State of California
The Resources Agency

Department of
Water Resources

California High Water 1981-82

Bulletin 69-82

August 1983

ON THE COVER: McDonald Island Levee Break during flooding in the Sacramento-San Joaquin Delta, August 28, 1982.

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Water Resources
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Gordon K. Van Vleck
Secretary for Resources

The Resources
Agency

George Deukmejian
Governor

State of
California

David N. Kennedy
Director

Department of
Water Resources

FOREWORD

Bulletin 69-82, the fifteenth in a series of reports on high water in California, presents information on storms, flooded areas, and damage during the 1981-82 water year (October 1, 1981 through September 30, 1982). Included are weir overflow graphs, and hydrographs of selected stream gages and reservoir operations.

Fears that the 1981-82 water year would be a repeat of the 1980-81 period with 75 percent of normal precipitation, or worse yet, the even drier 1976-77 period, were dispelled early. By December 1981, precipitation totals statewide ranged from 90 to 350 percent of normal for that three-month period.

In January, torrential rainfall brought such flooding and mud and debris flows to the central coast that the Governor proclaimed ten counties emergency areas.

The Sacramento River climbed out of its main channel six times between November and April and both the Sutter and Yolo Bypasses were flooded repeatedly. Fortunately the main storms were widely spaced and permitted major flood control reservoirs to catch the main runoff and then draw down storage in time to be ready for the next storm.

By mid-April nearly every reservoir in the San Joaquin River System was filled to capacity and on the verge of uncontrolled spilling. A period of cool weather with virtually no precipitation interceded and prevented the heavy Sierra snowpack from deluging the San Joaquin Valley.

Then in late August, when everything seemed secure, a levee burst in the San Joaquin Delta, flooding unharvested crops and natural gas facilities.

Information for this bulletin was provided by the Department of Water Resources, National Weather Service, U. S. Geological Survey, U. S. Army Corps of Engineers, U. S. Bureau of Reclamation, and other public and private sources whose assistance is gratefully acknowledged.

David N. Kennedy, Director
Department of Water Resources
The Resources Agency
State of California

CONTENTS

	Page
FOREWORD	iii
ORGANIZATION, DEPARTMENT OF WATER RESOURCES	vi
ORGANIZATION, CALIFORNIA WATER COMMISSION	vii
FLOOD EVENTS OF WATER YEAR 1981-82	1
WEATHER PATERNS OF 1981-82	5
SUMMARY OF FLOOD EVENTS	15
North Coast Hydrologic Area	15
Humboldt County	17
Del Norte County	19
Mendocino County	21
San Francisco Bay Area	22
Sonoma County	23
Napa County	24
Solano County	24
Marin County	28
Alameda County	29
Contra Costa County	31
San Mateo County	32
Santa Cruz County	35
Monterey County	35
Santa Clara County	35
Southern California	36
San Luis Obispo County	37
Sacramento River Drainage Basin	37
Sacramento Valley	40
San Joaquin Basin	45
San Joaquin River	47
Sacramento-San Joaquin Delta	53
Flooding in the Northern Owens Valley	57

FIGURES

No.		
Frontispiece.	Counties Proclaimed Emergency Areas Under Public Law 93-288	viii
1	Accumulated Precipitation at Blue Canyon, American River Basin, October 1, 1981 to April 30, 1982	4
2	Satellite Photos of Low-Pressure Center off the Pacific Coast, November 13 and 14, 1981	6
3	Isohyetal Map of the San Francisco Bay Area Storm of January 3-5, 1982	8
4	Satellite Photos of the San Francisco Bay Storm of January 4, 1982	10
5	Satellite Photo of Northern California Storm of February 15, 1982	11
6	Satellite Photo of Northern California Storm of mid-April 1982	11

CONTENTS (cont.)

7	Seasonal Precipitation, October 1, 1981 to September 30, 1982	12
8	Maximum Temperatures at Two Mountain Stations	13
9	Locations of Hydrographs	14
10	Hydrograph of the Eel River	18
11	Hydrograph of the Smith River	19
12	Hydrographs of the Klamath and Trinity Rivers	20
13	Hydrograph of the Russian River	23
14	Hydrograph of the Napa River	24
15	Hydrograph of the Sacramento River	41
16	Hydrograph of Shasta Lake and Lake Oroville	42
17	Hydrographs of New Bullards Bar Reservoir and Folsom Lake	46
18	Hydrograph of the Consumnes River	47
19	Hydrographs of the Comanche Reservoir and New Melones Reservoir	48
20	Hydrograph of the San Joaquin River	50
21	Hydrographs of New Don Pedro Reservoir and Lake McClure	51
22	Hydrographs of Millerton Lake and Pine Flat Reservoir	52
23	Hydrograph of Isabella Reservoir	53

Tables

1	Percentage of Normal Precipitation	5

Appendix

	Sacramento River Crest and Weir Overflow Records (Figures):	
A-1	Sacramento River, Highest Crest Profiles for Selected Years	59
A-2	Period of Record of Overflow of the Moulton Weir	60
A-3	Period of Record of Overflow of Colusa Weir	61
A-4	Period of Record of Overflow of the Tisdale Weir	62
A-5	Period of Record of Overflow of the Fremont Weir	63
A-6	Period of Record of Overflow of the Sacramento Weir	64
A-7	Period of Record of Inundation of the Yolo Bypass	65

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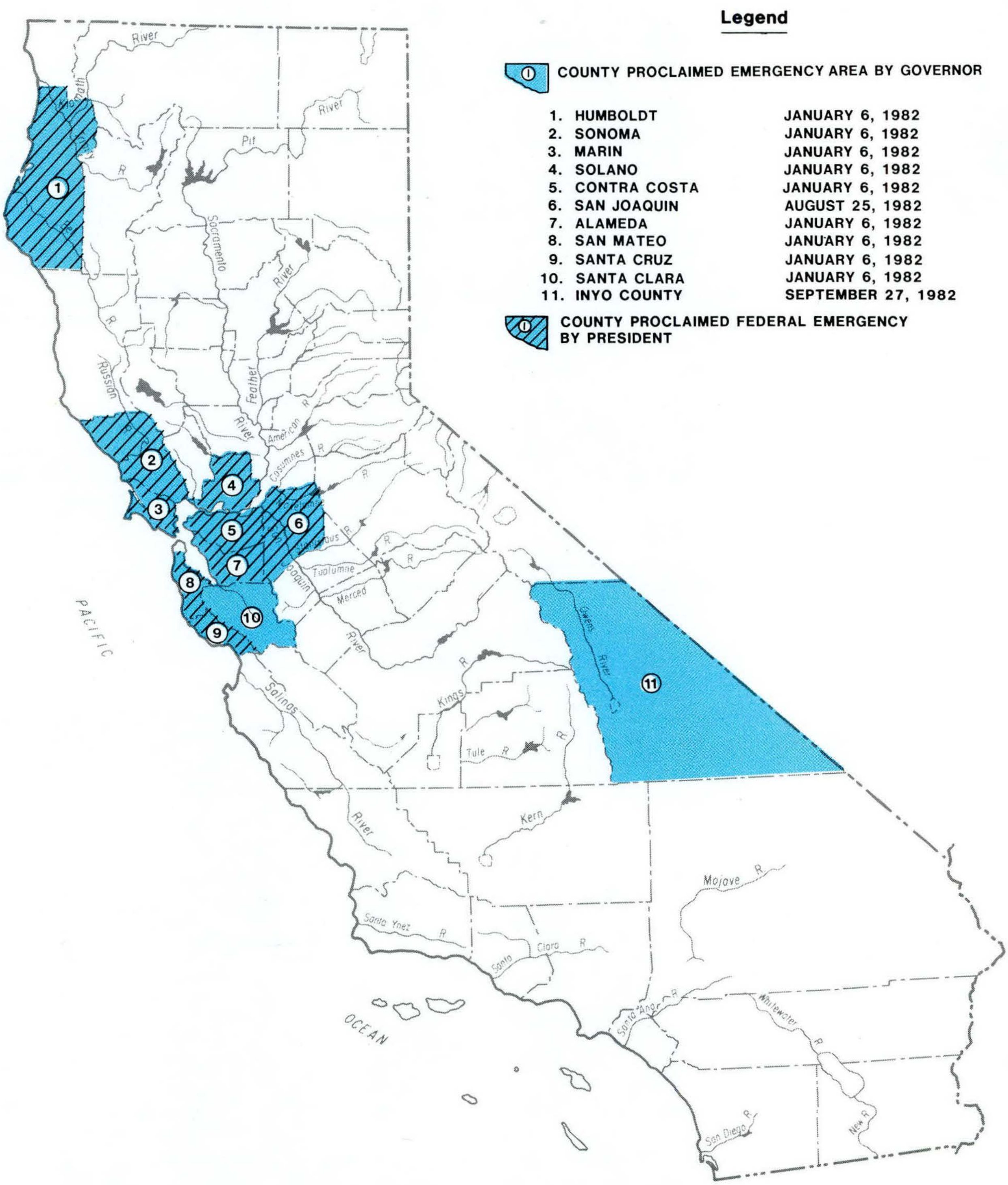
The California Water Commission serves as a policy advisory body to the Director of Water Resources on all California water resources matters. The nine-member citizen commission provides a water resources forum for the people of the State, acts as liaison between the legislative and executive branches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

COUNTIES PROCLAIMED EMERGENCY AREAS UNDER PUBLIC LAW 93-288



FLOOD EVENTS OF WATER YEAR 1981-82

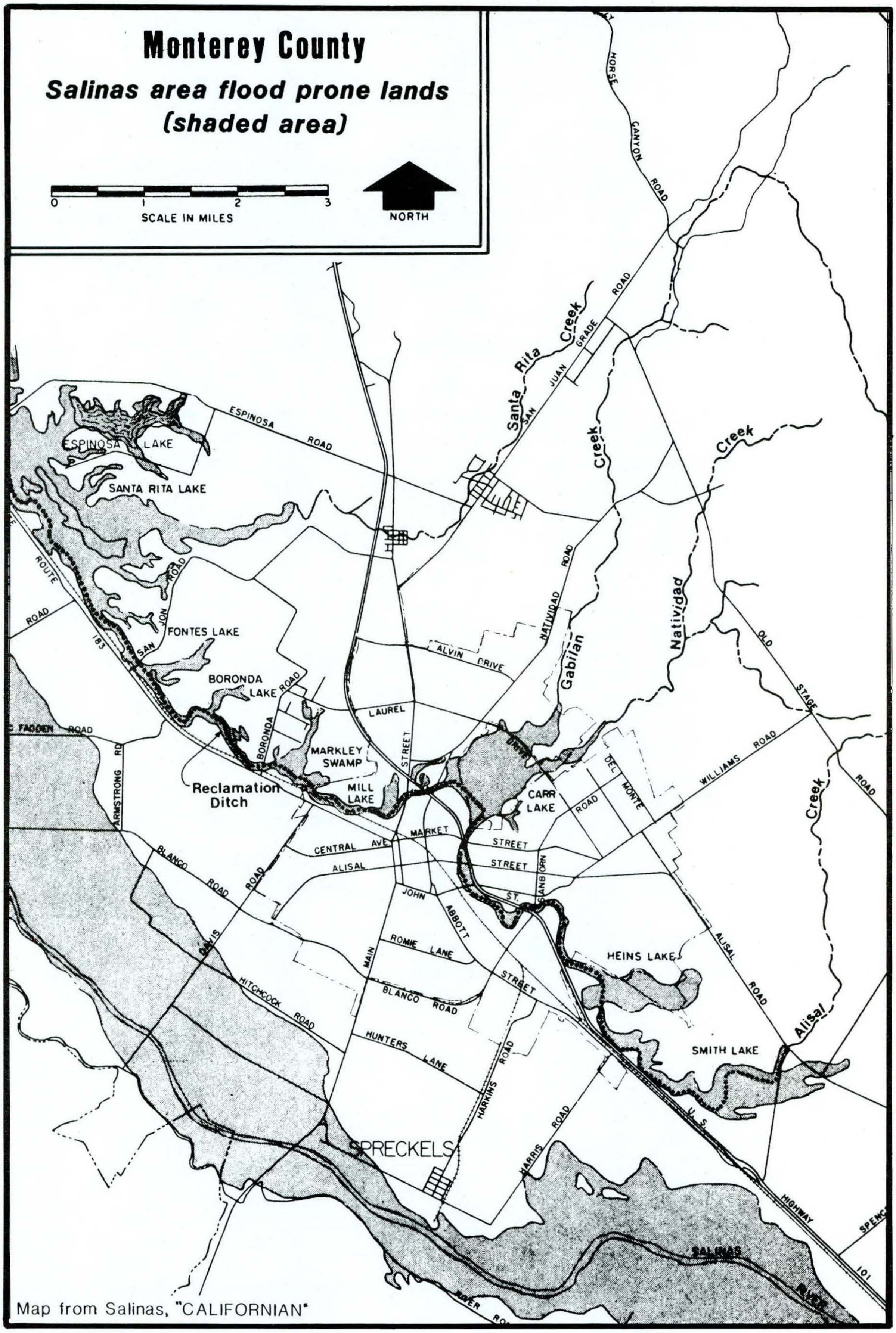
At the beginning of the new water year, California's water supply outlook was not favorable. Precipitation during the winter of 1980-81 was a disappointing 75 percent of the long-term average runoff. Reservoir storage was at a respectable 88 percent of the ten year average, but only because of a significant carryover from the previous year. Thus, year-end reservoir supply was not a true indication of dryness of the 1980-81 season. Water officials and principal users were gravely concerned. Another dry or below-normal year could deplete usable water supplies to dangerous levels. Under the above conditions, Californians could expect widespread water rationing, plus other stringent controls beginning early in 1982.

Fears of a repeat of the 1976-77 drought, however, were quickly dispelled when the first month of the new water year produced well above normal precipitation for most of Northern California. By mid-winter, precipitation amounts ranged from 10 percent to more than 250 percent of normal. The depleted reservoirs quickly filled, and untimely and substantial releases became necessary to meet flood-control criteria. Another encouraging factor was the above-average snowpack at higher elevations, which assured an adequate water supply for the coming summer. Within a few months, the water supply for Northern California had dramatically changed from a serious need to a surplus condition.

The major storm events of water year 1981-82 can generally be related to six distinct weather systems beginning in mid-November 1981. A series of weather fronts during October raised river elevations to flood and warning level on the North Coast and brought significant rises on the Sacramento River system, but the initial storm in terms of runoff was not of the magnitude of subsequent weather events. It should be noted, too, that in addition to the six major storm events, local showers and squalls contributed substantially to the total statewide flood damage.

The winter of 1982 will be long remembered, not particularly as the wettest of the century as proclaimed by the National Weather Service, but for the death and destruction resulting from the savage storms.

On January 6, 1982, the Governor of California requested that a major disaster be declared in California. The following day the President determined that damage in the State resulting from severe storms, mudslides, high tides, and flooding were of sufficient magnitude to warrant a major disaster declared under PL 93-288. The counties subsequently declared were Solano, Sonoma, San Mateo, Santa Cruz, Contra Costa, Alameda, Marin, and Inyo for individual and public assistance. Humboldt, San Joaquin, and Santa Clara were declared for public assistance only. In addition, the Small Business Administration declared Mendocino,


Monterey County
Salinas area flood prone lands
(shaded area)
0 1 2 3
SCALE IN MILES
NORTH
HORSE CANYON ROAD
Santa Rita Creek
SAN JUAN GRADE ROAD
ESPINOSA ROAD
ESPINOSA LAKE
SANTA RITA LAKE
SAN JON ROAD
FONTES LAKE
BORONDA LAKE
BORONDA ROAD
MARKLEY SWAMP
MILL LAKE
Reclamation Ditch
ROUTE 183
ROAD
ARMSTRONG RD
ALVIN DRIVE
LAUREL
STREET
NATIVIDAD ROAD
Gabilan Creek
Natividad Creek
Creek
OLD STAGE ROAD
WILLIAMS ROAD
DEL MONTE
CARR LAKE
MARKET STREET
CENTRAL AVE
ALISAL STREET
SANBORN
JOHN ST.
ABBOTT STREET
BLANCO ROAD
DAVIS ROAD
HITCHCOCK ROAD
MAIN
ROMIE LANE
BLANCO ROAD
HUNTERS LANE
HARKINS ROAD
HARRIS ROAD
HEINS LAKE
SMITH LAKE
ALISAL ROAD
Alisal Creek
SPRECKELS
U.S. HIGHWAY 101
SALINAS RIVER
RIVER RO
Map from Salinas, "CALIFORNIAN"

Napa, Sacramento, Monterey, San Benito, San Francisco and Yolo counties disaster areas for the Small Business Administration Program.

The most severe damage during the 1981-82 water year occurred in the north and central coastal area, where flooding and mud and debris flows destroyed many homes and businesses. The heaviest rainfall in 25 years during early January accounted for a heavy toll in death and property damage for this area.

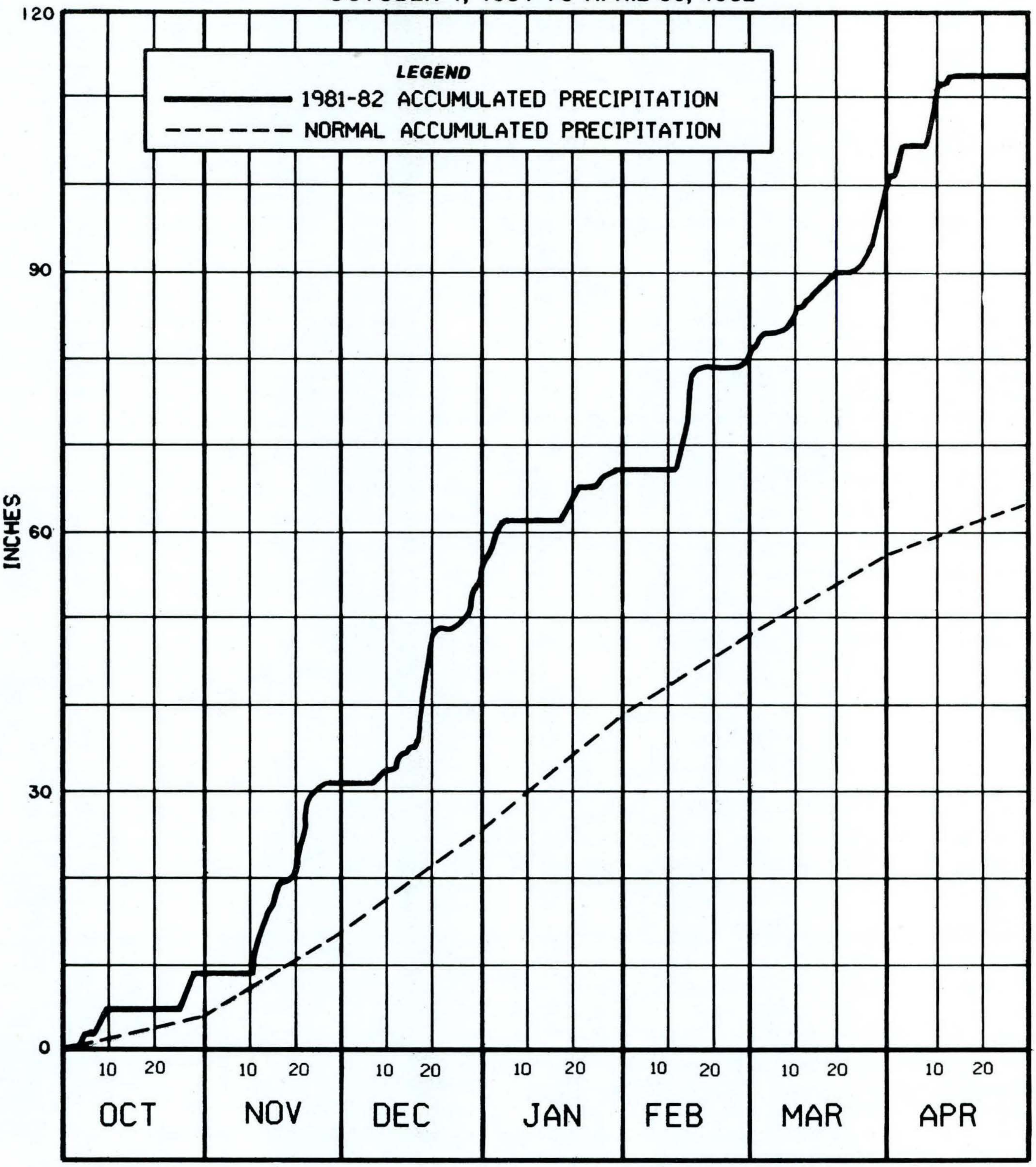
Joint Federal and State damage estimates for the December and January storms alone indicated that 6,300 residences in the Bay Area were damaged, of which 231 were destroyed. There were 1,500 businesses damaged, 65 of which were destroyed. Dollar estimates of damage were $109 million in public facilities and $172.4 million in private property. There were 33 storm-related deaths, which were largely attributed to mudslides.

The Flood Operations Center in Sacramento, with a wary eye on river and weather conditions, began extending operating hours on December 18, when a major storm struck the North Coast. On January 4, at the onset of the historic Bay Area storm, the Flood Center was raised to a "Flood Alert" status. Around-the-clock operations were then in effect. Additional experienced personnel from other branches of the Department and retired annuitants were enlisted to meet the influx of calls for pertinent data from anxious citizens, flood fight officials, and the media. The around-the-clock operation continued for more than a week as the impact of the storm brought flooding to much of Central California. The regular staff of the Center continued working long hours after the January crises, when recurring problems developed in the Delta, and river levels held above warning stages as strong releases from flood control reservoirs were sustained to make space for future storms.

In general, the 1981-82 Water Year was another classic example of the inconsistency of the California climate. The winter of 1981 was dry -- 1982, wet. Too little water or too much seems to be the dilemma faced by Californians and water officials annually. Recreation and agriculture interests are most affected by climate. Winter resorts live and die by snow conditions.

Without an ample and sustained flow of water, California's largest industry, agriculture, would be in jeopardy. It is easy to understand why little or no snow or a meager water supply could bring operations of these industries to their knees -- but what about too much water? The flood events described in this report, the killer snow avalanches and isolation of ski resorts in the Sierra Nevada, due to massive snowfall and the delayed and lost planting opportunities because of flooded and soggy soil late in the season, are evidence that California can receive too much water at times.

Figure 1. ACCUMULATED PRECIPITATION AT BLUE CANYON
AMERICAN RIVER BASIN
OCTOBER 1, 1981 TO APRIL 30, 1982



NOTE:
ELEVATION OF STATION 1610 METRES

The preceding paragraph is also a partial explanation of the frequently heard cries this season -- "Enough is enough!!"

The resolution of California's water supply problem, because of the variable and unpredictable climate, coupled with its uneven distribution of water production, continues to be a challenge to environmentalists, hydrological engineers, and water officials.

THE WEATHER PATTERNS OF 1981-82

The weather during 1981-82 (fall 1981, winter and spring 1982), which turned out to be very active, significantly affected the water supply outlook for Water Year 1982. Precipitation began early in the fall and continued well into April.

The upper-level wind currents over the Pacific Ocean, which are related to the jet stream and tracks of the migratory storms, were strong during early fall and continued so for the balance of the season. Thus, storm tracking to California from the Pacific was optimum for abundant precipitation.

As an overview of the precipitation over the important runoff regions of the State, Table 1 summarizes the precipitation, expressed in percentage of normal, for three areas: north, central, and south. The north includes the drainage basins of the Upper Sacramento and Feather Rivers; the central covers the area from the Yuba River to the Merced River; and the south includes the area from the Upper San Joaquin River to the Kern River.

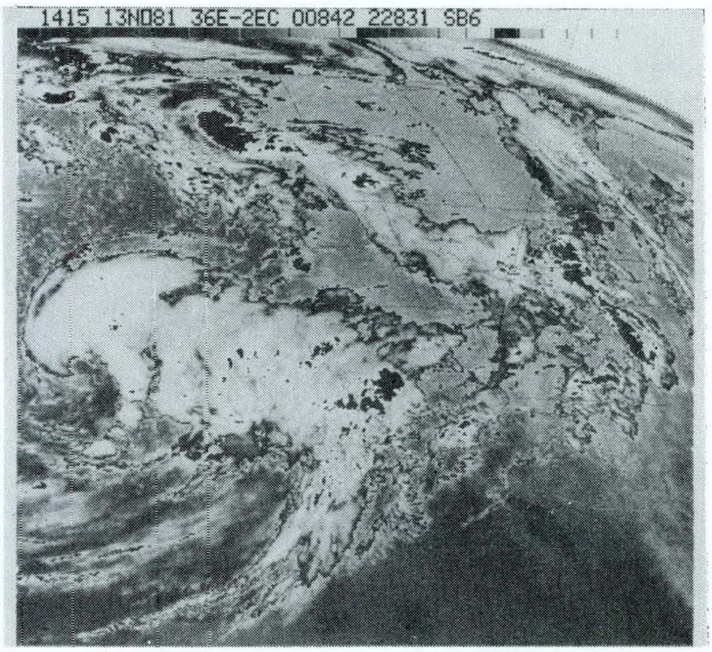
Table 1

	Percentage of Normal Precipitation		
Season	North	Central	South
Fall 1981	253	220	140
Winter 1982	101	141	110
Spring 1982	161	188	209
	Fall:	September, October, November	
	Winter:	December, January, February	
	Spring:	March, April, May	

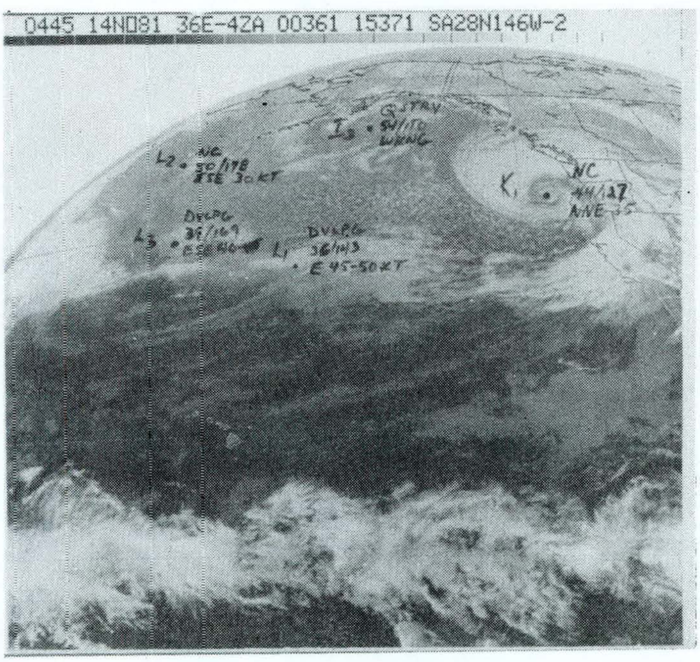
The wetness of the 1981-82 season is illustrated by a plot in Figure 1 of the accumulated precipitation at Blue Canyon in the American River Basin. The steep portions of the curve are during storm periods, when the accumulations rose rapidly. The October 1, 1981 to April 20, 1982 accumulation amounted to 112.5 inches compared to a normal of 63 inches. The 7-month total was 179 percent of normal.

Precipitation in October exceeded 200 percent of normal over the Sierra Nevada from north to the south. While there was some precipitation during the first half of the month, the important precipitation fell during the last five days of the month. The first significant rise of the north coastal rivers occurred with this storm system.

Figure 2



November 13, 1981, 1415 GMT (0615 PST) from GOES-West (enhanced infrared). The center of the deepening low pressure was at 38°N 136°W and tracking toward the northern California coast. Clouds had spread over California and rain was soon to begin in the coastal region.



November 14, 1981, 0445 GMT (2045 PST) from GOES-West. The low had deepened rapidly and was positioned off the Oregon coast as the track had curved northeastward paralleling the Oregon coastline. The entrainment of cloud-free air into the low-pressure center can be seen. Heavy precipitation and gusty winds were common over northern and central California. Notations on the photo are those of NESS meteorologists from their analysis of the various features of the cloud systems.

November was a very wet month, but the heavy concentration was confined to northern and central California. In the mountains the northern and central basins were well above 200 percent of normal. Overflow at three fixed-level weirs of the Sacramento Flood Control Project occurred during the latter half of the month, including Fremont Weir, which in the past has not flowed very often during November.

A strong storm system occurred on Friday the thirteenth of November and continued into Tuesday of the following week. The low-pressure center that formed near the California coast deepened rapidly, bringing heavy precipitation and strong, gale-force winds to northern and central California. A second storm developed on November 14 west of the 140th meridian, and the track of this storm was almost identical to the first storm -- eastward toward the California coast and then curving northward to parallel the Oregon-Washington coastline. Precipitation from these two storms over a six-day period varied from 5 inches at low elevations to 15 inches at mountain locations.

Two satellite pictures* (both infrared) for 1415 GMT (0615 PST) November 13 and 0445 GMT November 14 (2045 PST, November 13) are shown in Figure 2. These pictures show the first low-pressure system, which had a very strong circulation.

The winter season consists of December, January, and February. The December weather pattern over the Pacific continued as in the fall, with a favorable tracking of storms into California. The northern and central portion of the State again had excessive precipitation, with amounts ranging from 150 to 170 percent of normal, whereas the five basins, San Joaquin to Kern, in the south had less than 100 percent of normal.

The important storm in December occurred from the 18th to 21st, affecting northern and central California. Significant reservoir inflow occurred at Shasta, Oroville, and Folsom Reservoirs. Precipitation within these drainage basins varied from 5 to 13 inches, and the snow level was high, favoring runoff from substantial portions of the river basins. Maximum rates of precipitation in the American River Basin reached 0.4 inches per hour.

January was characterized by a shift of the heavy precipitation zone to include central and southern California. An important storm occurred at the beginning of the month, bringing heavy precipitation to the central coast, including Marin, San Francisco, San Mateo, and Santa Cruz counties. The storm formed 425 miles west of the coast, deepened rapidly, and tracked across the coast

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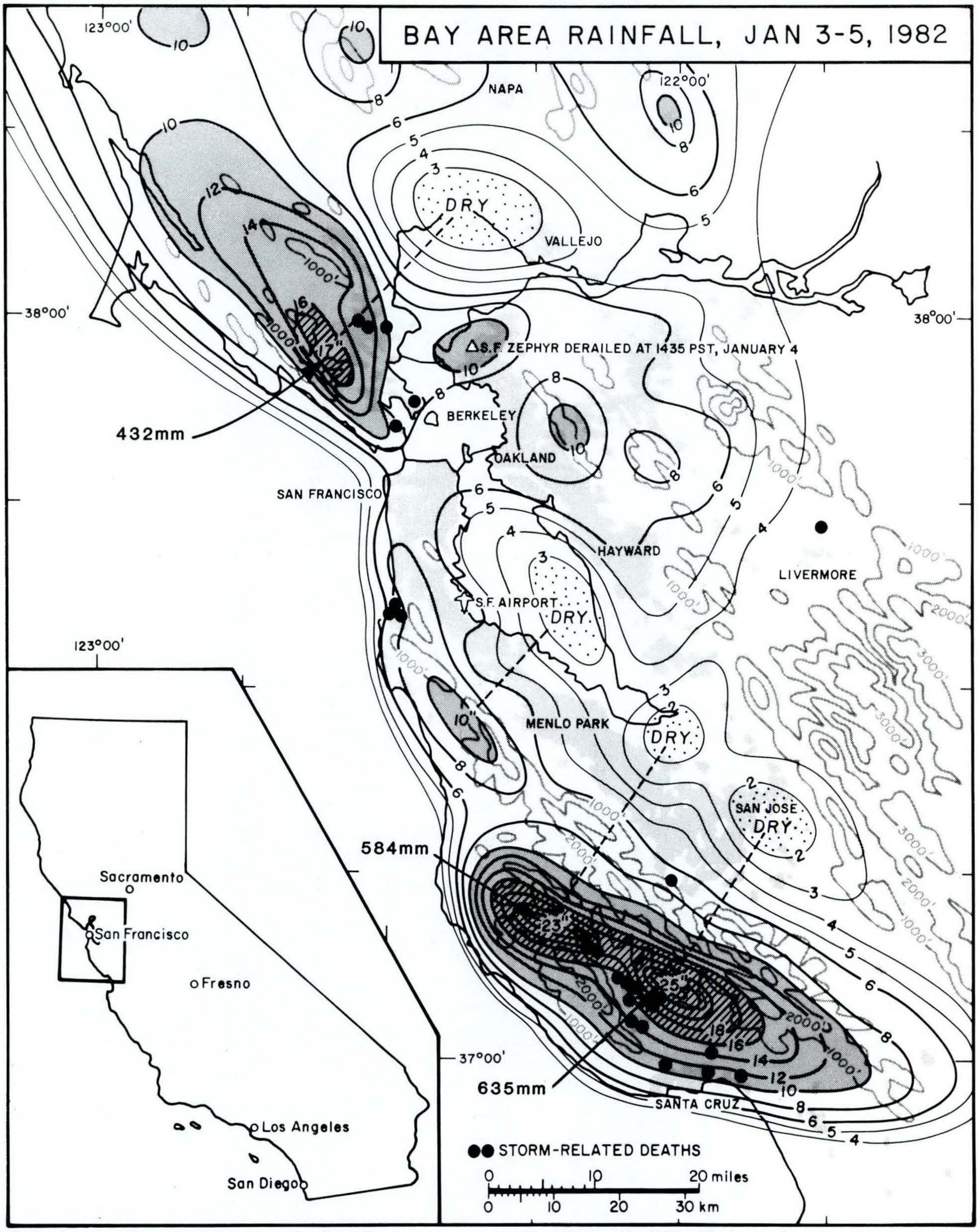
*The satellite pictures in this report are from the Geostationary Operational Environmental Satellite located in the eastern Pacific (designated GOES-West). Times are given in Greenwich Mean Time (Pacific Standard Time plus 8 hours). The pictures were furnished by National Environment Satellite Service (NESS).

Figure 3



514 raingage data collected by River Forecast Center, Sacramento, CA. Mapped by Fujita, Wakimoto, & Smith, Univ of Chicago

Isohyetal map of the San Francisco Bay Area storm of January 3-5, 1982, from NOAA publication "Storm Data, January 1982." The isohyets are in inches; 1 inch = 25.4 millimetres (mm). The maximum in Santa Cruz County was 635 mm; in Marin County it was 432 mm.

through the San Francisco Bay Area on January 5. An isohyetal map covering the 3-day period January 3-5, 1982 over the San Francisco Bay Area is shown in Figure 3; this chart is reproduced from the National Oceanic and Atmospheric Administration's publication "Storm Data" (Vol. 24, No. 1) for January 1982. Precipitation in Marin County reached 17 inches and in Santa Cruz County 25 inches.

Three satellite pictures of this storm are shown in Figure 4.

Some of the storm events of January were accompanied by colder temperatures with low snow levels, increasing the snowpack in the Sierra. For example, at Blue Canyon, elevation 5,282 feet, the snow on the ground measured 1.25 inches on January 1, and had increased to 9 inches by January 22. At Norden (6,900 feet), the snowpack increased to 133 inches by January 28 -- an increase of 71 inches since the first of the month.

In February, the heavy concentration of precipitation (exceeding normal) was in the central part of the State. A significant storm event occurred during the "presidents' holiday" weekend, February 12-15. The upper level charts showed the trajectory of airflow coming into California from the region just north of the Hawaiian Islands. The sequence of satellite pictures during this period also showed the cloud masses extending from the California coast to Hawaii. This storm was accompanied by a warm airmass, and rain occurred as high as 8,000 feet. Precipitation began on Saturday, February 12, and continued for the next two days. The heaviest precipitation fell on Monday, February 15, with maximum hourly rates in the central Sierra reaching 1.2 inches.

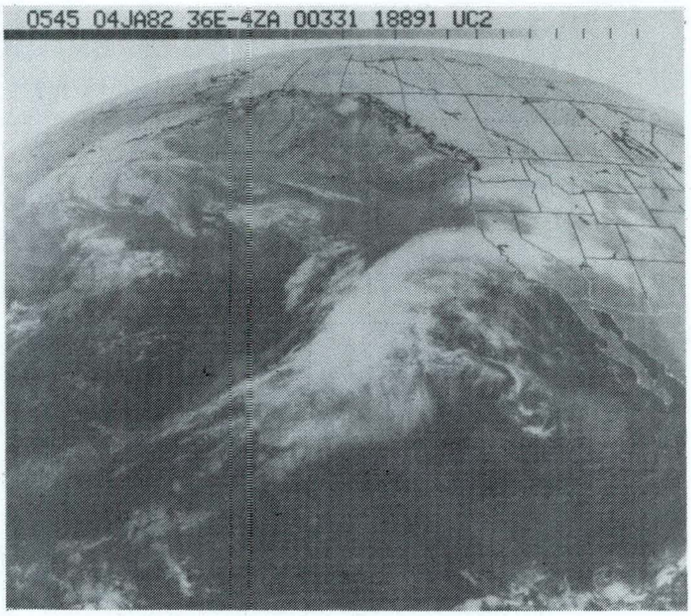
Total storm rainfall in the river basins from the Sacramento River to the Tuolumne River ranged from 8 to 13 inches. Heavy runoff was generated in the drainage basins above Shasta, Oroville, and Folsom dams, resulting in increased reservoir releases. Gates at the Sacramento Weir into the Yolo Bypass had to be opened to relieve the flows in the Sacramento River.

A satellite picture on the morning of February 15, the day of the heaviest rainfall, is shown in Figure 5. The extended band of clouds from a subtropical moisture source is seen clearly in this picture.

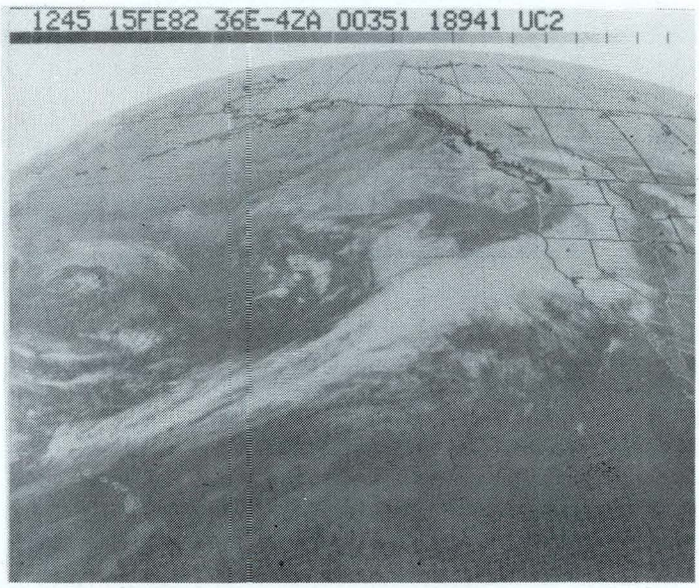
The spring months were wet, as shown in Table 1. The heavy contribution came from the precipitation in March and the first half of April. March had many rainy days, and April was overwhelmed by precipitation from a major mid-month storm, April 10-15.

Several of the March storms involved colder air masses with low snow levels, but the large accumulation of snowpack in the Sierra Nevada occurred with the storm at the end of March, which continued on into the first five days of April. The Southern Pacific station at Norden (elevation 6,900 feet) reported an increase in snowpack of 149 inches (almost 13 feet) from 27 to April 5. At a lower elevation, Blue Canyon (5,282 feet) reported an increase of

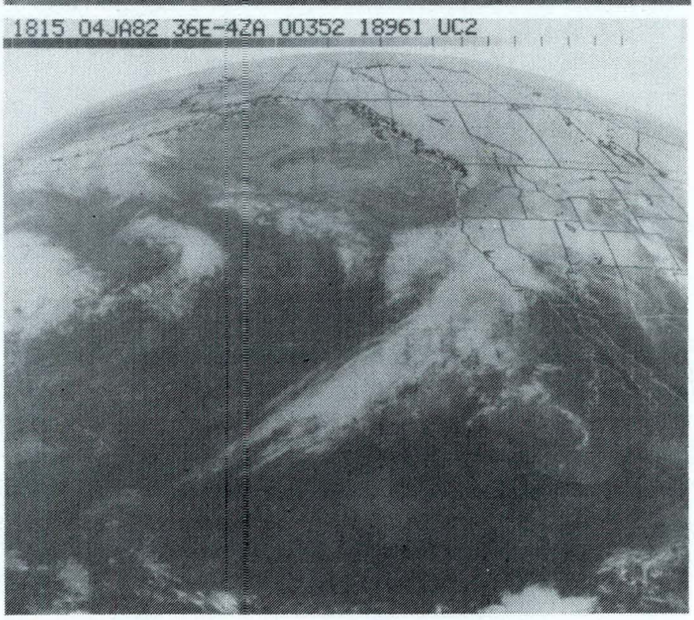
Figure 4.



January 4, 1982, 0545 GMT (2145 PST) from GOES-West. This infrared photo shows the extended band of storm clouds moving over California from the southwest. The low-pressure center at this time was forming near 35°N 140°W.

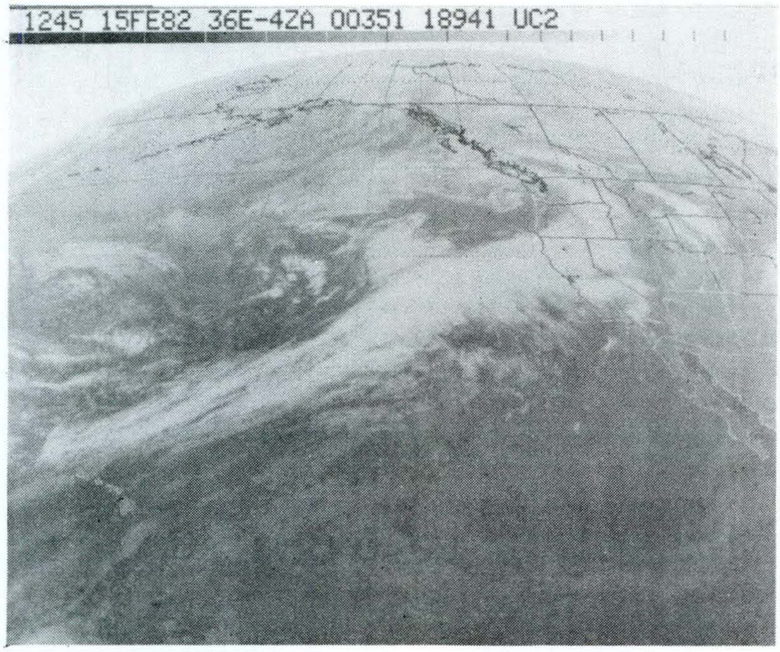


January 4, 1982, 1245 GMT (0445 PST) from GOES-West. This picture seven hours later shows the further development of the storm as the cloud mass takes on a cyclonic swirl near 135°W. The rainfall rate in the San Francisco Bay Area was increasing as the storm approached.



January 4, 1982, 1815 GMT (1015 PST) from GOES-West. At this time there had been further intensification of the low-pressure center as it tracked toward the San Francisco Bay Area. There were still 15 hours more of intense rainfall to be experienced in the Bay area.

Figure 5



February 15, 1982, 1245 GMT (0445 PST) from GOES-West. (visual depiction). A long stream of clouds emanating from the region north of Hawaii extends over California, Oregon, and Nevada. The clouds indicate a flow of warm, moist air from subtropical latitudes, bringing rain to high elevations in the California mountains over a four-day period.

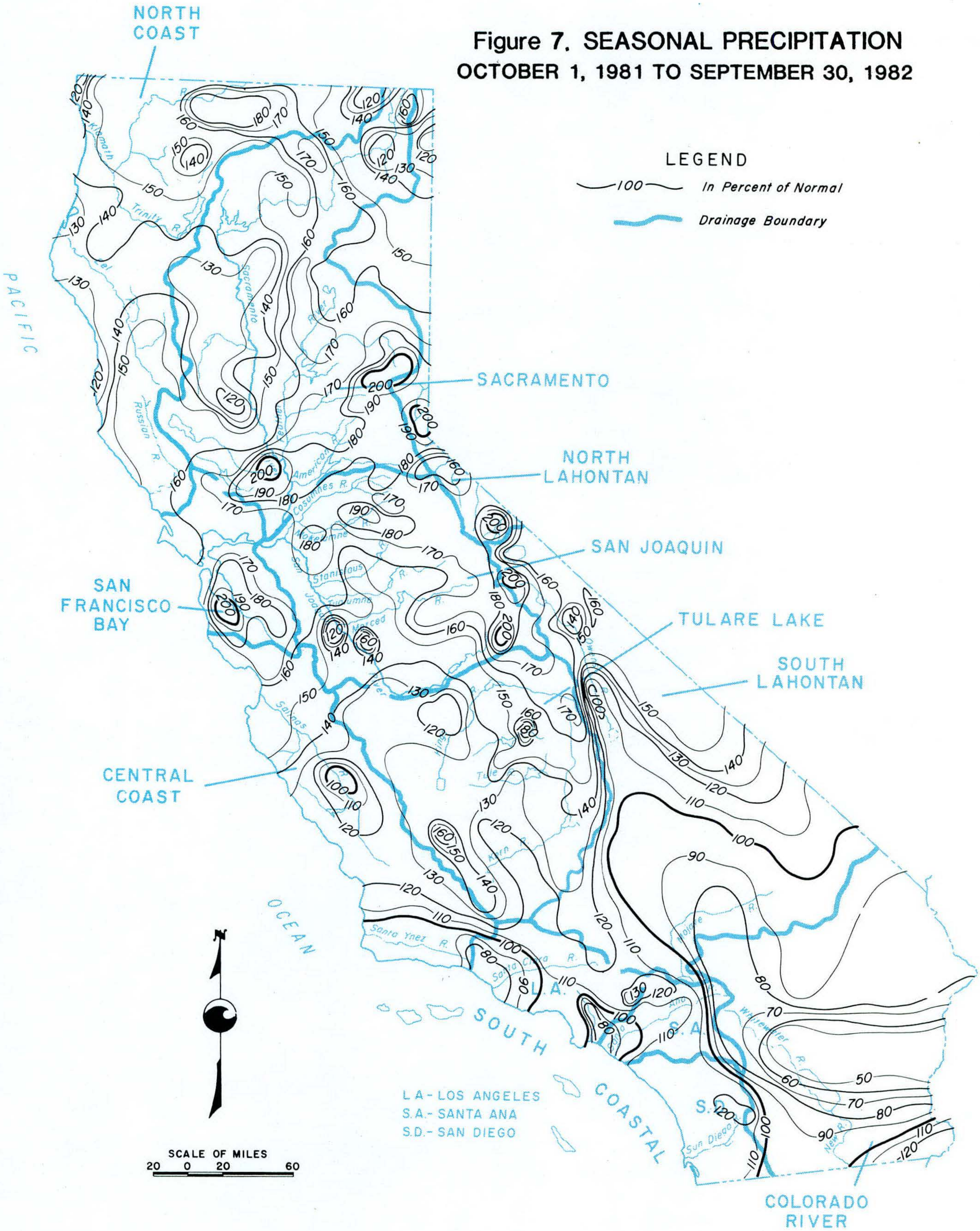
97 inches. These substantial increments added to a snowpack that had begun to accumulate in the winter months.

During the mid-April storm, many of the mountain stations experienced storm totals of 5 to 10 inches, with the heaviest in the Feather-Yuba drainages. The snow level resulting from this storm was high, with rain reported up to 7000 feet at Donner Summit. Inflow to the central Sierra reservoirs escalated from the rain, augmented by some snowmelt. Fifteen of the 48 gates of the Sacramento Weir were opened. (The year 1981-82 had two openings of the Sacramento Weir gates -- in February and in April.) A satellite picture on the morning of April 10, 1982 is shown in Figure 6.

Figure 6

April 10, 1982, 1845 GMT (1045 PST) from GOES-West (visual depiction). The low-pressure center was near 35°N 132°W at the time of the photo and tracking toward the California coast. The heavy precipitation in the Sierra Nevada was beginning on the morning of the 10th and was to continue for the next two days.

Figure 7. SEASONAL PRECIPITATION
OCTOBER 1, 1981 TO SEPTEMBER 30, 1982

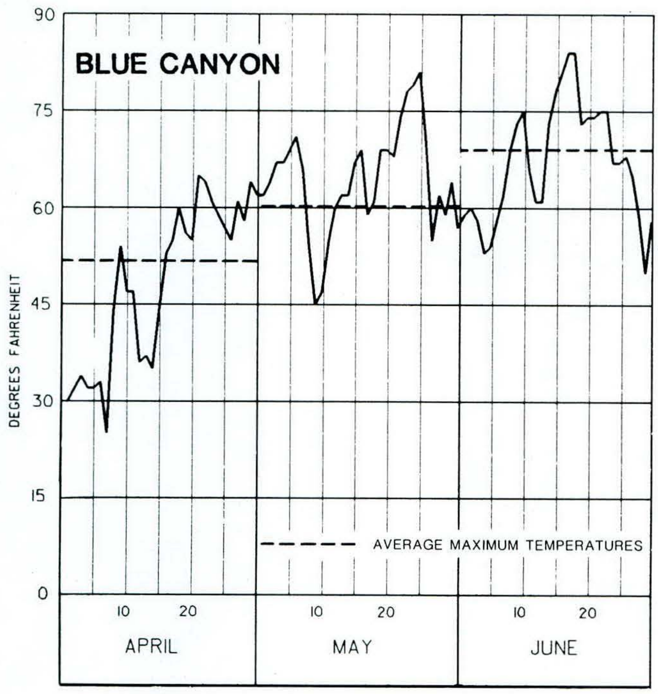


The seasonal precipitation to April 30 in percentage of normal over the State is shown in Figure 7. The overall statewide average was 150 percent of normal.

The clear weather (spring) snowmelt of the 1982 pack did not begin until late April and May. Moderate temperatures during the spring and early summer kept the snowmelt runoff in a tolerable sequence without posing too many problems for the reservoir operators. Warming during the latter half of May, with a peak warmth around May 25, generated the peak snowmelt rates of the season on most reservoirs south of the Stanislaus River Basin. Basins in the north State experienced their peak runoff rates earlier.

Plots of the daily maximum temperatures at two mountain stations, Blue Canyon (American River) and Yosemite National Park (Merced), are shown in Figure 8 for April 1 through June 30, 1982. The horizontal dash lines are the normal maximum temperatures for the respective months.

Figure 8. MAXIMUM TEMPERATURES AT TWO MOUNTAIN STATIONS



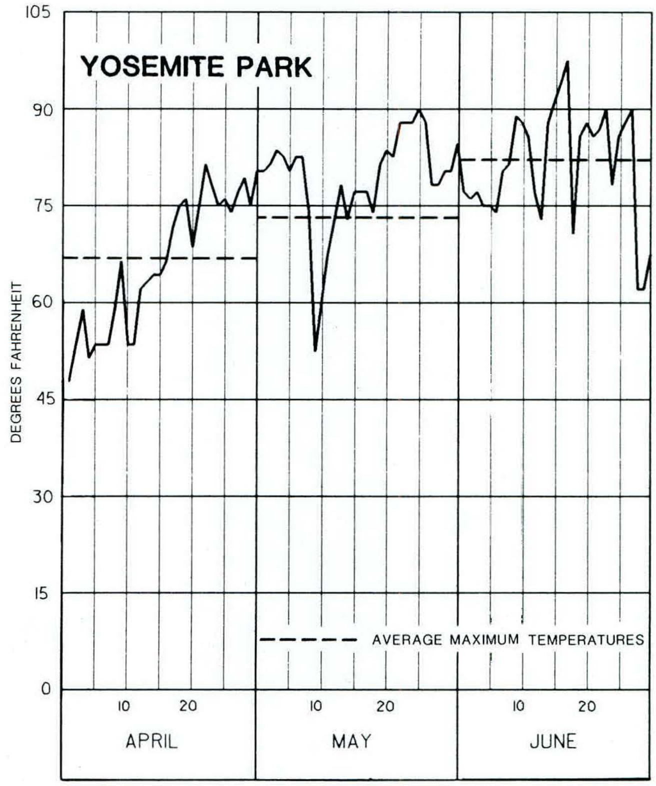


Figure 9. LOCATIONS OF HYDROGRAPHS

SUMMARY OF FLOOD EVENTS

The following discussion summarizes the significant flood events during water year 1981-82. A reference map to the hydrographs shown is provided in Figure 9.

NORTH COAST HYDROLOGIC BASIN

The North Coast was blessed with significant rainfall early in water year 1981-82, which brought much needed relief to the parched north State. By mid-November, a strong storm system had saturated the ground surfaces to the extent that fast runoff from the generous rains raised river levels significantly. Flood stages of short duration were reached on the Eel and Van Duzen Rivers, and warning stages prevailed in other major streams of the region. Despite the high river stages, which continued for nearly a week in mid-November, no notable damage excepting some inconveniences resulted from the early storms.

The next series of weather fronts began about December 5, centered mainly in the Smith River Basin. Warning stages were recorded on the lower reaches of the Smith River but damage was minimal.

On December 18, a major winter-type storm tracked through the north State and dropped copious amounts of rainfall throughout Northern California. The three-day storm generated flood and warning stages on all major streams and rivers on the North Coast. On the North Coast, precipitation amounts of 9.4 inches for the period were recorded at Elk Valley and 11 inches at Kettenpon. This pattern of precipitation was widespread and resulted in considerable damage from exceedingly high river stages and mudslides due to the saturated soil conditions. All of the major streams except the Smith reached flood stage at some point and warning levels were common.

Lack of dependable communication became a serious problem during the deluge. Numerous landslides, washouts, and threats of falling trees made travel to stricken areas difficult and often impossible. Some communities were completely isolated when major highways and secondary roads were blocked and power and telephone service disrupted.

The DWR satellite Flood Center in Eureka was besieged by telephone calls from newer residents who had either not witnessed runoff of such magnitude or were marooned because of road closures. Officials and utility company personnel worked long hours and frequently took great personal risks to restore much needed services.

A drastic change in the weather pattern following the storm of December 18-21 was a welcome reprieve to the storm-ravaged North Coast. Subsequent storms during the rest of the water year were

High Water on the Eel River

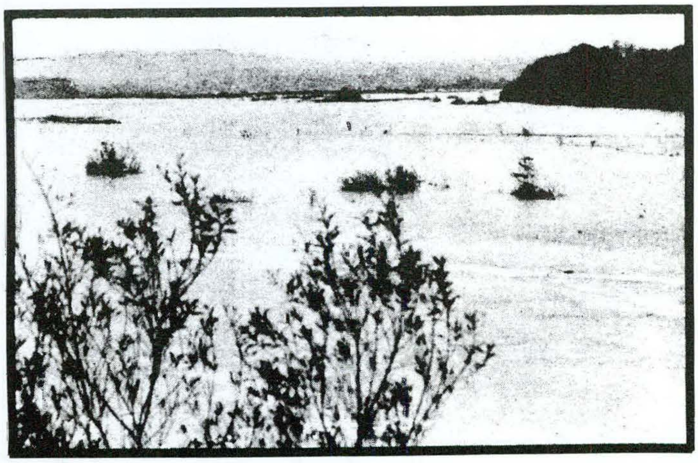
Humboldt County

Bridge wash out

Photo by NEIL GILCHRIST

Photo by J.L. SOUSA

Raging waters peril deck of cabin



High water at Ferndale

generally further south. Some minor weather fronts kept rivers at moderate to high stages but, in general, except for a two-day period in mid-February, precipitation was near or below normal after the December onslaught.

Humboldt County

Few if any resorts, communities, farms, industrial sites, roads, or public and private facilities in the North Coast Hydrologic Basin were left unscathed by the fury of the late fall and early winter storms. Humboldt County was hardest hit monetarily -- preliminary estimates of damage exceeded $2.5 million. On January 8, following a request by the Governor of California, the President declared Humboldt County a disaster area -- but eligible only for Public Assistance.

On the South Fork of the Eel River near Garberville, a massive landslide was first reported on December 20 in a known slide area about a quarter of a mile south of Redway. An estimated 200,000 cubic yards of rock, mud, and trees slid into the river, forming a dam approximately 197 feet wide, 590 feet long and 20 to 30 feet high. A reported 200 residents of the small communities of Phillipsville, Miranda, Myers Flat, Weott, and Redway were evacuated when it was feared that the blockage would give way to the rapidly increasing mass of water impounded by the obstruction. The possibility of additional portions of the hillside sliding into the river and creating a larger obstruction was also a matter of grave concern.

An all-night vigil by sheriff deputies and the National Guard was kept at the site and an impromptu warning system, consisting primarily of Sheriff vehicles and fire sirens, was developed. Residents in endangered areas were alerted via the Emergency Broadcast System. Local radio stations also responded to the request to stay on the air beyond authorized operating hours to keep officials and the public abreast of current conditions. Approximately 50 members of the California Conservation Corps and California Department of Forestry provided mutual aid and remained on standby.

The following morning, December 21, an inspection team consisting of officials of the County Department of Public Works and the U. S. Army Corps of Engineers surveyed the slide area to determine whether additional emergency work was necessary. Later in the day a geologist and a hydrologist from the Department of Water Resources flew to the site from Red Bluff to join the team.

It was observed that during the night or early morning, the force of the flow had cut a new channel east of the blockage, which reduced the volume of backup water and relieved pressure on the rapidly eroding face of the dam.

After considerable discussion, the group decided that the reduced volume of water behind the dam was no longer a threat to life and public property downstream from the obstruction. The "Alert Status" and emergency operations were suspended late in the evening of December 21. Although the immediate danger was over, the newly cut channel had significantly encroached residential property and seriously jeopardized the future of six to eight homes left precariously close to the river's edge.

The raging Eel River also left a path of destruction in many low-lying areas, including parks and recreation areas adjacent to Highway 101 and the river. Damage was particularly high in the Humboldt County portion at and near Benbow Lake State Recreation Area and Dyerville in the Humboldt Redwoods State Park (see Figure 10).

On the delta near Fernbridge the river crested at 23.6 feet near midnight December 19 (flood stage is 20 feet). Approximately 2,700 head of prime dairy stock, valued at $1,500 each, were removed from the "Dairy Center" of the State to higher ground at the County Fairgrounds. In addition 2,700 head of sheep were evacuated. No structures were lost but 40 persons had to leave the area for a short time. Cleanup damage was estimated at about $10,000.

Damage to levees on the lower Eel was generally limited to a slump 1,200 feet long on the toe of the Sandy Prairie levee about 500 feet upstream from the mouth of Strongs Creek.

Figure 10. HYDROGRAPH OF THE EEL RIVER

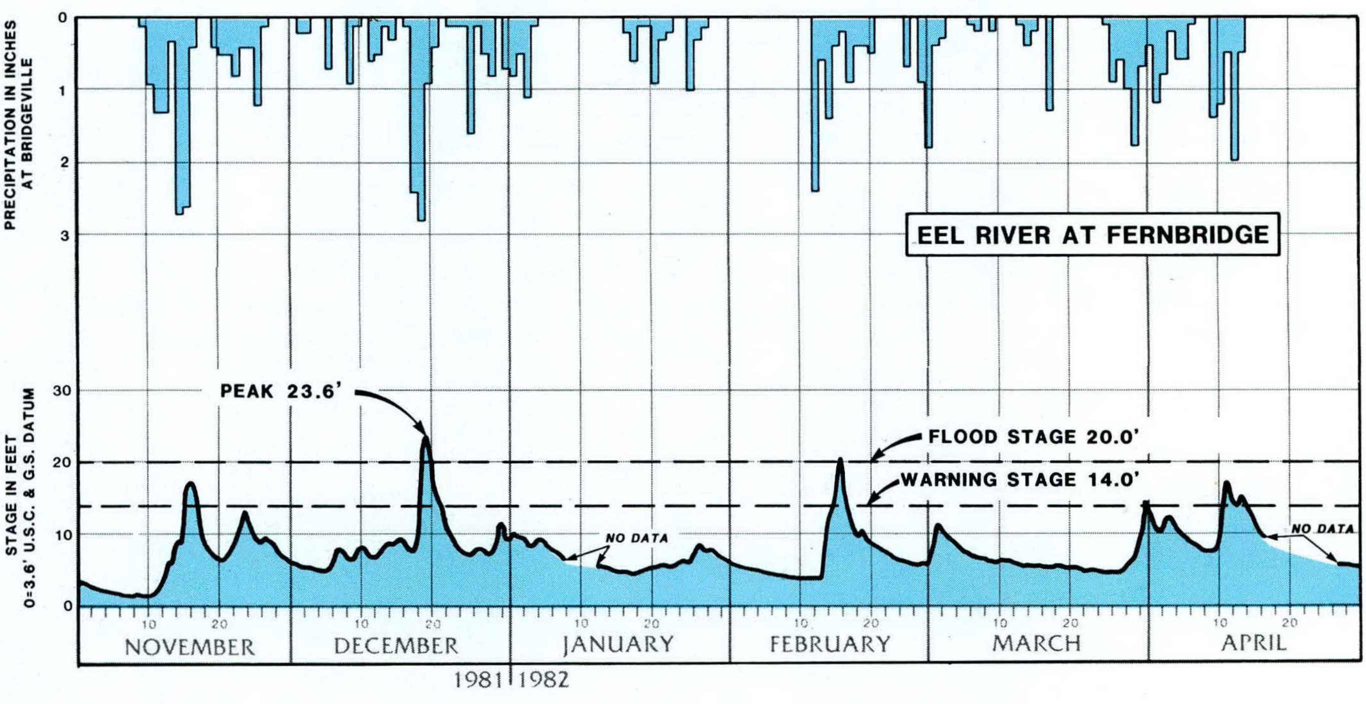
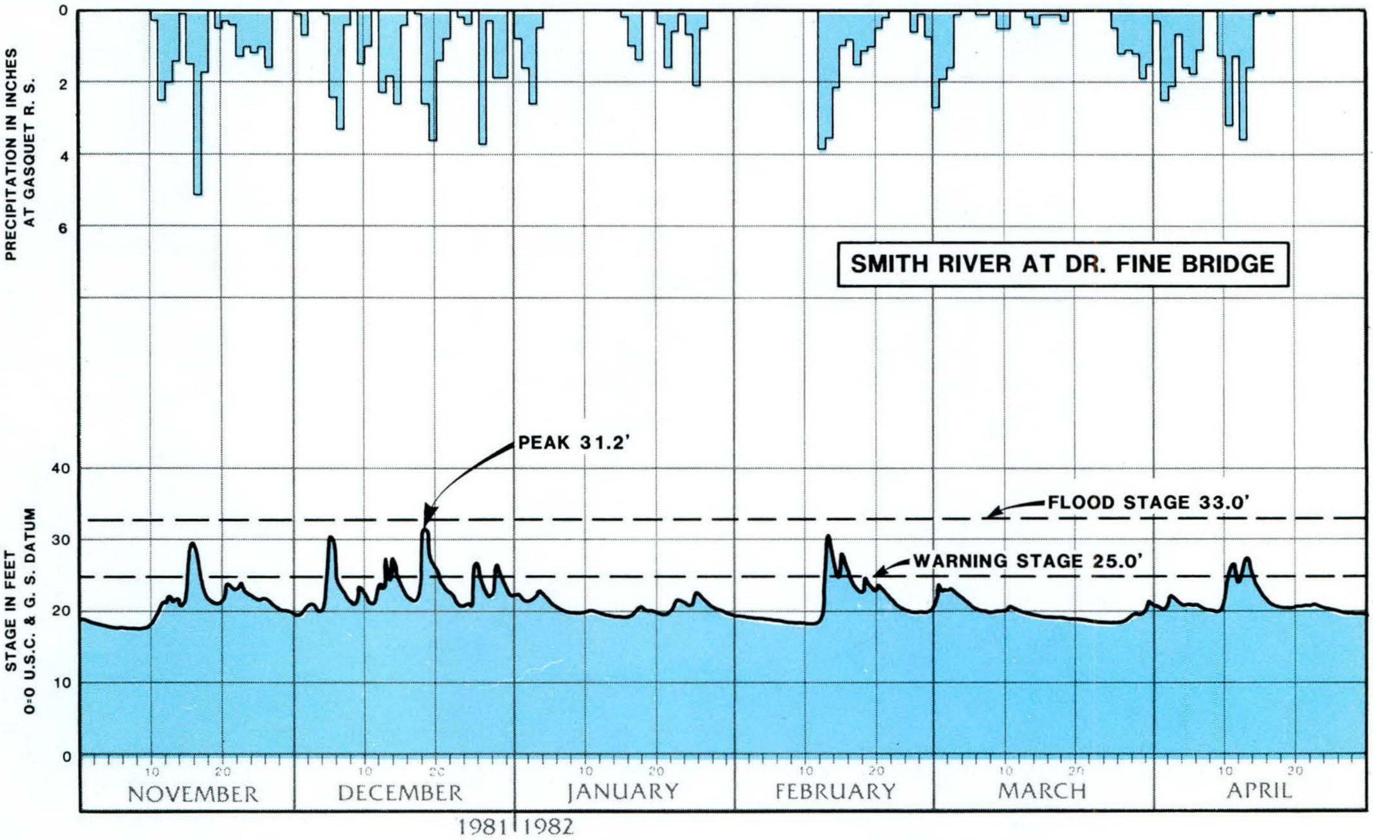


Figure 11. HYDROGRAPH OF THE SMITH RIVER



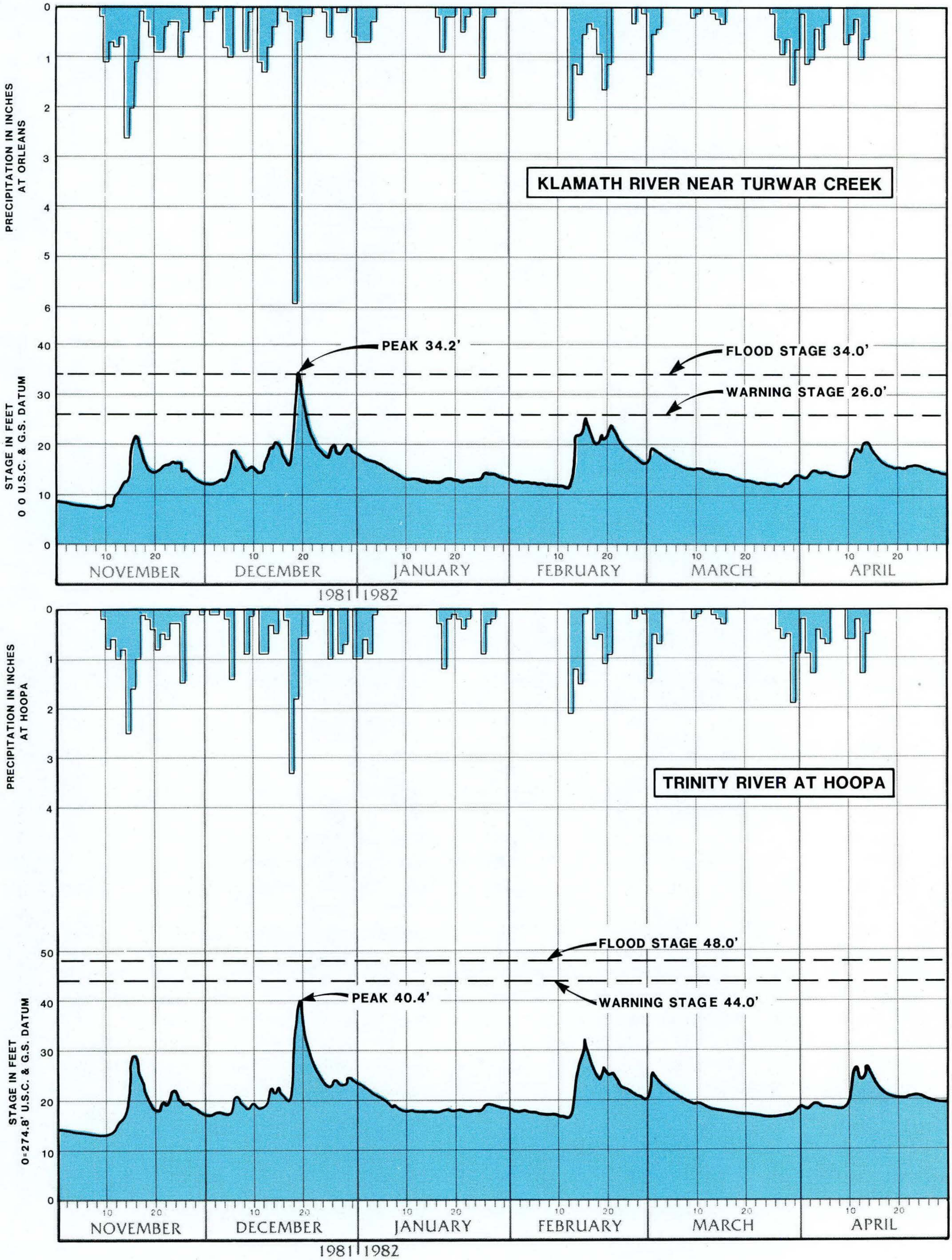
In the northern part of the county, the rampaging Mad River, choked with huge redwood trees, caused the collapse of the McIntosh Bridge at Blue Lake. Fortunately, no loss of life or injuries resulted from this incident, but damage to the bridge amounted to an estimated half-million dollars.

Del Norte County

The Smith River basin in Del Norte County is the wettest in California with a mean annual precipitation of more than 100 inches. This remote area, which drains 770 square miles of northwestern California and southwestern Oregon, has not been intensely studied, primarily because the Smith is geographically isolated from water-deficient areas. Recently, the U. S. Forest Service has begun to operate some recording rain gages scattered throughout the eastern portion of the watershed. These rain gages, known collectively as the "Fox Unit Study" have provided some interesting -- and surprising -- data regarding distribution and intensity of precipitation. In Water Year 1981-82, 257.9 inches were recorded at Camp Six. Fortunately, the rains were spread over a 9-month period, which alleviated the impact of the runoff (see Figure 11).

Mudslides, overflows, road closures, power outages, and much inconvenience were the general pattern of conditions in Del Norte County during late fall and early winter of Water Year 1981-82.

Figure 12. HYDROGRAPHS OF THE KLAMATH AND TRINITY RIVERS



High water came early in this portion of the State, bringing the Smith and Klamath Rivers to warning stages in mid-November and to flood stage on the Klamath in December. The Smith River fell short of flood stage during the numerous onslaughts but high water was persistent. Gale force winds from 50 to 100 miles per hour, which accompanied the mid-November storms, toppled hundreds of trees and contributed significantly to the total storm damage. Ripped roofs, downed power lines, blocked roads, damaged equipment, and personal property losses were widespread. Damage from high stream flows, however, was minimal. A peak stage of 34 feet was recorded on the Klamath near Turwar Creek on December 20. Much lowland flooding occurred, and Turwar Valley residents kept a watchful eye on the protective dike at Klamath Glen (see Figure 12).

Mendocino County

Huge landslides near Leggett closed Highway 101, a major north-south artery, for several days during the last part of December. Washouts and sinks north of Leggett caused by road culvert blockage from debris added to closures and forced commuters to take time-consuming detours.

On Coast Highway 1, extensive road and bridge damage occurred between Rockport and Manchester. Many small streams with short reaches, characteristic of the coastal area, were at flood stage and inundated stretches of Highway 1, causing lengthy closures and isolation of small communities.

Photo from "DEL NORTE TRIPLICATE" Crescent City

Del Norte County ***Giant waves pound coastline off Crescent City***

SAN FRANCISCO BAY AREA

The San Francisco Bay Area encompases ten bordering counties and is extremely varied in topography, population density, local climate and geology. Bay Area counties are: Sonoma, Marin, Napa, Solano, Contra Costa, Alameda, Santa Clara, San Mateo, San Francisco, and Santa Cruz.

Periodically, sections of the Bay Area experience damaging floods. The many flatlands that surround the Bay and extend into adjacent interior valleys are susceptible to flooding. Runoff from the nearby steep and rugged mountains and backup of streams from high tides make many areas highly floodprone. Heavy concentration of population in the flatlands and the increasing property values add significantly to flood damage totals. In recent years, settlement and development has extended to upland areas, where slope-stability problems due to rain saturation have become increasingly common.

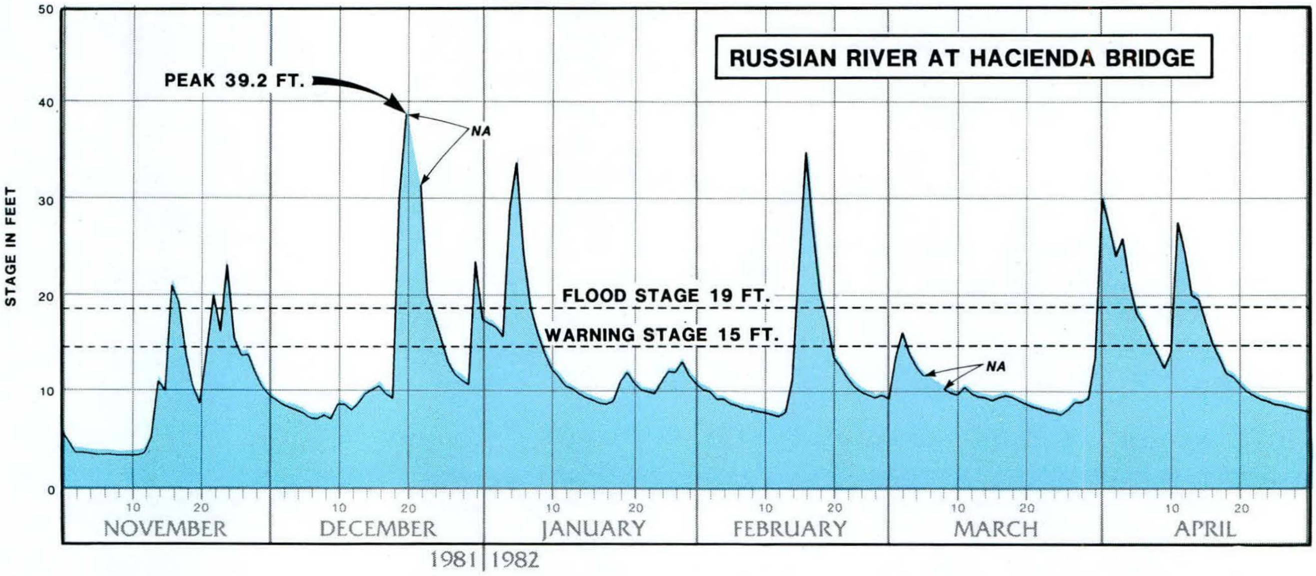
In early January of 1982, the 7,500 square-mile Bay Area experienced the heaviest rainfall in 25 years. In a three-day period (January 3, 4, 5) as much as 24 inches was recorded in many areas of the region. It is notable that intense rains of 0.5 to 11 inches per hour in Marin and Santa Cruz counties lasted nearly 30 hours, rather than the normal 6 to 12 hours at any one location. Seven of the Bay Area counties were declared disaster areas following the storm and became eligible for individual and public assistance. Counties in this category were Solano, Sonoma, San Mateo, Santa Cruz, Contra Costa, Alameda, and Marin. San Francisco and Napa counties were not included in the presidential disaster declaration. Santa Clara County was declared eligible for public assistance only.

The most severe damage from the early January deluge occurred in hills and coastal areas, where flooding and mud and debris flows wantonly destroyed homes and businesses. Most structural damage occurred in known flood plains or near mouths of canyons. Property damage approached the $300 million mark, and 33 people lost their lives. Land and mudslides accounted for 24 of the deaths. Disaster agencies, including Red Cross, Office of Emergency Services, National Guard, and California Conservation Corps personnel, did what was possible to alleviate suffering and assisted in rescue operations and the restoration of communications.

Subsequent rainfall and damage, particularly in mid-February and late March, fell short of the January 3-5 drenching but nevertheless caused much worry and anxiety.

Following the deluge in the Central Coast region, the Flood Operations Center joined with the National Weather Service in conducting a telephone survey to obtain additional rainfall data in areas

Figure 13. HYDROGRAPH OF THE RUSSIAN RIVER



of the most serious flooding. Radio and television announcements urged citizens with backyard rain gages to call a toll free number in Sacramento and report their measurements.

More than 600 reports were received. These data, in conjunction with reports from official gages, increased knowledge of the storm's intensity and will provide useful information for future highway, culvert, and bridge design as well as contributing to a better knowledge of storm potential and its impact on public safety conditions.

Sonoma County

Periodically, flooding occurs along the flood plain of the Russian River. The communities of Healdsburg and Guerneville, where summer homes, businesses, resorts, and recreation areas encroach the river front, are generally hardest hit.

The first flooding of note for Water Year 1981-82 occurred during the December 18-21 storm. Rainfall of 15 inches for the period was recorded in upper reaches of the river basin. Approximately 1,000 residents of the community of Guerneville and nearby resort areas were evacuated as the river level reached 7 feet above flood stage. The Red Cross was on hand to provide temporary lodging and food to the more unfortunate (see Figure 13).

Later storms in early January, mid-February, and late March were to bring additional flooding to Guerneville and vicinity but not of the proportions experienced in December. The full impact of the later storms was felt mostly south of the Russian River drainage area.

The inland communities of Santa Rosa, Petaluma, and Cotati were victimized by flash floods during the downpour of January 3-5.

Residential areas of the City of Petaluma were especially hard hit when Willow, Lynch, and Washington Creek, and the Petaluma River, which runs through the city, overflowed. The runoff from nearly 8 inches of rain and backup of the Petaluma from high tides resulted in the flooding of 550 homes and heavy damage to mobile home parks. Highway 101 was closed at the Marin County line.

Coastal towns also suffered damage from flash flooding. Bodega Bay and Jenner restaurants and resorts suffered significant business losses, and some were forced out of business because of loss of cash flow during isolation periods when bridges were washed out and roads closed.

Napa County

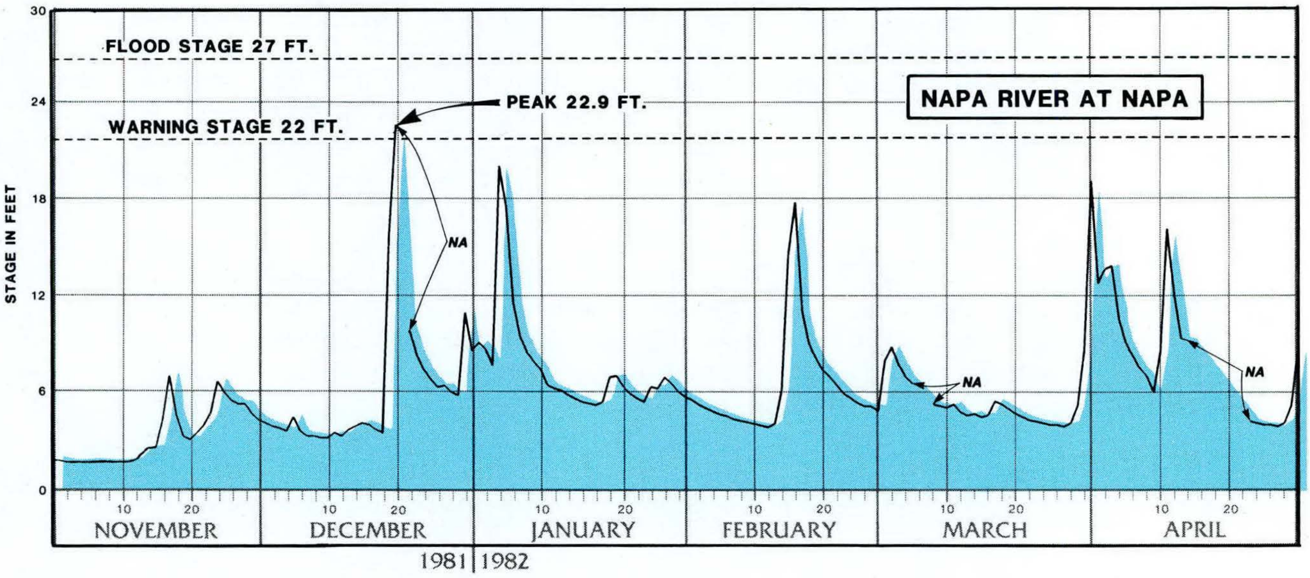
The heavy rains December 18-21, January 3-5, and February 16 produced flood stages on the Napa River. St. Helena on the Napa reached flood stage on all three occasions, but little damage occurred except flooding of vineyards and the temporary closure of Zinfindel Lane, the main road between St. Helena and Napa (see Figure 14).

The tropical storm of January 3-5 dumped more than 6 inches of rain during a 24-hour period in the southern portion of the Napa Valley. Roads were closed for a short period and small groups of people were evacuated in the towns of Yountville and Napa. The heaviest damage, however, was in the American Canyon, where rainwater flooded about two dozen houses. Damage may be close to $1 million.

Solano County

Solano residents were hard hit by two major storms during the winter of 1981-82. The first damaging onslaught began December

Figure 14. HYDROGRAPH OF THE NAPA RIVER



18, 1981, and lasted spasmodically for more than a week. Most damage reported for this period was blamed on inadequate drainage systems, but other factors contributed. Peak rainfall amounts during a 24-hour period exceeded 2 inches in some areas of the county, and widespread street flooding followed. Power outages and disrupted communication, normally associated with storms of this magnitude, were widespread. The combination of high tides and swollen streams flooded lowland mobile home parks and residential areas. Highway 12 was closed intermittently and numerous secondary roads were often impassable.

Solano County residents had not fully recovered from the late December drenching when the record breaking January 3-5 storm attacked. Six inches of new rainfall in a 30-hour period pelted the shocked residents, who had only recently escaped serious flooding damage from the late December storm.

Emergency officials' main concern during the rain was the rapidly rising level of Lake Chabot -- a 1,100 acre-foot capacity reservoir that serves Vallejo. Water began pouring over the spillway toward the end of the storm but the dam held. The surging water from the spill, however, was more than drain systems could handle and numerous homes in its path were flooded. Many of the hundreds of evacuees waded through waist-deep water; others were carried or helped by the police and firemen. Makeshift rafts and boats provided by marinas were used in the rescue.

Just west of Lake Chabot, 2,000 residents of an unincorporated area were evacuated as surging street water invaded their homes. They were miraculously spared from complete loss of their homes when the Old Valley Dam, an aged earthfill dam located directly above the community, withstood its worst stress in 112 years.

The record-breaking storm brought additional mudslides and flooding to Vallejo and suburban communities. Evacuation was necessary in areas endangered by mudslides and low-lying areas where street flooding was prevalent. Mobile estates and trailer parks were hard hit, but sandbagging in some instances minimized flood damage. A gasoline spill of an estimated 30,000 gallons compounded evacuation and traffic problems. The spill eventually settled in a flood-created lake, and cleanup measures were quickly begun to reduce the effects of contamination. An estimated $10 million in flood damage occurred in Vallejo and vicinity.

Vacaville, Suisun City and Fairfield fared the worst among North Solano County cities as the incessant rains closed roads and caused several creeks and canals to overflow. Costly damage occurred to the Putah South Canal and other flood control facilities. The overflow of Laurel Creek washed away sections of a main road artery, and some underpasses on principal routes contained up to 10 feet of standing water. Frequently, motorists were stranded when attempting to cross flooded intersections or were stalled by high street flows. County workers distributed

Vacaville

Solano County

Photo by TREY WEIR

Invading Waters Bring Work for Some

Fairfield Vicinity

Photos by RICHARD EVANS and GARY GOLDSMITH

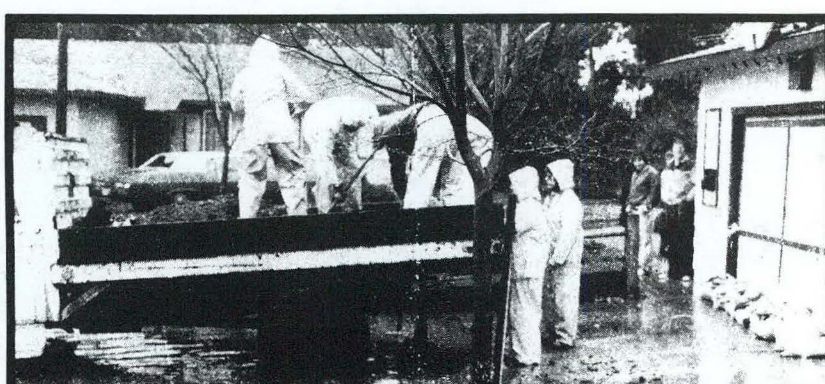


Photo by GARY REYES

Rancho Verde

Fun for Others

Fairfield Vicinity

Photos by RICHARD EVANS and GARY GOLDSMITH

sandbags to residents who chose to fight the flood, and hundreds of others were forced to evacuate.

High tides and onshore winds, which prevented runoff water from escaping to the bay, resulted in flood damage to waterfront trailer parks and businesses near Suisun City. Pumps used to remove the backup water were hindered by debris that clogged their intake pipes.

The cities of Rio Vista and surrounding agricultural lands, which are on higher grounds, fared much better. However, Highway 12 was closed for the second time in a short period, limiting traffic between Rio Vista and Fairfield.

The City of Dixon, at the extreme northeast portion of the County, was not affected to any great degree beyond the flooding of roads and crops. A few homes outside the city reported some water damage.

Flood damage in Solano County was exceedingly high. The toll for the January 3-5 storm alone accounted for more than $11 million in damage to public and private property. Five homes were lost and more than 800 were damaged. No businesses were destroyed, but 130 reported storm damage.

Marin County

The Corte Madera Creek watershed received 8 to 10 inches of rain in a 24-hour period during early January. Flooding from the high streamflows, coupled with high tides and slope failures due to soil saturation, resulted in nearly $100 million in damage for the county.

The cities of Fairfax, San Anselmo, Ross, Larkspur, the community of Kentfield, and the unincorporated town of Inverness, all suffered serious damage.

Fairfax experienced numerous slope failures. Six houses were destroyed, and almost all of the businesses in the commercial area were victims of water damage. Portions of the area were isolated by slides, which blocked roads. Power and telephone service were disrupted for extended peirods.

At San Anselmo, water 3 to 5 inches deep along the main street caused an estimated $4 million in damage to commercial properties and residences. One home was completely destroyed and one death was reported. The state of the utilities and public services was such that a curfew was imposed, car traffic was banned, and only merchants and their employees were allowed downtown for several days.

The commercial area of Ross was also heavily impacted. Water and silt damaged businesses, and slope failure in the nearby area destroyed and damaged numerous homes.

At least four homes in Larkspur were destroyed and others damaged. The Madrone Canyon area was also victimized by mudslides. Combined losses for the Madrone Canyon area and the Corte Madera Creek area are estimated at $3 million.

In the San Rafael area, 12 inches of rain in a 20-hour period prompted mass evacuation of the area. Water raced through the city streets, and National Guardsmen evacuated residents stranded in water-clogged cars and homes in low-lying areas. Ten homes were destroyed and another 60 damaged.

The residential development of the unincorporated town of Inverness is found primarily along roads that lead to three steep, rugged canyons. Commercial development is mainly located on the main access to Inverness. A combination of slope failure and flooding resulted in debris flows and destroyed at least 12 homes and severely damaged many others. Considerable debris and mud flowed into Tamales Bay and as much as 300,000 cubic yards of mud had to be removed from roads and other public property. The water system for Inverness was effectively destroyed when the main water line ruptured. The repair to the system and damaged reservoir was expected to take about eight months.

Adding to the woes of Marin County residents was the closure of Highway 101 and the Golden Gate bridge. Tens of thousands of commuters were affected. Six times the usual number of ferries were requisitioned to alleviate some of the trans-bay traffic problems, but monumental traffic jams during the morning and afternoon rush hours could not be avoided.

In Sausalito at the southern tip of the County, two homes were lost and numerous others threatened by landslides.

Total damage to businesses in Marin County is not yet determined, but damage was substantial. Twenty-five businesses were destroyed and 800 damaged. In addition, five persons lost their lives. Twenty-eight homes were destroyed and 2,900 homes, including four apartment complexes, were damaged. Damage to private property was estimated at $65 million and to public facilities about $15 million.

Alameda County

A flood-control drainage system developed in the 1960's may have averted damage comparable to that suffered by Santa Cruz and Marin Counties during the torrential January rains. Storm damage was held to minimum as a series of culverts, canals, and reservoirs caught the fast runoff and, for the most part, permitted controlled flows to the San Francisco Bay.

Damage from the rains, which were accompanied by 40 mph winds, was generally limited to road closures from mudslides and fallen trees. Broken limbs from trees also contributed significantly to structure and automobile damage.

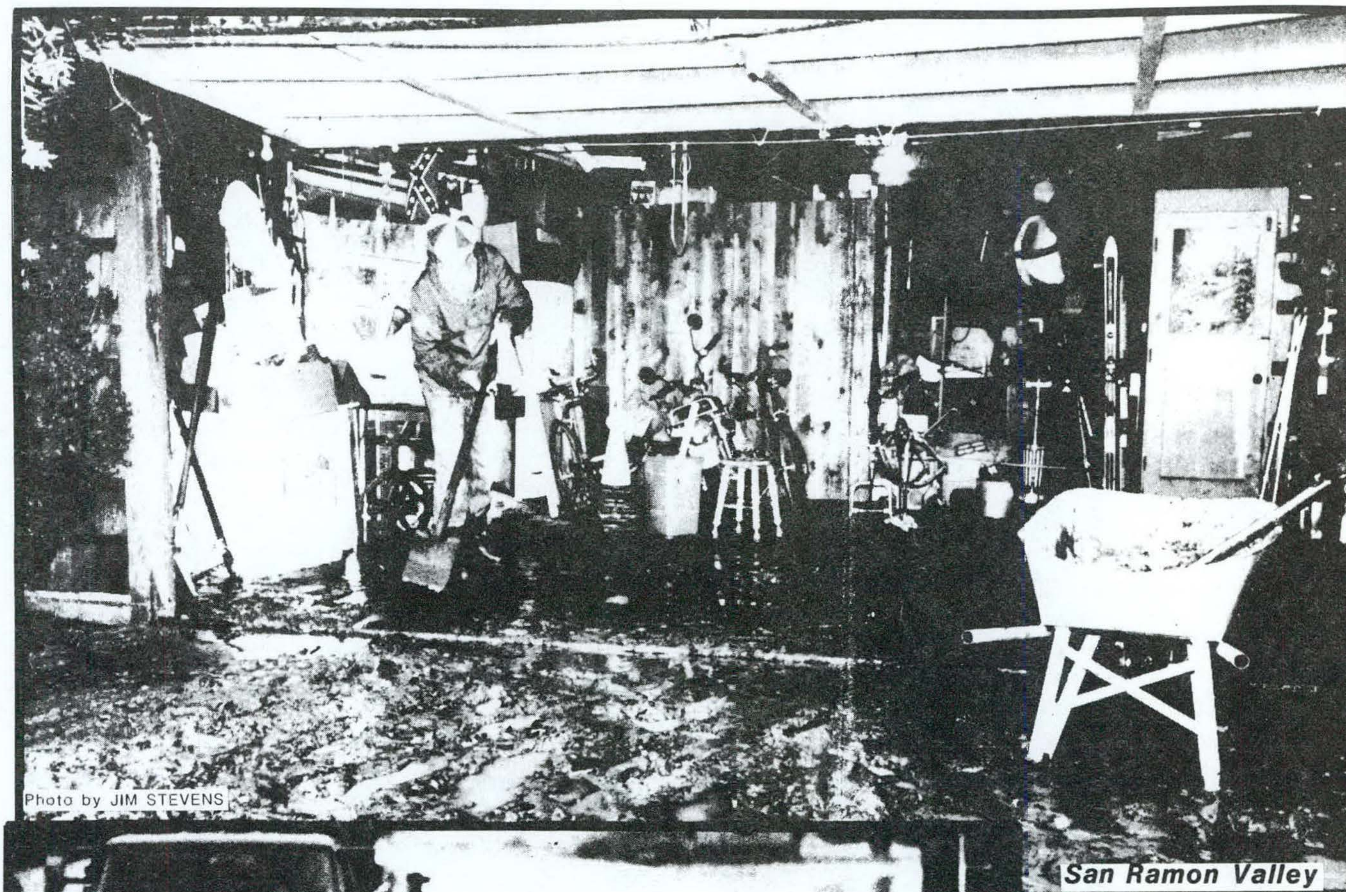


Photo by JIM STEVENS

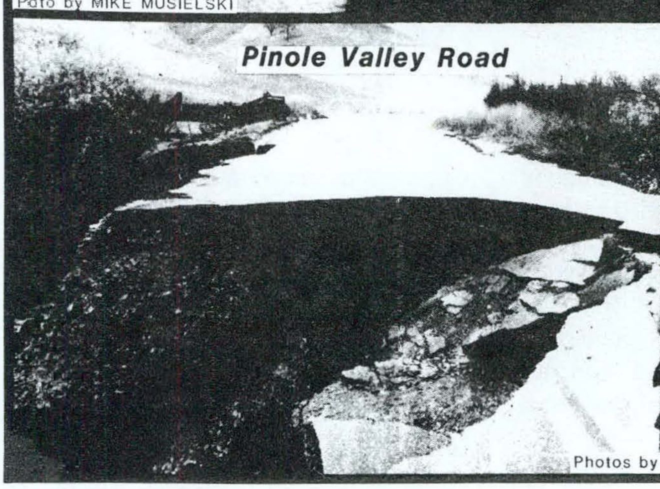
San Ramon Valley

Poto by MIKE MUSIELSKI

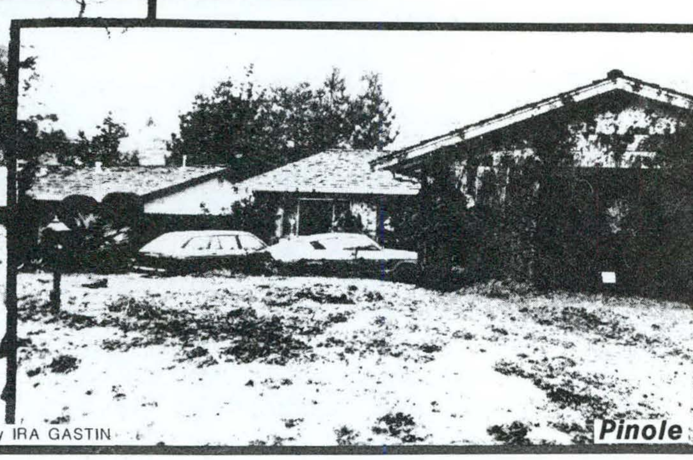
San Pablo

Mud Slides & High Water

Contra Costa County



Pinole Valley Road



Photos by IRA GASTIN

Pinole

In Berkeley, where nearly 4 inches of rain fell in a 24-hour period, access to the University campus was limited by flooded streets and downed trees. BART service was also disrupted for a short time.

The water levels of the Del Valle Reservoir rose considerably as a result of runoff from surrounding hills and creeks, but was never in danger of failing. Campgrounds and marinas on the lakefront, however, were affected by the rising water, which made the temporary closure of these facilities necessary.

Total damage in the county was estimated at $5 million. Included in the damage reports were houses and public facilities damaged in Livermore, Fremont, and Pleasanton. Three storm-related deaths were reported.

Contra Costa County

The western part of Contra Costa County was pelted with more than 8 inches of rain in a 48-hour period during the January 3-5 catastrophic storm. In Richmond, 6 inches fell in a 24-hour period, and only slightly lesser amounts fell elsewhere in the county. Rainfall of this magnitude resulted in disastrous flooding, mudslides, traffic accidents and a train wreck, all of which gave Contra Costa County the dubious distinction of being the most storm-ravaged county in the East bay.

There were no deaths attributed to the early January deluge in Contra Costa County but as many as 25 homes were destroyed, 300 damaged, and numerous businesses affected. Ten million dollars in public damage was reported, with an additional $3.5 million to private property.

Most seriously affected by the storm was north Richmond and west San Pablo. Overflowing of San Pablo Creek and nearby Wildcat Creek inundated more than 50 city blocks. The fire department and volunteers rescued numerous residents by boat. The disaster in San Pablo included the derailment of the San Francisco Zepher Amtrak train with 150 passengers aboard. Twenty-five passengers were injured as the train tore out almost 50 feet of rail where the rain had softened the roadbed. The city of Richmond suffered additional damage from mudslides and torrents of muddy water that rushed through residential and commercial streets.

The north and east portions of the county fared little better. Highway 4 near Brentwood and Pinole was beset with mudslides and flooding in low-lying areas and underpasses. Evacuation of homes, closed schools, street flooding, and mudslides prevailed through the area as slopes gave way due to saturation, and numerous minor streams overflowed their banks. Residences and businesses within the flood plain of Marsh, Kellog, Deer and Dry creeks, near Brentwood, and Alhambra Creek at Martinez were particularly hard hit.

Damage to Bethel Island was generally limited to structural damage by the high winds which accompanied the storm. Boat docks were ripped apart, barns and fences were blown down, and numerous dislodged trees and flying limbs severed powerlines and damaged homes.

A storm in late March and early April also contributed significantly to the total of flood damage to the county. Not nearly as devastating as the January 3-5 storm, the rains, which persisted for several days, nevertheless disrupted train services, flooded the county fair grounds, closed numerous roads, and posed a serious threat to tree crops. Sandbagging to protect homes and businesses on flooded streets was effective in most rural and urban areas, and undoubtedly minimized damage from flooding and slides. Significant damage, however, occurred to building complexes along Willow Pass Road near Pittsburg, where raging local creeks could not be controlled.

A detailed report of damage to Delta Island levees within Contra Costa and neighboring counties is covered elsewhere in this bulletin.

San Mateo County

The main impact of the January 3-5 storm was felt in the city of Pacifica in northern San Mateo County.

Rapid runoff from nearly 9 inches of rain in a 48-hour period resulted in flooding of densely developed single-family homes and commercial buildings in the San Pedro Creek basin. Five houses located on the steep and supersaturated slopes were destroyed, 300 were damaged, and an additional 495 houses were threatened. About 500 residents were evacuated. Three children were killed when a mudslide crushed their home.

The storm also left its mark at Pescadero Creek and La Honda Road in western San Mateo County. Landslides that blocked roads and damaged water supply systems became serious problems. Some levee damage also occurred at the mouth of the Pescadero River. In Daly City, ocean front homes were in peril as huge chunks of property slipped into the ocean.

On the bay-side of the county more than 100 homes were flooded in the Shore View, San Mateo Village, and San Mateo Park area. Flooding and disrupted power and telephone service occurred in Redwood City. The storm also forced the closure of portions of the Bay Shore Freeway and countless municipal streets. Hundreds of residents in South San Francisco and Brisbane were evacuated from homes and trailer parks and sought shelter in Red Cross Centers. An all time one-day record of 6 inches of rain was recorded at the San Francisco International Airport. Nearby Brisbane, San Bruno, Millbrae, Burlingame, and other communities felt the impact of this downpour. A mudslide destroyed homes and closed numerous streets and roads. Overflow from local creeks cascaded down busy streets and forced temporary closure of many businesses.

A total of five persons lost their lives due to landslides and flooding in San Mateo County and 700 persons were displaced. Three businesses were completely destroyed and another 300-plus damaged. Nearly $20 million in private damage was reported, including the loss of 15 homes and damage to 1,522 others. Combined business and private structural damage estimates exceed $30 million.

Santa Cruz County

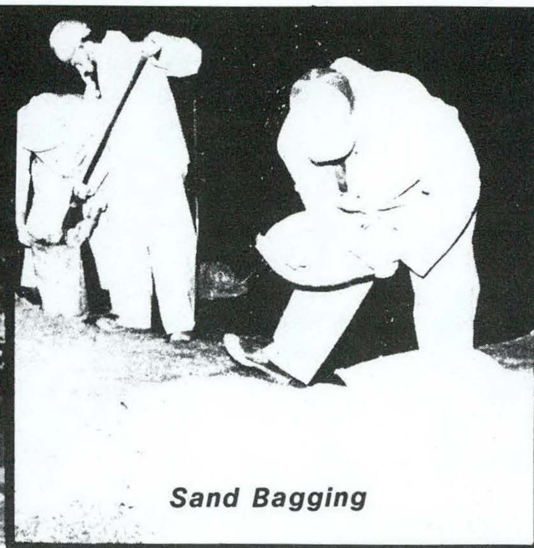
The most profound devastation in the history of Santa Cruz County occurred during the January 3-5 storm. Rainfall amounts of 10 to 26 inches were recorded in the Santa Cruz Mountains and throughout the Bay Area. Although extremely high streamflows resulted from the incessant downpour, flooding was not the worst problem. The combination of flooding and slope failure caused most of the damage.

The San Lorenzo River Basin was the most heavily affected area during the early January onslaught. The great weight of the rain in the soil, previously saturated by the late December drenching, triggered numerous land and mudslides. Huge trees, toppled by the combination of unstable soil and strong winds, intertwined with the mud and debris and made clearing paths and roads to stricken areas tedious and often fruitless work. An estimated 14 people were killed by the landslides on the slopes of the valley. Thirty-nine homes were completely destroyed and nearly 400 reported various degrees of damage. Over 400 families sought relief at Disaster Assistance Centers. The unincorporated towns of Elton, Ben Lomond, Brookdale, Lompico, and Boulder Creek were particularly hard hit by the land and mudslides. In the Love Creek area, the ratio of residents to lost homes and death was especially high.

In the city of Santa Cruz, power and telephone service were seriously disrupted, forcing the closure of schools and most county and public agencies. Three main telephone cables that serve the heart of the city were severed when the Soquel Avenue Bridge collapsed due to the swollen San Lorenzo River and battering by debris. The city's water supply also became critical when a 24-inch water pipe from Loch Lomond reservoir was ruptured by floods and mudslides. Emergency water use policies were adopted to meet the crises. Major flooding, however, was averted in the city, as the San Lorenzo River crested slightly below the top of the protective levee.

The towns of Soquel and Aptos were subjected to overflows from local streams and diverted water from blockages. About 10 feet of water and mud flowed through homes, businesses, and trailer

Rescue

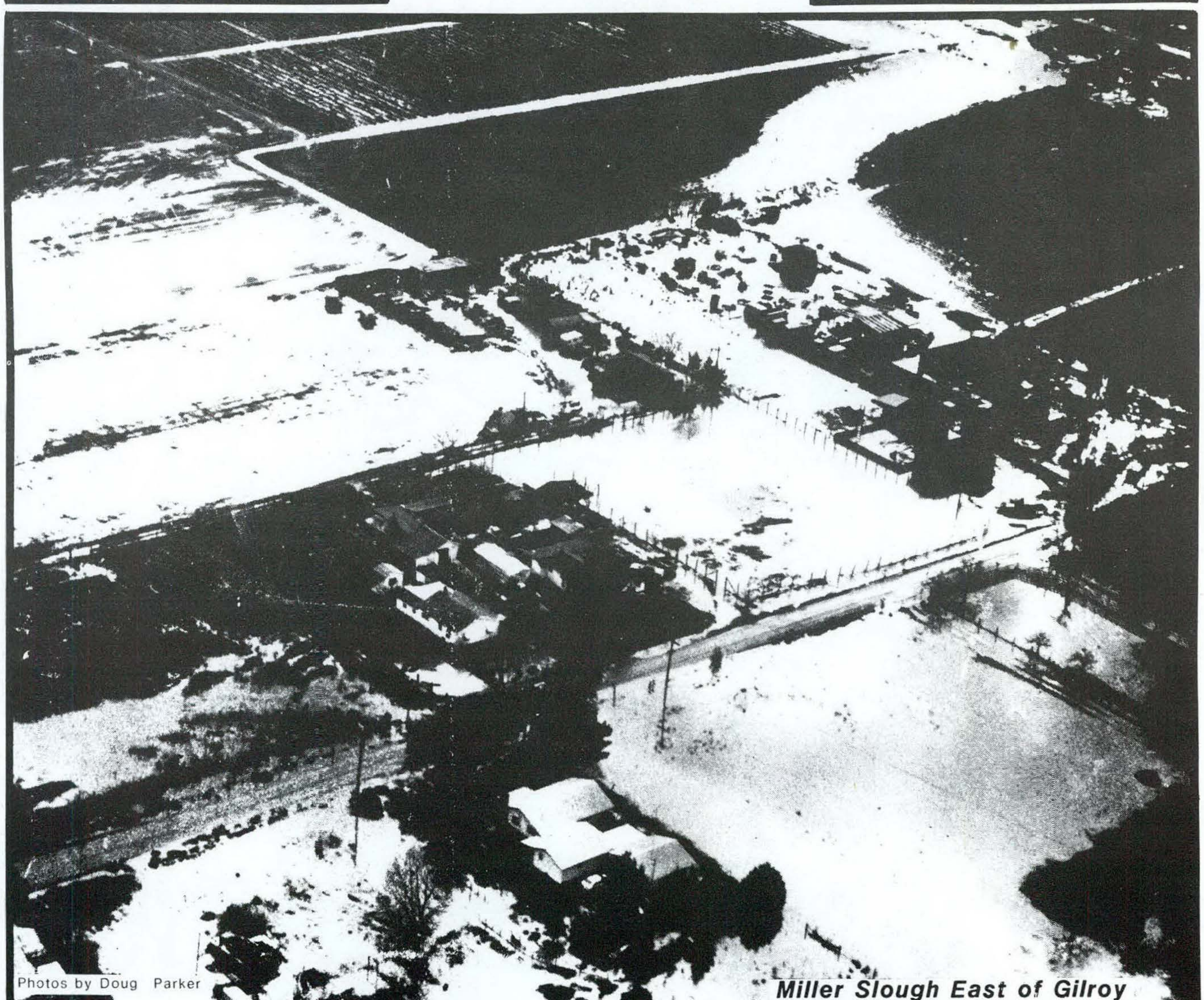


Sand Bagging

Flooded Home

Flood Scenes

Santa Clara County



Photos by Doug Parker

Miller Slough East of Gilroy

parks, completely destroying numerous public and private facilities and structures. Capitola and Scotts Valley suffered only minor flood damage but were without communication for extended periods.

In the southern part of the county, overflow from the Pajaro River inundated portions of Watsonville and neighboring agricultural land.

Total storm damage in Santa Cruz County exceeded $100 million. The storm claimed 22 lives, destroyed 135 homes and 10 businesses, and displaced 400 families. At least 300 homes and 35 businesses also suffered considerable damage. Agricultural losses were significant. Estimates of more than $1 million in crop damage resulted from the storm, but the losses were not expected to affect prices. Hardest hit were growers of strawberries, apples, and artichokes, where erosion, silting and floodwaters took their toll.

Monterey County

Only an oddity of nature spared Monterey County from the devastation of the January 3-5 storm that struck its neighboring counties to the north. Officials acknowledged that if the Salinas area of Monterey County had received the amount of rain experienced 100 miles northward, even the largest and most sophisticated flood control systems would have failed.

Much of Monterey County is highly flood prone. The Salinas River periodically rises above its banks and floods agricultural lands throughout the Salinas Valley. Homes, businesses, marinas and trailer parks in low-lying and waterfront areas sustain damage from flooding every few years. The winter of 1982 was no exception. Flood damage from the January storm, however, was generally limited to houses and trailer courts along Highway 101 a few miles north of Salinas. High ocean tides and currents built a sand bar at the mouth of the river, which diverted and backed up flows.

Shallow wells and aquifers that serve the Castroville area are usually affected by heavy rains. The perennial problem of poor and marginal water quality common to the area is aggravated by additional nitrates and bacteria brought by rains and flooding. Deeper wells and better drainage systems, while costly, appear to be the only solution to the problem.

Santa Clara County

The southern portion of Santa Clara County, principally in the Gilroy and Morgan Hill area, bore the brunt of the early January tempest. Palo Alto, in the north portion, reported only minor property damage but narrowly escaped serious flooding when flows were contained within the improved channel of San Francisco Creek.

City officials of Gilroy estimated damage to residences and businesses, including two auto dealer showrooms, at nearly $3 million. In addition, at least $1 million in damage to the water district facilities was reported and another $0.5 million to a sewage treatment plant jointly owned by Gilroy and Morgan Hill. The latter was caused by overflow of Llagas Creek, which ruptured levees of ten percolation ponds. Mudslides and washouts on Highways 129, 152, and 101 necessitated road closures and traffic control during and following the storm.

A late spring rain added significantly to the Santa Clara County storm damage. Nearly 2 inches of rain was recorded in the San Jose area from March 31 through April 1. The worst flooding in recent years occurred in San Jose during the "April Fools" storms. The adjacent hillsides, primed for fast runoff by early rains, caused spilling in every reservoir of the area except Steven Creek Reservoir, where low levels are maintained because of its questionable integrity. The overflow of six creeks in the area forced the evacuation of at least 50 homes, flooded streets, closed schools, and snarled commuter traffic. One death was attributed to the storm and more than 2,000 residents of mobile home parks in the north city were homeless as floodwater forced evacuation. Extensive damage to hundreds of cars and homes was reported.

Street flooding and numerous slides also occurred in Gilroy and Morgan Hill, but damage fell short of that experienced in mid-February.

SOUTHERN CALIFORNIA

With the exception of San Luis Obispo County, rain in destructive amounts was late in coming to Southern California. As late as February 1982, this vast region was living up to its arid reputation. The tempests of November, December, and January that ravaged much of northern and central California generally bypassed the southern part of the State. Rainfall in early February ranged from 50 to 70 percent of normal.

Flood events for this region in Water Year 1981-82 were few and widely spaced. The first event of note occurred February 9-10, when a tropical storm swept through the coastal and desert areas. A flash flood near Palm Springs in the southeast desert area flooded roads and resulted in one death. Four other deaths, mostly automobile related, were attributed to the short but intense storms.

The San Diego region was hard hit by a storm that brought some 1.5 inches of rain in a 24-hour period in mid-March. Strong runoff in the East San Diego area caused the collapse of one bridge and the closure of roads and streets, particularly in the Mission Valley area. No major accidents or deaths were attributed to this storm but power outages were widespread.

San Luis Obispo County

The ferocious storm of early January that battered central coastal counties also left its mark in portions of San Luis Obispo County. More than 6 inches of rain, coupled with hurricane force winds, caused power outages and mudslides. Highway 1 north of San Simeon was boulder-strewn from slides, and flooding from clogged road culverts made travel hazardous. The Hearst San Simeon National Monument reported damage to the castle and several trees were uprooted and fell across the entrance road.

Generally, the area south of Morro Bay escaped the wrath of the historic January storm that invaded central California.

A mid-April storm, however, dropped almost 2 inches of rain in the Arroyo Grande region, filled local reservoirs to capacity, and caused some road closures due to flooding. Agriculture was hardest hit by this late storm. Farmers were forced to delay or defer planting due to the saturated soil condition, and any harvested crops began to rot or became downgraded in quality due to exposure to the dampness.

SACRAMENTO RIVER DRAINAGE BASIN

The Sacramento River and its tributaries, the Feather, Yuba, and American, are principal outlets that drain high volumes of rain and snowmelt runoff from surrounding mountains and the valley floor. Two-thirds of California's water needs are fulfilled by water from this area.

Ironically, during the early fall of 1981, when California's water supply outlook was still in doubt, early and intense storms prompted the release of valuable water to the ocean. In fact, as a result of the early storms and the frequency and intensity of those that followed, more than a full year's water supply for California was yielded to the ocean to mitigate the impact of the runoff.

Shortly after the turn of the century, a vast, complex, and costly flood-control project was constructed to mitigate flood damage to the fast-growing agribusiness in the valley. Industrial complexes and population centers had also begun to mushroom in low-lying areas adjacent to streams.

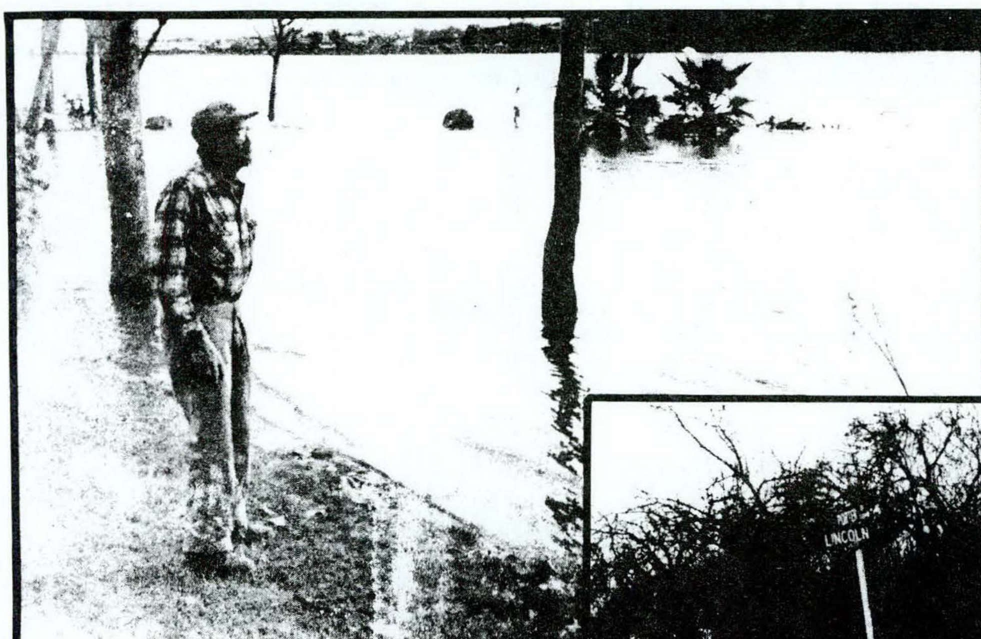
The Sacramento-San Joaquin River Flood Control Project consists mainly of reservoirs to intercept and store runoff; levees on the rivers to contain and increase carrying capacities; and weirs to permit excess river water to escape into bypasses. Huge pumping plants complement the project.

The system has proved to be highly efficient over the years and today, except for additional flood-control reservoirs, it remains essentially as originally constructed. The Sacramento Valley

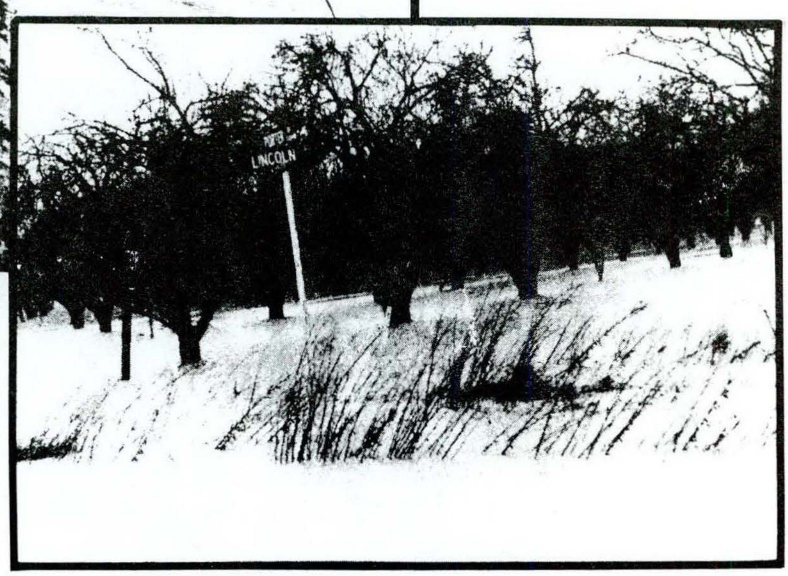
Dry Creek Flooding in Redding Area

Photo by TIM DUNN

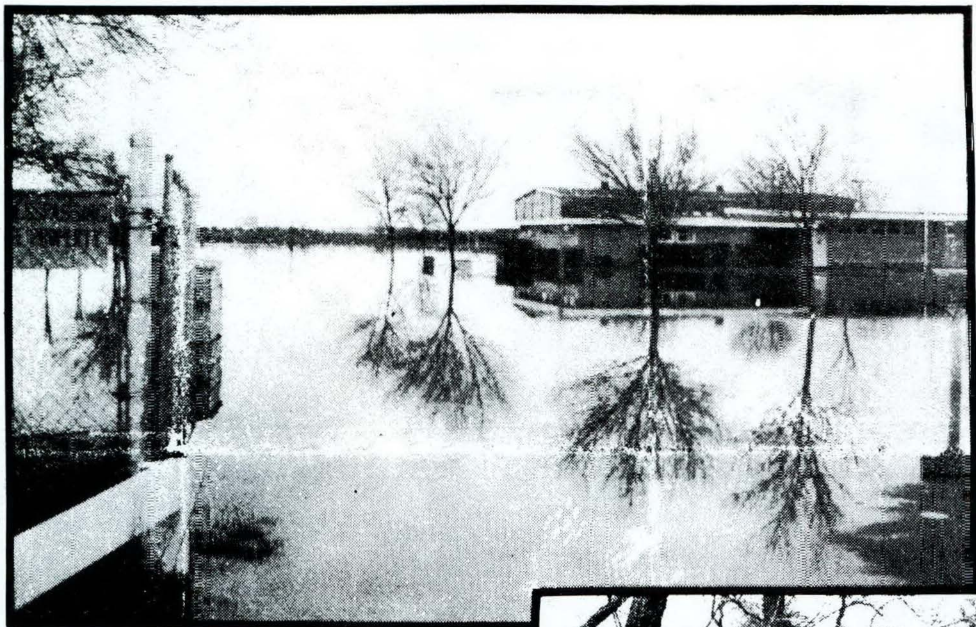
Storms Aftermath



Sacramento River below Shasta Dam

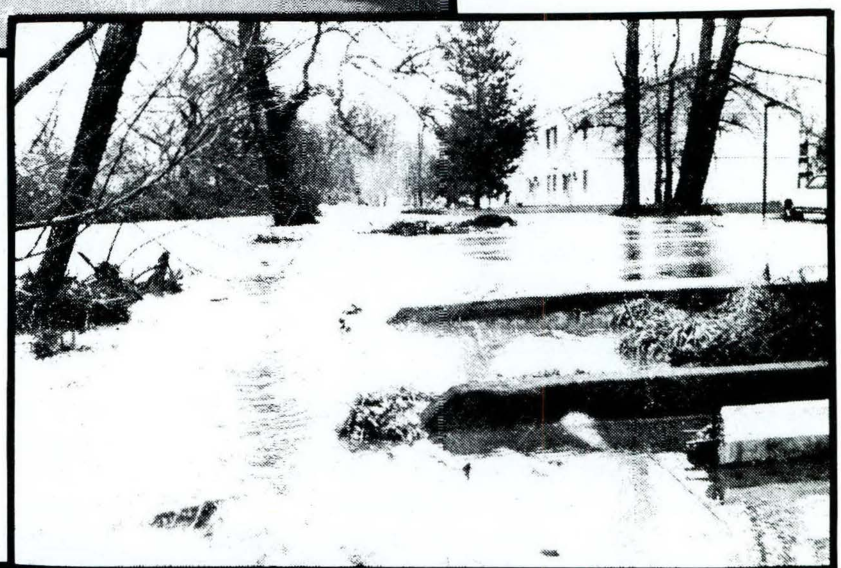


Flooded Dixon Orchard

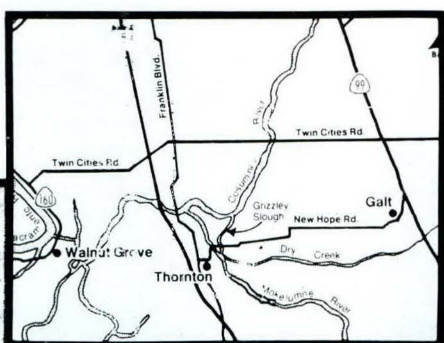


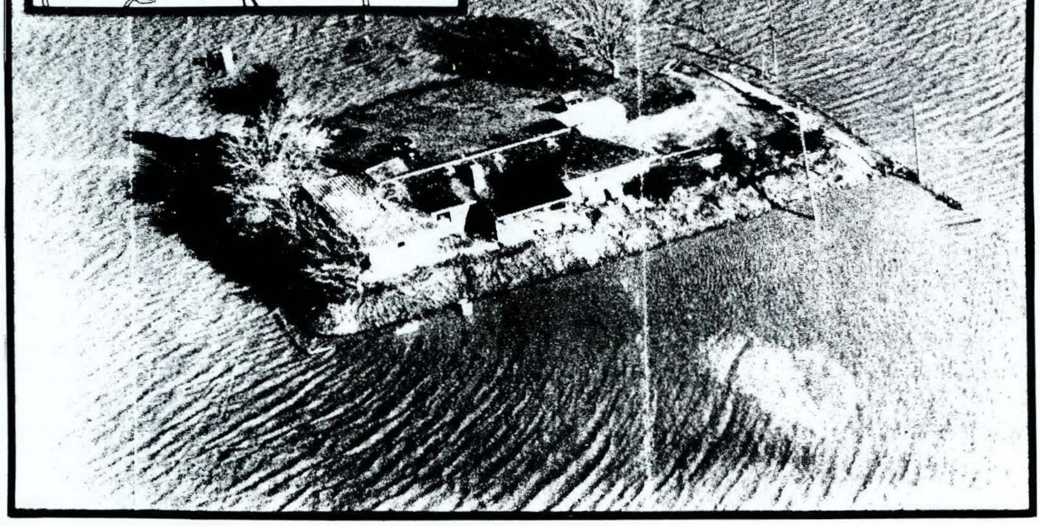
Schoolyard became a lake in West Sacramento

Sacramento Valley/Foothills



Winter runoff channel at Jackson tops its banks





Levee-breaking Cosumnes River maroons farmhouse

Photo by ERHARDT KRAUSE

portion of the project has been severely tested on several occasions and in general has performed effectively.

The Flood Control Project faced a severe challenge during the winter of 1981-82. Beginning in mid-November, six major storm systems tracked through the northern and central portion of the valley. Some were of record proportions; all were in the "severe" category.

Although the system has an excellent track record of discharging tremendous volumes of water into the Delta with a minimum of upstream flooding, it should not be considered infallible. Only timely spacing of this winter's storms may have averted major flooding. Almost miraculously, the storms ended just short of a crisis, and the intervals between events were generally sufficient to permit river flows to fall to below danger levels and allow operators of heavily encroached reservoirs to increase releases and create flood storage space for later storms.

What would have happened had the intervals between the storms been of less duration is a matter for conjecture, but the possibility of the blending of two or more major storm systems and the resulting consequences must be seriously considered by State and local disaster agencies.

The Sacramento Valley

The communities of Redding, Palo Cedro, and Bella Vista on the northerly slopes of the valley were seemingly the prime target for the onslaught of the first major storm of the season, which began in mid-November. As much as 9 inches of rain, accompanied with winds to 70 mph, flooded homes and streets, uprooted trees, and ripped down power and communication lines. Overflow of numerous local streams, including Dry Creek and Cow Creek in the vicinity of these communities, caused water damage to homes and destroyed out-lying structures. Several primary roads were limited to one-way or controlled traffic due to mudslides and fallen trees. The gale force winds added significantly to the damage totals.

Unseasonably high river flows resulted from heavy runoff from local streams. A flood stage was reached at Tehama Bridge, and overflow occurred into the Sutter Bypass at Moulton, Colusa, and Tisdale wiers. Some unharvested crops in the bypass areas were damaged. Additional rains later in the month forced unscheduled releases from encroached reservoirs and caused the overtopping of all fixed weirs, including the Fremont Weir, which releases excess flows into the Yolo Bypass (see Appendixes 2, 3, 4, and 5).

Fortunately, the period between November 3 and December 18 was relatively dry. River stages receded to below-danger levels, and operators of major reservoirs took the opportunity to make substantial releases to reclaim much needed flood storage space (see Figure 15).

The second series of major weather fronts struck the North Coast and Central Valley on December 18. By December 20, rainfall of 9 inches had fallen in Dunsmuir and the McCloud River drainage basin. Redding, Palo Cedro, and Bella Vista, still dripping from the soaking of a week earlier, were ravaged by the overflow of Olney, Dry, and Cow creeks.

Overflow of other local streams in the vicinity contributed to the flooding problem.

The storm was essentially a warm one and produced rain at higher elevations. Much of the snow at the 5,000 to 6,000 foot level was washed away. In the Feather River Basin, 13 inches in a 24-hour period was recorded at Bucks Lake.

The maximum bihourly inflow during the storm was 109,000 cubic feet per second (cfs) at Shasta Lake, 116,000 cfs at Lake Oroville, and at Folsom Lake. Inflows of this magnitude made flood-producing releases from the major reservoirs imperative. Shasta Dam upped releases to 88,000 cfs from December 22 through December 24; Oroville to 88,000 cfs for several hours on the 20th; and Folsom to 35,000 cfs from the afternoon of December 20 through December 24 (see Figure 16).

The high-volume releases were reflected in flood stages at Bend Bridge, Tehama Bridge, Vina Woodson Bridge, and Ord Ferry. Trailer parks and public facilities in low-lying areas suffered the consequences of local runoff and emergency releases from

Figure 15. HYDROGRAPH OF THE SACRAMENTO RIVER

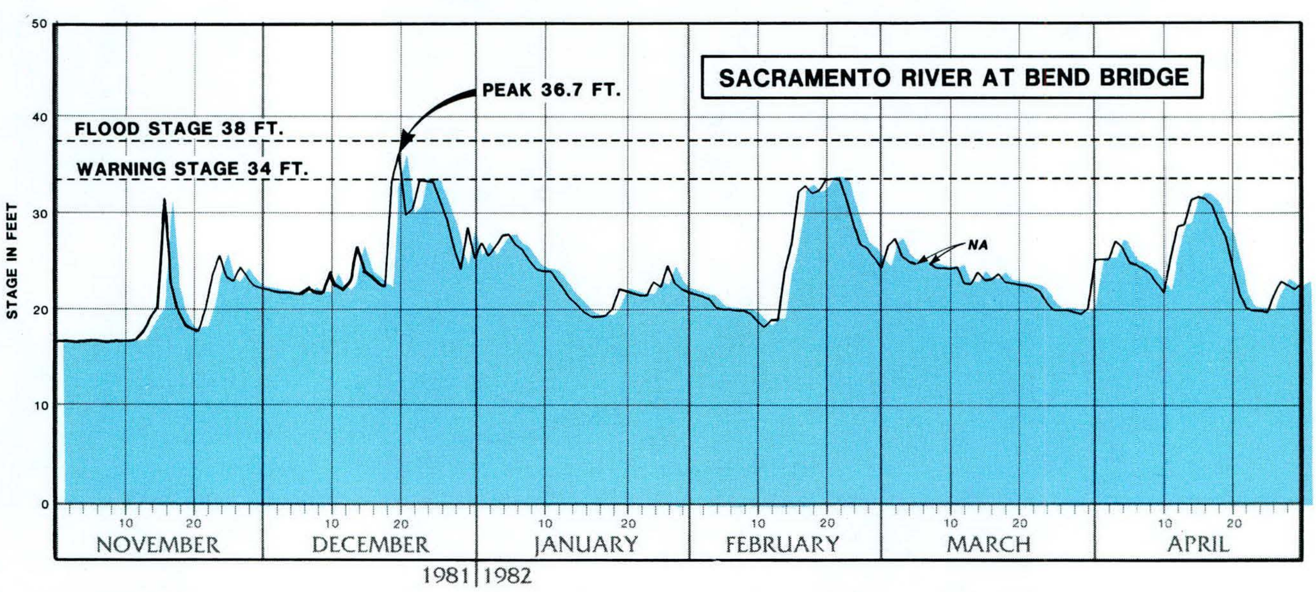
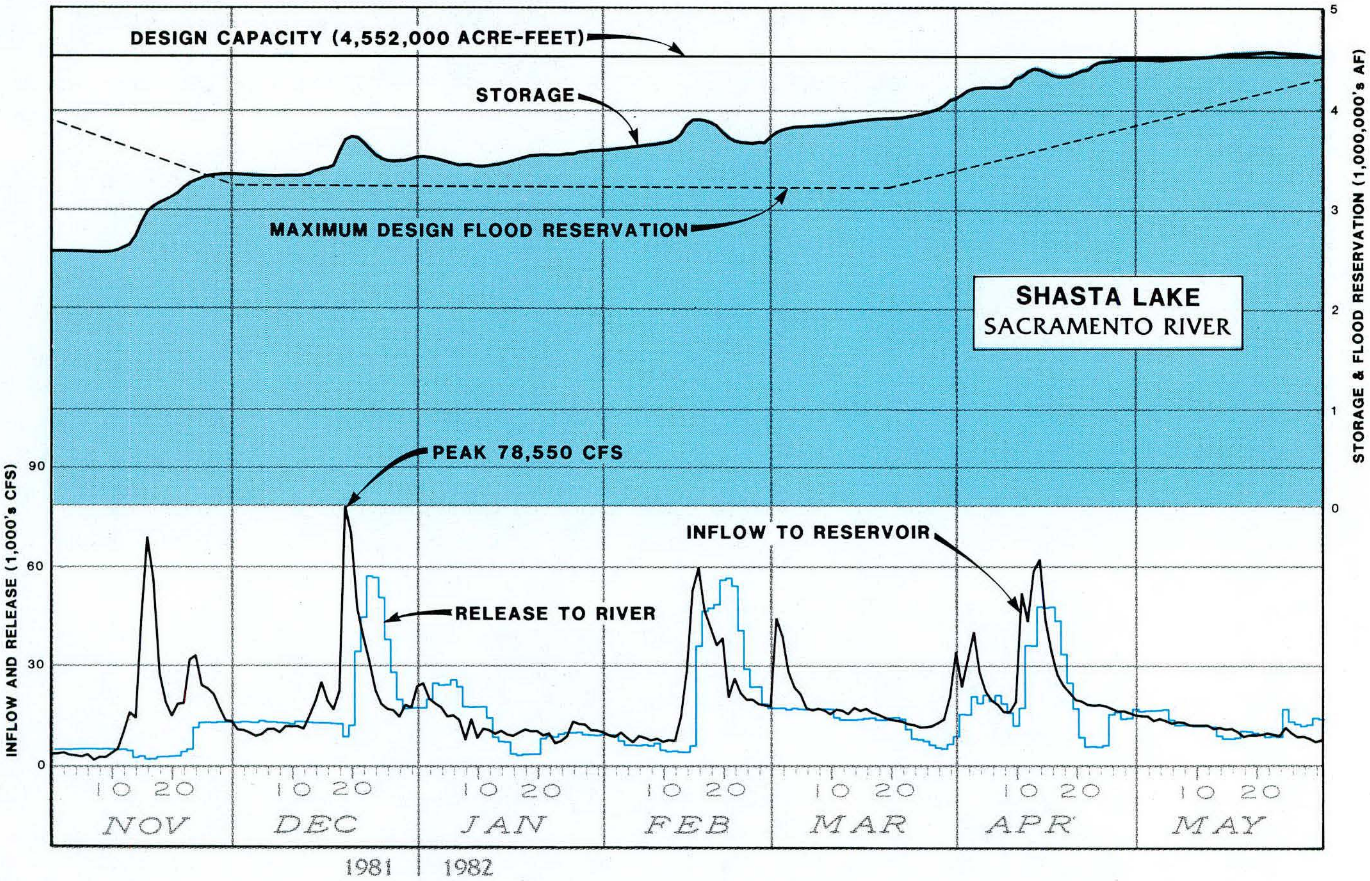
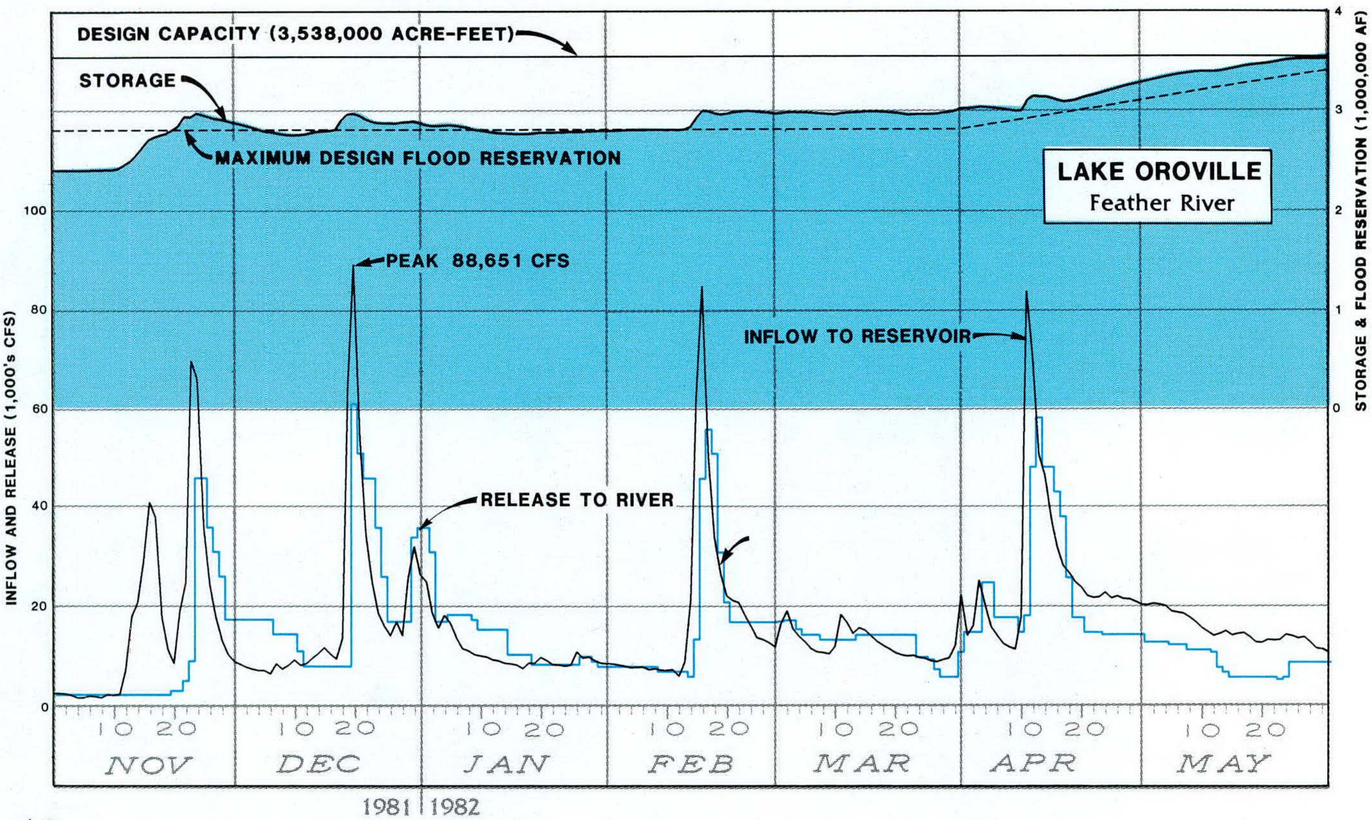


Figure 16. HYDROGRAPHS OF SHASTA LAKE AND LAKE OROVILLE





Shasta Lake. All fixed weirs were reactivated. Warning stages on the Sacramento River extended from the upper reaches of the River to the I Street Bridge in Sacamento. Levee patrols on a 24-hour basis were initiated on levees that protect the city of Sacramento and at other selected sites.

Problems also began to develop in the Delta as a result of the high tides abetted by heavy inflow from the Sacramento River and Yolo Bypass. The high-water problems relating to the Delta islands are described in another chapter of this report.

In the American River System, Blue Canyon recorded 13 inches of rain for the three-day period, and rain was falling as high as the 9000-foot elevation in the Central Sierra. The only damage of note from the late December storm, however, was the submerging of the Highway 49 Bridge between Auburn and Cool and the inundation of Discovery Park at the confluence of the American and Sacramento River.

The powerful storm of January 3-5 hit the Sierra Nevada in full force. The collision of two storm systems -- one conceived in Alaska and the other spawned in Hawaii -- literally tore up the Bay Area, but the impact was less in the Sacramento Valley. The storm that hit the Sierra Nevada was of the cold variety, bringing snow to lower elevations and minimizing runoff into the valley. The path of the storm was centered mainly between the Feather River basin and the Stanislaus River of the San Joaquin drainage system. Snow amounts in the higher elevations were short of records, but the driving snow replaced losses that occurred during the warm December rains and increased the snow water content to 100 percent of the April 1 average. It also created potentially hazardous avalanche conditions.

Highways 80 and 50 were closed on occasion from land and snow slides, and threats of avalanches persisted well into the spring months. Frequently, deliveries of food supplies to remote residents in the mountain areas and Tahoe Valley were limited due to road blockages.

The Sacramento Valley fared much better. The dropping of the snow line to lower elevations impeded runoff into reservoirs, but local runoff from the foothills and valley flow was heavy. Reservoirs continued to make above-normal releases to maintain encroachment criteria and as a result, river stages remained high. The Flood Control Project, however, continued to perform as designed, despite the saturated levees and persistent high flows.

Fortunately, the period January 29-February 13 was virtually dry. During the two-week rain-free period, floodway bypasses drained and levels in major reservoirs were reduced to limits prescribed by the U. S. Corps of Engineers.

The next series of major weather fronts, which began in mid-

February, encompassed much of the State. Most of the damage, however, occurred in the central portion of the valley, particularly in the Delta and tributaries of the San Joaquin River immediately south of the American River Basin (see "San Joaquin River").

On the Sacramento, Feather, and American rivers, another session of major releases from prime reservoirs became necessary as the heavy rains washed away the snow at lower levels, and the ensuing runoff quickly infringed the flood reservation space gained during the dry intervals. Releases of 60,000 cfs from Shasta, 55,000 cfs from Oroville, and 85,000 cfs from Folsom created flood and warning stages through the system, renewed flows in the bypasss, and prompted the opening of 30 of the 48 flood gates at the Sacramento Weir.

The release of 60,000 cfs from Shasta Reservoir coupled with heavy local runoff causd significant bank erosion along the upper Sacramento River. Particularly hard hit was the portion of the river downstream from the Deschutes Bridge east of Anderson. The high flows washed away substantial amounts of river-front property of at least 7 homes. On March 2, 1982, the Shasta County Board of Supervisors proclaimed a local emergency on the basis that conditions of extreme peril to the safety of persons and property had arisen as a result of flood flows commencing on 19 February 1982.

The Shasta County Department of Public Works has stated that another period of sustained high releases will cause significant structural property damage if corrective measures are not taken. The area of responsibility and source of funding for a proposed bank protection program for the area have not been determined, however.

By mid afternoon on February 16, the river stage at I Street in Sacramento reached 27.5 feet, which is the prime criterion for opening the Sacramento Weir flood gates. The Sacramento Weir is the last in the line of flood defense weirs and serves primarily to protect the city of Sacramento and downstream communities (see Appendix 6).

Precipitation during the period February 19-March 16 was generally light in Northern California, but high enough to sustain flood stages in unleveed portions of the Sacramento River. Warning levels continued through the system. The Moulton Weir ceased overflow shortly after the February storm, but Colusa, Tisdale, and the Fremont weirs flowed nearly continuously until the last week of March. At the Sacramento Weir, closure of the 30 gates that had been opened on February 16 was completed on February 20.

Normally with the advent of spring, Northern California can expect the major storm period to be over and can look forward to some decent weather. Such was not the case, however, in late March and much of April 1982. A series of weather fronts tracked through Northern and Central California and persisted sporadically until mid-April. The fronts varied in intensity and temperature, but were sufficient to renew flood and warning stages on major rivers in the Central Valley. An event of note resulting from the late storm was the opening of 15 of the Sacramento Weir gates on April 12 to relieve threatening flows. This marked the first time in 42 years that the gates had been opened this late in the year.

The snow depth at Donner Summit at the 7,000 foot level reached 202 inches on April 10. A maximum depth of 318 inches was recorded at this station on March 20, 1952, but by April 10 of that year, the snow had dwindled to 140 inches. In any event, the 202 inches at the Donner Summit, and even greater masses southward in the Sierra Nevada, posed another serious flood threat to the Central Valley (see Figure 17).

The prolonged high releases from the major reservoirs maintained flood and warning stages through the system and, much to the chagrin of farmers, continued flooding the heavily farmed bypasses. The flows in the Yolo Bypass continued until the end of April.

SAN JOAQUIN BASIN

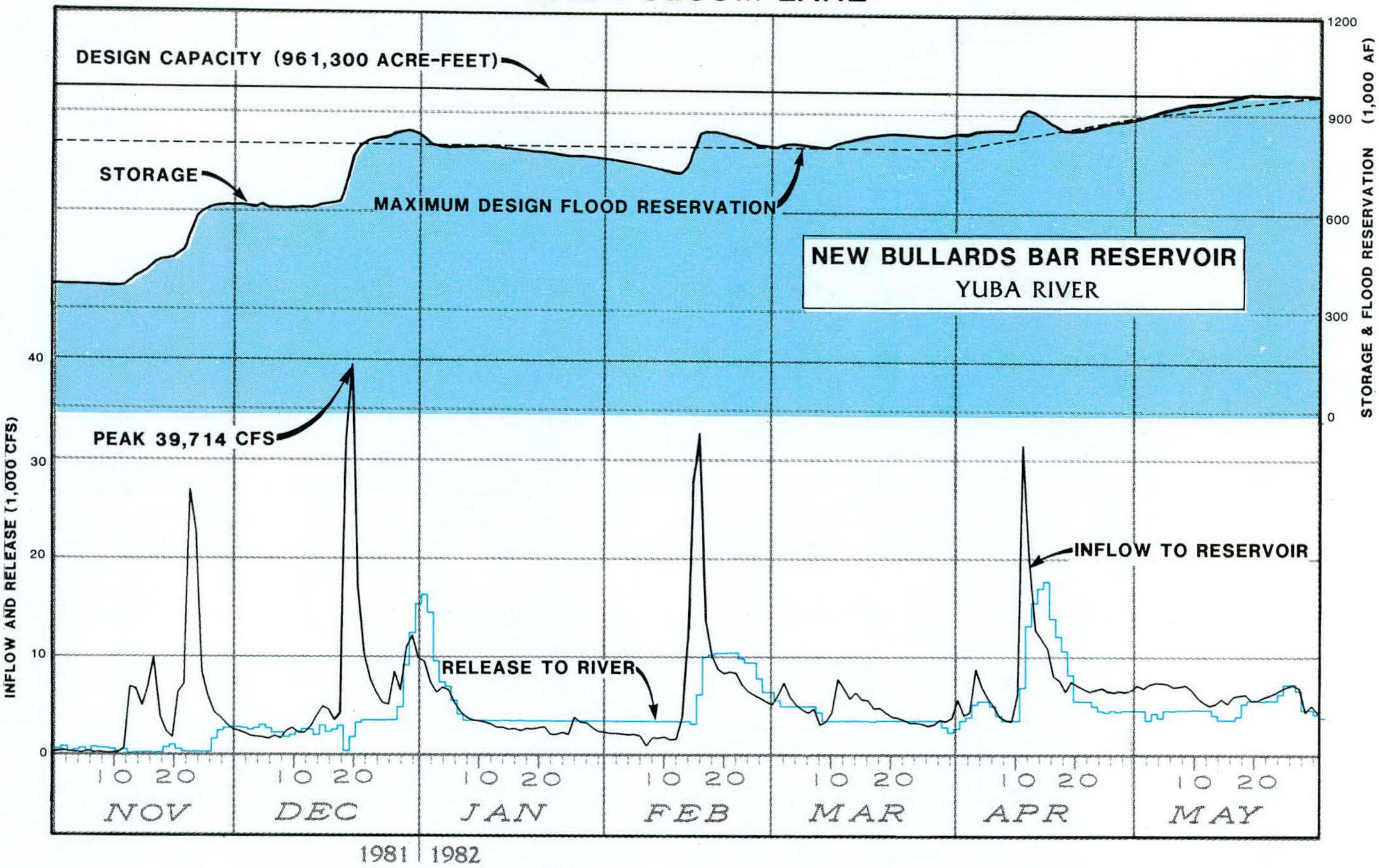
The northward flowing San Joaquin River and its Sierra Nevada tributaries were generally in the fringe area of the intense storms that pelted the northern portion of the State during late fall and early winter. Warning stages, however, were generated on November 21 and December 20 on the Cosumnes and Mokelumne rivers, the most northerly tributaries of the system. It wasn't until after the turn of the new year that the impact of the storms and areas of concern shifted to this prime agricultual area.

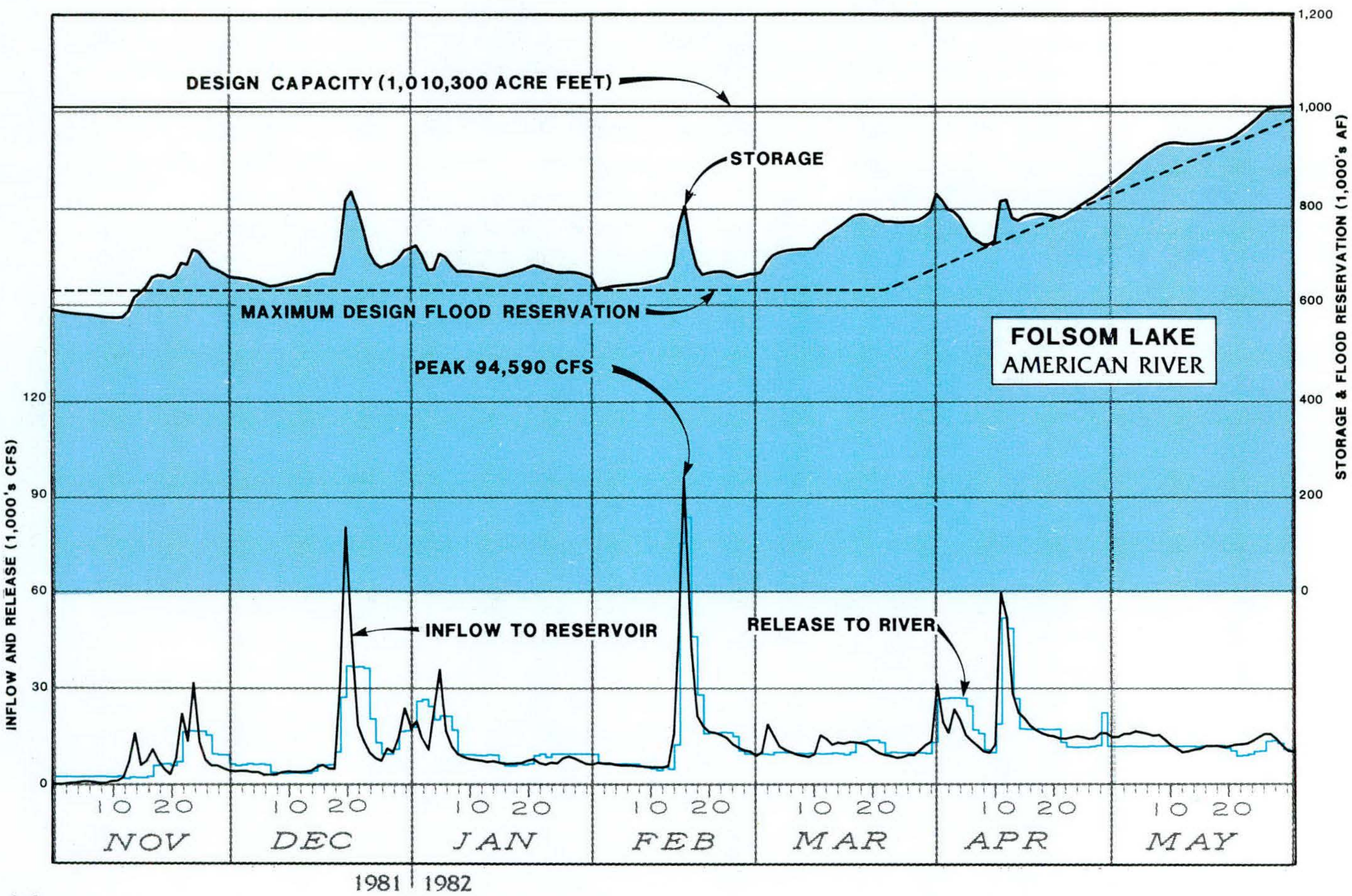
The San Joaquin Drainage system extends from the Kern River in the south to the Cosumnes River in the north. The San Joaquin River Flood Control Project, like its Sacramento River counterpart, consists of reservoirs, levees, streams, canals, bypasses, and pumping plants. A recent addition to the system is the Kern River Intertie, which permits excess flood water to flow into the California Aqueduct for delivery to needed areas. Activating this facility is the only way water may escape southward. All other water drains into the Sacramento-San Joaquin Delta or remains in Tulare Lake.

The foothills of the Sierra Nevada, which extend to the Tehachapi Mountains at the southern border, generally rise to higher elevations much faster than those of the northern range; thus, much of the precipitation falls as snow. Historically, snowmelt runoff in late spring or early summer is capable of producing damaging flooding, particularly to agricultural interests in the valley.

Snowmelt runoff damage of note occurred in the valley, but not to the extent of early forecasts. Manipulation of flood control releases, timely distribution of the excess waters, and coopera-

Figure 17. HYDROGRAPHS OF NEW BULLARDS BAR RESERVOIR AND FOLSOM LAKE





tion by the weather kept flood damage well below the projected levels.

San Joaquin River

Precipitation totals on January 1, 1982 for Water Year 1981-82 in the San Joaquin Valley ranged from 65 percent of normal at the extreme southern portion of the valley floor to slightly above normal in the central portion. Snow water content in the southern Sierra Nevada was below average, and, except for Camanche Reservoir on the Mokelumne River, storage in the major reservoirs was significantly below allowable flood reservation levels.

The major January 3-5 storm that brought much distress to the central portion of the State also left its mark on the lower reaches of the Cosumnes and Mokelumne Rivers and brought drastic changes in snow water content and reservoir levels.

A flood stage developed quickly at Michigan Bar on the Cosumnes River, causing failure of private farm levees in low-lying areas in the southern part of Sacramento County. Fifteen miles south of Sacramento, Highway 99 was closed for several hours when water flowed over the main thoroughfare north of Dillard Road. Numerous secondary roads were also closed for extended periods. Downstream, a record stage at the McConnell gaging station, near the Highway 99 bridge, was recorded prior to the upstream levee breaks. The 47.58-foot stage exceeded the peak of 46.3 feet that occurred on December 23, 1955 (see Figure 18).

The area on both sides of Highway 99 took on the appearance of a vast sea when farm levees failed, spreading water over thousands of sparsely populated acres. The high flows of the Cosumnes River backed up the swollen Mokelumne River in the Grizzley Slough and

Figure 18. HYDROGRAPH OF THE CONSUMNES RIVER

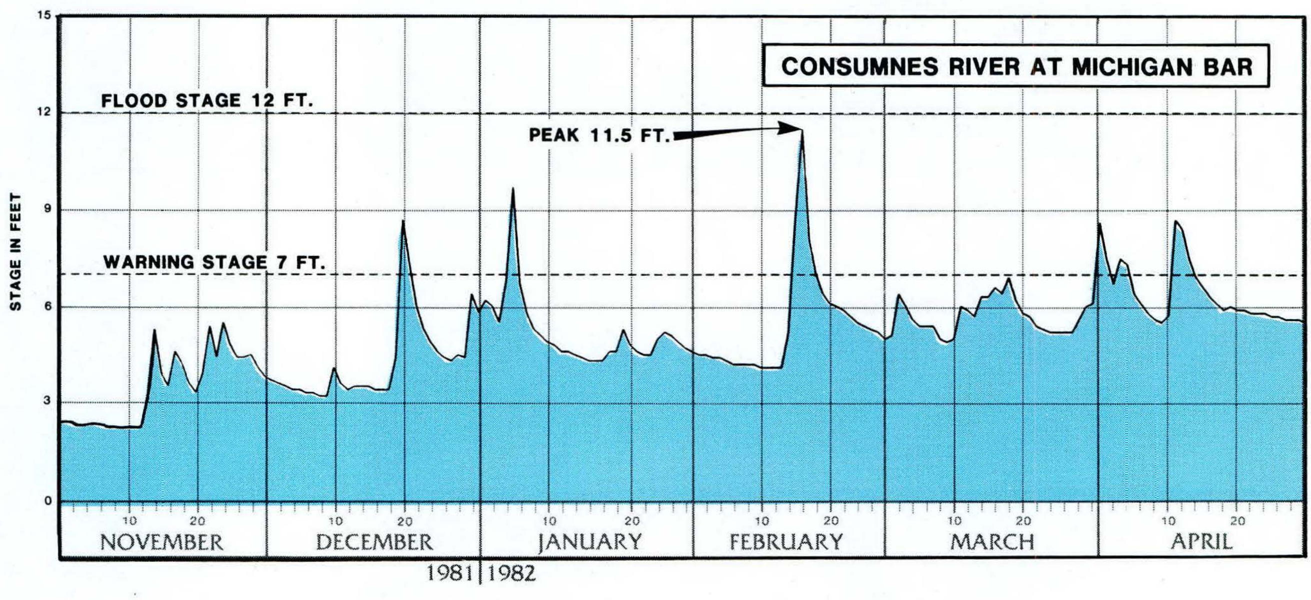
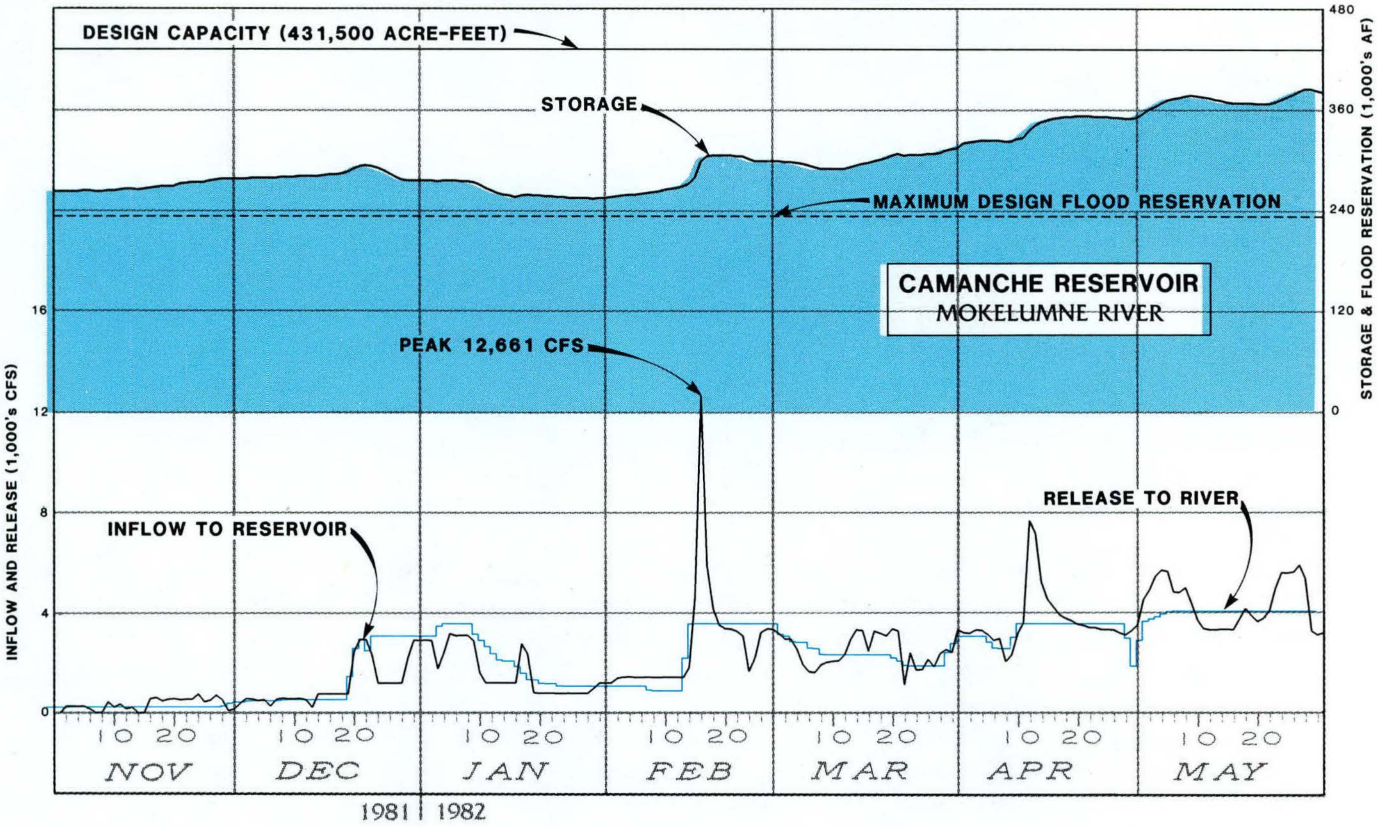
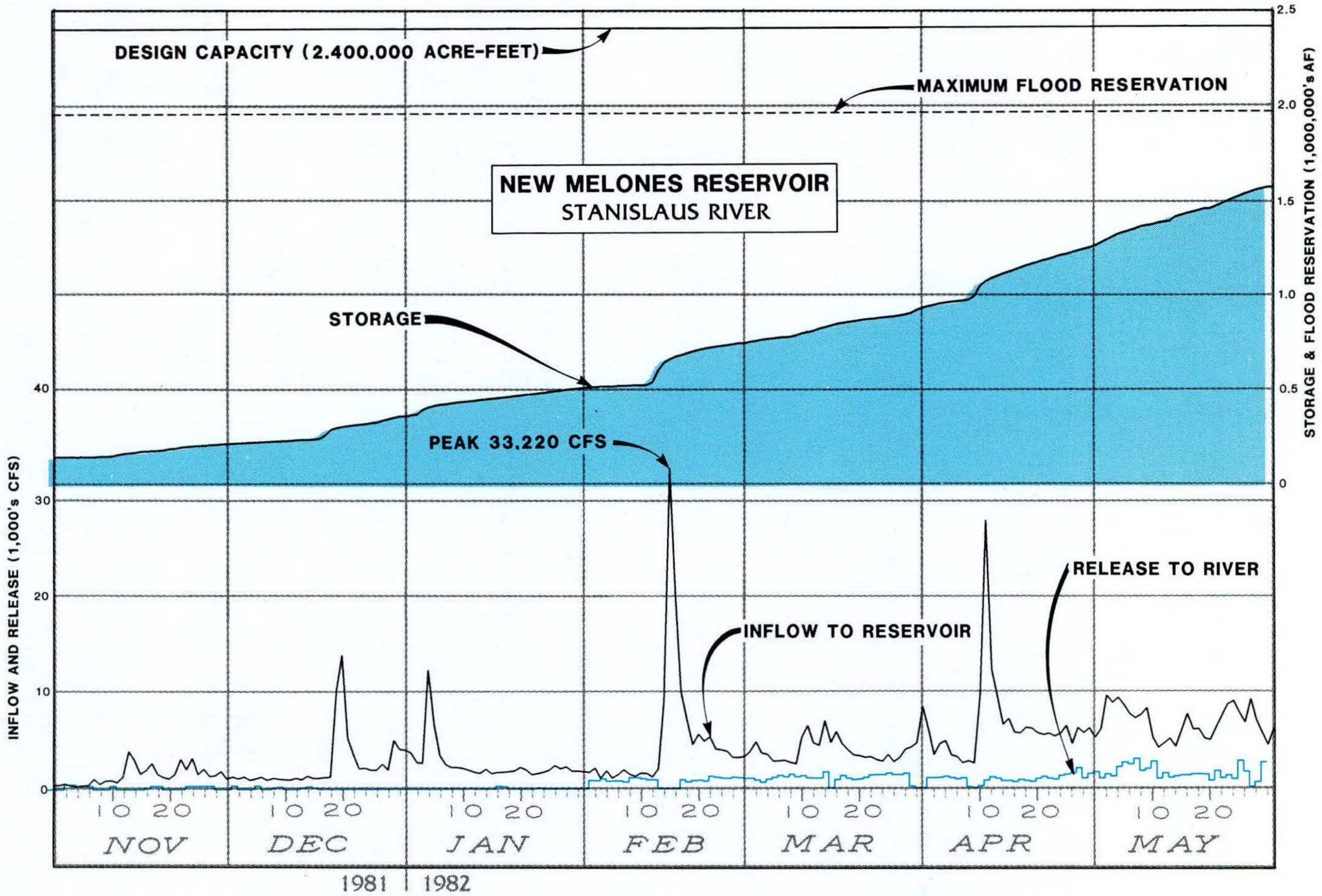


Figure 19. HYDROGRAPHS OF CAMANCHE RESERVOIR AND NEW MELONES RESERVOIR





Benson Ferry areas. The Sacramento County Sheriff's Office assisted in rescue and evacuation operations (see Figure 19).

Dollar damage from this storm event was lower than expected, considering the extent of the flooding, but many facilities were isolated for several days and some damage to bridges and roads was reported. Power service was also disrupted, and overflow of minor streams, particularly in the foothill portion of the Cosumnes and Mokelumne watershed, damaged bridges and roads.

The subtropical storm that invaded Central California in mid-February brought from 7 to 9 inches of rain in a 2 1/2-day period to watersheds of San Joaquin tributaries from the Merced River northward. The Yosemite Valley floor received 2.5 inches of rain in a 24-hour period, closing many roads in the park. Rain as high as 8,000 feet washed away snow at the lower elevations, and the ensuing runoff raised flood control reservoirs to near and above flood reservation levels for the first time since 1980. Emergency releases and spills from some reservoirs renewed flood and warning levels along the Mokelumne and Cosumnes Rivers. Highway 99 south of Sacramento was once again closed due to flooding, partly because the farm levees in the flood plains of the Cosumnes River, which were breached in January, had not been repaired.

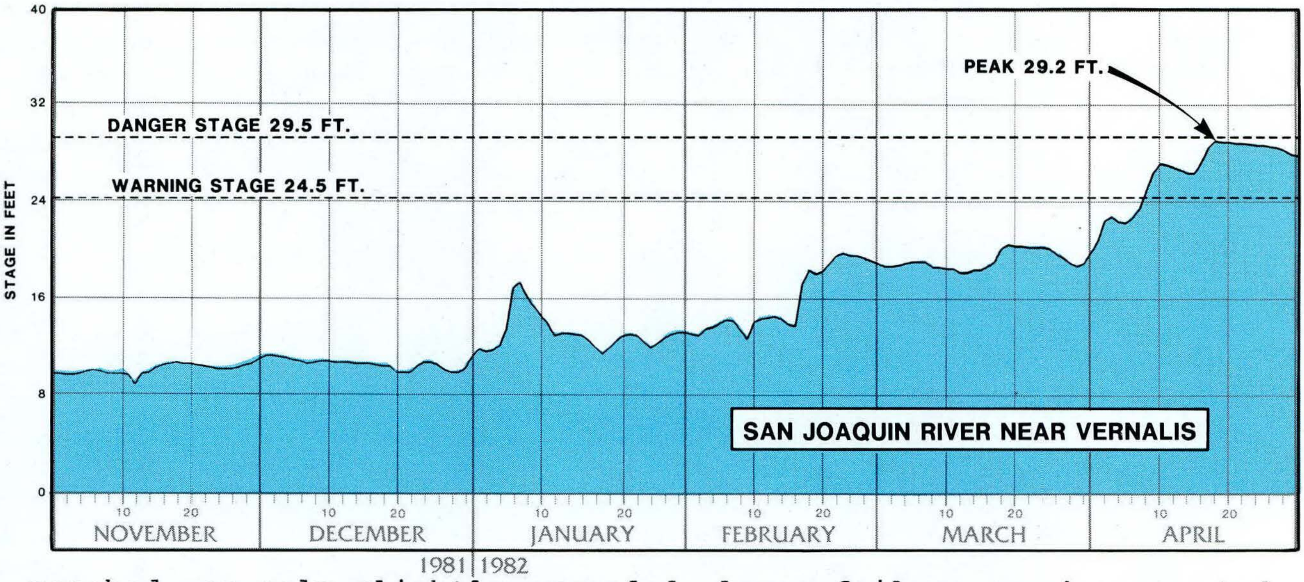
The January storm added significantly to the rainfall total in the lower valley, but the Fresno-Bakersfield area remained at 60 percent of normal. The snow water content, however, despite the drop in the snowline, was above average following the storm.

There was a general drying out period for the San Joaquin Valley following the mid-February onslaught, which lasted for the remainder of the month. March, however, came in like the proverbial lion, and with only brief interludes the showery weather lasted through the 19th. Snow continued to pile up during this session of showers, causing flood control officials to eye the escalating pack with increasing concern. Most flood control reservoirs had encroached maximum allowable levels and rivers were abnormally high, which meant that fast runoff, generated either by a hot weather spell or warm rains, could bring serious flooding problems to the Valley.

March did not go out like a lamb. A cold front hit the area about March 28 and dropped the snowline to 1,500 feet. The storm, which continued through April 3, was intense at times, prompting the closure of Highway 88 and numerous secondary roads. Reservoir operators hastened to make additional releases to prepare for the impending rush of snowmelt water.

Trailer park occupants within the floodplain between Vernalis and Stockton, who have learned from experience, saw the handwriting on the wall and began preparation to move their trailers. By April 10 a warning stage of 25 feet was reached at Vernalis, and the river continued to rise to a peak of 29 feet on the 15th. Danger stage at this station is 30 feet. When the danger stage is

Figure 20. HYDROGRAPH OF THE SAN JOAQUIN RIVER



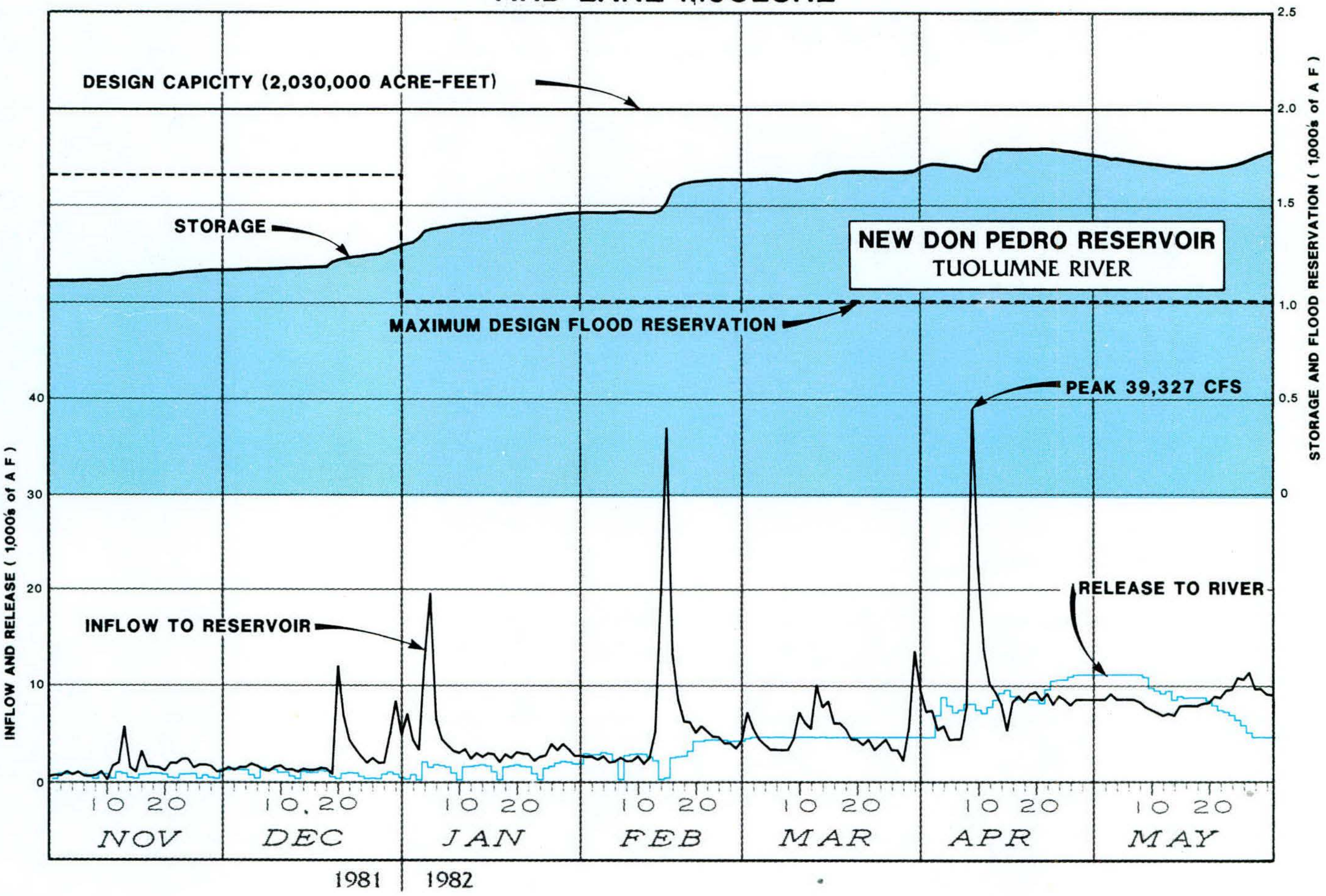
reached, or only slightly exceeded, levee failure can be expected. The warning stages continued for more than a month, but fortunately the volume of water fell short of earlier forecasts, which had predicted exceedingly high and prolonged river stages for the lower San Joaquin River. The fine tuning of reservoir releases and water distribution, coupled with timely breaks in storm sequence, were some of the reasons for the diminished flows. However, seepage problems, common to the area when the river exceeds warning stages for extended periods, plagued farmers with extensive agricultural lands near the river (see Figure 20).

Another late spring squall accompanied by strong winds hit about April 10. The foothill cities of the southern Sierra Nevada felt the brunt of this attack. The weekend deluge wreaked havoc, particularly on residents of Jackson, Sutter Creek, Sonora and Columbia, who were still reeling from the blasts of late winter and early spring storms. The high winds were the primary cause of this attack. Trees were toppled, roofs were ripped apart, and outbuildings were destroyed. The torrential rains also caused street flooding and widespread damage to roads.

The southern portions of the valley, which had been relatively free of storm-related problems to this point, began to feel the consequences of the southern Sierra snowpack, which exceeded 135 percent of the April 1 average water content (see Figures 21, 22, and 23).

The Kern River Intertie, which allows flood water to flow into the California Aqueduct, was activated on April 19. This valuable facility, in addition to providing excess water to areas of need, alleviates the effect of flooding, particularly in the Tulare Basin. Between April 19 and May 7, nearly 11,000 acre-feet of flood water escaped to the Aqueduct. Without the Intertie, however, that water would have flowed into the Tulare Basin.

Figure 21. HYDROGRAPHS OF NEW DON PEDRO RESERVOIR AND LAKE McCLURE



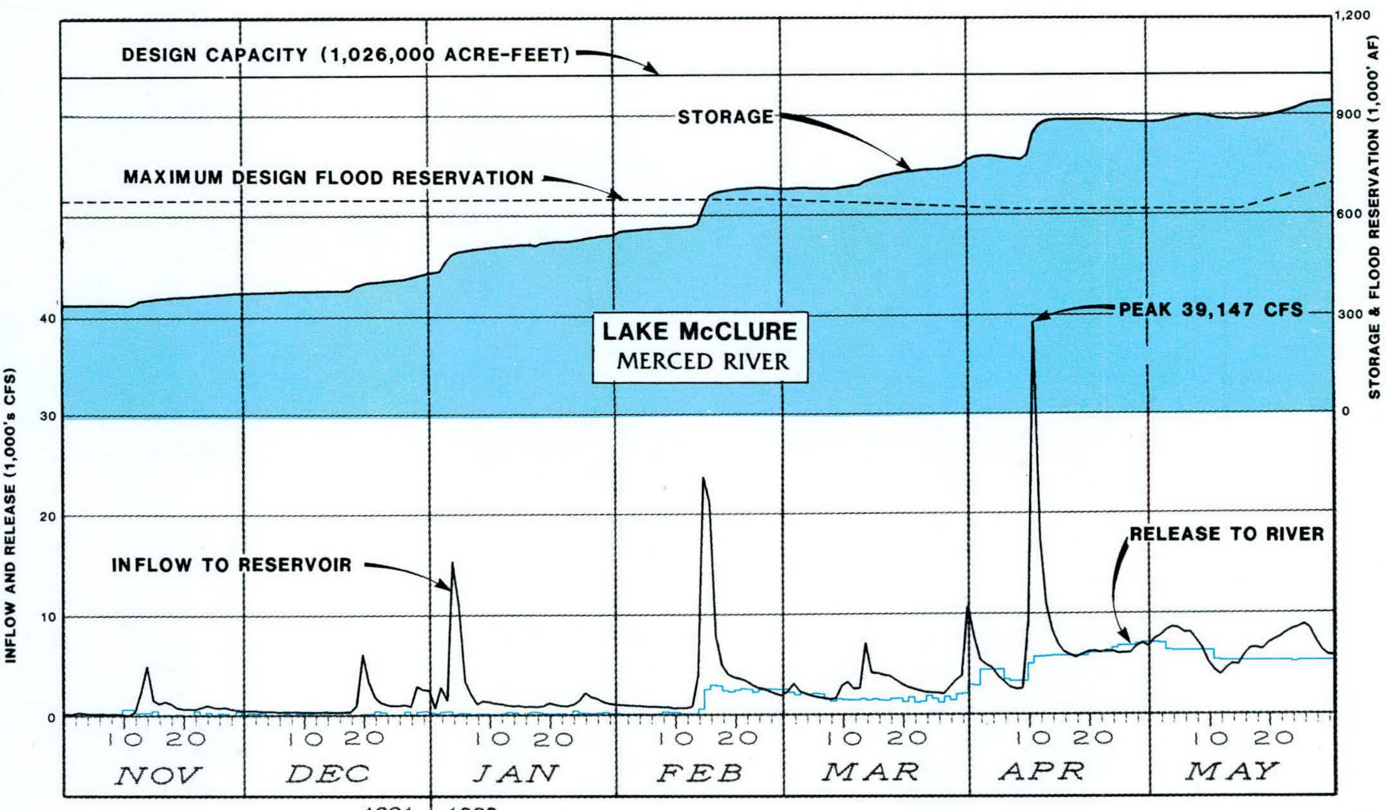
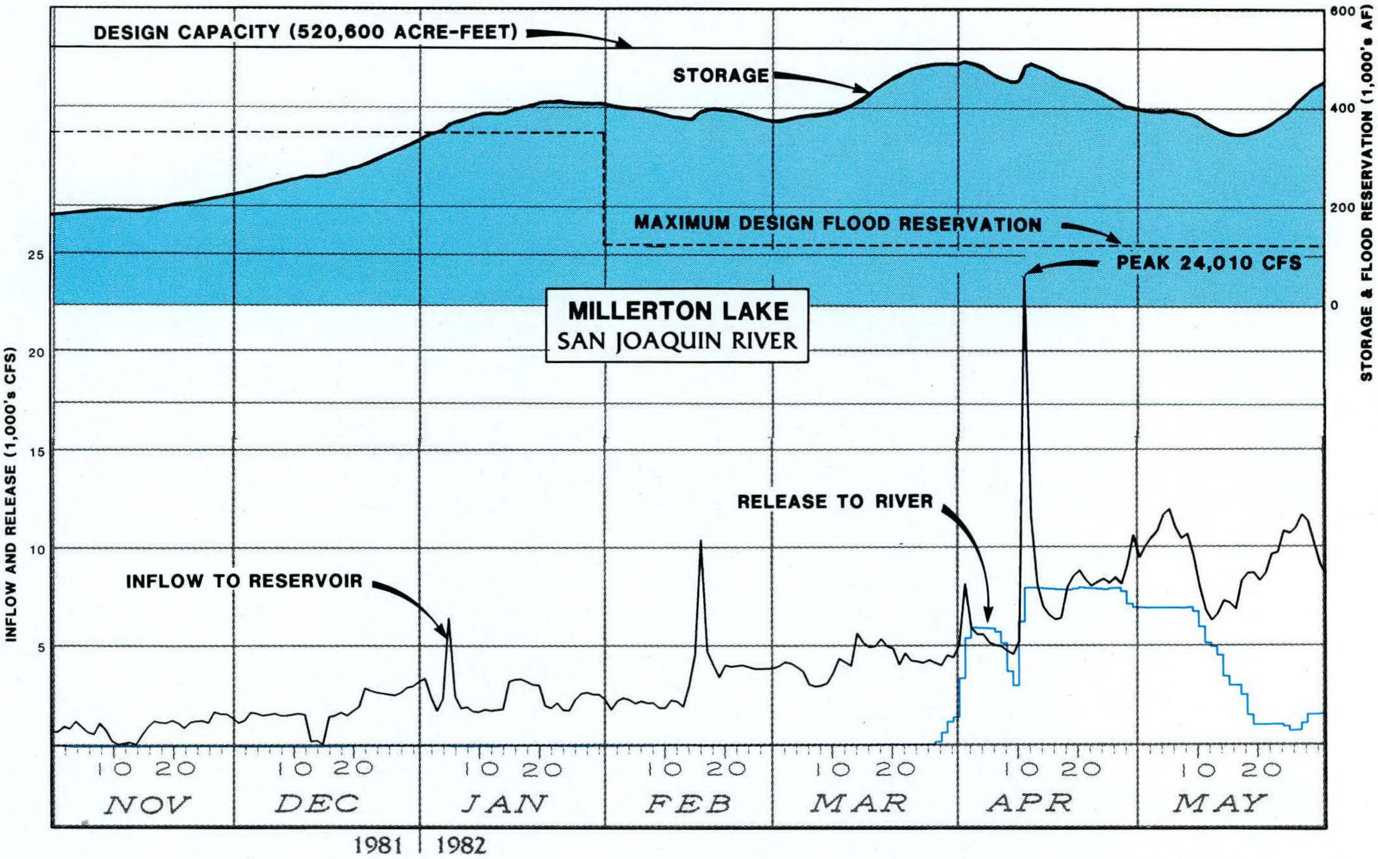


Figure 22. HYDROGRAPHS OF MILLERTON LAKE AND PINE FLAT RESERVOIR



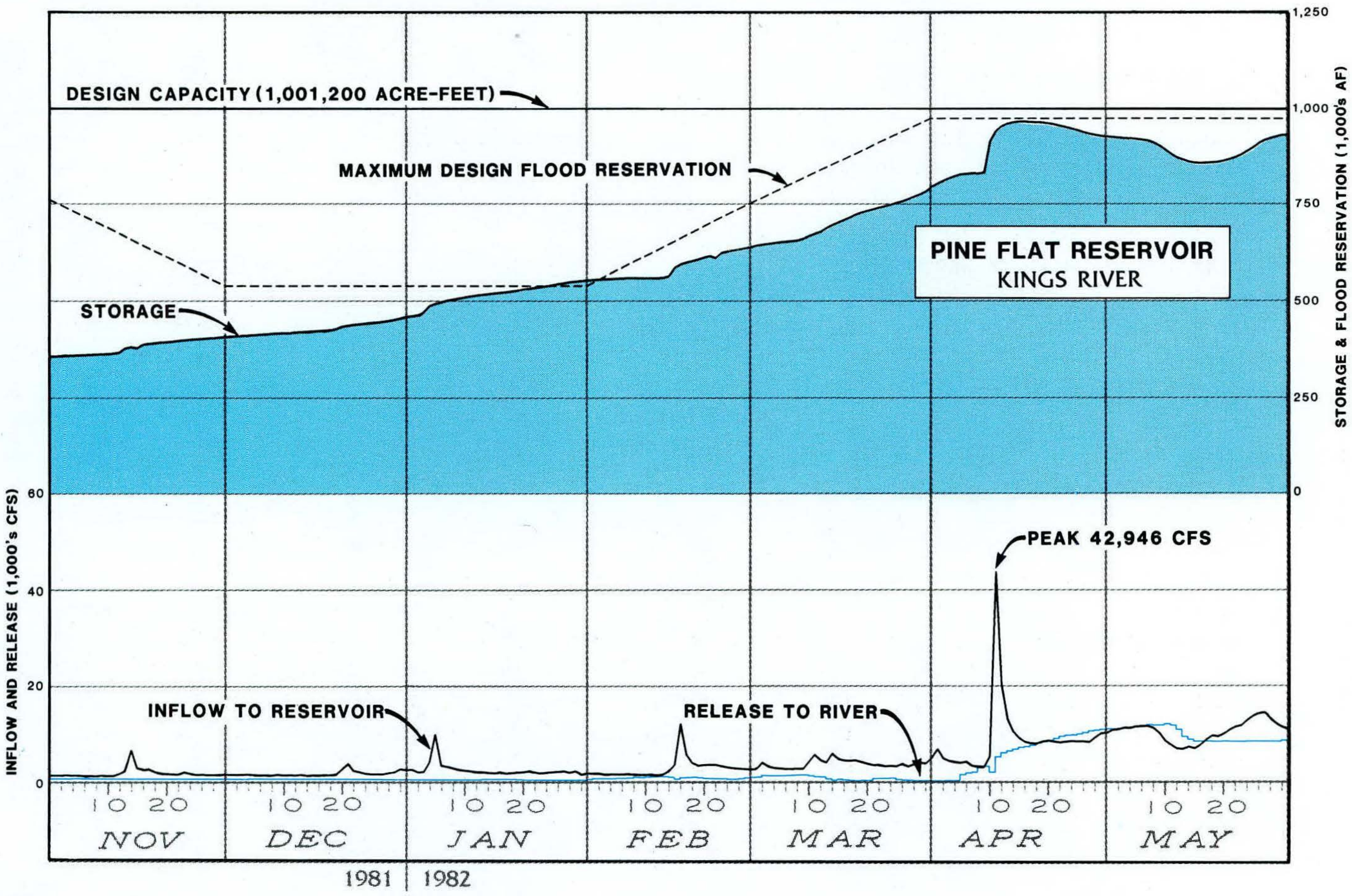
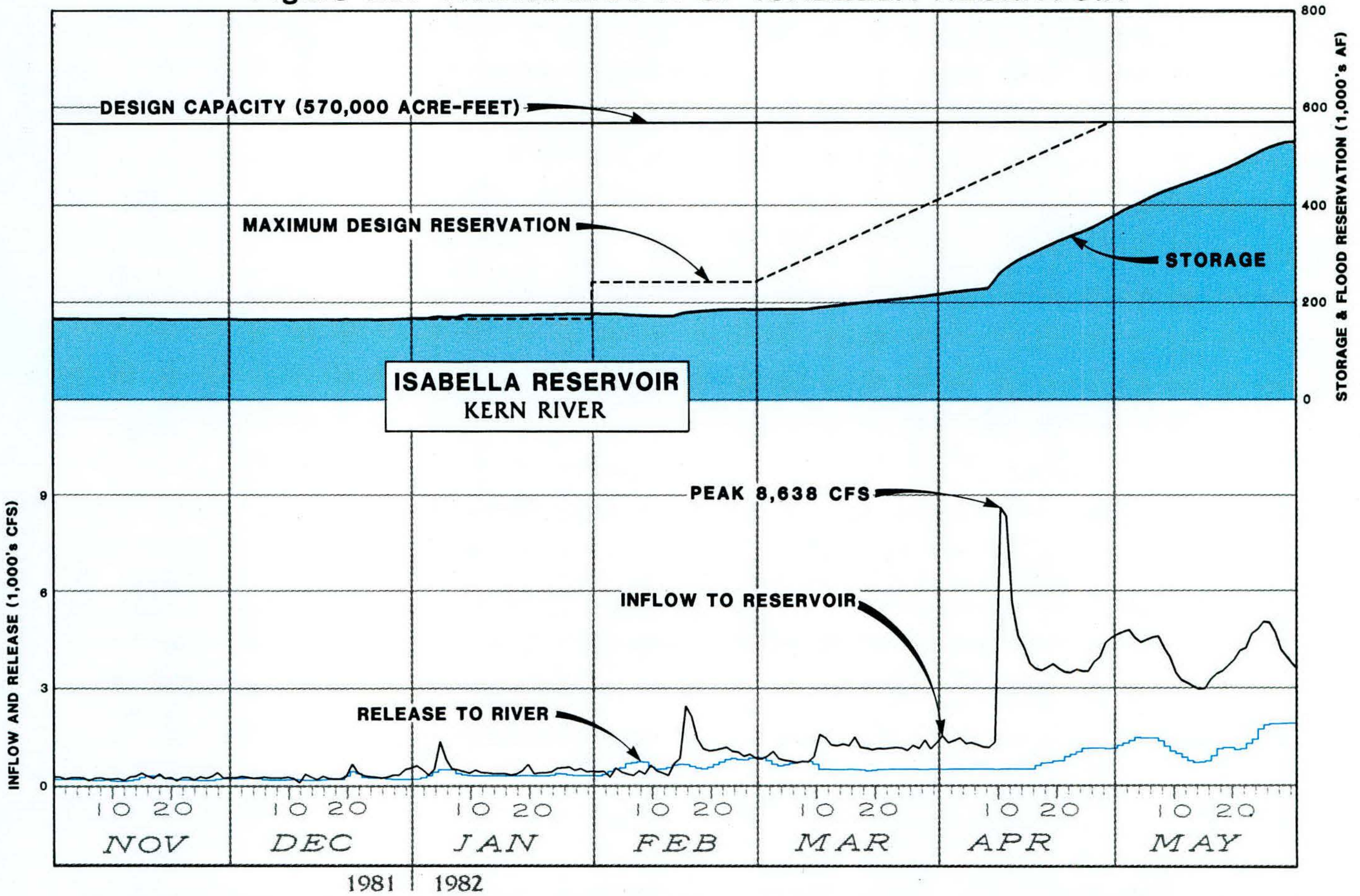


Figure 23. HYDROGRAPH OF ISABELLA RESERVOIR



Another flood-mitigation action that was proved to be effective in the past is the impounding of additional runoff water in Lake Success on the Tule River by raising the spillway elevation. In April 1982, placement of sandbags at the lip of the spillway raised the crest an additional 4 feet.

Sacramento-San Joaquin Delta

Failure of the fragile and substandard levees that protect 60 islands in the Sacramento-San Joaquin River Delta is not uncommon. During Water Year 1979-80 four levees failed due to the combination of high inflow, gale force winds, and above-warning-stage ocean tides. In addition, during the late summer of 1980, the north levee of the lower Jones Tract failed from causes other than tidal or weather conditions. It was assumed that animal burrows instigated the rift in the levee. Shortly afterward, the railroad embankment that separates upper and lower Jones Tract gave way.

Immediately following that catastrophe, the Director of the Department of Water Resources ordered a special inspection of the Delta levees to identify sites that could be problems in the future. The nonproject levees surrounding 52 islands and tracts that make up most of the reclaimed Delta were visually inspected and rated in accordance with Corps of Engineers standards.

The report revealed that the Delta levees could not withstand an extended siege of wet weather or high tides and were highly vulnerable to failure due to other conditions. Of the 52 tracts inspected, none were given good marks, only 20 were judged fair, 28 poor, and 4 very poor; Medford, Mildred, and Quimby islands and Webb Tract were in the very poor category.

Millions of dollars were spent following the report to restore badly deteriorated sites to acceptable standards and to upgrade other suspect areas. Fortunately, the winter of 1980-81 was relatively mild and interruptions of levee restoration programs were minimal. Evidently the work performed during this period had some positive effect. The damage to Delta levees in 1981-82 from the heavy storms was considerably less than what could be normally expected from storms of this level if extensive preventive measures had not been taken.

Early in the winter quarter of 1981-82, Delta Island Reclamation District officials, prompted by the heavy storms of October and November, called a meeting with operators of Federal and State flood control reservoirs. The first order of business was consideration of a plan to reduce the impact of high Delta inflows caused by the convergence of emergency releases from major reservoirs during critical periods. No firm policy or commitment was decided on, however, because in making such releases, the first consideration must be to save lives and property to maintain the integrity of the flood control system upstream of the Delta.

Although the preventive measures and mitigation action taken were effective to a certain point, Delta levees were nevertheless seriously damaged and threatened by the storms of 1981-82.

On December 23, a levee break at Prospect Island inundated approximately 1,100 acres of farmland. The break occurred near the section that failed in February of 1980. Shortly afterward, a levee failure occurred on Little Franks Tract and flooded an additional 200 acres. The levees affected were nonproject levees and were not the responsibility of State or Federal agencies; therefore, responsibility for the estimated $150,000 cost of closing the breaks and dewatering was borne by the landowners.

In the midst of the January 3-5 storm that ravaged Central California, cries of distress and appeals to State and Federal agencies for manpower and material to combat levee deterioration were heard from worried Reclamation District officials. The Department of Water Resources responded by dispatching California Conservation Corps and DWR personnel to stricken areas to combat wavewash erosion generated by the high tides and winds. Dredges were sent to critical areas by local Reclamation Districts to shore up subsiding and deteriorating levees. Chief areas of concern at this time were Bradford Island, Medford Island, and Webb Tract. The quick response and emergency patchwork is generally credited with saving Medford Island.

The Delta was beset with recurring high tides, continuous high inflow and frequent strong winds for the next few months. As the levees became supersaturated from the persistent rains and above-warning tides abetted by high inflows, levee deterioration spread to other islands. Much of the flood fight effort, however, was limited to the period January 3 to January 13. The restrictions placed on deep draft navigation in the Sacramento and Stockton channels were lifted on January 25, 1982.

In addition to the critical seepage and subsidence problem at Webb Tract and Mildred and Bradford Islands, levee overtopping was observed at Venice Island and the Empire Tract. Extensive seepage through the soggy levees, particularly at Bacon and Bouldin Islands, was an additional worry to the weary flood fighters and officials.

Fortunately, as has happened in the past, predicted tides of near flood stage at Rio Vista during the peak inflow in mid-January failed to materialize. A shifting of barometric pressure just prior to the critical periods lessened the tide height, changed wind direction, and unquestionably spared several Delta islands from costly flood damage.

Although the Delta levees weathered the persistent high tides and sustained high runoff reasonably well during the winter and spring, late summer brought additional problems.

On August 23, 1982 at approximately 3 a.m., the west levee of McDonald Island failed, and 5,800 acres of agricultural land valued at $11 million were inundated to depths of 20 feet.

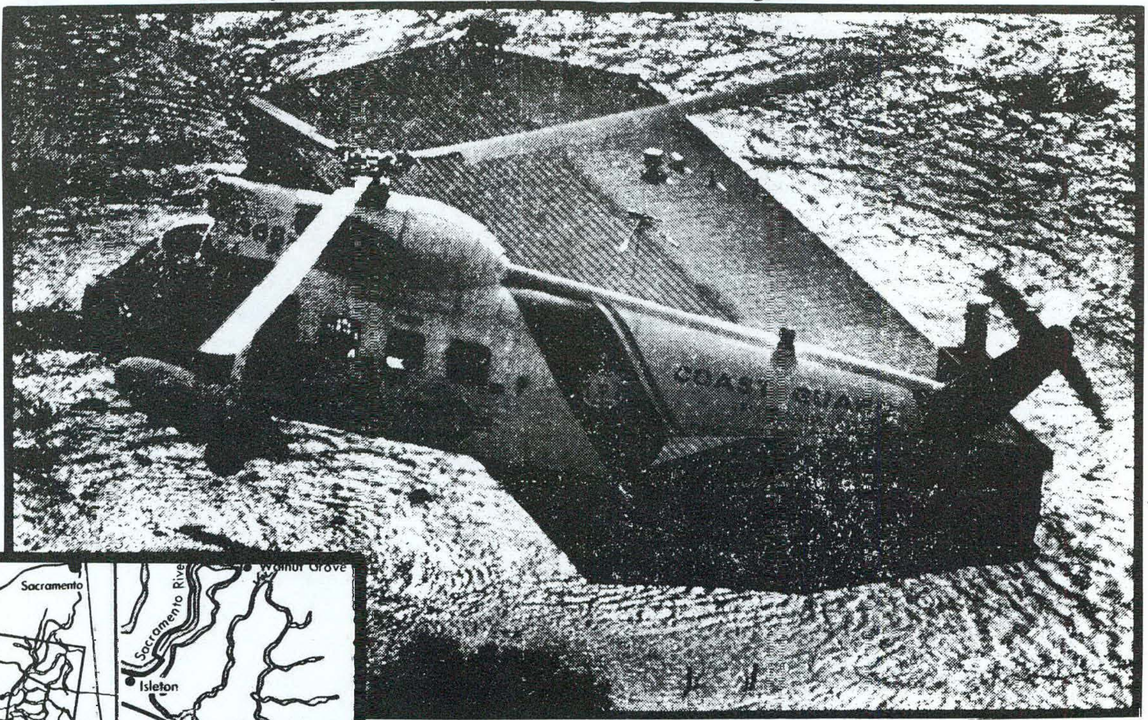
The break occurred at Latham Slough on the west side of the Island and the initial breach, which was about 200 feet wide, extended to about 600 feet wide and 85 feet deep before the inrushing water became stabilized. A dredge working in the area and a cable ferry boat in the vicinity were propelled through the breach by the force of the invading waters.

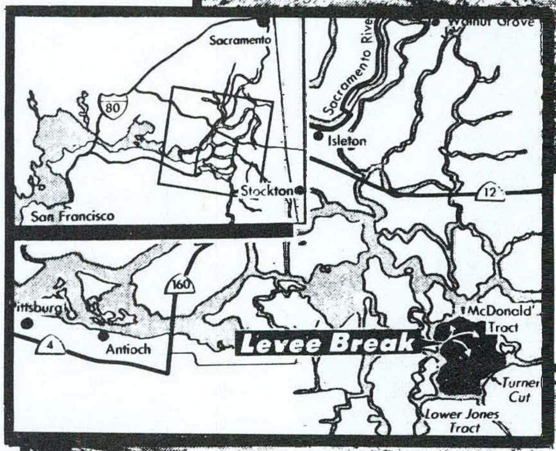
Fortunately, McDonald Island, like much of the Delta, is primarily agricultural and sparsely populated. About 100 persons, however, were evacuated by the California Highway Patrol, Sheriff's Deputies, and the Coast Guard by boat and helicopter. Some residents and domestic animals were rescued from rooftops of structures not completely under water. No loss of life or serious bodily injury occurred, but loss of personal property by residents was nearly total.

A Pacific Gas and Electric natural gas compound located on the Island escaped without serious damage to the facility but several work vehicles and equipment at the site were damaged by the high water.

Crop damage to corn, asparagus, potatoes, sunflowers, milo, grapes, and grass turf, due to the flooding, was estimated at over

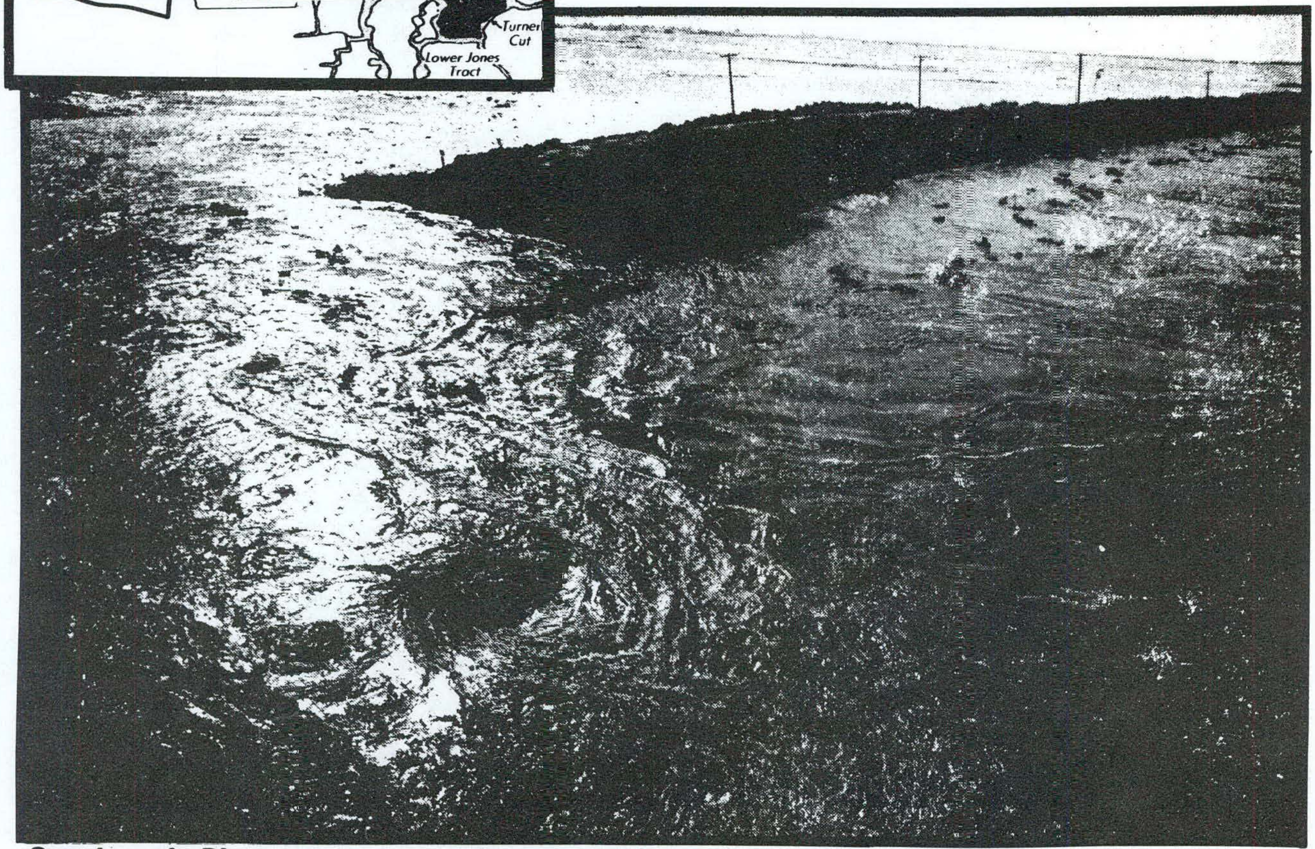
Coast Guard helicopter failed in attempt to rescue dog from barn roof





Mc Donald Island Levee Break

Sacramento/San Joaquin Delta



San Joaquin River waters surge through break

Photos by KIM KOMENICH

$5 million. Fortunately, 1,500 acres of wheat and barley had been harvested prior to the levee break. Farm equipment, drill rigs, and rolling stock inundated by the levee break were valued at $4 million, but many of these items were salvaged.

The Stanislaus County Supervisors immediately proclaimed the County a disaster area, the first step of an appeal for State and Federal funds to share the costs of repair and damage to crops, equipment, and facilities on the island. The Governor of California also responded by proclaiming the county an emergency area on August 25, 1982. An appeal to the President to proclaim the county a Federal Emergency was initially denied, but on September 24, 1982, was approved.

Repair of the breach began immediately after the waters stabilized and dewatering of the island began when the closure was completed. The complete restoration of the island is expected to be completed by year's end at a cost of about $7 million.

FLOODING IN THE NORTHERN OWENS VALLEY

On September 26, floodwaters from rain-gorged creeks surged down the eastern Sierra Nevada, bursting one small earthen dam, destroying homes, causing widespread property damage, and forcing the evacuation of nearly 1,400 residents.

First word of the failure of the Southern California Edison Company's North Lake Dam came about 9:00 a.m. Sunday, September 26, 1982. The dam, constructed in 1904, is located on the North Fork of Bishop Creek about 15 miles west of Bishop in Inyo County. The failure is attributed to two days of heavy rainfall, from tropical storm Olivia, on a fast melting snowpack. The Kaiser Point precipitation gauging station, located about 30 miles west of the dam, recorded 7.08 inches of rainfall over a 56-hour period beginning about 5:00 a.m. September 24.

The failure of North Lake Dam was only a contributing factor, not the cause of the flooding that occurred in the lower reaches of the Bishop Creek watershed. Even heavier damage was done by the overflowing waters of Big Pine Creek about 15 miles south of Bishop Creek. Both creeks are tributaries to the Owens River.

In Bishop, U. S. Highway 395, the main corridor through the Owens Valley, was cut on Sunday, September 26, by stream overflow from Bishop Creek. Bishop Creek was reported to be carrying about 1,700 cfs; the 100-year flood flow is 1,430 cfs. Most of the damage in the Bishop area occurred in the northwest side of town, where scores of homes and a trailer park were evacuated by sheriff's deputies.

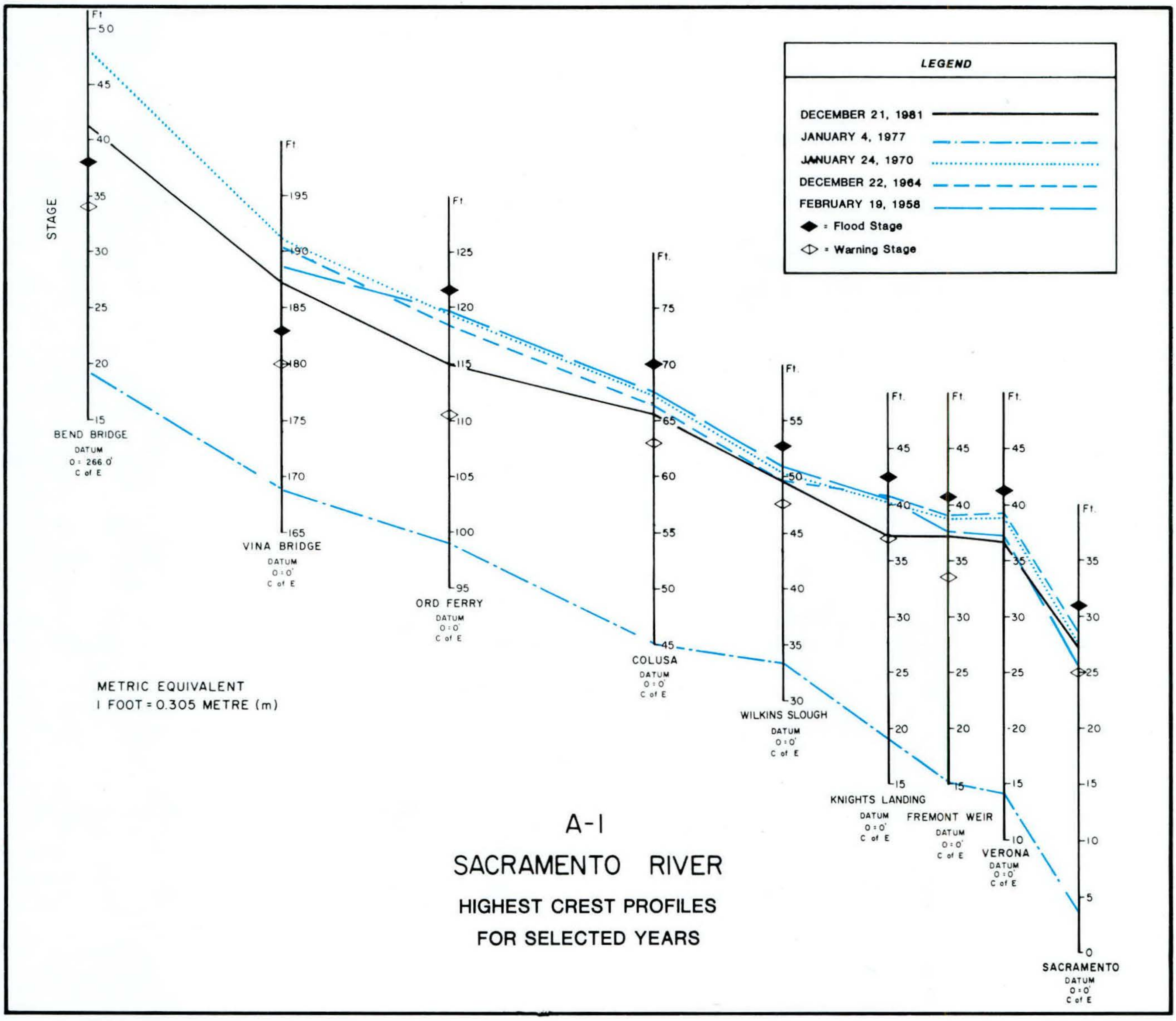
At Big Pine, a diversion channel on Big Pine Creek failed to contain the runoff, and water flowed into the Big Pine Indian Reservation, undermining homes and damaging cars and other property.

By Monday afternoon, receding waters permitted many of the 1,400 evacuees to return home. Preliminary reports indicate that 83 homes, 2 cabins and 5 businesses were damaged. The total damage to private homes and public facilities is estimated to be about $7.5 million.

On September 27, the Governor declared a state of emergency in Inyo County because of the flooding. The Federal Emergency Management Agency (FEMA) later denied the Governor's request of the President to proclaim Inyo County a Federal Emergency.

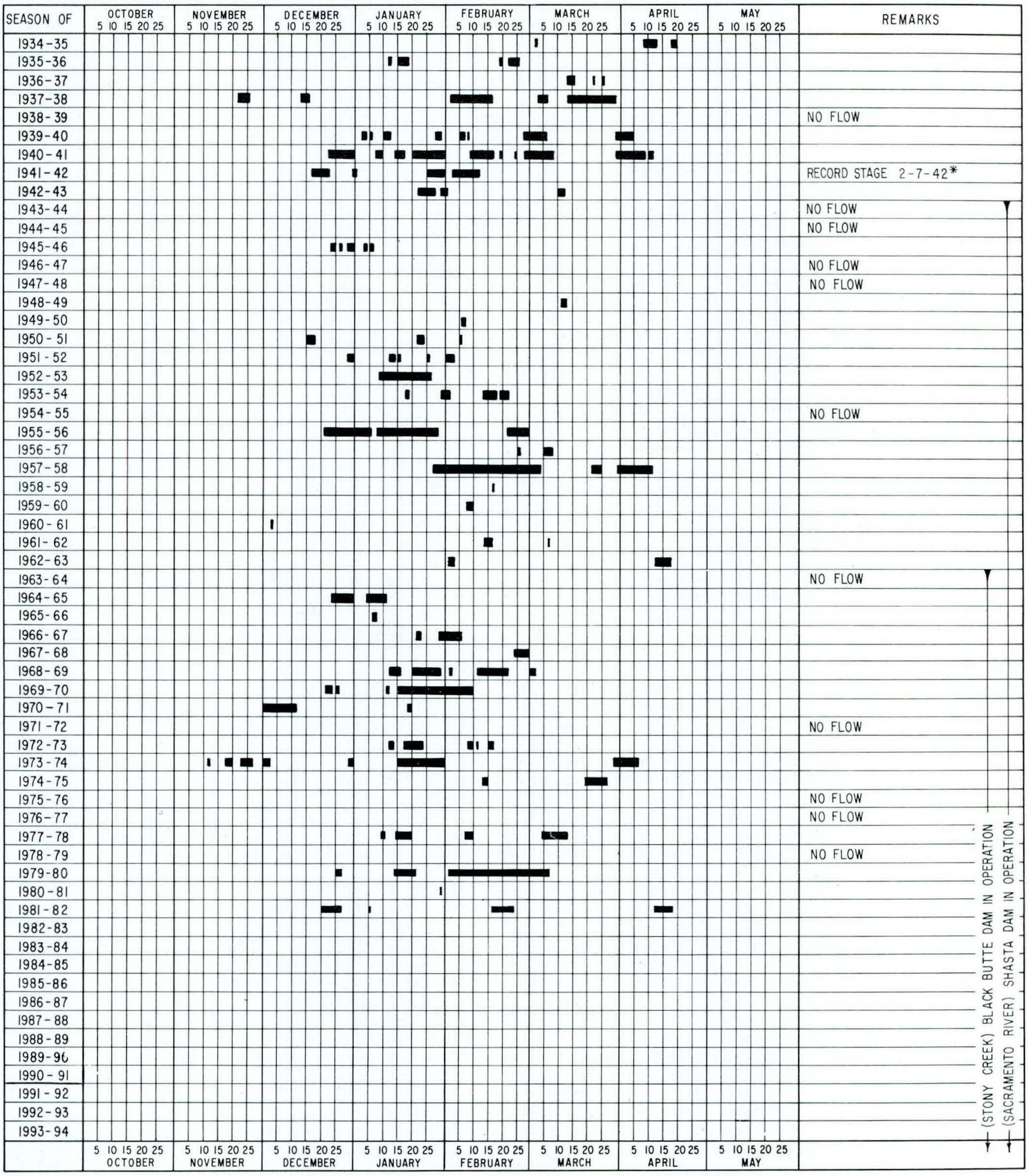
APPENDIX

Sacramento River Crest
and
Weir Overflow Records



A-1
SACRAMENTO RIVER
HIGHEST CREST PROFILES
FOR SELECTED YEARS

A-2. PERIOD OF RECORD OF OVERFLOW OF THE MOULTON WEIR



NOTE:

Data compiled from records of D.W.R. stream gaging station "Sacramento River at Moulton Weir."

Datum: 0 = 0' U.S.E.D.

Period of record: 1935 to present

Crest elevation = 76.75 feet

LEGEND

Designates periods of flow over weir

* 83.8 feet

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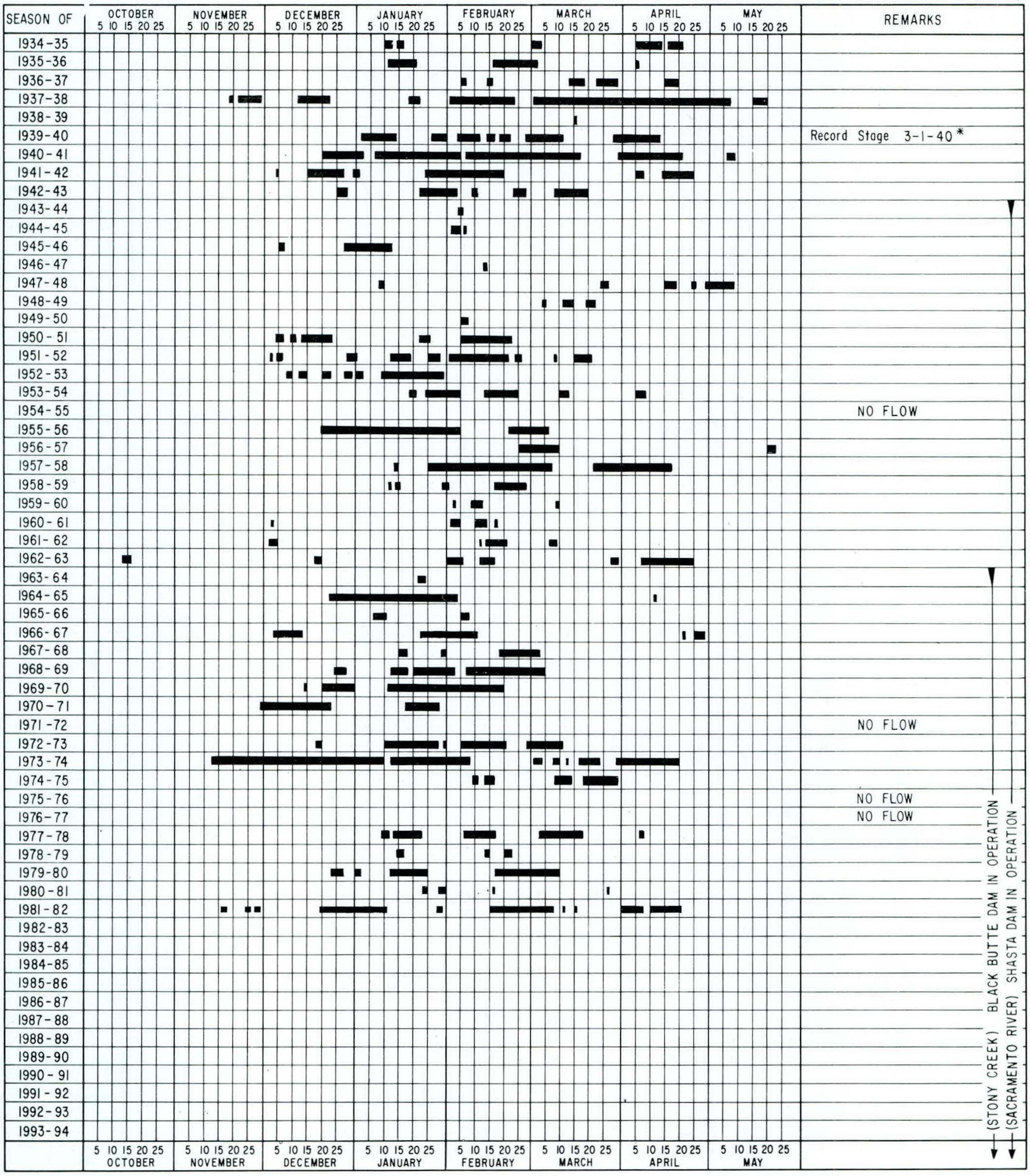
DEPARTMENT OF WATER RESOURCES

A-3. PERIOD OF RECORD OF OVERFLOW OF COLUSA WEIR



NOTE:

Data compiled from records of D.W.R. stream gaging station Sacramento River at Colusa Weir

Datum: 0 = 0' U.S.E.D.

Period of record: 1935 to present

Crest elevation: 61.80 feet

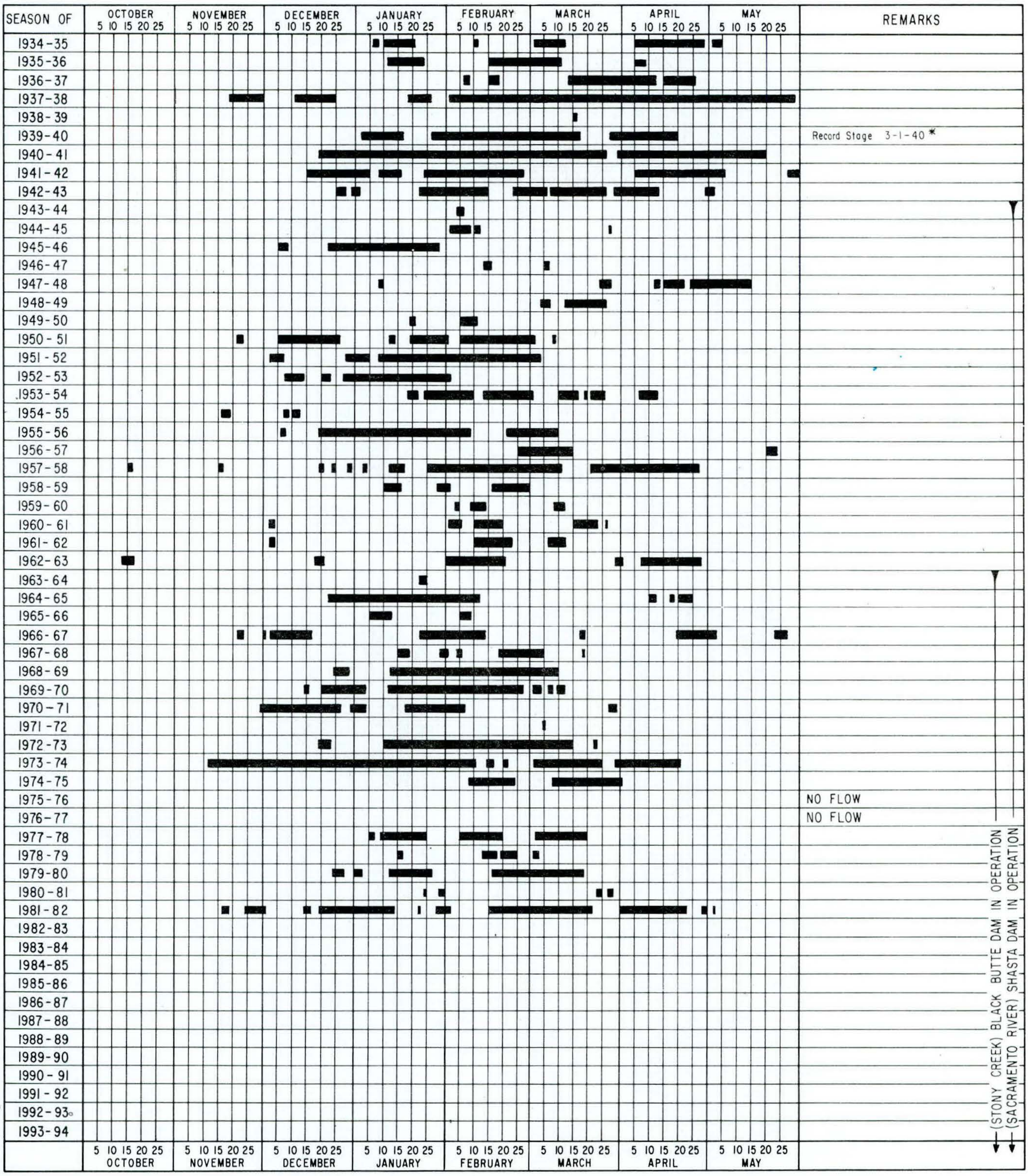
LEGEND

Designates periods of flow over weir

* 70.6 feet

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

A-4 PERIOD OF RECORD OF OVERFLOW OF THE TISDALE WEIR



NOTE:

Data compiled from records of D.W.R. stream gaging station "Sacramento River at Tisdale Weir"

Datum: 0=0' U.S.E.D.

Period of record: 1935 to present

Crest elevation = 45.45 feet

LEGEND

▬ Designates periods of flow over weir

*53.3 feet

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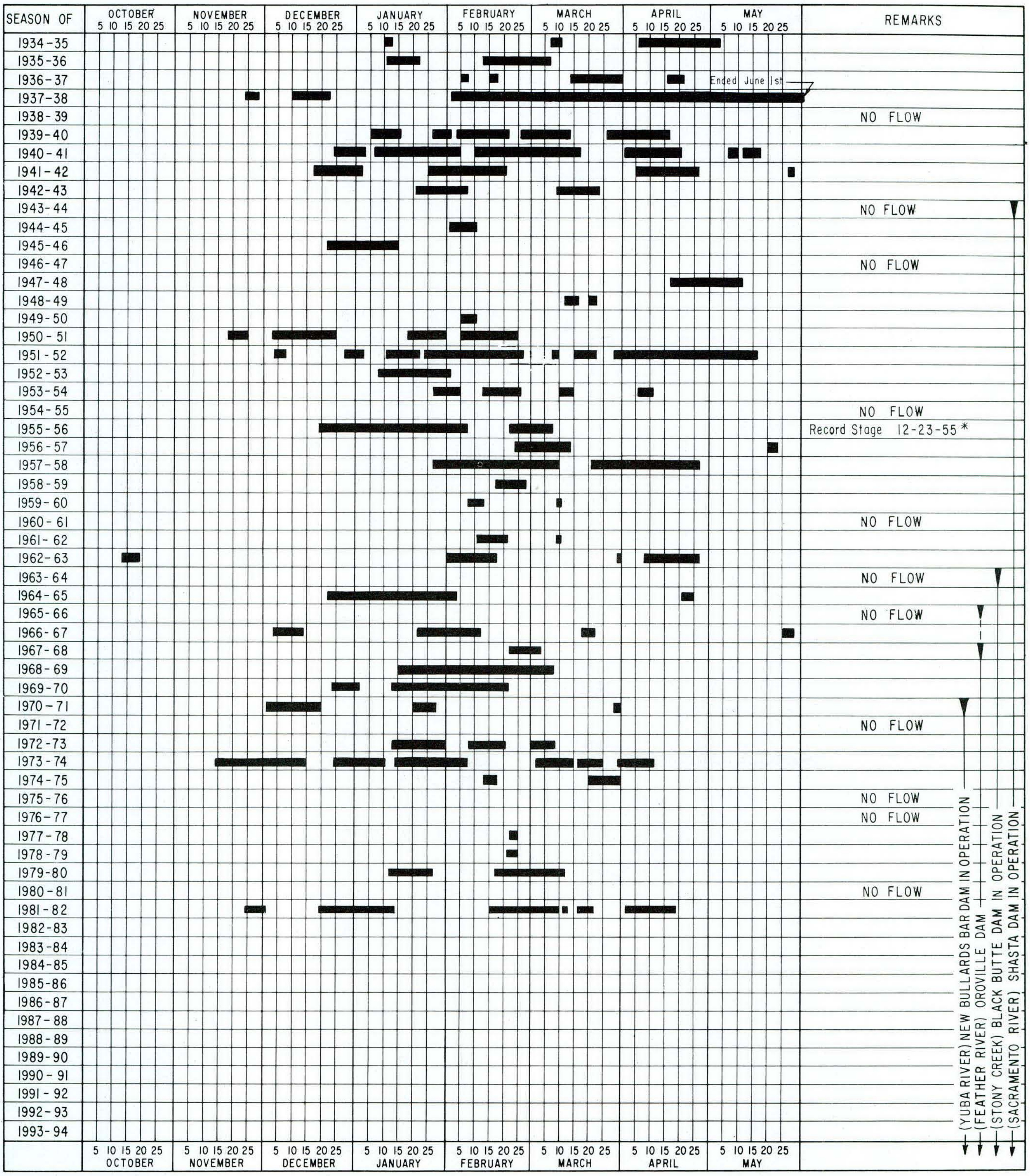
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

A-5. PERIOD OF RECORD OF OVERFLOW OF THE FREMONT WEIR



NOTE:

Data compiled from records of D.W.R. stream gaging station "Sacramento River at Freemont Weir, West End"

Datum: 0 = 0' U.S.E.D.

Period of record: 1934 to present

Crest elevation = 33.50 feet

LEGEND

Designates periods of flow over weir

* 39.7 feet

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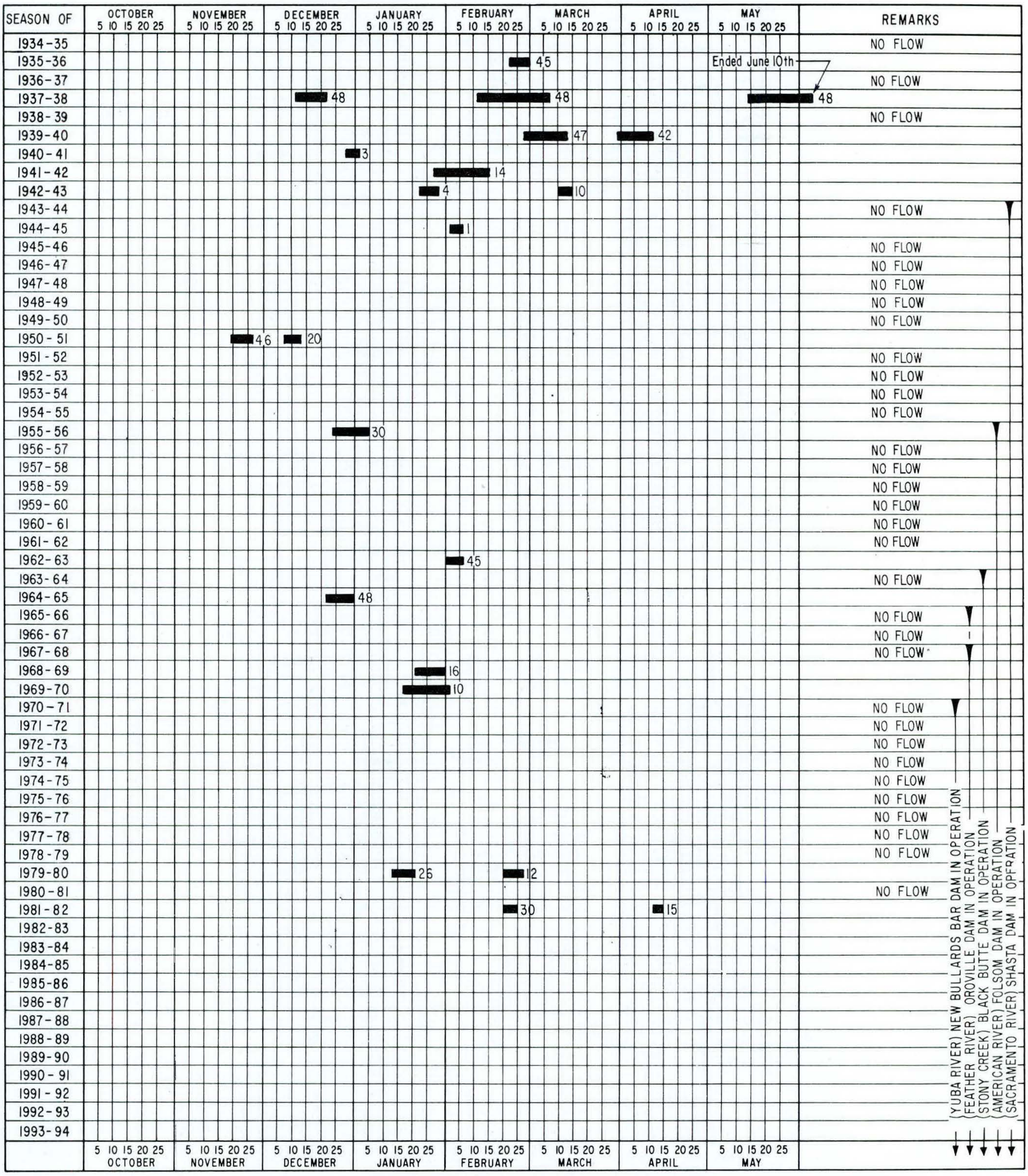
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

A-6. PERIOD OF RECORD OF OVERFLOW OF THE SACRAMENTO WEIR



NOTE:

Data compiled from records of D.W.R. stream gaging station "Sacramento Weir Spill to Yolo Bypass, near Sacramento.

Datum: 0=0' U.S.E.D.

Period of record: 1926 to present

Crest elevation = 24.75 feet

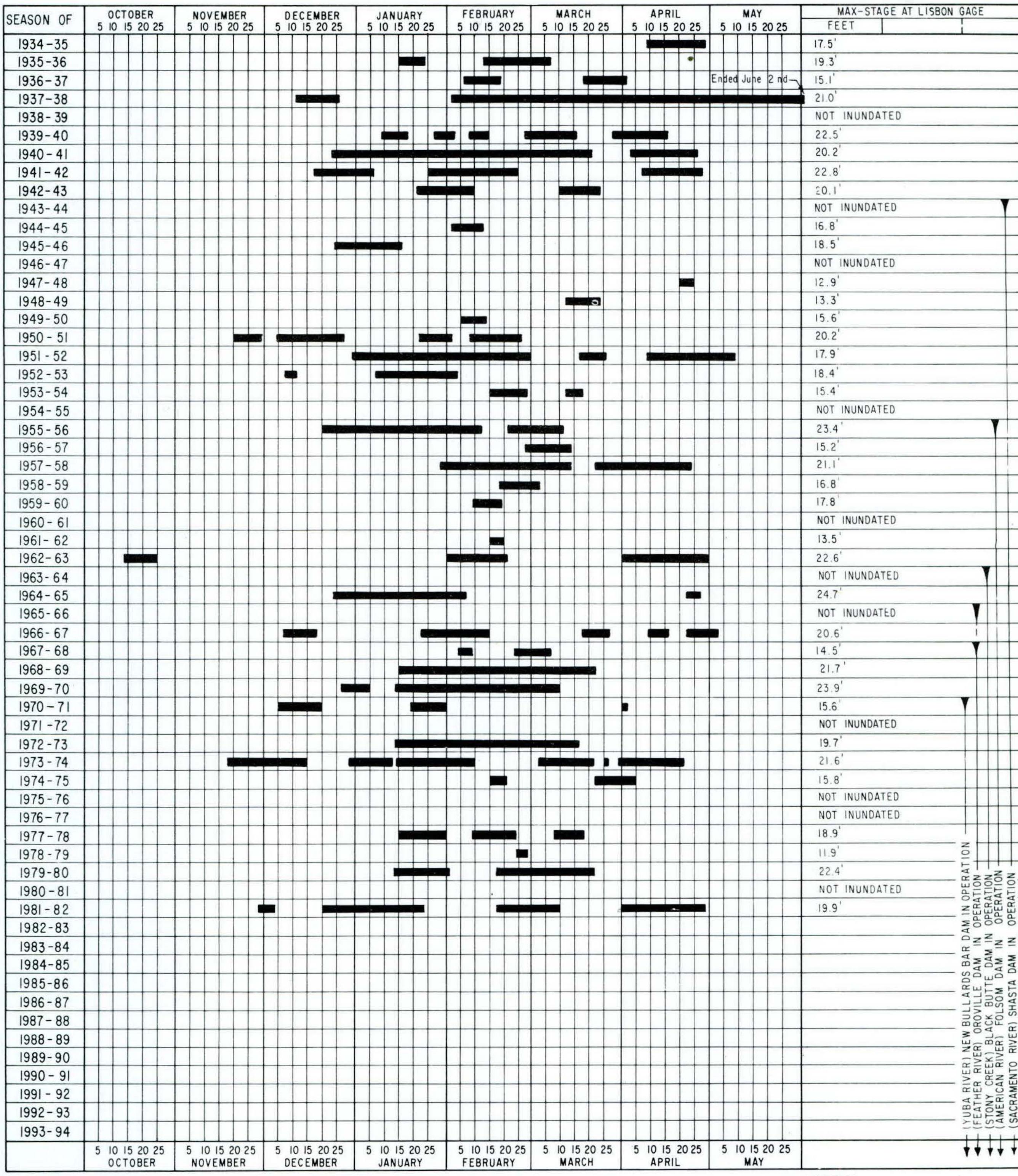
Elevation of top of gates = 31.0 feet

LEGEND

▬ 5 Designates periods of flow over weir and total number of gates opened.

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

A-7. PERIOD OF RECORD OF INUNDATION OF THE YOLO BYPASS



NOTE:

Data compiled from records of D.W.R. stream gaging station "Yolo Bypass near Lisbon."

Datum: 0=U.S.E.D. Datum

Period of Record: 1914 to Present

Assumed overflow of Bypass at stage above 11.5' on the Lisbon gage.

LEGEND

▬ Designates period of inundation of Bypass.

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

77551-950 8-83 1M OSP

CONVERSION FACTORS

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

State of California—Resources Agency
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