Floods of 1952 in California

FLOOD OF JANUARY 1952
N THE SOUTH SAN FRANCISCO BAY REGION

y S. E. RANTZ

NOWMELT FLOOD OF 1952 IN KERN RIVER, TULARE
AKE, AND SAN JOAQUIN RIVER BASINS

y H. M. STAFFORD

FLOODS OF 1952

GEOLOGICAL SURVEY WATER-SUPPLY PAPER 1260-D

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PREFACE

This report on the flood of January 1952 in the south San Fran-cisco Bay region and on the snowmelt flood of 1952 in the Kern Ri-ver, Tulare Lake, and San Joaquin River basins was prepared by he Geological Survey, Water Resources Division, C. G. Paulsen, chief, under the general direction of J. V. B. Wells, chief, Sur-ace Water Branch, and under the general supervision of R. C. Briggs, district engineer.

Basic records of discharge in the areas covered by this report are collected in cooperation with the Department of Public Works of California, through the State engineer; the Corps of Engineers, Department of the Army; the Bureau of Reclamation, Department of the Interior; the city of San Francisco; the Turlock and Modesto rrigation districts; Alameda County Flood Control and Water Con-servation District; and licencees of the Federal Power Commis-sion.

Several individuals and organizations contributed to this report. The Corps of Engineers furnished the information and statistics on lood damage. In part 1, a summary of the meteorological con-ditions associated with the flood-producing storm was furnished y Don L. Jorgensen, research forecaster, U. S. Weather Bureau; records of reservoir contents during the flood period and supple-mentary precipitation records were furnished by the Santa Clara Valley Water Conservation District, the San Francisco Water De-artment, and the San Jose Water Works. In part 2, the records or Kern River near Bakersfield were furnished by the Kern Coun-y Land Company.

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By S. E. Rantz and Harlowe M. Stafford

ABSTRACT

Two major floods occurred in California in 1952. The first was the flood of January 11-13 in the south San Francisco Bay region that resulted from heavy rains which began on the morning of January 11 and ended about noon January 13. This flood was notable for the magnitude of the peak discharges, although these discharges were reduced by the controlling effect of reservoirs for conservation and flood-control purposes. The flood damage was thereby reduced, and no lives were lost; damage, nevertheless, amounted to about $1,400,000.

The second flood was due, not to the immediate runoff of heavy rain, but to the melting of one of the largest snow packs ever recorded in the Sierra Nevada range. In the spring and summer of 1952, flood runoff occurred on all the major streams draining the Sierra Nevada. In the northern half of the Central Valley basin--the Sacramento River basin--flood volumes and maximum daily discharges were not exceptional, and flood damage was not appreciable. However, in the southern half, which is formed by the Kern River, Tulare Lake, and San Joaquin River basins, new records for snowmelt runoff were established for some streams; but for below-normal temperatures and shorter, less warm hot spells, record flood discharges would have occurred on many others. In the three basins an area of 200,000 acres, largely cropland, was inundated, and damage was estimated at $11,800,000.

FLOOD OF JANUARY 1952 IN THE SOUTH SAN FRANCISCO BAY REGION

By S. E. Rantz

Introduction

The flood of January 1952 in the south San Francisco Bay region was the result of a storm that centered near the summit of the Santa Cruz Mountains, where rainfall total exceeded 8 inches. Although peak discharges in January 1952 exceeded those previously recorded only at very few of the gaging stations in the area, a comparison on an area-wide basis of the 1952 flood with previous floods is difficult to make, owing to modifying effect of the larger number of regulating reservoirs now in existence, and to the fact that only three gaging stations in the area were in operation before 1930.

The report presents data on stages and discharges at 14 gaging stations, an analysis of flood damages, a brief analysis of the characteristics of the flood hydrographs, and other data pertaining to the flood.

Description of the Region

The region of the flood discussed in this report (fig. 72) comprises the drainage basins on the east side of San Francisco Bay south of San Lorenzo Creek, on the west side of the bay, south of

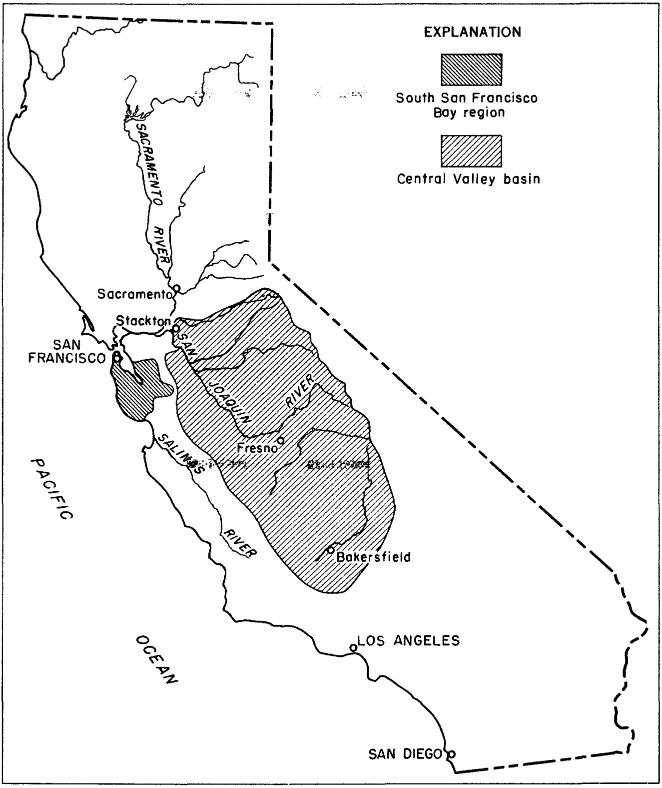

Figure 72.--Index map of California, showing location of the areas described in this report.

San Francisquito Creek, and the contiguous basins of Soquel Creek, San Lorenzo River, and Pescadero Creek that drain directly into the Pacific Ocean. The streams and their gaging stations and principal reservoirs are shown on plate 6. Table 1 lists these gaging stations and reservoirs and the numbers and letters that identify them on plate 6.

The three Pacific Ocean basins drained by Soquel Creek, San Lorenzo River, and Pescadero Creek, are classified as "mountain and foothill" areas, their slopes being greater than 200 feet per mile. Utilization of the waters of these streams is of relatively minor importance. By contrast, water for irrigation is a prime necessity in the highly developed Santa Clara Valley, which is the valley floor of all the streams draining into San Francisco Bay that are delineated on the map, except for those of Alameda and San Lorenzo Creek basins, and is highly developed agriculturally. The many reservoirs shown on the map (pl. 6) are primarily for conservation purposes, but the larger ones also have an important flood-control function. The gaging stations in the Santa Clara Valley are, in general, at the mouths of canyons from which the streams debouch onto the valley floor. A notable exception is the station on Guadalupe River at San Jose, which is out on valley floor proper. Of the two basins not a part of Santa Clara valley, Alameda Creek above the Niles gaging station drains an area that is about 85 percent mountain and foothill terrain, and virtually all of the San Lorenzo Creek drainage basin above the Hayward gaging station is in that category. There is little utilization of San Lorenzo Creek water, but Calaveras Reservoir in the Alameda Creek basin stores water for municipal use by the city of San Francisco.

Elevations in the south San Francisco Bay region range from slightly above sea level to more than 4,000 feet and topography has a marked influence on rainfall distribution and intensity. Average annual precipitation has a range of from about 14 inches in the valley to more than 60 inches in mountainous areas. There is often a marked relationship over large areas between storm precipitation and average annual precipitation. With rare exceptions, virtually all the precipitation occurs between mid-October and the latter part of April. Snow rarely falls in measurable quantities except at the highest altitudes. There is no record of floods that have been augmented to any appreciable extent by melting snow.

General Description of the Flood

The flood of January 11-13, 1952 caused considerable damage in the south San Francisco Bay region, particularly in the drainage basins of Alameda Creek and Guadalupe River. Flood conditions in the Guadalupe River basin were considerably alleviated,

Table 1.--Stream-gaging stations and principal reservoirs in south San Francisco Bay region

Stream gaging station	Index no. on pl. 6	Drainage area above station (sq mi)	Reservoir	Index letter on pl. 6	Drainage area above reservoir (sq mi)	Capacity (acre-ft)
PACIFIC OCEAN DRAINAGE						
Soquel Creek at Soquel	1	40.4	a/	--------	---------	-------
San Lorenzo River at Big Trees	2	110	a/	--------	---------	-------
Pescadero Creek near Pescadero	3	46.2	a/	--------	---------	-------
SAN FRANCISCO BAY DRAINAGE						
San Francisquito Creek at Stanford University.	4	37.7	Searsville	A	14.8	952
Stevens Creek near Cupertino	5	18.1	Stevens Cr.	B	16.9	4,000
Alamitos Creek near Edenvale	6	35.0	Almaden	C	11.9	2,000
			Calero	D	7.1	9,213
Los Capitancillos Creek at Guadalupe	7	12.6	Guadalupe	E	6.0	3,500
Los Gatos Creek below Los Gatos	8	43.6	Austrian	F	10.0	6,000
Guadalupe River at San Jose	9	131	Almaden Calero Guadalupe Austrian	C D E F	35	20,713
			Vasona	G	45	412
Saratoga Creek at Saratoga b/	10	8.8	a/	-------	---------	-------
Coyote Creek near Madrone	11	194	Coyote	H	120	24,560
			Anderson	J	193	75,000
Coyote Creek near Edenvale	12	229	Coyote Anderson	H J	193	99,560
Alameda Creek near Niles	13	633	Calaveras	K	100	96,800
San Lorenzo Creek at Hayward	14	38.0	a/		---------	-------

[a] No reservoir on stream.
[b] Shown as Campbell Creek on some maps.

however, by the modifying effect of storage reservoirs on the tributary streams and on Coyote Creek. Virtually the entire flow of Coyote Creek was stored in Coyote and Anderson Reservoirs. The effect of this storage in reducing potential flood damage in northwestern Santa Clara County becomes evident when it is realized that the only divide between Coyote Creek and Guadalupe River in their roughly parallel courses through the city of San Jose to San Francisco Bay is formed by the leveelike banks of silt that had been deposited by the streams at high stages.

Rain began to fall on the morning of January 11; it increased in intensity during that afternoon and night but slackened by noon of January 12. Streams began to rise on the afternoon of January 11; they rapidly peaked during the morning hours of January 12 and spread over the lowlands. Many highways were closed by slides and floodwater. In the towns of Campbell, Milpitas, San Jose, and Santa Clara, hundreds of basements and lower floors were flooded. Alviso, at the mouth of Guadalupe River, was inundated to depths ranging from 6 inches to 10 feet, causing all but about 50 of the town's 700 population to leave. In the Pleasanton area of Alameda Creek basin, many people were forced to leave their water-logged homes and farms. Floodwaters were slow in receding because the rain, which stopped on the 13th, began again on January 14 and continued for the next few days.

Flood Damage

No loss of life was attributable to the flood, but damage amounted to about $1,400,000. Table 2 summarizes the damage by type and by drainage basin.

Meteorology and Precipitation

Meteorology

[Prepared by Don L. Jorgensen 1/]

The heavy rains in the San Francisco Bay region during the 11th and 12th of January 1952 resulted from a storm that moved southward out of the Gulf of Alaska. On the morning of the 11th this storm was centered about 300 miles west of Portland, Oreg., with the storm front extending southward just off the coast of northern California. By the evening of the 11th the front had moved inland over Oregon and extreme northern California, and had become nearly stationary in the vicinity of the San Francisco

1/ Research forecaster, U. S. Weather Bureau.

Table 2. --Flood damage in south San Francisco Bay region

[Figures compiled by Corps of Engineers; damage slight in basins not listed]

Drainage basin	Agricultural	Residential	Commercial and industrial	Levee	Highway	Railroad	Utilities	Total
Stevens Creek ---	$9,000	----------	$2,500	$2,000	------	--------	--------	$18,500
Guadalupe River a/	113,000	$24,000	200,000	------	$37,000	$2,000	5,000	b 380,000
Saratoga Creek --	70,000	1,000	10,000	------	------	--------	--------	81,000
Alameda Creek --	635,000	24,000	49,000	45,000	68,000	5,000	5,000	831,000
San Lorenzo Creek	41,000	----------	15,000	10,000	5,500	1,500	3,500	76,000
Total --------	868,000	49,000	276,500	57,000	110,500	8,500	13,500	b 1,387,000

[a] Includes the following tributary basins: Alamitos Creek, Los Capitancillos Creek, and Los Gatos Creek.

[b] Includes expenditure of $4,000 by American Red Cross for removal of people from flooded areas.

Bay region. Early on the 12th the storm center had moved to a point just off the coast of central California. Under the influence of this center and a deep trough in the upper atmosphere, further development occurred along the quasi-stationary front. The resulting storm moved onto the coast on the 12th just to the north of San Francisco. Strong onshore flow of the convectively unstable air brought heavy rainstorms to coastal sections from the San Francisco Bay region southward.

Precipitation

Rainstorms began in the San Francisco Bay region in the early morning of January 11 and lasted until about noon of January 13. In general, however, about 85 percent of the precipitation fell during the 24-hour period ending at 9 a.m. on January 12. Strongly influenced orographically, the storm total ranged from 3 inches on the valley floor to more than 8 inches in the Santa Cruz Mountains. Observed maximum hourly precipitation ranged from 0.3 to 0.7 inch over most of the region, but reached 1.64 inches at Boulder Creek in the San Lorenzo River basin.

The isohyetal map (pl. 6) is a generalized picture of the areal distribution of the precipitation of January 11-13. The isohyets are drawn on the basis of records for 81 precipitation stations, 56 of which are operated by the U. S. Weather Bureau, and on the basis of the shape of the normal-annual isohyets for the region.

Stages and Discharges at Stream-Gaging Stations

Explanation of Data

Detailed records of discharge for the gaging stations in the south San Francisco Bay region appear on the following pages. For each station, the records include a description of the gaging station, daily mean discharge and total runoff for the 3-day period January 11-13, 1952, and gage height and discharge at 2-hour intervals for this period.

The description of the station gives information on the location, size of drainage area, type and completeness of gage-height record, definition of the stage-discharge relation, the maximum stage and discharge during the present flood and previous maxima of record, and other pertinent information.

A summary table gives the daily discharge for each day in the period January 11-13, the mean discharge for the period, and total runoff--both in inches and in acre-feet--for the period. A table of gage height and discharge at indicated time gives the gage height and discharge at 2-hour intervals during the period. As the peak occurred on January 12 at all the stations, the detailed discharge for the 3-day period is sufficient to delineate the flood hydrograph, although the streams were still comparatively high at the end of January 13.

Figure 73 presents discharge hydrographs at selected gaging stations for the 3-day period. The hydrographs are for unregulated flow (see section "Peak discharge" for further discussion of hydrograph preparation). The recessions in discharge have not been shown beyond midnight of January 13, because rain which began again on January 14 caused the streams to rise once more.

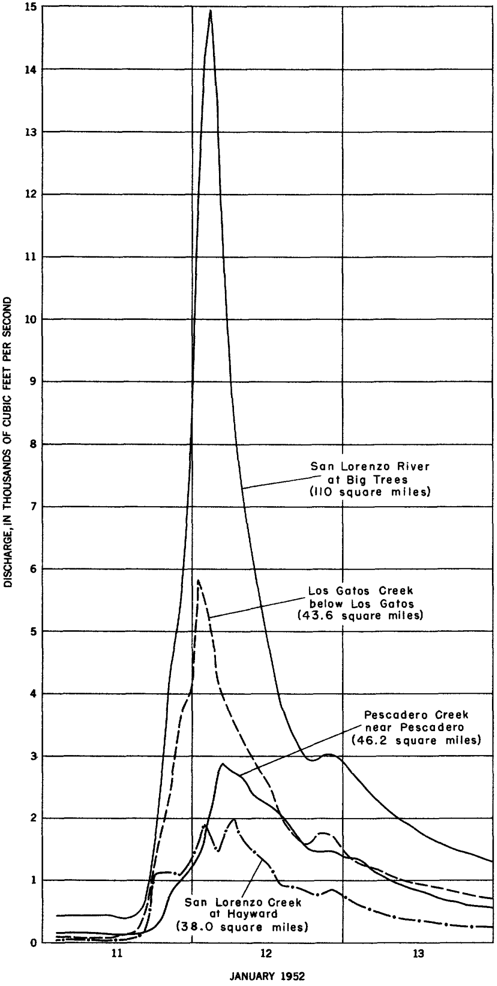

Figure 73. --Discharge hydrographs at selected stream-gaging stations.

Soquel Creek at Soquel, Calif.

Location.--Lat 36°59'29", long 121°57'17", in NE¼ sec. 10, T. 11 S., 1 W., on left bank 0.2 mile upstream from highway bridge in town Soquel.

Drainage area.--40.4 sq mi.

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

Discharge record.--Stage-discharge relation defined by current-meter measurements below 2,100 cfs and extended to peak stage by logarithmic plotting.

Maxima.--January 1952; Discharge, 4,910 cfs 5:30 a.m. Jan. 12 (ga height, 11.63 ft).

May to December 1951: Discharge, 3,500 cfs Dec. 28, 1951 (ga height, 10.58 ft), from rating curve extended above 2,100 cfs as explained above.

Remarks.--Small diversions above station for irrigation.

Mean discharge and runoff, January 11-13, 1952

Daily discharge, in cfs, January 11	555
Daily discharge, in cfs, January 12	2,290
Daily discharge, in cfs, January 13	678
Mean discharge, in cfs, for period	1,170
Runoff, in acre-feet	6,990
Runoff, in inches	3.24

Gage height, in feet, and discharge in cubic feet per second, at indicated time, 1952

Hour	Gage height	Discharge	Gage height	Discharge	Gage height	Discharge
	January 11		January 12		January 13	
2	4.72	126	10.18	3,080	7.54	1,040
4	4.73	127	11.30	4,420	7.32	930
6	4.74	129	11.00	4,000	7.16	850
8	4.73	127	10.30	3,200	6.98	760
10	4.73	127	9.77	2,670	6.78	662
N	4.72	126	9.10	2,080	6.65	610
2	4.71	124	8.32	1,520	6.50	550
4	4.76	131	7.87	1,240	6.40	510
6	5.80	340	7.63	1,100	6.30	480
8	8.10	1,380	7.41	975	6.20	450
10	9.56	2,460	7.78	1,190	6.13	429
12	9.90	2,800	8.00	1,320	6.08	414

San Lorenzo River at Big Trees, Calif.

ocation.--Lat 37°01'40", long 122°03'30", in Canada del Rincon Grant, Santa Cruz County, on right bank 0.5 mile south of Big Trees station on Southern Pacific Railroad, 1.6 miles downstream from Zayante Creek, and 4 miles north of Santa Cruz.

rainage area.--110 sq mi.

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

ischarge record.--Stage-discharge relation defined by current-meter measurements below 11,000 cfs and a slope-area determination of 24,000 cfs for the flood of Feb. 27, 1940.

laxima.--January 1952: Discharge, 14,900 cfs 3 a.m. Jan. 12 (gage height, 16.85 ft).

1937 to December 1951: Discharge, 24,000 cfs Feb. 27, 1940 (gage height, 21.1 ft), by slope-area determination.

emarks.--Many small diversions above station for domestic supply.

Mean discharge and runoff, January 11-13, 1952

Daily discharge, in cfs, January 11	1,610
Daily discharge, in cfs, January 12	6,400
Daily discharge, in cfs, January 13	1,890
Mean discharge, in cfs, for period	3,300
Runoff, in acre-feet	19,640
Runoff, in inches	3.35

Gage height, in feet, and discharge in cubic feet per second, at indicated time, 1952

Hour	Gage height	Dis-charge	Gage height	Dis-charge	Gage height	Dis-charge
	January 11		January 12		January 13	
2	3.57	415	16.48	14,200	8.15	2,650
4	3.56	412	16.13	13,500	7.85	2,420
6	3.56	412	13.65	9,190	7.55	2,200
8	3.57	415	12.25	7,110	7.30	2,030
10	3.54	406	11.38	5,930	7.10	1,910
N	3.52	400	10.46	4,830	6.90	1,790
2	3.52	400	9.50	3,820	6.73	1,690
4	4.10	582	8.99	3,340	6.57	1,590
6	6.90	1,790	8.57	2,990	6.37	1,480
8	9.70	4,020	8.52	2,950	6.23	1,420
10	11.00	5,460	8.62	3,030	6.13	1,360
12	13.40	8,800	8.50	2,930	6.00	1,300

Pescadero Creek near Pescadero, Calif.

Location.--Lat 37°15'40", long 122°19'40", in SW¼ sec. 6, T. 8 S., R 4 W., on left bank at downstream side of highway bridge, 3.0 miles east of Pescadero and 6.0 miles upstream from mouth.

Drainage area.--46.2 sq mi.

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

Discharge record.--Stage-discharge relation defined by current-meter measurements below 1,400 cfs and extended to peak stage by logarithmic plotting.

Maxima.--January 1952: Discharge, 2,860 cfs 4:45 a.m. Jan. 12 (gage height, 14.16 ft).

April to December 1951: Discharge, 2,310 cfs Dec. 4, 1951 (gage height, 12.73 ft), from rating curve extended above 1,400 cfs as explained above.

Remarks.--No regulation or diversion.

Mean discharge and runoff, January 11-13, 1952

Daily discharge, in cfs, January 11	305
Daily discharge, in cfs, January 12	2,000
Daily discharge, in cfs, January 13	877
Mean discharge, in cfs, for period.......	1,060
Runoff, in acre-feet	6,310
Runoff, in inches........................	2.56

Gage height, in feet, and discharge in cubic feet per second, at indicated time, 1952

Hour	Gage height	Dis-charge	Gage height	Dis-charge	Gage height	Dis-charge
	January 11		January 12		January 13	
2	3.81	133	11.15	1,750	9.82	1,320
4	3.78	130	13.85	2,740	9.42	1,200
6	3.77	129	13.95	2,780	9.03	1,090
8	3.75	127	13.55	2,620	8.63	984
10	3.74	126	12.85	2,350	8.28	897
N	3.73	125	12.42	2,200	7.93	815
2	3.73	125	12.00	2,050	7.63	749
4	3.88	141	11.25	1,790	7.37	694
6	4.90	264	10.50	1,520	7.15	650
8	7.30	680	10.30	1,460	6.87	594
10	8.70	1,000	10.35	1,480	6.72	566
12	9.54	1,230	10.07	1,390	6.55	535

San Francisquito Creek at Stanford University, Calif.

Location.--Lat 37°25'20", long 122°11'25", on right bank, in Rinconada del Arroyo de San Francisquito Grant, at golf course, 0.8 mile downstream from confluence with Los Trancos Creek and 1.2 miles west of Stanford University post office, Santa Clara County.
Drainage area.--37.7 sq mi.
Gage-height record.--Water-stage recorder graph.
Discharge record.--Stage-discharge relation defined by current-meter measurements below 810 cfs and extended to peak stage by logarithmic plotting.
Maxima.--January 1-13, 1952: Discharge, 1,610 cfs 10 a.m. Jan. 12 (gage height, 6.40 ft).

1931-41, 1950 to December 1951: Discharge, 3,650 cfs Nov. 18, 1950 (gage height, 10.4 ft), from rating curve extended above 810 cfs as explained above.
Remarks.--Flow regulated by storage at Searsville Reservoir (capacity, 952 acre-ft). About 900 acre-ft diverted annually to Los Trancos and Lagunita Canals for irrigation on the Stanford University campus below gaging station.

Mean discharge and runoff, January 11-13, 1952

Daily discharge, in cfs, January 11	344
Daily discharge, in cfs, January 12	1,020
Daily discharge, in cfs, January 13	353
Mean discharge, in cfs, for period	572
Runoff, in acre-feet	3,410
Runoff, in inches	1.69

Gage height, in feet, and discharge in cubic feet per second, at indicated time, 1952

Hour	Gage height	Dis-charge	Gage height	Dis-charge	Gage height	Dis-charge
	January 11		January 12		January 13	
2	1.55	62	5.35	1,140	4.01	617
4	1.54	61	5.00	998	3.83	556
6	1.55	62	5.15	1,060	3.65	498
8	1.55	62	5.50	1,210	3.51	453
10	1.55	62	6.40	1,610	3.16	352
N	1.57	64	5.35	1,140	3.11	339
2	1.74	83	4.90	956	2.55	212
4	3.92	587	4.65	856	2.46	193
6	4.30	720	4.45	777	2.41	184
8	4.35	739	4.48	788	2.37	177
10	4.81	920	4.33	731	2.49	199
12	5.85	1,360	4.20	684	2.63	228

Stevens Creek near Cupertino, Calif.

Location.--Lat 37°18'20", long 122°04'25", in SW¼ sec. 22, T. 7 S., R. 2 W., on left bank, on downstream side of county highway bridge, 0.6 mile downstream from Stevens Creek Dam and 2.5 miles southw of Cupertino.

Drainage area.--18.1 sq mi.

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

Discharge record.--Stage-discharge relation defined by current-meter measurements below 560 cfs and estimates of flow over Stevens Cree Dam.

Maxima.--January 1952: Discharge, 1,110 cfs 8:30 a.m. Jan. 12 (gage height, 5.82 ft).

1930 to December 1951: Discharge, 2,390 cfs Feb. 28, 1940 (gage height, 7.05 ft), from rating curve extended by logarithmic plotting above 350 cfs.

Remarks.--Flow regulated by Stevens Creek Reservoir (usable capacity 4,000 acre-ft).

Mean discharge and runoff, January 11-13, 1952

Daily discharge, in cfs, January 11	23
Daily discharge, in cfs, January 12	540
Daily discharge, in cfs, January 13	325
Mean discharge, in cfs, for period.......	296
Runoff, in acre-feet	1,760
Runoff, in inches.......................	1.82

Gage height, in feet, and discharge in cubic feet per second, at indicated time, 1952

Hour	Gage height	Dis-charge	Gage height	Dis-charge	Gage height	Dis-charge
	January 11		January 12		January 13	
2	1.56	7.1	2.55	108	4.06	392
4	1.56	7.1	3.50	334	3.97	382
6	1.56	7.1	5.60	926	3.80	366
8	1.56	7.1	5.71	1,010	3.70	356
10	1.56	7.1	5.55	890	3.55	340
N	1.56	7.1	5.23	684	3.48	330
2	1.58	7.9	4.77	510	3.41	321
4	1.63	8.8	4.54	464	3.32	311
6	2.01	34	4.36	433	3.24	290
8	2.08	40	4.35	433	3.15	263
10	2.39	80	4.35	433	3.05	234
12	2.55	108	4.21	413	3.03	228

Alamitos Creek near Edenvale, Calif.

Location.--Lat 37°14'20", long 121°52'15", in SW¼ sec. 16, T. 8 S., R. 1 E., on left bank 0.4 mile upstream from confluence with Los Capitancillos Creek and 4 miles southwest of Edenvale.

Drainage area.--35.0 sq mi.

Gage-height record.--Water-stage recorder graph until 1 a.m. Jan. 12, when gaging station washed out. Hydrograph for period 1 a.m. Jan. 12 to 12 p.m. Jan. 13 constructed on basis of 3 discharge measurements and comparison with records for nearby streams.

Discharge record.--Stage-discharge relation defined by current-meter measurements below 1,400 cfs and extended to peak stage by logarithmic plotting.

Maxima.--January 1952: Discharge, 2,000 cfs 1 a.m. Jan. 12 (gage height, 5.2 ft, datum used before Jan. 12, 1952).

1930 to December 1951: Discharge, 2,670 cfs Dec. 27, 1931 (gage height, 6.60 ft), from rating curve extended above 1,800 cfs by logarithmic plotting.

Remarks.--Flow regulated by Almaden Reservoir (capacity, 2,000 acre-ft) and Calero Reservoir (capacity, 9,213 acre-ft).

Mean discharge and runoff, January 11-13, 1952

Daily discharge, in cfs, January 11	195
Daily discharge, in cfs, January 12	1,390
Daily discharge, in cfs, January 13	410
Mean discharge, in cfs, for period	665
Runoff, in acre-feet	3,960
Runoff, in inches	2.12

Gage height, in feet, and discharge in cubic feet per second, at indicated time, 1952

Hour	Gage height	Discharge	Gage height	Discharge	Gage height	Discharge
	January 11		January 12		January 13	
2	1.85	18		1,950		730
4	1.85	18		1,840		640
6	1.85	18		1,730		550
8	1.85	18		1,620		460
10	1.85	18		1,520		390
N	1.85	18		1,400		340
2	1.87	19		1,300		300
4	1.93	22		1,200		270
6	2.90	140		1,100		250
8	4.00	500		1,000		240
10	4.72	892		910		230
12	5.0	1,300		820		220

Los Capitancillos Creek at Guadalupe, Calif.

Location.--Lat 37°13'05", long 121°54'35", in SW¼ sec. 19, T. 8 S., R. 1 E., on left bank 0.5 mile northwest of Guadalupe and 3.5 miles upstream fron confluence with Alamitos Creek.

Drainage area.--12.6 sq mi.

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

Discharge record.--Stage-discharge relation defined by current-meter measurements below 530 cfs and extended to peak stage by logarithmi plotting.

Maxima.--January 1952: Discharge, 1,330 cfs 2 a.m. Jan. 12 (gage height, 4.22 ft).

1930 to December 1951: Discharge, 1,160 cfs Dec. 28, 1931 (gage height, 4.05 ft), from rating curve extended above 840 cfs by logarithmic plotting.

Remarks.--Flow regulated by Guadalupe Reservoir (capacity, 3,500 acre-ft).

Mean discharge and runoff, January 11-13, 1952

Daily discharge, in cfs, January 11	205
Daily discharge, in cfs, January 12	538
Daily discharge, in cfs, January 13	129
Mean discharge, in cfs, for period	291
Runoff, in acre-feet	1,730
Runoff, in inches	2.57

Gage height, in feet, and discharge in cubic feet per second, at indicated time, 1952

Hour	Gage height	Discharge	Gage height	Discharge	Gage height	Discharge
	January 11		January 12		January 13	
2	.91	15	4.22	1,330	2.04	188
4	.91	15	3.63	958	1.96	166
6	.91	15	3.25	732	1.90	151
8	.91	15	3.01	600	1.85	140
10	.93	16	2.82	500	1.80	129
N	.95	18	2.61	400	1.76	121
2	1.00	22	2.44	326	1.72	114
4	1.40	65	2.31	278	1.68	107
6	2.62	404	2.23	249	1.64	100
8	3.11	656	2.23	249	1.60	93
10	3.22	716	2.20	238	1.58	90
12	3.70	1,000	2.08	199	1.58	90

Los Gatos Creek below Los Gatos, Calif.

Location.--Lat 37°14', long 121°58', in Rinconada de Los Gatos Grant, on left bank 350 ft downstream from Cypress Road Bridge and 0.9 mile northeast of railroad station in Los Gatos, Santa Clara County.

Drainage area.--43.6 sq mi.

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

Discharge record.--Stage-discharge relation defined by current-meter measurements below 2,600 cfs and extended to peak stage by logarithmic plotting.

Maxima.--January 1952: Discharge, 5,800 cfs 1 a.m. Jan. 12 (gage height, 10.0 ft).

1930 to December 1951: Discharge, 7,110 cfs Feb. 27, 1940 (gage height, 14.71 ft, site and datum then in use), from rating curve extended above 2,300 cfs by logarithmic plotting.

Remarks.--Flow regulated by Austrian Reservoir (capacity, 6,000 acre-ft) and several small reservoirs above station. Several diversions above station for irrigation.

Mean discharge and runoff, January 11-13, 1952

Daily discharge, in cfs, January 11	874
Daily discharge, in cfs, January 12	2,820
Daily discharge, in cfs, January 13	975
Mean discharge, in cfs, for period	1,560
Runoff, in acre-feet	9,260
Runoff, in inches	3.98

Gage height, in feet, and discharge in cubic feet per second, at indicated time, 1952

Hour	Gage height	Discharge	Gage height	Discharge	Gage height	Discharge
	January 11		January 12		January 13	
2	2.59	80	9.50	5,480	3.28	1,300
4	2.62	84	7.14	4,190	3.14	1,210
6	2.64	87	6.56	3,650	3.00	1,130
8	2.62	84	6.09	3,270	2.86	1,050
10	2.61	83	5.58	2,930	2.75	992
N	2.73	102	4.95	2,550	2.65	938
2	2.85	125	4.39	2,070	2.55	885
4	3.95	472	3.98	1,760	2.45	835
6	5.39	1,420	3.73	1,590	2.38	800
8	6.50	2,240	3.94	1,730	2.30	760
10	7.90	3,580	3.94	1,730	2.23	725
12	8.40	4,200	3.53	1,460	2.18	700

Guadalupe River at San Jose, Calif.

Location.--Lat 37°20'00", long 121°54'00", at San Jose, Santa Clara County, on right bank 100 ft downstream from Los Gatos Creek.

Drainage area.--131 sq mi.

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

Discharge record.--Stage-discharge relation defined by current-meter measurements below 4,800 cfs and extended to peak stage by logarithmic plotting.

Maxima.--January 1952: Discharge, 8,000 cfs 4 a.m. Jan. 12 (gage height, 15.20 ft).

1930 to December 1951: Discharge, 8,680 cfs Feb. 27, 1940 (gage height, 11.88 ft), from rating curve extended by logarithmic plotting above 3,200 cfs.

Remarks.--Flow regulated by several reservoirs (combined capacity, 21,000 acre-ft). Small diversions above station.

Mean discharge and runoff, January 11-13, 1952

Daily discharge, in cfs, January 11	586
Daily discharge, in cfs, January 12	4,910
Daily discharge, in cfs, January 13	1,890
Mean discharge, in cfs, for period	2,460
Runoff, in acre-feet	14,650
Runoff, in inches	2.10

Gage height, in feet, and discharge in cubic feet per second, at indicated time, 1952

Hour	Gage height	Discharge	Gage height	Discharge	Gage height	Discharge
	January 11		January 12		January 13	
2	3.65	24	12.10	5,000	9.50	2,960
4	3.62	22	15.20	8,000	9.00	2,610
6	3.61	22	14.49	7,290	8.50	2,260
8	3.74	34	13.18	5,980	8.20	2,060
10	3.81	44	12.22	5,100	7.92	1,890
N	3.90	61	11.54	4,550	7.77	1,800
2	3.92	67	10.90	4,040	7.42	1,590
4	4.50	200	11.17	4,260	7.21	1,470
6	5.40	500	10.71	3,890	7.05	1,380
8	7.00	1,300	10.35	3,600	6.90	1,300
10	9.00	2,610	10.14	3,430	6.80	1,240
12	11.20	4,280	9.81	3,180	6.65	1,160

Saratoga Creek at Saratoga, Calif.

[Shown as Campbell Creek on some maps]

Location.--Lat 37°15'15", long 122°02'25", in Quito Grant, on right bank 0.5 mile southwest of Saratoga, Santa Clara County.

Drainage area.--8.8 sq mi, approximately.

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

Discharge record.--Stage-discharge relation defined by current-meter measurements below 320 cfs and extended to peak stage by logarithmic plotting.

Maxima.--January 1952: Discharge, 1,430 cfs 1:30 a.m. Jan. 12 (gage height, 4.63 ft).

1933 to December 1951: Discharge, 2,540 cfs Feb. 27, 1940 (gage height, 5.35 ft), from rating curve extended above 510 cfs by logarithmic plotting.

Remarks.--Diversion and regulation above station by San Jose Water Works; negligible during high-water periods.

Mean discharge and runoff, January 11-13, 1952

Daily discharge, in cfs, January 11	136
Daily discharge, in cfs, January 12	387
Daily discharge, in cfs, January 13	168
Mean discharge, in cfs, for period	230
Runoff, in acre-feet	1,370
Runoff, in inches	2.92

Gage height, in feet, and discharge in cubic feet per second, at indicated time, 1952

Hour	Gage height	Discharge	Gage height	Discharge	Gage height	Discharge
	January 11		January 12		January 13	
2	1.80	27	4.20	940	2.88	200
4	1.80	27	3.79	614	2.86	194
6	1.80	27	3.47	435	2.83	185
8	1.80	27	3.29	351	2.82	182
10	1.82	28	3.15	295	2.81	179
N	1.88	32	3.10	275	2.78	171
2	2.15	56	3.05	257	2.75	163
4	2.72	155	3.00	239	2.71	153
6	3.03	250	3.03	250	2.68	145
8	3.06	261	3.05	257	2.65	138
10	3.25	335	2.99	236	2.63	134
12	4.01	778	2.95	222	2.61	129

Coyote Creek near Madrone, Calif.

Location.--Lat 37°10'06", long 121°38'55", near southeast corner of Laguna Seca Grant on right bank 1.2 miles downstream from Anderson Dam at mouth of canyon, and 1.8 miles northeast of Madrone, Santa Clara County.

Drainage area.--194 sq mi.

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

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--January 13-15, 1952: Discharge, 56 cfs 3 a.m. Jan. 12 (gage height, 2.44 ft).

1902-12, 1916 to Jan. 12, 1952: Discharge, 25,000 cfs Mar. 7, 1911 (discharge figure furnished by Duryea, Haehl & Gilman, consulting engineers).

Remarks.--Flow regulated by Coyote Reservoir (capacity, 24,560 acre-ft) and Anderson Reservoir (capacity, 75,000 acre-ft).

Mean discharge and runoff, January 11-13, 1952

Daily discharge, in cfs, January 11	50
Daily discharge, in cfs, January 12	16
Daily discharge, in cfs, January 13	13
Mean discharge, in cfs, for period.......	26
Runoff, in acre-feet	157
Runoff, in inches........................	0.02

Gage height, in feet, and discharge in cubic feet per second, at indicated time, 1952

Hour	Gage height	Discharge	Gage height	Discharge	Gage height	Discharge
	January 11		January 12		January 13	
2	2.40	50	2.43	54	2.05	11
4	2.40	50	2.11	16	2.05	11
6	2.40	50	2.03	10	2.05	11
8	2.40	50	1.98	6.5	2.05	11
10	2.40	50	1.97	6.0	2.05	11
N	2.40	50	1.94	5.0	2.05	11
2	2.40	50	2.07	13	2.05	11
4	2.40	50	2.06	12	2.13	17
6	2.40	50	2.05	11	2.13	17
8	2.40	50	2.05	11	2.13	17
10	2.40	50	2.05	11	2.13	17
12	2.40	50	2.05	11	2.13	17

Coyote Creek near Edenvale, Calif.

Location.--Lat 37°16'15", long 121°47'55", on left bank at east boundary of Santa Teresa Grant, at "The Narrows", 1.5 miles northeast of Edenvale, Santa Clara County, and 7 miles south of San Jose.

Drainage area.--229 sq mi.

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

Discharge record.--Stage-discharge relation defined by current-meter measurements below 330 cfs and extended to peak stage by logarithmic plotting. Backwater corrections applied from 10 a.m. Jan. 12 to 6 p.m. Jan. 13.

Maxima.--January 1952: Discharge, 768 cfs 10 a.m. Jan. 12 (gage height, 4.77 ft, backwater from debris).

1916 to December 1951: Discharge, 10,000 cfs Feb. 10, 1922 (gage height, 12.8 ft, from floodmarks), from rating curve extended by logarithmic plotting above 4,900 cfs.

Remarks.--Flow regulated by Coyote Reservoir (capacity, 24,560 acre-ft), Anderson Reservoir (capacity, 75,000 acre-ft), and by detention in percolating reservoir 6 miles above station.

Mean discharge and runoff, January 11-13, 1952

Daily discharge, in cfs, January 11	6.8
Daily discharge, in cfs, January 12	391
Daily discharge, in cfs, January 13	193
Mean discharge, in cfs, for period	197
Runoff, in acre-feet	1,170
Runoff, in inches	0.10

Gage height, in feet, and discharge in cubic feet per second, at indicated time, 1952

Hour	Gage height	Discharge	Gage height	Discharge	Gage height	Discharge
	January 11		January 12		January 13	
2	2.48	4.6	2.86	39	3.91	312
4	2.48	4.6	2.98	59	3.86	302
6	2.48	4.6	3.71	290	3.74	254
8	2.48	4.6	4.10	465	3.59	206
10	2.48	4.6	4.77	768	3.48	175
N	2.48	4.6	4.66	669	3.43	163
2	2.48	4.6	4.51	583	3.40	159
4	2.49	5.0	4.39	528	3.35	146
6	2.52	6.5	4.20	432	3.29	136
8	2.56	8.7	4.07	352	3.25	129
10	2.64	14	3.99	334	3.23	122
12	2.76	26	3.94	318	3.21	115

Alameda Creek near Niles, Calif.

Location.--Lat 37°35'15", long 121°57'35", in Arroyo de la Alameda Grant, on right bank 0.2 mile downstream from railroad bridge and 1.2 miles northeast of Niles, Alameda County.

Drainage area.--633 sq mi.

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

Discharge record.--Stage-discharge relation defined by current-meter measurements below 8,700 cfs and extended to peak stage by logarithmic plotting.

Maxima.--January 1952: Discharge, 18,500 cfs 4:30 p.m. Jan. 12 (ga height, 13.92 ft).

1916 to December 1951: Discharge, 15,100 cfs Nov. 19, 1950 (gage height, 12.5 ft), from rating curve extended above 8,700 cfs as explained above.

Remarks.--Flow partly regulated by Calaveras Reservoir (usable capacity, 96,800 acre-ft, most of which is diverted for San Francis water supply).

Mean discharge and runoff, January 11-13, 1952

Daily discharge, in cfs, January 11	940
Daily discharge, in cfs, January 12	13,800
Daily discharge, in cfs, January 13	7,640
Mean discharge, in cfs, for period.......	7,460
Runoff, in acre-feet	44,390
Runoff, in inches.......................	1.31

Gage height, in feet, and discharge in cubic feet per second, at indicated time, 1952

Hour	Gage height	Dis-charge	Gage height	Dis-charge	Gage height	Dis-charge
	January 11		January 12		January 13	
2	3.71	174	10.16	9,850	10.97	11,600
4	3.71	174	10.57	10,800	10.43	10,400
6	3.71	174	10.71	11,100	9.97	9,430
8	3.71	174	11.30	12,400	9.47	8,330
10	3.70	170	11.66	13,200	9.12	7,560
N	3.70	170	12.53	15,200	8.84	6,950
2	3.70	170	13.36	17,200	8.68	6,600
4	4.02	300	13.90	18,500	8.46	6,120
6	4.63	682	13.32	17,100	8.23	5,660
8	5.75	1,600	12.94	16,200	8.06	5,320
10	-	*4,000	12.32	14,700	7.88	4,960
12	-	*6,800	11.55	12,900	7.74	4,680

* Interpolated.

San Lorenzo Creek at Hayward, Calif.

Location.--Lat 37°41', long 122°04', on right bank at highway bridge on B Street, in San Lorenzo Grant, just outside city limits of Hayward, Alameda County, 0.5 mile downstream from Palomares Creek.

Drainage area.--38.0 sq mi.

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

Discharge record.--Stage-discharge relation defined by current-meter measurements below 1,200 cfs and a slope-area determination of 2,610 cfs for the flood of Dec. 3, 1950.

Maxima.--January 1952: Discharge, 1,990 cfs 6:30 a.m. Jan. 12 (gage height, 11.10 ft).

1940, 1946 to December 1951: Discharge, 2,990 cfs Feb. 27, 1940 (gage-height 13.13 ft).

Flood of Jan. 24, 1942 reached a stage of 15.7 ft, from floodmarks (discharge, about 4,200 cfs.

Remarks.--Very little diversion above station. No regulation.

Mean discharge and runoff, January 11-13, 1952

Daily discharge, in cfs, January 11	367
Daily discharge, in cfs, January 12	1,240
Daily discharge, in cfs, January 13	379
Mean discharge, in cfs, for period	662
Runoff, in acre-feet	3,940
Runoff, in inches	1.94

Gage height, in feet, and discharge in cubic feet per second, at indicated time, 1952

Hour	Gage height	Discharge	Gage height	Discharge	Gage height	Discharge
	January 11		January 12		January 13	
2	3.38	42	10.85	1,890	6.79	600
4	3.36	40	9.62	1,450	6.52	537
6	3.35	39	10.99	1,940	6.18	463
8	3.34	38	10.10	1,630	5.92	414
10	3.32	37	9.53	1,420	5.75	378
N	3.31	36	8.98	1,230	5.57	345
2	3.38	42	7.95	910	5.46	326
4	4.23	129	7.91	899	5.26	290
6	8.57	1,100	7.57	804	5.04	251
8	8.63	1,120	7.39	754	4.94	237
10	8.46	1,070	7.70	840	4.86	224
12	9.45	1,390	7.33	739	4.81	216

Peak Discharge

The flood of January 11-13, 1952 was notable for the peak discharges it produced on the streams in the south San Francisco Bay region. Double peaks, caused by a lull in the rainfall, occurred in the northernmost basins, San Francisquito, Alameda, and San Lorenzo Creeks, and probably on Stevens Creek. The greater peak discharges all occurred some hours after the lesser ones. These peak, or maximum, discharges, all of which occurred on January 12, are summarized in table 3, along with those previously known.

Many of the peak discharges were smaller than they might otherwise have been, because of the regulating effect of the many conservation and flood-control reservoirs in the region. Whereever possible, the discharges that were affected by the regulation were adjusted on the basis of change of reservoir content, in order to provide the figures of hypothetical unregulated discharge that are listed in table. A complicating factor in making the adjustments was the fact that at each reservoir, observations of stage had been made only once daily. This deficiency in reservoir data was overcome by drawing for each reservoir a synthetic hydrograph.representing stored inflow. Each synthetic hydrograph was drawn so that it met the following two requirements: (1) its shape resembled that of a hydrograph for a nearby unregulated stream of similar size, (2) the daily volumes of stored inflow indicated by the hydrograph equalled the daily changes in reservoir content.

Having prepared these synthetic reservoir hydrographs of stored inflow, it was possible to adjust the gaging-station hydrographs of observed discharge. Where a gaging station was immediately downstream from a reservoir, the ordinates of the reservoir hydrograph were added to those of the gaging station to give the hypothetical hydrograph of unregulated discharge at the gaging station. Gaging-station records so treated were those for Stevens Creek and Coyote Creek near Madrone. Stevens Creek Reservoir filled at some time between the start of the storm and the time of peak discharge, and the peak discharge of Stevens Creek apparently was unaffected by the regulation. Coyote Reservoir, however, stored nearly all the flow of Coyote Creek above the Madrone gaging station.

Where a gaging station was some distance downstream from a reservoir, an additional adjustment for channel storage was made on the basis of channel dimensions and rate of change of stage. Gaging-station records requiring this type of treatment were those for Los Capitancillos Creek and Alameda Creek. Adjusted discharge for the station on Coyote Creek near Edenvale was computed

Table 3. --Summary of flood discharges in south San Francisco Bay region, California for the flood of January 1952

[All peak discharges in 1953 computed from established stage-discharge relation]

No. on pl. 6	Stream and place of determination	Drainage area (sq mi)	Period of record	Maximum flood previously known				Maximum during present flood			
				Date	Gage height (feet)	Discharge (cfs)	Cfs per sq mi	Time on January 12	Gage height (feet)	Discharge (cfs)	Cfs per sq mi
	PACIFIC OCEAN DRAINAGE										
1	Soquel Creek at Soquel	40.4	1951-52	Dec. 28, 1951	10.58	3,500	86.6	5:30 a.m.	11.63	4,910	122
2	San Lorenzo River at Big Trees	110	1937-52	Feb. 27, 1940	21.1	24,000	218	3 a.m.	16.85	14,900	135
3	Pescadero Creek near Pescadero	46.2	1951-52	Dec. 4, 1951	12.73	2,310	50.0	4:45 a.m.	14.16	2,860	61.9
	SAN FRANCISCO BAY DRAINAGE										
4	San Francisquito Creek at Stanford University	37.7	1931-41, 1950-52	Nov. 18, 1950	10.4	3,650	96.8	10 a.m.	6.40	1,610	42.7
5	Stevens Creek near Cupertino	18.1	1930-52	Feb. 28, 1940	7.05	a 2,390	132	8:30 a.m.	5.82	1,110	61.3
6	Alamitos Creek near Edenvale	35.0	1930-52	Dec. 27, 1931	6.60	2,670	76.3	1 a.m.	5.2	a 2,000	57.1
7	Los Capitancillos Creek at Guadalupe	12.6	1930-52	Dec. 28, 1931	4.05	1,160	92.1	2 a.m.	4.22	a 1,330	106
8	Los Gatos Creek below Los Gatos	43.6	1930-52	Feb. 27, 1940	b 14.71	7,110	163	1 a.m.	10.0	5,800	133
9	Guadalupe River at San Jose	131	1930-52	Feb. 27, 1940	11.88	a 8,680	66.3	4 a.m.	15.20	a 8,000	61.1
10	Saratoga Creek at Saratoga	8.8	1933-52	Feb. 27, 1940	5.35	2,540	289	1:30 a.m.	4.63	1,430	162
11	Coyote Creek near Madrone	194	1902-12, 1916-52	Mar. 7, 1911	---------	c 25,000	129	3 a.m.	2.44	a 56	.3
12	Coyote Creek near Edenvale	229	1916-52	Feb. 10, 1922	12.8	10,000	43.7	10 a.m.	4.77	a 768	3.4
13	Alameda Creek near Niles	633	1916-52	Nov. 19, 1950	12.5	a 15,100	23.9	4:30 p.m.	13.92	a 18,500	29.2
14	San Lorenzo Creek at Hayward	38.0	1940, 1946-52	Feb. 27, 1940	13.13	2,990	78.7	6:30 a.m.	11.10	1,990	52.4
				Jan. 24, 1942	15.7	4,200	111				

[a] Regulated.

[b] Site and datum then in use.

[c] Discharge figure furnished by Duryea, Haehl & Gilman, consulting engineers.

from a correlation with peak discharges for the station near Madrone, using discharge records that antedate the construction of the reservoirs. No extrapolation was required in this correlation. Unregulated flow of the Alamitos Creek and Guadalupe River gaging stations was not computed because of the complexity of the reservoir system above those gaging stations. Reservoirs on San Francisquito and Los Gatos Creeks were filled before the start of the storm and had no regulating effects, therefore, on these streams. No great accuracy is claimed for the adjusted discharges of table 4, but they do indicate the order of magnitude of the unregulated peak discharges of the various streams.

Because of their usefulness in hydrograph analysis, maximum 24-hour discharges, both observed and adjusted, are tabulated in table 4. On figure 74, peak discharges for the January flood, expressed in cubic feet per second per square mile, are plotted against the corresponding drainage areas. Although the plotted points indicate a trend, they are scattered widely, undoubtedly a result of the complex interaction of the effects due to differences in amount of precipitation over the region and those due to the differences in hydrologic characteristics of the individual basins.

Hydrograph Characteristics

A detailed rainfall-runoff analysis of the flood of January 11-13, 1952, is beyond the scope of this report. However, examination of the basic data discloses certain storm and basin characteristics.

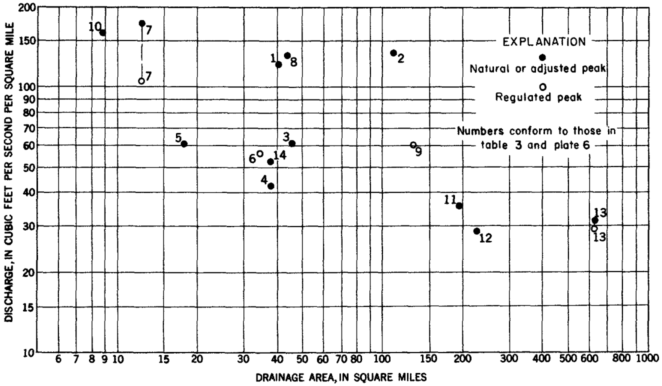

Figure 74. --Relation of peak unit discharge to size of drainage basin.

Table 4. --Summary of flood discharges in south San Francisco Bay region, January 11-13, 1952 as observed and as adjusted to natural flow conditions.

No. on pl. 6	Stream-gaging station	Momentary peak discharge				Maximum 24-hour discharge Cfs	
		Cfs		Cfs per sq mi			
		Observed	Adjusted	Observed	Adjusted	Observed	Adjusted
	PACIFIC OCEAN DRAINAGE						
1	Soquel Creek at Soquel a/----------	4,910	(a)	122	(a)	2,500	(a)
2	San Lorenzo Creek at Big Trees a/--	14,900	(a)	135	(a)	6,930	(a)
3	Pescadero Creek near Pescadero a/ -	2,860	(a)	61.9	(a)	2,000	(a)
	SAN FRANCISCO BAY DRAINAGE						
4	San Francisquito Creek at Stanford University.	1,610	(b)	42.7	(b)	1,070	(b)
5	Stevens Creek near Cupertino b/ ----	1,110	(b)	61.3	(b)	590	680
6	Alamitos Creek near Edenvale c/----	2,000	(c)	(c)	(c)	1,410	(c)
7	Los Capitancillos Creek at Guadalupe	1,330	2,200	--------	175	658	1,100
8	Los Gatos Creek below Los Gatos ---	5,800	(b)	133	(b)	3,130	(b)
9	Guadalupe River at San Jose --------	8,000	(c)	(c)	(c)	4,950	(c)
10	Saratoga Creek at Saratoga ---------	1,430	(a)	162	(a)	419	(a)
11	Coyote Creek near Madrone --------	56	7,000	--------	36.1	50	3,800
12	Coyote Creek near Edenvale --------	768	6,600	--------	28.8	446	4,200
13	Alameda Creek near Niles ----------	18,500	20,000	--------	31.6	14,200	16,500
14	San Lorenzo Creek at Hayward ------	1,990	(a)	52.4	(a)	1,340	(a)

[a] Discharge not affected; no reservoir on stream.

[b] Peak discharge not affected by reservoir.

[c] Insufficient reservoir data for estimate of natural flow.

Three elements roughly define the hydrographs of direct runoff that resulted from the rainfall excess: lag time; length, in time, of the base of the hydrograph; and the ratio of the momentary peak discharge to the maximum 24-hour discharge (adjusted for regulation, if necessary).

Lag time is defined as the time elapsing between the center of mass of rainfall excess and the occurrence of the peak discharge. The rainfall excess, which is defined as the volume of rainfall available for direct runoff, fell mainly during a 12-hour period, with the center of mass of this rainfall excess reached about 9 p.m. on January 11; hence, lag time is readily determined. The second element, length of the base of the hydrograph, can be measured directly from the hydrograph after an arbitrary separation of base flow has been made. The third element, the ratio of the momentary peak discharge to the maximum 24-hour discharge, entails a determination of the maximum 24-hour period, as it rarely coincides with the calendar day. This last factor is important in the San Francisco Bay region, because the small size of the drainage basins resulted in a large part of the rainfall excess running off within a period of 24 hours. This is true, to a degree, even in the comparatively large drainage basin of Alameda Creek, because the extremely dendritic stream pattern there reduces the travel time of direct runoff, and thereby partly compensates for the disparity in size of the basin. Total discharges were used in computing the ratios, because the refinement of separating base flow from total flow did not appear to be warranted. (Further discussions of this ratio as pertaining to California streams may be found in Water-Supply Papers 843 and 1137-F. 2/

Table 5 summarizes the three hydrograph characteristics discussed in the previous paragraph, and on figure 75 they are plotted against the corresponding drainage areas. Neither lag time nor length of base of the hydrograph was computed for those basins that were very highly regulated or experienced double peaks. In computing the length of the base of the hydrograph, use was made of the normal recession curves for the gaging stations, because none of the streams had receded to base flow before the start of the rains of January 14-17. Ratios of momentary peak discharge to maximum 24-hour average discharge were computed for all stations, except those on the highly regulated streams Alamitos Creek and Guadalupe River. As expected, those streams that experienced double peaks, San Francisquito, Alameda, and

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2/ McGlashan, H. D., and Briggs, R. C., 1939, Floods of December 1937 in northern Calif.: U. S. Geol. Survey Water-Supply Paper 843, p. 321-324, 341-345; U. S. Geol. Survey, 1953, Floods of 1950 in the Central Valley basin, Calif.: U. S. Geol. Survey Water-Supply Paper 1137-F, p. 767-774.

Table 5.--Hydrologic characteristics of drainage basins in south San Francisco Bay region, for rainfall excess of 12 hours duration, as derived from flood of January 11-13, 1952.

No. on pl. 6	Stream-gaging station	Drainage area (sq mi)	Lag time (hours)	Length of base of hydrograph (hours)	Ratio of momentary peak to maximum 24-hour discharge
	PACIFIC OCEAN DRAINAGE				
1	Soquel Creek at Soquel	40.4	8.5	84	1.96
2	San Lorenzo River at Big Trees	110	6.0	108	2.15
3	Pescadero Creek near Pescadero	46.2	7.75	96	1.43
	SAN FRANCISCO BAY DRAINAGE				
4	San Francisquito Creek at Stanford University.	37.7	(a)	(a)	1.50
5	Stevens Creek near Cupertino	18.1	(b)	(b)	1.63
6	Alamitos Creek near Edenvale	35.0	(b)	(b)	(b)
7	Los Capitancillos Creek at Guadalupe	12.6	5.0	(b)	2.00
8	Los Gatos Creek below Los Gatos	43.6	4.0	102	1.85
9	Guadalupe River at San Jose	131	(b)	(b)	(b)
10	Saratoga Creek at Saratoga	8.8	4.5	84	3.41
11	Coyote Creek near Madrone	194	(b)	(b)	1.84
12	Coyote Creek near Edenvale	229	(b)	(b)	1.57
13	Alameda Creek near Niles	633	(a)	(a)	1.21
14	San Lorenzo Creek at Hayward	38.0	(a)	(a)	1.49

[a] Not computed; hydrograph has double peak.

[b] Too highly regulated for reliable estimate.

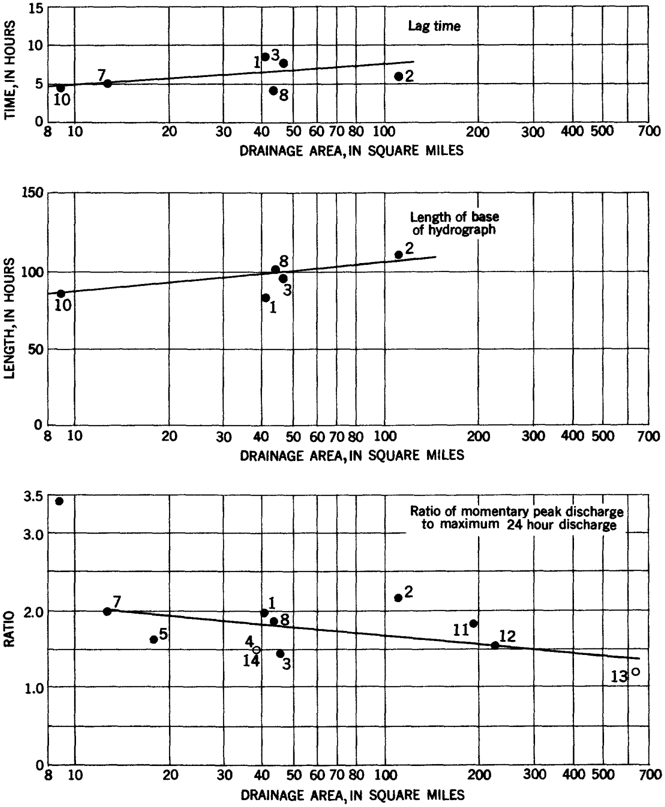

Figure 75.--Hydrologic characteristics of drainage basins for rainfall excess of 12 hours.

San Lorenzo Creeks, and probably Stevens Creek, showed ratios that were lower than the average trend. The ratio for Saratoga Creek [3] is much higher than that for the other streams, but the steepness of peaks on Saratoga Creek is often inconsistent with that for rises on the other gaged streams, being sometimes steeper and at other times flatter. This may be explained by the fact that the small size of drainage basin and short time of concentration of Saratoga Creek result in this stream being sensitive to changes of short-period rainfall intensity. A rain of steady

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[3] This stream is shown as Campbell Creek on some maps.

intensity will cause a flat peak, whereas a short interval of high-intensity rainfall, during a period of steady rain, will result in a sharply peaked hydrograph. In the larger drainage basins with longer times of concentration, the effect of a short interval of intense rainfall is modified.

It is emphasized that the hydrograph characteristics discussed are those for a rainfall excess of 12 hours duration, as interpreted from the records of a single flood. For a precise study, it would be necessary to divide the 12-hour duration period into shorter intervals, the records for many floods would have to be studied, and other basin parameters would have to be introduced—as for example, basin slope or a factor representing basin shape. The sketchy analysis used in this report does, however, give a generalized picture of the behavior of the streams in the region under a storm of the type described.

SNOWMELT FLOOD OF 1952 IN KERN RIVER, TULARE LAKE, AND SAN JOAQUIN RIVER BASINS

By Harlowe M. Stafford

Introduction

The snowmelt flood of 1952 in south-central California occurred in part of the same area (fig. 72) as the floods of November-December 1950, which are described in Water-Supply Paper 1137-F, Floods of November-December 1950 in the Central Valley basin, California. 4/ The cause of this flood was, however, quite different. Whereas the cause of the floods of 1950 was a series of heavy storms that brought rain, rather than snow, to unusually high altitudes in the Sierra Nevada, that of the flood of 1952 was the melting of an unusually heavy snow pack.

All the gaging stations listed in this report were also a source of data for Water-Supply Paper 1137-F. 4/ For convenience, the reference numbers assigned to the gaging stations in table 7 and on the map (figure 76) for this report conform to those in tables 6 and 8 and plate 15 of Water-Supply Paper 1137-F 5/.

The report contains no detailed records of discharge at individual gaging stations or tabulation of momentary peak discharges as commonly presented in flood reports. The discharge is expressed largely in terms of volume of runoff and the maximum daily discharge during the 4-month period from April 1 to July 31; comparisons of these figures are made with those of other years of high runoff from snowmelt. Figure 75 shows the location of the area described in this report.

Description of Basins

The Kern River, Tulare Lake, and San Joaquin River basins occupy the southern part of the Central Valley basin of California, which lies between the crest of the Sierra Nevada on the east and crests of the coastal ranges on the west. The Tulare Lake basin lies between the Kern River basin on the south and the San Joaquin River basin on the north. Its principal streams, named in south to north order, are the Tule, Kaweah, and Kings Rivers.

4/ U. S. Geol. Survey, 1953, Floods of November-December 1950 in the Central Valley basin, California: U. S. Geol. Survey Water-Supply Paper 1137-F. p. 505-789.

5/ Idem. p. 742, 743, and 768.

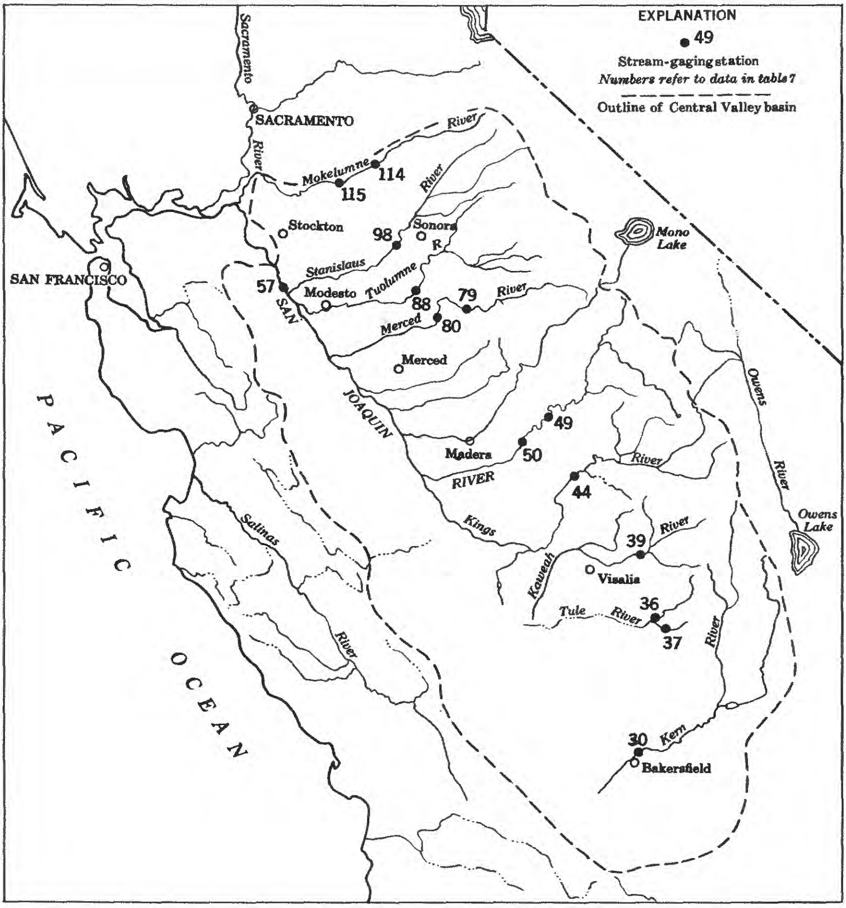

Figure 76. --Map showing location of gaging stations and outline of Central Valley basin.

The North and South Forks of the Kern River rise in the Sierra Nevada at an altitude of 14,000 feet near Mt. Whitney and drain the upper Kern River basin, about 2,400 square miles of the west slope of the Sierra, above the foothill line east of Bakersfield. These streams flow south to join at a point downstream from Kernville and within the reservoir formed by the partly completed (1952) Isabella Dam. From their juncture the main stem flows westward through a narrow canyon to emerge onto the valley floor within 18 miles of Bakersfield. Thence, the river flows southwesterly, over the valley floor for about 39 miles to Buena Vista Lake, a natural sump now modified by cross levees. The bed of the lake is cultivated when not inundated for streamflow storage purposes. Flow into the lake is artificially controlled. Floodwaters not stored in the lake for later irrigation use are diverted into Buena Vista Channel through which they may flow northwesterly through Sand

Ridge to Tulare Lake. Floodwaters may also reach Tulare Lake via Goose Lake Slough, a distributary channel of Kern River downstream from Bakersfield.

Tule River drains an area of about 390 square miles on the lower slope of the Sierra Nevada to the west of the upper Kern River basin. The main stream is formed by the confluence of the North and Middle Forks about 10 miles northeast of the point where it emerges from the foothills at Porterville. The South Fork joins the main stream 6 miles east of this point. Floodwaters flow westward across the valley through old delta channels to Tulare Lake.

Kaweah River drains a mountainous area of about 520 square miles east of the foothills north and west of and separated from the upper Kern River basin by a secondary ridge paralleling the main crest of the Sierra Nevada. Its headwaters rise in glacial lakes at an altitude of more than 12,000 feet. The main stream is formed about 10 miles upstream from the head of its delta by the confluence of the North, Middle, and South Forks near the town of of Three Rivers. Below the foothills it divides into several distributaries that cross the delta fan and enter Tulare Lake.

The headwaters of the Kings River rise in lakes and snowfields at altitudes of as much as 14,000 feet, and drain a mountain area of about 1,700 square miles, north of the upper Kaweah River basin. The South and Middle Forks unite at an altitude of about 2,200 feet, and the North Fork joins the main stream at an altitude of about 1,000 feet just upstream from the eastern end of Pine Flat Reservoir. Near the town of Piedra and about 4 miles downstream from the partly completed (1952) Pine Flat Dam, the river emerges from the foothills onto the valley floor, where it has built up a large delta. At a point about 25 miles south of the city of Fresno the river divides, part flowing northerly (as Kings River North) through James bypass and Fresno Slough to the San Joaquin River, and part flowing south (as Kings River South) to Tulare Lake. The Corps of Engineers has constructed control works and levees in the vicinity of the division point.

Little runoff reaches the bed of Tulare Lake except in years of exceptionally large flow. In order to facilitate farming the lake bed, a network of levees has been constructed to confine the water to as small an area as possible. Inflow amounting to 5,000 acre-feet can be stored between the leeves of the inlet channels. Inflow in excess of this amount will breach these levees and flood one or more of the cells within the network of levees in the lake bed. Part of the water stored is pumped out again for irrigation, and the remainder evaporates.

San Joaquin River rises in the Sierra Nevada northwest of the Kings River basin at altitudes above 10,000 feet, flows southwesterly until it emerges from the foothills onto the valley floor, thence westerly to a point midway on the valley floor near the town of Mendota, where it turns northwesterly to the delta and its confluence with Sacramento River at the head of Suisun Bay. At the edge of the foothills Millerton Lake, a reservoir formed by the construction of Friant Dam in 1941, affords storage capacity of 520,000 acre-feet. Above the reservoir the river drains a mountain area of about 1,600 square miles, and an aggregate of about 338,000 acre-feet of storage space is provided in five upstream reservoirs operated for power. Below Friant Dam the principal tributaries rise in the Sierra Nevada and enter the main stem from the east. From south to north they are: Fresno, Chowchilla, Merced, Tuolumne, Stanislaus, Calaveras, and Mokelumne Rivers. The principal reservoirs in the mountains and foothills provide usable storage capacity of about 281,000 acre-feet on Merced River, 646,000 on Tuolumne River, 162,000 on Stanislaus River, and 349,000 on Mokelumne River.

Description of the Flood

Antecedent Conditions

During the 1951-52 water year, precipitation in all the Central Valley basin was consistently greater than normal throughout the the winter. Widespread storms began in October and occurred intermittently until the end of March. The largest storms came in December and January. Most of the storms brought abnormally cold air and produced snow down to and below an altitude of 1,000 feet. Very little of this snow melted and a very large snow pack accumulated over the entire mountain area.

On April 1, 1952, the accumulated snow pack was 260 percent of normal in the Kern River basin, from 190 percent (Kings River) to 265 percent (Tule River) in the Tulare Lake basin, and from 180 percent (Merced and Tuolumne Rivers) to 200 percent (Stanislaus and Mokelumne Rivers) in the San Joaquin River basin. As shown in table 6, this snow pack, in all basins, exceeded that existing on the same date in 1938, which had been the greatest pack on record since the beginning of the California Cooperative Snow Surveys record in 1930. Moreover, examination of available records of snowfall at stations in these basins indicates that the 1952 snow pack equalled or exceeded the pack that caused the great snowmelt floods of 1906.

Thus, in April of 1952 enough snow had accumulated to cause the greatest snowmelt flood on record. That such a flood did not occur was largely due to the temperature pattern during the snowmelt period. Weather continued to be cold; temperatures from April through July were generally below normal-in June about 5° below normal. Moreover, the occasional intervals of hot weather that usually cause the peak flows during the period of the snowmelt runoff were short and not as hot as usual.

Table 6. --Comparison of snow packs existing on April 1 for the years 1938 and 1952 in the Kern River, Tulare Lake, and San Joaquin River basins expressed in percent of normal computed for the 62-year period 1880-1951, inclusive.

[Data from State Division of Water Resources, California Cooperative Snow Surveys]

Drainage basin	Average snow pack in basin (percent)	
	1952	1938
Kern River	260	205
Tulare Lake	195	155
Tule River	265	180
Kaweah River	220	155
Kings River	190	155
San Joaquin River:		
Upper San Joaquin River	190	170
Merced River	180	140
Tuolumne River	180	150
Stanislaus River	200	170
Mokelumne River	200	155

Flood Runoff

As it occurred, the volume of the April-July runoff approached closely that of 1938, and on Kern, Kaweah, Stanislaus, and Mokelumne Rivers exceeded it (see table 7). However, in no case where the period of the record includes the year 1906 did the 1952 snowmelt runoff exceed that of 1906. Figure 76 shows the location of the gaging stations listed in table 7.

As shown in table 7, the maximum daily discharge during the April-July runoff period was greater than the corresponding discharge in 1938 on the Kern, Kaweah, and Mokelumne Rivers. However, on those streams where the period of the record includes the year 1906, the maximum daily discharge during the snowmelt period did not exceed that of 1906.

Table 7.--Snowmelt runoff during the period April 1-July 31 for the years 1952 and 1938 and for the year of greatest snowmelt flood on record, Kern River, Tulare Lake, and San Joaquin River basins.

No.* on Fig. 76	Stream and gaging station	Period of record	Runoff in 1,000 acre-ft.				Maximum daily discharge						
			1952	1938	Maximum record		1952		1938		Maximum record		
						Year	Cfs	Date	Cfs	Date	Cfs	Year	Date
	KERN RIVER BASIN												
30	Kern River near Bakersfield a/	1893-1952	1,120	962	1,390	1906	8,360	May 31	7,300	June 4	9,500	1906	June 21
	TULARE LAKE BASIN												
36	Tule River near Porterville	1901-52	115	129	192	1906	860	Apr. 25	1,300	May 15	2,820	1923	Apr. 6
37	South Fork Tule River near Success	1932-52	36	40	40	1938	330	Apr. 6	364	Apr. 25	575	1937	Apr. 2
39	Kaweah River near Three Rivers	1903-52	588	562	814	1906	5,170	May 27	5,130	June 3	7,260	1906	May 28
44	Kings River at Piedra	1895-1952	2,200	2,320	2,980	1906	b 15,500	June 6	22,800	June 4	24,900	1906	June 20
	SAN JOAQUIN RIVER BASIN												
49	San Joaquin River below Kerckhoff powerhouse.	1937, 1943-52	c 1,830	--	c 1,830	1952	c 15,000	June 6	--	--	c 15,000	1952	June 6
50	San Joaquin River below Friant	1907-52	cd 1,730	c 2,340	2,540	1911	cd 9,520	June 18	c 17,700	May 15	23,100	1911	June 13
57	San Joaquin River near Vernalis	1922, 1930-52	c 4,510	c 6,160	c 6,160	1938	c 33,700	June 1	c 47,600	June 7	c 47,600	1938	June 7
79	Merced River at Bagby	1922-52	1,090	e 1,230	e 1,230	1938	9,660	May 28	e 12,300	May 15	e 15,900	1935	Apr. 8
80	Merced River at Exchequer	1916-52	c 1,050	c 1,200	c 1,200	1938	c 9,930	May 31	c 12,000	June 2	c 12,000	1938	June 2
88	Tuolumne River above La Grange Dam, near La Grange.	1896-1952	c 1,730	c 1,900	2,680	1906	c 11,300	May 16	c 19,000	June 5	20,200	1906	June 13
98	Stanislaus River below Melones powerhouse.	1931-52	c 1,320	c 1,310	c 1,320	1952	c 11,600	May 28	c 13,700	May 15	c 13,700	1938	May 15
114	Mokelumne River near Mokelumne Hill.	1928-52	c 819	c 727	c 819	1952	c 7,350	May 31	c 5,620	June 7	c 8,720	1943	June 1
115	Mokelumne River at Lancha Plana	f 1904-52	c 737	c 651	f 1,020	1906 1907	c 5,110	June 11	c 4,850	May 16	f 9,000	1906	June 12

[a] Records furnished by Kern County Land Co.

[b] Affected by regulation afforded by 150,000 acre-ft of storage space behind the partly completed in 1952 Pine Flat Dam.

[c] Affected by storage regulation.

[d] Includes diversion to Friant-Kern and Madera Canals.

[e] Station at Kittridge.

[f] Records for station near Clements used for period 1904-26.

[*] Reference numbers conform with those on plate 15 and table 6 of Water-Supply Paper 1137-F (1953).

On the Kern River, the volume of the April-July runoff that passed the site of Isabella Dam was 954,000 acre-feet, and the maximum daily discharge was 8,000 cfs on May 30. At the station near Bakersfield, the maximum daily discharge was 8,360 cfs as compared to a discharge of 7,300 cfs in 1938 and 9,500 cfs in 1906.

At the Tule River station near Porterville (upstream from the South Fork), the maximum daily discharge during the snowmelt period was 860 cfs on April 25. This was exceeded by the discharge of 1,300 cfs in 1938, of 2,780 cfs in 1906, and by the record discharge of 2,820 cfs in 1923.

Because a snowmelt runoff could occur on the Kings River on a scale as great or greater than that of 1938, when a maximum daily discharge of 22,800 cfs and an April-July volume of 2,320,000 acre-feet were recorded at Piedra, the Corps of Engineers stored water in partly completed Pine Flat Reservoir to limit damage downstream as much as possible. Of 150,000 acre-feet of storage space available on April 1, about 130,000 acre-feet was used in controlling the outflow to a maximum daily discharge of 15,500 cfs on June 6. Inflow to the reservoir reached a maximum of 18,400 cfs on May 28. If the storage facilities of the reservoir had not been used the Corps of Engineers estimated that instead of 250,000 acre-feet, about 320,000 acre-feet of runoff from Kings River would have entered Tulare Lake. The maximum daily flow to Tulare Lake was about 3,600 cfs and to San Joaquin River, about 4,600 cfs.

On San Joaquin River, the regulation of snowmelt runoff by Millerton Lake was such that the maximum daily outflow from the reservoir, including diversions to the Madera and Friant-Kern Canals, did not exceed the 9,520 cfs on June 18. At the station below Kerckhoff powerhouse, upstream from the reservoir, the maximum daily discharge was 15,000 cfs on June 6. In 1938, before the construction of Friant Dam, the maximum daily discharge below Friant during the snowmelt period was 17,700 cfs.

On Merced River, the maximum daily inflow to Lake McClure was 9,660 cfs and occurred on May 28. Maximum daily outflow from the reservoir was 9,930 cfs, on May 31; in 1938 the corresponding discharge was 12,000 cfs on June 2.

On April 1 there was a total of 370,000 acre-feet of space available in the foothill and mountain reservoirs of the Tuolumne River basin. Of this total, 100,000 acre-feet of space in Don Pedro Reservoir was reserved for flood control. In view of the large April 1 snow pack, flood-control space was held also in Hetch Hetchy Reservoir by the City of San Francisco. As recorded at the station near La Grange, the maximum daily outflow from Don Pedro Reservoir occurred on May 16 and was 11,300 cfs. The corresponding outflow during the 1938 snowmelt floods was 19,000 cfs. The record daily discharge near La Grange of 20,200 cfs was established during the snowmelt floods of 1906, before construction of the existing reservoirs.

On Stanislaus River, the maximum daily discharge below Melones Dam was 11,600 cfs as compared with a discharge of 13,700 cfs during the 1938 snowmelt period. The runoff volume for the period April through July, totaling 1,320,000 acre-feet, was slightly greater than that of 1938.

Although there was more than 180,000 acre-feet of combined storage space in Salt Springs and Pardee reservoirs on April 1, snowmelt flows of Mokelumne River exceeded downstream channel capacities. Salt Springs Reservoir filled about July 10 and Pardee Reservoir about July 4. Pardee Reservoir was operated for flood control purposes by the East Bay Municipal Utility District. As recorded at the Lancha Plana gaging station, the maximum daily outflow from Pardee Reservoir was 5,110 cfs on June 11. The corresponding discharge in 1938 was 4,850 cfs and occurred on May 16. In 1906, before the upstream reservoir development, the maximum daily discharge of snowmelt runoff at the station near Clements was 9,000 cfs. Total April-July volume of runoff at Lancha Plana in 1952 was 737,000 acre-feet and exceeded that of 1938 by 86,000 acre-feet. In 1906, the corresponding volume near Clements was 1,020,000 acre-feet.

An indication of the effectiveness of the principal reservoirs in the San Joaquin River basin in regulating the large April-July volumes of snowmelt runoff both in 1938 and in 1952 is shown by the data in table 8.

Extent and Character of Flooding

Damaging floods occurred along lower reaches of Kern River, principally along upper Goose Lake Slough and in Buena Vista Lake. Although floodwaters were stored in the lake and dams constructed across outlets of the river impounded water for future irrigation use in the Sand Ridge area, a total of 30,700 acres of agricultural lands--in native pasture or planted to cotton, alfalfa, and grain--was flooded; this total includes about 23,500 acres in Buena Vista Lake, 200 acres along Goose Lake Slough, and 7,000 acres that were intentionally flooded in the Sand Ridge area. Several county roads were washed out by flows in Goose Lake Slough, and one road was damaged near Tulare Lake.

Table 8. --Storage increment in principal reservoirs of the San Joaquin River basin during snowmelt period April 1-July 31, for the years 1938 and 1952.

Tributary basin	Reservoir	Storage increment April 1-July 31 (acre-feet)	
		1938	1952
Upper San Joaquin River--	Florence Lake------------	64,100	63,900
	Huntington Lake-----------	69,300	77,500
	Shaver Lake---------------	93,900	124,800
	Millerton Lake -----------	-------	159,900
Merced River -----------	Lake McClure ------------	49,700	14,500
Tuolumne River ---------	Lake Eleanor-------------	1,700	14,900
	Hetch Hetchy -------------	224,100	248,800
	Don Pedro ---------------	25,300	110,700
Stanislaus River---------	Melones -----------------	10,900	55,900
Mokelumne River--------	Salt Springs --------------	86,500	108,700
	Pardee ------------------	71,800	72,600

Upstream from the Tulare Lake area, about 300 acres of agricultural lands were flooded by Tule River water augmented by water from Kaweah River via Elk Bayou. Minor flooding occurred on Kings River as the result of a levee break upstream from Crescent weir, and on Kings River North about 5,100 acres were inundated within the levees. About 1,100 acres of crop lands along the Kings River downstream from the town of Laton suffered damage from seepage produced by the continuous high flows.

Major flooding occurred in the Tulare Lake area. Floodwaters from Kings, Kaweah, and Tule Rivers began entering Tulare Lake early in the snowmelt period, and water in the lake reached a maximum of about 500,000 acre-feet on or about June 20. As estimated by the Corps of Engineers, total volume of inflow to the lake during the snowmelt period amounted to 490,000 acre-feet. The corresponding inflow in 1938 was 850,000 acre-feet. A total of 72,700 acres of agricultural lands in Tulare Lake was flooded. Of this total, crops had been harvested on 14,700 acres before inundation. Levee failures within Tulare Lake occurred from March until June 2.

Below Friant Dam on the San Joaquin River about 2,500 acres of pasture and crop lands were flooded; in addition, 400 acres of crop lands were affected by water seeping through levees and canal banks along the river for about 15 miles upstream from Mendota Dam. Maximum releases from Millerton Lake in combination with a maximum inflow of about 4,600 cfs of Kings River water via

Fresno Slough produced a peak of about 8,800 cfs near Mendota on May 29. Downstream from Mendota Dam, inflow from the principal tributaries produced flows in excess of channel capacity at nearly all points along the lower San Joaquin River. Near Vernalis, and downstream from the confluence of Stanislaus River, the maximum daily discharge of 33,700 cfs on June 1 was only 3,900 cfs less than the corresponding discharge in 1938 on June 7. Between Mendota and the San Joaquin River delta, 77,600 acres of agricultural lands were flooded in scattered areas inadequately protected by levees and in normal overflow areas. About 65,700 acres of the flooded area was native pastureland and the remainder was cropland. An additional 10,600 acres of cropland was damaged by seepage through and under the levees, owing to the long duration of the period of high flows. Major levee breaks occurred near Dos Palos, in the reach between the Tuolumne and Stanislaus Rivers, and in Reclamation District 2075 downstream from the Stanislaus River. A large recreational area between the levees near Mossdale, many residential properties, and several miles of paved county roads were flooded.

About 2,600 acres of crop and pastureland and a county road were flooded, when overbank flow inundated bottom land along both banks of the Merced River in a narrow strip extending from the vicinity of Livingston to the mouth of the river.

Aside from the flooding of about 500 acres of river bottom land near its mouth and seepage damage to 190 acres of cropland below Tuolumne City bridge, flows from the Tuolumne River added substantially to the flooding along the San Joaquin River.

On the Stanslaus River, the flooded area extended from the vicinity of Oakdale to the San Joaquin River. It included about 4,100 acres of river bottom lands, of which 1,300 acres were in cultivated crops and the remainder in pasture. Near the mouth of the river about 1,200 acres were severely affected by seepage of water through the levee.

Agricultural lands flooded along Mokelumne River included about 3,900 acres near the confluence of the Cosumnes and Mokelumne Rivers; 650 acres, inundated by a levee break, near Lockeford; and 640 acres in a narrow belt along the river between the towns of Lockeford and Lodi. Waste-disposal works of several wineries along the river were damaged by floodwaters.

Flood Damage

During and immediately following the 1952 snowmelt floods, the Corps of Engineers began a survey of flood damage. This survey, which required approximately three months to complete, included the collecting of all available reports of damage by other agencies, and the making of personal interviews with many property owners and the personnel of local organizations, public utilities, and private firms that had suffered damage. The data on flood damage were embodied in a report presented by the Sacramento District, Corps of Engineers, entitled, "Report of 1952 Snow-Melt Floods, Sacramento-San Joaquin River Basins, California and Great Basin, California, Nevada, and Utah."

Table 9 as taken from that report gives the flooded areas and the flood damage in the Kern River, Tulare Lake, and San Joaquin River basins under four categories of damage. In these three basins, damage incurred as a result of the 1952 snowmelt floods included the flooding of 200,900 acres and amounted to a total of $11,828,000 distributed as follows:

Type of damage	Amount	Percent of total
Agricultural	$10,113,000	85.5
Residential	8,000	.1
Commercial and industrial.	25,000	.2
Public institutions, and public and private utilities.	1,682,000	14.2
Total:	$11,828,000	100.0

Table 9.--Flooded areas and flood damages, Kern River, Tulare Lake, and San Joaquin River basins, snowmelt flood of 1952.

[Compiled by Corps of Engineers]

Basin and stream	Flooded area (acres)	Direct flood damage			
		Agricultural	Commercial and industrial	Public institutions and utilities	Total
KERN RIVER BASIN					
Kern River	a 30,700	$1,210,000	0	$5,000	$1,215,000
TULARE LAKE BASIN					
Tule River	300	40,000	0	17,000	57,000
Kings River	5,200	136,000	0	63,000	199,000
Tulare Lake	72,700	6,877,000	0	1,418,000	8,295,000
Total, Tulare Lake basin	78,200	b 7,053,000	0	1,498,000	8,551,000
SAN JOAQUIN RIVER BASIN					
San Joaquin River:					
Friant to Mendota	2,500	60,000	0	10,000	70,000
Mendota to Merced River	60,900	728,000	$6,000	31,000	765,000
Merced R. to Tuolumne River	8,100	139,000	0	2,000	141,000
Tuolumne R. to Stanislaus River	3,300	150,000	0	13,000	163,000
Stanislaus River to Delta	5,300	414,000	14,000	26,000	c 462,000
Merced River	2,600	71,000	0	3,000	74,000
Tuolumne River	(d)	14,000	0	0	14,000
Stanislaus River	4,100	204,000	0	84,000	288,000
Mokelumne River	5,200	70,000	5,000	10,000	85,000
Total, San Joaquin River basin	92,000	e 1,850,000	25,000	179,000	c 2,062,000
Total, Kern River, Tulare Lake, and San Joaquin River basins	200,900	$10,113,000	$25,000	$1,682,000	$11,828,000

[a] Includes 23,500 acres in Buena Vista Lake.
[b] Includes $127,000 seepage damage.
[c] Includes $8,000 residential damage.
[d] Nominal.
[e] Includes $810,000 seepage damage.

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