Flood Hydrology of Butte Basin 1973 and 1974 Water Years Sacramento Valley California A Progress Report

U.S. GEOLOGICAL SURVEY

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Prepared in cooperation with the
CALIFORNIA DEPARTMENT OF WATER RESOURCES
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UNITED STATES DEPARTMENT OF THE INTERIOR

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CONVERSION FACTORS

Factors for converting English units to the International System of Units (*SI*) are given below to four significant figures. However, in the text, the metric equivalents are shown only to the number of significant figures consistent with the values for the English units.

English	*Multiply by*	*Metric (SI)*
acre-ft (acre-feet)	1.233×10^{-3}	hm^3 (cubic hectometres)
ft (feet)	3.048×10^{-1}	m (metres)
ft^3/s (cubic feet per second	2.832×10^{-2}	m^3/s (cubic metres per second
in (inches)	$2.540 \times 10^{+1}$	mm (millimetres)
mi (miles)	1.609	km (kilometres)
mi^2 (square miles)	2.590	km^2 (square kilometres)

FLOOD HYDROLOGY OF BUTTE BASIN, 1973 AND 1974 WATER YEARS SACRAMENTO VALLEY, CALIFORNIA--A PROGRESS REPORT

By R. G. Simpson

ABSTRACT

Stage and discharge data are being collected at selected locations to describe the flood hydrology of Butte Basin. Flooding in the basin is caused primarily by overflow from the Sacramento River which forms the western boundary of the basin. Overflow from the Sacramento River is measured along four roads which cross the basin--Ord Ferry Road, Afton Boulevard, State Highway 162, and Gridley Road--and at Moulton and Colusa Weirs.

During the 1973 water year only minor flooding occurred near the roads, and flows were carried by existing channels. Overflow at Colusa Weir reached a peak flow of about 40,000 ft^3/s (1,130 m^3/s) on January 20; overflow at this weir caused most of the flooding within the lower part of Butte Basin. A peak stage of 57.5 ft (17.53 m) was recorded in Butte Basin opposite Colusa Bypass.

Two floods, one during January and the second at the end of March caused significant overflow to Butte Basin during the 1974 water year. Peak overflow along Ord Ferry Road was about 70,000 ft^3/s (1,980 m^3/s) on January 17 and was about 38,000 ft^3/s (1,080 m^3/s) on March 31. About half the overflow from these floods returned to the main channel before reaching Afton Boulevard. Peak flows were measured along Afton Boulevard, State Highway 162, and Gridley Road, and ranged from about 39,000 ft^3/s to 44,000 ft^3/s (1,100 m^3/s to 1,250 m^3/s) on January 18 and from about 21,000 ft^3/s to 24,000 ft^3/s (595 m^3/s to 680 m^3/s) on April 1. Peak overflows at Moulton Weir were about 27,000 ft^3/s (764 m^3/s) on January 18 and 20,000 ft^3/s (566 m^3/s) on April 3. Peak overflows at Colusa Weir were nearly 60,000 ft^3/s (1,700 m^3/s) during both floods. Peak stages in Butte Basin opposite Colusa Bypass were 61.3 ft (18.68 m) on January 19 and 60.3 ft (18.38 m) on April 4.

INTRODUCTION

Butte Basin is between Chico and Meridian (fig. 1) in Butte, Glenn, Colusa, and Sutter Counties. It is bounded on the west by the Sacramento River whereas the eastern boundary, for this study, is considered to be the limits of past flooding. The basin is about 35 mi (56 km) long (north to south), ranges from 2 to 12 mi (3 to 19 km) in width, and consists mainly of sparsely-populated agricultural land. The basin serves as a storage area for overflow during floods on the Sacramento River, a conveyance channel for overflow south to Sutter Bypass, and a major wintering area for migratory waterfowl.

Major flooding occurred throughout Butte Basin in the 1940's, in 1958, and in January 1970. The peak flow on February 28, 1940, along Ord Ferry Road was estimated to have been 370,000 ft^3/s or 10,500 m^3/s (California Department Public Works, 1948, p. 54), of which possibly 180,000 ft^3/s (5,100 m^3/s) overflowed into Butte Basin at points north of Butte City. Since 1943 overflow to Butte Basin has been reduced in peak magnitude by regulation of the Sacramento River at Shasta Dam. Shasta Dam is located about 80 mi (129 km) north of Ordbend. During the floods of February 1958 and January 1970, peak overflow at points north of Butte City was estimated at about 100,000 ft^3/s (2,830 m^3/s).

Since the early 1900's, private interests have attempted to reclaim and protect areas within the basin that are subject to flooding. Land has been leveled and levees built that have changed the distribution of flow and the amount of flood overflow. In 1969, the California Water Commission (California Department Water Resources, 1970, p. 24) investigating the upper Sacramento River Basin requested that the California Department of Water Resources initiate hydrologic studies within Butte Basin.

In January 1972, the Geological Survey, at the request of The Reclamation Board, State of California, prepared a proposal for a flood-hydrology study of Butte Basin. After several meetings with the California Department of Water Resources and the U.S. Army Corps of Engineers, plans for this cooperative study were made with the objective of completing it in June 1977.

The objectives of the study are to document flood data collected by the Geological Survey and other agencies, including historic stages, inundated areas, discharge, timing and distribution of flow, and flow frequency and duration; to describe changes in the main channel of the Sacramento River (meanders, scour, and fill) in the reach from the mouth of Big Chico Creek to Glenn; and to discuss the effects of levee, weir, and highway construction in Butte Basin on floodflows that occur during the study period.

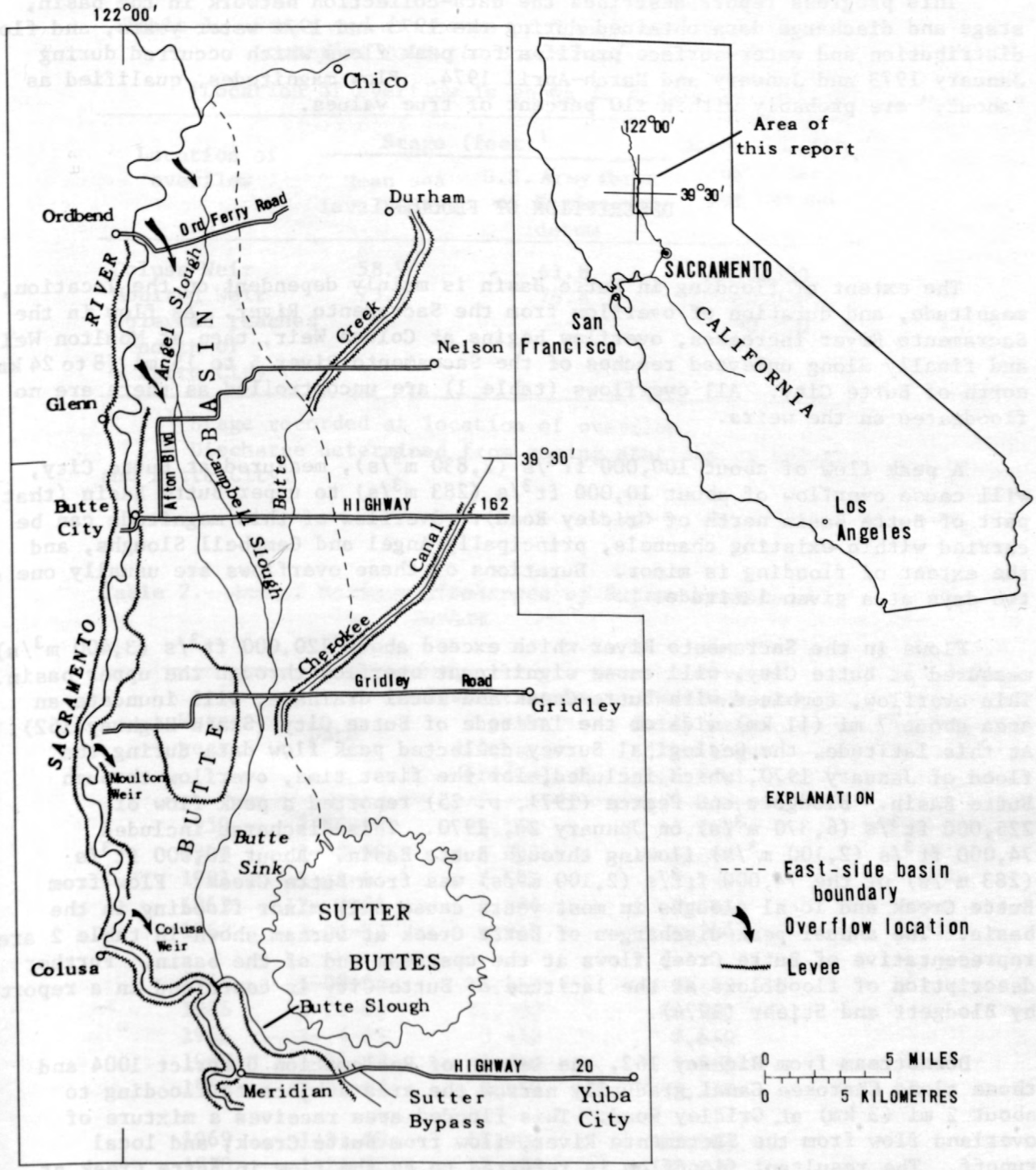


FIGURE 1.—Index map.

This progress report describes the data-collection network in the basin, stage and discharge data obtained during the 1973 and 1974 water years, and flow distribution and water-surface profiles for peak flows which occurred during January 1973 and January and March-April 1974. Flow magnitudes, qualified as "about," are probably within ±10 percent of true values.

DESCRIPTION OF FLOODING

The extent of flooding in Butte Basin is mainly dependent on the location, magnitude, and duration of overflow from the Sacramento River. As flow in the Sacramento River increases, overflow begins at Colusa Weir, then at Moulton Weir, and finally along unleveed reaches of the Sacramento River 5 to 15 mi (8 to 24 km) north of Butte City. All overflows (table 1) are uncontrolled as there are no floodgates on the weirs.

A peak flow of about 100,000 ft^3/s (2,830 m^3/s), measured at Butte City, will cause overflow of about 10,000 ft^3/s (283 m^3/s) to upper Butte Basin (that part of Butte Basin north of Gridley Road). Overflow of this magnitude can be carried within existing channels, principally Angel and Campbell Sloughs, and the extent of flooding is minor. Durations of these overflows are usually one or two days at a given latitude.

Flows in the Sacramento River which exceed about 120,000 ft^3/s (3,400 m^3/s), measured at Butte City, will cause significant overflow through the upper basin. This overflow, combined with Butte Creek and local drainage, will inundate an area about 7 mi (11 km) wide at the latitude of Butte City (State Highway 162). At this latitude, the Geological Survey collected peak flow data during the flood of January 1970, which included, for the first time, overflow through Butte Basin. Blodgett and Pearce (1971, p. 25) reported a peak flow of 225,000 ft^3/s (6,370 m^3/s) on January 24, 1970. This discharge included 74,000 ft^3/s (2,100 m^3/s) flowing through Butte Basin. About 10,000 ft^3/s (283 m^3/s) of the 74,000 ft^3/s (2,100 m^3/s) was from Butte Creek. Flow from Butte Creek and local sloughs in most years cause only minor flooding in the basin. The annual peak discharges of Butte Creek at Durham shown in table 2 are representative of Butte Creek flows at the upstream end of the basin. Further description of floodflows at the latitude of Butte City is contained in a report by Blodgett and Stiehr (1974).

Downstream from Highway 162, the levees of Reclamation District 1004 and those along Cherokee Canal gradually narrow the area subject to flooding to about 2 mi (3 km) at Gridley Road. This flooded area receives a mixture of overland flow from the Sacramento River, flow from Butte Creek, and local runoff. The resultant floodflow is referred to as the flow in Butte Creek at Gridley Road.

Table 1.--*Stage and discharge of Sacramento River when overflow to Butte Basin begins*

[Location of overflow is shown in figure 1]

Location of overflow	Stage (feet)[1]		Discharge,[2] in cubic feet per second
	Mean sea level datum	U.S. Army Corps of Engineers datum	
Colusa Weir	58.9	61.8	30,000
Moulton Weir	73.9	76.8	60,000
Unleveed reaches north of Butte City	--	--	90,000

[1] Stage recorded at location of overflow.

[2] Discharge determined from gaging stations at Colusa and Butte City.

Table 2.--*Annual maximum discharges of Butte Creek near Durham*

Water year	Date	Instantaneous peak discharge (ft^3/s)	Maximum daily mean discharge (ft^3/s)
1959	2-16-59	5,100	3,260
1960	2- 8-60	5,100	4,290
1961	1-31-61	3,600	2,330
1962	12- 2-61	7,380	3,790
1963	1-31-63	9,810	6,260
1964	1-20-64	5,110	2,180
1965	12-22-64	21,300	16,900
1966	1- 4-66	3,410	2,640
1967	1-21-67	7,810	5,560
1968	2-21-68	3,850	3,210
1969	1-21-69	15,900	12,900
1970	1-24-70	18,300	10,700
1971	3-12-71	3,750	3,190
1972	1-23-72	2,050	1,290
1973	1-16-73	7,000	4,760
1974[1]	3-29-74	13,900	6,280

[1] Data are preliminary.

Flooding of the lower basin is largely dependent on the duration and magnitude of overflow at Colusa Weir. During significant floods on the Sacramento River, the duration and magnitude of overland flow from the upper basin and overflow at Moulton Weir also are important. Inflow to the lower basin from Cherokee Canal and from local tributaries is minor and has not been described in this report.

Flood water leaves the lower basin by way of Butte Slough which empties into Sutter Bypass. Outflow is measured by the California Department of Water Resources at the gage on Butte Slough near Meridian.

DATA COLLECTION

Data needed to describe the flood hydrology of Butte Basin are water-surface and ground elevations throughout the basin, and discharge measurements at selected latitudes. In order to relate these data, all elevation measurements must be to the same datum. All elevations in this report are to mean sea level datum, supplementary adjustment of 1956.

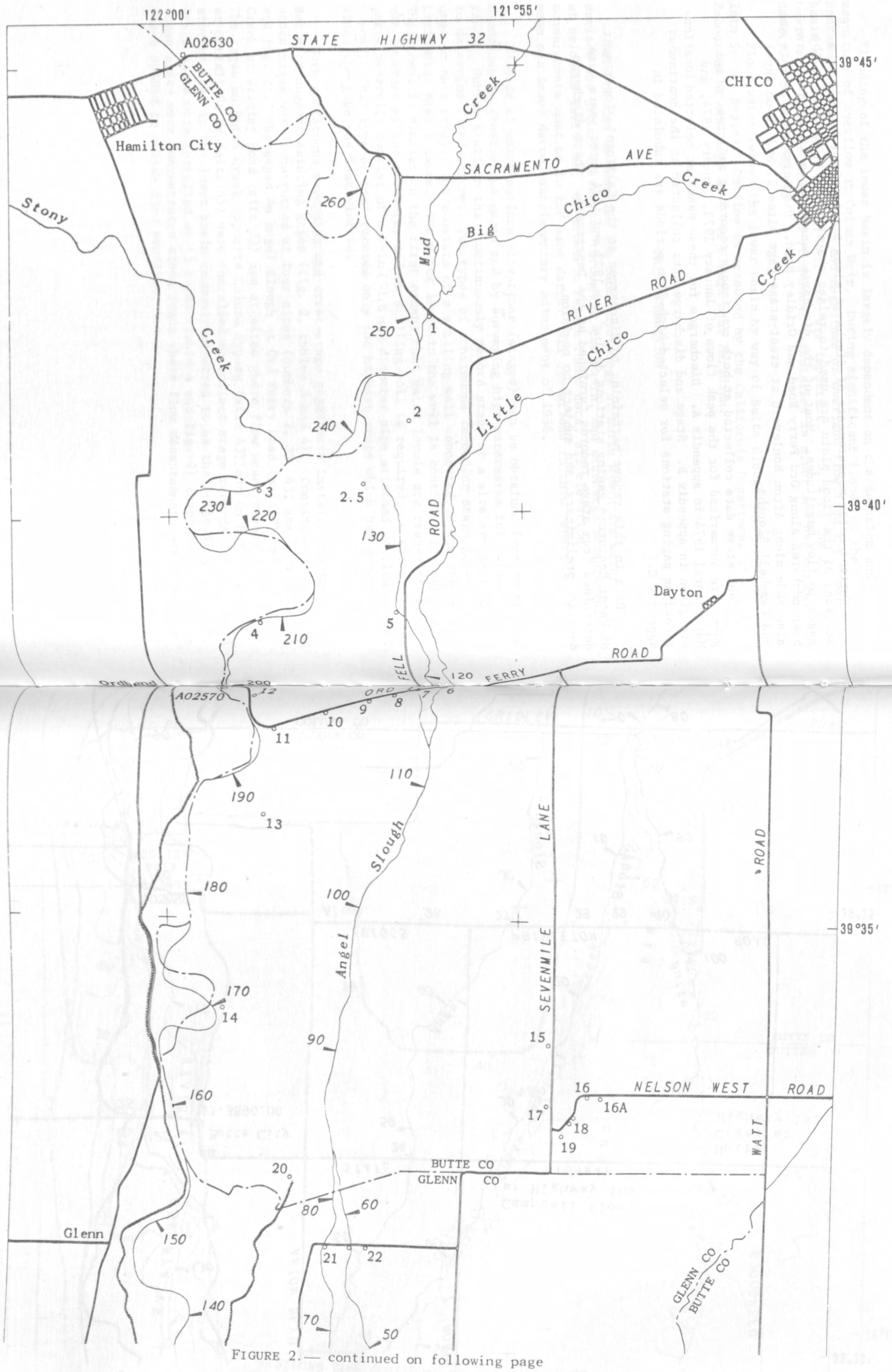
Records of water-surface elevations (stages) can be obtained from continuous recording or crest-stage gages and by surveying high watermarks following a flood. Gaging stations that continuously record stage at a site are desirable to determine flood volume. Two types of continuous recording stage gages are used in this study. One consists of a stilling well connected to the stream by horizontal pipe intakes. The water level in the well is continuously recorded. The second is similar to the first except that water levels are transmitted to the recorder by gas pressure, and no stilling well is required. Crest-stage gages generally consist of a 2-in (50.8 mm) diameter pipe attached vertically to a post. This type of gage records only the highest stage which has occurred since the gage was last visited.

Both continuous recording and crest-stage gages were installed in Butte Basin to augment existing gages (fig. 2, tables 3 and 4). Continuously recording stage gages were constructed at four sites (numbers 7, 33, 43, and 45 in table 3 and fig. 2). The gages on Angel Slough at Ord Ferry Road (site 7) and on Butte Creek at Gridley Road (site 33) are at sites where flow measurements are made. The gages on Butte Creek opposite Colusa Bypass (site 43) and on Butte Slough at Outfall Gates (site 45) were installed to collect stage records for the flood storage area in the lower basin commonly referred to as the Butte Sink. Crest-stage gages were installed at 45 sites (table 4 and fig. 2) throughout the basin. These gages were concentrated along roads where flow measurements are made, and where needed to define flow profiles.

Current-meter measurements of discharge along previously surveyed cross sections of the flood plain are used to relate the stage data obtained at the gages to flow magnitudes. Most of the discharge measurements of overflow have been centered along Ord Ferry Road and Gridley Road. Discharge measurements are also made along Afton Boulevard at crest-stage gage sites 21 and 22 on Angel and Campbell Sloughs.

Peak stage data collected at both continuous recording and crest-stage gages are summarized for the peak flows of January 1973, January 1974, and March-April 1974 in appendix A. Discharges for these peaks at selected locations are given in appendix B. Stage and discharge data collected at the continuous recording gaging stations for selected high-flow periods are tabulated in appendix C.

Data in this report pertaining to discharges at the California Department of Water Resources gaging stations during the 1973 and 1974 water years were determined from stage records furnished by the Department. These discharge data are preliminary, and subject to revision.



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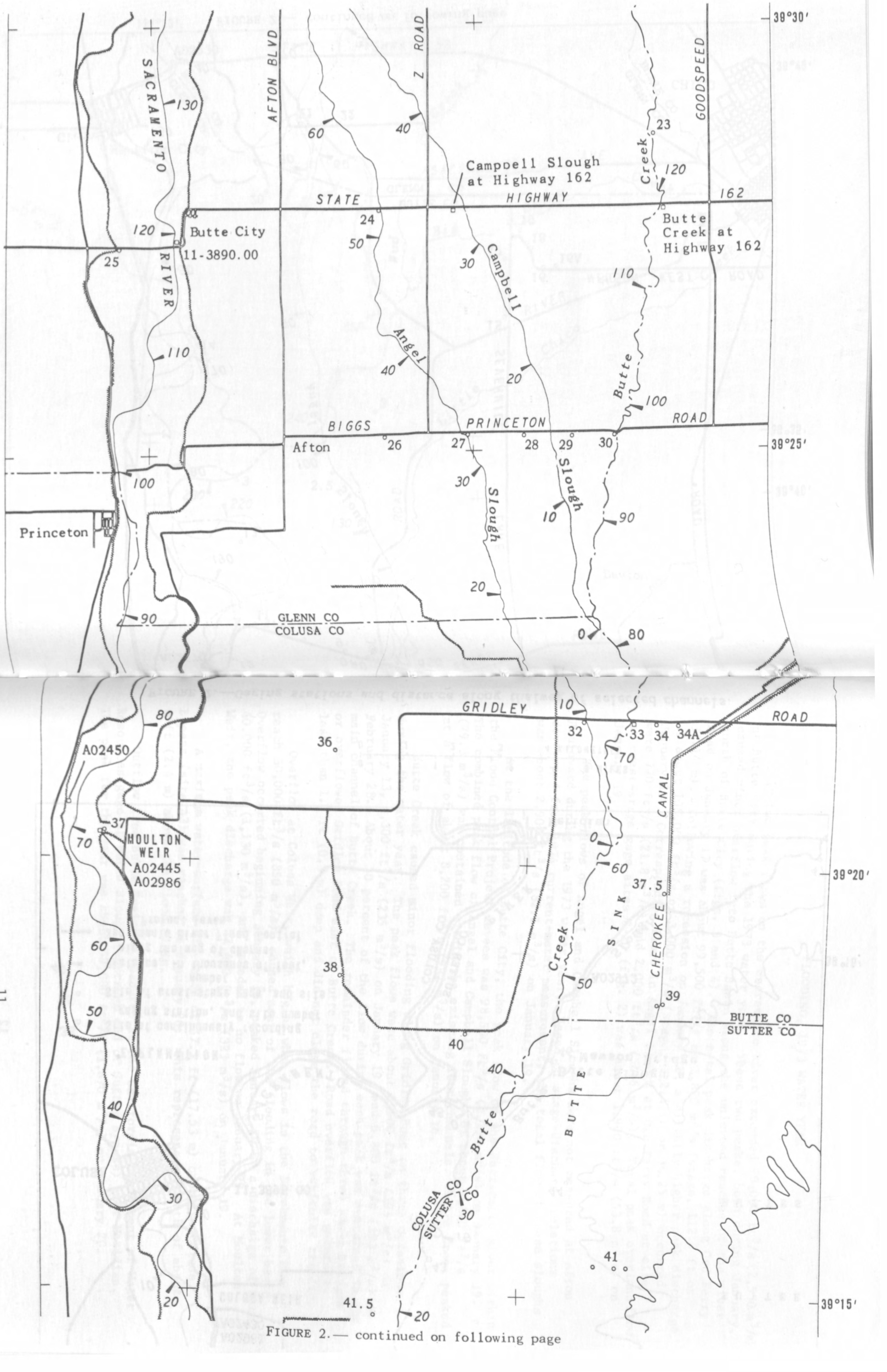

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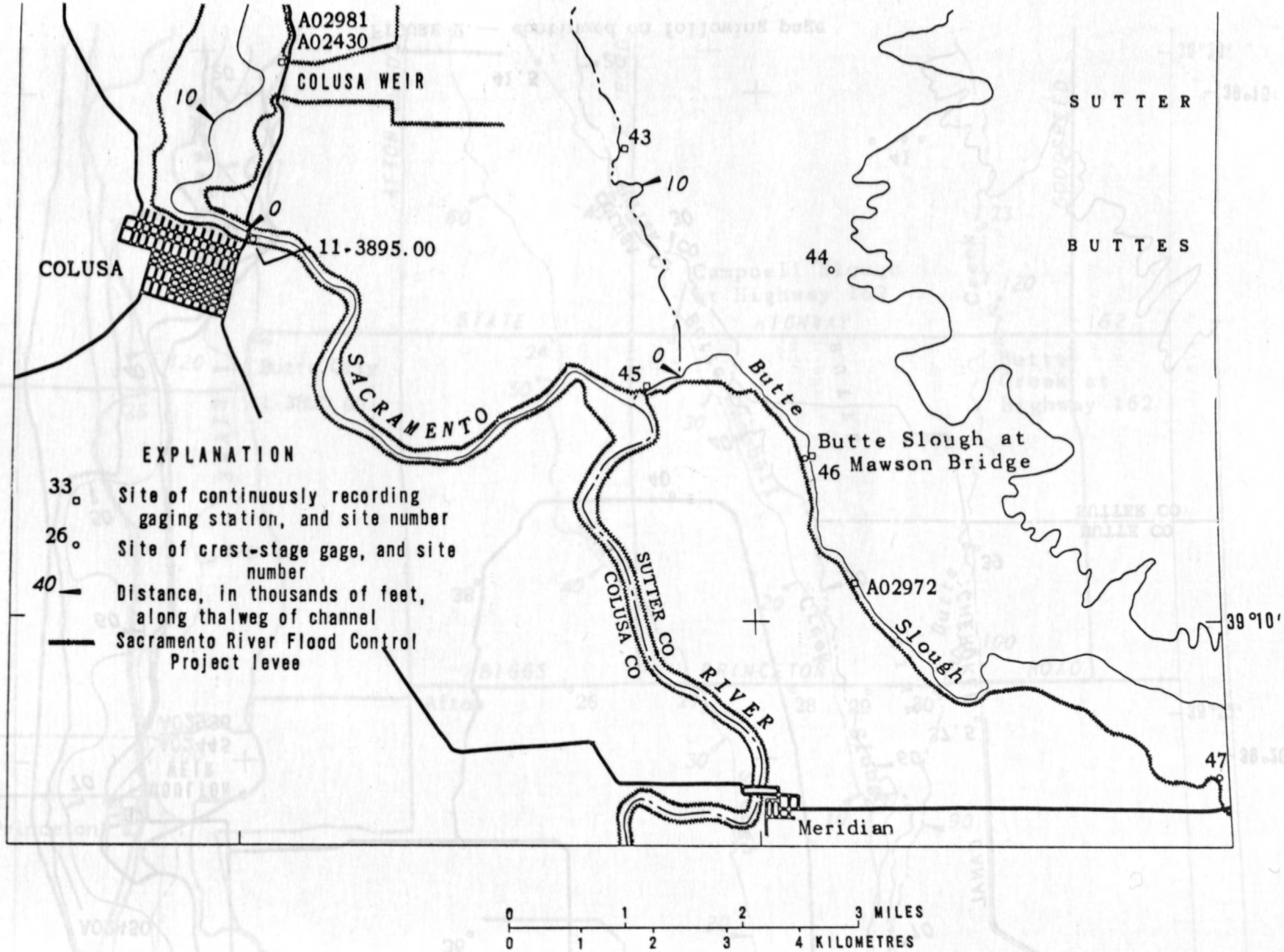


FIGURE 2.—Gaging stations and distance along thalweg of selected channels.

FLOODING, 1973 WATER YEAR

Only two peak flows on the Sacramento River exceeded 90,000 ft^3/s (2,550 m^3/s) at Butte City during the 1973 water year. These two peaks, both during January, caused minor overflow into Butte Basin along the unleveed reaches of the river north of Butte City (figs. 3 and 4). The total peak discharge along Ord Ferry Road on January 17 was about 99,500 ft^3/s or 2,820 m^3/s (stage, 112.0 ft or 34.14 m). Following a recession on January 18, a slightly higher peak discharge of about 106,000 ft^3/s or 3,000 m^3/s (stage, 112.4 ft or 34.25 m) occurred January 19. Corresponding flows in Angel Slough at Ord Ferry Road at site 7 were 770 ft^3/s (21.8 m^3/s) and 2,000 ft^3/s (56.6 m^3/s). Total peak overland flow at crest-stage gage sites 8-10 (fig. 2) was about 1,900 ft^3/s (53.8 m^3/s) on January 19.

The peak flows of Angel and Campbell Sloughs were not measured at Afton Boulevard during the 1973 water year. Based on stage-discharge relations developed from 1974 current-meter measurement, the total flow at these sloughs was about 2,900 ft^3/s (82.1 m^3/s) on January 19.

At the latitude of Butte City, the peak flow of the Sacramento River within the Flood Control Project levees was 98,500 ft^3/s (2,790 m^3/s) on January 19. The combined peak flow of Angel and Campbell Sloughs of about 2,800 ft^3/s (79.3 m^3/s) was contained within the existing four channels. Butte Creek peaked at a flow of about 8,200 ft^3/s (232 m^3/s) on January 16.

Butte Creek caused minor flooding along Gridley Road on three occasions during the water year. The peak flows were about 6,900 ft^3/s (195 m^3/s) on January 13, 8,300 ft^3/s (235 m^3/s) on January 19, and 6,800 ft^3/s (193 m^3/s) on February 28. About 50 percent of the flow during each peak was contained in the main channel of Butte Creek. The remainder flowed through three small bridges or overflowed Gridley Road east of Butte Creek. Road overflow was generally less than 1.0 ft (0.3 m) deep and did not close the road to vehicular traffic.

Overflow at Colusa Weir, which begins when flows in the Sacramento River reach 30,000 ft^3/s (850 m^3/s), caused most of the flooding in the lower basin. Overflow occurred beginning January 10, peaked January 20 at a discharge of about 40,000 ft^3/s (1,130 m^3/s), and receded to no flow on January 29. At Moulton Weir, the peak discharge was 11,400 ft^3/s (323 m^3/s) on January 19.

A maximum water-surface elevation of 57.5 ft (17.53 m) opposite Colusa Bypass (site 43) was reached on January 20. This represents a depth of about 8 ft (2.4 m) above the flood plain.

Outflow from Butte Basin is measured at the California Department of Water Resources gage at Butte Slough (upstream end of Sutter Bypass) near Meridian. The peak for the year was about 59,000 ft^3/s (1,670 m^3/s) on January 20.

Table 3.--*Continuous recording gaging stations in or near study area*

[Gaging station locations are shown in figure 2. For stations outside the area of figure 2, see California Department Water Resources (1972) and U.S. Geological Survey (1970). The gaging station, Butte Slough at Mawson Bridge, and those identified with State numbers (numbers prefixed with the letter A) are operated by the California Department Water Resources; all other stations are operated by the Geological Survey.]

Gaging station		Start of record	Type of record			
Number	Name		Stage and discharge	Stage	Stage and discharge, winter[1]	Stage, winter
A02630	Sacramento River at Hamilton City	April 1945 1927	X	X		
A02570	Sacramento River at Ord Ferry	Jan. 1948 1921	X	X		
11-3890.00	Sacramento River at Butte City	Oct. 1938	X			
A02450	Sacramento River opposite Moulton Weir	Oct. 1922		X		
A02986	Moulton Weir Spill to Butte Basin	Jan. 1940	X			
A02445	Sacramento River at Moulton Weir	Jan. 1935		X		
A02430	Sacramento River at Colusa Weir	Jan. 1935		X		
A02981	Colusa Weir Spill to Butte Basin	Jan. 1940	X			
11-3895.00	Sacramento River at Colusa	June 1940	X			
A04265	Butte Creek near Durham	Jan. 1958	X			
---	Butte Creek at Highway 162	Dec. 1969			X	
33	Butte Creek at Gridley Road	Sept. 1972			X	
43	Butte Creek opposite Colusa Bypass	Sept. 1972				X
45	Butte Slough at Outfall Gates	Oct. 1972 June 1924		X		X
---	Butte Slough at Mawson Bridge	-- 1972		X		
A02972	Butte Slough near Meridian	Jan. 1939 Nov. 1934	X	X		
A02984	Cherokee Canal near Richvale	July 1960	X			
7	Angel Slough at Ord Ferry Road	Sept. 1972			X	
---	Campbell Slough at Highway 162	Dec. 1969			X	
11-3885.00	Stony Creek near Hamilton City (discontinued 9-30-73)	Oct. 1940	X			
11-3880.00	Stony Creek below Black Butte Dam	July 1955	X			

[1] Winter as used in this report includes the high-flow period of the water year--generally about October 1 to April 30.

Table 4.--*Crest-stage gages in study area*

[Numbers correspond to crest-stage gages in figure 2]

Crest-stage gage		Type of record	
Number	Name	Peak stage and discharge	Peak stage
1	Big Chico Creek below Mud Creek		X
2	Sacramento River overflow above Stony Creek		X
2.5	Sacramento River overflow to Murphy Slough		X
3	Sacramento River below Stony Creek		X
4	Sacramento River above Ord Ferry		X
5	Angel Slough at Fell Road		X
6	Angel Slough Tributary 1 at Ord Ferry Road	X	
8	Angel Slough Tributary 2 at Ord Ferry Road	X	
9	Angel Slough Tributary 3 at Ord Ferry Road	X	
10	Angel Slough Tributary 4 at Ord Ferry Road	X	
11	Sacramento River overflow at Parrott Landing		X
12	Sacramento River overflow below Ord Ferry		X
13	Sacramento River overflow near Rancho Llano Seco		X
14	Sacramento River overflow near Glenn		X
15	Little Butte Creek 1 at Sevenmile Lane		X
16	Little Butte Creek 2 at Nelson West Road		X
16A	Little Butte Creek 2A at Nelson West Road		X
17	Little Butte Creek 3 at Sevenmile Lane		X
18	Little Butte Creek 4 at Nelson West Road	X	
19	Little Butte Creek 5 at Nelson West Road		X
20	Sacramento River overflow above Hartley Island		X
21	Angel Slough at Afton Boulevard	X	
22	Campbell Slough at Afton Boulevard	X	
23	Butte Creek upstream from Highway 162		X
24	Angel Slough at Highway 162	X	
25	Sacramento River west-bank overflow		
26	Angel Slough Tributary at Biggs-Princeton Road		X
27	Angel Slough at Biggs-Princeton Road		X
28	Campbell Slough at Biggs-Princeton Road		X
29	Howard Slough at Biggs-Princeton Road		X
30	Butte Creek at Biggs-Princeton Road		X
32	Angel Slough at Gridley Road	X	
34	Little Dry Creek Tributary at Gridley Road	X	
34A	Little Dry Creek at Gridley Road	X	
36	Drumheller Slough Tributary upstream from Gridley Road		X
37	Moulton Weir Spill to Butte Basin	X	
37.5	Cherokee Canal at Tule Goose Duck Club		X
38	Sacramento River overflow near Butte Creek School		X
39	Butte Sink at Wild Goose Country Club		X
40	Drumheller Slough Tributary at California Duck Club		X
41	Butte Sink at Sacramento Outing Club		X
41.5	Butte Creek overflow at Butte Lodge Outing Club		X
44	Butte Sink at West Butte Road		X
46	Butte Slough at Mawson Bridge	X	
47	Sutter Bypass at Long Bridge	X	

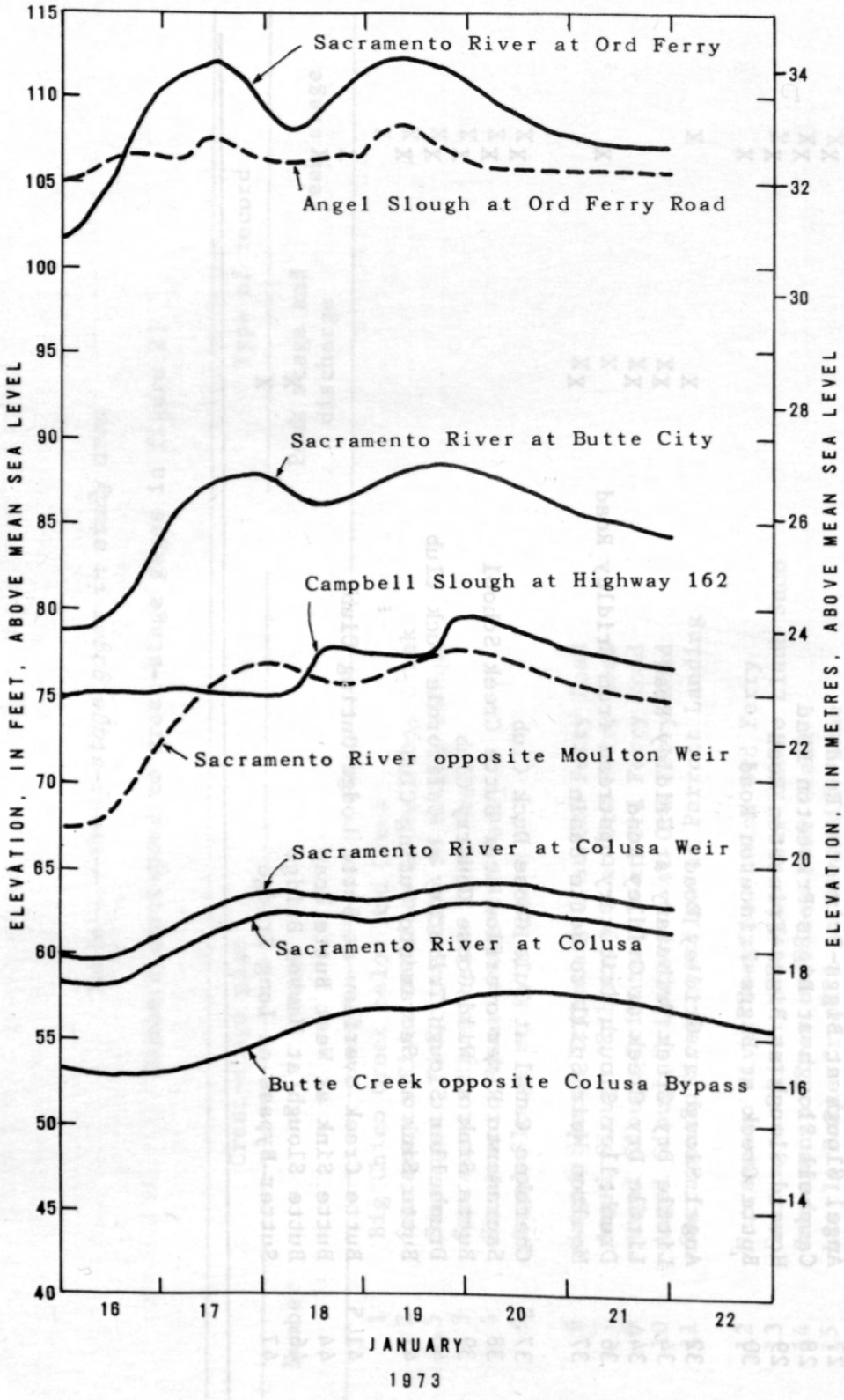


FIGURE 3.—Stage hydrographs for the flood of January 1973.

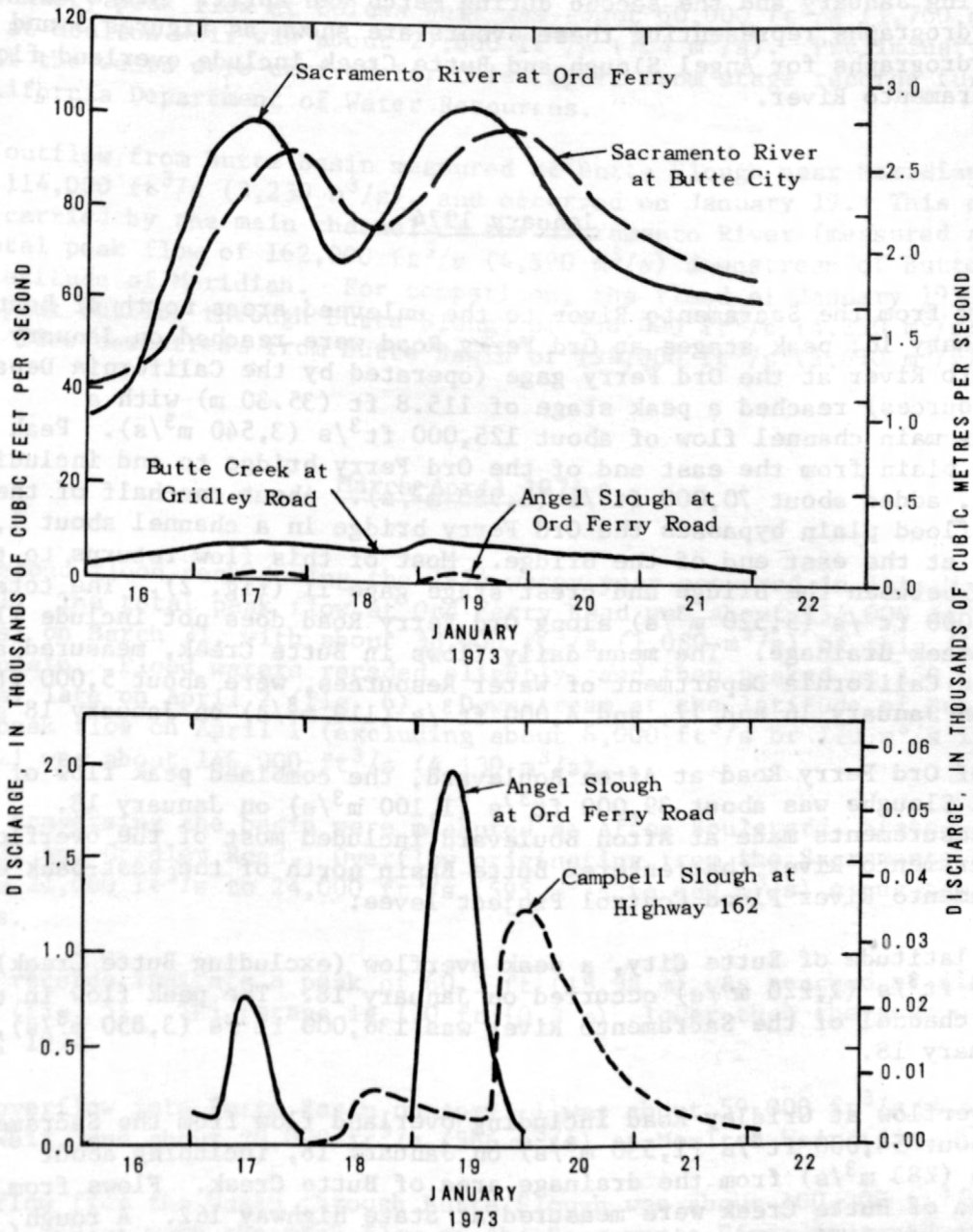


FIGURE 4.—Discharge hydrographs for the flood of January 1973.

FLOODING, 1974 WATER YEAR

Significant flooding occurred twice during the 1974 water year in Butte Basin as a result of overflow from the Sacramento River; the first overflow occurred during January and the second during March and April. Stage and discharge hydrographs representing these events are shown as figures 5 and 6. Discharge hydrographs for Angel Slough and Butte Creek include overland flows from the Sacramento River.

January 1974

Overflow from the Sacramento River to the unleveed areas north of Butte City began on January 16; peak stages at Ord Ferry Road were reached on January 17. The Sacramento River at the Ord Ferry gage (operated by the California Department of Water Resources) reached a peak stage of 115.8 ft (35.30 m) with a corresponding main channel flow of about 125,000 ft^3/s (3,540 m^3/s). Peak flow on the flood plain from the east end of the Ord Ferry bridge to and including Angel Slough, added about 70,000 ft^3/s (1,980 m^3/s). About one-half of the peak flow on the flood plain bypasses the Ord Ferry bridge in a channel about 1,500 ft (457 m) wide at the east end of the bridge. Most of this flow returns to the main channel between the bridge and crest stage gage 11 (fig. 2). The total peak flow of 195,000 ft^3/s (5,520 m^3/s) along Ord Ferry Road does not include flow from Butte Creek drainage. The mean daily flows in Butte Creek, measured at Durham by the California Department of Water Resources, were about 5,000 ft^3/s (142 m^3/s) on January 16 and 17, and 4,000 ft^3/s (113 m^3/s) on January 18 and 19.

South of Ord Ferry Road at Afton Boulevard, the combined peak flow of Angel and Campbell Sloughs was about 39,000 ft^3/s (1,100 m^3/s) on January 18. Discharge measurements made at Afton Boulevard included most of the overflow from the Sacramento River that entered Butte Basin north of the east-bank end of the Sacramento River Flood Control Project levee.

At the latitude of Butte City, a peak overflow (excluding Butte Creek) of about 43,000 ft^3/s (1,220 m^3/s) occurred on January 18. The peak flow in the leveed main channel of the Sacramento River was 136,000 ft^3/s (3,850 m^3/s), also on January 18.

Peak overflow at Gridley Road including overland flow from the Sacramento River was about 54,000 ft^3/s (1,530 m^3/s) on January 18, including about 10,000 ft^3/s (283 m^3/s) from the drainage area of Butte Creek. Flows from the drainage area of Butte Creek were measured at State Highway 162. A rough comparison of total flows at Ord Ferry Road and Gridley Road can be made by use of the hydrographs in figure 6. The hydrograph at Ord Ferry Road does not include the flow from the drainage area of Butte Creek. The hydrograph of main channel flow in the Sacramento River at Butte City plus flow in Butte Creek includes the flow from the drainage area of Butte Creek and overland flow from the Sacramento River.

Downstream from Gridley Road, flood overflow from the upper basin begins to pond, and no further discharge measurements of this overflow are possible. Records of stage are collected at site 41 (including staff-gage readings by an observer) and at the continuous recording gages at sites 43 and 45. The peak stage recorded at site 43 was 61.3 ft (18.68 m) on January 19.

The January peak flow at Colusa Weir was about 60,000 ft^3/s (1,700 m^3/s); peak flow at Moulton Weir was about 27,000 ft^3/s (764 m^3/s). Preliminary flows (fig. 7) at the weirs were derived for this report from stage records furnished by the California Department of Water Resources.

Peak outflow from Butte Basin measured at Butte Slough near Meridian (fig. 7) was about 114,000 ft^3/s (3,230 m^3/s), and occurred on January 19. This outflow, plus that carried by the main channel of the Sacramento River (measured at Colusa) gives a total peak flow of 162,000 ft^3/s (4,590 m^3/s) downstream of Butte Basin near the latitude of Meridian. For comparison, the flood of January 1970 reached a peak outflow through Butte Slough of 150,000 ft^3/s (4,250 m^3/s), and a total peak flow downstream from Butte Basin of 198,000 ft^3/s (5,610 m^3/s).

March-April 1974

The second flood peak during the 1974 water year occurred in late March and early April. The total peak flow at Ord Ferry Road was about 154,000 ft^3/s (4,360 m^3/s) on March 31, with about 38,000 ft^3/s (1,080 m^3/s) of this flow on the flood plain. Flood waters receded slightly, and then peaked at 150,000 ft^3/s (4,250 m^3/s) late on April 2 (fig. 6). Downstream at the latitude of Butte City, the total peak flow on April 1 (excluding about 6,000 ft^3/s or 170 m^3/s in Butte Creek) was about 146,000 ft^3/s (4,130 m^3/s).

Flows traversing the basin were measured at Afton Boulevard, State Highway 162, and Gridley Road. Overflow originating from the Sacramento River ranged from 21,000 ft^3/s to 24,000 ft^3/s (595 m^3/s to 680 m^3/s) along these three roads.

Stage records indicate a peak of 60.3 ft (18.38 m) was reached at site 43 on April 4 (fig. 5). This stage is 1.0 ft (0.3 m) lower than the peak of January 19, 1974.

Peak overflow into Butte Basin on April 1 was about 59,000 ft^3/s (1,670 m^3/s) at Colusa Weir, and about 20,000 ft^3/s (566 m^3/s) at Moulton Weir (fig. 8).

Peak flow from the basin through Butte Slough was about 100,000 ft^3/s (2,830 m^3/s), which with the peak flow of the Sacramento River measured at Colusa, gives a total downstream flow of 146,000 ft^3/s (4,130 m^3/s).

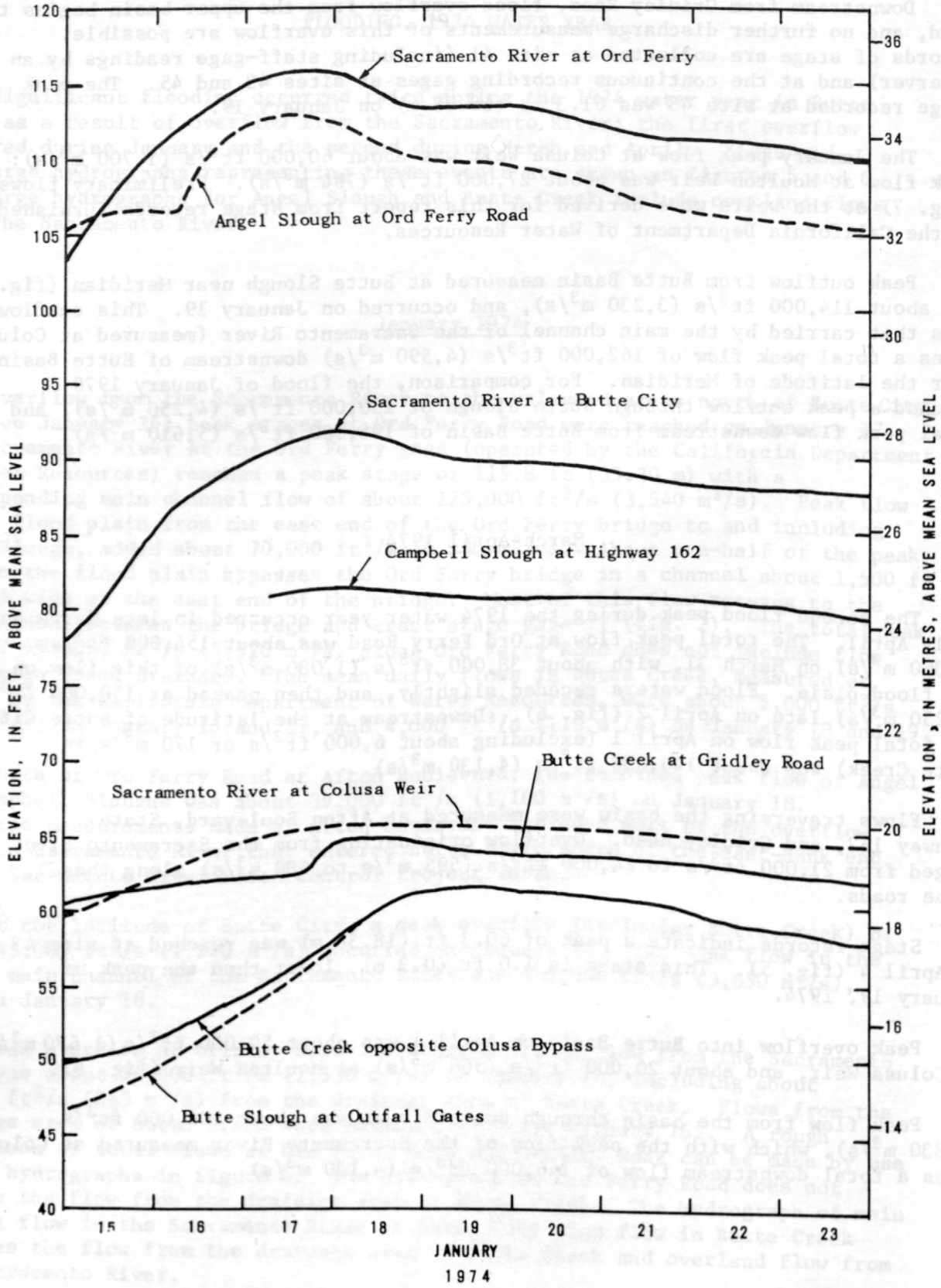
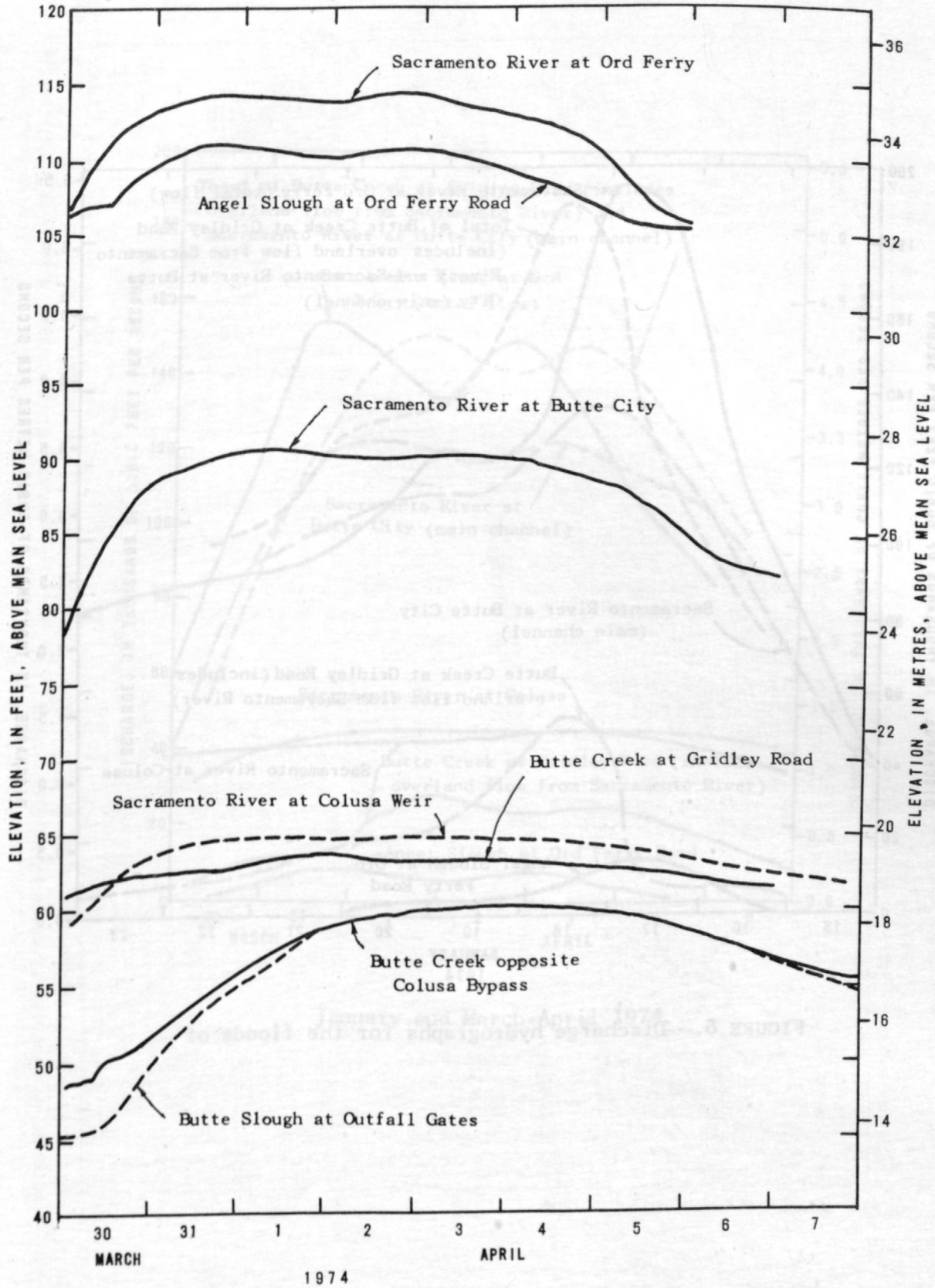


FIGURE 5.—Stage hydrographs for the floods of January and



March-April 1974.

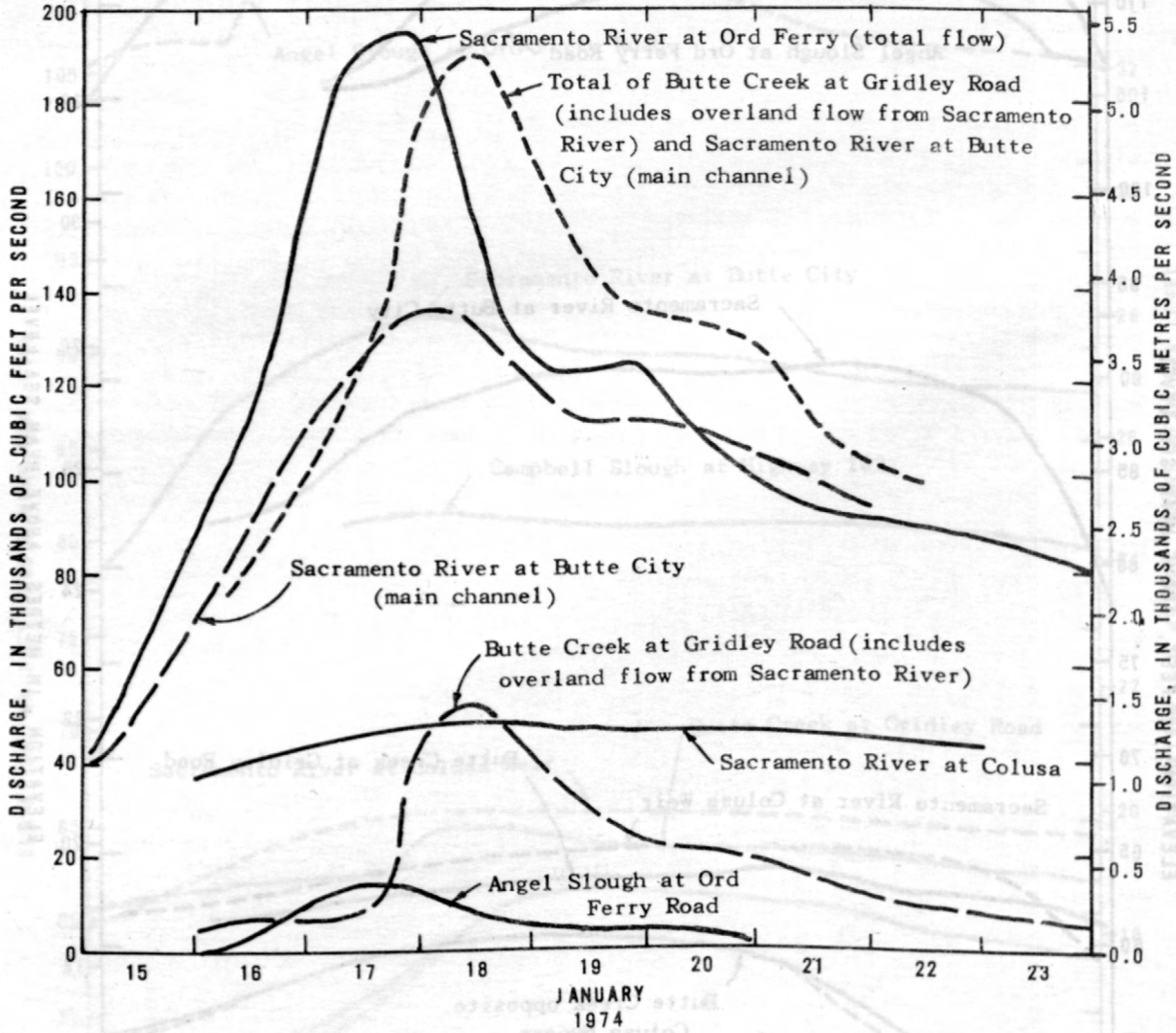
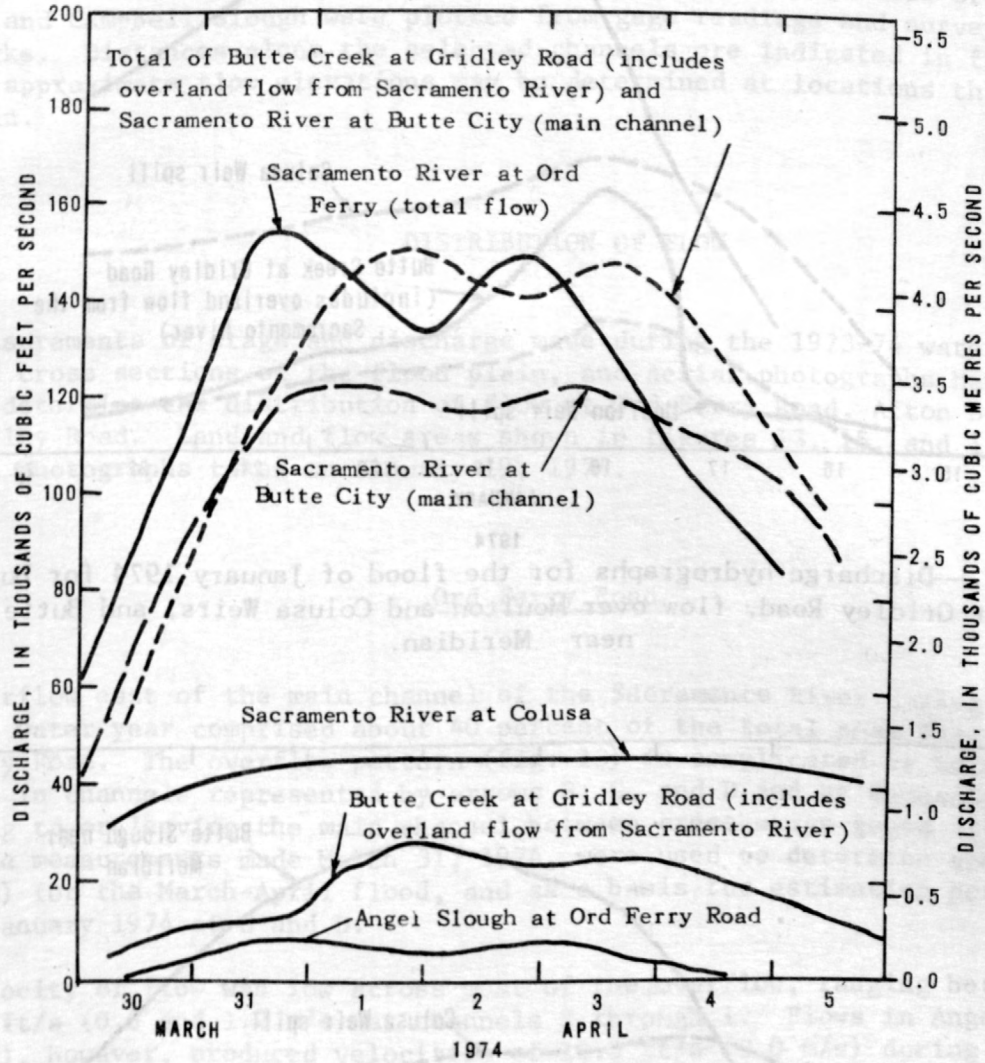


FIGURE 6.--Discharge hydrographs for the floods of



January and March-April 1974.

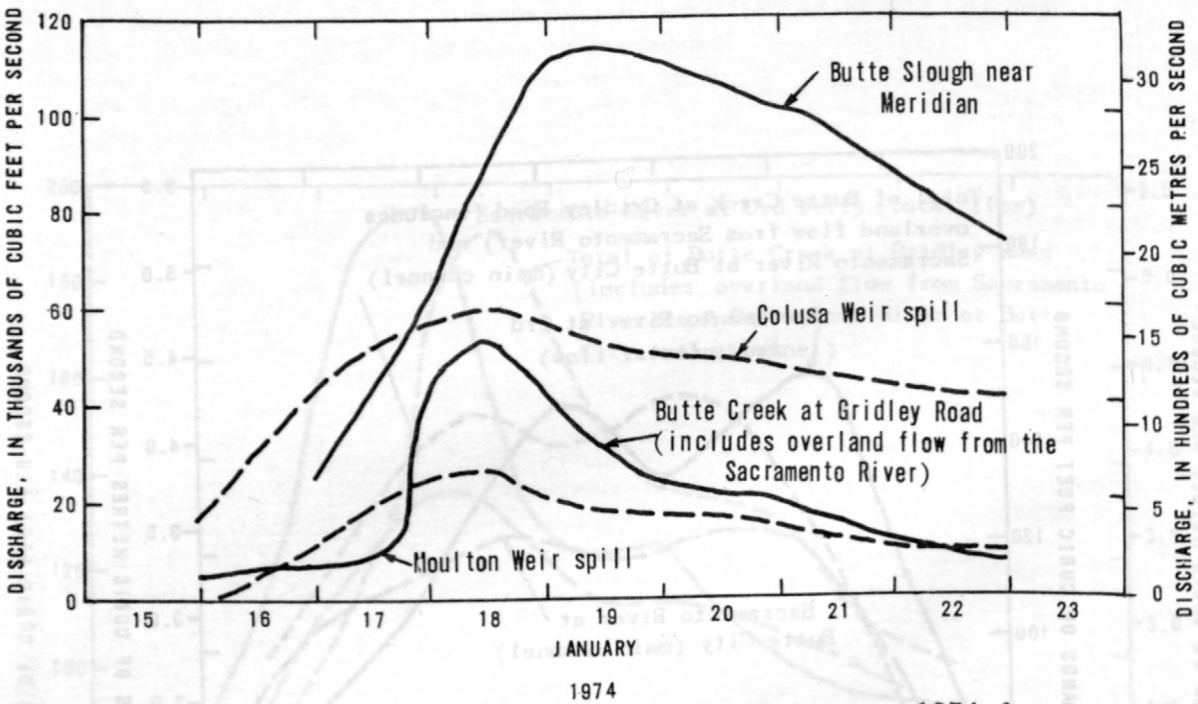


FIGURE 7.—Discharge hydrographs for the flood of January 1974 for Butte Creek at Gridley Road, flow over Moulton and Colusa Weirs, and Butte Slough near Meridian.

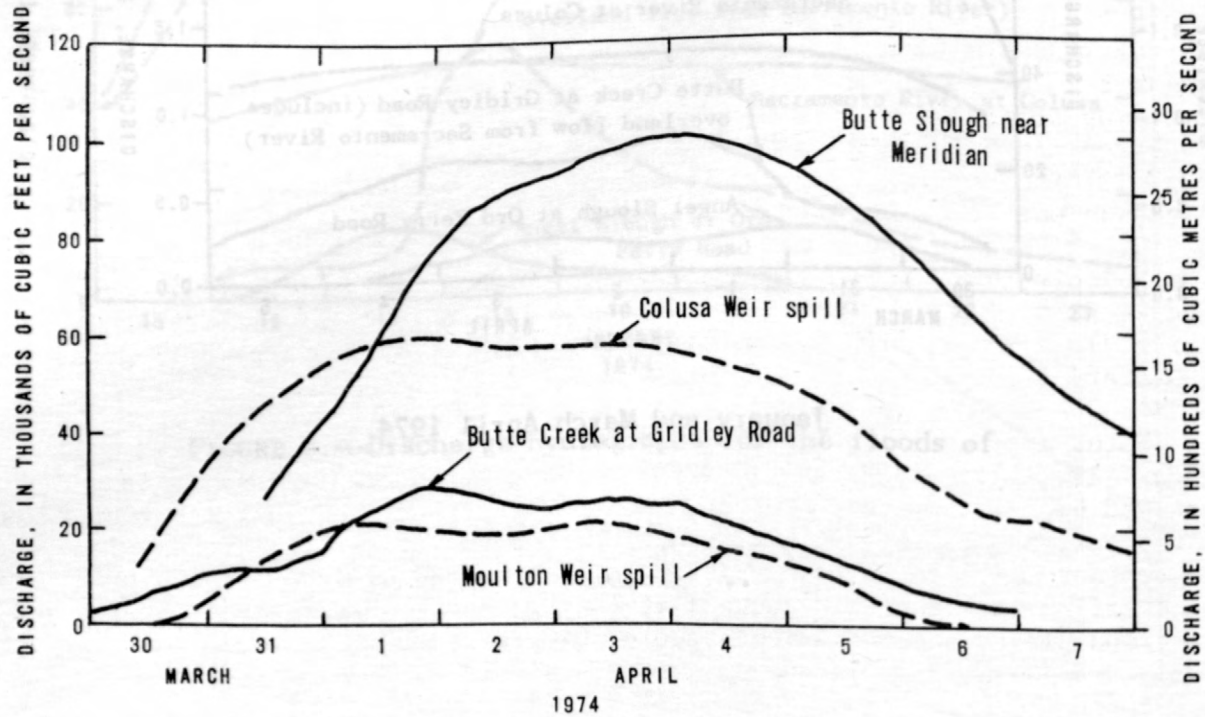


FIGURE 8.—Discharge hydrographs for the flood of March-April 1974 for Butte Creek at Gridley Road, flow over Moulton and Colusa Weirs, and Butte Slough near Meridian.

WATER-SURFACE PROFILES, 1973 AND 1974

Water-surface profiles for peak flows during the 1973 and 1974 water years (figs. 9-12) in the Sacramento River (1974 water year only), Butte Creek, Angel Slough, and Campbell Slough were plotted from gage readings and surveyed high watermarks. Distances along the selected channels are indicated in figure 2 so that approximate flow elevations may be determined at locations throughout the basin.

DISTRIBUTION OF FLOW

Measurements of stage and discharge made during the 1973-74 water years, surveyed cross sections of the flood plain, and aerial photographs have been used to determine the distribution of flow at Ord Ferry Road, Afton Boulevard, and Gridley Road. Land and flow areas shown in figures 13, 15, and 17 were based on photographs taken on January 19, 1974.

Ord Ferry Road

Overflow east of the main channel of the Sacramento River during floods in the 1974 water year comprised about 40 percent of the total peak flow along Ord Ferry Road. The overflow pattern (fig. 13) is complicated by intermingling of flows in channels represented by arrows B, C, and D and by unmeasured flows returning to or leaving the main channel between crest-stage gages 11 and 12. Discharge measurements made March 31, 1974, were used to determine the peak flow (fig. 13) for the March-April flood, and as a basis for estimating peak flows during January 1974 at C and D.

Velocity of flow was low across most of the overflow, ranging between 2 and 4 ft/s (0.6 and 1.2 m/s) at channels B through I. Flows in Angel Slough (arrow J), however, produced velocities of 10.0 ft/s (3.0 m/s) during the peak on January 17, 1974.

Water-surface elevations for the peak flows of January 19, 1973, January 17, 1974, and March 31, 1974, obtained from crest-stage gages and surveyed high watermarks, are shown on the cross section along the centerline of Ord Ferry Road (fig. 14). The differences in water-surface elevation along the cross section for a particular flood are caused by the variable origin of the overflow from the main channel of the Sacramento River, the topography of the flood plain, and the orientation of Ord Ferry Road.

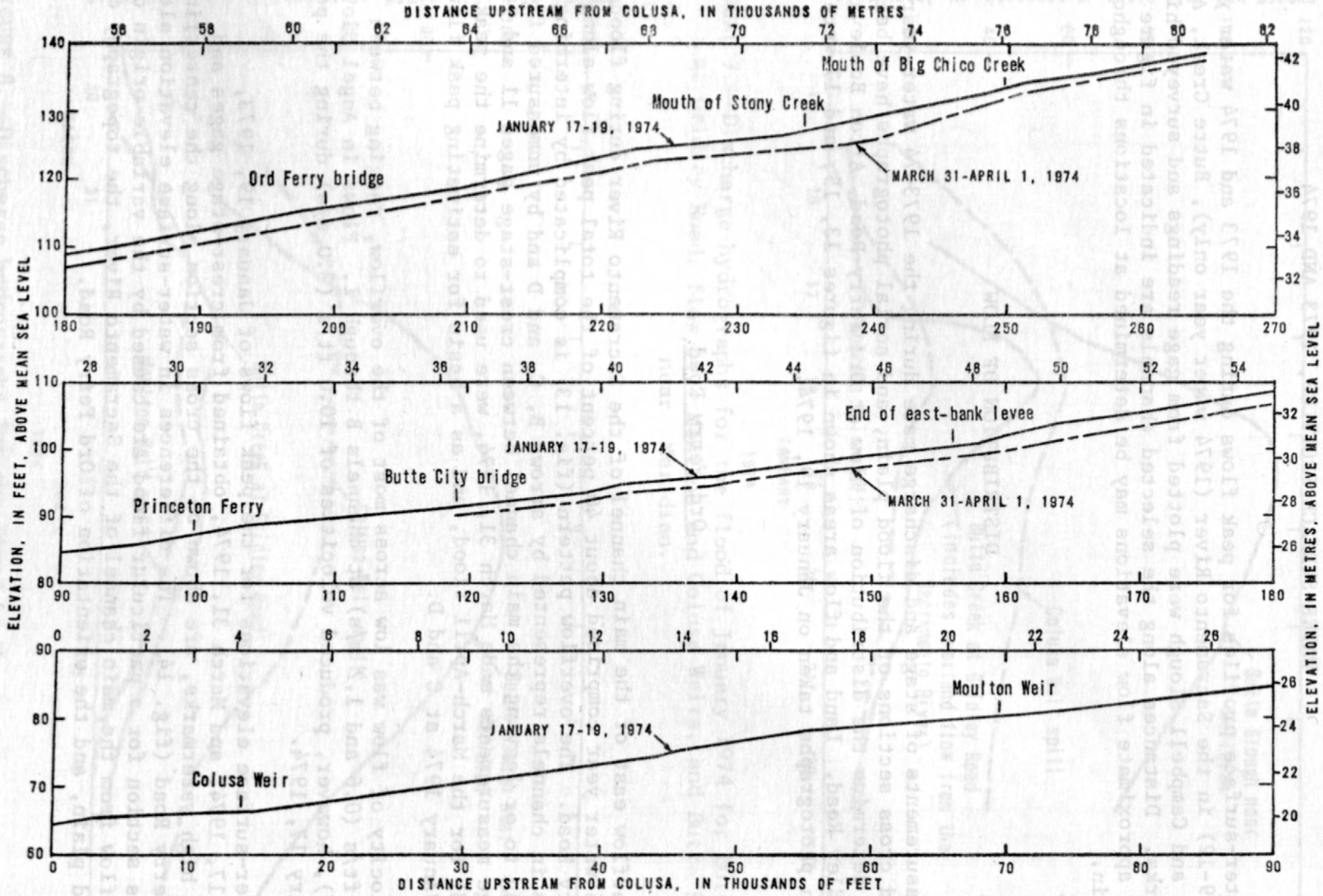


FIGURE 9.—Water-surface profiles for the Sacramento River for the floods of January and March-April 1974.

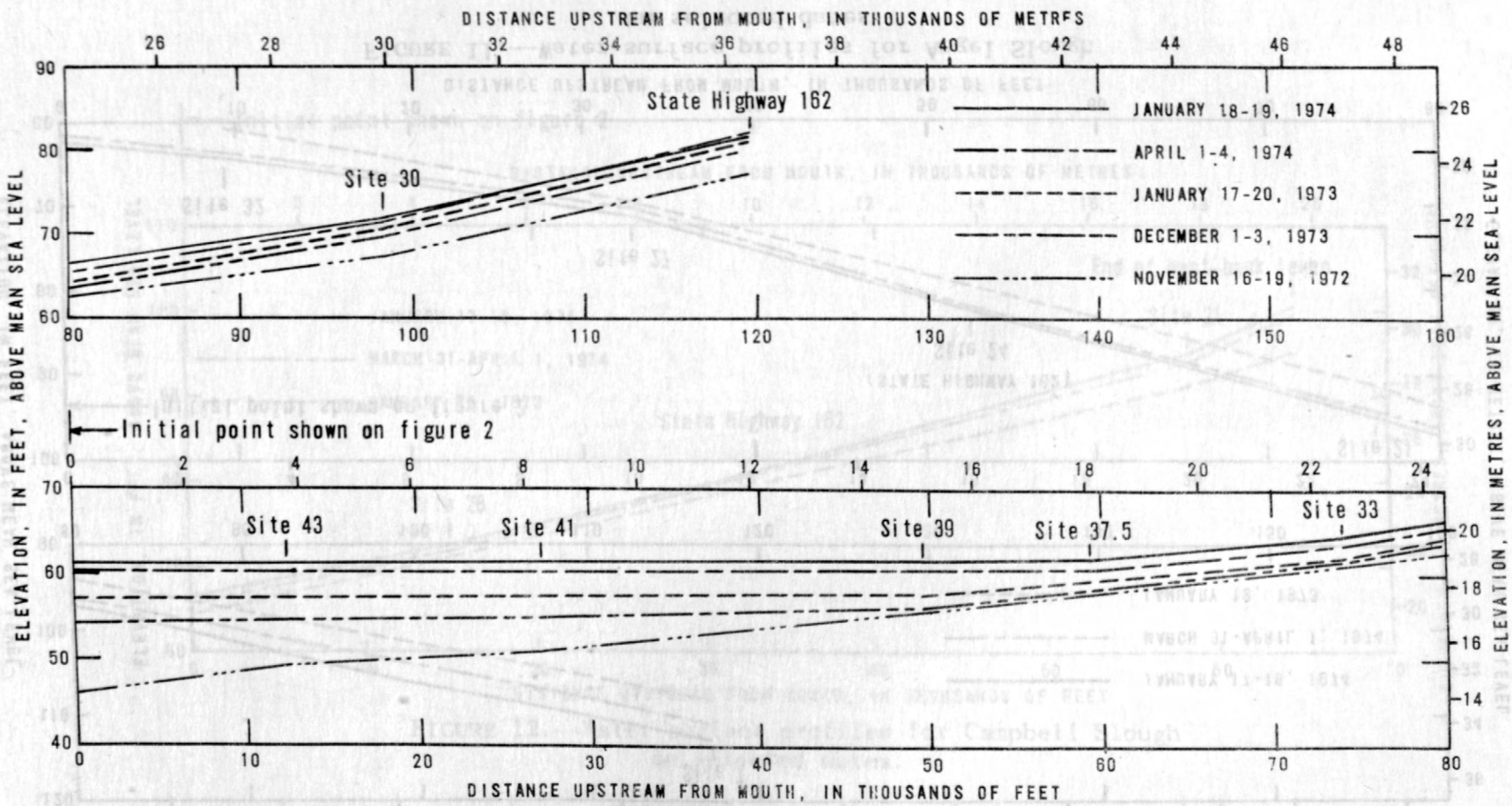


FIGURE 10.—Water-surface profiles for Butte Creek on selected dates.

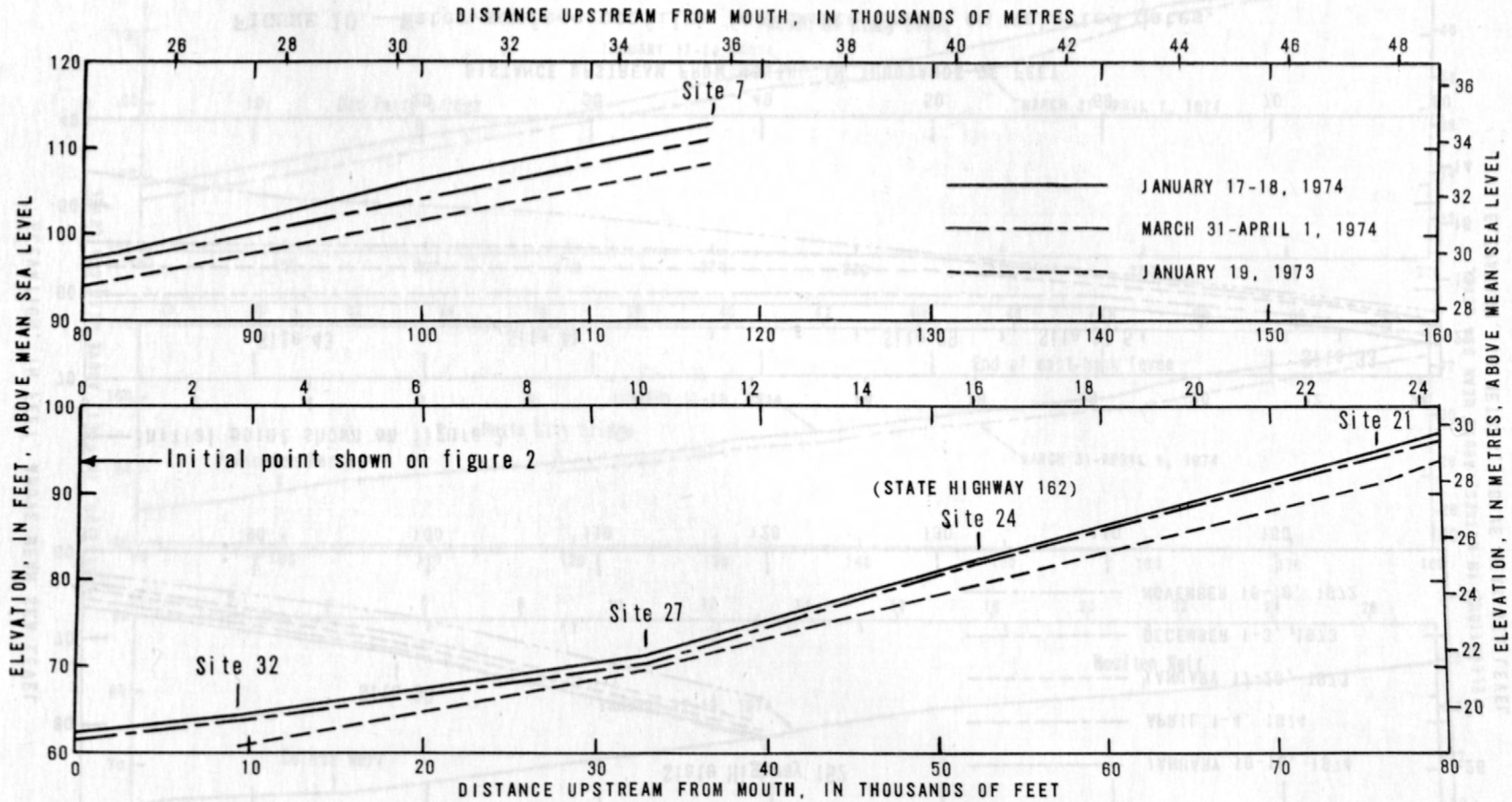


FIGURE 11.—Water-surface profiles for Angel Slough on selected dates.

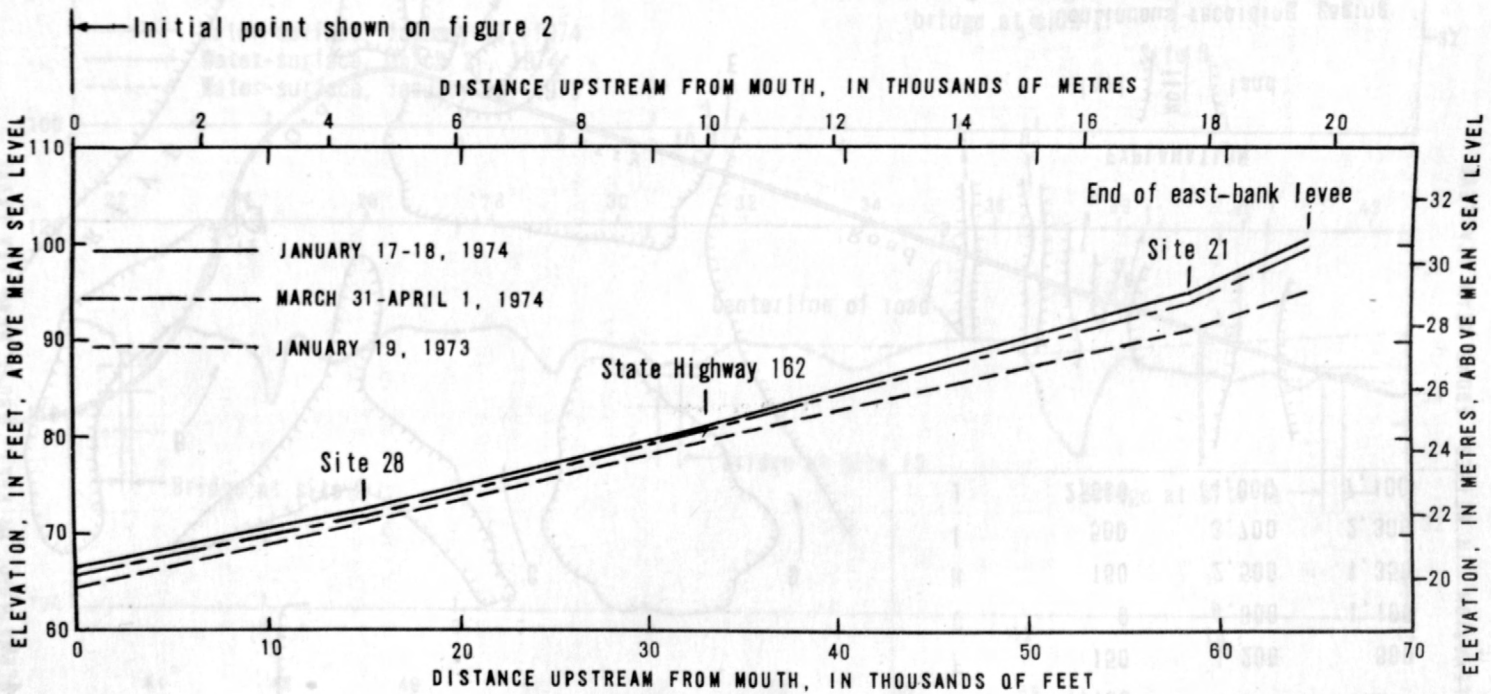


FIGURE 12.--Water-surface profiles for Campbell Slough on selected dates.

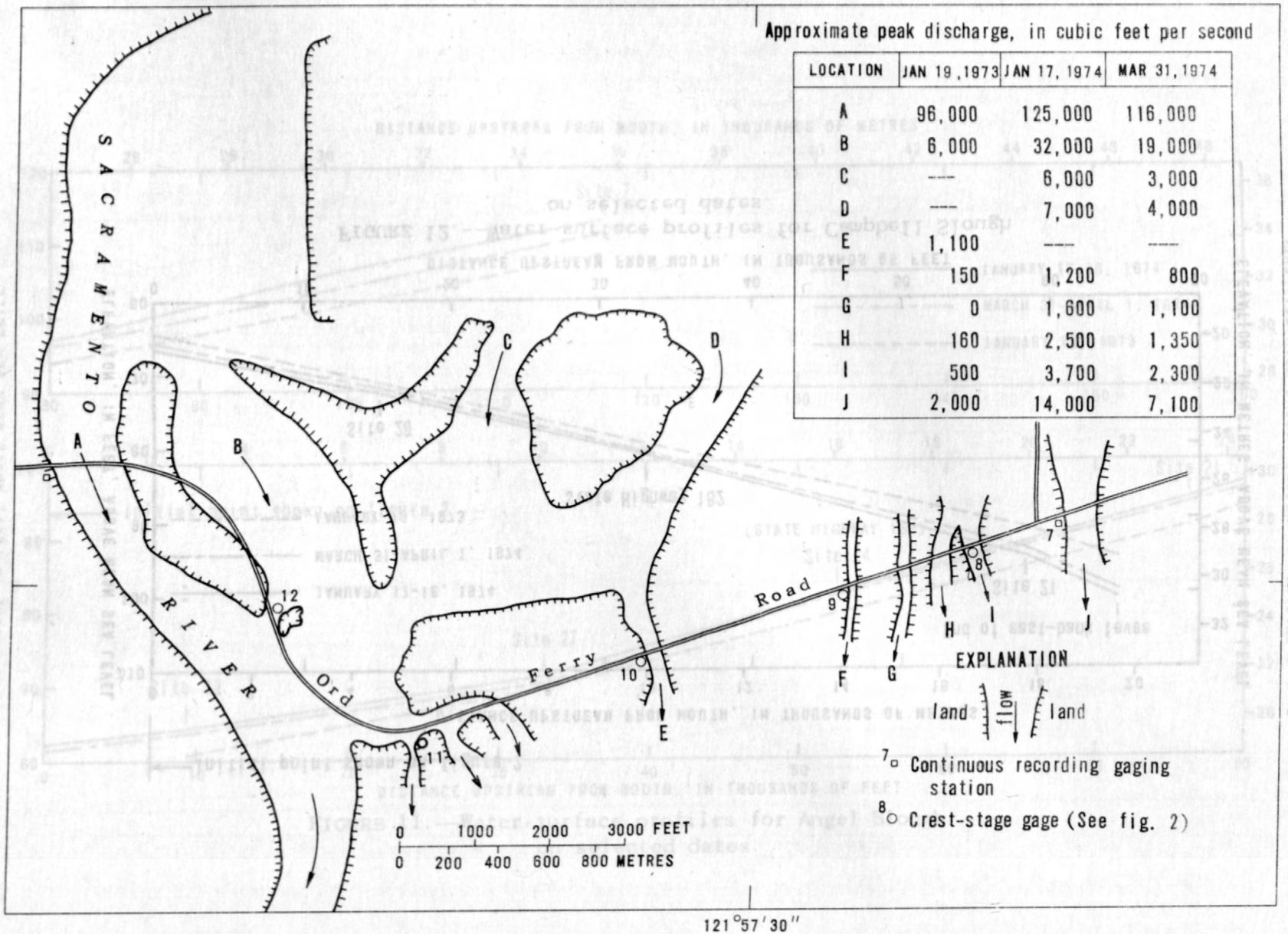


FIGURE 13.—Distribution of peak flow along Ord Ferry Road for the 1973-74 water years.

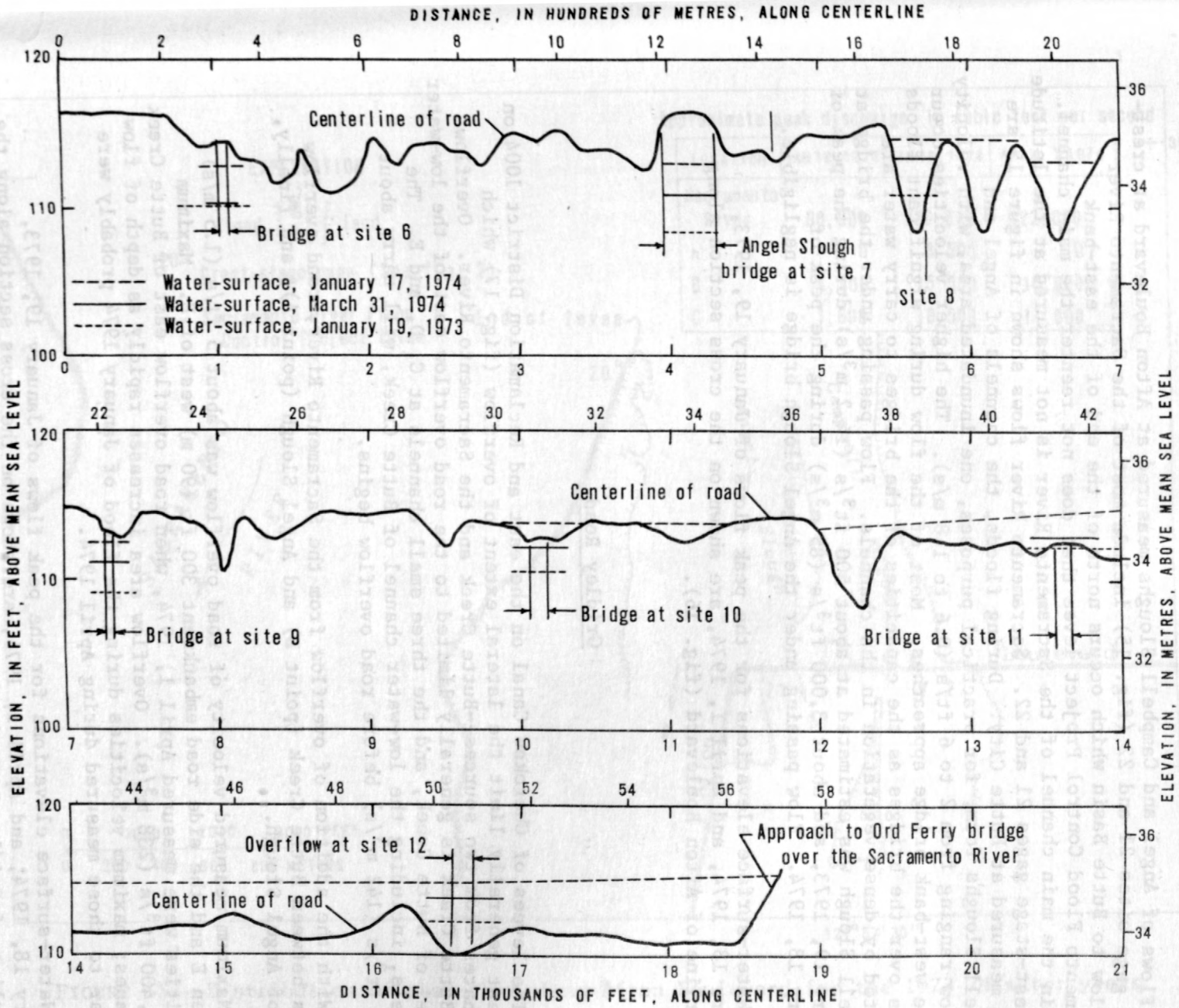


FIGURE 14.—Water-surface elevations along centerline of Ord Ferry Road for selected floods.

Afton Boulevard

Flows of Angel and Campbell Sloughs measured at Afton Boulevard at crest-stage gage sites 21 and 22 (fig. 15) include most of the Sacramento River overflow to Butte Basin which occurs north of the end of the east-bank Sacramento Flood Control Project levee that does not reenter the main channel. Flow in the main channel of the Sacramento River is not measured at the latitude of crest-stage gages 21 and 22. Sacramento River flows shown in figure 15 are those measured at Butte City. During floods, the channels of Angel and Campbell Sloughs form, for practical purposes, one inundated area, with velocity of flow ranging from 2 to 6 ft/s (0.6 to 1.8 m/s). The higher velocities occur at the west-bank bridge approaches. Most of the flow during significant floods passes over the bridges as the capacities of the bridges to carry water are affected by dense vegetation in the channels. Flow passing under the bridge at Campbell Slough was estimated at about 500 ft^3/s (14.2 m^3/s) during the peak of January 19, 1973, and about 3,000 ft^3/s (85 m^3/s) during the peak of January 18, 1974. Flow passing under the Angel Slough bridge is negligible.

Water-surface elevations for the peak flows of January 19, 1973, January 18, 1974, and April 1, 1974, are shown on the cross section along centerline of Afton Boulevard (fig. 16).

Gridley Road

The levees of Cherokee Canal on the east and Reclamation District 1004 on the west generally limit the lateral extent of overflow (fig. 17) which originates from two sources--Butte Creek and the Sacramento River. Overflow from Butte Creek is generally limited to the road overflow east of the low-water channel of Butte Creek, and the three small channels at C, D, and E. The channels, including the low-water channel of Butte Creek, will carry about 5,000 ft^3/s (142 m^3/s) before road overflow begins.

With the addition of overflow from the Sacramento River, road overflow occurs between Butte Creek (point B) and Angel Slough (point A), and finally, west of Angel Slough.

Maximum measured velocity of road overflow was about 5 ft/s (1.5 m/s) between E and the side road embankment 300 ft (90 m) west of E. Maximum velocities were measured April 1, 1974, when road overflow east of Butte Creek was 8,400 ft^3/s (238 m^3/s). Overflow area increases rapidly as depth of flow increases; maximum velocities during the flood of January 1974 probably were similar to those measured during April 1974.

Water-surface elevations for the peak flows of January 19, 1973, January 18, 1974, and April 1, 1974, are shown on the cross section along the centerline of Gridley Road (fig. 18).

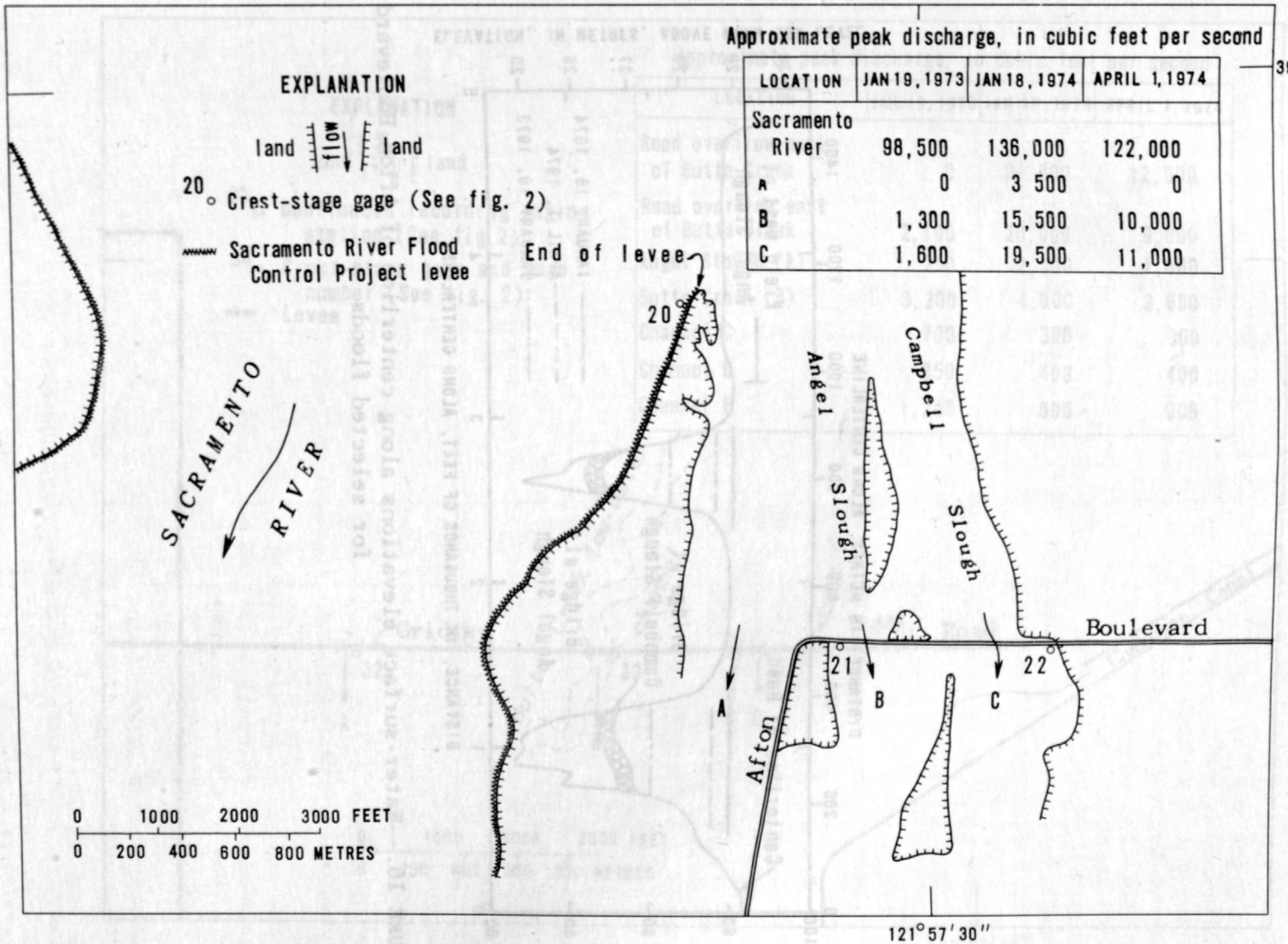


FIGURE 15.—Distribution of peak flow along Afton Boulevard for the 1973-74 water years.

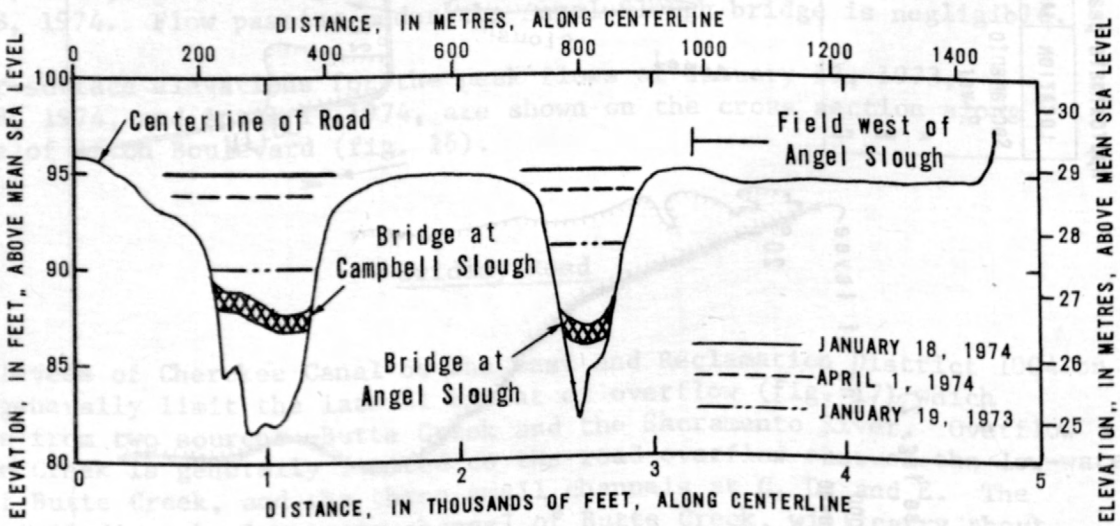


FIGURE 16.—Water-surface elevations along centerline of Afton Boulevard for selected floods.

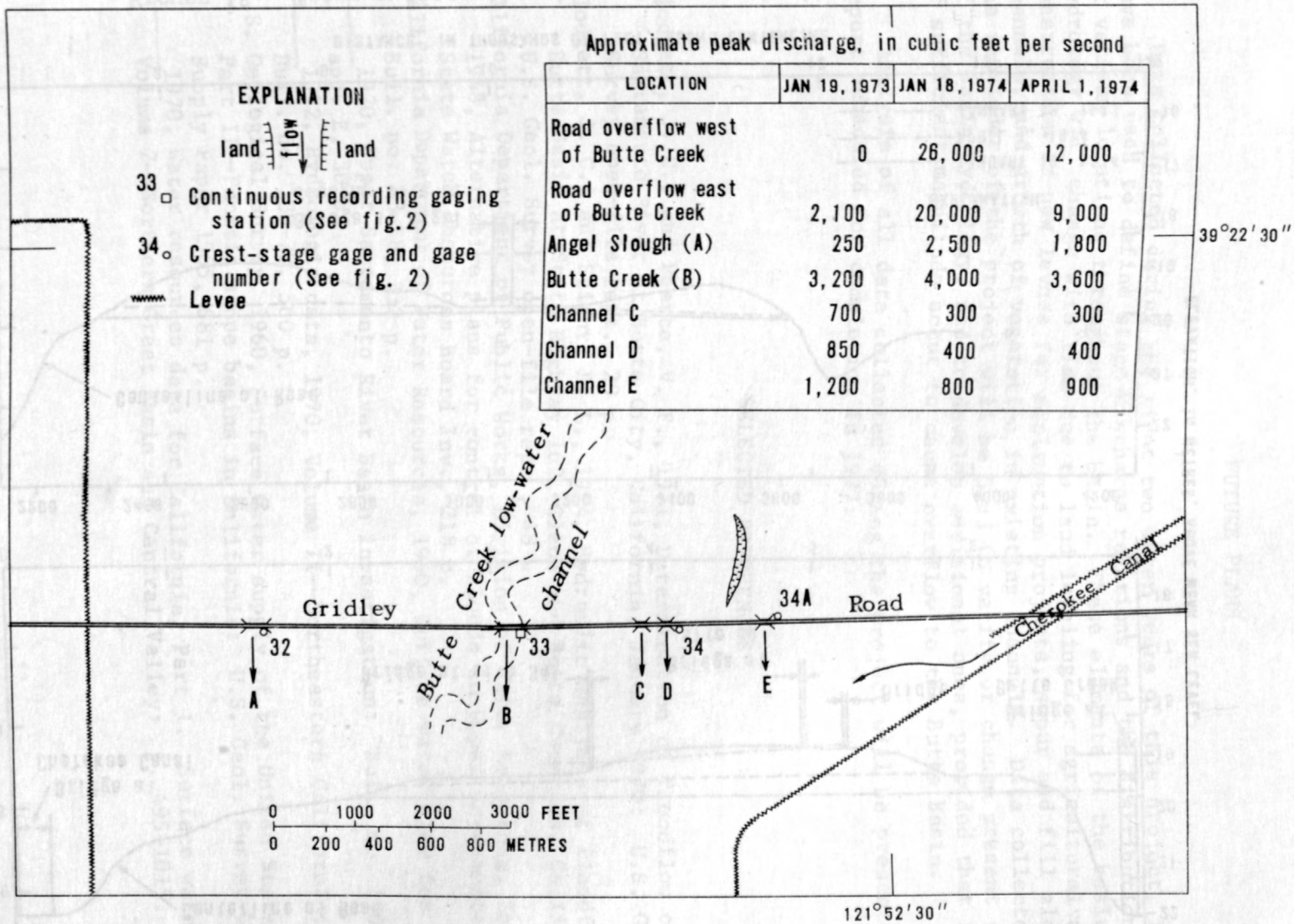


FIGURE 17.—Distribution of peak flow along Gridley Road for the 1973-74 water years.

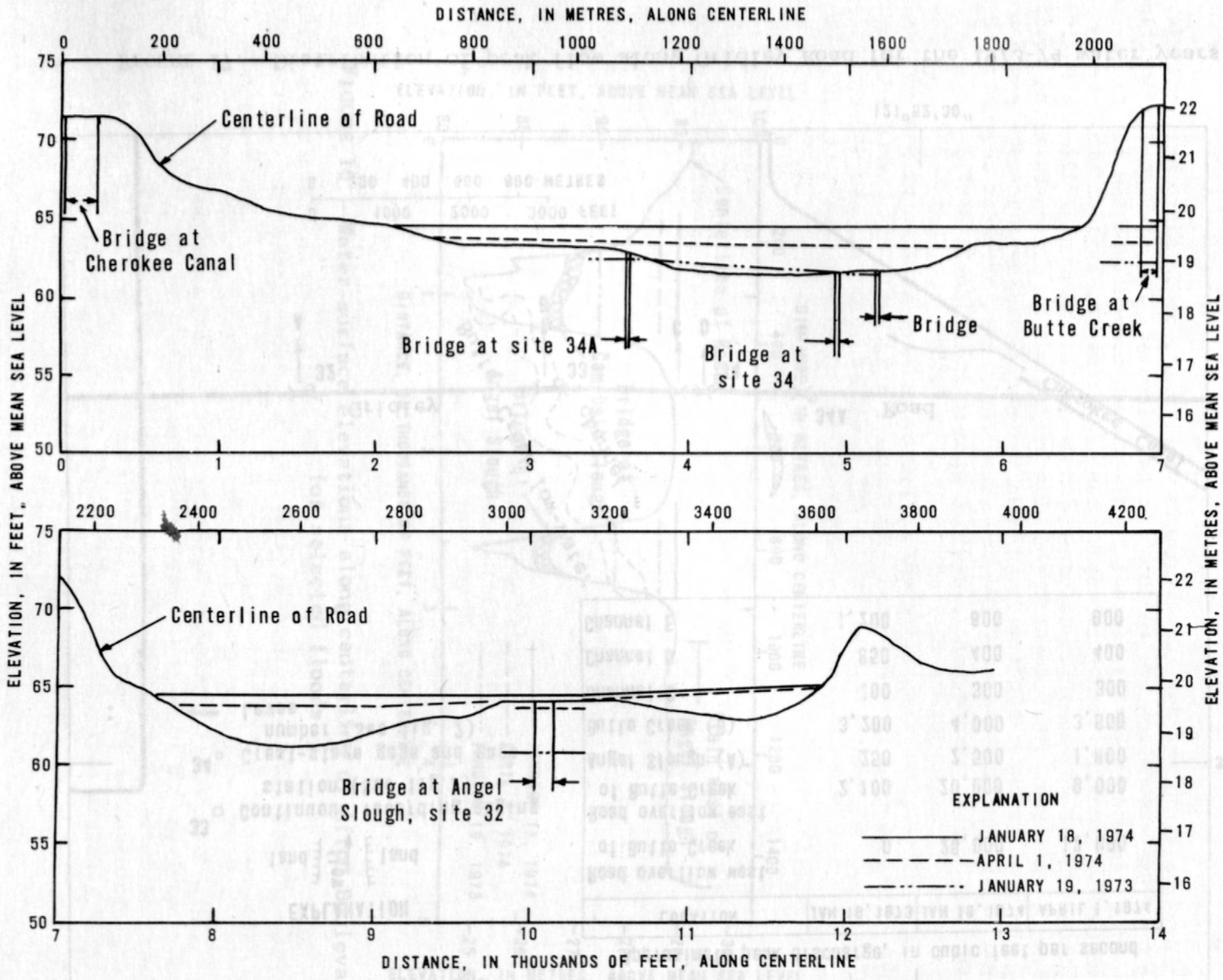


FIGURE 18.—Water-surface elevations along centerline of Gridley Road for selected floods.

FUTURE PLANS

Data collected during the first two water years of this project, 1973-74, have been used to define stage-discharge relations and the distribution of flow at various locations throughout the basin. These elements of the basin hydrology will change with time due to land leveling for agricultural uses, construction of new levees for reclamation projects, scour and fill along flow channels, and growth of vegetation in existing channels. Data collected during the remainder of the project will be used to verify or change present concepts of the basin hydrology, and to develop additional ones, provided that floods of sufficient magnitude occur to cause overflow to the Butte Basin.

Analysis of all data collected during the project will be presented in a report scheduled for completion in 1977.

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APPENDIX A

Summary of peak stages, 1973-74 water years
[Elevation of surface water downstream, d, and upstream, u, from road]

Gaging station number or name[1]	Stage, in feet, above mean sea level		
	Jan. 16-20, 1973	Jan. 17-19, 1974	March 30-April 4, 1974
1	d 130.93	d 133.54	d 132.60
2	127.45	129.84	127.39
2.5	--	128.43	124.87
3	123.39	126.68	--
4	115.51	118.62	117.23
5	u 114.21	u 118.54	u.113.53
6	d 110.30	d 112.80	d 110.22
7 Angel Slough at Ord Ferry Road	d 108.45	d 112.85	d 110.97
8	u 110.82	u 114.64	u 113.37
9	d 109.15	d 112.49	d 111.20
10	d 110.55	d 113.79	d 112.15
11	d 112.16	d 114.71	d 113.00
12	u 112.31	u 115.05	u 113.87
Sacramento River at Ord Ferry[2]	d 112.37	d 115.91	d 114.41
13	--	112.47	--
14	103.71	--	--
15	--	u 101.40	--
		d 100.77	
16	d 95.19	u 98.75	--
16A	--	u 98.61	--
		d 98.49	
17	u 97.29	u 100.67	u 97.29
		d 99.72	
18	u 95.43	u 97.90	--
19	d 96.54	d 97.07	--
20	95.09	100.76	99.5
21	d 91.24	u 95.57	u 94.47
		94.96	d 94.06
22	d 90.33	u 95.4	d 93.89
		d 95.0	
23	82.56	--	--
24	d 79.78	--	d 82.13
25	--	d 91.08	d 89.87
Sacramento River at Butte City[3]	u 88.49	u 91.62	u 90.45
Campbell Slough at State Hwy. 162	d 79.64	d 81.30	d 81.02
Butte Creek at State Hwy. 162	d 80.95	d 81.65	d 81.95
26	d 69.30	d 74.11	d 73.69
27	d 69.89	u 72.79	--
		d 72.25	
28	d 71.18	u 72.84	d 71.91
		d 72.47	
29	d 70.57	u 72.18	d 71.49
		d 72.11	

APPENDIX A.--Summary of peak stages, 1973-74 water years--continued

Gaging station number or name[1]	Stage, in feet, above mean sea level		
	Jan. 16-20, 1973	Jan. 17-19, 1974	March 30-April 4, 1974
30	d 70.80	d 71.99	d 71.63
32	d 60.95	d 64.57	d 63.77
33 Butte Creek at Gridley Road	d 62.22	d 64.55	d 63.59
34	d 61.52	u 64.45	u 63.31
34A	u 62.46	u 64.55	--
36	--	64.73	63.24
Sacramento River at Moulton Weir[4]	77.52	79.72	78.87
37	70.87	73.61	72.71
37.5	--	62.01	60.91
38	--	61.98	60.89
39	57.87	61.80	--
40	58.03	61.81	60.75
41	57.53	61.40	60.33
41.5	--	61.52	60.52
Sacramento River at Colusa Weir[5]	62.56	64.73	63.82
43 Butte Creek opposite Colusa Bypass	57.46	61.29	60.28
Sacramento River at Colusa	d 62.56	d 64.73	d 63.82
44	57.40	61.24	60.23
45	57.14	61.21	60.17
46	56.30	60.05	59.09
47	47.40	50.93	49.69

[1] See figure 2 for location of gaging stations.

[2] Add 2.52 feet to stage, in feet above mean sea level, to obtain gage datum.

[3] Add 2.92 feet to stage, in feet above mean sea level, to obtain gage datum.

[4] Add 2.82 feet to stage, in feet above mean sea level, to obtain gage datum.

[5] Add 2.86 feet to stage, in feet above mean sea level, to obtain gage datum.

APPENDIX B

Summary of peak flows, 1973-74 water years

Location of flow	Discharge, in cubic feet per second		
	January 1973	January 1974	March to April 1974
Sacramento River at Ord Ferry (main channel)	96,000	125,000	116,000
In channel at east end of Ord Ferry bridge[1]	6,000	32,000	19,000
East of site 11 along Ord Ferry Rd. (see figures 2 and 13)	4,000	38,000	19,000
Sacramento River main channel and flood plain at Ord Ferry Rd.	106,000	195,000	154,000
Angel and Campbell Sloughs at Afton Blvd.	2,900	39,000	21,000
Sacramento River at Butte City (main channel)	98,500	136,000	122,000
East-bank flood plain at latitude of Butte City (excluding Butte Creek)	2,800	43,000	24,000
Butte Creek at latitude of Butte City (State Highway 162)	8,200	10,000	6,000
Sacramento River main channel and flood plain at latitude of Butte City (excluding Butte Creek)	101,000	179,000	146,000
East-bank flood plain (including Butte Creek) at latitude of Butte City	11,000	53,000	30,000
Butte Creek at Gridley Rd.[2]	8,300	54,000	28,000
Moulton Weir	11,400	27,000	20,000
Colusa Weir	40,000	60,000	59,000
Butte Slough at Meridian[3]	59,100	114,000	100,000
Sacramento River at Colusa	42,000	48,000	46,000

[1] All of part of flow on flood plain between the east end of Ord Ferry bridge and high ground about 1,500 ft east (represented by the location B on figure 13) returns to the main channel of the Sacramento River between crest-stage sites 11 and 12.

[2] Flow figures for Butte Creek at Gridley Road include a mixture of overland flow from the Sacramento River, flow from the drainage area of Butte Creek, and flow from local sloughs.

[3] Includes all flow from Butte Basin to Sutter Bypass.

APPENDIX C

Selected flood stages and discharges

STATION NAME.--Angel Slough at Ord Ferry Road near Ordbend, Calif.

NUMBER.--7 (see fig. 2 for location).

LOCATION.--Lat 39°37'40", long 121°56'37", in Llano Seco Grant, T. 21 N., R. 1 W., Butte County, on right bank on downstream side of Ord Ferry Road, 3.3 miles east of Ordbend and 4.0 miles southwest of Dayton.

DATE ESTABLISHED.--August 31, 1972.

1973 water year

[Gage height, in feet, above mean sea level, and discharge, in cubic feet per second. Add 100 feet to obtain mean sea level datum.]

Hour	Gage height	Discharge
January 15		
2400	5.28	4.7
January 16,		
0400	5.33	5.5
0600	5.54	13
0800	5.90	37
1000	6.26	87
1200	6.52	146
1400	6.70	200
1600	6.79	236
1800	6.83	252
2000	6.80	240
2200	6.71	204
2400	6.62	176
	Mean	126
January 17		
0200	6.50	140
0400	6.45	128
0600	6.38	111
0700	6.80	240
0800	7.15	420
0900	7.43	624
1000	7.56	740
1100	7.59	770
1200	7.58	760
1400	7.49	672
1600	7.30	520
1800	7.00	330
2000	6.60	170
2200	6.40	115
2400	6.30	95
	Mean	355
January 18		
0400	6.11	62
0600	6.09	59
0800	6.26	87
1000	6.27	89
1200	6.30	95
1400	6.27	89
1600	6.40	115
1800	6.60	170
2000	6.62	176
2400	6.51	143
	Mean	108
January 19		
0100	6.86	264
0130	7.30	520
0200	7.54	720
0300	7.85	940
0400	8.12	1,430
0500	8.31	1,720
0700	8.43	1,960
0900	8.45	2,000
1000	8.39	1,880
1200	8.20	1,550
1400	7.90	1,120
1600	7.47	656
1800	7.10	390
2100	6.47	132
2400	6.16	69
	Mean	995
January 20		
0400	6.01	48
0600	5.91	38
1200	5.78	28
1800	5.73	24
2400	5.70	22
	Mean	34
January 21		
0600	5.70	22
1200	5.67	20
1600	5.67	20
2400	5.61	17
	Mean	20
January 22		
1200	5.56	14
2400	5.51	12
	Mean	14

APPENDIX C.--Selected flood stages and discharges--continued

STATION NAME.--Angel Slough at Ord Ferry Road near Ordbend--Continued

1974 water year

[Gage height, in feet, above mean sea level, and discharge, in cubic feet per second.]

Hour	Gage height	Discharge
January 14		
2400	5.42	8.7
January 15		
0100	5.43	9.0
0300	5.66	20
0600	5.93	40
0900	6.11	62
1200	6.39	113
1500	6.58	164
1800	6.71	204
2000	6.71	204
2400	6.60	170
	Mean	111
January 16		
0400	6.50	140
0700	6.37	109
0800	7.00	330
0900	7.80	1,000
1000	8.38	1,860
1100	9.20	2,930
1200	9.40	3,290
1230	9.50	3,490
1300	9.75	4,000
1500	10.20	5,050
1630	10.60	6,050
2100	11.50	e8,700
2400	11.93	e10,200
	Mean	3,800
January 17		
0600	12.57	e12,800
0900	12.74	e13,600
1200	12.82	14,000
1500	12.85	14,200
1800	12.84	14,100
2100	12.75	13,600
2400	12.62	13,000
	Mean	13,200
January 18		
0300	12.39	12,000
0600	11.92	10,200
0900	11.49	8,670
1200	11.02	7,260
1500	10.60	6,050
1800	10.19	5,020
2100	9.93	4,400
2400	9.78	4,070
	Mean	7,770
January 19		
0600	9.55	3,590
0900	9.53	3,550
1200	9.55	3,590
1500	9.57	3,630
1800	9.57	3,630
2100	9.56	3,610
2400	9.49	3,480
	Mean	3,650
January 20		
0300	9.40	3,290
0600	9.20	2,930
0900	9.00	2,590
1200	8.80	2,270
1800	8.45	1,790
2100	8.18	1,470
2400	7.88	1,150
	Mean	2,340
January 21		
0300	7.47	806
0600	7.18	598
0900	6.92	450
1200	6.70	340
1500	6.51	e264
1800	6.38	e214
2100	6.26	e178
2400	6.16	e148
	Mean	437
January 22		
0600	6.00	105
1200	5.86	80
1500	5.79	67
1800	5.73	58
2400	5.62	43
	Mean	84
January 23		
0600	5.51	30
1200	5.48	27
1800	5.45	24
2400	5.42	22
	Mean	28

e = estimated

APPENDIX C.--Selected flood stages and discharges--continued

STATION NAME.--Angel Slough at Ord Ferry Road near Ordbend--Continued

1974 water year

[Gage height, in feet, above mean sea level, and discharge, in cubic feet per second.]

Hour	Gage height	Discharge
March 29		
1900	5.30	14
2400	6.33	199
March 30		
0200	6.73	355
0400	6.84	410
0600	6.87	425
1000	6.84	410
1200	6.80	390
1300	7.30	680
1400	7.77	1,050
1500	8.08	1,350
1600	8.35	1,670
1800	8.70	2,130
2000	8.97	2,540
2200	9.38	3,250
2400	9.74	3,980
	Mean	1,260
March 31		
0400	10.26	5,200
0800	10.64	6,150
1200	10.89	6,870
1600	10.96	7,080
1700	10.97	7,110
1800	10.96	7,080
2400	10.84	6,720
	Mean	6,270
April 1		
0600	10.71	6,330
1200	10.53	5,880
1800	10.28	5,250
2400	10.19	5,030
	Mean	5,830
April 2		
0200	10.19	5,030
0600	10.26	5,200
1200	10.54	5,900
1800	10.78	6,540
2000	10.83	6,690
2200	10.80	6,600
2400	10.76	6,480
	Mean	5,860
April 3		
0600	10.48	5,750
1200	10.09	4,780
1800	9.60	3,690
2400	9.10	2,750
	Mean	4,710
April 4		
0600	8.68	2,100
1200	8.15	1,430
1800	7.48	814
2400	6.70	340
	Mean	1,470
April 5		
0200	6.36	208
0400	5.95	96
0600	5.78	66
1000	5.67	49
1400	5.56	36
1700	5.55	35
2400	5.46	25
	Mean	72
April 6		
1200	5.40	20
2400	5.33	16
	Mean	20

APPENDIX C.--Selected flood stages and discharges--continued

STATION NAME.--Butte Creek at Gridley Road, near Princeton, Calif.

NUMBER.--33 (see fig. 2 for location).

LOCATION.--Lat 39°21'44", long 121°53'28", in NE1/4NE1/2, sec. 6, T.17 N., R.1 E, Butte County, on left bank on downstream side of bridge on Gridley Road, 6.9 miles southeast of Princeton, and 8.9 miles southeast of Butte City.

DATE ESTABLISHED.--August 30, 1972.

1973 water year

[Gage height, in feet, above mean sea level, and discharge, in cubic feet per second.]

Hour	Gage height	Discharge
January 10		
2400	61.57	4,350
January 11		
1200	61.55	4,250
1800	61.56	4,300
2400	61.70	5,000
Mean		4,380
January 12		
0600	61.85	5,750
1200	61.99	6,540
1500	62.03	6,810
2400	62.03	6,810
Mean		6,270
January 13		
1200	62.04	6,880
1800	62.02	6,740
2400	61.97	6,420
Mean		6,770
January 14		
1200	61.78	5,400
2400	61.54	4,200
Mean		5,360
January 15		
1200	61.27	3,110
2400	61.10	2,630
Mean		3,260
January 16		
0300	61.13	2,690
0600	61.27	3,110
1200	61.50	4,000
1800	61.75	5,250
2400	62.00	6,600
Mean		4,220
January 17		
0300	62.10	7,300
0600	62.16	7,780
0900	62.18	7,940
1200	62.18	7,940
1800	62.18	7,940
2400	62.15	7,700
Mean		7,730
January 18		
0600	62.10	7,300
0800	62.11	7,380
1600	62.03	6,810
2400	62.19	8,020
Mean		7,320
Janaury 19		
0600	62.22	8,280
1200	62.20	8,100
1800	62.16	7,780
2400	62.07	7,090
Mean		7,930
January 20		
0600	62.03	6,810
1200	62.01	6,670
2400	61.87	5,850
Mean		6,550
January 21		
0600	61.75	5,250
1200	61.62	4,600
1800	61.50	4,000
2400	61.40	3,600
Mean		4,640

APPENDIX C.--Selected flood stages and discharges--continued

STATION NAME.--Butte Creek at Gridley Road, near Princeton--Continued

1974 water year

[Gage height, in feet, and discharge, in cubic feet per second]

Hour	Gage height	Discharge
January 15		
2400	61.70	5,000
January 16		
0600	61.90	6,000
1200	62.04	6,880
1600	62.03	6,810
2400	62.11	7,380
	Mean	6,490
January 17		
1200	62.29	8,910
1400	62.36	9,600
1600	62.54	11,700
1800	62.71	13,800
1900	63.00	17,800
2000	63.69	30,400
2100	63.90	35,000
2200	64.05	38,800
2300	64.15	41,500
2400	64.24	44,200
	Mean	14,800
January 18		
0200	64.34	47,200
0400	64.41	49,300
0600	64.46	50,800
0800	64.50	52,000
1000	64.55	54,000
1200	64.55	54,000
1400	64.53	53,200
1600	64.45	50,500
1800	64.37	48,100
2000	64.32	46,600
2200	64.26	44,800
2400	64.17	42,100
	Mean	49,500
January 19		
0600	63.90	35,000
1200	63.68	30,200
1800	63.50	26,400
2400	63.37	23,900
	Mean	31,200
January 20		
0600	63.28	22,200
1200	63.23	23,100
1800	63.17	20,300
2400	63.08	18,900
	Mean	21,800
January 21		
0600	62.90	16,400
1200	62.78	14,700
2400	62.55	11,800
	Mean	14,900
January 22		
1200	62.30	9,000
2400	62.07	7,090
	Mean	9,220
January 23		
1200	61.90	6,000
2400	61.72	5,100
	Mean	6,050
March 29		
2400	61.13	2,700
March 30		
0600	61.53	4,150
0900	61.72	5,100
1200	62.00	6,600
1500	62.14	7,620
1600	62.15	7,700
2400	62.46	10,700
	Mean	6,440
March 31		
0600	62.53	11,600
1200	62.54	11,700
1500	62.57	12,000
1800	62.65	13,000
2100	62.75	14,400
2400	62.82	15,300
	Mean	12,300
April 1		
0100	62.90	16,400
0300	63.09	19,100
0500	63.20	20,800
0900	63.35	23,500
1300	63.42	24,800
1800	63.56	27,600
2000	63.58	28,000
2130	63.59	28,200
2400	63.58	28,000
	Mean	24,000
April 2		
0600	63.53	27,000
1200	63.45	25,400
1800	63.38	24,000
2200	63.37	23,900
2400	63.37	23,900
	Mean	25,600
April 3		
0300	63.39	24,200
0600	63.41	24,600
1200	63.46	25,600
1500	63.47	25,800
1800	63.46	25,600
2000	63.41	24,600
2400	63.39	24,200
	Mean	24,900
April 4		
0600	63.29	22,400
1200	63.17	20,300
1800	63.05	18,500
2000	63.00	17,800
2400	62.93	16,800
	Mean	20,400
April 5		
0600	62.77	14,600
1200	62.60	12,400
1800	62.42	10,200
2400	62.23	8,370
	Mean	12,400
April 6		
0600	62.00	6,600
1200	61.81	5,550
1800	61.63	4,650
2400	61.49	3,950
	Mean	5,740

APPENDIX C.--Selected flood stages and discharges--continued

STATION NAME.--Butte Creek opposite Colusa Bypass, near Colusa, Calif.

NUMBER.--43 (see fig. 2 for location).

LOCATION.--Lat 39°13'33", long 121°56'19", in T.16 N., R.1 W., Sutter County, on left bank 400 feet downstream from wooden bridge, 1.7 miles downstream from Butte Lodge Outing Club, and 3.5 miles northeast of Colusa.

DATE ESTABLISHED.--Sept. 1, 1972.

1973 water year

[Gage height, in feet, above mean sea level.]

Hour	Gage height
January 12	
0300	50.27
0600	50.52
1200	51.20
1800	51.95
2400	52.73
January 13	
0600	53.33
1200	53.79
1800	54.16
2400	54.40
January 14	
0600	54.57
1000	54.62
1300	54.63
1700	54.62
2400	54.48
January 15	
0600	54.28
1200	53.98
2400	53.37
January 16	
0400	53.18
0700	52.97
0800	52.93
1200	52.92
1900	52.75
2200	52.78
2400	52.87
January 17	
0600	53.17
1200	53.65
1800	54.20
2400	54.73
January 18	
0600	55.38
1200	55.99
1600	56.19
2400	56.33
January 19	
0600	56.45
1900	56.95
2400	57.16
January 20	
0600	57.35
1200	57.45
1600	57.46
2000	57.46
2400	57.43
January 21	
1000	57.16
2400	56.57
January 22	
1200	56.09
2400	55.65
January 23	
1200	55.26
2400	54.90
January 24	
1200	54.56
2400	54.30
January 25	
1200	54.00
2400	53.70
January 26	
1200	53.34
2400	52.82
January 27	
0600	52.54
1700	51.99
2400	51.69
January 28	
0600	51.37
1200	51.08
1800	50.79
2400	50.52

APPENDIX C.--Selected flood stages and discharges--continued

STATION NAME.--Butte Creek opposite Colusa Bypass, near Colusa, Calif.

1974 water year

[Gage height, in feet, above mean sea level.]

Hour	Gage height
January 14	
0400	48.51
0600	48.64
1000	49.14
1200	49.35
1400	49.49
1800	49.69
2400	49.84
January 15	
0800	49.95
1400	50.13
2000	50.57
2400	51.02
January 16	
0400	51.50
0800	52.05
1400	52.75
2400	54.12
January 17	
0800	55.29
1600	56.49
2400	57.80
January 18	
0600	58.99
1200	59.91
1600	60.42
2000	60.82
2200	60.98
2400	61.10
January 19	
0200	61.18
0400	61.24
0800	61.29
1100	61.28
1400	61.25
1800	61.16
2400	61.01
January 20	
1200	60.70
2000	60.51
2400	60.45
January 21	
0800	60.13
1400	59.86
2400	59.44
January 22	
1200	58.91
2400	58.45
January 23	
1200	58.05
2400	57.72
January 24	
1200	57.33
2400	57.05
January 25	
1200	56.70
2400	56.49
January 26	
1200	56.29
2400	56.06
January 27	
1200	55.87
2400	55.63
January 28	
1200	55.37
2400	55.10
January 29	
1200	54.87
2400	54.61
January 30	
1200	54.36
2400	54.12
January 31	
1200	53.93
2400	53.73
February 1	
1200	53.43
1800	53.24
2400	53.07
February 2	
0600	52.96
1200	52.90
2400	52.74
February 3	
1440	52.48
2400	52.18
February 4	
1200	51.83
2400	51.35
February 5	
1200	51.19
2400	51.01

APPENDIX C.--Selected flood stages and discharges--continued

STATION NAME.--Butte Creek opposite Colusa Bypass, near Colusa, Calif.

1974 water year

[Gage height, in feet, above mean sea level.]

Hour	Gage height	Hour	Gage height	Hour	Gage height
March 29		**April 2**		**April 8**	
2400	48.57	0400	59.14	0600	54.81
March 30		0800	59.35	1200	54.45
0600	48.77	1200	59.54	1800	54.11
0830	48.88	1600	59.67	2400	53.83
0900	49.00	2000	59.81	**April 9**	
1000	49.56	2400	59.89	0600	53.60
1100	49.85	**April 3**		1200	53.37
1200	50.06	0400	59.97	1800	53.15
1300	50.19	0800	60.06	2400	52.96
1600	50.40	1200	60.14	**April 10**	
1800	50.56	1600	60.21	0600	52.78
2000	50.84	2000	60.25	1200	52.66
2200	51.18	2400	60.27	1800	52.53
2400	51.56	**April 4**		2400	52.43
March 31		0200	60.28	**April 11**	
0200	51.95	0600	60.27	1200	52.24
0400	52.32	1000	60.23	2400	52.02
0600	52.67	1400	60.15	**April 12**	
0900	53.11	1800	60.06	1200	51.86
1200	53.69	2400	59.89	2400	51.68
1600	54.43	**April 5**			
2000	55.07	0600	59.66		
2400	55.73	1200	59.40		
April 1		1800	59.05		
0400	56.35	2400	58.70		
0800	56.95	**April 6**			
1200	57.47	0600	58.21		
1600	58.10	1200	57.73		
1800	58.30	1800	57.22		
2000	58.50	2400	56.78		
2200	58.69	**April 7**			
2400	58.83	0600	56.32		
		1200	55.90		
		1800	55.52		
		2400	55.15		

APPENDIX C.--Selected flood stages and discharges--continued

STATION NAME.--Butte Slough at Outfall Gates near Meridian, Calif.

NUMBER.--45 (see fig. 2 for location).

LOCATION.--Lat 39°11'43", long 121°56'05", in SW1/4 NE1/4, sec. 35, T.16 N., R.1 W., Colusa County, on right bank at mouth of Butte Slough, 0.5 mile downstream from Butte Creek, 3.7 miles north of Meridian, and 4.1 miles southeast of Colusa.

DATE ESTABLISHED.--October 13, 1972.

1973 water year

[Gage height, in feet, above mean sea level.]

Hour	Gage height	Hour	Gage height	Hour	Gage height	Hour	Gage height
January 12		January 16		January 20		January 25	
0600	48.52	0300	52.11	0500	56.93	0600	53.21
1200	49.56	0500	51.94	0700	57.00	1000	53.10
1800	50.64	0700	51.68	0800	57.02	1500	53.05
2400	51.54	0900	51.66	1200	57.12	2000	52.87
January 13		1100	51.81	1300	57.14	2400	52.75
0600	52.27	1200	51.84	1500	57.14	January 26	
1200	52.80	1300	51.86	1600	57.12	0600	52.55
1800	53.22	1400	51.86	1900	57.12	1300	52.35
2400	53.48	1800	51.71	2200	57.12	2400	51.79
January 14		2000	51.64	2400	57.08	January 27	
0600	53.65	2200	51.63	January 21		0600	51.47
1200	53.73	2400	51.69	0600	56.92	1200	51.17
1400	53.74	January 17		1200	56.69	1800	50.79
1700	53.74	0100	51.71	1800	56.35	2400	50.46
1900	53.70	0600	51.97	2400	56.05	January 28	
2400	53.60	1200	52.54	January 22		1200	49.83
January 15		1800	53.07	0200	56.02	2400	49.13
0300	53.51	2400	53.62	0600	55.73		
0600	53.39	January 18		1200	55.43		
0900	53.26	0100	53.62	1800	55.13		
1200	53.08	0600	54.29	2400	54.84		
1500	52.93	1000	54.98	January 23			
1800	52.79	1100	55.11	0600	54.63		
2100	52.56	1500	55.45	1200	54.43		
2400	52.33	1800	55.57	1800	54.24		
		2100	55.63	2400	54.01		
		2400	55.69	January 24			
		January 19		1200	53.66		
		0300	55.74	2400	53.36		
		0600	55.82				
		0900	55.95				
		1200	56.12				
		1800	56.37				
		2400	56.69				

APPENDIX C.--Selected flood stages and discharges--continued

STATION NAME.--Butte Slough at Outfall Gates near Meridian--Continued

1974 water year

[Gage height, in feet, above mean sea level.]

Hour	Gage height	Hour	Gage height	Hour	Gage height	Hour	Gage height
January 12		January 19		January 24		January 29	
2400	45.28	0300	61.03	0900	57.22	0600	54.29
January 13		0600	61.13	1100	57.22	1200	54.16
0700	45.23	0900	61.18	1500	57.14	1500	54.13
1400	45.22	1200	61.20	2000	56.91	2400	53.89
2400	45.23	1400	61.21	2400	56.78	January 30	
January 14		1600	61.21	January 25		0900	53.69
0300	45.25	1800	61.14	0600	56.62	1700	53.55
0600	45.29	2100	61.00	1000	56.52	1900	53.47
0900	45.44	2400	60.91	1500	56.42	2400	53.35
1200	45.69	January 20		2400	56.14	January 31	
1500	45.92	0600	60.77	January 26		0600	53.23
1800	46.20	1200	60.62	0600	55.96	1200	53.11
2400	46.67	1500	60.57	0900	55.88	1800	53.00
January 15		2000	60.42	1100	55.88	2400	52.89
0600	47.02	2200	60.44	1100	55.88	February 1	
1200	47.42	2400	60.40	1200	55.91	0600	52.77
1500	47.98	January 21		1400	55.90	1200	52.66
1800	48.21	0200	60.40	2000	55.68	1800	52.44
2400	49.23	0600	60.25	2400	55.56	2400	52.23
January 16		1200	60.00	January 27		February 2	
0600	50.32	1800	59.67	0600	55.43	0600	52.12
1200	51.18	2400	59.39	1000	55.37	1200	52.06
1800	52.12	January 22		1400	55.35	2400	51.83
2400	53.08	0600	59.15	1800	55.24	February 3	
January 17		0700	59.15	2000	55.12	0800	51.65
0600	54.00	1000	58.97	2200	55.08	1400	51.55
1200	55.09	1300	58.89	2400	55.00	2400	51.19
1800	56.21	1800	58.62	January 28		February 4	
2400	57.32	2400	58.37	0600	54.90	0600	50.97
January 18		January 23		1200	54.78	1200	50.77
0600	58.61	0600	58.14	1800	54.62	2400	50.40
0900	59.15	0900	58.03	2400	54.42	February 5	
1200	59.61	1200	58.00			1200	50.10
1500	60.03	1500	57.93			2400	49.69
1800	60.42	1800	57.82				
2100	60.69	2400	57.60				
2400	60.87						

APPENDIX C.--Selected flood stages and discharges--continued

STATION NAME.--Butte Slough at Outfall Gates near Meridian--Continued

1974 water year

[Gage height, in feet, above mean sea level.]

Hour	Gage height
March 29	
2400	45.15
March 30	
0200	45.18
0400	45.24
0600	45.27
0930	45.37
1200	45.95
1500	46.73
1800	47.67
2100	48.90
2400	49.96
March 31	
0300	50.72
0600	51.43
1200	52.60
1800	53.75
2400	54.83
April 1	
0600	55.80
1200	56.88
1800	58.02
2100	58.34
2400	58.62
April 2	
0600	59.07
1200	59.43
1500	59.55
1800	59.63
2400	59.78
April 3	
0600	59.88
0800	59.95
1200	60.07
1800	60.17
2000	60.17
2400	60.15
April 4	
0600	60.13
0900	60.12
1200	60.14
1400	60.13
1800	60.04
2400	59.80
April 5	
0600	59.57
1200	59.35
1800	59.02
2400	58.62
April 6	
0600	58.16
1200	57.70
1800	57.14
2400	56.52
April 7	
0600	55.98
1200	55.50
1800	55.05
2400	54.58
April 8	
0600	54.19
1200	53.87
1800	53.49
2400	53.13
April 9	
0600	52.84
1200	52.69
1800	52.46
2400	52.16
April 10	
0600	51.96
0900	51.90
1200	51.85
1800	51.72
2400	51.55
April 11	
0200	51.54
0600	51.43
1200	51.38
1800	51.27
2130	51.16
2400	51.13
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