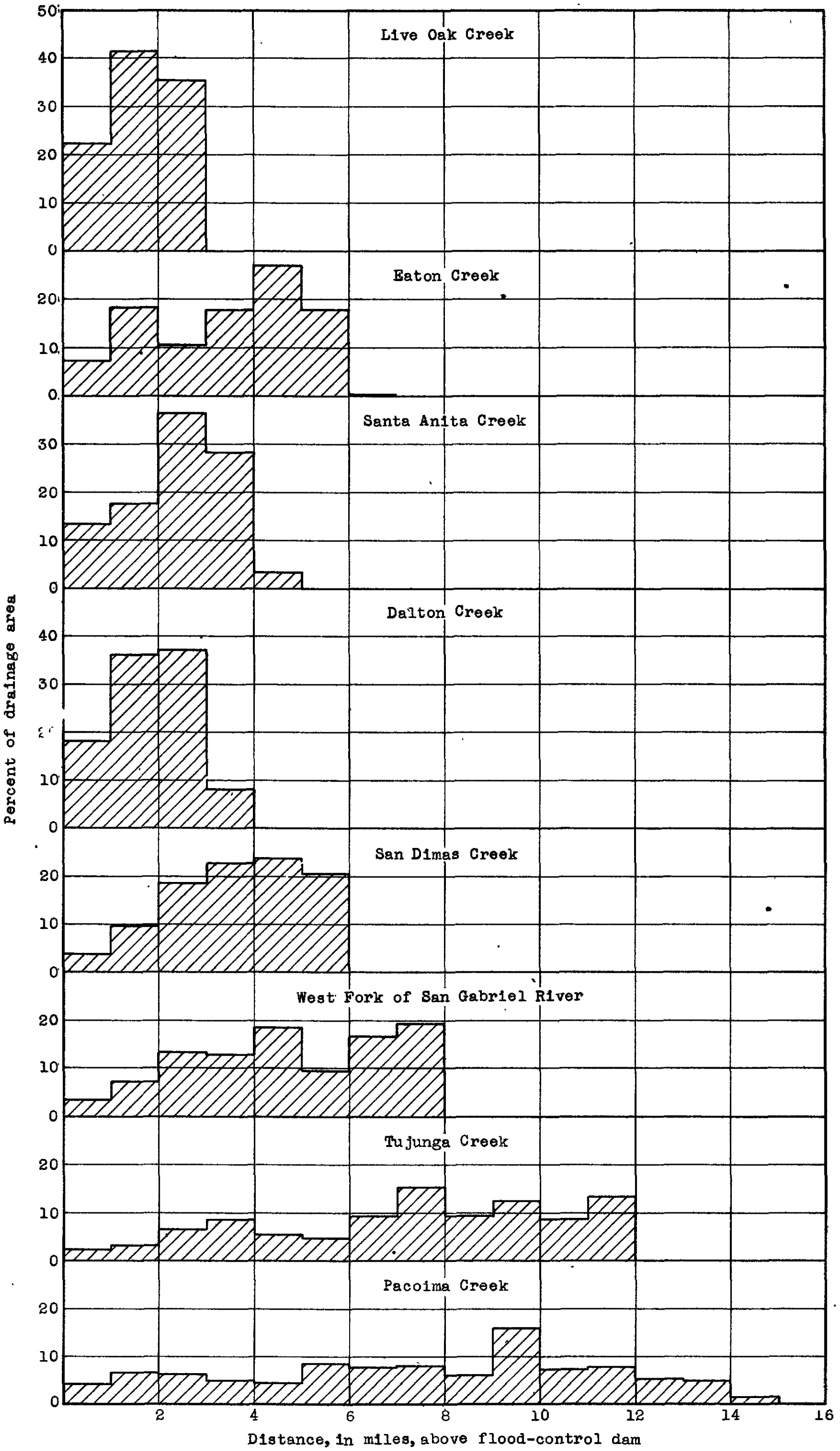

Figure 20.- Distribution of drainage area above flood-control dams in San Gabriel and Los Angeles River Basins.

However, the group of segments 6 to 8 miles upstream from the flood-control dam represents about 36 percent of the total drainage basin. Dalton Creek Basin shows a concentration of 37.9 percent of its area, or 1.7 square miles, within 2 to 3 miles of the dam. Table 14 shows the segment or group of segments, classified on the basis above described, that contains the maximum concentration of drainage area. For example, for Tujunga Creek the group of segments with the largest area (12.5 square miles) is 7 to 8 miles upstream from the flood-control dam measured along natural water courses. The average distance from the dam of all the segments in the entire drainage basin is shown in the last column to be 7.24 miles.

Table 14.- Characteristics of distribution of area in drainage basins above certain flood-control dams in San Gabriel and Los Angeles River Basins

Stream	Drainage area (square miles)	Maximum concentration of area in segment 1 mile wide (square miles)	Distance, in miles, from dam	
			To maximum concentration of area	To center of total drainage area
San Gabriel River Basin				
West Fork of San Gabriel River	40.4	7.9	7-8	4.92
San Dimas Creek	16.5	4.0	4-5	3.65
Dalton Creek	4.49	1.7	2-3	1.86
Thompson Creek	3.91	1.8	2-3	2.27
Sawpit Creek	3.27	1.3	2-3	1.78
Live Oak Creek	2.30	1.0	1-2	1.63
Los Angeles River Basin				
Tujunga Creek	81.4	12.5	7-8	7.24
Pacoima Creek	27.8	4.4	9-10	7.45
Santa Anita Creek	10.8	3.8	2-3	2.41
Eaton Creek	9.48	2.6	4-5	3.44
Little Santa Anita Creek	2.39	1.1	1-2	1.41

The topographic characteristics of the drainage basins studied herein are shown in table 15. The areas of these basins range from 0.063 square mile, for Fern Canyon Watershed No. 2, to 81.4 square miles, for Tujunga Creek Basin. The land slopes of all the basins are steep; the two Fern Canyon Watersheds have the greatest slope--65 percent--and Live Oak and Thompson Creek Basins have the smallest slope--36 percent. The average altitudes in these basins range between 2,000 and 5,000 feet. Excluding the small Fern Creek Watersheds, Tujunga Creek Basin has the highest average altitude.

The size of the contributing area, the slope of the land areas and stream channels, and the shape of the basin, inasmuch as they determine distances and time of travel of the flood waters, undoubtedly influence the period of concentration of the flood runoff. Brief study of the data given in tables 15 and 17 (see pp. 140 and 150) suggests that the concentration characteristics of the several basins listed may be related directly or

Table 15.- Topographic characteristics of certain drainage basins above point of measurement in Santa Ana, San Gabriel, and Los Angeles River Basins

Basin	Area in square miles	Altitude, in feet			Average slope (percent)	Length of main stream channel (miles)	Average slope of main stream channel (percent)
		Maximum	Minimum	Average			
Santa Ana River Basin							
Santiago Creek	62.5	5,680	680	2,120	45	13	7.3
San Gabriel River Basin							
West Fork of San Gabriel River	40.4	8,038	2,140	4,290	47	8.5	13
San Dimas Creek	16.5	5,558	1,350	3,130	42	6	13
Dalton Creek	4.49	3,686	1,565	2,590	40	3.5	11
Thompson Creek	3.91	4,700	1,582	2,670	36	2.5	24
Sawpit Creek	3.27	5,390	1,228	2,960	50	3.1	25
Live Oak Creek	2.30	3,694	1,430	2,220	36	2.75	16
Fern Canyon Watershed No. 3	.084	5,400	4,500	5,000	65	.52	33
Fern Canyon Watershed No. 2	.063	5,400	4,500	5,000	65	.41	42
Los Angeles River Basin							
Tujunga Creek	81.4	7,078	2,104	4,500	40	12	7.8
Pacoima Creek	27.8	6,500	1,650	3,890	41	15.6	5.2
Santa Anita Creek	10.8	5,886	1,100	3,560	47	4.2	20
Eaton Creek	9.48	6,156	840	3,100	52	6.0	17
Little Santa Anita Creek	2.39	5,433	1,110	3,170	50	3.0	27

indirectly to the mean land slope. Other influences can perhaps be detected, and the basic data are here recorded for examination by other investigators. Nevertheless, for the floods of March 1938 the rainfall characteristics seem to have greatly influenced, and indeed to have dominated, the runoff characteristics.

Runoff characteristics

There were four distinct phases in the runoff resulting from the storm of February 27 to March 4, corresponding in many respects to the four phases of the storm as previously described. The first phase is associated with the rain that fell on February 27 and 28. On February 27 there was generally very little stream flow, but beginning about noon February 28, the flow gradually increased and reached a minor peak near or shortly after midnight, following the higher rates of rainfall near the end of the 2-day period. The second runoff phase lasted from about 1 a.m. to midnight March 1 when there was an almost complete cessation of rain and a gradual decrease in stream flow. The third runoff phase began during the early morning of March 2 and reached a climax generally between 2 and 5 p.m. on the same day, when most streams reached their maximum rates of discharge for the flood. Although the rain did not cease until later, the discharge rates were generally lower after the early evening of March 2. The fourth runoff phase lasted from the time of the peak on March 2 through March 10.

For basins for which continuous observations of runoff are available throughout the flood, analyses have been made of hourly records of rainfall, runoff, and retention, or the difference between the accumulated rainfall and the runoff. These analyses have been used as a check on the accuracy of derivations of discharge made to complete records at streamflow measurement stations. They are presented herein for use by engineers and hydrologists interested in flood runoff, especially under the physiographic and climatic conditions existing in southern California.

Graphs of hourly rainfall and runoff, in mean depth in inches, in figures 21 and 22, and graphs of the accumulated precipitation, runoff, and retention, in figures 23 and 24, are presented for West Fork of San Gabriel River and Live Oak Creek Basins, the two drainage areas showing the widest range in these factors, for the period February 27 to March 5. In figures 23 and 24 the periods covered by the runoff phases are indicated. The method of determining the rainfall in the basins is described on page 151.

First phase, February 27 and 28

Table 16 shows the amount, in inches, of accumulated rain that fell over the 13 basins during the first storm, before the accumulated runoff beginning at midnight on February 26 equaled 0.10 inch, and the accumulated rainfall and runoff and the retention, or difference between the rainfall and runoff, at the time of the first peak, which occurred generally either shortly before or shortly after midnight February 28. With the exception of the basin of the West Fork of San Gabriel River there was an accumulated retention in each of the 13 basins of between 3 and 4.8 inches before there was an accumulated runoff of 0.10 inch; the average retention for the 13 basins was about 3.9 inches. This condition was reached toward noon on February 28, 24 hours or more after the beginning of the storm. Although the accumulated rain up to the time of the first peak averaged about 8.5 inches, the total runoff averaged only 0.7 inch, indicating an average retention at that time of about 7.8 inches. The duration of rainfall in the first storm at rates in excess of 0.02 inch an hour was about 30 hours, and on this time basis there was an average increase in retention in the basins of about 0.26 inch an hour.

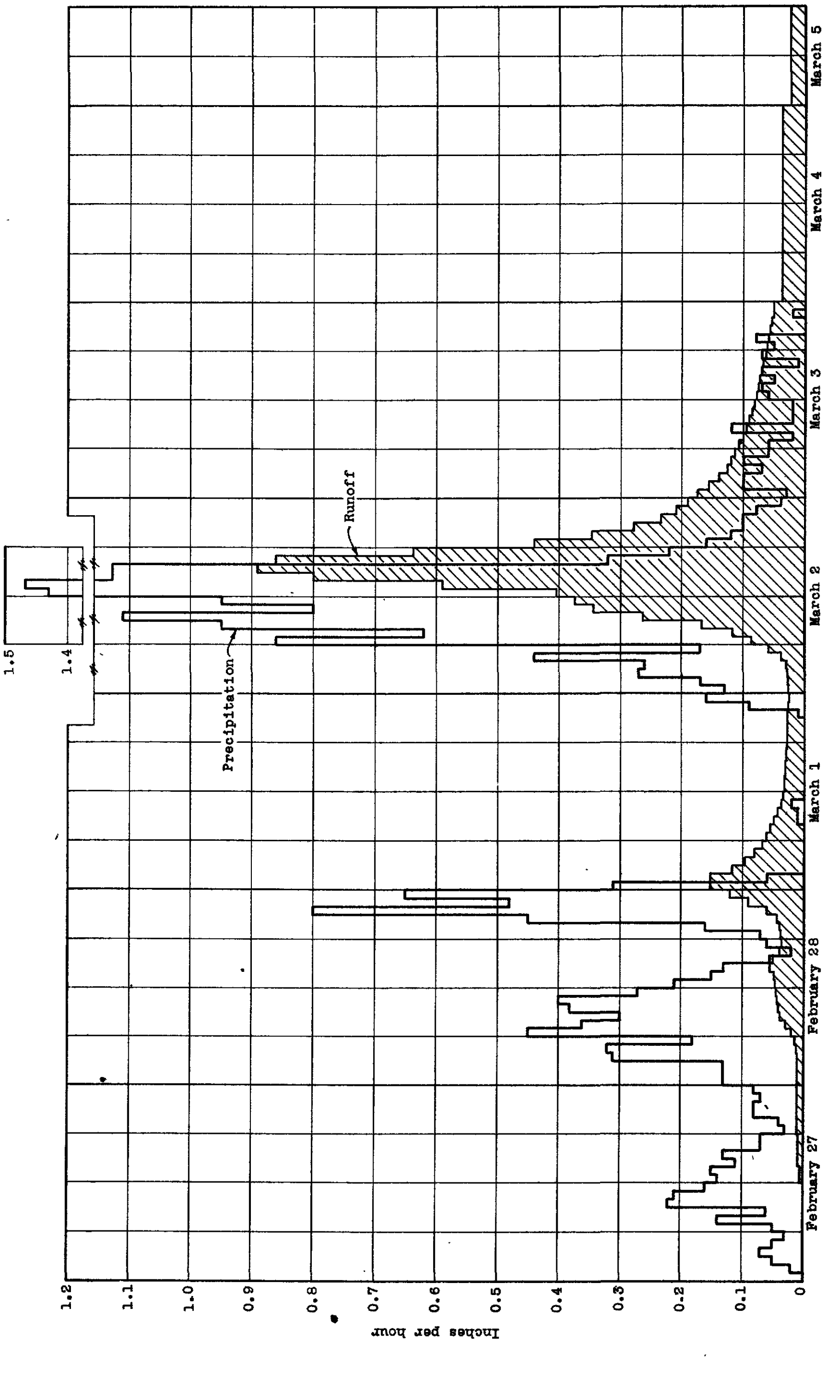

Figure 21.- Hourly precipitation and runoff, February 27 to March 5, for West Fork of San Gabriel River at flood-control dam No. 2.

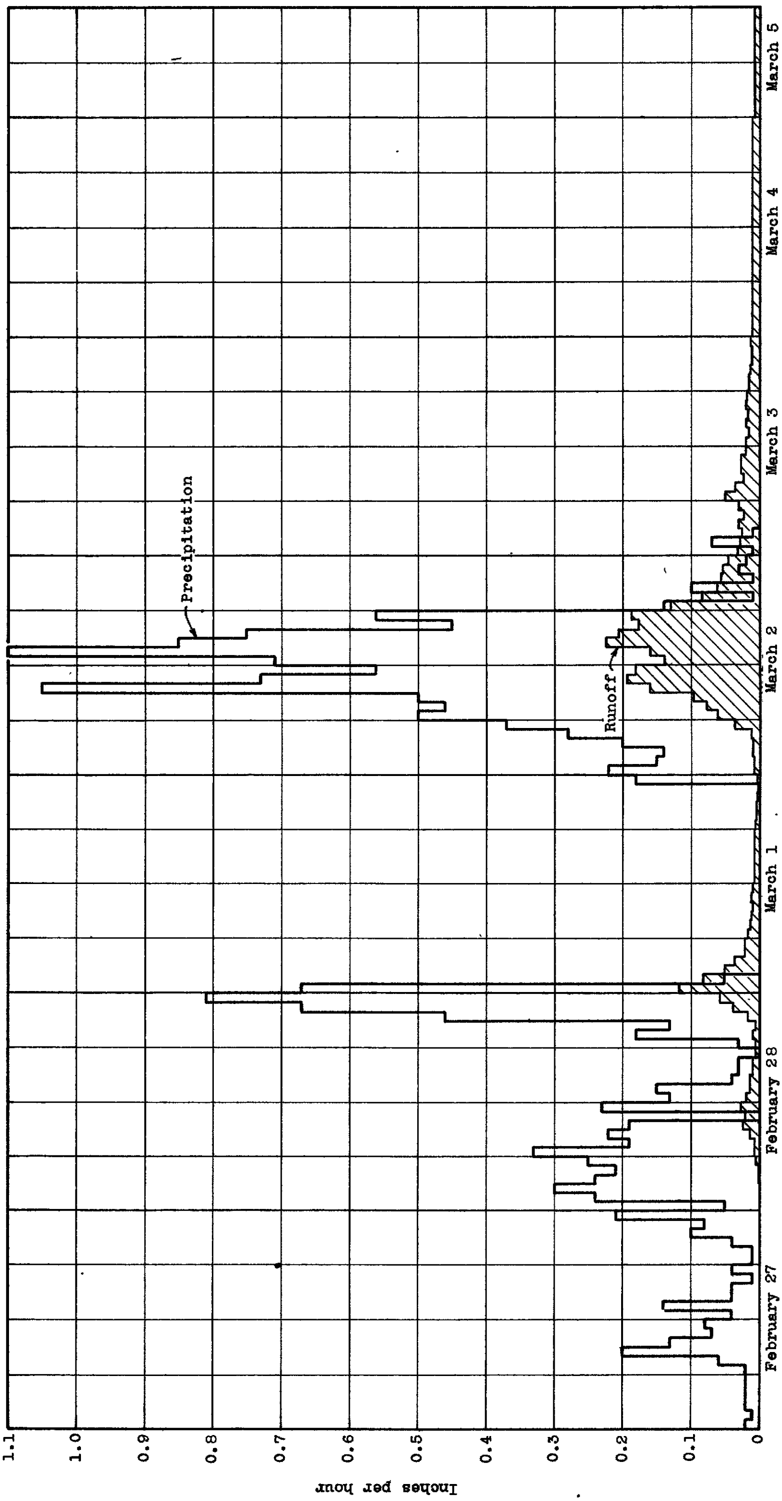

Figure 22.- Hourly precipitation and runoff, February 27 to March 5, for Live Oak Creek at flood-control dam.

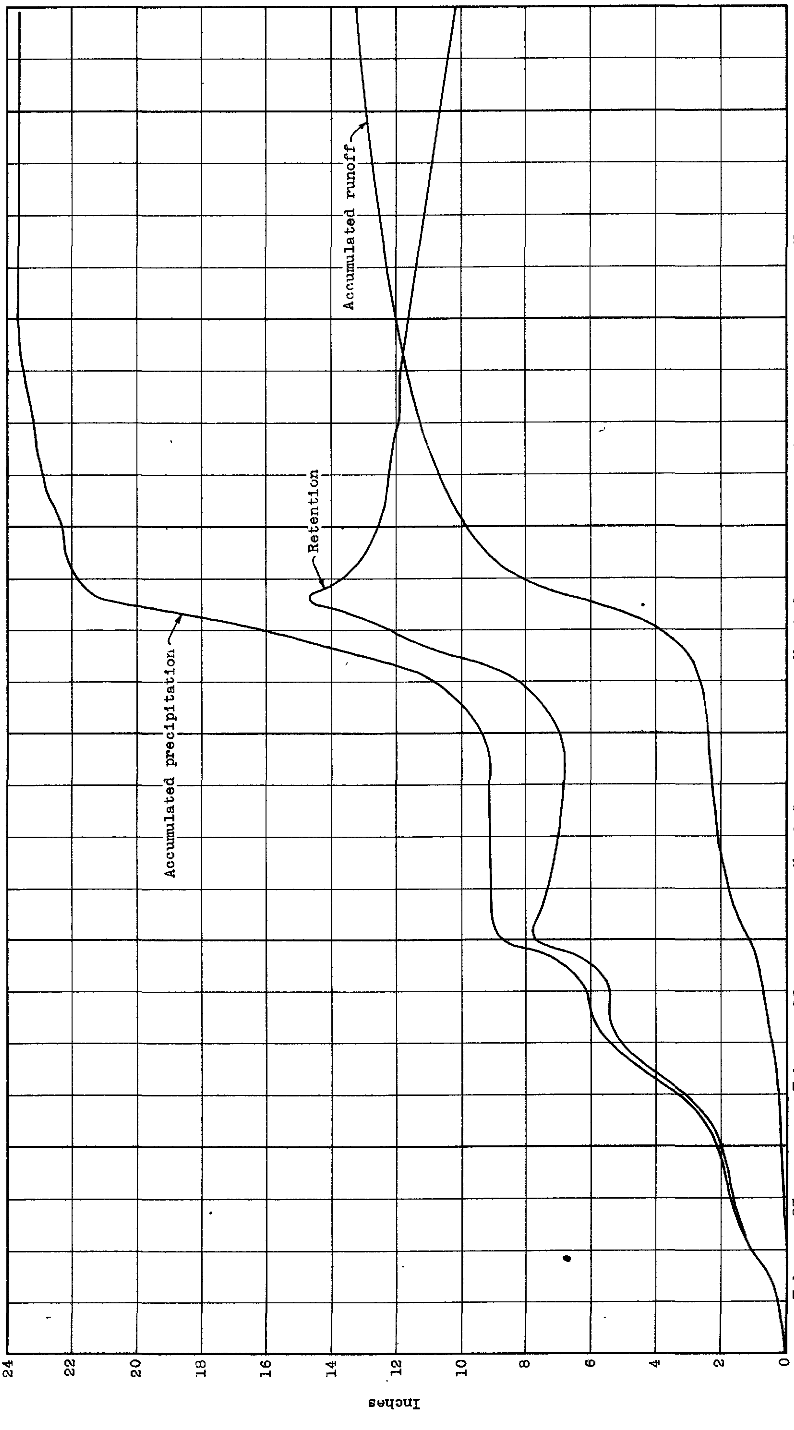

Figure 23.- Accumulated precipitation, accumulated runoff, and retention, February 27 to March 5, for basin of West Fork of San Gabriel River at flood-control dam No. 2.

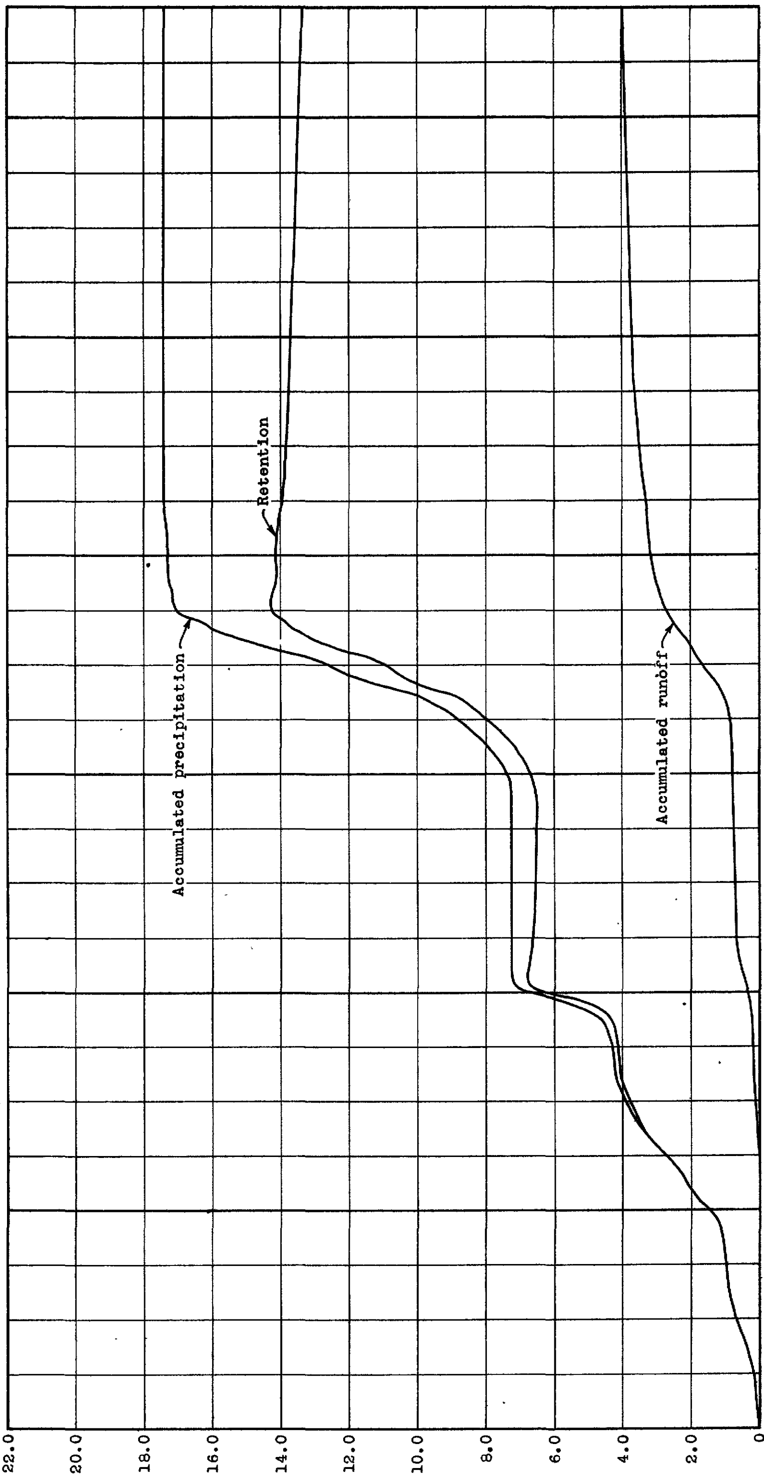

Figure 24.- Accumulated precipitation, accumulated runoff, and retention February 27 to March 5, for Live Oak Creek at flood-control dam.

Table 16.- Runoff characteristics during flood of February-March 1938 for certain areas in San Gabriel and Los Angeles River Basins

Stream	First phase, February 27-28: Drainage area (sq. mi.)	First phase: Accumulated rain before accumulated runoff equaled 0.10 inch	First phase: Accumulation, in inches, at time of peak: Rainfall	First phase: Accumulation at time of peak: Runoff	First phase: Accumulation at time of peak: Retention	Second phase, March 1: Time of 1st peak (end of 1st phase)	Second phase: Runoff from time of peak to 12 p.m. (inches)	Second phase: Average rate of runoff per hour during 1st depletion period (inches)	Third phase, March 2: Accumulation, in inches, at 12p.m. March 1: Rainfall	Third phase: At 12p.m. March 1: Runoff	Third phase: At 12p.m. March 1: Retention	Third phase: At time of 2d peak: Rainfall	Third phase: At time of 2d peak: Runoff	Third phase: At time of 2d peak: Retention	Fourth phase, March 3-10: Accumulation, in inches, at 12 p.m.: Rainfall Mar.3	Fourth phase: Accumulation: Runoff Mar.3	Fourth phase: Accumulation: Runoff Mar.10	Fourth phase: Retention, in inches: At 6 p.m. Mar. 2	Fourth phase: Retention at 12 p.m.: Mar.3	Fourth phase: Retention at 12 p.m.: Mar.5	Fourth phase: Retention at 12 p.m.: Mar.10	Average rate of runoff during depletion period, (inches per hour): 6 p.m. Mar. 2 to 12 p.m. Mar. 3	Average rate of runoff: Mar. 4-5	Average rate of runoff: Mar. 6-10
<u>San Gabriel River</u>																								
West Fork of San Gabriel River, inflow to flood-control reservoir No. 2 near Camp Rincon	40.4	1.89	9.02	1.23	7.79	1 a.m.	1.16	0.050	9.38	2.39	6.99	21.28	6.87	14.41	23.62	12.06	15.07	13.68	11.56	10.08	8.55	0.131	0.031	0.0128
San Dimas Creek, inflow to flood-control reservoir near San Dimas	16.5	4.34	8.34	.48	7.86	1 a.m.	.61	.027	8.54	1.09	7.45	18.73	3.31	15.42	20.71	5.69	7.24	15.43	15.02	14.29	13.47	.069	.015	.0068
Dalton Creek, inflow to flood-control reservoir, near Glendora	4.49	3.60	7.48	.63	6.85	1 a.m.	.64	.028	7.65	1.27	6.38	14.75	2.85	11.90	17.85	5.93	8.01	12.61	11.92	10.99	9.84	.069	.019	.0096
Thompson Creek, inflow to flood-control reservoir near Claremont	3.91	4.59	7.20	.19	7.01	1 a.m.	.35	.015	7.43	.54	6.89	16.45	2.12	14.33	17.41	3.95	4.84	14.68	13.46	-	12.57	.054	-	-
Sawpit Creek, inflow to flood-control reservoir near Monrovia	3.27	3.95	9.23	.62	8.61	1 a.m.	.85	.037	9.58	1.47	8.11	19.60	4.00	15.60	23.00	7.20	9.45	16.02	15.80	14.78	13.55	.094	.021	.0102
Live Oak Creek, inflow to flood-control reservoir near La Verne	2.30	3.87	7.20	.41	6.79	1 a.m.	.37	.015	7.43	.78	6.65	16.00	2.46	13.54	17.41	3.73	4.42	14.29	13.68	13.31	12.99	.034	.0077	.0027
Fern Canyon Watershed No. 3 near San Dimas	.084	4.78	8.86	.36	8.50	1 a.m.	.34	.015	9.18	.70	8.48	20.34	1.91	18.43	23.00	3.67	3.99	19.10	19.33	19.03	19.01	.037	.006	.0002
Fern Canyon Watershed No. 2 near San Dimas	.063	3.56	8.37	1.22	7.15	12 p.m.[a]	.79	.033	9.18	2.01	7.17	20.34	4.64	15.70	23.00	8.80	9.41	15.78	14.20	13.72	13.59	.098	.010	.0011

Los Angeles River																								
Tujunga Creek, inflow to flood-control reservoir near Sunland	81.4	3.02	6.16	.39	5.77	2 a.m.	.46	.021	6.42	.85	5.58	16.69	3.65	13.04	18.10	7.21	8.56	12.64	10.89	10.25	9.54	.098	.015	.006
Pacoima Creek, inflow to flood-control reservoir near San Fernando	27.8	3.99	6.34	.27	6.07	3 a.m.	.41	.020	6.70	.68	6.02	15.20	2.08	13.12	18.90	5.98	8.58	13.39	12.92	11.65	10.32	.107	.026	.011
Santa Anita Creek, inflow to flood-control reservoir near Sierra Madre	10.8	3.78	11.78	1.39	10.42	12 p.m.[a]	1.29	.054	12.19	2.65	9.54	24.21	6.52	17.69	25.76	11.06	14.58	17.35	14.70	13.07	11.18	.130	.033	.016
Eaton Creek, inflow to flood-control reservoir near Pasadena	9.48	4.45	10.03	.73	9.30	1 a.m.	.54	.028	10.50	1.27	9.23	20.93	3.51	17.43	22.39	5.90	7.70	17.33	16.49	15.68	14.69	.067	.017	.008
Little Santa Anita Creek, inflow to flood-control reservoir near Sierra Madre	2.39	4.52	10.20	.75	9.45	12 p.m.[a]	1.04	.043	10.76	1.79	8.97	20.40	3.55	16.85	22.74	6.94	9.91	17.53	15.80	14.46	12.83	.094	.028	.014

a Feb. 28.

Second phase, March 1

Table 16 shows the total retention in each basin at the time of the first peak, near or shortly after midnight February 28, the total runoff from the time of the peak until midnight March 1, and the average rate of runoff per hour. Since there was little rain on March 1, the latter represents essentially the rate of depletion in the water that was retained in the basin as ground or channel storage at the end of the first storm. The contribution to the runoff from groundwater storage due to antecedent rainfall was relatively inappreciable. This draining out on March 1, immediately following the first peak, averaged about 0.03 inch an hour over the several basins, or about a tenth of the average rate at which the retention accumulated.

Third phase, March 2

Rain of the second storm period started to fall at about 10 p.m. March 1 and continued until about midnight March 2, with the greatest intensity occurring near noon on March 2 and with fairly little intensity during the late afternoon and evening. All streams rose rapidly and reached maximum peaks generally between 2 and 5 p.m.

Table 16 shows the accumulated rainfall, the runoff, and the retention in inches at midnight on March 1, about the beginning of the second storm, and the accumulated rainfall, runoff, and retention at the peak of the flood. In the period of about 16 hours between midnight of March 1 and the peak on March 2, there was an average accumulation of about 10.0 inches of rain, 2.3 inches of runoff, and 7.7 inches of retention, the increase in the retention being at an average rate of about 0.48 inch an hour, or 85 percent in excess of the average rate of increase during the longer but less intense first storm. The average retention at the time of the peak was 15 inches.

Fourth phase, 6 p.m. March 2 to midnight March 10

Generally by about 6 p.m. March 2 all streams had started to recede and there was a gradual decrease in flow until March 11, when additional rain increased the flow. Table 16 shows the total accumulated rainfall at 12 p.m. March 3, which includes essentially all the rain associated with the floods and a small amount that fell after the major peak stages on March 3 and that may have influenced the rate of recession; the total accumulated runoff through 12 p.m. March 3, which probably includes essentially all water in channel and surface storage at the time of the peak; and the accumulated runoff at 12 p.m. March 10. Since there was relatively little rain from March 4 to 10, the difference in accumulated runoff at the two indicated times represents essentially a draining out of ground water. The retention as shown in table 16 at a stated hour on each of four days, namely, 6 p.m. on March 2 and midnight on March 3, 5, and 10, was not corrected for the evaporation and transpiration losses which may have occurred during the time intervals involved or for the rainfall from March 4 to 10. The results approximate the addition to basin storage because of the March storm. Table 16 shows also the average rates of runoff during three parts of the depletion period, namely, the 30-hour period from 6 p.m. March 2 to midnight March 3, the 2-day period of March 4 and 5, and the 5-day period of March 6 to 10. It may be noted that there was a marked decrease in the average rates of depletion in the three periods.

Relation between rates of precipitation and rates of runoff

The greatest rise of the floods of March 1938 occurred on March 2 and resulted from the rains that fell on the same day. It has been shown previously (fig. 14) that during the maximum 24 hours of rainfall, for periods of maximum rates of precipitation in progressively decreasing intervals of time, each succeeding period generally fell within the next longer period. Flood rises as shown on discharge hydrographs tend generally to have the same characteristic, and this is particularly true for the floods of March 1938, as will be illustrated hereafter. This tendency suggested a study of the relation of the maximum rates of precipitation to the maximum rates of runoff for corresponding intervals of time for drainage basins for which there are basic discharge records. Table 17 is a compilation of maximum rates of rainfall and runoff for 14 drainage basins for selected intervals of time ranging from 15 minutes to 24 hours each.

The average precipitation in the drainage basins was determined from the isohyetal map of the area for the total storm period February 27 to March 4. It was then distributed as to time on the basis of the records at a selected recording gage or gages. The rates of precipitation at the recording gages are summarized in table 2.

Table 17.- Maximum rates of rainfall and runoff, in inches per hour for given periods of time for certain areas in Santa Ana, San Gabriel, and Los Angeles River Basins

Stream Basin	Drainage area (sq.mi.)	Period of time: 15 minutes		30 minutes		1 hour		2 hours		3 hours		6 hours		12 hours		18 hours		24 hours	
		Rain-fall	Run-off	Rain-fall	Run-off	Rain-fall	Run-off	Rain-fall	Run-off	Rain-fall	Run-off	Rain-fall	Run-off	Rain-fall	Run-off	Rain-fall	Run-off	Rain-fall	Run-off
Santa Ana River Basin																			
Santiago Creek, inflow to Santiago Reservoir near Villa Park	62.5	1.63	0.243	1.35	0.241	0.90	0.237	0.80	0.231	0.70	0.226	0.63	0.206	0.53	0.170	0.43	0.142	0.37	0.124
San Gabriel River Basin																			
West Fork of San Gabriel River, inflow to flood-control reservoir near Camp Rincon	40.4	2.45	*.98	1.78	.96	1.55	.93	1.41	.91	1.33	.87	1.17	.70	.91	.52	.69	.42	.55	.34
San Dimas Creek, inflow to flood-control reservoir near San Dimas	16.5	2.50	.41	1.79	.40	1.26	.39	1.16	.38	1.10	.38	.85	.33	.73	.26	.56	.20	.44	.16
Dalton Creek, inflow to flood-control reservoir near Glendora	4.49	2.00	.47	1.53	.46	1.18	.41	1.00	.39	.92	.37	.72	.31	.64	.24	.51	.19	.40	.16
Thompson Creek, inflow to flood-control reservoir near Claremont	3.91	1.84	*.25	1.23	*.24	1.13	.23	1.00	.21	.92	.22	.86	.20	.70	.17	.54	.14	.43	.12
Sawpit Creek, inflow to flood-control reservoir near Monrovia	3.27	1.59	*.49	1.39	.47	1.12	.44	1.03	.42	.98	.40	.85	.34	.74	.28	.61	.23	.51	.19
Live Oak Creek, inflow to flood-control reservoir near La Verne	2.30	1.76	.23	1.17	.23	1.07	.23	.96	.22	.88	.20	.82	.18	.67	.16	.52	.13	.41	.10
Fern Canyon Watershed No. 3 near San Dimas	.084	1.62	.33	1.53	.32	1.48	.31	1.44	.31	1.35	.29	1.10	.24	.89	.16	.68	.12	.54	.10
Fern Canyon Watershed No. 2 near San Dimas	.063	1.62	.69	1.53	.67	1.48	.65	1.44	.61	1.35	.60	1.10	.52	.89	.37	.68	.29	.54	.24
Los Angeles River Basin																			
Tujunga Creek, inflow to flood-control reservoir near Sunland	81.4	2.09	*.63	1.71	.62	1.48	.62	1.22	.60	1.17	.59	1.06	.52	.76	.39	.56	.30	.45	.24
Pacoima Creek, inflow to flood-control reservoir near San Fernando	27.8	1.74	.48	1.36	.44	1.11	.43	.92	.38	.79	.36	.74	.31	.62	.24	.52	.20	.43	.17
Santa Anita Creek, inflow to flood-control reservoir near Sierra Madre	10.8	1.85	.76	1.56	.74	1.28	.73	1.20	.70	1.16	.67	1.02	.55	.87	.42	.68	.34	.54	.29
Eaton Creek, inflow to flood-control reservoir near Pasadena	9.48	2.24	.53	1.43	.47	1.10	.43	1.00	.39	.91	.34	.83	.30	.73	.23	.57	.19	.45	.16
Little Santa Anita Creek, inflow to flood-control reservoir near Sierra Madre	2.39	1.96	*.39	1.54	.37	1.30	.36	1.16	.33	1.04	.31	.89	.27	.76	.21	.60	.18	.47	.16

*Estimated.

The assumption that the average rates of precipitation over a drainage basin will vary as do the rates at a nearby recording gage or else those obtained by averaging the rates for two or more nearby gages has certain inherent features that would seem to make it more reliable for the longer than for the shorter intervals for which rates are determined. The precipitation appears to have been extraordinarily uniform over the entire area, and the drainage basins are small in relation to the velocity of the storm; consequently, the rates for the basins may be accepted as quite reliable for the longer intervals of time. Obviously, however, there may be a question as to whether the uniformity of precipitation for short intervals of time, such as 1 hour or less, is such that the average rates over a basin will be closely related, either as to intensity or as to time of occurrence, to the rates obtained at one or more recording stations in the basin or within a few miles of it.

The runoff records for the West Fork of San Gabriel River at flood-control dam No. 2 and for Live Oak Creek, as presented in the basic discharge records, are typical of the extremes of flood discharge as determined from the reservoir records.

In figure 25 the rates of precipitation and runoff for both the West Fork of San Gabriel River and Live Oak Creek Basins are plotted to logarithmic scales against the durations of these respective rates. For this plotting, the data in table 19 have been supplemented to obtain additional points in these basins, and rates of precipitation have been computed to the maximum 5-minute interval.

The major part of the drainage of the West Fork of San Gabriel River was within the zone of heaviest rainfall during the storm of March 1938, and characteristics of its rainfall are included among those shown for the group B stations on figures 11 to 15. From the isohyetal map (pl. 17) the average rainfall on this drainage area of 40.4 square miles was found to be 23.62 inches for the period of the storm. The distribution of the rainfall was based on the records at Opid's camp, Crystal Lake, and San Gabriel flood-control dam No. 2.

Live Oak Creek Basin, on the coastal side of the first divide, had somewhat less rainfall than the basin of the West Fork of San Gabriel River and averaged 17.41 inches over the 2.30 square miles. The rainfall intensities for this basin were distributed on the basis of the automatic record at the mouth of San Antonio Canyon, about 4 miles to the northeast, at an altitude a little above the average for Live Oak Creek Basin. The

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record from the San Antonio Canyon gage seems to put that station in group C (figs. 11 to 15).

Similarly, figure 26 shows the maximum rates of precipitation and runoff for periods of 5 minutes to 24 hours for San Dimas Creek and Fern Canyon Watersheds Nos. 2 and 3, which are within the basin of San Dimas Creek. This basin has an area of 16.5 square miles, and in it are 174 standard and 10 recording rain gages maintained by the United States Forest Service. The average precipitation over the basin during the storm was 20.71 inches, which was distributed on the basis of the recording rain gage at Tanbark Flats. The record at Tanbark Flats (altitude, 2,700 feet) puts this station in group C.

The rainfall record in Fern Canyon (altitude, 4,800 feet), also in the drainage basin of San Dimas Creek, seems to conform to the records of the group B stations. The drainage basin of San Dimas Creek has a mean altitude of about 3,130 feet, with maximum and minimum altitudes of about 5,600 and 1,400 feet, respectively. Evidently much of the rainfall in the basin would have followed more closely the Fern Canyon type of distribution than that shown by the Tanbark Flats station. The altitude of the latter station is nearer the mean altitude of the drainage area and so may represent the distribution of precipitation rates over the entire basin more accurately than the Fern Canyon station.

The rainfall over Fern Canyon Watersheds Nos. 2 and 3 was practically identical as determined by observations at 93 rain gages within these two drainage areas. The rainfall was analyzed on the basis of the Fern Canyon recording gage record.

It may be observed in the graphs for the five basins shown in figures 25 and 26 that under the method of plotting used, for time intervals of 1 hour or more the precipitation and runoff graphs for the respective basins are approximately parallel.

Graphs showing the runoff rates for Fern Canyon Watersheds Nos. 2 and 3 indicate marked differences in the characteristics of these two drainage basins. These differences seem to result in part from the differences in their geology. That part of the mountains in which the Fern Canyon Watersheds are situated is underlain by a metamorphic-igneous bedrock complex, the San Gabriel formation of Miller.[14] Schists and

14 Miller, W. J., Geology of western San Gabriel Mountains: Univ. Calif. at Los Angeles, Pubs. in Math. and Phys. Sciences, vol. 1, no. 1, pp. 50-51, 1934.

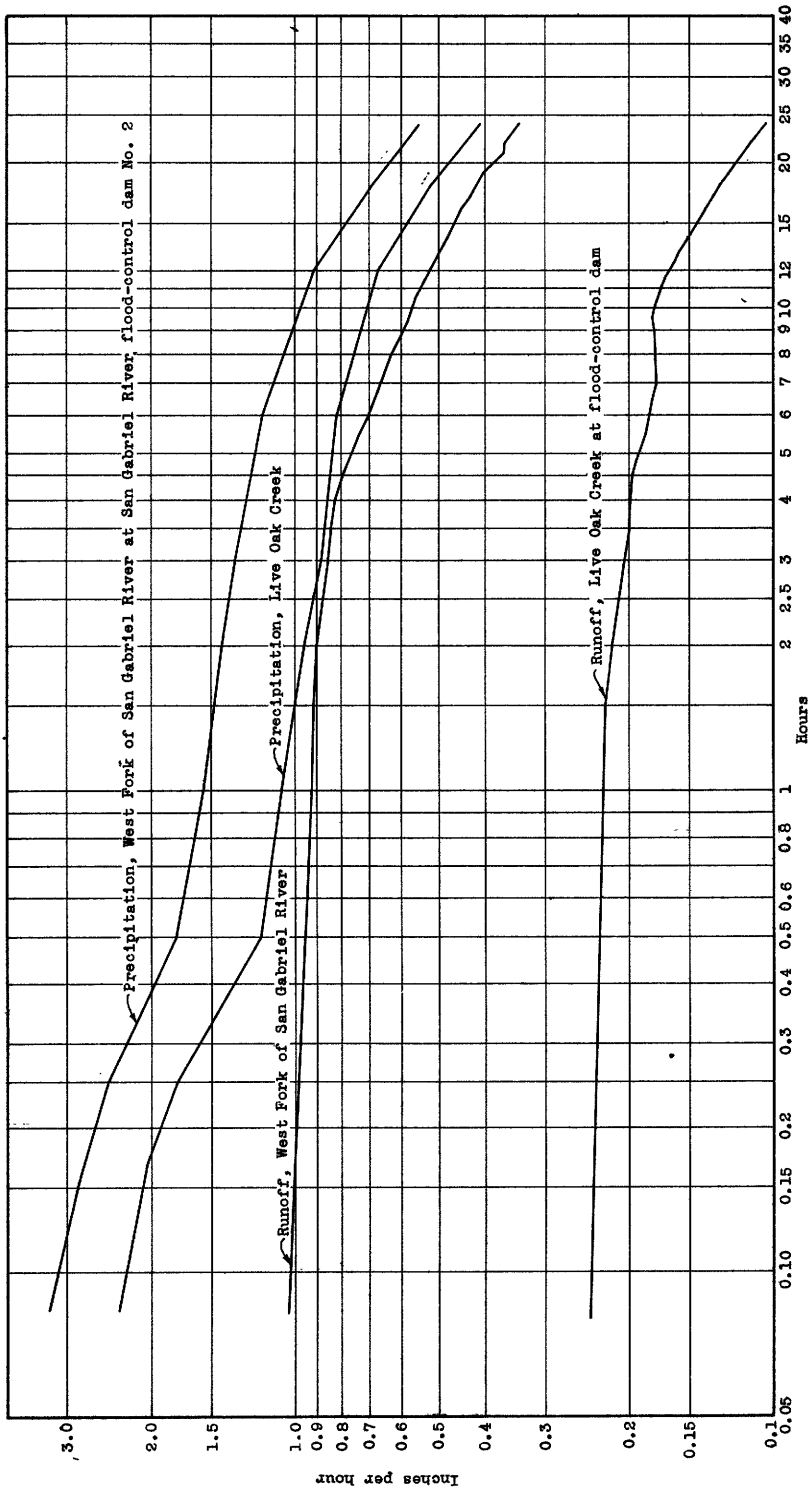

Figure 25.- Maximum rates of precipitation and runoff, for periods of 5 minutes to 24 hours, in basins of West Fork of San Gabriel River and Live Oak Creek.

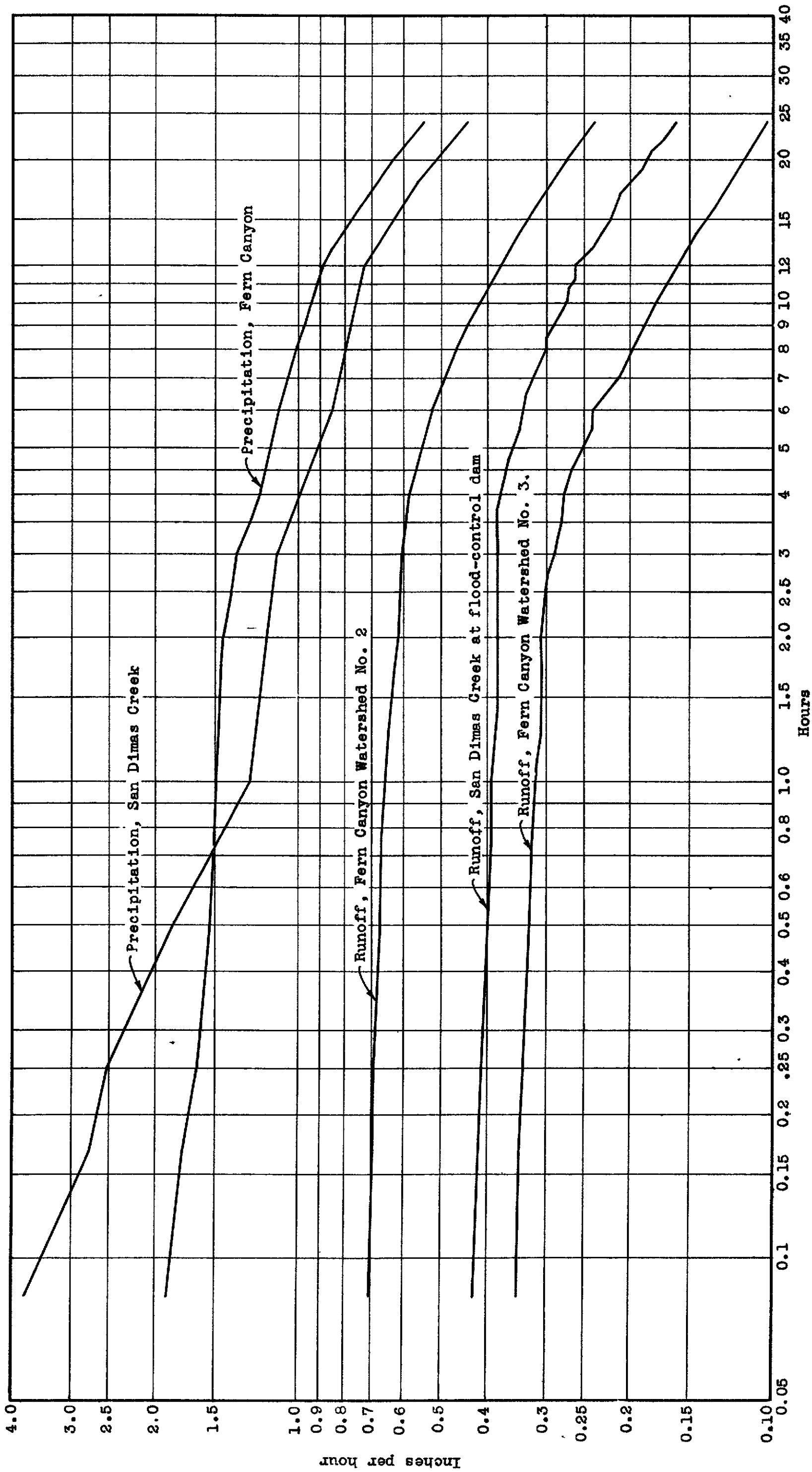

Figure 26.- Maximum rates of precipitation and runoff, for periods of 5 minutes to 24 hours, in San Dimas Creek Basin and Fern Canyon Watersheds Nos. 2 and 3.

granitic gneisses predominate and are intruded by many pegmatite and aplite dikes. The dikes, though locally crosscutting, generally follow schistosity planes in the metamorphic country rock for long distances. As a result of these conditions, the bedrock is characterized by a very prominent, steeply inclined planar structure of consistent orientation throughout the area.

In a report on a geologic examination [15] of the area after the 1938 flood it is indicated that watershed No. 3, although larger than No. 2, has always had less runoff, both for seasons and for individual floods. In watershed No. 3 the planar structure of the bedrock lies normal to the drainage axis and dips fairly steeply downstream. This permits a more rapid percolation of water than in watershed No. 2, which is so oriented that the schistosity planes of the same rock types intersect its drainage axis at an acute angle, with correspondingly less opportunity for percolation and more opportunity for runoff to reach the stream channel.

The relation between maximum rates of precipitation and runoff for intervals of 24 hours and less is shown on figure 27 for five representative basins, namely, Live Oak, San Dimas, and Santa Anita Creek Basins, West Fork of San Gabriel River Basin, and Fern Canyon Watershed No. 2. The data used in the plotting are those shown in table 19, supplemented by other data for better definition of the relation. The number noted against a plotted point indicates the length of the interval in hours applicable thereto.

The decided break in some of these curves for intervals longer than about 12 hours is due to the falling off of the rates of rainfall for these longer intervals as compared to the rates of runoff, the runoff reflecting in this way the influence of ground-water seepage in the basin. This relation indicates that the rates of runoff corresponding to a fixed rate of rainfall have a tendency to increase as the durations of such rates increase. This tendency is demonstrated by table 18, in which are compiled data taken from figure 27. For example, for an average rate of precipitation of 1.0 inch an hour, lasting for 1.5 hours, on Live Oak Creek, the resulting average runoff was 0.22 inch an hour, and for the same average precipitation lasting for 4 hours on San Dimas Creek, the resulting runoff was 0.38 inch an hour. The corresponding figures increase progressively to 9.7 hours and 0.59 inch on the West Fork of San Gabriel

15 Storey, H. C., The Fern watersheds, characteristic runoff differences: Mem. Rept. California Forest and Range Exp. Sta., San Dimas Exp. Forest, Sept. 19, 1939.

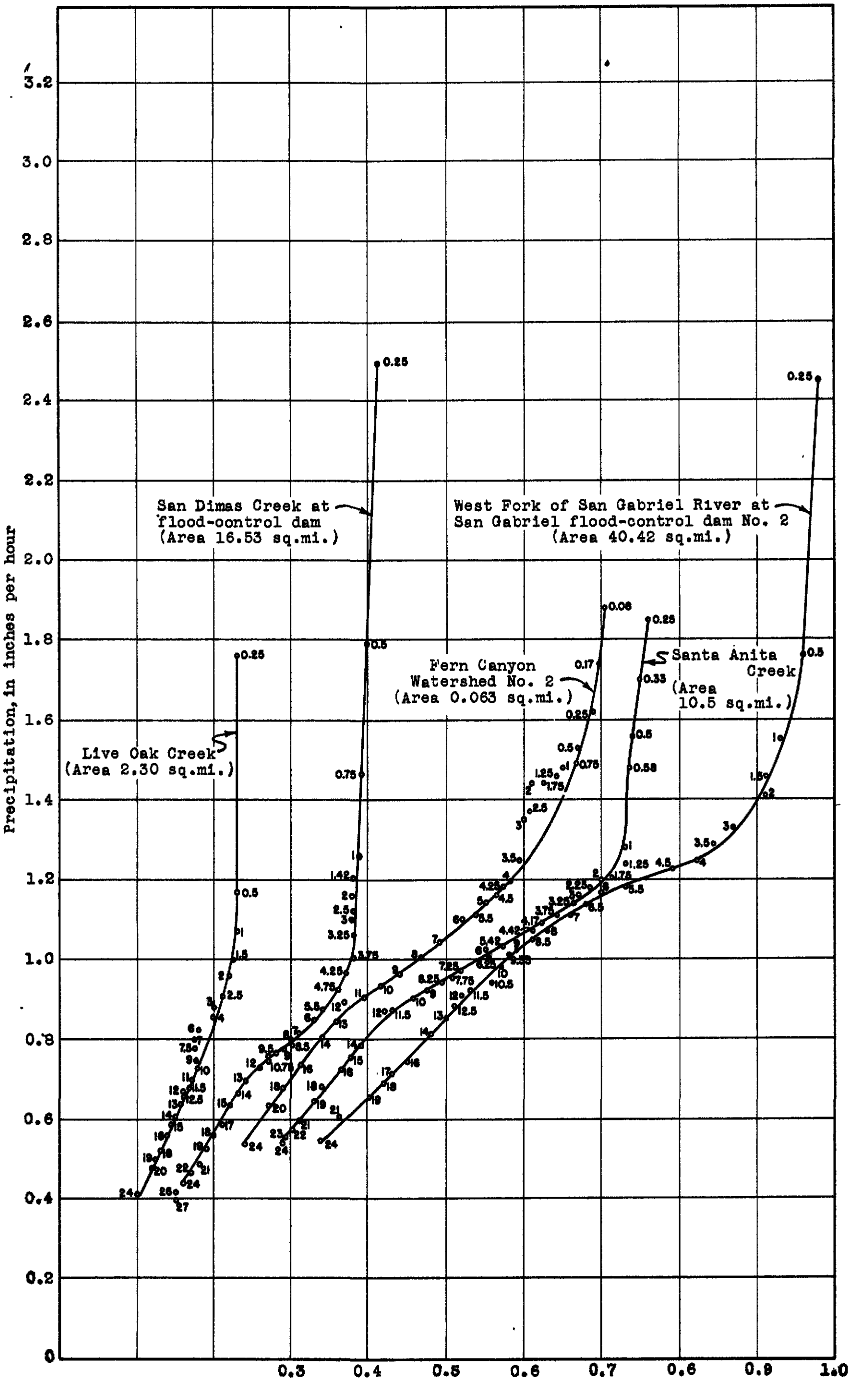

Figure 27.- Relation between rates of precipitation and rates of runoff during maximum periods of 24 hours and less for typical areas in San Gabriel and Los Angeles River Basins.

Table 18.– Duration, in hours, and rates of runoff, in inches per hour, for given rates of precipitation, at typical stations in the San Gabriel and Los Angeles River Basins

Station	Rates of precipitation, in inches per hour													
	1.8		1.6		1.4		1.2		1.0		0.8		0.6	
	Duration	Runoff	Duration	Runoff	Duration	Runoff	Duration	Runoff	Duration	Runoff	Duration	Runoff	Duration	Runoff
San Gabriel River Basin														
West Fork of San Gabriel River, inflow to flood-control reservoir near Camp Rincon	0.50	0.96	0.83	0.94	2.1	0.91	5.3	0.75	9.7	0.59	14.5	0.47	21.5	0.37
San Dimas Creek, inflow to flood-control reservoir near San Dimas	.5	.40	.63	.39	.82	.39	1.5	.38	4	.38	8	.30	16.5	.21
Live Oak Creek, inflow to flood-control reservoir near La Verne	-	-	-	-	-	-	-	-	1.5	.22	7	.18	14.5	.15
Fern Canyon Watershed No. 2 near San Dimas	.13	.70	.3	.68	2.2	.61	4	.58	8.2	.46	14	.34	21	.26
Los Angeles River Basin														
Santa Anita Creek, inflow to flood-control reservoir near Sierra Madre	-	-	.42	.74	.75	.73	1.8	.71	6.4	.55	14	.39	21	.31

Table 19.– Ratios of maximum rates of precipitation and runoff for given periods to those for the maximum 24-hour period for certain areas in San Gabriel River Basin

Stream	Period of time															
	15 minutes		30 minutes		1 hour		2 hours		3 hours		6 hours		12 hours*		18 hours	
	Precipitation	Runoff	Precipitation	Runoff	Precipitation	Runoff	Precipitation	Runoff	Precipitation	Runoff	Precipitation	Runoff	Precipitation	Runoff	Precipitation	Runoff
West Fork of San Gabriel River, inflow to flood-control reservoir near Camp Rincon	4.46	*2.88	3.24	2.82	2.82	2.74	2.57	2.68	2.42	2.56	2.13	2.09	1.65	1.53	1.25	1.22
San Dimas Creek, inflow to flood-control reservoir near San Dimas	5.70	2.56	4.16	2.50	2.86	2.44	2.64	2.38	2.52	2.38	1.93	2.06	1.66	1.62	1.27	1.25
Live Oak Creek, inflow to flood-control reservoir near La Verne	4.30	*2.26	2.86	2.21	2.61	2.17	2.34	2.08	2.15	1.96	2.00	1.83	1.63	1.57	1.27	1.24
Fern Canyon Watershed No. 3 near San Dimas	3.02	3.04	2.83	2.94	2.74	2.85	2.67	2.80	2.50	2.62	2.04	2.14	1.65	1.48	1.26	1.19
Fern Canyon Watershed No. 2 near San Dimas	3.02	2.91	2.83	2.83	2.74	2.74	2.67	2.59	2.50	2.54	2.04	2.20	1.65	1.56	1.26	1.22

*Estimated.

River. A like tendency is shown for parts of the curves representing rates for 18 to 24 hours. A study of the rates of rainfall and runoff for 24 hours, as given in the last two columns of table 17, discloses a rough relation between such rates, which may be used in estimating runoff from drainage basins for which only rainfall records were available.

For further illustration of the relation between precipitation and runoff the data of table 19 have been plotted in three groups, as in figures 28 to 30, in general accordance with the magnitude of the rates of runoff prevalent in the basins.

These graphs illustrate further the similarity in the intensity-duration relations for precipitation and runoff. The tendency of these curves to conform to straight lines drawn from the origin through the plotted points marks characteristics of the data that tended to produce parallelism in the logarithmic plotting of the relation as previously noted.

Table 19 shows, for the drainage basins analyzed in figures 25 and 26, the ratios to the maximum rates of precipitation and runoff for a 24-hour period of the maximum rates for selected shorter periods. It may be noted that, for the listed basins, the runoff ratio for the 1-hour period varies from the precipitation ratio by +4 to -17 percent. The table illustrates the similarity in the intensity-duration relation of precipitation and runoff for the several basins, such similarity being fundamentally the same as that referred to in the preceding paragraph as tending to produce parallel lines under logarithmic plotting.

The foregoing graphic and tabular analyses indicate that for periods of time shorter than 1 hour the rainfall rates seem to increase more sharply than the runoff rates. For example, table 19 shows that on San Dimas Creek, for the 1-hour and half-hour periods, respectively, the precipitation ratio changed from 2.86 to 4.16, whereas the runoff ratio changed from 2.44 to 2.50. This difference is explainable in part by the fact that surface detention and channel storage in the stream system tend to modulate the reflection of high rates of rainfall for short intervals into high rates of runoff for corresponding intervals. It is important in these analyses not to overlook the fact that the computed discharge, particularly the highest discharge, includes debris, which is a complicating factor of unknown but probably substantial amount.

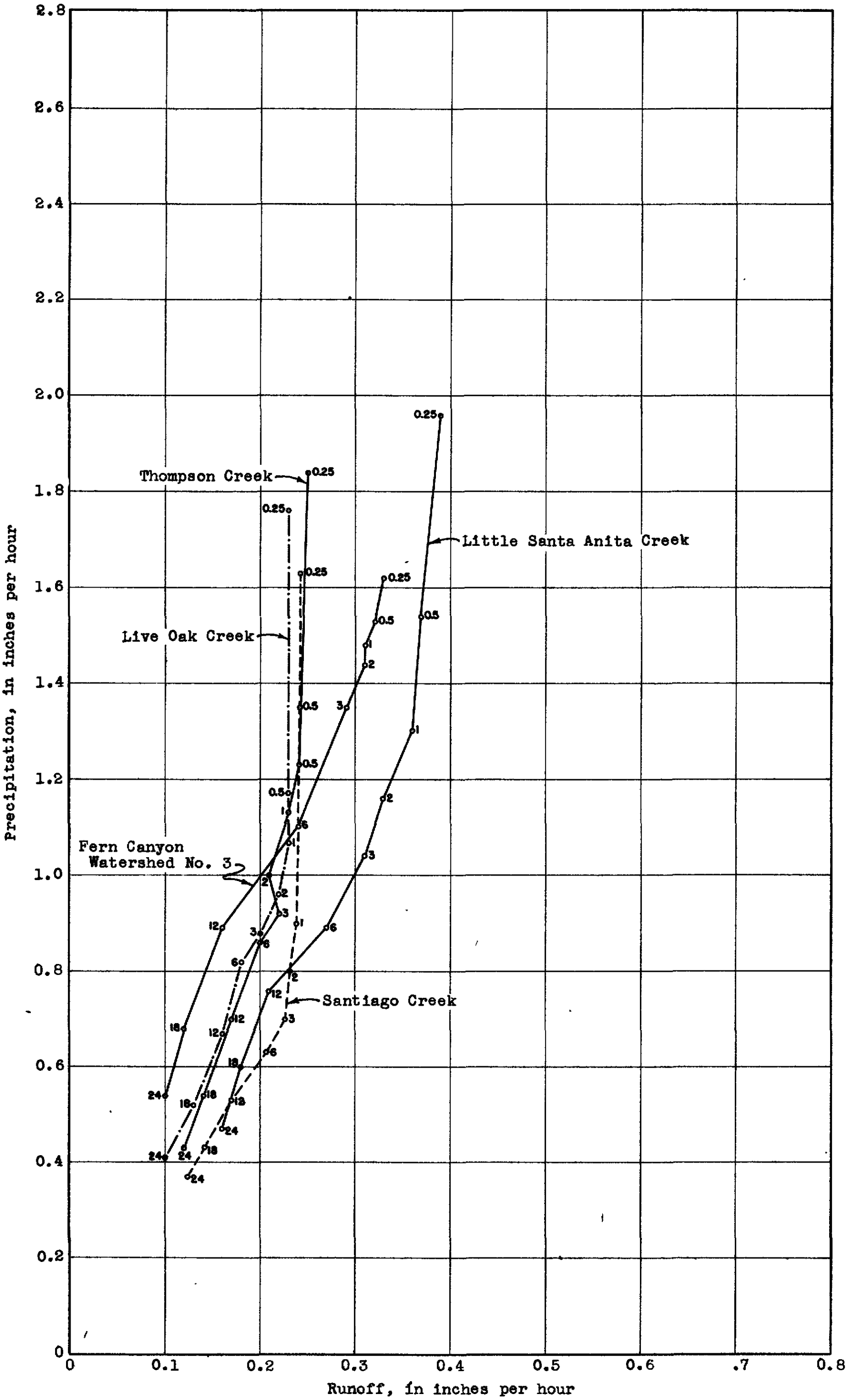

Figure 28.- Relation between maximum rates of precipitation and maximum rates of runoff during indicated periods of time for lowest rates of runoff.

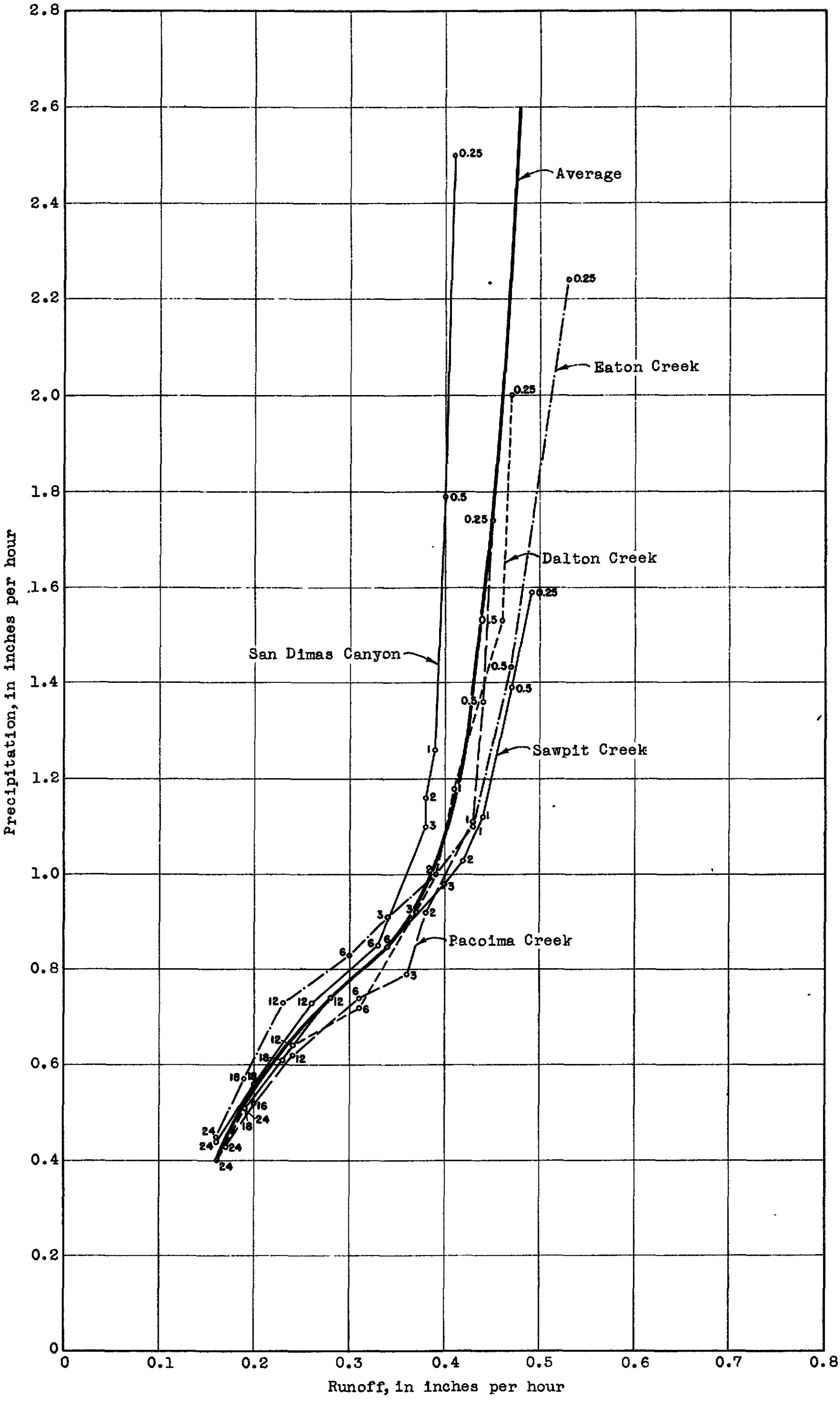

Figure 29.- Relation between maximum rates of precipitation and maximum rates of runoff during indicated periods of time for intermediate rates of runoff.

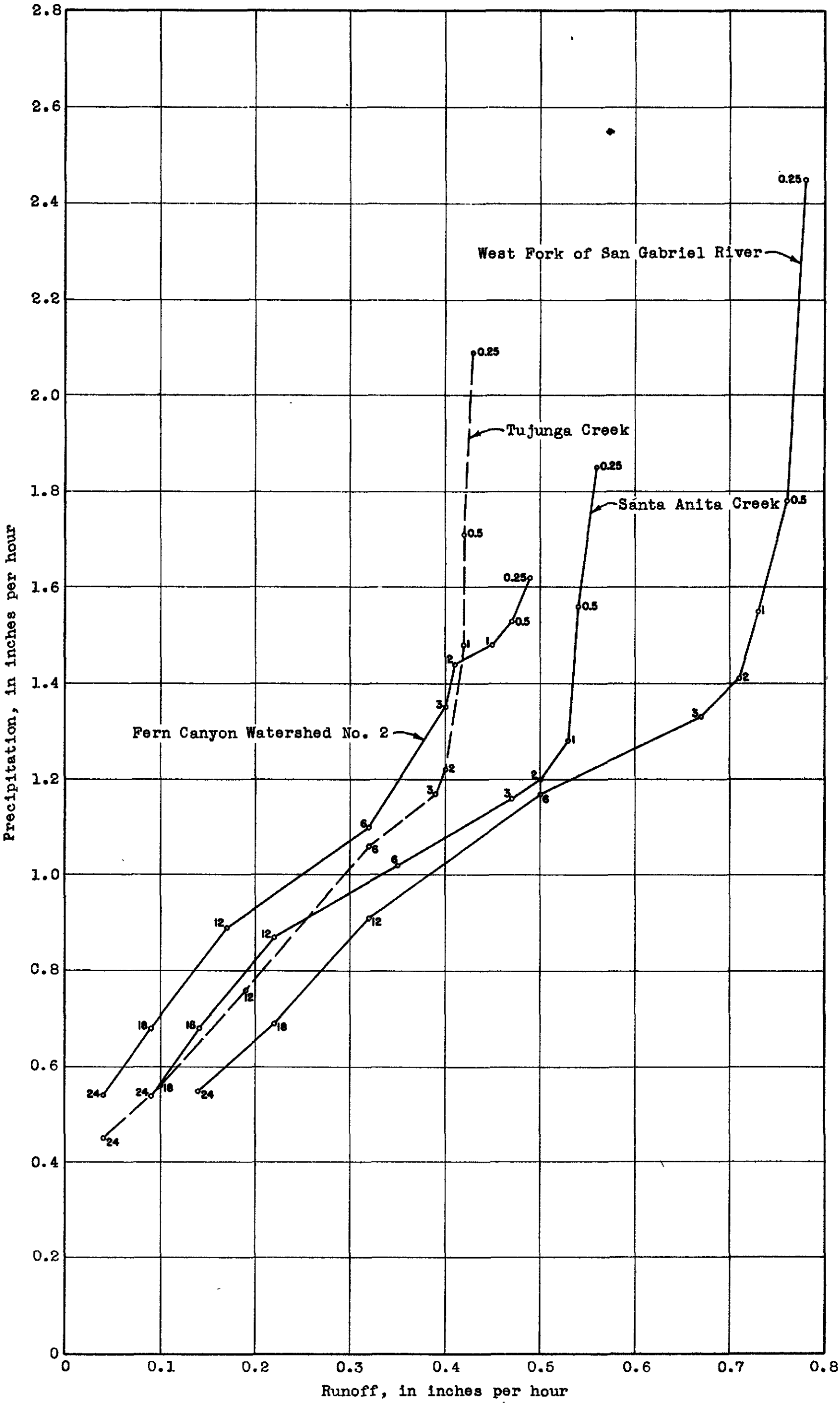

Figure 30.- Relation between maximum rates of precipitation and maximum rates of runoff during indicated period of time for highest rates of runoff.

The difference may be due also, in part, to the fact that the rainfall rates over a given basin are estimated on the basis of the average rates at one, or at the most, only a few recording rain gages, located in or near that basin, which method of procedure, as has previously been noted, may tend to make the computed rainfall rates less reliable for intervals of 1 hour or less.

Lag between precipitation and runoff

The systematic relations found between rates of precipitation and rates of runoff suggest a comparison, between different drainage areas, of the times of their occurrence similar to the comparison, furnished by figure 14, of the times of occurrence of maximum rates of precipitation. Figure 31 furnishes a comparison of the times of occurrence of maximum rates of precipitation and runoff in West Fork of San Gabriel River and Little Santa Anita Creek Basins and Fern Canyon Watershed No. 2.

The graphs representing runoff rates define periods of time which without exception are subsequent to those for the corresponding rainfall rates. The interval between the times corresponding to the centers of mass of the rainfall and runoff occurring in comparable periods, such as 1 hour or 2 hours, is denoted "lag". This term, as commonly used, is the time-difference in phase between salient features of rainfall and associated runoff. Table 20 shows, for the above-mentioned three basins and for Santa Anita Creek Basin, the time of occurrence of the center of mass of precipitation, of the center of mass of runoff, and of the lag as determined therefrom for selected periods ranging from 5 minutes to 24 hours each.

In Fern Canyon Watershed No. 2, the lag in time of occurrence between the rainfall and the associated runoff appears to be generally from 1½ to 3 hours for periods of 12 hours and less, which seems to be rather excessive for a drainage area of only 0.063 square mile with a maximum distance of water travel of about 0.4 mile from the divide to the gaging station. This apparently excessive lag tends to support the conclusion that much of the runoff moved through subterranean channels, with the result that the flow was slower than the flow in surface channels and may have been subjected to the influence of ground-water storage. The indicated lag may have been due in part to the peculiarities of rainfall distribution. The rainfall involved in this comparison continued until about 6 p.m. March 2, when it stopped almost completely as indicated by the mass curves on figures 9 and 13.

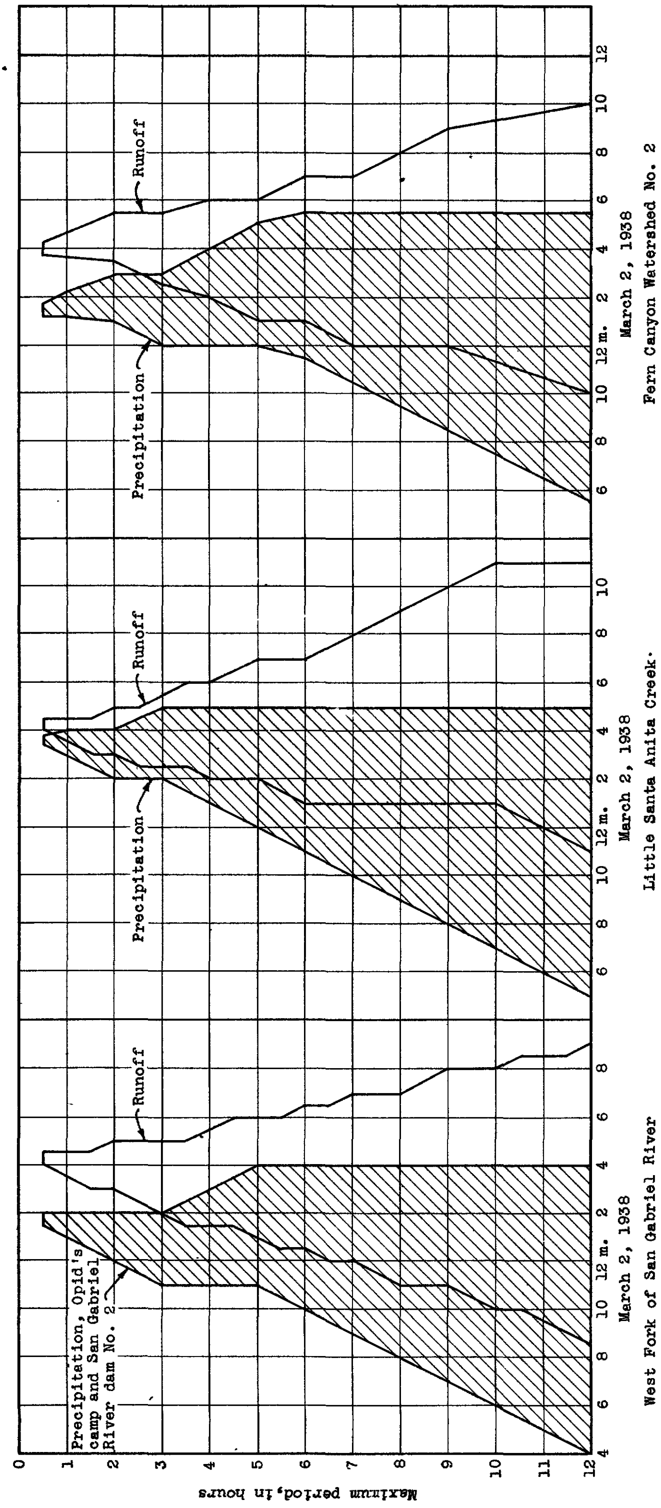

Figure 31.- Time of occurrence of maximum periods of precipitation and runoff for basins of West Fork of San Gabriel River and Little Santa Anita Creek and Fern Canyon Watershed No. 2.

Table 20.- Time of occurrence of center of mass of precipitation, center of mass of runoff, and lag between times of occurrence, at typical stations in San Gabriel and Los Angeles River Basins

Stations	Maximum period															
	Minutes					Hours										
	5	10	15	20	30	1	2	3	4	5	6	9	12	15	18	24
San Gabriel River Basin																
West Fork of San Gabriel River																
Precipitation a/	-	-	-	-	1:46pm	1:35pm	1:00pm	12:40pm	1:00pm	1:32pm	1:31pm	12:22pm	11:40am	11:20am	11:15am	11:16am
Runoff	-	-	-	-	4:15pm	4:01pm	4:01pm	3:35pm	3:34pm	3:35pm	3:35pm	3:34pm	3:22pm	3:44pm	3:50pm	4:06pm
Lag (in minutes)	-	-	-	-	147	146	181	175	154	123	124	192	222	264	275	290
Fern Canyon Watershed No. 2																
Precipitation b/	1:37pm	1:36pm	1:33pm	1:31pm	1:27pm	1:38pm	1:58pm	1:34pm	1:53pm	2:12pm	2:10pm	1:15pm	12:38pm	12:14pm	11:57am	12:07pm
Runoff	4:00pm	4:02pm	4:01pm	4:01pm	4:01pm	4:13pm	4:02pm	4:02pm	4:00pm	3:42pm	3:58pm	4:08pm	4:01pm	4:20pm	4:34pm	4:57pm
Lag (in minutes)	143	146	148	150	154	155	124	148	127	97	108	173	163	246	277	290
Los Angeles River Basin																
Santa Anita Creek																
Precipitation c/	-	-	-	3:30pm	3:35pm	3:36pm	3:04pm	3:28pm	3:05pm	2:47pm	2:22pm	1:05pm	12 m	11:21am	11:21am	11:22am
Runoff	-	-	-	4:10pm	4:15pm	4:30pm	4:02pm	4:15pm	4:06pm	4:06pm	4:06pm	3:55pm	4:03pm	4:12pm	4:32pm	4:52pm
Lag (in minutes)	-	-	-	40	40	54	58	47	61	79	104	170	243	291	311	330
Little Santa Anita Creek																
Precipitation c/	-	-	-	3:30pm	3:35pm	3:36pm	3:04pm	3:28pm	3:05pm	2:47pm	2:22pm	1:05pm	12 m	11:21am	11:21am	11:22am
Runoff	-	-	-	-	4:15pm	4:03pm	4:02pm	4:25pm	3:55pm	3:48pm	3:45pm	4:32pm	4:15pm	4:22pm	5:02pm	5:30pm
Lag (in minutes)	-	-	-	-	40	27	58	57	50	61	85	207	255	301	341	368

a Based on records for Opid's camp and San Gabriel River flood-control dam No. 2 stations.
b Based on record for San Dimas Experimental Forest, Fern Canyon station.
c Based on record for Hoegee's camp station.

Between 3:30 and 4 p.m. March 2, there was a sharp shower, direct surface runoff from which may have synchronized with the outflow from ground water from antecedent precipitation discharging into the channel and so have produced the maximum discharge at the gaging station.

The lag on the West Fork of San Gabriel River appears to vary between 2 and 3 hours for periods of 6 hours and less. For longer periods than the maximum 6 hours, the lag increases progressively to about 5 hours for the maximum 24-hour period, which probably indicates a greater influence of basin storage on the discharge.

Table 14 gives the travel distance from the center of the drainage area of the West Fork of San Gabriel River to the point of measurement as 4.92 miles. If it is assumed that this represents the average travel distance for each particle of water in runoff, and that the lag represents the average travel time, for the maximum period of 30 minutes, this travel time would have been 147 minutes, which represents a mean velocity of 2.95 feet a second. Mean velocities of similar magnitude may be determined for other maximum periods. Such velocities seem rather low for the average drainage basin slope of 47 percent. It is believed that these apparently low rates of travel may be due to the passage of many of the particles of water through the underlying rock formations, and to the slower passage of others as surface runoff down minute channels on the mountain slopes before joining the larger tributaries.

It is probable that the peak discharge of the West Fork of San Gabriel River was caused in part by a heavy, short shower just before 4 p.m., the direct surface runoff from which combined with a large contribution of ground-water seepage. It seems likely that this sharp shower would have influenced the lag less for the longer periods.

On Santa Anita Creek, for which the center of the drainage area is about 2.41 miles from the gaging station, the lag for the maximum 30-minute period was 40 minutes. On assumptions similar to those previously made, the time of travel of the particles from the time of their precipitation to the time they passed the point of measurement would indicate a velocity of 5.3 feet per second. On Little Santa Anita Creek the lag of 40 minutes for the maximum 30-minute period would indicate a velocity of 3.1 feet per second, which is comparable with the velocity indicated for the West Fork of San Gabriel River. In both the Santa Anita and Little Santa Anita Creek Basins, the maximum runoff was caused by the sharp shower which occurred between 3 and 4 p.m., and produced the maximum rates of rainfall for the storm period (see group B, Hoegee's camp, fig. 15).

The lag between rainfall and runoff is a manifestation of the retarding effect of the topographic and geologic characteristics of the basin--such as slope of the streams, roughness of channels, and vegetation cover--on the time required for rainfall to become runoff. Observations seem to indicate that the greater the lag the less close will be the relation between rates of rainfall and runoff for the shorter periods of time, and the less responsive in increase will the stream flow be to the rainfall. Moreover, as previously pointed out, the lag as determined may embody conditions with respect to the distribution of rainfall and the concentration of runoff, which were peculiar to the storm and floods of March 1938.

Infiltration

It is shown elsewhere in this report (see tables 16 and 26) that the quantities of water retained in surface and ground storage during the floods of March 1938 in southern California were exceptionally large. The high rates of retention are attributed in large part to the high rates of infiltration that have been found to prevail during flood periods throughout much of the mountain area in Los Angeles and San Bernardino Counties. Some interesting information concerning the characteristics of infiltration is available from data collected in the course of experiments by the United States Forest Service in the San Dimas Experimental Forest. Measurements of precipitation and direct surface runoff during the storm of March 1938 on experimental plots, each a fortieth of an acre in area, indicate extremely low rates of direct surface runoff or, conversely, extremely high rates of infiltration. The records of precipitation and runoff from three of a group of nine adjacent plots of the Fern Canyon series, showing greatest, medium, and lowest runoff, are shown in table 21.

The plots are at an altitude of about 5,000 feet and have a slope of about 60 percent, which makes them comparable with areas at the headwaters of most of the streams in the San Gabriel and San Bernardino Mountains that are subject to excessive floods. They are comparable, also, in geology, slope, and vegetative cover, with many of the headwater areas in other basins. The soil mantle on the plots is about 1 foot deep and overlies badly fractured bedrock. They have a fairly heavy and uniform growth of chaparral. Variations in soil mantle and the underlying rock structure, in addition to general tendencies toward inherent plot variability, are undoubtedly the cause of the main differences in the observed

Table 21.- Precipitation and runoff for given periods on 1/40-acre plots in Fern Canyon

Period	Precipitation in inches per hour	Maximum runoff in inches per hour		
		Plot 349	Plot 341	Plot 345
10 minutes	1.56	0.0186	0.0198	0.0086
15	1.52	.0186	.0176	.0065
30	1.36	.0176	.0121	.0055
1 hour	1.35	.0162	.0101	.0050
2	1.26	.0159	.0109	.0048
3	1.20	.0143	.0099	.0047
4	1.12	.0132	.0090	.0043
6	.98	.0107	.0085	.0036
9	.91	.0099	.0070	.0032
12	.79	.0083	.0056	.0027
Total, in inches, Feb. 27 to Mar. 3	20.44	.17	.08	.06

runoff rates. For a total rainfall of 20.44 inches during the storm, these three plots showed a direct surface runoff of only 0.17, 0.08, and 0.06 inch each, respectively. With an average rate of rainfall of 1.52 inches an hour for a 15-minute period, the direct surface runoff amounted to less than 0.02 inch an hour. Observations made on plots at Tanbark Flats showed characteristics very similar to those of the plots at Fern Canyon.

Fern Canyon Watersheds Nos. 2 and 3 (see pl. 15) are less than half a mile from the Fern Canyon plots. Of these watersheds, No. 2 showed a maximum runoff of 0.69 inch an hour for a 15-minute period, and No. 3 showed 0.33 inch an hour, maxima that are considerably higher than those for the plots.

Observations at the plots indicate a surface runoff of less than 0.2 inch, but a considerably higher rate of infiltration than watersheds Nos. 2 and 3, which, with a storm rainfall of 23 inches, produced a runoff of about 9 and 4 inches, respectively. (See table 16.) It appears that a considerable part of the precipitation that was absorbed by the soil mantle, as shown by the plot experiments, passed on through the underlying much-fractured rock and thence into the streams and that its movement was rather rapid. This procedure is more pronounced for Watershed No. 2 than Watershed No. 3. The geologic conditions which may account, in part, for this difference in rate of movement are discussed on page 334. The rate was undoubtedly influenced by the steepness of the land surface, the depth of the soil mantle, the nature and extent of rock outcrops, and the amount of water already in storage within the formations.

The apparently rapid flow of a large part of the infiltrated water to the stream channel seems to introduce difficulty in the derivation of infiltration capacities which are of practical utility.

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DETERMINATION OF FLOOD DISCHARGE

The method most commonly employed by the Geological Survey in the determination of stream discharge consists of the determination, first, of a stage-discharge relation or rating by means of current-meter measurements of discharge at various stages from low water to high water and the application of this rating to the records of stage. If the stage-discharge relation for a station has been determined throughout the range of flow, it is evident that if the stage at any particular time is known and normal flow conditions prevail, the rate of discharge past the station at that time may be ascertained by application of the rating. It is very difficult to determine the discharge during abnormal flood stages in most localities, and the accuracy of the result arrived at usually depends on surveys, analyses, and computations, by various more or less indirect methods, for extending the stage-discharge relation beyond the range covered by current-meter measurements.

The difficulties which make it practically impossible to obtain direct measurements of discharge or to define stage-discharge relations during flood periods at most stream-measurement stations in southern California have been discussed in the section on basic discharge records. Records of discharge during the floods of March 1938 have of necessity been determined by a combination of the methods that have been developed by the Geological Survey in connection with stream gaging and studies of other floods. Particularly helpful in this connection have been the checks upon estimates of discharge afforded by the relations between rainfall and runoff as developed from a study of the basic discharge records and described in the next preceding section of this report.

Computation of peak discharge

Peak discharges were evaluated in a variety of ways suited to the conditions at the site and the kind of basic information that was available or could be found. Wherever possible, the results as determined by one method were verified by checking them with results as determined by other methods.

The discharges were determined by slope-area surveys and related methods based fundamentally on the application of the Chezy formula. They were also determined from data concerning flow over weirs and through contracted openings, by the extension of rating curves with the aid of various techniques, by analyses of reservoir records as previously described, and by various methods involving comparison of basic factors.

Peak discharges computed from a survey of pertinent conditions made subsequent to the peak are subject to errors introduced by unstable channels. Valley-floor streams usually have beds composed of sand and light gravel. At many places in these streams there was considerable scour during the higher stages, and the scour was probably greatest at the time of the peak discharge. On these streams the bed was prodded with a round iron rod and the rod forced by hand to a comparatively firm bottom that was considered to have been the bottom of the section at the time of the peak discharge.

Streams in the mountain areas have steep slopes and consequently high velocities. Their beds are generally composed of loose boulders and gravel, which are moved in large quantities because of the high velocities. These swift streams move from side to side in the canyons, depositing or removing debris first on one side of the channel and then on the other. Cross-sectional areas determined after the floods have subsided may or may not be the same as at the time of the peak discharge. Debris moving downstream may have raised the water surface locally until it was higher for smaller discharges than for the peak discharge. Turbulence may have caused splash or run-up marks on the banks higher than the controlling high-water levels. Because it is necessary to apply indirect methods of determination for such streams attempts were made to select reaches where these unfavorable influences would be least complicating.

Field data were obtained for certain streams in the San Bernardino and San Gabriel Mountains at places where channel conditions were extremely unfavorable, and it was found desirable to discard peak discharges computed from the data obtained at some of these places. A view showing typical channel conditions on these streams is presented in plate 16,A.

Slope-area determinations

Peak discharges were determined at many river-measurement stations and on miscellaneous streams by means of slope-area studies. Discharges were computed from measurements of the cross-sectional areas and slope by the use of formulas which have had extensive practical application. The formula generally used was the Manning formula, usually written as:

$$V = \frac{1.486}{n} R^{2/3} S^{\frac{1}{2}}$$

in which V = mean velocity in feet per second, n = coefficient of roughness, R = hydraulic radius in feet, and S = friction slope.

The selection of values of n has been guided by the results of the Survey's experience in the use of the slope-area method, and the values chosen were selected in the light of the few data available for streams in southern California.

The friction slope was generally computed from the hydraulic gradient of the peak stage as determined from high-water marks, on the basis of the difference in weighted velocity heads at the end sections.[15a] For streams whose velocity at the downstream section was less than at the upstream section, it was assumed that there was a 50 percent recovery of the theoretical kinetic energy head. Cross sections were divided into parts to provide for variation in the hydraulic radii and coefficient of roughness.

As an example of the application of the slope-area method, the basic data used in determining the peak discharge of Lone Pine Creek near Keenbrook are shown in figure 32. A view of the reach is shown in plate 16,B.

On some streams reaches of channel were surveyed in which the changes in channel shape and slope made them unsuited to normal methods of analysis. The peak discharge was computed singly for each cross section on the basis of the Manning formula or the varied-flow equation given by Rouse.[16]

Flow over weirs

The basic formula for the computation of flow over weirs is commonly expressed as $Q = CLH^n$, in which Q = discharge in second-feet, C = coefficient for the weir, L = effective length of crest in feet, H = head in feet on the crest measured far enough above the weir to avoid surface draw-down, and n = the exponent of H. The exponent $\underline{n}$ may be assumed to be 1.5, and under this assumption the coefficient C will ordinarily vary with the head and with differences in slope of crest. The velocity of approach in the channel above the weir affects the discharge over the weir and practically increases the head on the crest by an amount equivalent to the corresponding velocity head.

15a Johnson, Hollister, The New York State flood of July 1935: U. S. Geol. Survey Water-Supply Paper 773-E, pp. 253-254, 1936.

16 Rouse, Hunter, Fluid mechanics for hydraulic engineers, p. 290, McGraw-Hill Book Co., 1938.

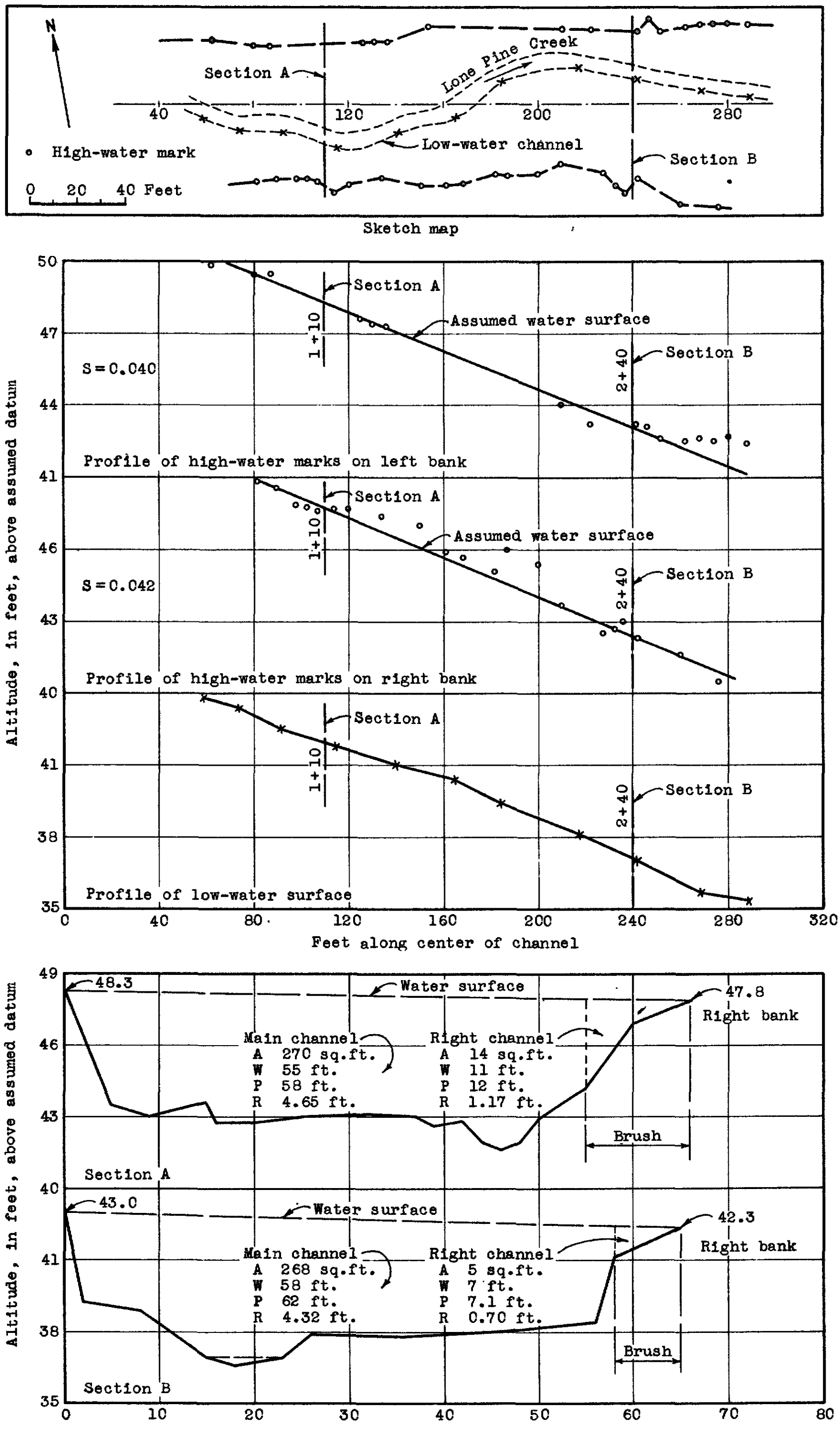

Figure 32.- Sketch map, water-surface profiles, and cross sections of the slope-area reach of Lone Pine Creek near Keenbrook.

The basic formula was modified to make it conform to conditions peculiar to the places of application. For example, if the crest of a weir was submerged, this submergence was considered in computing the discharge over the weir. The exponent n was generally taken as 1.5, and values of C were selected from data summarized in Water-Supply Paper 200, "Weir experiments, coefficients, and formulas," or from those contained in handbooks.

Flow through contracted openings

The peak discharge was computed at some sections where the stream channel was constricted by bridge abutments or by natural rock formations. At these sections, the area of the cross section of the opening was much less than that of a cross section of the channel above, resulting in an increase in velocity through the contracted section. This increase in velocity could be produced only by converting head into velocity, and the head so used caused a sharp drop in the water surface through the opening. The velocity was computed by the formula, $V = C\sqrt{2gh}$, in which V = velocity in feet per second, C = coefficient of section, g = gravity, and h = head at most contracted section (surface drop through opening plus velocity of approach).

The values selected for C have been based mostly on experiments by Yarnell.[17]

Extension of rating curves

The rating curve showing the relations of stage to discharge may, under favorable circumstances, be extended to stages and discharges higher than the range defined by current-meter measurements. The most favorable conditions for the accurate extension of a rating curve are furnished by well-defined rapids or riffles below the gaging station at all stages, and a uniform increase of channel cross section as the stage increases without abrupt changes in area or the addition of overflow channels.

Many of the gaging stations within the area affected by the March floods were of necessity located where both the banks and the bed of the natural stream channel were composed of easily erosible sand or light gravel, so that there was not a permanent relation between stage and discharge.

17 Yarnell, David L., Pile trestles as channel obstructions; U. S. Dept. Agri., Tech. Bull. 429, July 1934; Bridge piers as channel obstructions, U. S. Dept. Agri., Tech. Bull. 442, November 1934.

There were some channels, however, in which the process of scour and fill was less active. At these stations it is believed the rating curves can be extended with a fair degree of accuracy by assuming that nature, by scour and fill within the channel, maintains a rather definite relation between slope and elements of the cross section. This relation is obtained by plotting, to logarithmic scales, the mean depth against the mean velocity for each current-meter measurement. The rating curve may be extended to the peak stage by computing the mean depth from the cross section believed to have existed at this stage. The extension, of course, involves evaluation of the friction factor and slope through the range of stage. This method is further discussed in the succeeding section on "Discharge in unstable channels."

Discharge in unstable channels

For streams having unstable channels the relation between stage and discharge is generally variable, and the determination of discharge may involve the introduction into the process of one or more additional factors and the development of multiple rating curves. Conditions conducive to instability are prevalent in the alluvial channels of the streams of southern California, particularly during floods. It has been found useful on these streams to plot logarithmically mean depth against mean velocity for each discharge measurement.

It can be assumed that this relationship may be expressed as $V = Cd^n$, in which V = velocity in feet per second, C = a constant, d = mean depth in feet, and n = the exponent of d. In channels in which the width is great compared to the depth, the hydraulic radius of the Manning formula should approach in value the mean depth, and the exponent of the mean depth should approach the value of the exponent of the hydraulic radius. The results of a current-meter measurement at the control section will define the constant C, which represents the $(\frac{1.486\ S^{\frac{1}{2}}}{n})$ factor of the Manning formula. Assuming that this constant is applicable for a wide range of stage, then it is possible to develop a rating curve for this control section that was applicable at the time the measurement was made.

Additional current-meter measurements made at the same site may show a different constant, indicating a change in slope or friction factor. Using each new measurement and its resulting constant, additional rating curves can be developed that embody cross section, slope, and friction factor at the time the measurement was made.

In the application of this method to determine flood discharges, advantage should be taken of all pertinent information regarding the conditions of flow at the higher stages and of any determinations of discharge by other indirect methods as previously discussed.

Computation of continuous records of discharge

The most accurate continuous records of flow during the flood were based on volumetric determinations of discharge into reservoirs. The computations were made from records of stage in the reservoirs, taking into consideration, also, the information available concerning storage capacity and discharge through spillways and other outlet structures. The records of inflow to these reservoirs and of flow at certain other stations are included in a preceding section of this report, "Basic discharge records," in which the methods of determining them and their accuracy are discussed. The records in that section have been utilized in the analysis of basic relationships between rainfall and runoff.

Continuous records through the flood period were also available for a group of stations, principally on the valley floor, operated by the Corps of Engineers, United States Army, and the Los Angeles County Flood Control District. At these stations current-meter measurements of discharge were made at frequent intervals. For example, during the period February 28 to March 4, 1938, 18 measurements were made on Ballona Creek near Culver City and 44 on Los Angeles River at Los Angeles. Even at stations where frequent measurements were made, however, parts of the records are questionable because of unstable channel conditions.

At a large number of the gaging stations the records for the flood period were seriously deficient. At 26 stations the water-stage recorders and accompanying equipment installed by the Geological Survey were completely destroyed. Many water-stage recorders installed by the Los Angeles and Orange County Flood Control Districts were also destroyed. At these gaging stations all records made during and shortly prior to the major flood period were lost.

Several of the gage-house structures were battered and overtopped by the flood, which stopped the recorder clocks and caused the loss of subsequent records. The wells of many stations were filled with silt, making them inoperative during parts of the flood period. The scouring and filling of the stream beds at many stations made it impossible or very difficult to establish any relation between gage height and discharge. This is illustrated by figure 33, which shows actual cross sections of channel

A. EAST ETIWANDA CREEK NEAR ETIWANDA.

Looking downstream at reach below falls and near mouth of canyon: a typical mountain stream channel.

B. SLOPE-AREA REACH ON LONE PINE CREEK NEAR KEENBROOK.

Looking downstream.

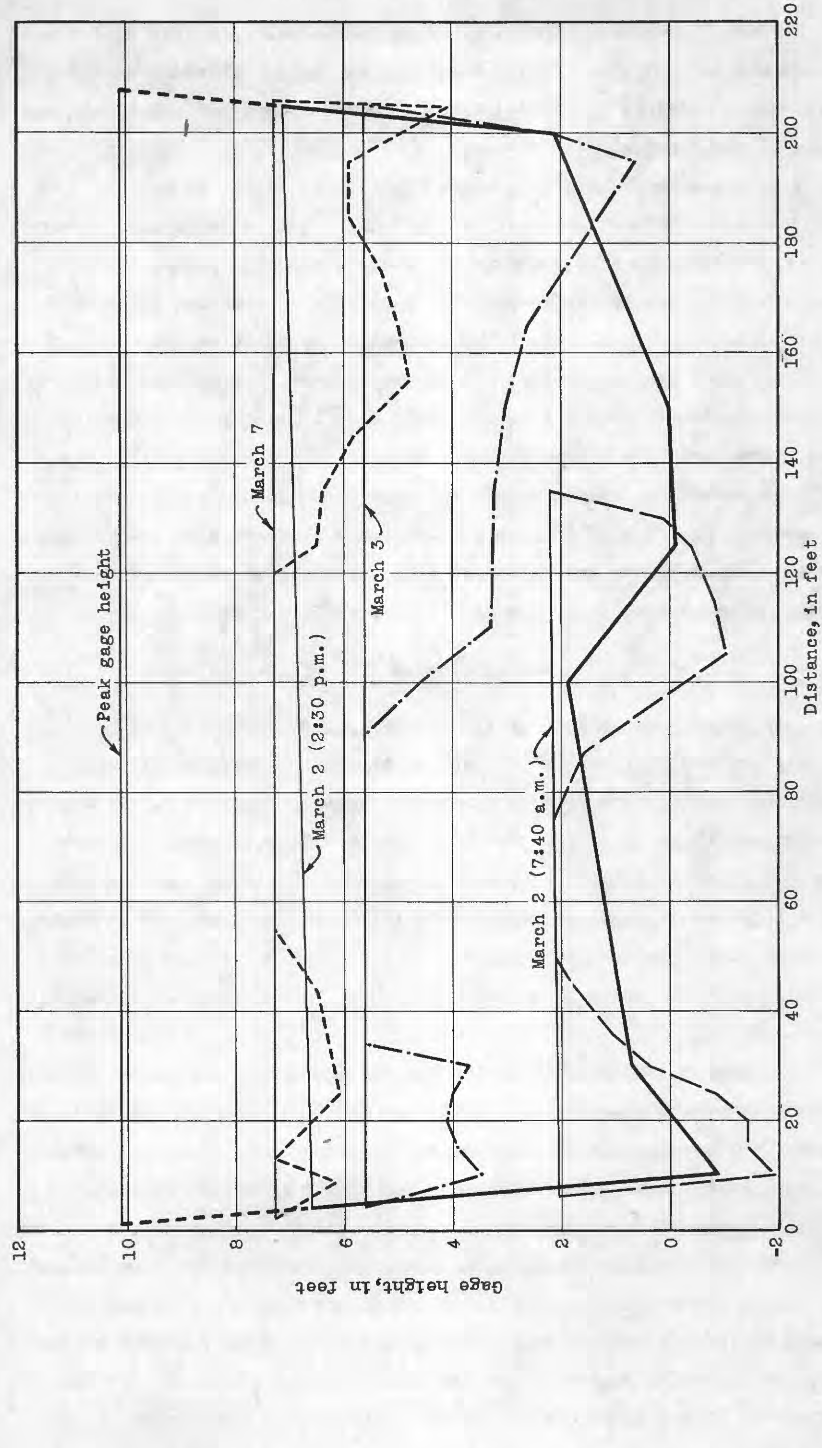

Figure 33.- Cross sections at cableway on East Fork of San Gabriel River near Camp Bonita, February and March 1938.

of the East Fork of San Gabriel River at the cableway at Camp Bonita as determined several times during the flood period. At several river-measurement stations artificial masonry controls were badly battered and rendered ineffective. The destruction of highways also interfered seriously in the work of obtaining needed data at gaging stations.

Every possible effort has been made to fill in missing records made during the flood so that wherever practicable complete records of discharge volumes may be available. All available information has been utilized to make these substituted records as reliable as possible. Many of the missing records were filled in and checked by comparing hydrographs for the stations to which they appertain with hydrographs for stations of like characteristics. The relations developed in the analysis of rainfall and runoff for the basic discharge records have also been utilized extensively in estimating missing records. A discussion of the procedure and an example of the derivation of flow for a gaging station with a period of missing record is discussed in the following section.

Derivation of discharge for periods of missing records

The general procedure for determining the discharge for periods of missing or unsatisfactory record was to prepare hydrographs based on all available data, including such discharges as were compiled from fragmentary observations of stage, current-meter measurements, and slope-area and other similar determinations of discharge. These hydrographs were plotted on semilogarithmic paper, with the discharge expressed in inches of runoff over the area or in second-feet per square mile in order that the data might be compared readily with those for adjacent or comparable areas.

In general, the records at the various gaging stations were complete and fairly satisfactory to the morning of March 2, although some had already been lost through the destruction of the recording-gage structures. Commonly, therefore, the problem resolved itself into a determination of the discharge during the period of the main flood, on March 2, and during the period of recession until such time as observations could be resumed.

In many instances helpful information regarding the flow was obtained by translating the rates of rainfall for a given drainage basin, based on recording rain-gage records within or near the basin for the maximum 24 hours, into rates of discharge by the application of relations determined from the basic discharge records. The method used in completing the missing record for City Creek near Highland is presented as a typical example of the procedure. The available information consisted of a gage-height record continuing until about noon March 2, and the results of a slope-area determination of the peak discharge.

The isohyetal map indicates that the average precipitation over City Creek Basin (drainage area, 19.8 square miles) during the entire storm period was about 19 inches. This rainfall was distributed through the period on the basis of continuous records obtained from the recording rain gage at Del Rosa (altitude, 2,250 feet), located near the mouth of Strawberry Creek, about 5 miles southwest of the center of City Creek Basin. On this basis the precipitation for the basin was 11.2 inches for the maximum 24-hour period, or at a rate of 0.47 inch an hour; 8.5 inches for the maximum 12-hour period, or at a rate of 0.71 inch an hour; and proportionately less for shorter periods down to the maximum 15-minute period, for which the rate was estimated as 2.3 inches an hour. These rainfall rates are plotted on figure 34.

The relation between rates of rainfall and runoff for City Creek Basin are assumed to be very similar to those for the basins of Eaton, Dalton, Sawpit, Pacoima, and San Dimas Creeks as shown in figure 29. For this group, the maximum 24-hour rainfall ranged from 9.6 to 12.2 inches, the average being 11.0 inches.

On figure 29 is shown also an average curve of these relations for the basins above named, which was assumed to apply also to City Creek. By applying the assumed rates of rainfall to this average curve the corresponding rates of runoff were determined and used to define the runoff curve shown on figure 34. This figure is comparable with figures 25 and 26.

The slope-area determination for City Creek near Highland indicates a peak discharge of 6,900 second-feet which is equivalent to 348 second-feet to the square mile, or a rate of runoff of 0.54 inch an hour. This hourly rate is plotted on figure 34 as representing a discharge that lasted for 5 minutes. By this point and the other points representing rates of runoff, obtained as above described, a line is defined that is assumed to show the rates of runoff for the City Creek station for periods of time ranging from 5 minutes to 24 hours.

On figure 35 are plotted the times of occurrence of the various maximum rainfall periods as observed for the recording rain gages at Del Rosa and Devil Canyon.

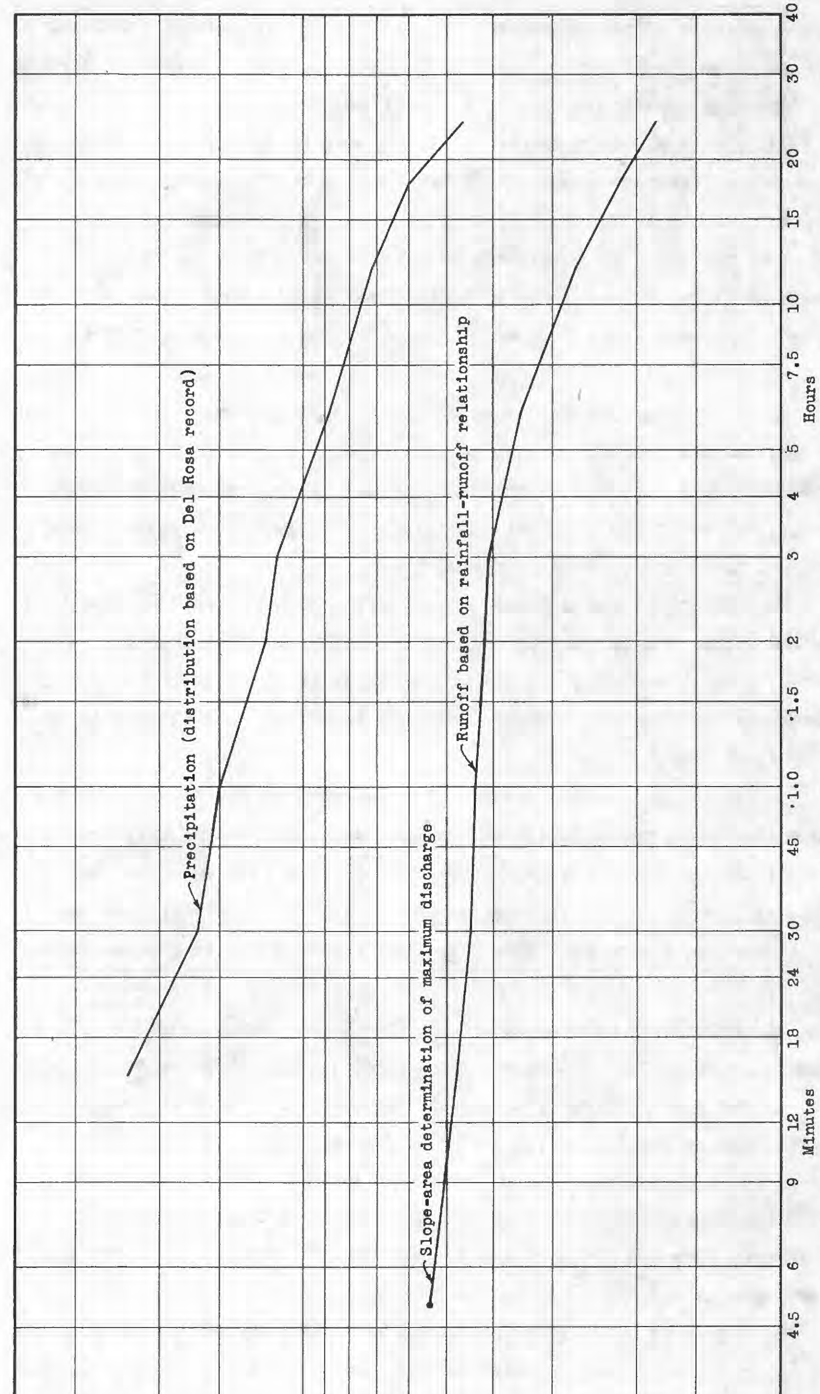

Figure 34.- Rates of precipitation and runoff, for periods of 5 minutes to 24 hours, for City Creek near Highland.

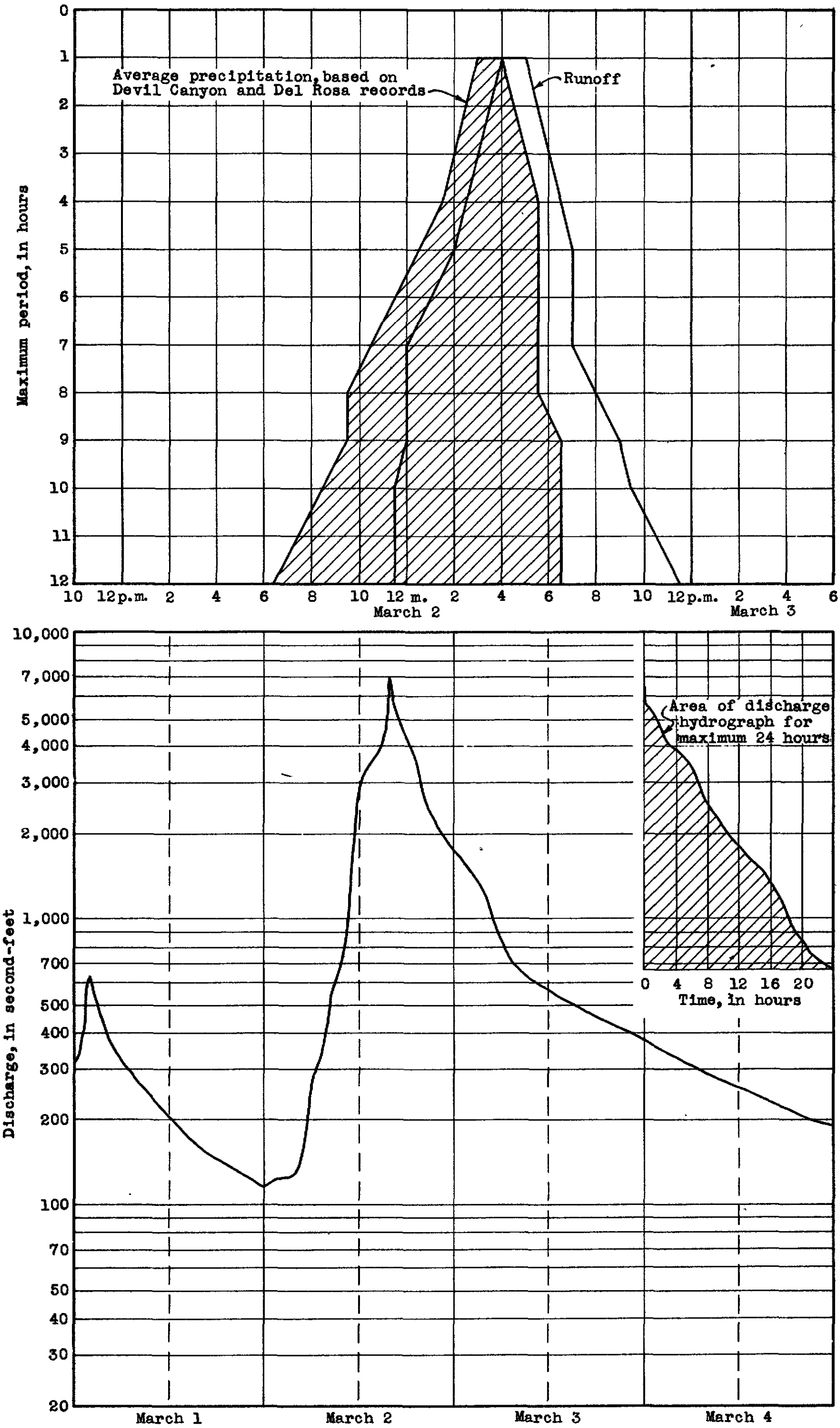

Figure 35.- Time of occurrence of indicated maximum precipitation periods as observed at Devil Canyon and Del Rosa, and probable time of occurrence of runoff of City Creek, with discharge hydrograph of City Creek near Highland, March 1-4.

On the basis of the general knowledge of the behavior of streams in the region, the lag between rainfall and runoff on City Creek for the maximum 1-hour period was assumed to be about an hour. The beginnings of the maximum periods of more than 6 hours were within the period of the observed record. The lag for the 12-hour period is assumed to be 5 hours and is comparable with the data shown on figure 31.

On figure 36 is shown, also, the estimated hydrograph of City Creek for the period March 1-4. The record of discharge from midnight of February 28 to noon of March 2 was obtained from the gage-height record and a fairly well defined stage-discharge relation.

In the upper right hand part of the lower part of figure 35 is a curve that shows the rates of discharge for the maximum 24-hour period, ranged in the order of magnitude as derived from the data obtained from the runoff curve shown on figure 34. With this curve showing the rates of discharge and the curve in the upper part of figure 35 indicating the times of occurrence of maximum average rates for specified intervals, the hydrograph was completed through the maximum 24-hour period.

Table 22 furnishes a comparison, between City Creek and San Dimas Creek on the basis of the ratios of the maximum discharge and the maximum average discharge for selected periods to the discharge and average discharge for the maximum 24-hour period as well as the ratio of the maximum average discharge of each of the 14 areas given in table 13 to the average discharge for the maximum 24-hour period in that area. The values derived for City Creek seem reasonable on the basis of this comparison. The slight differences in storm pattern and topography between the basins of City and San Dimas Creeks may account for the higher ratio on City Creek of the maximum discharge to discharge for the maximum 24-hour period.

Table 22.- Ratio of maximum discharge for indicated periods to the maximum 24-hour discharge for City and San Dimas Creeks and for the average of 14 areas in southern California

Stream	Drainage area	Peak	1 hour	3 hours	6 hours	12 hours	18 hours
<u>Santa Ana River Basin</u>							
City Creek	19.8	3.11	2.50	2.33	2.01	1.52	1.25
<u>San Gabriel River Basin</u>							
San Dimas Creek	16.5	2.63	2.44	2.38	2.06	1.62	1.25
Average of 14 areas[a]	-	2.72	2.45	2.22	1.92	1.48	1.19

a From table 13.

The discharge of City Creek for the period March 4-11 was estimated on the basis of a general study of recession characteristics as described below and a current-meter measurement on March 11.

On figure 36 are drawn retention curves for several of the stations listed in table 17. The characteristics of these curves shown on logarithmic projection seem to conform to a theory that the discharges following flood peaks, if so plotted, approximate a linear relation to the amounts of water retained as ground storage.

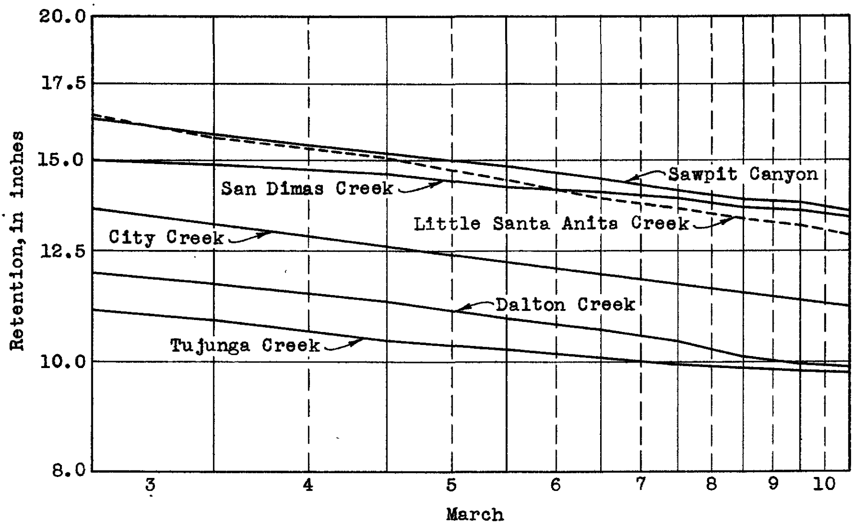

Figure 36.- Retention curves for certain stations in Santa Ana, San Gabriel, and Los Angeles River Basins.

Beginning with the retention in City Creek Basin at noon on March 3, computed from the hydrograph just developed, a straight line was drawn approximately parallel to the other lines, and the runoff for each day was then determined from the drop in this retention curve. These amounts of runoff appear reasonable and were checked by the current-meter measurement on March 11. The significance of retention is discussed at some length in a later section of this report.

The determination of the record by the foregoing procedure necessarily involves assumptions with respect to the factors entering into it, such as the rainfall rates that occurred on City Creek, the time of their occurrence, the selection of a suitable relationship between rainfall rates and runoff, and the estimate of the lag between rainfall and runoff in City Creek Basin. Also affecting the computed record are the possible complicating influences due to basing the fundamental rainfall-runoff records on discharge that includes more or less debris flow. The procedure involves to a large degree the application of the experience and knowledge of the authors, gained in their long-time observation of the runoff characteristics of streams in southern California.

From the records of discharge throughout the flood period as thus deduced, the mean daily discharge for each of the missing days may be readily computed and complete record thus be provided for publication.

The foregoing method and modifications of it for adaptation to varying circumstances, as well as other devices, have been used to fill in the discharge record for days for which this record is missing. The description accompanying the discharge tables gives information regarding the methods used in completing the records. High accuracy cannot be claimed for the results, but they are believed to be trustworthy enough to be used in studying the general characteristics of flood runoff in the region.

Consistency of determinations of flood discharge

Comparison of the intensity-duration relation for the runoff of City Creek Basin near Highland, as shown in figure 34, with the intensity-duration relation for the runoff of other drainage areas, as shown in figures 25 and 26 and elsewhere, seems to demonstrate that the maximum runoff rates of City Creek Basin as indicated by the rainfall-runoff study and also by the slope-area determination tend to be mutually confirmatory. Similar confirmation was obtained at several other places.

At the following gaging stations substantial differences were found between estimates of discharge obtained by rainfall-runoff studies and those obtained by slope-area and other methods: Devil Canyon Creek near San Bernardino, Waterman Canyon Creek near Arrowhead Springs, Cucamonga Creek near Upland, San Antonio Creek near Claremont, and Strawberry Creek near Arrowhead Springs. These differences reflect the difficulties inherent in the determination of peak discharges under the existing conditions as well as the part played by personal judgment in the interpretation of the data. The estimates of discharge as published in this report are intermediate between those obtained by rainfall-runoff studies and those obtained by slope-area or other methods. An evaluation of the maximum discharge of these streams has been made on the basis of the composite judgment of engineers of the Geological Survey.

There was a wide discrepancy between the estimates of discharge of the Santa Ana River near Prado as obtained by different methods and different engineers. These estimates ranged from less than 80,000 to more

A. SAN GABRIEL RIVER NEAR AZUSA.
In lower end of San Gabriel Canyon. Slope of channel about 1 percent.

B. CUCAMONGA CREEK NEAR UPLAND.
Shelter is designed to withstand rocks falling from the canyon walls. Slope of channel about 4 percent.

RECONSTRUCTED GAGING STATIONS REPLACING STRUCTURES DESTROYED DURING THE FLOODS OF MARCH 1938.

A. SAN ANTONIO CREEK NEAR CLAREMONT.
In steep mountain canyon. Slope of channel about 12 percent.

B. DEEP CREEK NEAR HESPERIA.
At lower end of canyon in desert area. Slope of channel about 1 percent.

RECONSTRUCTED GAGING STATIONS REPLACING STRUCTURES DESTROYED DURING THE FLOODS OF MARCH 1938.

than 140,000 second-feet. The difficulties at this gaging station included that of the uncertainty as to the cross-sectional area of the channel, that of the definition of the slope of the water surface at the time of the maximum discharge, and other complications typical of the shifting channels found in the unstable alluvial material of flood plains on the valley floor. The maximum discharge adopted for publication in this report is 100,000 second-feet. Obviously this estimate is subject to considerable error, and wherever it is used appropriate allowance should be made for its possible inaccuracy.

Great effort was made to collect accurate and complete field data on practically all the larger streams in the area covered by the flood in order to better determine their maximum discharges. The surveys were made by engineers of the Geological Survey chosen either because they had long been familiar with the streams in this region or because of their long experience in studying floods in other sections of the United States. A large amount of time was spent, both in the field and office, in attempting to coordinate and reconcile results that were discordant because of the extraordinarily unfavorable conditions prevailing along these stream channels. A record of all the information collected, however, and the results of the computations are on file at the Los Angeles office of the Survey and are available to anyone who may wish to make further study of them.

RECORDS OF STAGE AND DISCHARGE AT STREAM-GAGING STATIONS

One of the principal purposes of this report is to record the available information regarding the discharge of streams in southern California during the floods of March 1938 in more detail than appears in Water-Supply Papers 860 and 861, the reports on this region for 1937-38 published by the Geological Survey as parts 10 and 11 of its annual series on surface water supply of the United States. This information is useful in comparative studies of the characteristics of floods and in planning flood protection and control by means of reservoirs, levees, and channel improvements. The records should also be helpful in the planning of future bridge and highway construction as well as in the design and layout of hydraulic and other structures that may have a relation to the channels of the streams or their flood plains.

The records published in this report are for streams on which floods occurred in March 1938 or which are adjacent to the margins of the storm area and therefore serve to define the extent of the floods. In this section are presented the available records for most of the stream-gaging stations in the flooded region. The records for a few stations have already been presented as basic discharge records. The latter were analyzed to bring out details that might lead to a better interpretation of the often meager data available at most stations.

Explanation of data

The data systematically collected at stream-gaging stations consist of records of stage, measurements of discharge, and other technical information useful in determining the daily flow. The records of stage are generally obtained by water-stage recorders, which give a continuous graphic record of the fluctuations. Measurements of discharge are usually made with a current-meter according to methods outlined in standard textbooks on the measurement of stream discharge. Typical stream-gaging stations, equipped with water-stage recorder and measuring cable and car, are shown in plates 17 and 18.

Because of the unusually destructive character of the floods of March 1938, as already outlined, many of the regular stream-gaging stations were destroyed or so badly damaged that no record of stage was obtained. Furthermore, it was practically impossible during the flood period to obtain current-meter measurements in either the mountain or the valley-floor areas. Other difficulties in the determination of discharge have been discussed in the preceding section and at other places in this report.

In general the data presented for each stream-gaging station comprise a description of the station, a table of daily and monthly discharge throughout the 3-month period February to April 1938, and a table of stage and discharge at hourly or other indicated intervals, if these are available, generally from February 27 to March 4. The presentation of the data has followed a uniform plan as far as practicable.

The description of the station contains, in the first paragraph, information relating to the location of the gage and the approximate altitude of the stream channel at the gage. The second paragraph gives certain characteristics of the drainage area. The third paragraph, which relates to the gage-height record, gives a statement as to the type of record and the period for which a gage-height record was available. The fourth paragraph, entitled "Discharge record," contains information concerning the method used to compute the discharge. If a gage-height record was available and the stage-discharge relation could be defined, information is given concerning the range to which the rating curve is defined by current-meter measurements and the method used to extend the rating curve to the peak of the flood. The fifth paragraph, headed "Maxima," lists the discharge, time, day, and gage height, if available, of the peak flow during the March flood. Similar information is included for the largest flood that occurred during the period of record preceding March 1938. The sixth and final paragraph, under the heading "Remarks," furnishes data concerning storage or diversions upstream from the station and other miscellaneous information.

The table following each station description shows the mean daily discharge in second-feet, mean monthly discharge in second-feet, and monthly runoff in acre-feet, generally for the period February 1 to April 30, 1938. This covers the flood period and sufficient time before and after to show the relation of flood discharges to the prevalent discharges and to give a general perspective of the March floods.

The table of gage heights and discharges at indicated times was designed to present the details of the rise and recession of the flood. It is accompanied by footnotes giving supplemental records of discharge if these are needed to define more accurately the subsidiary peaks or valleys in the hydrograph that would otherwise not be disclosed in the hourly or bihourly listing. For those stations for which there is little fluctuation in the hydrograph, mean values are sometimes used, as indicated by braces showing the period for which the mean is given. The stages at indicated times were obtained from the water-stage recorders insofar as such records were available. The discharges at indicated times were generally obtained from the gage heights by application of the rating table, usually allowing for corrections due to shifting-control.

The records are arranged in accordance with the regular plan used by the Geological Survey in its annual series of reports on the surface water supply of the United States. The only exception is that in the annual series, records for the part of the Great Basin that is in California (part 10) are published separately from those for the remainder of California (part 11), whereas in this report the Great Basin records follow immediately after those for the south Pacific slope basins.

Reference should be made to the water-supply papers of the Geological Survey for other records of flow of many of the streams discussed in this report.

The records in this report are based on all the information available at the time of its compilation. Any revisions found necessary will be published in subsequent water-supply papers.

Tia Juana River Basin

Cottonwood Creek at Morena Dam, Calif.

Location.- Lat. 32°41'00", long. 116°32'55", in SW¼ sec. 14 T. 17 S., R. 4 E., at Morena Dam, 1-3/4 miles above junction with Hauser Creek. Altitude of stream bed, 2,882 feet.

Drainage area.- 120 square miles.

Gage-height record.- Gage read daily at 7 a.m.

Remarks.- Records of discharge computed from discharge over spillway, change in contents, leakage, evaporation, and direct rainfall on surface of reservoir. Altitude of top of spillway gates, 3,045 feet. Storage capacity, 67,211 acre-feet. Records furnished by City of San Diego Water Department.

Gage height, in feet, and contents, in acre-feet, 1938

Day	February		March		April	
	Feet	Acre-feet	Feet	Acre-feet	Feet	Acre-feet
1	149.99	46,553	151.88	49,179	160.38	63,307
2	150.13	46,746	152.18	49,606	160.41	63,363
3	150.15	46,773	155.00	53,680	160.45	63,436
4	150.21	46,856	156.22	55,494	160.49	63,510
5	150.29	46,967	156.65	56,137	(a)	-
6	150.31	46,994	156.89	56,503	160.55	63,620
7	150.31	46,994	157.05	56,748	160.59	63,694
8	150.32	47,008	157.22	57,007	(a)	-
9	150.33	47,022	157.40	57,282	160.66	63,823
10	150.41	47,132	157.51	57,450	160.69	68,878
11	150.43	47,160	157.60	57,587	160.73	63,952
12	150.67	47,491	157.87	58,000	160.76	64,007
13	150.71	47,547	158.42	58,848	(a)	-
14	150.73	47,574	158.73	59,328	160.92	64,302
15	150.76	47,616	158.90	59,591	160.96	64,375
16	150.78	47,643	159.03	59,831	161.03	64,504
17	150.81	47,685	159.17	60,232	161.06	64,559
18	150.82	47,699	159.29	60,576	161.09	64,615
19	150.92	47,837	159.39	60,832	161.13	64,688
20	150.95	47,878	159.48	61,119	161.15	64,725
21	150.97	47,906	159.55	61,320	161.18	64,780
22	150.98	47,919	159.63	61,549	161.20	64,817
23	150.99	47,933	159.71	61,778	161.23	64,873
24	151.00	47,947	159.78	61,978	161.25	64,909
25	(a)	-	159.84	62,150	161.28	64,965
26	151.01	47,961	159.90	62,321	161.33	65,057
27	151.09	48,072	160.00	62,608	161.37	65,130
28	151.50	48,643	160.08	62,755	161.39	65,167
29			160.16	62,902	161.41	65,204
30			160.25	63,068	161.44	65,259
31			160.32	63,197		

	February	March	April
Mean monthly discharge, in second-feet	53.3	247	48.3
Runoff, in acre-feet	2,960	15,190	2,870

a Unable to read gage owing to heavy wind.

Cottonwood Creek near Dulzura, Calif.

Location.- Lat. 32°40'45", long. 116°40'20", in NW¼ sec. 22, T. 17 S., R. 3 E., at Barrett Dam, about 1 mile downstream from junction with Pine Valley Creek, and about 17 miles northeast of Dulzura. Altitude of stream bed, 1,446 feet.

Drainage area.- 250 square miles.

Gage-height record.- Gage read daily at 7 a.m.

Remarks.- Records of discharge represent flow into Barrett Reservoir, computed from discharge over spillway, change in contents, leakage, evaporation, and direct rainfall on surface of reservoir. Altitude of top of spillway gatee, 1,615 feet. Storage capacity, 42,796 acre-feet. Additional storage obtained by placing sandbags on spillway. Records furnished by City of San Diego.

Gage height, in feet, and contents, in acre-feet, 1938

Day	February		March		April	
	Feet	Acre-feet	Feet	Acre-feet	Feet	Acre-feet
1	160.02	35,501	162.56	37,524	168.93	42,839
2	160.14	35,595	163.20	38,043	168.94	42,848
3	160.21	35,651	169.20	43,073	168.92	42,831
4	160.28	35,706	169.59	43,411	168.91	42,822
5	160.35	35,761	169.32	43,177	168.90	42,814
6	160.39	35,793	169.19	43,064	168.93	42,839
7	160.44	35,832	169.09	42,977	168.94	42,848
8	160.45	35,840	169.05	42,943	168.95	42,856
9	160.50	35,879	169.05	42,943	168.91	42,822
10	160.59	35,950	169.01	42,908	168.90	42,814
11	160.63	35,982	169.00	42,899	168.93	42,839
12	160.81	36,124	169.10	42,986	168.94	42,848
13	160.90	36,195	169.38	43,229	168.98	42,882
14	161.00	36,274	169.29	43,151	169.10	42,986
15	161.03	36,298	169.17	43,047	169.19	43,064
16	161.08	36,338	169.10	42,986	169.25	43,116
17	161.11	36,362	169.07	42,960	169.31	43,168
18	161.14	36,386	169.05	42,943	169.38	43,229
19	161.25	36,473	169.01	42,908	169.45	43,289
20	161.30	36,513	169.00	42,899	169.50	43,333
21	161.31	36,521	168.99	42,891	169.55	43,376
22	161.34	36,545	168.98	42,882	169.58	43,402
23	161.37	36,569	168.96	42,865	169.60	43,419
24	161.39	36,585	168.94	42,848	169.61	43,428
25	161.41	36,601	168.93	42,839	169.66	43,471
26	161.43	36,617	168.95	42,856	169.70	43,506
27	161.50	36,673	168.97	42,874	169.73	43,532
28	162.00	37,072	168.94	42,848	169.75	43,549
29			169.95	42,856	169.78	43,575
30			168.94	42,848	169.79	43,584
31			168.95	42,856		

	February	March	April
Mean monthly discharge, in second-feet............	37.1	212	93.4
Runoff, in acre-feet..............................	2,060	13,040	5,560

Cottonwood Creek above Tecate Creek, near Dulzura, Calif.

Location.- Water-stage recorder, lat. 32°34'10", long. 116°45'40", in sec. 27, T. 18 S., R. 2 E., half a mile upstream from confluence with Tecate Creek and 5½ miles south of Dulzura. Altitude, about 580 feet.

Drainage area.- 316 square miles.

Gage-height record.- Water-stage recorder graph.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 540 second-feet; extended to peak stage on the basis of mean depth-mean velocity relation.

Maxima.- 1938: Discharge, 2,360 second-feet 2:30 p.m. Mar. 3 (gage height, 9.07 feet).
1936-37: Discharge, 2,775 second-feet Feb. 7, 1937 (gage height, 9.65 feet).

Remarks.- Records good. Regulation at Barrett and Morena Reservoirs, 10 and 18 miles, respectively, above station.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	3.5	120	92	11	6	219	41	21	3.5	167	7.5
2	5	281	82	12	20	497	37	22	3.2	144	6.5
3	2.5	1,460	78	13	10	606	41	23	3.0	135	6.5
4	3.9	1,040	79	14	7	517	37	24	2.8	128	6
5	3.5	631	75	15	6	397	25	25	2.5	121	7
6	2.3	427	67	16	5.5	328	19	26	2.3	121	7.5
7	2.1	326	63	17	4.8	292	13	27	22	121	6
8	1.9	298	59	18	3.9	259	10	28	47	116	5
9	2.5	283	51	19	6	219	8	29		114	4.2
10	5	238	42	20	5	192	7.5	30		106	6
								31		96	
Mean monthly discharge, in second-feet......................									6.88	323	33.0
Runoff, in acre-feet..									382	19,830	1,960

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1		March 2		March 3		March 4	
1			3.20	101	2.78	52	2.98	73	8.00	1,820	6.65	1,150
2			3.08	85	2.80	54	2.98	73	8.15	1,900	6.60	1,130
3			2.96	71	2.85	58	2.99	74	7.75	1,700	6.60	1,130
4			2.87	61	2.93	67	3.03	79	7.20	1,420	6.60	1,130
5			2.80	54	3.35	124	3.04	80	6.70	1,170	6.60	1,130
6	2.12	7.8	2.74	48	3.35	124	3.07	84	6.35	1,000	6.60	1,130
7			2.69	43	3.38	128	3.09	86	6.10	890	6.60	1,130
8			2.65	40	3.43	136	3.13	92	6.20	936	6.60	1,130
9			2.62	37	3.60	165	3.30	116	6.18	928	6.60	1,130
10			2.69	35	3.73	190	3.42	135	6.10	890	6.60	1,130
11			2.57	34	3.68	180	3.48	144	6.25	956	6.60	1,130
N			2.57	34	3.67	178	3.54	154	7.40	1,520	6.55	1,105
1			2.57	34	3.74	192	3.60	165	7.60	1,620	6.50	1,080
2			2.56	33	3.67	178	3.75	194	8.80	2,220	6.45	1,060
3			2.57	34	3.57	160	4.00	247	9.00	2,320	6.40	1,030
4	2.28	15	2.60	36	3.48	144	4.17	286	8.70	2,170	6.30	980
5			2.62	37	3.38	128	4.26	307	8.45	2,040	6.25	956
6			2.62	37	3.30	116	4.27	310	7.85	1,740	6.20	936
7			2.60	36	3.23	106	4.30	318	7.15	1,400	6.15	915
8			2.59	35	3.15	93	4.60	403	7.00	1,320	6.10	890
9	2.50	29	2.59	35	3.12	90	5.00	524	6.95	1,300	6.05	866
10			2.62	37	3.07	84	6.10	965	6.85	1,240	6.00	846
11	2.70	44	2.69	43	3.02	78	6.50	1,160	6.75	1,200	5.95	826
M	3.13	92	2.73	47	2.98	73	7.75	1,280	6.70	1,170	5.90	806

Supplemental record.- Mar. 3, 2:30 p.m., 9.07 feet., 2,360 sec.-ft.; Mar. 5, 6 a.m., 5.66 ft., 710 sec.-ft.; 6 p.m., 5.24 ft., 552 sec.-ft.

Tia Juana River near Dulzura, Calif.

Location.- Water-stage recorder, lat. 32°33'50", long. 116°46'25", in sec. 33, T. 18 S., R. 2 E., half a mile downstream from confluence of Cottonwood and Tecate Creeks, and 5½ miles south of Dulzura. Altitude, about 550 feet.

Drainage area.- 478 square miles, of which 62 square miles is in Mexico.

Gage-height record.- Water-stage recorder graph.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 659 second-feet; extended to peak stage on basis of mean depth-mean velocity relation.

Maxima.- 1938: Discharge, 3,520 second-feet 11 a.m. Mar. 3 (gage height, 5.77 feet).
1936-37: Discharge, 4,700 second-feet Feb. 7, 1937, (gage height, 6.60 feet).

Remarks.- Records good. Flow subject to regulation by storage in Morena and Barrett Reservoirs, operated by City of San Diego.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	9	293	123	11	13	286	59	21	11	227	23
2	13	510	113	12	57	552	55	22	10	205	22
3	10	2,650	109	13	39	732	63	23	8.5	190	22
4	11	1,180	107	14	25	655	63	24	8.5	179	21
5	14	800	104	15	21	499	50	25	6.5	164	23
6	11	550	96	16	18	406	42	26	5.5	164	26
7	8.5	428	88	17	16	354	37	27	40	167	23
8	7	384	80	18	14	314	31	28	124	156	21
9	7.5	367	69	19	16	277	27	29		154	19
10	13	314	62	20	16	247	24	30		146	22
								31		131	
Mean monthly discharge, in second-feet									19.8	441	54.1
Runoff, in acre-feet									1,100	27,140	3,220

Gage height, in feet, and discharge, in second-feet at indicated time, 1938

Hour	February 27		February 28		March 1		March 2		March 3		March 4	
	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
1					2.07	124	2.33	230	4.80	2,230		
2			2.18	141	2.10	134	2.34	235	4.97	2,440		
3					2.17	160	2.33	230	5.32	2,800		
4	1.56	14			2.19	168	2.34	235	5.55	3,120		
5					2.29	212	2.36	247	5.45	3,020		
6			2.12	120	2.32	226	2.36	247	5.40	2,980		
7					2.40	271	2.37	253	5.46	3,080		
8					2.42	283	2.41	277	5.53	3,180		
9					2.47	314	2.45	302	5.50	3,140		
10	1.73	34			2.57	381	2.50	334	5.65	3,350		
11					2.66	446	2.57	381	5.77	3,520		
N			2.05	98	2.64	430	2.55	367	5.68	3,390		
1					2.64	430	2.56	374	5.27	2,830		
2					2.63	423	2.60	402	5.32	2,900		
3					2.61	409	2.73	502	4.85	2,400		
4	1.81	50			2.58	388	2.80	564	4.90	2,460		
5					2.55	367	2.87	627	5.15	2,680		
6			2.05	98	2.49	328	2.91	663	4.83	2,380		
7					2.46	308	2.93	681	4.62	2,160		
8					2.43	289	3.03	780	4.50	2,040		
9			2.02	88	2.39	265	3.27	890	4.37	1,900		
10	1.93	80			2.37	253	3.68	1,170	4.33	1,860		
11					2.36	247	3.88	1,330	4.38	1,910		
M			2.07	104	2.34	235	4.20	1,620	4.32	1,850		

Supplemental records.- Mar. 3, 2:30 p.m., 2,550 sec.-ft.; 4:15 p.m., 2,540 sec.-ft.; 5:45 p.m., 2,540 sec.-ft.

Tia Juana River near Nestor, Calif.

Location.- Water-stage recorder, lat. 32°32'55", long. 117°05'15", on line between secs. 3 and 4, T. 19 S., R. 2 W., 1½ miles south of Nestor, and 3 miles upstream from mouth. Altitude, 25 feet.

Drainage area.- 1,668 square miles, of which 1,198 square miles is in Mexico.

Gage-height record.- Water-stage recorder graph.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 4,100 second-feet; extended to peak stage on basis of mean depth-mean velocity relation.

Maxima.- 1938: Discharge, 6,760 second-feet 8 a.m. Mar. 3 (gage height, 6.38 feet).
1936-37: Discharge, 17,700 second-feet Feb. 7, 1937 (gage height, 8.20 feet).

Remarks.- Records good. Flow subject to regulation by storage in Morena and Barrett Reservoirs, operated by city of San Diego, and Rodriguez Reservoir, operated by Government of Mexico.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	0	221	144	11	0	322	59	21	5	272	26
2	0	439	130	12	0	816	57	22	4.4	240	20
3	0	4,950	122	13	0	1,540	61	23	3.5	220	19
4	0	3,010	119	14	0	1,100	67	24	2.8	205	18
5	0	1,640	116	15	3.3	670	63	25	1.7	193	18
6	0	1,090	110	16	3.5	496	49	26	0	185	18
7	0	680	100	17	3.7	398	42	27	14	189	20
8	0	618	88	18	3.9	358	36	28	42	189	20
9	0	601	76	19	3.9	322	31	29		181	18
10	0	412	63	20	4.4	294	28	30		169	17
								31		158	
Mean monthly discharge, in second-feet									3.43	715	58.5
Runoff, in acre-feet									191	43,990	3,480

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	March 1		March 2		March 3		March 4	
1	2.93	85	3.63	405	5.15	2,880		
2	2.93	85	3.62	398	5.37	3,470		4,030
3	2.99	100	3.61	391	5.63	4,200		
4	3.01	105	3.59	377	5.95	5,220		
5	3.02	108	3.56	358	6.05	5,560		
6	3.04	113	3.54	334	6.15	5,920		3,120
7	3.06	122	3.50	328	6.25	6,300		
8	3.08	127	3.47	310	6.38	6,760		
9	3.10	134	3.46	304	6.30	6,480		
10	3.13	144	3.43	288	6.10	5,810		
11	3.16	154	3.41	277	5.95	5,280		2,890
N	3.17	158	3.40	272	5.90	5,110		
1	3.22	177	3.41	277	5.95	5,280		
2	3.34	230	3.42	282	5.90	5,110		
3	3.45	288	3.44	294	5.67	4,370		3,064
4	3.52	328	3.48	316	5.50	3,890		
5	3.56	352	3.53	346	5.30	3,330		
6	3.58	364	3.65	426	5.35	3,470		
7	3.58	370	3.75	512	5.55	4,030		
8	3.57	364	3.83	583	5.90	5,110		2,790
9	3.58	370	3.90	650	6.20	6,160		
10	3.61	391	4.00	754	6.17	6,060		
11	3.63	405	4.25	1,080	6.05	5,640		2,420
M	3.63	405	4.55	1,560	5.97	5,360		

Campo Creek near Campo, Calif.

Location.- Water-stage recorder, lat. 32°35'20", long. 116°31'35", in sec. 24, T. 18 S., R. 4 E., at State highway about 3½ miles southwest of Campo. Altitude, about 2,180 feet.

Drainage area.- 84 square miles, of which 4 square miles are in Mexico.

Gage-height record.- Water-stage recorder graph except for period 3 p.m. Mar. 4 to 12 m. Mar. 8, gage heights for which were estimated.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 42 second-feet; extended to peak stage on basis of mean depth-mean velocity relation.

Maxima.- 1938: Discharge, 584 second-feet 1 a.m. Mar. 3 (gage height, 2.73 feet).
1936-37: Discharge, 1,470 second-feet Feb. 6, 1937 (gage height, 3.80 feet).

Remarks.- Records good.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	11	42	14	11	13	26	9.5	21	8.5	18	7
2	13	89	12	12	24	60	10	22	7	18	9
3	7.5	315	12	13	15	39	17	23	7	17	10
4	9	161	12	14	11	31	18	24	6.5	17	7.5
5	10	41	12	15	9.5	27	14	25	6	16	9
6	6.5	41	11	16	10	26	11	26	6	19	10
7	5.5	45	10	17	9	26	9.5	27	34	23	9.5
8	4.8	41	9.5	18	8	24	8.5	28	34	18	8.5
9	6.5	32	9.5	19	15	21	9	29		21	8.5
10	9.5	26	9.5	20	11	21	8.5	30		18	11
								31		15	
Mean monthly discharge, in second-feet									11.4	43	10.6
Runoff, in acre-feet									630	2,650	628

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1		March 2		March 3		March 4	
1	0.75	9.1	1.13	41	1.06	32	0.99	26	2.73	584	1.77	173
2	.78	10.9	1.12	40	1.05	31	.99	26	2.48	450	1.85	197
3	.79	11.4	1.12	40	1.06	32	.99	26	2.33	376	1.87	203
4	.83	14	1.11	39	1.10	37	.99	26	2.17	309	1.87	203
5	.86	16	1.10	38	1.13	40	1.00	26	2.16	304	1.87	203
6	.90	19	1.08	36	1.18	47	1.05	31	2.16	304	1.89	210
7	.96	24	1.06	33	1.35	73	1.08	34	2.18	313	1.90	213
8	1.02	29	1.05	32	1.34	71	1.08	34	2.25	342	1.90	213
9	1.03	30	1.03	30	1.33	69	1.10	37	2.35	385	1.90	213
10	1.03	30	1.03	30	1.30	65	1.12	39	2.48	450	1.91	216
11	1.04	31	1.02	29	1.25	57	1.15	42	2.41	415	1.90	213
N	1.07	34	1.02	29	1.20	49	1.23	54	2.33	376	1.89	210
1	1.06	33	1.03	30	1.18	47	1.30	65	2.20	321	1.87	203
2	1.08	36	1.03	30	1.17	45	1.45	91	2.10	281	1.77	173
3	1.10	38	1.03	30	1.15	44	1.40	82	2.07	269	1.70	153
4	1.13	41	1.03	30	1.12	39	1.35	73	2.05	262	1.60	128
5	1.18	48	1.06	33	1.10	37	1.34	71	2.01	248	1.53	110
6	1.30	66	1.11	39	1.08	34	1.36	75	1.97	234	1.48	100
7	1.32	75	1.10	38	1.07	33	1.40	82	1.94	223	1.40	84
8	1.27	61	1.09	37	1.05	31	1.50	102	1.91	213	1.40	84
9	1.23	55	1.08	36	1.03	29	1.65	138	1.87	200	1.39	82
10	1.18	48	1.07	34	1.01	27	2.00	244	1.86	197	1.38	80
11	1.16	45	1.06	33	.98	25	2.45	435	1.76	167	1.37	78
M	1.15	44	1.06	33	.98	25	2.65	536	1.70	151	1.37	78

Otay River Basin

Otay River at Savage Dam, Calif.

Location.- Lat. 32°36'40", long. 116°55'40", in NW¼ sec. 18, T. 18 S., R. 1 E., at Savage Dam, at Lower Otay Reservoir. Zero of gage is 347.20 feet above mean sea level. Altitude of stream bed, 347 feet.

Drainage area.- Area, 98 square miles. Average altitude, 1,535 feet. Maximum altitude, 3,755 feet. Average slope, 26 percent. Length of main stream channel, 15 miles. Average slope of main stream channel, 4.1 percent.

Gage-height record.- Gage read daily at 7 a.m.

Remarks.- Records of discharge represent inflow to Lower Otay Reservoir, computed from discharge over spillway, change in contents, leakage, evaporation, and direct rainfall on surface of reservoir. Altitude of top of spillway gates, 491 feet. Storage capacity, 56,314 acre-feet. Records furnished by City of San Diego Water Department.

Gage height, in feet, and contents, in acre-feet, 1938

Day	February		March		April	
	Feet	Acre-feet	Feet	Acre-feet	Feet	Acre-feet
1	139.93	51,944	139.78	51,768	143.52	56,339
2	139.95	51,968	140.04	52,075	143.51	56,327
3	139.92	51,933	142.98	55,666	143.49	56,301
4	139.89	51,897	144.46	57,550	143.45	56,251
5	139.91	51,921	144.41	57,486	143.41	56,200
6	139.90	51,909	144.21	57,228	143.40	56,187
7	139.86	51,862	143.98	56,922	143.38	56,162
8	139.83	51,827	143.92	56,846	143.36	56,137
9	139.81	51,803	143.88	56,795	143.28	56,036
10	139.78	51,768	143.84	56,745	143.28	56,036
11	139.76	51,744	143.81	56,707	143.26	56,010
12	139.83	51,827	143.88	56,795	143.26	56,010
13	139.83	51,827	144.13	57,125	143.26	56,010
14	139.79	51,780	144.18	57,189	143.25	55,998
15	139.76	51,744	144.07	57,047	143.23	55,972
16	139.74	51,721	144.07	57,047	143.23	55,972
17	139.73	51,709	143.92	56,846	143.22	55,960
18	139.72	51,697	143.84	56,745	143.21	55,947
19	139.68	51,650	143.78	56,669	143.19	55,922
20	139.66	51,627	143.76	56,643	143.18	55,909
21	139.63	51,591	143.73	56,601	143.18	55,909
22	139.61	51,568	143.70	56,567	143.19	55,922
23	139.57	51,521	143.70	56,567	143.19	55,922
24	139.55	51,497	143.68	56,542	143.20	55,934
25	139.51	51,450	143.64	56,491	143.20	55,934
26	139.47	51,403	143.62	56,466	143.21	55,947
27	139.46	51,391	143.60	56,441	143.22	55,960
28	139.58	51,532	143.58	56,415	143.22	55,960
29			143.56	56,390	143.23	55,972
30			143.56	56,390	143.25	55,998
31			143.54	56,365		

	February	March	April
Mean monthly discharge, in second-feet............	15.1	282	4.32
Runoff, in acre-feet...........................	840	17,340	257

Sweetwater River Basin

Sweetwater River at Sweetwater Dam, Calif.

Location.- Lat. 32°41'20", long. 117°00'35", at Sweetwater Dam, in La Nacion grant, 6 miles east of National City, San Diego County, and about 8 miles upstream from mouth. Altitude of stream bed, about 150 feet.

Drainage area.- Area, 181 square miles. Average altitude, 2,277 feet. Maximum altitude, 6,515 feet. Average slope, 29 percent. Length of main stream channel, 43 miles. Average slope of main stream channel, 2.7 percent.

Gage-height record.- Staff gage read daily between 7 and 8 a.m.

Remarks.- Records of discharge represent flow into Sweetwater Reservoir, computed from discharge over spillway, change in contents, leakage, evaporation, and direct rainfall on surface of reservoir. Storage capacity, 30,973 acre-feet. Records furnished by California Water and Telephone Company.

Gage height, in feet, and contents, in acre-feet, 1938

Day	February		March		April	
	Feet	Acre-feet	Feet	Acre-feet	Feet	Acre-feet
1	81.44	21,624	83.14	23,026	89.68	29,045
2	81.51	21,680	83.96	23,719	89.73	29,096
3	81.59	21,744	89.57	28,934	89.75	29,117
4	81.64	21,784	89.76	29,127	89.72	29,086
5	81.70	21,833	89.45	28,812	89.70	29,065
6	81.76	21,882	89.49	28,853	89.69	29,055
7	81.81	21,923	89.54	28,903	89.70	29,065
8	81.83	21,940	89.74	29,107	89.68	29,045
9	81.86	21,965	89.58	28,944	89.68	29,045
10	81.91	22,006	89.58	28,944	89.69	29,055
11	81.94	22,031	89.63	28,994	89.70	29,065
12	82.06	22,129	89.68	29,045	89.70	29,065
13	82.19	22,236	89.42	28,782	89.70	29,065
14	82.24	22,277	89.18	28,540	89.73	29,096
15	82.26	22,294	89.12	28,478	89.74	29,107
16	82.29	22,319	89.10	28,458	89.73	29,096
17	82.34	22,360	89.14	28,499	89.68	29,045
18	82.36	22,376	89.15	28,509	89.68	29,045
19	82.40	22,409	89.16	28,519	89.71	29,075
20	82.42	22,425	89.39	28,752	89.75	29,117
21	82.45	22,450	89.66	29,025	89.76	29,127
22	82.47	22,466	89.72	29,086	89.74	29,107
23	82.48	22,475	89.68	29,045	89.72	29,086
24	82.48	22,475	89.69	29,055	89.73	29,096
25	82.49	22,483	89.68	29,045	89.75	29,117
26	82.49	22,483	89.67	29,035	89.76	29,127
27	82.54	22,524	89.71	29,075	89.77	29,138
28	82.72	22,673	89.71	29,075	89.75	29,117
29			89.69	29,055	89.74	29,107
30			89.67	29,035	89.74	29,107
31			89.66	29,025		

	February	March	April
Mean monthly discharge, in second-feet	34.6	391	48.2
Runoff, in acre-feet	1,920	24,060	2,870

San Diego River Basin

San Diego River at El Capitan Dam, near Lakeside, Calif.

Location.- Lat. 32°53'00", long. 116°48'40", in NE¼ sec. 7, T. 15 S., R. 2 E., at El Capitan Dam, 1 mile downstream from mouth of Chocolate Creek, and 7 miles east of Lakeside. Altitude of stream bed, 553 feet.

Drainage area.- Area, 190 square miles. Average altitude, 2,905 feet. Maximum altitude, 6,515 feet. Average slope, 38 percent. Length of main stream channel, 14.5 miles. Average slope of main stream, 7.5 percent.

Gage-height record.- Gage read daily at 7 a.m.

Remarks.- Records of discharge represent flow into El Capitan Reservoir, computed from discharge over spillway, change in contents, leakage, evaporation, and direct rainfall on surface of reservoir. Altitude of spillway, 750 feet. Storage capacity, 116,500 acre-feet. Additional storage obtained by placing sandbags on spillway. Records furnished by City of San Diego Water Department.

Gage height, in feet, and contents, in acre-feet, 1938

Day	February		March		April	
	Feet	Acre-feet	Feet	Acre-feet	Feet	Acre-feet
1	177.65	88,377	180.68	92,460	197.77	117,664
2	177.75	88,509	181.46	93,530	197.87	117,823
3	177.80	88,576	188.15	103,024	197.92	117,902
4	177.84	88,629	192.50	109,497	197.99	118,013
5	177.98	88,815	194.06	111,877	198.07	118,140
6	178.05	88,909	194.95	113,249	198.10	118,188
7	178.09	88,962	195.50	114,102	198.08	118,156
8	178.11	88,989	195.85	114,647	198.05	118,108
9	178.14	89,029	196.36	115,444	198.02	118,061
10	178.22	89,135	196.68	115,945	197.99	118,013
11	178.27	89,202	196.93	116,338	197.97	117,981
12	178.56	89,590	197.23	116,811	197.96	117,966
13	178.70	89,778	197.78	117,680	197.96	117,966
14	178.79	89,898	197.86	117,807	198.04	118,092
15	178.82	89,939	197.59	117,379	198.05	118,108
16	178.86	89,993	197.48	117,206	198.02	118,061
17	178.90	90,046	197.39	117,063	198.01	118,045
18	178.94	90,100	197.37	117,032	198.00	118,029
19	179.01	90,194	197.33	116,969	198.02	118,061
20	179.06	90,262	197.30	116,921	198.07	118,140
21	179.10	90,315	197.29	116,906	198.11	118,204
22	179.12	90,342	197.28	116,890	198.14	118,251
23	179.14	90,369	197.27	116,874	198.17	118,299
24	179.16	90,396	197.27	116,874	198.18	118,316
25	179.14	90,369	197.26	116,858	198.21	118,363
26	179.13	90,356	197.25	116,842	198.29	118,490
27	179.21	90,464	197.26	116,858	198.28	118,474
28	179.84	91,316	197.24	116,827	198.25	118,426
29			197.23	116,811	198.24	118,410
30			197.40	117,079	198.28	118,474
31			197.60	117,395		

	February	March	April
Mean monthly discharge, in second-feet..........	86.1	687	85.9
Runoff, in acre-feet..........................	4,780	42,250	5,110

San Diego River near Santee, Calif.

Location.- Water-stage recorder, lat. 32°49'20", long. 117°03'25", in Mission Gorge, in Ex Mission San Diego grant, 6 miles west of Santee, San Diego County. Altitude, about 205 feet.

Drainage area.- Area, 380 square miles. Average altitude, 2,070 feet. Maximum altitude, 6,515 feet. Average slope, 38 percent. Length of main stream channel, 40 miles. Average slope of main stream channel, 2.9 percent.

Gage-height record.- Water-stage recorder graph.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 4,570 second-feet; extended logarithmically to peak stage.

Maxima.- 1938: Discharge, 7,350 second-feet 2 a.m. Mar. 3 (gage height, 7.05 feet).
1912-37: Discharge, 70,200 second-feet Jan. 27, 1916, by slope-area method.

Remarks.- Records good. Flow partially regulated by El Capitan Reservoir, 26 miles upstream. City of San Diego diverts water from El Capitan Reservoir.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	0.6	496	31	11	1.0	87	65	21	0.4	230	12
2	.4	1,700	24	12	2.1	379	60	22	.3	210	11
3	.4	3,770	24	13	1.2	1,250	68	23	.3	193	13
4	.4	925	27	14	.9	1,220	75	24	.3	174	13
5	.4	470	31	15	.7	745	75	25	.3	168	24
6	.2	295	80	16	.9	590	75	26	.2	156	68
7	.2	200	91	17	.9	486	77	27	5.5	153	63
8	.2	189	82	18	.6	400	77	28	24	145	52
9	.6	165	77	19	1.0	307	26	29		137	43
10	.9	100	75	20	.6	259	14	30		63	54
								31		37	
Mean monthly discharge, in second-feet......................									1.62	506	49.9
Runoff, in acre-feet..									90	31,140	2,970

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1		March 2		March 3		March 4	
1	0.13	0.3	0.70	37	0.60	21	1.63	307	6.95	7,110	3.14	1,230
2	.17	.5	.69	35	.64	27	1.63	307	7.05	7,350	3.10	1,200
3	.19	.6	.68	34	.75	47	1.68	328	6.57	6,250	3.03	1,130
4	.20	.7	.64	27	1.11	132	1.69	332	6.00	5,160	3.02	1,120
5	.21	.8	.62	24	2.00	480	1.75	358	5.75	4,710	3.00	1,110
6	.22	.9	.61	23	2.40	710	1.95	455	5.53	4,320	2.92	1,040
7	.23	.9	.60	21	2.40	710	2.10	535	5.45	4,160	2.91	1,030
8	.27	1.3	.60	21	2.31	656	2.18	579	5.55	4,360	2.90	1,020
9	.30	1.5	.59	20	2.21	596	2.30	650	5.80	4,800	2.91	1,030
10	.31	1.8	.58	19	2.92	1,100	2.50	780	5.60	4,440	2.94	1,060
11	.32	2.1	.58	19	2.80	1,000	3.09	1,250	5.58	4,420	2.99	1,100
N	.34	2.7	.58	19	2.50	780	3.01	1,180	5.73	4,670	2.93	1,050
1	.34	2.7	.58	19	2.37	692	2.95	1,120	5.68	4,570	2.80	944
2	.34	2.7	.58	19	2.31	656	3.35	1,490	5.31	3,910	2.70	871
3	.41	5	.58	19	2.25	620	3.73	1,900	4.78	3,120	2.63	822
4	.44	6.7	.58	19	2.17	573	3.68	1,830	4.32	2,480	2.58	787
5	.49	9.4	.58	19	2.10	535	3.54	1,680	3.97	2,060	2.52	745
6	.50	10	.58	19	2.02	491	3.41	1,550	3.70	1,770	2.50	731
7	.50	10	.58	19	1.95	455	3.48	1,620	3.54	1,610	2.45	698
8	.49	9.4	.58	19	1.87	415	4.32	2,560	3.40	1,470	2.41	674
9	.49	9.4	.58	19	1.79	375	5.70	4,690	3.34	1,410	2.39	662
10	.50	10	.58	19	1.73	349	6.45	6,050	3.24	1,320	2.33	626
11	.60	21	.60	21	1.69	332	6.50	6,110	3.17	1,260	2.31	614
M	.72	41	.60	21	1.65	315	6.50	6,110	3.10	1,200	2.30	608

Boulder Creek at Cuyamaca Reservoir, near Julian, Calif.

Location.- Lat. 32°59'15", long. 116°35'10", in NE¼ sec. 8, T. 14 S., R. 4 E., at Cuyamaca Reservoir, 7 miles south of Julian. Altitude of stream bed, 4,590 feet.

Drainage area.- Area, 12.0 square miles. Average altitude, 4,976 feet. Maximum altitude, 6,515 feet. Average slope, 20 percent. Length of main stream channel, 3.5 miles. Average slope of main stream channel, 7.5 percent.

Gage-height record.- Gage read daily at 7 a.m.

Remarks.- Records of discharge computed from discharge over spillway, change in contents, leakage, evaporation, and direct rainfall on surface of reservoir. Altitude of crest of dam, 4,633 feet. Storage capacity, 11,600 acre-feet. Records furnished by La Mesa, Lemon Grove, and Spring Valley Irrigation District.

Gage height, in feet, and contents, in acre-feet, 1938

Day	February		March		April	
	Feet	Acre-feet	Feet	Acre-feet	Feet	Acre-feet
1	30.62	7,565	32.83	9,414	35.33	11,525
2	30.83	7,738	33.00	9,551	35.33	11,525
3	30.83	7,738	35.25	11,457	35.37	11,559
4	30.92	7,806	35.79	11,904	35.37	11,559
5	31.12	7,978	35.58	11,732	35.37	11,559
6	31.12	7,978	35.33	11,525	35.37	11,559
7	31.12	7,978	35.25	11,457	35.37	11,559
8	31.12	7,978	35.33	11,525	35.37	11,559
9	31.12	7,978	35.33	11,525	35.33	11,525
10	31.21	8,047	35.33	11,525	35.33	11,525
11	31.21	8,047	35.37	11,491	35.33	11,525
12	31.37	8,185	35.75	11,870	35.29	11,491
13	31.50	8,288	35.58	11,732	35.37	11,559
14	31.50	8,288	35.42	11,595	35.42	11,595
15	31.50	8,288	35.33	11,525	35.46	11,629
16	31.50	8,288	35.42	11,595	35.46	11,629
17	31.50	8,288	35.37	11,559	35.46	11,629
18	31.50	8,288	35.42	11,595	35.42	11,595
19	31.62	8,391	35.42	11,595	35.42	11,595
20	31.67	8,426	35.42	11,595	35.42	11,595
21	31.71	8,460	35.42	11,595	35.42	11,595
22	31.71	8,460	35.42	11,595	35.42	11,595
23	31.71	8,460	35.42	11,595	35.37	11,542
24	31.71	8,460	35.42	11,595	35.37	11,542
25	31.71	8,460	35.42	11;595	35.37	11,542
26	31.71	8,460	35.46	11,629	35.46	11,629
27	31.83	8,564	35.46	11,629	35.46	11,629
28	32.33	9,000	35.46	11,629	35.46	11,629
29			35.50	11,663	35.46	11,629
30			35.50	11,663	35.50	11,663
31			35.42	11,595		

	February	March	April
Mean monthly discharge, in second-feet...........	33	116	16
Runoff, in acre-feet...........................	1,849	7,146	940

San Vicente Creek at Foster, Calif.

Location.- Water-stage recorder, lat. 32°54'40", long. 116°55'35", in sec. 31, T. 14 S., R. 1 E., half a mile north of Foster. Altitude, about 750 feet.

Drainage area.- Area, 75 square miles. Average altitude, 1,640 feet. Maximum altitude, 4,132 feet. Average slope, 36 percent. Length of main stream channel, 14 miles. Average slope of main stream channel, 4.5 percent.

Gage-height record.- Water-stage recorder graph except Feb. 1-10, 20-26, Apr. 1-18 and 20-30.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 1,320 second-feet; extended to peak stage on basis of mean depth-mean velocity relation. Discharge for periods of missing gage-height record determined from current-meter measurements and comparable hydrographs of adjacent streams.

Maxima.- 1938: Discharge, 5,270 second-feet 11 p.m. Mar. 2 (gage height, 5.59 feet).
1915, 1916, 1936-37: Discharge, 18,600 second-feet Jan. 27, 1916, by slope-area method.

Remarks.- Records fair.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	0.2	433	26	11	1.0	143	19	21	0.2	58	10
2	.1	1,380	25	12	.2	346	20	22	.2	52	9
3	.1	1,790	24	13	.2	302	23	23	.1	49	9
4	.3	545	22	14	.2	198	20	24	.1	42	10
5	.2	272	21	15	.2	143	17	25	.1	40	20
6	.1	160	20	16	.2	122	16	26	.1	34	17
7	.1	133	18	17	.1	118	14	27	65	35	14
8	.1	154	17	18	.1	100	12	28	123	35	12
9	.2	138	17	19	.2	91	11	29		38	10
10	.2	143	18	20	.2	67	10	30		34	10
								31		29	
Mean monthly discharge, in second-feet									6.89	233	16.4
Runoff, in acre-feet									383	14,330	974

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1		March 2		March 3		March 4	
1			1.47	225	1.49	250	1.03	128	5.36	4,840		
2			1.35	184	1.69	334	1.01	125	4.30	2,970		
3			1.25	154	1.99	479	.98	118	3.48	1,880		
4			1.15	128	2.35	690	.98	118	3.27	1,650	1.63	519
5			1.06	105	2.90	1,100	1.00	125	3.27	1,660		
6			.95	80	3.00	1,190	1.10	151	3.50	1,940		
7			.90	71	3.25	1,440	1.19	178	3.54	2,000	1.70	576
8			.93	76	2.70	952	1.27	204	3.35	1,780	1.93	731
9		0.2	.98	87	1.90	442	1.41	257	3.67	2,180	2.09	857
10			.97	87	1.80	398	1.74	398	4.50	3,400	1.84	697
11			.99	91	1.68	343	2.65	976	4.50	3,420		
N			1.03	100	1.64	326	3.75	2,080	4.10	2,820	1.70	622
1			1.03	102	1.61	313	4.25	2,760	3.20	1,670		
2			1.02	100	1.55	287	3.90	2,290	2.80	1,280		
3			1.02	100	1.48	261	3.00	1,280				
4			1.07	115	1.40	236	2.79	1,100	2.48	1,020	1.52	542
5			1.16	138	1.33	211	2.72	1,050				
6			1.16	138	1.27	191	2.76	1,090	2.18	808		
7			1.12	130	1.21	172	2.94	1,240				
8			1.11	128	1.17	160	3.65	2,010				
9			1.08	120	1.14	154	4.50	3,200				
10	1.77	343	1.09	125	1.11	146	5.14	4,340	1.83	605	1.27	426
11			1.13	135	1.08	138	5.59	5,270				
M			1.25	169	1.05	133	5.41	4,920				

San Dieguito River Basin

Santa Ysabel Creek near Mesa Grande, Calif.

Location.- Water-stage recorder, lat. 33°07'15", long. 116°48'30", in NE¼NW¼ sec. 20, T. 12 S., R. 2 E., half a mile upstream from confluence with Black Canyon Creek and 4½ miles southwest of Mesa Grande. Altitude, about 2,000 feet.

Drainage area.- Area, 58 square miles. Average altitude, 3,360 feet. Maximum altitude, 5,577 feet. Average slope, 40 percent. Length of main etream channel, 7.6 miles. Average slope of main stream channel, 8.9 percent.

Gage-height record.- Water-stage recorder graph, except for period 4 p.m. Mar. 3 to 12 m. Mar. 6, gage heights for which were interpolated.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 1,140 second-feet; extended to peak stage on basis of mean depth-mean velocity relation.

Maxima.- 1938: Discharge, 8,000 second-feet 11:20 p.m. Mar. 2 (gage height, 7.30 feet). 1912-28, 1936-37: Discharge, 21,100 second-feet Jan. 27, 1916.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	16	443	68	11	88	68	54	21	18	128	34
2	14	1,750	65	12	66	709	51	22	16	113	32
3	11	2,000	66	13	34	612	76	23	16	103	34
4	50	769	68	14	26	402	76	24	16	94	34
5	26	454	86	15	26	283	64	25	14	94	54
6	17	247	79	16	26	212	46	26	13	103	46
7	13	138	76	17	22	226	40	27	163	103	38
8	13	176	72	18	19	162	38	28	195	98	40
9	14	103	65	19	32	143	34	29		108	42
10	22	76	60	20	20	143	34	30		98	49
								31		82	
Mean monthly discharge, in second-feet									35.2	330	63.6
Runoff, in acre-feet									1,960	20,310	3,190

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1		March 2		March 3		March 4	
1			2.15	240	2.25	312	2.00	138	5.50	3,930		
2			2.10	205	2.30	350	2.01	143	4.50	2,410		
3			2.05	169	2.50	496	2.08	191	4.30	2,150		
4			2.00	138	3.05	894	2.10	205	4.10	1,910		
5			2.00	138	3.35	1,160	2.20	276	3.95	1,740		
6			1.95	113	3.44	1,230	2.30	350	4.00	1,800		
7			2.00	138	3.10	934	2.40	426	4.10	1,910		
8			2.00	138	2.80	706	2.60	566	4.20	2,030		
9	1.45	6.6	2.05	159	2.70	636	2.85	741	5.70	4,270		
10			2.06	169	2.50	566	3.50	1,280	5.75	4,360		
11			2.05	169	2.50	496	4.50	2,420	4.70	2,680		
M			2.00	138	2.40	425	5.10	3,300	4.00	1,800		
1			2.00	138	2.30	350	4.40	2,290	3.76	1,520		
2			2.10	205	2.20	276	4.10	1,800	3.68	1,450		
3	1.55	14	2.20	276	2.17	254	3.90	1,690	3.62	1,390		
4	1.65	26	2.30	350	2.14	233	3.80	1,580	3.58	1,350		
5	1.85	72	2.20	276	2.10	205	3.75	1,520	3.53	1,300		
6	2.35	388	2.15	240	2.10	205	3.85	1,630	3.49	1,240		
7	3.20	1,010	2.10	205	2.05	169	4.10	1,910	3.45	1,230		
8	3.10	934	2.13	226	2.00	138	4.70	2,680	3.40	1,180		
9	2.75	671	2.11	212	2.00	138	5.16	3,360	3.35	1,140		
10	2.35	388	2.15	240	2.00	138	5.70	4,270	3.31	1,100		
11	2.25	312	2.10	206	2.00	138	6.85	6,540	3.28	1,080		
M	2.20	276	2.13	226	2.00	138	6.00	4,840	3.23	1,030		

Supplemental record.- Mar. 2, 11:20 p.m., 7.30 ft., 8,000 sec.-ft.

San Dieguito River at Lake Hodges, Calif.

Location.- Lat. 33°02'55", long. 117°07'25", in NW¼ sec. 18, T. 13 S., R. 2 W., at Lake Hodges Dam, 5⅛ miles southwest of Escondido. Altitude of stream bed, 200 feet.

Drainage area.- Area, 303 square miles. Average altitude, 1,690 feet. Maximum altitude, 4,132 feet. Average slope, 38 percent. Length of main stream channel, 37 miles. Average slope of main stream channel, 1.8 percent.

Gage-height record.- Staff gage read daily at 7 a.m.

Remarks.- Records of discharge represent flow into Lake Hodges, computed from discharge over spillway, change in contents, leakage, evaporation, and direct rainfall on surface of lake. Altitude of spillway, 315 feet. Storage capacity, 37,530 acre-feet. Additional storage obtained by placing sandbags on spillway. Diversions for irrigation in San Pasquel Valley above Lake Hodges. Record furnished by City of San Diego Water Department.

Gage height, in feet, and contents, in acre-feet, 1938

Day	February		March		April	
	Feet	Acre-feet	Feet	Acre-feet	Feet	Acre-feet
1	109.09	30,256	115.29	37,917	115.73	38,504
2	109.28	30,474	116.08	38,975	115.67	38,424
3	109.39	30,601	120.94	45,933	115.66	38,410
4	109.59	30,832	117.22	40,538	115.65	38,397
5	109.73	30,995	116.28	39,247	115.62	38,357
6	109.90	31,193	115.91	38,746	115.66	38,410
7	109.98	31,287	115.72	38,491	115.71	38,477
8	110.05	31,369	115.66	38,410	115.71	38,477
9	110.13	31,463	115.67	38,424	115.71	38,477
10	110.20	31,546	115.58	38,303	115.71	38,477
11	110.30	31,663	115.51	38,209	115.72	38,491
12	110.63	32,055	115.52	38,223	115.72	38,491
13	111.02	32,521	116.31	39,288	115.73	38,504
14	111.18	32,714	116.13	39,043	115.85	38,665
15	111.29	32,847	115.78	38,571	115.91	38,746
16	111.40	32,980	115.67	38,424	115.91	38,746
17	111.51	33,114	115.62	38,357	115.89	38,719
18	111.59	33,211	115.61	38,343	115.88	38,705
19	111.70	33,345	115.57	38,290	115.81	38,611
20	111.85	33,529	115.54	38,250	115.89	38,719
21	111.94	33,639	115.58	38,303	115.97	38,826
22	112.00	33,713	115.48	38,169	116.04	38,921
23	112.04	33,762	115.46	38,143	116.09	38,988
24	112.11	33,848	115.60	38,330	116.11	39,016
25	112.14	33,885	115.69	38,451	116.13	39,043
26	112.17	33,922	115.75	38,531	116.17	39,097
27	112.25	34,021	115.78	38,571	116.15	39,070
28	113.51	35,603	115.79	38,585	116.11	39,016
29			115.76	38,544	116.06	38,948
30			115.80	38,598	116.10	39,002
31			115.77	38,558		

	February	March	April
Mean monthly discharge, in second-feet	145	1,147	110
Runoff, in acre-feet	8,050	70,600	6,530

San Luis Rey River Basin

San Luis Rey River near Bonsall, Calif.

Location.- Water-stage recorder, lat. 33°15'05", long. 117°14'55", in NE¼ sec. 1, T. 11 S., R. 4 W., three-quarters of a mile downstream from highway bridge on Fallbrook-Escondido road, and 3 miles southwest of Bonsall. Altitude, about 120 feet.

Drainage area.- Area, 514 square miles. Average altitude, 2,510 feet. Maximum altitude, 6,405 feet. Average slope, 25 percent. Length of main stream channel, 58 miles. Average slope of main stream channel, 2.1 percent.

Gage-height record.- Water-stage recorder graph.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 2,360 second-feet; extended to peak stage on basis of mean depth-mean velocity relation.

Maxima.- 1938: Discharge, 18,100 second-feet 1 a.m. Mar. 3 (gage height, 12.60 feet).
1912-18, 1929-37: Discharge, 16,700 second-feet Feb. 7, 1937.

Remarks.- Records good. Regulation at Lake Henshaw, 41 miles upstream.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	58	2,060	130	11	64	345	72	21	43	246	69
2	48	4,040	118	12	106	1,310	76	22	42	229	67
3	43	9,660	112	13	78	1,140	100	23	42	193	64
4	81	2,180	106	14	58	739	102	24	38	172	64
5	112	1,110	108	15	53	505	89	25	36	178	89
6	67	757	99	16	56	439	85	26	35	190	81
7	51	608	87	17	50	401	81	27	116	164	71
8	47	591	81	18	43	341	74	28	a504	159	67
9	50	475	78	19	53	294	71	29		162	67
10	51	394	76	20	54	266	71	30		148	81
								31		136	
Mean monthly discharge, in second-feet									a74.2	956	84.5
Runoff, in acre-feet									a4,120	58,770	5,030

a Revised; supersedes figures published in Water-Supply Paper 861, p. 24.

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feb. 27 Feet	Feb. 27 Sec.-ft.	Feb. 28 Feet	Feb. 28 Sec.-ft.	Mar. 1 Feet	Mar. 1 Sec.-ft.	Mar. 2 Feet	Mar. 2 Sec.-ft.	Mar. 3 Feet	Mar. 3 Sec.-ft.	Mar. 4 Feet	Mar. 4 Sec.-ft.	Mar. 5 Feet	Mar. 5 Sec.-ft.
1			1.57	365	2.35	751	2.75	994	12.60	18,100	4.95	3,050		
2			1.48	329	2.90	1,110	2.65	929	12.25	17,200	4.63	2,660	3.33	1,390
3			1.45	317	3.50	1,580	2.75	994	11.75	15,900	4.65	2,680		
4			1.42	305	3.97	2,030	2.75	994	11.50	15,400	4.52	2,540	3.17	1,260
5			1.55	357	4.50	2,560	2.86	1,070	11.45	15,200	4.4	2,420		
6	0.40	45	1.70	421	4.34	2,400	3.00	1,170	11.0	14,000	4.32	2,340	3.2	1,280
7			1.78	457	4.47	2,530	3.15	1,270	10.5	12,900	4.35	2,370		
8			1.81	470	5.27	3,520	3.50	1,570	10.1	12,000	4.21	2,230	3.05	1,170
9			1.81	470	5.31	3,560	3.75	1,790	9.65	10,900	4.37	2,390		
10			1.80	466	5.07	3,250	4.23	2,270	9.25	10,100	4.26	2,280	3.05	1,170
11			1.80	466	4.72	2,820	4.48	2,520	8.85	9,340	4.23	2,250		
N			1.95	540	4.34	2,400	4.58	2,620	8.7	9,040	4.35	2,370	2.95	1,100
1			2.06	597	4.07	2,130	4.88	2,990	8.55	8,940	4.28	2,300		
2			2.13	635	4.17	2,230	5.73	3,990	8.15	7,950	4.17	2,190	2.8	993
3	.62	81	2.09	612	4.41	2,470	6.32	4,950	7.8	7,340	4.07	2,090		
4			2.04	586	4.40	2,460	6.48	5,180	7.5	6,780	3.93	1,950	2.75	961
5			2.09	612	4.17	2,230	6.58	5,330	7.0	5,930	3.88	1,900		
6			2.06	597	3.90	1,960	6.63	5,400	6.6	5,330	3.90	1,920	2.76	961
7	.95	156	2.07	602	3.60	1,660	6.88	5,780	6.15	4,650	3.68	1,700		
8			2.06	597	3.45	1,550	7.53	6,850	5.85	4,220	3.65	1,670	2.75	954
9	1.14	211	2.05	590	3.15	1,290	7.88	7,540	5.6	3,880	3.5	1,550		
10	1.50	337	2.05	590	3.00	1,180	8.83	9,340	5.35	3,550	3.5	1,550	2.80	987
11	1.77	452	2.07	602	2.80	1,040	10.40	12,700	5.15	3,310	3.5	1,550		
M	1.75	444	2.06	597	2.80	1,040	12.00	16,600	5.1	3,250	3.45	1,510	2.75	954

San Luis Rey River at Oceanside, Calif.

Location.- Water-stage recorder, lat. 33°12'40", long. 117°22'40", in NW¼ sec. 23, T. 11 S., R. 5 W., half a mile above State highway bridge at Oceanside. Altitude, about 20 feet.

Drainage area.- Area, 557 square miles. Average altitude, 2,334 feet. Maximum altitude, 6,400 feet. Average slope, 33 percent. Length of main stream channel, 62.5 miles. Average slope of main stream channel, 1.9 percent.

Gage-height record.- Water-stage recorder graph.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 2,320 second-feet; extended to peak stage on basis of mean depth-mean velocity relation. Discharge computed by shifting-control method and based in part on comparison with discharge of San Luis Rey River near Bonsall.

Maxima.- 1938: Discharge, 16,500 second-feet 5:30 a.m. Mar. 3 (gage height, 10.77 feet).
1912-14, 1916, 1929-37: Discharge, 95,600 second-feet Jan. 12, 1916.

Remarks.- Records poor, due to shifting control. Storage at Lake Henshaw; numerous diversions above station.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	38	2,000	122	11	52	390	66	21	55	301	51
2	44	2,860	113	12	81	1,160	69	22	46	262	51
3	38	11,300	113	13	88	1,140	91	23	38	213	51
4	51	2,650	110	14	65	613	110	24	35	193	53
5	85	1,480	117	15	55	462	95	25	34	166	84
6	70	1,060	117	16	54	402	87	26	32	200	102
7	47	798	98	17	57	421	77	27	57	161	69
8	40	674	80	18	52	421	69	28	347	151	53
9	38	568	66	19	55	391	61	29		161	51
10	44	465	64	20	61	330	53	30		156	61
								31		137	
Mean monthly discharge, in second-feet									62.8	1,022	80.1
Runoff, in acre-feet									3,490	62,850	4,770

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1		March 2		March 3		March 4	
1			4.41	114	5.27	517	5.74	1,250	9.10	11,200		4,300
2			4.48	136	5.38	587	5.75	1,160	9.77	13,100		3,800
3			4.70	210	5.45	640	5.77	1,140	10.18	14,400		3,600
4			4.94	310	5.47	656	5.77	1,070	10.40	15,200		3,400
5			5.01	345	5.97	1,070	5.80	1,010	10.74	16,400		3,300
6			4.99	340	6.35	1,500	5.82	938	10.45	16,000		3,100
7			4.94	315	6.52	1,710	5.91	1,019	9.95	15,500		2,920
8			4.85	274	6.55	1,750	6.04	1,150	9.58	14,900		2,800
9			4.82	270	6.56	1,890	6.16	1,280	8.97	14,100		2,600
10			4.83	265	6.84	2,460	6.42	1,590	8.65	13,900		2,500
11			4.91	305	6.93	2,960	6.57	1,770	8.22	13,300		2,430
N			4.97	335	6.91	3,300	6.72	1,980	7.98	12,500		2,400
1			5.02	360	6.75	3,180	6.83	2,140	7.70	11,900		
2			5.03	365	6.55	2,990	6.82	2,120	7.40	10,900		
3			5.04	376	6.34	2,610	6.82	2,400	7.10	10,000	4.76	2,320
4			5.07	393	6.26	2,490	7.17	3,150	6.70	9,800		
5			5.10	409	6.36	2,640	7.48	3,960	6.51	9,600		
6			5.19	463	6.37	2,650	7.55	4,400	6.26	8,800		
7			5.20	475	6.28	2,520	7.64	4,910	5.94	8,000		
8			5.22	487	6.16	2,340	7.70	5,400	5.68	7,190	4.63	2,150
9			5.22	487	6.00	2,090	7.78	5,960	5.48	6,400		
10			5.26	511	5.85	1,880	8.00	6,850	5.31	5,800		
11			5.25	505	5.78	1,660	8.30	8,000	5.17	5,200	4.55	2,050
M			5.22	487	5.77	1,520	8.65	9,450	5.11	4,600		

Supplemental record.- Mar. 3, 5:30 a.m., 10.77 ft., 16,500 sec.-ft.

Santa Margarita River Basin

Temecula Creek at Nigger Canyon, near Temecula, Calif.

Location.- Water-stage recorder, lat. 33°29'40", long. 116°59'00", in Pauba grant, at upper end of Nigger Canyon, a quarter of a mile downstream from Arroyo Seco, and 10 miles east of Temecula, Riverside County. Altitude, about 1,350 feet.

Drainage area.- Area, 319 square miles. Average altitude, 3,490 feet. Maximum altitude, 6,200 feet. Average slope, 30 percent. Length of main stream channel, 26.5 miles. Average slope of main stream channel, 3.4 percent.

Gage-height record.- Water-stage recorder graph, except Mar. 4 to 3 p.m. Mar. 6.

Discharge record.- Discharge estimated from hydrograph defined by current-meter measurements, gage-height record, and comparison with adjacent stations.

Maxima.- 1938: Discharge, 14,600 second-feet 10 p.m. Mar. 2, (gage height, 11.27 feet).
1923-37: Discharge, 17,100 second-feet Feb. 16, 1927.

Remarks.- Records poor, due to extreme shifting of channel at high stages. No diversions above station. Results of some discharge measurements furnished by Santa Margarita Ranch.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	23	180	42	11	48	95	37	21	25	60	27
2	22	4,100	39	12	79	235	38	22	21	60	26
3	35	3,500	44	13	69	195	38	23	16	65	25
4	95	1,300	34	14	65	180	36	24	16	62	23
5	50	400	30	15	62	155	33	25	16	65	30
6	28	140	30	16	55	115	29	26	16	68	18
7	18	125	30	17	46	115	28	27	35	55	17
8	17	115	30	18	41	110	26	28	50	50	19
9	20	95	30	19	43	80	28	29		55	26
10	24	90	36	20	33	60	27	30		48	30
								31		41	
Mean monthly discharge, in second-feet									38.1	388	30.2
Runoff, in acre-feet									2,120	23,830	1,800

Temecula Creek at Railroad Canyon, near Temecula, Calif.

Location.- Water-stage recorder, lat. 33°28'25", long. 117°08'35", in Temecula grant, at upper end of Temecula or Railroad Canyon, an eighth of a mile downstream from junction with Murrieta Creek, and 1½ miles south of Temecula, Riverside County. Altitude, about 950 feet.

Drainage area.- Area, 592 square miles. Average altitude, 2,663 feet. Maximum altitude, 6,200 feet. Average slope, 26 percent. Length of main stream channel, 41 miles. Average slope of main stream channel, 2.4 percent.

Gage-height record.- Water-stage recorder graph.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 9,220 second-feet. Discharge estimated from hydrograph based on current-meter measurements and gage-height record, and by comparison with adjacent stations.

Maxima.- 1938: Discharge, 21,700 second-feet (estimated) 10 p.m. Mar. 2 (gage height, 13.91 feet).
1923-37: Discharge, about 27,600 second-feet Feb. 16, 1927.

Remarks.- Records poor, due to extreme shifting of channel. Flood flow not affected by diversions. Gage-height record and results of discharge measurements furnished by Santa Margarita Ranch.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	18	2,620	60	11	42	180	35	21	16	100	32
2	11	11,500	59	12	46	1,810	40	22	14	92	29
3	13	8,000	58	13	25	740	61	23	12	98	28
4	27	1,700	50	14	19	360	54	24	12	90	27
5	18	950	51	15	15	290	47	25	13	90	35
6	12	320	50	16	12	210	31	26	14	90	27
7	11	250	44	17	12	200	28	27	130	82	21
8	11	350	41	18	13	160	25	28	450	73	27
9	19	220	46	19	21	120	25	29		78	30
10	23	190	40	20	18	115	25	30		70	44
								31		63	
Mean monthly discharge, in second-feet									37.4	1,007	39.0
Runoff, in acre-feet									2,080	61,910	2,320

Santa Margarita River near Fall Brook, Calif.

Location.- Water-stage recorder, lat. 33°24'05", long. 117°15'10", in sec. 12, T. 9 S., R. 4 W., 2 miles north of Fall Brook. Altitude, about 350 feet.

Drainage area.- Area, 645 square miles. Average altitude, 2,541 feet. Maximum altitude, 6,200 feet. Average slope, 33 percent. Length of main stream channel, 50 miles. Average slope of main stream channel, 2.2 percent.

Gage-height record.- Water-stage recorder graph.

Discharge record.- Discharge estimated from hydrograph based on current-meter measurements and gage-height record, and by comparison with adjacent stations.

Maxima.- 1938: Discharge, 28,000 second-feet (estimated) 11 p.m. Mar. 2 (gage height, 14.0 feet).
1924-37: Discharge, about 33,100 second-feet Feb. 16, 1927.

Remarks.- Records poor, due to extreme shifting of channel. No diversions during flood period. Results of discharge measurements furnished by Santa Margarita Ranch.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	30	3,890	92	11	80	300	65	21	15	165	50
2	23	12,000	92	12	88	2,140	66	22	15	155	43
3	20	10,400	90	13	45	950	120	23	15	150	40
4	48	2,000	80	14	30	500	88	24	15	145	37
5	30	1,000	79	15	26	450	70	25	14	140	55
6	21	700	76	16	22	365.	54	26	13	135	45
7	20	400	68	17	20	300	54	27	156	130	37
8	22	450	66	18	22	270	46	28	580	125	45
9	40	360	70	19	30	240	45	29		125	50
10	43	320	64	20	20	200	44	30		113	100
								31		110	
Mean monthly discharge, in second-feet									53.7	1,249	64.4
Runoff, in acre-feet									2,980	76,820	3,830

Santa Margarita River at Ysidora, Calif.

Location.- Water-stage recorder, lat. 33°14'40", long. 117°22'50", in Santa Margarita y Los Flores grant, 1 mile downstream from Ysidora, San Diego County, and about 2 miles upstream from mouth. Altitude, about 15 feet.

Drainage area.- Area, 740 square miles. Average altitude, 2,327 feet. Maximum altitude, 6,200 feet. Average slope, 31 percent. Length of main stream channel, 65 miles. Average slope of main stream channel, 1.7 percent.

Gage-height record.- Water-stage recorder graph.

Discharge record.- Discharge estimated from hydrograph based on current-meter measurements and gage-height record, and by comparison with adjacent stations.

Maxima.- 1938: Discharge, 31,000 second-feet (estimated) 1 a.m. Mar. 3, (gage height, 12.70 feet).
1923-37: Discharge, 33,600 second-feet (estimated) Feb. 16, 1927.

Remarks.- Records poor, due to extreme shifting of channel. No diversions during flood period. Gage-height record and results of discharge measurements furnished by Santa Margarita Ranch.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	44	6,270	125	11	80	350	92	21	50	235	70
2	48	13,000	117	12	240	2,600	90	22	40	220	60
3	35	15,500	111	13	100	1,600	125	23	36	210	77
4	51	3,000	107	14	80	950	135	24	34	205	66
5	66	1,600	104	15	70	690	104	25	30	190	80
6	43	1,300	101	16	50	550	88	26	28	170	80
7	35	840	100	17	43	450	83	27	200	200	65
8	33	900	98	18	36	340	79	28	975	205	55
9	55	550	96	19	50	330	76	29		190	60
10	60	390	94	20	65	300	74	30		160	80
								31		130	
Mean monthly discharge, in second-feet									94.2	1,730	89.7
Runoff, in acre-feet									5,230	106,400	5,340

Murrieta Creek at Temecula, Calif.

Location.- Water-stage recorder, lat. 33°29'00", long. 117°08'50", in Temecula grant, 0.6 mile upstream from debouchment into Temecula Creek and half a mile south of Temecula, Riverside County. Altitude, about 1,050 feet.

Drainage area.- Area, 220 square miles. Average altitude, 1,710 feet. Maximum altitude, 4,500 feet. Average slope, 23 percent. Length of main stream channel, 31 miles. Average slope of main stream channel, 2.1 percent.

Gage-height record.- Water-stage recorder graph.

Discharge record.- Discharge estimated from hydrograph based on current-meter measurements and gage-height record, and by comparison with adjacent stations.

Maxima.- 1938: Discharge, 16,800 second-feet (estimated) 8 p.m. Mar. 2 (gage height, 8.7 feet).
1930-37: Discharge, 7,500 second-feet Feb. 16, 1932.

Remarks.- Records poor, due to extreme shifting of channel. Gage-height record and several discharge measurements furnished by Santa Margarita Ranch.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	5.0	1,870	11	11	21	33	5.0	21	3.5	22	4.1
2	4.0	7,200	9.0	12	24	950	5.5	22	3.4	20	4.0
3	2.8	3,200	8.5	13	8.0	250	7.5	23	3.2	19	3.8
4	6.0	360	8.0	14	4.6	105	6.5	24	3.2	17	3.8
5	4.7	120	7.5	15	3.9	71	5.5	25	3.0	17	5.0
6	2.8	83	7.5	16	3.8	48	5.0	26	3.0	16	4.5
7	2.4	62	6.5	17	3.5	45	4.9	27	68	15	4.1
8	2.3	85	5.5	18	3.5	39	4.5	28	320	13	3.8
9	7.0	54	5.5	19	6.5	29	4.1	29		14	3.7
10	8.0	40	5.5	20	4.6	25	4.0	30		14	5.0
								31		13	
Mean monthly discharge, in second-feet									19.1	479	6.63
Runoff, in acre-feet									1,060	29,450	355

San Juan Creek Basin

San Juan Creek near San Juan Capistrano, Calif.

Location.- Water-stage recorder, lat. 33°30'50", long. 117°37'40", in Mission Viejo grant, at Ortega State Highway Bridge, 2½ miles east of San Juan Capistrano, Orange County. Altitude, about 150 feet.

Drainage area.- Area, 110 square miles. Average altitude, 1,470 feet. Maximum altitude, 4,525 feet. Average slope, 30 percent. Length of main stream channel, 18 miles. Average slope of main stream channel, 4.6 percent.

Gage-height record.- Water-stage recorder graph except 12 m. Feb. 28 to 2 p.m. Mar. 1 and 10 a.m. Mar. 2 to 12 m. Mar. 14.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 436 second-feet; peak discharge determined by slope-area measurement. Records from 12 m. Feb. 28 to 2 p.m. Mar. 1 and 9 a.m. Mar. 2 to Apr. 30 based on current-meter measurements, slope-area measurement of peak discharge, and comparison with record of inflow to Santiago Reservoir.

Maxima.- 1938: Discharge, 13,000 second-feet about 10 p.m. Mar. 2.
1929-37: Discharge, 8,300 second-feet Feb. 6, 1937.

Remarks.- Records poor.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	18	550	77	11	11	188	51	21	7.5	170	41
2	10	4,100	74	12	47	600	50	22	8	160	37
3	10	3,400	71	13	15	540	50	23	8	150	38
4	14	1,000	68	14	10	480	50	24	8	139	39
5	9	600	67	15	8.5	410	50	25	8	115	41
6	9	410	63	16	8	330	47	26	8	115	43
7	9	315	61	17	7	230	44	27	10	112	44
8	8.5	265	54	18	7.5	195	41	28	41	115	45
9	8.5	265	53	19	7.5	183	38	29		90	46
10	8.5	225	52	20	7	175	39	30		85	46
								31		80	
Mean monthly discharge, in second-feet									11.8	509	50.7
Runoff, in acre-feet									660	31,320	3,010

Trabuco Creek near San Juan Capistrano, Calif.

Location.- Water-stage recorder, lat. 33°31'30", long. 117°40'15", in SW¼ sec. 25, T. 7 S., R. 8 W., at State highway bridge, 1½ miles north of San Juan Capistrano. Altitude, 200 feet.

Drainage area.- Area, 36.5 square miles. Average altitude, 1,770 feet. Maximum altitude, 5,680 feet. Average slope, 41 percent. Length of main stream channel, 20 miles. Average slope of main stream channel, 5.2 percent.

Gage-height record.- Water-stage recorder graph except Mar. 3-4 owing to silting of well.

Discharge record.- Stage-discharge relation fairly well defined below 300 second-feet by current-meter measurements, and extended above on basis of slope-area determinations. Discharge for Mar. 3 and 4 was obtained by comparison with other streams.

Maxima.- 1938: Discharge, 4,400 second-feet Mar. 2.
1930-37: Discharge, 9,240 second-feet Feb. 6, 1937.

Remarks.- Records furnished by Orange County Flood Control District, through M. N. Thompson, chief engineer.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	0.1	254	32	11	0.1	79	19	21	0	76	10
2	0	1,480	30	12	15	215	18	22	0	64	10
3	.1	820	29	13	4.0	211	17	23	0	58	10
4	0	331	27	14	0	182	16	24	0	54	10
5	0	245	26	15	0	169	15	25	0	51	27
6	0	195	24	16	0	152	14	26	0	47	19
7	0	156	23	17	0	138	14	27	0	44	12
8	0	113	22	18	0	115	13	28	15	40	11
9	0	92	21	19	0	103	12	29		38	12
10	0	85	20	20	0	92	11	30		34	22
								31		33	
Mean monthly discharge, in second-feet									1.23	186	18.2
Runoff, in acre-feet									68	11,440	1,080

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1		March 2		March 3		March 4	
1					3.18	91	3.30	140	5.78	1,570		
2					4.45	720	3.30	140	5.50	1,410		
3					4.15	550	3.40	180	5.31	1,300		
4					4.47	730	3.80	360	5.12	1,200		
5					4.20	580	3.70	320	4.98	1,120		
6					4.07	500	3.90	420	4.80	1,030		
7					3.95	440	4.12	430	4.69	980		
8					3.85	390	4.30	640	4.53	900		
9					3.75	340	4.10	520	4.42	840		
10					3.46	220	4.65	840	4.31	790		
11					3.40	180	5.15	1,150	4.20	740		
N					3.40	180	6.00	1,700	4.12	710		
1			2.68		3.36	170	5.80	1,570	4.02	670		
2			2.69		3.30	140	6.10	1,770	3.91	620		
3			2.69		3.26	120	6.60	2,130	3.86	600		
4			2.69		3.22	110	6.85	2,350	3.78	570		
5			2.74		3.20	95	7.05	2,640	3.70	540		
6			2.76		3.18	91	7.15	2,910	3.65	520		
7			2.78		3.16	86	7.30	3,420	3.58	490		
8			2.78		3.15	84	7.50	4,400	3.50	460		
9			2.79		3.15	84	7.15	2,910	3.47	460		
10			2.80		3.15	84	6.70	2,220	3.40	430		
11			2.89		3.16	86	6.30	1,910	3.36	420		
M			3.20		3.38	180	6.00	1,700	3.32	400		

Aliso Creek Basin

Aliso Creek at El Toro, Calif.

Location.- Water-stage recorder, lat. 33°37'15", long. 117°41'20", in Canada de los Alisos grant, at Second Street Bridge at El Toro, Orange County. Altitude, 440 feet.

Drainage area.- Area, 8.5 square miles. Average altitude, 997 feet. Maximum altitude, 2,430 feet. Length of main stream channel, 5 miles. Average slope of main stream channel, 7.5 percent.

Gage-height record.- Water-stage recorder graph.

Discharge record.- Stage-discharge relation defined below 300 second-feet by measurements; extended above on basis of slope-area determination.

Maxima.- 1938: Discharge, 1,280 second-feet Mar. 2.
1930-37: Discharge, 1,950 second-feet Feb. 6, 1937.

Remarks.- Records furnished by Orange County Flood Control District, through M. N. Thompson, chief engineer.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	9	104	0	11	17	0.2	0	21	0	4.0	0
2	0	404	0	12	7	46	0	22	0	1.0	0
3	.1	66	0	13	0	26	0	23	0	0	0
4	.8	15	0	14	0	7	0	24	0	0	0
5	0	7	0	15	0	5	0	25	0	0	3.1
6	0	2.5	0	16	0	3.0	0	26	0	0	0
7	0	1.0	0	17	0	3.0	0	27	.1	0	0
8	0	17	0	18	0	3.0	0	28	39	0	0
9	8	1.0	0	19	0	4.0	0	29		0	0
10	0	.7	0	20	0	5	0	30		0	0
								31		0	
Mean monthly discharge, in second-feet									2.89	23.4	0.10
Runoff, in acre-feet									161	1,440	6

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1		March 2		March 3		March 4	
1			4.93		6.50	190	5.30	90	5.35	27	5.90	
2				0.4	9.60	1,050	5.40	83	5.28	18	5.70	
3					6.90	310	5.15	32	5.20	10	5.45	
4			4.96	.1	5.70	100	6.30	180	5.20	9	5.39	
5			5.40	44	5.29	55	6.60	210	5.55	47	5.38	
6			5.20	18	5.08	39	7.70	420	8.15	580		
7			5.52	54	4.98	36	7.10	290	7.00	290		
8			5.48	46	4.84	29	7.20	320	6.85	260		
9			5.33	26	4.74	27	7.30	350	6.00	110		
10			5.28	18	4.63	23	9.10	840	5.55	44		
11			5.25	13			8.78	750	5.42	27		
N			5.26	12			7.60	440	5.40	24		
1			5.27	11			8.00	550	5.38	21		
2			5.25	7			8.80	780	5.35	17		
3			5.25	5			10.30	1,280	5.34	15		
4			5.25	5			8.50	700	5.34	14		
5			5.25	5		15	6.75	260	5.34	14		
6			5.15	1.0			9.30	940	5.33	12		
7			5.02	.5			9.37	960	5.32	10		
8			4.97	.1			6.90	290	5.32	10		
9			5.27	7			6.50	200	5.31	8		
10			5.60	44			5.50	47	5.30	6		
11			6.50	180			5.35	28	5.30	6		
M			7.84	480	4.90	56	5.40	34	5.69	44		

Santa Ana River Basin

Santa Ana River near Mentone, Calif.

Location.- Water-stage recorder, lat. 34°06'40", long. 117°06'00", in SW¼ sec. 4, T. 1 S., R. 2 W., near mouth of canyon, 0.4 mile upstream from Mentone power plant of Southern California Edison Co., and 3½ miles northeast of Mentone. Altitude, about 1,900 feet.

Drainage area.- Area, 144 square miles (excluding Bear Valley). Average altitude, 6,422 feet. Maximum altitude, 11,485 feet. Average slope, 42 percent. Length of main stream channel, 28 miles. Average slope of main stream channel, 6.4 percent.

Gage-height record.- Water-stage recorder graph except 9 a.m. Mar. 2 to Mar. 23.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 900 second-feet prior to Mar. 2 and below 400 second-feet after Mar. 23. Maximum discharge by slope-area method. Discharge for maximum 24 hours determined from rainfall-runoff relation, using the records from recording rain gages at Devils Canyon and Del Rosa as a basis for distribution of the storm rainfall; discharge for Mar. 2-22 obtained by comparison with adjacent streams.

Maxima.- 1938: Discharge, 52,300 second-feet about 7 p.m. Mar. 2.
1896-1937: Discharge, 29,100 second-feet Jan. 27, 1916, by slope-area method.

Remarks.- Records fair except those for Mar. 2-23, which are poor. Practically no release from Bear Valley Reservoir during flood period. Discharge is for natural flow of the stream and includes flow in Southern California Edison Co.'s canal and Greenspot pipe line; no flow in canal and pipe line Feb. 28 to Apr. 30.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	72	979	248	11	119	500	264	21	70	355	431
2	64	15,500	250	12	207	1,240	250	22	71	345	440
3	90	8,080	255	13	126	1,970	280	23	71	342	424
4	277	2,550	266	14	108	1,150	255	24	62	340	400
5	105	1,550	271	15	86	760	250	25	63	321	379
6	85	1,000	259	16	76	580	248	26	63	304	338
7	64	800	250	17	75	480	257	27	129	297	352
8	61	670	246	18	67	430	268	28	611	285	352
9	78	600	250	19	100	390	330	29		285	355
10	108	550	255	20	85	370	379	30		285	347
								31		253	
Mean monthly discharge, in second-feet									114	1,405	305
Runoff, in acre-feet									6,330	86,400	18,150

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 28		March 1		March 2	
1	2.76	343	4.15	865	3.62	578
2	2.90	385	5.60	1,650	3.60	570
3	3.05	438	5.70	1,720	3.59	566
4	3.10	455	5.75	1,760	3.58	562
5	3.16	476	5.70	1,720	3.59	566
6	3.40	530	5.50	1,580	3.65	590
7	3.70	690	5.00	1,280	3.92	700
8	3.95	815	4.80	1,160	4.15	815
9	4.00	840	4.70	1,100	4.45	965
10	3.95	815	4.50	990		
11	3.95	815	4.36	920		
N	3.88	770	4.25	865		
1	3.82	730	4.12	800		
2	3.72	674	4.00	740		
3	3.68	650	3.90	690		
4	3.65	630	3.85	670		
5	3.62	618	3.80	650		
6	3.58	602	3.78	642		
7	3.56	594	3.76	634		
8	3.54	586	3.73	622		
9	3.52	578	3.71	614		
10	3.50	570	3.69	606		
11	3.50	570	3.66	594		
M	3.75	670	3.65	590		

Santa Ana River near Prado, Calif.

Location.- Water-stage recorder, lat. 33°52'05", long. 117°40'20", in Lomas de Santiago grant, at Riverside-Orange County line, in lower Santa Ana Canyon, 3 miles downstream from Rincon bridge, and 3 miles southwest of Prado, Riverside County. Altitude, about 400 feet.

Drainage area.- Area, 1,520 square miles (excluding Bear Valley and San Jacinto River). Average altitude, 2,494 feet. Maximum altitude, 11,485 feet. Average slope, 28 percent. Length of main stream channel, 66.7 miles. Average slope of main stream channel, 3.1 percent.

Gage-height record.- Water-stage recorder graph except 4 p.m. Mar. 2 to Mar. 29. Staff gage read 6 to 10 times daily Mar. 9-29.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 3,000 second-feet and extended above on basis of mean depth-mean velocity relation. Maximum discharge obtained from studies of results of slope-area determinations, mean depth-mean velocity relation, and a cross section made Mar. 5, 1938, together with comparison with maximum discharge of Santa Ana River at Santa Ana (see pp. 182-183). Discharge for some periods estimated by comparison with Santa Ana River at Santa Ana.

Maxima.- 1938: Discharge, about 100,000 second-feet at 12:15 a.m. Mar. 3 (gage height, 17.32 feet).
1919-37: Discharge, about 18,000 second-feet Feb. 16, 1927.

Remarks.- Records fair, except for the period Mar. 2-20, which are poor. No diversions during flood period. Slight regulation at Bear Valley Reservoir.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	186	1,750	326	11	195	400	240	21	128	480	395
2	146	12,300	290	12	324	3,020	272	22	125	430	456
3	130	28,600	295	13	180	5,210	302	23	125	410	485
4	170	4,480	290	14	149	3,500	290	24	125	410	522
5	144	1,900	302	15	141	2,800	313	25	118	420	616
6	110	1,280	326	16	132	1,100	302	26	118	410	529
7	108	1,020	295	17	128	1,300	277	27	176	410	420
8	106	780	235	18	128	1,300	272	28	345	400	400
9	162	570	199	19	146	890	302	29		380	390
10	196	440	224	20	132	610	350	30		470	413
								31		450	
Mean monthly discharge, in second-feet									156	2,514	344
Runoff, in acre-feet									8,670	154,600	20,490

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 28		March 1		March 2	
1			3.60	870	3.20	630
2			4.25	1,360	3.05	555
3			3.82	1,030	3.00	530
4			3.55	840	2.90	480
5			3.65	905	3.10	580
6			3.95	1,120	4.00	1,160
7			4.20	1,320	4.70	1,760
8			4.65	1,620	5.25	2,350
9	2.30	247	4.70	1,760	5.60	2,780
10			4.65	1,620	6.20	3,600
11			4.70	1,760	6.90	4,700
N			4.75	1,810	8.00	6,850
1			5.00	2,070	9.20	9,800
2			5.50	2,650	9.90	11,700
3			6.00	3,300	10.20	12,800
4			6.00	3,300	10.40	13,400
5	2.58	334	6.20	3,600		
6			6.00	3,300		
7			5.35	2,470		
8			4.65	1,720		
9			4.20	1,320		
10	3.25	648	3.90	1,090		
11			3.55	840		
M			3.35	720		

Santa Ana River at Santa Ana, Calif.

Location.- Water-stage recorder and concrete weir control, lat. 33°45'00", long. 117° 54'20", in Las Bolsas land grant, an eighth of a mile above Fifth Street Bridge in Santa Ana, Orange County, and 2 miles below junction with Santiago Creek. Altitude, about 80 feet.

Gage-height record.- Water-stage recorder graph except Mar. 3-6 and Apr. 18-30, when stilling well was filled with silt.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 10,000 second-feet; extended to peak discharge determined by slope-area method. Discharge 7 a.m. Mar. 3 to Mar. 6 based on comparison with Santiago Creek at Santa Ana and current-meter measurements.

Maxima.- 1938: Discharge, 46,300 second-feet about 3 a.m. Mar. 3 (gage height, 10.2 feet).
1923-37: Discharge, about 25,000 second-feet Feb. 16, 1927.

Remarks.- Records fair, except those for Mar. 3-6, which are poor. No diversions during flood period. Some regulation at Bear Valley and Santiago Creek Reservoirs.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	14	991	57	11	32	250	71	21	10	350	37
2	0	8,590	52	12	82	2,700	70	22	0	200	36
3	0	20,300	51	13	15	5,710	68	23	0	180	34
4	0	5,070	52	14	1.7	3,660	64	24	0	170	33
5	0	2,100	53	15	.3	2,770	60	25	1.0	170	31
6	0	1,500	54	16	.2	1,020	56	26	.2	160	30
7	0	1,370	54	17	.1	1,200	52	27	23	150	29
8	0	920	53	18	3.0	1,100	45	28	74	140	28
9	87	470	53	19	30	700	41	29		110	27
10	6	300	68	20	28	400	39	30		80	25
								31		60	
Mean monthly discharge, in second-feet									14.6	2,029	47.4
Runoff, in acre-feet									808	124,700	2,820

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 28		March 1		March 2		March 3	
1	0.68	18	1.70	700	1.92	1,460	6.60	22,500
2	.65	16	2.10	900	1.78	1,090	8.0	30,400
3	.70	21	2.30	1,270	1.70	900	10.2	46,300
4	.80	33	2.30	1,270	1.65	800	9.0	36,600
5	.90	53	2.22	948	1.68	860	8.5	33,400
6	1.05	90	2.15	800	2.00	1,700	8.0	30,400
7	1.30	194	2.00	540	2.40	3,200		
8	1.22	158	1.90	420	2.70	4,350		
9	1.22	158	1.75	275	2.72	4,430		
10	1.10	109	1.65	206	2.86	4,950		
11	1.02	84	1.60	176	3.25	6,500		
N	.94	64	1.65	206	3.40	7,100		
1	.82	46	1.77	388	3.60	7,900		
2	.77	44	1.80	420	3.90	9,100		
3	.74	43	1.80	540	4.40	11,400		
4	.80	55	1.80	540	4.80	13,300		
5	.77	48	1.78	668	5.00	14,300		
6	.74	46	1.88	984	5.20	15,200		
7	.68	36	2.10	1,750	5.30	15,700		
8	.68	36	2.14	2,210	5.40	16,200		
9	.72	46	2.20	2,450	5.60	17,200		
10	.78	59	2.22	2,530	5.70	17,700		
11	1.00	95	2.20	2,450	6.00	19,200		
M	1.50	420	2.05	1,880	6.40	21,400		

Mill Creek near Craftonville, Calif.

Location.- Water-stage recorder and concrete control, lat. 34°05'15", long. 117°02'25", in NE¼ sec. 13, T 1 S., R. 2 W., at mouth of canyon, below bridge on Redlands-Bear Valley highway, and 5 miles northeast of Craftonville. Altitude, 2,950 feet.

Drainage area.- Area, 42.9 square miles. Average altitude, 6,805 feet. Maximum altitude, 11,480 feet. Average slope, 41 percent. Length of main stream channel, 12.6 miles. Average slope of main stream channel, 11 percent.

Gage-height record.- Record lost with the destruction of recorder shelter and control on Mar. 2.

Discharge record.- Maximum discharge obtained by slope-area method. Discharge for maximum 24-hour period determined from rainfall-runoff relation using the Del Rosa recording rain gage as a base for distribution of total storm precipitation. The remainder of the period was determined by comparison with records for Santa Ana River near Mentone.

Maxima.- 1938: Discharge, 18,100 second-feet Mar. 2.
1919-37: Discharge, 4,500 second-feet (estimated) Feb. 16, 1927.

Remarks.- Records poor. Discharge is for natural flow of the stream and includes flow in Mill Creek power canals Nos. 1, 2, and 3; no flow in canals Mar. 3 to Apr. 30.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	31	346	138	11	38	350	148	21	31	152	152
2	31	6,300	138	12	46	360	150	22	30	150	150
3	32	2,820	136	13	43	570	152	23	31	148	146
4	45	1,080	136	14	37	350	156	24	31	146	144
5	38	920	136	15	35	240	158	25	30	145	142
6	34	690	137	16	32	200	158	26	30	144	140
7	31	580	139	17	32	180	160	27	36	142	139
8	30	580	140	18	31	170	160	28	216	140	136
9	34	460	142	19	35	160	158	29		140	135
10	36	350	146	20	32	155	155	30		140	135
								31		140	
Mean monthly discharge, in second-feet									40.6	595	145
Runoff, in acre-feet									2,260	36,590	8,650

Plunge Creek near East Highlands, Calif.

Location.- Water-stage recorder, lat. 34°07'10", long. 117°08'30", in NE¼NE¼ sec. 1, T. 1 S., R. 3 W., at mouth of canyon at crossing at North Fork ditch siphon, 2 miles northeast of East Highlands. Altitude, about 1,625 feet.

Drainage area.- Area, 16.9 square miles. Average altitude, 4,036 feet. Maximum altitude, 6,350 feet. Average slope, 38 percent. Length of main stream channel, 7.5 miles. Average slope of main stream channel, 12 percent.

Gage-height record.- Water-stage recorder graph except Mar. 3-11.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 300 second-feet; extended to 2,900 second-feet on basis of mean depth-mean velocity relation. Maximum discharge determined by slope-area method and checked by rainfall-runoff study. Discharge for the maximum 24 hours determined by rainfall-runoff studies; the rainfall was distributed on the basis of the Del Rosa recording rain gage record. Discharge Mar. 1-11 based on gage height, rainfall-runoff study, and comparative hydrographs.

Maxima.- 1938: Discharge, 5,340 second-feet about 6 p.m. Mar. 2 (gage height, 7.0 feet).
1919-37: Discharge, 1,420 second-feet Feb. 16, 1927 (gage height, 3.8 feet).

Remarks.- Records good, except those for Mar.1-23, which are poor.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	22	219	32	11	36	62	13	21	15	53	12
2	17	1,500	31	12	53	174	12	22	14	50	13
3	35	1,130	28	13	31	189	32	23	13	45	11
4	75	413	26	14	23	126	24	24	12	46	16
5	27	240	27	15	20	100	20	25	10	44	32
6	15	162	23	16	16	84	19	26	10	42	23
7	11	110	20	17	14	73	16	27	29	42	19
8	9.5	87	18	18	13	67	15	28	167	40	17
9	14	74	17	19	26	61	14	29		42	23
10	17	67	16	20	18	55	14	30		38	30
								31		33	
Mean monthly discharge, in second-feet									27.2	176	20.4
Runoff, in acre-feet									1,510	10,850	1,220

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1		March 2		March 3		March 4	
1			1.72	144	3.00	435	1.56	116				
2			1.72	144	3.40	555	1.62	126				
3			1.71	142	3.00	435	1.62	126				
4			1.69	138	2.66	345	1.63	128				
5			1.75	150	2.50	305	1.70	140				
6			1.98	193	2.35	271	2.00	197				
7	0.73	14	2.07	211	2.20	238	2.30	260				
8			2.09	215	2.12	221	2.70	355				
9			2.06	209	2.02	201	2.84	393				
10			1.98	193	2.00	197	3.10	465				
11			1.92	182	1.96	189	3.60	620				
N			1.87	172	1.90	178						
1			1.90	178	1.85	169						
2			1.94	186	1.80	159						
3			1.91	180	1.75	150						
4			1.86	170	1.73	146						
5			1.82	163	1.71	142						
6	1.00	35	1.77	153	1.70	140						
7			1.72	144	1.67	135						
8			1.69	138	1.64	130						
9			1.67	135	1.62	126						
10			1.66	133	1.60	123						
11	1.40	91	1.80	159	1.58	119						
M			2.15	228	1.56	116						

Supplemental record.- Mar. 1, 1:30 a.m., 605 sec.-ft.

San Timoteo Creek near Redlands, Calif.

Location.- Water-stage recorder and concrete control, lat. 34°01'55", long. 117°12'30", in NW¼NW¼ sec. 4, T. 2 S., R. 3 W., 2 miles southeast of Redlands. Altitude, about 1,260 feet.

Drainage area.- Area, 118 square miles. Average altitude, 3,048 feet. Maximum altitude, 8,700 feet. Average slope, 36 percent. Length of main stream channel, 22.0 miles. Average slope of main stream channel, 6.4 percent.

Gage-height record.- Water-stage recorder graph except Mar. 3-11, when stilling well was filled with silt.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 1,200 second-feet; extended to peak discharge determined by slope-area method. Discharge estimated Mar. 3-11 by comparison with nearby streams.

Maxima.- 1938: Discharge, 7,460 second-feet about 9 p.m. Mar. 2 (gage height, 6.6 feet).
1926-37: Discharge, 3,600 second-feet Feb. 6, 1937 (gage height, 5.5 feet).

Remarks.- Records fair.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	1.2	286	0.1	11	28	0.3	0.1	21	0	0.5	0
2	1.1	1,860	.1	12	.1	61	0	22	0	.3	0
3	.4	296	.1	13	0	20	0	23	0	.2	0
4	2.4	35	.1	14	0	5	0	24	0	.2	0
5	2.1	15	.1	15	0	3	0	25	0	.2	0
6	1.7	7	.1	16	0	2	0	26	0	.1	0
7	1.2	3.7	.1	17	0	1.5	0	27	0	.1	0
8	1.0	2.0	.1	18	0	1.0	0	28	2.4	.1	0
9	.9	1.1	.1	19	0	.8	0	29		.1	0
10	.8	.6	.1	20	0	.6	0	30		.1	0
								31		.1	0
Mean monthly discharge, in second-feet									1.55	84.0	0.04
Runoff, in acre-feet									86	5,160	2

Discharge, in second-feet, at indicated time, 1938

Hour	Feb. 28	Mar. 1	Mar. 2	Mar. 3	Mar. 4
1	0	24	70	1,300	
2	0	61	65	900	51
3	.5	1,900	65	650	
4	0	1,750	65	500	47
5	0	775	65	400	
6	0	500	60	320	42
7	1.3	350	60	260	
8	3.0	250	60	220	39
9	1.5	225	60	190	
10	1.2	200	60	165	36
11	1.9	180	100	150	
N	4.0	160	810	135	33
1	5	140	1,900	120	
2	5.5	120	2,350	110	30
3	3.0	110	2,420	100	
4	2.0	100	2,580	93	28
5	1.9	95	3,600	86	
6	1.8	90	3,600	80	26
7	1.7	85	4,400	76	
8	1.5	80	5,500	71	24
9	1.5	75	7,460	66	
10	1.5	75	5,100	63	22
11	2.8	70	3,200	60	
M	13	70	1,900	57	21

Warm Creek near Colton, Calif.

Location.- Water-stage recorder, lat. 34°04'00", long. 117°18'30", in San Bernardino grant, at Colton Avenue Bridge, 1¼ miles east of Colton, San Bernardino County. Altitude, about 970 feet.

Gage-height record.- Water-stage recorder graph prior to 6 a.m. Mar. 2.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 1,250 second-feet. Discharge 6 a.m. Mar. 2 to Apr. 30 based on comparative hydrograph and five discharge measurements.

Maxima.- 1938: Discharge, 27,500 second-feet 7 p.m. Mar. 2.
1920-37: Discharge, 2,780 second-feet Dec. 21, 1921.

Remarks.- Records fair. Discharge is for natural flow of stream and includes flow in Meeks and Daley canal; flow in canal Feb. 1-28 and Mar. 6 to Apr. 30 was 0.1 second-foot or less and did not affect flood flow.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	98	666	101	11	112	185	108	21	45	88	97
2	36	10,225	102	12	94	329	107	22	45	86	96
3	77	5,715	103	13	61	413	106	23	46	85	95
4	172	925	104	14	53	308	105	24	45	87	94
5	36	490	105	15	47	220	104	25	44	89	93
6	36	349	107	16	47	170	102	26	45	92	91
7	36	277	108	17	45	138	101	27	105	94	90
8	35	239	109	18	47	116	100	28	448	95	88
9	55	214	110	19	53	101	99	29		97	87
10	34	194	109	20	44	94	98	30		99	85
								31		100	
Mean monthly discharge, in second-feet									72.9	722	100
Runoff, in acre-feet									4,050	44,390	5,960

Discharge, in second-feet, at indicated time, 1938

Hour	Feb. 27	Feb. 28	Mar. 1	Mar. 2
1	49	184	652	225
2	50	163	850	225
3	50	157	1,140	225
4	50	163	1,260	225
5	50	224	1,360	253
6	50	305	1,270	543
7	50	370	1,130	
8	55	488	975	
9	70	498	853	
10	120	407	782	
11	160	416	702	
N	240	524	637	
1	150	750	572	
2	100	822	494	
3	92	828	434	
4	90	768	352	
5	91	641	316	
6	93	562	270	
7	104	524	254	
8	114	486	237	
9	156	377	232	
10	194	354	228	
11	220	349	226	
M	204	522	225	

Strawberry Creek near Arrowhead Springs, Calif.

Location.- Water-stage recorder and broad-crested weir control, lat. 34°10'45", long. 117°15'55", in SE¼ sec. 11, T. 1 N., R. 4 W., upstream from Del Rosa Water Co.'s lower diversion dam, and half a mile south of Arrowhead Springs. Altitude, about 1,650 feet.

Drainage area.- Area, 8.6 square miles. Average altitude, 3,520 feet. Maximum altitude, 6,150 feet. Average slope, 47 percent. Length of main stream channel, about 4.8 miles. Average slope of main stream channel, 18 percent.

Gage-height record.- Water-stage recorder graph except 12 m. Mar. 2 to Mar. 15.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 300 second-feet; extended above on the basis of mean depth-mean velocity relation and levels of March 1938 and confirmed by rainfall-runoff data. Maximum discharge estimated by consideration of slope-area studies, rainfall-runoff studies, and knowledge of local conditions. Records for maximum 24 hours derived by rainfall-runoff study, using Del Rosa recording rain gage as a base for distribution of total storm precipitation.

Maxima.- 1938: Discharge, 3,360 second-feet 4 p.m. Mar. 2 (gage height, 5.30 feet).
1919-37: Discharge, 492 second-feet Feb. 6, 1937 (gage height, 4.15 feet).

Remarks.- Records good except those for 12 m. Mar. 2 to Mar. 15, which are poor.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	12	106	22	11	13	34	17	21	7.5	35	14
2	6.5	792	20	12	18	148	18	22	7	34	14
3	26	414	20	13	14	206	22	23	6.5	31	13
4	50	132	20	14	11	92	19	24	6	29	16
5	19	76	21	15	10	63	17	25	5.5	28	22
6	12	62	19	16	9	55	16	26	5.5	26	18
7	9	55	18	17	8	49	16	27	12	26	16
8	8	51	17	18	8	44	14	28	63	26	14
9	14	39	17	19	11	42	14	29		26	21
10	12	34	17	20	8.5	39	14	30		24	26
								31		22	
Mean monthly discharge, in second-feet									14.0	91.6	17.7
Runoff, in acre-feet									778	5,630	1,060

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1		March 2		March 3		March 4	
1			2.25	40	3.50	275	2.27	42				
2			2.32	47	3.55	295	2.31	45				
3			2.28	42	3.28	223	2.33	48				
4	1.54	5.5	2.20	35	3.10	175	2.36	49				
5			2.20	35	3.02	157	2.52	69				
6			2.31	45	2.95	145	2.74	103				
7			2.43	56	2.85	115	3.14	180				
8	1.57	6	2.44	57	2.79	111	3.35	250				
9			2.36	49	2.72	99	3.50	310				
10			2.36	49	2.66	89	3.75	425				
11			2.48	62	2.59	78	4.00	580				
N	1.67	8	2.62	81	2.56	74	4.10	740				
1			2.62	81	2.54	71						
2			2.70	93	2.50	66						
3			2.74	98	2.48	63						
4	1.85	14	2.60	77	2.43	58						
5			2.54	68	2.41	55						
6			2.46	59	2.38	52						
7			2.43	55	2.36	50						
8	1.85	14	2.40	52	2.34	48						
9			2.39	51	2.32	46						
10			2.42	54	2.29	43						
11			2.80	108	2.28	42						
M	2.27	42	3.14	181	2.27	41						

Waterman Canyon Creek near Arrowhead Springs, Calif.

Location.- Water-stage recorder and broad-crested weir control, lat. 34°11'35", long. 117°16'35", in SW¼SW¼ sec. 2, T. 1 N., R. 4 W., 600 feet upstream from old toll house, and 1 mile northwest of Arrowhead Springs. Altitude, about 2,125 feet.

Drainage area.- Area, 4.55 square miles. Average altitude, 3,620 feet. Maximum altitude, 5,400 feet. Average slope, 50 percent. Length of main stream channel, 4.5 miles. Average slope of main stream channel, 14 percent.

Gage-height record.- Water-stage recorder graph, except 10 a.m. Mar. 2 to Mar. 15.

Discharge record.- Stage-discharge relationship defined by current-meter measurements below 100 second-feet and extended to 500 second-feet on basis of mean depth-mean velocity relation. Concrete control was destroyed during afternoon of Mar. 2. Maximum discharge estimated by consideration of slope-area studies, rainfall-runoff studies, and knowledge of local conditions. Discharge for the maximum 24-hour period determined from rainfall-runoff study, using the Del Rosa, Etiwanda, and Devil Canyon recording rain gage records as a basis for distribution of total storm precipitation. Discharge for the remainder of the period, Mar. 2-15, determined from retention study and comparison with nearby stations.

Maxima.- 1938: Discharge, 2,350 second-feet about 4 p.m. Mar. 2.
1919-37: Discharge, 390 second-feet Feb. 6, 1937 (gage height, 4.10 feet).

Remarks.- Records good, except for the period Mar. 2-15, which are poor. Several small diversions for domestic supply above station.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	12	55	12	11	8.7	29	9.5	21	4.5	31	7.5
2	3.1	478	12	12	11.5	109	10	22	4.3	29	7
3	26	156	11	13	8.5	111	12	23	3.8	27	7
4	21	74	11	14	6.5	63	10	24	3.8	25	8.5
5	7	51	12	15	5.5	48	9.5	25	3.6	23	12
6	5.5	41	11	16	5.5	43	9	26	3.4	20	9
7	4.8	35	11	17	4.8	42	9	27	13	19	8.5
8	4.3	32	10	18	5.5	38	8.5	28	38	17	9
9	2.9	30	10	19	6.5	35	8.5	29		17	10
10	1.3	29	10	20	4.8	34	8.2	30		15	9
								31		14	
Mean monthly discharge, in second-feet									8.22	57.1	9.72
Runoff, in acre-feet									456	3,510	579

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1		March 2		March 3		March 4	
1	2.78	3.4	3.15	33	3.65	120	3.37	29				
2	2.78	3.4	3.12	27	3.70	134	3.37	29				
3	2.79	3.6	3.09	21	3.47	60	3.39	34				
4	2.79	3.6	3.15	31	3.51	65	3.49	69				
5	2.79	3.6	3.23	42	3.52	65	3.50	86				
6	2.80	3.8	3.21	38	3.51	62	3.56	120				
7	2.82	4.3	3.15	27	3.52	62	3.59	154				
8	2.83	4.5	3.13	24	3.50	57	3.63	199				
9	2.85	5	3.33	60	3.50	57	3.85	308				
10	2.90	6.5	3.34	62	3.50	57						
11	2.94	9	3.37	68	3.49	54						
N	2.94	9	3.36	65	3.48	51						
1	2.99	13	3.35	62	3.47	49						
2	3.04	18	3.32	51	3.46	46						
3	3.01	15	3.20	25	3.45	44						
4	2.96	11	3.18	22	3.44	42						
5	2.93	8.5	3.16	20	3.43	40						
6	2.95	10	3.13	15	3.42	38						
7	2.98	12	3.16	15	3.40	35						
8	3.04	18	3.18	17	3.41	36						
9	3.15	33		18	3.43	40						
10	3.17	36	3.26	29	3.41	36						
11	3.14	31	3.50	88	3.40	35						
M	3.14	31	3.50	82	3.37	29						

City Creek near Highland, Calif.

Location.- Water-stage recorder and concrete control, lat. 34°08'20", long. 117°11'25", in NW¼SW¼ sec. 27, T. 1 N., R. 3 W., 1¼ miles northeast of Highland. Altitude, about 1,520 feet.

Drainage area.- Area, 19.8 square miles. Average altitude, 3,830 feet. Maximum altitude, 6,350 feet. Average slope, 47 percent. Length of main stream channel, 7.6 miles. Average slope of main stream channel, 12 percent.

Gage-height record.- Water-stage recorder graph except 12 m. Mar. 2 to Mar. 11.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 250 second-feet; extended to peak discharge determined by slope-area method. Discharge for the maximum 24 hours determined from rainfall-runoff relation, using the Del Rosa recording rain gage record as a base for distribution of total storm precipitation. Discharge Mar. 2-11 determined from retention study and comparison with adjacent stations.

Maxima.- 1938: Discharge, 6,900 second-feet 4 p.m. Mar. 2.
1919-37: Discharge, 2,360 second-feet Apr. 5, 1926.

Remarks.- Records good except those for Mar. 2-10, which are poor. Discharge is for natural flow of the stream and includes flow in City Creek Water Co.'s canal.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	23	255	43	11	36	74	32	21	17	86	27
2	14	1,990	43	12	52	338	32	22	15	78	27
3	33	738	42	13	35	491	44	23	14	70	26
4	97	264	41	14	28	336	36	24	13	64	28
5	45	208	42	15	24	240	35	25	12	60	40
6	27	160	38	16	20	194	34	26	12	55	34
7	20	144	36	17	16	155	32	27	26	54	31
8	16	96	34	18	16	125	30	28	170	54	28
9	25	80	33	19	22	108	28	29		58	32
10	26	78	32	20	19	96	28	30		51	42
								31		46	
Mean monthly discharge, in second-feet									31.2	221	34.3
Runoff, in acre-feet									1,730	13,580	2,040

Discharge, in second-feet, at indicated time, 1938

Hour	Feb. 27	Feb. 28	Mar. 1	Mar. 2
1		103	397	122
2		103	661	126
3		104	529	128
4		107	450	130
5	13	107	357	147
6		124	328	251
7		166	299	322
8		186	279	427
9		182	261	600
10		175	242	741
11		177	224	1,100
N		186	210	2,600
1		205	196	
2		230	182	
3		228	169	
4	30	224	160	
5		208	152	
6		196	148	
7		177	143	
8		168	136	
9	55	162	133	
10		157	125	
11		206	122	
M		290	118	

Devil Canyon Creek near San Bernardino, Calif.

Location.- Water-stage recorder and concrete control, lat. 34°12'05", long. 117°20'10", in Muscupiabe grant, 7.3 miles northwest of San Bernardino, San Bernardino County. Altitude, about 1,800 feet.

Drainage area.- Area, 6.16 square miles. Average altitude, 3,560 feet. Maximum altitude, 5,350 feet. Average slope, 42 percent. Length of main stream channel, 4.5 miles. Average slope of main stream channel, 13 percent.

Gage-height record.- Water-stage recorder graph except 2 p.m. Mar. 2 to Mar. 7.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 80 second-feet; extended logarithmically to 600 second-feet. Stream divided above station during storm period, only part of the flow passing gage (data in table includes both channels). Maximum discharge estimated by consideration of slope-area studies, rainfall-runoff studies, and knowledge of local conditions. Discharge for the maximum 24 hours determined from rainfall-runoff study, using the recorde from the recording rain gages at Del Rosa, Etiwanda, and Devil Canyon to determine distribution of total storm rainfall.

Maxima.- 1938: Discharge, 3,320 second-feet about 4 p.m. Mar. 2.
1913-14, 1919-37: Discharge, 220 second-feet Apr. 7, 1926.

Remarks.- Records good except for the period Mar. 2-11, which are poor. City of San Bernardino diverts water above gage. There was no diversion during period of flood flow.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	0.1	48	21	11	3.9	31	14	21	1.6	37	11
2	.1	495	21	12	7	143	15	22	1.4	36	10
3	5.5	359	20	13	5.5	141	17	23	1.0	33	12
4	15.0	137	19	14	4.0	70	15	24	.8	32	14
5	8.0	60	20	15	2.2	50	13	25	.7	29	21
6	5.5	46	19	16	1.5	48	13	26	.6	28	14
7	3.3	40	18	17	1.0	48	12	27	1.0	27	14
8	1.3	36	16	18	1.3	44	11	28	32	25	.13
9	2.2	34	15	19	2.1	42	11	29		25	14
10	2.4	32	15	20	1.8	39	11	30		23	16
								31		23	
Mean monthly discharge, in second-feet									4.03	72.9	15.2
Runoff, in acre-feet									224	4,480	902

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 28		March 1		March 2	
1	2.00	8.5	3.00	65	2.65	29
2	2.04	9	3.07	77	2.65	29
3	2.10	11	3.17	90	2.66	30
4	2.23	14	3.12	80	2.67	31
5	2.38	19	3.07	72	2.72	35
6	2.46	22	3.02	67	2.85	46
7	2.51	24	2.99	63	3.02	67
8	2.51	24	2.91	53	3.14	83
9	2.52	25	2.90	52	3.18	90
10	2.55	27	2.87	49	3.35	118
11	2.66	35	2.82	44	3.37	130
N	2.75	43	2.78	39	3.50	150
1	2.82	51	2.75	37		250
2	2.82	51	2.74	36		1,300
3	2.82	51	2.73	36		
4	2.78	45	2.71	34		
5	2.75	42	2.70	33		
6	2.73	40	2.68	32		
7	2.70	37	2.67	31		
8	2.68	35	2.66	30		
9	2.67	34	2.66	30		
10	2.71	36	2.65	29		
11	2.83	47	2.64	29		
M	2.92	57	2.63	28		

Lytle Creek near Fontana, Calif.

Location.- Two water-stage recorders, lat. 34°12'05", long. 117°26'50", in NW¼ sec. 6, T. 1 N., R. 5 W. (unsurveyed), a quarter of a mile below Lytle Creek power plant of Southern California Edison Co., and 7½ miles north of Fontana. Altitude, about 2,200 feet.

Drainage area.- Area, 47.9 square miles. Average altitude, 6,038 feet. Maximum altitude, 10,080 feet. Average slope, 45 percent. Length of main stream channel, 15.7 square miles. Average slope of main stream channel, 9.4 percent.

Gage-height record.- Graphs from two water-stage recorders of little value due to inability to confine flow to channel near gages.

Discharge record.- Maximum discharge determined by slope-area measurement. Discharge for the maximum 24 hours determined from rainfall-runoff studies, using the records from the recording rain gages at Camp Baldy and Etiwanda as a basis for distribution of the rainfall. Rainfall-runoff relation based on the record of Fern Canyon Watershed No. 2. The remainder of the record determined by current-meter measurements and daily estimates of flow made by the Fontana Union Water Co.

Maxima.- 1938: Discharge, 25,200 second-feet about 5 p.m. Mar. 2.
1918-21, 1922-37: Discharge, about 5,300 second-feet Feb. 16, 1927.

Remarks.- Records poor. Discharge is for natural flow of the stream and includes flow in Fontana pipe line; no flow in pipe line Mar. 3-9.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	67	1,020	191	11	156	714	168	21	56	274	155
2	41	8,960	191	12	130	944	166	22	54	258	158
3	268	2,330	189	13	89	805	166	23	54	257	160
4	268	1,080	187	14	85	436	164	24	51	244	161
5	82	883	184	15	72	361	164	25	49	232	175
6	60	692	180	16	67	289	160	26	49	221	177
7	53	600	172	17	56	284	156	27	156	211	168
8	50	550	173	18	58	254	153	28	830	197	174
9	83	550	169	19	58	322	151	29		186	178
10	72	502	168	20	60	301	152	30		191	184
								31		193	
Mean monthly discharge, in second-feet									113	785	170
Runoff, in acre-feet									6,300	48,280	10,100

Lytle Creek (east channel) at San Bernardino, Calif.

Location.- Water-stage recorder, lat. 34°05'50", long. 117°19'05", in San Bernardino grant, near Atchison, Topeka & Santa Fe Railway bridge, a quarter of a mile upstream from Mt. Vernon Street Bridge, at San Bernardino, San Bernardino County. Altitude, about 1,050 feet.

Gage-height record.- Water-stage recorder graph prior to 3 a.m. Mar. 1.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 1,500 second-feet; peak discharge determined by contracted-opening method. Discharge 3 a.m. Mar. 1 to Mar. 4 obtained by comparison with Lytle Creek at Fontana, Cajon and Lone Pine Creeks near Keenbrook, and west channel of Lytle Creek at Colton, and Mar. 4 to Apr. 30 by comparison with daily discharge of Lytle Creek at Foothill Boulevard (about 1 mile upstream) as furnished by the Fontana Water Co., and station on Warm Creek.

Maxima.- 1938: Discharge, 21,500 second-feet 7:30 p.m. Mar. 2.
1929-37: Discharge, 1,060 second-feet, Feb. 14, 1937.

Remarks.- Records poor.

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Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	18	604	20	11	77	32	23	21	0	24	28
2	1.0	7,640	19	12	41	103	25	22	0	20	29
3	91	4,460	18	13	3.8	119	27	23	0	22	28
4	167	625	17	14	.3	74	28	24	0	27	26
5	4.3	228	17	15	0	54	29	25	0	30	25
6	2.8	160	17	16	0	56	28	26	0	33	27
7	.5	100	17	17	0	43	27	27	2.7	34	32
8	.1	68	17	18	0	38	26	28	255	33	39
9	.7	44	19	19	0	27	27	29		30	47
10	2.2	27	20	20	0	12	28	30		26	64
								31		22	
Mean monthly discharge, in second-feet									23.8	478	26.5
Runoff, in acre-feet									1,320	29,390	1,580

Discharge, in second-feet, at indicated time, 1938

Hour	February 27	February 28	March 1
1	0	50	110
2	0	50	950
3	0	50	1,350
4	0	50	
5	0	50	
6	0	70	
7	0	140	
8	0	220	
9	0	200	
10	0	190	
11	0	350	
N	0	600	
1	0	940	
2	0	860	
3	0	650	
4	0	450	
5	0	320	
6	0	210	
7	0	165	
8	0	130	
9	6	105	
10	18	95	
11	24	98	
M	36	100	

Lytle Creek (west channel) at Colton, Calif.

Location.- Water-stage recorder, lat. 34°04'00", long. 117°19'15", in San Bernardino grant, at F Street near Colton Avenue, at Colton, San Bernardino County. Altitude, about 980 feet.

Gage-height record.- Water-stage recorder graph except 2 p.m. Mar. 2 to 4 p.m. Mar. 3, and 5 a.m. Mar. 4 to Mar. 15.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 480 second-feet; extended logarithmically to peak stage. Records for periods of missing gage heights obtained from peak discharge computation and by comparison with east channel of Lytle Creek.

Maxima.- 1938: Discharge, 7,900 second-feet 7 p.m. Mar. 2.
1929-37: Discharge, 20 second-feet Jan. 5, 1935.

Remarks.- Records fair except 2 p.m. Mar. 2 to 4 p.m. Mar. 3, and 5 a.m. Mar. 4 to Mar. 15, which are poor. Flood flow not affected by diversions.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	0.6	6.2	0	11	0.1	0	0	21	0	0	0
2	0	2,180	0	12	0	0	0	22	0	0	0
3	.1	817	0	13	0	0	0	23	0	0	0
4	.1	27	0	14	0	0	0	24	0	0	0
5	0	1.6	0	15	0	0	0	25	0	0	0
6	0	.4	0	16	0	0	0	26	0	0	0
7	0	0	0	17	0	0	0	27	.3	0	0
8	0	0	0	18	0	0	0	28	.1	0	0
9	.6	0	0	19	0	0	0	29		0	0
10	0	0	0	20	0	0	0	30		0	0
								31		0	
Mean monthly discharge, in second-feet									0.07	97.8	0
Runoff, in acre-feet									3.8	6,010	0

Discharge, in second-feet, at indicated time, 1938

Hour	March 1	March 2	March 3	March 4
1	9.5	0.1		47
2	6.5	.6		36
3	1.4	4.7		34
4	.5	4.7		49
5	62	9		41
6	29	14		
7	12	15		
8	7	10		
9	5	8.5		
10	4.2	10		
11	3.7	16		
N	2.4	12		
1	1.7	1,200		
2	.9	2,250		
3	.3			
4	.3		280	
5	.2		215	
6	.2		158	
7	.1		172	
8	.1		192	
9	.1		170	
10	.1		118	
11	.1		88	
M	.1		72	

Cajon Creek near Keenbrook, Calif.

Location.- Two water-stage recorders, lat. 34°15'50", long. 117°27'50", near north boundary of sec. 13, T. 2 N., R. 6 W., 300 feet and 1,800 feet above mouth of Lone Pine Creek, and about 1 mile north of Keenbrook. Altitude, about 2,620 feet.

Drainage area.- Area, 40.9 square miles. Average altitude, 3,960 feet. Maximum altitude, 6,917 feet. Average slope, 47 percent. Length of main stream channel, 13 miles. Average slope of main stream channel, 6.1 percent.

Gage-height record.- Water-stage recorder graph at lower station except 10 a.m. Mar. 2 to Mar. 11; at upper station except 2 p.m. Mar. 2 to Mar. 17.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 600 second-feet; peak discharge determined by slope-area measurement. Discharge for the maximum 24 hours determined largely from a rainfall-runoff relation, using the Del Rosa and Devil Canyon recording rain gage records as a basis for distribution of the storm rainfall. Discharge Mar. 2-15 based on rainfall-runoff studies, partial gage-height record, discharge measurements and comparison with nearby streams.

Maxima.- 1938: Discharge, 14,500 second-feet about 5 p.m. Mar. 2.
1919-37: Discharge, about 5,000 second-feet Dec. 20, 1921.

Remarks.- Records good except those for Mar. 2-15, which are poor. No diversion or regulation above gage.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	52	580	26	11	322	75	22	21	14	42	11
2	11	3,800	24	12	77	150	22	22	13	34	11
3	83	2,050	26	13	34	80	20	23	12	33	11
4	112	535	24	14	25	75	19	24	11	30	11
5	29	231	22	15	21	64	17	25	11	28	14
6	22	160	21	16	18	56	14	26	10	26	12
7	18	130	21	17	17	48	13	27	76	31	11
8	15	110	21	18	19	40	12	28	533	29	11
9	73	90	21	19	23	43	12	29		28	13
10	41	80	21	20	17	44	12	30		27	12
								31		29	
Mean monthly discharge, in second-feet									61.0	283	16.9
Runoff, in acre-feet									3,390	17,410	1,010

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1		March 2		March 3		March 4	
1			2.91	119		2,100		200				
2			3.51	345		2,700		200				
3			3.38	280		1,150		205				
4			3.73	460		700		210				
5	1.70	11	3.58	385		600		230				
6			3.51	350		520		380				
7			3.53	360		470		1,500				
8			3.67	435		435		2,000				
9			4.25	720		410		2,400				
10			5.14	1,220		380		2,500				
11	2.50	46	4.58	900		355		2,500				
N			4.15	680		335		2,250				
1			3.74	482		320		2,700				
2			3.60	415		300		3,300				
3			3.56	400		280						
4			3.69	465		270						
5			3.45	345		260						
6	3.00	140	3.37	305		250						
7			3.37	305		235						
8			3.37	305		225						
9			3.36	300		215						
10			4.55	895		210						
11			5.61	1,510		205						
M			6.09	1,790		200						

Lone Pine Creek near Keenbrook, Calif.

Location.- Water-stage recorder, lat. 34°15'55", long. 117°27'55", in SW¼ sec. 12, T. 2 N., R. 6 W., 50 feet upstream from Atchison, Topeka & Santa Fe Railway bridge, and 1 mile north of Keenbrook. Altitude, about 2,630 feet.

Drainage area.- Area, 15.3 square miles. Average altitude, 4,700 feet. Maximum altitude, 8,500 feet. Average slope, 48 percent. Length of main stream channel, 10.2 miles. Average slope of main stream channel, 11 percent.

Gage-height record.- Record lost due to destruction of gage shelter and well.

Discharge record.- Maximum discharge obtained by slope-area measurement. Discharge for the maximum 24 hours determined from rainfall-runoff study; the average rainfall on the area was distributed on the basis of records from the Del Rosa and Devil Canyon recording rain gages. Remainder of record determined from current-meter measurements and by comparison with record for Cajon Creek near Keenbrook.

Maxima.- 1938: Discharge, 6,180 second-feet Mar. 2.
1919-37: Discharge, 810 second-feet (estimated) Dec. 19, 1921.

Remarks.- Records poor. No diversion or regulation above station.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	18	206	5.5	11	60	7	5	21	1.2	3.5	4.7
2	.7	1,480	5.5	12	12	34	5	22	1.1	3.4	4.7
3	10	840	5.5	13	3.9	8	5	23	.9	3.4	4.8
4	9.5	190	6	14	1.8	5	5	24	.9	3.3	5
5	1.3	90	5.5	15	.9	4.7	4.9	25	.8	3.2	5
6	1.1	46	5.5	16	1.0	4.5	4.8	26	.7	3.2	5
7	.9	28	5.5	17	1.2	4.2	4.8	27	4.0	3.4	5
8	.8	18	5	18	1.4	3.9	4.8	28	67	3.7	5
9	12	13	5	19	1.7	3.8	4.7	29		4.2	5
10	8	9	5	20	1.4	3.7	4.7	30		4.7	5.5
								31		5.5	
Mean monthly discharge, in second-feet									8.01	98.1	5.08
Runoff, in acre-feet									445	6,030	302

Day Creek near Etiwanda, Calif.

Location.- Water-stage recorder and broad-crested weir, lat. 34°11'00", long. 117°32'25", in SW¼ sec. 8, T. 1 N., R. 6 W., a quarter of a mile downstream from confluence of two main forks, and 6 miles north of Etiwanda. Altitude, about 2,940 feet.

Drainage area.- Area, 4.8 square miles. Average altitude, 5,208 feet. Maximum altitude, 8,911 feet. Average slope, 52 percent. Length of main stream channel, 4.0 miles. Slope of main stream channel, 28 percent.

Gage-height record.- Record lost due to destruction of recording gage.

Discharge record.- Maximum discharge and discharge for the maximum 24-hour period obtained by rainfall-runoff studies, using records from Camp Baldy and Etiwanda recording rain gages as basis for distributing the rainfall. Records Mar. 4-11 obtained by use of retention curves; other records computed from current-meter measurements and by comparison with nearby stations.

Maxima.- 1938: Discharge, 4,200 second-feet Mar. 2.
1929-37: Discharge, 192 second-feet Feb. 11, 1936.

Remarks.- Records poor. No regulation or diversion above gage during flood period.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	11	108	31	11	31	50	23	21	17	40	25
2	7	1,055	31	12	33	130	22	22	14	39	23
3	50	449	30	13	25	180	23	23	13	38	23
4	49	121	29	14	20	78	24	24	12	37	23
5	29	80	28	15	19	63	23	25	12	36	20
6	19	60	27	16	19	55	18	26	12	36	20
7	13	55	27	17	17	50	17	27	14	34	20
8	11	52	26	18	17	46	18	28	107	33	20
9	16	50	25	19	17	43	23	29		33	20
10	19	50	24	20	17	42	26	30		32	22
								31		32	
Mean monthly discharge, in second-feet									22.9	103	23.7
Runoff, in acre-feet									1,270	6,360	1,410

Cucamonga Creek near Upland, Calif.

Location.- Water-stage recorder and concrete control, lat. 34°10'15", long. 117°37'55", in NE¼ sec. 17, T. 1 N., R. 7 W., 6 miles north of Upland. Altitude, about 2,550 feet.

Drainage area.- Area, 10.1 square miles. Average altitude, 5,275 feet. Maximum altitude, 8,911 feet. Average slope, 54 percent. Length of main stream channel, 5 miles. Average slope of main stream channel, 24 percent.

Gage-height record.- Water-stage recorder graph except Mar. 2 to Apr. 15.

Discharge record.- Stage-discharge relation well defined below 100 second-feet prior to March 2. Concrete control destroyed and station buried in debris on March 2. Maximum discharge estimated by consideration of slope-area studies, rainfall-runoff studies, and knowledge of local conditions. Discharge for the maximum 24 hours determined from rainfall-runoff study, using the records from Camp Baldy and Etiwanda recording rain gages as a basis for distributing the storm rainfall. Discharge Mar. 4-11 obtained by use of retention curves.

Maxima.- 1938: Discharge, 10,300 second-feet about 3 p.m. Mar. 2.
1928-37: Discharge, 475 second-feet Feb. 11, 1936.

Remarks.- Records fair. No regulation or diversions above gage during flood period.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	14	223	36	11	43	68	28	21	14	55	29
2	7	2,120	35	12	46	167	27	22	13	53	26
3	60	719	34	13	33	242	28	23	12	51	24
4	53	266	33	14	25	108	29	24	12	49	25
5	32	149	32	15	20	80	30	25	11	47	21
6	21	122	31	16	20	69	23	26	11	45	21
7	14	109	30	17	18	66	19	27	16	43	21
8	12	81	30	18	17	63	20	28	222	42	21
9	22	68	29	19	18	60	29	29		40	22
10	24	68	28	20	16	58	29	30		39	22
								31		37	
Mean monthly discharge, in second-feet									29.5	174	27.1
Runoff, in acre-feet									1,640	10,720	1,610

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1	
1	1.76	11	2.82	37	4.87	520
2	1.78	12	3.01	49	4.50	355
3	1.80	12	3.21	67	4.65	418
4	1.79	12	3.46	96	4.45	336
5	1.78	12	3.64	123	4.45	336
6	1.78	12	3.67	129	4.35	302
7	1.79	12	3.66	127	4.30	285
8	1.82	13	3.86	167	4.15	240
9	1.88	14	4.00	198	3.73	140
10	1.93	15	4.10	225	3.65	125
11	1.93	15	4.02	203	3.68	130
N	1.92	15	4.43	329	3.90	175
1	1.92	15	4.25	270	4.08	220
2	1.98	17	4.20	255	3.65	125
3	2.01	18	4.00	198	3.65	125
4	2.02	18	4.28	279	3.75	144
5	2.02	18	3.95	186	3.75	144
6	2.02	18	4.03	206	3.80	154
7	2.02	18	4.07	217	3.78	150
8	2.05	19	4.06	214	3.78	150
9	2.20	23	4.31	288	3.69	132
10	2.21	23	4.68	431	3.65	125
11	2.20	23	5.15	580	3.64	123
M	2.18	22	5.15	580	3.72	138

San Jacinto River near San Jacinto, Calif.

Location.- Staff-gage, lat. 33°44'05", long. 116°49'45", in SE¼ sec. 13, T. 5 S., R 1 E., at highway bridge, 8¼ miles southeast of San Jacinto. Altitude, about 1,980 feet.

Drainage area.- Area, 140 square miles. Average altitude, 5,250 feet. Maximum altitude, 10,800 feet. Average slope, 41 percent. Length of main stream channel, 21 miles. Average slope of main stream channel, 8.7 percent.

Gage-height record.- Staff gage read daily; more frequently during flood period.

Discharge record.- Stage-discharge relation fairly well defined by current-meter measurements below 200 second-feet; peak discharge is mean of slope-area and contracted opening determinations. Discharge Feb. 28 to Mar. 4 based on gage-heights, current-meter measurements, and estimates of discharge furnished by Metropolitan Water District of Southern California.

Maxima.- 1938: Discharge, 14,300 second-feet about 12 p.m. Mar. 2.
1920-37: Discharge, 45,000 second-feet (estimated) Feb. 16, 1927.

Remarks.- Records poor. Some regulation during flood at Lake Hemet; no diversions.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	0.6	890	134	11	29	355	99	21	17	355	88
2	15	3,170	128	12	74	2,070	99	22	16	355	86
3	4.6	5,100	128	13	45	1,280	99	23	16	174	79
4	45	1,500	128	14	30	940	111	24	16	162	75
5	35	780	112	15	24	655	98	25	18	153	84
6	28	522	115	16	24	550	100	26	16	153	158
7	17	407	126	17	18	494	98	27	22	170	138
8	13	368	103	18	13	444	84	28	316	157	110
9	13	343	99	19	23	374	88	29		157	94
10	37	295	99	20	21	368	88	30		145	108
								31		140	
Mean monthly discharge, in second-feet									33.8	743	105
Runoff, in acre-feet									1,880	45,670	6,260

San Jacinto River at Railroad Canyon Reservoir, near Elsinore, Calif.

Location.- Water-stage recorder, lat. 33°41'40", long. 117°16'20", in NW¼SW¼ sec. 2, T. 6 S., R. 4 W., 3 miles east of Elsinore. Altitude, about 1,330 feet.

Drainage area.- 709 square miles.

Gage-height record.- Water-stage recorder graph.

Inflow record.- Obtained from stage-capacity curve and operation records.

Maximum.- 1938: Inflow, 3,150 second-feet about 8 p.m. Mar. 2.

Remarks.- Records furnished by Corps of Engineers, U. S. Army.

Mean daily inflow, in second-feet, 1938

Feb. 27	150	Mar. 3	971
28	150	4	1,820
Mar. 1	150	5	2,190
2	1,340		
Runoff, in acre-feet	13,430		

Inflow, in second-feet, at indicated time, 1938

Hour	March 2	March 3	March 4	March 5	March 6
1	150	1,800	900		
2	200	1,650	1,000	2,600	1,850
3	230	1,500	1,050		
4	260	1,400	1,140	2,500	1,750
5	300	1,300	1,250		
6	400	1,200	1,350	2,370	1,700
7	475	1,130	1,430		
8	575	1,100	1,530	2,250	1,620
9	725	1,000	1,620		
10	900	900	1,690	2,150	1,620
11	1,100	800	1,760		
N	1,160	750	1,850	2,100	
1	1,350	700	1,920		
2	1,500	660	2,000	2,100	
3	1,650	650	2,100		
4	1,900	630	2,170	2,050	
5	2,150	620	2,250		
6	2,500	625	2,300	2,030	
7	2,900	640	2,400		
8	3,150	670	2,450	2,000	
9	2,980	700	2,500		
10	2,400	740	2,580	1,900	
11	2,100	780	2,630		
M	1,900	800	2,650	1,880	

San Jacinto River near Elsinore, Calif.

Location.- Water-stage recorder, lat. 33°39'45", long. 117°17'45", near east line of sec. 9, T. 6 S., R. 4 W., 2 miles east of Elsinore, and 2½ miles upstream from Elsinore Lake (low-water stage). Altitude, about 1,270 feet.

Drainage area.- Area, 717 square miles. Average altitude, 2,710 feet. Maximum altitude, 10,805 feet. Average slope, 34 percent. Length of main stream channel, 61.5 miles. Average slope of main stream channel, 1.6 percent.

Gage-height record.- Water-stage recorder graph.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 1,790 second-feet; extended logarithmically to peak stage. Record verified by comparison with outflow from Railroad Canyon Reservoir 1½ miles upstream.

Maxima.- 1938: Discharge, 2,790 second-feet 2 to 4 a.m. Mar. 5 (gage height, 8.41 feet).
1916-37: Discharge, about 16,000 second-feet Feb. 17, 1927 (gage height, 11.8 feet).

Remarks.- Records good. Storage at Railroad Canyon Reservoir and Lake Hemet; several diversions for irrigation. Seepage from Metropolitan Water District's San Jacinto tunnel was pumped into San Jacinto River above gage.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	52	180	126	11	59	476	49	21	50	371	49
2	48	961	115	12	66	468	47	22	51	324	49
3	47	1,400	103	13	59	399	45	23	53	288	45
4	55	1,570	88	14	56	436	53	24	56	252	41
5	51	2,470	79	15	54	675	68	25	53	220	42
6	46	1,500	81	16	52	765	75	26	52	194	48
7	46	964	78	17	51	684	70	27	86	169	81
8	46	604	78	18	52	576	65	28	100	149	105
9	53	594	74	19	58	496	58	29		143	99
10	54	536	59	20	53	420	50	30		141	86
								31		136	
Mean monthly discharge, in second-feet									55.7	599	70.2
Runoff, in acre-feet									3,090	36,820	4,180

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	March 2		March 3		March 4		March 5	
1								
2	4.20	169	7.92	2,270	5.78	730	8.41	2,790
3								
4	4.22	174	7.70	2,070	5.73	706	8.41	2,790
5								
6	4.30	192	7.44	1,840	5.72	702	8.37	2,750
7								
8	4.52	246	7.18	1,630	5.78	730	8.33	2,710
9								
10	4.70	297	6.92	1,430	5.96	830	8.26	2,610
11					6.50	1,130		
N	5.20	472	6.71	1,270	7.25	1,690	8.19	2,540
1								
2	5.70	689	6.50	1,140	7.52	1,920	8.11	2,430
3								
4	6.90	1,410	6.29	1,020	7.79	2,160	8.03	2,330
5								
6	7.42	1,820	6.14	930	8.03	2,390	7.93	2,220
7								
8	7.88	2,230	6.02	860	8.20	2,570	7.84	2,120
9								
10	8.19	2,550	5.92	806	8.32	2,700	7.75	2,020
11								
M	8.04	2,390	5.84	760	8.38	2,760	7.66	1,920

Elsinore Lake at Elsinore, Calif.

Location.- Staff gage, lat. 33°40'35", long. 117°21'30", in La Laguna grant, on northeast shore at Aloha Beach Club, Elsinore, Riverside County. Zero of gage is 1,200 feet above mean sea level.

Gage-height record.- Staff-gage readings about once daily during flood periods.

Remarks.- Elsinore Lake overflows only during and after years of heavy rainfall. Temescal Creek is the high water outlet of lake. There was flow in creek during most of 1916 and the first half of 1917. A history of the lake is given in Water-Supply Papers 426, 429, and 441. Part of record furnished by D. R. Crane, Elsinore, Calif.

Gage height, in feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1		51.0	58.5	11		56.0	58.7	21		57.8	58.8
2		51.1	58.5	12		56.3	58.7	22		57.9	58.8
3		52.4	58.6	13		56.4	58.7	23	50.5	58.0	58.8
4		52.9	58.6	14	50.3	56.6	58.7	24		58.1	58.8
5		53.7	58.6	15		56.7	58.7	25		58.2	58.8
6	50.0	54.5	58.6	16		57.0	58.7	26		58.3	58.8
7	50.0	55.0	58.6	17		57.2	58.7	27	50.6	58.3	58.8
8		55.4	58.6	18		57.4	58.7	28		58.3	58.8
9		55.6	58.6	19		57.6	58.8	29		58.4	58.8
10		55.8	58.7	20	50.4	57.7	58.7	30		58.4	58.9
								31		58.4	

Elsinore Lake, capacity table*

Gage-height (feet)	Acre-feet	Gage-height (feet)	Acre-feet	Gage-height (feet)	Acre-feet
45	60,000	50	82,000	55	107,500
46	64,500	51	86,500	56	112,500
47	68,500	52	92,000	57	118,000
48	73,000	53	97,500	58	124,000
49	77,500	54	102,500	59	130,000

* From unpublished report by P. H. Albright, Elsinore Valley Water Supply.

Temescal Creek near Corona, Calif.

Location.- Water-stage recorder, lat. 33°50'30", long. 117°30'45", in El Sobrante de San Jacinto grant, half a mile upstream from Blue Diamond Quarry, and 4 miles southeast of Corona, Riverside County. Altitude, 730 feet.

Drainage area below Elsinore Lake.- Area, 157 square miles (924 square miles including San Jacinto River). Average altitude, 1,451 feet. Maximum altitude, 5,680 feet. Average slope, 33 percent. Length of main stream channel, 22 miles. Slope of main stream channel, 4.1 percent.

Gage-height record.- Water-stage recorder graph except Mar. 2-14.

Discharge record.- Stage-discharge relation poorly defined by current-meter measurements below 100 second-feet; peak discharge determined by slope-area measurement. Discharge for maximum 24 hours determined from rainfall-runoff relation, using the Silverado and Riverside recording rain gage records as a basis for distribution of the storm precipitation. Discharge Mar. 4-14 determined from one current-meter measurement and by comparison with nearby stations.

Maxima.- 1938: Discharge, 14,900 second-feet 7 p.m. Mar. 2.
1929-37: Discharge, 2,350 second-feet Feb. 6, 1937.

Remarks.- Records poor. Drainage area above Elsinore Lake did not contribute any runoff during flood. Lee Lake dam failed in the late afternoon of Mar. 2.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	4.0	88	100	11	8	216	64	21	4.4	75	46
2	9	3,460	88	12	8	152	55	22	4.4	96	46
3	7	2,520	82	13	6	125	50	23	4.0	108	42
4	7.5	432	84	14	7	120	46	24	4.0	104	42
5	6	194	91	15	7	116	46	25	4.0	100	39
6	5.5	136	87	16	6	112	46	26	4.8	118	33
7	6	112	72	17	5	107	47	27	10	115	24
8	7	106	68	18	5	123	48	28	11	129	22
9	7.5	102	65	19	5.5	100	46	29		130	28
10	8	100	64	20	4.4	87	49	30		122	25
								31		102	
Mean monthly discharge, in second-feet									6.29	313	54.8
Runoff, in acre-feet									349	19,250	3,260

Chino Creek near Prado, Calif.

Location.- Water-stage recorder, lat. 33°53'40", long. 117°38'40", in El Rincon grant, at Chino-Rincon road, 1 mile west of Prado, Riverside County. Altitude, 460 feet.

Drainage area.- About 176 square miles.

Gage-height record.- Water-stage recorder graph except 1 p.m. Mar. 2 to Mar. 21.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 300 second-feet; extended logarithmically to peak discharge determined by slope-area measurement of the main channel (5,000 sec.-ft.) plus estimated discharge of secondary channels. Discharge Mar. 2 to Apr. 30 computed by interpolating between discharge measurements and by comparison with adjacent streams.

Maxima.- 1938: Discharge, 5,200 second-feet about 6 p.m. Mar. 2.
1929-37: Discharge, 1,440 second-feet Jan. 1, 1934.

Remarks.- Records fair. No diversion or regulation during flood.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	78	302	13	11	47	130	6.5	21	15	60	9.5
2	32	1,580	11	12	96	190	7	22	14	50	11
3	21	1,200	9	13	29	250	7.5	23	14	44	13
4	50	371	8.5	14	20	190	8	24	14	88	14
5	21	205	8.5	15	19	140	8	25	14	35	15
6	13	155	9	16	17	100	8.5	26	13	32	14
7	11	140	8	17	15	90	8.5	27	42	28	12
8	9.5	132	6.5	18	14	86	8	28	89	24	10
9	47	130	6	19	19	76	8	29		21	9
10	67	128	6	20	16	66	8.5	30		18	10
								31		15	
Mean monthly discharge, in second-feet									30.6	196	9.38
Runoff, in acre-feet									1,700	12,050	558

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1		March 2		March 3		March 4	
1			3.93	76	4.60	116	5.48	178				
2			3.75	68	4.70	122	5.35	168		2,200		510
3			3.56	59	5.00	142	5.25	160				
4	2.14	13	3.45	54	6.20	237	5.15	153		1,850		480
5			3.35	50	7.30	345	5.25	160				
6					7.90	411	5.75	199		1,600		440
7					8.40	476	6.20	238				
8			3.25	46	8.62	503	7.30	346		1,300		410
9	2.27	15			8.50	491	8.20	452				
10					8.25	456	9.30	593		1,150		380
11					7.90	411	10.85	835				
N					7.60	379	11.00	858		1,000		350
1	2.45	20	3.55	59	7.40	357	10.90	900				
2	2.55	22	4.20	92	7.30	346		1,000		900		330
3	2.65	25	4.65	119	7.20	335		1,200				
4	2.77	29	4.75	125	7.00	314		2,200		810		310
5	2.95	35	4.85	132	6.77	291		3,500				
6	3.50	36	5.07	147	6.51	265		5,200		730		290
7	4.23	93	5.18	154	6.30	247		4,400				
8	4.77	126	5.20	156	6.15	233		4,000		660		280
9	4.85	131	5.10	149	6.05	224		3,600				
10	4.70	121	4.90	135	5.90	212		3,200		600		265
11	4.40	103	4.70	122	5.75	200		2,900				
M	4.13	87	4.50	110	5.60	188		2,700		550		255

San Antonio Creek near Claremont, Calif.

Location.- Water-stage recorder and concrete control, lat. 34°12'50", long. 117°40'00", in NW¼SE¼ sec. 36, T. 2 N., R. 8 W., at highway bridge, half a mile above Southern California Edison Co.'s Sierra power plant, and 8 miles northeast of Claremont. Altitude, about 3,400 feet.

Drainage area.- Area, 16.9 square miles. Average altitude, 6,580 feet. Maximum altitude, 10,080 feet. Average slope, 49 percent. Length of main stream channel, 5.75 miles. Average slope of main stream channel, 21 percent.

Gage-height record.- Water-stage recorder graph except 10 a.m. Mar. 2 to Mar. 29.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 125 second-feet; extended logarithmically to 900 second-feet. Concrete control was destroyed on Mar. 2. The stream changed its channel above gage, so that only a small part of the flood runoff passed the gage. Maximum discharge estimated by consideration of slope-area studies, rainfall-runoff studies, and knowledge of local conditions. Discharge for the maximum 24 hours determined from rainfall-runoff study using Camp Baldy recording rain gage record as a basis for distribution of total storm precipitation; for remainder of the period of missing record determined from measurements made by the Los Angeles County Flood Control District at the mouth of the canyon, from retention studies, and by a comparison with other streams.

Maxima.- 1938: Discharge, 21,400 second-feet about 4 p.m. Mar. 2.
1917-37: Discharge, 1,020 second-feet Dec. 19, 1921.

Remarks.- Records good except for Mar. 2-29, which are poor. Discharge is for natural flow of the stream and includes flow in Southern California Edison Co.'s canal; no flow in canal Mar. 2 to Apr. 30.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	19	227	125	11	52	136	140	21	25	151	94
2	16	4,110	125	12	35	274	130	22	24	151	92
3	26	954	130	13	25	375	130	23	24	150	90
4	30	436	140	14	24	202	125	24	24	150	87
5	27	364	140	15	26	175	120	25	24	148	85
6	23	272	140	16	26	168	115	26	24	143	82
7	22	227	150	17	25	163	110	27	26	140	80
8	20	227	150	18	24	158	105	28	119	138	78
9	28	136	150	19	26	154	102	29		135	76
10	26	136	140	20	25	153	98	30		133	75
								31		130	
Mean monthly discharge, in second-feet									29.1	342	113
Runoff, in acre-feet									1,620	21,060	6,750

Discharge, in second-feet, at indicated time, 1938

Hour	February 28	March 1	March 2
1	31	771	94
2	36	581	95
3	41	451	98
4	47	356	102
5	49	301	110
6	53	266	120
7	56	231	140
8	64	211	180
9	70	191	350
10	83	176	740
11	83	166	
N	86	153	
1	96	130	
2	109	112	
3	109	108	
4	128	104	
5	123	100	
6	119	98	
6			
7	117	96	
8	119	95	
9	141	94	
10	196	93	
11	435	93	
M	921	93	

Santiago Creek near Villa Park, Calif.

Location.- Water-stage recorder, lat. 33°49'10", long. 117°46'30", in SW¼ sec. 13, T. 4 S., R. 9 W., five-eighths of a mile below diversion dam of Serrano and Carpenter Irrigation Districts, and 1-3/4 miles northeast of Villa Park. Altitude, about 420 feet.

Drainage area.- Area, 83.8 square miles. Average altitude, 1,934 feet. Maximum altitude, 5,680 feet. Average slope, 43 percent. Length of main stream channel, 16.5 miles. Slope of main stream channel, 6.0 percent.

Gage-height record.- Water-stage recorder graph except Feb. 1-14, Mar. 4-6, and Apr. 21-30.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 1,200 second-feet; extended above on basis of a slope-area measurement of the peak. Discharge for period of missing gage-height record based on discharge measurements and comparison with Santiago Creek at Santa Ana.

Maxima.- 1938: Discharge, 5,200 second-feet 7 p.m. Mar. 2 (gage height, 6.27 feet).
1920-37: Discharge, 11,000 second-feet Feb. 16, 1927 (gage height, 8.4 feet), by slope-area method.

Remarks.- Records fair. Flow partly regulated by storage in Santiago Reservoir. Irvine Company and Serrano and Carpenter Irrigation Districts divert above gage.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	14	176	68	11	0.7	186	65	21	0.7	180	10
2	5	2,660	68	12	.8	583	68	22	.6	160	9
3	3.0	3,190	62	13	.8	1,030	65	23	.6	150	8
4	2.0	1,190	62	14	.8	646	62	24	.5	117	6
5	1.5	420	62	15	.8	442	65	25	.3	101	15
6	1.2	275	54	16	.8	322	46	26	.3	70	12
7	1.0	264	44	17	.6	281	27	27	1.4	82	10
8	.9	253	32	18	.7	253	17	28	13	79	8
9	.8	219	36	19	.9	214	17	29		73	8
10	.7	197	54	20	.8	197	17	30		70	7
								31		70	
Mean monthly discharge, in second-feet									1.97	456	36.1
Runoff, in acre-feet									109	28,070	2,150

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1		March 2		March 3		March 4	
1	0.52	0.3	0.83	4.4	2.70	590	0.85	96	5.63	4,480		
2	.52	.3	.80	3.7	3.03	722	.90	109	5.47	4,290		
3	.52	.3	.80	3.7	3.05	730	.94	139	5.33	4,130		
4	.52	.3	.82	4.2	2.35	447	1.30	287	5.15	3,950		1,640
5	.52	.3	.91	7	1.96	309	2.00	750	5.04	3,840		
6	.52	.3	.94	8	1.77	241	2.57	1,230	4.95	3,740		
7	.52	.3	1.06	15	1.54	158	2.77	1,410	4.87	3,660		
8	.53	.4	1.01	12	1.40	117	2.79	1,430	4.84	3,620		1,350
9	.56	.5	.96	9	1.25	82	2.95	1,590	4.77	3,550		
10	.59	.7	.90	6.5	1.12	59	3.40	2,050	4.67	3,440		
11	.62	.9	.89	6.5	1.04	51	3.93	2,650	4.56	3,320		
N	.63	1	.87	5.5	.97	43	3.84	2,570	4.47	3,220		1,120
1	.64	1.1	.85	4.9	.93	41	4.03	2,750	4.37	3,110		
2	.65	1.1	.83	4.4	.88	38	4.35	3,080	4.26	2,990		
3	.66	1.3	.82	4.2	.85	38	4.80	3,580	4.09	2,810		
4	.67	1.5	.80	3.7	.81	39	4.90	3,690	4.00	2,720		930
5	.68	1.6	.79	3.5	.77	40	4.90	3,690	3.91	2,630		
6	.70	1.9	.78	3.3	.74	43	5.73	4,600	3.82	2,540		
7	.72	2.2	..77	3.1	.70	44	6.27	5,200	3.71	2,410		
8	.73	2.3	.76	2.8	.68	49	6.22	5,120	3.60	2,280		770
9	.75	2.6	.77	3.1	.68	58	6.27	5,200	3.54	2,210		
10	.77	3.1	.93	10	.67	56	6.20	5,100	3.47	2,130		
11	.89	6.5	1.23	41	.68	58	6.18	5,080	3.40	2,050		
M	.85	4.9	1.94	281	.74	69	5.93	4,820	3.35	2,000		650

Santiago Creek at Santa Ana, Calif.

Location.- Water-stage recorder, lat. 33°46'00", long. 117°52'45", in Santiago de Santa Ana grant, at end of Baker Street, Santa Ana, Orange County. Altitude, about 120 feet.

Gage-height record.- Water-stage recorder graph except for low stages when water was below intake, and Mar. 5-6, when intake was clogged by silt.

Discharge record.- Stage-discharge relation fairly well defined below 1,000 second-feet by current-meter measurements; extended to peak stage on basis of mean depth-mean velocity relation. Shifting control corrections used throughout. Discharge for periods of missing gage-height record based on discharge measurements and comparison with Santa Ana River at Santa Ana.

Maxima.- 1938: Discharge, 4,400 second-feet 8:30 p.m. Mar. 2 (gage height, 7.40 feet).
1929-37: Discharge, 3,270 second-feet Feb. 6, 1937 (gage height, 6.90 feet).

Remarks.- Records fair. Regulation at Santiago Reservoir.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	32	340	17	11	53	54	64	21	10	74	0
2	0	1,990	17	12	15	254	68	22	1.0	71	0
3	0	2,320	17	13	.5	660	68	23	.5	67	0
4	0	1,060	21	14	.1	500	68	24	0	61	0
5	0	650	25	15	0	323	71	25	10	55	7
6	0	300	29	16	0	208	67	26	5	47	0
7	0	151	28	17	0	166	35	27	40	43	0
8	0	149	25	18	10	136	12	28	80	39	0
9	68	116	29	19	37	111	1.0	29		34	0
10	2.5	69	62	20	30	91	.5	30		28	4.2
								31		25	
Mean monthly discharge, in second-feet									14.1	329	24.5
Runoff, in acre-feet									783	20,220	1,460

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	March 1		March 2		March 3		March 4	
1	2.70	710		180	6.95	3,950	3.20	1,260
2	4.30	1,460		210	6.85	3,850	3.15	1,230
3	3.00	830		250	6.50	3,520	3.12	1,220
4	2.65	690		350	6.20	3,270	3.07	1,190
5	2.40	600		500	5.95	3,050	3.05	1,180
6	2.00	465	3.10	1,050	5.70	2,890	3.00	1,160
7		380	3.50	1,250	5.55	2,740	2.95	1,140
8		300	3.55	1,280	5.40	2,620	2.90	1,120
9		240	3.30	1,150	5.24	2,500	2.87	1,100
10		190	3.25	1,120	5.10	2,410	2.85	1,090
11		180	4.00	1,510	4.9	2,270	2.80	1,060
N		170	4.20	1,630	4.75	2,170	2.77	1,060
1			4.70	1,930	4.60	2,070	2.74	1,040
2			5.00	2,130	4.40	1,940	2.70	1,020
3			6.20	3,010	4.20	1,820	2.66	1,000
4			6.40	3,180	4.05	1,700	2.63	990
5			5.90	2,780	3.90	1,640		
6		150	5.60	2,620	3.77	1,560		
7			6.00	3,010	3.66	1,500		
8			7.25	4,300	3.57	1,450	2.50	930
9			7.30	4,300	3.50	1,410		
10			7.00	4,000	3.40	1,360		
11			7.05	4,050	3.33	1,320		
M			7.00	4,000	3.25	1,280		

Supplemental record.- Mar. 2, 8:30 p.m., 7.40 ft., 4,400 sec.-ft.

Irvine Ranch drainage canal near Tustin, Calif.

Location.- Water-stage recorder, lat. 33°40'30", long. 117°50'05", in San Joaquin grant at Lane Road Bridge, 5 miles south of Tustin, Orange County. Altitude, about 26 feet.

Drainage area.- 93 square miles.

Gage-height record.- Water-stage recorder graph.

Discharge record.- Stage-discharge relation fairly well defined below 2,200 second-feet by current-meter measurements, extended to peak on basis of slope-area determinations.

Maxima.- 1938: Discharge, 5,710 second-feet Mar. 2 (gage height, 18.2 feet).
1930-37: Discharge, 5,020 second-feet Feb. 6, 1937.

Remarks.- Canal carries storm runoff from foothills, crosses ranch, and drains a small area between Tustin and the ocean. Records furnished by Orange County Flood Control District, through M. N. Thompson, chief engineer.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	10	373	0.5	11	12	1.0	0.3	21	0.1	1.0	0.2
2	.1	3,200	.4	12	5	146	.3	22	0	1.0	.2
3	0	1,040	.4	13	.3	98	.3	23	0	1.0	.2
4	7	12	.4	14	.3	6	.3	24	0	1.0	.2
5	0	10	.3	15	.2	5	.3	25	0	1.0	.2
6	0	7	.3	16	.2	4.0	.3	26	0	.9	.2
7	0	5	.3	17	.2	3.0	.2	27	1.8	.8	.2
8	0	4.0	.3	18	.2	2.0	.2	28	30	.7	.2
9	15	3.0	.3	19	.1	1.0	.2	29		.6	.2
10	2.2	2.0	.3	20	.1	1.0	.2	30		.5	.2
								31		.5	
Mean monthly discharge, in second-feet									2.78	159	0.27
Runoff, in acre-feet									154	9,780	16

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	February 27		February 28		March 1		March 2		March 3		March 4	
	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
1					10.00	1,010	3.35	14		3,980		
2					11.70	1,600	5.25	93		3,310		
3					12.70	2,040	6.95	330		2,670		
4				7.0	11.95	1,700	7.50	430		2,040		
5					10.10	1,050	9.20	800		1,420		
6					8.30	590	11.70	1,610		1,120		
7	3.0		4.10	25	7.00	340	12.85	2,120		1,030		
8	3.05		4.35	33	6.20	210	13.30	2,340		1,510		
9			5.00	61	5.60	130	13.80	2,620		1,570		
10			4.45	39	5.00	71	14.65	3,120		960		
11			4.25	33	4.60	49	15.60	3,720		590		
N			4.10	29	4.25	37	15.30	3,520		420		
1			3.90	23	4.00	29	15.10	3,390		300		
2			3.75	20	3.75	22	15.45	3,620		200		
3			3.75	20	3.50	17	16.75	4,540		240		
4	3.10		3.60	17	3.40		17.40	5,030		92		
5	3.57		3.60	17			17.60	5,200		68		
6	3.40		3.55				17.90	5,450		56		
7	3.30						18.10	5,620		47		
8	3.25			15		12	18.20	5,710		39		
9							18.10	5,620		35		
10								5,450		31		
11			3.45					5,110		27		
M	3.10		7.00	334	3.00			4,660		25		

San Gabriel River Basin

East Fork of San Gabriel River near Camp Bonita, Calif.

Location.- Water-stage recorder, lat. 34°14'15", long. 117°49'10", in SW¼ sec. 22, T. 2 N., R. 9 W., upstream from mouth of Susanna Canyon, and 3 miles west of Camp Bonita. Altitude, 1,500 feet.

Drainage area.- Area, 91.4 square miles. Average altitude, 5,230 feet. Maximum altitude, 10,080 feet. Average slope, 54 percent. Length of main channel, 17.8 miles. Average slope of main stream channel, 9.1 percent.

Gage-height record.- Water-stage recorder graph.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 21,300 second-feet and extended to peak stage on basis of mean depth-mean velocity relation.

Maxima.- 1938: Discharge, 46,000 second-feet Mar. 2 (gage height, 10.1 feet).
1932-37: Discharge, 8,500 second-feet Jan. 1, 1934.

Remarks.- Maximum discharge determined by the Geological Survey; other records furnished by Los Angeles County Flood Control District, through H. E. Hedger, Chief engineer.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	79	1,980	350	11	364	620	310	21	137	640	295
2	60	10,000	345	12	359	2,100	305	22	137	600	285
3	188	5,100	340	13	272	1,850	295	23	127	570	280
4	299	2,750	340	14	228	1,400	290	24	132	540	268
5	186	2,000	350	15	197	1,200	280	25	137	520	271
6	134	1,550	340	16	172	1,050	270	26	132	490	264
7	110	1,250	330	17	160	930	265	27	182	460	236
8	103	1,150	320	18	164	830	265	28	1,270	430	232
9	123	900	320	19	160	740	280	29		400	235
10	186	720	315	20	142	690	300	30		370	232
								31		350	
Mean monthly discharge, in second-feet									212	1,430	294
Runoff, in acre-feet									11,760	87,630	17,470

Discharge, in second-feet, at indicated time, 1938

Hour	February 27	February 28	March 1
1			4,400
2	130		4,630
3			4,340
4	132	284	
5			3,150
6	134	396	2,040
7			1,510
8	137	850	2,000
9	142		2,510
10	163	1,180	
11	168		
N	174	1,430	2,180
1		1,310	1,260
2	180	2,120	1,270
3		1,550	
4	198	1,520	1,300
5		1,670	
6	236	1,650	1,400
7		1,940	
8	242	1,760	1,380
9		1,850	
10	264	2,400	
11			
M	264	3,480	1,650

San Gabriel River at Foothill Boulevard, near Azusa, Calif.

Location.- Water-stage recorder, lat. 34°08'15", long. 117°56'35", in Azusa (Duarte) land grant, at highway bridge at Foothill Boulevard, 2 miles west of Azusa, Los Angeles County. Altitude, about 580 feet.

Drainage area.- Area, 230 square miles. Average altitude, 4,330 feet. Maximum altitude, 10,080 feet. Average slope, 43 percent. Length of main stream channel, 30 miles. Average slope of main stream channel, 5.9 percent.

Gage-height record.- Water-stage recorder graph prior to 1:30 a.m. Mar. 3.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 35,500 second-feet; extended to maximum discharge determined by slope-area method.

Maxima.- 1938: Discharge, 61,800 second-feet 7:35 p.m. Mar. 2 (gage-height, 20.5 feet).
1932-37: Discharge, 10,000 second-feet Jan. 19, 1933.

Remarks.- Records fair. Flow partially regulated by San Gabriel River flood-control dams Nos. 1 and 2 and Morris Dam. Water diverted near mouth of San Gabriel Canyon for irrigation and spreading. Base data for Feb. 27 to Mar. 3 and entire record Feb. 1-26, Apr. 20, 27, and 29, furnished by Los Angeles County Flood Control District, through H. E. Hedger, chief engineer.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	27	913		11	114			21	29		
2	12	11,600		12	124			22	28		
3	154			13	98			23	27		
4	118			14	76			24	79		
5	58			15	72			25	254		
6	37			16	68			26	217		
7	30			17	62			27	160		*23
8	26			18	45			28	527		
9	42			19	35			29			*17
10	50			20	31		*410	30			
								31			
Mean monthly discharge, in second-feet									92.9		
Runoff, in acre-feet									5,160		

* Discharge measurement.

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1		March 2		March 3		March 4	
1	6.00	222			8.48	2,530	6.39	356	15.42	25,000		
2	6.01	224	5.51	78	8.16	2,050	6.44	382				
3					7.90	1,730	6.47	397				
4	6.02	227	5.66	113	7.75	1,550	6.58	446				
5					7.63	1,380	6.74	559				
6	6.02	227	5.96	207	7.48	1,210	6.96	708				
7					7.35	1,070	7.83	906				
8	6.04	235	6.41	402	7.24	948	7.77	1,220				
9					7.12	840	8.15	1,550				
10	6.09	254	6.88	708	7.04	777	8.95	2,530				
11	6.10	258	6.99	793	6.99	738	9.35	2,900				
N	5.79	154	6.93	746	6.90	678	9.62	3,200				
1	5.66	118	6.97	769	6.85	635	10.08	3,680				
2	5.64	113	6.96	761	6.77	581	11.17	5,560				
3			6.92	730	6.69	526	11.65	6,360				
4	5.55	91	6.92	730	6.62	483	11.77	6,410				
5			6.79	635	6.59	464	13.30	9,840				
6	5.50	82	6.69	566	6.53	430	14.55	16,100				
7			6.60	501	6.53	430	17.50	37,900				
8	5.49	78	6.55	464	6.44	382	18.65	47,500				
9			6.58	483	6.40	361	18.50	46,900				
10	5.49	78	6.84	656	6.37	347	16.90	35,500				
11			7.48	1,220	6.33	328	16.45	33,600				
M	5.48	74	7.88	1,710	6.35	333	15.65	29,000				

Supplemental record.- Mar. 2, 7:35 p.m., 20.5 ft., 61,800 sec.-ft.

San Gabriel River at Pico, Calif.

Location.- Water-stage recorder, lat. 34°00'20", long. 118°04'05", in Paso de Bartolo grant, at Beverly Boulevard Bridge, half a mile east of Pico, Los Angeles County. Altitude, about 180 feet.

Drainage area.- Area indeterminate due to a natural split near Arrow Highway, which divides the San Gabriel River into two branches; the west branch, known as the Rio Hondo, flows into the Los Angeles River; the east branch retains the name San Gabriel River.

Gage-height record.- Water-stage recorder graph except Mar. 4-6.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 12,700 second-feet; extended logarithmically to peak discharge on basis of a slope-area measurement of the peak. Discharge for period of missing gage-height record obtained from measurements and comparable hydrographs of adjacent streams.

Maxima.- 1938: Discharge, 22,700 second-feet 10:30 p.m. Mar. 2.
1928-37: Discharge, 22,000 second-feet Jan. 1, 1934.

Remarks.- Records fair. Flow partially regulated by San Gabriel River flood-control dams Nos. 1 and 2, Morris Dam, Big Dalton Creek, San Dimas Creek, Puddingstone, Live Oak Creek, and Thompson Creek flood-control dams, and Puddingstone diversion dam. The City of Pasadena diverts water from the San Gabriel River at Morris Dam. There are also several diversions for irrigation. Records furnished by Los Angeles County Flood Control District, through H. E. Hedger, chief engineer.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	304	2,040	12	11	321	615	254	21	47	121	48
2	55	11,400	167	12	196	1,020	150	22	38	115	65
3	60	6,080	254	13	106	759	100	23	38	176	61
4	88	3,190	221	14	69	704	54	24	42	314	61
5	60	1,420	384	15	66	597	35	25	106	384	69
6	55	1,030	503	16	77	386	61	26	95	384	69
7	52	916	469	17	69	203	78	27	216	134	52
8	47	1,270	242	18	66	254	78	28	840	78	52
9	326	2,030	278	19	63	278	65	29		121	61
10	95	1,050	314	20	49	221	39	30		140	56
								31		70	
Mean monthly discharge, in second-feet									130	1,210	145
Runoff, in acre-feet									7,230	74,380	8,630

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1		March 2		March 3		March 4	
1					9.00	5,600	5.76	400		8,000		
2			5.87	95	9.30	6,500	5.78	400		5,800		
3					9.60	7,900	6.10	800		5,100		
4			5.87	95	9.20	6,400	6.70	2,000		4,500		
5					8.75	4,700	7.57	4,200		3,900		
6			5.87	95	8.20	3,100	8.60	7,400		3,500		
7			6.00	151	7.85	2,500	9.45	9,800				
8			6.40	459	7.25	1,600	9.90	9,800				
9			6.57	670	6.90	1,100	10.12	13,400				
10			6.69	845	6.65	900	10.85	14,200				
11			6.57	670	6.45	700	10.52	11,800				
N			7.43	2,550	6.30	650	10.05	10,700				
1			7.25	2,180	6.12		10.20	11,400				
2			6.95	1,550	5.98		10.08	10,000				
3			6.77	1,220		500	9.90	11,400				
4			6.64	1,020			10.55	16,400				
5			6.53	848			11.45	19,200				
6			6.52	836			11.35	17,400				
7			6.40	692			11.00	16,400				
8			6.41	704			11.25	18,300				
9			6.47	776	5.70	400	11.02	20,300				
10			6.47	776				22,000				
11			6.65	1,020				20,000				
M			7.45	2,620	5.75			11,600				

San Gabriel River at Spring Street, near Los Alamitos, Calif.

Location.- Water-stage recorder, lat. 33°48'40", long. 118°05'30", in Los Alamitos grant, at Spring Street Bridge, 1½ miles west of Los Alamitos, Orange County. Altitude, about 22 feet.

Drainage area.- Area indeterminate due to a natural split near Arrow Highway, which divides the San Gabriel River into two branches; the west branch known as the Rio Hondo, flows into the Los Angeles River; the east branch retains the name of San Gabriel River.

Gage-height record.- Water-stage recorder graph.

Discharge record.- Stage-discharge relation poorly defined; shifting-control corrections used throughout period. Discharge Mar. 2, 3, 6, 8, and 11 determined by comparison with other stations. Maximum discharge determined by slope-area computation.

Maxima.- 1938: Discharge, 27,300 second-feet Mar. 2.
1928-37: Discharge, 15,000 second-feet Jan. 1, 1934.

Remarks.- See San Gabriel River at Pico for regulations and diversions. Maximum discharge determined by the Geological Survey; other records furnished by Los Angeles County Flood Control District, through H. E. Hedger, chief engineer.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	56	1,870	5.5	11	89	248	87	21	0	103	0
2	.8	14,500	0	12	107	690	36	22	0	42	0
3	0	9,250	5.5	13	6	416	0	23	0	0	0
4	3.0	6,190	35	14	0	440	0	24	0	34	0
5	0	1,950	95	15	0	312	0	25	0	54	0
6	0	1,070	210	16	0	202	0	26	0	34	0
7	0	802	248	17	0	142	0	27	46	27	0
8	0	743	270	18	0	112	0	28	362	18	0
9	156	1,660	166	19	0	109	0	29		38	0
10	75	911	188	20	0	112	0	30		37	0
								31		30	
Mean monthly discharge, in second-feet									32.2	1,360	44.9
Runoff, in acre-feet									1,790	83,600	2,670

West Fork of San Gabriel River at Camp Rincon, Calif.

Location.- Water-stage recorder, lat. 34°14'30", long. 117°51'50", near center of sec. 19, T. 2 N., R. 9 W., a quarter of a mile above Camp Rincon, and half a mile downstream from North Fork of San Gabrial River. Altitude, 1,600 feet.

Drainage area.- Area, 102 square miles. Average altitude, 4,260 feet. Maximum altitude, 8,240 feet. Average slope, 50 percent. Length of main stream channel, 14.4 miles. Average slope of main stream channel, 8.7 percent.

Gage-height record.- Water-stage recorder graph except Mar. 2 to Apr. 4.

Discharge record.- Stage-discharge relation fairly well defined. Discharge obtained by comparison with adjacent stations Mar. 2 to Apr. 4.

Maxima.- 1938: Discharge, 34,000 second-feet Mar. 2 (estimated).
1927-37: Discharge, 5,320 second-feet Jan. 1, 1934

Remarks.- Flow partly regulated by flood-control dam upstream. Base data and peak discharge for March and entire record for February and April furnished by Los Angeles County Flood Control District, through H. E. Hedger, chief engineer.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	136	1,900	330	11	598	480	177	21	115	660	144
2	69	17,000	330	12	441	1,200	186	22	111	750	140
3	322	8,900	320	13	280	1,000	186	23	108	670	135
4	448	3,650	315	14	218	935	182	24	106	670	146
5	231	1,800	320	15	179	960	164	25	102	650	150
6	151	1,650	302	16	156	690	164	26	100	620	142
7	117	1,550	276	17	139	670	158	27	197	515	132
8	102	1,350	241	18	139	690	156	28	1,310	490	122
9	166	1,950	212	19	151	720	152	29		490	130
10	181	980	180	20	126	660	150	30		435	124
								31		385	
Mean monthly discharge, in second-feet									232	1,776	196
Runoff, in acre-feet									12,890	109,200	11,640

Rogers Creek near Azusa, Calif.

Location.- Water-stage recorder, lat. 34°09'55", long. 117°54'20", in NW¼NW¼ sec. 23, T. 1 N., R. 10 W., half a mile above mouth of creek, and 2½ miles north of Azusa. Altitude, about 800 feet.

Drainage area.- Area, 6.4 square miles. Average altitude, 2,500 feet. Maximum altitude, 4,541 feet. Average slope, 50 percent. Length of main stream channel, 5.0 miles. Average slope of main stream channel, 14 percent.

Gage-height record.- Water-stage recorder graph except 7 a.m. Mar. 2 to Mar. 15.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 319 second-feet; extended logarithmically to peak discharge. Discharge for period of missing gage-height record determined from rainfall records, comparison with nearby streams, and one discharge measurement.

Maxima.- 1938: Discharge, about 2,070 second-feet 4:30 p.m. Mar. 2.
1917-37: Discharge, about 2,600 second-feet Apr. 7, 1926.

Remarks.- Records good except those for period of missing gage-height record, which are poor. Diversions above gage at times.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	11	233	15	11	54	28	13	21	6	30	9.5
2	5.5	738	15	12	42	87	14	22	6	28	9.5
3	131	202	15	13	23	85	14	23	5.5	25	9
4	50	108	15	14	19	75	12	24	4.9	24	9.5
5	20	86	15	15	17	69	11	25	4.9	23	10
6	11	62	15	16	9.5	62	11	26	4.7	22	9.5
7	9.5	45	15	17	8	51	10	27	8.5	19	9
8	9	41	14	18	8	44	9.5	28	212	19	8.5
9	18	41	14	19	8.5	37	9.5	29		18	9
10	16	38	13	20	7	34	9.5	30		17	9
								31		16	
Mean monthly discharge, in second-feet									26.1	77.6	11.7
Runoff, in acre-feet									1,450	4,770	698

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 28		March 1		March 2	
1	2.91	14	6.96	512	4.36	135
2	3.02	20	6.67	461	4.46	146
3	3.23	35	6.34	391	4.60	160
4	3.52	62	5.97	336	4.66	168
5	3.80	91	5.97	336	4.85	190
6	3.96	113	5.67	292	5.23	236
7	4.05	128	5.52	272	5.76	304
8	4.93	242	5.38	264		
9	4.89	237	5.21	233		
10	5.10	269	5.08	218		
11	5.10	269	4.94	201		
N	5.27	299	4.85	190		
1	5.28	314	4.74	177		
2	5.23	316	4.70	172		
3	5.12	300	4.58	159		
4	4.96	270	4.49	149		
5	4.88	254	4.43	142		
6	4.78	236	4.38	137		
7	4.76	227	4.36	135		
8	4.75	220	4.33	131		
9	4.85	226	4.32	130		
10	5.52	306	4.32	130		
11	6.47	442	4.32	130		
M	6.90	501	4.29	127		

Fish Creek near Duarte, Calif.

Location.- Water-stage recorder, lat. 34°10'00", long. 117°55'25", in SW¼SW¼ sec. 15, T. 1 N., R. 10 W., three-quarters of a mile above mouth of canyon, and 3 miles northeast of Duarte. Altitude, about 1,000 feet.

Drainage area.- Area, 6.5 square miles. Average altitude, 2,750 feet. Maximum altitude, 5,390 feet. Average slope, 45 percent. Length of main stream channel, 4.7 miles. Average slope of main stream channel, 17.6 percent.

Gage-height record.- Recorder not in operation during flood. Daily staff-gage readings obtained after Mar. 15.

Discharge record.- Discharge prior to Mar. 15 estimated from current-meter measurements, rainfall records, and by comparison with nearby streams. Peak discharge determined from rainfall-runoff studies. After Mar. 15 discharge determined from rating curve defined by current-meter measurements.

Maxima.- 1938: Discharge, about 2,100 second-feet about 5 p.m. Mar. 2, from rainfall-runoff studies.
1916-37: Discharge, about 2,180 second-feet Apr. 4, 1925.

Remarks.- Records poor. No regulation or diversions.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	19	267	24	11	56	33	16	21	6.5	40	11
2	9	752	23	12	45	90	17	22	6.5	37	11
3	140	303	23	13	25	80	16	23	6	34	11
4	59	135	20	14	21	68	15	24	5.5	33	12
5	23	96	22	15	19	58	15	25	5.5	30	13
6	12	70	20	16	12	52	13	26	5	30	11
7	11	61	19	17	8.6	49	12	27	9	28	10
8	10	52	19	18	9	45	11	28	190	28	10
9	20	44	19	19	9.5	46	11	29		27	11
10	18	35	18	20	7.5	41	11	30		25	11
								31		26	
Mean monthly discharge, in second-feet									27.4	87.5	15.2
Runoff, in acre-feet									1,520	5,390	908

Sawpit Creek near Monrovia, Calif.

Location.- Water-stage recorder and broad-crested weir control, lat. 34°10'20", long. 117°59'25", in NW¼SW¼ sec. 13, T. 1 N., R. 11 W., 0.2 mile downstream from confluence of two main branches, and 2 miles north of Monrovia. Altitude, about 1,100 feet.

Drainage area.- Area, 5.7 square miles. Average altitude, 3,050 feet. Maximum altitude, 5,390 feet. Average slope, 50 percent. Length of main stream channel, 3.6 miles. Average slope of main stream channel, 14 percent.

Gage-height record.- Water-stage recorder graph Feb. 1-11 and Apr. 12, 16-23, and 25-30.

Discharge record.- Stage-discharge relation well defined within the range of use. Concrete control and station destroyed Mar. 2. Discharge for Feb. 12 to Apr. 11, Apr. 13-15, and 24 determined from hydrograph based on records at flood-control dam and five discharge measurements.

Maxima.- 1938: Discharge, about 1,800 second-feet Mar. 2, computed on basis of inflow to flood-control reservoir above gage.
1916-37: Discharge, about 2,000 second-feet Apr. 7, 1926, estimated from flow of Rogers Creek.

Remarks.- Records fair. Flow partly regulated by operation of flood-control dam about 0.3 mile upstream.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	1.1	114	13	11	14	22	10	21	1.0	17	9
2	.5	450	13	12	11	41	10	22	.9	16	8.5
3	11	235	13	13	11	34	10	23	.8	18	8
4	19	108	13	14	10.5	30	10	24	.8	14	7.5
5	9.5	92	12	15	7	26	10	25	.7	13	7
6	8	91	12	16	5	24	9	26	.6	13	6
7	5	76	12	17	4.5	22	9	27	10	13	6
8	8	37	12	18	3.5	20	9	28	89	13	6
9	10	25	11	19	1.8	19	9	29		14	6
10	1.5	24	11	20	1.4	18	9	30		14	7
								31		13	
Mean monthly discharge, in second-feet									8.82	53.7	9.60
Runoff, in acre-feet									490	3,300	571

San Dimas Creek near San Dimas, Calif.

Location.- Water-stage recorder and broad-crested weir control, lat. 34°08'45", long. 117°46'35", in SW¼NE¼ sec. 25, T. 1 N., R. 9 W., at mouth of San Dimas Canyon, 3 miles northeast of San Dimas. Altitude, about 1,245 feet.

Drainage area.- Area, 18.3 square miles. Average altitude, 3,130 feet. Maximum altitude, 5,558 feet. Average slope, 42 percent. Length of main stream channel, 7.5 miles. Average slope of main stream channel, 10 percent.

Gage-height record.- Water-stage recorder graph except Feb. 18-27 and Mar. 20-27.

Discharge record.- Stage-discharge relation well defined below 250 second-feet prior to Mar. 2; on Mar. 2 control was partly destroyed. Discharge Feb. 18-27, Mar. 2-9 and 20-27, determined from outflow from flood-control reservoir.

Maxima.- 1938: Discharge, 4,250 second-feet 6 p.m. Mar. 2.
1914, 1916-37: Discharge, 2,950 second-feet February 1914.

Remarks.- Records good. Flow almost completely regulated by flood-control reservoir 0.7 mile upstream.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	1.6	281	27	11	2.8	36	24	21	6	57	2.4
2	.5	1,340	26	12	8	88	24	22	5	57	2.3
3	1.7	750	25	13	15	115	9.5	23	4	53	2.4
4	2.0	340	25	14	15	127	2.1	24	2	49	2.8
5	1.2	210	25	15	15	117	2.1	25	1	48	2.7
6	.9	110	25	16	12	93	2.2	26	2	46	1.8
7	.7	96	25	17	12	90	2.2	27	15	39	4.0
8	.6	65	25	18	11	47	2.2	28	87	33	10
9	1.7	62	25	19	10	93	2.4	29		33	14
10	1.3	42	25	20	8	70	2.4	30		33	14
								31		32	
Mean monthly discharge, in second-feet									8.68	150	12.8
Runoff, in acre-feet									482	9,230	75.9

Dalton Creek near Glendora, Calif.

Location.- Water-stage recorder and concrete control, lat. 34°09'20", long. 117°49'50", in center of sec. 21, T. 1 N., R. 9 W., at Glendora Irrigation Co.'s dam, a quarter of a mile above mouth, and 2½ miles northeast of Glendora. Altitude, about 1,150 feet.

Drainage area.- Area, 7.5 square miles. Average altitude, 2,440 feet. Maximum altitude, 3,686 feet. Average slope, 42 percent. Length of main stream channel, 5.0 miles. Average slope of main stream channel, 10 percent.

Gage-height record.- Water-stage recorder graph except Feb. 25-27 and Mar. 24-28.

Discharge record.- Stage-discharge relation well defined by current-meter measurements below 80 second-feet. Discharge Feb. 25-27 interpolated. Discharge Mar. 2-7 determined by release from flood-control reservoir and computed runoff for area between flood-control dam and gaging station. Discharge Mar. 24-28 taken from comparative hydrograph based on four discharge measurements, release from flood-control reservoir, and estimated inflow between dam and gage.

Maxima.- 1938: Discharge, about 850 second-feet 5 p.m. Mar. 2 (gage height, 4.90 feet).
1914, 1919-37: Discharge, 1,070 second-feet February 1914.

Remarks.- Records good except those for Mar. 2-7, which are fair. Flood-control dam located about 1 mile upstream.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	0.9	28	9	11	2.3	30	3.0	21	0.3	23	1.6
2	.3	266	8	12	3.0	37	2.7	22	.3	22	1.4
3	1.2	219	8	13	2.4	28	2.3	23	.3	16	1.4
4	1.3	193	8	14	2.2	28	1.8	24	.2	12	1.6
5	.9	122	8	15	1.7	30	1.6	25	.2	10	2.6
6	.6	112	7.5	16	1.0	30	1.6	26	.1	10	2.6
7	.4	76	7.5	17	.6	40	1.4	27	.1	13	2.1
8	.3	70	7	18	.5	33	1.3	28	14	15	1.4
9	1.0	54	5	19	.8	27	1.4	29		12	1.5
10	.8	50	3.1	20	.4	23	1.4	30		11	1.6
								31		10	
Mean monthly discharge, in second-feet									1.36	53.2	3.58
Runoff, in acre-feet									76	3,270	213

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	February 27 Feet	February 27 Sec.ft.	February 28 Feet	February 28 Sec.ft.	March 1 Feet	March 1 Sec.ft.	March 2 Feet	March 2 Sec.ft.	March 3 Feet	March 3 Sec.ft.	March 4 Feet	March 4 Sec.ft.
1				0.1	2.60	58	2.49	41	2.95	255	4.05	400
2				.1	2.44	30	2.50	42	2.80	255	4.00	395
3				.1	2.47	34	2.51	54	2.69	252	3.95	390
4				.1	2.46	33	2.52	55	2.60	242	3.80	385
5				.1	2.44	30	2.52	55	2.51	201	3.55	380
6				.1	2.45	31	2.52	55	2.47	170	3.50	375
7				.1			2.59	57	2.42	190	3.40	370
8				.1			2.68	75	2.38	213		180
9			2.32	19			2.76	93	2.37	215		40
10			2.32	19			2.88	121	2.36	213		38
11			2.32	19			2.80	100	2.41	197		120
N			2.32	19			2.75	90	2.40	182		195
1			2.28	13	2.40	24	2.83	109	2.38	177		180
2			2.25	9.8			2.96	144	2.39	172		164
3			2.25	9.8			3.35	267	2.50	229		90
4			2.23	9.5			3.85	485	2.41	187		90
5			2.18	8.8			4.70	850	2.57	183		60
6			2.17	8.5			4.70	800	2.60	218		90
7			2.16	8.2			4.40	620	2.48	214		90
8			2.16	8.2	2.41	26	4.40	590	2.52	208		90
9			2.25	21	2.45	31	4.40	580	2.56	204		90
10			2.47	39	2.46	33	4.25	450	2.55	200		90
11			2.50	42	2.46	33	4.15	445	2.51	300		90
M			2.65	68	2.48	38	3.90	350	3.85	405		90

Little Dalton Creek near Glendora, Calif.

Location.- Water-stage recorder, lat. 34°09'30", long. 117°50'15", in SE¼ sec. 20, T. 1 N., R. 9 W., 500 feet above mouth of Little Dalton Canyon, and 2 miles northeast of Glendora. Altitude, about 1,110 feet.

Drainage area.- 3.3 square miles.

Gage-height record.- Water-stage recorder graph except 7 p.m. Mar. 2 to Mar. 12.

Discharge record.- Stage discharge relation defined by current-meter measurements below 151 second-feet; extended logarithmically to peak discharge as determined by a slope-area measurement. Discharge for periods of missing record estimated from discharge measurements and records of inflow to flood-control reservoir on Dalton Creek.

Maxima.- 1938: Discharge, 960 second-feet 4:55 p.m. Mar. 2 (gage height, 5.9 feet).
1914, 1929-37: Discharge, 1,020 second-feet February 1914.

Remarks.- Records fair. Small diversion above station. Record furnished by Los Angeles County Flood Control District through H. E. Hedger, chief engineer.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	2.0	81	6.5	11	6.0	12	4.3	21	1.5	13	3.3
2	.8	381	6	12	5.5	31	4.3	22	1.3	12	2.6
3	9.5	105	6	13	4.2	30	4.3	23	1.2	12	2.6
4	5.5	66	6	14	3.2	22	4.1	24	1.1	10	3.3
5	3.0	30	5.5	15	2.6	20	3.8	25	1.0	9.5	4.3
6	2.1	23	5	16	2.4	19	3.8	26	1.0	9	3.8
7	1.8	18	4.8	17	1.9	16	3.3	27	3.7	8.5	3.3
8	1.5	18	4.8	18	2.1	15	3.1	28	45	8.5	3.1
9	3.3	17	4.5	19	2.6	15	3.1	29		8	2.9
10	1.6	12	4.5	20	1.8	14	3.6	30		7.5	3.6
								31		7	
Mean monthly discharge, in second-feet									4.26	33.9	4.14
Runoff, in acre-feet									236	2,080	246

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1		March 2		March 3		March 4	
1					3.08	346						
2					2.45	214						
3			0.72	8.3	2.23	169						
4					2.05	132	1.42	48				
5			.91	17.8			1.53	66				
6						90	1.95	132				
7	0.48	1.4	.95	19.7								
8	.50	1.6	2.03	148		63	2.50	234				
9	.65	6.0	1.30	46	1.60	52	3.24	387				
10			1.31	47		49	3.36	412				
11			1.25	42			3.36	412				
N			1.15	33		44						
1							4.04	559				
2			1.36	52.0		39	4.05	561				
3	.57	3.7										
4				34	1.47	35	4.70	700				
5	.55	3.2										
6				23			5.40	851				
7			.96	19			5.00	765				
8			.96	19		24						
9			1.12	30								
10	.53	2.8	1.65	87		18						
11			2.05	149	1.20	15						
M	.55	3.2	2.36	205	1.26	19						

Supplemental record.- Mar. 2, 4:55 p.m., 5.9 ft., 960 sec.-ft.

Walnut Creek near Baldwin Park, Calif.

Location.- Water-stage recorder, lat. 34°03'55", long. 117°59'00", in La Puente grant, at Covina Boulevard, near Baldwin Park, Los Angeles County. Altitude, about 335 feet.

Drainage area.- 99 square miles.

Gage-height record.- Water-stage recorder graph except 2 a.m. Mar. 3 to 12 m. Mar. 7. Gage heights estimated from occasional staff-gage readings for period of missing record.

Discharge record.- Stage-discharge relation defined by 13 current-meter measurements, made during period Feb. 27 to Mar. 3, up to 4,200 second-feet and extended above.

Maxima.- 1938: Discharge, 4,290 second-feet 5 p.m. Mar. 2 (gage height, 5.50 feet).
1928-37: Discharge, 8,060 second-feet Jan. 1, 1934.

Remarks.- Records good. Flow partially regulated by Dalton, San Dimas, Puddingstone diversion, Puddingstone, Live Oak, and Thompson Creek Dams. Some water diverted for irrigation at Puddingstone Dam. Records furnished by Los Angeles County Flood Control District, through H. E. Hedger, chief engineer.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	93	443	0.4	11	85	36	0	21	0	69	1.4
2	0	2,580	0	12	35	94	2.8	22	0	64	2.8
3	5.5	517	.2	13	0	35	2.8	23	0	86	2.8
4	1.2	253	.2	14	0	99	2.4	24	0	64	0
5	0	117	0	15	0	89	2.4	25	0	33	.6
6	0	123	.2	16	0	103	1.2	26	0	20	0
7	0	45	.8	17	0	89	2.8	27	20	17	.1
8	0	124	.8	18	0	45	1.1	28	406	3.6	0
9	70	110	.2	19	0	64	.6	29		.8	0
10	0	89	.2	20	0	86	1.1	30		.4	.9
								31		.4	
Mean monthly discharge, in second-feet									25.6	177	0.96
Runoff, in acre-feet									1,420	10,900	57

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	February 27 Feet	February 27 Sec.ft.	February 28 Feet	February 28 Sec.ft.	March 1 Feet	March 1 Sec.ft.	March 2 Feet	March 2 Sec.ft.	March 3 Feet	March 3 Sec.ft.	March 4 Feet	March 4 Sec.ft.
1					5.10	2,900	2.36	58	3.00	805		
2		0		0	5.10	2,950	2.56	132	2.96	790		
3		0		0	4.10	1,400	2.84	283				
4		0		0	3.25	474	3.10	174	2.91	740		
5		0		0	3.00	310	3.59	840				
6		0	2.38	61	2.90	251	4.38	2,060	2.85	705		
7		0	2.80	283			5.10	3,250	3.34	1,300		
8		0	2.92	385	2.62	125	5.38	3,730	2.91	1,110		
9		0	3.30	795			5.68	4,230				
10		0	4.40	2,370	2.46	75	5.60	4,080	2.74	615		
11	2.10	2.8	3.90	1,510			5.50	3,890				
N	2.47	50	3.25	665	2.38	56	5.00	3,300	2.45	378		
1	2.80	170	2.90	342			4.60	2,470				
2	2.70	124			2.33	43	4.91	2,710	2.31	283		
3	2.55	69					5.30	3,780				
4	2.33	37	2.53	79	2.29	35	5.50	4,200	2.27	251		
5	2.20	14	2.40	44			5.50	4,290				
6		0	2.30	18	2.22	24	5.40	4,180	2.24	220		
7			2.24	12			5.15	3,810				
8		0	2.22	7.5	2.20	20	4.50	2,760	2.30	271		
9		0	2.25	11			4.27	2,370				
10		0	2.32	17	2.14	13	4.00	2,130	2.21	185		
11			4.12	1,420			3.60	1,550				
M		0	4.38	1,790	2.18	18	3.10	904	2.23	193		

San Jose Creek near Whittier, Calif.

Location.- Water-stage recorder, lat. 34°01'25", long. 118°02'05", in Paso de Bartolo grant, at Workman-Mill road bridge, and about 3 miles north of Whittier, Los Angeles County. Altitude, about 230 feet.

Drainage area.- 85.2 square miles.

Gage-height record.- Water-stage recorder graph except April 21-29.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 7,500 second-feet; extended logarithmically to peak discharge. Discharge for period of missing gage-height record based on current-meter measurements.

Maxima.- 1938: Discharge, 9,350 second-feet 4:40 p.m. Mar. 2 (gage height, 10.3 feet).
1929-37: Discharge, 13,100 second-feet Jan. 1, 1934.

Remarks.- Flow partially regulated by Thompson Creek Dam. Several small diversions. Records furnished by Los Angeles County Flood Control District, through H. E. Hedger, chief engineer.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	156	769	1.3	11	165	5.4	1.6	21	0.9	1.6	1.8
2	6.0	4,380	1.3	12	81	342	2.3	22	.9	1.6	1.9
3	4.4	505	1.6	13	14.0	55	2.3	23	.9	1.6	1.9
4	31	115	1.3	14	2.1	23	1.8	24	2.0	1.6	2.1
5	2.4	32	1.4	15	1.0	7	1.8	25	2.7	1.6	2.1
6	.8	9	1.3	16	.8	4.4	2.3	26	1.3	1.6	2.2
7	.8	3.9	1.4	17	.7	2.3	1.3	27	86	1.8	2.2
8	.8	3.9	2.3	18	.7	1.6	1.1	28	340	1.4	2.2
9	193	4.4	1.6	19	.8	1.6	1.6	29		1.6	2.3
10	26	3.9	1.1	20	.8	1.6	1.8	30		1.3	2.3
								31		1.3	
Mean monthly discharge, in second-feet									40.1	203	1.78
Runoff, in acre-feet									2,230	12,470	106

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	February 27		February 28		March 1		March 2		March 3		March 4	
	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
1					7.10	2,490			4.55	872		
2							2.52	32				
3					7.55	2,900	4.05	424	3.60	515		
4			2.62	12	7.00	2,310	5.00	936				
5					6.40	1,730	6.40	2,190	3.30	355		
6	2.06	3.0	3.40	125	5.70	1,170	7.30	3,300	3.55	488		
7			3.95	293	5.10	782	7.80	3,960				
8	2.10	4.4	4.05	337	4.70	588	9.40	6,940	4.26	968		
9							9.75	7,580	3.92	724		
10	2.20	9	4.00	329	4.25	432	10.25	8,880				
11	2.70	38							4.10	850		
N	3.55	190	4.18	406	3.70	276	9.00	6,120	4.00	780		
1	3.85	265	4.10	378			8.50	5,160				
2			4.33	496	3.32	180	8.20	4,600	3.52	471		
3			4.10	406			8.40	5,060	3.40	405		
4	3.80	223			3.05	113	9.40	7,080	3.32	365		
5												
6	3.55	155	3.53	205	2.80	68	9.50	7,380	3.00	225		
7							8.90	6,180				
8	3.18	76			2.60	41	8.20	4,800	2.90	187		
9			3.30	145			7.50	3,630	2.93	198		
10			3.90	290	2.52	32						
11			6.10	1,670			5.30	1,190				
M	2.80	27	6.90	2,410	2.52	32	4.75	896	2.88	181		

Supplemental record.- Mar. 2, 4:40 p.m., 10.3 ft., 9,350 sec.-ft.

Coyote Creek near Artesia, Calif.

Location.- Water-stage recorder, lat. 33°50'45", long. 118°03'30", in Coyote grant, on line between Orange and Los Angeles Counties, just above Pacific Electric Railway bridge 2½ miles southeast of Artesia. Altitude, about 35 feet.

Drainage area.- 110 square miles.

Gage-height record.- Water-stage recorder graph.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 3,580 second-feet; extended logarithmically to peak stage.

Maxima.- 1938: Discharge, 4,000 second-feet 8 p.m. Mar. 2 (gage height, 12.15 feet).
1929-37: Discharge, 4,190 second-feet Feb. 6, 1937 (gage height, 10.1 feet).

Remarks.- Records good. No regulation or diversions. Records furnished by Los Angeles County Flood Control District, through H. E. Hedger, chief engineer, and by Corps of Engineers, U. S. Army.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	7.5	886	2.2	11	37	8.5	1.3	21	1.8	4.2	0.5
2	22	2,540	2.0	12	94	156	1.2	22	1.3	3.2	.5
3	4.0	2,840	2.2	13	32	80	1.0	23	1.0	4.0	.5
4	4.4	228	2.0	14	11	32	.8	24	.8	4.2	.7
5	7.5	69	2.0	15	4.4	13	.8	25	.7	4.2	1.3
6	6.5	38	2.2	16	2.4	6	.7	26	.6	4.2	1.6
7	2.2	23	2.4	17	1.8	6	.6	27	8.5	3.2	1.0
8	1.2	18	1.9	18	1.2	4.4	.6	28	109	3.0	.8
9	131	14	1.4	19	1.4	4.4	.5	29		3.2	.8
10	149	13	1.3	20	1.9	4.2	.5	30		3.4	1.4
								31		2.7	
Mean monthly discharge, in second-feet									23.1	227	1.22
Runoff, in acre-feet									1,280	13,930	73

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1		March 2		March 3		March 4	
1	3.45	0.3	4.55	66	6.33	510	5.20	180	11.90	3,750	6.80	605
2			4.51	60	7.00	780	5.20	180	11.81	3,700	6.54	500
3					7.65	1,110	5.35	215				
4	3.46	.3	4.45	53	8.12	1,360	5.60	280	11.55	3,500		
5					8.68	1,700	6.10	415			5.86	310
6					8.96	1,880	6.92	655	11.05	3,050	5.71	275
7	3.47	.3			8.93	1,860	7.88	1,220			5.60	245
8			4.32	39	8.85	1,800	8.73	1,700	10.25	2,490	5.50	220
9					8.75	1,730	9.74	2,350	10.00	2,300		
10			4.30	37	8.45	1,540	10.38	2,760	9.85	2,200		
11	3.55	.6	4.70	88	8.02	1,300	10.96	3,150	10.50	2,660	5.29	178
N	3.59	.7	4.95	130	7.55	1,050	11.34	3,400	11.35	3,300	5.29	178
1			5.10	160	7.15	850	11.69	3,650	11.65	3,600		
2	3.71	1.0	5.13	166	6.75	670	11.88	3,780	11.74	3,670	5.18	156
3			5.15	170	6.40	520	11.95	3,850	11.75	3,680		
4	3.79	2.9	5.14	168	6.15	450	11.96	3,870	11.67	3,620	5.08	137
5			5.95		5.95	380	11.95	3,850	11.45	3,400		
6			5.11	162	5.80	330	12.02	3,890	11.09	3,100	4.98	120
7	3.83	4.2			5.70	305	12.06	3,910	10.59	2,700		
8	3.84	4.5	5.05	150	5.57	270	12.15	4,000	9.58	2,000	4.89	105
9	4.18	25			5.45	240	12.04	3,890	8.58	1,420		
10	4.45	53	5.05	150	5.35	215	12.05	3,900	7.82	1,025	4.79	90
11	4.54	64	5.13	165	5.27	200	12.05	3,900	7.57	910	4.73	82
M	4.55	66	5.55	265	5.22	185	11.99	3,880			4.69	76

Brea Creek at Fullerton, Calif.

Location.- Water-stage recorder, lat. 33°52'25", long. 117°55'40", in San Juan Cajon de Santa Ana grant, at Ford Avenue Bridge, at Fullerton, Orange County. Altitude, about 250 feet.

Drainage area.- Area, 26.4 square miles. Average altitude, 800 feet. Maximum altitude, 1,476 feet. Average slope, 21 percent. Length of main stream channel, 16 miles. Average slope of main stream channel, 1.5 percent.

Gage-height record.- Water-stage recorder graph.

Discharge record.- Stage-discharge relation fairly well defined by measurements below 250 second-feet and extended above on basis of slope-area determinations.

Maxima.- 1938: Discharge, 1,970 second-feet Mar. 2 (gage height, 9.55 feet).
1930-37: Discharge, 1,600 second-feet Oct. 17, 1934 (gage height, 7.60 feet).

Remarks.- Records furnished by Orange County Flood Control District, through M. N. Thompson, chief engineer.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	8.5	157	0	11	8	0.1	0	21	0	0	0
2	0	944	0	12	8.5	2.4	0	22	0	0	0
3	.6	22	0	13	.4	.4	0	23	0	0	0
4	.8	1.8	0	14	0	.2	0	24	0	0	0
5	0	.9	0	15	0	0	0	25	0	0	0
6	0	.5	0	16	0	0	0	26	0	0	0
7	0	.2	0	17	0	0	0	27	6.5	0	0
8	0	.1	0	18	0	0	0	28	50	0	0
9	59	.1	0	19	.1	0	0	29		0	0
10	12	.1	0	20	0	0	0	30		0	0
								31		0	
Mean monthly discharge, in second-feet									5.51	36.4	0
Runoff, in acre-feet									306	2,240	0

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	February 27		February 28		March 1		March 2		March 3		March 4	
	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
1		0	1.00	3.9	4.65	580	1.90	62	1.90	62		
2		0	.96	3.4	4.26	490	2.12	90	1.50	35		
3		0	.90	2.8	3.60	330	2.20	102	1.20	22		
4		0	.86	2.4	3.11	240	3.00	280	1.00	14		
5		0	1.05	5	3.32	280	5.00	870	.82	9		
6		0	1.86	50	3.06	230	6.93	1,450	1.60	40		
7		0	1.90	54	3.12	240	6.60	1,350	1.92	64		
8	0.90	1.8	1.90	54	2.80	180	5.80	1,100	1.50	35		
9	.83	1.2	1.83	49	2.50	140	6.38	1,280	1.17	21		
10	1.40	14	1.82	49	2.18	95	6.79	1,410	.97	13		
11	1.24	7.5	1.82	50	2.12	89	6.30	1,260	.93	12		
N	1.27	8.5	1.83	50	2.03	79	5.78	1,100	1.00	14		
1	1.33	11	1.77	47	1.95	74	6.40	1,280	.91	11		
2	1.40	15	1.73	44	1.85	67	9.00	1,910	.80	8.5		
3	1.50	20	1.72	44	1.78	64	8.70	1,860	.77	8		
4	1.48	20	1.69	42	1.72	61	6.80	1,420	.73	7		
5	1.40	16	1.62	38	1.65	57	8.50	1,830	.70	6.5		
6	1.34	13	1.60	36	1.59	55	7.32	1,560	.68	6		
7	1.28	10	1.56	34	1.53	52	5.90	1,140	.65	5.5		
8	1.22	8.5	1.60	37	1.47	50	4.50	720	.62	5		
9	1.14	6	2.05	74	1.42	49	4.10	600	.60	4.6		
10	1.09	5	2.40	113	1.39	49	3.60	450	.58	4.3		
11	1.00	3.6	2.55	136	1.42	53	3.00	280	.56	4.0		
M	1.00	3.7	3.10	230	1.75	88	2.38	140	.53	3.5		

Carbon Creek at Olinda, Calif.

Location.- Water-stage recorder, lat. 33°53'20", long. 117°50'40", in San Juan Cajon de Santa Ana grant, at Golden Avenue Bridge, 1½ miles south of Olinda, Orange County. Altitude, 352 feet.

Drainage area.- Area, 20.0 square miles. Average altitude, 1,010 feet. Maximum altitude, 1,780 feet. Average slope, 30 percent. Length of main stream channel, 9.5 miles. Average slope of main stream channel, 1.9 peresnt.

Gage-height record.- Water-stage recorder graph to Mar. 1; no record thereafter. Peak stage from floodmarks.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 410 second-feet, and extended to peak stage on basis of slope-area determinations.

Maxima.- 1938: Discharge, 1,760 second-feet Mar. 2 (gage height, 4.0 feet).
1930-37: Discharge, 728 second-feet Jan. 1, 1934.

Remarks.- Record furnished by Orange County Flood Control District, through M. N. Thompson, chief engineer.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	2.8	46		11	8			21	0		
2	0			12	3.5			22	0		
3	.2			13	0			23	0		
4	1.0			14	0			24	0		
5	0			15	0			25	0		
6	0			16	0			26	0		
7	0			17	0			27	2.3		
8	0			18	0			28	15		
9	7			19	0			29			
10	3.8			20	0			30			
								31			
Mean monthly discharge, in second-feet									1.56		
Runoff, in acre-feet									86		

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1		March 2		March 3		March 4	
1				0	1.40	164						
2				0	2.60	465						
3			-0.25	0	1.00	99						
4			.10	6.5	.68	53						
5			.03	4.5	.50	32						
6			.06	5.5	.43	26						
7			.20	10	.39	22						
8			.30	15	.34	18						
9	-0.25		.30	15	.31	16						
10	.05		.29	14	.29	15						
11	- .10		.15	8.5	.26	13						
N	- .20		.18	9.5	.23	12						
1	.20		.20	10	.21	11						
2	.20		.25	13	.20	10						
3	.18		.22	11	.19	9.5						
4	.05		.14	8	.18	9.5						
5	.06		.09	6	.16	8.5						
6	.05		.09	6	.15	8.5						
7	- .01		0	3.7	.13	7.5						
8	- .09		.10	6.5	.12	7						
9	- .17		.38	22	.11	7						
10	- .18		.38	22	.11	7						
11	- .21		.70	56	.12	7						
M	- .30		1.10	114	.26	13						

Los Angeles River Basin

Los Angeles River near Van Nuys, Calif.

Location.- Water-stage recorder, lat. 34°09'30", long. 118°26'55", in Ex Mission San Fernando grant, on Van Nuys Boulevard Bridge, about 2 miles south of Van Nuys, Los Angeles County. Zero of gage is 635.75 feet above mean sea level.

Drainage area.- 157 square miles.

Gage-height record.- Water-stage recorder graph Feb. 1 to 2:30 p.m. Mar. 2; peak stage observed on staff gage.

Discharge record.- Stage-discharge relation defined by six discharge measurements made Feb. 27 to Mar. 2.

Maxima.- 1938: Discharge, 11,600 second-feet 5 p.m. Mar. 2.
1928-37: Discharge, 7,380 second-feet, Jan. 1, 1934.

Remarks.- Flow slightly regulated by Chatsworth Reservoir, Upper and Lower San Fernando Reservoirs, Twin Lakes Dams, dam on tributary of Limekiln Creek, and Encino Reservoir. Peak discharge determined by the Geological Survey, other records furnished by Los Angeles County Flood Control District, through H. E. Hedger, chief engineer.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	211	974		11	477			21	7		
2	10	5,870		12	45			22	7		
3	58			13	11			23	6.5		
4	50			14	9			24	6.5		
5	8.5			15	8			25	6		
6	6.5			16	8			26	6		
7	6.5			17	7.5			27	45		
8	7			18	8			28	509		
9	73			19	10			29			11
10	20			20	7.5			30			11
								31			
Mean monthly discharge, in second-feet									58.4		
Runoff, in acre-feet									3,240		

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	February 27		February 28		March 1		March 2		March 3		March 4	
	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
1				41		2,900		250				
2			2.72	37		3,080		280				
3			2.60	33		3,100		500				
4				45		2,700		1,350				
5				64		2,450		2,250				
6			3.60	50		2,150		3,300				
7				100		1,500		4,400				
8	1.76	11		160		800		4,900				
9	2.16	20	5.00	225		540		6,100				
10	2.64	35	6.54	550		400		6,700				
11	2.99	50	6.70	600		320		6,900				
N	3.17	58	7.03	680	5.00	280		7,500				
1	3.62	84		720		250		9,600				
2	3.71	90		640	5.47	220		10,700				
3		90		550		180						
4		105	6.25	450	5.85	160						
5		94		380		150						
6	3.60	83	5.30	290	6.15	140						
7		70		200		130						
8		63		170	6.39	120						
9		57	6.15	420	6.45	100						
10	3.10	54	9.56	2,000	6.59	100						
11		50	10.15	2,400	6.65	110						
M	2.90	45	10.55	2,700	6.03	170						

Los Angeles River near Universal City, Calif.

Location.- Water-stage recorder, lat. 34°08'35", long. 118°22'10", in Ex Mission San Fernando grant, at Vineland Avenue Bridge, near Universal City, Los Angeles County. Altitude, about 550 feet.

Drainage area.- After leaving its canyon, Tujunga Creek splits into two normally dry washes, one of which, known as Tujunga Wash, enters Los Angeles River upstream from this station and the other downstream. The drainage area of Los Angeles River, exclusive of Tujunga Creek Basin above the split (157 square miles), is 245 square miles.

Gage-height record.- Water-stage recorder graph 7 a.m. Feb. 27 to 8:50 a.m. Mar. 2.

Discharge record.- Stage-discharge relation defined by four current-meter and two float measurements, made during period Feb. 27 to Mar. 2, and a slope-area measurement of the peak.

Maxima.- 1938: Discharge, 37,700 second-feet Mar. 2.
1930-36: Discharge, 9,140 second-feet Jan. 1, 1934.

Remarks.-Records poor. Flow partially regulated by Tujunga Dam, Pacoima Dam, Haines Debris Basin, Twin Lakes Dams, Chatsworth Reservoir, Upper and Lower San Fernando Reservoirs, Encino Reservoir, and a dam on a tributary of Limekiln Creek. Records furnished by Los Angeles County Flood Control District, through H. E. Hedger, chief engineer, and by Corps of Engineers, U. S. Army.

Mean daily discharge, in second-feet, 1938

February 27	42
February 28	589
March 1	1,240

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1		March 2		March 3		March 4	
1		0	2.66	22		3,700	4.26	240				
2			2.65	22	8.18	3,400	4.35	260				
3				19	8.06	3,300	4.70	370				
4				35	7.95	3,100	5.30	620				
5				79		2,650		1,770				
6			3.50	105	7.42	2,400	7.95	3,050				
7	1.35	0		280		2,030	8.65	4,100				
8	1.40	.1	4.55	320	6.60	1,500	9.26	5,400				
9	1.60	.2	4.82	410	6.05	1,070						
10	2.15	6	5.07	520	5.55	750						
11	2.60	20	5.46	700	5.20	580						
N	2.90	37	5.76	860	4.97	480						
1	3.35	85		835		425						
2	3.45	94		925	4.64	360						
3		110		855		280						
4		149	5.45	700		245						
5		124		545								
6	3.56	110	4.86	420	4.26	240						
7		95	4.62	350								
8	3.24	70	4.44	300	4.26	240						
9	2.94	40	4.83	420								
10	2.82	32		1,180	4.26	240						
11	2.85	33	7.50	2,500								
M	2.75	27	8.20	3,450	4.26	240						

Supplemental record.- Float measurements Mar. 2, 9:30 a.m., 13,400 sec.-ft.; 3:45 p.m., 26,300 sec.-ft.

Los Angeles River at Los Angeles, Calif.

Location.- Water-stage recorder, lat. 34°04'50", long. 118°13'35", in San Rafael grant, at Figueroa Street Bridge (formerly Dayton Avenue), Los Angeles, Los Angeles County, 0.1 mile upstream from Arroyo Seco. Altitude, 298 feet.

Drainage area.- 510 square miles.

Gage-height record.- Water-stage recorder graph for most of period.

Discharge record.- Computed on basis of current-meter measurements and area and velocity studies; 140 current-meter measurements, ranging up to 22,000 second-feet, were made during period Feb. 1 to Apr. 30, of which 44 were made during period Feb. 27 to Mar. 4. Peak discharge determined by slope-area method.

Maxima.- 1938: Discharge, 67,000 second-feet 10 p.m. Mar. 2.
1929-37: Discharge, 22,000 second-feet Jan. 1, 1934.

Remarks.- Records fair. Regulation by Twin Lakes Dams, Chatsworth Reservoir, Upper and Lower San Fernando Reservoirs, Encino Reservoir, Pacoima Dam, and Tujunga Dam. Records except peak discharge furnished by Los Angeles County Flood Control District, through H. E. Hedger, chief engineer.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	598	2,300	66	11	766	800	54	21	42	340	38
2	111	27,900	65	12	188	1,320	53	22	41	340	37
3	260	8,210	64	13	84	1,190	62	23	40	330	37
4	242	1,790	62	14	65	800	51	24	43	330	37
5	92	930	61	15	55	540	49	25	38	180	37
6	61	650	60	16	48	360	47	26	40	90	37
7	45	600	68	17	44	340	45	27	252	80	37
8	43	900	57	18	45	370	43	28	1,390	74	36
9	271	800	56	19	95	350	41	29		68	36
10	110	770	55	20	55	350	39	30		68	50
								31		67	
Mean monthly discharge, in second-feet									184	1,720	48.7
Runoff, in acre-feet									10,240	105,600	2,890

Discharge, in second-feet, at indicated time, 1938

Hour	Feb. 27	Feb. 28	Mar. 1	Mar. 2	Mar. 3	Mar. 4
1	0	115	8,180	1,140	29,000	2,700
2	0	280	5,800	1,100	23,000	2,540
3	0	330	4,400	2,000	18,000	2,600
4	0	580	4,700	3,500	14,000	2,500
5	0	1,000	4,390	6,200	11,200	2,320
6	0	1,800	4,210	8,100	8,800	2,130
7	0	2,500	3,220	10,900	7,000	1,860
8	0	1,390	2,680	15,600	5,460	1,750
9	340	1,680	2,230	19,100	5,670	1,810
10	510	1,880	1,690	25,000	5,120	1,800
11	621	1,440	1,210	17,700	4,820	1,810
N	724	1,160	1,010	14,900	4,640	1,650
1	673	1,100	880	22,800	4,640	1,560
2	548	1,120	790	30,600	4,700	1,450
3	400	1,170	690	36,000	4,640	1,430
4	312	1,090	630	44,800	4,150	1,550
5	265	900	590	46,300	3,800	1,420
6	220	860	540		3,400	1,330
7	190	800	490		3,310	1,380
8	170	680	495		3,310	1,370
9	150	1,070	490		3,130	1,400
10	140	3,120	510	67,000	2,960	1,360
11	130	4,030	550		2,860	1,300
M	120	6,600	890	36,000	2,790	1,230

Los Angeles River near Downey, Calif.

Location.- Water-stage recorder, lat. 33°56'45", long. 118°10'25", in San Antonio grant, at Stewart and Gray Road Bridge, half a mile above junction with Rio Hondo, and 2½ miles west of Downey, Los Angeles County. Staff gages for slope readings 500 feet upstream and downstream. After Mar. 4, gage moved 0.4 of a mile upstream to Firestone Boulevard Bridge. Altitude, about 100 feet at new site.

Drainage area.- 614 square miles.

Gage-height record.- Water-stage recorder graph Feb. 1-16 and Apr. 11-30. Frequent staff gage readings during storm period Feb. 28 to Mar. 4. After 9 p.m. Mar. 2, readings taken at upstream slope gage.

Discharge record.- Stage discharge relation at Stewart and Gray Road defined by current-meter measurements below 19,700 second-feet; extended to peak discharge on basis of slope-area determinations. Discharge Mar. 3-4 based on Manning formula and a cross section taken after flood. Occasional measurements during periods Feb. 15-27 and Mar. 5 to Apr. 11. Stage discharge relation at Firestone Boulevard defined by current-meter measurements below 988 second-feet.

Maxima.- 1938: Discharge, 79,700 second-feet 10 p.m. Mar. 2.
1928-37: Discharge, 29,400 second-feet Jan. 1, 1934.

Remarks.- Records fair. Regulation at Pacoima Creek flood-control dam, Tujunga Creek flood-control dam, andDevils Gate dam on Arroyo Seco. Records except peak discharge furnished by Los Angeles County Flood Control District, through H. E. Hedger, chief engineer.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	1,580	4,910	82	11	1,300	1,000	30	21	55	530	29
2	200	40,000	75	12	830	1,500	27	22	42	520	22
3	525	15,500	70	13	235	1,100	26	23	39	510	21
4	418	2,500	64	14	180	840	39	24	37	500	26
5	130	1,600	59	15	115	680	29	25	39	250	39
6	80	1,300	54	16	68	560	31	26	41	130	52
7	72	1,000	50	17	58	520	27	27	400	125	52
8	71	1,500	44	18	60	560	26	28	2,750	120	42
9	512	1,200	39	19	110	550	22	29		108	42
10	140	1,050	34	20	80	540	34	30		96	81
								31		88	
Mean monthly discharge, in second-feet									363	2,625	42.3
Runoff, in acre-feet									20,170	161,400	2,520

Discharge, in second-feet, at indicated time, 1938

Hour	February 28	March 1	March 2
1	320	16,700	2,400
2	540	18,500	2,900
3	670	12,000	2,800
4	800	8,300	4,500
5	1,400	7,100	10,300
6	2,600	6,300	16,300
7	3,700	7,100	20,700
8	5,400	6,000	25,000
9	7,300	4,600	35,000
10	5,100	3,700	37,000
11	4,000	3,200	38,000
N	2,900	2,750	36,500
1	2,200	2,200	35,000
2	1,530	1,750	40,000
3	1,300	1,720	
4	1,330	1,600	
5	1,330	1,450	
6	1,200	1,400	
7	1,040	1,320	
8	940	1,230	
9	2,900	1,160	
10	5,000	1,080	
11	7,300	1,000	
M	10,000	1,300	

Los Angeles River at Long Beach, Calif.

Location.- Water-stage recorder, lat. 33°47'25", long. 118°12'20", in Los Cerritos grant, at State Street Bridge at Long Beach, Los Angeles County.

Gage-height record.- Water-stage recorder graph.

Discharge record.- Stage-discharge relation poorly defined; shifting-control method used throughout period. Discharge Mar. 2-11 determined by comparison with adjacent stations.

Maxima.- 1938: Discharge, 99,000 second-feet Mar. 2.
1928-37: Discharge, 20,500 second-feet Feb. 14, 1937.

Remarks.- See Los Angeles River at Los Angeles for regulation. Record furnished by Los Angeles County Flood Control District, through H. E. Hedger, chief engineer.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	1,960	7,090	831	11	1,720	2,300	1,730	21	45	1,060	190
2	282	50,000	1,400	12	873	2,630	1,360	22	41	986	352
3	690	30,000	1,500	13	160	2,880	784	23	37	914	450
4	815	8,000	1,650	14	107	2,370	310	24	32	1,140	510
5	233	5,400	2,290	15	75	2,150	266	25	22	1,190	465
6	60	3,900	2,460	16	63	1,900	288	26	26	1,210	422
7	32	3,800	2,580	17	58	1,420	255	27	1,140	1,130	366
8	24	4,400	2,690	18	58	1,420	233	28	3,250	1,130	324
9	1,370	4,800	2,600	19	81	1,630	222	29		1,080	288
10	450	4,100	2,060	20	50	1,130	200	30		1,050	244
								31		980	
Mean monthly discharge, in second-feet									491	4,942	977
Runoff, in acre-feet									27,280	303,800	58,160

Browns Creek at Chatsworth, Calif.

Location.- Water-stage recorder, lat. 34°15'25", long. 118°35'45", in Ex Mission San Fernando grant, at Devonshire Street Bridge at Chatsworth, Los Angeles County. Altitude, about 1,100 feet.

Drainage area.- 14.3 square miles.

Gage-height record.- Water-stage recorder graph except Mar. 4-11.

Discharge record.- Stage discharge relation defined by current-meter measurements below 296 second-feet; extended by computations based on cross section at gage and mean depth-mean velocity relation. Discharge for period of missing gage-height record determined by discharge measurements and comparison with adjacent stations.

Maximum.- 1938: Discharge, 870 second-feet 10 a.m. Mar. 2 (gage height, 2.83 feet).

Remarks.- Records poor. Flow slightly regulated by Twin Lakes Dams. No diversions. Records, except for the period Mar. 1-3, furnished by Los Angeles County Flood Control District through H. E. Hedger, chief engineer.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	0	53	1.2	11	17	1.7	0	21	0	2.2	0
2	0	512	1.1	12	.8	26	0	22	0	2.1	0
3	0	198	1.0	13	0	7	0	23	0	2.0	0
4	0	70	.9	14	0	8	0	24	0	1.9	0
5	0	18	.8	15	0	7	0	25	0	1.8	0
6	0	8	.7	16	0	6	0	26	0	1.8	0
7	0	3.0	.6	17	0	3.0	0	27	0	1.7	0
8	0	1.7	.6	18	0	2.5	0	28	9	1.6	0
9	0	1.1	0	19	0	2.4	0	29		1.5	0
10	0	.8	0	20	0	2.3	0	30		1.4	.4
								31		1.3	
Mean monthly discharge, in second-feet									0.96	30.7	0.24
Runoff, in acre-feet									53	1,890	14

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1		March 2		March 3		March 4	
1												
2							0.48	77	0.97	191		
3												
4							.82	170	.93	179		
5												
6							2.62	794				
7			0.06	3.0								
8												
9									1.04	212		
10					0.29	53	2.83	870				
11									1.04	212		
N			.12	9			2.45	719				
1					.28	49	2.81	859				
2				5.8			2.17	817				
3												
4					.23	38	2.44	712	.92	176		
5												
6							1.95	529	.87	161		
7												
8					.21	30	1.60	402				
9												
10		0	.14	8			1.30	296				
11												
M	0.03	1.4	.62	95	.21	27	1.08	225	.73	120		

Pacoima Creek near San Fernando, Calif.

Location.- Water-stage recorder, lat. 34°20'02", long. 118°23'55", in SE¼NE¼ sec. 24, T. 3 N., R. 15 W., 600 feet upstream from mouth of canyon, 0.2 mile below Pacoima flood-control dam, and 4 miles northeast of San Fernando.

Drainage area.- 27.9 square miles.

Remarks.- For records of discharge see Pacoima Creek at flood-control reservoir near San Fernando, outflow records.

Pacoima Creek at Mission Acres, Calif.

Location.- Water-stage recorder, lat. 34°13'40", long. 118°27'30", in Ex Mission San Fernando grant, at Parthenia Street Bridge in Mission Acres, Los Angeles County, 3 miles northwest of Van Nuys. Altitude, about 820 feet.

Drainage area.- 50.6 square miles.

Gage-height record.- Water-stage recorder graph Feb. 1 to 3:40 a.m. Mar. 3; occasional staff-gage readings thereafter.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 1,270 second-feet; extended logarithmically to peak stage. After 3:40 a.m. Mar. 3 discharge estimated from outflow at Pacoima Dam and several current-meter measurements.

Maxima.- 1938: Discharge, 2,270 second-feet 3:40 a.m. Mar. 3.
1929-37: Discharge, 477 second-feet Feb. 8, 1932.

Remarks.- Records poor. Flow partially regulated by Pacoima Dam. Small diversions near mouth of canyon. Records, except peak discharge, furnished by Los Angeles County Flood Control District, through H. E. Hedger, chief engineer.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	6.5	34		11	12			21	0		
2	0	470		12	0			22	0		
3	5.5			13	0			23	0		
4	.4			14	3.7			24	0		
5	0			15	1.5			25	0		
6	0			16	0			26	0		
7	0			17	0			27	.6		
8	0			18	0			28	26		
9	1.3			19	0			29			
10	0			20	0			30			
								31			
Mean monthly discharge, in second-feet									2.05		
Runoff, in acre-feet									114		

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1		March 2		March 3		March 4	
1	2.63	0		0	4.00	300	3.53	100	6.24	1,970		
2		0		0	3.60	170	3.51	95	6.20	1,910		
3		0		0	3.35	50	3.49	90	6.20	1,910		
4		0		0	3.25	30	3.64	90				
5		0	2.77	0	3.10	20	3.85	160				
6		0	2.98	8	3.03	12	3.95	225				
7		0	2.93	4	2.97	7	3.85	210				
8		0	3.04	14	2.94	5	3.55	170				
9		0	3.03	13	2.92	3	3.75	150				
10	2.63	0	3.10	22	2.89	1	3.90	200				
11	2.80	.1	3.20	37	2.87	1	4.10	405				
N	2.80	.1	3.25	47	2.86	.5	4.06	375				
1	2.94	6	3.20	37			4.03	345				
2	2.96	5.5	3.13	26			4.25	310				
3	2.87	.8	3.05	15			4.45	470				
4	2.80	.1	2.98	8			4.60	580				
5	2.77	0	2.92	3			4.72	650				
6	2.73	0	2.88	1			4.40	430				
7		0	2.85	.5			4.58	520				
8		0	2.95	5			4.75	630				
9		0	3.00	10			5.20	1,000				
10		0	3.44	89		0	5.60	1,350				
11		0	3.55	118	2.86	5	5.75	1,680				
M	2.62	0	3.90	240	3.50	75	6.22	1,950				

Supplemental record.- Mar. 3, 3:40 a.m., 2,270 sec.-ft.

Tujunga Creek near Colby Ranch, Calif.

Location.- Water-stage recorder, lat. 34°18'10", long. 118°09'35", 25 feet upstream from crossing of Edison Road, 300 feet downstream from Lucas Creek, 3½ miles west of Colby Ranch, Los Angeles County, and 4 miles upstream from Tujunga flood-control dam No. 1. Altitude, 2,450 feet.

Drainage area.- Area, 66.9 square miles. Average altitude, 4,510 feet. Maximum altitude, 7,078 feet. Average slope, 40 percent. Length of main stream channel, 13.5 miles. Average slope of main stream channel, 6.6 percent.

Gage-height record.- Water-stage recorder graph except for Feb. 14-21 and Mar. 1-29.

Discharge record.- Stage-discharge relation fairly well defined. Discharge Feb. 14-21 and Mar. 1-29 determined by comparison with adjacent stations.

Maxima.- 1938: Discharge not determined; occurred Mar. 2.
1930-37: Discharge, 3,910 second-feet Feb. 8, 1932.

Remarks.- No regulation or diversion. Record furnished by Los Angeles County Flood Control District, through H. E. Hedger, chief engineer.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	46	870	83	11	517	130	63	21	26	140	44
2	18	8,200	81	12	208	580	65	22	24	130	42
3	67	1,600	80	13	89	390	65	23	22	125	42
4	110	690	77	14	67	285	60	24	20	120	43
5	44	450	72	15	59	240	56	25	20	115	44
6	28	330	68	16	50	210	52	26	19	110	42
7	22	255	66	17	43	195	51	27	87	106	41
8	20	205	65	18	37	180	49	28	420	102	40
9	44	175	65	19	32	165	47	29		98	42
10	74	150	65	20	30	150	46	30		86	41
								31		84	
Mean monthly discharge, in second-feet									80.1	538	56.6
Runoff, in acre-feet									4,450	33,060	3,370

Tujunga Creek near Sunland, Calif.

Location.- Water-stage recorder, lat. 34°17'55", long. 118°16'10", near center of sec. 32, T. 3 N., R. 13 W. (unsurveyed), a quarter of a mile downstream from a partly constructed and abandoned dam, 2 miles upstream from mouth of canyon, and 4 miles northeast of Sunland. Altitude, 1,600 feet.

Drainage area.- Area, 106 square miles. Average altitude, 4,220 feet. Maximum altitude, 7,078 feet. Average slope, 40 percent. Length of main stream channel, 21.5 miles. Average slope of main stream channel, 3.9 percent.

Gage-height record.- Water-stage recorder graph.

Discharge record.- Stage-discharge relation fairly well defined below 1,700 second-feet. Discharge Feb. 15, 16, Mar. 2, 3, 8-12, 14-30, and Apr. 8-20, obtained by comparison with record at flood-control dam.

Maxima.- 1938: Discharge 50,000 second-feet Mar. 2.
1916-37: Discharge, 8,500 second-feet Dec. 19, 1921.

Remarks.- Flow partly regulated by flood-control reservoir 5.4 miles upstream. Record furnished by Los Angeles County Flood Control District, through H. E. Hedger, chief engineer.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	38	763	159	11	206	280	105	21	68	300	27
2	22	13,000	157	12	147	600	105	22	66	260	26
3	98	3,700	154	13	96	643	105	23	67	230	24
4	79	1,280	150	14	86	475	105	24	68	240	28
5	62	841	168	15	94	440	90	25	64	130	30
6	50	910	190	16	48	520	49	26	62	230	24
7	46	1,220	186	17	62	510	48	27	50	230	22
8	42	886	140	18	59	380	38	28	206	200	21
9	38	692	105	19	46	340	31	29		160	23
10	24	445	105	20	69	300	27	30		160	40
								31		164	
Mean monthly discharge, in second-feet									73.7	985	82.7
Runoff, in acre-feet									4,090	60,540	4,920

Tujunga Creek near San Fernando, Calif.

Location.- Water-stage recorder, lat. 34°15'50", long. 118°22'50", in Ex Mission San Fernando grant, at Stonehurst Avenue Bridge, about 3 miles southeast of San Fernando, Los Angeles County. Altitude, about 995 feet.

Drainage area.- 148 square miles.

Gage-height record.- Water-stage recorder graph.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 1,360 second-feet; extended to peak discharge on basis of a slope-area measurement of the peak.

Maxima.- 1938: Discharge, 51,000 second-feet about 6 p.m. Mar. 2.
1931-36: Discharge, 3,750 second-feet (estimated) Jan. 1, 1934.

Remarks.- Records poor. Flow partially regulated by Tujunga Dam and by Haines Debris Basin. Records furnished by Los Angeles County Flood Control District, through H. E. Hedger, chief engineer, and by Corps of Engineers, U. S. Army.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	41	1,120		11	234			21	61		
2	24			12	178			22	61		
3	129			13	132			23	61		
4	108			14	110			24	66		
5	69			15	81			25	59		
6	49			16	38			26	56		
7	44			17	61			27	56		
8	47			18	61			28	211		
9	47			19	47			29			
10	36			20	61			30			
								31			
Mean monthly discharge, in second-feet									79.6		
Runoff, in acre-feet									4,420		

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1		March 2		March 3		March 4	
1			2.95	27	5.20	4,000	3.68	980				
2			2.87	20	5.20	4,000	3.70	1,000				
3			2.82	18	4.40	2,000	3.72	1,050				
4			2.84	19	3.95	1,350	3.78	1,120				
5			2.94	26	3.77	1,100	3.88	1,220				
6			2.94	26	3.62	960	3.96	1,360				
7			3.07	39	3.56	860	3.95	1,350				
8			3.20	56	3.50	820	4.25	1,750				
9			3.33	88	3.44	780	4.62	2,600				
10			3.38	100	3.35	700	5.00	3,400				
11			3.48	140	3.35	700	5.50	4,900				
N			3.55	160	3.38	720	5.65	5,600				
1			3.70	260	3.29	640	5.65	5,600				
2			3.78	300	3.26	600	8.20	20,400				
3			3.78	300	3.26	600	9.10	27,500				
4			3.72	265	3.28	620	9.15	27,700				
5			3.63	220	3.30	660	8.50	22,500				
6			3.55	160	3.31	670						
7			3.60	200	3.31	670						
8			3.80	310	3.32	680						
9			3.82	320	3.33	690						
10			3.88	390	3.45	780						
11			4.30	1,000	3.68	980						
M			4.47	1,500	3.61	920						

Little Tujunga Creek near San Fernando, Calif.

Location.- Water-stage recorder, lat. 34°16'30", long. 118°22'20", in Tujunga grant, at Foothill Boulevard Bridge, 4 miles east of San Fernando, Los Angeles County. Altitude, 1,250 feet.

Drainage area.- Area, 21.0 square miles. Average altitude, 2,500 feet. Maximum altitude, 5,215 feet. Average slope, 38 percent. Length of main stream channel, 8.0 miles. Average slope of main stream channel, 9.3 percent.

Gage-height record.- Water-stage recorder graph except Mar. 2 to Apr. 12.

Discharge record.- Stage-discharge relation fairly well defined. Discharge, Mar. 2 to Apr. 12, computed by comparison with adjacent stations; discharge, Apr. 12-30, obtained by interpolation between discharge measurements.

Maxima.- 1938: Discharge, 8,500 second-feet Mar. 2.
1928-37: Discharge, 1,360 second-feet Jan. 1, 1934.

Remarks.- Records furnished by Los Angeles County Flood Control District, through H. E. Hedger, chief engineer.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	7	209	8.5	11	71	41	6.5	21	1.4	34	5.5
2	1.5	1,300	8	12	28	95	6.5	22	1.3	29	5.5
3	36	750	7.5	13	15	139	6.5	23	1.1	25	5.5
4	22	275	7	14	9	108	6	24	1.0	22	5.5
5	5.5	123	6.5	15	7.5	84	6	25	1.0	19	5.5
6	3.2	93	6.5	16	6	71	6	26	.8	16	5
7	1.3	76	6.5	17	4.1	61	6	27	4.4	14	5
8	1.1	62	6.5	18	4.6	52	6	28	64	12	5
9	3.5	51	6.5	19	3.8	45	6	29		11	4.6
10	4.3	45	6.5	20	1.7	39	5.5	30		9.5	4.2
								31		9	
Mean monthly discharge, in second-feet									11.1	126	6.08
Runoff, in acre-feet									617	7,770	362

Haines Creek near Tujunga, Calif.

Location.- Water-stage recorder and concrete control, lat. 34°15'50", long. 118°16'15", in W½NW¼ sec. 17, T. 2 N., R. 13 W., 800 feet above mouth of canyon, and 1½ miles northeast of Tujunga. Altitude, about 2,200 feet.

Drainage area.- Area, 1.2 square miles. Average altitude, 3,322 feet. Maximum altitude, 5,000 feet. Average slope, 71 percent. Length of main stream channel, 2.0 miles. Average slope of main stream channel, 26 percent.

Gage-height record.- Water-stage recorder graph except Mar. 5, 6, and Apr. 3-7.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 3.2 second-feet; extended to peak stage by weir formula. Discharge Mar. 5, 6, Apr. 3-7, estimated.

Maxima.- 1938: Discharge, 265 second-feet 1:30 p.m. Mar. 2 (gage height, 4.60 feet).
1917-34, 1935-37: Stage, 11.0 feet Jan. 1, 1934 (discharge not determined).

Remarks.- Records fair. No diversion or regulation during flood period.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	0.3	8	0.9	11	4.0	1.6	0.8	21	0	1.6	0.6
2	0	70	1.0	12	.8	2.8	1.0	22	0	1.5	.6
3	1.4	30	1.0	13	.2	3.3	1.0	23	0	1.4	.6
4	.1	12	.9	14	0	2.4	.8	24	0	1.2	.6
5	0	6.5	.9	15	0	2.2	.6	25	0	1.2	.7
6	0	4.3	.9	16	0	2.0	.6	26	0	1.1	.7
7	0	3.4	.9	17	0	1.9	.6	27	.1	1.0	.7
8	0	3.1	.8	18	0	1.8	.6	28	5.5	1.0	.7
9	.3	2.1	.8	19	0	1.7	.6	29		1.0	.7
10	.4	1.6	.8	20	0	1.6	.6	30		1.0	.7
								31		.9	
Mean monthly discharge, in second-feet									0.47	5.65	0.76
Runoff, in acre-feet									26	348	45

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1		March 2		March 3		March 4	
1			1.20	0.1				3.9				
2			1.20	.1		16		3.9		47		
3			1.30	.4				4.0				
4			1.79	3.9		12		4.3		42		15
5			1.53	1.4				6.5				
6			1.60	1.9		9.5	2.20	12		38		
7			1.62	2.1			2.15	11				
8			1.57	1.7		8	2.76	32		34		14
9			1.74	3.2			2.97	43				
10			1.70	2.8		6.5	3.10	52		31		
11			1.85	4.6			3.17	58				
N			1.83	4.3		6	3.40	77		28		12
1			1.77	3.7			4.30	202				
2			1.70	2.9		5.5	4.40	222		26		
3			1.61	2.0			4.40	222				
4			1.59	1.9		4.8		135		24		11
5			1.60	1.9				105				
6			1.59	1.9		4.4		90		22		
7			1.59	1.9				80				
8			1.75	3.4		4.0		71		20		10
9			2.70	26				65				
10			2.35	14		3.9		59		19		
11			2.50	19				55				
M			2.74	29		3.9		52		18		9

Supplemental records.- Feb. 28, 11:30 p.m., 3.18 feet, 54 sec.-ft.; Mar. 2, 11:15 a.m., 3.85 feet, 130 sec.-ft.; 1:30 p.m., 4.60 feet, 265 sec.-ft.

Verdugo Creek at Del Valle Avenue, Glendale, Calif.

Location.- Water-stage recorder, lat. 34°11'05", long. 118°13'35", in San Rafael grant, at Del Valle Avenue, Glendale, Los Angeles County. Altitude, about 915 feet.

Drainage area.- 19.1 square miles.

Gage-height record.- Water-stage recorder graph.

Discharge record.- Stage-discharge relation determined by computations of discharge by Manning's equation; the channel is concrete lined and of uniform cross section.

Maxima.- 1938: Discharge, 3,500 second-feet 2:12 p.m. Mar. 2 (gage height, 2.10 feet).
1935-37: Discharge, 1,020 second-feet Jan. 5, 1935.

Remarks.- Records good. Basic data furnished by Los Angeles County Flood Control District, through H. E. Hedger, chief engineer, and by Corps of Engineers, U. S. Army.

Mean daily discharge, in second-feet, 1938

February 27	0.8
February 28	50
March 1	40
March 2	662
Runoff, in acre-feet	1,490

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1		March 2		March 3		March 4	
1	0	0	0.08	0.5	0.73	207	0.36	32				
2	0	0	.09	.7	.62	134	.28	16				
3	0	0	.07	.4	.53	90	.31	21				
4	0	0	.22	8	.47	65	.58	113				
5	.04	.1	.17	4.5	.41	45	.67	165				
6	.04	.1	.21	7.5	.38	37	.68	171				
7	.06	.3	.31	21	.33	25	.78	247				
8	.12	1.7	.28	16	.30	19	.84	301				
9	.15	3.0	.32	24	.27	15	1.22	895				
10	.16	3.6	.38	37	.25	12	1.53	1,590				
11	.16	3.6	.38	37	.22	8	1.07	590				
N	.16	3.6	.36	32	.19	5.5	1.32	1,100				
1	.13	2.0	.36	32	.18	5	1.52	1,570				
2	.06	.3	.32	24	.17	4.5	1.90	2,720				
3	.06	.3	.28	16	.16	3.6	1.88	2,660				
4	.09	.7	.22	8	.15	3.0	1.40	1,280				
5	.05	.2	.20	6.5	.15	3.0	1.18	810				
6	.06	.3	.18	5	.15	3.0	.97	446				
7	.04	.1	.18	5	.15	3.0	.85	310				
8	.03	0	.22	8	.16	3.6	.82	280				
9	.03	0	.46	62	.16	3.6	.73	205				
10	.05	.2	.87	330	.16	3.6	.68	170				
11	.03	0	.78	247	.18	5		140				
M	.03	0	1.01	500	.27	15		120				

Supplemental record.- Mar. 2, 2:12 p.m., 2.10 ft., 3,500 sec.-ft.

Verdugo Creek at Glendale, Calif.

Location.- Water-stage recorder, lat. 34°09'25", long. 118°16'25", in San Rafael grant, at Estelle Ave., Glendale, Los Angeles County, 0.4 mile above junction with Los Angeles River. Altitude, about 465 feet.

Drainage area.- 22.4 square miles.

Gage-height record.- Water-stage recorder graph except 4 p.m. Mar. 2 to Mar. 9. Staff gage readings Mar. 3 and 8.

Discharge record.- Stage-discharge relation defined by current-meter measurements Feb. 1-26 and Mar. 14 to Apr. 30. Discharge Feb. 27 to Mar. 2 and Mar. 8-13 computed by Manning's formula, using coefficients based on current-meter measurements of 110 second-feet and less. Discharge estimated Mar. 3-7.

Maxima.- 1938: Discharge, 4,500 second-feet 2:25 p.m. Mar. 2 (gage height, 2.9 feet).
1935-37: Discharge, 1,100 second-feet Mar. 30, 1936.

Remarks.- Records good except those estimated, which are poor. Channel is concrete lined and of uniform section and slope. Basic data for Feb. 27 to Mar. 13 and entire record for Feb. 1-26 and Mar. 14 to Apr. 30 furnished by Los Angeles County Flood Control District, through H. E. Hedger, chief engineer.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	33	121	0.4	11	59	17	0.4	21	0.4	2.0	0.8
2	3.5	1,250	.4	12	13	38	.4	22	.4	1.2	1.2
3	18	95	.4	13	3.8	27	.5	23	.3	1.2	1.2
4	31	43	.4	14	1.5	11	1.5	24	.3	.6	.8
5	8.5	25	.4	15	.5	9.5	.8	25	.2	.5	.8
6	3.8	18	.4	16	1.2	9.5	.8	26	.3	.6	1.2
7	2.5	14	.4	17	.5	13	.6	27	12	.6	.8
8	1.6	16	.4	18	.5	8.5	.4	28	140	.8	.6
9	23	8	.4	19	.6	6.5	.4	29		.6	.5
10	6.5	9.5	.4	20	.4	4.5	.5	30		.6	.8
								31		.4	
Mean monthly discharge, in second-feet									13.1	56.6	0.63
Runoff, in acre-feet									727	3,480	38

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1		March 2		March 3		March 4	
1	0.06	0.2	0.18	3.7	1.19	650	0.53	68				
2	.06	.2	.33	19	.97	385	.52	64				
3	.15	2.3	.32	18	.85	243	.54	71				
4	.20	5	.40	32	.75	171	.87	258				
5	.19	4.2	.39	30	.65	117	1.06	480				
6	.15	2.3	.40	32	.58	86	1.12	515				
7	.15	2.3	.71	149	.52	64	1.36	920				
8	.20	5	.58	86	.49	55	1.44	1,080				
9	.35	23	.65	117	.47	49	1.76	1,740				
10	.40	32	.61	98	.45	44	2.37	3,180				
11	.46	46	.62	103	.44	41	1.71	1,640				
N	.44	41	.61	98	.42	36	1.82	1,860				
1	.38	28	.57	82	.41	34	2.14	2,600				
2	.30	15	.53	68	.41	34	2.50	3,500				
3	.30	15	.47	49	.41	34	2.51	3,520				
4	.30	15	.39	30	.41	34	2.05	2,410				
5	.31	16	.35	23	.40	32						
6	.30	15	.34	21	.40	32						
7	.29	14	.33	19	.40	32						
8	.20	5	.35	23	.40	32						
9	.17	3	.65	117	.40	32						
10	.16	2.5	1.35	900	.40	32						
11	.16	2.5	1.19	650	.41	34						
M	.18	3.7	1.48	1,160	.52	64						

Supplemental record.- Mar. 2, 2.25 p.m., 2.9 ft., 4,500 sec.-ft.

Arroyo Seco near Pasadena, Calif.

Location.- Water-stage recorder and concrete control, lat. 34°13'20", long. 118°10'40", near north line of sec. 31, T. 2 N., R. 12 W., 1½ miles above mouth of Millard Canyon, and 5½ miles northwest of Pasadena. Altitude, about 1,400 feet.

Drainage area.- Area, 16.4 square miles. Average altitude, 3,692 feet. Maximum altitude, 6,152 feet. Average slope, 46 percent. Length of main stream channel, 6.6 miles. Average slope of main stream channel, 14 percent.

Gage-height record.- Water-stage recorder graph except 10 a.m. Mar. 2 to Mar. 28.

Discharge record.- Stage-discharge relation fairly well defined by current-meter measurements below 300 second-feet; peak discharge obtained by slope-area method. Discharge for the maximum 24 hours obtained from rainfall-runoff studies, and for the remainder of the period Mar. 2-28 by comparison with the inflow into Devils Gate flood-control reservoir, 1½ miles downstream.

Maxima.- 1938: Discharge, 8,620 second-feet about 4 p.m. Mar. 2.
1910-37: Discharge, about 5,630 second-feet Feb. 20, 1914.

Remarks.- Records fair. No diversions or regulation above gage.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	21	565	50	11	232	108	30	21	12	87	24
2	8.5	2,700	46	12	81	158	29	22	11	80	24
3	164	808	42	13	50	152	26	23	10	73	24
4	118	261	40	14	38	147	26	24	10	72	24
5	49	208	38	15	34	135	25	25	9.5	71	24
6	28	178	36	16	21	125	25	26	9.5	70	23
7	19	158	35	17	17	117	25	27	20	69	23
8	15	143	32	18	16	109	25	28	351	68	23
9	37	125	31	19	16	102	25	29		64	25
10	42	112	30	20	14	94	24	30		58	25
								31		54	
Mean monthly discharge, in second-feet									51.9	235	29.3
Runoff, in acre-feet									2,880	14,420	1,740

Discharge, in second-feet, at indicated time, 1938

Hour	Feb. 27	Feb. 28	Mar. 1	Mar. 2
1	9	30	2,000	225
2	9	30	1,400	220
3	9	30	1,080	200
4	9	30	940	280
5	10	62	820	390
6	10	74	740	510
7	10	155	680	770
8	11	160	620	940
9	14	200	554	1,050
10	19	255	490	1,500
11	24	340	440	
N	26	450	390	
1	27	480	335	
2	30	450	300	
3	32	410	255	
4	32	390	230	
5	33	340	215	
6	37	320	195	
7	36	240	178	
8	35	200	170	
9	33	250	165	
10	32	600	162	
11	31	1,230	165	
M	30	1,850	210	

Santa Anita Creek near Sierra Madre, Calif.

Location.- Water-stage recorder, lat. 34°11'45", long. 118°01'05", in SW¼SE¼ sec. 3 (revised), T. 1 N., R. 11 W., at head of Hermits Falls, 4 miles northeast of Sierra Madre. Altitude, about 1,400 feet.

Drainage area.- Area, 10.5 square miles. Average altitude, 3,560 feet. Maximum altitude, 5,886 feet. Average slope, 47 percent. Length of main stream channel, 4.0 miles. Average slope of main stream channel, 20 percent.

Gage-height record.- Water-stage recorder graph Mar. 18 to Apr. 30. Station was destroyed Mar. 2 including the gage-height record for the period Feb. 1 to Mar. 2; station reestablished Mar. 18.

Discharge record.- Discharge Feb. 1 to Mar. 17 determined by comparison with inflow into flood-control reservoir about half a mile below station. Stage-discharge relation fairly well defined Mar. 18 to Apr. 30.

Maxima.- 1938: Discharge, about 5,200 second-feet Mar. 2.
1916-37: Discharge, about 3,300 second-feet Apr. 7, 1926.

Remarks.- Records fair. No regulation or diversion above station.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	17	433	36	11	60	68	25	21	10	67	22
2	8	1,580	34	12	60	138	27	22	9	62	21
3	43	511	33	13	42	122	27	23	8.5	57	20
4	63	230	33	14	28	105	25	24	8	54	24
5	31	162	33	15	25	94	24	25	7.5	52	22
6	19	130	30	16	19	88	23	26	7	48	20
7	14	107	28	17	17	84	22	27	17	45	19
8	12	90	26	18	16	82	21	28	334	44	19
9	21	79	25	19	14	79	20	29		42	20
10	24	72	25	20	12	73	22	30		40	22
								31		37	
Mean monthly discharge, in second-feet									33.4	157	24.9
Runoff, in acre-feet									1,860	9,670	1,480

Little Santa Anita Creek near Sierra Madre, Calif.

Location.- Water-stage recorder, lat. 34°11'15", long. 118°02'35", near center of NW¼ sec. 9, T. 1 N., R. 11 W., 2 miles northeast of Sierra Madre. Altitude, about 2,200 feet.

Drainage area.- Area, 1.9 square miles. Average altitude, 3,430 feet. Maximum altitude, 5,433 feet. Average slope, 50 percent. Length of main stream channel, 2.0 miles. Average slope of main stream channel, 31 percent.

Gage-height record.- Water-stage recorder graph except Mar. 1-18.

Discharge record.- Stage-discharge relation fairly well defined below 60 second-feet. Discharge Mar. 1-18 obtained from records of inflow into flood-control reservoir about 1 mile below station.

Maxima.- 1938: Discharge, 536 second-feet Mar. 2.
1916-37: Stage, 11.75 feet Apr. 7, 1926 (discharge not determined).

Remarks.- Records fair. No regulation or diversion above gage.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	1.7	57	10	11	5.5	16	6	21	1.6	12	3.3
2	1.1	182	10	12	6.5	32	6	22	1.5	12	3.3
3	5.5	100	10	13	7.5	30	6	23	1.4	11	3.0
4	8	41	10	14	4.0	16	5.5	24	1.3	10	3.0
5	3.6	33	10	15	3.3	25	4.9	25	1.3	10	2.7
6	2.6	26	7.5	16	3.1	18	4.7	26	1.2	10	2.7
7	2.0	23	6	17	2.7	16	4.2	27	2.0	10	2.6
8	1.6	14	6	18	2.5	14	3.9	28	42	10	2.6
9	2.2	16	6	19	2.4	13	3.6	29		10	2.6
10	2.6	14	6	20	2.0	12	3.4	30		10	2.6
								31		10	
Mean monthly discharge, in second-feet									4.38	26.2	5.27
Runoff, in acre-feet									243	1,610	314

Eaton Creek near Pasadena, Calif.

Location.- Water-stage recorder, lat. 34°11'40", long. 118°06'15", in SE¼ sec. 2, T. 1 N., R. 12 W., at mouth of canyon, just upstream from Mount Wilson toll bridge site, and 4 miles northeast of Pasadena. Altitude, 1,230 feet.

Drainage area.- Area, 6.5 square miles. Average altitude, 3,830 feet. Maximum altitude, 6,156 feet. Average slope, 61 percent. Length of main stream channel, 4.0 miles. Average slope of main stream channel, 23 percent.

Gage-height record.- Water-stage recorder graph except Feb. 16 to Mar. 29; staff gage read twice daily Mar. 21-29. Station destroyed Mar. 2 with loss of gage-height record for Feb. 16 to Mar. 2; station reestablished Mar. 21.

Discharge record.- Stage-discharge relation fairly well defined below 100 second-feet. Discharge Feb. 16 to Mar. 29 obtained by comparison with the inflow into flood-control reservoir about 2 miles downstream.

Maxima.- 1938: Discharge, 2,400 second-feet 5 p.m. Mar. 2.
1918-37: Discharge, about 1,360 second-feet Apr. 7, 1926.

Remarks.- Records good except those for Feb. 16 to Mar. 29, which are poor. Diversions above gage by City of Pasadena not included in daily and monthly records.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	9	142	18	11	45	43	9	21	2	32	8
2	1.9	836	13	12	40	66	14	22	2	28	7
3	36	268	9	13	20	66	12	23	2	26	6
4	46	111	11	14	11	60	10	24	2	24	5.5
5	20	82	12	15	7.5	51	8.5	25	2	23	5
6	4.6	70	11	16	6	45	8	26	20	24	4.5
7	0	63	11	17	12	40	7	27	20	24	4.5
8	0	58	10	18	5	35	6	28	144	23	4.5
9	9	50	8	19	5	39	6	29		22	3.5
10	6.5	37	8.5	20	3	35	7.5	30		18	4.5
								31		17	
Mean monthly discharge, in second-feet									17.2	79.0	8.42
Runoff, in acre-feet									955	4,860	501
Diversions, in acre-feet									154	6	257

Eaton Creek near El Monte, Calif.

Location.- Water-stage recorder, lat. 34°05'15", long. 118°03'55", in San Francisquito grant, at Sunset Avenue Bridge, near El Monte, Los Angeles County. Altitude, about 288 feet.

Drainage area.- 18.4 square miles.

Gage-height record.- Water-stage recorder graph and staff-gage readings.

Discharge record.- Defined by current-meter measurements below 400 second-feet; extended to peak discharge determined by slope-area method.

Maxima.- 1938: Discharge, about 2,300 second-feet 6 p.m. Mar. 2 (gage height, 9.0 feet).
1930-37: Discharge, 2,180 second-feet Jan. 1, 1934.

Remarks.- Record poor. Partial regulation at Eaton Creek flood-control dam. The Pasadena Water Department diverts water just above Eaton Wash debris dam. Records except for the period Feb. 28 to Mar. 2 furnished by Los Angeles County Flood Control District, through H. E. Hedger, chief engineer.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	38	200		11	18	0		21	0	0	
2	0	770		12	3.5	13		22	0	0	
3	29	251		13	0	14		23	0	0	
4	4.5	138		14	0	0		24	0	0	
5	0	92		15	0	7.5		25	0	0	
6	0	100		16	0	16		26	0	0	
7	0	62		17	0	8		27	18	0	
8	0	23		18	1.1	9.5		28	107	0	
9	30	34		19	2.6	11		29		6	
10	0	44		20	0	5		30		.8	
								31		0	
Mean monthly discharge, in second-feet									8.99	58.2	0
Runoff, in acre-feet									499	3,580	0

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1		March 2		March 3		March 4	
1	2.79	0	3.31	0	5.31	339	5.50	199				
2			3.65	.8	5.25	303	5.45	181				
3	2.79	0	3.91	19			5.48	187				
4	3.08	.6	4.02	29	5.30	293	5.70	255				
5			4.35	104			6.10	392				
6	3.09	.6	4.30	64	5.32	270	6.30	463				
7			4.02	12			6.50	535				
8	3.30	3.0	5.93	582	5.32	248	6.66	594				
9	3.48	10	5.07	255			6.75	625				
10	3.45	4.6	4.90	190	5.35	222	6.70	598				
11	4.15	112	4.35	48			6.28	429				
N	4.34	145	4.25	34	5.35	190	6.21	396				
1	4.10	73	4.12	17			7.31	862				
2	3.90	30			5.32	148	7.00	836				
3	3.92	29					7.70	1,240				
4	3.78	9		5	5.15	110	8.90	1,950				
5	3.74	4.6					6.20	750				
6	3.58	.2			5.08	97	9.00	2,300				
7	3.50	0					7.60	1,500				
8	3.30	0		5	5.06	87	6.65	1,030				
9	3.40	0	4.26	64			6.61	990				
10	3.57	.1	5.42	436	5.20	120	6.66	990				
11	3.40	0	5.35	418	5.33	154	6.32	823				
M	3.29	0	5.67	501	5.33	151	5.58	516				

Rubio Canyon Wash at Rosemead, Calif.

Location.- Water-stage recorder, lat. 34°04'30", long. 118°04'35", in NW¼ sec. 19, T. 1 S., R. 11 W., at Glendon Way in Rosemead. Altitude, about 290 feet.

Drainage area.- 13.4 square miles.

Gage-height record.- Water-stage recorder graph.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 1,470 second-feet; extended logarithmically to peak stage.

Maxima.- 1938: Discharge, 2,700 second-feet 9 a.m. Mar. 2 (gage height, 2.55 feet).
1930-37: Discharge, 2,070 second-feet Dec. 31, 1933.

Remarks.- Records good. Channel is concrete lined and of uniform section. Base data Feb. 27 to Mar. 3 and entire record Feb. 1-26 and Mar. 27 to Apr. 30 furnished by Los Angeles County Flood Control District, through H. E. Hedger, chief engineer.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	107	101	0.2	11	69	9	0.2	21	0.8	1.2	0
2	7.5	815	.2	12	9	58	1.1	22	.4	.8	0
3	54	59	.2	13	.4	18	4.8	23	.2	.8	0
4	21	10	.2	14	1.6	4.8	1.6	24	0	.4	2.3
5	.1	6.5	.4	15	.1	4.1	.2	25	0	.4	4.1
6	.1	2.5	.4	16	0	3.3	.1	26	0	.4	.2
7	0	6.5	.2	17	0	2.5	.1	27	86	.4	0
8	2.9	14	.1	18	4.1	2.1	0	28	322	.4	0
9	61	2.1	.2	19	10	2.1	0	29		.4	0
10	2.5	1.2	.2	20	0	1.6	0	30		.2	.4
								31		.2	
Mean monthly discharge, in second-feet									27.1	36.4	.58
Runoff, in acre-feet									1,510	2,240	35

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1		March 2		March 3		March 4	
1	0.04	0.1	0.15	15	1.05	535	0.75	285				
2			.55	163	.62	200	.50	136	0.35	70		
3	.06	.3	.40	90			.68	240				
4	.32	60	.45	113	.37	78	1.10	580	.28	46		
5	.30	53	.75	285			1.30	780	.42	100		
6	.26	40	.53	152			1.20	680	.90	400		
7	.20	25	1.15	625			1.72	1,310				
8	.27	44	1.31	796	.28	50	1.47	980	.32	50		
9	.65	220	.97	460			2.55	2,700			0.18	10
10	.70	252	1.04	525			2.20	2,020	.26	28		
11	.80	325	.48	127			1.15	625				
N	.70	252	.58	180	.24	35	1.35	850	.32	50		
1	.65	220	.60	190			1.45	960				
2	.52	148	.46	117			1.55	1,070	.20	14		
3							2.00	1,720				
4	.35	70	.30	52	.20	25	1.81	1,420				
5							1.70	1,280				
6	.26	40	.36	74			1.18	660				
7							.85	360				
8	.23	33	.30	52			.71	260				
9			1.25	730								
10	.18	20	1.71	1,300			.55	163				
11			1.28	760	.20	25						
M	.18	20	1.80	1,420	.50	137	.45	113	.19	12		

Alhambra Wash at Alhambra, Calif.

Location.- Water-stage recorder, lat. 34°03'20", long. 118°05'10", in Potrero Grande grant, about 250 feet above Short Street in Alhambra, Los Angeles County. Zero of gage is 243.8 feet above mean sea level.

Drainage area.- 14.5 square miles.

Gage-height record.- Water-stage recorder graph.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 456 second-feet; extended to peak discharge on basis of a slope-area measurement of the peak. Discharge Feb. 27 to Mar. 2, computed by Manning's formula and five current-meter measurements made during the period.

Maxima.- 1938: Discharge, 4,100 second-feet 9 a.m. Mar. 2, (gage height, 5.50 feet).
1930-37: Discharge, 4,890 second-feet Jan. 1, 1934.

Remarks.- Records fair. No regulation or diversion. Channel is concrete lined and of uniform section and slope. Records furnished by Los Angeles County Flood Control District, through H. E. Hedger, chief engineer, and by Corps of Engineers, U. S. Army. Discharge Feb. 27 to Mar. 2 computed by Corps of Engineers, U. S. Army.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	177	101	0	11	113	3.9	0	21	0	0	0
2	.8	803	0	12	7	75	0	22	0	0	0
3	84	30	0	13	0	33	0	23	0	0	0
4	11	.2	0	14	0	7	0	24	0	0	0
5	0	0	0	15	0	1.6	0	25	0	0	0
6	0	.8	0	16	0	.4	0	26	0	0	0
7	0	2.1	0	17	0	.4	0	27	178	0	0
8	0	7	0	18	.4	0	0	28	562	0	0
9	76	0	0	19	4.8	0	0	29		0	0
10	12	0	0	20	0	0	0	30		0	0
								31		0	
Mean monthly discharge, in second-feet									43.8	34.4	0
Runoff, in acre-feet									2,430	2,110	0

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1		March 2		March 3		March 4	
1				80		740		265		14		
2	0.40	0		135		185		130		12		
3				134		125		190				
4	.50	16		156		105		660				
5				250		85		1,500				
6	.58	23		190		65		1,200				
7				800		49		1,660				
8	.96	70		2,000		37		1,400				
9	2.05	380		1,120		29	5.50	4,100				
10	2.10	400		940		22	4.00	1,600				
11	2.43	560		200		18		340				
N	2.17	430		170		15		235				
1		310		145		12		610				
2		260		90		10		520				
3		285		72		9		1,250				
4		225		65		7.5		900				
5		203		59		7		1,100				
6		197		55		6		183				
7				53		5.5		60				
8		180		52		5		28				
9				800		4.7		19				
10		156		2,300		4.4		17				
11				1,600		4.2		16				
M		170		3,650		4.8		15				

Rio Hondo near El Monte, Calif.

Location.- Water-stage recorder, lat. 34°05'35", long. 118°01'55", in San Francisquito grant, at Lower Azusa road bridge, 1¼ miles north of El Monte, Los Angeles County. Altitude, about 295 feet.

Drainage area.- A natural split near Arrow Highway divides the San Gabriel River into two branches. The west branch is known as the Rio Hondo. The San Gabriel River drainage area above the split is 230 square miles; the Rio Hondo drainage area from the split to Lower Azusa road is 54.9 square miles.

Gage-height record.- Water-stage recorder graph.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 3,860 second-feet; extended logarithmically to peak discharge on basis of a slope-area measurement of the peak.

Maxima.- 1938: Discharge, 31,800 second-feet 9 p.m. Mar. 2 (gage height, 7.56 feet).
1932-36: Discharge, 5,860 second-feet Jan. 1, 1934.

Remarks.- Records poor. Regulation by Santa Anita, San Gabriel No. 1, San Gabriel No. 2, and Morris Dams. The City of Pasadena diverts water from the San Gabriel River and the City of Monrovia diverts water from Monrovia Creek; there are several diversions for irrigation. Records furnished by Los Angeles County Flood Control District, through H. E. Hedger, chief engineer, and by Corps of Engineers, U. S. Army.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	64	1,270	331	11	51	1,230	1,120	21	0	596	225
2	0	7,700	837	12	68	1,550	305	22	0	290	241
3	76	11,000	531	13	48	1,990	225	23	1.4	773	237
4	62	2,960	735	14	35	1,720	222	24	9	1,010	222
5	32	2,800	909	15	25	1,390	229	25	83	986	117
6	13	2,730	1,780	16	24	1,050	245	26	81	986	.2
7	10	4,280	1,800	17	13	780	284	27	79	996	0
8	11	3,660	1,780	18	10	1,200	260	28	415	986	0
9	36	4,510	1,780	19	7	1,460	210	29		986	0
10	11	2,200	1,520	20	0	1,120	199	30		986	0
								31		674	
Mean monthly discharge, in second-feet									45.2	2,12	544
Runoff, in acre-feet									2,510	130,60	32,400

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1		March 2		March 3		March 4	
1	2.51	85			4.21	3,300	3.28	520	6.04	14,400		
2			2.17	33	4.45	3,800	3.30	526	5.44	9,200	4.57	4,950
3			2.29	50	4.15	2,700	3.49	730	5.36	8,500		
4	2.52	88			4.00	2,200	3.67	1,000	5.20	7,400	4.21	3,440
5					3.82	1,750	3.92	1,450				
6					3.83	1,700	4.06	1,800	5.94	13,500	4.10	3,110
7			2.70	190	3.81	1,600	4.06	1,800	6.13	15,500		
8	2.54	96	3.16	440	3.67	1,300	4.12	1,900	6.06	15,000		
9			3.45	900			4.25	2,300	5.84	13,000		
10	2.65	130	3.21	610	3.56	1,050	4.20	2,100	5.88	13,500		
11			3.10	500			4.30	2,400	5.76	12,000		
N	2.73	170	3.07	460	3.47	860	4.45	3,100	5.69	11,600	3.89	2,230
1							4.72	4,000	5.83	13,000		
2	2.53	98	3.05	440	3.43	800	4.96	5,300	5.70	12,000		
3							5.07	6,000	5.75	12,400		
4	2.28	43	3.07	460	3.42	740	5.38	8,100	5.84	13,000		
5							6.03	13,600	5.71	12,000	3.49	1,780
6	2.17	30	2.98	380	3.35	640	6.14	15,000	5.42	9,600		
7							6.02	14,000	5.21	8,000	3.48	1,980
8	2.16	28	2.95	360	3.33	600	5.90	13,000	4.87	5,800		
9			3.00	400			7.56	31,800	5.02	6,800		
10	2.16	30	3.40	860	3.23	480	6.94	24,000	5.12	7,500		
11			3.60	1,200			6.71	21,500	5.13	7,600		
M	2.15	28	3.60	1,200	3.38	630	6.41	18,000	5.03	6,800	3.58	3,030

Rio Hondo near Montebello, Calif.

Location.- Water-stage recorder, lat. 34.01'55", long. 118°04'15", in Potrero Grande grant, at Montebello oil field, about 1,000 feet upstream from Mission Bridge, and 2 miles northeast of Montebello, Los Angeles County. Altitude, about 200 feet.

Drainage area.- A natural split near Arrow Highway divides the San Gabriel River into two branches; the west branch is known as the Rio Hondo. The San Gabriel River drainage area above the split is 230 square miles; the Rio Hondo drainage area from the split to this station is 113 square miles.

Gage-height record.- Water-stage recorder graph except Feb. 1, Mar. 3-8, 9-11, 17, 21-23, 26-29, Apr. 12-15, 28-30.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 8,800 second-feet; extended to peak discharge determined by slope-area method on basis of other discharge information. Discharge estimated for days of missing record.

Maxima.- 1938: Discharge, 28,000 second-feet 11 p.m. Mar. 2 (gage height, 12.83 feet).
1928-37: Discharge, 11,800 second-feet Jan. 1, 1934.

Remarks.- Records fair. Flow partially regulated by Sierra Madre, Santa Anita, Sawpit, San Gabriel No. 2, and Morris Dams. The City of Pasadena diverts water from Eaton Creek and from the San Gabriel River; the City of Monrovia diverts water from Monrovia Creek; several diversions for irrigation. Records furnished by Los Angeles County Flood Control District, through H. E. Hedger, chief engineer.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	560	1,290	556	11	364	1,400	1,300	21	25	578	332
2	72	9,500	1,120	12	230	1,820	325	22	32	255	300
3	335	12,600	968	13	163	1,850	250	23	34	610	280
4	187	2,960	1,320	14	125	1,770	250	24	38	1,010	249
5	66	2,600	2,040	15	80	1,790	269	25	96	980	122
6	54	2,800	2,240	16	63	1,490	259	26	110	1,000	30
7	62	2,900	1,960	17	49	915	232	27	419	1,000	26
8	76	3,490	1,760	18	46	1,100	172	28	1,520	1,000	28
9	345	3,640	1,720	19	60	1,080	207	29		1,060	31
10	65	2,200	2,010	20	11	854	241	30		1,280	34
								31		808	
Mean monthly discharge, in second-feet									189	2,182	688
Runoff, in acre-feet									10,490	134,100	40,920

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1		March 2		March 3		March 4	
1				200	8.42	5,000	6.15	1,300		22,000		
2	4.89	132	4.81	200	7.55	3,600	5.96	1,200		20,000		
3			5.35	600	7.17	2,500	5.85	1,000		18,000		
4	4.93	150	5.20	500	6.85	2,000	6.85	2,500		16,000		
5			6.06	1,100	6.58	1,700	7.90	4,700		14,000		
6	5.04	211	5.65	900	6.34	1,400	8.45	6,300		11,000		
7			5.55	700	6.12		8.80	6,700		9,000		
8	5.05	222	7.75	4,000	6.00		9.29	7,300		7,800		
9	5.49	532	7.57	3,600			10.13	10,000		12,000		
10	5.96	1,020	7.59	3,800	5.78	874	9.57	8,500		16,000		
11	6.10	1,190	6.45	2,000			8.82	6,000		15,000		
N	6.19	1,320	6.15	1,400	5.60	759	8.07	4,300		14,000		
1	5.92	1,020	5.68	1,200			8.82	7,000		14,000		
2	5.66	820	5.77	1,300	5.48	682	8.91	7,700		13,000		
3	5.38	630	5.50	1,000			9.94	12,000		13,000		
4	5.20	540	5.35	800	5.30	580	10.15	13,000		12,000		
5	4.80	306	5.33	700			10.77	15,000		12,000		
6	4.78	274	5.15	600	5.18	520	10.65	16,000		11,000		
7	4.58	179		500			10.30	13,000		9,800		
8			5.05	500	5.14	503	10.02	12,000		8,700		
9			5.50	1,400			9.97	12,000		7,600		
10	4.50	152	7.45	3,600	5.10	492	11.62	18,000				
11	4.52	157	7.95	4,100			12.83	28,000				
M	4.76	234	8.19	4,400	5.16	538		24,000				

Rio Hondo near Downey, Calif.

Location.- Water-stage recorder, lat. 33°56'40", long. 118°09'50", in San Antonio grant, at Stewart and Gray Road Bridge, half a mile upstream from confluence with Los Angeles River, and 1⅛ miles west of Downey, Los Angeles County. Altitude, about 95 feet.

Drainage area.- 140 square miles not including San Gabriel River above the split which forms Rio Hondo (see Rio Hondo near El Monte).

Gage-height record.- Water-stage recorder graph except 7 p.m. Mar. 2 to 9 a.m. Mar. 3. Maximum stage read on staff gage.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 9,420 second-feet; extended logarithmically to peak discharge as determined by slope-area measurement. Discharge for the period of missing gage-height record determined by comparison with adjacent stations.

Maxima.- 1938: Discharge, 24,400 second-feet 1 a.m. Mar. 3 (gage height, 13.5 feet).
1914, 1928-37: Discharge, 20,900 second-feet February 1914.

Remarks.- Records poor. Regulation at San Gabriel No. 1, San Gabriel No. 2, Morris, Sawpit, and Santa Anita Dams, and Eaton Creek Debris Dam. The City of Pasadena diverts water from the San Gabriel River, the City of Monrovia diverts water from Monrovia Creek; several diversions for irrigation. Records furnished by Los Angeles County Flood Control District, through H. E. Hedger, chief engineer.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	415	1,870	444	11	222	1,210	799	21	0	544	172
2	0	11,100	908	12	111	1,630	291	22	0	158	205
3	205	12,700	800	13	9	1,850	172	23	0	456	223
4	159	3,690	1,110	14	0	2,050	128	24	0	824	235
5	9	2,690	1,750	15	0	1,820	136	25	2.0	800	14
6	1.1	2,500	1,930	16	0	1,380	141	26	3.3	752	0
7	0	2,520	1,700	17	0	788	156	27	279	728	0
8	0	2,780	1,400	18	0	997	166	28	1,360	800	0
9	272	3,520	1,340	19	0	968	161	29		788	0
10	40	2,570	1,220	20	0	707	161	30		812	.1
								31		831	
Mean monthly discharge, in second-feet									110	2,156	525
Runoff, in acre-feet									6,120	132,600	31,260

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1		March 2		March 3		March 4	
1					10.05	8,600	6.52	820	13.50	24,400		
2			5.96	115	9.55	7,100	6.87	1,100				
3					8.77	5,000	7.48	1,800				
4			5.95	113	8.03	3,400	7.39	1,650				
5					7.65	2,750	8.20	2,800				
6			6.05	138	7.37	2,300	9.80	6,300				
7			6.30	210	7.13	2,000	10.35	7,900				
8			7.21	700	7.01	1,850	10.60	8,600				
9			7.80	1,280	6.91	1,750	10.85	9,400	9.10	9,700		
10			9.40	4,900	6.80	1,500	11.03	11,000				
11	6.20	225	8.90	3,800	6.70	1,310	10.98	11,600				
N	7.05	695	8.08	2,500	6.64	1,180	10.35	10,200				
1	7.59	1,180	7.25	1,480	6.57	1,090	9.45	7,900				
2	7.66	1,220	6.97	1,260	6.53	1,030	10.22	10,500				
3	7.45	970	6.75	1,120	6.56	1,040	10.40	11,000				
4	7.13	675	6.60	1,020	6.54	1,010	11.15	14,000				
5	6.88	560	6.54	1,000			11.60	15,700				
6	6.65	365	6.46	950	6.41	870	12.05	17,700				
7	6.48	290	6.46	960			12.40	19,000				
8	6.30	215	6.41	940	6.36	790						
9	6.25	200	6.49	1,020								
10	6.16	173	6.89	1,480	6.33	730						
11			8.76	4,800								
M	6.05	140	9.40	6,500	6.39	730						

Ballona Creek Basin

Centinela Creek near Culver City, Calif.

Location.- Water-stage recorder, lat. 33°58'35", long. 118°23'05", in Aguaje de la Centinela grant, 25 feet south of Centinela Boulevard, between Centinela Boulevard and Pacific Electric R. R., and 2¼ miles south of Culver City, Los Angeles County. Altitude, about 47 feet.

Drainage area.- 5.17 square miles.

Gage-height record.- Water-stage recorder graph Feb. 27 to 5 p.m. Mar. 2; staff gage reading at 12 m. Mar. 4.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 580 second-feet; extended logarithmically to peak discharge determined by slope-area method.

Maxima.- 1938: Discharge, 1,900 second-feet 5 a.m. Mar. 2 (gage height, 7.83 feet).
1932-37: Discharge, 1,590 second-feet Mar. 2, 1935.

Remarks.- Records fair. No regulation or diversions. Records furnished by Los Angeles County Flood Control District, through H. E. Hedger, chief engineer, and by Corps of Engineers, U. S. Army.

Mean daily discharge, in second-feet, 1938

February 28	267
March 1	117

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1		March 2		March 3		March 4	
1			2.00	1	4.50	480	3.75	250				
2			2.00	1	2.76	41	6.50	1,260				
3			2.00	1			7.58	1,780				
4			2.00	1	2.76	41	7.52	1,730				
5			2.50	13			7.83	1,900				
6			4.50	480	2.76	41	7.30	1,640				
7			5.74	950			7.15	1,570				
8			5.74	950	2.76	41	7.00	1,500				
9			4.25	395			6.00	1,060				
10			2.75	41	2.75	40	3.90	290				
11			2.68	34			4.57	505				
N	3.23	125	2.61	21	2.75	40	4.00	320			2.92	0
1	3.25	128	2.60	20			4.50	480				
2	2.86	55	2.59	19	2.75	40	4.75	565				
3	2.70	34	2.58	18			5.70	935				
4	2.55	16	2.57	18	2.75	40	4.75	565				
5	2.40	8	2.57	18			3.43	163				
6	2.27	6	2.56	17	2.74	39						
7	2.18	3	2.55	16								
8	2.09	2	3.50	185	2.74	39						
9	2.00	1	5.10	695	2.74	39						
10	2.00	1	5.00	660	4.00	320						
11	2.00	1	6.55	1,285	4.70	550						
M	2.00	1	6.17	1,120	3.60	210						

Ballona Creek near Culver City, Calif.

Location.- Water-stage recorder, lat. 33°59'50", long. 118°24'10", in La Ballona grant, at Sawtelle Boulevard Bridge, about 1½ miles south of Culver City, Los Angeles County. Altitude, about 40 feet.

Drainage area.- 112 square miles.

Gage-height record.- Water-stage recorder graph.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 18,000 second-feet; extended logarithmically to peak stage.

Maxima.- 1938: Discharge, 19,000 second-feet 9:40 a.m. Mar. 2 (gage height, 15.25 feet).
1928-37: Discharge, 11,300 second-feet Jan. 1, 1934.

Remarks.- Records fair. Records furnished by Los Angeles County Flood Control District, through H. E. Hedger, chief engineer, except those for period Feb. 27 to Mar. 5, which were furnished by Corps of Engineers, U. S. Army.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	2,050	1,210	9.5	11	991	362	14	21	17	46	18
2	134	7,410	10	12	119	605	13	22	17	36	18
3	375	280	12	13	18	251	14	23	17	27	17
4	264	100	12	14	65	108	15	24	17	22	30
5	17	69	12	15	17	103	15	25	17	20	180
6	17	59	11	16	17	89	15	26	17	19	18
7	17	55	12	17	17	86	16	27	948	18	16
8	92	84	12	18	85	72	16	28	2,710	16	16
9	698	59	12	19	114	68	17	29		12	16
10	88	59	13	20	17	56	17	30		9	83
								31		9	
Mean monthly discharge, in second-feet									320	368	22.6
Runoff, in acre-feet									17,800	22,650	1,350

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1		March 2		March 3		March 4	
1	2.61	170	3.00	250	10.30	6,820	8.35	3,890				
2	2.60	168	4.05	558	7.55	2,970	7.30	2,730				
3	2.60	168	3.95	523	6.15	1,740	7.33	2,770				
4	2.91	230	3.90	505	5.08	1,030	11.05	8,240				
5	4.35	683	6.35	1,900	4.50	750	14.00	15,300				
6	3.96	526	5.47	1,260	4.20	615	12.70	11,800				
7	3.52	386	10.80	7,770	3.99	537	14.30	16,200				
8	3.48	374	11.25	8,640		500	14.58	17,000				
9	6.50	2,020	10.10	6,470	3.80	470	14.70	17,300				
10	7.40	2,820	7.75	3,190	3.60	410	14.85	17,700				
11	7.40	2,820	6.50	2,020	3.47	371	12.00	10,200				
N	7.20	2,630	5.70	1,410	3.38	344	9.80	5,990				
1	6.60	2,100	4.97	975	3.31	323	10.60	7,390				
2	6.10	1,700	5.00	990	3.30	320	10.25	6,730				
3	5.40	1,220	4.17	603	3.29	318	10.2	6,640				
4	5.07	1,020	3.73	449	3.28	315	8.52	4,100				
5	4.95	965	3.59	407	3.26	310	10.95	8,050				
6	4.45	728	3.46	368	3.26	310	8.89	4,580				
7	4.07	565	3.37	341			7.48	2,900				
8	3.58	404	3.51	383	3.26	310	6.52	2,030				
9	3.24	305	7.40	2,820			5.92	1,560				
10	3.12	277	12.10	10,400	3.26	310	5.55	1,310				
11	3.05	261	9.50	5,510	3.26	310						
M	3.01	252	13.70	14,500	7.95	3,420	5.20	1,100				

Supplemental record.- Mar. 2, 9:40 a.m., 15.25 ft., 19,000 sec.-ft.

Benedict Canyon storm drain at Culver City, Calif.

Location.- Water-stage recorder, lat. 34°01'23", long. 118°23'00", in Rincon de los Bueyes grant, 400 feet south of Pacific Electric Railway, on east side of Wesley Street, Culver City, Los Angeles County. Altitude, about 95 feet.

Drainage area.- 6.96 square miles.

Gage-height record.- Water-stage recorder graph.

Discharge record.- Discharge through 90-inch concrete pipe, computed by Kutter's formula.

Maxima.- 1938: Discharge, 648 second-feet 7:10 a.m. Mar. 2 (gage height, 7.0 feet).
1935-37: Discharge, 248 second-feet Feb. 12, 1936.

Remarks.- Record good. No regulation or diversions. Records furnished by Los Angeles County Flood Control District, through H. E. Hedger, chief engineer, and by Corps of Engineers, U. S. Army.

Mean daily discharge, in second-feet, 1938

February 28	128
March 1	65
March 2	308
March 3	91
Runoff, in acre-feet	1,170

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1		March 2		March 3		March 4	
1			0.81	13	2.50	140	2.30	117	2.16	102		
2					1.97	85	2.18	104	2.14	100		
3			.83	14			4.00	337				
4			.90	17	1.94	81	6.30	617	2.12	98	1.62	57
5			.97	20			6.02	592				
6			.98	20			6.40	624				
7			5.08	482			6.65	640				
8			3.50	269	1.71	64	6.15	605	2.12	98		
9			2.90	191			5.93	583				
10			2.00	87			4.80	445				
11							2.95	197				
N	1.00	21	2.00	87	1.47	48	3.50	269	2.09	95		
1			1.98	85			3.62	285				
2			1.90	78			3.50	269				
3							3.23	234				
4	1.00	21	1.58	55	1.27	35	3.70	295	2.03	90		
5							3.10	217	2.01	88		
6							2.86	186				
7	1.00	21	1.18	30			2.69	164				
8			1.18	30	1.15	29	2.53	144	1.90	79		
9			4.35	384			2.40	128				
10			3.60	282			2.30	117				
11			4.60	418	1.14	28	2.22	108				
M	.83	14	5.10	485	2.50	140	2.18	104	1.72	64		

Supplemental record.- Mar. 2, 7:10 a.m., 7.0 ft., 648 sec.-ft.

Topanga Creek Basin

Topanga Creek near Topanga Beach, Calif.

Location.- Water-stage recorder, lat. 34°03'50", long. 118°35'10", in Boca de Santa Monica grant, at highway bridge, 2 miles north of Topanga Beach, Los Angeles County. Altitude, about 270 feet.

Drainage area.- Area, 17.9 square miles. Average altitude, 1,355 feet. Maximum altitude, 2,477 feet. Average slope, 40 percent. Length of the main stream channel, 6.4 miles. Average slope of the main stream channel, 5.2 percent.

Gage-height record.- Water-stage recorder graph.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 6,100 second-feet; extended above to slope-area determination of peak discharge.

Maxima.- 1938: Discharge, 7,960 second-feet 9:40 a.m. Mar. 2 (gage height, 11.20 feet).
1930-37: Discharge, 4,510 second-feet Dec. 31, 1933.

Remarks.- Records, except those for Feb. 27 to Mar. 4, furnished by Los Angeles County Flood Control District, through H. E. Hedger, chief engineer.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	213	501	6	11	239	49	6	21	4.1	23	3.4
2	3.1	2,670	6	12	147	213	6	22	3.9	23	3.2
3	135	269	5.5	13	63	209	6	23	3.6	23	2.6
4	86	101	5.5	14	28	81	4.8	24	3.3	21	2.9
5	48	63	5.5	15	16	53	4.8	25	1.9	16	3.2
6	31	46	4.8	16	7	34	4.3	26	1.9	13	2.9
7	18	36	5	17	5	21	3.4	27	12	11	3.4
8	9	36	5	18	4.8	21	3.4	28	643	10	4.3
9	49	33	5.5	19	5	22	3.4	29		9	4.6
10	16	33	5.5	20	4.1	22	3.4	30		7.5	5.5
								31		5.5	
Mean monthly discharge, in second-feet									64.3	151	4.53
Runoff, in acre-feet									3,570	9,270	270

Discharge, in second-feet, at indicated time, 1938

Hour	Feb. 27	Feb. 28	Mar. 1	Mar. 2	Mar. 3	Mar. 4
1	8.5	28	2,090	134	464	148
2	8.5	29	1,750	206	414	143
3	8.4	35	1,720	259	376	137
4	8.3	55	977	679	345	131
5	8.4	113	732	1,700	334	128
6	8.5	136	514	2,410	339	121
7	8.4	302	400	4,370	355	117
8	8.3	449	325	4,160	307	112
9	8.5	935	275	5,580	294	108
10	13	1,730	233	7,020	278	104
11	10	1,140	202	4,950	252	100
N	14	793	169	4,525	240	96
1	18	546	149	6,490	238	92
2	21	370	134	4,840	224	89
3	23	278	123	4,490	217	85
4	37	219	114	3,590	208	81
5	41	185	109	2,420	202	78
6	39	173	103	1,680	189	78
7	35	200	100	1,280	181	77
8	33	355	95	1,020	175	75
9	29	1,120	89	815	167	73
10	29	2,940	89	669	162	71
11	28	1,890	87	593	158	70
M	26	2,810	94	526	155	70

Supplemental record.- Mar. 2, 9:40 a.m., 11.20 ft., 7,960 sec.-ft.

Malibu Creek Basin

Malibu Creek at Crater Camp, near Calabasas, Calif.

Location.- Water-stage recorder, lat. 34°04'30", long. 118°42'10", in SW¼ sec. 18, T. 1 S., R. 17 W., a quarter of a mile below Crater Camp, and 6 miles southwest of Calabasas. Altitude, about 460 feet.

Drainage area.- Area, 103 square miles. Average altitude, 1,226 feet. Maximum altitude, 3,050 feet. Average slope, 38 percent. Length of main stream channel, 17.5 miles. Average slope of the main stream channel, 6.9 percent.

Gage-height record.- Water-stage recorder graph except Mar. 3-8.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 1,200 second-feet and extended above to estimated maximum discharge. Record Mar. 3-8 obtained by comparison with adjacent stations and one current-meter measurement

Maxima.- 1938: Discharge, 10,000 second-feet 1 p.m. Mar. 2 (gage height, 15.9 feet).
1931-37: Discharge, 9,650 second-feet Jan. 1, 1934 (gage height, 13.73 feet).

Remarks.- Records furnished by Los Angeles County Flood Control District, through H. E. Hedger, chief engineer.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	146	1,960	27	11	300	103	19	21	11	77	14
2	38	5,090	25	12	185	835	19	22	12	66	14
3	100	1,600	26	13	61	809	19	23	12	60	14
4	86	609	24	14	42	509	18	24	12	56	13
5	32	330	24	15	39	299	18	25	12	56	13
6	26	250	22	16	29	190	18	26	12	55	13
7	25	190	21	17	23	135	16	27	19	53	12
8	25	150	19	18	22	109	15	28	612	55	12
9	37	123	18	19	30	96	13	29		57	12
10	28	98	20	20	13	87	13	30		56	11
								31		41	
Mean monthly discharge, in second-feet									71.0	458	17.4
Runoff, in acre-feet									3,950	28,170	1,040

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1		March 2		March 3		March 4	
1					13.15	5,750						
2			4.98	40			7.05	530				
3					12.85	5,290	7.50	710				
4					11.90	4,120	8.70	1,360				
5			5.13	56			9.90	2,220				
6			5.52	108			11.35	3,550				
7			6.15	235			13.00	5,520				
8			6.55	344			14.00	6,850				
9			6.90	443			14.20	7,150				
10			7.50	666			15.70	9,640				
11			7.15	518			15.15	8,710				
N			7.00	455	8.00	995	14.90	8,300				
1							15.90	10,000				
2			6.50	293	7.67	830		9,300				
3			6.55	302				8,200				
4			6.70	344	7.37	686		7,200				
5												
6					7.10	578		5,200				
7												
8			7.00	455	6.90	498		4,000				
9			8.00	895								
10			9.80	2,050				3,300				
11			10.95	3,060	6.70	431						
M			13.00	5,420	6.70	431		2,800				

Santa Clara River Basin

Santa Clara River near Saugus, Calif.

Location.- Water-stage recorder, lat. 34°25'42", long. 118°35'23", in San Francisco grant, on pier of old highway bridge, 3 miles west of Saugus, Los Angeles County.

Drainage area.- 355 square miles.

Gage-height record.- Water-stage recorder graph.

Discharge record.- Stage-discharge relation poorly defined. Shifting-control corrections used throughout period. Discharge determined by comparison with adjacent stations Feb. 6-9, 13-26, Mar. 5-9, 17, 18. Discharge Mar. 22 to Apr. 30 determined by interpolation between discharge measurements.

Maxima.- 1938: Discharge, 24,000 second-feet (estimated) 7:30 p.m. Mar. 2.
1929-37: Discharge, 3,870 second-feet Jan. 1, 1934.

Remarks.- Slight regulation at reservoirs in Bouquet and Dry Canyons. Records furnished by Los Angeles County Flood Control District, through H. E. Hedger, chief engineer.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	38	349	51	11	175	80	11	21	0.9	89	9.5
2	.4	6,370	44	12	20	275	10	22	.8	88	9.5
3	58	2,310	37	13	1.5	513	10	23	.7	87	9
4	11	394	30	14	1.4	306	10	24	.6	86	9
5	5	102	24	15	1.3	99	10	25	.5	85	9
6	4.4	65	18	16	1.2	67	10	26	.5	84	9
7	4.4	84	11	17	1.1	43	10	27	2.0	84	9
8	4.4	46	11	18	1.0	49	10	28	113	78	8.5
9	4.4	46	11	19	1.1	68	10	29		71	8.5
10	4.4	67	11	20	1.0	84	9.5	30		64	8.5
								31		58	
Mean monthly discharge, in second-feet									16.4	396	14.6
Runoff, in acre-feet									908	24,380	869

Discharge, in second-feet, at indicated time, 1938

Hour	March 2	March 3
1	100	4,700
2	150	3,900
3	300	3,500
4	450	3,000
5	450	2,800
6	900	2,600
7	1,350	2,650
8	1,600	2,650
9	1,650	2,500
10	1,800	2,400
11	2,200	2,300
N	2,700	2,200
1	3,100	2,100
2	5,200	2,000
3	5,900	2,000
4	11,300	1,950
5	16,000	1,550
6	21,500	1,400
7	23,400	1,300
8	20,000	1,200
9	12,500	1,150
10	10,000	1,050
11	7,000	1,000
M	5,500	1,000

Supplemental records.- Mar. 2, 7:30 p.m., 24,000 sec.-ft.

Piru Creek near Piru, Calif.

<u>Location</u>.- Water-stage recorder, lat. 34°25'30", long. 118°45'45", in southern part of Temescal grant, about 1-3/4 miles northeast of Piru, Ventura County, and 2 miles upstream from junction with Santa Clara River. Altitude, about 780 feet.

<u>Drainage area</u>.- Area, 432 square miles. Average altitude, 4,200 feet. Maximum altitude, 8,800 feet. Average slope, 35.5 percent. Length of main stream channel, 54 miles. Average slope of main stream channel, 2.8 percent.

<u>Gage-height record</u>.- Water-stage recorder graph except 12 m. Mar. 2 to 12 m. Mar. 4.

<u>Discharge record</u>.- Stage-discharge relation defined by current-meter measurements below 2,110 second-feet; extended logarithmically to peak discharge determined by slope-area method. Shifting-control corrections applied during period of record. Discharge from 12 m. Mar. 2 to 12 m. Mar. 4 and Mar. 13-21 determined from comparative hydrograph based on records of Santa Paula Creek near Santa Paula and Coyote Creek near Ventura.

<u>Maxima</u>.- 1938: Discharge, 35,600 second-feet 1:30 p.m. Mar. 2.
1911-13, 1927-37: Discharge, 15,800 second-feet Feb. 9, 1932.

<u>Remarks</u>.- Records fair. Flood flow not affected by diversions. Station maintained in cooperation with Ventura County Water Survey.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	657	5,510	232	11	2,610	655	192	21	160	400	125
2	159	13,140	221	12	681	1,530	195	22	150	395	124
3	655	4,960	221	13	418	819	198	23	130	405	124
4	440	2,110	221	14	300	750	201	24	127	400	118
5	192	1,560	224	15	245	700	194	25	120	375	127
6	95	1,150	224	16	202	620	165	26	111	347	126
7	45	774	217	17	188	550	150	27	114	317	118
8	37	742	215	18	188	520	138	28	1,610	288	120
9	199	678	210	19	233	490	133	29		273	120
10	294	618	202	20	181	450	126	30		256	125
								31		242	
Mean monthly discharge, in second-feet									376	1,356	170
Runoff, in acre-feet									20,910	83,350	10,130

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1		March 2		March 3		March 4	
1					6.70	6,700	4.57	4,440		7,000		
2			3.00	134	6.46	6,380	4.76	4,790				
3					6.25	5,960	5.10	5,460		6,600		2,300
4					6.00	5,660	5.35	6,380				
5			3.13	177	6.15	5,960	5.87	7,690		7,500		
6			3.45	337	6.80	7,450	6.70	9,900				
7			3.55	424	7.15	8,480	7.30	11,600		6,800		
8			3.65	605	6.70	7,650	7.60	12,000				
9			3.93	1,100	6.25	6,600	7.80	12,800		5,800		2,130
10			3.82	964	5.94	6,140	8.10	13,800				
11			3.92	1,220	5.65	5,560	9.15	17,200		5,400		
N			4.03	1,620	5.45	5,150	11.70	25,900				
1			4.02	1,610	5.25	4,960	14.00	34,600		4,300		
2			3.95	1,520	5.10	4,860		30,000				
3			3.98	1,550	4.90	4,680		23,000		3,600		
4			3.97	1,540	4.85	4,680		16,000				
5			3.93	1,490	4.75	4,590		14,000		3,500		
6			3.92	1,480	4.65	4,400		12,000				2,010
7			4.02	1,610	4.56	4,320		11,000		3,300		
8			4.19	1,850	4.51	4,240		9,800				
9			4.53	2,340	4.48	4,310		9,200		3,000		
10			5.20	3,600	4.44	4,230		8,500				
11			6.20	5,460	4.45	4,250		8,000		2,700		
M			7.10	7,650	4.48	4,310		7,500				

Supplemental record.- Mar. 2, 1:30 p.m., 35,600 sec.-ft.

Sespe Creek near Fillmore, Calif.

Location.- Water-stage recorder, lat. 34°26'55", long. 118°55'35", in NE¼ sec. 12, T. 4 N., R. 20 W., 0.1 mile downstream from junction with Little Sespe Creek, and 3½ miles north of Fillmore. Altitude, about 590 feet.

Drainage area.- Area, 254 square miles. Average altitude, 4,040 feet. Maximum altitude, 7,480 feet. Average slope, 37 percent. Length of main stream channel, 44 miles. Average slope main stream channel, 2.9 percent.

Gage-height record.- Water-stage recorder graph Feb. 1-11; no record Feb. 12 to Apr. 30.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 2,160 second-feet; extended logarithmically to peak discharge determined by slope-area method. Shifting-control corrections applied for period of record. Discharge for Feb. 12 to Apr. 30 determined from comparative hydrograph based on Santa Paula Creek record, nine current-meter measurements, and slope-area determination of peak discharge.

Maxima.- 1938: Discharge, 56,000 second-feet about 2 p.m. Mar. 2.
1927-37: Discharge, about 34,000 second-feet Dec. 31, 1933.

Remarks.- Records fair except those for Feb. 1-11, which are good. No diversions above gage. Station maintained in cooperation with Ventura County Water Survey.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	2,560	3,800	370	11	10,680	1,810	244	21	430	775	177
2	301	14,840	350	12	2,160	4,410	230	22	384	700	177
3	4,320	7,090	340	13	970	3,000	220	23	344	640	177
4	1,620	4,110	340	14	758	2,100	210	24	290	586	177
5	672	2,920	339	15	660	1,600	200	25	261	550	180
6	396	2,350	328	16	600	1,290	193	26	257	520	176
7	354	2,120	314	17	580	1,110	185	27	262	490	174
8	343	2,080	295	18	566	960	180	28	1,570	460	172
9	956	1,840	277	19	572	880	177	29		435	171
10	1,400	1,600	260	20	480	820	177	30		418	170
								31		398	
Mean monthly discharge, in second-feet									1,241	2,152	233
Runoff, in acre-feet									68,920	132,300	13,840

Santa Paula Creek near Santa Paula, Calif.

Location.- Water-stage recorder, lat. 34°23'40", long. 119°04'35", near east boundary of Ex Mission San Buenaventura grant, 50 feet upstream from Santa Paula Water Works diversion dam, and about 3 miles north of Santa Paula, Ventura County. Altitude, about 650 feet.

Drainage area.- Area, 39.8 square miles. Average altitude, 3,220 feet. Maximum altitude, 6,704 feet. Average slope, 44 percent. Length of main stream channel, 10 miles. Average slope of main stream channel, 11 percent.

Gage-height record.- Water-stage recorder graph except 6 p.m. Mar. 2 to 6 p.m. Mar. 4, and 1 p.m. Mar. 12 to 1 p.m. Mar. 14. Gage heights interpolated 6 p.m. to 12 p.m. Mar. 2 and 1 p.m. Mar. 12 to 1 p.m. Mar. 14.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 575 second-feet; extended logarithmically to peak discharge determined by slope-area method. Shifting-control corrections applied to gage-height record. Discharge Mar. 3 and 4 determined from comparative hydrograph.

Maxima.- 1938: Discharge, 13,500 second-feet 2 p.m. Mar. 2 (gage height, 10.56 feet).
1927-37: Discharge, about 10,000 second-feet Dec. 31, 1933.

Remarks.- Records good except those for Mar. 2-4 and 12-14, which are fair. Flood flow not affected by diversion above gage. Station maintained in cooperation with Ventura County Water Survey.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	287	683	90	11	771	299	59	21	85	196	44
2	48	3,040	81	12	384	754	58	22	81	174	44
3	819	1,100	79	13	201	565	53	23	77	151	43
4	312	639	79	14	155	400	48	24	66	140	45
5	120	434	77	15	108	326	45	25	62	133	51
6	90	339	72	16	95	280	44	26	61	124	44
7	81	299	68	17	95	247	43	27	66	117	42
8	79	299	66	18	90	225	42	28	410	111	39
9	144	269	61	19	98	211	42	29		108	43
10	166	247	61	20	88	201	45	30		101	44
								31		95	
Mean monthly discharge, in second-feet									184	397	55.1
Runoff, in acre-feet									10,190	24,410	3,280

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1		March 2		March 3		March 4	
1			2.58	68	4.50	1,540	3.60	650		1,060		
2			2.58	68	4.22	1,230	3.75	778		1,030		
3			2.59	70	4.05	1,060	3.95	960		1,350		750
4			2.63	79	3.95	960	4.45	1,480		1,550		
5			2.75	111	3.85	865	4.90	2,000		1,780		
6			2.84	140	3.75	778	4.93	2,040		1,500		
7			2.95	182	3.70	735	4.80	1,880		1,160		
8			3.12	275	3.65	692	4.72	1,780		1,120		
9			3.07	247	3.60	650	4.80	1,880		1,180		660
10			3.07	247	3.55	610	5.50	2,810		1,210		
11			3.10	264	3.50	570	7.12	5,540		1,150		
N			3.15	299	3.46	538	7.25	5,800		1,090		
1			3.15	299	3.42	506	8.55	8,450		1,060		
2			3.23	352	3.40	490	10.56	13,500		1,030		
3			3.20	332	3.38	478	7.95	7,800		1,000		
4			3.15	299	3.35	455	6.00	4,050		970		600
5			3.12	280	3.33	441	5.00	2,530		950		
6			3.10	275	3.31	427	4.35	1,700		920		
7			3.10	275	3.30	420	4.17	1,510		900		
8			3.25	372	3.28	406	4.05	1,380		880		
9			3.72	735	3.26	393	3.97	1,290		860		545
10			4.48	1,507	3.28	406	3.88	1,190		840		
11			4.90	1,990	3.32	434	3.82	1,130		820		
M			4.98	2,104	3.40	490	3.77	1,080		800		

Ventura River Basin

Matilija Creek at Matilija, Calif.

Location.- Water-stage recorder, lat. 34°29'05", long. 119°18'30", in NE¼ sec. 29, T. 5 N., R. 23 W., half a mile northwest of Matilija. Altitude, about 970 feet.

Drainage area.- Area, 55 square miles. Average altitude, 3,630 feet. Maximum altitude, 6,025 feet. Average slope, 47 percent. Length of main stream channel, 13.7 miles. Average slope of main stream channel, 6.8 percent.

Gage-height record.- Water-stage recorder graph except 10 a.m. Mar. 2 to Mar. 4 and Mar. 28 to Sept. 30.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 800 second-feet; extended to slope-area determination of peak discharge. Discharge 10 a.m. Mar. 2 to Mar. 4 and Mar. 28 to Sept. 30 based on 43 discharge measurements and comparative hydrograph.

Maxima.- 1938: Discharge, 15,900 second-feet 12:30 p.m. Mar. 2.
1927-37: Discharge, 7,000 second-feet Dec. 31, 1933 (gage height, 7.20 feet).

Remarks.- Records good, except those for Mar. 2-4, and Mar. 28 to Apr. 30, which are fair. No diversions above gage. Station maintained in cooperation with Ventura County Water Survey.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	427	888	170	11	1,970	792	109	21	143	332	82
2	66	4,850	160	12	766	1,860	105	22	134	313	82
3	516	2,120	150	13	408	1,350	96	23	123	294	82
4	268	1,280	147	14	332	816	89	24	115	276	88
5	155	1,270	143	15	262	544	83	25	113	262	95
6	111	816	137	16	217	480	79	26	113	245	86
7	90	765	129	17	191	445	76	27	111	232	86
8	81	786	122	18	188	412	76	28	410	220	83
9	235	694	116	19	175	377	76	29		205	83
10	319	632	112	20	157	356	82	30		192	79
								31		182	
Mean monthly discharge, in second-feet									293	784	103
Runoff, in acre-feet									16,260	48,170	6,150

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	February 27		February 28		March 1		March 2		March 3		March 4	
	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
1			2.94	109	5.60	1,940	4.35	808		2,450		
2			2.94	109	5.20	1,500	4.70	1,070		2,350		
3			2.95	111	4.95	1,270	5.07	1,410		2,700		1,420
4			3.00	123	4.80	1,140	5.35	1,700		3,600		
5			3.06	136	4.55	948	6.30	2,810		3,800		
6			3.14	157	4.40	840	6.75	3,640		2,800		
7			3.19	170	4.35	808	6.40	2,920		2,400		
8			3.22	180	4.35	808	6.65	3,380		2,200		
9			3.23	183	4.40	856	6.50	3,070		2,120		1,310
10			3.24	188	4.43	880		7,000		2,050		
11			3.24	188	4.43	888		13,000		2,000		
N			3.24	188	4.46	910		15,000		1,940		
1			3.23	188	4.30	793		14,000		1,880		
2			3.22	185	4.15	694		8,500		1,830		
3			3.21	183	4.10	670		6,500		1,780		1,230
4			3.20	183	4.07	654		5,500		1,740		
5			3.20	183	4.02	626		4,600		1,700		
6			3.19	183	3.98	597		4,100		1,670		
7			3.25	202	3.92	561		3,700		1,630		
8			3.50	287	3.89	538		3,400		1,600		
9			4.15	597	3.93	561		3,100		1,570		1,180
10			5.50	1,760	3.95	573		2,800		1,540		
11			6.30	2,700	4.05	626		2,700		1,510		
M			6.20	2,570	4.20	712		2,550		1,490		

Supplemental record.- Mar. 2, 12:30 p.m., 15,900 sec.-ft.

Ventura River near Ventura, Calif.

Location.- Water-stage recorder, lat. 34°20'55", long. 119°18'20", in southeast corner of Santa Ana grant, at highway bridge at entrance to Foster Memorial Park, a quarter of a mile downstream from Ventura diversion dam and Coyote Creek, and 5 miles north of Ventura, Ventura County. Altitude, about 210 feet.

Drainage area.- Area, 187 square miles. Average altitude, 2,310 feet. Maximum altitude, 6,025 feet. Average slope, 46 percent. Length of main stream channel, 23.7 miles. Average slope of main stream channel, 5 percent.

Gage-height record.- Water-stage recorder graph except 1 p.m. Mar. 2 to 9:30 a.m. Mar. 3. Peak gage height observed.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 6,600 second-feet; extended to slope-area determination of peak discharge. Discharge 1 p.m. Mar. 2 to 9:30 a.m. Mar. 3 based on hydrograph.

Maxima.- 1938: Discharge, 39,200 second-feet 2:15 p.m. Mar. 2 (gage height 19.2 feet).
1911-13, 1929-37: Discharge, 23,000 second-feet Dec. 31, 1933 (gage height, 14.6 feet).

Remarks.- Records good. Flood flow not affected by diversions. Station maintained in cooperation with Ventura County Water Survey.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	1,700	2,890	304	11	6,410	1,190	219	21	231	592	161
2	174	17,950	288	12	1,890	5,840	219	22	206	541	153
3	1,540	6,970	267	13	832	3,060	219	23	201	510	149
4	812	2,770	257	14	730	1,880	206	24	197	478	161
5	406	1,660	257	15	524	1,480	197	25	185	449	184
6	264	1,300	247	16	407	1,170	188	26	182	421	165
7	206	1,100	237	17	341	1,010	180	27	182	400	149
8	177	1,310	228	18	301	848	172	28	1,060	381	149
9	421	1,020	228	19	295	746	161	29		363	146
10	494	882	219	20	255	652	165	30		344	153
								31		321	
Mean monthly discharge, in second-feet									737	1,953	201
Runoff, in acre-feet									40,910	120,100	11,960

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1		March 2		March 3		March 4	
1					11.70	13,600	7.40	1,150		12,200		
2					10.80	10,270	7.85	1,860		11,700	7.35	3,660
3			6.30	185	9.85	6,950	8.18	2,510		10,700		
4					9.20	4,970	8.95	4,390		10,000		
5					8.75	3,780	10.40	8,970		9,400	7.23	3,390
6					8.38	2,870	12.00	14,870		8,600		
7					8.16	2,380	11.70	13,760		8,000		
8					8.00	2,060	11.82	14,200		7,500	7.12	3,150
9			6.50	279	7.85	1,790	12.25	15,800		7,100		
10					7.80	1,700	12.60	16,940	8.48	6,580		
11					7.72	1,570	13.80	21,500	8.40	6,360	6.99	2,880
N					7.60	1,380	16.00	29,260	8.30	6,060		
1			6.59	330	7.50	1,290	17.35	34,000	8.20	5,790		
2			6.58	324	7.40	1,150		38,700	8.10	5,530	6.87	2,620
3			6.56	312	7.30	1,020		35,000	8.10	5,530		
4			6.54	301	7.15	832		29,500	8.10	5,560		
5			6.52	290	7.05	722		26,500	8.08	5,500	6.73	2,340
6			6.52	290	7.01	680		23,900	7.84	4,900		
7			6.51	284	6.98	651		21,800	7.75	4,650		
8			6.59	330	6.95	622		19,400	7.67	4,460	6.63	2,140
9			7.00	660	6.95	622		17,700	7.61	4,300		
10			8.70	3,620	6.95	622		16,000	7.55	4,140		
11			10.45	9,000	6.97	642		14,600	7.49	4,000	6.56	2,000
M			11.65	13,420	7.05	722		13,500	7.43	3,850		

Supplemental record.- Mar. 2, 2:15 p.m., 19.2 ft., 39,200 sec.-ft.

Coyote Creek near Ventura, Calif.

Location.- Water-stage recorder, lat. 34°21'20", long. 119°18'50", near southeast corner of Santa Ana grant, 200 feet downstream from highway bridge, half a mile upstream from junction with Ventura River, and 5½ miles northwest of Ventura, Ventura County. Altitude, about 250 feet.

Drainage area.- Area, 41.1 square miles. Average altitude, 1,590 feet. Maximum altitude, 4,870 feet. Average slope, 34 percent. Length of main stream channel, 11.0 miles. Average slope of main stream channel, 7.9 percent.

Gage-height record.- Water-stage recorder graph.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 525 second-feet; extended to slope-area determination of peak discharge.

Maxima.- 1938: Discharge, 11,500 second-feet 1:30 p.m. Mar. 2 (gage height, 12.00 feet).
1927-32, 1933-37: Discharge, 5,600 second-feet Feb. 14, 1937.

Remarks.- Records good. No diversions above gage. Station maintained in cooperation with Ventura County Water Survey.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	465	524	34	11	663	173	25	21	31	66	18
2	54	3,470	32	12	271	516	25	22	30	62	18
3	303	800	31	13	131	303	24	23	26	61	16
4	254	350	28	14	104	190	24	24	25	59	16
5	100	247	27	15	71	145	23	25	21	58	15
6	51	162	27	16	61	122	22	26	20	51	15
7	36	157	27	17	50	102	21	27	20	48	14
8	28	142	27	18	44	91	20	28	328	46	14
9	96	120	26	19	51	80	19	29		42	14
10	91	106	25	20	37	72	18	30		38	16
								31		36	
Mean monthly discharge, in second-feet									124	272	22
Runoff, in acre-feet									6,870	16,740	1,310

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1		March 2		March 3		March 4	
1			1.95	19	5.20	1,550	3.56	486	4.31	896		
2			1.95	19	4.60	1,080	3.60	504	4.25	860		
3			2.00	22	4.31	896	3.69	548	4.31	896		
4			2.04	28	4.13	788	3.86	636	4.91	1,320		
5			2.07	32	4.00	713	6.91	3,240	5.11	1,470		
6			2.10	36	3.75	578	8.20	4,950	4.57	1,050		
7			2.19	47	3.62	514	8.01	4,680	4.39	938		
8			2.30	62	3.51	463	7.34	3,790	4.38	926		
9			2.30	64	3.48	449	6.89	3,220	4.43	956		
10			2.40	79	3.39	409	7.61	4,140	4.34	902		
11			2.61	118	3.31	373	9.51	6,940	4.21	818		
N			2.61	118	3.27	357	10.32	8,310	4.11	759		
1			2.56	99	3.22	338	11.15	9,840	4.01	702		
2			2.48	93	3.19	326	11.79	11,000	3.97	674		
3			2.41	80	3.13	303	8.71	5,650	3.96	669		
4			2.39	79	3.10	291	7.01	3,360	3.89	625		
5			2.37	76	3.08	284	6.11	2,380	3.94	652		
6			2.34	71	3.04	268	5.66	1,950	3.95	658		
7			2.40	82	3.00	257	5.26	1,600	3.89	620		
8			2.70	145	2.99	254	4.98	1,370	3.88	614		
9			3.29	338	2.97	247	4.79	1,220	3.69	514		
10			6.10	2,320	2.98	250	4.64	1,110	3.65	495		
11			6.49	2,720	3.02	264	4.51	1,020	3.61	476		
M			6.00	2,270	3.41	418	4.38	938	3.58	458		

Supplemental record.- Mar. 2, 1:30 p.m., 12.00 ft., 11,500 sec.-ft.

Santa Ynez River Basin

Santa Ynez River at Juncal Reservoir, near Montecito, Calif.

Location.- Water-stage recorder, lat. 34°29'30", long. 119°30'50", in sec. 28, T. 5 N., R. 25 W., at Juncal Reservoir dam, 8.5 miles northeast of Montecito. Altitude of stream bed, about 1,950 feet.

Drainage area.- Area, 16.0 square miles. Average altitude, 3,550 feet. Maximum altitude, 6,025 feet. Average slope, 64 percent. Length of main stream channel, 5.2 miles. Average slope of main stream channel, 15 percent.

Gage-height record.- Water-stage recorder graph.

Discharge record.- Discharge computed from reservoir gage-height record, rainfall, evaporation, release, and overflow.

Maximum.- 1938: Mean hourly discharge, 4,160 second-feet Mar. 2.

Remarks.- No diversion during flood period. Record furnished by Montecito County Water District.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	162	272	32	11	585	78	29	21	15	38	15
2	85	1,240	32	12	147	509	29	22	13	47	13
3	194	467	32	13	71	293	28	23	14	49	16
4	85	197	32	14	32	159	29	24	12	41	22
5	30	116	31	15	26	124	28	25	10	38	25
6	17	89	32	16	26	97	27	26	10	37	23
7	11	119	31	17	13	75	27	27	10	34	22
8	10	185	31	18	13	61	27	28	15	35	19
9	29	125	31	19	15	47	27	29		32	19
10	57	87	31	20	17	42	15	30		30	21
								31		25	
Mean monthly discharge, in second-feet									61.6	155	25.9
Runoff, in acre-feet									3,420	9,500	1,540

Discharge, in second-feet, at indicated time, 1938

Hour	March 1	March 2	March 3	March 4
1	943	135	547	233
2	625	163	519	233
3	519	195	510	226
4	419	260	547	206
5	343	563	595	200
6	290	891	557	195
7	252	1,050	547	195
8	208	1,030	527	195
9	188	1,010	481	195
10	170	1,140	437	189
11	157	1,720	384	189
N	153	2,550	375	189
1	140	3,740	375	189
2	129	4,160	375	189
3	129	3,450	367	182
4	124	2,440	343	182
5	115	1,790	320	176
6	110	1,460	297	163
7	105	1,200	290	157
8	105	1,010	275	152
9	110	868	260	146
10	110	752	253	140
11	115	667	246	135
M	124	605	233	135

Santa Ynez River near Santa Barbara, Calif.

Location.- Water-stage recorder, lat. 34°31'40", long. 119°41'00", about on line between secs. 10 and 11, T. 5 N., R. 27 W., at Gibraltar Dam, 7 miles north of Santa Barbara. Altitude, about 1,200 feet.

Drainage area.- Area, 219 square miles. Average altitude, 3,400 feet. Maximum altitude, 6,828 feet. Average slope, 42 percent. Length of main stream channel, 17.5 miles. Average slope of main stream channel, 6 percent.

Gage-height record.- Water-stage recorder graph.

Discharge record.- Inflow computed from fluctuation in reservoir level.

Maximum.- 1938: Discharge (mean from 1:45 p.m. to 2 p.m.), 38,200 second-feet Mar. 2.

Remarks.- Records represent flow into reservior at Gibralter Dam and are good. Regulation at Juncal Reservoir except during flood periods. Records furnished by City of Santa Barbara.

Mean daily discharge, in second-feet, 1938*

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	792	1,390	222	11	4,400	713	162	21	197	405	130
2	122	**9,130	216	12	1,630	4,480	164	22	212	340	122
3	775	5,440	210	13	552	2,620	161	23	220	334	120
4	604	2,020	203	14	406	1,560	156	24	165	328	124
5	310	1,130	201	15	351	1,100	155	25	150	312	152
6	191	794	198	16	276	835	155	26	131	300	139
7	150	618	188	17	247	669	151	27	126	280	130
8	128	1,000	180	18	244	562	145	28	175	267	122
9	180	870	174	19	252	491	144	29		259	124
10	408	699	168	20	207	450	139	30		248	126
								31		231	
Mean monthly discharge, in second-feet									486	1,286	159
Runoff, in acre-feet									26,980	79,090	9,480

* Discharges are for 24-hour period ending 6 p.m. of day indicated.
** Mean discharge for calendar day Mar. 2, 11,300 second-feet.

Discharge, in second-feet, at indicated time, 1938

Hour	March 1	March 2	March 3
1		781	5,600
2		895	5,320
3		1,290	5,100
4		1,870	4,930
5		2,830	4,800
6		4,600	4,660
7		6,170	4,490
8		6,940	4,280
9		7,390	4,120
10		8,790	4,020
11		12,800	3,880
N		21,300	3,740
1		31,800	3,590
2		35,200	3,460
3		29,500	3,350
4		22,200	3,230
5		16,900	3,120
6	489	13,800	2,990
7	467	11,700	
8	481	19,300	
9	526	8,340	
10	582	7,370	
11	641	6,630	
M	718	6,020	

Supplemental record.- Mar. 2, mean from 1:45 to 2 p.m., 38,200 second-feet.

Santa Ynez River below Gibraltar Dam, near Santa Barbara, Calif.

Location.- Water-stage recorder, lat. 34°31'40", long. 119°41'00", about on line between secs. 10 and 11, T. 5 N., R. 27 W., downstream from Gibraltar Dam, 7 miles north of Santa Barbara. Altitude, about 1,200 feet.

Drainage area.- Area, 219 square miles. Average altitude, 3,400 feet. Maximum altitude, 6,828 feet. Average slope, 42 percent. Length of main stream channel, 17.5 miles. Average slope of main stream channel, 6 percent.

Gage-height record.- Water-stage recorder graph.

Discharge record.- Discharge computed from rating of gate valve Feb. 12-17 and Mar. 1-6, and rating of spillway, Feb. 2 to Apr. 30.

Maximum.- 1938: Discharge, 35,500 second-feet 2:15 p.m. Mar. 2.

Remarks.- Flow regulated by storage in reservoir and diversion to city of Santa Barbara; during flood period City of Santa Barbara diverted 149 acre-feet. No diversions from Gibraltar Reservoir Feb. 3-14 and Mar. 1 to Apr. 3. Records furnished by City of Santa Barbara.

Mean daily discharge, in second-feet, 1938*

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	0	1,360	222	11	4,130	696	161	21	195	410	129
2	0	**8,530	216	12	1,900	4,320	161	22	201	346	120
3	623	5,950	209	13	595	2,730	161	23	222	333	117
4	669	2,150	203	14	415	1,610	155	24	170	330	121
5	365	1,170	200	15	369	1,130	152	25	149	315	153
6	206	821	197	16	286	853	152	26	131	301	137
7	158	632	188	17	249	683	149	27	123	283	129
8	132	981	179	18	236	570	143	28	156	268	120
9	166	888	173	19	264	497	140	29		259	123
10	395	714	167	20	210	454	137	30		249	129
								31		234	
Mean monthly discharge, in second-feet									454	1,290	158
Runoff, in acre-feet									25,220	79,430	9,400

* Discharges are for 24-hour period ending 6 p.m. of day indicated.
** Mean discharge for calendar day Mar. 2, 10,900 second-feet.

Discharge, in second-feet, at indicated time, 1938

Hour	March 1	March 2	March 3
1		646	6,110
2		695	5,690
3		795	5,380
4		1,100	5,170
5		1,550	4,980
6		2,470	4,840
7		4,160	4,690
8		5,930	4,530
9		6,740	4,320
10		7,270	4,190
11		9,150	4,060
N		14,000	3,910
1		24,800	3,780
2		34,800	3,630
3		33,400	3,510
4		25,100	3,400
5		20,200	3,280
6	550	15,500	3,170
7	527	13,800	
8	506	11,200	
9	506	9,520	
10	516	8,290	
11	550	7,400	
M	585	6,680	

Supplemental record.- Mar. 2, 2:15 p.m., 35,500 second-feet.

Santa Ynez River near Santa Ynez, Calif.

Location.- Water-stage recorder, lat. 34°35'20", long. 120°01'25", in Canada de los Pinos grant, at San Marcos Road Bridge, 4 miles southeast of Santa Ynez, Santa Barbara County. Altitude, about 500 feet.

Drainage area.- Area, 435 square miles. Average altitude, 2,890 feet. Maximum altitude, 6,828 feet. Average slope, 34 percent. Length of main stream channel, 41.5 miles. Average slope of main stream channel, 3 percent.

Gage-height record.- Water-stage recorder graph.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 3,360 second-feet and by float measurements up to 34,100 second-feet; extended logarithmically to peak stage.

Maxima.- 1938: Discharge, 43,700 second-feet 6 p.m. Mar. 2 (gage height, 17.9 feet).
1929-31, 1932-37: Discharge, 7,990 second-feet Feb. 6, 1937 (gage height, 10.67 feet).

Remarks.- Records good. The cities of Santa Barbara and Montecito divert water above gage. Flood flows affected by regulation at Gibralter and Juncal Reservoirs.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	796	2,800	535	11	9,700	2,130	343	21	386	1,170	224
2	172	17,910	509	12	3,400	9,180	343	22	356	1,030	214
3	1,490	9,140	488	13	1,660	6,120	348	23	331	958	203
4	2,040	4,210	463	14	1,250	4,120	325	24	335	894	217
5	974	3,250	473	15	1,010	3,190	309	25	294	810	277
6	441	2,470	428	16	766	2,380	289	26	269	750	250
7	278	2,940	400	17	591	1,920	281	27	254	715	200
8	197	3,280	380	18	491	1,600	266	28	421	679	183
9	265	2,520	366	19	496	1,390	254	29		644	193
10	728	2,180	356	20	478	1,260	242	30		600	193
								31		572	
Mean monthly discharge, in second-feet									1,067	2,994	318
Runoff, in acre-feet									59,240	184,100	18,950

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1		March 2		March 3		March 4	
1			4.79	248	8.02	2,908	6.85	1,520	11.69	13,600	8.94	5,130
2			4.80	254	8.20	3,180	6.88	1,560	11.40	12,400	8.84	4,940
3			4.82	263	8.66	3,960	6.95	1,610	11.44	12,600	8.80	4,840
4			4.83	266	8.34	3,430	7.12	1,780	11.70	13,600	8.74	4,260
5			4.84	269	8.04	2,980	7.40	2,060	11.34	12,200	8.69	4,620
6			4.84	272	7.82	2,690	7.71	2,410	11.12	11,400	8.64	4,540
7			4.84	272	8.04	3,010	8.24	3,120	10.74	10,100	8.54	4,330
8			4.84	275	8.74	4,110	8.89	4,150	10.54	9,420	8.54	4,350
9			4.85	278	9.14	4,840	9.79	5,900	10.54	9,420	8.50	4,260
10			4.86	285	8.98	4,540	10.61	7,840	10.56	9,480	8.52	4,330
11			4.87	288	8.59	3,860	12.50	16,840	10.40	9,000	8.50	4,280
N			4.88	294	8.32	3,430	14.20	24,400	10.30	8,700	8.42	4,140
1			4.89	298	7.99	2,910	15.80	32,100	10.19	8,370	8.34	3,980
2			4.89	301	7.82	2,660	16.35	34,900	10.14	8,220	8.34	4,000
3			4.89	301	7.64	2,420	16.00	33,100	10.04	7,920	8.30	3,920
4			4.91	311	7.46	2,200	15.75	31,800	9.94	7,620	8.30	3,940
5			4.94	324	7.34	2,060	16.70	36,900	9.80	7,250	8.30	3,940
6			4.97	338	7.20	1,900	17.90	43,700	9.60	6,750	8.25	3,870
7			5.02	360	7.09	1,790	17.20	39,700	9.56	6,650	8.24	3,850
8			5.12	402	7.01	1,700	15.60	31,000	9.49	6,480	8.22	3,830
9			5.30	482	6.90	1,590	14.65	26,400	9.36	6,150	8.18	3,750
10			5.87	785	6.87	1,550	13.60	21,400	9.30	6,000	8.15	3,720
11			6.90	1,590	6.85	1,540	12.65	17,400	9.20	5,750	8.14	3,700
M			7.69	2,460	6.84	1,510	12.10	15,200	9.05	5,380	8.14	3,720

Santa Ynez River near Lompoc, Calif.

Location.- Water-stage recorder, lat. 34°38'30", long. 120°25'50", near boundary of La Mission Vieja de la Purisima grant, at highway bridge, 1½ miles east of Lompoc, Santa Barbara County. Altitude, about 100 feet.

Drainage area.- Area, 790 square miles. Average altitude, 1,884 feet. Maximum altitude, 6,828 feet. Average slope, 28 percent. Length of main stream channel, 71 miles. Average slope of main stream channel, 1.7 percent.

Gage-height record.- Water-stage recorder graph except 9 p.m. Mar. 2 to 4:30 a.m. Mar. 3.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 5,050 second-feet and by float measurements below 37,600 second-feet; extended logarithmically to peak stage. Shifting-control corrections used throughout the period. Discharge estimated 9 p.m. Mar. 2 to 4:30 a.m. Mar. 3.

Maxima.- 1938: Discharge, 50,100 second-feet 4 a.m. Mar. 3 (gage height, 28.10 feet). 1906-18, 1925-37: Discharge, 41,800 second-feet Jan. 25, 1914 (gage height, 13.0 feet, former site and datum).

Remarks.- Records good. The cities of Santa Barbara and Montecito divert water above gage. Flood flows affected by regulation at Gibralter and Juncal Reservoirs.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	643	2,590	726	11	6,330	2,970	475	21	694	1,680	337
2	746	8,150	679	12	15,010	4,890	444	22	623	1,460	318
3	992	24,760	646	13	3,520	6,620	434	23	542	1,190	288
4	2,190	7,050	620	14	2,220	4,740	428	24	485	1,150	293
5	1,940	4,160	601	15	1,540	3,830	422	25	458	1,090	313
6	1,100	3,180	588	16	914	3,430	417	26	398	1,020	322
7	628	2,670	562	17	1,040	2,420	400	27	355	955	303
8	441	2,960	531	18	855	2,210	379	28	463	895	288
9	522	3,050	506	19	791	2,010	358	29		858	279
10	738	2,980	493	20	766	1,970	342	30		812	298
								31		774	
Mean monthly discharge, in second-feet									1,676	3,501	436
Runoff, in acre-feet									93,110	215,300	25,960

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1		March 2		March 3		March 4	
1			12.10	339	15.44	2,580	17.32	4,830		32,000	20.05	11,300
2			12.09	334	15.00	2,120	17.56	5,230		39,000	19.85	10,600
3			12.09	334	14.58	1,720	17.50	5,180		46,700	19.60	9,900
4			12.09	334	14.20	1,420	17.33	5,000	28.10	50,100		
5			12.09	334	13.88	1,180	16.97	4,520	27.43	45,600	19.40	9,350
6			12.09	329	13.70	1,040	16.91	4,510	26.35	39,000	19.20	8,600
7			12.08	324	14.00	1,220	16.97	4,680	25.25	32,900		
8			12.08	324	14.65	1,680	16.95	4,720	24.05	27,000	18.90	8,100
9			12.08	324	15.14	2,090	17.10	5,030	23.50	24,500		
10			12.08	324	15.33	2,250	17.17	5,210	23.10	22,700		
11			12.08	324	15.30	2,200	17.39	5,600	22.85	21,600	18.20	6,720
M			12.08	324	15.22	2,090	17.81	6,380	22.73	20,900		
1			12.08	324	15.45	2,300	18.10	6,980	22.63	20,500		
2			12.08	324	15.75	2,570	18.58	7,910	22.35	19,400	17.50	5,920
3			12.08	310	16.00	2,820	18.83	8,500	22.25	19,000		
4			12.08	300	16.25	3,120	18.67	8,180	22.00	18,000		
5			12.08	290	16.43	3,360	18.35	7,620	21.55	16,300	17.13	5,560
6			12.09	285	16.42	3,400	18.47	7,880	21.17	15,000		
7			12.15	295	16.37	3,360	18.63	8,360	20.82	13,800		
8			12.17	280	16.51	3,570	19.12	9,490	20.70	13,400	16.80	5,270
9			12.35	355	16.76	3,920	20.00	11,700	20.55	13,000		
10			13.70	1,180	16.92	4,150		18,700	20.38	12,400		
11			14.50	1,740	17.15	4,500		23,000	20.18	11,800	16.50	4,960
M			15.44	2,610	17.21	4,620		28,000	20.00	11,300		

Santa Maria River Basin

Cuyama River near Santa Maria, Calif.

Location.- Water-stage recorder, lat. 35°00'50", long. 120°16'45", in Suey grant, at highway bridge, 3 miles upstream from Alamos Creek, and 10 miles northeast of Santa Maria, Santa Barbara County. Altitude, about 610 feet.

Drainage area.- Area, 902 square miles. Maximum altitude, 7,488 feet. Length of main stream channel, 76 miles.

Gage-height record.- Water-stage recorder graph except 6 a.m. Feb. 6 to Feb. 12 and 9 a.m. Mar. 3 to Mar. 9. Maximum gage height determined from high-water marks in gage well.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 4,370 second-feet; extended logarithmically to peak discharge determined by slope-area method. Shifting-control corrections used through the period of record. Discharge Feb. 6-12 and Mar. 3-9 based on comparable hydrograph of Huasna River near Santa Maria.

Maxima.- 1938: Discharge, 17,300 second-feet 9 a.m. Mar. 3 (gage height, 16.6 feet).
1929-37: Discharge, 5,220 second-feet Feb. 6, 1937 (gage height, 7.60 feet).

Remarks.- Records fair except those for Feb. 6-12 and Mar. 3-9, which are poor. No diversions above station.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	73	114	71	11	2,920	220	56	21	74	204	43
2	48	325	74	12	992	962	58	22	71	183	39
3	326	5,350	72	13	326	1,240	62	23	68	159	38
4	157	2,120	69	14	246	690	62	24	68	146	51
5	134	800	76	15	144	615	58	25	66	129	69
6	115	400	68	16	104	400	55	26	64	119	64
7	100	290	64	17	87	332	51	27	64	104	51
8	94	375	60	18	76	290	49	28	72	96	46
9	200	290	59	19	87	256	47	29		90	58
10	428	220	66	20	78	232	44	30		78	57
								31		72	
Mean monthly discharge, in second-feet									260	542	57.6
Runoff, in acre-feet									14,440	33,320	3,430

Huasna River near Santa Maria, Calif.

Location.- Water-stage recorder, lat. 35°01'20", long. 120°19'20", in Suey grant, half a mile upstream from junction with Cuyama River, and 8 miles northeast of Santa Maria, Santa Barbara County. Altitude, about 600 feet.

Drainage area.- Area, 119 square miles. Average altitude, 1,371 feet. Maximum altitude, 3,185 feet. Average slope, 31 percent. Length of main stream channel, 22 miles. Average slope of main stream channel, 22 percent.

Gage-height record.- Water-stage recorder graph.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 1,080 second-feet; extended to peak discharge determined by slope-area method. Shifting-control corrections used throughout the period.

Maxima.- March 1938: Discharge, 1,190 second-feet 5 p.m. Mar. 2 (gage height, 4.47 feet).
1929-February 1938: Discharge, 11,400 second-feet 10:20 a.m. Feb. 11, 1938 (gage height, 11.26 feet).

Remarks.- Records fair. No diversions above station.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	304	271	59	11	4,630	261	40	21	147	169	28
2	143	546	55	12	986	929	39	22	123	157	26
3	597	910	52	13	493	1,156	39	23	101	139	25
4	427	615	48	14	552	640	36	24	87	135	28
5	243	427	51	15	395	467	36	25	74	121	40
6	163	334	47	16	306	363	35	26	64	111	35
7	127	377	44	17	240	295	33	27	59	97	30
8	105	490	43	18	218	243	32	28	78	89	30
9	193	334	42	19	252	212	30	29		83	35
10	340	264	42	20	173	190	30	30		72	35
								31		64	
Mean monthly discharge, in second-feet									415	341	38.2
Runoff, in acre-feet									23,050	20,950	2,270

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1		March 2		March 3		March 4	
1					2.73	292	2.35	192	3.65	705		
2					3.02	399	2.39	202	3.72	740		
3					2.95	375	2.41	208	3.68	720		
4					2.98	391	2.41	208	3.80	782		
5					2.89	359	2.40	205	3.84	804		
6					2.84	341	2.44	215	3.90	838		
7					2.80	327	2.50	231	3.95	868		
8					2.75	310	2.52	237	4.07	940		
9			1.71	59	2.70	292	2.51	234	4.14	982		
10					2.65	276	2.55	246	4.10	958		
11					2.59	258	2.87	352	4.12	970		
N					2.58	255	3.20	484	4.18	1,010		
1					2.54	243	3.35	552	4.17	1,000		
2					2.52	237	3.78	765	4.37	1,130		
3					2.50	231	4.15	982	4.35	1,120		
4					2.47	222	4.32	1,090	4.30	1,080		
5					2.45	218	4.47	1,190	4.25	1,050		
6			1.72	62	2.44	215	4.24	1,050	4.15	988		
7			1.73	63	2.41	208	4.14	982	4.05	928		
8			1.75	66	2.39	202	3.92	850	4.02	910		
9			1.75	66	2.37	198	3.79	776	4.00	898		
10			1.82	77	2.35	192	3.68	720	3.95	868		
11			2.88	344	2.36	195	3.60	680	3.87	820		
M			2.85	334	2.35	192	3.60	680	3.80	782		

Salton Sea Basin

Palm Canyon Creek near Palm Springs, Calif.

Location.- Water-stage recorder, lat. 33°44'55", long. 116°32'15", in S½ sec. 11, T. 5 S., R. 4 E., three-quarters of a mile upstream from Murray Canyon Creek, and 6 miles south of Palm Springs post office. Altitude, about 700 feet.

Drainage area.- 94 square miles.

Gage-height record.- Water-stage recorder graph except Mar. 15-30.

Discharge record.- Stage-discharge relation fairly well defined below 30 second-feet; extended above by mean velocity-mean depth relation. Discharge Mar. 15-30 obtained by comparison with Mill Creek near Craftonville and Santa Ana River near Mentone.

Maxima.- 1938: Discharge, 2,380 second-feet 10 p.m. Mar. 2 (gage height, 4.43 feet).
1930-37: Discharge, 3,850 second-feet Feb. 6, 1937 (gage height, 5.60 feet).

Remarks.- Records good. No regulation or diversion above gage.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	12	106	15	11	5.5	16	12	21	3.1	16	10
2	6.5	731	15	12	10	125	12	22	2.8	16	10
3	3.9	813	15	13	6	82	14	23	2.6	16	9.5
4	11	224	15	14	4.8	34	15	24	2.6	16	9.5
5	11	77	14	15	4.5	26	13	25	2.4	16	13
6	5.5	50	13	15	4.5	22	13	26	2.4	16	13
7	4.2	41	13	17	3.9	20	12	27	9	16	10
8	3.6	38	12	18	3.3	19	11	28	22	16	9.5
9	4.5	31	12	19	4.2	18	11	29		16	9.5
10	5.5	26	12	20	3.6	17	10	30		16	9.5
								31		16	
Mean monthly discharge, in second-feet									5.89	86.8	12.1
Runoff, in acre-feet									327	5,340	719

Discharge, in second-feet, at indicated time, 1938

Hour	March 1	March 2	March 3
1	19	56	1,120
2	21	55	1,000
3	30	54	936
4	100	54	825
5	248	56	754
6	238	64	721
7	202	70	862
8	183	86	1,050
9	175	150	1,080
10	148	366	1,260
11	130	491	1,110
N	123	533	1,000
1	112	658	862
2	100	616	804
3	95	501	754
4	89	599	664
5	84	741	628
6	77	1,012	570
7	72	1,900	544
8	69	2,200	528
9	66	2,210	522
10	62	2,380	496
11	59	1,840	470
M	58	1,460	440

Mojave River Basin

Deep Creek near Hesperia, Calif.

Location.- Water-stage recorder, lat. 34°20'30", long. 117°13'40", in SE¼ sec. 18, T. 3 N., R. 3 W., half a mile upstream from confluence with West Fork of Mojave River, and 8 miles southeast of Hesperia. Altitude, about 3,050 feet.

Drainage area.- Area, 137 square miles. Average altitude, 5,850 feet. Maximum altitude, 8,500 feet. Average slope, 38 percent. Length of main stream channel, 21.6 miles. Average slope of main stream channel, 4.5 percent.

Gage-height record.- No record.

Discharge record.- Discharge Feb. 1 to Apr. 20 computed on basis of discharge measurements and studies of flow at other stations in the Mojave River Basin; April 21-30 by standard methods at temporary station a quarter of a mile downstream. Maximum discharge determined by slope-area method.

Maxima.- 1938: Discharge, 46,600 second-feet Mar. 2.
1929-37: Discharge, 7,900 second-feet Feb. 9, 1932.

Remarks.- Records poor. Storage in Lake Arrowhead. No diversion during flood period.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	100	2,850	240	11	730	550	225	21	50	760	235
2	340	12,000	240	12	560	2,200	215	22	43	620	218
3	530	5,700	260	13	295	2,700	240	23	41	510	190
4	1,230	1,900	290	14	190	2,100	235	24	36	430	178
5	370	1,200	305	15	160	1,600	240	25	30	420	250
6	160	880	290	16	98	1,550	380	26	30	420	278
7	60	740	250	17	52	1,375	360	27	490	380	191
8	40	600	235	18	38	1,210	300	28	3,100	350	155
9	250	550	240	19	155	960	280	29		350	159
10	265	530	235	20	74	850	260	30		300	167
								31		300	
Mean monthly discharge, in second-feet									340	1,512	245
Runoff, in acre-feet									18,880	93,000	14,560

Mojave River at lower narrows, near Victorville, Calif.

Location.- Water-stage recorder, lat. 34°34'25", long. 117°19'10", in SW¼SE¼ sec. 29, T. 6 N., R. 4 W., 500 feet upstream from bridge on U. S. Highway No. 66, and 3 miles northwest of Victorville. Altitude, about 2,640 feet.

Drainage area.- 530 square miles.

Gage-height record.- Water-stage recorder graph except 7:30 p.m. Mar. 2 to Mar. 29.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 10,300 second-feet; peak discharge determined by slope-area method. Discharge Mar. 2-29 determined from discharge measurements and studies of flow at other stations in the Mojave River Basin.

Maxima.- 1938: Discharge, 70,600 second-feet 7:30 p.m. Mar. 2 (gage height, 16.70 feet).
1930-37: Discharge, 12,500 second-feet Feb. 9, 1932.

Remarks.- Records fair except those for Mar. 2-29, which are poor. Storage at Lake Arrowhead and Lake Gregory. No diversions during flood.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	47	4,350	330	11	54	780	297	21	77	1,050	245
2	48	16,000	330	12	288	3,000	285	22	64	890	221
3	50	10,000	365	13	166	4,200	330	23	60	760	187
4	48	3,000	403	14	120	3,400	319	24	61	620	176
5	50	1,800	440	15	102	2,400	323	25	57	580	226
6	48	1,300	416	16	90	2,200	405	26	55	530	360
7	49	1,100	342	17	75	2,050	376	27	65	485	303
8	52	960	319	18	64	1,850	303	28	2,660	430	215
9	50	850	330	19	73	1,400	271	29		410	159
10	53	800	309	20	107	1,200	271	30		354	209
								31		354	
Mean monthly discharge, in second-feet									169	2,229	302
Runoff, in acre-feet									9,390	137,100	17,980

Mojave River at Barstow, Calif.

Location.- Water-stage recorder, lat. 34°54'25", long. 117°01'20", in SW¼SE¼, sec. 31, T. 10 N., R. 1 W., on U. S. Highway No. 91 at Barstow. Altitude, about 2,090 feet.

Gage-height record.- Water-stage recorder graph.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 5,200 second-feet; extended to peak discharge determined by slope-area method. Discharge Mar. 4-11, 20-31 determined from discharge measurements and studies of flow at other stations in the Mojave River Basin. Discharge for Apr. 1-30 determined by interpolation between measurements.

Maxima.- 1938: Discharge, 64,300 second-feet 2 a.m. Mar. 3 (gage height, 8.60 feet).
1930-37: Discharge, 8,300 second-feet Feb. 9, 1932.

Remarks.- Records fair. Storage at Lake Arrowhead and Lake Gregory. No diversions during flood.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	0	3,070	290	11	0	730	240	21	0	900	200
2	0	3,720	285	12	0	1,600	236	22	0	757	197
3	0	18,100	280	13	0	4,000	232	23	0	680	198
4	0	3,200	275	14	0	3,500	228	24	0	580	199
5	0	1,850	270	15	0	2,240	224	25	0	520	200
6	0	1,250	265	16	0	2,060	220	26	0	460	201
7	0	1,050	260	17	0	1,890	216	27	0	410	202
8	0	920	255	18	0	1,920	212	28	0	360	203
9	0	820	250	19	0	1,350	208	29		340	204
10	0	770	245	20	0	1,140	204	30		320	205
								31		300	
Mean monthly discharge, in second-feet									0	1,962	230
Runoff, in acre-feet									0	120,600	13,690

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1		March 2		March 3		March 4	
1					2.50	415	3.67	4,050	6.65	31,800		
2					2.65	610	3.50	3,250	8.60	64,300		
3					2.90	1,070	3.55	3,500	7.90	50,800		
4					2.90	1,070	3.45	3,040	7.00	36,800		
5					3.13	1,650	3.35	2,680	6.45	29,400		
6					3.05	1,430	3.35	2,680	5.95	23,000		
7					3.25	2,020	3.37	2,760	5.65	19,700		
8					3.22	1,920	3.32	2,600	5.45	17,700		
9					3.05	1,430	3.34	2,680	5.40	17,200		
10					3.15	1,700	3.27	2,400	5.35	16,700		
11					3.17	1,760	3.18	2,120	5.25	15,800		
N					3.15	1,700	3.20	2,190	5.08	14,200		
1					3.10	1,560	3.37	2,840	4.91	12,700		
2					3.25	2,020	3.30	2,600	4.75	11,400		
3					3.55	3,200	3.40	3,000	4.60	10,300		
4					3.90	5,000	3.40	3,040	4.45	9,250		
5					4.15	6,600	3.50	3,500	4.34	8,480		
6					4.25	6,800	3.65	4,300	4.22	7,640		
7					4.35	7,710	3.64	4,250	4.11	6,870		
8					4.13	6,320	3.55	3,850	4.00	6,200		
9					3.95	5,400	3.70	4,600	3.90	5,700		
10					3.89	5,100	4.00	6,480	3.83	5,350		
11					3.85	4,950	4.35	8,480	3.80	5,200		
M					3.75	4,450	4.90	12,600	3.75	4,950		

West Fork of Mojave River near Hesperia, Calif.

Location.- Water-stage recorder, lat. 34°20'20", long. 117°14'35", in SE¼ sec. 13, T. 3 N., R. 4 W., at highway bridge, half a mile upstream from confluence with Deep Creek, and 7 miles southeast of Hesperia. Altitude, about 3,050 feet.

Drainage area.- Area, 74.8 square miles. Average altitude, 4,270 feet. Maximum altitude, 6,150 feet. Length of main stream channel, 12.5 miles. Average slope of main stream channel, 3.7 percent.

Gage-height record.- Water-stage recorder graph except 11 a.m. Mar. 2 to Mar. 14.

Discharge record.- Stage-discharge relation defined by current-meter measurements below 2,060 second-feet; extended logarithmically to maximum discharge determined by slope-area method. Discharge for period of missing gage-height record determined from discharge measurements and studies of flow at other stations in the Mojave River Basin.

Maxima.- 1938: Discharge, 26,100 second-feet Mar. 2.
1930-37: Discharge, 6,000 second-feet Feb. 8, 1932.

Remarks.- Records good except those for Mar. 2-14, which are poor. Storage at Lake Gregory.

Mean daily discharge, in second-feet, 1938

Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.	Day	Feb.	Mar.	Apr.
1	67	2,090	178	11	375	330	108	21	64	388	74
2	197	7,000	164	12	298	1,300	102	22	58	324	74
3	287	3,300	161	13	174	1,600	150	23	56	275	70
4	603	1,100	158	14	122	1,200	114	24	50	235	67
5	212	700	164	15	103	844	108	25	43	232	171
6	108	520	147	16	89	740	102	26	43	232	128
7	71	410	128	17	67	660	98	27	264	214	102
8	54	380	125	18	52	560	91	28	1,410	201	88
9	151	330	114	19	106	480	78	29		201	90
10	160	310	111	20	79	429	88	30		187	174
								31		187	
Mean monthly discharge, in second-feet									192	870	118
Runoff, in acre-feet									10,640	53,470	7,000

Gage height, in feet, and discharge, in second-feet, at indicated time, 1938

Hour	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.	Feet	Sec.ft.
	February 27		February 28		March 1		March 2		March 3		March 4	
1	0.87	43	3.20	690	6.00	2,480	3.43	940				
2			3.10	646	7.75	3,780	3.38	920				
3			3.15	666	8.70	4,540	3.39	925				
4			3.22	710	9.33	5,050	3.42	940				
5			3.40	800	8.20	4,130	3.58	1,020				
6	.87	43	3.65	930	6.75	3,020	3.66	1,070				
7			3.86	1,040	6.00	2,480	3.95	1,220				
8			4.15	1,210	5.70	2,290	5.00	1,840				
9	.87	43	4.40	1,370	5.43	2,120	6.25	2,660				
10	.95	52	4.50	1,430	5.15	1,940	7.10	3,220				
11	1.03	62	4.60	1,500	4.85	1,750	7.70	3,710				
N	1.12	74	5.10	1,870	4.67	1,650						
1	1.28	98	5.60	2,220	4.47	1,530						
2	1.57	148	5.94	2,440	4.38	1,470						
3	1.85	208	5.70	2,290	4.25	1,400						
4	2.20	298	5.52	2,170	4.15	1,340						
5	2.65	446	5.18	1,950	4.05	1,280						
6	3.00	582	4.83	1,740	3.95	1,220						
7	3.27	695	4.60	1,600	3.85	1,170						
8	3.30	715	4.35	1,460	3.75	1,120						
9	3.32	730	4.16	1,340	3.65	1,070						
10	3.35	745	4.05	1,280	3.60	1,040						
11	3.30	725	4.10	1,310	3.55	1,010						
M	3.25	705	4.50	1,550	3.50	990						

SUMMARY OF FLOOD DISCHARGES

In table 23, "Summary of flood discharges," are assembled the results of the determinations of maximum flood discharges at stream-gaging stations and other places on streams in southern California. For convenience, several gaging stations that are plotted on the isohyetal maps are included, although the maximum discharge at those stations was not determined. The table gives the following information: (1) Map reference number, to aid in locating the place where the discharge was determined, as plotted on plates 11, 12, and 13; (2) name of stream and place where discharge was determined; (3) latitude and longitude of place of measurement; (4) approximate altitude of place of measurement as determined from topographic maps; (5) drainage area, in square miles, tributary to the stream at the place where discharge was determined; (6) period of record—which conforms to period of operation of the station—given only for existing stream-gaging stations; (7) date and magnitude of the maximum discharge recorded prior to the March 1938 floods, that is, during the period of record given in the preceding column; (8) day and hour, if known, and rate in second-feet, total and per square mile, of the maximum discharge in March 1938; (9) a brief notation as to the method used in determining the maximum discharge.

Water-Supply Papers 391 (pp. 89-91) and 447 (pp. 544-550) give, among other data, tables of estimated flood discharge of streams in the vicinity of Los Angeles, Calif., during the storms of January and February 1914. At that time, under the direction of J. B. Lippincott, of the board of engineers for flood control, Los Angeles County, sections were selected and data collected for computing flood flow. The summary of flood discharges as given in this report (table 23) is primarily concerned with records made since continuous and systematic stream-gaging was inaugurated, and therefore the estimates of flood discharge from the storms of January and February 1914 were not generally considered in the preparation of the table. A summary of information concerning floods prior to the general period of record is given in the section of this report on "History of floods in southern California". (See pp. 385-394.)

The methods employed are described in detail in the section of this report entitled "Determination of flood discharge". (See pp. 168-182.) The basic data used in determining the discharges are filed in the Los Angeles office of the Geological Survey, where they may be examined.

Table 23.- Summary of flood discharges

No. on map (pl.11, 12, 13)	Stream and place of determination	Latitude	Longitude	Altitude	Drainage area (sq. mi.)	Period of record	Maximum discharge previously known		Maximum discharge March 2, 1938			
							Date	Sec.-ft.	Time	Sec.-ft.	Sec.-ft. per sq.mi.	Method of Determination
	PACIFIC SLOPE BASINS	° ' "	° ' "									
	Tia Juana River Basin											
1	Cottonwood Creek at Morena Dam	32 41 00	116 32 55	2,882	120	1916 1936-38	-	-	-	-	-	-
2	Cottonwood Creek near Dulzura	32 40 45	116 40 20	1,446	250	1906-15 1936-38	-	-	-	-	-	-
3	Cottonwood Creek above Tecate Creek, near Dulzura	32 34 10	116 45 40	580	316	1936-38	Feb. 7, 1937	2,775	2:30 p.m.[a]	2,360	7.5	Extension of rating curve.
4	Tia Juana River near Dulzura	32 33 50	116 46 25	550	478	1936-38	Feb. 7, 1937	4,700	11 a.m.[a]	3,520	7.4	Do.
5	Tia Juana River near Nestor	32 32 55	117 05 15	25	1,668	1915 1936-38	Feb. 7, 1937	17,700	8 a.m.[a]	6,760	4.1	Do.
6	Campo Creek near Campo	32 35 20	116 31 35	2,180	84	1936-38	Feb. 6, 1937	1,470	1 a.m.[a]	584	7.0	Do.
	Otay River Basin											
7	Otay River at Savage Dam	32 36 40	116 55 40	347	98	1936-38	-	-	-	-	-	-
	Sweetwater River Basin											
8	Sweetwater River at Sweetwater Dam	32 41 20	117 00 35	150	181	1887-1938	-	-	-	-	-	-
	San Diego River Basin											
9	San Diego River at El Capitan Dam, near Lakeside	32 53 00	116 48 40	553	190	1936-38	-	-	-	-	-	-
10	San Diego River near Santee	32 49 20	117 03 25	205	380	1912-38	Jan.27, 1916	70,200	2 a.m.[a]	7,350	19.3	Do.

a Occurred Mar. 3.

Table 23.- Summary of flood discharges—Continued

No. on map (pl.11, 12, 13)	Stream and place of determination	Latitude	Longitude	Altitude	Drainage area (sq. mi.)	Period of record	Maximum discharge previously known		Maximum discharge March 2, 1938			
							Date	Sec.-ft.	Time	Sec.-ft.	Sec.-ft. per sq.mi.	Method of Determination
		° ' "	° ' "									
	PACIFIC SLOPE BASINS—Con.											
	San Diego River Basin—Con.											
11	Boulder Creek at Cuyamaca Reservoir, near Julian	32 59 15	116 35 10	4,590	12.0	1912-26 1935-38	-	-	-	-	-	-
12	San Vicente Creek at Foster	32 54 40	116 55 35	750	75	1916 1936-38	Jan.27, 1916	18,600	11 p.m.	5,270	70.3	Extension of rating curve.
	San Dieguito River Basin											
13	Santa Ysabel Creek near Mesa Grande	33 07 15	116 48 30	2,000	58	1912-28 1936-38	Jan.27, 1916	21,100	11:20 p.m.	8,000	138	Do.
14	San Dieguito River at Lake Hodges	33 02 55	117 07 25	200	303	1916-38	-	-	-	-	-	-
	San Luis Rey River Basin											
15	San Luis Rey River near Bonsall	33 15 05	117 14 55	120	514	1912-18 1929-38	Feb. 7, 1937	16,700	1 a.m.[a]	18,100	35.2	Do.
16	San Luis Rey River at Oceanside	33 12 40	117 22 40	20	557	1912-14 1916 1929-38	Jan.12, 1916	95,600	5:30 a.m.[a]	16,500	29.6	Do.
	Santa Margarita River Basin											
17	Temecula Creek at Nigger Canyon, near Temecula	33 29 40	116 59 00	1,350	319	1923-38	Feb.16, 1927	17,100	10 p.m.	14,600	45.8	Estimated.
18	Temecula Creek at Railroad Canyon, near Temecula	33 28 25	117 08 35	950	592	1923-38	Feb.16, 1927	27,600	10 p.m.	21,700	36.7	Do.
19	Santa Margarita River near Fall Brook	33 24 05	117 15 10	350	645	1924-38	Feb.16, 1927	33,100	11 p.m.	28,000	43.4	Do.
20	Santa Margarita River at Ysidora	33 14 40	117 22 50	15	740	1923-38	Feb.16, 1927	33,600	1 a.m.[a]	31,000	41.9	Do.
21	Murrieta Creek at Temecula	33 29 00	117 08 50	1,050	220	1930-38	Feb.16, 1932	7,500	8 p.m.	16,800	76.4	Do.

	Arroyo San Onofre Basin											
22	Arroyo San Onofre near San Onofre	33 23 20	117 32 50	100	39.8	-	-	-	-	4,140	104	Slope-area.
	San Juan Creek Basin											
23	San Juan Creek near San Juan Capistrano b/	33 30 50	117 37 40	150	110	1929-38	Feb. 6, 1937	8,300	10 p.m.	13,000	118	Do.
24	Trabuco Creek near San Juan Capistrano c/	33 31 30	117 40 15	200	36.5	1930-38	Feb. 6, 1937	9,240	-	4,400	121	-
	Aliso Creek Basin											
25	Aliso Creek at El Toro c/	33 37 15	117 41 20	440	8.5	1930-38	Feb. 6, 1937	1,950	-	1,280	151	-
	Laguna Creek Basin											
26	Laguna Creek at Laguna Beach	33 32 40	117 47 00	25	8.8	-	-	-	-	2,140	243	Slope-area.
	Santa Ana River Basin											
27	Santa Ana River near Mentone	34 06 40	117 06 00	1,900	d 144	1896-1938	Jan.27, 1916	29,100	7 p.m.	52,300	363	Do.
28	Santa Ana River at Riverside Narrows, near Arlington	33 58 00	117 26 30	690	845	1929-38	Feb. 7, 1937	12,000	-	100,000	118	Do.
29	Santa Ana River near Prado	33 52 05	117 40 20	400	e1,520	1919-38	Feb.16, 1927	18,000	12:15 a.m.[a]	100,000	65.8	Extension of rating curve.
30	Santa Ana River at Santa Ana	33 45 00	117 54 20	80	-	1923-38	Feb.16, 1927	25,000	3 a.m.[a]	46,300	-	Slope-area.
31	Bear Creek, inflow to Bear Valley Reservoir near Pine Knot b/	34 14 30	116 58 35	6,700	42.2	-	-	-	-	10,000	237	-
32	Mill Creek near Craftonville	34 05 15	117 02 25	2,950	42.9	1919-38	Feb.16, 1927	4,500	-	18,100	422	Slope-area.
33	Plunge Creek near East Highlands	34 07 10	117 08 30	1,625	16.9	1919-38	Feb.16, 1927	1,420	6 p.m.	5,340	316	Do.
34	San Timoteo Creek near Redlands	34 01 55	117 12 30	1,260	118	1926-38	Feb. 6, 1937	3,600	9 p.m.	7,460	63.2	Do.

a Occurred Mar. 3.
b Records furnished by Corps of Engineers, U. S. Army.
c Records furnished by Orange County Flood Control District.
d Excluding Bear Valley.
e Excluding Bear Valley and San Jacinto River.

Table 23.- Summary of flood discharges—Continued

No. on map (pl.11, 12, 13)	Stream and place of determination	Latitude	Longitude	Altitude	Drainage area (sq. mi.)	Period of record	Maximum discharge previously known		Maximum discharge March 2, 1938			
							Date	Sec.-ft.	Time	Sec.-ft.	Sec.-ft. per sq.mi.	Method of determination
	PACIFIC SLOPE BASINS—Con.	° ' "	° ' "									
	Santa Ana River Basin—Con.											
35	Redlands waste at Sterling Avenue, near Redlands	34 03 30	117 14 40	1,105	-	-	-	-	-	589	-	Slope-area.
36	Warm Creek at San Bernardino	34 06 15	117 16 55	1,020	57.8	-	-	-	-	3,650	63.1	Do.
37	Warm Creek near Colton	34 04 00	117 18 30	970	-	1920-38	Dec.21, 1921	2,780	7 p.m.	27,500	-	Do.
38	Sand Creek near Del Rosa	34 09 20	117 13 35	1,580	3.0	-	-	-	-	780	260	Do.
39	Strawberry Creek near Arrowhead Springs	34 10 45	117 15 55	1,650	8.6	1919-38	Feb. 6, 1937	492	4 p.m.	3,360	391	Rainfall-runoff and slope-area studies.
40	Waterman Canyon Creek near Arrowhead Springs	34 11 35	117 16 35	2,125	4.55	1919-38	Feb. 6, 1937	390	4 p.m.	2,350	516	Do.
41	City Creek near Highland	34 08 20	117 11 25	1,520	19.8	1919-38	Apr. 5, 1926	2,360	4 p.m.	6,900	348	Slope-area.
42	Devil Canyon Creek near San Bernardino	34 12 05	117 20 10	1,800	6.16	1913-14 1919-38	Apr. 7, 1926	220	4 p.m.	3,320	539	Rainfall-runoff and slope-area studies.
43	Lytle Creek near Fontana	34 12 05	117 26 50	2,200	47.9	1918-21 1922-38	Feb.16, 1927	5,300	-	25,200	526	Slope-area.
44	Lytle Creek (east channel) at San Bernardino	34 05 50	117 19 05	1,050	-	1929-38	Feb.14, 1937	1,060	7:30 p.m.	21,500	-	Orifice.
45	Lytle Creek (west channel) at Colton	34 04 00	117 19 15	980	-	1929-38	Jan. 5, 1935	20	7 p.m.	7,900	-	Extension of rating curve.
46	Cajon Creek near Keenbrook	34 15 50	117 27 50	2,620	40.9	1919-38	Dec.20, 1921	5,000	5 p.m.	14,500	355	Slope-area.
47	Lone Pine Creek near Keenbrook	34 15 55	117 27 55	2,630	15.3	1919-38	Dec.19, 1921	810	-	6,180	404	Do.
48	Day Creek near Etiwanda	34 11 00	117 32 25	2,940	4.8	1929-38	Feb.11, 1936	192	-	4,200	875	Rainfall-runoff study.
49	Cucamonga Creek near Upland	34 10 15	117 37 55	2,550	10.1	1928-38	Feb.11, 1936	475	3 p.m.	10,300	1,020	Rainfall-runoff and slope-area studies.
50	San Jacinto River near San Jacinto	34 44 05	116 49 45	1,980	140	1920-38	Feb.16, 1927	45,000	12 p.m.	14,300	102	Mean of contracted opening and slope-area.
51	San Jacinto River at Railroad Canyon Reservoir, near Elsinore b/	33 41 40	117 16 20	1,330	709	-	-	-	8 p.m.	3,150	4.4	Reservoir record.

52	San Jacinto River near Elsinore	33 39 45	117 17 45	1,270	717	1916-38	Feb.17, 1927	16,000	2 to 4 a.m.[f]	2,790	3.9	Extension of rating curve.
53	Elsinore Lake at Elsinore (inflow) h/	33 40 35	117 21 30	1,200	798	-	-	-	5 p.m.	4,500	5.6	Reservoir record.
54	Temescal Creek near Corona	33 50 30	117 30 45	730	g157	1929-38	Feb. 6, 1937	2,350	7 p.m.	14,900	94.9	Slope-area.
55	Chino Creek near Chino	33 56 50	117 40 05	530	88.2	-	-	-	-	5,000	56.7	Mean of contracted opening and slope-area plus weir.
56	Chino Creek near Prado	33 53 40	117 38 40	460	176	1929-38	Jan. 1, 1934	1,440	6 p.m.	5,200	29.5	Slope-area plus estimate.
57	San Antonio Creek near Claremont	34 12 50	117 40 00	3,400	16.9	1917-38	Dec.19, 1921	1,020	4 p.m.	21,400	1,270	Rainfall-runoff and slope-area studies.
58	San Antonio Creek near Chino	34 01 35	117 43 40	760	36.7	-	-	-	-	2,010	54.8	Weir.
59	Santiago Creek at Santiago Reservoir, near Villa Park (inflow) h/	33 47 00	117 43 35	680	62.5	-	-	-	5 p.m.	9,850	153	Reservoir record.
60	Santiago Creek near Villa Park h/	33 49 10	117 46 30	420	83.8	1920-38	Feb.16, 1927	11,000	7 p.m.	5,200	62.1	Slope-area.
61	Santiago Creek at Santa Ana	33 46 00	117 52 45	120	-	1929-38	Feb. 6, 1937	3,270	8:30 p.m.	4,400	-	Extension of rating curve.
62	Irvine Ranch drainage canal near Tustin c/	33 40 50	117 51 30	26	93	1930-38	Feb. 6, 1937	5,020	-	5,710	61.4	-
	San Gabriel River Basin											
63	East Fork of San Gabriel River near Camp Bonita	34 14 15	117 49 10	1,500	91.4	1932-38	Jan. 1, 1934	8,500	-	46,000	503	Extension of rating curve.
64	San Gabriel River at flood-control reservoir No. 1, near Azusa (inflow) h/	34 12 15	117 51 20	1,200	202	-	-	-	4 p.m.	90,000	446	Reservoir record.
65	San Gabriel River at Morris Reservoir, near Azusa											
	Inflow i/	34 10 25	117 52 50	950	211	-	-	-	7:25 p.m.	66,200	514	Do.
	Outflow					1894-1938	Jan.18, 1916	40,000	7:05 p.m.	65,700	-	Spillway rating.
66	San Gabriel River at Foothill Boulevard, near Azusa h/	34 08 15	117 56 35	580	230	1932-38	Jan.19, 1933	10,000	7:35 p.m.	61,800	269	Slope-area.

b Records furnished by Corps of Engineers, U. S. Army.
c Records furnished by Orange County Flood Control District.
f Occurred Mar. 5.
g Area below Elsinore Lake.
h Records furnished by Los Angeles County Flood Control District.
i Records furnished by City of Pasadena Water Department.

Table 23.- Summary of flood discharges—Continued

No. on map (pl.11, 12, 13)	Stream and place of determination	Latitude	Longitude	Altitude	Drainage area (sq. mi.)	Period of record	Maximum discharge previously known		Maximum discharge March 2, 1938			
							Date	Sec.-ft.	Time	Sec.-ft.	Sec.-ft. per sq.mi.	Method of determination
		° ′ ″	° ′ ″									
	PACIFIC SLOPE BASINS—Con.											
	San Gabriel River Basin—Con.											
67	San Gabriel River at Pico h/	34 00 20	118 04 05	180	-	1928-37	Jan. 1, 1934	22,000	10:30 p.m.	22,700	-	Slope-area.
68	San Gabriel River at Spring Street, near Los Alamitos	33 48 40	118 05 30	22	-	1928-38	Jan. 1, 1934	15,000	-	27,300	-	Do.
69	West Fork of San Gabriel River at flood-control reservoir No. 2, near Camp Rincon (inflow) h/	34 14 45	117 57 50	2,140	40.4	-	-	-	4:15 p.m.	26,900	666	Reservoir record.
70	West Fork of San Gabriel River at Camp Rincon h/	34 14 30	117 51 50	1,600	102	1927-38	Jan. 1, 1934	5,320	-	34,000	333	Estimate.
71	Rogers Creek near Azusa	34 09 55	117 54 20	800	6.4	1917-38	Apr. 7, 1926	2,600	4:30 p.m.	2,070	323	Extension of rating curve.
72	Fish Creek near Duarte	34 10 00	117 55 25	1,000	6.5	1916-38	Apr. 4, 1925	2,180	5 p.m.	2,100	323	Rainfall-runoff studies.
73	Sawpit Creek at flood-control reservoir near Monrovia (inflow) h/	34 10 30	117 59 00	1,228	3.27	1932-38	Jan. 1, 1934	j 240	4:15 p.m.	1,000	306	Reservoir record.
74	Sawpit Creek near Monrovia	34 10 20	117 59 25	1,100	5.7	1916-38	Apr. 7, 1926	2,000	-	1,800	316	Do.
75	San Dimas Creek at flood-control reservoir near San Dimas (inflow) h/	34 09 15	117 46 15	1,350	16.5	1932-38	Jan. 1, 1934	j 422	5:10 p.m.	4,600	279	Do.
76	San Dimas Creek near San Dimas	34 08 45	117 46 35	1,245	18.3	1916-38	February 1914	2,950	6 p.m.	4,250	232	Do.
77	Fern Canyon Watershed No. 2, near San Dimas k/	34 11 55	117 42 08	4,500	.063	-	-	-	4 p.m.	28.8	457	Parshall Flume.
78	Fern Canyon Watershed No. 3, near San Dimas k/	34 11 53	117 42 09	4,500	.084	-	-	-	4 p.m.	19.0	226	Do.
79	Wolfskill Creek near San Dimas k/	34 10 35	117 45 25	1,700	2.78	-	-	-	2:43 p.m.	830	299	Do.

80	West Fork of San Dimas Creek near San Dimas k/	34 10 10	117 46 15	1,600	1.66	-	-	-	4:05 p.m.	664	400	Do.
81	Dalton Creek at flood-control reservoir near Glendora (inflow) h/	34 10 10	117 48 30	1,565	4.49	1929-38	Jan. 1, 1934	j 227	3:15 p.m.	1,350	301	Reservoir record.
82	Dalton Creek near Glendora	34 09 20	117 49 50	1,150	7.5	1919-38	February 1914	1,070	5 p.m.	850	-	Reservoir record plus estimate.
83	Little Dalton Creek near Glendora h/	34 09 30	117 50 15	1,110	3.3	1929-38	February 1914	1,020	4:55 p.m.	960	291	Slope-area.
84	Walnut Creek near Baldwin Park h/	34 03 55	117 59 00	335	99	1928-38	Jan. 1, 1934	8,060	5 p.m.	4,290	43.3	Rating curve.
85	Live Oak Creek at flood-control reservoir near La Verne (inflow) h/	34 07 45	117 44 45	1,430	2.30	1936-38	Feb. 6, 1937	j 139	3:45 p.m.	373	162	Reservoir record.
86	San Jose Creek near Whittier h/	34 01 25	118 02 05	230	85.2	1929-38	Jan. 1, 1934	13,100	4:40 p.m.	9,350	110	Rating curve.
87	Thompson Creek at flood-control reservoir near Claremont (inflow) h/	34 08 30	117 42 30	1,582	3.91	1932-38	Feb. 9, 1932	j 91	2:30 p.m.	669	172	Reservoir record.
88	Coyote Creek near Artesia b/ h/	33 50 45	118 03 30	35	110	1929-38	Feb. 6, 1937	4,190	8 p.m.	4,000	36.4	Extension of rating curve.
89	Brea Creek at Fullerton c/	33 52 25	117 55 40	250	26.4	1930-38	Oct.17, 1934	1,600	-	1,970	74.6	-
90	Carbon Creek at Olinda c/	33 53 20	117 50 40	352	20.0	1930-38	Jan. 1, 1934	728	-	1,760	88	Slope-area.
	<u>Los Angeles River Basin</u>											
91	Los Angeles River near Van Nuys h/	34 09 30	118 26 55	636	157	1928-38	Jan. 1, 1934	7,380	5 p.m.	11,600	73.9	Mean of float and orifice.
92	Los Angeles River near Universal City b/ h/	34 08 35	118 22 10	550	-	1930-38	Jan. 1, 1934	9,140	-	37,700	-	Slope-area.
93	Los Angeles River at Los Angeles h/	34 04 50	118 13 35	298	510	1929-38	Jan. 1, 1934	22,000	10 p.m.	67,000	131	Do.
94	Los Angeles River near Downey h/	33 56 45	118 10 25	88	614	1928-38	Jan. 1, 1934	29,400	10 p.m.	79,700	130	Do.
95	Los Angeles River at Long Beach h/	33 47 25	118 12 20	-	-	1928-38	Feb.14, 1937	20,500	-	99,000	-	Estimated.

b Records furnished by Corps of Engineers, U. S. Army.
c Records furnished by Orange County Flood Control District.
h Records furnished by Los Angeles County Flood Control District.
j Mean for 1 hour.
k Records furnished by U. S. Forest Service.

Table 23.- Summary of flood discharges—Continued

No. on map (pl. 11, 12, 13)	Stream and place of determination	Latitude	Longitude	Altitude	Drainage area (sq. mi.)	Period of record	Maximum discharge previously known		Maximum discharge March 2, 1938			
							Date	Sec.-ft.	Time	Sec.-ft.	Sec.-ft. per sq. mi.	Method of determination
		° ' "	° ' "									
	PACIFIC SLOPE BASINS—Con.											
	Los Angeles River Basin—Con.											
96	Browns Creek at Chatsworth h/	34 15 25	118 35 45	1,100	14.3	1929-32 1936-38	Feb. 9, 1932	152	10 a.m.	870	61	Extension of rating curve.
97	Pacoima Creek at flood-control reservoir near San Fernando (inflow) h/	34 20 00	118 23 45	1,650	27.8	1927-38	Jan. 1, 1934	j 914	3:50 p.m.	8,450	304	Reservoir record.
98	Pacoima Creek near San Fernando h/	34 20 02	118 23 55	1,650	27.9	1916-38	February 1914	5,400	-	-	-	-
99	Pacoima Creek at Mission Acres h/ h/	34 13 40	118 27 30	820	50.6	1929-38	Feb. 8, 1932	477	3:40 a.m.[a]	2,270	44.9	Extension of rating curve.
100	Tujunga Creek near Colby Ranch h/	34 18 10	118 09 35	2,450	66.9	1930-38	Feb. 8, 1932	3,910	-	-	-	-
101	Tujunga Creek at flood-control reservoir near Sunland (inflow) h/	34 17 30	118 11 10	2,104	81.4	1931-38	Jan. 1, 1934	j2,430	5 p.m.	35,000	430	Reservoir record.
102	Tujunga Creek near Sunland h/	34 17 55	118 16 10	1,600	106	1916-38	Dec. 19, 1921	8,500	-	50,000	472	Estimated.
103	Tujunga Creek near San Fernando h/ h/	34 15 50	118 22 50	995	148	1931-38	Jan. 1, 1934	3,750	6 p.m.	51,000	345	Slope-area.
104	Little Tujunga Creek near San Fernando h/	34 16 30	118 22 20	1,250	21.0	1928-38	Jan. 1, 1934	1,360	-	8,500	405	Estimated.
105	Haines Creek near Tujunga	34 15 50	118 16 15	2,200	1.2	1917-38	Jan. 1, 1934	-	1:30 p.m.	265	221	Extension of rating curve.
106	Verdugo Creek at Del Valle Avenue, Glendale h/ h/	34 11 05	118 13 35	915	19.1	1935-38	Jan. 5, 1935	1,020	2:12 p.m.	3,500	183	Slope-area.
107	Verdugo Creek at Glendale h/	34 09 25	118 16 25	465	22.4	1935-38	Mar. 30, 1936	1,100	2:25 p.m.	4,500	201	Do.
108	Arroyo Seco near Pasadena	34 13 20	118 10 40	1,400	16.4	1910-38	Feb. 20, 1914	5,630	4 p.m.	8,620	526	Do.

109	Arroyo Seco at Devils Gate Dam, near Pasadena (inflow) h/	34 11 10	118 10 30	1,000	30.6	-	February 1914	11,400	-	11,400	373	-
110	Santa Anita Creek near Sierra Madre	34 11 45	118 01 05	1,400	10.5	1916-38	Apr. 7, 1926	3,300	-	5,200	495	Estimated.
111	Santa Anita Creek at flood-control reservoir near Sierra Madre (inflow) h/	34 11 10	118 01 10	1,100	10.8	1932-38	Jan. 1, 1934	m 323	4:10 p.m.	5,490	508	Reservoir record.
112	Little Santa Anita Creek near Sierra Madre	34 11 15	118 02 35	2,200	1.9	1916-38	Apr. 7, 1926	-	-	536	282	Estimated.
113	Little Santa Anita Creek at flood-control reservoir near Sierra Madre (inflow) h/	34 10 40	118 02 40	1,110	2.39	-	-	-	4:10 p.m.	633	265	Reservoir record.
114	Eaton Creek near Pasadena	34 11 40	118 06 15	1,230	6.5	1918-38	Apr. 7, 1926	1,360	5 p.m.	2,400	369	Estimated.
115	Eaton Creek at flood-control reservoir near Pasadena (inflow) h/	34 10 05	118 05 30	840	9.48	-	-	-	4:40 p.m.	3,340	352	Reservoir record.
116	Eaton Creek near El Monte h/	34 05 15	118 03 55	288	18.4	1930-38	Jan. 1, 1934	2,180	6 p.m.	2,300	125	Slope-area.
117	Rubio Canyon Wash at Rosemead h/	34 04 30	118 04 35	290	13.4	1930-38	Dec.31, 1933	2,070	9 a.m.	2,700	201	Extension of rating curve.
118	Alhambra Wash at Alhambra h/ h/	34 03 20	118 05 10	244	14.5	1930-38	Jan. 1, 1934	4,890	9 a.m.	4,100	283	Slope-area.
119	Rio Hondo near El Monte h/ h/	34 05 35	118 01 55	295	-	1932-38	Jan. 1, 1934	5,860	9 p.m.	31,800	-	Do.
120	Rio Hondo near Montebello h/	34 01 55	118 04 15	200	-	1928-38	Jan. 1, 1934	11,800	11 p.m.	28,000	-	Do.
121	Rio Hondo near Downey h/	33 56 40	118 09 50	95	-	1928-38	February 1914	20,900	1 a.m.[a]	24,400	-	Do.
	Ballona Creek Basin											
122	Centinela Creek near Culver City h/ h/	33 58 35	118 23 05	47	5.17	1932-38	Mar. 2, 1935	1,590	5 a.m.	1,900	368	Do.
123	Ballona Creek near Culver City h/ h/	33 59 50	118 24 10	40	112	1928-38	Jan. 1, 1934	11,300	9:40 a.m.	19,000	171	Rating curve.
124	Benedict Canyon storm drain at Culver City h/ h/	34 01 23	118 23 00	95	6.96	1935-38	Feb.12, 1936	248	7:10 a.m.	648	93.1	Slope-area

a Occurred Mar. 3.
b Records furnished by Corps of Engineers, U. S. Army.
h Records furnished by Los Angeles County Flood Control District.
j Mean for 1 hour.
m Mean for day.

Table 23. Summary of flood discharges—Continued

No. on map (pl.11, 12, 13)	Stream and place of determination	Latitude	Longitude	Altitude	Drainage area (sq. mi.)	Period of record	Maximum discharge previously known		Maximum discharge March 2, 1938			
							Date	Sec.-ft.	Time	Sec.-ft.	Sec.-ft. per sq.mi.	Method of determination
	PACIFIC SLOPE BASINS—Con.	° ' "	° ' "									
	Topanga Creek Basin											
125	Topanga Creek near Topanga Beach h/	34 03 50	118 35 10	270	17.9	1930-38	Dec.31, 1933	4,510	9:40 a.m.	7,960	445	Slope area.
	Malibu Creek Basin											
126	Malibu Creek at Crater Camp near Calabasas h/	34 04 30	118 42 10	460	103	1931-38	Jan. 1, 1934	9,650	1 p.m.	10,000	97.1	Estimated.
	Calleguas Creek Basin											
127	Calleguas Creek near Camarillo	34 10 40	119 02 30	55	249	-	-	-	-	10,900	43.8	Contracted opening.
128	Happy Camp Creek at Moorepark	34 17 10	118 51 30	590	12.0	-	-	-	-	235	19.6	Slope-area.
129	Arroyo Conejo near Camarillo	34 12 15	118 55 00	460	35.1	-	-	-	-	4,500	128	Do.
130	Honda Barranca at Berylwood Road, near Somis n/	34 17 22	119 02 32	562	1.35	-	-	-	9:05 p.m.p	256	190	Weir rating.
131	Honda Barranca at Perkins Road, near Somis n/	34 16 05	119 02 55	349	2.86	-	-	-	9:20 p.m.p	486	170	Do.
	Santa Clara River Basin											
132	Santa Clara River near Ravenna	34 26 20	118 18 35	2,030	116	-	-	-	-	28,200	243	Mean of weir and slope-area reach.
133	Santa Clara River near Saugus h/	34 25 42	118 35 23	-	355	1929-38	Jan. 1, 1934	3,870	7:30 p.m.	24,000	67.6	Estimated.
134	Santa Clara River near Santa Paula	34 19 40	119 04 35	210	1,533	-	-	-	1:30 p.m.	120,000	78.3	Slope-area.
135	Agua Dulce Creek near Lang	34 26 30	118 19 55	1,960	29.5	-	-	-	-	1,930	65.4	Do.
136	Sand Creek near Lang	34 23 20	118 25 05	1,755	7.4	-	-	-	-	3,910	528	Do.

137	Bouquet Creek near Saugus	34 31 55	118 26 25	1,990	q 21.2	-	-	-	-	890	-	Do.
138	San Francisquito Creek near Saugus	34 31 15	118 31 55	1,490	40.5	-	-	-	-	5,000	123	Do.
139	Castaic Creek near Castaic	34 32 40	118 37 40	830	77.7	-	-	-	-	6,520	83.9	Do.
140	San Martinez Chiquito Creek near Del Valle	34 25 05	118 39 25	930	4.8	-	-	-	-	504	105	Weir.
141	Piru Creek near Piru	34 25 30	118 45 45	780	432	1911-13 1927-38	Feb. 9, 1932	15,800	1:30 p.m.	35,600	82.4	Slope-area.
142	Pole Creek at Fillmore	34 24 30	118 54 25	630	7.8	-	-	-	-	3,100	397	Do.
143	Sespe Creek near Fillmore	34 26 55	118 55 35	590	254	1927-38	Dec.31, 1933	34,000	2 p.m.	56,000	220	Do.
144	Santa Paula Creek near Santa Paula	34 23 40	119 04 35	650	39.8	1927-38	Dec.31, 1933	10,000	2 p.m.	13,500	339	Do.
145	Adams Creek near Santa Paula	34 20 40	119 06 10	310	8.4	-	-	-	-	1,590	189	Mean of contracted opening and slope-area.
146	Wheeler Creek near Santa Paula	34 20 05	119 08 25	335	8.0	-	-	-	-	810	101	Slope-area.
147	Aliso Creek near Santa Paula	34 19 45	119 09 10	340	12.5	-	-	-	-	3,170	254	Do.
148	Harmon Creek near Saticoy	34 17 30	119 11 55	450	3.4	-	-	-	-	452	133	Do.
	Hall Creek Basin											
149	Hall Creek at Ventura	34 16 40	119 15 50	110	5.4	-	-	-	-	572	106	Do.
	Ventura River Basin											
150	Matilija Creek at Matilija	34 29 05	119 18 30	970	55	1927-38	Dec.31, 1933	7,000	12:30 p.m.	15,900	289	Do.
151	Ventura River near Ventura	34 20 55	119 18 20	210	187	1911-13 1929-38	Dec.31, 1933	23,000	2:15 p.m.	39,200	210	Do.
152	Senor Creek near Ojai	34 28 10	119 12 05	1,150	5.7	-	-	-	-	894	157	Contracted opening.
153	San Antonio Creek near Ojai	34 25 25	119 15 30	580	33.9	-	-	-	-	6,110	180	Slope-area.
154	Gridley Creek near Ojai	34 28 05	119 12 20	1,100	3.6	-	-	-	-	896	249	Do.
155	Coyote Creek near Ventura	34 21 20	119 18 50	250	41.1	1927-32 1933-38	Feb.14, 1937	5,600	1:30 p.m.	11,500	280	Do.
156	Santa Ana Creek near Oak-view	34 23 45	119 20 25	435	11.3	-	-	-	-	3,780	335	Do.
157	Cañada del Diablo near Ventura	34 18 35	119 19 05	205	4.7	-	-	-	-	162	34.5	Do.

h Records furnished by Los Angeles County Flood Control District.
n Records furnished by U. S. Soil Conservation Service.
p Occurred Feb. 28.
q Affected by storage.

Table 23.- Summary of flood discharges—Continued

No. on map (pl. 11, 12, 13)	Stream and place of determination	Latitude	Longitude	Altitude	Drainage area (sq. mi.)	Period of record	Maximum discharge previously known		Maximum discharge March 2, 1938			
							Date	Sec.-ft.	Time	Sec.-ft.	Sec.-ft. per sq. mi.	Method of Determination
	PACIFIC SLOPE BASINS—Con.	° ' "	° ' "									
	Carpinteria Creek Basin											
158	Carpinteria Creek at Carpinteria	34 23 30	119 30 40	30	13.9	-	-	-	-	1,350	97.1	Slope-area.
	Santa Ynez River Basin											
159	Santa Ynez River at Juncal Reservoir, near Montecito r/	34 29 30	119 30 50	1,950	16.0	-	-	-	-	j 4,160	260	Reservoir record.
160	Santa Ynez River near Santa Barbara s/	34 31 40	119 41 00	1,200	219	-	-	-	-	t 38,200	174	Do.
161	Santa Ynez River below Gibraltar Dam near Santa Barbara s/	34 31 40	119 41 00	1,200	219	-	-	-	2:15 p.m.	35,500	162	Spillway and valve ratings.
162	Santa Ynez River near Santa Ynez	34 35 20	120 01 25	500	435	1929-31 1932-38	Feb. 6, 1937	7,990	6 p.m.	43,700	100	Extension of rating curve.
163	Santa Ynez River near Lompoc	34 38 30	120 25 50	100	790	1906-18 1925-38	Jan. 25, 1914	41,800	4 a.m.[a]	50,100	63.4	Do.
	Santa Maria River Basin											
164	Cuyama River near Santa Maria	35 00 50	120 16 45	610	902	1929-38	Feb. 6, 1937	5,220	9 a.m.[a]	17,300	19.2	Slope-area.
165	Huasna River near Santa Maria	35 01 20	120 19 20	600	119	1929-38	Feb. 11, 1938	u11,400	5 p.m.	1,190	10.0	Rating curve.

	THE GREAT BASIN											
	Salton Sea Basin											
166	Whitewater River above Whitewater	33 58 55	116 39 20	2,100	51.4	-	-	-	-	42,000	817	Slope area.
167	Whitewater River near Indian Wells	33 42 55	116 18 20	85	525	-	-	-	(v)	29,000	55.2	Do.
168	San Gorgonio River near Banning	33 57 05	116 52 45	2,740	21.2	-	-	-	-	17,000	802	Do.
169	Palm Canyon Creek near Palm Springs	33 44 55	116 32 15	700	94	1930-38	Feb. 6, 1937	3,850	10 p.m.	2,380	25.3	Extension of rating curve.
	Mojave River Basin											
170	Deep Creek near Hesperia	34 20 30	117 13 40	3,050	137	1929-38	Feb. 9, 1932	7,900	-	46,600	340	Do.
171	Mojave River at lower narrows, near Victorville	34 34 25	117 19 10	2,640	530	1930-38	Feb. 9, 1932	12,500	7:30 p.m.	70,600	133	Do.
172	Mojave River at Barstow	34 54 25	117 01 20	2,090	-	1930-38	Feb. 9, 1932	8,300	2 a.m.[a]	64,300	-	Do.
173	West Fork of Mojave River near Hesperia	34 20 20	117 14 35	3,050	74.8	1930-38	Feb. 8, 1932	6,000	-	26,100	349	Do.

a Occurred Mar. 3.
j Mean for 1 hour.
r Records furnished by Montecito County Water District.
s Records furnished by City of Santa Barbara.
t Mean for 15 minutes.
u Slope-area measurement.
v Occurred Mar. 2 or 3.

PHYSIOGRAPHIC AND GEOLOGIC FEATURES AFFECTING FLOOD RUNOFF

By Harold V. Peterson

Introduction

In a region in which the structures are as diverse and the topographic and geologic contrasts as sharp as they are in southern California it is evident that any attempt to discuss the relation between flood runoff and the physiographic and geologic features on an areal basis, must be a generalization. Stream flow resulting from rain falling on a drainage basin represents the combined influence of many factors, chief among which are distribution, rate, and amount of rainfall, antecedent rain, climate, shape of the drainage area, condition of the channel, and the ability of the surface mantle and underlying bedrock to absorb and to retain the rain. Geology has an important bearing on the last-named factor, because the type and texture of the surface mantle and the character and structure of the underlying bedrock are the result of geologic agencies and processes. Soil conditions often determine the type and extent of vegetal covering, which has an important influence on the rainfall-runoff relation, although the climate of the region has a far-reaching influence on this relation as well as on stream development.

As rain falls on the surface of the ground, it is disposed of in three ways: it may be evaporated, it may be absorbed by the soil mantle, or it may run off as surface flow. Of the rain that becomes runoff from any particular area, a part may evaporate from the open water surface and the remainder may flow by devious routes to the ultimate drainage channel or be partly or entirely absorbed into available subsurface storage along the route. The storage capacity of the surface mantle and the underlying formations and the rate at which absorption will take place are factors that affect the rainfall-runoff relation. Both are largely determined by the geologic characteristics of the drainage basin. Runoff studies of many southern California streams indicate that geologic features exert considerable influence on both ordinary and flood flows, and no doubt most of the other streams of the region also, are affected by the geology of their drainage basins, although the relationship is not so obvious nor so easily recognized.

The southern California region consists of a series of mountain ranges representing great upfaulted or upfolded blocks of the earth's crust. The intervening valleys occupy depressed segments filled with debris eroded from the surrounding mountains. Surface features affecting runoff throughout this region range from steep outcrops of practically impervious unweathered rock to almost level surfaces underlain by thick deposits of highly permeable alluvium. In areas of the first type practically all the rain that falls will become runoff, but in areas of the second type the permeable material will absorb all the rain and prevent runoff. Between these extremes are gradations, which vary according to the topography, character of the surface mantle, and condition of the subsurface bedrock.

Physiographic features of the region are youthful in character. The steep mountain ranges rise abruptly from the relatively flat valleys. Streams within the mountain area occupy deep V-shaped canyons separated by sharp narrow ridges. The canyon walls are, as a rule, extremely steep, their slope in many places being only slightly less than the angle of repose of the materials covering them. Mechanical weathering is the dominant factor in rock disintegration and is instrumental in maintaining the steep and rugged form of the mountain area. This process is constantly acting to supply loose material susceptible of being transported by stream action.

Erosion within this mountain area and deposition on the floors of the adjacent valleys are proceeding at an active rate. The great alluvial cones found at the mouths of practically all the canyons are products of these processes. Owing to the seasonal or cyclic character of the storms common to the region, erosion and deposition do not occur at regular intervals; instead, dry periods, during which many of the stream beds are being aggraded, alternate with flood periods, when great quantities of water transport the already disintegrated and loosened debris from the mountains to the valleys. This sharp contrast in both quantity of flow and debris load causes unstable channel conditions, especially over the cone area, with the result that streams often overflow and shift their positions during heavy storms. The recurrence of this shifting of the streams with its accompanying deposition of debris over a long period of years has, of course, been responsible for the natural development of the cones.

The floors of the alluvium-filled valleys represent the flood plains. They consist of a wide expanse of nearly flat lands that merge into the gently sloping cones near the valley margin. The streams, as a rule, are not established in permanent courses but occupy shallow channels cut in the soft, unconsolidated valley fill. In times of flood they overflow and spread, often forming new channels, with the partial or complete abandonment of the old. Wide shifting is known to have occurred on the Santa Ana, Los Angeles, and San Gabriel Rivers within historic times, and a repetition of this action is possible on these and other streams during any future major flood. Efforts to confine the streams are successful only to the limit of capacity of levees or other flood-control structures, and once their capacity is exceeded, as it was in many localities during the flood of March 1938, the flow is essentially uncontrolled.

Owing to the torrential nature of the storms common to the region, coupled with the unstable character of the stream beds and the low relief of the valley floors, floods in southern California are a greater potential source of damage than in areas where the stream channels and flood plains are well defined and easily distinguished.

In the following discussion the purpose has been to outline briefly the main geologic features of the region and to point out what appear to be some of the relations between these features and the runoff from rainfall. Some of the relations seem well-defined and easily recognized, but others are indistinct or obscured by other factors. Neither the time nor the opportunity was available to make detailed field investigations on any phase of the subject, and as a consequence only general aspects of the relations are herein considered. Information covering the general geology of the region has been obtained largely from publications of the Geological Survey of the Department of the Interior, the Division of Water Resources of the State of California, and the University of California. Other reports and studies relating to the subject have been made available by the Los Angeles County Flood Control District. For convenience in discussion, the region has been divided into districts, each of which is characterized by similarity of topographic and geologic features.

San Diego area [18]

That part of western San Diego County extending from the crest of the main mountain range west to the Pacific Ocean and from the international boundary north to the Orange County line is naturally divided into two physiographic and topographic units. To the east lie the mountain highlands, and to the west the narrow coastal belt characterized by dissected terrace formations that terminate at the ocean in a line of sea cliffs.

18 See also Ellis, A. J., and Lee, C. H., Geology and ground water of the western part of San Diego County, Calif.: U. S. Geol. Survey Water-Supply Paper 446, 1919.

Mountain highlands [19]

The mountains of the San Diego area belong to the Peninsular Range, which extends southeast from the Santa Ana Range through the peninsula of Lower California. In the higher, eastern part the general altitude of the range is more than 3,000 feet above sea level; in the western part it is 500 to 1,500 feet above sea level. The highest peaks rise to altitudes of about 6,000 feet. The topography, as a rule, is that of a mature, eroded surface. Slopes are gentle to moderately steep, and the main streams have cut to or near a graded surface.

Within the mountain highlands are several broad valleys, the most notable being Cajon, Santa Maria, Green, Escondido, Poway, San Jose, and San Felipe Valleys. In general, each is partly or completely surrounded by hills or mountains, and their floors are level or gently rolling, occasionally broken by low hills or knobs of granite. Their isolated position and the remoteness of most of them from any large river channel indicate that these valleys were formerly a part of an old peneplained surface.

Some faulting has occurred within the mountain highlands. Two faults have been mapped by Ellis,[20] both apparently southeast extensions of the Elsinore fault systems. One of these strikes southeast from the town of Temecula. The upper part of the San Luis Rey River, above the Pala Indian Reservation, follows the line of this fault. About 8 miles to the northeast a rather prominent northeastward-facing scarp extending from Pauba Valley to San Jose Valley marks the line of a second fault parallel to the first. The upper part of Temecula Creek flows along the course of this fault for a distance of about 15 miles. Farther west several lines of topographic expression indicate the presence of faults, but definite evidence of their existence is not available.

The broken character of the crystalline complex, which allowed pronounced weathering and deep disintegration, is undoubtedly due to strains in the earth's crust that were contemporary with faulting, but the sharp structural breaks between mountains and valleys and the gravel-filled troughs common to the San Bernardino and San Gabriel Ranges are not found in the San Diego area. Certain surface and subsurface conditions created

19 See also Sauer, Carl, Land forms in the Peninsular Range of California as developed about Warner's Hot Springs and Mesa Grande: Calif. Univ., Pub. in Geography, vol. 3, no. 4, pp. 199-290, 1929; Miller, W. J., Geomorphology of the southern Peninsular Range of California: Geol. Soc. Am. Bull., vol. 46, pp. 1535-62, October 1935.

20 Ellis, A. J., and Lee, C. H., op. cit., pl. 3.

by faulting no doubt have some effect on the flood runoff, but definite evidence of a relationship between the structural features and runoff is lacking.

Coastal belt

A narrow belt underlain by sedimentary rocks of Eocene age and younger follows the coast line and extends eastward a distance of 5 to 20 miles. As previously noted, it consists largely of level or gently rolling broad-topped terraces dissected by streams. North of the Otay River these terraces slope toward the sea from an altitude of 500 feet along the eastern margin of the belt to 300 feet near the coast. South of the river they slope in the opposite direction and range in altitude from 550 feet at the coast to 500 feet 4 miles inland. Structural deformation appears to be responsible for this contrast.

The terraces, locally called mesas, are capped by a shallow reddish-brown soil containing mixtures of partly weathered sand, gravel, and clay. The underlying formations consist of well-consolidated marine sediments, including sandstones, shales, and conglomerates. For the most part both the surface and subsurface deposits are rather tight and impervious, a condition that permits only a small amount of absorption and consequently a small yield of water from underground sources.

River valleys

The Tia Juana, Sweetwater, San Diego, San Dieguito, and San Luis Rey Rivers all head near the summit of the Peninsular Range and flow southwest or west to the ocean. The Otay River occupies a small basin that heads near Lyons Peak, which is several miles west of the main divide. The Santa Margarita River has cut beyond the divide and drains a large area between the Santa Ana and San Jacinto Ranges.

As with other features of the San Diego area, the regimen of the streams has been controlled to a large extent by oscillation of the land. Within the mountain highlands the streams have cut deep gorges with steep side slopes, but the valleys are generally wide and their floors are graded, indicating that at one time the land surface was considerably higher than at present. Subsequent sinking and filling on the valley floors resulted in the present conditions. The fill consists of alluvial deposits of sand, gravel, and clay, in which sand predominates. Within the coastal belt a similar condition prevails. The sides of the valley are steep, although comparatively low. The floors are wide and flat.

Near the coast most of the streams are partly drowned, giving rise to marshy tidelands of considerable extent.

The valley fill ranges in thickness from a thin layer to more than 100 feet. In some reaches of the canyons, especially in the higher mountain areas, the stream beds are narrow and the bedrock crops out at the surface. Commonly, however, the valleys are wider both above and below the canyons and the bedrock is buried under alluvial fill. Differential movement in the earth's crust appears to be responsible for this condition. The few available well logs that show the total thickness of alluvium in the valley fills indicate that the deposits range in depth from 60 to 150 feet in the Tia Juana, Sweetwater, and San Diego River Basins, to more than 200 feet in the San Luis Rey and Santa Margarita River Basins. Much of this fill is favorable to the storage of water, and a large part of the agricultural development in San Diego County has taken place on these valley lands, from the subsurface reservoirs of which water for irrigation is pumped.

Effect of geology on flood runoff

The greater part of the San Diego area is characterized by geologic features favorable to the absorption of rainfall. The widespread distribution in the mountain highlands of deeply weathered and disintegrated granite, with its granular and porous soil covering, is especially favorable to this action. The moderate slopes and limited extent of outcrops of the bare rock likewise facilitate absorption. The quantity of rainfall that such an area will absorb is not accurately known, nor can the rate of absorption be definitely stated. It is known, however, that storms of moderate intensity and duration produce little runoff unless they have been preceded by substantial amounts of rain.

Large supplies of ground water have been developed in the granite residium in a number of the upland valleys and flatter slopes. In the vicinity of Fallbrook, for example, a group of wells sunk into the disintegrated granite yields sufficient water to support a considerable acreage of citrus groves. Similar conditions exist in a number of other localities, indicating that a large part of the mountain area has surface and subsurface characteristics favorable to the absorption of rainfall.

Conditions over the coastal belt generally are less favorable to rainfall absorption. Except in areas covered by recent alluvial deposits, the soils are shallow, in most areas not exceeding 12 to 18 inches in depth. They tend toward the compact clayey type and are underlain by a tight, partly or completely cemented subsoil, which merges into impervious marine sediments below. Such surfaces are likely to yield large runoff from rains, because their retentive capacity is limited to a part of the pore space of the upper few inches.

The river valleys, with their extensive alluvial deposits, have a large capacity for subsurface storage and hence should contribute materially to the reduction of runoff peaks. However, two factors tend to prevent this reduction. The first is the factor of time: peak flows last only a few hours as a rule and the amount of percolation that can take place during such a short period is necessarily relatively small. The second is the factor of available storage space: in many of the valleys no attempt is made to utilize the subsurface water supplies, so that in some places the ground water stands within a foot of the surface during most of the year, and in many areas where pumping is practiced the water table is lowered only a few feet during the irrigation season. The net result is a relatively small reduction of flood flows. This condition is probably responsible, in part, for the high stream flows that result from rains that have been preceded by heavy storms. The small available storage is filled by the runoff from the earlier storms, leaving no capacity for retention of subsequent flows. The effect of antecedent precipitation is carried over from one season to the next and may extend over two seasons, as is indicated by the following table prepared by Charles H. Lee on the basis of his investigations in this area.[21] (See table 24.)

Table 24.- Average depth of precipitation, in inches, required to produce runoff on certain streams in the San Diego area

Stream	First year after year with less than 90 percent of average rainfall or second year after one with 70 percent or less	Following an average year (90 to 110 percent of average rainfall)	Following a year with more than 110 percent of average rainfall, except second year after one with 70 percent or less
San Luis Rey River near Pala	6.7	4.3	1.4
Santa Ysabel Creek near Ramona	7.6	4.9	3.7
San Diego River at diverting dam	8.5	5.3	3.1
Sweetwater River at Sweetwater dam	11.3	7.8	5.7

21 Ellis, A. J., and Lee, C. H., Geology and ground waters of the western part of San Diego County, Calif.: U. S. Geol. Survey Water-Supply Paper 446, p. 97, 1919.

It is not clear whether the water retained from wet years is distributed over an entire drainage basin or is confined to its alluvial valleys, but it is probable that the whole basin is affected.

In general, geologic conditions are such that runoff from the Tia Juana, Otay, Sweetwater, San Diego, San Dieguito, San Luis Rey, and Santa Margarita Rivers will be affected approximately as follows: in the part of the area underlain by the granite, light and moderately heavy rains occurring early in the rainy season will be largely absorbed by the surface mantle, and any water that reaches the streams will probably percolate into the alluvial fill of the river beds. On the mesa lands of the coastal belt, runoff is likely to follow all except the lightest storms. Heavy and intense late-season storms, especially if preceded by other heavy rains, are likely to produce flood flows from the mountain areas, and such flows will probably not be reduced by absorption in the river channels. Heavy precipitation in the preceding year will cause greater runoff from all parts of the area and from storms of all types.

San Bernardino mountain area [22]

The San Bernardino Mountains include the eastern part of the great uplifted mountain block that extends from the Salton Sea depression northwest to the Santa Clara River Valley. The San Andreas fault cuts diagonally through the block near its central part, forming Cajon Pass, which has been adopted as the dividing line between the San Bernardino Range on the east and the San Gabriel Range on the west.

The San Bernardino Range is bounded on the south by that part of the San Andreas fault which extends southeastward from Cajon Creek through Potato Canyon and San Gorgonio Pass. The remarkably straight southwest front of the mountains is the dissected scarp of this fracture. San Gorgonio Pass is considered to be a graben associated with this same faulting, the depressed block forming the divide between the San Bernardino and San Jacinto Ranges. On the north side of the San Bernardino Range, less spectacular but nevertheless distinct fault lines and escarpments mark the boundary between the mountains and the Mojave Desert. Thus the mountain mass consists of a great block of the earth's crust pushed up several thousand feet between two lines of faulting.

22 See also Vaughan, F. E., Geology of San Bernardino Mountains north of San Gorgonio Pass: California Univ., Dept. Geol. Sci., Bull., vol. 13, no. 9, pp. 319-411, 1922. Eckis, Rollin, Geology and ground water storage capacity of valley fill: California Dept. Public Works, Water Resources Div., Bull. 45, 1934; Noble, L. F., Excursion to the San Andreas fault and Cajon Pass: 16th Internat. Geol. Cong. Guidebook 15, pp. 10-21, 1932.

The structural features associated with the foundation of the range have caused two distinct and contrasting types of topography--steep north and south boundaries and a comparatively subdued plateau area that forms the interior of the range. This plateau area, which includes Bear Valley and the part of the Santa Ana drainage basin above Seven Oaks, is 10 to 15 miles wide, and about 30 miles long. The subdued topography, gentle slopes, and extensive open valleys indicate that it may formerly have been a partly peneplained area uplifted with the mountain range. North of this plateau the surface slopes sharply to the level of the desert, and south of it to the upper Santa Ana River Valley. Here the streams and washes have cut deep gorges into the frontal scarps, resulting in the characteristic rugged terrain common to the mountain boundaries.

Geology of the San Bernardino Range

Information concerning the distribution of rock types in the San Bernardino Range is incomplete, but the general extent of the various formations and their effect on the rainfall-runoff relation may be outlined. The most widespread formation found in the mountain area consists of a coarse crystalline granite locally intruded by dikes of siliceous porphyry. One large mass of this granite extends from Cienaga Seca and Rattlesnake Creeks eastward to the limits of the range; another mass extends south and west from Big Meadows and Santa Ana Canyon to the faulted sections along the southern boundary; and a third mass extends west from Bear Lake, which is north of the crest of the range, to Cajon Pass. In certain areas along the stream beds the granite is buried under fan deposits of unconsolidated alluvium. One such area parallels the Santa Ana River between Big Meadows and Seven Oaks; and others occur in Bear Valley, along Holcomb Creek, and in Millard, Hathaway, and Protrero Canyons. These deposits represent remnants of a formation that formerly extended across the canyon floors when the range was at a considerably lower altitude. Subsequent uplift and rejuvenated stream action have caused partial erosion, leaving the remainder of these deposits as benchlike features flanking the stream beds.

Associated with the granite are widespread masses and belts of contorted schists and gneisses of variable character. The largest mass extends south from the San Bernardino and San Gorgonio Mountains to San Gorgonio Pass and the mouth of Whitewater River. Another mass follows the crest of the range west from Bear Creek Gorge to Cajon Pass and occupies practically all the area between the San Andreas and Cleghorn faults. The metamorphic rocks are intruded in many places by granite, with the foliation commonly extending through the granite.

Sedimentary rocks including limestone and quartzites of carboniferous age or older, make up much of the range on the desert side east of Arrastre and Rattlesnake Creeks. These rocks are folded and faulted, and in many places are intimately associated with the adjacent schistose and granitic formations. One belt of quartzite extends north from Cienaga Seca and Sugarloaf Mountain across Broom Flat and Baldwin Lake. Holcomb Valley, northwest of Baldwin Lake, is surrounded by exposures of limestone and quartzite, with younger alluvium occupying its central parts.

Deposits of shale, sandstone, and conglomerate of Tertiary Age or younger occupy narrow belts and wedges along the San Andreas fault below Cajon Pass and San Gorgonio Pass. East of Devil Canyon the fault block between the San Andreas and Mission Creek faults consists largely of a coarse-grained arkose sandstone and conglomerate. The upper reaches of the Cajon Creek Basin, including the area north of the San Andreas fault, are underlain by coarse-grained sandstone interbedded with small deposits of shale and impure limestone. This same formation appears between Cleghorn Mountain and Horsethief Canyon and the flanks of the mountains along the Mojave Desert. The position of these isolated sedimentary blocks is due to fault movements, and the beds as a rule are highly distorted and displaced. Dips up to 70° are not uncommon, and some of the strata are overturned.

Much of the major faulting in the San Bernardino Range is confined to the south-border areas and is a part of or closely associated with the San Andreas fault system. The Mission Creek fault is one of this group. Its scarp lies a few miles to the north of and parallel with the San Andreas fault, and it extends from Devil Canyon through Mill Creek and the headwaters of the Whitewater River into Mission Creek. The spectacular box canyon at the head of Mill Creek appears to have resulted from stream erosion along this break. There is evidence that several other faults, whose strikes range from east to northeast, branch off from the Mission Creek fault. Most of these appear to be inactive and their effect on the topography has been largely obliterated by erosion. On the north side of the range several faults are known to strike northwest from the mountain area into the desert, but their influence on runoff is probably not significant.

Between Waterman Canyon and Lone Pine Canyon several lines of faulting that strike east and southeast branch off from the San Andreas system. One line cuts through Waterman Canyon and is the source of the hot springs known as Arrowhead Hot Springs, while another branches off at Cable Canyon and cuts through Devil Canyon about 1½ miles from its mouth. The complex structure found in the lower part of Lone Pine Canyon and reaching through Cleghorn Canyon into the West Fork of Mojave River has resulted from movement along the San Andreas and Cleghorn faults.

In addition to the major faulting in the San Bernardino mountain area, practically the whole of the mountain surface is broken by innumerable closely spaced intersecting fractures and joints. Although this faulting action was probably not so severe as that affecting the San Gabriel Range, nevertheless it is of major importance in its effect on runoff. Each break offers opportunity for the absorption and retention of rainfall. It likewise is conducive to weathering and the creation of a residual covering, because fractured and jointed surfaces are subject to deep disintegration and rock decay due both to the weakened condition of the bedrock and to the accessibility of percolating waters.

Effect of the geology on the runoff

Several geologic features of the San Bernardino Mountains have notable effect on the runoff. There are, for example, considerable differences in the types of soil mantle covering the different formations. Generally, the metamorphic rocks are more resistant to weathering than the granites, and in the main they form steeper slopes and are covered with a shallower, more altered, and less pervious mantle, which in turn supports a lighter growth of vegetation. Bedrock fractures, although prominent, do not exhibit the deep disintegration found in the granites, and as a consequence there is less opportunity for percolation of rainfall. Runoff from such areas is, therefore, likely to be at a maximum. The unconsolidated fan deposits found in places along the rivers and in some of the upland valleys are, on the other hand, exceptionally well situated to absorb large quantities of rain, and runoff from these areas should be at a minimum. The granite areas, with their deep mantle of granular soil and heavy vegetal covering, and the areas of older sedimentary rocks, blanketed with extensive accumulations of talus, will show runoff characteristics between these extremes.

Faulting has an influence on runoff for a number of reasons. The recently formed fault scarps are generally very steep, their soil mantle is shallow, and rock outcrops are common. These factors, unfavorable to rainfall absorption, are somewhat offset by the deep gravel deposits generally found in the beds of the streams that have eroded their channels along fault lines. Some water probably percolates to considerable depth along fault lines, but the amount may be too small to have any noticeable effect on direct runoff.

Streams draining the San Bernardino Range may be divided into two classes--those that drain the interior parts of the range and those that drain only the steep frontal area surrounding the range. The Santa Ana and Mojave Rivers belong to the first class; while many smaller streams and washes, each of which debouches independently upon the desert or valley floor, make up the second class. Mill, Cajon, and Lone Pine Creeks have drainage basins that have been materially affected by faulting, and they will be discussed separately.

Mojave River

The basin of the Mojave River includes all the northwest part of the San Bernardino mountain area and extends from the divide west of Bear Lake to Cleghorn Mountain. Although this drainage area is extensive, most of the flow from it originates in a belt a few miles wide just north of the divide. The rainfall diminishes rapidly from this belt to the northern edge of the plateau, where desert conditions are prevalent.

In the northern part of the basin the streams have cut deep gorges, but these are separated by wide stretches of flat or gently rolling tablelands. The country rock is predominantly a massive coarse-grained granite, closely jointed and fractured. It weathers to a coarse porous mantle that is only slightly altered. Vegetation is scattered and sparse. Generally, conditions are those characteristic of a non-water-producing area. The shallow side washes and the lack of erosion channels indicate a scanty runoff, and it is unlikely that this area produces runoff in any considerable amount except during the most intense storms.

In the upper part of this drainage basin, near the crest, there is a marked change in both topography and surface covering. The canyons change to open valleys with subdued divides and gentle slopes, and in many places they widen to form broad flats in which the ground-water table is near the surface and marshy conditions prevail. The country rock which includes both schist and granite, is generally buried under a thick soil mantle. Observations in dam excavations and road cuts show that the mantle may be from 5 to 30 feet deep in the valley areas and somewhat less on the side slopes. In section it ranges from a fine loam at the surface through a well-decomposed somewhat clayey subsoil to the disintegrated bedrock below. The area is well forested with pines, except on the higher ridges, where a heavy growth of chaparral thrives.

The prevailing type of soil mantle has a large capacity for absorbing water, but apparently the infiltration takes place slowly. Drainage likewise is slow, as indicated by the prevalence of seeps and springs in road cuts and in favorable spots along the slopes, many of which flow until late in the summer. Marshlands remain saturated throughout the year. The amount of flood runoff from such areas is largely controlled by the intensity of the rainfall and the amount of antecedent rain. So long as the rain falls at a rate that does not exceed the rate at which infiltration will take place and ground storage remains available, there is likely to be little surface runoff, but as the rainfall increases and the ground storage becomes filled only a part of the water is retained and runoff takes place. Again, if the antecedent rainfall has been sufficient to partly or completely fill all the ground storage, runoff can be expected from any storm. This was substantially the condition during the storm of March 1938. Most of the heavy precipitation of the 1936-37 season had been in the form of snow, and much of the water had been retained as ground water, as indicated by the prevalence of springs, seeps, and marshlands throughout the area during the late summer of 1937. Rains prior to the storm of March 1938 may have been sufficient to practically fill the remaining storage space, and therefore the high intensities of the March storms were especially effective in producing the disastrous floods.

Santa Ana River

The drainage basin of the Santa Ana River above Mentone may be roughly divided into an upper and a lower part, distinguished mainly by their topographic differences. The lower third of the basin, which includes the area between the valley floor and Filirea Flat and Bear Valley, has a rugged terrain characterized by the deep V-gorges of the river and its larger tributaries, exceptionally steep to precipitous slopes, narrow ridges, and an almost total absence of flat or moderately sloping lands. The country rock consists of schist and gneiss intruded by coarse granite, both types being intensely fractured and jointed. The metamorphic rocks break down to a compact, well-altered, somewhat clayey type of soil, which, on the south slopes is usually shallow and capable of supporting only a light growth of vegetation, but on the north slopes is somewhat deeper and carries heavier vegetation. Such areas produce practically no talus accumulation and only a small amount of rock litter. The granites, on the other hand, weather to a coarse granular soil of considerable depth, on which rock litter is prevalent and vegetation as a rule is heavy.

The upper two-thirds of the basin, including most of the Santa Ana River Valley above Filirea Flat and all of Bear Valley, is in the high plateau region already described. With the exception of a few steep slopes leading from the higher mountains and ridges, the topography is mature and characterized by subdued ridges and broad open valleys.

Both Bear Valley and the lower part of the Santa Ana River Valley above Filirea Flat are underlain by fan deposits. In Bear Valley a considerable part of these deposits is submerged under the Bear Valley Reservoir and hence has no visible effect on the rainfall-runoff relation. Along the south bank of the Santa Ana, however, they occupy a bench ranging in width from a few hundred feet to more than a mile and extending from Big Meadows to Filirea Flat. Smaller fan deposits also occur along the north side of the river at the mouth of Cienaga Seca Creek, between Holcomb Creek and Convers Flat, and at Filirea Flat. These deposits consist largely of unconsolidated coarse gravel, boulders, and sand, and their permeability is shown by the result of spreading operations being carried on by the Bear Valley Irrigation Co. at Barton Flat. This company has succeeded in increasing the summer flow in some of the tributaries of the Santa Ana River by spreading several thousand acre-feet of the spring runoff from South Fork.

The country rock along the mountain slopes above the bench south of the river consists of schist and gneiss intruded by granite. At lower altitudes the surface mantle is a deep, much disintegrated, but somewhat rocky soil. These lower areas are covered with trees. On the higher reaches near the summits of San Bernardino Peak and San Gorgonio Mountain and the ridge connecting the two, vegetation is sparse and the slopes are mantled with a disintegrated but unaltered rock litter. North of the river sedimentary rocks, consisting of quartzite with minor amounts of limestone, crop out along the steep south flanks of Sugarloaf Mountain and the ridges leading from the mountains to the east. The quartzite.

breaks down into blocky fragments, occasionally forming talus slopes of angular rock particles almost devoid of fine material. West of Sugarloaf Mountain the country rock is granite, and the slopes are covered with a shallow, porous mantle formed by the disintegration of this rock. All of the area except the quartzite talus slopes support a moderately heavy growth of brush.

In any generalization regarding the effect of geology on the flood runoff from the Santa Ana River Basin the relative influence of the two parts of the basin must be considered. Because argillaceous types of shallow soil cover most of the steep slopes of the lower part, percolation is restricted and ground storage is limited. This part of the drainage basin is, therefore, likely to show some runoff after any except light or moderate rains occurring early in the rainy season. If antecedent rains have been sufficient to fill the larger part of the pore space in the soil, its retentive capacity is limited and the runoff is likely to be substantially increased. Under these conditions, rains of high intensity and long duration are practically certain to furnish runoff of flood proportions. These were the prevailing conditions during the storm of March 1938, and it is probable that a large part of the Santa Ana River flood that followed that storm originated on these slopes.

With extensive subsurface storage available in the upper reaches of the drainage basin, only the larger storms are likely to produce runoff in any great amount. The belt of alluvial deposits that parallels the Santa Ana River on the south between Seven Oaks and Big Meadows shows evidence of only a small amount of runoff from the storm of March 1938. The opposite or north side of the river yielded considerable runoff from the same storm. No extensive deposits of porous material are found along the south slopes of Sugarloaf Mountain. The light vegetation and the comparatively tight quartzite bedrock of those slopes appear to favor copious runoff. The flood waters that damaged Seven Oaks and other resorts along the river appear to have originated on these quartzite slopes. Convers Flat, Filirea Flat, and Big Meadows are alluvial-fill areas providing considerable ground-water storage, and no doubt they acted to reduce the runoff to some extent. The porous granite slopes west of Sugarloaf Mountain would have a similar effect.

The records indicate that the direct runoff resulting from the storm of March 1938 was proportionately less along the Santa Ana River than along any of the neighboring streams. The subsequent summer runoff was likewise less and the retention correspondingly greater. The fact that the Santa Ana River is the only stream in the immediate vicinity that has belts of alluvium along its upstream drainage area appears to explain the condition adequately. These areas absorb water readily and apparently yield it slowly, the carry-over perhaps extending from one season to another or even longer.

In considering the runoff from an entire drainage basin, such as the Santa Ana River above Mentone, the geologic factors may effect a balance between those areas that will yield almost complete direct runoff from rainfall and those that will absorb most of the rainfall and yield it mainly from subsurface sources. Where geologic formations produce tight, nonabsorbent surfaces, such as rock outcrops or impervious clay soils, the flood peaks will be at a maximum and the drainage will be rapid, but where geologic formations produce surfaces that favor rapid infiltration, the flood peaks will be reduced and the draining process will extend over a longer period. The parts of the Santa Ana River Basin possessing characteristics favorable for retention of water have a tendency to show a smaller flood peak and higher subsequent runoff than other parts of the basin.

Mill Creek

Although Mill Creek drains a part of the frontal area, it shows a rainfall-runoff relation differing materially from that of the other streams. Both the flood runoff and the summer runoff from its basin are consistently higher than from neighboring basins. Geologic features appear to be, in a large measure, responsible for this difference.

Mill Creek is a typical structural stream, and from its headwaters, just south of San Gorgonio Mountain, to a point about 2 miles northeast of the Crafton Hills it has excavated its canyon along the line of the Mission Creek fault. About 2 miles above its mouth the stream turns abruptly to the southwest, leaves the fault line, and cuts through the narrow block separating the Mission Creek and San Andreas faults, entering the Santa Ana Valley about 2 miles east of Mentone.

For about five-sixths of its length the creek is flanked on the north by a steep, precipitous fault scarp that is only slightly eroded and dissected by a few steep, narrow gorges. Most of the tributaries entering from this side pass over waterfalls or steep cascades or flow down steep, shallow rock-floored washes. The slopes on the opposite side of the stream are considerably less precipitous in the lower parts of the basin but become steeper upstream, especially above High Creek, where they form the south wall of the box canyon.

The bedrock north of the canyon consists of granites, schists, and gneisses. The granites appear to predominate in the lower part of the canyon, and the metamorphic rocks in the upper reaches. The rocks of both types are only slightly disintegrated, rock exposures are common, and the mantle, if present, is shallow and rocky. Vegetation is sparse.

The high, steep ridge on the south that separates the basins of Mill and Potato Creeks, is made up largely of granite, although parts of it are underlain by a hard, coarse-grained, well-consolidated sandstone, designated by Vaughan [23] as the Potato sandstone. A wedge-shaped mass of the same material occurs north of the creek below the point where the canyon leaves the fault line near Morton Peak. Both the sandstone and granite have weathered on the moderate slopes, to fairly deep, granular mantles, which support a heavy growth of vegetation. The upstream steeper slopes are barren.

Mill Creek Canyon is floored by coarse gravel and boulder alluvium. The deposits range in width from 200 feet above Fall Creek to a quarter of a mile or more in certain sections near the mouth of the canyon. The thickness of this alluvial fill is not known, but it is probably 100 feet or more. The many seeps and springs that originate in the fill are evidence of its pervious character and account for the comparatively large summer flow.

The rainfall-runoff relation in Mill Creek Basin may be interpreted from its geologic features. Within the northern part of the basin, where steep slopes, shallow soil mantles that support only sparse vegetation, and large exposures of rock, are characteristic, all storms are likely to furnish rapid runoff. Features such as these are especially prominent east of Fall Creek, and there is evidence in the canyon that a large part of the floodwaters of March 1938 originated in washes draining from this area. In the box canyon at the head of the basin, both sides furnished heavy runoff. In contrast, the southern part of the basin, with its dense vegetation and porous mantle, would probably have little or no runoff from any but heavy storms. It is possible that the storm of March 1938 produced some runoff from this area but from surface appearances most of the rain that fell here was absorbed.

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23 Vaughan, F. E., Geology of San Bernardino Mountains north of San Gorgonio Pass: California Univ., Dept. Geol. Sci., Bull., vol. 13, No. 9, pp. 319-411, 1922.

The summer flow in Mill Creek seems to come largely from the alluvial fill in the channel. A few streams on the north, including Fall, Mountain Home, and Town Creeks, have their sources on the high slopes of the San Bernardino Mountains and are perennial, but their contributions account for only part of the flow. All the streams draining from the south ordinarily dry up during the summer. The opportunity for infiltration presented by the flood waters flowing over several miles of the porous fill in Mill Creek channel favors a large absorption during storm periods with subsequent draining out during spring and summer.

The frontal streams

The frontal area of the San Bernardino Mountains may be defined as the steep belt surrounding the range and forming the transition between the high and comparatively level interior plateau and the lowlands of the Santa Ana Valley and the Mojave Desert. It extends from San Gorgonio Pass on the southeast around through Cajon Pass on the west to Burns Canyon on the northeast.

Of the streams that drain this frontal area only those debouching into the upper Santa Ana River Basin have flood problems that are of economic importance. The north frontal washes draining the belt between Cajon Pass and Burns Canyon are subject to periodic and at times intense and spectacular floods. They debouch, however, onto a sparsely settled or uninhabited desert area, and their geologic features are not here discussed.

From Cajon Pass to the Santa Ana River the south front of the San Bernardino Range represents the dissected scarps of the San Andreas and associate fault systems. A number of streams have established drainage basins on the mountain front, each of these empties independently onto the valley floor. For the most part, they are typical consequent streams that have carved their pattern on the uplifted mountain block. In general, the area is characterized by steep slopes and narrow ridges, rugged in places, with bedrock outcrops, deep main gorges with shallower, steeper tributary gorges arranged in dendritic patterns. A medium to heavy growth of chaparral and brush covers the area except on rocky patches and on some of the steepest slopes, where the soil mantle is too shallow and unstable to support plant growth.

The bedrock of the frontal area consists mainly of schists and gneisses intruded by dikes and large bodies of massive coarsely crystalline granite. The location and extent of the intruded granite rocks are not accurately known, but outcrops have been observed in the lower parts of Devil and Waterman Canyons and in the upper reaches of Strawberry Creek. It is probable that a detailed examination would disclose these rocks in other parts of the area. Minor exposures of sedimentary rocks are also found in the area, distributed along the north side of the San Andreas fault. From Cable Canyon a narrow belt of nonmarine sandstone and conglomerate, half a mile to a mile wide, extends west along the fault line into Cajon Canyon. Another belt of rocks of the same type extends east from Devil Canyon and forms the block that separates the San Andreas and Mission Creek faults. Both the sedimentary and crystalline rocks are closely fractured, although the sedimentary deposits, being rather poorly consolidated, show little surface evidence of this weakness. The surface mantle ranges in character from a deep granular, much disintegrated and altered soil in the more level areas, which are underlain by the granite formations, to the shallow clayey types of soil found on the steeper slopes, which are underlain by the metamorphic rocks. Occasional small outcrops of bare rock are found on the steepest slopes. Accumulations of talus are rare, and the stream beds are, for the most part, swept clean of debris.

The frontal area is similar in many respects to the lower part of the Santa Ana River Basin and the rainfall-runoff relationship of the two areas is comparable. Light rains are retained, but as ground storage is limited, owing to the shallowness of the soil covering and the lack of talus deposits, intense storms cause rapid runoff and flashy floods with sharp peaks, followed by rapid recession as the storm ends. The summer flow is small and is limited to the larger streams. The smaller streams are dry except during short periods following substantial rains.

Cajon Creek

The headwaters of Cajon Creek and most of its drainage basin are in a wide valley lying between the San Andreas fault and the summit of the San Bernardino Range and known locally as the Cajon Ampitheatre. Faulted and tilted sedimentary rocks, predominantly sandstones of Miocene and Pliocene age, underlie most of the basin, and thick gravel deposits of Pleistocene age overlie the sandstones along the rim to the north, forming a series of infacing bluffs. Nearly half of the basin is blanketed under deposits of alluvial gravel. These follow the main stream channel and extend in a fingerlike pattern over the lower depressions of the basin.

Southeast of this basin, in the vicinity of Cleghorn Mountain and between Cleghorn Canyon and the San Andreas fault, the country rock consists of granite, schist, and gneiss. These resistant rocks form steep slopes, many of them showing rock exposures, and the remainder only partly covered by a thin veneer of sandy and rocky material. Below the point where Cajon Creek crosses the San Andreas fault at the mouth of Lone Pine Canyon, the stream is flanked on the south by a low ridge of schist and granite and on the north by a belt, a mile or so wide, of low ridges and mounds lying between the channel and the fault. These ridges and mounds are capped by gravel deposits that are apparently remnants of old terraces. Below Cable Canyon, the canyon widens as the wash enters the upper reaches of the broad, flat alluvial cone.

The influence of geology on the rainfall-runoff relation in Cajon Creek Basin appears to be restricted to the ability of the porous alluvial gravels to absorb the runoff from the surrounding impervious formations. The exposed sedimentary rocks in the upper basin appear as steeply tilted blocks, the inclined strata, in many instances forming steep dip slopes that are almost devoid of any covering. In localities where the slopes are less steep the mantle covering usually consists of a very thin layer of porous sand. The underlying bedrock, though well jointed, may be considered as too impermeable to have any appreciable effect on runoff. The granite and metamorphic formations found in Cleghorn Canyon and in the steep northeast escarpment of the San Andreas fault which parallels the lower part of Cajon Canyon are also characterized by a thin soil mantle, sparse vegetation, and considerable areas of bare rock slopes. These areas can be expected to yield a high runoff from any but light rains. The many local floods which are common in this vicinity originate on these slopes, and, although they are flashy and spectacular at particular points, their effect is not widespread, because their waters are usually absorbed by the porous gravels of the lower stream bed. Under ordinary storm conditions it appears that all runoff would be absorbed by the gravels and that only during long intense rains would flood conditions prevail over the entire stream.

Lone Pine Creek

Lone Pine Creek is unusual among the streams of the immediate mountain area in that it not only shows very little runoff from individual storms but it also requires a longer period in draining out. Geological conditions appear to be responsible for this behavior. The stream follows the line of the San Andreas fault for its entire length, and its drainage basin has the long narrow outline typical of structural basins. Although this basin is 10 miles in length, its maximum width does not exceed 2 miles. In common with other areas along the fault in this vicinity, opposite sides of the valley show dissimilar rock formations. The ridge on the south is composed of Pelona schist, the formation which is found also on the north side of Lytle Creek and is described in connection with that stream. The relatively gentle slopes of this ridge are mantled with a fine-textured micaceous soil that carries a small amount of rock litter but no talus accumulations. Although the surface is covered by a moderate growth of brush, there is evidence of considerable erosion, and many of the shallow side washes are floored on bedrock.

Rocks found in the ridge along the opposite north flank of the canyon include both sedimentary and granitic types. For several miles upstream from the mouth of the canyon at Cajon Creek, the ridge is made up of sedimentary rock broken into a series of complex fault blocks. A well-consolidated arkosic sandstone is the predominating type. North of these faulted structures, the ridge continues as a narrow wedge of only slightly weathered granite. Both the sedimentary and granitic slopes have characteristics unfavorable to the retention of rainfall. The soil mantle is thin and scattered, being interrupted by many small areas of exposed rock. Vegetation is sparse and consists mainly of scattered clumps of stunted brush.

The floor of the valley is covered with deposits of alluvial fill throughout most of its length. On the south these deposits extend well up on the slopes, but on the north there is a sharp line of demarcation between the comparatively level floor of the valley and the steep sandstone and granite slopes. A cross section of the fill as exposed in a recently eroded wash near the mouth of the canyon shows it to be composed of unconsolidated gravel and sand, with many thin beds of micaceous silt. The depth of the fill at this point is about 60 feet, but inasmuch as the exposure occurs near the ridge several hundred feet south of the fault line and at a point of rising ground water, this depth cannot be considered as representative of the entire valley. Recent action along the San Andreas fault has affected the fill structure. The sag pond near the mouth of the canyon, known locally as Lost Lake, and several low ridges and scarps farther up the valley appear to be the results of movement along the fault line.

The comparatively low flood runoff from storms falling on the Lone Pine Creek Basin may be attributed to the absorptive capacity of the gravels in the valley floor, but the reason for the slow draining out is not entirely clear. One possible explanation is that recent fault action may have formed a series of isolated pervious pockets in the fill. Slow drainage from these pockets would furnish a stable flow to the stream for long periods. It is possible also that water may escape along the fault and appear at the surface at points outside the drainage area. Some observers believe that water passes through the complex fault lines at the mouth of the canyon, moving from the Lost Lake area into Cajon Creek at a point above the Cajon Creek measuring station. Again it may be that the presence of lenses and beds of the fine micaceous silts in the fill has some effect on runoff. These saturated beds would yield water at slow rates for long periods. There is no visible evidence to support any of these assumptions, and it may be that the stream's behavior is due to a combination of all of them.

Upper Santa Ana Valley

The southwest front of the San Bernardino Range is flanked by the eastern part of the upper Santa Ana Valley. Structurally this part of the valley is a buried fault block depressed between the San Andreas and San Jacinto faults. On the northeast side the boundary is sharply defined by the straight-line contact between the valley alluvium and the crystalline rock of the mountains. The San Jacinto fault has a less distinct, though definite, surface expression in the low escarpment that marks the south bank of Lytle Creek. It is well known that this escarpment, known locally as the Bunker Hill Dike, acts as a barrier to underground flow.

The valley floor is a broad alluvial plain whose slopes converge toward the intersection of Warm Creek and the Santa Ana River near Colton. At the front of the mountains the streams have built up a series of alluvial cones that extends eastward from Lytle Creek to the Santa Ana River. From Devil Canyon to the Santa Ana River the cones coalesce to form a continuous upland bench broken at the valley margins by the interconal depressions. Near their apexes the slope of the cones is from 150 to 250 feet to the mile, but it gradually decreases until at the lower end of the valley floor it is 25 to 50 feet to the mile. The upper parts of the cones have been dissected and the parent streams occupy well-defined channels. Lower down these channels are broader and divide to form a network of gravel-strewn washes, dry except during periods of high stream flow.

The valley fill consists of unconsolidated sands, clays and gravels in many places more than 1,000 feet deep. There is little or no evidence of sorting or classification of materials except along the stream courses. There the deposits reflect the changing gradients from the relatively steep alluvial cones to the flat valley lands, with coarse materials predominating in the area near the mountains and fine silts and clays predominating in the adjoining low lands. This sorting is by no means regular, however, for accumulations of coarser debris in the valley fill occur throughout its extent. In the vicinity of San Bernardino several of these more pervious beds are capped with partly impervious clay blankets near the surface, and this clay covering together with the barrier formed by the San Jacinto fault, is responsible for the well-known San Bernardino artesian basin.

The Santa Ana Valley is an important source of underground water in southern California. The capacity of the basin to absorb additional water no doubt exceeds the runoff from any single storm or series of storms likely to occur, but the opportunity for absorption is limited by the rate at which percolation can take place during the usually short periods of high runoff. Ordinarily the water of streams entering the valley is entirely absorbed within a few miles beyond the mountains. Because of their low flow the streams seldom spread to any great extent, and the absorption takes place along a single channel area. As the runoff increases the streams tend to spread and occupy additional channels and washes, thus increasing the area over which absorption can take place. During the larger floods the streams, unless artificially restricted, spread and occupy a large part of the cone area; percolation thereby is naturally increased and peak flows are proportionately decreased. The cones at the mouths of the Santa Ana River, City Creek, and Plunge Creek are especially well situated to absorb additional water by this process. The relatively short period of the flood flows--seldom more than a few days--limits the amount of flood water actually percolating underground.

San Gabriel mountain area

The San Gabriel Mountains and the valleys flanking them on the south form two distinct physiographic and geologic units. The mountain area characterized by high, sharp crests, deep canyons, steep and precipitous slopes, and sharply dissected boundaries, is in direct contrast to the broad, gently sloping valleys beyond. The economic value of the tillable lands in these valleys is due to this contrast, for without the mountains to induce precipitation from the moisture-laden air masses moving eastward from the Pacific Ocean and thus develop streams, the fertile valley lands would be nothing more than a desert. At the same time this contrast is responsible for a flood hazard that increases in gravity as the population increases and the lands become more valuable.

San Gabriel Mountains

The San Gabriel Mountains represent the western part of the great uplifted block of which the San Bernardino Range is the eastern part. In extent the San Gabriel Mountains reach from Cajon Pass on the east to San Fernando Pass and the Santa Clara River on the west and northwest, and from the Mojave Desert on the north to the Santa Ana, San Gabriel, and San Fernando Valleys on the south and southwest. Within this area the mountain tops range in altitude from 3,000 feet in the foothills south of the Santa Clara River to more than 10,000 feet at San Antonio Peak, near the northeast edge of the range. The main crest of the range follows an irregular line nearer to the north boundary than the south boundary, but there is a secondary, parallel crest of slightly lower altitude extending along the south edge of the mountains and forming the ridge between the East and West Forks of San Gabriel River and the valley.

A narrow belt of more subdued topography occurs just south of the main divide, extending from Charlton Flats on Tujunga Creek to Pine Flat on the North Fork of San Gabriel River. This belt ranges in altitude from 3,000 to 6,000 feet and is considered to be the uplifted segment of an ancient land surface. Although its topographic features are similar to those found in the plateau region of the San Bernardino Mountains, the total area of the San Gabriel belt is much less extensive. It is probably sufficiently large, however, to exert an influence on flood runoff, as its topography, geology, and vegetation are all favorable to the rapid absorption of rainfall.

The main streams draining the San Gabriel Range have cut deep V-gorges, and most of these are at or near grade. There is evidence of some aggrading in the stream channels, particularly in the lower reaches of the San Gabriel, Tujunga, and Arroyo Seco Canyons. The channels of most of the other streams are swept clean. Tributaries to the main rivers and creeks are numerous, with the result that the mountain topography is a complex network of steep canyons and sharp narrow ridges.

Geology of the mountain area [24]

Igneous and metamorphic rocks are the predominant types of rock formations found within the San Gabriel Mountains. Alluvial deposits flank the range on the south at the elevation of the stream valleys and on the north at the level of the desert, and a few scattered remnants of old alluvial stream terraces are found in belts and patches along some of the stream channels. A small area of sedimentary rocks consisting largely of sandstone and conglomerate of Tertiary age crops out in the uplifted fault block south of the San Gabriel fault between Tujunga Canyon and Pacoima Wash. With these exceptions no unmetamorphosed deposits of sedimentary origin are found within the mountain area.

The metamorphic rocks have the greatest areal extent. They consist mainly of a complex mass of granitic and dioritic schists and gneisses with occasional lenses of quartzite and altered limestones, some of which are more than a hundred feet in width. This aggregation has been intruded by large masses of crystalline granitic rocks, and the whole mass has in turn been cut by sharply defined dikes of aplite and diabase. In typical sections of gneiss the bands vary from a few inches to a foot in width, the lighter bands being composed of quartz and feldspar, the darker ones usually including biotite and hornblend. Much of the schist has a ribbon-like structure. Parting along the foliation planes in both the gneisses and the schists is not common in the unweathered rock, but as weathering increases the formations show a tendency to part along these planes and thus give rise to talus and litter composed of flat spalls.

The igneous rocks consist chiefly of granites, granodiorites, and diorites, but there is a large area of anorthosite in the northwestern part of the range, extending from the upper Tujunga and Pacoima Basins to Soledad Canyon. The igneous rocks show considerable variation in texture and structure, which is, in turn, reflected in the type of mantle they produce. The granite at the head of Eaton, Rubio, and Millard canyons is coarsely crystalline and disintegrates to a deep, loose, granular soil.

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24 See also Eckis, Rollin, Geology and ground-water storage capacity of valley fill: California Dept. Public Works, Div. Water Resources Div., Bull. 45, 1934; Hill, M. L., Structure of the San Gabriel Mountains north of Los Angeles, California: California Univ., Dept. Geol. Sci., Bull., 19, no. 6, pp. 137-170, 1930; Noble, L. F., The San Andreas rift and some other active faults in the desert region of southeastern California: Carnegie Inst. Washington Year Book, No. 25, pp. 415-428, 1926; Miller, W. J., Geology of the western San Gabriel Mountains of California: California Univ., Pub. in Math. and Phys. Sci., vol. 1, no. 1, pp. 1-114, 1934.

The granodiorites and anorthosites in the western part of the range have a similar texture but produce only shallow mantles of granular particles containing considerable rock litter. On the other hand, the diorites, which outcrop at the head of the North Fork of San Gabriel River in the vicinity of Mount Islip and Mount San Antonio, are fine-grained and dense and weather slowly to blocky fragments only slightly disintegrated.

Details concerning the distribution of the various rock formations, so far as they are known, will be discussed in connection with the descriptions of the individual drainage basins.

Faulting

The northeast boundary of the San Gabriel Range follows the trend of the well-known San Andreas rift. Toward the east the fault line cuts through the flank of the range and is reflected in the long, narrow depressions of Lone Pine Canyon and Swarthout Valley. West of Swarthout Valley the boundary of the range swings several miles south of the fault, forming a broad reentrant between Rock Creek and the mouth of Leonis Valley. Beginning at the latter locality the fault again cuts the flank of the range, passing northwestward through the narrow Leonis Valley and Pine Canyon sections. On the south of the range, the irregular but sharp boundary between the valley and mountain areas is formed by the Sierra Madre fault systems. In addition to these major faults, the interior part of the range is cut into a series of blocks by other faults whose displacements vary from a few feet to hundreds of feet.

Many of the larger faults in the interior part of the range are reflected in the topography, because the weakened fracture planes are especially susceptible to stream erosion. The great canyon of the East and West Forks of San Gabriel River has been eroded along the line of the San Gabriel fault. The courses of Pacoima and Tujunga Creeks have been determined in part by fault lines. Lytle Creek follows the line of the San Jacinto fault. Several of the frontal streams along the south flank of the range, notably Sawpit, Dalton, and San Dimas Creeks, have had their courses determined in part by arcuate faults branching off from the Sierra Madre system. La Cañada and Tujunga Valleys occupy a narrow fault graben that separates the Verdugo and San Rafael Hills from the main San Gabriel Range.

Minor faults and fractures are so numerous that it is inadvisable, in a report such as the present one, to attempt to discuss their location or movement. Their combined effect has been to convert the entire range into a weakened and fractured mass. Miller writes:[25]

> Still another feature should be mentioned here, namely, the high degree of minor fracturing of the whole San Gabriel region of 1,200 square miles. The writer has never seen another area of comparable size so remarkably fractured. * * * It would seem that, during the uplift of the vast San Gabriel block of crystalline rocks, the whole mass was subjected to stresses which, in part at least, found relief in the development of countless fractures running in all directions.

Effect of geology on flood runoff

The San Gabriel Mountains possess two contrasting characteristics that affect the runoff from rainfall. The first is the very steep topography, which would ordinarily be expected to produce a large volume and high rate of runoff; the second is the exceptionally porous nature of the greater part of the mountain surface, which acts as an absorbent and tends to reduce direct runoff. The actual runoff from both ordinary and flood-producing storms represents a balance between these influences. Another unusual condition is the apparent lack of direct surface runoff in certain areas, even under the most intense rains, although the total discharge from such areas is substantial and the elapsed time between the peak rainfall on the drainage basin and the peak discharge in the river channel at the gaging station is practically the same as would normally be expected in areas where direct surface runoff takes place. The explanation of this seeming contradiction is probably to be found in certain geologic and physiographic characteristics. Except where rock surfaces are exposed, the mountain area is for the most part covered with a mantle of disintegrated but only partly altered rock particles, which ranges in depth from a few inches to several feet. On steep slopes this material shows a tendency to creep, with the result that the mass is continually being disturbed, the fine particles are buried and the coarse particles remain near the surface. Plants establish their root systems in the finer subsurface layers and deposit their litter at the surface, where it mingles with the coarser rock fragments. When it rains this surface functions as an absorbent, and water enters the mantle. Some of this water percolates to a considerable depth, and the remainder moves about through the myriad of

25 Miller, W. J., Geomorphology of the southwestern San Gabriel Mountains of California: Calif. Univ., Dept. Geology, Bull. 17, No. 6. pp. 203-4, 1928.

pore openings in the mixture of coarse fragments and litter and eventually escapes into the many gullies and canyons leading down the slopes. During intense storms, such as those prevalent in March 1938, it is likely that most of the rain water remains under ground for only a short period and reappears almost immediately as stream flow, yet there is relatively little evidence of erosion except in the channels of streams that drain a large area, where a concentration of water is to be expected. In many of the drainage basins, the general surface shows little effect of erosion and the vegetal litter and soil particles are undisturbed, yet the floors of the stream channels are cut to bedrock.

Streams draining the San Gabriel Mountains may be divided into two general groups--those that drain the steep frontal slopes, and those that have cut through the frontal scarp and drain the interior of the range. Streams of the first group include Deer, Cucamonga, San Antonio, San Dimas, Dalton, Rogers, Fish, Sawpit, Santa Anita, Eaton, and Millard Creeks and Arroyo Seco and many smaller streams. Although the courses of many of these streams show the influence of faulting, they are for the most part typical consequent streams developed on the frontal scarp of the range and are characterized by steep slopes, many tributaries arranged in a dendritic pattern, and fanshaped watersheds. Tujunga and Pacoima Creeks and San Gabriel River belong in the second group. These are characterized by larger watersheds of irregular outline, main stream beds of low gradient, following fault lines over a large part of their courses, and tributaries of high gradient that generally enter the parent stream at right angles.

San Gabriel River

Although the courses of the East and West Forks of San Gabriel River follow the line of a recognized fault, it is doubtful if this structural feature has any significant influence on flood runoff. The canyon does not appear to have any of the characteristics of a fault graben, and although the zone of fracturing seems to be fairly wide, the surface features of the zone are not materially different from those of the areas flanking it. Type of country rock, depth and stage of disintegration and overlying vegetal cover appear to be the controlling factors in the relation of runoff to rainfall.

A belt of rocks consisting mainly of diorite gneiss intruded by masses of granodiorite and diorite extends along the East and West Forks of San Gabriel River from the head of Cow Canyon to the head of the West

Fork. North of this belt, which includes the larger part of the drainage basins of Devil Canyon, Bear Creek, and North Fork of San Gabriel River and the part of the East Fork of San Gabriel River above Laurel Gulch, the country rock is predominantly granodiorite. A small outcrop of mica schist is found in the vicinity of Vincent Gulch and Prairie Fork at the head of East Fork of San Gabriel River, and the Crystal Lake region is buried under material that in some ways resembles morainal deposits. West of Chileno Canyon and south of the West Fork of San Gabriel River, the underlying bedrock is predominantly diorite and granodiorite; these are part of the same intrusive mass that appears throughout the Sawpit, Santa Anita, and Eaton Creek Basins.

Several features that influence the rainfall-runoff relation and the behavior of flood flows over certain areas appear to be traceable to the type of the underlying bedrock. One noticeable example is the sharp contrast between the north- and south-facing slopes along the West Fork of San Gabriel River. On the north-facing slopes south of the river the granodiorite and diorite are weathered to deep granular soils that contain considerable humus and support a heavy growth of chaparral and conifers. Much of this area lies in a zone of heavier than ordinary rainfall, as noted in the section on local rainfall characteristics, p. 49. There are practically no exposures of bedrock, and the stream channels are, for the most part, only slightly eroded, indicating that even during the storm of March 1938 the runoff was not excessive. In contrast to this condition the south-facing slopes north of the river, underlain by gneisses and schists, show unmistakable evidence of heavy runoff. Here the planes of schistosity stand almost vertical and the rock breaks down to small, angular, flat fragments only slightly disintegrated or decomposed. The soil covering is thin and finely granular. Steeper slopes show many areas devoid of soil covering, and the whole region is cut into a network of shallow washes and gullies, each of which is almost invariably eroded to bedrock.

A similar contrast, though perhaps not so distinct, is apparent along the north-facing slopes south of the East Fork of San Gabriel River. The resistant metamorphic formations found north of the West Fork of San Gabriel River continue eastward into the valley of East Fork. The bedrock of the prominent, bold slopes along both the north and south flanks of the river is of this type. There slopes are bare or thinly mantled with soil, the vegetation is sparse, and the washes are rock-floored, all of which features indicate a heavy runoff. About 2 miles south of the river the bedrock changes to a deeply disintegrated and well-altered schist. The schist is exposed in the upper part of Horse Canyon and in road cuts along the divide between San Dimas and Dalton Creeks and the San Gabriel River. Rounded ridges, moderate slopes, deep soil, and a heavy growth of brush characterize the area, all of them evidences of a comparatively light runoff.

The granodiorite that underlies most of the northern part of the San Gabriel River Basin is commonly of porphyritic texture and consists of white or light-colored plagioclase feldspar and quartz through which crystals of biotite and hornblende are scattered. The biotite and hornblende constitute only 1 to 5 percent of the total volume. Although the granodiorite is somewhat disintegrated by weathering, it shows little evidence of decomposition, and the thin rocky to sandy mantle contains very little clay. The lower slopes are covered by coarse talus deposits of medium depth. Vegetation is sparse on the steeper slopes but is somewhat thicker over flatter areas. At the head of Devil Canyon and on the slopes of Mount Waterman, Mount Islip, and other observed places, the gullies and washes have all been eroded to bedrock. In most areas the larger tributary channels have been similarly eroded. The high runoff and concentration of flow in the West Fork of San Gabriel River during the storm of March 1938 appear to have resulted from the rain that fell on the thinly protected slopes of the Bear Creek, Devil Canyon, and Trail Fork Basins. Precipitation during the same storm seems to have been sufficient to saturate the talus accumulations as well as the soil mantle. Storms that do not provide enough water to saturate the soil will ordinarily give little runoff.

The formation at the head of the East Fork of San Gabriel River appears to be a part of the Pelona schist described by Noble,[26] which occurs between the San Andreas and Lytle Creek faults. The formation readily disintegrates to particles of dustlike fineness and produces a deep mantle of fine, compact soil, which would probably show high runoff from any but light rains. Farther south, in the basins of Iron Fork and South Fork of Iron Fork, the rock is decidedly more resistant, and weathering has produced great quantities of only slightly disintegrated rock slabs. These basins, for the most part, are devoid of soil or vegetation, and their surface would furnish direct runoff from any storm.

26 Noble, L. F., Excursion to the San Andreas fault and Cajon Pass: 16th Internat. Geol. Cong. Guidebook 15, p. 12, 1932.

The floor of the valley of North Fork of San Gabriel River is covered with a heterogenous mixture of angular rock fragments, soil, and litter that has the appearance of a glacial deposit. Crystal Lake occupies a lower depression in the characteristically hummocky surface of the area. The head of the canyon is a cirquelike amphitheatre considerably modified by erosion. Slopes surrounding this amphitheatre are steep to precipitous; many of them showing rock outcrops, and the remainder are mantled by shallow coverings of coarse rock fragments and talus. Several springs of substantial flow occur along the south margin of the alluvium above Sycamore Flat, indicating that these deposits are highly pervious. It is probable that in moderate storms much of the runoff from the surrounding area is absorbed, but when rainfall is intense the steep slopes of the amphitheatre must yield almost complete runoff, and from appearances only a part of this flow infiltrates to the subsurface storage. The wide, deeply eroded wash that crosses the area indicates a high runoff from the storm of March 1938, and it is probable that any storm of similar intensity lasting more than a few hours, will yield a proportionately high runoff.

Tujunga and Pacoima Creeks

The basins of Tujunga and Pacoima Creeks have for the most part, neither the altitude nor the sharp, rugged topography characteristic of the San Gabriel Range farther east. Underlying rock formations are in part responsible for the difference. A belt composed of gneiss and schist occupies the south front of the range, forming an areal link between the granite and diorite that occur in the vicinity of Echo Mountain and Mount Wilson and the sedimentary rocks that crop out in the head of Placerita Canyon. This belt covers the lower part of Pacoima Wash and the part of Tujunga Creek Basin south of an irregular line running from the mouth of Trail Canyon to Mount Josephine. The gneiss and schist have been intruded by several wide dikes and other irregular masses of diorite and granodiorite, but in both its topographic form and the character of its mantle this belt resembles the belt of similar rocks north of the San Gabriel River. Sharp, craggy ridges, steep slopes, narrow V-shaped canyons, a thin, rock-littered mantle, and many rock outcrops are characteristic features.

On the north side of this metamorphic belt the country rock is of a distinctly different character. Pacoima Creek Basin is underlain by diorite and anorthosite. The bedrock in the upper reaches of Tujunga Creek

Basin consists of granodiorite, diorite, and anorthosite. These rocks are less resistant than the metamorphic types and have weathered to subdued ridges and somewhat open stream valleys. The moderately deep mantle covering them consists of rather finely disintegrated particles that grade almost imperceptibly into the intensely fractured parent rock. On the higher slopes this covering is perceptibly thinner, and there are occasional outcrops of rock, but on the more level surfaces and in the valley areas it increases in thickness, forming heavy accumulations of rather compact, well-altered clay soils. Vegetation is sparse on the steeper slopes but moderately heavy on soil-covered reaches. Both the surface and subsurface characteristics of this formation are favorable to the absorption of rainfall in small amounts, and for this reason light to moderate storms of short duration seldom produce increased stream flow. However, in intense storms, especially those of long duration, the comparatively shallow mantle along the slopes would probably reach saturation and, in that event, with deductions limited to the water that might percolate to the cracks and fissures of the bedrock, the runoff would be high. The impervious nature of the clay-filled valley soils would also contribute to high runoff from intense storms. These features probably account for the flashy floods shown by the streams under heavy precipitation.

The frontal streams

The frontal streams of the San Gabriel Range are similar to those of the San Bernardino Range in that they drain only the steep mountain fronts, in contrast to the larger streams that cut into and drain the interior of the range. The San Gabriel frontal streams include Cucamonga, San Antonio, San Dimas, Dalton, Rogers, Fish, Sawpit, Santa Anita, Eaton, and Millard Creeks and Arroyo Seco and many other small streams. Their basins as a rule are fan-shaped, the stream and its tributaries commonly forming a dendritic pattern. Considerable variation both in type of bedrock and in nature of soil and vegetal covering is found in the frontal area, which in turn accounts for a noticeable difference in runoff characteristics.

The bedrock in the frontal area between Lytle Creek and the San Gabriel River is almost exclusively metamorphic, the predominating type being a diorite gneiss in which the gneissic bands are almost vertical and trend in an east-west direction, parallel with the range. The bands in general range in width from a fraction of an inch to 3 or 4 inches, but a few widen to approximately a foot. In many areas the bands are very narrow and have a ribbonlike appearance. The formation has been considerably shattered and broken.

The main stream channels have cut directly across the trend of this banding, forming deep canyons with steep walls, and this steepness, combinded with the structural arrangement of the bedrock, which exposes only the edges of the bands, has prevented the formation of a deep mantle. Such soil as does exist consists largely of a thin blanket of disintegrated bedrock with a small amount of clay and considerable rock litter. Many of the slopes are almost devoid of soil, but are covered by shallow talus accumulations of small, flat rock fragments. Side washes and gullies are generally floored with bedrock. The vegetation is moderately heavy to sparse.

The areas drained by Etiwanda Creek, Day Canyon, Deer Canyon, a large part of Cucamonga Canyon and the lower part of San Antonio Creek Canyon all show these features. The runoff from such areas depends to a large extent on the characteristics of the storm that produced it. Both the soil mantle and the talus slopes are highly absorbent, but their retention capacity is low. They act, however, in carrying the water to the cracks and fissures of the underlying bedrock. In intense storms the rainfall is likely to exceed the retention capacity of both the mantle and the bedrock, and then the excess must appear as runoff, the amount of which will be in direct proportion to the amount of rainfall. This water accumulates in the many side washes and gullies, where the increased flow has removed all debris and cleaned the channels to bedrock. Drainage from the watersheds is rapid, and all these streams, with the exception of San Antonio Creek, show only small amounts of summer runoff.

San Antonio Creek Basin differs from the basins of the adjacent streams to the east in that it has a substantial summer runoff. Naturally, much of the ordinary summer flow can be attributed to the snowfall along the higher slopes of San Antonio Peak, but certain geologic conditions also favor this runoff. North of an east-west line crossing the saddle at the head of Cattle Canyon, which is about the line of the eastward extension of the San Gabriel fault, the bedrock changes from the metamorphic types already described to slightly altered granodiorite and diorite. Jointing in these formations is more widely spaced, and the rock breaks down to coarse angular, blocky fragments. Rock exposures are common along the higher slopes, but the lower slopes are blanketed with heavy accumulations of talus. The upper reaches of the tributary stream channels are eroded to bedrock but the lower parts, extending for some distance above the confluence with the main stream are floored with coarse angular alluvium.

In the vicinity of the old Toll House and extending upstream to about the mouth of Icehouse Canyon the bed of San Antonio Creek consists of gravel deposits. These range from about 200 feet to nearly a quarter of a mile in width. Above Icehouse Canyon the gravels are confined to a narrow belt along the stream channel. The thickness of these deposits is not known, but in one area above Icehouse Canyon more than 100 feet is exposed.

With storm precipitation in the form of rain, as in March 1938, these gravels act as an equalizing influence, absorbing a part of the direct runoff from the surrounding region, to be released later. The extensive talus deposits along the slopes and in the lower reaches of the side streams would act in the same way. It is evident that with storms of high intensity similar to that of March 1938 only a part of the runoff is retained, but with moderate rains it appears that only minor amounts of runoff would escape. The remarkably consistent summer flow of San Antonio Creek indicates a long period of carry-over, extending from one season to another or perhaps longer.

The bedrock throughout the greater part of the San Dimas and Dalton Creek Basins is a soft, well-disintegrated, and partly decomposed dark-colored schist with occasional areas of unaltered granite. The formation weathers to rounded ridges, broad canyons, and moderately steep slopes. The surface mantle is a granular and porous soil containing many partly disintegrated grains of quartz and feldspar and a small amount of rock litter. It varies in thickness from 1 or 2 feet on the slopes to 20 feet or more on the rounded ridges and in the flat areas. Observations in road cuts and other places where the subsurface material is exposed show that the soil mantle merges almost imperceptibly into the shattered, well-disintegrated, underlying bedrock. There are practically no accumulations of talus, very few exposures of rock, and most of the area included in the two basins is covered with a moderate to heavy growth of chaparral.

The amount of runoff from rain falling on this type of watershed depends in a large measure on the rate of rainfall and on the amount of antecedent precipitation. Although the degree of porosity of the mantle is high, its rate of absorption is necessarily limited by the small pore openings and does not approach that prevailing in the coarse rocky soils of other drainage areas. Drainage likewise takes place slowly. Light to moderate rains will seldom yield an appreciable amount of runoff unless they have been preceded during the season by an average or greater than average amount of precipitation. The floods of 1914, 1916, and 1938 show an aggravated stage of these unfavorable conditions, an intense storm of several hours duration occurring in a season of unusually high antecedent rainfall. Under these circumstances, the porous but relatively impermeable subsoil and disintegrated bedrock were probably near saturation before the storm occurred, and absorption during the rain was limited to the available pore space in the top few inches of the mantle. Although there was copious stream flow during the storm of March 1938, only a small part of it appeared as direct surface flow, as shown by the observations of the United States Forest Service on plots in the San Dimas Experimental Forest.

The various drainage basins between the San Gabriel and Arroyo Seco Canyons are underlain mostly by diorite and granodiorite. Occasional narrow belts of schist and gneiss are found closely associated with and paralleling the fault lines, but with these exceptions the rock is unaltered and retains most of its original crystalline texture. In most of the basins the rock is intensely fractured and disintegrated to a depth of several feet. Partial decomposition at the surface has produced a granular soil mantle carrying large quantities of rock particles. Some of the steepest slopes in the mountain region are found in this area, yet there are few exposures of rock, and the slopes are generally covered with a medium to dense growth of vegetation. Large accumulations of talus are lacking. The main stream channels are generally floored with bedrock in the upper reaches but are covered with alluvium near the valley. In Arroyo Seco Canyon these deposits form the aquifers for a number of springs and seeps. Runoff characteristics in this area are similar to those in the San Dimas and Dalton Creek Basins, with the amount of runoff depending to a large extent on the rate and duration of the rainfall and the amount of antecedent rainfall.

The effects of geologic conditions on the rainfall-runoff relationship are evident in the contrast between this area of granitic rocks and the area underlain by metamorphic rocks just north of the San Gabriel River. These two areas receive comparable amounts of rainfall, both have southward-facing slopes, and the topography is similar, yet owing to the difference in the bedrock there is a notable difference in the type and thickness of the soil mantle, in the density of vegetation, and consequently in the runoff characteristics. On the other hand, a comparison of the same San Gabriel area with the Cucamonga Creek and lower San Antonio Canyon drainage basins, shows a marked similarity in topography and surface features and a very close relationship in runoff characteristics. These two areas are underlain by metamorphic rocks of the same general type.

In addition to the absorption that takes place over the mountain area of the frontal drainage basins flood peaks are further reduced by percolation in the extensive cone structures developed at the mouth of each stream. Two conditions, however, mitigate against the full influence of percolation as a factor--first, the short duration of flood flow, and second, artificial restriction of the stream channels. Any unfavorable alteration of these conditions such as speeding up the flow by diverting the stream to lined conduits or further increase in the practice of channel confinement will, by reducing percolation in the coarse gravels of the cone, tend to increase the amount of flood water reaching the valley floor.

Lytle Creek

The characteristics of flood runoff in this basin appear to be materially influenced by both the structural formation of the canyon and the type of underlying bedrock. The lower part of the main stream and the Middle Fork follow the line of the San Jacinto fault, and the upper reach of the stream above Glen Ranch follows the line of the Loma Linda fault. It is probable that the canyon above Glen Ranch occupies a depressed fault slice, although the evidence of a double line of faulting is hidden under alluvial fill.

The movement along these faults has been of sufficient magnitude to cause unlike formations to appear on opposite sides of the canyon throughout practically its entire length. The long narrow ridge to the northeast which forms the divide between Lytle Creek Basin and Cajon and Lone Pine Creek drainage basins is composed of Pelona schist, a formation which Noble[27] describes as being "composed chiefly of bluish-gray quartz-sericite-albite schist but includes beds of chlorite schist, actinolite schist, greenstone, quartzite, and limestone". The rock disintegrates readily, forming a mantle of fine, compact soil that supports a heavy growth of brush. Slopes throughout this area are moderately steep, with rounded ridges and shallow washes. There are practically no extensive exposures of rock and talus accumulations are almost unknown, but many of the washes show bedrock floors. The upturned edges of the schists may be observed in these channels. Southwest of the fault the country rock is largely diorite gneiss and granodiorite. Metamorphic types are exposed from the mouth of the canyon to a point above Glen Ranch, but northwest of this point the predominating rock is a fine-grained crystalline granodiorite, the same formation as that found in the headwaters of San Antonio Creek. In fact, conditions along the west side of the Lytle Creek Basin are similar in many ways to those in the upper San Antonio Creek Basin. Heavy accumulations of angular talus cover the lower slopes whereas the higher slopes show many areas of thin mantle or bare rock.

The opposite sides of the canyon show a distinct dissimilarity in conditions of runoff from rainfall. Although the slopes underlain by the Pelona schist are well covered, it is apparent that they would yield a high proportionate runoff from intense storms. The very fine micaceous soils have a high porosity and high retention capacity but an exceptionally low permeability. Percolation to the subsurface storage would, therefore, be extremely slow, and the surface runoff would be increased. On the other hand, the coarse talus accumulations common to the opposite sides of the canyon favor absorption of rainfall in large quantities. The topographic expression of this dissimilar behavior is clearly shown in the fill above Glen Ranch. Throughout this part of the canyon, where the width of the alluvium ranges from about 500 feet to more than a quarter of a mile, the northeast margin of the fill is 20 to 30 feet higher than the southwest margin. Moreover the stream channel, which would normally be expected to occupy the lowest depression, follows a course near the top of the fill close to the schist slopes. The lower depression shows little evidence of stream flow, but the higher watercourse is a wide, much-eroded wash. This condition apparently results from high runoff and movement of debris from the schistose slopes, in contrast to low runoff and slight erosion from the opposite side. This behavior would probably prevail only in storms of high intensity. Under light to moderate rains, it would appear that the heavy vegetal covering on the schistose slopes would delay surface flow long enough to allow percolation of the water to underground storage.

In addition to high direct runoff from heavy storms, Lytle Creek also furnishes a substantial summer flow. Part of this flow no doubt comes from water retained in the extensive talus deposits of the southern slopes, but it is likely that a larger part has its source in the extensive porous gravel deposits of the canyon. These deposits extend through almost the entire length of the stream and range in width from a few hundred feet to nearly half a mile. All of the tributaries empty on the deposit, and many of them have built small alluvial cones flanking the main stream. The probable fault-slice structure of the canyon above Glen Ranch appears to be especially well suited for storage, as shown by the substantial amounts of water that rise to the surface between Glen Ranch and the mouth of Middle Fork of Lytle Creek, where the main stream cuts through a block separating two lines of faulting. Contributions from the Middle and South Forks of Lytle Creek are mainly from talus deposits, as these streams have only small amounts of channel gravel. It is likely that a considerable part of the early summer flow originates in melting snow on the northeast slopes of the San Antonio Peak ridge, percolating through the gravel fill of the canyon.

The valleys [28]

San Fernando and San Gabriel Valleys, and the west half of the San Bernardino Valley flank the San Gabriel Range on the south, and each of the streams draining from the mountain area south of the crest passes through one of them in its course to the Pacific Ocean. In topography and structure the valleys are similar--each represents a depressed segment of the earth's crust buried under deposits of alluvial fill, and each has a comparatively flat surface that slopes gently away from the base of the mountains. From the standpoint of their influence on the flood flow of streams, the important feature of the valley structures is the great depth and porous character of the alluvial cones, which occur at the mouths of all canyons and washes, and of the widespread valley fill. The cones extend in an almost continuous coalescing belt from the mouth of Arroyo Seco Canyon to the mouth of Cajon Canyon. Naturally the height of the individual cones and the distance they extend into the valley floor vary with the size and drainage area of the parent streams, but their internal structure is similar. Coarse gravel and boulders predominate near the apexes of the cones, fine silts and clays are the chief constituents at their outer edges, and material of intermediate texture occupies their central zones. This distribution, however, is by no means regular, for,

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28 See also Mendenhall, W. C., Groundwater and irrigation enterprises in the foothill belt, southern California: U. S. Geol. Survey Water-Supply Paper 719, 1908; Eckis, Rollin, Geology and ground-water storage capacity of valley fill: California Dept. Public Works, Water Resources Div., Bull. 45, 1934.

as the cones are the result of deposition by streams in all stages of flow, there has been constant shifting of deposition zones, with the result that many types and textures of debris are indiscriminately distributed throughout the mass of the cone. This heterogeneous collection of debris is, as a rule, very porous, and its effect on flood flow is limited by the rate at which water can percolate during the comparatively short duration of the flood. Confining the stream to a single channel or otherwise restricting its lateral spread over the cone naturally reduces the absorption area, and infiltration is correspondingly reduced. Distributing the water over the ground, on the other hand, augments percolation.

The coastal plain [29]

An intermediate belt of low hills and mountains, including the Santa Monica Mountains, the Repetto Hills, the Puente Hills, and the northwestern part of the Santa Ana Mountains, separates the San Fernando, San Gabriel, and San Bernardino Valleys from the coastal plain. The Los Angeles, San Gabriel, and Santa Ana Rivers enter this plain through gaps cut through the mountainous belt, and each has deposited a low, broad alluvial cone at the southern base of the hills. From the base of the cones the surface slopes gradually to the Pacific Ocean as a flood plain broken only by occasional hills and low mesas and the isolated San Pedro Hills, which rise abruptly at the coast line in the southwestern part. The flood plain is about 50 miles long, extending from Santa Monica to Newport Beach, and 12 miles wide, spreading from the ocean to the hills.

Oscillations in sea level, together with some differential land movement, have left the surface somewhat uneven. Some areas are well above the level of present deposition and are being actively eroded, whereas others are below that level and are being aggraded. The higher surfaces coincide with segments of the earth's crust that have been uplifted by faulting or folding, and the lower surfaces occupy the troughs between the uplifted blocks. The Beverly-Newport uplift, extending southeast from Beverly Hills to Newport Beach, and the Santa Fe Springs-Coyote Hills uplift, extending from the subdued Santa Fe Springs dome to the much higher Coyote Hills, several miles farther east, are the most prominent of these areas of uplift. Between them are broad troughs filled with several hundred feet of Pleistocene and Recent alluvium. Where the streams have cut

29 See also Eckis, Rollin, Geology and ground-water storage of valley fill: California Dept. Public Works, Water Resources Div.; Bull. 45, 1934.

through the uplifted segments, they occupy deep, well entrenched channels, but across the troughs, in which the underlying formation is largely alluvial fill, the channels are usually unstable and shallow, most of them less than 10 feet in depth. There is considerable evidence to show that the streams have, in the past, meandered over a large part of the trough area. It is known, for example, that within historical time the Los Angeles River has reached the ocean through Ballona Creek. During the same period the San Gabriel River has shifted several times between its present channel, the bed of the Rio Hondo, and the former course of the Los Angeles River. The Santa Ana River, also, has occupied several channels within an area extending from Anaheim Creek to Newport Bay. Thus the lower part of the coastal basin is in reality a flood plain fed by the flows of these rivers, and in times of high flood discharge it is not unusual to find free intermingling of their waters in a sheet spreading across the lowlands between Anaheim, Nigger Slough, and the ocean.

Before the arrival of man and the restrictions he imposed on the streams by building various bridges, dikes, and other confining structures, it is probable that none of the streams had stable channels but that they meandered over the wide flat plains, as in fact, they do today in places where natural and artificial channels are inadequate to carry the runoff.

In the coastal plain conditions favoring the infiltration of water to underground storage are less favorable than in the upper Santa Ana, San Gabriel, and San Fernando Valleys. The material making up the alluvium represents the outwash from small streams draining the predominantly sedimentary formations of the surrounding hills plus contributions of fine debris from the three larger rivers. As a consequence, the channel bottoms are covered with fine, poorly assorted gravel and sand that includes a substantial proportion of clay and silt. Much of the surrounding area is covered with a surface mantle of heavy clay soil. Under these conditions it is apparent that the capacity for absorbing flood water is limited and that the greater part of the water must escape through some channel to the ocean.

Santa Clara, Ventura, Santa Ynez, and Santa Maria drainage basins [30].

The basins of the Santa Clara, Ventura, Santa Ynez, and Santa Maria Rivers differ materially in geologic structures and rock types from those of the streams that drain from the San Gabriel Range. Basin characteristics, including shape, slope, and topography, as well as mantle covering and vegetation reflect this difference. The influence that such factors exert on flood runoff from rainfall is likewise shown to some extent.

The country rock of the area is predominantly sedimentary. Small outcrops of igneous and metamorphic rocks are found along the west edge of the San Gabriel Range in the headwaters of the Santa Clara River, and again along the foothills of the San Rafael Range, reaching from Zaca Creek, southwest of Lookout Mountain, to the neighborhood of Little Pine Mountain, but these are comparatively unimportant in their effect on flood runoff. The exposures of extrusive andesite and basalt found in the Santa Susana Mountains and the western part of the Santa Monica Mountains are too limited in areal extent to have any appreciable effect on the rainfall-runoff relation in the area. Of the sedimentary rocks, sandstone, conglomerate, and shale predominate, and impure limestone and siliceous shale occur in smaller amounts. For the most part, the shales weather to rounded hills with gentle slopes, and the harder sandstones, conglomerates, and siliceous shales appear as steep ridges and cliffs. The mantle covering is largely residual and varies in thickness and texture with the slope of the terrain and the type of the underlying formations. Sandstones and conglomerates weather to coarse porous mantles, shallow on the steep slopes and thicker on the gentler ones, but shale forms an almost impervious, compact covering on any slopes. The vegetal growth reflects, to a great extent, the underlying formation. The sandy soils support a heavy cover of chaparral, especially on the protected northern slopes of the mountains, but the shaly soils are usually entirely barren or have only a sparse growth of short grass or stunted sage. Between these extremes are variations of all types of cover and vegetation, depending on the proportion of sand or shale in the soil, the direction of slope, and the availability of water.

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30 See also Eldridge, G. H., and Arnold, Ralph, The Santa Clara Valley, Puente Hills, and Los Angeles oil districts, southern California: U. S. Geol. Survey Bull. 309, 1907; Arnold, Ralph, Geology and oil resources of the Summerland district, Santa Barbara County, Calif.: U. S. Geol. Survey Bull. 321, 1907; Arnold, Ralph, and Anderson, Robert, Geology and oil resources of the Santa Maria oil district, Santa Barbara County, Calif.: U. S. Geol. Survey Bull. 322, 1907; and Kew, W. S. W., Los Angeles to Santa Barbara: 16th Internat. Geol. Cong., Guidebook 15, pp. 48-68, 1932.

The structural features of the area under discussion differ considerably from those of the San Gabriel Range. Uplift in the San Gabriel Range occurred along fault lines, and the massive igneous and metamorphic rocks yielded by fracture rather than folding, the fractures being distributed through the mass of the mountain block in the form of innumerable joints, faults, and fissures. The sedimentary country rock of the area northwest of the San Gabriel Range yielded to mountain-building forces mainly by folding, with faulting of secondary importance. As a result of this action a series of east-west trending folds have been developed, these folds determining the outline of the characteristic parallel mountain ranges and their intervening valleys. In this pattern the valleys generally occupy the synclinal troughs, and the mountains represent the anticlinal crests. The pattern has been modified somewhat by differential erosion and, in some small areas, by faulting, but in general the drainage follows the structural outline. For the most part, the main streams flow westward, following the synclinal troughs, and their tributaries enter at right angles, having cut deep, narrow canyons across the upfolded mountainous areas.

Relation of rainfall and runoff to geology

Whatever effect geologic formations have on runoff from rainfall depends on the amount of water that can be absorbed by the surface mantle and the pervious parts of the underlying bedrock and the rate at which the absorption proceeds. The topography and the thickness, texture, and composition of the mantle are the principal factors affecting this relationship, and all are the result of geologic processes.

The sedimentary rocks of this area have yielded to deformation by folding. The process required a long period of time, during which geologic forces were constantly being applied and readjustments in the rock structure were continually taking place. Both the nature of the change and the plastic character of the deeply buried sediments were unfavorable to the fracturing and associated disintegration such as took place in the San Gabriel Range. Consequently, the country rock of the area is characteristically impervious, and percolation of rainfall is therefore limited to the porous areas of the surface mantle and to the alluvial fill of the river valleys. In areas covered by a deep sandy mantle little runoff from rainfall is to be expected. The heavy growth of vegetation usually found on such areas stimulates both the percolation and the retention of water. On the other hand, rock outcrops favor complete runoff from rainfall, and shaly areas, with their impervious clay mantle and sparse vegetation, are almost as effective in preventing the percolation of rainfall. Coarse valley fill favors percolation from both rainfall and stream flow, but with finer textured fills percolation is less effective. The proportionate acreage of the different types of rock and surface cover found in the various areas will determine the characteristics of the rainfall-runoff relationship.

Santa Clara River

The Santa Clara River occupies a somewhat modified structural depression that extends westward from the west flank of the San Gabriel Range to the Pacific Ocean, a distance of 75 miles. Its headwaters are on the western edge of the San Gabriel Mountains, but most of its drainage area lies north of the stream, between Antelope Valley and Pine Mountains. All of its larger tributaries, including Castaic, Piru, Sespe, and Santa Paula Creeks, named from east to west, drain from the north and flow in a general southerly direction through tortuous courses that have been determined in part by rock structure and in part by erosion. Their canyons are deep, many of them cliff-bound, and almost their entire drainage basins are steep and rugged. The mountainous parts of their basins are generally covered with a fairly thick growth of chaparral, but in the foothills vegetation is sparse.

Both the Santa Clara Valley and the lower parts of its tributary valleys are floored with alluvium. These deposits range in width from half a mile to 3 miles in the main valley, and from a few hundred feet to half a mile in the valleys of the side streams. The texture and porosity of the fill vary according to the locality; deposits in the upper part of the main stream channel consist principally of clean coarse gravel and sand derived from the igneous and conglomerate formations common to the headwater area, whereas those in the lower part of the main channel and in the tributary streams include sand, clay, and silt eroded from the surrounding fine-textured sedimentary rocks. The depth of the fill ranges from a few inches along the edge to more than a hundred feet in the central areas. At a few places in the channel the deposits are interrupted by exposures of bedrock. One such exposure occurs in the main stream about 3 miles east of Piru Creek and forms the area of rising ground water reaching upstream to the mouth of Castaic Creek. Another occurs between Filmore and Santa Paula, forming a similar but smaller area of rising ground water.

It is evident that only in certain reaches of the stream channel, that is, above the mouth of Castaic Creek and between the bedrock exposures east of Piru and the mouth of Sespe Creek, are conditions favorable for an appreciable reduction of flood flow by percolation to the alluvial fill. The fineness of the alluvium in the lower section of the valley and in valleys of the tributaries makes it unfavorable to rapid percolation, and, naturally, areas of rising water would have no capacity for additional storage.

The bedrock of the Santa Clara Basin is sedimentary throughout, except on the northwest slopes of the San Gabriel Mountains. In this locality it is igneous, predominantly anorthosite intruded by many dikes of dark-colored diabase, and conditions are similar to those in the upper Tujunga and Pacoima drainage basins. The surface features are favorable for the absorption of rain only in small amounts, and when precipitation is heavy copious runoff is to be expected. The rock-floored gullies and severely eroded washes are evidences of the large runoff from the storm of March 1938.

In the part of the basin that lies above Piru Creek the country rock consists of thick deposits of conglomerate and sandstone with lenses of variegated shale and fine-grained sandstone. These beds have been thrown into monoclines and more complex folds. Over much of the area east of Castaic Creek they crop out as a series of more or less parallel hogback ridges, with massive resistant conglomerate or sandstone strata occupying the crests. Dip slopes are commonly entirely barren. Between Castaic and Piru Creeks the beds have been thrown into a number of eastward-trending folds that appear to have had some influence on the topography. Broad ridges alternate with open stream valleys, and the slopes are moderate.

The rocks weather slowly to form a shallow soil mantle that is sandy and filled with rock litter where it overlies sandstone or conglomerate, but dense and impervious where it is derived from shale. Brush is generally sparse, but much of the area is covered with a fair growth of grass and desert annuals.

The bedrock of the area is somewhat pervious, a few wells derive small flows of water from some of the more porous strata, and it is possible that some rainfall percolates to considerable depth. The amount appears to be relatively small, however, and it is believed that absorption is limited mainly to areas covered with a porous soil mantle.

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Piru Creek

The formations underlying the Piru Creek Basin are somewhat finer in texture than those immediately to the east. They consist mainly of shale, siliceous shale, and fine-grained sandstone with occasional beds of conglomerate. Structural deformation has cast the beds into a great number of more or less parallel folds; some of these are broad with the beds inclined at a low angle, and others are squeezed, so that the beds often stand nearly vertical. Piru Creek has cut across the prevailing trend of these folds, and its tributaries drain through canyons that are more or less parallel to them.

Slopes along the lower 15 miles of the creek and its tributaries are exceptionally steep. A shallow sandy and rocky soil mantle, in most places not more than a few inches thick, is the prevailing type of cover and a considerable part of the area shows bare rock slopes. Many of these appear to be due to small landslides that were generated during the storm of March 1938. Nearly all the steeper washes are eroded to bedrock. Soil-covered spots support a moderate growth of brush and grass. The fine-textured, rather thin-bedded rocks show little tendency to break into spalls or large fragments, and consequently there are no talus deposits.

The topography in the upper reaches of the drainage basins is more mature; the canyons open to valleys, the slopes are moderate, and there are few areas of exposed rock. The soil mantle, although somewhat thicker than on the steeper slopes, is relatively shallow, but the vegetal covering is moderate to heavy. With the exception of rock exposures, surface features appear to be favorable to the absorption of moderate amounts of rainfall. However, as absorption in this basin is definitely limited to the surface mantle because of the impervious character of the bedrock, heavy rains of long duration are likely to furnish a proportionately higher runoff, than in the San Gabriel Range, but probably not so high as in the neighboring Sespe Creek Basin.

Sespe Creek

Features that favor the absorption and retention of rainfall are probably less prevalent in the Sespe Creek Basin that in any similar area in the Santa Clara drainage basin. The type of bedrock, the character and small extent of the surface mantle, and the structural arrangement of the mountain mass appear to be responsible for this condition. The bedrock throughout the larger part of this creek basin is dark brown or chocolate-colored and is composed of fine-grained sandstone interbedded with shale and, in a few places, deposits of conglomerate. These beds are easily recognized and are known to geologists as the Sespe formation. In the lower part of the drainage basin, between Sespe and Little Sespe Creeks, the beds are mainly thin and shaly, but in the higher parts of the basin they become thick and massive. In both localities, however, the rocks are dense and compact, and appear to be practically impervious to water. Folding and faulting have caused many variations in structure, and in most areas the beds dip at high angles. Dip slopes are prevalent, and many of them have been eroded until they are entirely barren of soil or vegetation. In the plateau section, between Sespe and Little Sespe Creeks, it is estimated that as much as 25 percent of the area has been denuded of soil; in other sections the percentage is much less.

The Sespe formation weathers to a shallow fine-textured soil mantle, somewhat sandy in most areas but tight and clay-filled in localities underlain by shaly deposits. The bedrock shows practically no weathering or disintegration below the soil mantle, and extensive talus deposits are lacking. Vegetation on soil-covered areas is, as a rule, heavy. The Sespe Creek channel is filled with alluvium below the junction of Sespe and Little Sespe Creeks, but above that point both streams and most of their tributaries contain only shallow fills of debris or have been eroded to bedrock.

The unusually high percentage of bare rock slopes in the Sespe Creek Basin is naturally reflected in the runoff characteristics of the stream, since these slopes furnish complete and direct runoff from storms of practically any type or intensity. Much of the remaining soil-covered area has characteristics that are unfavorable to extensive absorption. The soil covering when dry, appears to be open and porous, but close examination reveals that most of it contains enough clay to render it nearly impervious when wet. This condition prevails on the plateau between Sespe and Little Sespe Creeks and was noted also on the north slopes of the Topatopa Mountains. Once this material has been thoroughly soaked at the surface by antecedent rains, its capacity for absorbing additional quantities of water is greatly reduced. Even in areas where the soil covering is highly porous, the retention of rainfall is limited by the shallowness of the mantle and the compact, impervious nature of the bedrock.

Other parts of Santa Clara drainage basin

Conditions over the remainder of the Santa Clara drainage basin, which includes the north-facing slopes of the Santa Susana Mountains, Oak Ridge, South Mountain, and the south-facing slopes of Sulphur Mountain, are somewhat more favorable to retention of rainfall, and comparable rains are therefore not likely to show as high a proportion of runoff as on Sespe Creek. The bedrock over the area is of the same type and character as that in the Piru and Sespe Creek Basins, but the structural features are not so sharply defined and the slopes are less steep. Barren dip slopes are lacking, and although there are a few patches of exposed rock, they are fewer than in the Piru Creek Basin. The soil mantle, although relatively shallow, is generally sandy and porous. Brush is, as a rule, sparse, especially on north-facing slopes, but the surface is well protected during the winter by a heavy growth of native grass. The absorptive capacity of the cover appears to be sufficient to enable it to retain practically all the rainfall from light or moderate storms, and the only runoff likely to appear under these conditions is from the small areas of exposed bedrock. Intense and protracted rains, on the other hand, are likely to furnish heavy runoff.

Ventura River

The Ventura River and its chief tributaries, Coyote Creek and Matilija Creek, drain an area that includes the Ojai Valley and the mountainous region to the north, west, and east. Ojai Valley is an alluvium-filled structural depression, resulting partly from fault action and modified by erosion, measuring about 12 miles from east to west and 2 miles from north to south. Streams from the mountains have built up steep alluvial cones along the north margin of the valley, and from the base of these cones the valley floor slopes gradually toward the southwest. Both the cones and the valley fill are important as sources of ground water, and their capacity for storage of additional water is usually sufficient to insure the absorption of the ordinary runoff of streams and washes draining across them.

A comparatively low but rugged range of hills lies between the Ojai Valley and the Pacific Ocean. This range is a part of the complex, upfolded mass that extends west from Piru Creek to the ocean, and its sedimentary bedrock is of the same age and approximately the same character as that found in the Piru and Sespe Creek Basins. Ventura River has cut directly across this range, forming a wide but steep-sided canyon. Coyote Creek, entering from the west, and Canada Larga, from the east, are the largest tributaries. The lower parts of the basins of these streams, together with the Ventura Valley, are graded and filled with alluvium. They provide considerable underground storage.

The largest and most important part of the Ventura River Basin, from the standpoint of water production, lies to the northwest of the Ojai Valley. It is drained by Matilija Creek and its tributaries. This area includes the northward-facing slopes at the western end of the Santa Ynez Mountains and the southward-facing slopes of Ortega Hills.

The country rock in the area is of sedimentary origin and consists of interstratified shale, sandstone, and conglomerate, all so well consolidated that it may be considered to be impervious. The beds have been folded and tilted, though probably less than in the lower reaches of Piru and Sespe Creeks, and over much of the area they appear as a succession of sharp ridges and canyons, with massive resistant strata forming the ridge crests and softer beds flooring the valleys. Slopes are generally steep but as a rule are not precipitous except in occasional stretches along some of the steeper, narrower canyons.

The soil mantle is residual and varies in texture and composition according to the nature of the parent rock. Sandy types seem to prevail. The covering is rarely more than 1 or 2 feet thick, but it is widespread and there are only occasional small areas of exposed bedrock. Vegetation is usually heavy on the north-facing slopes but scattered and sparse in other places. Clay soils overlying shale beds can generally be distinguished by their sparse vegetal covering.

As impervious bedrock underlies the greater part of the Ventura River Basin, the absorption of rainfall will be restricted to the soil mantle of the mountain section and the alluvial fill of the stream and valley areas. As the capacity of the soil to hold water is necessarily small because of its shallowness, it is evident that only light or moderate rainfall will be absorbed. Storms of greater intensity and longer duration must eventually yield the greater part of their precipitation as runoff, and this will appear in the valley and in the alluvium-filled sections of the streams. The most favorable locality for absorption of either ordinary or flood runoff is along the Ventura River where it crosses the Ojai Valley, but storage in this area is limited by the high ground-water level that usually prevails in the lower parts of the valley.

Measurements made by the State Division of Water Resources [31] indicate that considerable rainfall may percolate to ground storage during early-season storms, but that the amount dwindles rapidly as later storms tend to fill the available storage. Storage in the alluvial belts found along the Ventura River between Ojai Valley and the ocean and the lower parts of the basins of the larger tributaries, notably Coyote, San Antonio, and Santa Ana Creeks and Canada Larga, is limited by the relatively small extent of the deposits.

The limited storage available in both the mountain and valley areas would indicate a relatively high flood runoff for the Ventura River.

Santa Ynez River

The Santa Ynez River occupies a structural trough that trends slightly north of east and follows the north flank of the Santa Ynez Mountains. Besides the north slope of these mountains its drainage basin includes the southwest slope of the eastern part of the San Rafael Mountains, the south slope of the Purisima Hills, and the wide valley areas around Santa Ynez and north of Lompoc. Toward the south the slopes rise steeply in a series of steps to the crest of the Santa Ynez Mountains, but toward the north they rise gradually from the terraces and sand hills west of the Santa Ynez Valley, becoming steeper, with pronounced ridges and sharp canyons, as they merge with the south slopes of the San Rafael Range.

In its upper reaches the river flows through a well-defined canyon, and has a gradient of about 125 feet to the mile. Throughout most of this stretch there is a little fill on the canyon floor and that only in thin deposits. Beginning at a point east of Santa Ynez and extending to the coast, the gradient drops to 25 feet to the mile and the valley opens to the north over wide terraces. In this stretch deposits of recent alluvium underlie the river channel.

The north-facing slopes of the Santa Ynez Range carry a fairly heavy growth of vegetation, but north of the river the covering is limited to a sparse growth of brush and grass, with occasional patches of more luxuriant vegetation in shaded and protected places.

The rock of the Santa Ynez Range consists of marine sediments, including sandstone, shale, and conglomerate, with small areas of limestone. Sandstone occurs in the foothills, shale in the intermediate belt, and sandstone and conglomerate at the crest of the range. Both the sandstone

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31 Conkling, Harold, Ventura County investigation: Bull. 46, p. 62, 1934.

and the shale are well consolidated, so that the absorption of rainfall would take place only in the soil mantle.

Terrace deposits of considerable extent occur in the Santa Ynez Valley at its coastal end, west and north of Lompoc, and throughout its middle and upper reaches. The deposits consist of a veneer of sand and gravel, usually not more than 25 feet thick, normally soft and porous but in places compacted and cemented. Where they are soft and porous, the deposits are capable of absorbing the rainfall from all but the most intense storms. These deposits and the underlying formations probably also act as reservoirs for water percolating from the river, though of course this percolation can take place only in the immediate vicinity of the stream.

The bedrock in the Purisima Hills and in small areas in the foothills of the San Rafael Range includes thick deposits of diatomaceous shale. This shale also underlies much of the terrace deposits of the river valley. Where the shale has not been altered by close folding or siliceous cementation it has a porous texture favorable to absorption of water. Although definite information is lacking, it appears that in a large part of the Purisima Hills area and a smaller part of the San Rafael district the exposed bedrock is of this character. Areas underlain by silicified and folded strata are likely to yield complete runoff from any but the lightest storms.

The remaining areas in the San Rafael part of the Santa Ynez River Basin are underlain by sedimentary rocks ranging in texture from coarse sands and conglomerates of fluvial origin to well-compacted fine sands and shale of marine origin. The harder beds prevail over the higher parts of the area, and the softer beds occupy the foothill area near the river. A narrow belt of old crystalline rock half a mile to a mile in width and several miles in length strikes southwest from the head of Lisque Creek.

Owing to the diversified types of bedrock and mantle found within the Santa Ynez River Basin any relation between flood runoff and geologic conditions is indefinite. Although the exposures of impervious bedrock are limited in their areal extent, medium rains are likely to provide almost complete runoff from these areas and local floods are to be expected. Except in the more intense and widespread storms, such runoff should be largely absorbed by the more porous sands and the valley fill.

Santa Maria River

The Santa Maria Valley is a broad triangular area bounded on the southwest by the Casmalia and Solomon Hills and on the northeast by the San Rafael Mountains. The Cuyama and Sisquoc Rivers with their tributaries drain the San Rafael Mountains and debouch on the valley floor to form the wash of the Santa Maria River. The Santa Maria flows only in times of flood. Streams from the Solomon Hills also debouch on the valley floor but seldom, if ever, reach the river. The runoff from Casmalia Hills is largely intercepted by Guadalupe Lake.

The valley is a wide flood plain, the interior part of which is floored with thick deposits of Recent alluvium. Along the edges of the valley are terraces that fringe the San Rafael Mountains on the northeast and rise gradually to the Casmalia and Solomon Hills on the southwest. The alluvial fill consists mainly of coarse gravel and sand, with some finer sediments near the ocean, all capped by fine-textured soil. The fill is favorable to water percolation and storage and is the source of irrigation water used in the extensive agricultural development of the valley. The terrace deposits are similar to those found along the Santa Ynez River, and percolation in them is limited to the more porous areas.

The principal source of supply for the Santa Maria River is the runoff from the southwest slopes of the San Rafael Mountains. The bedrock on these slopes includes a belt of thin-bedded siliceous shale paralleling the valley along the foothills and, contiguous to it on the northwest, older sedimentary rocks, mainly sandstone, conglomerate, and shale. The beds are considerably folded, and in many places their thinly mantled edges appear at the surface. A wide belt which follows the crest of the range, is made up of a thick series of alternating thin-bedded dark-colored shale and more massive sandstone. These beds are not so strongly folded as the younger formations, but in places they are steeply upturned.

In general, flood flows in the Santa Maria River originate on the southwest slopes of the San Rafael Mountains. The higher mountains have the greatest rainfall, and the thin-bedded shales and the hard, massive sandstone found in this area are least favorable to water absorption; the shallow soil mantle, especially where it overlies shale, is itself largely impervious, and the underlying rock is almost completely so. Softer parts of the siliceous shale favor absorption on low to moderate slopes, and these areas probably do not contribute runoff except in severe storms.

RAINFALL, RUNOFF, AND RETENTION

The amount of runoff that reached stream channels during the flood of March 1938 and the degree to which this runoff was concentrated with respect to time were governed mainly by the rates of rainfall, absorption, and retention during the storm period and by the amount of water in the ground at the beginning of the storm period. The antecedent rainfall, to the extent that it was filling the natural surface and subsurface storage at the beginning of the storm, had an important effect on the runoff and on the maximum rates of discharge, as continuing rains not accompanied by a corresponding draining out of the infiltrated water may result in a condition approaching saturation. Any decrease in the ability of the ground to absorb the storm rainfall, especially during periods of heavy precipitation, would tend to increase the flood runoff.

Practically all the major floods of record in southern California have been preceded by about 8 inches of antecedent rainfall within a period of a few weeks, and the floods of March 1938 were no exception.[32] In February 1938, as shown in table 8 on page 82, there had been copious rainfall, in excess of normal, throughout southern California, and as a result a part of the absorptive capacity of the drainage basins was utilized when the storm period began.

Antecedent precipitation and retention

The retention in a drainage area is the difference between the rainfall and the runoff (including water losses), accumulated from an appropriately selected time of beginning. It may serve as an index of the state of the ground-storage capacity in the area immediately before a storm and hence of the effect of antecedent precipitation on direct runoff from the storm. To illustrate this point a study of retention has been made in Strawberry and Santa Anita Creek Basins for the rainy seasons of 1925-26, 1926-27, and 1937-38. Strawberry Creek, with a drainage area of 8.6 square miles above the gaging station, is in the San Bernardino Mountains, and Santa Anita Creek, with a drainage area of 10.5 square miles, is in the San Gabriel Mountains.

In this study it is necessary to make a distinction between gross retention and net retention. The gross retention in a drainage area is the difference between the rainfall and the runoff from a given time, as

32 Lynch, H. B., The history of floods in California; Am. Geophys. Union Trans., 1939.

for example, the beginning of the rainy season, and exceeds in amount the actual water in ground storage in the drainage area by the amount removed by evapo-transpiration or other depletion. For Strawberry and Santa Anita Creek Basins, the influence of ground-water flow to or from the drainage area at the point of measurement is assumed to be negligible. Moreover, the phreatic divide is assumed to conform to the divide of surface drainage.

In southern California the short mild winters with considerable moisture are more favorable to the growth of vegetation than the long hot, dry summers. Consequently, in this area, unlike mountain areas in many other States, there is considerable winter evaporation and transpiration. The average annual evapo-transpiration is estimated to range from 15 to 18 inches in the valley areas to 20 to 25 inches in the highest mountain areas. The type of vegetation and hence the transpiration would seem to bear a relation to the available water supply.[33]

Although there has been some investigation of evapo-transpiration losses, the data are not sufficient for satisfactory evaluation of net retention. For this reason and because of the possible influence of ground-water flow to or from the basin, any determination of net retention must be subject to some speculation.

As a rough approximation for use in the present illustration, it is assumed that, in the drainage areas considered, the rate of transpiration is 1 inch per month in winter, and, on the basis that transpiration is largely a function of solar radiation, that this rate increases to 2 inches per month in summer. The rate of loss will be modified somewhat by the amount of water available at the surface, and therefore after a heavy storm it may exceed the estimated monthly rate. In this study the evaporation loss following a heavy storm has been assumed to be 0.5 inch for each storm period. If the rainfall for the entire storm period was less than 0.5 inch, the entire amount is assumed to have been lost.

The average rainfall for Strawberry Creek Basin is based on the records at Squirrel Inn (altitude, 5,300 feet), which is within the drainage basin, and at San Bernardino (altitude, 1,048 feet), which is just south of the mouth of the canyon of Strawberry Creek. The average rainfall for Santa Anita Creek Basin is based on the records at Mount Wilson (altitude, 5,850 feet) and at Santa Anita Canyon ranger station (altitude, 1,950 feet), both of which are within the drainage basin.

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33 Sonderegger, A. L., Water supply from rainfall on valley floor, Am. Soc. Civ. Eng. Trans., vol. 94 p. 1263, 1930.

Table 25 shows for Strawberry and Santa Anita Creek Basins the rainfall, the runoff, and the net retention, estimated as explained above, for periods preceding the major storms and during the major storm for the rainy seasons of 1925-26, 1926-27, 1937-38. The rainfall for the major storm period as given in this table is the actual rainfall minus the estimated amount of water lost by evaporation during the storm. The flood runoff for these three years was the highest in about 20 years of streamflow records at these two gaging stations. The estimated net retention in each basin, although subject to inaccuracy, as previously explained, is an index of the soil moisture in that basin before and after the major storm periods.

Table 25.- Net retention in Strawberry and Santa Anita Creek Basins for the rainy seasons 1925-26, 1926-27, and 1937-38

Basin, stream, and season	Period preceding major storm					Major storm period				Total net retention
	Date	Rainfall	Evapo-loes (a)	Runoff	Net retention	Date	Rainfall (b)	Runoff	Net retention	
Santa Ana River										
Strawberry Creek near Arrowhead Springs										
1925-26	Dec. 1 to Mar. 30	14.68	7.73	1.28	5.67	Apr. 1 to 10	18.76	1.97	16.79	22.46
1926-27	Nov. 21 to Feb. 10	11.09	6.08	.93	4.08	Feb. 11 to 20	15.62	2.83	12.79	16.87
1937-38	Dec. 11 to Feb. 25	20.65	6.71	2.10	11.84	Feb. 25 to Mar. 3	16.39	5.24	11.15	22.99
Los Angeles River										
Santa Anita Creek near Sierra Madre										
1925-26	Dec. 1 to Mar. 30	14.48	8.27	1.07	5.14	Apr. 1 to 15	16.23	3.90	12.33	17.47
1926-27	Dec. 25 to Feb. 10	13.07	6.06	.90	6.11	Feb. 11 to Mar. 5	16.62	4.60	12.02	18.13
1937-38	Dec. 5 to Feb. 26	24.68	7.30	2.70	14.68	Feb. 27 to Mar. 3	24.60	11.11	13.49	28.17

a Estimated evaporation from rainfall and transpiration.
b Adjusted for estimated evaporation losses during the period.

The retention and therefore the runoff reeulting from a given storm depend fundamentally on the following factors:

(1) The retention in the basin from antecedent rainfall, which serves to occupy some of the available storage and thus to decrease the absorptive capacity of the soil.

(2) The amount and rate of storm rainfall.

The data in table 25 indicate that in Strawberry Creek Basin the retention preceding each of the three storm periods listed was of about the same magnitude as in Santa Anita Creek Basin. In Strawberry Creek Basin, the rainfall during the 1926 and 1927 storm periods averaged about the same as for 1938, but the retention in this basin prior to the March 1938 storm was 11.84 inches, as compared with 5.67 and 4.08 inches during the earlier seasons, and as a result the proportion of the storm rainfall appearing as runoff was greater than for the two earlier storms.

In Santa Anita Creek Basin the retention preceding the storms of 1926 and 1927 was 5.14 and 6.11 inches, respectively. The rainfall during each of these two storm periods was about the same and averaged about 16.4 inches; the runoff averaged 4.3 inches, adding an increment to the basin retention that averaged 12.2 inches, giving a total average retention of 17.8 inches. However, the net retention in the basin preceding the storm of March 1938 was 14.68 inches, which was about 9 inches more than the average for the earlier years. As a result of 24.6 inches of storm rainfall there was a runoff of 11.11 inches, adding an increment to the basin retention of 13.49 inches, or an average of only 1.3 inches more than resulted from the materially lighter storms of 1926 and 1927. The runoff that resulted from the storm of March 1938 was correspondingly greater than that from the 1926 and 1927 storms, and seemingly for two reasons--greater antecedent retention and greater storm rainfall.

Figures 37 and 38 show the precipitation, runoff, gross retention, and net retention, estimated as indicated above, for Strawberry and Santa Anita Creek Basins, for the rainy seasons of 1926-27 and 1937-38.

In the "New Year's storm of 1934," at Hoegee's camp, in the headwaters of Santa Anita Creek, 19.20 inches of rain fell in 2 days, but the maximum discharge at the gaging station was only 54 second-feet per square mile. This low runoff is explained by the relatively light antecedent precipitation of only 13.59 inches during the preceding 3 months, much of which had already been lost by transpiration and evaporation, thus affording a relatively large retention capacity.

One of the outstanding floods of the period of record in southern California occurred in January 1916.[34] Analysis of that flood on the San Diego River near Lakeside indicates the outstanding influence that retention within the basin has on subsequent flood runoff. Prior to January

34 McGlashan, H. D., and Ebert, F. C., Southern California floods of January 1916: Geol. Survey Water-Supply Paper 426, 1918.

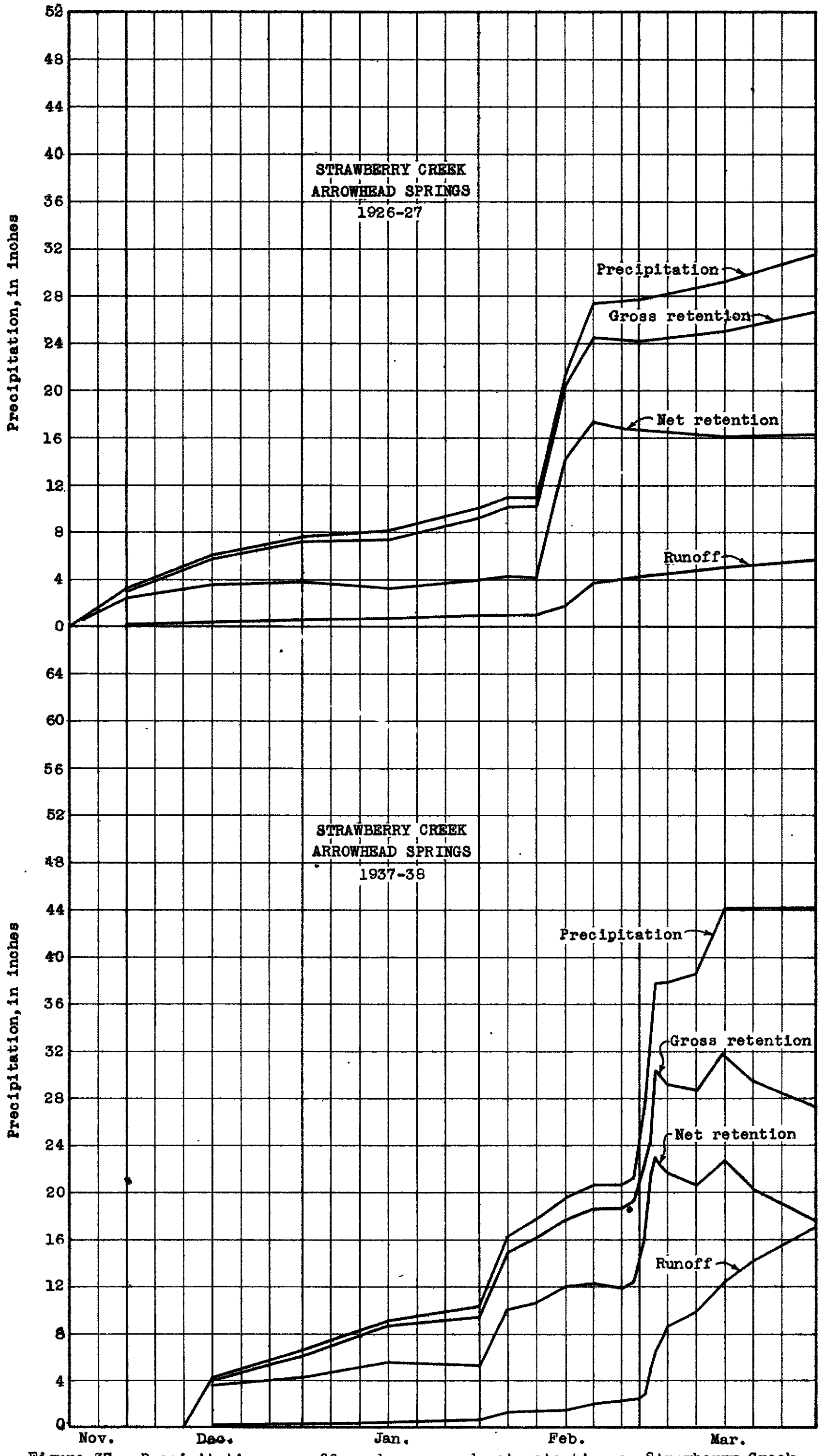

Figure 37.- Precipitation, runoff, and gross and net retention on Strawberry Creek during rainy seasons of 1926-27 and 1937-38.

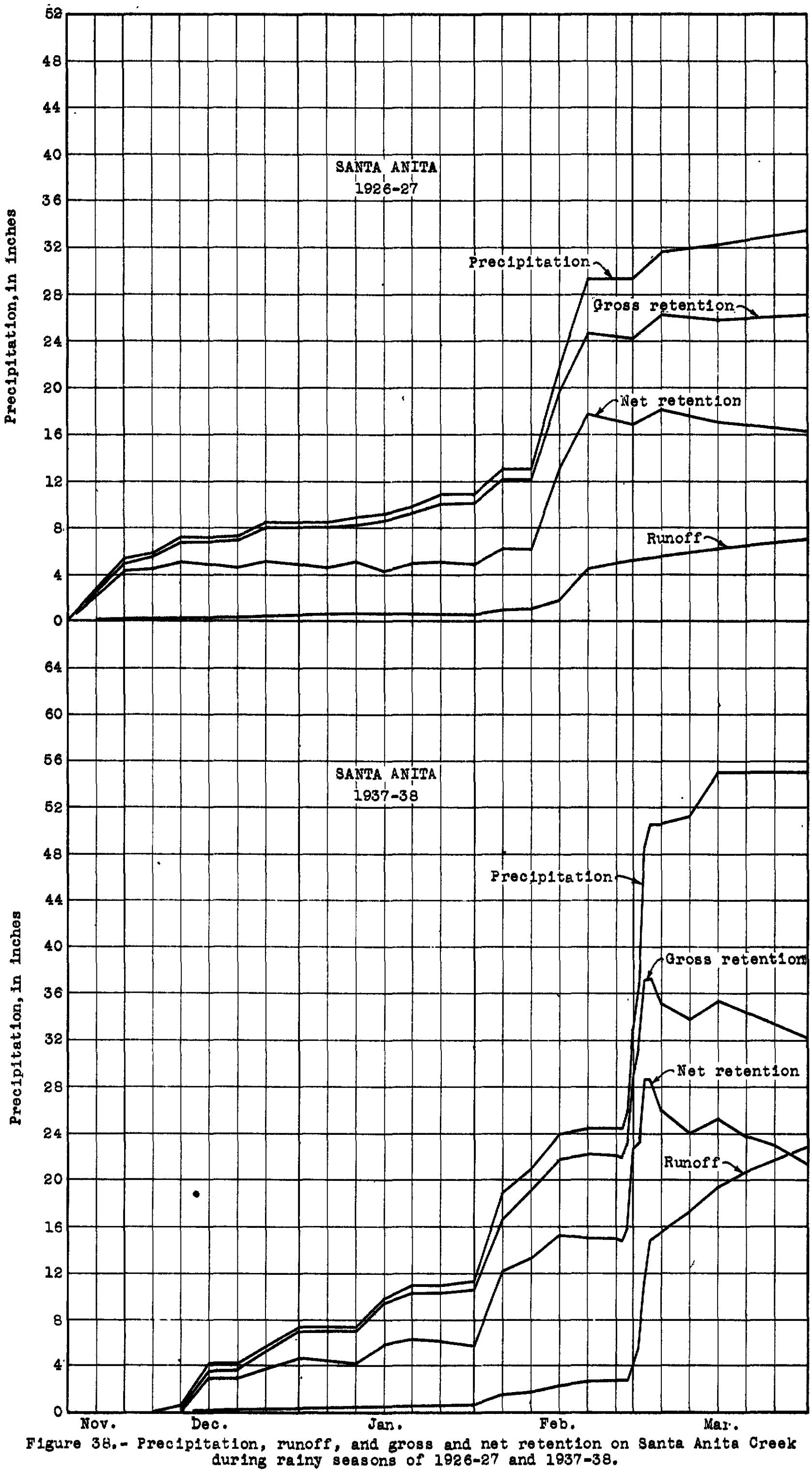

Figure 38.- Precipitation, runoff, and gross and net retention on Santa Anita Creek during rainy seasons of 1926-27 and 1937-38.

13, 1916, the total precipitation for the season had amounted to an average of 10.02 inches on the San Diego River drainage basin, fully half of which is estimated to have evaporated or transpired by January 13. Between January 13 and 21 the precipitation was 16.33 inches, of which about 4.94 inches ran off, leaving a gross retention from the beginning of the storm of 11.39 inches on January 23. During a 7-day storm period beginning January 23, 11.27 inches of rain fell, which was about 70 percent of the rainfall in the first storm. The runoff from this second storm was about 100 percent, indicating that the limit of storage capacity in the ground had been practically reached during the first storm.

The rather large absorptive capacity shown for Strawberry and Santa Anita Creek Basins seems to be typical of much of the San Gabriel and San Bernardino mountain areas. Additional evidence of absorptive capacity can be seen by an inspection of the runoff records subsequent to the storm of March 1938. The subsequent period utilized for this study extended to September 30, 1938. The detailed records of stream flow subsequent to March 10 are given in Geological Survey Water-Supply Paper 861, covering stream-flow measurements in southern California for the year ending September 30, 1938. The runoff data for the period following March 10 as used or cited in this discussion were obtained from that source.

The runoff of San Antonio Creek Basin near Claremont during the period March 4 to September 30, 1938, was 32.1 inches. During this period the rainfall was only about 7.5 inches, of which it is estimated about 1.5 inches evaporated. The loss by transpiration during the period is estimated at about 11.5 inches. On the basis of these records and estimates, and assuming also that the influence of ground-water flow to or from the basin at the point of measurement was negligible, there must have been a net retention of about 37.6 inches (32.1 + 1.5 + 11.5 - 7.5) in San Antonio Creek Basin above the river-measurement station near Claremont on March 4. A calculation based on the same rainfall, evaporation, and transpiration, indicates that Mill Creek Basin had about 28.2 inches in retention on March 4, and Lytle Creek Basin about 30.6 inches. If this analysis is correct, these three stream basins showed the ability to retain at least 28 to 37 inches of water in subsurface storage. If the estimates of evaporation following rains (1.5 inches) and of transpiration from the chaparral cover (11.5 inches) during the period March 4 to September 30, 1938, are too small, the estimate of retention must be increased accordingly. In order to supply the observed stream flow during the period March 4 to September 30 and the estimated evapo-transpiration requirements for the same period, it is assumed that there must have been in storage prior to the March storm at least 20.9 inches (37.6 inches, total retention, minus 16.7 inches, retention from March storm) in San Antonio Creek Basin, 10.5 inches in Mill Creek Basin, and 13.5 inches in Lytle Creek Basin. To each of these amounts should be added the ground-water storage still retained on September 30, 1938, to obtain the actual net retention in each basin prior to the March 1938 storm.

Variations in the geologic structure of the basins of San Antonio, Mill, and Lytle Creeks undoubtedly affect the absorption, storage, and flow of ground water, and perhaps the position of the phreatic divide in relation to the surface divide. Consequently, the results for these three streams may indicate a retention that is higher than would be generally representative of streams in the region.

For example, the drainage area of Lone Pine Creek is contiguous to that of Lytle Creek, referred to above. The retention for the storm period ending March 3, 1938, was 16.83 inches for the former and 17.09 inches for the latter. (See table 26) However, the runoff March 4 to September 30, following the storm, was only 3.1 inches for Lone Pine Creek as compared with 25.1 inches for Lytle Creek. The difference of 22 inches in runoff indicates dissimilar geologic formations or other conditions that affect the rate at which ground-water storage is released to the streams in these basins.

San Diego, San Dieguito, San Luis Rey, and Santa Margarita River Basins

As shown on the isohyetal map, the storm of March 1938 was relatively light in San Diego County and flood conditions were not severe. Table 26 lists for 10 stream-measurement stations in San Diego County the average rainfall for the period February 27 to March 3; the runoff in inches and acre-feet for the periods February 27 to March 3 and March 4 to 10 and also for the maximum 24-hour period; and the difference between rainfall and runoff at midnight on March 3 and March 10. The indicated retention relates only to the March flood period and does not include retention from precipitation prior to February 27. The periods used in table 26, as previously indicated in the text, show characteristic phases of the March flood.

A limited amount of regulation during the flood period was effected by Cuyamaca and El Capitan Reservoirs on San Diego River and Lake Henshaw on San Luis Rey River. The records for all other streams in San Diego County listed in table 26 represent conditions of natural flow.

The average rainfall by basins for the storm period of March 1938 in San Diego County ranged from 8.41 to 15.10 inches, which is considerably less than was recorded during the storm of 1916.[35] The rainfall on San Diego River Basin upstream from the gaging station near Santee was 21.4 inches during the storm period of January 1916, as compared with only 9.53 inches during the storm of March 1938. Likewise the rain on San Luis Rey River Basin upstream from Oceanside was 22.6 inches during the 1916 storm and only 11.20 inches during the March 1938 storm.

The runoff for the different basins ranged from 0.59 to 2.91 inches during the period when it was heaviest, February 27 to March 3. The least runoff was in San Diego River near Santee, possibly a result in part of regulation at El Capitan Reservoir, where 12,560 acre-feet, or 0.62 inch depth on the drainage area above Santee, was placed in storage during the March flood period. The flood runoff of San Diego River Basin for the March storm has been exceeded four times during the period of record, 1912-38, as follows: January 26-30, 1916 (at Old Town Station), 5.16 inches; February 14-18, 1927, 3.54 inches; December 26-28, 1921, 2.00 inches; and April 6-9, 1926, 0.96 inch.

Table 26 shows that the runoff during the maximum 24-hour period represented from 58 to 75 percent of the total storm runoff of February 27 to March 3, 1938, with the San Diego River Basin near Santee showing the greatest concentration and Temecula Creek Basin at Railroad Canyon, near Temecula, the least. High concentration of flood runoff with respect to time seems to be typical of semiarid areas. The peak discharge rate of Santa Ysabel Creek near Mesa Grande was 2.8 times that of the maximum 24-hour period, which is the highest ratio in the entire group. The lowest ratio between rate of peak discharge and maximum 24-hours was 1.4 on San Luis Rey River at Oceanside; this may have been due in part to regulation by Lake Henshaw.

35 McGlashan, H. D., and Ebert, F. C. Southern California floods of January 1916, U. S. Geol. Survey Water-Supply Paper 426, 1918.

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Table 26.- Rainfall, runoff, and retention for selected streams

No. on pls. 11,12, 13	Stream and point of measurement	Drainage area (square miles)	Mean areal rainfall Feb. 27 to Mar. 3 (inches)
	San Diego River Basin		
10	San Diego River near Santee (a)	380	9.53
12	San Vicente Creek at Foster	75	8.96
	San Dieguito River Basin		
13	Santa Ysabel Creek near Mesa Grande	58	15.10
	San Luis Rey River Basin		
15	San Luis Rey River near Bonsall (b)	514	11.46
16	San Luis Rey River at Oceanside (b)	557	11.20
	Santa Margarita River Basin		
17	Temecula Creek at Nigger Canyon, near Temecula	319	8.41
18	Temecula Creek at Railroad Canyon, near Temecula	592	8.51
19	Santa Margarita River near Fall Brook	645	8.91
20	Santa Margarita River at Ysidora	740	9.51
21	Murrieta Creek at Temecula	220	8.42
	Santa Ana River Basin		
27	Santa Ana River near Mentone	c144	24.63
29	Santa Ana River near Prado	d1,520	13.59
32	Mill Creek near Craftonville	42.9	25.86
33	Plunge Creek near East Highlands	16.9	19.98
34	San Timoteo Creek near Redlands	118	11.28
39	Strawberry Creek near Arrowhead Springs	8.6	17.34
40	Waterman Canyon Creek near Arrowhead Springs	4.55	18.59
41	City Creek near Highland	19.8	19.21
42	Devil Canyon Creek near San Bernardino	6.16	16.51
43	Lytle Creek near Fontana	47.9	27.33
46	Cajon Creek near Keenbrook	40.9	20.85
47	Lone Pine Creek near Keenbrook	15.3	23.14
48	Day Creek near Etiwanda	4.8	25.27
49	Cucamonga Creek near Upland	10.1	25.38
50	San Jacinto River near San Jacinto	140	11.14
52	San Jacinto River near Elsinore	717	7.74
54	Temescal Creek near Corona	e157	10.84
57	San Antonio Creek near Claremont	16.9	28.58
60	Santiago Creek near Villa Park	83.8	13.23
	San Gabriel River Basin		
69	West Fork of San Gabriel River, at flood-control reservoir No. 2 near Camp Rincon	40.4	23.62
71	Rogers Creek near Azusa	6.4	20.83
72	Fish Creek near Duarte	6.5	21.77
73	Sawpit Creek at flood-control reservoir near Monrovia	3.27	23.00
75	San Dimas Creek, at flood-control reservoir near San Dimas	16.5	20.71

* Maximum daily mean.
a Runoff not corrected for regulation by Cuyuma and El Capitan Reservoir.
b Runoff not corrected for regulation by Lake Henshaw.

for the period February 27 to March 10, 1938, in southern California

Runoff						Retention (inches)	
Inches			Acre-feet				
Feb. 27 to Mar. 3	Mar. 4-10	Maximum 24 hours	Feb. 27 to Mar. 3	Mar. 4-10	Maximum 24 hours	12 p.m. Mar. 3	12 p.m. Mar. 10
0.59	0.23	0.44	11,890	4,650	8,830	8.94	8.71
1.88	.77	1.25	7,520	3,060	5,020	7.08	6.31
2.91	1.26	1.77	9,030	3,890	5,490	12.19	10.93
1.21	.44	.79	33,220	12,130	21,560	10.25	9.81
1.10	.51	.77	32,850	15,260	22,910	10.10	9.59
.92	.26	.68	15,600	4,490	11,620	7.49	7.23
1.43	.25	.83	45,020	7,890	26,320	7.08	6.83
1.56	.89	.96	53,610	30,550	33,220	7.35	6.46
1.81	.43	1.03	71,300	17,020	40,780	7.70	7.27
2.14	.14	1.48	25,110	1,590	17,320	6.28	6.14
6.56	2.01	5.41	50,020	14,310	41,300	18.07	16.06
1.06	.26	.82	85,630	20,770	66,510	12.53	12.27
8.17	3.94	6.67	19,180	9,240	15,650	17.69	13.75
6.70	2.54	4.74	6,040	2,290	4,270	13.28	10.74
.77	.02	.65	4,850	128	4,120	10.51	10.49
5.99	1.94	4.15	2,750	891	1,900	11.35	9.41
6.05	2.39	4.45	1,470	579	1,080	12.54	10.15
5.97	1.93	4.31	6,290	2,040	4,540	13.24	11.31
5.65	2.33	4.17	1,850	762	1,370	10.86	8.53
10.24	3.76	7.69	26,190	9,600	19,660	17.09	13.33
6.40	1.21	4.26	13,960	2,650	9,300	14.45	13.24
6.31	.96	4.59	5,150	781	3,750	16.83	15.87
13.43	3.63	9.51	3,440	928	2,430	11.84	8.21
12.14	3.18	8.91	6,550	1,710	4,790	13.26	10.08
2.51	1.26	*1.36	18,700	9,360	*10,120	8.63	7.37
.14	.43	.14	5,410	16,340	5,180	7.60	7.17
1.07	.21	.88	12,080	2,340	10,000	9.77	9.56
11.84	3.96	10.14	10,680	3,570	9,140	16.74	12.78
2.68	1.25	1.80	11,980	5,590	8,050	10.55	9.30
12.06	3.01	8.26	25,860	6,470	17,790	11.56	8.55
8.10	2.45	4.42	2,760	835	1,510	12.73	10.28
8.70	2.82	4.80	3,020	978	1,660	13.07	10.25
7.20	2.25	4.57	1,250	391	798	15.80	13.55
5.69	1.55	3.94	5,010	1,370	3,469	15.02	13.47

c Excluding Bear Valley.
d Excluding Bear Valley and San Jacinto River.
e Area below Elsinore Lake.

Table 26.- Rainfall, runoff, and retention for selected streams in southern

No. on pls. 11,12, 13	Stream and point of measurement	Drainage area (square miles)	Mean areal rainfall Feb. 27 to Mar. 3 (inches)
	San Gabriel River Basin--Continued		
81	Dalton Creek at flood-control reservoir near Glendora	4.49	17.85
83	Little Dalton Creek near Glendora	3.3	19.87
85	Live Oak Creek at flood-control reservoir near La Verne	2.30	17.41
86	San Jose Creek near Whittier	85.2	10.74
87	Thompson Creek at flood-control reservoir near Claremont	3.91	17.41
89	Brea Creek at Fullerton	26.4	11.22
	Los Angeles River Basin		
97	Pacoima Creek at flood-control reservoir near San Fernando	27.8	18.90
101	Tujunga Creek at flood-control reservoir near Sunland	81.4	18.10
105	Haines Creek near Tujunga	1.2	19.38
108	Arroyo Seco near Pasadena	16.4	21.86
111	Santa Anita Creek at flood control reservoir near Sierra Madre	10.8	25.76
113	Little Santa Anita Creek at flood-control reservoir near Sierra Madre	2.39	22.74
115	Eaton Creek at flood-control reservoir near Pasadena	9.48	22.39
	Santa Clara River Basin		
141	Piru Creek near Piru	432	12.35
143	Sespe Creek near Fillmore	254	14.96
144	Santa Paula Creek near Santa Paula	39.8	15.89
	Ventura River Basin		
150	Matilija Creek at Matilija	55	15.44
151	Ventura River near Ventura	187	13.32
155	Coyote Creek near Ventura	41.1	12.78
	Santa Ynez River Basin		
159	Santa Ynez River at Juncal Reservoir near Montecito	16.0	14.69
161	Santa Ynez River below Gibraltar Dam, near Santa Barbara	219	12.62
162	Santa Ynez River near Santa Ynez	435	12.12
163	Santa Ynez River near Lompoc	790	10.08
	Santa Maria River Basin		
164	Cuyama River near Santa Maria	902	5.31
165	Huasna River near Santa Maria	119	4.16

* Maximum daily mean.

the period February 27 to March 10, 1938, for California--Continued

Runoff						Retention (inches)	
Inches			Acre-feet				
Feb. 27 to Mar. 3	Mar. 4-10	Maximum 24 hours	Feb. 27 to Mar. 3	Mar. 4-10	Maximum 24 hours	12 p.m. Mar. 3	12 p.m. Mar. 10
5.93	2.08	3.83	1,420	496	917	11.92	9.84
6.11	1.94	*3.14	1,010	321	*520	13.76	11.82
3.73	.69	2.50	457	85	307	13.68	12.99
2.62	.08	*1.93	11,940	341	*8,790	8.12	8.04
3.95	.89	2.75	845	186	573	13.46	12.57
1.66	.01	*1.33	2,340	734	*1,870	9.56	9.55
5.98	2.60	4.17	8,820	3,850	6,177	12.92	10.32
7.21	1.36	5.73	31,290	5,820	24,865	10.89	9.54
3.52	1.02	2.48	225	65	159	15.86	14.84
10.10	2.69	6.83	8,820	2,350	5,970	11.76	9.07
11.06	3.52	6.84	6,380	2,020	3,941	14.70	11.18
6.94	2.97	3.87	888	377	493	15.80	12.83
5.90	1.80	3.79	2,970	916	1,918	16.49	14.69
2.18	.66	1.16	50,250	15,140	26,710	10.17	9.51
4.02	2.48	2.30	54,670	33,760	31,220	10.94	8.46
4.95	2.36	2.89	10,510	5,010	6,140	10.94	8.58
5.66	4.22	3.49	16,620	12,380	10,240	9.78	5.56
5.78	2.00	3.90	57,620	19,920	38,900	7.54	5.54
4.65	1.16	3.16	10,200	2,550	6,930	8.13	6.97
4.67	2.14	3.32	3,980	1,820	2,830	10.02	7.88
2.76	1.21	2.07	32,250	14,130	24,160	9.86	8.65
2.61	1.78	1.83	60,550	41,360	42,880	9.51	7.73
1.71	1.23	1.22	72,040	51,670	51,190	8.37	7.14
.24	.19	.22	11,800	8,920	10,600	5.07	4.88
.58	.89	.28	3,700	5,640	1,800	3.58	2.69

The basin in which the natural storage drains out most rapidly is that of Santa Ysabel Creek. During the period March 4 to 10 the runoff in this basin was 1.26 inches and during the longer period March 4 to September 30 it was 5.90 inches, an amount which with the transpiration losses during the same period, must have exhausted the retention of 12.19 inches left by the March storm. In the San Vincente Creek Basin, the runoff was 0.77 inch for the period March 4-10 and 2.13 inches for the period March 4 to September 30, 1938; in this basin, also, it appears that the retention of 7.08 inches from the March storm was hardly enough to satisfy the demands of transpiration and the runoff during the period. Murrieta Creek Basin had the least runoff--0.14 inch March 4-10 and 0.50 inch March 4 to September 30. As in the other stream basins already discussed, it is doubtful if the retention of 6.28 inches on March 3 could have been more than equal to the losses by transpiration and the runoff during the period of March 4 to September 30. It seems very probable, therefore, that antecedent precipitation had an important but indeterminate effect on the runoff during this period.

Santa Ana, San Gabriel, and Los Angeles River Basins

The rainfall during the storm of March 1938 was heavier in the Santa Ana, San Gabriel, and Los Angeles River Basins than in any other parts of southern California. The amount of rainfall for these basins, together with the runoff for two characteristic phases of the storm period, February 27 to March 3 and March 4 to 10, and the differences between rainfall and runoff are shown in table 26.

The average storm rainfall on the drainage areas listed ranged from 7.74 inches on the valley floor to 28.58 inches at high altitudes in the mountains. In most of the area it was the heaviest rainfall experienced in many years.

The discharge for the maximum 24-hour period was apparently governed by the rates of rainfall, the rates of infiltration, and the amount of water already in groundwater storage. During the maximum 24-hour period, the records from the flood-control reservoirs in Los Angeles County showed an average runoff of 4.55 inches, which represents about 66 percent of the entire flow during the 5-day period February 27 to March 3. Of these reservoir stations, that of the West Fork of San Gabriel River recorded the greatest runoff for the maximum 24-hour period, a total of 8.26 inches, which was 68 percent of the flood runoff to and including March 3.

The runoff from the drainage area above the Live Oak Creek Reservoir was the least for the group--2.50 inches during the maximum 24-hour period, or 67 percent of the runoff for the part of the flood period ending March 3, a percentage almost identical with that of the West Fork of the San Gabriel River. The discharge for the maximum 24-hour period on Tujunga Creek accounted for 80 percent of the flood runoff for the same period and was the greatest concentration of inflow reported for any of the reservoirs. Little Santa Anita Creek showed the least concentration of runoff, that for the maximum 24-hour period being equal to 56 percent of that for the 5-day storm period February 27 to March 3. On the whole, most of the runoff records compiled from the other reservoirs were much more consistent, the maximum 24-hour runoff generally falling within 4 percent of the average, indicating uniformity of storm characteristics and other conditions in these particular areas.

In that part of the San Gabriel and San Bernardino Mountains drained by the Santa Ana River, the computed runoff for the maximum 24-hour period was 75 percent of the runoff for the 5-day storm period, a percentage considerably higher than that indicated by the reservoir records. This greater concentration of runoff may have resulted from the heavier rainfall and the generally steeper slopes, especially in that part of the San Gabriel Mountains tributary to the Santa Ana River.

The three main streams in the Santa Ana River Basin draining the San Gabriel Mountains are San Antonio, Cucamonga, and Day Creeks. Of these streams, San Antonio Creek had the greatest runoff during the maximum 24-hour period as well as the greatest concentration. During the maximum 24-hour period the runoff amounted to 86 percent of that for the 5-day period. Day Creek had a concentration during the maximum 24 hours of 71 percent, and Cucamonga Creek 73 percent.

The drainage areas of Lytle, Cajon, and Lone Pine Creeke have many characteristics in common, including slope and altitude, and all three streams drain both the San Gabriel and San Bernardino Mountains. The runoff of Lytle Creek during the maximum 24-hour period was 74 percent of the runoff during the 5-day storm period February 27 to March 3; that of Cajon Creek was 67 percent; and Lone Pine Creek, 73 percent. These ratios are in fairly close agreement with the average of the Santa Ana River stations in the San Gabriel and San Bernardino Mountains.

The southern slopes of the San Bernardino Mountains are drained by the Santa Ana River and by Mill, Plunge, City, Strawberry, Waterman Canyon, and Devil Canyon Creeks. The discharge of Santa Ana River and of Mill Creek for the maximum 24 hours indicated a runoff equal to 82 percent of the storm runoff for the period February 28 to March 3, which represents the greatest concentration of runoff in this group. Strawberry Creek showed the least concentration--69 percent. The average concentration of runoff for these streams is greater than that shown by the flood-control reservoir records in the basins of San Gabriel and Los Angeles Rivers.

The San Jacinto River Basin above San Jacinto possesses many characteristics similar to those of the other tributaries of Santa Ana River. However, owing to a lighter rainfall in this area, there was no exceptionally high runoff during the storm of March 1938. The maximum daily runoff was 1.36 inches, or 54 percent of that for the 5-day storm period. The peak discharge during the March storm was 14,300 second-feet on March 2, as compared with 14,000 second-feet on February 6, 1937. A peak discharge of 30,000 second-feet near San Jacinto was recorded in January 1916, and one of 45,000 second-feet on February 16, 1927, the latter caused, in part, by the failure of a dike at Hemet Reservoir.

The longest record of runoff in the San Gabriel River Basin is that for the station on the main stem of the river near Azusa, which was established in 1894. The determination of the natural runoff at this station is now difficult owing to the regulation at the two flood-control reservoirs and at Morris Dam. The maximum discharge of the San Gabriel River at the Azusa station might have been as high as 100,000 second-feet during the flood of March 1938 had there been no regulation. The maximum previously recorded was 40,000 second-feet on January 18, 1916.

All the streams in the Los Angeles River Basin listed in table 26 drain the San Gabriel Mountains. The discharge for the maximum 24-hour period for stations on these streams shows a greater variation in degree of concentration than in any of the other areas in southern California. The two extremes for this basin, as already mentioned, are Tujunga and Little Santa Anita Creeks.

The storm runoff March 4 to 10 represents a draining out of ground water, which in its characteristics of amount and rate of movement would seem to be closely related to the characteristics of the geologic formations with respect to their capacity for storing water. The draining out was also dependent on the retention from the March storm and from antecedent precipitation, which may have included some ground-water storage remaining from the abnormally high rainfall during the season of 1936-37. During the period March 4 to 10, the average runoff, as based on the flood-control reservoir records, was 2.16 inches. Santa Anita Creek had the largest runoff--3.51 inches--and Live Oak Creek the least--0.69 inch.

For the Santa Ana River near Mentone the runoff during the draining out period, March 4 to 10, was 2.01 inches. For the adjacent basin of Mill Creek during the same period the runoff was 3.94 inches, or nearly twice as great. For the period March 4 to September 30, 1938, the runoff for the Santa Ana River near Mentone was 13.27 inches, as compared with 22.61 inches for Mill Creek. During the same period, the runoff from Lone Pine Creek was only 3.1 inches. As shown by table 26, the retention in these three basins was nearly the same at midnight March 3.

Strawberry Creek, which is typical of the short mountain tributaries in the San Bernardino Mountains, had a runoff of 1.94 inches for the 7-day period March 4 to 10 and for the longer period March 4 to September 30, 13.7 inches.

In that part of the San Gabriel River Basin draining the San Gabriel Mountains, the West Fork of San Gabriel River showed the most rapid release of ground water, with 3.01 inches of runoff between March 4 and 10. San Dimas Creek had the least runoff with 1.55 inches for the same period.

Because of storage losses and diversion during the summer, it was not practicable to compare the runoff from the basins of the controlled streams for the longer period March 4 to September 30. Fish Creek, in the San Gabriel River Basin, which is not regulated, had a runoff during this period of 14.1 inches, which is comparable to the runoff for Strawberry Creek, in the Santa Ana River Basin.

In the Los Angeles River Basin during the period March 4 to 10 Santa Anita Creek had the largest runoff, 3.51 inches, and Haines Creek had the least, 1.02 inches. The average runoff for the entire group in this basin as shown in table 26 was 2.28 inches. During the period March 4 to September 30, 1938, the runoff of Arroyo Seco was 11.8 inches, and that of Santa Anita Creek was 14.3 inches.

Santa Clara and Ventura River Basins

There was no regulation or diversion on any of the streams in the Santa Clara and Ventura River Basins for the period February 27 to March 10. The average runoff at the stations on these streams was 4.54 inches for the period February 27 to March 3, which is somewhat less than the average for the streams in the Santa Ana, San Gabriel, and Los Angeles River Basins, probably on account of the lighter rainfall.

In the Santa Clara River Basin, the ratio of the runoff for the maximum 24-hour period to the runoff for the period February 27 to March 3 was 53 percent on Piru Creek, 57 percent on Sespe Creek, and 58 percent on Santa Paula Creek.

In the Ventura River Basin, the ratio of runoff for the maximum 24 hours to that for the period February 27 to March 3 was 62 percent on Matilija Creek, 67 percent on Ventura River, and 68 percent on Coyote Creek.

During the draining-out period March 4 to 10, the average runoff from these six streams in the Santa Clara and Ventura River Basins was 2.15 inches, which approximates closely the average of the records from the flood-control reservoirs in Los Angeles County. Piru Creek had the least runoff, 0.66 inch during the period March 4 to 10 and 2.5 inches during the period March 4 to September 30. Sespe Creek, an adjacent stream, had a runoff of 2.48 inches during the period March 4 to 10 and 7.8 inches March 4 to September 30.

Santa Ynez and Santa Maria River Basins

The Santa Ynez and Santa Maria River Basins are situated on the extreme northern edge of the area affected by the storm of March 1938. In the main, the characteristics of the rainfall, runoff, and retention in these two basins were very similar to those in the Santa Clara and Ventura River Basins. The heavy rainfall in February had increased the ground storage in about the same proportion as in some of the basins to the south.

The average runoff from streams in these basins (see table 26) for the maximum 24-hour period was 1.49 inches, which is 71 percent of the total average runoff for the period February 27 to March 3. Santa Ynez River at Juncal Reservoir had the highest maximum 24-hour runoff in these basins, 3.32 inches. This rate is only slightly less than that for San

Dimas, Eaton, Dalton, and Little Santa Anita Creeks. Although those latter stations had a rainfall for the maximum 24-hour period of 9.5 to 11.3 inches, it is doubtful if the rainfall on the Santa Ynez River Basin above Juncal Reservoir exceeded 8.0 inches for the same period. The other stations on the Santa Ynez River, and those on the Santa Maria River show considerably less runoff, owing principally to a much lighter rainfall.

The runoff of Santa Ynez River at Juncal Reservoir during the period March 4 to 10 was 2.14 inches and for the period March 4 to September 30, 11.22 inches.

The rainfall in the Santa Maria River Basin was comparatively light and the flood was not especially severe.

ARTIFICIAL STORAGE

The detention and retardation of flood flows by storage reduces the peak stages of streams at critical times and, to the limit of the available storage capacity, is an effective method of reducing flood damage. In the mountainous headwater areas of the Santa Ana, San Gabriel, and Los Angeles River Basins are a number of reservoirs used either for water supply or flood control purposes.

The influence of reservoirs on the flood of March 1938 is shown by the data presented in table 27, many of which are taken from the report by Burke.[36] The table gives the total storage capacity and the storage available at the beginning of the maximum 24-hour period of runoff, the runoff for the 3 days prior to the maximum 24-hour period, the runoff for the maximum 24-hour period, the peak inflow, the peak outflow, the interval between time of peak inflow and peak outflow, and other pertinent data.

The difficulty of operating the reservoirs for material reduction of flood peaks such as occurred on March 2, 1938, can be seen by comparing the capacity with the volume of inflow. The total capacity, at spillway level, of the reservoirs operated primarily for flood control in San Gabriel and Los Angeles River Basins was 105,000 acre-feet; the runoff during the 3 days prior to the maximum 24-hour period was about 41,400 acre-feet, and the runoff during the maximum 24-hour period was about 146,000 acre-feet.

36 Burke, M. F., Flood of Mar. 2, 1938, Los Angeles County Flood Control District, May 20, 1938. (Mimeographed)

Table 27.- Storage and flow at reservoirs in Santa Ana, San Gabriel, and Los Angeles River Basins during floods of February and March 1938

No. on plates 11 to 13	Reservoir	Stream	Drainage area (sq.mi.)	Storage at spillway level (acre-feet)	Storage available at beginning of maximum 24-hour runoff (acre-feet)	Total runoff for 3 days prior to maximum 24-hour runoff (acre-feet)	Maximum 24-hour runoff (acre-feet)	Peak inflow (sec.-ft.)	Peak outflow (sec.-ft.)	Delay of peak (hours)
	Santa Ana River Basin									
31	Bear Valley a/	Bear Creek	42.2	52,500	-	3,600	10,360	10,000	96	17
51	Railroad Canyon a/	San Jacinto River	709	11,000	-	6,790	4,730	3,150	2,550	2
53	Elsinore Lake b/	San Jacinto River	798	c130,000	c41,000	5,180	7,240	4,500	0	-
59	Santiago a/	Santiago Creek	62.5	25,000	-	2,800	9,950	9,850	5,760	4.5
	San Gabriel River Basin									
64	San Gabriel No. 1 d/	San Gabriel River	202	53,334	30,180	21,500	74,350	90,000	56,700	3.2
65	Morris a/	San Gabriel River	211	31,700	e7,124	-	48,730	66,200	65,700	.1
69	San Gabriel No. 2 d/	West Fork of San Gabriel River	40.4	12,298	1,685	5,630	17,790	26,900	24,200	.2
73	Sawpit d/	Sawpit Creek	3.27	389	282	300	798	1,000	665	1.8
75	San Dimas d/	San Dimas Creek	16.5	1,426	523	1,060	3,469	4,600	4,370	0
81	Big Dalton d/	Dalton Creek	4.49	1,053	561	400	917	1,350	739	2.8
85	Live Oak d/	Live Oak Creek	2.30	242	172	100	307	373	200	1.8
87	Thompson d/	Thompson Creek	3.21	812	-	140	573	669	133	22
	Los Angeles River Basin									
97	Pacoima d/	Pacoima Creek	27.8	5,592	2,354	1,480	6,177	8,450	2,440	8.8
101	Tujunga d/	Tujunga Creek	81.4	6,240	893	4,210	24,865	35,000	32,500	.4
109	Devils Gate d/	Arroyo Seco	30.6	3,825	1,355	2,200	7,420	11,400	7,060	3.5
111	Santa Anita d/	Santa Anita Creek	10.8	1,010	469	1,780	3,941	5,490	5,260	.2
113	Sierra Madre d/	Little Santa Anita Creek	2.39	47.4	31	340	493	633	630	0
115	Eaton d/	Eaton Creek	9.48	940	486	560	1,918	3,340	2,800	.2

a Water-supply reservoir.
b Natural lake.
c Approximate.
d Flood-control reservoir.
e Storage above spillway level.

The runoff incident to the first phase of the storm utilized about half of the total available capacity, and in consequence only about a third of the runoff during the 24 hours of maximum discharge on March 2 could be retained. Although on some of the streams the effect on the maximum peak discharge may have been relatively small, the general effect was to reduce the total amount of water that accumulated in overflow areas below the reservoirs, and all the reservoirs acted as debris basins, effectively trapping large accumulations of silt that might otherwise have been deposited outside the mountain areas.

At several flood-control dams the silt and debris accumulated to an altitude above that of some of the outlets, which interfered with the regulating of the gates to achieve maximum flood-control efficiency.

Several reservoirs on smaller streams in the Santa Ana River Basin contributed substantially to the lowering of the flood peaks on those streams but had little effect on the peak in the Santa Ana River. Elsinore Lake, fed by the San Jacinto River, did not overflow. Overflow from this lake would pass down Temescal Creek to the Santa Ana River.

The San Gabriel River was effectively controlled by storage in San Gabriel River Flood-control Reservoir No. 1, the peak discharge being reduced from 90,000 to 56,700 second-feet. No water was released from Puddingstone Reservoir, storage in which reduced the peak discharge on Walnut Creek. This reservoir also stored water diverted from San Dimas Creek, thereby reducing the flow in the lower reaches of that stream. Other smaller flood-control reservoirs in the basin had little effect on the flood in the San Gabriel River.

In the Los Angeles River Basin there are a number of reservoirs, whose combined capacity, at spillway level, is about 54,000 acre-feet, of which about 18,000 acre-feet is operated solely for flood control. The effect of these reservoirs on the flood peak in the Los Angeles River was not material.

Although reservoirs on the smaller streams did not appreciably reduce the peak discharge of the larger rivers, they did retain large amounts of silt and debris and thus materially reduced the damage to the highly developed areas adjoining the streams at lower altitudes.

DEBRIS

Interception of debris by reservoirs and debris basins

As already noted, the streams that have their sources on the southern slopes of the San Gabriel and San Bernardino Mountains flow into the San Fernando, San Gabriel, Chino, and upper Santa Ana Valleys. As disclosed by well drilling in the central part of San Gabriel Valley, all these valleys are, in the main, underlain by alluvial deposits 1,000 to 2,000 feet deep. At the heads of the valleys are a series of debris cones, some of enormous size, all bearing witness to large debris movements in the past.

In earlier years the debris-laden streams meandered during flood periods more or less at will over the debris cones and valley floor, as explained in the subsequent chapter on history of floods. As the valley floor was populated, it became more and more necessary to confine the meandering streams to fixed channels. Until recent years the accommodation of the accumulating debris was not a serious problem, as the debris cones still afforded areas for further deposition.

As settlement has increased, however, the tillable lands along the cones have been utilized for orchards, homes, and in some places for considerable urban development. Because of this use of the lands the control of the movement of debris on the cones has become an important economic problem. Streams that formerly meandered and dropped much of their bed load and silt content over the cones in a normal, natural manner now have to be confined within fixed channels in order to protect man's improvements. The practice of confining these streams to direct routes across the debris cones has necessarily resulted in the transportation to the valleys below of much of the debris that formerly was deposited on the cones. (See pl. 9.) In an attempt to alleviate this situation, at least in part, debris or catchment basins have been excavated in the stream channels near the apexes of some of the cones. The capacity of these basins ranges from about 12.5 acre-feet to 98 acre-feet.

One of the debris basins, located on the Dunsmuir Creek debris cone, is illustrated on plate 19, which shows the inlet structure and the outlet structure with the overflow weir. Between these two structures is the excavated basin in the cone, which has debris storage capacity of about 80 acre-feet. The steepness of the cone is clearly shown in plate 19,A, and a part of the urban development in the valley below can be seen in plate 19,B.

To maintain the effectiveness of these basins it is necessary to remove the accumulated debris after each heavy storm and to transport it elsewhere. With the continued extension of improvements in the area, the disposal of the material trapped in the debris basins has become a serious problem. Plate 20 shows the Dunsmuir Creek debris basin immediately following the March flood and before its re-excavation had started.

The flood-control reservoirs that have been constructed for the storage and temporary retention of flood runoff also act as debris basins. Table 28 gives pertinent data, furnished by the Los Angeles County Flood Control District and the United States Soil Conservation Service, relating to deposits of debris in the debris basins and flood-control reservoirs. For the flood-control reservoirs, the column "Debris deposited" indicates the total volume of debris per square mile removed from each drainage area; but for the debris basins, because their capacity for catchment may have been exceeded, the volume shown in this column may not be the total volume of debris so removed. The volume of debris listed in the table includes not only the material actually trapped in the basin or reservoir, but also the deposits in the channel just upstream from the debris basin. The runoff in acre-feet per square mile for the maximum 24-hour period is given if available.

The loss in capacity of the reservoirs as shown in table 29 is for the period between the last previous survey and the flood of March 1938. It is believed that practically all of the movement of debris causing this loss in capacity occurred during the storm period of March 1938 and that most of the debris was deposited within the maximum 24-hour period of flood runoff.

The data in table 28, shown graphically in figure 39, indicate a relation between the average slope of a drainage basin and the accumulation of debris. The slope of these drainage basins is extraordinarily steep, the average increase in altitude within a horizontal distance of 100 feet ranging from 36 to 76 feet. Detailed field studies made in connection with the flood on New Year's Day, 1934, in the La Cañada area [37] indicate that the debris moved out of the canyon area during severe storms represents the gradual accumulation in channels during a period of years of low runoff rather than the direct movement from the area as a whole during a single flood period.

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37 Troxell, Harold C., and Peterson, John Q. Flood in La Cañada Valley, Calif., January 1, 1934: U. S. Geol. Survey Water-Supply Paper 796-C, p. 93, 1937.

Table 28.- Deposition of debris in reservoirs and debris basins of the Los Angeles County Flood Control District

Reservoir or basin	Drainage area (sq.mi.)	Average slope of drainage area (percent)	Debris deposited (acre-feet per sq.mi.)	Maximum 24-hour inflow (acre-feet per sq.mi.)
Flood-control reservoirs				
Big Dalton	4.5	40	19.6	204
Devils Gate (Arroyo Seco)	30.6	-	41.5	242
Eaton Creek	9.5	58	50.9	203
Live Oak Creek	2.3	36	6.5	134
Pacoima Creek	27.8	41	21.4	225
San Dimas Creek	16.5	42	17.3	212
San Gabriel River No. 1	202	49	38.3	368
San Gabriel River No. 2 (West Fork)	40.4	47	39.2	442
Santa Anita Creek	10.8	47	40.1	360
Sierra Madre (Little Santa Anita Creek)	2.4	50	16.7	207
Sawpit Creek	3.3	50	24.5	242
Thompson Creek	3.9	36	7.7	147
Tujunga Creek	81.4	44	19.7	306
Debris basins				
Brand	1.03	62	8.1	-
Dunsmuir	.84	67	43.4	-
Eagle-Goss	.61	65	41.5	-
Fair Oaks	.21	61	35.3	-
Fern	.30	62	42.8	-
Haines	1.53	71	21.1	-
Hall-Beckley	.84	74	68.8	-
Hay	.20	56	39.0	-
Las Flores	.42	65	55.2	-
Lincoln	.50	51	21.1	-
Nichols	.94	54	11.8	-
Pickens	1.84	69	50.8	-
Shields	.27	76	74.4	-
Snover	.23	49	45.2	-
West Ravine	.25	69	73.1	-

Runoff that might be sufficient to transport debris on slopes as steep as these canyon walls may lack the force to move it along slopes as flat as those found in the canyon floors. Thus material washed off the mountainsides may accumulate in stream beds until such time as the area is visited by a major flood, when most of the accumulation may be moved out on the debris cone or valley floor. This is, in a measure, indicated by the observations at the reservoirs. For example, San Dimas Creek flood-control reservoir, built in September 1922, has lost to date 22.8 percent of its capacity, of which it is estimated 18.1 percent was lost during the flood of March 1938. For the 15-year period prior to this flood the capacity of the reservoir had been reduced by only about 4.7 percent, although during that time there were at least three severe storms. It seems

A. EXCAVATED BASIN AND INFLOW STRUCTURE.

B. OUTFLOW STRUCTURE.

DUNSMUIR DEBRIS BASIN AFTER EXCAVATION OF DEBRIS.

Courtesy of Corps of Engineers, U. S. Army.

A. VIEW UPSTREAM SHOWING DEBRIS DEPOSITS UP TO ALTITUDE OF INFLOW STRUCTURES.

B. VIEW DOWNSTREAM.

DUNSMUIR DEBRIS BASIN FULL OF DEBRIS, MARCH 11, 1938.

Courtesy of Corps of Engineers, U. S. Army.

Table 29.- Loss in capacity of reservoirs of the Los Angeles County Flood Control District

Reservoir or basin	Altitude of spillway*	Date storage began	Original capacity acre-feet	Date of last survey prior to Mar.1938	Capacity below spillway level		Loss in capacity	
					Prior to Mar.1938	Apr.1938	Acre-feet	Percent**
Big Dalton	1,706	Aug. 1929	1,060	Oct.1937	1,040	†974	66	6.2
Devils Gate (Arroyo Seco)	1,054	June 1920	4,563	Dec.1936	3,825	2,967	848	18.6
Eaton Creek	888	Feb. 1937	940	Nov.1937	940	698	242	25.7
Live Oak Creek	1,497	Nov. 1922	250	Mar.1936	242	229	13	5.2
Pacoima Creek	1,950	Feb. 1929	6,060	Jan.1936	5,592	5,004	588	9.7
San Dimas Creek	1,462	Sept.1922	1,496	Oct.1937	1,399	†1,188	211	14.1
San Gabriel River No. 1	1,453	Nov. 1937	53,334	Jan.1938	53,334	47,191	6,143	11.5
San Gabriel River No. 2 (West Fork)	2,385	Apr. 1935	12,320	Oct.1935	12,298	10,787	1,511	12.3
Santa Anita Creek	1,316	Mar. 1927	1,043	Feb.1936	1,010	683	327	31.4
Sawpit Creek	1,360	June 1927	431	Oct.1935	389	320	69	16.0
Sierra Madre (Little Santa Anita Creek)	1,172	Feb. 1928	49.5	Mar.1932	47.4	8.5	38.9	78.6
Thompson Creek	1,640	Mar. 1928	812	Apr.1932	812	786	26	3.2
Tujunga Creek	2,290	July 1931	6,240	Feb.1929	6,240	4,734	1,506	24.1
Total			88,608.5		87,168.4	75,579.5	11,588.9	13.1

Note.- Data furnished by U. S. Soil Conservation Service.
* Altitude in feet above mean sea level.
** Percentage of original capacity lost since last survey.
† October 1938.

probable that the debris moved into the reservoir by the storm of March 1938 represents a part of the debris removed from the canyon walls and accumulated in the stream bed during a relatively long preceding period.

Santa Anita Creek flood-control reservoir has had a reduction of 34.5 percent in capacity since its construction in March 1927, of which about 31.4 percent occurred during the storm of March 1938. Thus during the 11 years preceding March 1938 the reduction was only 3.1 percent.

A large part of the mountain drainage area in the vicinity of La Cañada was burned over in the fall of 1933, and the fire was followed by the severe storm that caused the New Year's flood of 1934. Large amounts of debris that had accumulated during the preceding years of below-normal precipitation were transported out of the canyons during that flood. The basins in which flood-control reservoirs had been constructed were not within the area in which the 1934 flood was heaviest, and the movement of debris down the stream channels was not nearly so great as in the La Cañada area. Following the New Year's flood of 1934, many debris basins were constructed, most of them in the La Cañada area. This may explain the indication of figure 39 that for the storm of March 1938, in drainage basins of equal slope, the debris movement into the reservoirs, in acre-feet per square mile of drainage area, was considerably greater than the movement into the debris basins.

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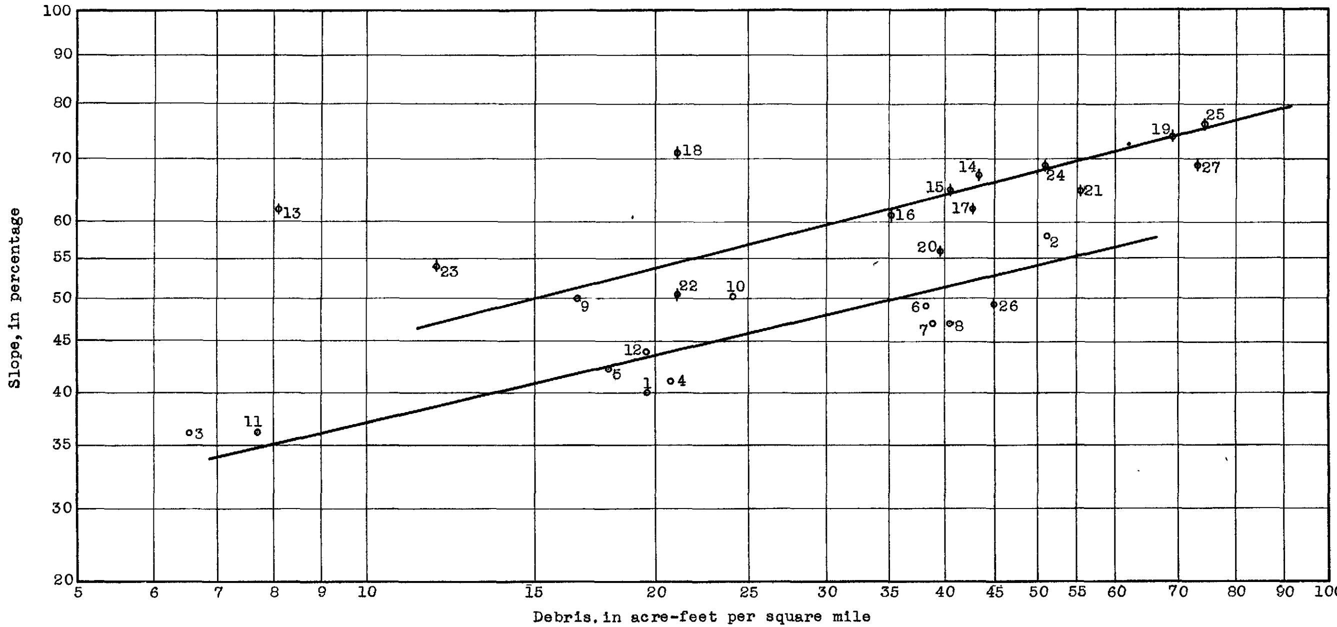

EXPLANATION

o = Flood control reservoirs

1. Dalton Creek
2. Eaton Creek
3. Live Oak Creek
4. Pacoima Creek
5. San Dimas Creek
6. San Gabriel River No. 1
7. San Gabriel River No. 2 (West Fork)
8. Santa Anita Creek
9. Sierra Madre (Little Santa Anita Creek)
10. Sawpit Creek
11. Thompson Creek
12. Tujunga Creek

ϕ = Debris basins

13. Brand
14. Dunsmuir
15. Eagle Cross
16. Fair Oaks
17. Fern
18. Haines
19. Hall-Beckley
20. Hay
21. Las Flores
22. Lincoln
23. Nicholas
24. Pickens
25. Shields
26. Snover
27. West Ravine

Figure 39.- Relation between average slope of drainage basin and deposition of debris in reservoirs and debris basins of the Los Angeles County Flood Control District

Movement of debris in stream channels on the valley floor

The movement of debris in stream channels is not confined to the mountain areas but extends downstream to the flatter slopes, where the debris accumulates in the channels on the valley floor until such time as the area is visited by a major storm. Figure 40 shows the change in altitude of the point of zero flow for the channel of the Santa Ana River near Prado during the period 1919-38. This change is an indicator of stream-bed scour and fill. The maximum discharge and the date of its occurrence are given for each flood that caused noticeable scour in the channel. The storm of February 1927 lowered the point of zero flow 3.5 feet and appears to have caused the greatest stream-bed scour during the period of record. Except for the scouring and filling, the channel characteristics at the gaging station have remained fairly constant throughout the period of record.

It will be noted that following each storm period there is a noticeable deposition in the stream channel, amounting in some years to almost 0.5 foot. During the comparatively dry period from July 1927 to December 1931 the channel appears to have been built up about 1.3 feet.

About three months before the storm of March 1938, in connection with a study of certain hydraulic features of the Prado flood-control dam, the Corps of Engineers, United States Army, surveyed a series of 22 cross sections in the channel of the Santa Ana River over a stretch of 4¼ miles below the site of the proposed dam. Immediately following the storm the sites of these sections were relocated and new cross sections were determined. The changes in the sections with respect to scour or fill are shown in table 30.

During February 1937 the Orange County Flood Control District surveyed a series of cross sections under each of the highway bridges across the Santa Ana River in Orange County. Immediately after the flood of March 1938 these sections were redetermined. The indicated scour at each section is likewise shown in table 30.

Only 2 of the 30 sections included in table 30 showed a fill in the channel during the flood period. At the other sections the scour was as much as 6.79 feet at the State Highway bridge at the mouth of the river. The average depth of scour for the entire group was about 1.47 feet over the entire width of the channel.

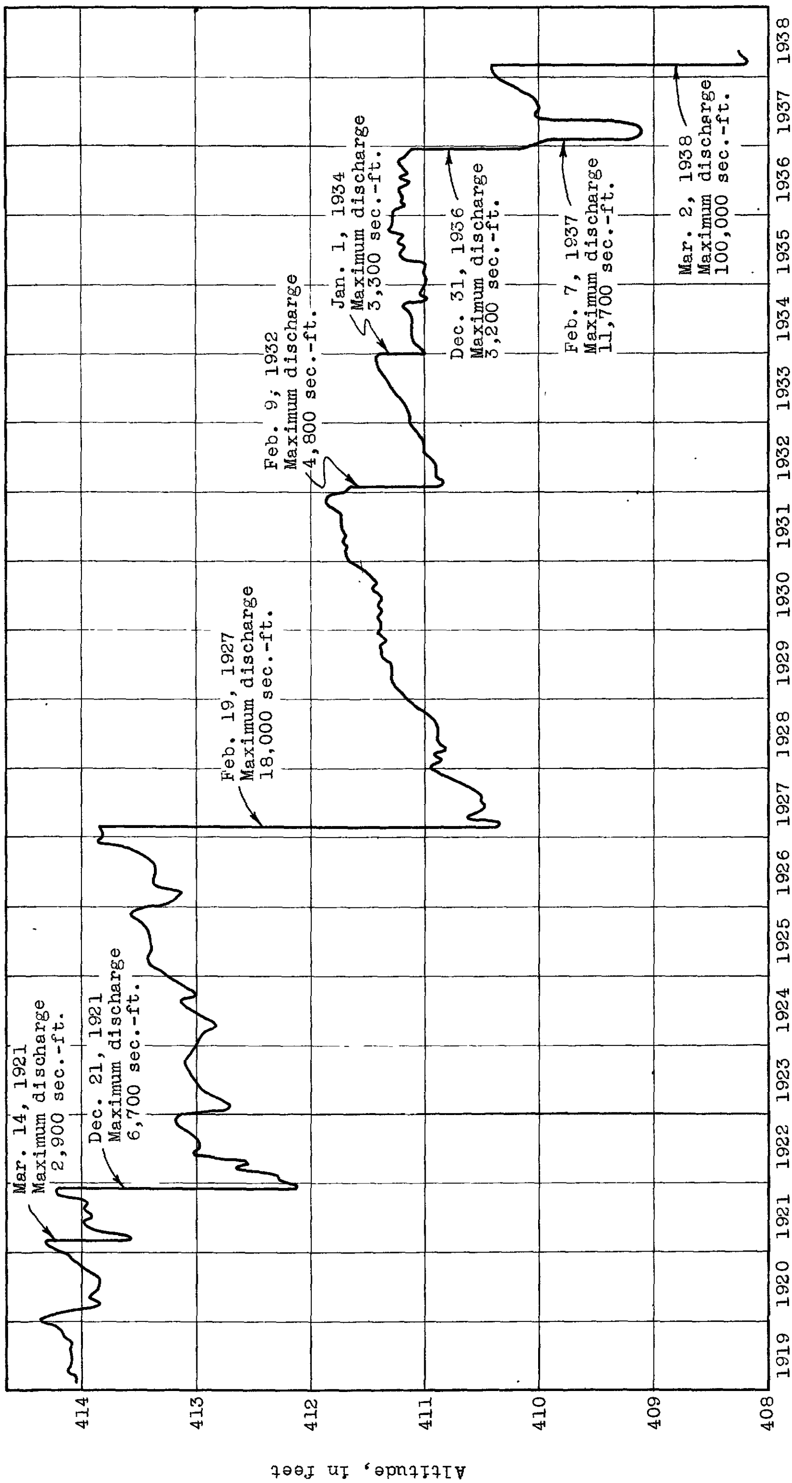

Figure 40.- Altitude of point of zero flow at stream-gaging station on Santa Ana River near Prado, 1919-38.

Table 30.- Scour and fill in channel of the Santa Ana River due to flood of March 1938

Distance above coast highway (miles)	Width (feet)	Change in cross section		Change in mean depth	
		Scour (square feet)	Fill (square feet)	Scour (feet)	Fill (feet)
31.59	2,000	-	1,190	-	0.60
31.50	1,850	100	-	0.05	-
31.46	1,900	1,220	-	.64	-
31.43	2,000	1,830	-	.92	-
31.41	1,400	1,430	-	1.02	-
31.37	1,450	1,820	-	1.26	-
31.34	1,250	1,630	-	1.30	-
31.30	1,350	1,250	-	.93	-
31.21	1,300	590	-	.45	-
30.99	1,300	2,570	-	1.98	-
30.80	1,600	500	-	.31	-
30.61	2,000	780	-	.39	-
30.41	1,750	2,560	-	1.46	-
30.19	1,250	4,000	-	3.20	-
29.91	1,800	3,860	-	2.14	-
29.68	1,750	4,350	-	2.49	-
29.38	3,250	2,110	-	.65	-
29.07	1,700	2,250	-	1.32	-
28.84 (a)	750	1,330	-	1.77	-
28.40	2,000	-	7,340	-	2.67
27.93	1,500	2,010	-	1.34	-
27.36	1,800	8,500	-	4.72	-
20.43 (b)	1,000	1,150	-	1.15	-
17.51 (c)	-	274	-	-	-
17.06 (d)	942	1,726	-	1.83	-
15.45 (e)	1,000	1,824	-	1.82	-
13.70 (f)	1,277	594	-	.47	-
8.83 (g)	346	166	-	.48	-
5.28 (h)	291	611	-	2.10	-
0 (i)	520	3,531	-	6.79	-

a River-measurement station near Prado.
b Yorba Bridge.
c Jefferson Street Bridge.
d A.T.& S.F.Ry.Bridge.
e Anaheim-Olive Bridge.
f Southern Pacific Co. Bridge.
g Fifth Street Bridge.
h Talbert Avenue Bridge.
i Coast Highway Bridge.

There is a wide variation in the degree to which the sand deposits in the channel will scour during periods of flood runoff. Many bridge piers were undermined and many buried pipe lines across the stream channels were wrecked during the flood of March 1938.

Not all sections of the stream channels across the valley floor were subject to appreciable scour. In order to obtain additional data on scour, the Corps of Engineers, United States Army, on October 1, 1936, placed three series of boulders in the deep sandy channel of the Los Angeles River between Firestone Boulevard and Stewart and Grey Road.

The first series consisted of five boulders weighing about 400 pounds each, which were placed in line across the channel and buried a short distance below the surface. Two of these boulders have shown no change in position except for a slight settlement; one moved downstream about 40 feet during the relatively moderate storm of February 1937, but there was no movement in March 1938; another disappeared in February 1937; and only one appears to have moved during the flood of March, 1938.

Two hundred feet farther downstream was the second series, a row of six rocks each weighing 200 pounds and similarly placed. One of these was lost and two moved between 300 and 400 feet in February 1937; three disappeared and two showed no change in location during the flood of March 1938.

The third series of six rocks, each weighing 100 pounds, was placed 200 feet downstream from the second series. All the boulders in this series disappeared during the storm of February 1937.

The results of this experiment seem to indicate that the storm of February 1937 had a greater scouring effect at this particular location than the considerably more severe storm of March 1938.

Much debris set in motion by the runoff from the storm of March 1938 was deposited in the ocean at the mouths of the streams. The report by the Corps of Engineers [38] indicates that at the mouth of the Los Angeles River a deposit of 8,120,000 cubic yards of debris formed above an altitude of 30 feet below sea level and within a strip 3,000 feet wide, bounded by the breakwater on the west and extending approximately 1 mile seaward. If the estimated quantity of fill beyond the limit of surveys is included, the total deposit was approximately 11,000,000 cubic yards. This represents the volume of debris deposited during a period of more than 10 years, as the last previous survey was made in 1927, by the city of Long Beach. During that period tidal currents undoubtedly had an effect on the deposition of debris. From a study of aerial photographs and a few soundings made between 1927 and 1938, it is estimated that 60 percent of the total, or 6,600,000 cubic yards of debris, was deposited by the flood of March 1938 in the immediate area. Further uncertainty as to the total volume carried by the river is caused by the possibility that some part of the debris may have been deposited outside this immediate area.

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38 Corps of Engineers, U. S. Army, Report on engineering aspects, flood of March 1938, p. 37, 1938.

Similar data collected at the mouth of the San Gabriel River show a deposit of 273,000 cubic yards of debris above an altitude of 15 feet below sea level within a strip 1,600 feet wide extending directly seaward for 2,200 feet from the mouth of the river. The volume at the mouth of the San Gabriel River has undoubtedly been more accurately determined than that at the mouth of the Los Angeles River. It is based upon a survey made in September 1937. The absence of a breakwater here reduced the probability of excessive tidal effects, although tidal deposits and scour remain undetermined factors. As before, no estimate can be made of the volume of debris deposited outside the area surveyed.

FLOOD DAMAGE

Southern California sustained damages amounting to $78,602,000 from the storm of February 27 to March 4, 1938, according to the report compiled by the Corps of Engineers, United States Army, Los Angeles district; of this total, $27,413,000 has been estimated as indirect damage and $51,189,000 as direct damage. A large number of homes and business houses were either completely destroyed or badly damaged. Railroads [39] and highways suffered losses estimated at many millions of dollars, owing to destruction of bridges and roadbeds. Other utilities, such as the telegraph, telephone, gas, and water systems, were severely crippled. For a time some localities were cut off from all lines of communication and others were served only by airplane or radio.

The inundated area in Los Angeles County included about 108,000 acres; in the Santa Ana River Basin in San Bernardino, Riverside, and Orange Counties, 182,300 acres; and in Ventura and Santa Clara River Basins, 6,200 acres. Plates 21-26, from photographs made March 3 show flood damage along the Santa Ana River.

Maps of southern California showing areas damaged by the flood of March 1938 have been prepared by the Corps of Engineers, United States Army; by the United States Department of Agriculture; and by the Los Angeles County Flood Control District (Los Angeles County only).

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39 Kirkbride, W. H., A railroad fights floods: Civil Engineering, vol. 9, No. 12, pp. 711-714, December 1939.

Loss of life

The total number of deaths caused by flood in southern California in 1938 was reported as 87, of which 77 occurred in the Los Angeles and Santa Ana River Basins. Three months after the flood, 9 other persons were still reported as missing. The number of lives lost in each river basin is given in table 31.

Table 31.- Loss of life in southern California due to storm of February 27 to March 3, 1938

Drainage basin	Lives lost
San Juan and Aliso Creek and other small basins in Orange County	2
Santa Ana River, including Coyote Creek	34
San Gabriel River, excluding Coyote Creek	1
Los Angeles River, excluding Rio Hondo	43
Rio Hondo	2
Ballona and Topanga Creek and other coastal areas in Los Angeles County	3
Ventura River	1
Mojave River	1
	87

Flood-damage survey

Immediately after the storm the Corps of Engineers, United States Army began a thorough field investigation to determine the extent of the damage. Every property owner or renter in the affected areas that could be located was interviewed, and an itemized estimate of flood damage was made. Reports on the damage were obtained also from State, county, and city officials, from public and private utility agencies, and from private corporations.

In making this flood-damage survey the Corps of Engineers endeavored to determine, with reasonable accuracy, the indirect damage as well as the direct physical damage caused by the storm. According to the report,[40] direct and indirect damage are defined as follows:

a. Direct damage--Physical damage to property, measured by the cost of repair or replacement in kind, including cost of clean-up.

40 Wyman, Theodore, Jr., Report on flood damage in Los Angeles Engineers District from storm of February 27--March 3, 1938.

b. <u>Indirect damage</u>--Indirect losses resulting from the direct flood damage:

(1) Loss of wages by employed persons.

(2) Loss of income from interruption of or delay in business, other than (4) or (5), below.

(3) Depreciation of property values in areas damaged.

(4) Loss of business by transportation companies due to damaged bridges and roadways.

(5) Loss to utilities of income of nonrecoverable types, owing to interruption of services.

As it was not practicable to obtain a complete evaluation of the indirect damage in all areas, ratios of indirect to direct damage were determined from the fairly complete data available for the Los Angeles and San Gabriel River Basins, including San Antonio Creek, and applied to other areas for which only data on direct damage were available.

Flood damages, segregated in table 32 for various types of property, are based on compilations made by the Los Angeles District, Corps of Engineers, United States Army. Table 32 does not in the main, except for public utilities, include any of the losses that occurred in the mountain areas, most of which are within the boundaries of the Angeles, Padre, San Bernardino, and Cleveland National Forests. The losses due to the flood, in certain of these areas, though large, have not been completely determined. Among the items for which figures are available are $89,500 for Government-owned recreational facilities and 18 miles of Government-owned telephone lines valued at about $12,550, both within the Angeles National Forest. The flood damage in San Antonio Canyon, also in the Angeles National Forest, as determined by a survey conducted by the Corps of Engineers, amounted to $328,700, the largest item of which was the destruction of 219 privately-owned cabins on Government leases. The supervisor of the Angeles National Forest reported the loss, in all, of 520 privately-owned cabins on Government leases. In most of the mountain canyons, however, the losses were considerably less than in San Antonio Canyon.

Table 32.- Damage in southern California caused by storm of February 27 to March 4, 1938

Drainage basin	Drainage area (sq.mi.)	Damaged area (acres)	Direct damage								
			Residential	Business	Industrial	Agriculture	Roads, bridges	Railroads	Utilities	Other	Total
Tia Juana River	461	1,920	None	None	None	$ 1,000	60,000	None	None	$ 3,000	$ 64,000
San Diego River	518	6,520	None	None	None	6,000	45,000	None	$ 10,000	5,000	66,000
San Luis Rey River	565	19,200	None	None	None	87,000	74,000	None	9,000	3,000	173,000
Otay, Sweetwater, San Dieguito, and Santa Margarita Rivers and San Clemente and Escondido Creeks	1,736	5,390	None	$ 5,000	None	92,000	191,000	$ 3,000	8,000	5,000	304,000
San Juan and Aliso Creeks and miscellaneous Orange County streams	284	660	$ 2,000	None	$ 44,000	64,000	165,000	13,000	26,000	29,000	343,000
Santa Ana River	2,476	182,303	1,159,000	564,000	806,000	2,670,000	3,227,000	1,175,000	1,856,000	2,501,000	13,958,000
Coyote Creek (San Gabriel Basin)	181	61,056	899,000	518,000	30,000	1,446,000	172,000	106,000	125,000	65,000	3,361,000
San Gabriel River, except Coyote Creek	515	6,249	183,000	137,000	39,000	243,000	367,000	116,000	245,000	975,000	2,305,000
Los Angeles River, except Rio Hondo	783	25,231	2,166,000	1,020,000	70,000	447,000	6,135,000	511,000	1,952,000	4,675,000	16,976,000
Rio Hondo	141	6,280	380,000	137,000	61,000	176,000	240,000	72,000	180,000	483,000	1,729,000
Ballona and Topanga Creeks and miscellaneous coastal streams in Los Angeles County	491	9,379	369,000	249,000	15,000	63,000	850,000	None	1,593,000	31,000	3,170,000
Calleguas Creek	228	-	1,000	3,000	None	141,000	116,000	3,000	None	None	264,000
Santa Clara River	1,598	5,000	46,000	40,000	188,000	1,264,000	1,254,000	605,000	90,000	71,000	3,558,000
Ventura River	227	1,200	54,000	72,000	163,000	170,000	272,000	3,000	31,000	12,000	777,000
Coastal streams in Ventura County	76	-	4,090	None	35,000	45,000	54,000	None	6,000	10,000	154,000
Mojave River	545	60,392	131,000	15,000	62,000	471,000	None	1,678,000	65,000	59,000	2,481,000
Whitewater River	516	36,520	587,000	50,000	None	44,000	238,000	52,000	163,000	12,000	1,146,000
Miscellaneous areas	-	-	30,000	None	1,000	None	314,000	10,000	3,000	2,000	360,000
Total direct damage	11,341	427,300	6,011,000	2,810,000	1,514,000	7,430,000	13,774,000	4,347,000	6,362,000	8,941,000	51,189,000
Estimated indirect damage	-	-	13,223,000	7,313,000	1,968,000	1,485,000	None	1,592,000	1,631,000	201,000	27,413,000
Total direct and indirect damage	-	-	-	-	-	-	-	-	-	-	78,602,000

HISTORY OF FLOODS IN SOUTHERN CALIFORNIA

Since January 7, 1770, when Father Juan Crespi first observed the evidence of a great flood along the Los Angeles River, the flood runoff from the San Gabriel and San Bernardino Mountains and other parts of the Coast Ranges has periodically submerged, damaged, and washed away crops, homes, missions, bridges, highways, railroads, and other structures located by man for his convenience in, on, or over flood channels and flood plains that had been established by Nature for the passage of flood waters from the mountains to the sea. Only through discriminating consideration of these past floods can plans be formulated for protection from and control of future floods, which will inevitably occur. That damaging floods occurred in the past is unquestionable; little is known, however, of their relative magnitude. All were sufficiently severe to cause damage and temporary inconvenience, and some caused loss of life. Residents of southern California should realize that, in spite of the application of our most advanced technical and scientific knowledge of flood-control structures and practices, those who continue to occupy natural flood channels, flood plains, and debris cones are defying inexorable laws of nature.

Records of floods in southern California are found in a wide variety of publications and in mission records, special reports, transcripts of court hearings, and statements of old-time residents of the country. The earliest references to floods are found in the diaries of the Spanish Mission Fathers. These early records indicate that there were floods in 1770-71, 1771-72, 1775-76, and 1779-80.

Testimony in the case of Daneri v. The Southern California Railway Co., in the Superior Court of Los Angeles County in 1897, and statements obtained in 1915 from a large number of old residents and compiled by Reagan [41] were to the effect that there were floods on the Los Angeles and San Gabriel Rivers in 1811, 1815, 1822, 1825, 1832, 1842, 1851-52, 1859-60, 1862, 1867, 1884, 1886, 1889, 1891, and 1914.

Transcripts of public hearings concerning flood control held during 1938 by the United States district engineer, War Department, recorded floods on the Ventura River in 1832, 1862, 1867, 1875, 1884, 1905, 1907, 1911, 1914, 1926, 1927, 1934, and 1937, and on the Santa Ana River in 1862, 1867, 1884, 1886, 1889, 1890, 1906, 1908, 1909, 1914, 1916, 1918, 1921, and 1926.

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41 Reagan, J. W., Flood history of Los Angeles County, compiled from all available sources, 1914-15 (unpublished report).

Official weather observations in southern California were begun at San Diego in 1851, at Santa Barbara in 1867, and at Los Angeles in 1878. Except for the floods recorded in their diaries by the Mission Fathers and a few isolated recorded statements by others, floods prior to 1851 mentioned in the various reports are described by the various witnesses from their personal recollections or from what others had told them about earlier floods. It is quite possible that there may have been other floods that were not recalled and also that the relative magnitude of the floods as given may be open to question.

The first known estimates of flood discharge actually made at the time of a flood were two separate and independent estimates made on the Los Angeles River for the flood of 1889, one by William Mulholland and the other by H. Hawgood.[42]

Actual current-meter measurements of major peak discharges have never been made, but since about 1894, continuous stream-flow records have been collected for the major streams in southern California, and peak discharges have been computed or estimated by various methods. These records are available in the annual reports on surface-water supply and special reports published by the Geological Survey.

1770

Father Juan Crespi [43] gives us the first record of a flood in California. The following is quoted from his diary:

> Jan. 17, 1770, * * * we saw the Poiciuncula [Los Angeles] River. We crossed the plain in a southeasterly direction, arrived at the river, and forded it, observing on its sand, rubbish, fallen trees, and pools on either side, for a few days previously there had been a great flood which had caused it to leave its bed.

The San Gabriel Mission was built about a mile from the banks of the San Gabriel River channel and about 3 miles directly south of El Monte. The fathers planted and cultivated the low bottom lands around the mission, but the crops of the first year were overflowed and destroyed in 1772. In 1776, owing to the recurrence of heavy flood flows, the mission was moved to its present location in San Gabriel, some 6 miles back from the river.

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42 Reports of the Board of Flood Control Engineers to the Board of Supervisors, Los Angeles County, Calif., p. 144, 1915.

43 Crespi, Father Juan, in Bolton, H. E., New California, vol. 2, p. 256, 1926.

1780

The flood of 1780 is reported in the following note, taken from the annual report dated December 31, 1780, at San Diego, by Fathers Lasuen and Serra:[44]

A few days ago we had a heavy rainfall which filled the river bed and the lowlands where the wheat and barley had been planted * * *. The indians are now working hard to remedy the trouble for the present and to prevent similar disasters in the future.

Little is recorded of the flood of 1811.

1815

In 1815 there was a flood that changed the course of the Los Angeles River within what is now the city limits of Los Angeles from the east to the west side of the valley. The river turned and ran down where Alameda Street now is, broke westward near Fourth and Fifth Streets and joined Ballona Creek, thence emptying into Santa Monica Bay.

1821

A flood on the San Diego River in 1821 is reported by Smythe.[45]

By the year 1821, the little patches of cultivated land had multiplied at the base of Presidio Hill and even spread up and across Mission Valley. Don Blas Aguilar, who was born in San Diego in 1811, recalled 15 such rancherias, as they were called, which were occupied prior to the great flood of that year. At two places in the valley there were vineyards. Most of the rancherias were washed away or greatly damaged by the flood, which occurred in September or October and in a single night filled the valley and changed the course of the river.

1822

In 1822 another great flood on the Los Angeles River covered all the lowlands and reached a greater height than was ever known before.[46]

Probably the greatest of the earlier recorded floods was that of 1824-25, of which Warner [47] writes:

In 1825 the rivers of this country were so swollen that their beds, their banks, and the adjoining lands were greatly changed. At the date of the settlement of Los Angeles City a large portion of the country from the central part of the city to the tidewater of the sea, through and over which the Los Angeles River now finds its way to the ocean, was largely covered with a forest, interspersed with tracts of marsh. From that time until 1825 it was seldom, if in any year, that the river discharged, even during the rainy season, its waters into the sea. Instead of having a riverway to the sea the waters spread over the country, filling the depressions in the surface and forming lakes, ponds, and marshes.

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44 Engelhardt, Father Zephyrin, Mission San Diego, p. 109, 1920.
45 Smythe, W. E., History of San Diego, p. 99, 1907.
46 McGlashan, H. D., and Ebert, F. C., Southern California floods of January 1916: U. S. Geol. Survey Water-Supply Paper 426, p. 36, 1918.
47 Warner, J. J., Hayes, Benjamin, and Widney, J. P., Historical sketch of Los Angeles County, p. 17, 1876.

The river water, if any, that reached the ocean, drained off from the land at so many places, and in such small volume, that no channel existed until the flood of 1825, which by cutting a riverway to tidewater drained the marshland and caused the forests to disappear.

There are numerous references that testify to the fact that the Los Angeles River made the big change in its course during the flood of 1824-25. It was commonly understood and talked of in early days by old Mexican settlers that, until the flood of 1825, the Los Angeles River flowed out through the southwest part of the city into Ballona Creek and thence into Santa Monica Bay. But in 1825 the floods were probably the greatest for many years, causing the river to break eastward into San Pedro Bay.

Pio Pico, former Governor of Alta California under the Mexican regime, and others have affirmed that up to 1825 the Los Angeles River flowed along the high bank just east of Main Street down to about Seventeenth Street, thence southwesterly into Cienega Creek, which in turn flowed into Ballona Creek.

J. R. Ramirez, who furnished the following account, was born in Los Angeles in 1839. His great-great-grandfather settled there in 1786, and this pioneer's descendants have lived on the old home place ever since. Mr. Ramirez says:[48]

> In those early days up to 1825 the river flowed along San Fernando Street, which is just below North Broadway at this point. In 1825, the floods were the greatest in the past 100 years. This flood filled the whole Los Angeles River Valley from the bank between North Broadway and San Fernando Streets to the Southern Pacific yards on the other side of the river. This flood changed the course of the Los Angeles River eastward from its old bank, along Main Street, to somewhere near Alamada Street. Its entire course was changed to the south side of the city. The river flowed out through Ballona Creek before this flood, but after this time it passed near the foot of the hills at Dominguez and into San Pedro Bay.

The flood of 1825 changed the course of the Santa Ana River also. Previous to that year the Santa Ana entered the ocean several miles to the northwest of its present channel.

1832

According to Warner,[49] the flood of 1832 produced considerable change in the contour of the country south of the city. He says:

> The flood of 1832 so changed the drainage in the neighborhood of Compton and the northeastern portion of the San Pedro Ranch that a number of lakes and ponds, covering a large area of the latter ranch, lying north and westerly from Wilmington, which to that date had been permanent, became dry a few years thereafter.

The drainage of these ponds and lakes completed the destruction of the forests that Warner says covered a large part of the county south and

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48 Ramirez, J. R., in Regan, J. W., op. cit., p. 142.
49 Warner, J. J., op. cit., p. 18.

west of the city. These forests were in all probability willow thickets or copse, the same as grew until quite recently on the low grounds near the mouth of the Santa Ana River and in the swampy lands along the San Gabriel River.

In Ventura County, the flood of 1832 destroyed the chapel of San Miguel. This is the first authentic record of flood damage along the lower reaches of the Ventura River. Father Engelhardt states:[50]

> Fr. Uria remarks, in his report (1832), that the chapel of San Miguel, the pride of Father Senan, could not be saved, the floods having destroyed it entirely.

1849 to 1860

Floods of various magnitude occurred in 1849-50, 1851-52, 1859-60.

1861-62

The flood of 1861-62, has been called the "great flood" and the "Noachian deluge of California floods." During the flood period in 1862 the entire valley area from Los Angeles to the ocean, both toward San Pedro and toward Ballona, was a great lake. The Los Angeles River in the city of Los Angeles extended from Alameda Street to the bluff on the Pico Heights side. A little below Vernon, about where Vernon Avenue now is, the river split, and part of it went through Los Cienagas grant into Ballona Creek.

During the same flood the San Gabriel River overflowed its banks, broke from its course east of El Monte, and started a new channel to the west of El Monte, taking about the same course as later taken in 1867 to form what was then known as New River.

In San Bernardino, Riverside, and Orange Counties, the Santa Ana River became a raging torrent during the flood of 1862. The prosperous colonies along the banks of the river were completely inundated, and vineyards, orchards, and grain fields were transformed into a barren waste.

Flood waters of 1862 on the Ventura River are reported to have spread from the bluff on the Taylor Ranch to the hills east of Ventura Avenue, thus attaining a width of about 4,000 feet. Many houses were submerged and several destroyed. Parts of the old Mission waterworks, which brought water to Ventura, were destroyed.

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50 Engelhardt, Father Zephyrin, San Buenaventura Mission, p. 68, 1930.

In describing this flood, Guinn [51] states:

The great flood of 1861-62 was the Noachian deluge of California floods. The season's rainfall footed up to nearly 50 inches. The valley of the Sacramento was a vast inland sea. * * * In our country, on account of the smaller area of the valleys, there was but little loss of property. The rivers spread over the low lands, but stock found safety from the flood on the hills. The Santa Ana for a time rivaled the "Father of Waters" in magnitude. In the town of Anaheim, 4 miles from the river, the water ran 4 feet deep and spread in an unbroken sheet to the Coyote Hills, 3 miles beyond. The Arroyo Seco, swollen to a mighty river, brought down from the mountains and canyons great rafts of driftwood which were scattered over the plains below the city and furnished fuel for the poor people of the city for several years. It began raining on December 24, 1861, and continued for thirty days with but two slight interruptions. The "Star" published the following local: "A Phenomenon--on Tuesday last the sun made its appearance. The phenomenon lasted several minutes and was witnessed by a great number of persons."

An interesting account of this flood is given by Mrs. Crafts,[52] who says:

The fall of 1861 was sunny, dry, and warm until Christmas, which proved to be a rainy day. All through the holidays there continued what we would call a nice, pleasant rain, as it often rains in this section for days at a time. This much-needed moisture and wetting of the parched earth lasted until the 18th of January, 1862, when there was a downpour for 24 hours or longer. All the flat, from the Santa Ana River to Pine's hotel was under water, a perfect sea of water, inundating the valley for miles up and down the river, and Lytle Creek came rushing down D Street, across Third, finding an outlet through an open space into Warm Creek. Many families fled in the night to higher ground, losing everything they had stored away for the winter. * * * The constant rain on the adobe houses turned them to mud, and, of course, they fell to pieces.

Heavy rains extended into San Diego County, according to a report by Davis,[53] in which he states:

In the winter of 1861-62 unusually heavy rains fell in San Diego County, being 30 inches, the average fall for that section of the State being 9 inches.

1867-68

The flood of 1867-68 caused the San Gabriel River to break out of its channel and form New River. It broke out a little above the old Temple place and continued south, instead of making the turn toward the point of hills just below Old Mission settlement, and all the water of the San Gabriel went into the New River. Several thousand acres of land were washed away. Willows had grown up so thick and large down by the Old Mission settlement that when the flood came it simply knocked the trees down and covered them up with sand and boulders, forming a barrier that changed the channel and caused the flow to pass by the Pico Rancho and on to Los Alamitos Bay.

51 Guinn, J. M., A history of California, p. 428, 1915.
52 Crafts, Mrs. E. P. R., Pioneer days in San Bernardino Valley, p. 71, 1906.
53 Davis, W. H., Seventy-five years in California, p. 335, 1929.

A short time before the founding of Downey, a small settlement named Galatin had been started nearby, but the flood of 1868 caused the otherwise dry rivers to change their courses and Galatin was washed away.[54]

Concerning the Santa Ana River, Brown and Boyd,[55] report as follows:

> There was no further year of heavy rainfall until that of 1867-68, when the winter proved rainy, but, while the precipitation was continuous, it was not as heavy as in 1862, and as a result less damage resulted.

The Ventura River overflowed its banks, and according to Hobson,[56] the whole of that portion of the town west of the point of the schoolhouse hill (this location being a little north and east of the present junction of Main Street and Ventura Avenue) was submerged.

1884

No serious floods occurred from 1868 to 1884, a period of 16 years. Then southern California experienced a series of wet years, with floods in 1885, 1886, 1889, and 1891.

The flood of 1884 ranks among the major floods--in fact, there were two floods in 1884. The first came the latter part of February; it did little damage, but a great quantity of water fell, apparently utilizing much of the absorptive capacity of the ground. A second flood came within 6 or 8 days after the first and did a great deal of damage. All the bridges across the Los Angeles River were washed out except one, the old Downey Avenue Bridge. Many houses were washed away, and several people drowned. The water broke out of the river banks and flowed toward Alameda Street, which was lower than the river bed; came up on First Street halfway between Los Angeles and Main Streets, and also flooded the lower part of the city. At Maple and Twenty-fourth Streets the water was between 3 and 4 feet deep. The flood waters flowed westward along the then Washington Road and Jefferson Street and thence southwest into Ballona Creek through which it reached Ballona Bay. All of the Cienega country became a great lake, and the country back of Venice a veritable sea.

San Fernando Valley was flooded from Chatsworth to Glendale. The Southern Pacific railroad was washed out in many places.

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54 Newmark, Harris, Sixty years in southern California (1853-1913), p. 362, 1926.
55 Brown, John, Jr., and Boyd, James, History of San Bernardino and Riverside Counties, vol. 1, p. 145, 1922.
56 Hobson, W. D., unpublished manuscript, 1876.

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The Santa Ana River cut a new channel to the sea. Beginning at a point below where Santiago Creek enters the Santa Ana, the river cut through the fertile lands east of the old channel and discharged into the ocean about 3 miles southeast of its former outlet. According to Brown and Boyd [57]

The year of 1884 proved to be the great flood year of later times, and 37.50 inches were reported during the season for San Bernardino, while over 40 inches were registered at Los Angeles and more at other points.

In San Diego County the flood of 1884 was very severe. Smythe [58] says:

Thus far all appeared to be going well, but there was more trouble in store for San Diego and its railroad hopes. In February 1884 a series of violent storms descended and literally destroyed the section of the railroad through Temecula Canyon.

The season of 1883-84 was the wettest winter on record in San Diego County, with 27.59 inches of rainfall at San Diego and 50.51 inches at Escondido.

In Ventura County, 30 inches of rain fell in 27 days, of which 6 inches fell in 34 hours, causing the Ventura River to rise higher than it had been since the flood of 1867. It was estimated that 65 inches fell during February and March in the San Antonio Valley, whose drainage is tributary to the Ventura River, causing the worst flood known in the valley. Casitas Bridge, crossing Ventura River at Foster Park, was washed out.

1886

Heavy rainfall with streams reaching flood stages and causing considerable damage was recorded in 1886-87. According to Newmark [59]

The great flood of 1886 reached its first serious state on January 19th. All of Los Angeles between Wilmington Street and the hills on the east side was inundated; levees were carried off as if they were so much loose sand and stubble, and for two or three weeks railway communication with the outside world was impossible.

1889

The flood of 1889 was comparable in magnitude to that of 1884. It came on Christmas Day, and the greatest damage occurred on that day. The Evening Express, Los Angeles, in its issue of December 26, 1889, says:

Much damage has been done in and about the city. Streets cut up, conduits filled with sand, bridges carried away, railroad tracks covered with dirt, and much other damage done.

57 Brown, John, Jr., and Boyd, James, op. cit., vol. 1, p. 145.
58 Smythe, W. E., op. cit., p. 405.
59 Newmark, Harris, op. cit., p. 551.

The approaches to the Kuhrts Street bridge were washed away. About half the Santa Fe bridge over the Los Angeles River swept away and dashed against the Buena Vista bridge, weakening the piers and badly damaging it. The S. P. [Southern Pacific] pile bridge, below Kuhrts Street Bridge, almost entirely carried away. The 7th and 9th street bridges so badly damaged as to render them unserviceable.

The storm was general all over the southern section of the State. No trains on the Santa Fe or S. P. have either arrived or departed except one to Santa Monica. Levees in numerous places have been washed away.

The country between this city and the sea is in many places covered by water, and many ranchers will lose heavily. The extensive vegetable gardeners south of the city will lose heavily.

At Compton the water is very high. The citizens resorted to boats and made their way about town in that way. The country in that vicinity is flooded, and it will be weeks before the surface will be dry.

Hon. H. T. Gage says that the new San Gabriel, the old San Gabriel, and the Los Angeles Rivers have formed one body near Downey and are sweeping toward the ocean, carrying everything with them. On the Laguna Ranch a lake 5 miles in width has formed, and the water nearly to the top of the hay stacks. The Los Angeles River, 2 miles below the city has swerved from its channel and is running down the Downey Road.

1891

In 1891, floods were recorded on the Santa Ana River and some of its tributaries, and on the San Luis Rey River above Bonsall.[60]

1909

The following extract from the Riverside Daily Press gives an account of a flood on the Santa Ana River in 1909:

December 31, 1909.- Santa Ana River was at its highest flood stage in 20 years. Portions of the Crestmore Electric Railroad line bridge, between Riverside and Crestmore, washed out. Chinese truck gardens, roads, crops, trees, fences, and farm buildings in the path of the flood were washed out. Head works of the power company's canal at the Salt Lake Railroad bridge washed out. * * * Barn on the Voorhes Ranch, above the Salt Lake Railroad bridge, was washed away. Flood waters destroyed Evens Lake and dam below the bridge on the west side of the river. Ranch homes threatened. Many large cottonwood trees were uprooted and carried downstream.

Between Menifee and Ethanac, flood waters rushing off the San Jacinto Mountains into San Jacinto River and Bautista Canyon Creek washed out the Santa Fe Railroad. Heavy runoff through Cajon Pass caused landslides on Santa Fe Railroad along a stretch of 13 miles between Summit and Devore stations. All train schedules abandoned. At Etiwanda, the Santa Fe Railroad washed out. Same road badly damaged at East Highland by rush of flood water off the San Bernardino Mountains. Railroad service between San Bernardino and Los Angeles abandoned.

With reference to this same storm, the San Bernardino Sun for January 1, 1910, says:

At 2 o'clock this morning, storm and flood conditions are quite serious. Rain was falling in torrents. Unless relief comes by daybreak, damages will run into thousands of dollars. Engine and three coaches of work train turned over 1 mile north of Devore.

The Santa Fe Railroad roundhouse at San Bernardino surrounded by floodwater and that city has suffered more severely from floodwater than at any time in its history.

Approaches to Colton Avenue Bridge, Pacific Electric bridge, washed out. Colton entirely cut off from outside world. Lytle Creek out of its channel and threatening Salt Lake Railroad shops at Colton. * * *

60 Surface water supply of the Pacific slope of southern California: U. S. Geol. Survey Water-Supply Paper 447, pp. 549, 550, 1921.

The Southern Pacific "newspaper special train" from Los Angeles plunged into the Santa Ana River while crossing the bridge near Colton. Floodwaters had undermined piling of the bridge. Two coaches toppled over on the 30-inch pipe line of the Riverside-Highland Water Co., breaking it. Two sections of the pipe line toppled into the river when the cement piers crumbled under the force of the raging stream.

Traffic on the Santa Fe Railroad through the Santa Ana River canyon was abandoned because of landslides.

At San Jacinto, floodwaters out of the San Jacinto River and Bautiste Creek canyon ripped bad breaks in the river levee near San Jacinto and the lowlands between Gilman Hot Springs and Railroad Canyon Dam of the Temescal Water Co. near Elsinore were badly flooded. Four inches of rain fell at Lake Hemet, raising the water in the lake to 112 feet.

Because of the washout of the approach to the West Riverside Bridge on the west side of the Santa Ana River, entrance to Riverside was by way of the Salt Lake Railroad bridge and by way of Colton. Two spans of the Crestmore trolley line bridge were washed out.

1911

In March 1911 there was a serious flood on the Ventura River. January and February of that year were rainy months. Although no excessive downfall occurred, the soil was wet and conditions were ripe for a rapid runoff following the heavy rain of March 9. According to the Ventura Free Press for March 9, 1911,

> The Ventura River perhaps was never higher. It is overflowing its banks from Casitas to the sea. The Casitas Bridge, 17 feet above the water at normal flow, is under water; the Avenue is awash; the western part of Ventura is under water; at 3:15 the big steel bridge [Southern Pacific Railroad] broke and 50 feet of the structure went down and out into the ocean.

1914

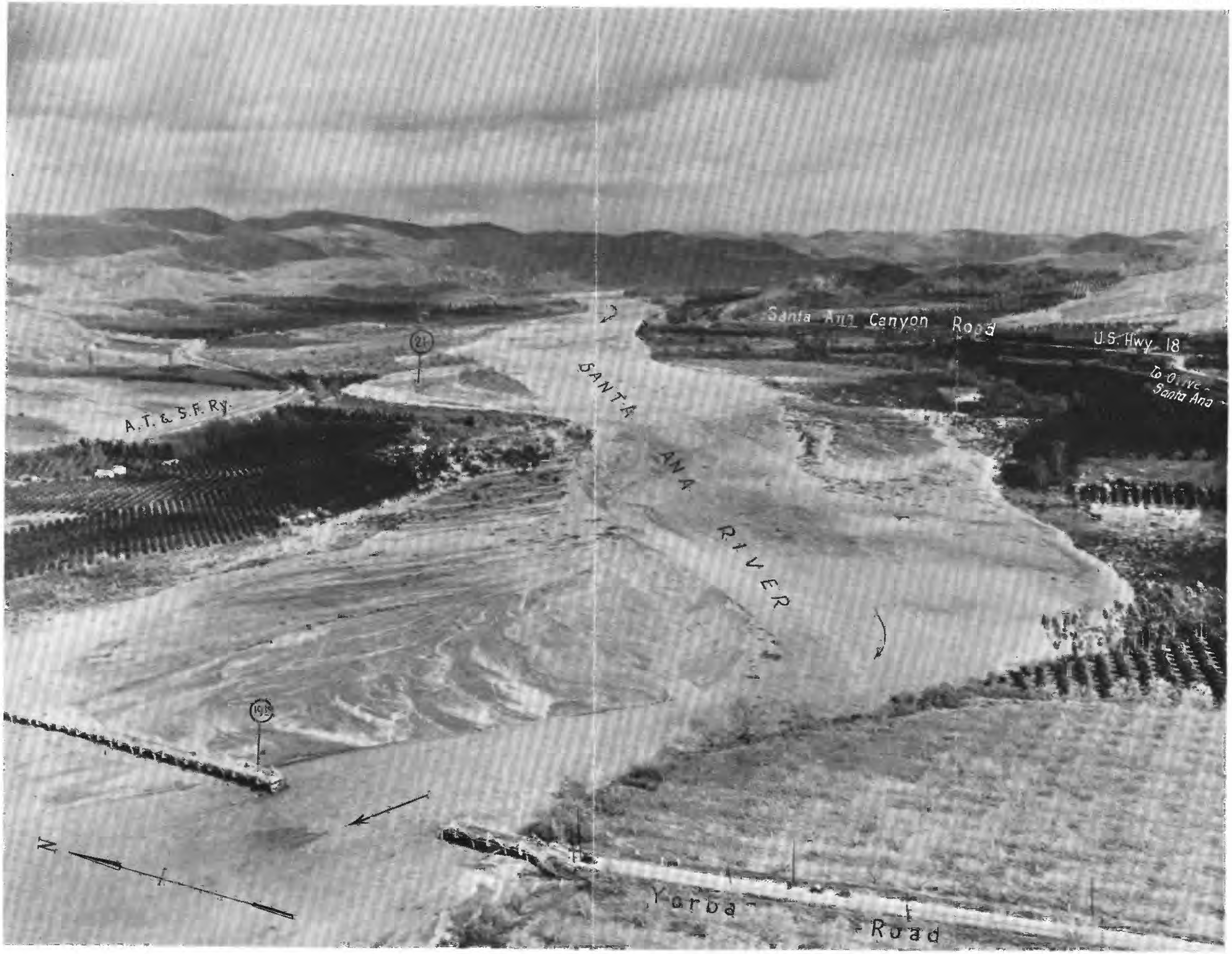
Floods of January and February 1914 were very destructive in southern California and were responsible for increased interest in stream-flow records. Water-Supply Papers 391 and 447 contain estimates of peak discharges available for this period.

1916

The flood of 1916 is covered by Geological Survey Water-Supply Paper 426, Southern California floods of January, 1916, by H. D. McGlashan and F. C. Ebert.

1916 to 1938

No major floods occurred in the southern California region between 1916 and 1938, except the flood of January 1, 1934, which did considerable damage in La Cañada Valley area. This flood is described in Water-Supply Paper 796-C, Flood in La Cañada Valley, California, January 1, 1934, by Harold C. Troxell and John Q. Peterson. Minor floods, causing damage in certain areas, occurred during 1918, 1921-22, 1926, 1927, 1931, 1932, 1934, 1936, and 1937.

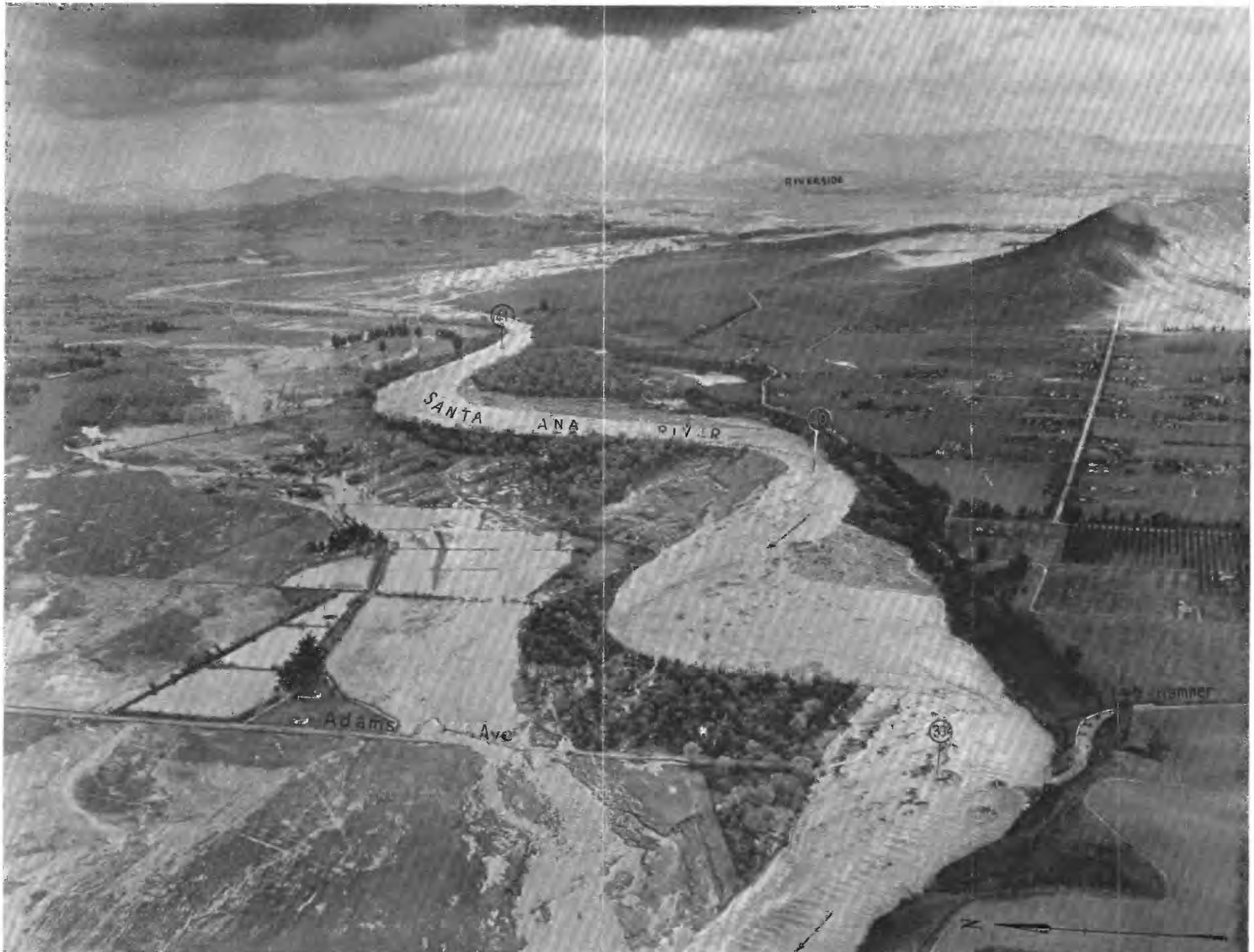


SANTA ANA RIVER BELOW LOWER SANTA ANA CANYON, MARCH 3, 1938.

Courtesy of Fairchild Aerial Surveys, Inc.

SANTA ANA RIVER AT MOUTH OF CHINO CREEK, MARCH 3, 1938.

Courtesy of Fairchild Aerial Surveys, Inc.



SANTA ANA RIVER NEAR NORCO, MARCH 3, 1938.

Courtesy of Fairchild Aerial Surveys, Inc.

BREAK IN LEVEE OF SANTA ANA RIVER, MARCH 3, 1938.

Note development of debris cone, lower right, which formed bank of new channel. Courtesy of Fairchild Aerial Surveys, Inc.

OVERFLOW AREA ALONG SANTA ANA RIVER, MARCH 3, 1938.

Courtesy of Fairchild Aerial Surveys, Inc.

FLOODED CITRUS AND WALNUT GROVES ALONG SANTA ANA RIVER, MARCH 3, 1938.

Courtesy of Fairchild Aerial Surveys, Inc.

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