Summary of Floods in the United States During 1969

By J. K. REID *and* others

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SUMMARY OF FLOODS IN THE UNITED STATES DURING 1969

By J. K. REID and others

ABSTRACT

The most outstanding floods in the United States during 1969 are described in chronological order. The areas most seriously affected by flooding were: Central and southern California (January and February); the upper Midwestern States of North Dakota, South Dakota, Minnesota, Iowa, Wisconsin, and Illinois (April); north-central Ohio (July); Mississippi, Alabama, and Virginia (Hurricane Camille in August); and Florida and Georgia (September).

Severe floods in central and southern California were caused by three storms during January and February. At least 60 lives were lost. Homes and property were destroyed or damaged, by rainstorms, floods, and mudflows. Many floods approached or exceeded the maximum known. The severe flood damage was due partly to recent home construction in floodprone areas.

The April floods in the upper Midwestern States of North Dakota, South Dakota, Minnesota, Iowa, Wisconsin, and Illinois were expected because of a large accumulation of snow containing as much as 8 inches of water. Flood-protection procedures, together with cool temperatures, had a mitigating effect on the flood. The floods were the largest since the late 1800's, and their recurrence intervals exceeded 50 years at many of the gaged sites. Estimates of flood damage were about $147 million. More than a million acres of rich agricultural land were inundated, thousands of culverts and bridges were washed out, 23,000 people were forced from their homes and 11 lives were lost in the six-State flood area.

Intense rainstorms and wind with gusts as much as 100 miles per hour, July 4–5, caused record floods in north-central Ohio, July 4–8. The storm and floods left trees uprooted, more than $66 million in damage, and 41 deaths. In many places the floods were the largest of record. Together with the wind and rainstorm, the hydrologic conditions were among the most significant experienced in the area.

Hurricane Camille was the most intense hurricane on record to enter the United States mainland. It struck the Mississippi-Alabama coast on August 18, with tidal waves as high as 25 feet above mean sea level and wind velocities more than 190 miles per hour. Tidal wave and flood damage was about $1.3 billion. In Mississippi the known dead totaled 139 and 76 other persons were missing. The hurricane intensity decreased as it moved inland until it merged with severe rainstorms over the Appalachian mountains.

The intensified hurricane then caused record-breaking floods of streams in a 50-mile-wide area as it moved eastward from Sulphur Springs, W. Va., to Fredericksburg, Va. Total flood damage in Virginia exceeded $116 million. There were 113 known deaths, 102 injuries, and 39 people missing.

A tropical storm that was nearly stationary over northwest Florida for about 48 hours, September 20–23 produced record rains and floods. Near Quincy, Fla., the total rainfall for the period exceeded 20 inches. On Little River near Quincy, the peak discharge was nearly twice the previous maximum of record and was three times that of a 50-year flood. Flood damage to agricultural lands, bridges, culverts, and roads was about $1.7 million.

INTRODUCTION

This publication summarizes information on outstanding floods in the United States during 1969. The floods reported were unusual hydrologic events in which either large areas were affected, or great damage resulted, or record-high discharges or stages occurred, and sufficient data were available for the preparation of a report.

U.S. Geological Survey open-file reports, "Floods of January and February 1969 in central and southern California," and "Floods of April-May 1969 in upper Midwestern United States," are examples of special reports that describe floods in detail in their respective areas. The areas for which special flood reports have been prepared for 1969 are shown in figure 1 by shaded pattern, whereas, the areas discussed only in this flood summary are indicated by a crosshatched pattern.

A flood may be defined as the inundation of land area as a result of either overflow from a watercourse, or impoundment of runoff, or onshore waves or tides, or from other causes.

A large number of stream floods, caused by overflow of existing stream channels, occur every year in the United States, varying in size from those that may recur on the average of once every 2 or 3 years to those rare floods whose probability of occurrence is extremely small. Many of these floods occur in uninhabited places, and descriptive data are not obtained.

A smaller number of floods, caused by unusually high onshore waves on large lakes or reservoirs, or tsunami or hurricane tides along ocean shores, or by ice jams on streams in northern States, occur irregularly, and some of these, also, may not be reported.

The variability of all types of floods is spaciotemporal. Some factors associated with the spatial variability of rainfall and snowmelt floods include the latitude, the distance from moisture source, and the topography on the basin. The temporal variability of these floods is associated with the variability of short-term

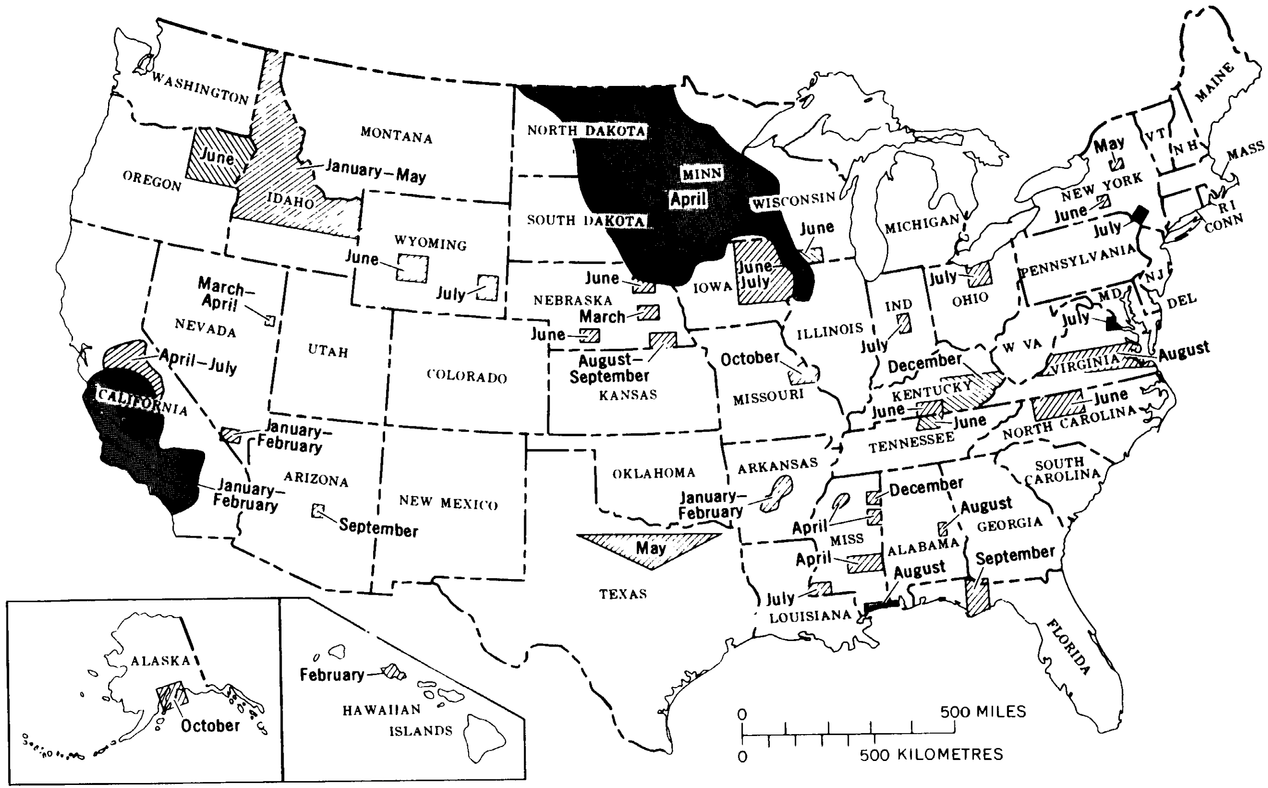


FIGURE 1.—Areas and months of occurrence of outstanding floods in 1969 in the conterminous United States, Alaska, and Hawaii. Shaded pattern indicates the area for which additional information is available in a separate flood report.

rainfall and short-term temperature changes, and the seasonal variability of snowfall and vegetative cover in the basin. Tidal or onshore -wave flooding caused by hurricane or gale-force winds is subject to the spaciotemporal variability associated with the meteorological forces generating those winds. Tidal flooding caused by tsunami is subject to the spaciotemporal variability associated with submarine earthquakes, or other large-scale, short-duration disturbances of the ocean floor.

The 1969 floods described in this publication were selected as the most outstanding of those for which information is available but do not necessarily include all outstanding floods of that year.

According to the National Weather Service (formerly U.S. Weather Bureau), 1969 flood damage of $902.6 million, along the Nation's watercourses, was the largest since 1955 when $995 million was reported. These losses were more than twice the national average of $400 million based on the 15-year period 1951–65, adjusted to the 1965 price index, according to Nelson and Haley (1970). In addition, the area in the path of Hurricane Camille had a $1.3 billion loss in August due to combined stream flooding and tidal-wave damage.

A reported 297 lives were lost to stream flooding, which was the most since 1955 when 302 lives were lost. These figures compare to 31 lives in 1968 and the 44-year average of 77 lives lost annually during the period 1925–68. The American Red Cross reported an additional 144 lives lost and 76 missing from the Hurricane Camille-Mississippi-area tidal floods.

Many of the flood reports herein contain information about the amounts of rainfall and the duration of the storm causing the flood. Recurrence intervals of the storms may be determined from the U.S. Weather Bureau (1961) or from a simplified set of isopluvial maps and charts contained in a report by Rostvedt (1965).

Continuing investigation of water resources in the United States, Puerto Rico, Guam, U.S. Samoa, and Okinawa is being done by the U.S. Geological Survey in cooperation with State agencies, the Corps of Engineers, U.S. Army, the Bureau of Reclamation, and other Federal and local agencies.

Collection of data, computations, and preparation of most of the text were done by district offices of the U.S. Geological Survey in areas where the floods ocurred. Additional data were obtained from other government and State agencies.

DEFINITION OF TERMS AND ABBREVIATIONS

The definition of hydrologic terms used herein are:

Acre-foot (acre-ft). The quantity of water required to cover an area of one acre to a depth of 1 foot and is equivalent to 43,560 cu ft (cubic feet) or 325,851 gal (gallons).

Contents. The volume of water in a reservoir or lake. Unless otherwise indicated, volume is computed on the basis of a level surface, and it does not include bank storage.

Cubic foot per second (cfs). The rate of discharge representing a volume of 1 cu ft passing a given point during 1 second and is equivalent to 7.48 gal/s (gallons per second).

Discharge. The volume of water in a stream which passes a given point in a unit of time.

Drainage area. Area of a stream upstream from above a specified location is that area, measured in a horizontal plane, enclosed by a topographic divide from which direct surface runoff from precipitation normally drains by gravity into the river upstream from the specified point. Figures of drainage area given herein include all closed basins, or noncontributing areas, unless otherwise noted.

Gage height. The water-surface elevation referred to some arbitrary gage datum. Gage height often is used interchangeably with **stage.**

Gaging station. A particular site on a stream, canal, lake, or reservoir where systematic observations of gage height and or discharge are obtained. When used in connection with a discharge record, the term is applied herein only to those gaging stations where a continuous record of discharge is obtained.

Peak stage. The maximum stage reached during a period of rising and falling water level.

Stage. See gage height.

WSP. Used as an abbreviation for "Water-Supply Paper" in reference to previously published reports of the U.S. Geological Survey.

DOWNSTREAM ORDER AND STATION NUMBER

The flood-determination points for each report herein are arranged in downstream order. In a downstream direction along the main stem, all points on a tributary entering above a main-stem point are listed before that point. If a tributary enters between two main-stem points it is listed between them. A similar order is followed in listing points on first rank, second rank, and other ranks of tributaries.

As an added means of identifying gaging stations where records have been collected systematically, numbers have been assigned in the same downstream order described above. Gaps are left between the numbers to allow for new stations that may be established; hence the numbers are not consecutive. The complete 8-digit numbr for each station, such as 06794000, includes the part number "06" plus a 6-digit number. The United States is represented by 16 parts shown in figure 2.

DETERMINATION OF FLOOD STAGES AND DISCHARGES

Peak stages and peak (maximum) discharges in this flood summary were obtained and compiled using standard procedures of flood investigations adopted by the U.S. Geological Survey and other Federal and State agencies.

The usual method of determining stream discharge at a gaging station is the application of a stage-discharge relation to an observed stage. The stage-discharge relation is usually defined by current-meter measurements of discharge through as much of the range of stage as possible. Short extensions may be made to the graph of relation by logarithmic extrapolation, by velocity-area

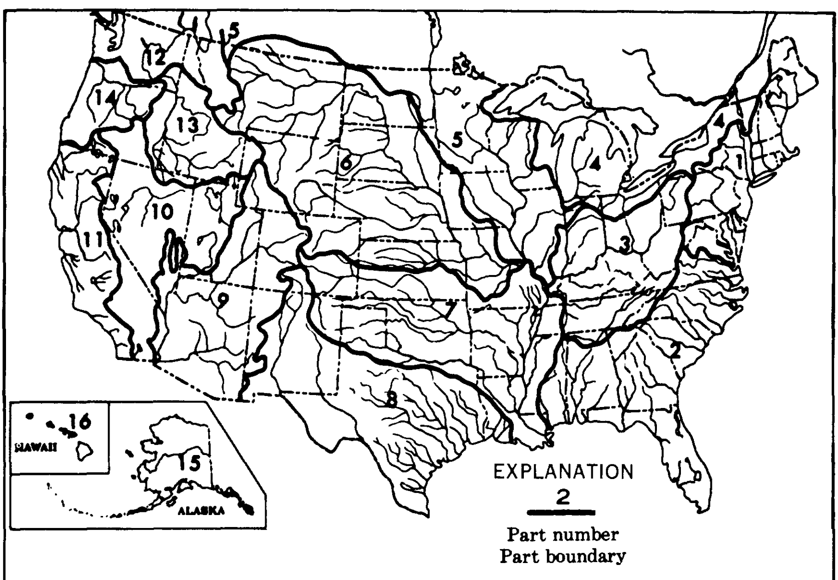


FIGURE 2.—Map of the United States showing the parts covered by this flood summary.

studies, or by use of other measureable hydraulic factors to obtain peak discharges greater than the range of the stage-discharge relation defined by discharge measurements.

Peak discharges that are far beyond the range of the stage-discharge relation at the gaging stations, and peak discharges at miscellaneous sites (which have no defined stage-discharge relation), may be determined by various types of indirect measurements. During major floods, adverse conditions often make it impossible to obtain current-meter measurements at some sites. Peak discharges may be determined after the flood has subsided by indirect methods based on detailed surveys of selected channel reaches. The description of the indirect methods used by the Geological Survey is given in a series of publications titled "Techniques of Water-Resources Investigations of the United States Geological Survey, Book 3."

EXPLANATION OF DATA

The floods are described in chronological order. The data for each flood include: a description of the storm, the flood, and the flood damage; a map of the flood area showing flood-determination points and, for some storms precipitation stations or isohyets; rainfall amounts and intensities; and peak stages and discharges for the streams affected. When limited rainfall data are available they are presented in tabular form showing daily or storm totals. When sufficient data are available to determine the pattern and distribution of rainfall, an isohyetal map may be shown.

A summary table of peak stages and peak (maximum) discharges is given for each flood. Where the number of flood-determination points in the flood area is small, these data are shown in the text with the flood peak being referred to as maximum discharge if it is the highest peak of record. The first column in this table, headed "No. ——," is a set of sequential numbers that relate the flood data precisely to a point identified on a flood report map. The first column under "Maximum floods" gives the period of known floods prior to the 1969 floods. This period does not necessarily correspond only to the period of gaging station operation, but may extend back to an earlier date. A period is shown whenever it can be associated with a maximum stage, even though the corresponding discharge may not be known.

The second column under Maximum floods shows the year, within the period of known floods prior to the 1969 flood being reported, in which the maximum stage or discharge occurred. The third column gives the date of the peak stage or discharge of the 1969 flood.

The last column shows the recurrence interval for the 1969 flood-peak discharges. The recurrence interval is the average interval, in years, in which a flood of a given magnitude will be exceeded once as an annual maximum. A flood having a recurrence interval of 20 years can be expected to occur, on the average, once in 20 years, or it is one that has a 5-percent chance of occurring in any year. The recurrence intervals shown in this column were obtained from U.S. Geological Survey reports on flood magnitude and frequency. In nearly all flood-frequency reports used, the data limit the determination of recurrence intervals to 50 years. In a few reports the limit is less than 50 years. The severity of a flood whose recurrence interval exceeds the limit of determination is expressed as a ratio of its peak discharge to the discharge of a flood that has a recurrence interval equal to the limit of determination.

OTHER PUBLICATIONS ON FLOODS

Many reports on floods have been prepared by the Geological Survey and are listed in "Publications of the Geological Survey, 1879–1961 and 1962–70." Selected publications by number, title, and year are listed below:

WSP *Title*

147—Destructive floods in the United States in 1904.

162—Destructive floods in the United States in 1905.

771—Floods in the United States, magnitude and frequency.

798—The Floods of March 1936, Part 1, New England Rivers.

799—The Floods of March 1936, Part 2, Hudson River to Susquehanna River region.

800—The Floods of March 1936, Part 3, Potomac, James, and upper Ohio Rivers.

847—Maximum discharges at stream-measurement stations through September 1938.

967–A—Notable local floods of 1939, part 1, Floods of September 1939 in Colorado River Basin below Boulder [Hoover] Dam.

994—Cloudburst floods in Utah, 1850–1938.

1137—Floods of 1950.

1227—Floods of 1951.

1260–F—Summary of floods in the United States during 1952.

WSP	*Title*
1320	Floods of 1953.
1370–C	Summary of floods in the United States during 1954.
1455–B	Summary of floods in the United States during 1955.
1530	Summary of floods in the United States during 1956.
1652	Floods of 1957.
1660–B	Summary of floods in the United States during 1958.
1750–B	Summary of floods in the United States during 1959.
1790–B	Summary of floods in the United States during 1960.
1810	Summary of floods in the United States during 1961.
1820	Summary of floods in the United States during 1962.
1830–B	Summary of floods in the United States during 1963.
1840–C	Summary of floods in the United States during 1964.
1850–E	Summary of floods in the United States during 1965.
1870–D	Summary of floods in the United States during 1966.
1880–C	Summary of floods in the United States during 1967.
1970–B	Summary of floods in the United States during 1968.

OTHER DATA AVAILABLE

Other reports by the Geological Survey contain tabular data on streamflow, peak discharge, floods, and other data about water. A list of Geological Survey publications may be obtained by writing the Director, Geological Survey, National Center, 12201 Sunrise Valley Drive, Reston, Va. 22092.

Geological Survey publications may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402, who will also furnish lists giving prices.

Geological Survey publications are available for reference at the District Offices of the Survey's Water Resources Division and at most large libraries.

SUMMARY OF FLOODS

FLOODS OF JANUARY-FEBRUARY IN CENTRAL AND SOUTHERN CALIFORNIA

After A. O. WAANANEN (1969)

Intense floods in central and southern California due to storms that occurred between January 18 and February 25 caused severe damage over a large area. The major flood-affected area (fig. 3) includes the basins of many streams that have their sources in the central and south-coastal ranges, in the southern part of the San Joaquin Valley, and the southern Sierra Nevada foothills from the Kern River basin on the south to the Mariposa Creek basin north of Fresno.

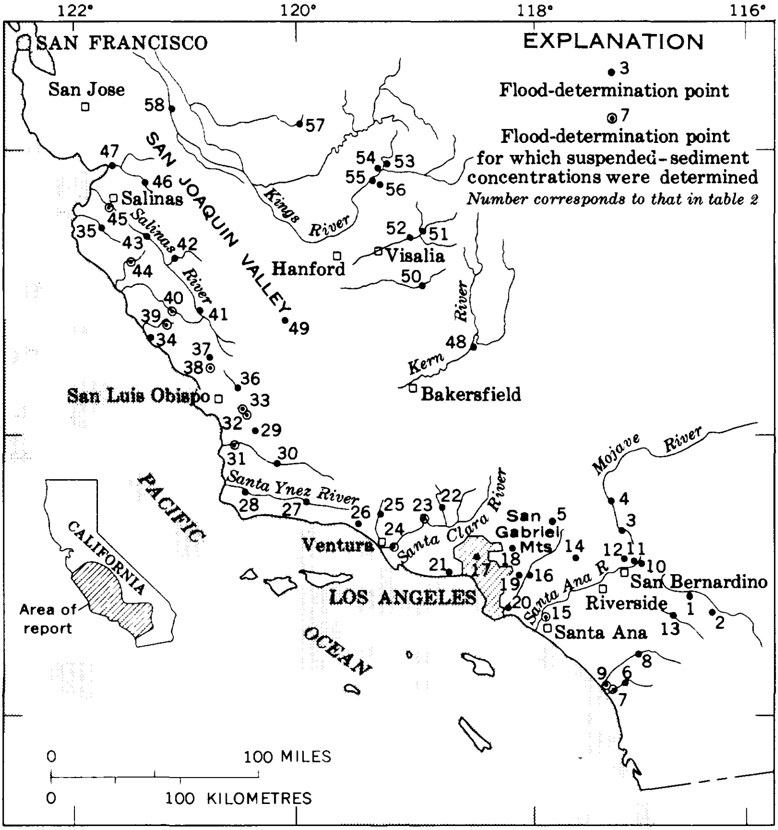


FIGURE 3.—Locations of sites where peak flows and suspended-sediment concentrations were determined for floods of January–February in central and southern California.

Many floods were the largest in 30 years of record and in southern California approached the magnitude of those of March 1938. On a few streams such as the Santa Clara, Santa Ynez, and Salinas Rivers, previous flood peaks of record were exceeded. Peaks on these streams may have approached those of 1861–62.

The flood area was experiencing a drought until a series of storms began in January. Early January precipitation was minor, and moderate precipitation occurred on January 13 and 14. Late January storms, with two distinct periods of precipitation January 18–22 and 24–27, (table 1) were caused by a strong flow of warm moist air originating in a tropical zone southwest of southern California. A brief break in the precipitation was caused by a high-pressure ridge that moved through the area January 22–23. Total precipitation January 18–27 ranged from an average of 10–15 inches in the lowlands and less on the valley floor near

Bakersfield to 49.95 inches at the community of Mount Baldy Notch near San Bernardino (figs. 4 and 5.) Precipitation data indicate that the month of January was the wettest on record at most of the observation stations reported by the National Weather Service. New rainfall records were established at many points. Recurrent precipitation during February culminated with heavy rain February 22–25 producing totals for the month that equaled or exceeded records in several areas. The average accumulation for February was 8–12 inches in the lowlands and 20–25 inches in the mountains (table 1). A 24-hour total of 13.48 inches was recorded February 24–25 at Opids Camp and 12.55 inches at Cogswell dam, both in the San Gabriel Mountains (fig. 6).

Storm totals were 24.50 inches at Matilija Canyon in the Santa Ynez Mountains north of Ventura and 23.86 inches at Lake Arrowhead in the San Bernardino Mountains (fig. 6).

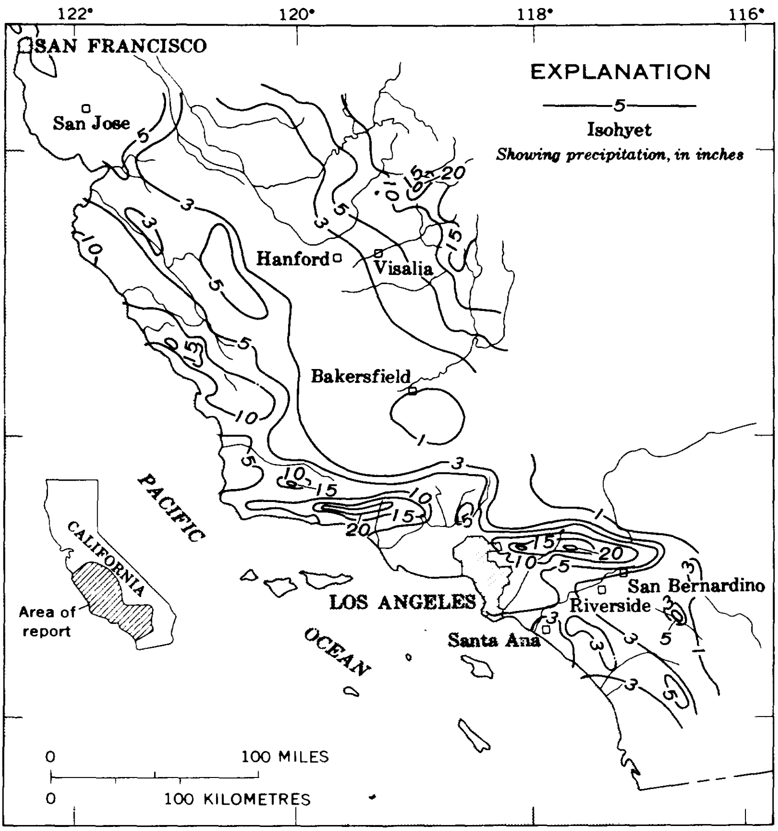


FIGURE 4.—Isohyets of total precipitation on January 18–22, in central and southern California.

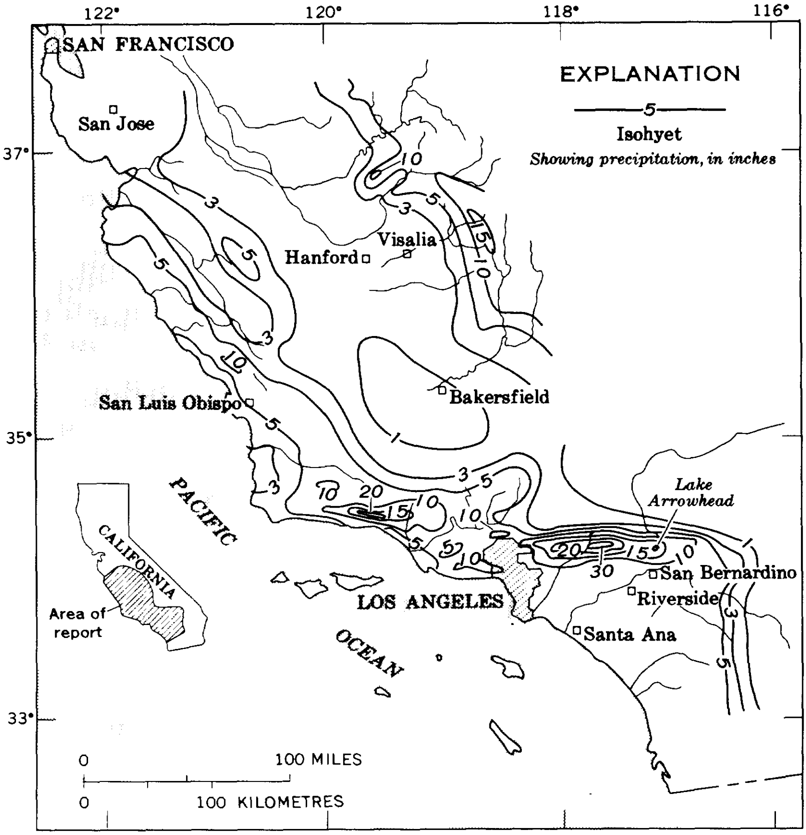


FIGURE 5.—Isohyets of total precipitation on January 24–27, in central and southern California.

Total precipitation reported for the 2-month period January and February 1969 reached a maximum of 84.65 inches at Mount Baldy Notch, 81.86 inches at Lake Arrowhead, and 78.78 inches at Opids Camp. At Los Angeles the combined January and February precipitation was the largest 2-month total since that of February and March 1884.

Precipitation totals for the periods January 18–22, 24–27, and February 22–25 are shown by the isohyets in figure 4, 5, and 6 and data for selected stations are listed in table 1.

Floods of January 18–22 were generally widespread but moderate. However, in localized areas, floods and damage were severe, notably at San Luis Obispo and in the Glendora-Azusa foothill area of the San Gabriel Mountains. Ten campers lost their lives when trapped by the Sespe Creek flood and four other drownings were reported elsewhere in the region.

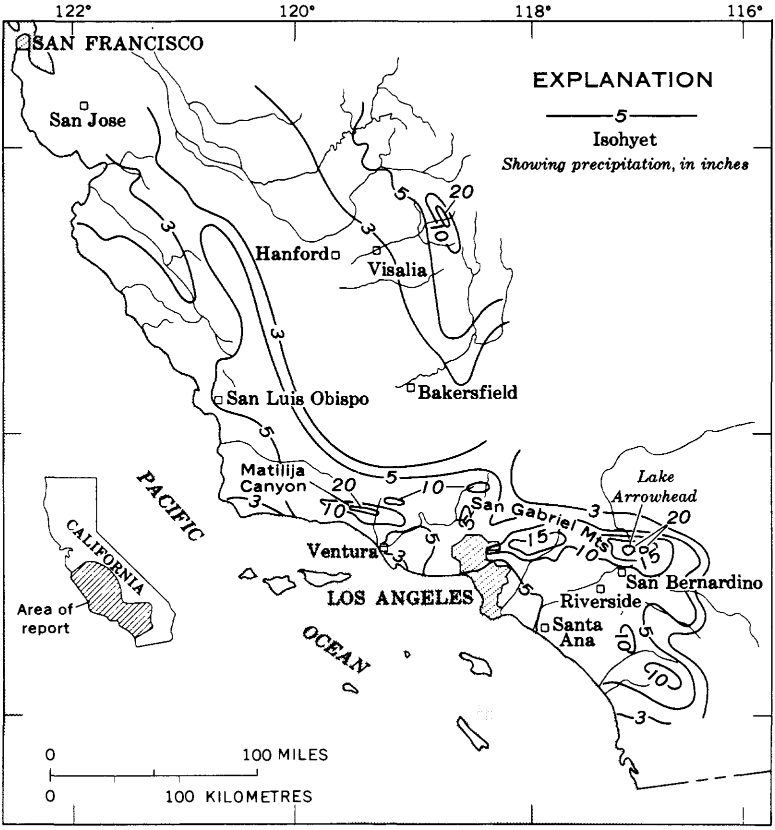


FIGURE 6.—Isohyets of total precipitation on February 22–25, in central and southern California.

The intense storm of January 24–27 on previously saturated soils produced extreme floods with catastrophic effects. The runoff from populated areas in mountain and foothill areas in the San Gabriel Mountains and coastal areas west of Los Angeles washed out bridges, roads, and streets; rail transportation was interrupted; homes were destroyed; and severe landslides occurred. Twenty-five lives were lost during the floods, and about 10,000 persons were evacuated from their homes in these areas. Stream transportation and deposition of debris created additional problems.

The January 25 flood was generally comparable to that of March 1938 which had been the most damaging flood of recent times in southern California, at least since the legendary flood of 1861–62 (table 2). East of Los Angeles County the 1938 flood was greater, whereas west of Los Angeles County the 1969 flood was greater.

TABLE 1.—*Precipitation, in inches, at selected stations during January and February in central and southern California*

[Data from National Weather Service. Dates shown refer to those in climatological data reports]

Precipitation station and subbasin	Altitude (feet)	January 18-22		January 24-27		Total January 18-27	January total	February 22-25		February total
		Maximum 1 day	Storm total	Maximum 1 day	Storm total			Maximum 1 day	Storm total	
The Great Basin										
Nightingale (Whitewater River)	4,025	0.30	0.71	1.70	1.90	2.61	3.45	0.35	0.77	3.54
Morongo Valley (Whitewater River)	2,580	1.37	3.16	4.64	6.96	10.17	11.37	1.12	2.03	4.93
Mount San Jacinto WSP (Whitewater River)	8,417	3.07	5.44	6.59	9.61	15.05	18.30	3.97	9.97	16.65
Palm Springs (Whitewater River)	411	.37	.79	2.17	2.61	3.40	3.79		.56	1.56
Lake Arrowhead (Mojave River)	5,205	5.14	15.53	14.24	25.66	41.19	45.92	9.75	23.86	35.94
Hesperia (Mojave River)	3,195	1.41	2.16	1.64	3.09	5.25	5.31	2.40	6.03	6.07
Big Pines Park FC838 (Antelope Valley)	6,862	4.09	9.39	5.74	13.65	23.04	25.47	6.96	14.25	20.18
Fairmont (Antelope Valley)	3,060	3.45	6.49	3.03	7.15	13.92	14.40	6.34	9.84	14.69
Coastal basins south of the Santa Ana River										
Escondido (Escondido Creek)	660	.72	1.67	2.17	3.35	5.02	7.23	1.05	2.97	6.43
Henshaw Dam (San Luis Rey River)	2,700	2.25	5.44	5.14	9.36	15.38	19.09	3.48	9.82	16.72
Palomar Mountain Observatory (San Luis Rey River and Santa Margarita River)	5,545	2.69	5.61	8.00	14.63	20.41	25.78	6.00	13.27	24.23
Oceanside (San Luis Rey River)	84	.43	1.01	1.67	2.96	3.97	5.11	1.88	3.55	6.42
Temecula (Santa Margarita River)	970	1.43	3.11	4.05	7.38	10.54	----	3.52	8.57	13.81
Laguna Beach (Aliso Creek)	35	1.33	2.89	2.62	3.66	6.55	7.90	2.38	6.23	9.06
Coastal basins from the Santa Ana River to the Los Angeles River										
Big Bear Lake (Santa Ana River)	6,745	3.77	6.55	9.40	14.50	20.96	24.87	6.43	12.80	19.89
Mount Baldy Notch (Santa Ana River)	7,735	7.35	16.80	14.00	33.15	49.95	53.70	6.45	14.75	30.95
Riverside Fire Station R3 (Santa Ana River)	840	.59	1.59	2.19	3.51	5.10	6.76	2.41	5.27	8.00
Elsinore (San Jacinto River)	1,285	2.11	3.12	3.59	4.93	8.05	9.40	2.97	7.09	11.65
Corona (Santa Ana River)	710	1.22	3.28	3.66	5.71	8.99	10.90	2.60	6.08	9.08
Colbys FC53D (Los Angeles River)	3,675	7.51	12.40	11.91	19.15	31.55	33.12	10.13	18.29	25.65
Los Angeles Civic Center (Los Angeles River)	270	3.30	6.65	3.43	6.25	13.15	14.94	2.11	3.83	8.03

Severe flooding occurred again February 22–25 with extreme flooding on Santiago Creek and the lower Santa Ana River basins in Orange county. Flows in the Santa Ynez River basins again exceeded maximum flows of record, and new record flows occurred on the Salinas River. Twelve lives were lost as a direct result of the February floods in these basins.

Suspended-sediment concentration in many streams greatly exceeded any previously measured in the flood-affected area (table 3). The period between time of sediment sampling and time of peak discharge is shown in addition to observed suspended-sediment concentrations.

Despite record-breaking or near record-breaking precipitation and floods, damage was minimal in older developed areas that were protected against inundation and debris damage by carefully planned flood-control facilities, such as debris basins and flood-conveyance channels. By contrast, extensive damage occurred in more recently developed areas where flood-control development had not kept pace with expanded urbanization (Rantz, 1970). Total lives lost as a result of the floods of January and February were 60, and physical damage was nearly $400 million, according to Nelson and Haley (1970).

TABLE 2.—*Flood stages and discharges, January-February in central and southern California*

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods					
			Known before January 1969		January, February 1969	Gage height (feet)	Discharge	
			Period of known floods	Year			Cfs	Recurrence interval (yrs)
	Salton Sea basin							
1	10256500, Snow Creek near White Water	10.8	1921–31, 1959–69	1965		12.1	4,200	[1] 1.9
					Jan. 25	13.8	13,000	[1] 5.8
					Feb. 25	7.87	1,770	41
2	10258500, Palm Canyon Creek near Palm Springs	93.3	1930–42, 1947–69	1937		5.80	3,850	13
					Jan. 25	5.58	1,490	5
					Feb. 25	4.05	520	2

See footnotes at end of table.

TABLE 2.—*Flood stages and discharges, January-February in central and southern California*—Continued

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before January 1969: Period of known floods	Known before January 1969: Year	January, February 1969	Gage height (feet)	Discharge: Cfs	Discharge: Recurrence interval (yrs)
	Mojave River basin							
3	10260500, Deep Creek near Hesperia	136	1904–22, 1929–69	1938		----	46,600	[1]2.8
					Jan. 25	12.83	23,000	[1]1.3
					Feb. 25	10.75	17,600	50
4	10261500, Mojave River at lower narrows near Victorville	514	1899–1906, 1930–69	1938		20.7	70,600	[1]1.4
					Jan. 25	13.5	33,800	32
					Feb. 25	9.80	34,500	34
	Antelope Valley basin							
5	10263500, Big Rock Creek near Valyermo	22.9	1923–69	1938		----	8,300	[1]2.1
					Jan. 25	7.7	4,760	[1]1.2
					Feb. 25	6.25	2,850	34
	San Luis Rey River basin							
6	11041000, San Luis Rey River near Bonsall	512	1916–18, 1929–69	1891		----	128,000	[1]3.5
				1938		16.04	[2]18,100	17
					Jan. 25	11.86	[2]4,970	4
					Feb. 25	11.43	[2]7,700	5
7	11042000, San Luis Rey River at Oceanside	557	1912–16, 1929–42, 1946–69	1916		----	95,600	[1]2.4
					Jan. 25	13.2	3,010	2
					Feb. 26	([3])	11,500	3
	Santa Margarita River basin							
8	11043000, Murrieta Creek at Temecula	222	1924–69	1943		13.82	17,500	48
					Jan. 25	9.94	6,660	14
					Feb. 25	12.34	10,400	25
9	11046000, Santa Margarita River at Ysidora	739	1923–69	1927		[4]18.00	33,600	38
					Jan. 25	16.26	16,100	12
					Feb. 24	16.85	------	---
					Feb. 25	15.89	19,200	16

See footnotes at end of table.

TABLE 2.—*Flood stages and discharges, January-February in central and southern California*—Continued

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before January 1969: Period of known floods	Known before January 1969: Year	January, February 1969	Gage height (feet)	Discharge: Cfs	Discharge: Recurrence interval (yrs)
	Santa Ana River basin							
10	11051500, Santa Ana River near Mentone	209	1896–1969	1938		14.3	52,300	---
					Jan. 25	14.68	15,300	---
					Feb. 25	12.3	10,000	---
11	11055500, Plunge Creek near East Highlands	16.9	1919–69	1938		----	5,340	35
					Jan. 25	5.96	4,610	29
					Feb. 25	4.60	3,400	19
12	11055800, City Creek near Highland	19.6	1919–69	1938		----	6,900	47
					Jan. 25	8.83	3,240	15
					Feb. 25	9.39	7,000	48
13	11069500, San Jacinto River near San Jacinto	141	1920–69	1927		----	45,000	[1] 2.4
					Jan. 25	10.15	7,410	14
					Feb. 26	8.50	4,080	7
14	11073470, Cucamonga Creek near Upland	10.1	1927–69	1938		----	10,300	[1] 1.9
					Jan. 25	12.44	14,100	[1] 2.6
					Feb. 25	7.51	4,090	33
15	11078000, Santa Ana River at Santa Ana	1,685	1923–69	1938		[4] 10.20	46,300	---
					Jan. 26	5.70	[2] 9,200	---
					Feb. 25	6.90	[2] 19,100	---
	San Gabriel River basin							
16	11870200, San Gabriel River above Whittier Narrows Dam	353	1955–57, 1963–69	1967		8.25	[2] 17,300	---
					Jan. 25	10.90	[2] 46,600	---
					Feb. 25	9.90	[2] 33,600	---
	Los Angeles River basin							
17	11092450, Los Angeles River at Sepulveda Dam	158	1929–69	1965		10.98	[2] 13,000	---
					Jan. 25	11.42	[2] 13,800	---
					Feb. 25	10.08	[2] 11,500	---
18	11098000, Arroyo Seco near Pasadena	16.0	1910–69	1938		9.42	8,620	[1] 1.4
					Jan. 25	7.30	4,560	32
					Feb. 25	9.37	8,540	[1] 1.4

See footnotes at end of table.

TABLE 2.—*Flood stages and discharges, January-February in central and southern California*—Continued

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before January 1969: Period of known floods	Year	January, February 1969	Gage height (feet)	Discharge: Cfs	Discharge: Recurrence interval (yrs)
	Los Angeles River basin—Continued							
19	11102300, Rio Hondo below Whittier Narrows		1966–69	1967		----	[2]19,100	---
					Jan. 25	13.82	[2]38,800	---
					Feb. 25	11.22	[2]31,600	---
20	11103000, Los Angeles at Long Beach	832	1928–69	1938		----	99,000	---
					Jan. 25	16.0	[2]102,000	---
					Feb. 22	12.52	[2]65,700	---
	Malibu Creek basin							
21	11105500, Malibu Creek at Crater Camp, near Calabasas	105	1931–69	1965		17.27	20,600	[1]1.4
					Jan. 25	21.43	33,800	[1]2.3
					Feb. 25	13.70	12,000	34
	Santa Clara River basin							
22	11109600, Piru Creek above Lake Piru	372	1955–69	1962		12.20	12,200	17
					Jan. 25	13.9	20,800	34
					Feb. 25	18.6	31,200	[1]1.2
23	11113000, Sespe Creek near Fillmore	251	1911–13, 1927–69	1938		----	56,000	[1]1.7
					Jan. 25	20.80	60,000	[1]1.8
					Feb. 25	24.95	45,000	[1]1.4
24	11113920, Santa Clara River at Saticoy	1,595	1927–32, 1949–69	1938		----	120,000	---
					Jan. 25	23.07	165,000	---
					Feb. 25	21.45	152,000	---
	Ventura River basin							
25	11115500, Matilija Creek at Matilija Hot Springs	54.6	1927–69	1938		----	15,900	[1]1.0
					Jan. 25	16.5	20,000	[1]1.3
					Feb. 25	13.25	15,000	48
	Carpinteria Creek basin							
26	11119500, Carpinteria Creek near Carpinteria	13.1	1941–69	1966		8.60	2,720	18
					Jan. 25	14.90	4,560	47
					Feb. 24	5.39	3,600	28

See footnotes at end of table.

TABLE 2.—*Flood stages and discharges, January-February in central and southern California*—Continued

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before January 1969: Period of known floods	Known before January 1969: Year	January, February 1969	Gage height (feet)	Discharge: Cfs	Discharge: Recurrence interval (yrs)
	Santa Ynez River basin							
27	11124500, Santa Cruz Creek near Santa Ynez	73.9	1941–69	1966		10.30	5,800	12
					Jan. 25	10.91	6,620	14
					Feb. 24	11.2	7,050	15
28	11133500, Santa Ynez River near Lompoc	790	1908–18,	1907		22.0	[2] 120,000	[1] 1.2
			1925–69	1938		29.3	45,000	38
					Jan. 25	24.20	80,000	[1] 2.0
					Feb. 25	18.22	70,000	[1] 1.4
	Santa Maria River basin							
29	11137900, Huasna River near Arroyo Grande	104	1959–69	1966		14.55	14,300	---
					Jan. 25	15.9	21,000	---
					Feb. 24	13.25	15,000	---
30	11138500, Sisquoc River near Sisquoc	281	1929–33,	1938		[4] 8.1	11,000	10
			1943–69	1966		15.75	23,200	32
					Jan. 25	15.39	21,400	27
					Feb. 24	14.36	17,800	---
31	11141000, Santa Maria River at Guadalupe	1,742	1940–69	1952		8.18	32,800	12
					Jan. 25	9.5	[2] 24,300	---
					Feb. 25	10.0	[2] 27,200	---
	Arroyo Grande basin							
32	11141150, Arroyo Grande above Phoenix Creek, near Arroyo Grande	13.4	1967–69	1968		2.43	26	---
					Jan. 25	6.83	1,270	---
					Feb. 24	6.15	552	---
33	11141280, Lopez Creek near Arroyo Grande	21.4	1967–69	1968		2.79	32	---
					Jan. 25	9.26	2,830	---
					Feb. 24	8.14	1,690	---
	Arroyo de la Cruz basin							
34	11142500, Arroyo de la Cruz near San Simeon	41.2	1950–69	1966		15.27	35,200	[1] 2.8
					Jan. 19	13.45	23,700	[1] 1.9
					Feb. 24	10.78	13,300	[1] 1.1

See footnotes at end of table.

TABLE 2.—*Flood stages and discharges, January-February in central and southern California*—Continued

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before January 1969 — Period of known floods	Year	January, February 1969	Gage height (feet)	Discharge: Cfs	Recurrence interval (yrs)
	Carmel River basin							
35	11143200, Carmel River at Robles del Rio	193	1957–69	1955		11.7	6,930	7
				1958		10.50	7,100	7
					Jan. 26	10.52	6,900	8
					Feb. 24	9.05	4,250	4
	Salinas River basin							
36	11145000, Salinas River above Pilitas Creek near Santa Margarita	114	1942–69	1966		12.45	[2] 11,900	---
					Jan. 25	14.90	[2] 16,600	---
					Feb. 24	13.35	[2] 13,500	---
37	11147000, Jack Creek near Templeton	25.3	1949–69	1966		9.58	5,070	14
					Jan. 25	10.57	6,740	24
					Feb. 24	11.28	8,160	36
38	11147070, Santa Rita Creek near Templeton	18.2	1961–69	1966		10.53	3,680	15
					Jan. 19	11.12	6,060	34
					Feb. 24	9.92	3,770	16
39	11148800, Nacimiento River near Bryson	140	1955–69	1955		24.63	30,300	[1] 1.3
					Jan. 25	24.60	39,100	[1] 1.6
					Feb. 24	22.03	31,400	[1] 1.3
40	11149900, San Antonio River near Lockwood	223	1965–69	1966		9.2	11,000	---
					Jan. 26	8.25	14,000	---
					Feb. 24	6.59	7,870	---
41	11150500, Salinas River near Bradley	2,536	1948–69	1966		16.2	[2] 34,000	---
					Jan. 25	18.88	[2] 56,200	---
					Feb. 24	20.34	[2] 117,000	---
42	11151300, San Lorenzo Creek below Bitterwater Creek, near King City	233	1958–69	1966		9.74	3,630	5
					Jan. 25	15.33	10,800	18
					Feb. 24	14.38	9,210	15
43	11151700, Salinar River at Soledad	3,563	1969			----	------	---
					Jan. 25	23.39	[2] 67,300	---
					Feb. 25	23.31	[2] 106,000	---

See footnotes at end of table.

TABLE 2.—*Flood stages and discharges, January-February in central and southern California*—Continued

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before January 1969: Period of known floods	Known before January 1969: Year	January, February 1969	Gage height (feet)	Discharge: Cfs	Discharge: Recurrence interval (yrs)
	Salinas River basin—Continued							
44	11151870, Arroyo Seco near Greenfield	113	1961–69	1966		12.50	21,800	16
					Jan. 26	11.97	18,900	16
					Feb. 24	9.60	9,800	6
45	11152500, Salinas River near Spreckels	4,157	1900–1901, 1929–69	1938		25.0	75,000	18
				1952		26.85	------	---
					Jan. 27	26.1	[2]73,200	16
					Feb. 26	26.51	[2]83,100	23
	Pajaro River basin							
46	11158500, San Benito River near Hollister	586	1949–69	1958		16.30	11,600	8
					Jan. 25	11.23	4,110	---
					Feb. 24	16.10	8,900	---
47	11159000, Pajaro River at Chittenden	1,186	1939–69	1955		32.46	24,000	11
				1958		[5]33.11	------	---
					Jan. 26	22.39	12,000	4
					Feb. 25	23.90	17,800	6
	Buena Vista Lake basin							
48	11190500, Isabella Reservoir near Isabella	2,074	1953–67			----	------	---
					Jan. 25	----	[6]32,400	---
					Feb. 25	----	[6]5,490	---
	Tulare Lake basin							
49	11197250, Avenal Creek near Avenal	57.1	1961–69	1966		5.72	1,540	---
					Jan. 25	7.54	2,420	---
					Feb. 24	7.89	2,600	---
50	11204700, Lake Success near Success	391	1961–69			----	------	---
					Jan. 25	----	[6]22,500	---
					Feb. 25	----	[6]18,000	---
51	11209900, Kaweah River at Three Rivers	418	1958–69	1966		16.69	73,000	[1]2.0
					Jan. 25	12.49	24,200	22
					Feb. 24	9.97	11,900	6

See footnotes at end of table.

TABLE 2.—*Flood stages and discharges, January-February in central and southern California*—Continued

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before January 1969: Period of known floods	Year	January, February 1969	Gage height (feet)	Discharge: Cfs	Recurrence interval (yrs)
	Tulare Lake basin—Continued							
52	11210900, Lake Kaweah near Lemoncove	560	1961–69	---		----	------	---
					Jan. 25	----	[6] 35,100	---
					Feb. 24	----	[6] 20,500	---
53	11220000, Big Creek above Pine Flat Reservoir near Trimmer	69.9	1953–69	1955		9.21	10,400	[1] 1.5
					Jan. 25	10.43	16,400	[1] 2.4
					Feb. 24	6.94	3,780	15
54	11220500, Sycamore Creek above Pine Flat Reservoir, near Trimmer	56.1	1953–69	1955		9.78	6,760	[1] 1.6
					Jan. 25	13.83	14,600	[1] 3.5
					Feb. 24	8.51	5,720	[1] 1.4
55	11221000, Pine Flat Reservoir near Piedra	1,545	1951–69	---		----	------	---
					Jan. 25	----	[6] 70,600	---
					Feb. 26	----	[6] 7,120	---
56	11221700, Mill Creek near Piedra	120	1938–69	1966		9.53	11,000	[1] 1.4
					Jan. 25	9.24	10,300	[1] 1.3
					Feb. 24	7.57	9,520	[1] 1.2
	San Joaquin River basin							
57	11259000, Chowchilla River at Buchanan damsite near Raymond	235	1921–23, 1930–69	1955		16.50	30,000	[1] 2.0
					Jan. 15	12.71	12,900	31
					Feb. 24	12.92	13,700	38
58	11274500, Orestimba Creek near Newman	134	1932–69	1958		6.57	10,200	28
					Jan. 25	8.40	5,080	9
					Feb. 24	7.33	2,810	5

[1] Ratio to 50-year flood discharge.
[2] Affected by regulation, storage, and (or) diversion.
[3] Unknown
[4] Site and (or) datum then in use.
[5] Maximum observed.
[6] Maximum bihourly inflow.

TABLE 3.—*Summary of maximum observed suspended-sediment concentrations in central and southern California*

[Time from peak: Minus figure indicates hours before peak stream discharge; plus figure indicates hours after peak stream discharge]

No.	Station number	Stream and place of determination	Drainage area (sq mi)	Period of record	Maximum observed suspended sediment		
					1969	Concentration (mg/l)	Time from peak (hr)
7	11042000	San Luis Rey River at Oceanside	557	1968–69	Feb. 26	21,100	+12
9	11046000	Santa Margarita River at Ysidora	739	1968–69	Feb. 25	10,100	—2
15	11078000	Santa Ana River at Santa Ana	1,685	1967–69	Jan. 24	7,930	--
					Feb. 26	72,300	+33
					Mar. 8	9,780	--
23	11113000	Sespe Creek near Fillmore	251	1966–69	Jan. 21	25,500	+2
					Jan. 25	26,000	+11
					Feb. 24	37,700	—10
					Dec. 6	18,400	—9
24	11113920	Santa Clara River at Saticoy	1,595	1967–69	Jan. 25	75,000	—1
					Feb. 23	56,600	—2
					Mar. 8	12,400	+1
31	11141000	Santa Maria River at Guadalupe	1,742	1968–69	Jan. 25	72,000	—1
					Feb. 25	60,500	+7
32	11141150	Arroyo Grande above Phoenix Creek, near Arroyo Grande	13.4	1967–69	Jan. 24	15,600	—11
					Feb. 28	41,900	[1] +89
33	11141280	Lopez Creek near Arroyo Grande	21.4	1967–69	Jan. 19	32,400	—1
38	11147070	Santa Rita Creek near Templeton	18.2	1967–69	Jan. 26	1,910	+14
					Feb. 24	6,150	+4
39	11148800	Nacimiento River near Bryson	140	1958–59	Jan. 25	1,190	+12
				1960–64	Feb. 25	419	+30
				1965–69			
40	11149900	San Antonio River near Lockwood	223	1965–69	Jan. 21	9,820	[2] 0
					Feb. 24	3,230	—2
44	11151870	Arroyo Seco near Greenfield	113	1962–69	Jan. 25	1,760	[3] +4
					Feb. 24	1,260	+2
45	11152500	Salinas River near Spreckels	4,157	1966–69	Jan. 26	15,100	—14
					Feb. 26	22,100	+1

[1] After principal peak February 24; lower peak February 28. Concentration of 39,300 mg/l observed February 23, 31 hours before peak.

[2] At peak of January 21; principal peak January 26.

[3] After peak of January 25 (13,200 cfs); 20 hours before principal peak January 26 (15,200 cfs).

FLOOD OF JANUARY 25 NEAR LAS VEGAS, NEVADA

The general storm of January 19–26 caused floods in widely scattered parts of Nevada. However, the most intense floods were in the area southeast of Charleston Peak near Blue Diamond southwest of Las Vegas (fig. 7). The National Weather Service rain gage at Little Red Rock recorded 2.95 inches on January 25 and 4.56 inches for the January 19–26 storm period. The National Weather Service rain gage at Las Vegas Airport recorded 0.24 of an inch on January 25 and 1.02 inches for the period.

The flood peak of January 25 at station 09419670, Red Rock Wash near Blue Diamond, was 3.5 times the previous maximum of 2,500 cfs in 1966 (table 4). By contrast, the flood peak of January 25 at station 09419680, Cottonwood Valley near Blue Diamond, had a maximum discharge which only slightly exceeded the peak of 1966. Peak discharges were much less at the gages on Flamingo Wash at Las Vegas and Duck Creek at Whitney, which are downstream from Red Rock Wash and Cottonwood Valley, respectively. Lovell Wash near Blue Diamond had a maximum

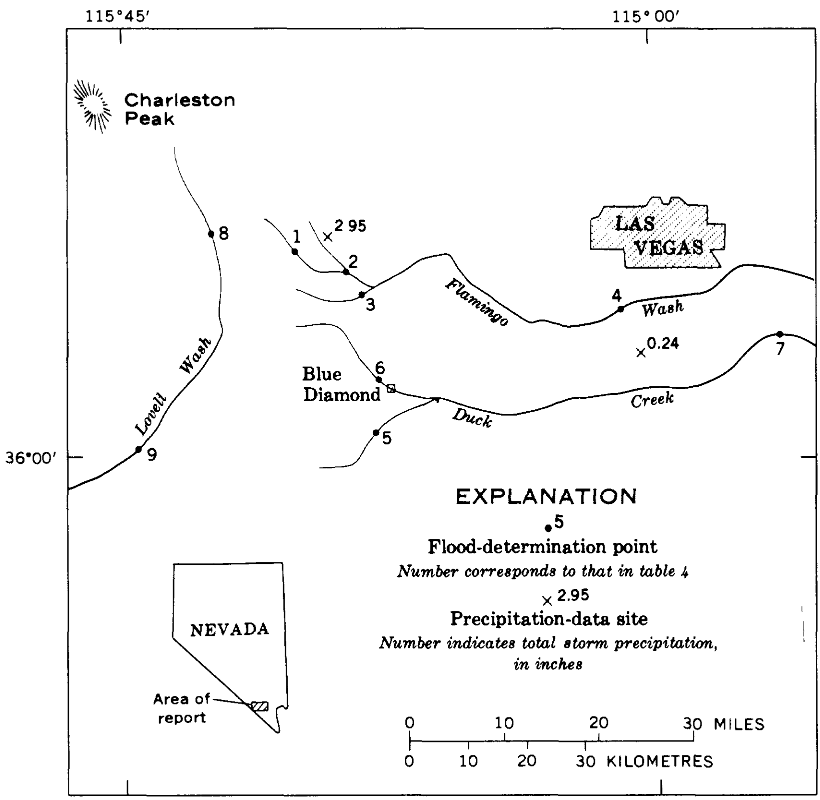


FIGURE 7.—Location of flood-determination points and precipitation-data sites, flood of January 25, near Las Vegas, Nev.

discharge of 4,150 cfs on January 25, which was 7.4 times that of the previous known maximum. Flood-frequency relations for the Las Vegas Wash basin have not been defined, and recurrence intervals for these floods are not shown in table 4.

Damage was minor in the relatively unpopulated area west of Las Vegas. Several cars were buried in mud, sections of county roads were inundated or washed out and blocked, and Spring Mountain Youth Camp, upstream from Husiteon Lovell Wash near Blue Diamond had to be abandoned. Most of the damage occurred along Flamingo Wash in the unincorporated residential and business area south of Las Vegas. Winterwood sub-

TABLE 4.—*Flood stages and discharges, January 25, near Las Vegas, Nev.*

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before January 1969: Period of known floods	Known before January 1969: Year	January 1969	Gage height (feet)	Discharge: Cfs	Discharge: Recurrence interval (yrs)
	Las Vegas Wash basin							
1	09419670, Red Rock Wash near Blue Diamond	7.60	1962–69	1966		4.6	2,500	---
					Jan. 25	6.6	8,780	---
2	White Rock Spring Wash near Blue Diamond	9				----	------	---
					Jan. 25	----	[1]1,300	---
3	Pine Creek near Blue Diamond	11				----	------	---
					Jan. 25	----	[1]700	---
4	09419675, Flamingo Wash at Las Vegas	86	1966–69	1966		----	814	---
					Jan. 25	5.29	1,630	---
5	09419680, Cottonwood Valley near Blue Diamond	18.3	1961–69	1966		7.24	946	---
					Jan. 25	8.53	1,100	---
6	Blue Diamond Wash at Blue Diamond	24.6				----	------	---
					Jan. 25	----	4,950	---
7	09419690, Duck Creek at Whitney	239	1961–69	1961		6.75	3,570	---
					Jan. 25	2.47	[1]300	---
	Pahrump and Mesquite Valleys							
8	Lovell Wash near Charleston Park	14	1966	1966		----	421	---
					Jan. 25	----	[1]2,000	---
9	10251980, Lovell Wash near Blue Diamond	52.7	1965–69	1967		5.98	559	---
					Jan. 25	----	4,150	---

[1] Field estimate.

division, at the southeast corner of Las Vegas, was flooded and a few houses had 3 feet of mud in them. Many streets on the flat valley floor were under water and blocked for several hours.

Flooding also occurred in areas around Caliente, Reno, and Winnemucca.

The peak discharges of record were exceeded at four short-term gaging stations. The maximum discharge in the 31-year record for long-term gaging station, 10329000, Little Humboldt River near Paradise Valley (north of Winnemucca) was exceeded by a peak discharge of 2,380 cfs, (gage height 8.40 feet) on January 21, which was more than twice as much as the previous maximum discharge of 1,100 cfs on February 2, 1952.

FLOODS OF JANUARY-FEBRUARY IN CENTRAL ARKANSAS

By R. C. GILSTRAP

Intense rains of January 29–30 in central Arkansas caused outstanding floods on many streams. The storm centered on the divide between the hills of northwest and the alluvial plains of southeast Arkansas.

The rains were uniformly distributed throughout the report area from early January 29 till late in the morning of January 30. Total amounts of precipitation for the 30-hour storm period ranged from 3.08 inches at Leola to 8.58 inches at Blakely Mountain Dam, and averaged 6.3 inches at 23 precipitation stations (table 5). The cumulative precipitation during the storm period at Blakely Mountain Dam, Alum Fork, Little Rock, and Arkadelphia is shown in figure 8. The maximum intensity was 1.2 inches per hour at Alum Fork.

Flows in Cypress Bayou, Bayou Meto, and Hurricane Creek were at about bankfull stage January 16–28. Saline River was above normal during the same period. Many of the streams rose rapidly in the 30-hour storm period. Except on the larger and slower flowing streams, most of the floods were of short duration. Flooding occurred principally on Cypress Bayou, Bayou Meto, Fourche Creek, Saline River, and Ouachita River from Blakely Mountain Dam to Arkadelphia. Floods on Hurricane Creek were not outstanding (fig. 9).

Rains had been general and frequent January 16–27. Totals ranged from 1.10 inches at Leola to 2.96 inches at Malvern.

Floods in the White River basin were mostly on Cypress Bayou and tributaries. The maximum rate of runoff was 648 cfs per sq mi (cubic feet per second per square mile) from a drainage area of 0.64 of a square mile at Key Branch near Searcy. The

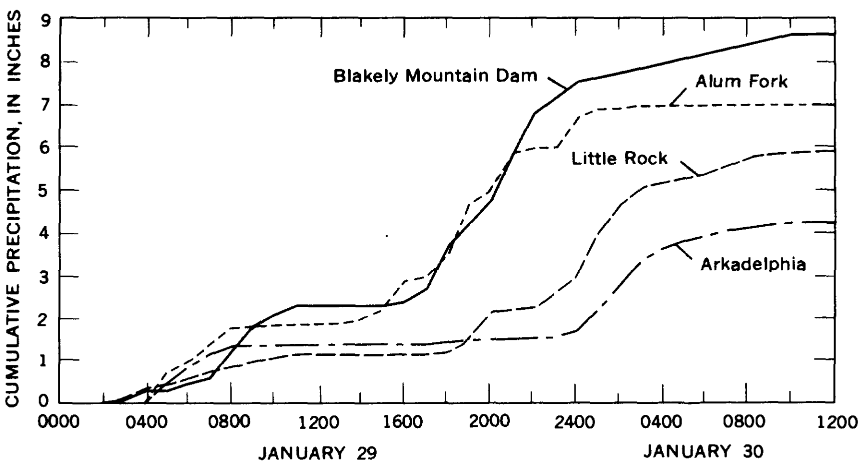


FIGURE 8.—Cumulative precipitation in central Arkansas, January 29–30. From National Weather Service data.

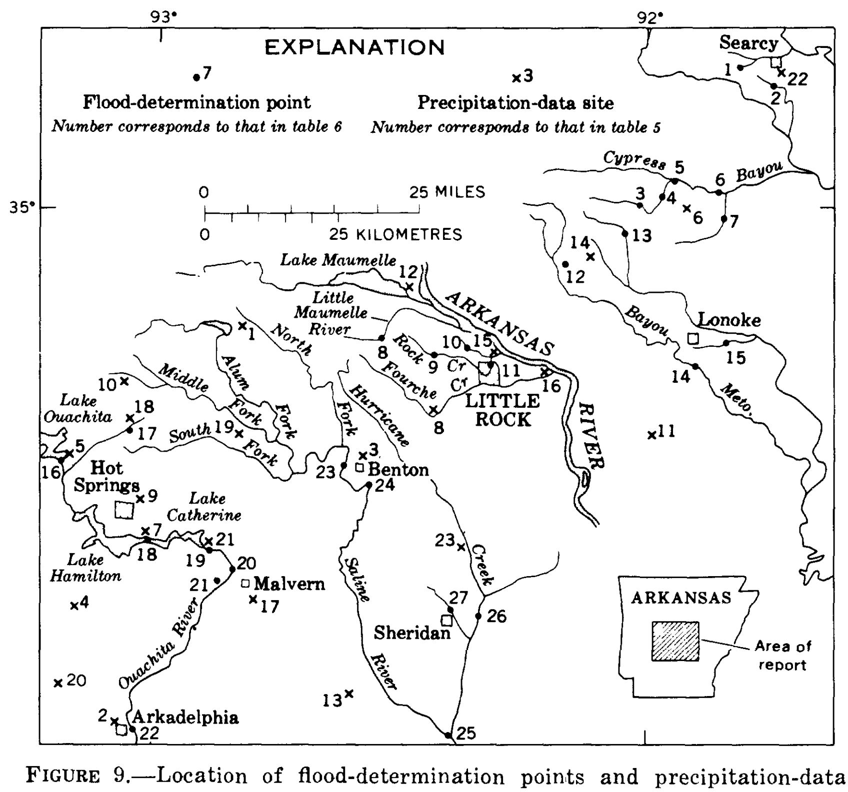


FIGURE 9.—Location of flood-determination points and precipitation-data sites, floods of January–February in central Arkansas.

TABLE 5.—*Precipitation at National Weather Service stations, January 28–31, 1969, in central Arkansas*

No.	Station	Time of observation	Precipitation, in inches			
			January			
			28	29	30	31
1	Alum Fork	1700	0.32	1.58	5.45	0.15
2	Arkadelphia	0700	---	1.31	2.81	.16
3	Benton	0600	.05	.98	4.62	.25
4	Bismarck	0700	---	.95	5.60	.02
5	Blakely Mountain Dam	0800	.05	.65	7.88	.13
6	Cabot	1800	---	1.27	6.29	.39
7	Carpenter Dam	0700	.01	.68	5.30	.21
8	Crystal Valley	0700	.09	.56	6.15	.55
9	Hot Springs 1NNE	1700	.04	1.83	5.50	.44
10	Jessieville	0700	.01	.80	6.52	.05
11	Keo	1900	.01	1.32	3.48	.48
12	Lake Maumelle	1200	.10	2.25	5.05	.39
13	Leola	0700	---	.88	2.20	.43
14	Little Rock Air Force Base [1]	1200	---	4.77	2.98	.38
15	Little Rock Filter Plant	1200	.03	2.00	3.65	---
16	Little Rock Airport	2400	---	2.99	2.91	.45
17	Malvern	1700	.01	1.45	4.44	.47
18	Mountain Valley [2]	2400	---	6.48	.03	1.92
19	Owensville	0800	.04	1.60	5.97	.10
20	Piney Grove	0700	.03	1.05	4.26	.12
21	Remmel Dam	0700	.04	1.26	4.92	.13
22	Searcy	0700	---	.54	5.96	.25
23	Sheridan Tower	1800	.09	1.13	4.28	.15

[1] Little Rock Air Force Base station.
[2] U.S. Geological Survey station.

peak discharge of 24,100 cfs at Cypress Bayou at the relocated U.S. Highway 67 at Ward was 2.1 times that of a 50-year flood. Frequency relations on small drainage areas are not well defined, but ratios of the peak discharges on the smaller streams probably were 1.5 to 2.0 times those of a 50-year flood (table 6).

Floods in the Arkansas River basin were on Bayou Meto and tributaries, Fourche Creek and tributaries, and Little Maumelle River. The maximum unit runoff was 633 cfs per sq mi from a drainage area of 14.9 sq mi at Little Maumelle River at Ferndale. The peak discharge on Bayou Two Prairie probably was 1.5 to 2.0 times that of a 50-year flood, based on the ratio of the peak discharges on nearby Cypress Bayou to those of the 50-year flood. Peak discharge on three tributaries of Fourche Creek, Rock Creek at Shackleford Road, Grassy Flat Creek at Rodney Parham Road, and Coleman Creek at 28th Street in the western part of Little Rock, ranged from 25 to 87 percent greater than those at the same sites in 1968.

Floods on Bayou Meto were mostly greater than those of 1968. At Cypress Branch near Jacksonville, which was in backwater from Bayou Meto during both floods, the stage at the downstream gage was 3.27 feet higher than in 1968; however, at the gaging

TABLE 6.—*Flood stages and discharges, January-February in central Arkansas*

No.	Station number, stream, and place of determintaion	Drainage area (sq mi)	Maximum floods: Known before January 1969: Period of known floods	Known before January 1969: Year	January, February 1969	Gage height (feet)	Discharge: Cfs	Discharge: Recurrence interval (yrs)
	White River basin							
1	07076630, Key Branch tributary near Searcy	0.64	1961–69	1966		7.07	457	---
					Jan. 30	6.86	415	---
2	07076820, Gum Springs Creek near Higginson	9.94	1961–69	1962		11.38	1,460	---
					Jan. 30	11.77	1,880	---
3	Fourmile Creek at relocated U.S. Highway 67 near Austin	16.0						---
					Jan. 30	[1] 249.0	5,740	---
4	Fourmile Creek at relocated U.S. Highway 67 near Ward	23.2						---
					Jan. 30	[1] 235.1	[2] 7,000	---
5	Cypress Bayou at relocated U.S. Highway 67 at Ward	130						---
					Jan. 30	[1] 223.9	24,100	[3] 2.1
6	07076850, Cypress Bayou near Beebe	166	1961–69	1964			11,900	---
				1968		14.27		---
					Jan. 31	16.09	21,000	[3] 1.6
7	07076870, Pigeon Roost Creek at Butlerville	23.0	1961–69	1964		11.84	5,000	---
					Jan. 30	12.30	7,400	---
	Arkansas River basin							
8	07263400, Little Maumelle River at Ferndale	15.0	1963–69	1966		12.19	4,300	---
					Jan. 30	14.55	9,430	---
9	Rock Creek at Shackleford Road in Little Rock	8.50		1968		[1] 370.66	3,450	---
					Jan. 30	[1] 371.80	4,970	---
10	Grassy Flat Creek at Rodney Parham Road in Little Rock	4.71	1968–69	1968		[1] 336.92	1,560	---
					Jan. 30	[1] 337.44	2,920	---

See footnotes at end of table.

TABLE 6.—*Flood stages and discharges, January-February in central Arkansas*—Continued

No.	Station number, stream, and place of determintaion	Drainage area (sq mi)	Maximum floods: Known before January 1969: Period of known floods	Known before January 1969: Year	January, February 1969	Gage height (feet)	Discharge: Cfs	Discharge: Recurrence interval (yrs)
	Arkansas River basin—Continued							
11	Coleman Creek at 28th Street in Little Rock	2.78	1968–69	1968	------	[1]274.30	1,140	---
			-----	-----	Jan. 30	[1]274.71	1,430	---
12	07263910, Cypress Branch near Jacksonville	2.38	1961–69	1963	------	12.06	1,280	---
			-----	-----	Jan. 30	[4]15.84	1,300	---
13	Bayou Two Prairie at U.S. Highway 67 near Cabot	13.1	-----	-----	------	------	-------	---
			-----	-----	Jan. 30	[1]270.5	7,100	---
14	07264000, Bayou Meto near Lonoke	203	1954–69	1968	------	26.55	4.700	---
			-----	-----	Feb. 4	25.86	3,920	30
15	07264100, White Oak Branch near Lonoke	8.41	1961–69	1964	------	9.34	1,500	---
			-----	-----	Jan. 30	9.14	1,160	---
	Red River basin							
16	07357500, Lake Ouachita near Hot Springs	1,105	1952–69	1968	------	[1]588.63	[5]2,609.3	---
			-----	-----	Feb. 3	[1]575.61	[5]2,057	---
17	07357700, Glazypeau Creek at Mountain Valley	4.3	1961–69	1963	------	12.41	2,110	---
			-----	-----	Jan. 29	12.25	2,120	---
18	07358500, Lake Hamilton near Hot Springs	1,441	1930–69	1945	------	[1]402.28	[6]208,100	---
			-----	-----	Jan. 30	[1]401.29	[6]199,900	---
19	07359000, Lake Catherine at Jones Mill	1,516	1924–69	1927	------	[1]315.75	[6]59,160	---
			-----	-----	Jan. 30	[1]308.58	[6]42,710	---
20	07359500, Ouachita River near Malvern	1,562	1903–5, 1922–69	1923	------	30.3	140,000	---
			-----	-----	Jan. 30	24.11	[7]84,200	[3]1.2
21	07359520, Ouachita River tributary near Malvern	3.0	1962–69	1968	------	8.26	650	---
			-----	-----	Jan. 30	9.83	1,200	---

See footnotes at end of table.

TABLE 6.—*Flood stages and discharges, January-February in central Arkansas*—Continued

No.	Station number, stream, and place of determintaion	Drainage area (sq mi)	Maximum floods: Known before January 1969: Period of known	Year	January, February 1969	Gage height (feet)	Discharge: Cfs	Recurrence interval (yrs)
	Red River basin—Continued							
22	07360000, Ouachita River at Arkadelphia	2,311	1905–6	1945				
					Jan. 31	28.02	[8] 121,000	40
23	07363000, Saline River at Benton	569	1927–69	1927		30.5	110,000	---
					Jan. 30	29.68	100,000	[3] 1.2
24	07363050, Holly Creek tributary near Benton	1.46	1962–69	1964		6.51	475	---
					Jan. 30	6.53	480	---
25	07363200, Saline River near Sheridan	1,129	1938–69	1938		21	64,000	---
				1968		21.38	63,000	---
					Feb. 1	22.4	72,000	25
26	07363300, Hurricane Creek near Sheridan	204	1938–69	1960		18.55	52,300	---
					Jan. 31	15.34	11,500	2
27	07363330, West Fork Big Creek at Sheridan	4.86	1960–69	1960		18.74	3,720	---
					Jan. 30	13.22	390	---

[1] Elevation in feet.
[2] Estimated.
[3] Ratio of peak discharge to that of the 50-year flood.
[4] Affected by backwater.
[5] Contents in thousands of acre-feet.
[6] Contents in acre-feet.
[7] Affected by reservoirs (floodflow from 457 sq mi below Blakely Mountain Dam).
[8] Affected by reservoirs (floodflow from 1,206 sq mi below Blakely Mountain Dam).

station Bayou Meto near Lonoke, the stage, which was the second highest for the period 1954–69, was 0.69 of a foot lower than in 1968. Rainfall at the Little Rock Air Force Base in the drainage area of Cypress Branch was 7.75 inches for a 30-hour period in 1969, compared with only 3.70 inches for a 24-hour period in 1968.

Floods in the Red River basin were on the Ouachita River and tributaries from Blakely Mountain Dam to Arkadelphia and on Saline River. The peak discharge of 84,200 cfs on Ouachita River near Malvern from a drainage area of 457 sq mi downstream from Blakely Mountain Dam was 1.2 times the discharge for a 50-year flood. Runoff upstream from Blakely Mountain Dam was stored in Lake Ouachita.

The flow in Ouachita River is controlled by three reservoirs: Lake Ouachita, formed by Blakely Mountain Dam; Lake Hamilton, formed by Carpenter Dam; and Lake Catherine, formed by Remmel Dam. Reduction in peak stages on the Ouachita River by storage in Lake Auachita was estimated by the Corps of Engineers, U.S. Army, to have been 5.2 feet near Malvern and 4.2 feet at Arkadelphia. Storage in DeGray Reservoir (under construction) had a negligible effect on stage on the Ouachita River at Arkadelphia. The recorded peak stage on the Ouachita River at Arkadelphia was 28.02 feet, which was only 2.3 feet lower than the maximum since 1913.

On the basis of the ratios of the peak discharges on the larger streams in the area to those of the 50-year flood, the peak discharges of 2,120 cfs at Glazypeau Creek at Mountain Valley and 1,200 cfs at Ouachita River tributary near Malvern probably were equal to those of a 50-year flood.

Floods on Saline River were outstanding. The highest peak stage since 1927 was recorded on Saline River at Benton. The peak discharge of 100,000 cfs was only 9 percent less than the discharge of the 1927 flood. The highest peak stage and discharge for the period 1938–69 were recorded at the gaging station Saline River near Sheridan. Based on the ratio of the peak discharge on Holly Creek tributary near Benton probably exceeded that of a 50-year flood.

Flood damages along Fourche Creek were estimated by the Corps of Engineers, U.S. Army to be $540,000. Many residences and businesses were flooded by Fourche and Rock Creeks in the south and southwest parts of Little Rock. State Highway 367 south of Little Rock was closed. Two persons lost their lives in Little Rock.

Flood damages along Ouachita River between Blakely Mountain Dam and Arkadelphia were estimated by the Corps of Engineers, U.S. Army to be $165,000. Two persons lost their lives in Hot Springs.

Estimates of flood damage for Saline River, Bayou Meto, and Cypress Bayou and tributaries are not available.

FLOODS OF JANUARY-MAY IN IDAHO

By C. A. Thomas

Early January snow cover was more than 150 percent of average, soil-moisture storage was near capacity, and high January precipitation occurred over most of the State, thus floods were expected. Cool temperatures mitigated flood peaks, but extended the high-flow period, and the snowmelt floods continued through May (fig. 10).

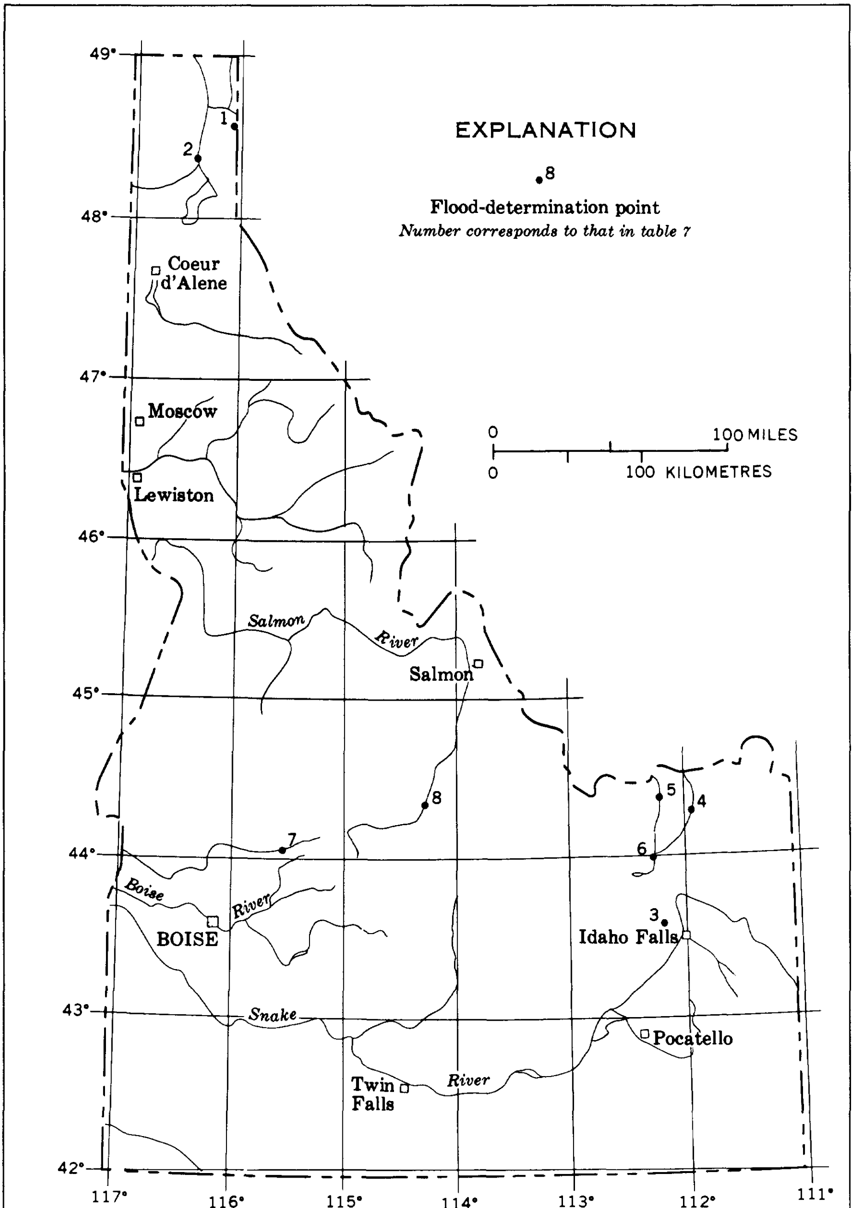


FIGURE 10.—Location of flood determination points, floods of January–May in Idaho.

TABLE 7.—*Flood stages and discharges, January-May in Idaho*

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before January 1969 — Period of known floods	January, May 1969	Gage height (feet)	Discharge: Cfs	Discharge: Recurrence interval (yrs)
	Kootenai River basin						
1	12305500, Boulder Creek near Leonia	[1] 53	1928–69	1947	7.85	2,700	70
				May 30	5.81	2,720	70
	Pend Oreille River basin						
2	12392300, Pack River near Colburn	124	1958–69	1961	12.35	3,180	10
				May 30	13.69	4,370	70
	Snake River basin						
3	13061100, Snake River tributary near Osgood	7.64	1961–69	1962	12.40	387	--
				Jan. 21	13.68	450	--
	Mud Lake-Lost River basins						
4	13108500, Camas Creek at Eighteenmile Shearing Corral near Kilgore	[1] 210	1937–53, 1969	1952	7.51	2,030	30
				May 8	7.04	2,590	80
5	13113000, Beaver Creek at Spencer	120	1940–52, 1969	1952	7.5	549	25
				Apr. 24	7.63	642	50
6	13114000, Beaver Creek at Camas	510	1921–69	1962	----	229	65
				May 11	4.03	229	65
	Payette River basin						
7	13235100, Rock Creek at Lowman	14.6	1962–69	1967	1.85	220	--
				May 14	1.96	270	--
	Salmon River basin						
8	13298300, Malm Gulch near Clayton	9.38	1962–69	1965	5.07	400	--
				Apr. 1	5.90	440	--

[1] Approximately.

Maximum floods of record occurred in many places (table 7). Recurrence intervals of peak discharges at some gaging stations ranged from 50 to 80 years. In addition to peak flows, the record 30-day average flows were exceeded on Camas Creek at Eighteenmile Shearing Corral, near Kilgore (1,160 cfs, May 2–31), Beaver Creek at Spencer (400 cfs, April 23 to May 22), and Beaver Creek at Camas (216 cfs, May 4 to June 2).

Several hundred homes were evacuated in the Idaho Falls area. Flood damage was relatively light because of mitigating hydrologic conditions and the diversion of high flows onto permeable desert areas in the Mud Lake and Big Wood River basins.

FLOODS OF FEBRUARY 1 IN NORTHEASTERN AND NORTHERN OAHU, HAWAII

Intense rains mostly on the northeastern slopes of Koolau Mountains produced large floods on the windward area of Oahu February 1st. Rainfall intensities were several times greater on the windward side of the mountain than on the southwestern side.

At two sites in Kahaluu Valley, Ahuimanu Loop and Kahaluu, more than 22 inches of precipitation were recorded during the storm, and more than 12 inches fell in the 2 hours before midnight, February 1. During the 24-hour period, 21.45 inches of rainfall was recorded at the Poamoho No. 2 above Wahiawa site, 19 inches at Ahuimanu Loop and Kahaluu, and 18.54 inches on the Haiku plantation site (table 8). Precipitation on the leeward side of Oahu ranged from zero to a maximum of 6 inches. An isohyetal map for the storm is shown in figure 11.

TABLE 8.—*Total precipitation, in inches, 24 hours, 0800 February 1 to 0800 February 2 on Oahu, Hawaii*

Station name	*Rainfall, in inches*
Waimanalo	0.09
U.S. Magnetic Observatory	.26
Beretania pumping stations	.38
HSPA Experiment Station	.87
Manoa	1.63
Waialae-Kahala	.26
Manoa tunnel 2	2.06
Palolo Valley	1.64
Portlock	.07
Kamehameha	.55
Field 43	.10
Reservoir 2	.91
Waipahu	[1] 1.25
Moanalua	.59
North Halawa	4.8
Halawa Shaft	1.0
Moanalua (USGS)	5.9

TABLE 8.—*Total precipitation, in inches, 24 hours, 0800 February 1 to 0800 February 2 on Oahu, Hawaii*—Continued

Station name	*Rainfall, in inches*
Jack Lane Nursery	2.70
Tantalus 2	2.52
Kaneohe Mauka	[1] 14.6
Kamooalii	14.0
Kokokahi	7.80
Nuuanu Reservoir 4	5.70
Pauoa Flats	5.10
Maunawili HSPA	5.85
St. Stephens Seminary	11.43
Pali	15.0
Kailua Fire Station	1.80
Waimanalo	4.70
Waianae	0
Lualualei	.06
Kunia	4.00
Camp 84 CPC	4.22
PRI Wahiawa	4.0
Kutree Dam	6.42
Koolau Dam	8.14
Adit 8	5.45
Waiahole	[1] 18.0
Kaalaea	14.63
Kahaluu	19.0
USNCF (Haiku)	17.50
Coconut Island	5.93
Kawaihapai	5.93
Mount Kaala	3.61
Waialua	4.15
Kemoo 5	4.11
Halemano 9	5.02
Opaeula 8	8.63
Wahiawa Dam	3.60
Pomoho	4.77
Brodie 2	[1] 5.75
Opaelua Reservoir	10.5
Halemano Int	10.5
Poamoho No. 1	16.5
Poamoho No. 2	21.45
Kahana	18.96
Kaaawa	9.0
Kahana (USGS)	13.8
Waikane Stream	9.3
Waimea	4.92
Kawailoa 19	8.79
Kawailoa 20 Makai	9.73
Kawailoa 20 Mauka	8.84
Laie	1.30
Papakoko	2.3
Kapaka Makai	2.25
Kawela Mauka	1.58
Aikahi Park	2.17
Waihee (BWS)	16.70
Ball	.32
Haiku Plantation	18.54
Maunawili (office)	8.47
Ahuimanu Loop	[1] 19.0

[1] Estimated.

TABLE 9.—*Flood stages and discharges, February 1 on Oahu, Hawaii*

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before February 1969: Period of known floods	Known before February 1969: Year	February 1969	Gage height (feet)	Discharge: Cfs	Discharge: Recurrence interval (yrs)
1	16211200, Poamoho Stream at Waialua	10.9	1967–69	1968		20.93	2,740	---
					Feb. 1	22.38	6,500	---
2	16254000, Makawao Stream near Kailua	2.04	1912–16, 1958–69	1965		12.41	6,000	---
					Feb. 1	6.16	766	---
3	16260500, Maunawili Stream at Highway 61 near Kailua	5.34	1968–69	1965		15.62	9,690	---
					Feb. 1	10.3	2,360	---
4	16270500, Kamooalii Stream below Kuou Stream near Kaneohe	3.21	1967–69	1968		8.82	2,820	---
					Feb. 1	12.42	10,760	---
5	16270900, Lulaka Stream at an altitude of 220 ft, near Kaneohe	.44	1968–69	1968		4.85	296	---
					Feb. 1	6.09	620	---
6	16273900, Kamooalii Stream at Kaneohe	4.38	1959–63, 1965–69	1958		8.3	6,610	---
					Feb. 1	10.16	12,000	---
7	16274499, Keaahala Stream at Kamehameha Highway at Kaneohe	0.62	1958–69	1965		11.5	2,750	---
					Feb. 1	8.34	1,860	---
8	16275000, Haiku Stream near Heeia	.97	1914–19, 1939–69	1965		7.94	5,740	---
					Feb. 1	3.83	1,150	---
9	16283000, Kahaluu Stream near Heeia	.28	1935–69	1965		8.46	1,730	---
					Feb. 1	6.06	390	---
10	16283500, Kahaluu Stream at Kahaluu	3.73	1960–62, 1965–69	1968		15.06	2,950	---
					Feb. 1	16.98	4,310	---

TABLE 9.—*Flood stages and discharges, February 1 on Oahu, Hawaii*—Continued

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before February 1969: Period of known floods	Year	February 1969	Gage height (feet)	Discharge: Cfs	Recurrence interval (yrs)
11	16284000, Waihee Stream near Heeia	.93	1935–69	1965		8.72	5,110	---
					Feb. 1	5.50	930	---
12	16284500, Waihee Stream at Kahaluu	2.26	1967–69	1968		19.19	1,760	---
					Feb. 1	11.70	4,100	---
13	16296500, Kahana Stream at an altitude of 30 ft, near Kahana	3.74	1958–69	1963		8.10	5,430	---
					Feb. 1	7.54	4,620	---
14	16304200, Kaluanui Stream near Punaluu	1.11	1967–69	1967		9.29	1,260	---
					Feb. 1	10.00	1,700	---
15	16340000, Anahulu River near Haleiwa	13.5	1958–69	1968		12.23	8,730	---
					Feb. 1	13.3	10,000	---
16	16343000, Helemano Stream at Haleiwa	14.2	1967–69	1968		15.34	7,390	---
					Feb. 1	17.63	11,300	---
17	16345000, Opaeula Stream near Wahiawa	2.98	1959–69	1964		8.82	2,800	---
					Feb. 1	10.12	3,900	---
18	16350000, Opaeula Stream near Haleiwa	5.98	1958–69	1968		16.73	4,460	---
					Feb. 1	18.43	5,970	---

The storm caused record flood peaks on streams near Kaneohe and Kahaluu. The peak discharge of 12,000 cfs from 4.38 square miles on Kamooalii stream at Kaneohe was the largest in the 11-year period of record (table 9). The peak discharges of 4,310 cfs from a drainage area of 3.73 square miles on Kahaluu Stream at Kahaluu, and 4,100 cfs from a drainage area of 2.26 square miles on Waihee Stream at Kahaluu, Oahu, are the largest since the stations were established. However, on many streams with longer record the flood peaks of May 1965 were larger than these February peaks.

On the northwest shore in the Haleiwa-Waialua area the highest peaks of record occurred on five streams with 2 to 13 years of record (figure 12).

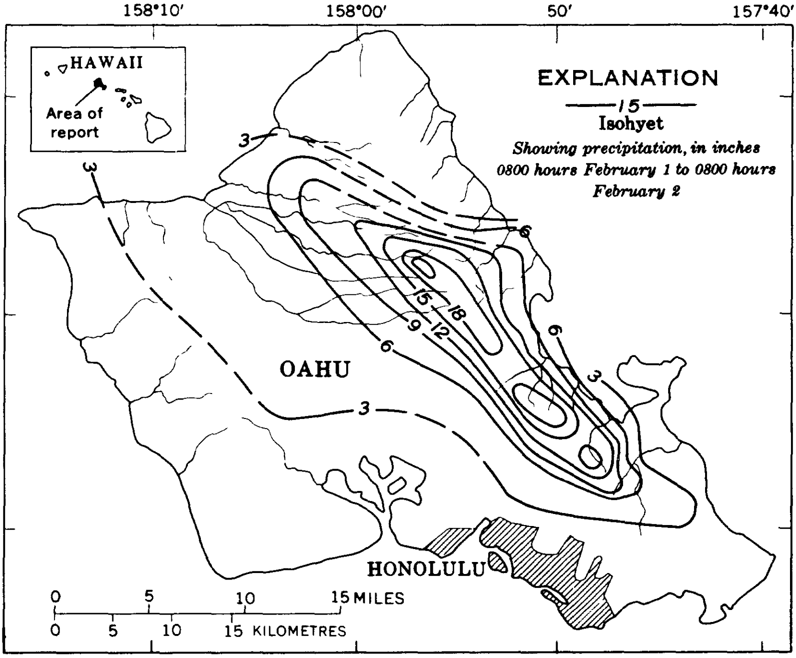


FIGURE 11.—Isohyets for storm of February 1–2 on Oahu, from map by Corps of Engineers, U.S. Army, Hawaii Division

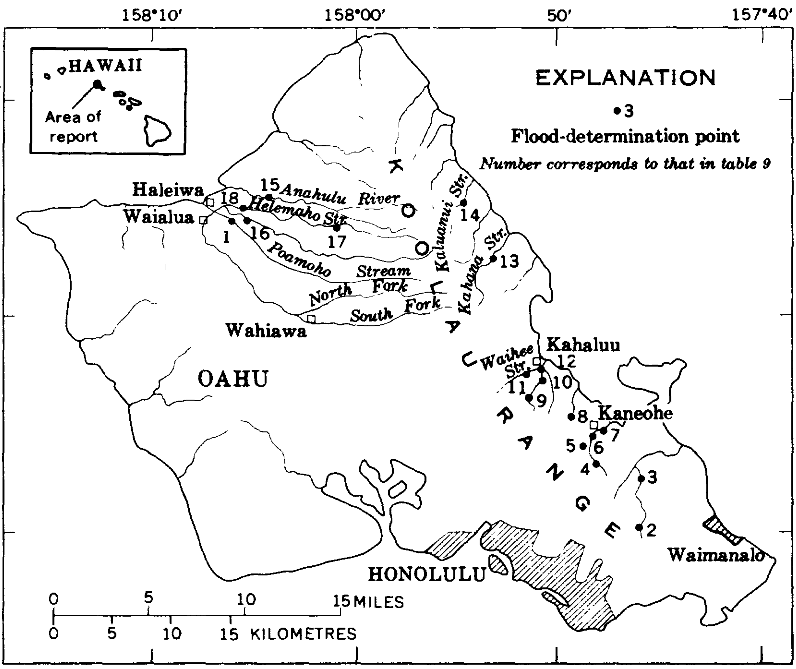


FIGURE 12.—Location of flood-determination points, flood of February 1 on Oahu, Hawaii.

Flood damages exceeded $700,000 according to the Corps of Engineers, U.S. Army, Island Post flood report (1969). This includes damage due to erosion of stream channels as well as overflow and inundation of business areas and private homes. Some of the most serious flooding was in the Keapuka area. Damage from Kamooalii Stream was $331,000 of which residence and personal losses were $300,000. In the Kapunahala area total flood damages were $130,900 of which $80,000 was to residences and personal property. In the Kahaluu area, flood losses were $67,000 of which $24,000 were to businesses and $10,000 to residences. Automatic warning devices gave advance warning of the floods and may have been an important factor in preventing injuries or deaths.

FLOODS OF FEBRUARY 24–26 NEAR BEATTY, NEVADA

A widespread storm over southern Nevada February 24 and 25 caused floods near Beatty (fig. 13).

The floods were mainly in the headwater areas of the Amargosa River and were caused by heavy rain and melting snow on Pahute Mesa northeast of Beatty. Precipitation data for the storm area are not available, as the only National Weather Service rain gage in the area was inundated. The nearest rain gages outside the flood area recorded less than 1.5 inches of precipitation on February 24 and 25.

Flood-determination points are shown in figure 13, and peak-discharge data are listed in table 10. Flood magnitude and frequency relations for this area have not been defined, thus the recurrence intervals for these floods are unknown. On Amargosa River near Beatty the maximum discharge of 16,000 cfs occurred near midnight February 24. U.S. Highway 95 was washed out in several places near and in Beatty and was damaged at Forty Mile Canyon near Lathrop Wells. The highway was closed for almost a week and through-traffic between Las Vegas and Tonopah was routed over a 50-mile detour. A trailer court at the north end of Beatty was washed out, and a number of houses were damaged by mud and water. Water and electric services were interrupted. Estimated total damages were $1 million for the Beatty area, of which three-fourths of this amount was damage to U.S. Highway 95.

The Nevada Test Site of the Atomic Energy Commission which is located north and east of Highway 95, also was affected by the storm. Electric power was cut off temporarily. Roads were closed and work was curtailed for several days by flooding and heavy snow. Two drilling crews were marooned on Pahute Mesa.

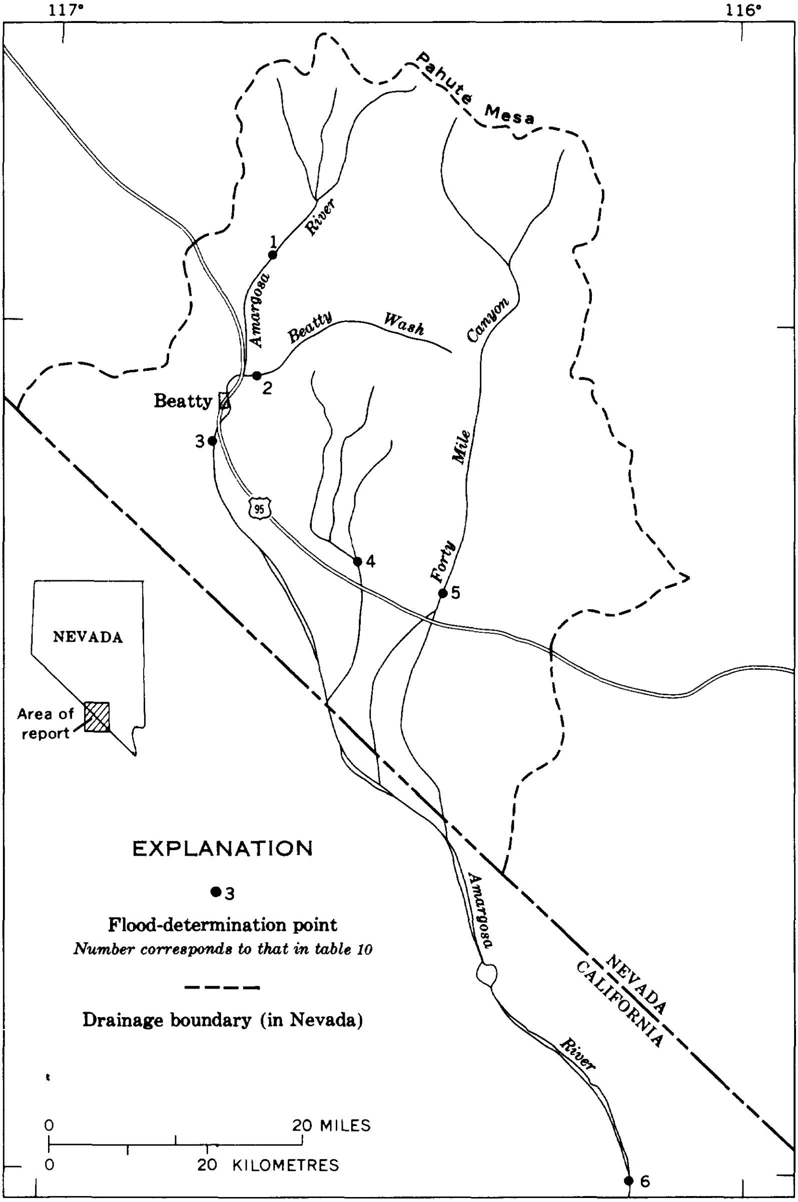


FIGURE 13.—Location of flood-determination points, floods of February 24–26, near Beatty, Nev.

TABLE 10.—*Flood stages and discharges, February 24–26 near Beatty, Nev.*

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before February 1969: Period of known floods	Known before February 1969: Year	February 1969	Gage height (feet)	Discharge: Cfs	Discharge: Recurrence interval (yrs)
	Death Valley							
1	Amargosa River near Springdale, Nev	226	----	----		----	------	---
					Feb. 24	----	6,130	---
2	Beatty Wash near Beatty, Nev	94.2	----	----		----	------	---
					Feb. 24	----	3,440	---
3	10251220, Amargosa River, near Beatty, Nev	470	1964–69	1967		5.86	4,220	---
					Feb. 24	----	16,000	---
4	Amargosa River tributary Lathrop Wells, Nev	104	1963	1963		----	[1] 660	---
					Feb. 24	----	3,000	---
5	Forty Mile Canyon near Lathrop Wells, Nev	325	1969	[2] 1969		----	[3] 1,000	---
					Feb. 25	----	3,330	---
6	10251300, Amargosa River at Tecopa, Calif	([4])	1962–69	1965		10.10	950	---
					Feb. 26	18.34	5,000	---

[1] At site 3 miles downstream.
[2] January 25, 1969.
[3] Field estimate.
[4] Not determined.

FLOODS OF MARCH IN EASTERN NEBRASKA

By H. D. BRICE

Ice breakup and ice jams caused damaging floods along the Loup River from St. Paul to Columbus during March 18–21 (fig. 14). The breakup had been delayed by freezing temperatures that persisted over much of the Loup River basin during the first half of March. A sharp rise in the daily maximum temperature from about 43°F on March 15 to about 58°F on March 18 caused a quick thaw of the heavy snowpack that contained from 2 to 4 inches of water. The resulting rapid runoff began to break up the river ice, much of which was 2 feet thick.

Daily minimum temperatures continued below freezing, however, and the resulting diurnal fluctuation in streamflow contributed to a major ice jam about 1 mile downstream from U.S. Highway 81 bridge in Columbus during the evening of March 18. Within 2 hours Pawnee Park in Columbus was inundated (fig. 15). Later in the evening U.S. Highway 30 was flooded at the site of the State scales and the nearby motel was evacuated.

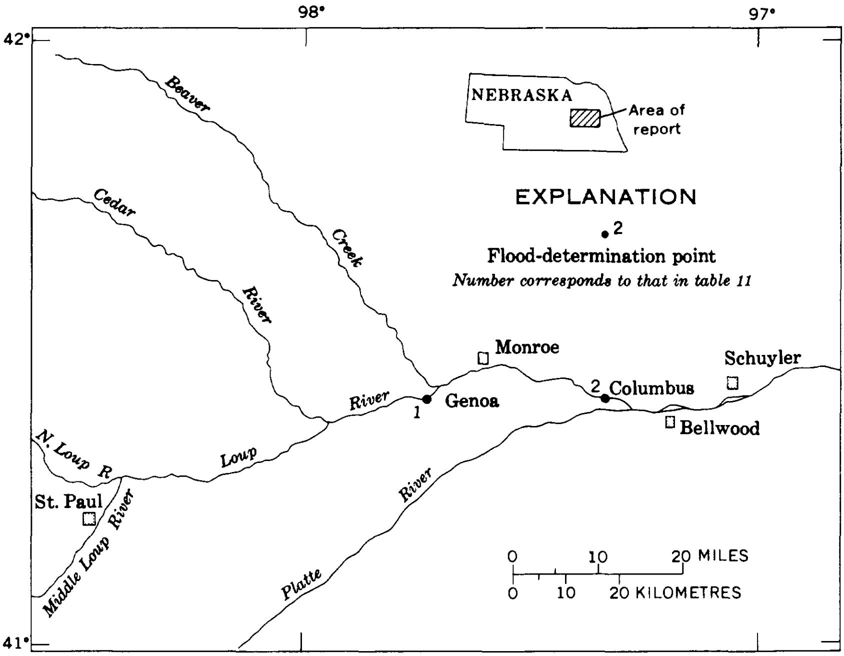


FIGURE 14.—Location of flood determination points, flood of March 18–21 in eastern Nebraska.

The jam increased with the continuing influx of ice from upstream and by March 19–20 all low-lying residential areas near Wagners Lake and Stires Lake (fig. 15) were flooded and more than 175 families had vacated their homes. Property damage was extensive. Also, by March 20 the ice jam diverted flow from the river channel into Barnum Creek (fig. 15). The flow in Barnum Creek greatly exceeded the hydraulic capacity of the bridge on U.S. Highway 81, and water overtopped the highway fill and washed out the approach to the bridge.

By March 21, ice jams had formed throughout the reach of Loup River extending from Columbus to St. Paul. This caused some flooding and damage in the lower areas of Monroe and to a substantial amount of farmland between St. Paul and Genoa. On that date the jam downstream from Columbus was blasted out, releasing floodwaters from upstream and causing temporary flooding of lowland in the Bellwood and Schuyler areas. Damage in these downstream areas was not extensive.

The maximum stages recorded at the Columbus and Genoa gaging stations were not as high as those reached during the 1966 flood (table 11). The maximum stages due to the ice jams be-

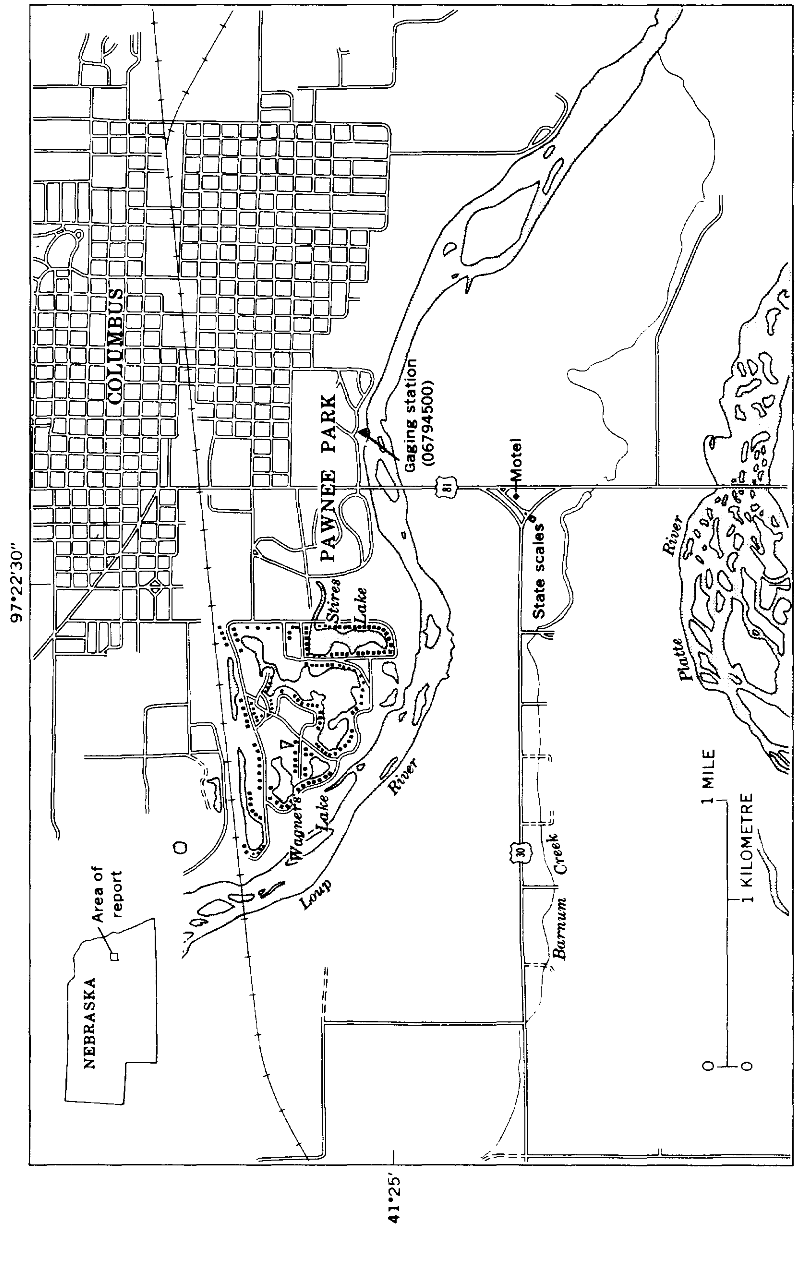


FIGURE 15.—Location of sites and areas flooded March 18–21 at and near Columbus, Nebr.

tween Columbus and Genoa, which caused the flooding at Monroe and Wagners and Stires Lakes, may have been relatively higher than those recorded and shown in table 11.

TABLE 11.—*Flood stages and discharges, ice-jam flood of March 19, 20 in eastern Nebraska*

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before March 1969: Period of known floods	Known before March 1969: Year	March 1969	Gage height (feet)	Discharge: Cfs	Discharge: Recurrence interval (yrs)
			Platte River basin					
1	06793000, Loup River near Genoa	14,400, [2] 6,000	1928–32, 1943–69	1966	------	13.93	129,000	[1] 2.9
					Mar. 19	[3] 10.80	15,800	4
2	06794500, Loup River at Columbus	15,200 [2] 6,530	1894–1915, 1931, 1933–69	1966	------	14.42	119,000	[1] 2.5
					Mar. 21	[3] 11.00	[4] 18,000	5

[1] Ratio of peak discharge to that of a 50-year flood.
[2] Contributing drainage area.
[3] Backwater from ice.
[4] Occurred on March 20.

FLOOD OF MARCH 29 TO APRIL 2 AT ELY, NEVADA

Rapid melting of an unusually heavy snow accumulation with a water content about 200 percent of normal caused flooding in Ely (fig. 16) from Gleason Creek. The peak flow of 410 cfs occurred at 2100 hours on April 2 at the Corps of Engineers, U.S. Army, gaging station, drainage area 77 square miles. However, smaller diurnal peaks (fig. 17) occurred on the preceding three nights. Fortunately, there was no snowmelt flow from Murry Creek during this time.

The storm-sewer system in Ely could not handle discharges larger than about 200 cfs. The overflow went through the business district along Aultman Street (U.S. Highways 6 and 50) and through the alley north of Aultman Street. Lower areas of the residential part of central Ely were flooded. The streets, highways, and the Nevada Northern Railroad were also damaged. Total damage was estimated at $400,000.

Flood-magnitude and frequency relations for this part of Nevada are not well defined, but the recurrence interval of this flood event, probably was in the 10- to 25-year range. However,

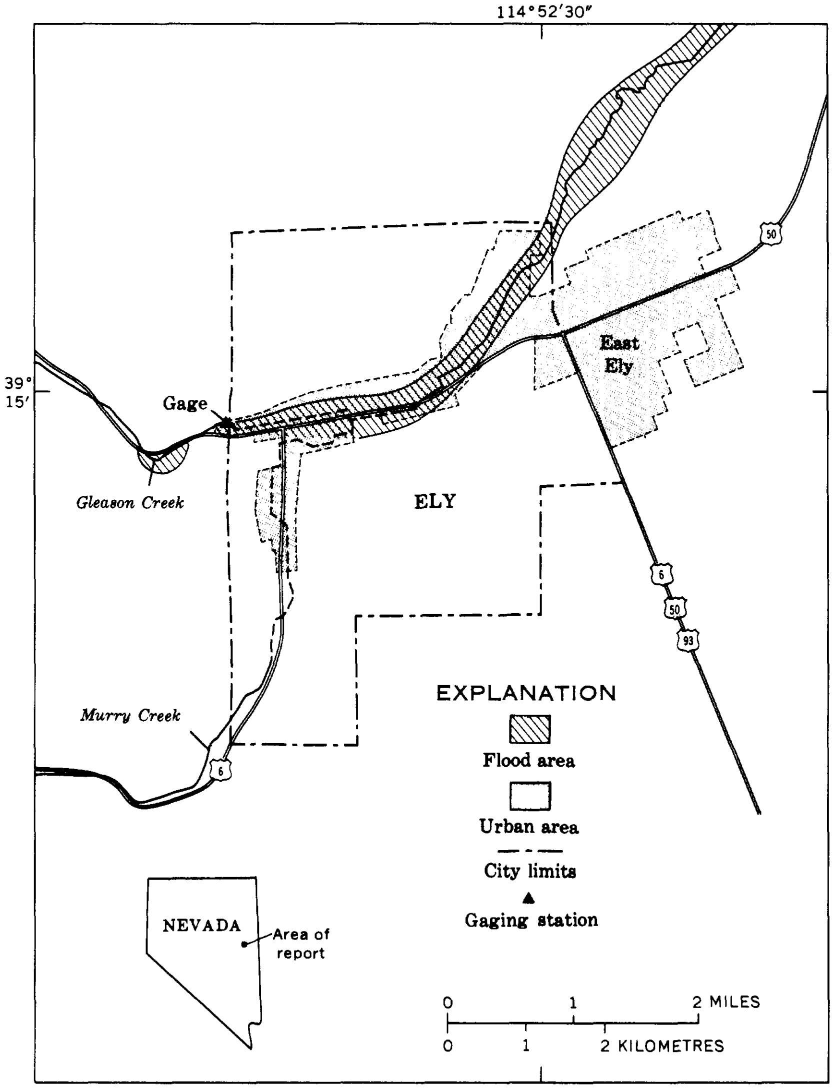


FIGURE 16.—Location of flood-determination point and area inundated, floods of March 29 to April 2, at Ely, Nev.

according to local residents, there has been no comparable runoff in more than 30 years.

High snowmelt runoff also occurred in the Jakes Wash basin which is adjacent to the Gleason Creek headwaters to the southwest. A peak discharge of 700 cfs occurred March 29 at a site about 18 miles southwest of Ely, at U.S. Highway 6, from a drainage area of 150 sq mi.

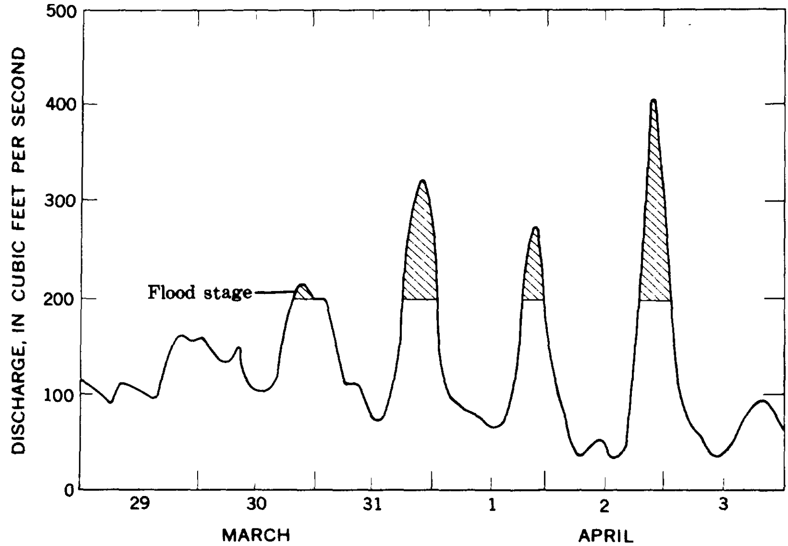


FIGURE 17.— Discharge in Gleason Creek, March 29 to April 3, at Ely, Nev.

FLOODS OF APRIL IN MISSISSIPPI

By K. V. WILSON

Storms on April 9–10, 12–14, and 17–18 each caused severe flooding. Many of the weather stations in the State reported between 10 and 13 inches of rain during April. The annual maximum stage occurred between April 10 and 20 at about 160 of the approximately 250 stream-gaging stations in the State.

Rainstorms over northern parts of Mississippi during the night of April 9–10, 1969, caused extreme flood conditions on some streams draining less than 150 sq mi and lesser floods on larger streams (fig. 18). Floods resulting from the storm in northwestern Mississippi were unusually severe on Pigeon Roost Creek and on the Coldwater River. The flood on recently canalized Pigeon Roost Creek at State Highway 305 undermined some of the bridge piling and caused considerable damage to the bridge. Extreme floods, some with recurrence intervals greater than 50 years, occurred on several streams in the Kosciusko-Louisville-Macon area, April 10. Small streams overtopped State Highways 15 and 25 just north of Louisville, and Coopwood Creek overtopped State Highway 397 at a point 9 miles southeast of Louisville.

According to W. T. Boyette, the maximum stage of the flood of April 10 at station 02482300 on Lobutcha Creek at Zama was only 1 foot lower than the flood of 1906. The recurrence interval of 40 years (table 12), for the April 10 maximum discharge is based on regionalized data.

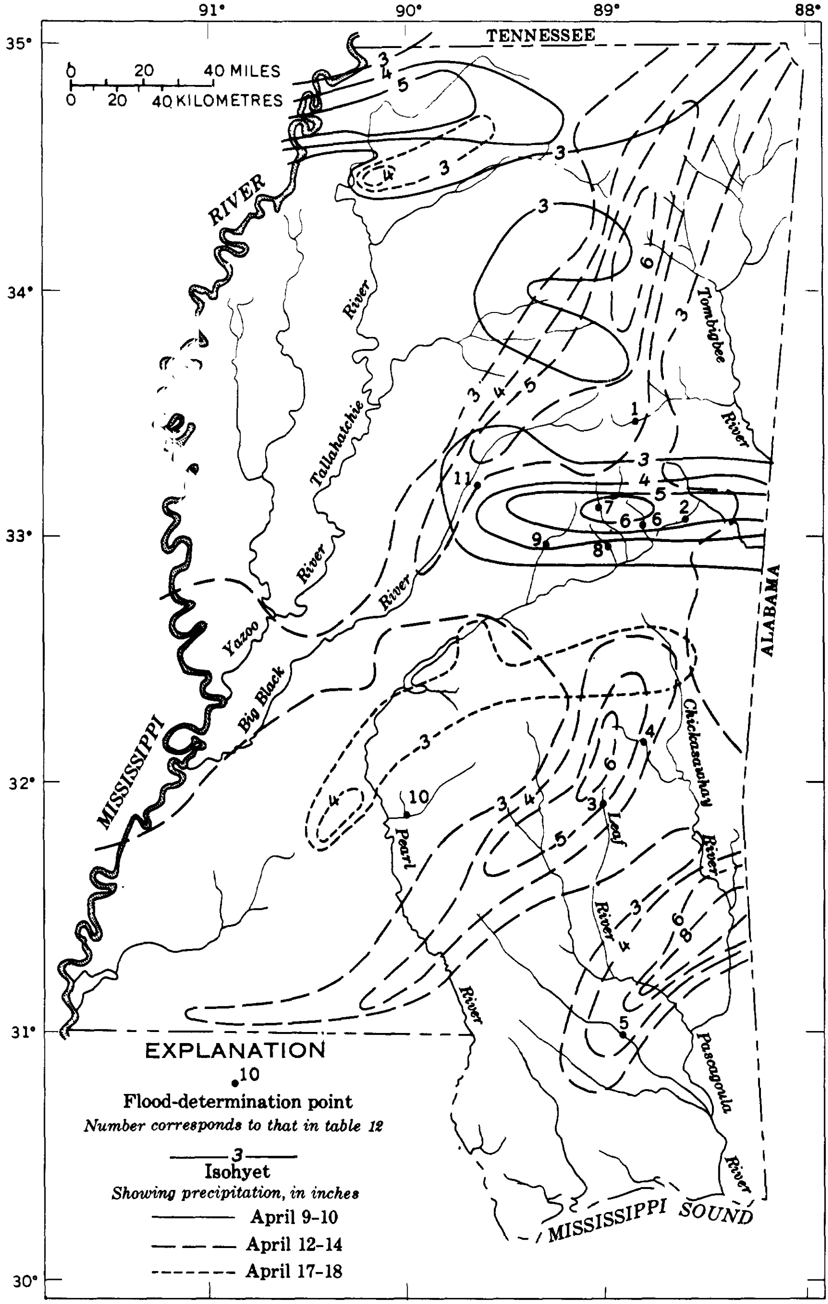


FIGURE 18.—Location of flood-determination points and isohyets, floods of April 9–18, in Mississippi. Isohyets by U.S. Geological Survey; data from National Weather Service.

TABLE 12.—*Flood stages and discharges, April in Mississippi*

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before April 1969 — Period of known floods	Year	April 1969	Gage height (feet)	Discharge — Cfs	Recurrence interval (yrs)
	Mobile River basin							
1	02440800, Trim Cane Creek at U.S. Highway 82, 6 miles west of Starkville	39.6	1951–69	1951		26.9	5,710	----
					Apr. 14	27.04	11,300	50
2	02447800, Hashuqua Creek at State Highway 14, 7.6 miles west of Macon	95.1	1952–69	1961		96.63	6,300	----
					Apr. 10	97.69	11,700	50+
	Pascagoula River basin							
3	02473460, Tallahala Creek at State Highway 528, 0.8 of a mile west of Waldrup	100	1961–69	1964		313.4	22,000	----
					Apr. 14	311.77	11,800	50
4	02477095, Souinlovey Creek at I-59 near Pachuta	158	----	----		----	------	----
					Apr. 14	271.6	14,700	40
5	02479155, Cypress Creek at State Highway 29, 1.3 miles east of Janice	52.2	1959, 1966–69	1959		32.06	22,800	----
				1967		20.43	4,020	----
					Apr. 13	26.01	7,720	30
	Pearl River basin							
6	02481705, Nanawaya Creek at State Highway 397, half a mile west of Handle	90	1961	1961		12.3	7,000	----
					Apr. 10	13.3	10,000	50
7	02481810, Tallahaga Creek at State Highway 15, 1¼ miles north of Noxapater	53	1953–69	1964		94.30	6,400	----
					Apr. 10	95.72	11,400	50+
8	02481840, Noxapater Creek at State Highway 15, 2 miles south of Noxapater	33.1	1952–69	1961		94.82	5,300	----
					Apr. 10	95.74	5,950	50+

TABLE 12.—*Flood stages and discharges, April in Mississippi*—Continued

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before April 1969: Period of known floods	Year	April 1969	Gage height (feet)	Discharge: Cfs	Recurrence interval (yrs)
	Pearl River basin—Continued							
9	02482300, Lobutcha Creek at county road at Zama	145	1938–39	1939		406.36	5,000	----
					Apr. 10	410.81	13,400	40
10	02487750, Big Creek at State Highway 28, 8½ miles west of Pinola	44.0	1948–69	1955		27.39	7,560	----
					Apr. 13	27.61	8,200	40
	Big Black River basin							
11	07289330, Zilpha Creek at State Highway 35, 12½ miles north of Kosciusko	90	1953–69	1955		27.49	16,000	----
					Apr. 10	27.1	13,000	50+

Another rainstorm moved into Mississippi during the night of April 12 and continued over most of the State through the following night. Rainfall was intense in the area of Vaiden-Tupelo, Tylertown-Newton, and Brooklyn-Waynesboro (fig. 18).

In central Mississippi, flooding occurred on small streams, notably Big Creek near Pinola (table 12). The peak discharge of 8,200 cfs on April 13 was the largest in 22 years of record, and on the basis of regionalized data has a recurrence interval of 40 years.

The heavy rainfall in the Vaiden-Tupelo area caused 3- to 10-year floods at many gaged sites in the Big Black River basin, in the upper part of the Yalobusha River basin, and in the west edge of the Tombigbee River basin.

More than 4 inches of rain fell in a belt between Tylertown and Newton and more than 6 inches fell in the area just south of Newton. The flood on Tallahala Creek at Waldrup had a recurrence interval more than 50 years (table 12). The smaller streams in the heavy rainfall belt generally had floods larger than any since about 1964.

The Brooklyn-Waynesboro area had nearly 10 inches of rain in places, and unusually large floods occurred on very small ungaged drainage basins. Carter's Creek overtopped U.S. Highway 98 at Beaumont, temporarily closing the road. A bridge over Big Branch on the Janice-Brooklyn Road a mile west of Janice was washed out.

Rain between April 4 and April 18 had cumulative effects on the peak stages of the larger streams in the State. Between April 10 and April 24 the Big Black, Pearl, Leaf, Chickasawhay, Pascagoula, and Tombigbee Rivers had flows ranging from mean-annual floods to 7-year floods.

FLOODS OF APRIL IN UPPER MIDWESTERN STATES

After DAVID B. ANDERSON and HARLAN H. SCHWOB (1970)

April floods in North Dakota, South Dakota, Minnesota, Iowa, Wisconsin, and Illinois were caused by a large accumulation of winter snow with a (fig. 19) water content of as much as 8 inches, rapid thawing early in April, and significant amounts of rainfall during the period April 7–10 in parts of the area. Extensive spring flooding in the six-State area was forecast in December 1968, and flood protection preparations subsequently were made.

At most gaging stations the floods were the second largest in many years of record, and recurrence intervals exceeded 50 years at 71 of the 178 sites for which they were computed (table 13).

The flood discharges might have been larger, but climatological conditions were mitigating. The first heavy snowfall in November 1968 provided more than usual ground insulation, and because winter frost penetration was moderate the soil was able to absorb much moisture during the spring snowmelt.

Although the April temperatures were above normal, monthly precipitation was below normal at 20 of 26 representative National Weather Service stations.

Some areas, however, experienced heavy rainfall April 7–10, with the greatest amount, 3 inches, falling at Pelican Rapids in the upper Red River basin. Rain also fell in the southeast corner of North Dakota, which drains into the Red River, and on the upper Minnesota River tributaries, April 7–10, just as the snowmelt runoff was increasing. Significant precipitation occurred at other localities late in the month, after the flood peaks had passed.

In the Red River of the North basin, exclusive of Souris River basin, floods were severe. The April 10 flood peak of 9,000 cfs, on Antelope Creek at Dwight, N. Dak., was 3.2 times that of a 50-year flood. Many peaks in upper Red River basin were the largest ever recorded (table 13). On the Red Lake River at Crookston, Minn., the peak stage of 27.33 feet and maximum discharge of

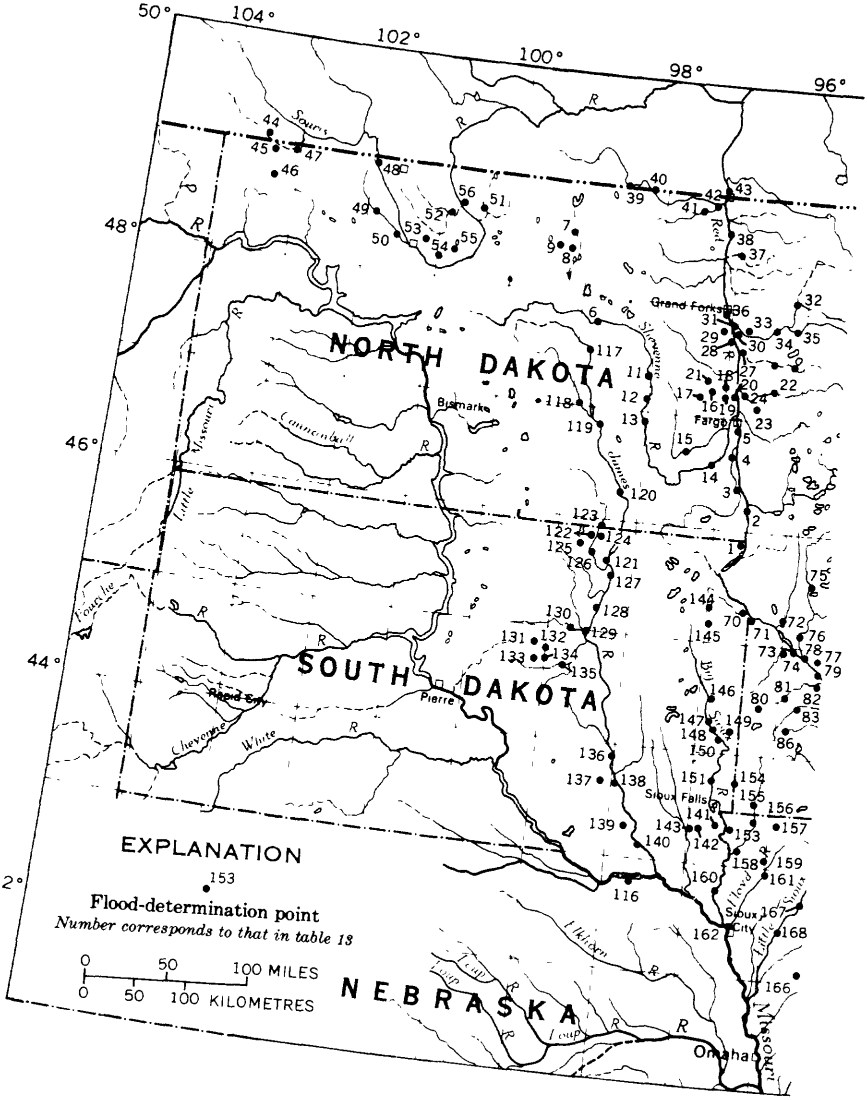
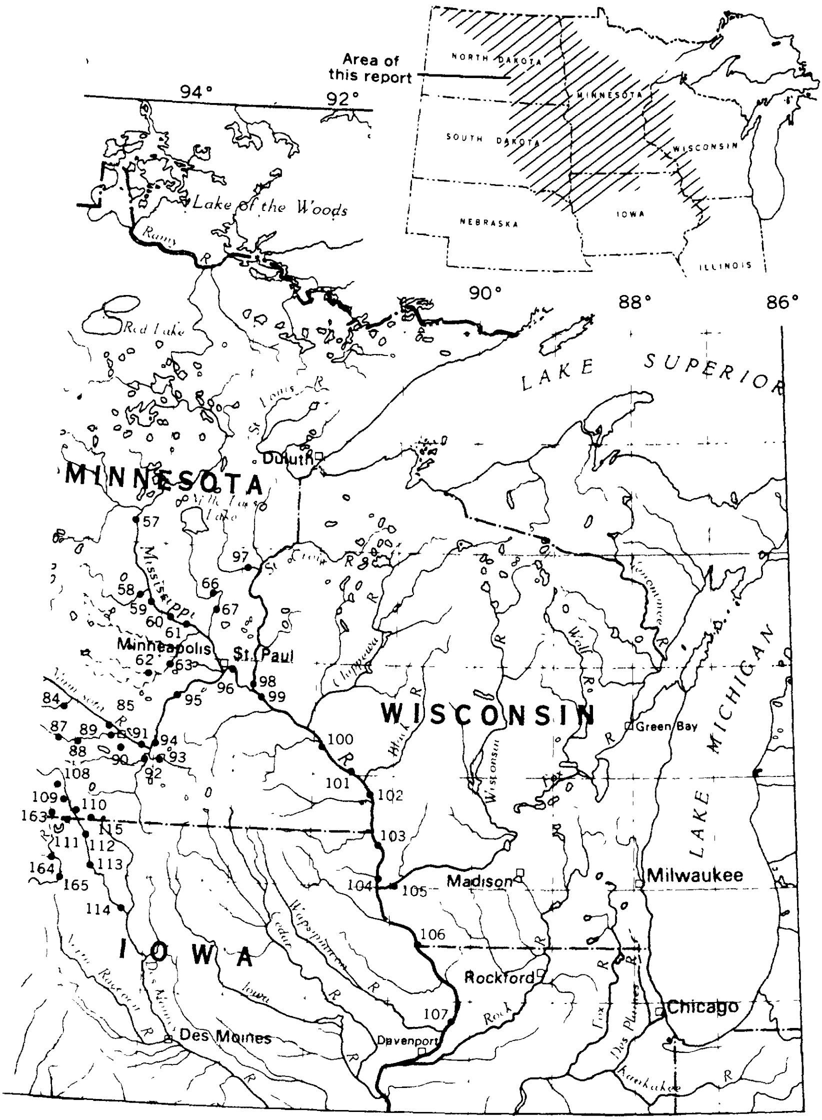


FIGURE 19.—Location of flood-determination points,

28,400 cfs from a 5,280 sq mi drainage area on April 12 were the largest since at least 1897. The flood exceeded the 1950 maximum by 1.6 feet in stage and 1,000 cfs in discharge.

Continuous records are available since 1882 for the Red River of the North at Grand Forks, N. Dak., where the peak discharge of 53,500 cfs on April 16 was slightly greater than that of a 50-



floods of April in upper Midwestern States.

year flood and was nearly two-thirds the maximum discharge of 80,000 cfs in 1897. Recurrence intervals of the peak discharges on the main stem of the Red River decreased in a downstream direction from 1.4 times that of a 50-year flood at Fargo, N. Dak., to that of a 30-year flood at Emerson, Manitoba, at the international boundary.

TABLE 13.—*Flood stages and discharges, April in upper Midwestern States*

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before April 1969: Period of known floods	Known before April 1969: Year	April 1969	Gage height (feet)	Discharge: Cfs	Discharge: Recurrence interval (yrs)
	Red River of the North basin							
1	05050000, Bois de Sioux River near White Rock, S. Dak	1,160	1941–69	1962		11.41	[1] 1,620	---
					Apr. 19–21	15.07	[1] 3,770	---
2	05051500, Red River of the North at Wahpeton, N. Dak	4,010	1897,	1897		17.0	------	---
			1942–69	1952		14.99	7,130	---
					Apr. 10	16.34	9,200	---
3	05052500, Antelope Creek at Dwight, N. Dak	[2] 294	1944–47,			16.31	3,670	---
			1949–69	1952				
					Apr. 10	17.82	9,000	[3] 3.2
4	05053000, Wild Rice River near Abercrombie, N. Dak	[2] 2,080	1897,	1897		27.5	------	---
			1933–69	1943		21.02	5,500	---
					Apr. 11	24.58	9,540	[3] 1.4
5	05054000, Red River of the North at Fargo, N. Dak	6,800	1882,			[4] 40.1	25,000	---
			1897	1897		28.79	16,300	---
			1902–69	1952		--------	------	---
					Apr. 15	37.34	25,300	[3] 1.4
6	05056000, Sheyenne River near Warwick, N. Dak	[3] 2,070	1950–69	1956		7.83	4,250	---
					Apr. 14	7.51	4,660	50
7	05056040, Mauvais Coulee tributary No. 2 near Cando, N. Dak	8.48	1955–69	1956		--------	180	---
				1960		--------	180	---
				1962		[5] 5.5	([6])	---
					Apr. 11	6.52	520	---

8	05056060, Mauvais Coulee, tributary No. 3 near Cando, N. Dak	60.2	1955–69	1956		7.0	850	---
					Apr. 14	9.35	2,300	---
9	05056080, Mauvais Coulee tributary No. 4 near Bisbee, N. Dak	24.4	1955–69	1956		3.09	450	---
					Apr. 11	5.17	1,100	---
10	05056900, Sheyenne River tributary near Cooperstown, N. Dak	15.2	1959–69	1965		---	700	---
				1966		[5] 9.81	---	---
					April [7]	9.80	1,000	---
11	05057000, Sheyenne River near Cooperstown, N. Dak	[2] 6,470	1945–69	1950		18.69	7,830	---
					Apr. 17	18.07	5,050	30
12	05057200, Baldhill Creek near Dazey, N. Dak	[2] 691	1956–69	1965		[5] 9.90	---	---
				1966		---	1,880	---
					Apr. 10	[5] 11.21	---	---
					Apr. 11	---	2,510	28
13	05058500, Sheyenne River at Valley City, N. Dak		1919,			---	---	---
			1938–69	1948		17.51	4,580	---
					Apr. 19	17.62	4,520	---
14	05059000, Sheyenne River near Kindred N. Dak	[2] 8,800	1947 or 1948,			22.1	3,600	---
			1950–69	1966		20.50	3,380	---
					Apr. 14	[5] 21.54	---	---
					Apr. 15	21.03	4,690	---
15	05059700, Maple River near Enderlin, N. Dak	[2] 843	1957–69	1965		11.05	3,390	---
					Apr. 11	13.55	5,750	[3] 1.2

See footnotes at end of table.

TABLE 13.—*Flood stages and discharges, April in upper Midwestern States*—Continued

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before April 1969: Period of known floods	Known before April 1969: Year	April 1969	Gage height (feet)	Discharge: Cfs	Discharge: Recurrence interval (yrs)
	Red River of the North basin—Continued							
16	05059800, Swan Creek near Absaraka, N. Dak	22	1955–69	1966		[5] 6.14	------	---
				1967			307	---
					April [7]	6.69	620	---
17	05059850, Swan Creek tributary near Ayr, N. Dak	4.24	1955, 1957–69	1965		4.98	73	---
					Apr. 10	6.56	120	---
18	05059900, Swan Creek near Casselton, N. Dak	56.6	1955–69	1965		[5] 9.19	2,000	---
					Apr. 10	[5] 8.2	550	---
19	05059950, Swan Creek tributary near Casselton, N. Dak	14.1	1955–69	1965		6.98	200	---
					Apr. 11	8.47	225	---
20	05060000, Maple River near Mapleton, N. Dak	[2] 1,450	1945–69	1952		[5] 18.91	------	---
				1953		--------	4,810	---
					Apr. 11	14.00	7,000	[3] 1.1
21	05060500, Rush River at Amenia, N. Dak	116	1947–69	1947		--------	1,230	---
				1966		[5] 12.15	------	---
					Apr. 10	11.41	1,690	50
22	05061000, Buffalo River near Hawley, Minn	322	1945–69	1955		9.31	1,590	---
					Apr. 9	9.07	1,880	38
23	05061500, South Branch Buffalo River at Sabin, Minn	522	1945–69	1962		17.04	6,340	---
					Apr. 10	18.12	6,410	[3] 2.0

24	05062000, Buffalo River near Dilworth, Minn	1,040	1931–69	1962	23.56	6,140	---
				Apr. 11	25.55	10,400	[3] 2.1
25	05062470, Marsh River tributary near Mahnomen, Minn	6.57	1961–69	1965	[5] 12.90	241	---
				Apr. 11	13.76	436	---
26	05062500, Wild Rice River at Twin Valley, Minn	888	1909–17, 1930–69	1909	[4] 20.0	9,200	---
				Apr. 10	11.83	4,850	[3] 1.1
27	05064000, Wild Rice River at Hendrum, Minn	1,600	1944–69	1965	[4] 29.52	6,800	---
				Apr. 15	31.42	8,300	---
28	05064500, Red River of the North at Halstad, Minn	21,800	1897, 1936–37,	1897	38.5	([6])	---
			1942–69	1966	[4] 35.35	26,800	---
				Apr. 18	38.29	35,700	[3] 1.3
29	05066500, Goose River at Hillsboro, N. Dak	1,203 [2] 1,093	1882, 1897–	1950	14.96	------	---
			1904,	1950	--------	9,420	---
			1916,	------	--------	------	---
			1931–69	------	--------	------	---
				Apr. 12	14.14	7,640	[3] 1.3
30	05067500, Marsh River near Shelly, Minn	151	1944–69	1950	18.96	4,660	---
				Apr. 12	22.28	3,910	---
31	05069000, Sandhill River at Climax, Minn	--------	1943–69	1965	[4] 17.81	4,560	---
				Apr. 14	--------	4,180	[3] 1.4
				Apr. 17, 18	[5] 28.22	------	---
32	05078000, Clearwater River at Plummer, Minn	512	1939–69	1962	--------	3,640	---
				1965	[5] 11.97	------	---
				Apr. 10	[5] 12.31	------	---
				Apr. 11	11.89	3,630	[3] 1.1

See footnotes at end of table.

TABLE 13.—*Flood stages and discharges, April in upper Midwestern States*—Continued

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before April 1969: Period of known floods	Year	April 1969	Gage height (feet)	Discharge: Cfs	Recurrence interval (yrs)
	Red River of the North basin—Continued							
33	05078230, Lost River at Oklee, Minn	266	1897–1969	1950		18.39	------	---
			1960–69	1967		14.17	[6] 2,880	---
					Apr. 11	14.91	3,210	[3] 1.2
34	05078500, Clearwater River at Red Lake Falls, Minn	1,370	1909–17,	1913		17.5	------	---
			1934–69	1950		--------	9,310	---
					Apr. 12	11.82	9,740	48
35	05079000, Red Lake River at Crookston, Minn	5,280	1901–69	1950		25.70	27,400	---
				1965		[5] 25.82	------	---
					Apr. 12	27.33	28,400	[3] 1.8
36	05082500, Red River of the North at Grand Forks, N. Dak	30,100	1882–1969	1897		[4] 50.2	80,000	---
					Apr. 16	45.69	53,500	[3] 1.1
37	05087500, Middle River at Argyle, Minn	265	1945,	1950		15.25	2,790	---
			1950,	1965		--------	2,590	---
			1951–69	1966		[5] 16.00	------	---
					Apr. 11	[5] 15.92	2,530	31
38	05092000, Red River of the North at Drayton, N .Dak	[2] 31,000	1860–1969	1950		41.58	86,500	---
					Apr. 19	41.35	59,000	40
39	05099100, Snowflake Creek near Snowflake, Manitoba	348	1961–69	1967		6.54	[8] 310	---
					Apr. 10	7.80	[8] 623	---

40	05099300, Pembina River near Windygates, Manitoba	3,020	1962–69	1967		[5] 11.80	1,890	---
					Apr. 19	[5] 17.29	8,170	---
41	05099400, Little Pembina River near Walhalla, N. Dak	[2] 182	1957–69	1960		13.28	4,160	---
					Apr. 9	12.76	6,000	1.7
42	05099600, Pembina River at Walhalla, N. Dak	3,350	1940, 1942–69	1950		19.2	20,400	---
					Apr. 20	14.58	8,440	30
43	05102500, Red River of the North at Emerson, Manitoba	[2] 36,400	1913–69	1950		90.89	95,500	---
					Apr. 26	87.59	54,700	30
44	05113360, Long Creek at western crossing of international boundary	[2] 2,020	1959–69	1960		[5] 8.61	[8] 1,330	---
					Apr. 10	12.17	3,970	---
45	05113450, Long Creek tributary No. 2 near Crosby, N. Dak	6.69	1960–69	1967		[5] 5.29	43	---
					Apr. 6	7.07	260	---
46	05113520, Long Creek tributary near Crosby, N. Dak	.35	1960–69	1965		4.13	20	---
					Apr. 6	6.99	55	---
47	05113600, Long Creek near Noonan, N. Dak	[2] 1,790	1960–69	1960		[5] 14.4	3,200	---
					Apr. 10	16.23	4,980	[3] 1.2
48	05114000, Souris (Mouse) River near Sherwood, N. Dak	8,940	1930–31, 1933–69	1948		23.80	7,400	---
					Apr. 11	[5] 24.72	12,400	[3] 1.2
49	05116200, Des Lacs River tributary near Donnybrook, N. Dak	3.82	1956–69	1963		6.40	135	---
					Apr. 6	6.79	160	---
50	05116550, Fuller Coulee at Foxholm, N. Dak	12.8	1955–69	1955		4.73	140	---
					Apr. 6	5.65	222	---

See footnotes at end of table.

TABLE 13.—*Flood stages and discharges, April in upper Midwestern States*—Continued

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before April 1969: Period of known floods	Year	April 1969	Gage height (feet)	Discharge: Cfs	Recurrence interval (yrs)
	Red River of the North basin—Continued							
51	05123400, Willow Creek near Willow City, N. Dak	[2] 1,160	1957–69	1960		14.03	1,190	---
					Apr. 12	16.76	5,900	[3] 1.3
52	05123510, Deep River near Upham, N. Dak	[1] 975	1951, 1953–69	1951		16	------	---
				1960		10.90	580	---
					Apr. 12	18.18	6,760	[3] 2.1
53	05123520, Egg Creek near Glenburn, N. Dak	20.9	1955–69	1956		4.59	75	---
					April [7]	5.19	165	---
54	05123540, Egg Creek near Ruthville, N. Dak	108.4	1955–69	1963		2.62	430	---
					April [7]	4.28	600	---
55	05123600, Egg Creek near Granville, N. Dak	[2] 289	1957–69	1960		5.44	258	---
					Apr. 10	7.28	1,710	35
56	05123900, Boundary Creek near Landa, N. Dak	[2] 230	1958–69	1960		10.22	660	---
					Apr. 9	12.70	3,580	[3] 1.7
	Mississippi River main stem							
57	05267000, Mississippi River near Royalton, Minn	11,600	1924–69	1965		-------	[8] 37,700	---
					Apr. 14	-------	[5] 32,400	29

				Sauk River basin				
58	05270500, Sauk River near St. Cloud, Minn	925	1909–13, 1929–69	1965		10.68	9,100	---
					Apr. 11	7.96	5,300	[3] 1.1
				Mississippi River main stem				
59	Mississippi River at St. Cloud, Minn	--------	1965–69	1965		[9] 984.9	------	---
						971.2	------	---
					Apr. 14	[9] 982.6	42,900	---
						968.8	------	---
				Elk River basin				
60	05275000, Elk River near Big Lake, Minn	615	1911–17, 1931–69	1965		10.86	7,360	---
					Apr. 10	10.08	5,980	[3] 1.2
				Mississippi River main stem				
61	05275500, Mississippi River at Elk River, Minn	14,500	1915–69	1965		17.20	62,000	---
					Apr. 13	14.28	48,100	40
				Crow River basin				
62	South Fork Crow River at Hutchinson, Minn	462	1965–69	1965		[9] 1,044.10	4,670	---
						1,044.44	------	---
					Apr. 9	[9] 1,041.9	3,100	[3] 1.5
						1,038.0	------	---
63	05279000, South Fork Crow River near Mayer, Minn	1,170	1910–11	1965		19.23	16,100	---
					Apr. 11	16.48	9,770	[3] 1.5
64	South Fork Crow River at Delano, Minn	--------	1965–69	1965		18.40	------	---
					Apr. 11–12	15.10	9,680	---

See footnotes at end of table.

TABLE 13.—*Flood stages and discharges, April in upper Midwestern States*—Continued

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before April 1969: Period of known floods	Year	April 1969	Gage height (feet)	Discharge: Cfs	Recurrence interval (yrs)
	Crow River basin—Continued							
65	05280000, Crow River at Rockford, Minn	2,520	1909–17, 1929–69	1965		19.27	22,400	---
					Apr. 13	16.51	15,100	[3] 1.2
	Rum River basin							
66	Rum River at West Point, Minn	--------	1958–69	1965		29.38	10,800	---
					Apr. 10	29.15	8,900	---
67	Rum River at Isanti, Minn	--------	1958–69	1965		[10] 907.60	9,400	---
					Apr. 13	[10] 907.46	9,100	---
68	05286000, Rum River near St. Francis, Minn	1,360	1905–6, 1910–13, 1929–69	1965		11.57	10,100	---
					Apr. 13	11.63	10,100	[3] 1.1
	Mississippi River main stem							
69	05288500, Mississippi River near Anoka, Minn	19,100	1931–69	1965		19.53	91,000	---
					Apr. 14	16.84	72,500	[3] 1.1
	Minnesota River basin							
70	05291000, Whetstone River near Big Stone City, S. Dak	389	1899–1903, 1910–69, 1910–12, 1931–69	1919		26	([6])	---
				1947		13.95	------	---
				1952		-------	5,710	---
				-------		-------	------	---
					Apr. 8	14.32	6,870	35

71	05292000, Minnesota River at Ortonville, Minn	1,160	1938–69	1952		12.92	3,060	---
					Apr. 13	12.09	2,550	---
72	05294000, Pomme de Terre River at Appleton, Minn	905	1931–69	1952		[4] 10.13	5,050	---
					Apr. 9	[5] 14.58	------	---
					Apr. 11	13.78	5,520	[3] 1.2
73	05300000, Lac qui Parle River near Lac Qui Parle, Minn	983	1910–14,	1952		-------	11,000	---
			1931–69	1965		[5] 19.37	------	---
					Apr. 10	18.94	17,100	[3] 1.9
74	05301000, Minnesota River near Lac qui Parle, Minn	4,050	1942–69	1952		37.98	19,700	---
					Apr. 12	39.75	29,400	---
75	05303450, Hassel Creek near Clontarf, Minn	4.03	1962–69	1962		11.92	177	---
					Apr. 7	[5] 12.62	190	---
76	05304500, Chippewa River near Milan, Minn	1,870	1937–69	1952		[5] 12.29	------	---
				1952		-------	6,930	---
					Apr. 9	15.45	11,400	[3] 1.2
77	05305200, Spring Creek near Montevideo, Minn	16.3	1959–69	1962		18.22	492	---
					Apr. 7	17.94	463	---
78	05311000, Minnesota River at Montevideo, Minn	6,180	1909–69	1952		20.02	24,500	---
					Apr. 12	21.68	35,100	[3] 1.6
79	Minnesota River at Granite Falls, Minn	--------			Apr. 13	[5] 895.49	43,400	---
80	05311200, North Branch Yellow Medicine River near Ivanhoe, Minn	14.8	1960–69	1967		[4] 14.17	540	---
					Apr. 7	18.70	940	---
81	05311400, South Branch Yellow Medicine River at Minnesota, Minn	111	1960–69	1960		11.10	1,830	---
					Apr. 8	13.41	4,430	[3] 1.6

See footnotes at end of table.

TABLE 13.—*Flood stages and discharges, April in upper Midwestern States*—Continued

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before April 1969: Period of known floods	Known before April 1969: Year	April 1969	Gage height (feet)	Discharge: Cfs	Discharge: Recurrence interval (yrs)
	Minnesota River basin—Continued							
82	05313500, Yellow Medicine River near Granite Falls, Minn	653	1919–69	1919		17.5	([6])	---
			1931–69	1957		12.41	11,800	---
					Apr. 10	14.90	17,200	[3] 1.1
83	05315000, Redwood River at Marshall, Minn	307	1940–69	1951		11.05	------	---
				1957		-------	5,370	---
					Apr. 10	-------	5,590	[3] 1.0
84	05316500, Redwood River near Redwood Falls, Minn	697	1909–14, 1930–69	1957		15.92	19,700	---
					Apr. 9	14.58	14,100	42
85	05316770, Minnesota River at New Ulm, Minn	[2] 9,530	1881, 1967–69	1881		29.17	([5])	---
				1968		[5] 21.88	------	---
				1968		-------	7,220	---
					Apr. 15	30.65	58,000	[3] 1.8
86	05316800, Cottonwood River tributary near Balaton, Minn	.50	1959–69	1963		6.74	73	---
					Apr. 4	[5] 8.41	------	---
					Apr. 6	7.74	106	---
87	Cottonwood River near Lamberton Minn	--------	-------	----	------	-------	------	---
					Apr. 8	[10] 1,062.23	[11] 8,720	---
88	Cottonwood River at Springfield, Minn	--------	-------	----	------	-------	------	---
					Apr. 8	[10] 1,019.17	20,500	---

89	05317000, Cottonwood River near New Ulm, Minn	1,280	1909–13, 1931–69	1965		[5] 20.86	26,000	---
					Apr. 10	19.15	28,700	[3] 2.4
90	Little Cottonwood River at Searles, Minn	---	---	---	---	---	---	---
					Apr. 7	---	[11] 2,310	---
91	05317500, Minnesota River at Judson, Minn	11,200	1881, 1938–69	1881		[10] 790.5	---	---
				1965		---	58,000	---
					Apr. 13	[10] 788.6	64,000	[3] 1.7
92	05320000, Blue Earth River near Rapidan, Minn	2,430	1909–10, 1939–45, 1949–69	1965		21.36	43,100	---
					Apr. 10	13.54	21,100	[3] 1.0
93	05320500, Le Sueur River near Rapidan, Minn	1,100	1939–45, 1949–69	1960		22.72	---	---
				1965		---	24,700	---
					Mar. 27	12.75	10,900	[3] 1.5
94	05325000, Minnesota River at Mankato, Minn	14,900	1881–1969	1881		29.9	90,000	---
				1965		29.09	94,100	---
					Apr. 12	27.07	76,700	[3] 1.2
95	05330000, Minnesota River near Jordan, Minn	16,200	1934–69	1965		---	117,000	---
				1965		[5] 34.37	---	---
					Apr. 14	32.85	84,600	[3] 1.3
	Mississippi River main stem							
96	05331000, Mississippi River at St. Paul, Minn	36,800	1851–1969	1965		26.01	171,000	---
					Apr. 15	24.52	156,000	[3] 1.5

See footnotes at end of table.

TABLE 13.—*Flood stages and discharges, April in upper Midwestern States*—Continued

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before April 1969: Period of known floods	Known before April 1969: Year	April 1969	Gage height (feet)	Discharge: Cfs	Discharge: Recurrence interval (yrs)
	St. Croix River basin							
97	05338500, Snake River near Pine City, Minn	958	1913–17, 1950–69	1950		-------	[11] 12,500	---
				1965		9.56	11,500	---
					Apr. 12	9.08	10,200	30
98	St. Croix River at Prescott, Wis	---------				-- -----	------	---
					Apr. 16	-------	[11] 38,400	---
	Mississippi River main stem							
99	05344500, Mississippi River at Prescott, Wis	44,800	1928–69	1965		93.11	228,000	---
					Apr. 16	91.48	199,000	[8] 1.4
100	Mississippi River at Lock and Dam 4 near Alma, Wis	---------	1935–69	1965		[9] 676.45	256,000	---
						675.78	------	---
					Apr. 17–18	[9] 674.20	214,000	---
						673.60	------	---
101	05378500, Mississippi River at Winona, Minn	59,200	1880–1969	1965		20.77	268,000	---
					Apr. 19	19.48	218,000	[8] 1.1
102	05383500, Mississippi River at La Crosse, Wis	62,800	1880–1969	1965		17.96	278,000	---
					Apr. 20	15.7	214,000	50
103	Mississippi River at Lansing, Iowa	66,280	1880–1969	1965		[10] 643.8	272,000	---
					Apr. 22	[10] 631.14	205,000	---
104	05389500, Mississippi River at McGregor, Iowa	67,500	1937–69	1965		25.38	276,000	---
					Apr. 22	21.57	216,000	[8] 1.0

	Wisconsin River basin							
105	Wisconsin River at Bridgeport, Wis	11,700			Apr. 15	-------	[11] 41,100	---
					Apr. 23	[5] 26.47	------	---
	Mississippi River main stem							
106	Mississippi River at Dubuque, Iowa	81,600	1965	1965		26.71	304,000	---
					Apr. 23	23.11	230,000	42
107	05420500, Mississippi River at Clinton, Iowa	85,600	1873–1969	1965		24,65	[8] 307,000	---
					Apr. 25, 26	21.52	[8] 231,000	40
	Des Moines River basin							
108	05475800, West Fork Des Moines River tributary near Jackson, Minn	1.42	1960–69	1962		[5] 16.34	69	---
					Apr. 4	[5] 17.57	------	---
					Apr. 6	-------	77	---
109	05475900, West Work Des Moines River tributary near Lakefield, Minn	4.52	1960–69	1963		7.00	199	---
					Apr. 7	8.76	221	---
110	05476000, West Fork Des Moines River at Jackson, Minn	1,220	1909–13, 1930–69	1965		[5] 18.62	------	---
				1965		-------	9,530	---
					Apr. 11	19.45	15,700	[3] 2.0
111	05476100, Story Brook near Petersburg, Minn	25.2	1960–69	1962		12.77	2,110	---
					Apr. 5	[5] 16.54	------	---
					Apr. 6	-------	1,790	---
112	05476500, West Fork Des Moines River at Estherville, Iowa	1,372	1952–69	1953		15.53	10,800	---
					Apr. 12	17.68	16,000	[3] 1.8
113	West Fork Des Moines River at Emmetsburg, Iowa	1,671			Apr. 13	[10] 1,210.4	16,100	[3] 1.4

See footnotes at end of table.

TABLE 13.—*Flood stages and discharges, April in upper Midwestern States*—Continued

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before April 1969: Period of known floods	Known before April 1969: Year	April 1969	Gage height (feet)	Discharge: Cfs	Discharge: Recurrence interval (yrs)
	Des Moines River basin—Continued							
114	05476750, West Fork Des Moines River at Humboldt, Iowa	2,256	1940–69	1965		13.90	14,400	---
					Apr. 14	15.40	18,000	[3] 1.2
115	05476900, East Fork Des Moines River tributary near Dunnel, Minn	7.88	1960–69	1962		16.15	2,200	---
					Apr. 6	13.71	421	---
	Mississippi River main stem							
116	06467500, Missouri River at Yankton, S. Dak	279,500	1881–1969	1881		[5] 50.5	([6])	---
			1930–69	1952		35.5	480,000	---
					Apr. 25	21.67	[1] 33,600	---
	James River basin							
117	06468170, James River near Grace City, N. Dak	[2] 1,060			Apr. 13	12.00	3,100	30
118	06469500, Pipestem Creek near Buchanan, N. Dak	[2] 758	1950–69	1950		11.89	------	---
			-------	----	------	-------	4,480	---
					Apr. 10	12.08	6,080	[3] 1.5
119	06470000, James River at Jamestown, N. Dak	[2] 2,820	1928–33, 1938–39, 1943–69	1950		[4] 15.82	6,390	---
					Apr. 11	16.94	6,330	---
120	06470500, James River at La Moure, N. Dak	[2] 4,390	1950–69	1950		15.34	5,730	---
					Apr. 14	16.17	6,800	---

121	06471000, James River at Columbia, S. Dak	7,050	1945–69	1950	16.89	5,420	---
				1952	-------	[12] 1,860	---
				Apr. 11	-------	[12] 1,750	---
				Apr. 22	17.09	4,670	37
122	06471050, Elm River tributary near Leola, S. Dak	14.7	1956–69	1964	8.62	418	---
				Apr. 8	11.0	720	---
123	06471200, Maple River at North Dakota-South Dakota State line	[2] 750	1956–69	1966	12.43	2,620	---
				Apr. 11	[5] 16.05	------	---
				Apr. 11	15.22	5,930	[3] 1.4
124	06471350, Maple River at Frederick, S. Dak	552	1956–69	1962	12.70	3,000	---
				Apr. 11	[5] 14.3	------	---
				Apr. 11	13.2	6,000	[3] 1.3
125	06471400, Willow Creek, tributary near Leola, S. Dak	3.74	1956–69	1964	2.58	33	---
				Apr. 9	4.81	260	---
126	06471450, Willow Creek tributary near Barnard, S. Dak	.18	1956–69	1960	2.59	20	---
				Apr. 9	4.93	78	---
127	06471500, Elm River at Westport S. Dak	1,680	1945–69	1952	20.10	7,520	---
				Apr. 10	22.11	12,600	[3] 1.6
128	06472000, James River near Stratford, S. Dak	[2] 9,990	1950–68	1950	-------	5,580	---
				1952	18.13	------	---
				Apr. 19	18.18	([5])	---
129	06473000, James River at Ashton, S. Dak	[2] 11,000	1945–69	1950	-------	5,170	---
				1952	19.59	------	---
				1952	-------	1,500	---
				Apr. 9	-------	[1] 2,100	---
				Apr. 13	[5] 21.17	------	---
				Apr. 24	20.63	5,680	[3] 1.1

See footnotes at end of table.

TABLE 13.—*Flood stages and discharges, April in upper Midwestern States*—Continued

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before April 1969: Period of known floods	Maximum floods: Known before April 1969: Year	Maximum floods: April 1969	Maximum floods: Gage height	Maximum floods: Discharge: Cfs	Maximum floods: Discharge: Recurrence interval (yrs)
	James River basin—Continued							
130	06473500, South Fork Snake Creek, near Athol, S. Dak	[2] 1,820	1950–69	1952		[5] 16.42	2,200	---
					Apr. 7	[5] 19.15	------	---
					Apr. 7	19.03	6,810	40
131	06473800, Matter Creek tributary near Orient, S. Dak	5.41	1956–69	1960		-------	325	---
				1966		[5] 7.90	------	---
					Apr. 3	9.01	410	[3] 2.3
132	06473820, Shaefer Creek near Orient, S. Dak	45.1	1956–69	1960		5.12	870	---
					Apr. 3	5.98	1,280	[3] 1.7
133	06473850, Shaefer Creek tributary near Orient, S. Dak	6.08	1956–69	1960		6.12	221	---
					Apr. 3	7.98	350	[3] 1.9
134	06473880, Shaefer Creek tributary near Miller, S. Dak	5.75	1959–69	1960		4.61	120	---
				1967		4.61	120	---
					Apr. 3	6.40	245	[3] 1.4
135	06474300, Medicine Creek near Zell, S. Dak	210	1959–69	1966		10.28	1,250	---
					Apr. 5	12.41	2,210	40
136	06477000, James River near Forestburg, S. Dak	[2] 13,810	1920	1920		18	------	---
			1950–69	1962		16.40	12,000	---
					Apr. 9	17.16	12,500	50
137	06477500, Firesteel Creek near Mount Vernon, S. Dak	540	1955–69	1960		-------	5,780	---
				1962		16.85	------	---
					Apr. 3	[5] 17.12	------	---
					Apr. 4	15.34	6,610	40

138	06478000, James River near Mitchell, S. Dak	19,800	1953–58, 1965–69		---	---	---
				1966	12.98	2,750	---
				Apr. 11	18.32	13,800	46
139	60478260, North Branch Dry Creek near Parkston, S. Dak	37.0	1956–69	1962	8.76	1,540	---
				Apr. 8	10.28	3,200	[3] 1.2
140	06478500, James River near Scotland, S. Dak	[2] 21,550	1928–69	1962	18.74	15,200	---
				Apr. 13	18.55	14,000	24
	Vermillion River basin						
141	06478800, Saddlerock Creek near Canton, S. Dak	14.8	1956–69	1965	8.81	945	---
				Apr. 8	[5] 8.80	700	[3] 1.3
142	06478820, Saddlerock Creek tributary near Beresford, S. Dak	2.32	1956–69	1965	6.79	97	---
				Apr. 8	4.53	32	---
143	06478840, Saddlerock Creek near Beresford, S. Dak	26.3	1956–69	1965	9.80	1,480	---
				Apr. 8	8.39	900	[3] 1.1
	Big Sioux River basin						
144	06479240, Big Sioux River tributary No. 2 near Summit, S. Dak	.26	1956–69	1962	5.16	53	---
				Apr. 6	4.32	40	---
145	06479260, Big Sioux River tributary No. 3 near Summit, S. Dak	6.60	1959–69	1965	6.15	600	---
				Apr. 8	10.11	800	[3] 2.6
146	06479750, Pek Munky Run near Estelline, S. Dak	25.4	1956–69	1965	7.29	1,540	---
				Apr. 7	7.25	1,480	30
147	06479800, North Deer Creek near Estelline, S. Dak	48.3	1956–69	1962	7.61	590	---
				Apr. 7	8.45	3,550	[3] 1.3

See footnotes at end of table.

TABLE 13.—*Flood stages and discharges, April in upper Midwestern States*—Continued

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before April 1969: Period of known floods	Maximum floods: Known before April 1969: Year	Maximum floods: April 1969	Maximum floods: Gage height (feet)	Maximum floods: Discharge: Cfs	Maximum floods: Discharge: Recurrence interval (yrs)
	Big Sioux River basin—Continued							
148	06479900, Sixmile Creek tributary near brookings, S. Dak	9.42	1956–69	1965		6.68	820	---
					Apr. 8	[5] 9.08	1,000	[3] 1.0
149	06479950, Deer Creek near Brookings, S. Dak	4.21	1956–69	1961		5.83	194	---
					Apr. 8	7.72	750	---
150	06480000, Big Sioux River near Brookings, S. Dak	[2] 4,420	1953–69	1962		12.95	10,600	---
					Apr. 9	14.77	33,900	[3] 2.6
151	06481000,Big Sioux River near Dell Rapids, S. Dak	[2] 5,060	1948–69	1962		15.14	18,400	---
					Apr. 9	16.47	41,300	[3] 2.6
152	06482100, Big Sioux River near Brandon, S. Dak	[2] 5,810	1959–69	1962		19.93	17,100	---
					Apr. 10	24.56	36,800	[3] 1.6
153	06482870, Little Beaver Creek tributary near Canton, S. Dak	.22	1956–69	1968		3.54	([6])	---
					Apr. 8	[5] 4.91	65	---
154	06482950, Mound Creek near Hardwick, Minn	2.47	1959–69	1960		10.49	106	---
					Apr. 7	11.54	274	---
155	06483000, Rock River at Luverne, Minn	440	1911–14	1914		[10] 1,437.78	11,600	---
					Apr. 8	[10] 1,439.39	19,500	---
156	06483270, Rock River at Rock Rapids, Iowa	788	1960–69	1962		9.56	16,400	---
					Apr. 8	10.23	29,000	50

157	06483380, Little Rock River at Little Rock, Iowa	134			-------	------	---
				Apr. 6	[10] 1,435.02	9,100	31
158	Little Rock River at George, Iowa	195			-------	------	---
				Apr. 6	[10] 1,355.98	10,200	29
159	06483500, Rock River near Rock Valley, Iowa	1,600	1949–69	1962	16.91	28,400	---
				Apr. 7	17.32	40,400	42
160	06485500, Big Sioux River at Akron, Iowa	[2] 9,030	1928–69	1962	22.08	54,300	---
				Apr. 9	22.99	80,800	[3] 1.2
			Floyd River basin				
161	06600100, Floyd River at Alton, Iowa	265	1953, 1956–69	1953	-------	45,500	---
				1962	18.35	12,200	---
				Apr. 4	17.78	8,510	27
162	06600500, Floyd River at James, Iowa	882	1935–69	1953	25.3	71,500	---
				Apr. 5	21.54	17,300	28
			Little Sioux River basin				
163	06603530, Little Sioux River near Spafford, Minn	---------	1962–69	1965	[5] 11.08	2,700	---
				Apr. 6	10.03	2,040	---
164	06605100, Little Sioux River at Spencer, Iowa	990	1936–69	1953	20.20	30,000	---
				Apr. 8	16.1	[5] 16,700	[3] 2.7
165	06605600, Little Sioux River at Gillett Grove, Iowa	1,334	1953, 1958–69	1953	17.87	24,000	---
				1965	18.67	20,200	---
				Apr. 8	17.78	15,900	45
166	06606300, Mill Creek near Cherokee, Iowa	292	-------	1953	14.30	11,500	---
				Apr. 6	10.9	7,300	45

See footnotes at end of table.

TABLE 13.—*Flood stages and discharges, April in upper Midwestern States*—Continued

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before April 1969, Period of known floods	Known before April 1969, Year	April 1969	Gage height (feet)	Discharge, Cfs	Discharge, Recurrence interval (yrs)
	Little Sioux River basin—Continued							
167	Little Sioux River at Cherokee, Iowa	2,173	-------	1965		25.6	33,700	---
					Apr. 7	24.24	21,000	43
168	06606600, Little Sioux River at Correctionville, Iowa	2,500	1891, 1918–69	1891		29.34	(6)	---
				1965		25.86	29,800	---
					Apr. 8	23.61	21,000	32

1 Flow regulated or partly regulated.
2 Includes noncontributing area.
3 Ratio of maximum discharge to that of 50-year flood.
4 At different site and (or) datum; see station description.
5 Affected by back water.
6 Unknown.
7 Day of month not known.
8 Daily mean discharge.
9 Headwater and tailwater elevations in mean sea level.
10 Mean sea level elevation.
11 From discharge measurement at or near peak.
12 Daily reverse flow.

Total urban damages in the Red River basin, exclusive of the Souris River basin, were estimated at $5.5 million. Total agricultural damages were set at $22 million, of which $2.8 million occurred to more than 750 farmsteads. Damages to railroads, highways, and secondary roads were estimated at $3 million.

In the North Dakota part of the Souris River basin, water equivalent of the snow ranged from 3 to 4 inches.

The peak discharge on April 11 at gaging station on Souris (Mouse) River near Sherwood, N. Dak., was 12,400 cfs which is 1.2 times that of a 50-year flood. A secondary peak discharge of 6,300 cfs occurred April 20 at this station. At Minot the peak discharge of April 19 was the largest since 1904; however, the 1904 peak discharge was nearly twice that of the April 19 flood and is reported to have had a stage about 2 feet lower than the 1882 flood. Many downstream Souris River tributaries had peak discharges greater than those of 50-year floods.

Estimated urban flood damage in the Souris River basin was $12.5 million, of which 88 percent occurred at Minot, N. Dak. Including agriculture losses, total damages in the basin were about $18 million.

In the Mississippi River basin, upstream from the Minnesota River, the water equivalent of the snow on the ground at the end of March ranged from 5 to 7 inches. Flood peaks on many tributaries exceeded those for 50-year floods, and at many points were second highest in the period of record. Floods of 1965 were generally larger than those for April, 1969 (Anderson and Burmeister, 1970). Tributary inflow to the Mississippi River, upstream from Anoka, combined with the flow of the main stem upstream from St. Cloud resulted in a discharge on the Mississippi River greater than that of the 50-year flood downstream from Anoka.

The peak discharge of 72,500 cfs on April 14 on the Mississippi River near Anoka, Minn., was 1.1 times that of a 50-year flood. This was the third highest peak in 39 years, being exceeded by a peak of 91,000 cfs in April 1965 and 75,900 cfs in April 1952.

Just downstream from Anoka, the Mississippi and Minnesota Rivers join at the Twin Cities of Minneapolis and St. Paul, Minn. Maximum discharge occurred April 14 on each river at this confluence. This is the first time in 35 years of concurrent records when the maximum discharges of significant snowmelt floods occurred on the same day. Minneapolis has very little low-lying area along the Mississippi River, and flood damage was minimal in April 1969. The flood peak of 156,000 cfs on April 15, on the

Mississippi River at St. Paul, Minn., was 1.5 times that of a 50-year flood and was the second highest peak since at least 1851. Flood warning and advance preparation prevented greater flood damage in St. Paul, but some areas that were unprotected by dikes were inundated.

The flood damage in Minneapolis was about $165,000, whereas St. Paul had $1.8 million in damage. This amount includes the cost of fighting floods plus economic losses in wages and profits. This was the largest loss experienced by any city along the Mississippi River.

Snow cover at the end of March in the headwaters of the Minnesota River basin had a water content of about 6 inches, and as much as 1.5 inches of rain fell on the upper part of the basin April 7–10 just as the snowmelt runoff was nearing its peak. On many tributaries to the Minnesota River the flood was the greatest known, and in most places the peak discharges were in excess of those for 50-year floods.

The peak discharges April 10 on Lac qui Parle River near Lac qui Parle, Minn., and April 15 on the Minnesota River at New Ulm, Minn., were nearly twice those of 50-year floods. On the Cottonwood River near New Ulm, Minn., the maximum discharge April 10 was 2.4 times that of a 50-year flood, which is one of the highest ratios computed for the April floods. Flood damage to agricultural lands in the Cottonwood River basin was about $2.5 million. The Flandrau Dam at New Ulm was severely damaged and the right bank washed out. The dam had been washed out and rebuilt in 1947 and again in 1965.

The peak discharge of the Minnesota River at Judson, Minn., (64,000 cfs on April 13) was 1.7 times that of a 50-year flood, the greatest since 1881. The discharge for the 1881 flood is not known, but the stage was 1.9 feet higher than that on April 13, 1969.

The total flood damages in the Minnesota River basin were $33.4 million, more than half the $60 million total damages in the entire Mississippi River basin upstream from Guttenberg, Iowa.

On the main stem of the Mississippi River from St. Paul, Minn., to Clinton, Iowa, the peak discharge of the April flood decreased from 1.5 times that of a 50-year flood to that of a 40-year flood. Flood damage through this reach was localized and diminished progressively downstream.

The next major tributary to the Mississippi River downstream from the Minnesota River is the Des Moines River, which heads in southwestern Minnesota. Most of the flooding in the Des Moines

River basin occurred in the headwaters in southwestern Minnesota and northwestern Iowa. Peak flow of West Fork Des Moines River at Jackson, Minn., (15,700 cfs on April 11) was 2.0 times that of a 50-year flood. Flood-peak recurrence intervals decreased progressively downstream from Jackson. About 16 miles downstream from the confluence of the East and West Forks of the Des Moines Rivers the recurrence interval was only 5 years.

A flood potential existed over most of the Missouri River basin in North Dakota throughout the winter, but alternate freezing and thawing in March alleviated the flood threat. Flooding was confined mostly to the main stem tributaries flowing from the east, the downstream reaches of the western tributaries, and the James River. Recurrence intervals of peaks on the eastern tributaries ranged from 5 to 20 years, but most were less than 10 years.

In the James River basin, the maximum discharge on Elm River at Westport, S. Dak., was 12,600 cfs on April 10, which was 1.6 times that of a 50-year flood and was nearly twice the previously recorded peak of 7,520 cfs in 1952. Recurrence intervals were greater than 50 years at several gaging stations in the James River basin, but at James River near Scotland (near the mouth) the recurrence interval for the flood of April 13 was only 24 years.

Floods in the Big Sioux River basin were severe. Ratios of peak discharges to those of 50-year floods ranged from 2.6 at Brookings, S. Dak., (April 19) to 1.2 at Akron, Iowa, (April 9) near the mouth.

Flood damages were estimated to be about $147 million in the six States of North Dakota, South Dakota, Minnesota, Iowa, Wisconsin, and Illinois. Eleven lives were lost to the flood, more than 23,000 persons were forced from their homes, more than a million acres of rich agricultural land were inundated, and thousands of culverts and bridges were washed out or damaged.

SNOWMELT FLOODS OF APRIL-JULY 1969 IN THE BUENA VISTA LAKE, TULARE LAKE, AND SAN JOAQUIN RIVER BASINS IN CALIFORNIA

By WILLARD W. DEAN

Record-breaking snowmelt runoff from the southern Sierra Nevada occurred during the period April to July 1969 from an extremely heavy snowpack. The snowpack had accumulated as a result of major winter and spring storms. The storms had caused intensive flooding in foothill and lowland areas in January and February 1969.

The snowmelt runoff was distinguished by large volumes of flow, rather than high peak discharge. Runoff in the Kern, Tule, and Kings River basins was the greatest since the beginning of runoff records in 1893, 1901, and 1895, respectively. In the Kaweah River basin the runoff was nearly equal to the record runoff in 1906.

This report summarizes information on the snowmelt floods of 1969 in the Buena Vista Lake, Tulare Lake, and San Joaquin River basins of California. The area affected by the snowmelt floods is shown in figure 20. The flood discharges are expressed largely in terms of volumes of runoff, and selected data are presented to indicate the runoff magnitudes. Daily and peak discharges at many gaging stations during the snowmelt for the period April to July 1969 are published in the U.S. Geological Survey annual basic-data report (1971).

The snowmelt floods occurred in an area that includes the Buena Vista Lake, Tulare Lake, and San Joaquin River basins in the southern part of the Central Valley in California between the Sierra Nevada on the east and the coastal ranges on the west. The area is about 120 miles wide by 240 miles long and is oriented along a northwest-southeast axis. The Sierra Nevada and foothills constitute the eastern 40 percent of the area. A large part of the Sierra Nevada extends above an altitude of 5,000 feet, and many peaks reach altitudes of 10,000 to 14,000 feet. The valley floor includes about 10,000 sq mi of flat cultivated alluvial land that slopes generally about 1 foot per mile from southeast to northwest.

Nine major streams flow southwesterly from the Sierra Nevada to the valley floor. The Kern, Tule, Kaweah, Kings, San Joaquin, Merced, Tuolumne, Stanislaus, and Mokelumne Rivers (fig. 20), drain practically all of the higher Sierra Nevada where snow normally accumulates.

The Kern River terminates in several distributary channels and Buena Vista Lake. Buena Vista Lake has been divided by cross levees, and the lakebed has been dry and cultivated most of the time in recent years. During historic flood years excess Kern River water drained northward over and through a low divide called Sand Ridge to Tulare Lake. Kern River flow still can be diverted to Tulare Lake through Buena Vista Channel, Goose Lake Slough, and other distributary channels.

Runoff from the Tule, Kaweah, and Kings Rivers drains into Tulare Lake, a shallow depression forming a flooded sump. Tulare Lake was an 800-square mile inland lake after the historic flood years of 1861–62 and 1967–68 (S. T. Harding, written commun., 1949) when it reached its maximum elevation of 216 feet above

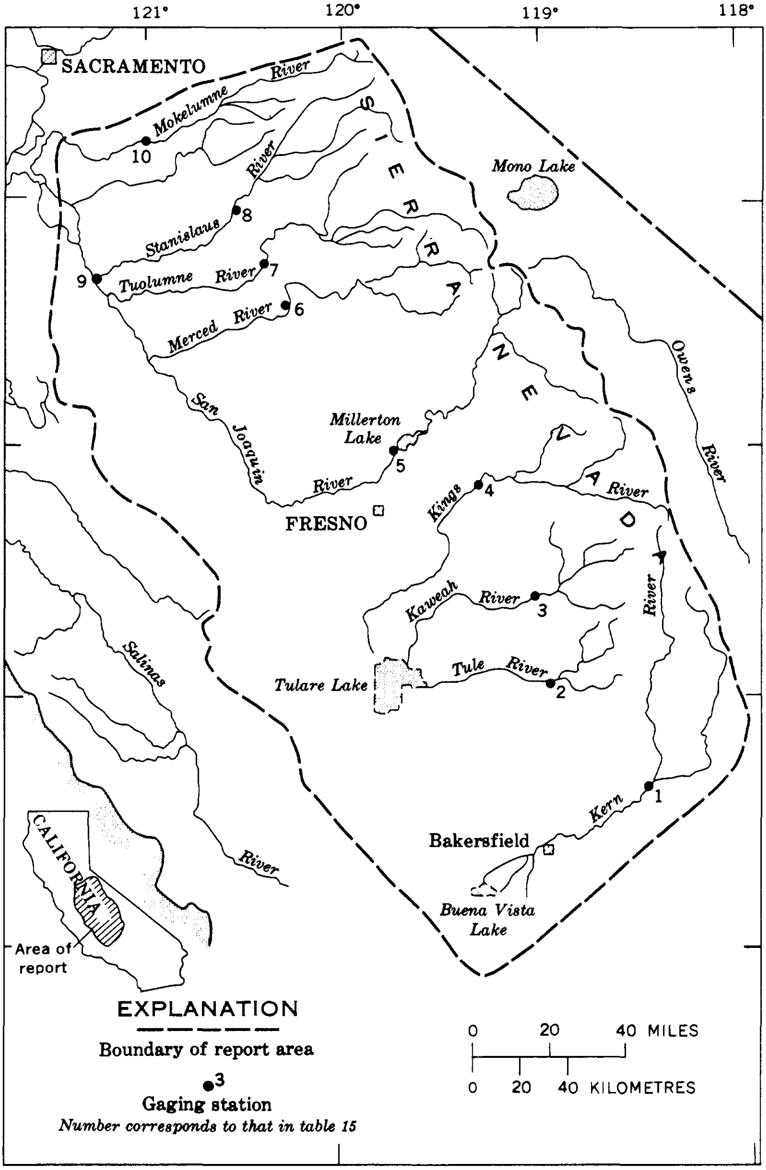


FIGURE 20.—Area affected by extreme snowmelt runoff during the period April to July in central California.

mean sea level. Outflow from the lake north to Fresno Slough and the San Joaquin River can occur at a lake elevation of 207 feet; from a study of available records Harding concluded that there had been no outflow since 1878. Tulare Lake bed has been dry and cultivated in most recent years as the result of lesser runoff, increased irrigation diversions, .nd reservoir storage upstream. Flood runoff from the Kings River can be controlled so that part flows into the San Joaquin River through Fresno Slough and part enters Tulare Lake. For control and management, Tulare Lake bed has been divided into several large cells separated by levees and connected by canals and drainage channels.

The San Joaquin River flows southwesterly until it reaches the valley floor and then turns northwesterly to the delta and confluence with the Sacramento River at the head of Suisun Bay. As it flows northwesterly, it is augmented by the Merced, Tulolumne, Stanislaus, and Mokelumne Rivers and smaller streams. Most of the banks of the San Joaquin River and other major channels on the valley floor are lined with levees which contain normal flow and most flood runoff.

One or more large storage reservoirs are operated on each major stream for water conservation and flood control. Many of these, notably Isabella Reservoir on the Kern River, Success Reservoir on the Tule River, Terminus Reservoir on the Kaweah River, and Pine Flat Reservoir on the Kings River, in the Buena Vista and Tulare Lake basins, have been completed since the great snowmelt floods of 1952 (Stafford, 1956).

A series of storms from January 18 through January 27, 1969, brought extremely heavy rain and snow to central and southern California. During this period, rain in the San Joaquin Valley and Sierra Nevada foothills ranged from 14.5 inches at an altitude of 2,000 feet at Auberry in the San Joaquin River basin to 25.0 inches at an altitude of 4,700 feet at Johnsondale in the Kern River basin. At higher altitudes, precipitation was greater—as much as 38.2 inches at an altitude of 6,600 feet at Grant Grove in the Kaweah River basin—but was mostly snow above an altitude of about 6,000 feet. A second storm period February 22–25 brought additional heavy precipitation over the same area (5.0 inches at Auberry, 6.4 inches at Johnsondale, and 9.0 inches at Grant Grove). The February storms were colder, and caused snow accumulation down to an altitude of 5,000 feet. Finally, above-normal precipitation in March brought rain to the valley but added more snow to an already deep snowpack in the Sierra Nevada.

Rainfloods during January and February 1969 have been described by Waananen (1969). Peak flows in January or February in streams draining lower altitudes were very high, and in several streams were the greatest of record. In the Sierra Nevada, little storm runoff occurred above an altitude of 6,000 feet, as demonstrated in a report (Dean, 1971) for the East Fork Kaweah River basin where several stream gages provide data on runoff from different middle and high altitude zones.

Monthly reports of water conditions, prepared by the California Department of Water Resources (1969), first commented on the heavy snowpack accumulation in the report for March 1, 1969, and alerted water managers to forecasts of much-above normal or record-high runoff during the April through July snowmelt season. The April 1, 1969, report confirmed the March 1 outlook and included a prediction of the greatest snowmelt runoff of record in the Kern and Tule River basins, runoff equal to the greatest of record in the Kaweah and Kings River basins, and only slightly less than the record high in the San Joaquin River basin to the north. The water equivalent of first-of-April snowpack in 1969 ranged from 295 percent of the 1931–65 average in the Kern River basin at the south end of the area affected by the snowmelt runoff to 205 percent in the Stanislaus River basin at the north end. At 78 of 104 snow courses measured in this area, the April 1, 1969, water equivalent was greater than the previous maximum. Water-equivalent data for 10 selected snow courses are given in table 14.

The 10 snow courses were chosen to illustrate the variation in water equivalent at different altitudes in several river basins. The location of each snow course is not considered significant, but the data are representative of the variations found during the snow surveys.

TABLE 14.—*Snow-water equivalent at selected snow courses in central California*

Snow course	Altitude (feet)	First-of-month water equivalent (inches)			
		April average 1931–65	April 1969	May 1969	June 1969
Buena Vista Lake basin					
Siberian Pass	10,900	18.0	48.4	44.4	27.3
Round Meadow	9,000	25.3	70.2	66.2	24.2
Monache Meadow	8,000	7.5	40.8	22.1	.0
Tulare Lake basin					
Bishop Pass	11,200	29.8	78.4	74.1	61.7
Panther Meadow	8,600	35.9	98.8	100.9	73.9
Quaking Aspen	7,000	13.3	44.7	19.1	.0
Giant Forest	6,400	16.7	49.9	42.5	.0
San Joaquin River basin					
Piute Pass	11,300	34.2	80.1	80.9	68.7
Huntington Lake	7,000	20.2	53.6	39.8	.0
Tuolumne Meadows	8,600	21.9	50.5	45.5	2.2

The cooperative snow surveys and runoff forecast program of the State of California began in 1930. The April 1, 1969, snow-water equivalent in the Buena Vista Lake, Tulare Lake, and San Joaquin River basins, expressed as an average for the area, was 235 percent of the 1931–65 average. Prior to 1969, the greatest snowpack accumulation was measured in 1952. The 1952 snowpack was about 210 percent of the 1931–65 average, on the basis of data supplied by the California Department of Water Resources. The snowpack in 1969 was proportionately greater in the southern river basins; the 1952 snowpack was more uniformly distributed.

During April and for the first 5 days of May in 1969, precipitation was above normal and temperatures were below normal. Snowmelt runoff from altitudes above 8,000 feet was delayed, and the snowpack at some high altitude snow courses increased contraseasonally (table 14). Temperatures were considerably above normal from May 6 through June 5 and caused high rates of snowmelt during this period. Peak runoff from high altitudes occurred at the end of May and during the first week in June. Beginning June 6, temperatures dropped below normal and remained low for most of the month. Less than average precipitation together with above-normal temperatures occurred in May and above-normal precipitation fell in June, but these variations caused insignificant changes in runoff compared to the temperature effects on snowmelt runoff. Temperatures were near normal in late June and in July; however, by this time the snowpack was so depleted that snowmelt continued to recede.

Snowmelt runoff during April through July in the nine major streams in the flood area is tabulated in table 15, which shows the maximum, 50-year average, and actual 1969 runoff. The data listed are the observed runoff adjusted for upstream storage and major diversions except for the San Joaquin River near Vernalis, and thus are indicative of the natural runoff. The maximums of record are those for the year 1906 and represent either measured runoff, or correlative figures furnished by the California Department of Water Resources. The earliest streamflow records began about 1900.

Snowmelt runoff in 1969 exceeded the previous maximums of 1906 in the Kern, Tule, and Kings River basin, and was only slightly less than the runoff in 1906 in the Kaweah, upper San Joaquin, Merced, and Tuolumne River basins. At the north end of the flood area, the 1969 April through July runoff in the Stanislaus and Mokelumne River basins was substantially less than that in 1906, but was still about twice the 50-year average. The snowmelt runoff throughout the flood area generally exceeded the runoff in 1938 and 1952 (Stafford, 1956).

Unadjusted runoff data for the San Joaquin River near Vernalis are included because the flow past Vernalis plus Mokelumme River runoff is the outflow from the highly regulated San Joaquin River system which discharges into the Sacramento-San Joaquin Delta and through San Francisco Bay to the ocean. Data for San Joaquin River at Vernalis are available only since 1930, and the greatest April through July runoff of 6,155,000 acre-feet was measured in 1938. Runoff in April 1938 included the recession from the March 1938 flood. The runoff of 4,845,000 acre-feet in 1969 was less than that in 1938 mainly because storage space was available in 1969 in many additional reservoirs.

During the April through July 1969 period, 1,030,000 acre-feet of Kings River runoff was diverted through James bypass and the Fresno Slough to the San Joaquin River. Also, about 55,000

TABLE 15.—*April through July runoff at selected stations in central California*

Number [1]	Permanent station number	Station name	Runoff, in thousands of acre-feet: Maximum of record [2]	50-year average 1916–65 [2]	[3] 1969
		Buena Vista Lake basin			
1	11191000	Kern River below Isabella Dam	1,086	410	1,657
		Tulare Lake basin			
2	11204900	Tule River below Success Dam	169	56	224
3	11210950	Kaweah River below Terminus Dam	814	261	799
4	11221500	Kings River below Pine Flat Dam	2,959	1,143	3,114
		San Joaquin River basin			
5	11251000	San Joaquin River below Friant	3,355	1,173	2,901
6	11270900	Merced River below Merced Falls Dam	1,491	599	1,367
7	11288000	Tuolumne River above La Grange Dam	2,680	1,179	2,472
8	11302000	Stanislaus River below Goodwin Dam	1,710	711	1,390
9	11303500	San Joaquin River near Vernalis	[4, 5] 6,155	[4, 5] 1,585	[4] 4,845
10	11319500	Mokelumne River near Mokelumne Hill	1,065	464	883

[1] Corresponds to gaging station number in figure 20.
[2] Computed by the California Department of Water Resources from actual and correlative records.
[3] Adjusted for upstream storage and major diversions.
[4] Observed runoff, unadjusted.
[5] For period of record 1930–68.

acre-feet of Kern River flood water was pumped from the Buena Vista Flood Channel into the California Aqueduct and pumped northward (up) through the aqueduct for irrigation use west of the aqueduct and away from the flood area.

As with most other snowmelt floods, the sustained volume of runoff during the high flows of May and June 1969 was notable, but the peak flows were considerably lower than those caused by winter rain floods. The snowmelt floodflows of April–July 1969 on three representative streams are compared with the peak flows in January 1969 and the record flows of December 1966 in the following table.

River and location	Peak flow during period, in cubic feet per second		
	April–July 1969	January 1969	December 1969
Kern River at Kernville	11,200	26,900	74,000
Kaweah River at Three Rivers	7,050	24,200	73,000
Kings River above North Fork	19,600	35,000	41,000

Only at high altitudes were peak flows during April through July 1969 greater than previous maximums of record. For example, the peak discharge of 430 cfs on May 31, 1969, in Golden Trout Creek near Cartago, which drains a 23.6-sq mi area between 9,000 and 12,000 feet in altitude in the Kern River basin, was more than twice the previous maximum of 202 cfs on June 12, 1967. The peak discharge of 4,980 cfs on June 3, 1969, in Merced River at Happy Isle Bridge, which drains a 181-sq mi area from 4,000 to 13,000 feet altitude, exceeded the previous maximum of 4,660 cfs on June 4, 1938. Streams with more low-altitude drainage area had peaks about equal to previous maximums. An example is the Kings River above North Fork, drainage area 952 sq mi from 1,000 to 13,000 feet altitude, with peaks of 19,600 cfs on June 2, 1969, and 19,700 cfs on June 4, 1938.

Accurate forecasts of snowmelt runoff nearly 3 months in advance allowed excellent planning, coordination, and utilization of all possible measures to handle the expected runoff and minimize flooding and flood damage. Extensive emergency work was done in advance of the snowmelt peaks strengthening levees and improving river channels to contain and pass the expected high flows. Federal, State, and local agencies cooperated fully in the operation of reservoir storage, irrigation diversion and spreading, and wildlife refuge area storage to utilize as much snowmelt runoff as possble for beneficial uses and to reduce damaging flows in the valley.

From April 1 through July 31, storage in major upstream reservoirs increased 972000 acre–feet in the Buena Vista Lake and Tulare Lake basins, and 2,300,000 acre-feet in the San Joaquin River basin, as shown in table 16. Evacuation of storage space from major reservoirs including Pine Flat Reservoir, Millerton Lake, and others, had been started in March and continued in April, but the rates of release were restricted by downstream channel capacities. After the record snowmelt began in May, the reservoirs were operated on the basis of long-term and short-term forecasts of runoff to release the maximum quantities that downstream channels could carry and to make effective use of available storage space.

Total flood-control storage space in the Buena Vista Lake and

TABLE 16.—*Gain in storage in the principal reservoirs of central California during the April 1 to July 31 snowmelt period in 1952 and 1969*

River	Reservoir	Gain in storage in acre-feet April 1–July 31	
		1952	1969
	Buena Vista Lake basin		
Kern	Isabella	------	376,400
	Tulare Lake basin		
Tule	Lake Success	------	13,200
Kaweah	Lake Kaweah	------	61,200
Kings	Courtright	------	106,200
	Wishon	------	110,700
	Pine Flat	[1] 127,000	304,100
	Tulare Lake	[2] 500,000	379,200
Total in Buena Vista Lake and Tulare Lake basins		627,000	1,351,000
	San Joaquin River basin		
Upper San Joaquin	Lake Thomas A. Edison	------	119,300
	Florence Lake	63,900	63,600
	Mammoth Pool	------	105,300
	Huntington Lake	77,500	76,600
	Shaver Lake	124,000	120,800
	Millerton Lake	159,900	360,300
Merced	Lake McClure	14,500	353,200
Tuolumne	Hetch Hetchy	248,800	279,100
	Cherry Lake	------	190,700
	Lake Eleanor	14,900	21,200
	Don Pedro	110,700	111,500
Stanislaus	Donnell Lake	------	56,000
	Beardsley Lake	------	28,100
	Melones	55,900	81,800
	Tulloch	------	47,700
Mokelumne	Salt Springs	108,700	106,100
	Pardee	72,600	24,000
	Camanche	------	136,100
Total in San Joaquin River basin		1,052,300	2,281,400

[1] Temporary storage, April 1–June 23.
[2] Estimated.

Tulare Lake basins is 1,800,000 acre-feet, of which 1,100,000 acre-feet was available April 1. Practically all the available space was filled by the time of maximum snowmelt runoff in early June. Runoff data in table 15 indicate a total adjusted runoff of 5,800,000 acre-feet in the four major streams during April through July. Of the 4,700,000 acre-feet of runoff that could not be stored in upstream reservoirs, about 40,000 acre-feet was stored in Buena Vista Lake, 55,000 acre-feet was pumped north in the California Aqueduct, 61,000 acre-feet was stored in a temporary detention reservoir at Sand Ridge, 1,030,000 acre-feet was released to the San Joaquin River through Fresno Slough, and 379,200 acre-feet was in storage in Tulare Lake as of July 31. The balance of 3,200,000 acre-feet was diverted for irrigation, spread to increase ground-water recharge, or lost by evapotranspiration during April through July. Storage in Tulare Lake increased to a maximum of 997,00 acre-feet at an altitude of 192.5 feet above mean sea level on June 24, 1959, having held 527,800 acre-feet of winter flood runoff on March 31, 1969. As the result of considerable effort in raising and strengthening levees the area flooded in Tulare Lake was limited to 90,000 acres.

Snowmelt runoff of the five major rivers in the San Joaquin River basin was 9 million acre-feet during the period April through July 1969. An additional 1 million acre-feet was diverted from Kings River. Of the 10 million acre-feet total, 4,845,000 acre-feet flowed to the delta past the gaging station on the San Joaquin River near Vernalis, and 350,000 acre-feet flowed from the Mokelumne River basin directly to the delta. Major upstream reservoirs stored 2,280,000 acre-feet during the snowmelt period. The remaining 2,500,000 acre-feet was used for irrigation, percolated into the ground, or was lost to evapotranspiration.

Significant flooding from snowmelt in 1969 was limited to areas adjacent to river channels on the valley floor and to the low areas in Buena Vista Lake, Sand Ridge, and Tulare Lake where water accumulated but could not be used, discharged, or stored elsewhere. Headwater streams at high altitudes had record-high peak flows during snowmelt, but the resultant temporary flooding of mountain meadows and the perimeters of high-altitude lake was more beneficial than damaging. Peak flows in main channels were much lower than those during rain floods and caused few problems.

Flooding from stream overflow was mostly confined to floodplain areas within leveed floodways. Prolonged high flows resulted in considerable seepage through levees and resultant flooding of low-lying land outside the levees. The Corps of Engineers, U.S. Army (1970) reports that a total of 221,000 acres of agricultural land was flooded by snowmelt runoff along the Kern, Kaweah, Kings, Stanislaus, and San Joaquin Rivers. Of this total, 90,000 acres was in the Tulare Lake bed and about 75,000 acres in the lower Kern River system of the Buena Vista Lake basin.

The principal damage caused by the snowmelt floods of 1969 was related to agriculture in the flooded area. The agricultural losses were about 55 percent of the total and included losses to orchards, crops, and crop yields, land damage, deposition of debris, and damage to irrigation facilities. Other damage was to roads, power and communication facilities, and commercial and recreational facilities along the rivers. The following summary of flood damage has been reported by the Corps of Engineers, U.S. Army (1970). The public facility losses reported include the costs of road repair, restoration, and flood fighting in advance of and during the floods.

Area	Primary flood damage (thousands of dollars)					
	Agricultural	Residential	Commercial	Industrial and utilities	Public facilities	Total
Buena Vista Lake and Tulare Lake basins	10,317	51	246	2,926	7,357	20,897
San Joaquin River basin	2,955	0	279	7	175	3,416
Total	13,272	51	525	2,933	7,532	24,313

FLOODS OF MAY 5-7 IN NORTH-CENTRAL TEXAS

By Leo G. Stearns

General rains accompanied by severe thunderstorms occurred in north-central Texas, May 4–10. Floods occurred in parts of the Sabine, Sulphur, Trinity, and Brazos River basins within a triangular area bounded by Lubbock, Texarkana, and Waco (fig. 21). Peak discharges for the year occurred at 80 of 122 stream-gaging stations on essentially unregulated streams within this area.

Figure 21 show the locations and table 17 shows the peak discharges at station sites where significant floods were measured. Maximum discharges for periods of record were recorded at 10 of these 16 sites.

At Cleburne, in Johnson County, rainfall in excess of 8 inches was measured for the period May 6–7, (fig. 22).
Most of this rain fell during the evening of May 6 and the early morning hours of May 7. Two streams, East and West Buffalo

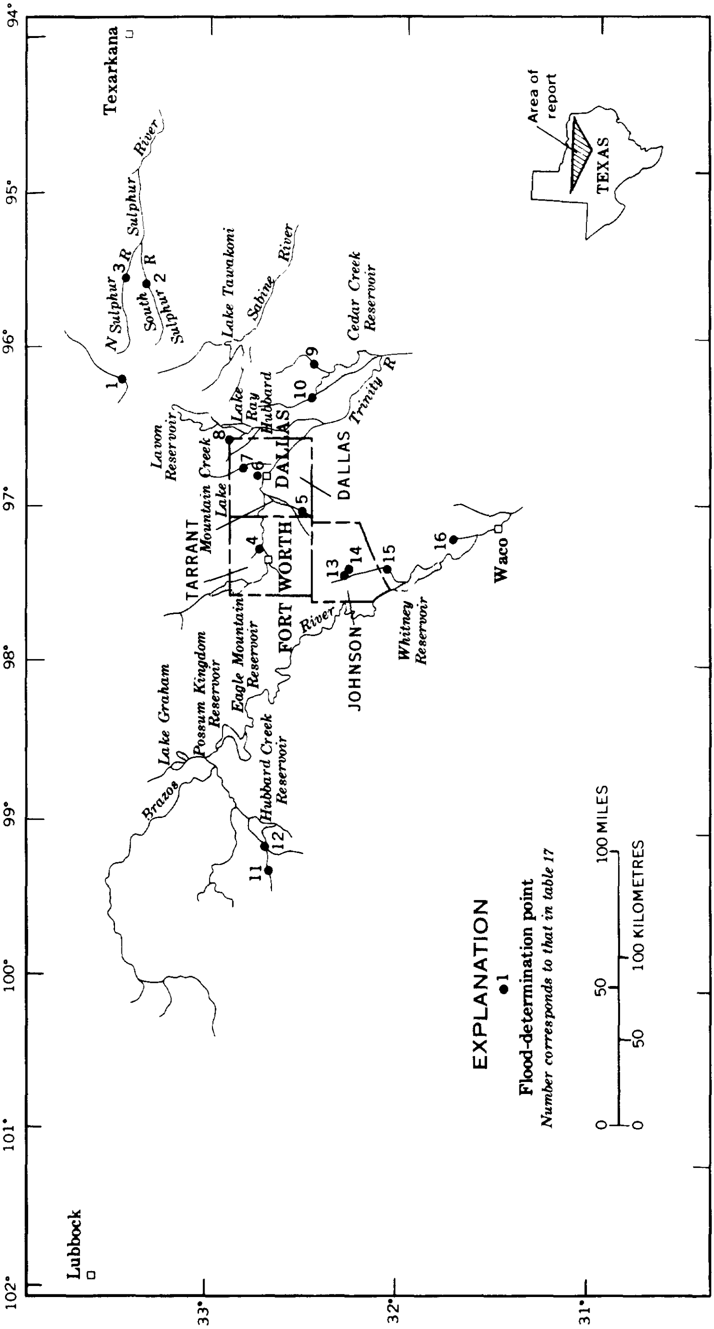


FIGURE 21.—Location of flood-determination points for May 5–7, in north-central Texas.

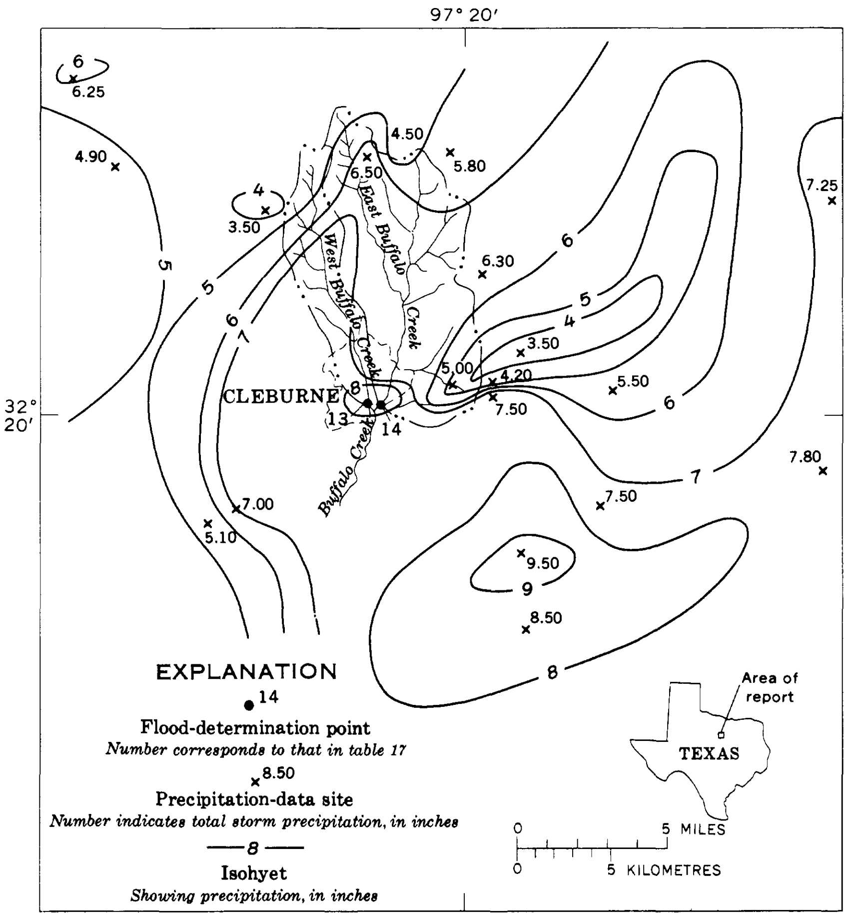


FIGURE 22.—Location of flood-determination points, precipitation-data sites, and isohyets for May 6–7 flood of May 7 at Cleburne, Tex. Isohyets by U.S. Geological Survey; data from National Weather Service and Corps of Engineers, U.S. Army.

Creeks, had peak discharges May 7 that were about 1½ times a 50-year flood discharge (table 17).

Flood damage was greatest in Dallas, Johnson, and Tarrant Counties (fig. 21). The Corps of Engineers, U.S. Army, estimated damages in the Trinity River basin, where an estimated 55,000 acres were inundated, to be about $4.6 million. The Small Business Administration estimated losses in Johnson County to be more than $400,000. Four facilities, three in Johnson County and one in Dallas County, were attributed to the flooding.

TABLE 17.—*Flood stages and discharges, May 5–7 in north-central Texas*

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before May 1969: Period of known floods	Known before May 1969: Year	May 1969	Gage height (feet)	Discharge: Cfs	Discharge: Recurrence interval (yrs)
	Red River basin							
1	07332600, Bois d'Arc Creek near Randolph	72	1962–69	1966		19.66	11,600	---
					May 7	20.69	9,960	[1] 1.2
2	07342500, South Sulphur River near Cooper	527	1942–69	1966		23.02	30,500	---
					May 7	22.77	31,500	37
3	07343000, North Sulphur River near Cooper	276	1949–69	1965		27.00	48,000	---
					May 7	29.00	54,000	25
	Trinity River basin							
4	08048800, Big Fossil Creek at Haltom City	52.8	1959–69	1962		26.90	27,000	---
					May 7	10.30	11,600	26
5	08049600, Mountain Creek near Cedar Hill	119	1960–69	1966		24.54	23,100	---
					May 7	25.10	28,300	[1] 1.3
6	08056500, Turtle Creek at Dallas	7.98	1951–69	1966		10.54	12,200	---
					May 6	9.96	8,840	35
7	08057200, White Rock Creek at Greenville Ave. Dallas	66.4	1961–69	1964		[2] 490.43	38,100	---
					May 7	[2] 488.76	19,600	[1] 1.2
8	08061540, Rowlett Creek near Sachse	120	1968–69	1968		27.30	17,700	---
					May 7	28.54	24,400	[1] 1.2
9	08062800, Cedar Creek near Kemp	189	1963–69	1966		16.00	29,000	---
					May 7	15.67	23,500	[1] 1.4
10	08062900, Kings Creek near Kaufman	233	1963–69	1966		22.73	29,700	---
					May 7	23.34	33,000	[1] 1.7
	Brazos River basin							
11	08086150, North Fork Hubbard Creek near Albany	38.4	1962–69	1966		11.76	4,660	---
					May 5	19.22	9,520	[1] 1.6
12	08086212, Hubbard Creek below Albany	621	1966–69	1968		26.21	27,200	---
					May 5	26.44	27,800	25
13	West Buffalo Creek at Cleburne	11.8			May 7	[2] 743.90	8,870	[1] 1.5

See footnotes at end of table.

TABLE 17.—*Flood stages and discharges, May 5–7, in north-central Texas* —Continued

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before May 1969: Period of known floods	Known before May 1969: Year	May 1969	Gage height (feet)	Discharge: Cfs	Discharge: Recurrence interval (yrs)
	Brazos River basin—Continued							
14	East Buffalo Creek at Cleburne	35.6			May 7	[1]743.44	18,500	[2]1.6
15	08092000, Nolan River at Blum	276	1924–25, 1947–69	1949		24.0	25,000	---
					May 7	31.23	[3]62,200	25
16	08093500, Aquilla Creek near Aquilla	306	1888–1969	1936		33	74,200	---
					May 7	29.53	32,600	32

[1] Ratio of peak discharge to that of a 50-year flood.
[2] Elevation above mean sea level.
[3] Partly regulated by reservoir.

FLOODS OF MAY 20 AND JUNE 23 IN CENTRAL NEW YORK

After F. LUMAN ROBISON (1969)

Intense rains May 18–20 and an evening cloudburst June 23 caused severe floods in north-central New York on May 20 and June 23.

In northern Cayuga and Onondaga counties and in the southwestern Adirondacks the May 18–20 precipitation totals ranged from 3.5 to 6.0 inches. In Oneida county, 5.7 inches precipitation was recorded at Boonville and 6.5 inches at Forestport. A 24-hour rainfall of 3.13 inches was measured at Syracuse (fig. 23).

The May 20 peak discharge of 11,300 cfs from 295 sq mi on Black River near Boonville was the second highest in 59 years of record and is considered to have a recurrence interval of about 50 years (table 18). Floods occurred on other streams in the area, but their magnitudes did not approach the peaks of record. The recurrence intervals for flood peaks on these streams were between 20 and 30 years.

A late evening cloudburst June 23 over eastern Cortland County in south central New York caused severe flooding in McGraw (fig. 23). Rainfall of 4.6 inches at Cincinnatus and nearly 6 inches at McGraw was reported.

The June 23 peak discharge of 2,480 cfs from 8.84 sq mi on Smith Brook at McGraw was 2.1 times that of a 50-year flood and the peak discharge of 5,230 cfs from 40 sq mi on Trout Brook

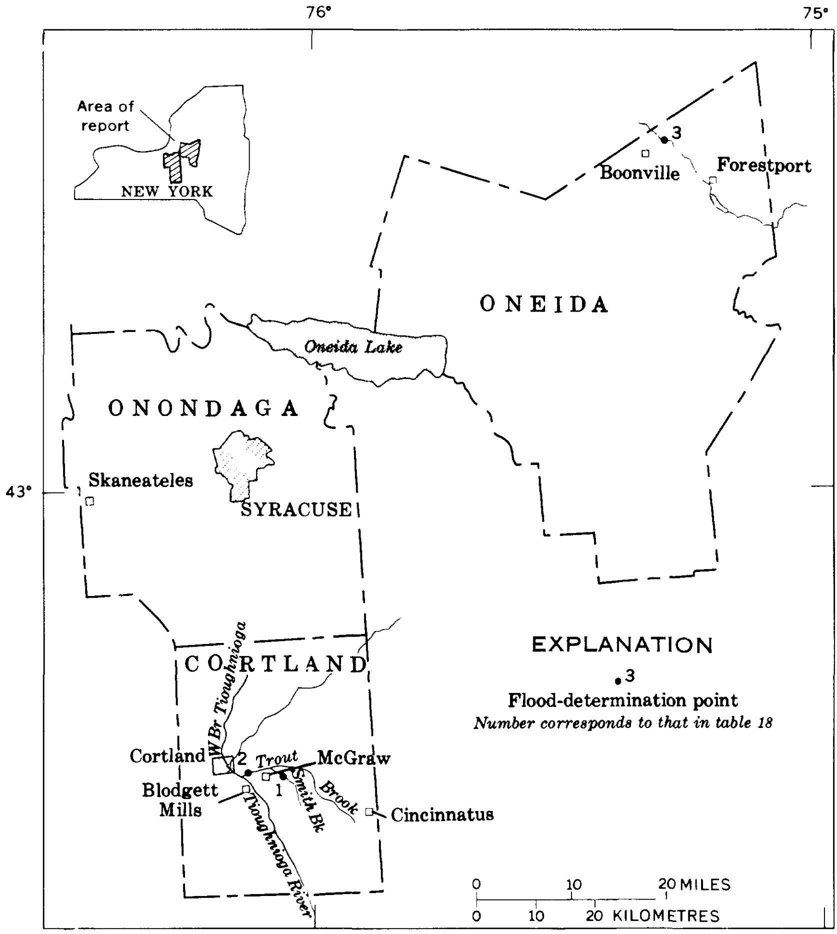


FIGURE. 23.—Location of flood-determination points, floods of May 20 and June 23 in central New York.

near Cortland was 1.4 times that of a 50-year flood (table 18).

Flood damage May 20 was due mostly to overflow of streams, which flooded basements and commercial establishments. In Syracuse one furniture store had a $100,000 loss, and in Skaneateles, thousands of dollars damage was done. The June 23 flood damages were estimated at $500,000. In addition to flooding of three factories and a park, a washout near Blodgett Mills caused derailment of 3 locomotives and 14 freight cars, which injured 4 trainmen.

TABLE 18.—*Flood stages and discharges, May 20 and June 23 in central New York*

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before January 1969: Period of known floods	Year	May, June 1969	Gage height (feet)	Discharge: Cfs	Recurrence interval (yrs)
	Susquehanna River basin							
1	Smith Brook at McGraw	8.84	1969		June 23		2,480	[1] 2.1
2	Trout Brook near Cortland	[2] 40	1969		June 23		5,230	[1] 1.4
	Streams tributary to Lake Ontario							
3	04252500, Black River near Boonville	295	1911–69	1913		[3] 12.5	12,400	---
					May 20	11.27	11,300	[3] 50

[1] Ratio of peak dicharge to that of a 50-year flood.
[2] Approximately.
[3] About.

FLOODS OF JUNE AND JULY IN CENTRAL AND SOUTHEASTERN WYOMING

By D. J. O'CONNELL

A combination of snowmelt and rainfall east of the Wind River Range June 7 to 10 and failure of an irrigation dam July 8 near Wheatland caused floods in central and southeastern Wyoming.

June floods in central Wyoming occurred on streams in the Yellowstone River and Platte River basins (fig. 24).

Snowpack on the Wind River was melting when the rainstorms began June 7. Rainfall in inches June 7–11, reported by the National Weather Service, is listed below:

Date	Lander WB Airport	Gas Hills 4 E	Sand Draw	Atlantic City Ore Mine	Riverton	South Pass City
June 7	2.16	0	0	0	0.01	0.06
8	1.00	Trace	.15	0	.21	1.06
9	0	.08	.87	1.64	.65	0
10	1.38	.12	.16	.12	.19	.14
11	.14	.76	.31	.82	.47	1.14
Totals	4.68	.96	1.49	2.58	1.53	2.40

The peak discharge of 2,360 cfs on Twin Creek near Lander June 7 was due to an intense local thunderstorm over only about 9 sq mi of the basin's 84 sq mi. The peak discharge was 1.8 times that of a 50-year flood (table 19).

The peak discharge of 202 cfs from 5.92 square miles on Slate Creek near Atlantic City was 1.5 times that of a 50-year flood.

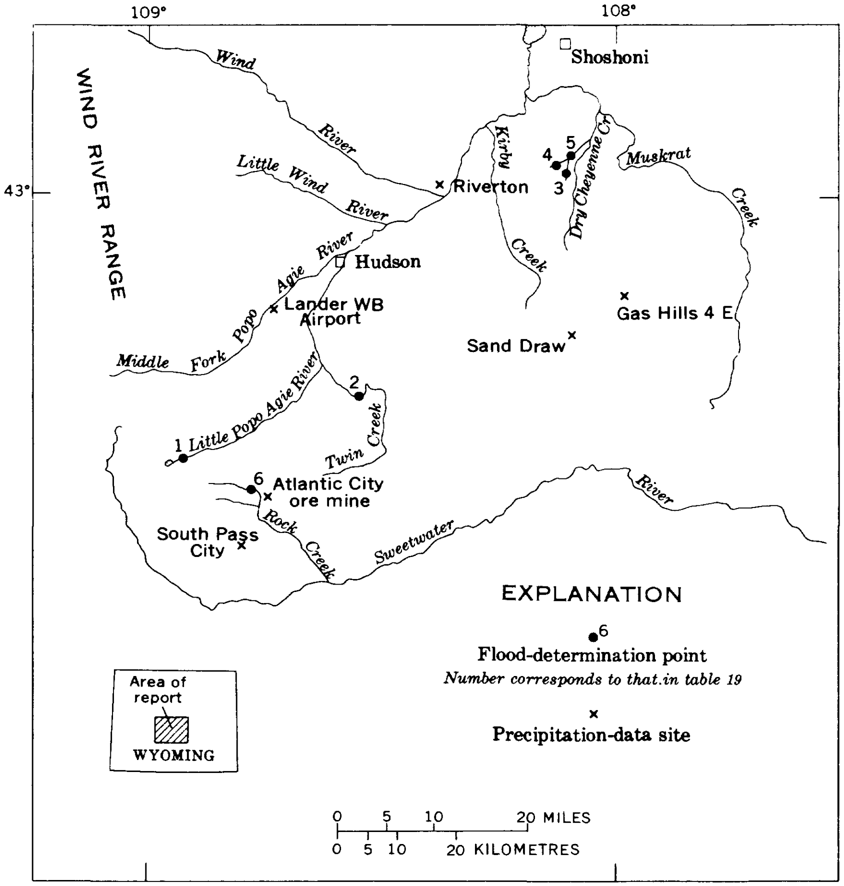


FIGURE 24.—Location of flood-determination points and precipitation-data sites, floods of June 7–10 in central Wyoming.

This flood was caused by spill from an upstream reservoir and rainstorms on the melting snow. Flood damage was confined to ranchers' corrals along Twin Creek.

Failure of Wheatland Irrigation District's No. 1 Dam about 0500 hours July 8 caused floods on Sybille Creek and the upper reaches of the Laramie River (fig. 25).

The U.S. Bureau of Reclamation estimated the peak discharge at the dam to be 28,000 cfs. The dam impounded about 9,000 acre-feet and the reservoir emptied in about 2 hours.

The peak discharge of 13,400 cfs on the Laramie River at I–25 crossing near Wheatland, Wyo., was 1.5 times a 50-year flood. The flood peak passed the station at about 1100 hours July 8.

Thirty miles farther downstream, due to attenuation, the peak discharge was only 1,740 cfs on the Laramie River at Fort

TABLE 19.—*Flood stages and discharges, June and July in central and southeastern Wyoming*

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before June 1969: Period of known floods	Known before June 1969: Year	June, July 1969	Gage height (feet)	Discharge: Cfs	Discharge: Recurrence interval (yrs)
	Yellowstone River basin							
1	06232800, Little Popo Agie River near Atlantic City	5.99	1958–69	1965	-----	2.73	154	---
			-----	-----	June 8	2.83	171	(1)
2	06233050, Twin Creek near Lander	[2]84	-----	-----	June 7	------	2,360	[3]1.8
3	06238760, West Fork Dry Cheyenne Creek at upper station near Riverton	.69	1965–69	1967	-----	3.28	176	---
			-----	-----	June 10	3.86	275	(1)
4	06238780, West Fork Dry Cheyenne Creek tributary near Riverton	1.85	1965–69	1967	-----	2.20	60	---
			-----	-----	June 10	6.74	421	(1)
5	06238790, West Fork Dry Cheyenne Creek near Riverton	3.52	1965–69	1967	-----	1.79	(1)	---
			-----	-----	June 10	4.53	720	(1)
	Platte River basin							
6	06637900, Slate Creek near Atlantic City	5.92	1957–69	1965	-----	4.02	296	---
			-----	-----	June 8	3.79	202	[3]1.5
7	06667050, Laramie River at I-95 crossing near Wheatland	[2]3,100	-----	-----	July 8	------	13,000	[3]1.5
8	06670500, Laramie River near Fort Laramie	[4]4,546	1915–69	1917	-----	[5]4.20	4,280	---
			-----	-----	July 10	6.89	1,740	4

1 Not determined.
2 Approximately.
3 Ratio of peak discharge to that of a 50-year flood.
4 Of which 631 sq mi is probably non contributing.
5 Site and datum then in use.

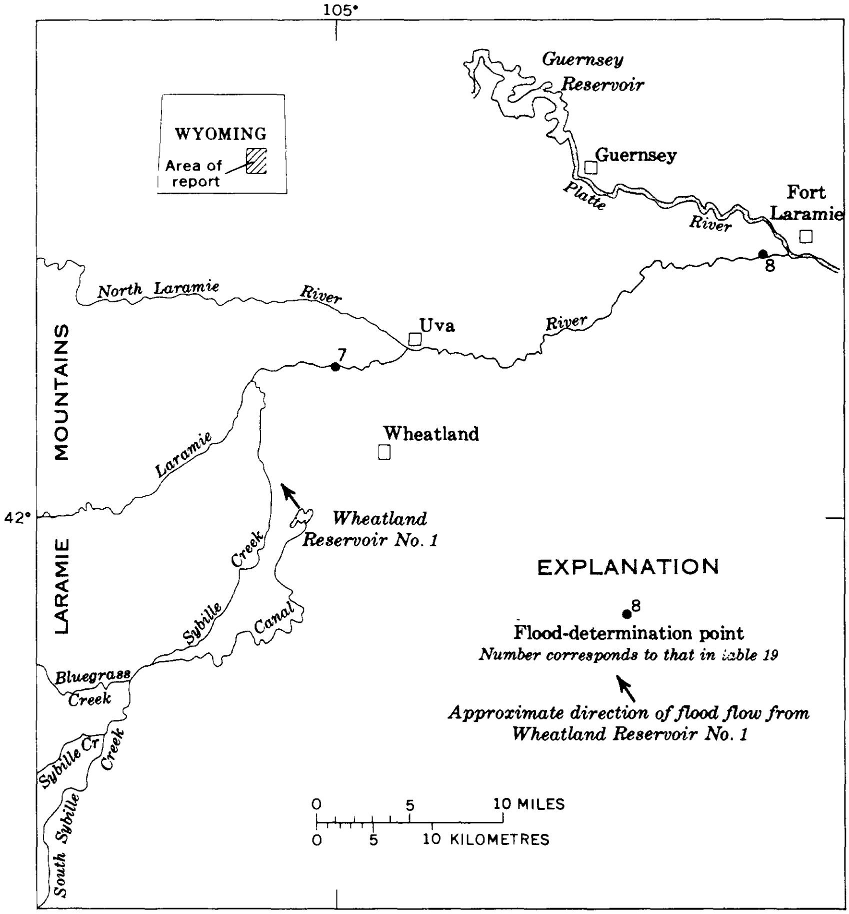


FIGURE 25.—Location of flood-determination points, flood of July 8–10 in southeastern Wyoming.

Laramie, Wyo., and the recurrence interval was 4 years. The flood crest time-of-travel between the Wheatland Dam and Fort Laramie (fig. 26) was about 50 hours.

Total flood damage to the dam, canal works, roads, homes, and agricultural lands was estimated at $750,000. Of this sum, $624,000 was for damage to the dam and canal works.

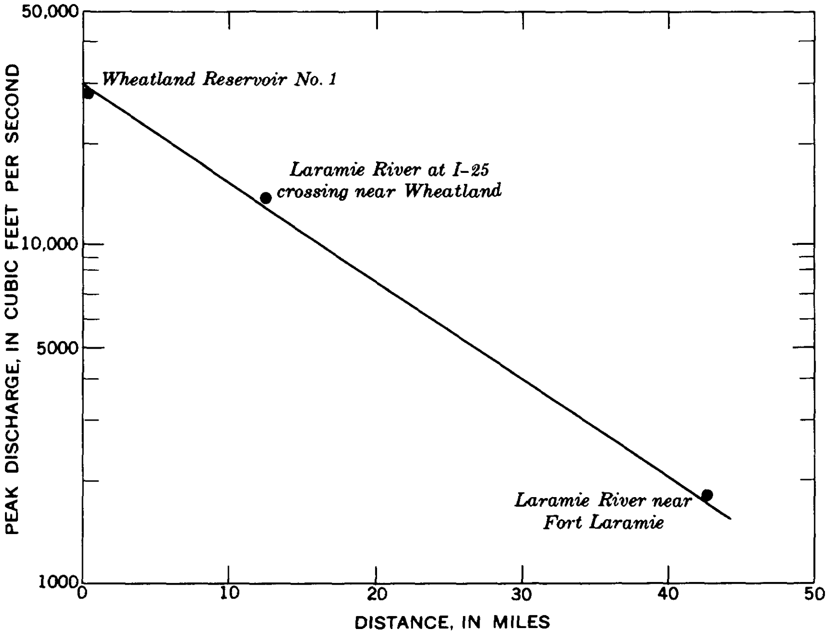


FIGURE 26.—Relation of peak discharge to distance downstream from Wheatland Irrigation District Dam No. 1, Laramie River, flood of July 8 in southeastern Wyoming.

FLOODS OF JUNE 9-10 IN NORTHEASTERN OREGON

By D. D. HARRIS

Rainstorms during the evening of June 9 caused floods on some streams in northeastern Oregon. Seven inches of precipitation was measured about 4 miles east of John Day, and more than 2 inches was measured at several sites between John Day and Prairie City.

The peak discharge on John Day River near John Day was 2.52 times that of a 50-year flood (table 20), whereas the recurrence interval of the peak discharge at Prairie City was 50-years. Recurrence intervals have not been determined for all gaging-station sites. The peak discharge of 2,660 cfs on Shobe Creek at Heppner, from 6.22 square miles represents an average of 428 cfs per sq mi (fig. 27).

Flood damage to roads and private property in the vicinity of Prairie City was estimated at about $250,000. Flood damage in Heppner was only a few thousand dollars for repairing roads and cleaning up mud and debris. No lives were lost during the June 9–10 floods.

Flood stages and peak discharges for the flood areas are shown in table 20.

TABLE 20.—*Flood stages and discharges, June 9–10, in northeastern Oregon*

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before June 1969: Period of known floods	Known before June 1969: Year	June 1969	Gage height (feet)	Discharge: Cfs	Discharge: Recurrence interval (yrs)
	Willow Creek basin							
1	14034500, Willow Creek at Heppner	[1] 87	1903, 1951–69	1903		([2])	36,000	([2])
					June 10	4.69	514	12
2	Shobe Creek at Heppner	6.22	1969		June 9	----	2,660	([2])
3	Hinton Creek at Heppner	42.5	1969		June 9	----	495	([2])
4	14036000, Willow Creek near Arlington	[1] 850	1906, 1960–69	1964		11.05	14,700	([2])
					June 10	10.34	6,680	([2])
	John Day River basin							
5	143038500, John Day River at Prarie City	231	1925–69	1964		8.07	2,400	([2])
					June 9	17.02	1,800	50
6	14038530, John Day River near John Day	386	1969		June 9	10.80	5,830	[3] 2.52
7	14040500, John Day River at Picture Gorge, near Dayville	[1] 1,680	1926–69	1964		14.97	8,170	([2])
					June 10	7.65	2,720	([2])

[1] Approximately.
[2] Not determined.
[3] Ratio of peak discharge to that of a 50-year flood.

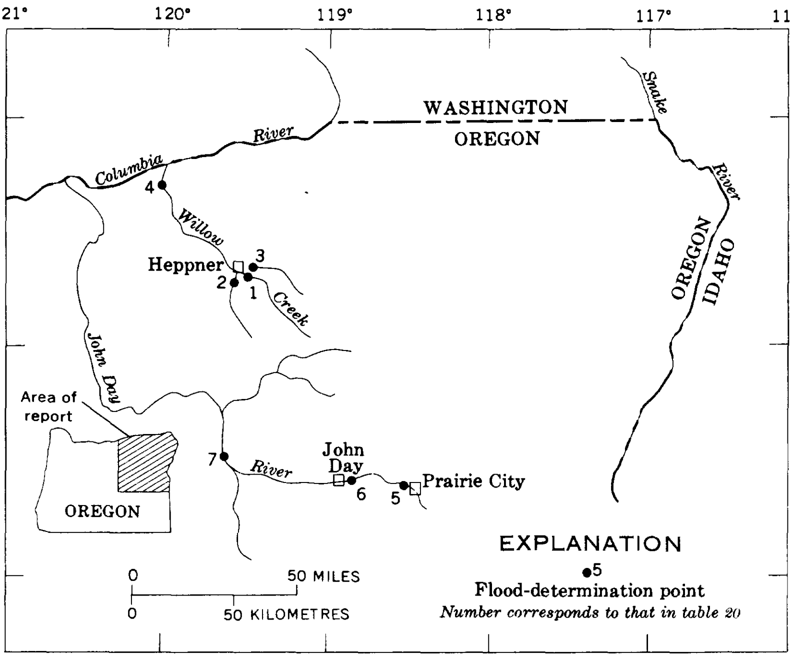


FIGURE 27.—Location of flood-determination points, floods of June 9-10 in northeastern Oregon.

FLOOD OF JUNE 10 IN SOUTHWESTERN NEBRASKA

By H. D. BRICE

Following the storm of late evening June 10, on an area extending along Elkhorn Canyon from southwest of Maywood to the Hayes-Frontier County line, residents reported rainfall as much as 6 inches. At Curtis, 5.1 inches fell during the 6-hour period prior to 12 p.m. June 10. The recurrence interval of such rainfall intensity is more than 100 years in the Maywood-Curtis vicinity, according to U.S. Weather Bureau (1961). The rainfall in inches, reported by the National Weather Service, at Wellfleet, Curtis, Moorefield, and Stockville, and the observed rainfall at U.S. Geological Survey rain gages Nos. Frn. 2 and 3, for the 24-hour period prior to 0700 hours June 11, is shown in figure 28.

Recurrence intervals for the peak discharges on June 10 at each of the three gaging stations in table 21 were 30 years, which suggests that the rainfall producing the peaks was uniformly distributed over the two basins of Elkhorn Canyon and Frazier Creek. By contrast, the 1956 and 1967 flood data shown in table 21 illustrate the usual pattern of highly variable and

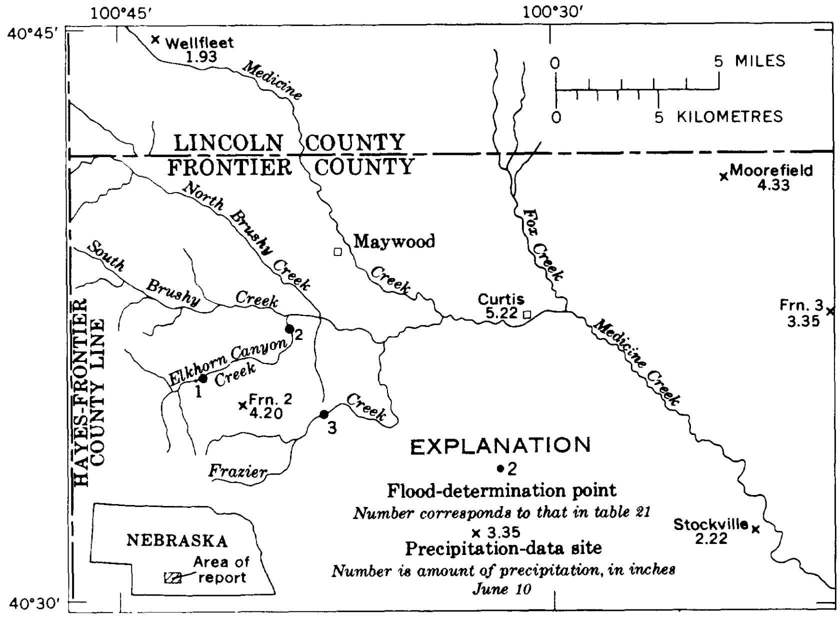


FIGURE 28.—Location of flood-determination points and precipitation-data sites, flood of June 10 in southwestern Nebraska.

TABLE 21.—*Flood stages and discharges, June 10 in southwestern Nebraska*

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before June 1969 — Period of known floods	Year	June 1969	Gage height (feet)	Discharge: Cfs	Recurrence interval (yrs)
	Kansas River basin							
1	06839200, Elkhorn Canyon near Maywood	6.74	1952–69	1956		17.44	1,220	6
				1967		18.29	1,920	12
					June 10	19.00	3,370	30
2	06839400, Elkhorn Canyon southwest of Maywood	13.2	1952–69	1956		26.5	8,660	[1]1.2
				1967		22.58	5,000	33
					June 10	23.13	4,680	30
3	06839600, Frazier Creek near Maywood	11.3	1952–69	1956		27.3	11,200	[1]2.1
				1967		28.55	9,370	[1]1.8
					June 10	18.32	4,150	30

[1] Ratio of peak discharge to that of a 50-year flood.

localized rainfall that produces flooding in this part of Nebraska.

Crop damage ranged from moderate to severe in the storm area and was attributed to a combination of high-intensity rainfall, hail, erosion, and flooding.

FLOODS OF JUNE 15-16 IN NORTH CAROLINA

By HERBERT G. HINSON

Scattered thunderstorms June 11-16 caused floods over much of North Carolina. Precipitation of 4.20 inches was recorded June 15 at the National Weather Service station at Greensboro and unofficially as much as 9 inches was reported in the city. A monthly maximum precipitation for June of 15.28 inches was recorded at Mortimer, on the eastern slopes of the Blue Ridge Mountains, and 6.25 inches of that amount fell June 15.

The peak discharge of 6,600 cfs June 16 on North Buffalo Creek near Greensboro was the largest recorded in 42 years and its recurrence interval was 30 years. (fig. 29).

The peak discharges of 3,370 cfs and 8,660 cfs respectively, on Yadkin River at Patterson and Elk Creek at Elkville both had recurrence intervals of 25 years (table 22).

Only moderate damage was caused by the floods.

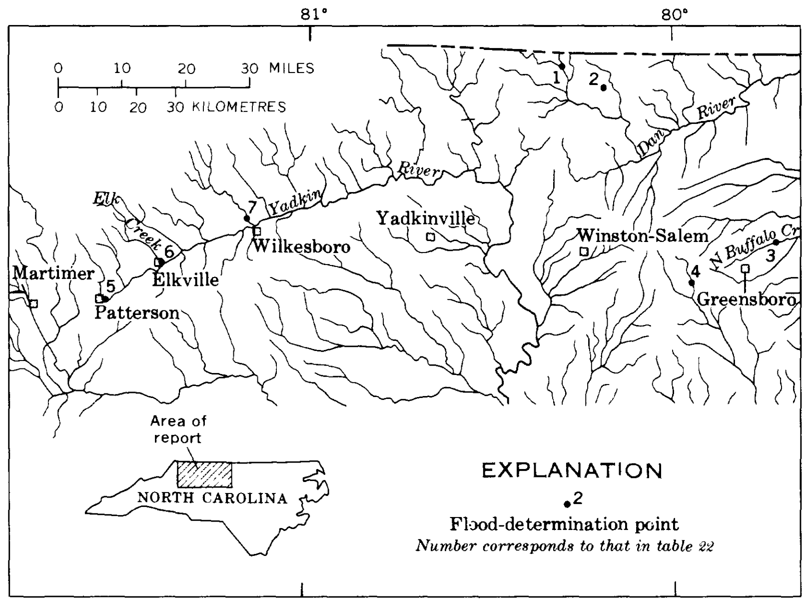


FIGURE 29.—Location of flood-determination points, flood of June 15-16 in North Carolina.

TABLE 22.—*Flood stages and discharges, June 15–16 in North Carolina*

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before June 1969 — Period of known floods	Known before June 1969 — Year	June 1969	Gage height (feet)	Discharge — Cfs	Discharge — Recurrence interval (yrs)
	Roanoke River basin							
1	02068500, Dan River near Francisco	124	1916,	1916		15	([1])	---
			1924–69	1937		12.45	12,400	17
					June 16	8.73	6,760	7
2	02686600, Little Snow Creek near Lawsonville	5.4	1954–69	1962		23.52	2,000	21
					June 16	21.96	955	5
	Cape Fear River basin							
3	02095500, North Buffalo Creek near Greensboro	37.0	1928–69	1947		15.96	6,000	23
					June 16	16.63	6,600	30
4	02099000, East Fork Deep River near High Point	14.7	1928–69	1947		10.87	6,300	24
					June 15	9.91	4,770	14
	Yadkin-Pee Dee River basin							
5	02111000, Yadkin River at Patterson	29.0	1939–69	1940		12.70	16,200	[2]2.5
					June 15	6.60	3,370	25
6	02111180, Elk Creek at Elkville	50.9	1940,	1940		22	70,000	[2]6.0
			1965–69	1966		7.28	6,560	14
					June 15	8.33	8,660	25
7	02111500, Reddies River at North Wilkesboro	93.9	1939–69	1940		22.02	27,000	[2]1.8
					June 15	9.08	3,770	3

[1] Unknown.
[2] Ratio of peak discharge to that of a 50-year flood.

TABLE 23.—*Rainfall, in inches, at National Weather Service stations June–July in northeastern Iowa, listed in downstream order*

No.	Station	June 22-30	June total	July 6-9	July 15-18	July total
	Turkey River basin					
1	Waucoma	6.97	10.09	1.21	----	3.37
	Maquoketa River basin					
2	Delaware 3 WSW	3.80	10.65	2.95	3.69	9.45
3	Cascade	6.13	12.60	3.35	.40	6.28
	Wapsipinicon River basin					
4	New Hampton	8.71	12.60	1.37	3.14	6.07
5	Tripoli	5.59	8.10	2.49	.55	4.65
6	Oelwein 2 SE	2.25	6.99	2.89	1.57	6.94
7	Independence 2 SW	1.96	5.59	3.87	1.97	7.02
8	Anamosa 1 NW	7.31	13.55	2.63	.97	8.62
	Iowa River basin					
9	Brit	7.09	8.78	2.86	.17	4.92
10	Iowa Falls 1 W	4.43	7.92	7.33	.86	10.36
11	Eldora	3.33	8.09	8.61	1.85	12.97
12	Marshalltown	2.62	6.78	3.57	.49	5.85
13	Toledo	3.78	10.01	3.66	1.94	9.50
14	Belle Plaine	3.32	9.15	1.94	1.27	6.47
15	Grinnell 3 SW	4.13	10.38	1.83	.78	4.08
16	Williamsburg	5.21	11.25	3.98	1.73	9.12
17	Iowa City	5.01	8.48	4.58	1.23	8.18
18	Osage	8.34	11.76	1.08	.38	5.62
19	Charles City	8.20	11.42	2.30	.22	4.71
20	Hampton 3 NNE	8.76	11.52	5.31	.84	8.12
21	Allison	7.37	9.48	4.35	1.00	9.07
22	Northwood	6.77	8.57	2.77	--	4.21
23	Forrest City	6.30	8.47	--	.04	--
24	Mason City 3 N	8.22	11.51	2.63	1.20	6.02
25	Grundy Center	3.12	7.51	6.14	4.88	12.79
26	Waterloo WB airport	2.07	4.82	4.93	2.91	8.90
27	Vinton	2.27	6.97	3.44	4.48	9.05
28	Cedar Rapids No. 1	5.56	12.02	2.74	4.18	9.41

FLOODS OF JUNE-JULY IN NORTHEASTERN IOWA

By A. J. HEINITZ

Three large storms in northeastern Iowa on June 22–30, July 6–9 and July 15–18 caused many flood peaks with discharges exceeding those of a 50-year flood. The total rainfall for some individual storms was nearly 9 inches.

Record June rainfalls were reported in some localities including Anamosa (13.55 inches), Cascade (12.60 inches), and New Hampton (12.60 inches). Record July rainfalls were reported at Eldora (12.97 inches) and Grundy Center (12.79 inches). Rainfall records from 28 National Weather Service stations in northeastern Iowa are listed in table 23; flood-determination points are shown in figure 30.

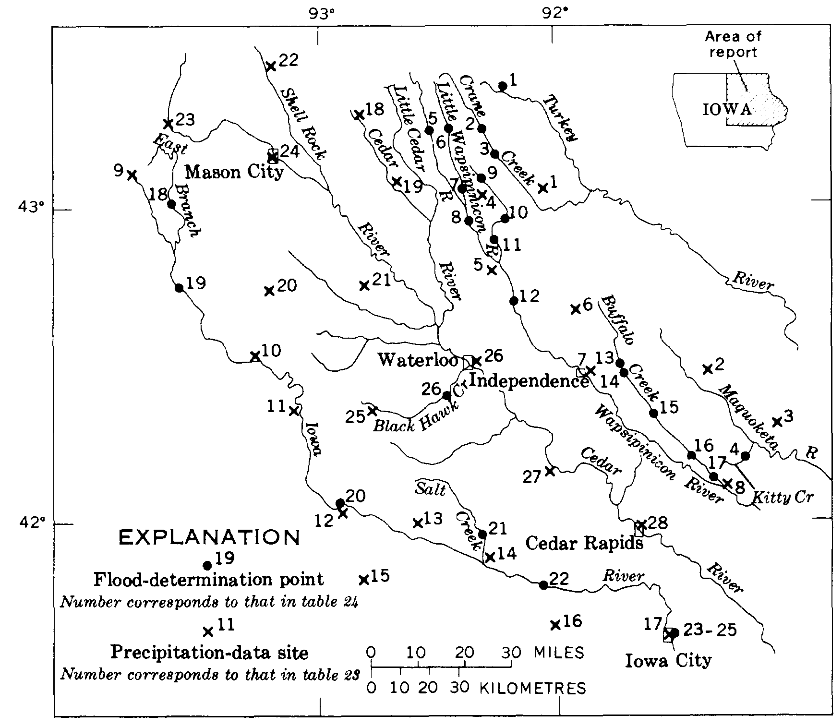


FIGURE 30.—Location of flood-determination points and precipitation-data sites, floods of June–July in northeastern Iowa.

Large floods occurred on the East Branch Wapsipinicon River on June 27. The peak discharge of 11,000 cfs from 30.3 square miles on the East Branch Wapsipinicon River near New Hampton was 3.7 times that of the 50-year flood (table 24).

The peak discharges on Buffalo Creek, July 18–19 ranged from 1.6 to 1.7 times those of a 50-year flood. The peak discharge of 17,500 cfs from 219 square miles on Buffalo Creek near Anamosa was 1.6 times that of a 50-year flood. Considerable damage was done to bridges and roads along this creek.

Record stages occurred at Marshalltown and Marengo gaging stations. The July 9 stage of 19.10 was 1.36 feet above the record stage of 1918, and the peak discharge of 31,900 cfs on the Iowa River at Marshalltown was 1.2 times the 50-year flood. Records have been collected at this station intermittently for 51 years since 1903. Protective dikes were overtopped in Marshalltown and Marengo, which caused flooding of many homes in low lying areas. State Highway 14 was under water and closed to traffic during the crest of the flood. Many homes in other towns in the

TABLE 24.—*Flood stages and discharges, June–July in northeastern Iowa*

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before June 1969: Period of known floods	Known before June 1969: Year	June, July 1969	Gage height (feet)	Discharge: Cfs [1]	Discharge: Recurrence interval (yrs)
	Turkey River basin							
1	05411530, North Branch Turkey River near Cresco	19.5	1969		June 29	92.72	4,400	>50
2	05411650, Crane Creek tributary near Saratoga	4.06	1953–69	1962		6.32	1,830	---
					June 29	6.29	1,530	[2] 1.1
3	05411700, Crane Creek near Lourdes	75.8	1953–69	1962		15.70	11,900	---
					June 29	14.10	8,840	[2] 1.2
	Maquoketa River basin							
4	05417590, Kitty Creek near Langworthy	14.4			July 19	90.24	3,700	([3])
	Wapsipinicon River basin							
5	05420560, Wapsipinicon River near Elma	95.2	1959–69	1962		14.84	5,700	---
					June 29	14.53	5,500	[2] 1.1
6	05420640, Little Wapsipinicon River at Elma	37.3	1953–69	1962		12.53	5,740	---
					June 26	12.48	5,700	[2] 1.9
7	05420650, Little Wapsipinicon River near New Hampton	95.0	1966–69	1966		[4] 1,077.47	2,250	---
					June 27	[4] 1,079.04	9,200	[2] 1.6
8	Wapsipinicon River Near Fredericksburg	296	1969		June 30	[4] 1,043.71	20,000	[2] 1.8
9	05420690, East Branch Wapsipinicon River near New Hampton	30.3	1966–69	1966		[4] 1,131.35	4,350	---
					June 27	[4] 1,134.92	11,000	[2] 3.7
10	East Branch Wapsipinicon River at Fredericksburg	83.5	1966–69	1966		[4] 1,062.59	7,800	---
					June 27	[4] 1,063.74	11,600	[2] 2.4
11	East Branch Wapsipinicon River near Fredericksburg	123	1966–69	1966		[4] 1,027.68	8,240	---
					June 27	[4] 1,028.61	11,700	[2] 1.8
12	Wapsinicon River near Readlyn	535	1969		July 1	[4] 961.82	17,800	[2] 1.1

See footnotes at end of table.

TABLE 24.—*Flood stages and discharges, June–July in northeastern Iowa*—Continued

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before June 1969: Period of known floods	Known before June 1969: Year	June, July 1969	Gage height (feet)	Discharge: Cfs [1]	Discharge: Recurrence interval (yrs)
	Wapsipinicon River basin—Continued							
13	05421550, Buffalo Creek above Winthrop	68.2	1957–69	1968		19.36	14,100	---
					July 18	18.74	8,800	[2] 1.7
14	05421600, Buffalo Creek near Winthrop	71.4	1953–55					
			1966–69	1968		91.38	14,800	---
					July 18	90.36	8,800	[2] 1.7
15	Buffalo Creek near Robinson	133	1969		July 18	[4] 919.96	11,800	[2] 1.6
16	Buffalo Creek near Central City	185	1968–69	1968		[4] 848.58	4,000	---
					July 18	[4] 856.25	15,500	[2] 1.6
17	Buffalo Creek near Anamosa	219	1969		July 19	[4] 803.43	17,500	[2] 1.6
	Iowa River basin							
18	East Branch Iowa River near Klemme	133	1944, 1948–69	1954		11.2	5,960	---
					June 29	9.87	2,770	[2] 1.6
19	05449500, Iowa River near Rowan	429	1941–69	1954		14.88	8,460	---
					July 1	12.36	4,250	39
20	05451500, Iowa River at Marshalltown	1,546	1903 1915–27, 1929–30, 1933–69	1918		17.74	42,000	---
					July 9	19.37	-----	---
					July 9	19.10	31,900	[2] 1.2
21	0545200, Salt Creek near Elberon	201	1944	1944		19.9	30,000	---
			1946–69	1947		17.6	35,000	---
					July 18	17.78	12,500	25
22	05453100, Iowa River at Marengo, Iowa	2,794	1957–69	1960		19.21	30,800	---
					July 12	19.79	28,300	10
23	05453750, Rapid Creek southwest of Morse	15.2	1951–69	1965		29.42	4,260	---
					July 8	27.59	2,220	31
24	05453950, Rapid Creek tributary near Iowa City	3.43	1951–69	1956		24.35	1,850	---
					July 8	25.83	1,080	32

See footnotes at end of table.

TABLE 24.—*Flood stages and discharges, June--July in northeastern Iowa*—Continued

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before June 1969: Period of known floods	Known before June 1969: Year	June, July 1969	Gage height (feet)	Discharge: Cfs [1]	Discharge: Recurrence interval (yrs)
	Iowa River basin—Continued							
25	05454000, Rapid Creek near Iowa City	25.3	1938–69	1965		14.10	6,100	---
					July 8	13.10	4,100	[2] 1.3
26	05463500, Black Hawk Creek at Hudson	303	1952–69	1960		16.93	9,000	---
					July 9	18.23	19,300	[2] 1.4

[1] Computed using Iowa Highway Research Board Bulletin No. 28.
[2] Ratio of peak discharge to that of a 50-year flood.
[3] Not determined.
[4] Elevation, in feet, above mean sea level (1929 adjustment).

vicinity of Marshalltown were flooded. On Iowa River at Marengo the record stage of 19.79 feet July 12 was 0.58 of a foot above the previous high set in 1960, and the peak discharge on July 12 was 28,300 cfs. At Marengo the recurrence interval for this flood was only 10 years, but much flooding occurred in the vicinity.

Intense local rainstorms following general antecedent rains caused high discharges in the Iowa City area. The July 8 discharge of 4,100 cfs from 25.3 square miles on Rapid Creek near Iowa City was the highest peak since 1965 and was 1.3 times that of a 50-year flood. Along the Iowa River, large releases on July 8 from the Coralville Reservoir, which was filled to record capacity, resulted in severe flooding and crop damage on the flood plain downstream fom Iowa City.

Record monthly mean discharges for the month of July occurred on nearly all northeastern Iowa streams.

FLOODS OF JUNE 23 IN MACON AND SUMNER COUNTIES, TENNESSEE

By CHARLES R. GAMBLE

Torrential rains fell over parts of Macon and Sumner Counties during the early morning hours of June 23, causing major flooding and considerable property damage.

Unofficial reports estimated rainfall totals to be in excess of 9 inches and possibly as much as 10 inches over a part of the Salt Lick Creek basin near Red Boiling Springs (fig. 31). The recordng rain gage nearest to the center of the storm area is

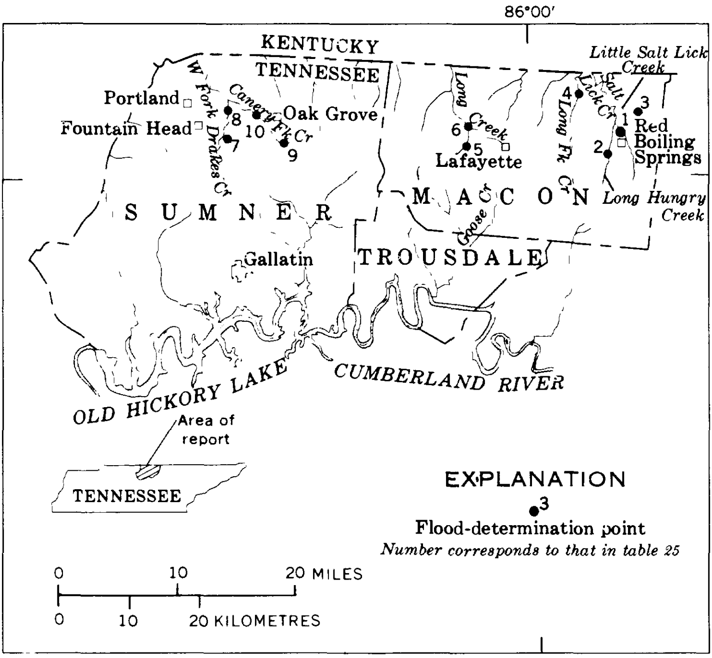


FIGURE 31.—Location of flood-determination points, floods of June 23 in Macon and Sumner Counties, Tenn.

located about 6 miles northeast of the post office in Portland. At this gage, a total of 8.5 inches of rainfall was recorded in an 8-hour period, 5.2 inches of which fell in 2 hours (fig. 32). Both of these rainfall rates have recurrence intervals longer than 100 years on the basis of U.S. Weather Bureau Technical Paper 40 (1961).

Most of the streams in the area are relatively small headwater streams of the Barren River basin where no streamflow records have been obtained. However, longtime residents reported that this was the greatest flood in their memories on many of the streams.

Indirect measurements of peak discharge were made at two short-term flood-hydrograph stations and eight miscellaneous sites (table 25). Maximum discharge rates occurred on Salt Lick Creek, which flows through the town of Red Boiling Springs, and Little Salt Lick Creek. Little Salt Lick Creek had a discharge of 2,340 cfs per sq mi from an area of 5.72 square miles, and Salt Lick Creek had a discharge of 1,370 cfs per sq mi from an area of 14.6 square miles .

Property damage in Red Boiling Springs was estimated to be

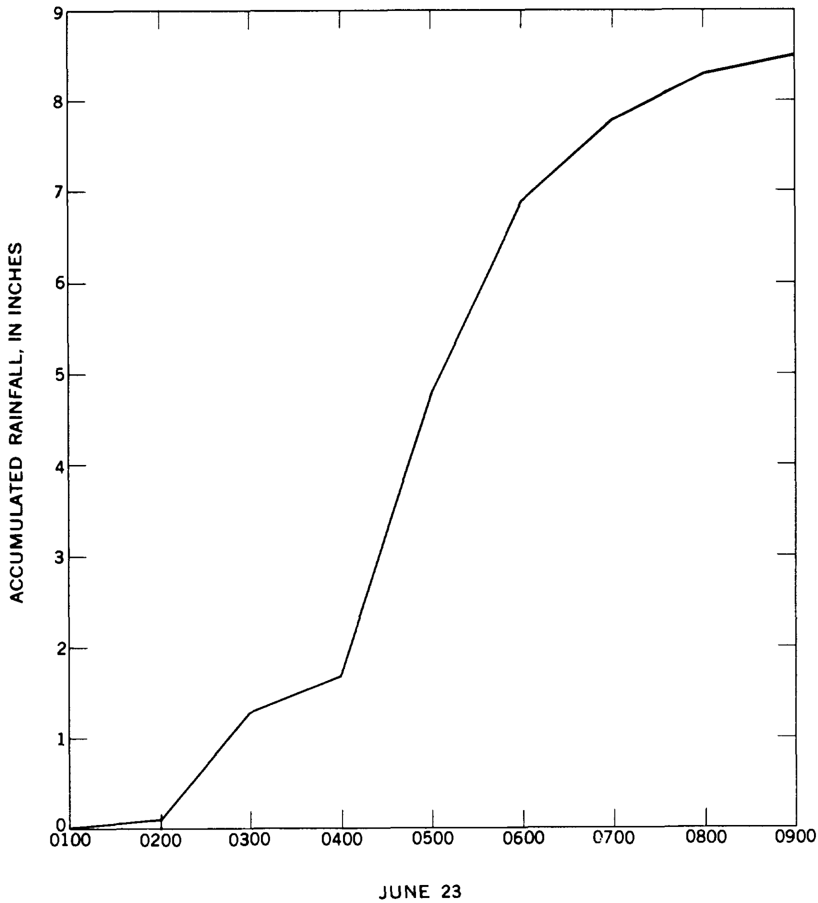


FIGURE 32.—Cumulative precipitation, June 23, near Portland, Tenn. Data from National Weather Service.

in excess of $2 million. Two small children were drowned. About 75 percent of the town was affected by the flood. Several homes were destroyed and many were damaged. Most businesses in the downtown area sustained damage. Many automobiles, trucks, utility trailers, lumber, and other debris were washed against buildings, lodged under bridges or strewn over the town. Much of the pavement on downtown streets was ripped up by the swift and turbulent waters. Throughout the flood area many roads and bridges were washed out, isolating families and blocking rural mail routes. In addition, corn and tobacco crops and vegetable gardens sustained considerable damage.

TABLE 25.—*Flood stages and discharges, June 23 in Macon and Sumner Counties, Tenn.*

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before June 1969: Period of known floods	Year	June 1969	Gage height (feet)	Discharge: Cfs	Recurrence interval (years)
	Green River basin							
1	Salt Lick Creek near Red Boiling Springs	14.6			June 23	----	20,000	(1)
2	Long Hungary Creek near Red Boiling Springs	7.25			June 23	----	6,490	(1)
3	Little Salt Lick Creek near Red Boiling Springs	5.72			June 23	----	13,400	(1)
4	Long Fork Creek near Lafayette	29.7			June 23	----	20,800	[2] 2.39
5	Long Creek near Lafayette	8.85			June 23	----	5,000	(1)
6	----do	17.2			June 23	----	6,890	(1)
7	03313600, West Fork Drakes Creek tributary near Fountain Head	.95	1967–69	1968	-----	4.18	----	---
					June 23	9.28	524	(1)
8	West Fork Drakes Creek near Portland	35.0			June 23	----	6,910	9
9	03313620, West Prong Caney Fork Creek near Oak Grove	3.03	1967–69	1967	-----	3.57	503	---
					June 23	3.76	692	(1)
10	Caney Fork Creek near Oak Grove	13.9			June 23	----	4,000	(1)

[1] Not determined.
[2] Ratio of peak discharge to that of a 50-year flood.

FLOODS OF JUNE 23–24 IN SOUTH-CENTRAL KENTUCKY

By CURTIS H. HANNUM

Heavy rains fell in south-central Kentucky during the night of June 22 and the morning of June 23, with most of the rainfall occurring in the early hours of June 23. Scottsville had a 6-hour total rainfall of 8.34 inches and a 12-hour total of 9.32 inches, and Bowling Green had 7.21 inches on June 23. The isohyets of figure 33 show the rainfall distribution.

Flood stages and discharges were much greater than those previously recorded at many sites. Peak discharges were as

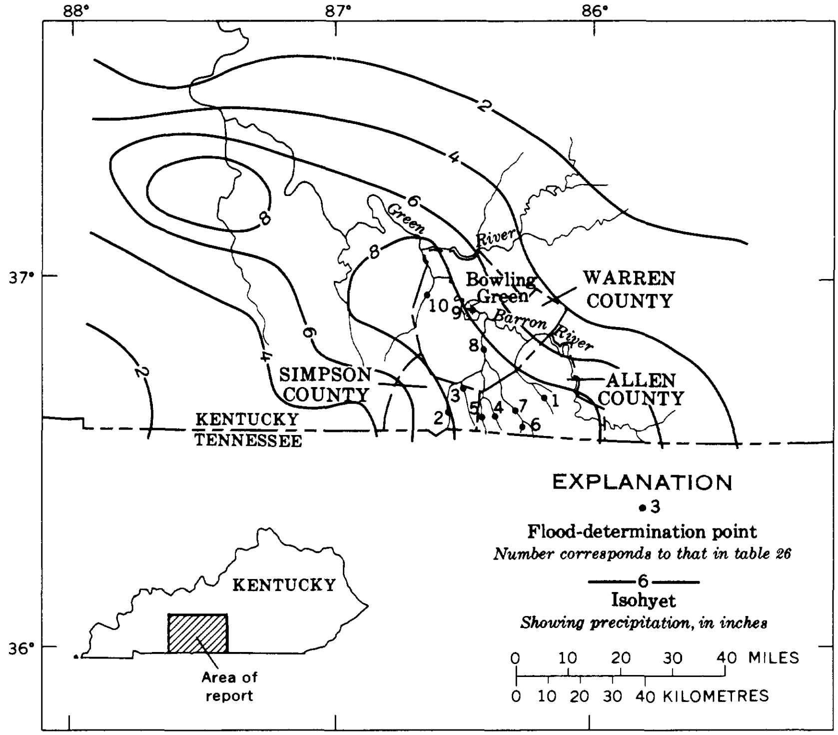


FIGURE 33.—Location of flood-determination points and isohyets for June 23–24, floods of June 23–24 in south-central Kentucky. Isohyets by U.S. Geological Survey; data by the National Weather Service.

much as five times those of a 50-year flood (table 26).

The floods washed out one railroad bridge, several highway bridges, and damaged highways, many homes, and buildings. The waterplant at Scottsville was damaged and out of operation for several days. Drinking water was trucked in from surrounding towns. The sewage plant at Franklin was out of operation for a day. Much top soil in cultivated fields was washed away, and about 50 percent of the crops were destroyed. Two residents of Petroleum lost their lives when their home was washed away by the Little Trammel Creek flood. Local officials in Allen County estimated total flood damages to be about $30 million. Flood damages in Simpson and Warren Counties were much less than that in Allen County because, except at Bowling Green, there was no urbanization in the intense flood area. Most of the damage in Simpson and Warren counties was to highways and cropland adjacent to Barren River and in Drakes Creek basin.

TABLE 26.—*Flood stages and discharges, June 23–24 in south-central Kentucky*

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before June 1969: Period of known floods	Year	June 1969	Gage height (feet)	Discharge: Cfs	Recurrence interval (years)
			Green River basin					
1	03313500, West Bays Fork at Scottsville	7.47	1950–69	1952		6.09	----	---
				1957		6.06	1,720	---
					June 23	8.34	7,050	([1])
2	03313700, West Fork Drakes Creek near Franklin	110	1969		June 23	17.33	9,930	3
3	03313800, Lick Creek near Franklin	21.1	1959–69	1962		6.83	3,650	---
					June 23	8.09	6,280	29
4	Middle Fork Drakes Creek at Alonzo	42.3	1969		June 23	[2]95.48	26,500	[3]2.4
5	Sulphur Fork near Hickory Flat	36.5	1969		June 23	[2]90.42	28,100	[3]2.8
6	Little Trammel Creek near Petroleum	25.9	1969		June 23	[2]98.12	40,000	[3]5.1
7	03313900, Trammel Creek near Scottsville	93.4	1969		June 23	[2]90.70	79,800	[3]4.3
8	03314000, Drakes Creek near Alvaton	478	1937					
		[4]358	1939–69	1962		33.8	49,500	---
					June 23	40.43	96,400	[3]2.1
9	03314500, Barren River at Bowling Green	1,848	1913,	1913		52.2	([1])	---
		[4]1,358	1938–69	1962		49.55	[5]85,000	---
					June 24	41.67	[5]59,000	([1])
10	Gasper River at Hadley	190			June 23	[2]90.35	36,200	[3]1.6

[1] Not determined.
[2] Arbitrary datum.
[3] Ratio of peak discharge to that of a 50-year flood.
[4] Drainage area contributing to flood flows.
[5] Affected by storage in Barren River Reservoir.

FLOOD OF JUNE 25–26 IN NORTHEASTERN NEBRASKA

By H. D. BRICE

Rain over northeastern Nebraska on four consecutive days, June 22–25, resulted in damaging floods in the basins of Beaver Creek, Shell Creek, Elkhorn River, and Logan Creek. Rainfall in excess of 3 inches fell at some places during the first 3 days prior to the rainstorm that began about midnight June 24 and continued until about 0430 hours June 25. National Weather Service records for the storm (beginning at midnight on the 24th) show 4.03 inches of rain at Norfolk, 3.15 inches at Oakdale, 3.66 inches at Albion, 3.45 inches at Meadow Grove, 3.25 inches at Laurel, and more than 2 inches at many other stations (totals for entire 4-day period shown in fig. 34). Unofficially, storm totals of 5 inches at Newman Grove and Hoskins and 4 inches at Battle Creek were reported. According to the U.S. Weather Bureau (1961) a 5-inch rainfall in 4½ hours has a recurrence interval of more than 100 years in this area of Nebraska.

The largest amount of rainfall occurred in Beaver Creek basin upstream from Albion. It caused severe flooding June 25 along the reach extending from near Albion to near St. Edwards. State Highway 39 was flooded between those two towns, and appreciable areas of pasture and cropland were inundated. The flood peak that reached the gaging station at Genoa on June 26

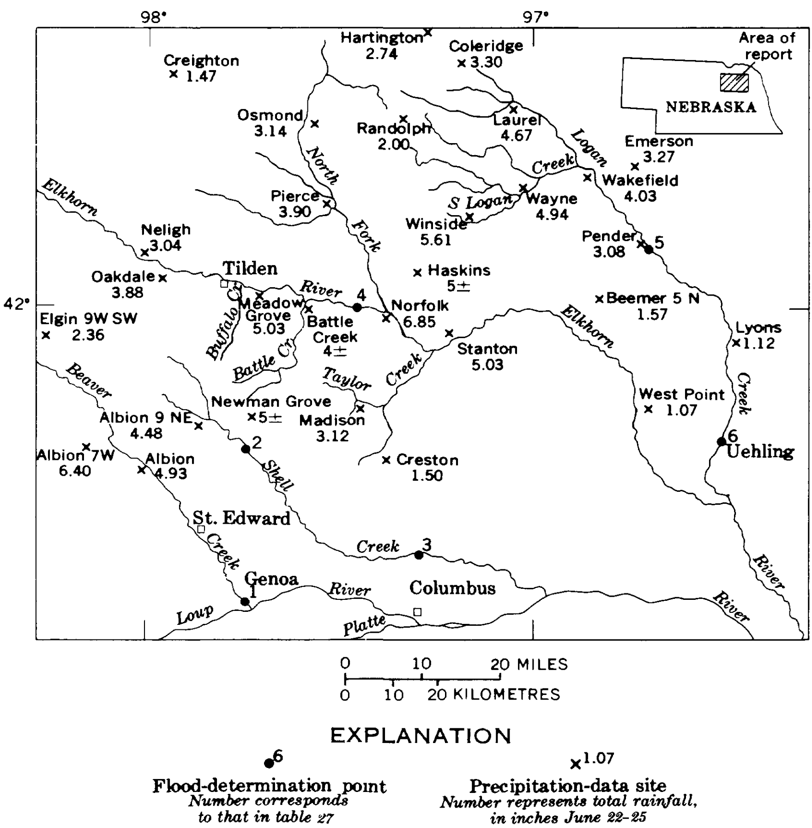


FIGURE 34.—Location of flood-determination points and precipitation-data sites, flood of June 25–26 in northeastern Nebraska.

was much less than the maximum of record but had a recurrence interval of 45 years (table 27). The peak discharge in the Albion-St. Edward reach on June 25 probably exceeded that of a 50-year flood.

Flooding also was severe in the upper reaches of Shell Creek near Newman Grove. The peak discharge of 8,000 cfs on Shell Creek at Newman Grove was less than the maximum of record, but it was 1.5 times that of a 50-year flood. The peak discharge of 2,460 cfs for the downstream station on Shell Creek near Columbus shows the attenuation in peak discharge between the Newman Grove station on June 25 and the downstream station near Columbus 2 days later. Valley storage in the form of cropland and pasture flooding caused this reduction in peak flow.

Flooding along the main stem of the Elkhorn River was most severe downstream from Neligh (fig. 34). At a site 4 miles south and 1 mile east of Tilden, about 5 inches of rain fell during

TABLE 27.—*Flood stages and discharges, June 25, 26 in northeastern Nebraska*

No.	Station number, steam, and place of determination	Drainage area (sq mi)	Maximum floods: Known before June 1969: Period of known floods	Known before June 1969: Year	June 1969	Gage height (feet)	Discharge: Cfs	Discharge: Recurrence interval (yrs)
	Platte River basin							
1	06794000, Beaver Creek at Genoa	627	1940–69	1950		[1]18.70	21,200	[2]2.1
		[3]410			June 26	17.22	9,270	45
2	06795000, Shell Creek at Newman Grove	122	1949–67, 1969	1966		21.20	14,500	[2]2.6
					June 25	20.37	8,000	[2]1.5
3	06795500, Shell Creek near Columbus	270	1947–69	1950		21.38	5,970	35
					June 27	20.13	2,460	15
4	06799000, Elkhorn River near Norfolk	2,790	1896–1903, 1945–69	1967		8.52	16,900	15
		[3]1,790			June 25	8.22	16,300	14
5	06799450, Logan Creek at Pender	731	1965–69	1967		22.08	22,100	[2]1.2
					June 25	20.14	18,300	50
6	06799500, Logan Creek near Uehling	1,030	1941–69	1962		20.15	19,400	40
					June 26	16.93	11,900	14

[1] Site and datum then in use.
[2] Ratio of peak discharge to that of a 50-year flood.
[3] Contributing drainage area.

the June 25 storm and resulted in overflow of ungaged Elkhorn River tributaries such as Buffalo Creek and Battle Creek. Rural roads were flooded at stream crossings to depths above the fenceposts. Three bridges over Battle Creek were washed out, and the new stream channel at the bend near the northeast corner of the town of Battle Creek was severly scoured. The June 25 peak discharge of 16,300 cfs on the Elkhorn River near Norfolk was 96 percent of the maximum for the 24-year period of record, but the recurrence interval for this discharge was only 14 years.

Local flooding occurred along Corporation Gulch in the city of Norfolk as a result of excessive rainfall June 22 and again June 25. On June 25, a debris jam at the Highway 81 bridge over the stream channel caused flooding of the highway and several adjacent properties.

Along North Fork Elkhorn River, floods occurred upstream from Norfolk, but the recently constructed bypass channel routed floodflows around the city and prevented serious flooding along the original channel through the city. The situation June 25 compared to that on May 12, 1944, was described in the June 26 edition of the Norfolk Daily News as follows: "With conditions remarkedly similar to those preceding the city's most damaging flood of May 12, 1944, officials were unanimous in believing that the North Fork River flood-control bypass channel northeast of Norfolk saved the city from a disaster which could have exceeded that of 1944. * * * In 1969, the Corps of Engineers, U.S. Army, estimated that the flood of 1944 caused $4,338,000 in damage to Norfolk property." Flood-stage and discharge data are not obtained on either the old North Fork channel through the city or the new bypass channel.

Local citizens residing near Winside reported that on June 25, South Logan Creek was the highest in their memories. Downstream the flood peak of 18,300 cfs on Logan Creek at Pender occurred at a stage that was about 2 feet lower than the 1967 flood peak (table 27). Flood-frequency data show a recurrence interval of 95 years for the 1967 peak (the peak discharge was 1.2 times that of the 50-year flood) and 50 years for the peak of June 25, 1969. Flooding continued along the lower reaches of Elkhorn River and Logan Creek. The flood-crest discharge on Logan Creek near Uehling decreased to 11,800 cfs on June 26 from 18,300 cfs at Pender on June 25, with a reduction in recurrence interval to 14 years. Flood damage affected low-lying farmland and rural roads primarily and was not extensive.

FLOODS OF JUNE 29–30 IN SOUTHWESTERN WISCONSIN

By DONALD C. HURTGEN

Heavy rainfall in southwest Wisconsin on June 29 caused excessive flooding throughout Lafayette County. This was preceded by large amounts that fell locally on the 22d, 25th, and 26th. Consequently the soil was very wet and streamflows were above normal when the intense 4-hour storm of continuous heavy rainfall struck Lafayette County about 1830 hours June 29. A tornado touched down north of Shullsburg just prior to this storm. Darlington received 6.35 inches of precipitation in the 4-hour period, which was the greatest single rain ever reported there. Unofficial data obtained by the Corps of Engineers, U.S. Army, indicated that an area west of Darlington received 7 inches and that most of Lafayette County received in excess of 4 inches precipitation (fig. 35).

The Pecatonica River rose so rapidly that in spite of the efforts of the businessmen and residents of Darlington to move merchandise and other property to higher ground, they were unable to complete the work before the floodwaters arrived. A stage of 19.23 feet, with a peak discharge of 17,200 cfs, was reached at 0030 hours June 30 on the Pecatonica River at Darlington.

The flood was the second highest on record and was 1.5 feet below the peak of July 16, 1950. Pecatonica River at Martintown, Galena River at Buncombe, and Pat's Creek near Elk Grove exceeded previous peaks of record. Runoff per square mile on many small streams was very high, some exceeding 1,000 cfs per sq mi and one exceeding 2,000 cfs per sq mi (table 28).

Flood damage was estimated by county authorities to be several million dollars. Fourteen bridges, including State, county, and township, were destroyed and many others were damaged. Repair costs to State highway bridges alone were $134,000, and county and township bridge repair costs more than double that total. Roads were washed out, trees uprooted, barns and powerlines blown down, and more than 42,000 acres of land were flooded. Sixty percent of the flooded area was planted in corn. Federal disaster funds of $375,000 were received by the county. No lives were lost.

An isohyetal map of total rainfall prepared from unofficial data obtained by the Corps of Engineers, U.S. Army, Rock Island, Ill., is shown in figure 35.

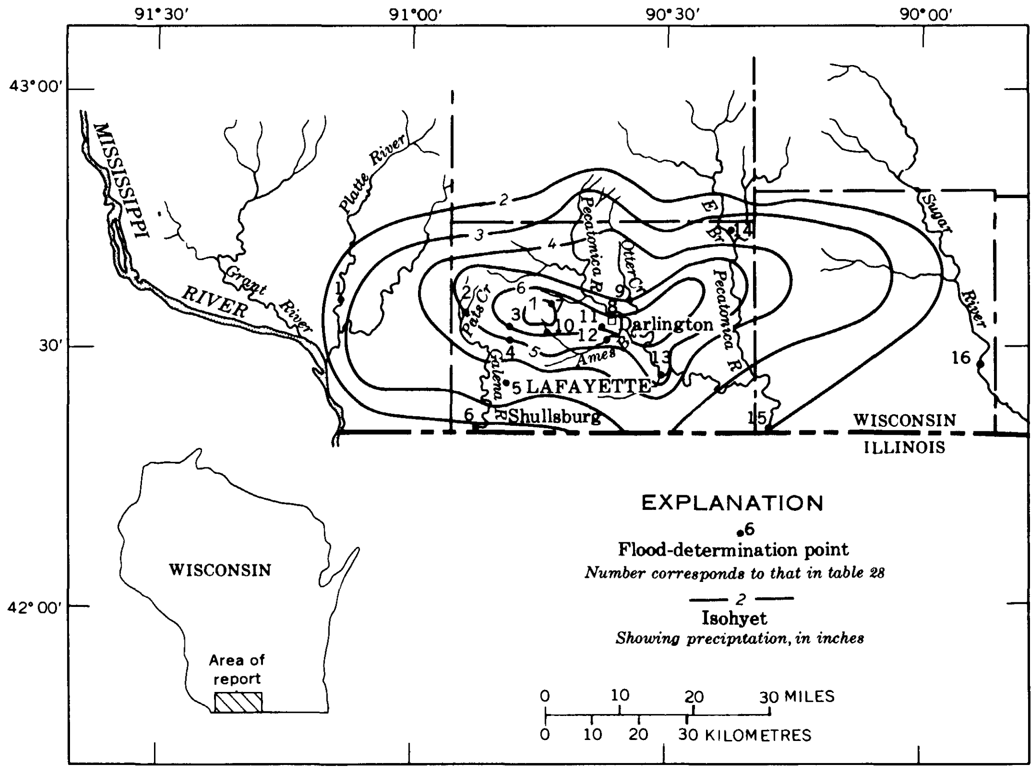


FIGURE 35.—Location of flood-determination points and isohyets for June 29–30, floods of June 29 to July 1, in southwestern Wisconsin. Isohyets by U.S. Geological Survey; data from Corps of Engineers, U.S. Army.

TABLE 28.—*Flood stages and discharges, June 29–30 in southwestern Wisconsin*

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before June 1969: Period of known floods	Maximum floods: Known before June 1969: Year	Maximum floods: June July 1969	Maximum floods: Gage height (feet)	Maximum floods: Discharge: Cfs	Maximum floods: Discharge: Recurrence interval (yrs)
	Platte River basin							
1	05414000, Platte River near Rockville	139	1934–69	1950		17.26	43,500	[1] 2.1
					June 29	10.70	4,980	<2.3
	Galena River basin							
2	05414900, Pats Creek near Elk Grove	8.49	1960–69	1967		15.24	1,680	2.5
					June 29	17.32	7,040	[1] 1.4
3	05414918, Madden Branch tributary near Belmont	6.49			June 29	----	6,260	---
4	05414922, Madden Branch tributary near Lead Mine	4.51			June 29	----	6,220	---
5	05414970, Shullsburg Branch near Lead Mine	31.2			June 29	----	9,270	---
6	05415000, Galena River at Buncombe	128	1939–69	1937		17.1	18,000	32
					June 29	19.57	29,700	[1] 1.4
	Rock River basin							
7	05432450, Wood Branch tributary near Calamine	1.97			June 29	----	3,100	---
8	05432500, Pecatonica River at Darlington	274	1939–69	1950		20.71	22,000	[1] 1.7
					June 30	19.23	17,200	[1] 1.3
9	05432525, Otter Creek near Darlington	49.2			June 29	----	19,200	---
10	05432535, North Fork Ames Branch near Shullsburg	5.27			June 29	----	7,160	---
11	05432540, Ames Branch near Darlington	33.7			June 29	----	28,700	---
12	05432545, Ames Branch tributary near Darlington	5.83			June 29	----	11,700	---
13	05432620, Pecatonica River near Gratiot	[2] 450			June 30	----	20,700	---
14	05433000, East Branch Pecatonica River near Blanchardville	221	1939–69	1948		15.74	11,700	[1] 1.8
					June 30	12.14	2,280	<2.3

See footnotes at end of table.

TABLE 28.—*Flood stages and discrarges, June 29-30 in southwestern Wisconsin*—Continued

No.	Station number, steam, and place of determination	Drainage area (sq mi)	Maximum floods: Known before June 1969: Period of known floods	Known before June 1969: Year	June July 1969	Gage height (feet)	Discharge: Cfs	Discharge: Recurrence interval (yrs)
	Rock River basin—Continued							
15	05434500, Pecatonica River at Martintown	1,040	1939–69	1959	-----	20.23	14,200	21
					July 1	21.29	15,100	27
16	05436500, Sugar River near Broadhead	527	1914–69	1915	-----	11.4	14,800	[1] 1.3
					June 30	7.21	2,980	---

[1] Ratio of peak discharge to that of a 50-year flood.
[2] Approximately.

FLOODS OF JULY 4–8 IN NORTH-CENTRAL OHIO

By EARL E. WEBBER and RONALD I. MAYO

Record floods occurred at many places in north-central Ohio due to intense rainstorms July 4–5. The most intense precipitation occurred between 7:00 p.m. on the 4th and 7:00 a.m. on the 5th, and was accompanied by wind gusts up to 100 mph (miles per hour) as the storm moved east-southeast over north-central Ohio. Following the first storm, a zone of atmospheric instability that was almost stationary for nearly 8 hours caused numerous thunderstorms over an area extending approximately 30 miles either side of a line from Toledo to Dennison. The cumulative precipitation for two representative sites that depicts the intensity of the first storm is shown in figure 36. The storm subsided by noon on July 5 and as much as 14.8 inches of rainfall was reported. Isohyets that show the extent of the storms that produced amounts of 4 to more than 12 inches of precipitation on an area of more than 6,000 square miles, and the location of the flood determination points are shown in figure 37.

The isohyets shown are based on records for National Weather Service stations supplemented by more than 400 determinations of rainfall from a bucket survey made by the Ohio Department of Natural Resources, Division of Water.

Runoff from the heavy rains exceeded the capacity of drainage systems and resulted in rapid and severe inundation of much of the area. Data listed in table 29 give the results of determinations of flood-peak stage and discharge for 55 sites in the affected area.

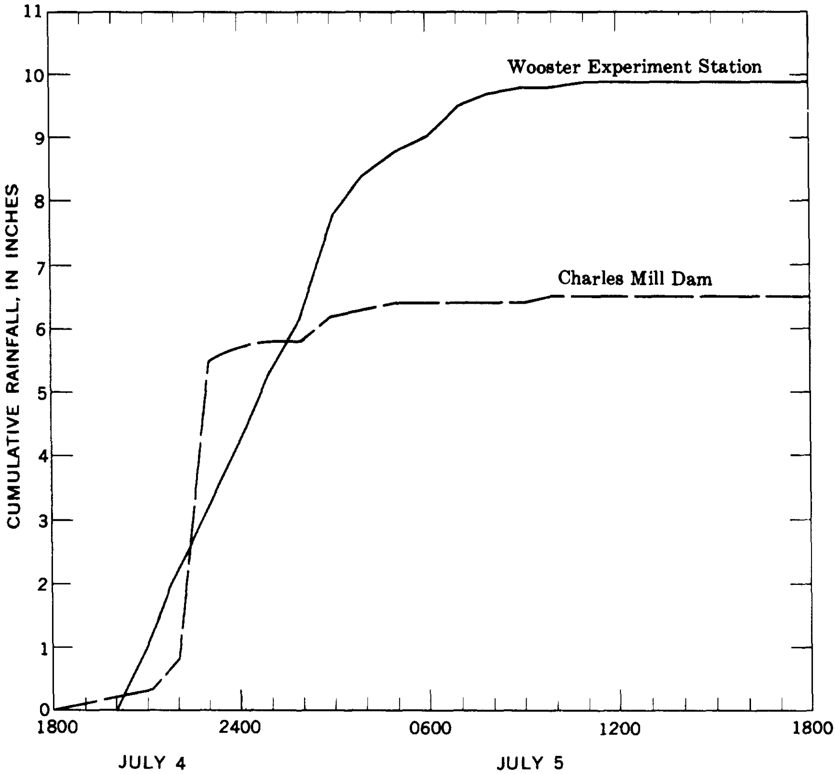


FIGURE 36.—Cumulative precipitation, July 4–5, at selected recording stations in north-central Ohio.

Locations of the sites are shown on the map in figure 37. The severity of the 1969 flood is apparent from table 29, by comparing the 1969 flood with the maximum flood during the periods of record and with the 50-year flood for unregulated sites. Black River at Elyria and Jerome Fork at Jeromesville experienced discharges that were more than double the previously known peak discharges during 25- and 44-year periods. Figure 38 illustrates the severity and the rare expectancy of the 1969 flood by graphically comparing the peak discharge with the corresponding 50-year flood discharge for 40 unregulated sites in the flood area. A quarter of the sites experienced discharges that were more than triple the 50-year flood.

Streams tributary to Lake Erie that experienced the most severe flooding were the Huron, Vermilion, and Black Rivers. In the community of Monroeville, on the West Branch Huron River, many

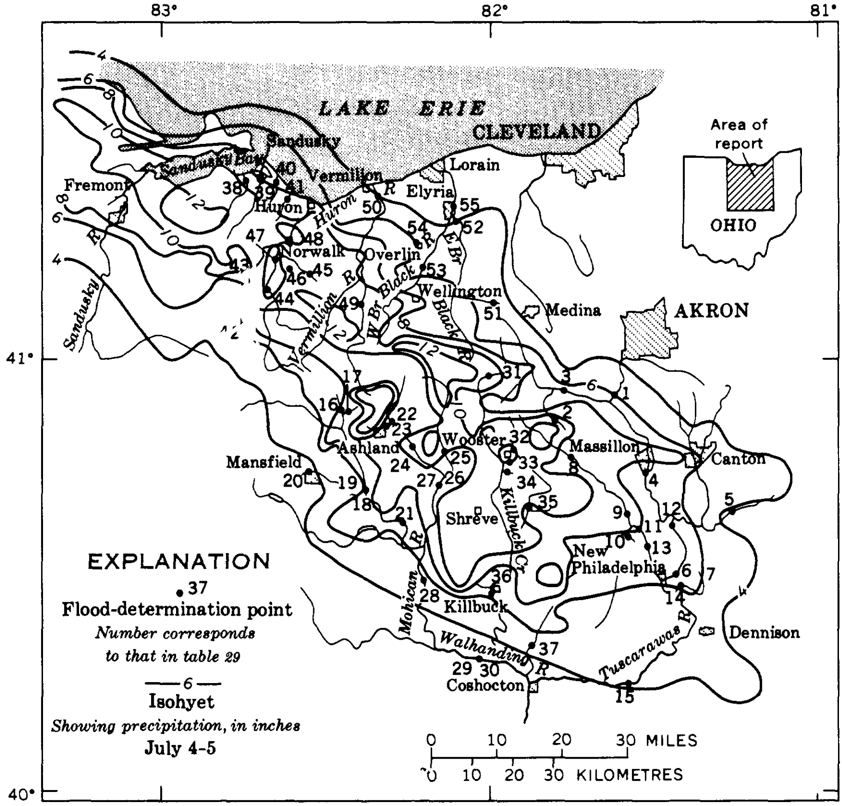


FIGURE 37.—Location of flood-determination points and isohyets for July 4–5, floods of July 4–8, in north-central Ohio. Isohyets by Ohio Department of Natural Resources, Division of Water.

streets lay under 4 feet of water for 3 days. The dam at the lower water-supply reservoir for the city of Norwalk was breached about 9:30 a.m. on July 5, releasing millions of gallons of water into the downtown area.

Norwalk Creek flowed several hundred feet wide, cutting off the city and eliminating traffic on all major north and south arteries.

The flood of March 1913 was the largest known on the Vermilion River near Vermilion prior to the 1969 flood. Thus the 1969 flood is the maximum known since the early 1900's. It exceeded the previous maximum observed stage, that was due to an extensive ice jam in March 1963, by 1.3 feet.

Information by the Corps of Engineers, U.S. Army (1970) indicates that the 1969 flood was the largest known along the Black

River. Other major floods on Black River, in decreasing order of magnitude, occurred in March 1913, January 1959, May 1956, February 1959, and June 1937. The 1969 stages were about 5 feet higher along the main stem and about 3 feet higher along the East Branch and West Branch than those of the 1959 flood at most locations.

Several streams in the headwater area of the Muskingum River also experienced record-breaking floods (table 36). Extremely heavy rain fell on Killbuck Creek in Wayne County. The unit discharge for Apple Creek at Wooster (station 49), a tributary to Killbuck Creek, was 545 cfs per sq mi. The crest at Killbuck (station 52) was 4.63 feet higher than the maximum observed in the previous 39 years, and it inundated about 95 percent of the village.

The greater part of the rainfall in the Muskingum River basin occurred upstream from the system of 15 flood-control reservoirs. The rainfall distribution was such that the Mohicanville and Beach City reservoirs were in the area of maximum runoff and they were utilized to capacity. The water level came within 8 inches of spillway elevation at Mohicanville Reservoir and within 3 inches at Beach City Reservoir. The Corps of Engineers, U.S. Army, reported that "since a major part of the rainfall occurred upstream

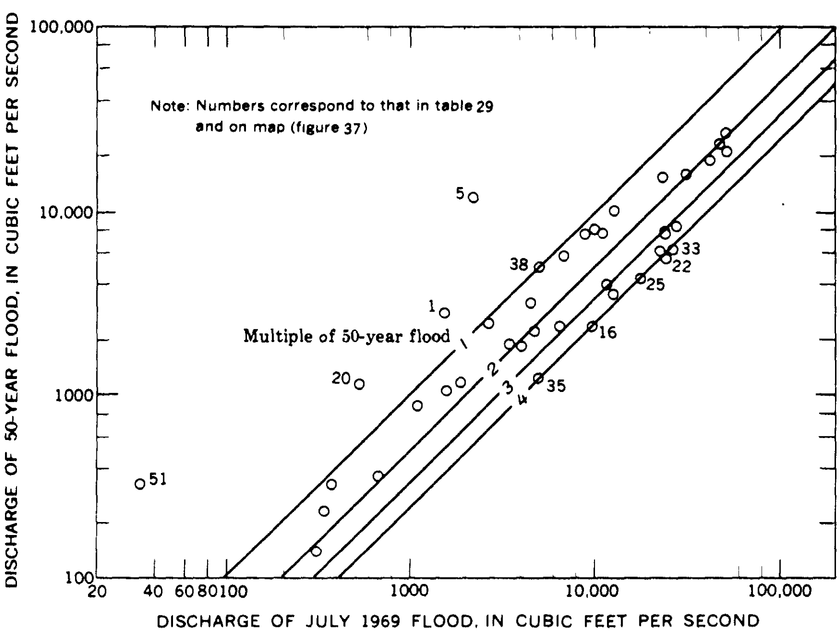


FIGURE 38.—Relation of peak discharge of July floods with corresponding 50-year flood discharges at selected sites in north-central Ohio.

TABLE 29.—*Flood stages and discharges, July 4–8 in north-central Ohio*

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before June 1969: Period of known floods	Known before June 1969: Year	July 1969	Gage height (feet)	Discharge: Cfs	Discharge: Recurrence interval (yrs)
	Muskingum River basin							
1	03116000, Tuscarawas River at Clinton	174	1913	1913		22.2	---	---
			1927–69	1935		14.82	2,700	---
					July 6–7	17.00	1,500	---
2	03116100, Little Chippewa Creek near Smithville	16.4	1947–69	1959		14.30	1,800	---
					July 5	17.17	3,930	[1] 2.1
3	03116200, Chippewa Creek at Easton	146	1959–69	1959		14.17	10,100	---
					July 5	16.02	12,500	[1] 1.2
4	03117000, Tuscarawas River at Massilon	518	1938–69	1959		13.46	7,220	---
					July 5	16.43	10,700	[1] 1.4
5	03117500, Sandy Creek at Waynesburg	253	1939–69	1959		10.05	15,000	---
					July 6	5.30	2,180	---
6	03122000, Dover Reservoir near Dover	1,404	1939–69	1947		902.68	[2] 92,890	---
					July 12	905.00	[2] 109,000	---
7	03122500, Tuscarawas River below Dover Dam near Dover	1,405	1913,	1913		23.5	62,000	---
			1924–69	1937		15.51	26,400	---
					July 15	8.10	7,130	---
8	Sugar Creek near Dalton	52.5	1969		July 5	----	12,300	[1] 3.4
9	03123000, Sugar Creek above Beach City Dam at Beach City	160	1945–69	1959		20.04	[3] 7,960	---
					July 5	[4] 23.76	10,000	[1] 1.2
10	03123400, Dundee Creek at Dundee	.71	1966–69	1967		21.03	72	---
					July 5	30.18	340	[1] 1.4
11	03123500, Beach City Reservoir near Beach City	300	1939–69	1959		973.24	[2] 53,520	---
					July 6	976.25	[2] 70,120	---
12	03124000, Sugar Creek below Beach City Dam near Beach City	300	1939–69	1939		9.53	7,500	---
					July 6	11.26	7,520	---

See footnotes at end of table.

TABLE 29.—*Flood stages and discharges, July 4–8 in north-central Ohio*—Continued

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before June 1969: Period of known floods	Known before June 1969: Year	July 1969	Gage height (feet)	Discharge: Cfs	Discharge: Recurrence interval (yrs)
	Muskingum River basin—Continued							
13	03124500, Sugar Creek at Strasburg	311	1932–33, 1935–39, 1962–69	1935		14.70	19,700	---
					July 7	9.40	7,700	---
14	03125000, Home Creek near New Philadelphia	1.64	1937–69	1961		4.45	299	---
					July 7	5.77	378	[1]1.2
15	03129000, Tuscarawas River at Newcomerstown	2,443	1913, 1922–69	1913		21.5	83,000	---
				1937		20.65	46,800	---
					July 8	9.43	12,100	---
16	Whetstone Creek at Olivesburg	11.8	1969		July 5	----	9,610	[1]4.0
17	03129300, Whetstone Creek tributary near Olivesburg	.24	1950–69	1956		5.71	155	---
					July 5	8.25	310	[1]2.2
18	03129500, Charles Mill Reservoir near Mifflin	215	1939–69	1959		1,013.53	[2]53,780	---
					July 10	1,010.86	[2]42,450	---
19	03130000, Black Fork below Charles Mill Dam near Mifflin	217	1913, 1939–69	1913		----	11,700	---
				1963		8.45	2,800	---
					July 5	6.39	1,810	---
20	03130500, Touby run at Mansfield	5.44	1947–69	1947		4.17	965	---
					July 5	2.73	527	---
21	03131500, Black Fork at Loudonville	349	1932–69	1959		13.65	7,780	---
					July 5	14.11	8,460	---
22	Jerome Fork at Ashland	38.3	1969		July 5	----	23,700	[1]4.2
23	Town Run at Ashland	6.86		1913		15.1	----	---
				1959		13.9	[5]13,000	---
			1969		July 5	----	3,400	[1]1.8
24	03134000, Jerome Fork at Jeromesville	120	1913, 1926–49, 1959, 1962–64, 1966–69		July 5	17.5	[1]27,000	[1]3.2

See footnotes at end of table.

TABLE 29.—*Flood stages and discharges, July 4–8 in north-central Ohio*—Continued

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before June 1969: Period of known floods	Known before June 1969: Year	July 1969	Gage height (feet)	Discharge: Cfs	Discharge: Recurrence interval (yrs)
	Muskingum River basin—Continued							
25	Muddy Fork near West Salem	30.3	1969		July 5	----	17,500	[1]4.1
26	03134500, Mohicanville Reservoir near Mohicanville	271	1939–69	1947		957.60	[2]59,820	---
					July 7	962.35	[2]96,340	---
27	03135000, Lake Fork below Mohicanville Dam near Mohicanville	271	1939–69	1939		9.34	3,920	---
					July 5	14.32	5,490	---
28	03136000, Mohican River at Greer	948	1913,	1913		27.0	[5]55,000	---
			1922–69	1935		13.63	17,700	---
					July 5	14.59	20,500	---
29	03138000, Mohawk Reservoir near Nellie	1,504	1939–69	1959		873.94	[2]176,100	---
					July 14	868.50	[2]146,000	---
30	03138500, Walhounding River below Mohawk Dam at Nellie	1,505	1913, 1922–69	1937		18.8	24,000	---
					Aug. 1	11.80	8,000	---
31	Killbuck Creek at Burbank	42.4	1969		July 5	----	6,810	[1]1.2
32	Little Apple Creek at Wooster	10.9	1969		July 5	----	6,260	[1]2.6
33	Apple Creek at Wooster	48.3	1969		July 5	----	26,300	[1]4.2
34	03138900, Jennings Ditch tributary near Wooster	.90	1946, 1966–69	1946		29.0	1,880	---
					July 5	27.67	670	[1]1.8
35	North Branch Salt Creek at Fredericksburg	10.9	1946	1946		----	4,000	---
			1969		July 5	----	4,910	[1]4.0
36	03139000, Killbuck Creek at Killbuck	462	1931–69	1935		21.77	28,800	---
					July 5	26.40	47,500	[1]2.0
37	03140000, Mill Creek near Coshocton	27.2	1937–69	1957		12.73	7,650	---
					July 5	13.92	8,720	[1]1.1

See footnotes at end of table.

TABLE 29.—*Flood stages and discharges, July 4–8 in north-central Ohio*—Continued

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before June 1969: Period of known floods	Known before June 1969: Year	July 1969	Gage height (feet)	Discharge: Cfs	Discharge: Recurrence interval (yrs)
	Streams tributary to Lake Erie							
38	Mills Creek at State Highway 387, Sandusky	40.5	1966	1966	-----	----	3,650	---
			1969		July 5	----	4,940	48
39	Pipe Creek at State Highway 2, Sandusky	20.3	1966	1966	-----	----	2,360	---
			1969		July 5	----	4,500	[1] 1.4
40	Plum Brook at U.S. Highway 250, Bogart	3.46	1966	1966	-----	----	727	---
			1969		July 5	----	1,100	[1] 1.3
41	Sawmill Creek near Huron	13.5	1969		July 5	----	4,610	[1] 2.1
42	West Branch Huron River tributary at Holiday Lake near Willard	13.8	1969		July 5	----	2,630	[1] 1.1
43	West Branch Huron River at Monroeville	218	1969		July 5	----	30,800	[1] 1.9
44	East Branch Huron River at Peru	29.2	1969		July 5	----	11,400	[1] 2.8
45	04198100, Norwalk Creek near Norwalk	4.92	1947–69	1956	-----	14.37	1,060	---
					July 5	17.19	1,880	[1] 1.6
46	Norwalk Creek at Norwalk	10.1	1969		July 5	----	[5,6] 5,100	---
47	04198500, East Branch Huron River near Norwalk	85.5	1924–35,	1929	-----	9.5	4,700	---
			1959,	1959	-----	12.3	----	---
			1969		July 5	16.45	[5] 22,000	[1] 3.6
48	04199000, Huron River at Milan	371	1951–69	1959	-----	24.08	25,800	---
					July 5	31.1	49,600	[1] 1.8
49	Vermilion River at Fitchville	107	1969		July 5	----	23,400	[1] 3.0
50	04199500, Vermilion River near Vermilion	262	1951–69	1959	-----	13.80	20,500	---
					July 6	17.14	40,800	[1] 2.1
51	04199800 Neff Run near Litchfield	.76	1966–69	1969	-----	20.52	152	---
					July 5	18.27	34	---

See footnotes at end of table.

TABLE 29.—*Flood stages and discharges, July 4–8 in north-central Ohio*—Continued

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before June 1969: Period of known floods	Known before June 1969: Year	July 1969	Gage height (feet)	Discharge: Cfs	Discharge: Recurrence interval (yrs)
	Streams tributary to Lake Erie—Continued							
52	04200000, East Branch Black River at Elyria	217	1923–35	1933	-----	10.10	11,400	---
			--------	1959	-----	14.7	-----	---
			1959–69	----	July 5	17.5	23,100	[1] 1.5
53	West Branch Black River at Pittsfield	79.4	1969	-------	July 5	----	23,600	[1] 3.1
54	04200100, Plum Creek at Oberlin	4.83	1947–69	1959	-----	16.13	990	---
			-----------		July 5	17.70	1,560	[1] 1.5
55	04200500, Black River at Elyria	396	1945–69	1959	-----	22.9	24,000	---
			-----------		July 6	26.4	51,700	[1] 2.5

[1] Ratio of peak discharge to that of a 50-year flood.
[2] Maximum contents in acre-feet.
[3] Daily mean discharge.
[4] Maximum gage height July 6, 1969 (backwater from Beach City Reservoir).
[5] Estimated.
[6] Dam failure.

from the existing reservoir projects, the system was extremely effective in retaining runoff. Without the reservoirs flood damage would have been considerably increased."

The first thunderstorms moved over the Lake Erie shore when people were gathering at shoreline parks for 4th of July programs, and small-boat owners had anchored their crafts just offshore to observe the fireworks. Three lives were lost on the lake, and hundreds of boaters were caught by the storm. Thousands of trees were uprooted as the initial wind gusts moved onshore. In Toledo alone, city officials estimated that at least 250 of the 5,000 downed trees either fell onto houses or blocked streets.

In the entire flood area, 41 deaths were attributed to the storm, of which 25 persons were drowned, 8 killed by falling trees, 6 by electrocution from fallen wires, 1 by lightning, and 1 died from storm-related injuries. Estimates of damages resulting from the storm including wind and flood damages are summarized on the basis of data from the American Red Cross, U.S. Department of Agriculture, Corps of Engineers, U.S. Army, Civil Defense, and newspaper reports.

Type of property	*Damage*
Private property	$ 5,407,000
Crops and livestock	20,520,000
Boats	1,248,750
Cars	4,000,000
Public property and utilities	35,000,000
Total	$66,175,750

FLOODS OF JULY 19 AND 23 IN WILKINSON AND ADAMS COUNTIES, MISSISSIPPI

The northern part of Wilkinson County received extremely heavy rainfall on July 19 and again on July 23. More than 12 inches fell during the July 19 storm and more than 8 inches fell on the July 23 storm. The rainfall map (fig. 39) is based on rain gaged in the area and on a bucket survey made soon after the rains. Total rainfall of the two storms on a small area north of the

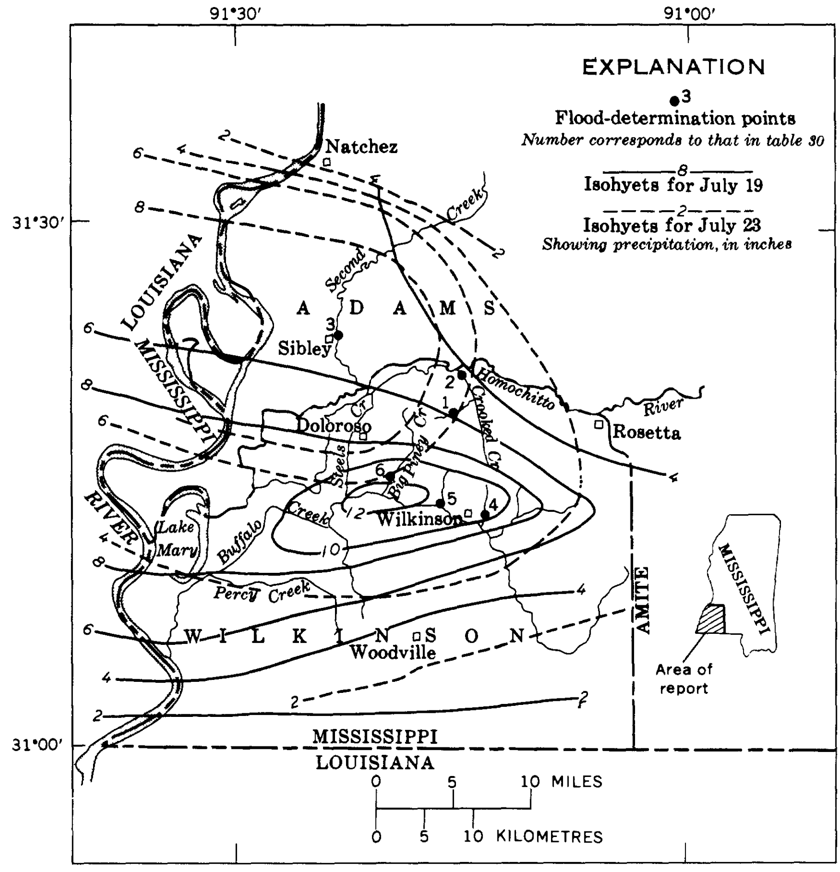


FIGURE 39.—Location of flood-determination points and isohyets, floods of July 19 and 23 in Wilkinson and Adams Counties, Miss. Isohyets by U.S. Geological Survey; data from the National Weather Service.

Buffalo River at U.S. Highway 61 was about 18 inches. Each of the storms had rainfall-intensity-duration-frequency intervals greater than 100 years, based on U.S. Weather Bureau Technical Paper No. 40 (1961).

Most of the rain on July 19 fell during the 12-hour period between 0200 and 1400 hours. The area with more than 10 inches of rainfall (fig. 39) had a 12-hour rain with a recurrence interval of well over 100 years. (Nine inches of rain in a 12-hour period in this area has a 100-year recurrence interval.) In the area of heaviest precipitation, the recurrence intervals of some rainfall intensities during short periods probably exceeded 100 years.

The July 23 storm moved into the area from the northwest, and most of the rain fell between 0945 and 1145 hours, according to reports of local residents. Radar pictures showed 7 hours of heavy cloud coverage, which suggests that the area of heaviest rainfall (fig. 39) received three-fourths of the 8-inch total in a 2-hour period. According to Technical Paper No. 40 of the U.S. Weather Bureau (1961), 6 inches of rain during a 2-hour period in this area is slightly more than a 100-year rainfall.

The most rainfall of the July 19 storm fell in an area (fig. 39) west of Wilkinson, Miss., which extended westward into Louisiana. The rainfall covered the lower half of the Buffalo River basin and the part of the Homochitto River basin downstream from U.S. Highway 61. Lake Mary, through which the Homochitto River flows, was reported to have risen about 3 feet.

Residents along the lower part of the Buffalo River reported that flooding was severe and crop damage heavy on July 19. Flooding was severe in the lower parts of Smith, Percy, Beaver, Little Beaver, Steels, and Big Piney Creeks. The flood plains of some of these creeks were inundated as much as 5 feet, but discharge data are not available.

On July 19, six or more streams overtopped the county road paralleling Buffalo River from U.S. Highway 61 to Wilkinson. On Browns Creek the recurrence interval of the peak discharge, 1,660 cfs, July 19 (stage 7.95 feet), from 1.05 square miles, was more than 50-years. East of Browns Creek on Silver Creek and Piney Creek flooding was not as great.

On July 23 severe flooding occurred on small streams in the vicinity of Doloroso (fig. 39). The Homochitto River was slightly higher on July 23 than on July 19, but the peak discharges were less than those of a mean-annual flood at Rosetta and Doloroso.

The flood of July 23 at Big Piney Creek at U.S. Highway 61 (table 30) was 1 or 2 feet higher than the July 19 flood and 1.5 feet higher than the April 1955 flood, which was the highest flood during the previous 30 years, according to Mr. and Mrs. Joe Davis, who live near the bridge. Many trees in and along the channel were destroyed.

Floods washed out the county highway bridge 1 mile above the mouth of Crooked Creek. Smaller basin streams also had greater than 50-year floods. Steels Creek washed out a bridge on a county road in the upper part of the basin.

TABLE 30.—*Flood stages and discharges, July 19, 23 in southwestern Mississippi*

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before July 1969: Period of known floods	Maximum floods: Known before July 1969: Year	Maximum floods: July 1969	Maximum floods: Gage height (feet)	Maximum floods: Discharge: Cfs	Maximum floods: Discharge: Recurrence interval (yrs)
	Homochitto River basin							
1	07293496, Duval Creek at County Highway, 6 miles east of Doloroso	2.81	--------	--------	July 23	99.90	3,800	[1] 50
2	07393498, Crooked Creek at bridge on County Highway, 7.4 miles northeast of Doloroso	21.8	--------	--------	July 23	45.65	14,000	[1] 50
3	07294000, Second Creek at County Highway 0.9 mile east of Sibley	[2] 53.9	1951–69	1953	------	114.77	22,500	---
			--------	--------	July 23	109.7	12,000	30
	Buffalo River basin							
4	07294930, Silver Creek at State Highway 563, 0.8 mile east of Wilkinson	4.15	--------	--------	July 19	146.10	2,680	25
5	07294940, Browns Creek at culvert on County Highway 2.3 miles west of Wilkinson	1.05	1955	1955	------	7.26	1,030	---
			--------	--------	July 19	7.95	1,660	50
6	07295050 Big Piney Creek at State Highway 61, 3.8 miles southwest of Doloroso	14.8	--------	--------	July 23	95.42	17,200	50

[1] About.
[2] Reservoir stores contribution from 32.1 sq mi of the 53.9 sq mi total drainage area (since 1966).

FLOODS OF JULY 20 AND 22 IN CENTRAL INDIANA

By R. E. HOGGATT

A series of thunderstorms that were locally intense in some areas caused severe flooding in central Indiana July 20 and 22.

More than 9 inches of rain fell at Greenwood in 10 hours on July 20. The highest intensities occurred from 0330 to 0430 hours and 0730 to 0830 hours.

Precipitation amounting to 7½ inches fell in 3½ hours during the morning of July 22, 3 miles south of Martinsville.

Although flood-frequency relations are only approximate for these small drainage areas, the peak discharges for all floods listed in table 31 and shown in figure 40 are greater than those for 50-year floods on the basis of a flood study by Green and Hoggatt (1960). Floods on both Pleasant Run and Jordans Creek were reported to have been the highest in at least 50 years.

The flood on Jordans Creek near Martinsville on July 22 had a peak discharge of 2,540 cfs from a 1.84 square mile drainage area. The peak runoff at this site, 1,380 cfs per sq mi, is one of the largest unit-runoff rates measured in Indiana.

The Greenwood area was severely affected by the July 20 floods. More than 200 residents in the vicinity were forced to leave their homes, 24 roads were closed, and several bridges damaged. Backwater at drainage structures increased the severity of the flood.

TABLE 31.—*Flood stages and discharges, July 20 and 22 in central Indiana*

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before July 1969: Period of known floods	Known before July 1969: Year	July 1969	Gage height (feet)	Discharge: Cfs	Discharge: Recurrence interval (yrs)
	Wabash River basin							
1	Pleasant Creek at U.S. Highway 31 at Greenwood	3.90	1969		July 20		1,300	[1]1.2
2	Pleasant Run at State Road 135 near Greenwood	14.2	1969		July 20		4,540	[1]1.5
3	Little Indian Creek at State Road 37 near Martinsville	10.1	1969		July 22		5,260	[1]1.0
4	Jordans Creek near Martinsville	1.84	1969		July 22		2,540	([2])

[1] Ratio of peak discharge to that of a 50-year flood.
[2] Not determined.

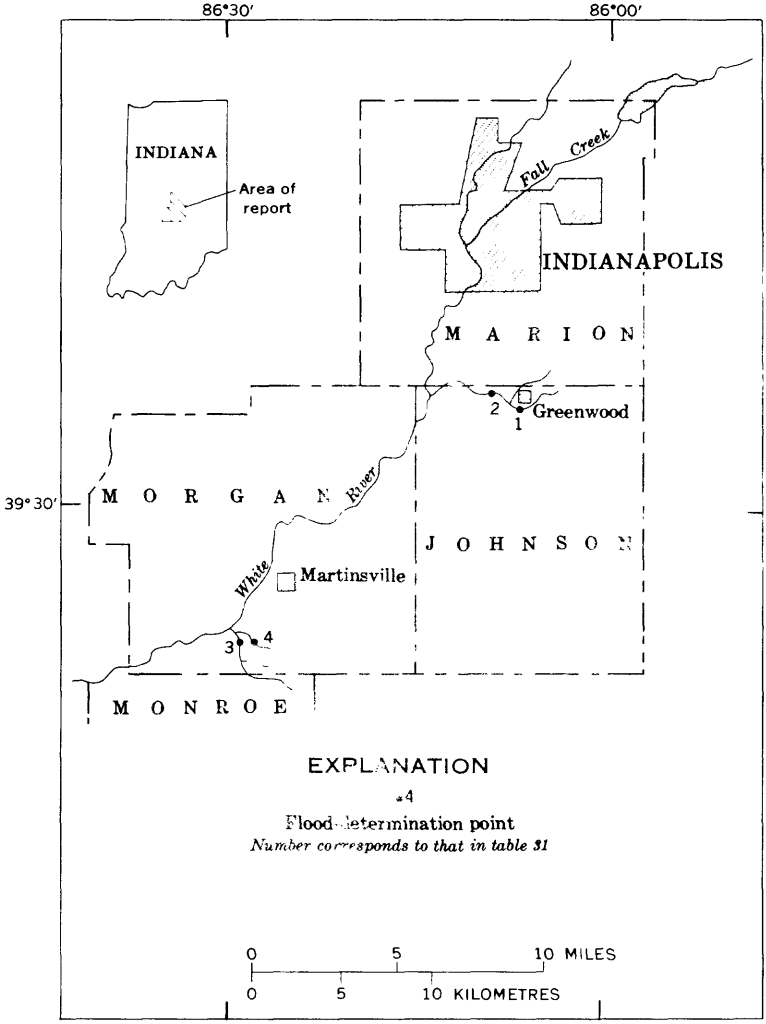


FIGURE 40.—Location of flood-determination points, floods of July 20, 22 in central Indiana.

In the Martinsville area the flood damage of July 22 was restricted mostly to roads and culverts, with State Road 37 being washed out by the Little Indian Creek flood, causing considerable traffic delay.

FLOODS OF JULY 22 AND 23 IN NORTHEASTERN VIRGINIA

After E. M. MILLER and E. P. KAPINOS (1970)

Heavy rainfall during a thunderstorm the night of July 22 produced record flooding in parts of the Washington, D.C., metropolitan area of northeastern Virginia. The floods occurred on an unusually highly developed urban area, and homes, apartments, and stores were damaged. A map of the flood area with flood-determination points is shown in figure 41.

The National Weather Service reported that at the Washington National Airport the rain began at 1905 hours, and by 2000 hours 3.06 inches had fallen. This is only 0.36 inches less than the record 1-hour rainfall of 3.42 inches established September 12, 1934. The July 22 recorded precipitations at this airport are compared with prior maximums as follows:

July 22	*Inches*	*Previous record*	*Inches*
15 minutes	1.53	July 30, 1913	1.51
30 do	2.53	Aug. 12, 1934	2.45
1 hour	3.42	Sept. 12, 1934	3.78
2 do	4.18	Aug. 4, 1939	3.91
3 do	4.35	Sept. 2, 1922	4.14

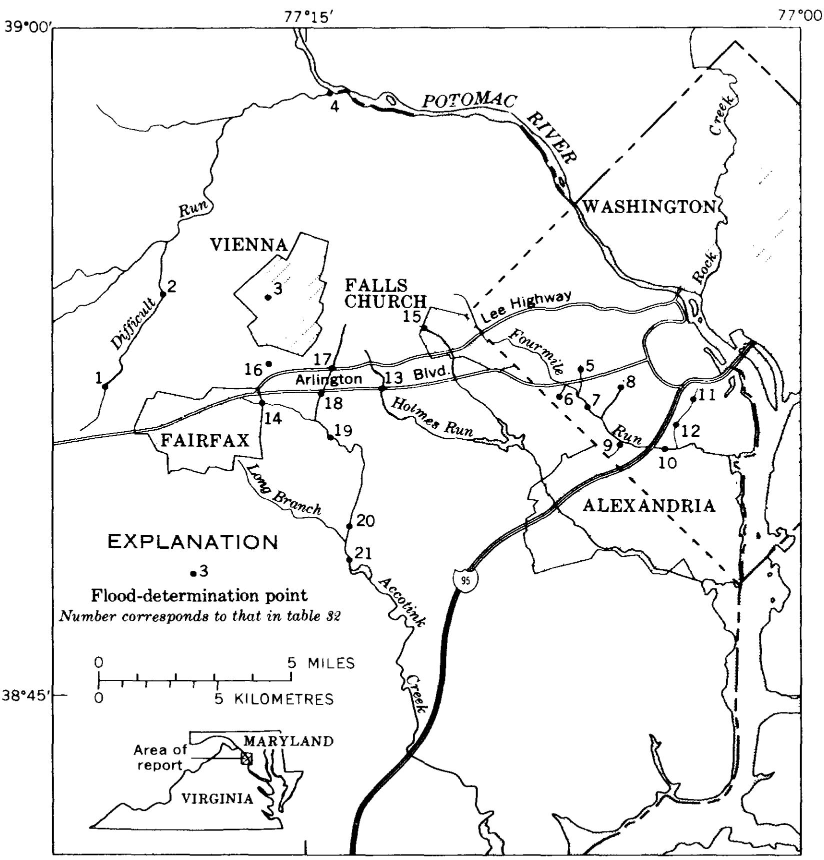


Figure 41.—Location of flood-determination points, floods of July 22 and 23 in northeastern Virginia.

By 2100 hours an estimated 7.4 inches of rain had fallen at Vienna, Va. That was the maximum amount observed for the storm.

Isohyets for the storm showing the total precipitation for the period beginning the evening of July 22 and ending the morning of July 23 are shown in figure 42.

At 10 of the 21 flood-measurement sites, new maximum peaks of record were established (table 32). The relation of peak discharge to drainage area for the July floods was large (fig. 43). Flood re-

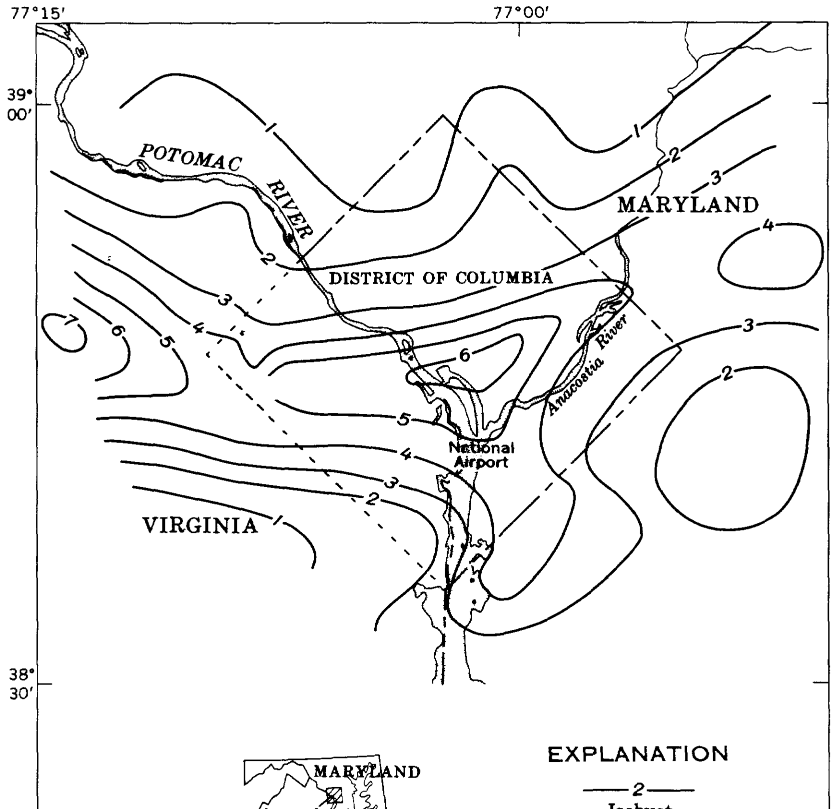


FIGURE 42.—Isohyets of total precipitation, in inches, July 22 and 23 in northeastern Virginia and southern Maryland. Data from the National Weather Service.

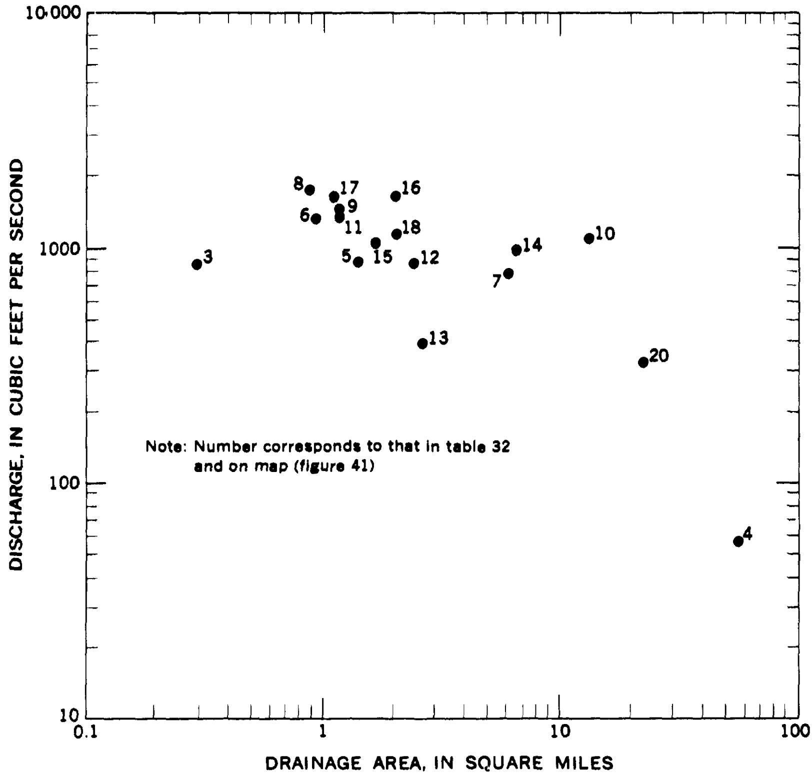


FIGURE 43.—Relation of peak discharges to drainage area, flood of July 22 and 23 in Virginia.

currence intervals at most sites in this and other urban areas have not been defined.

The peak discharge of 14,600 cfs from a 14.4 square mile drainage on Fourmile Run at Alexandria, Va., exceeded the record of 11,700 cfs established August 20, 1963. The peak had a recurrence interval of 75 years based on present urban development and a runoff rate of 1,010 cfs per sq mi.

Most flood damage occurred along Fourmile Run where hundreds of stores, homes, and apartment buildings were flooded. At the mouth of Fourmile Run, 100 new cars were swept downstream and destroyed. Estimates of the damage from the flood range from $3 million to $5 million.

TABLE 32.—*Flood stages and discharges, July 22 and 23 in northeastern Virginia*—Continued

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before July 1969, Period of known floods	Known before July 1969, Year	July 1969	Gage height (feet)	Discharge, Cfs	Discharge, Cfs per sq. mi [1]
	Potomac River basin							
1	01645700, Difficult Run near Fairfax	4.29	1950–69	1967		7.8	1,180	----
					July 22	8.7	----	----
2	01645725, Difficult Run near Vienna	10.4	1961–69	1967		6.46	----	----
					July 22	6.97	----	----
3	01645800, Piney Branch at Vienna	0.29	1963–69	1967		6.2	280	----
					July 22	5.9	250	862
4	01646000, Difficult Run near Great Falls	58	1935–69	1967		13.18	6,610	----
					July 23	10.97	3,360	58
5	01652380, Lubber Run at Arlington Blvd. at Arlington	1.51	1969		July 22	----	1,330	880
6	01652400, Long Branch at Arlington	.94	1961–69	1961		7.02	930	----
					July 22	26.9	1,280	1,360
7	01652420, Fourmile Run at Arlington	6.20	1969		July 22	----	4,800	774
8	01652430, Doctor's Run at Arlington	.90	1966–69	1967		3.81	460	----
					July 22	8.6	1,600	1,780
9	01652470, Lucky Run at Arlington	1.22	1966–69	1967		6.00	620	----
					July 22	9.5	1,900	1,560
10	01652500, Fourmile Run at Alexandria	14.4	1951–69	1963		9.89	11,700	----
					July 22	11.6	14,600	1,010
11	01652520, Long Branch tributary at Army Navy Drive at Arlington	1.27	1969	1968		----	1,050	----
					July 22	----	1,760	1,380
12	01652530, Long Branch at Arna Valley at Arlington	2.57	1969		July 22	----	2,200	856

See footnotes at end of table.

TABLE 32.—*Flood stages and discharges, July 22 and 23 in northeastern Virginia*—Continued

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before July 1969: Period of known floods	Year	July 1969	Gage height (feet)	Discharge: Cfs	Cfs per sq. mi [1]
	Potomac River basin—Continued							
13	01652600, Holmes Run at Merrifield	2.70	1960–69	1967		5.40	2,330	----
					July 22	5.9	1,130	418
14	01653900, Accotink Creek at Fairfax	6.80	1961–69	1967		8.98	3,900	----
					July 22	9.90	6,350	934
15	01653915, Accotink Creek tributary near Fairfax	1.77	1969	1967		----	1,320	----
					July 22	----	1,800	1,020
16	01653925, Bear Branch near Vienna	2.04	1961–69	1967		5.38	1,660	----
					July 22	6.9	3,500	1,720
17	01653950, Long Branch at Vienna	1.18	1964–69	1967		35.34	1,640	----
					July 22	38.3	2,000	1,690
18	01653960, Long Branch near Vienna	2.12	1969		July 22	----	2,460	1,160
19	01653975, Accotink Creek at Prosperity Avenue near Fairfax	14.9	1961–69	1967		8.07	----	----
					July 22	9.6	----	----
20	01654000, Accotink Creek at Annandale	23.6	1947–69	1967		11.84	7,870	----
					July 22	11.85	7,870	333
21	01654550, Accotink Creek at Springfield	30.5	1961–69	1967		9.48	----	----
					July 22	9.9	----	----

[1] Cubic feet per second per square mile.

and isohyets are shown on the flood-area map (fig. 44). The most intense part of the storm extended approximately on a north-south line across central Sullivan county, northwestern Ulster county, and into Delaware county.

The peak discharge of 15,700 cfs from about 63 square miles on Willowemoc Creek near Livingston Manor, was 1.5 times the previous 32-year peak of record, and the recurrence interval was about 200 years. The peak of 10,500 cfs from 40.8 square miles on Beaver Kill near Turnwood was 1.4 times the previous 12 year peak of record and had a recurrence interval of 100 years (table 34).

A hydrograph for the July 27–30 flood on Willowemoc Creek near Livingston Manor is shown in figure 45.

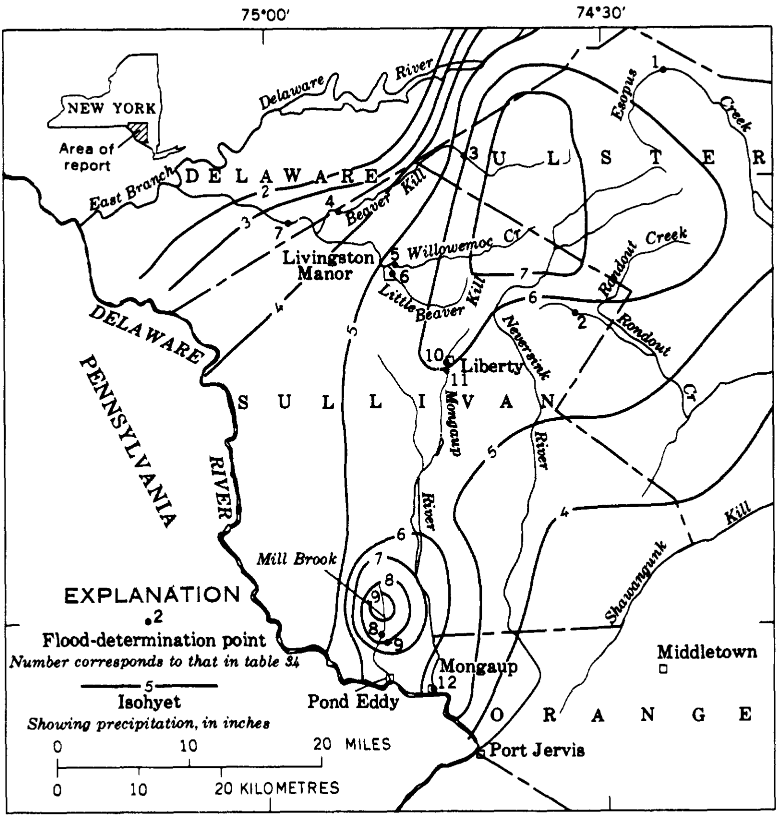


FIGURE 44.—Location of flood-determination points and isohyets for July 27–28 and floods of July 28–29 in southeastern New York. Isohyets by U.S. Geological Survey; data from the National Weather Service and New York City Board of Water Supply.

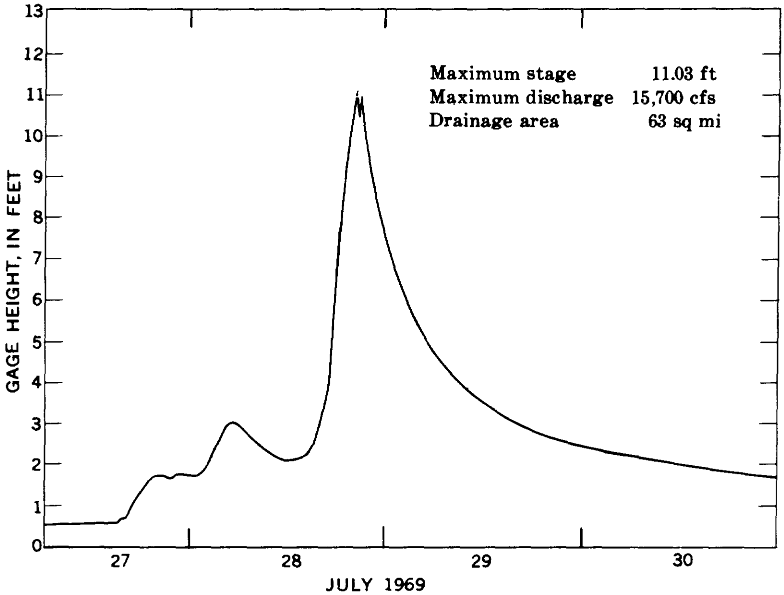


FIGURE 45.—Stage hydrograph of Willowemoc Creek near Livingston Manor, N.Y., July 27–30.

TABLE 33.—*Total rainfall July 27–29 in southeastern New York*

Location of rain gage	County	Rainfall, in inches
Cooks Falls	Delaware	3.40
Downsville	do	1.57
Fishs Eddy	do	1.87
Mary Smith	do	2.08
Middletown	Orange	3.58
Oakland Valley	do	4.11
Port Jervis	do	3.47
Barryville	Sullivan	4.55
Butternut Brook	do	7.84
Callicoon	do	4.35
Claryville	do	7.24
Craigie Clair	do	3.18
Forestburg	do	6.59
Lake Champion	do	9.20
Lewbeach	do	4.34
Liberty	do	6.11
Mongaup Valley	do	5.33
Neversink	do	5.92
Rock Hill	do	4.06
Ashokan	Ulster	5.56
Balsam Lake	do	7.85
Ellenville	do	5.56
Frost Valley	do	6.79
Phoenicia	do	5.01
(1)	----	

1 Rainfall, in inches, in Hawley, Pa.: 4.58.

TABLE 34.—*Flood stages and discharges, July 28 and 29 in southeastern New York*

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before July 1969: Period of known floods	Known before July 1969: Year	July 1969	Gage height (feet)	Discharge: Cfs	Discharge: Recurrence interval (yrs)
	Hudson River basin							
1	01362198, Esopus Creek at Shandaken	59.5	1963–69	1967		6.79	1,270	
					July 28	10.38	7,870	
2	01365500, Chestnut Creek at Grahamsvile	20.9	1938–69	1955		5.02	4,640	
					July 28	4.60	3,630	15
	Delaware River basin							
3	01418000, Beaver Kill near Turnwood	40.8	1948–59, 1969	1950		9.16	7,400	
					July 28	10.50	10,500	100
4	01418500, Beaver Kill at Craigie Clair	[1]82	1937–69	1942		10.74	10,300	
					July 28	10.00	8,300	15
5	01419500, Willowemoc Creek near Livingston Manor	[1]63	1937–69	1951		9.01	10,500	
					July 28	11.03	15,700	200
6	01420000, Little Beaver Kill near Livingston Manor	19.8	1924–69	1928		8.7	3,420	
					July 28	7.15	2,780	20
7	01420500, Beaver Kill at Cooks Falls	241	1913–69	1951		16.02	31,600	
					July 28	15.11	27,500	40
8	Mill Brook near Glen Spey	8.07	1969		July 28		1,120	
9	Mill Brook tributary near Glen Spey	5.38	1969		July 28		672	
10	Mongaup Brook at Liberty	1.23	1969		July 28		844	
11	Middle Mongaup River at Liberty	10.1	1969		July 28		2,710	50
12	01433500, Mongaup River near Mongaup	202	1939–69	1955			[2]12,300	
					July 29	10.10	6,870	

[1] Approximately.
[2] Maximum daily discharge.

Stage and discharge data for other floods in the area are shown in table 34. Recurrence intervals for all floods shown have not been determined. Additional streamflow and peak-discharge data are published in the U.S. Geological Survey annual basic data report for New York (1969).

Damage was mostly to homes, stores, highways, streets, and bridges. In Livingston Manor about 20 families were forced to evacuate their homes, and the new sewage treatment plant was damaged. Liberty, the largest community in the flood area, sustained $1 million damage to stores, secondary streets, and pavements. Several other communities were similarly affected, and damage to public facilities alone, such as highways, streets, and bridges was estimated at $1,380,000 by the State of New York.

FLOOD OF AUGUST 2 NEAR CENTRAL, ALABAMA

By J. F. McCain

During the evening hours of August 2, a severe thunderstorm produced outstanding flooding in two small basins in east-central Alabama (fig. 46). The most intensive rainfall occurred in the Paterson Creek basin northwest of Central. During the 4-hour

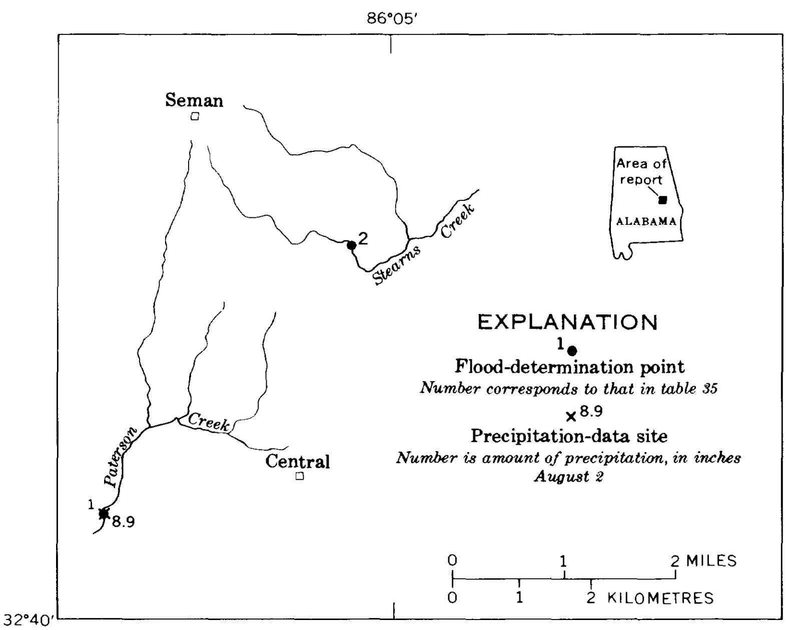


FIGURE 46.—Location of flood-determination points and precipitation-data sites, flood of August 2 near Central, Ala.

period from 1900 to 2300 hours, a total rainfall of 8.9 inches was recorded at the gaging station on Paterson Creek. Stearns Creek lies just northeast of Paterson Creek and the two basins have a common boundary near the headwaters. Thus, the rainfall record for Paterson Creek may be considered representative of rainfall for the Stearns Creek basin. Based on U.S. Weather Bureau Technical Paper No. 40 (1961), this rainfall event has a recurrence interval much greater than 100 years. The National Weather Service does not have a rainfall station in the area of heaviest rainfall. Rainfall amounts in the general vicinity of the flood area, as reported by the National Weather Service ranged from 1 to 3 inches except at two rain-gage sites located 15 to 2 miles southeast where more than 5 inches were reported. On Paterson Creek, the peak discharge of 4,310 cfs on August 2 was nearly twice the previous peak discharge of 2,250 cfs in 1961 during 16 years of record (table 35).

The unit discharge was 845 cfs per sq mi for Paterson Creek, and 528 cfs per sq mi for Stearns Creek. The fairly uniform rainfall produced a single peaked hydrograph for Paterson Creek, whereas the hydrograph for Stearns Creek probably consisted of a complex series of rises.

Property damage resulting from the flood was minor. Both basins are in a sparsely populated area and consist largely of pasture and timberland. Crop damage and soil erosion also were minor.

TABLE 35.—*Flood stages and discharges, August 2 near Central, Ala.*

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods					
			Known before August 1969		August 1969	Gage height (feet)	Discharge	
			Period of known floods	Year			Cfs	Recurrence interval (yrs)
			Mobile River basin					
1	02410000, Paterson Creek and Central	4.95	1953–69	1961		9.10	2,250	---
					Aug 2	10.10	4,310	---
2	02417400, Stearns Creek near Seman	1.28	1966–69	1969		6.14	530	---
					Aug 2	6.57	676	---

TIDAL FLOODS OF AUGUST 18 BY HURRICANE CAMILLE IN MISSISSIPPI-ALABAMA

By K. V. Wilson

Camille was the most intense hurricane of record to enter the United States mainland. According to the National Weather Service maximum winds were estimated to be at least 190 mph. Central atmospheric pressure observed by an Air Force reconnaissance plane was 26.61 inches of mercury. For the North Atlantic and Gulf this low pressure is second only to the 26.35 inches recorded in the Florida Keys during the 1935 Labor Day hurricane. The eye of the storm, 5 miles in diameter and traveling almost due north, passed over the Waveland-Bay St. Louis area. Hurricane force winds of more than 75 mph extended approximately 50 miles on either side of the eye. Maximum local precipitation during the hurricane was 10 inches, recorded at the Mississippi Test Facility, 18 miles northwest of Bay St. Louis. Insignificant flooding resulted from rainfall, but tidal inundation was devastating (figs. 47 and 48).

Flooding was the most severe in the Pass Christian-Long Beach area where tides reached elevations about 25 feet above mean sea level. In St. Louis Bay the maximum flood elevations were about 18 feet, and in Back Bay of Biloxi about 15 feet.

The tide crest of 15.5 feet at the Biloxi gage is estimated to have a recurrence interval of about 170 years, according to a statistical

FIGURE 47.—Typical damage: Biloxi beachfront home and seagoing boat virtually destroyed by floodtide. Photograph by U.S. Geological Survey.

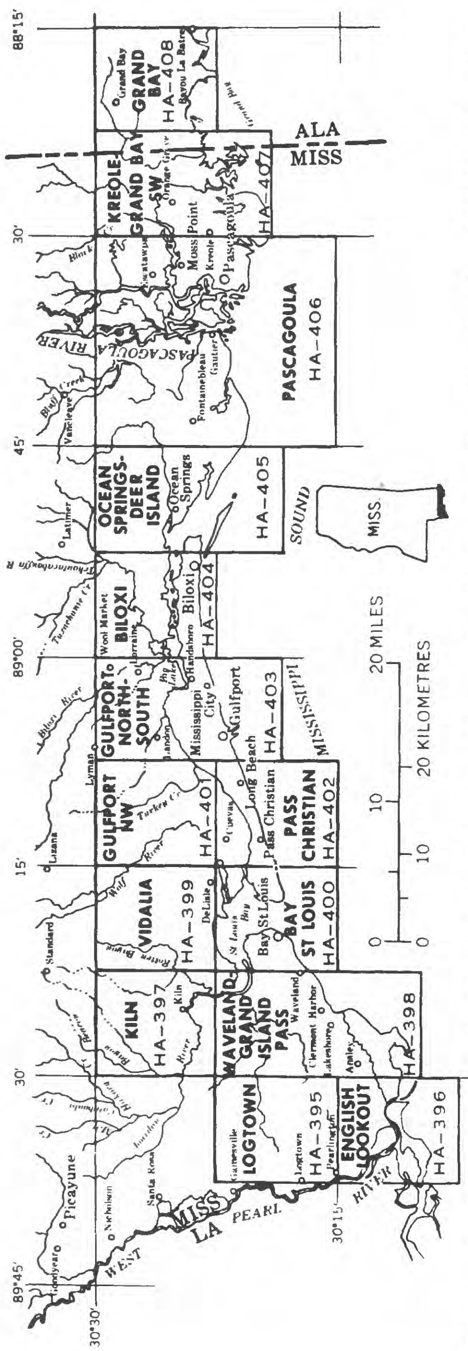


FIGURE 48.—Index map of the Mississippi-Alabama gulf coast showing location of quadrangles for which flood boundaries of Hurricane Camille, August 18, are delineated. Hydrolic Atlas numbers (HA) refer to maps by Wilson and Hudson (1969).

study of tide records from that gage for the period 1882–1969. Because of the dissipation of the tidal waves as they move into the bays and estuaries, the frequency data at the Biloxi gage are applicable only near the gage site.

Hurricane Camille inundated a land area of more than 320 square miles along the Mississippi-Alabama gulf coast. The flooded areas and numerous flood elevations were shown in color on 14 topographic maps by Wilson and Hudson (1969).

Other notable U.S. Government publications concerning Hurricane Camille are: "Hurricane Camille, August 1969," by Corps of Engineers, U.S. Army, Mobile, Ala., District (1970); "Hurricane Camille, August 1969," by Corps of Engineers, U.S. Army, New Orleans, La., District (1970); "Hurricane Camille," by U.S. Department of Commerce Environmental Science Services Administration (1969). These reports contain broad coverage of Camille with particular emphasis on the activities of the agency involved.

American Red Cross casualty figures listed 139 known dead and 76 missing in Mississippi; 5 known dead in Louisiana. The number of persons injured was estimated to be 8,931. The total damage caused by Hurricane Camille, as reported by the Office of Emergency Planning, was $1.3 billion; damage by Hurricane Betsy in 1965 was $400 million.

FLOODS OF AUGUST 20–23, 1970, IN CENTRAL VIRGINIA

After J. D. CAMP and E. M. MILLER (1970)

Record-breaking floods occurred as Hurricane Camille passed eastward over central Virginia on the night of August 19 and morning of August 20.

The floods, rain induced landslides, property damage, and deaths indicate that this hurricane was the worst natural disaster ever to strike Virginia (Camp and Miller, 1970).

The eye of the hurricane struck the coast just east of Bay St. Louis, Miss., with severely damaging wind gusts estimated to be at least 190 mph. Camille weakened as she moved inland on a curving path through Mississippi, Tennessee, Kentucky, and West Virginia during the 17th, 18th, and 19th of August.

The evening of August 19, Camille intensified rapidly as she passed eastward over the Appalachian Mountain ridge. By about 2200 hours August 19 the hurricane had merged with heavy showers and thunderstorms. This merger resulted in a very intense band of rain about 50 miles wide that extended from White Sulphur Springs, W. Va., to Fredericksburg, Va. In Nelson County, Va., the 27- to 28-inch rainfall in about 8 hours represents one of the record meteorological events in the United States, and it was more than triple the previous record Virginia rainfall of 8.4 inches in 12 hours at Big Meadows on the Skyline Drive during the 1942 hurricane, according to the National Weather Service (figs. 49 and 50).

Record floods occurred in the streams along Camille's path, many with recurrence intervals well in excess of 50 years and some in excess of 100 years. The flood at station 02028000, Tye River near Norwood, with a stage of 41.0 feet and a maximum discharge of 200,000 cfs August 20, from 360 square miles, had a discharge 5.5 times that of a 50-year flood and far exceeded the stream's previous peaks of 33,500 cfs in both 1942 and 1944. At station 02035000, James River at Cartersville, with a stage of 33.75 feet and a maximum discharge of 250,000 cfs August 21, from 6,242 square miles, the discharge was 1.2 times that of a 100-year flood. The previous maximum discharge at this station, for a period of 70 years of flood record, was 180,000 cfs in 1944.

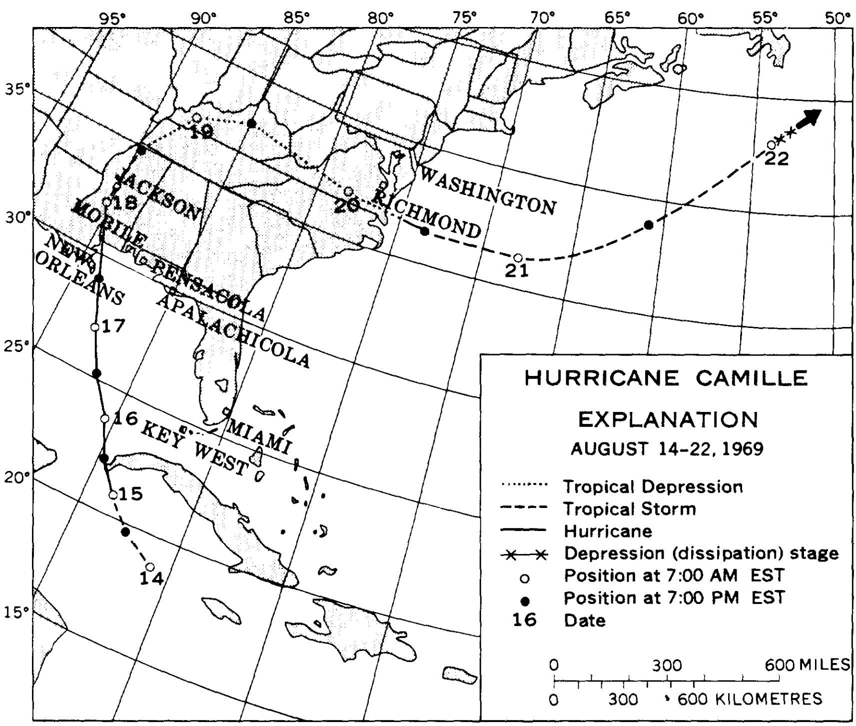


FIGURE 49.—Storm path of Hurricane Camille, August 14–22 (from National Weather Service).

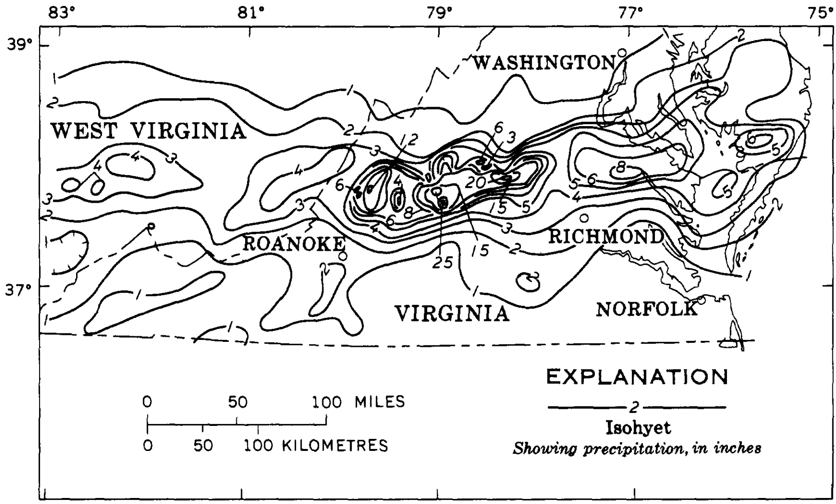


FIGURE 50.—Isohyets of precipitation from Hurricane Camille for the period 1200 hours August 19th to 2400 hours August 20th in central Virginia.

At station 02037500, James River near Richmond, for a stage of 24.95 feet, the maximum discharge was 222,000 cfs August 21 from 6,757 square miles. This discharge is 1.2 times that of a 100-year flood. In 35 years of record the previous maximum was 175,000 cfs in 1936. Many other record breaking floods with large recurrence intervals but lower discharges are included in the report, "Water Resources Data for Virginia" (1969). More information on the flood is available in the open-file report by Camp and Miller (1970).

As of November 13, 1969, there were 113 deaths, 102 injuries, and 39 people missing, all directly or indirectly attributable to Hurricane Camille. Total flood damage in Virginia exceeded $116 million.

FLOOD OF AUGUST 31 ON LITTLE BLUE RIVER IN SOUTHEASTERN NEBRASKA

By H. D. BRICE

A record-breaking flood occurred along the upper reaches of the Little Blue River on August 31, due to two storms that crossed the long, narrow basin August 23–26 and August 30–31 (fig. 51).

National Weather Service precipitation stations at Blue Hill 3 SW, Holdrege 3 SW, and Holdrege 1 E received total rainfall amounts of 2.09, 1.83, and 1.75 inches, respectively, during the

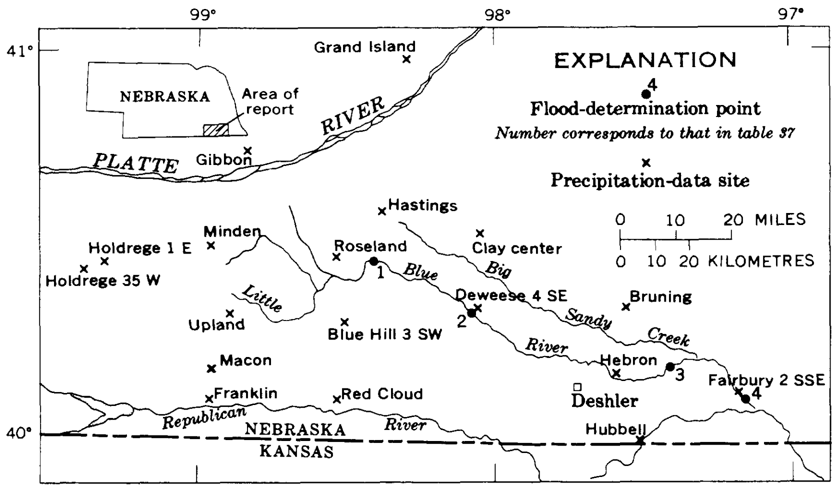


FIGURE 51.—Location of flood-determination points and precipitation-data sites, floods of August 31 and September 2–3 in southeastern Nebraska.

first storm on August 23–26 (table 36). Lesser amounts were observed at Hastings, Minden, and Upland.

The second storm began about 1400 hours and ended about midnight August 30. During this 10- to 12-hour storm, precipitation stations at Gibbon, Grand Island, and Macon recorded 1.3, 2.2, and 3.8 inches, respectively. The maximum rainfall observed was 6.09 inches August 31 at Hastings. It was unofficially reported that rainfall amounts of 8 to 10 inches fell in the vicinity of Roseland.

Rainfall of about 5½ inches in 12 hours has a recurrence interval of 100 years for the headwaters area of this basin, according to U.S. Weather Bureau Technical Report No. 40 (1961). By comparison, rainfall of 8 to 10 inches in 10 to 12 hours would have a recurrence interval considerably greater than 100 years.

The peak discharge of 27,000 cfs on Little Blue River below Pawnee Creek near Pauline, August 31, was 1.5 times the previous maximum discharge of record and 1.8 times the 50-year peak discharge. Downstream the peak discharge of 25,100 cfs on Little Blue River near Deweese was 1.5 times the previous maximum of record and 1.5 times the 50-year peak discharge (table 37).

The rainfall that caused the flooding was concentrated in an area upstream from Deweese, and the flood peak decreased as it moved downstream out of the storm area. Near Gilead and Fairbury, peak discharges on September 2 and 3 were only 54 percent,

TABLE 36.—*Daily precipitation, in inches, August 20 to September 1 in southeastern Nebraska*

[Tr., trace]

Station	Time of observation	August												September	
		20	21	22	23	24	25	26	27	28	29	30	31	1	Total
Blue Hill 3 SW	7:00	---	---	---	.26	1.73	.10	---	---	---	---	---	5.33	.05	7.47
Bruning	7:00	---	---	---	.03	.04	---	---	---	---	---	---	.63	---	.70
Clay Center	7:00	Tr.	---	Tr.	---	.06	---	.26	---	---	---	---	3.14	---	3.46
Deweese 4 SE	8:00	---	---	---	---	---	.48	---	---	---	---	---	---	1.70	2.18
Fairbury 2 SSE	8:00	.69	.14	---	---	---	.02	---	---	---	---	---	.72	1.32	2.89
Franklin	7:00	---	---	---	---	.30	.67	---	---	---	---	---	3.35	---	4.32
Gibbon	(1)	---	---	---	---	---	---	---	---	---	---	1.3	---	---	1.3
Grand Island	(1)	---	---	---	---	---	---	---	---	---	---	2.20	---	---	2.2
Hastings	7:00	Tr.	Tr.	Tr.	---	.27	.45	---	---	---	---	---	6.09	---	6.81
Hebron	8:00	---	---	---	---	---	.02	---	---	---	---	---	.57	---	.59
Holdrege 3 SW	6:00	.04	---	---	---	1.22	.61	---	---	---	---	---	3.26	---	5.13
Holdrege 1 E	8:00	---	---	---	---	1.21	.30	.24	---	---	---	---	2.04	---	3.79
Hubbell	7:00	.34	.08	Tr.	Tr.	Tr.	.01	Tr.	---	---	---	---	.16	1.06	1.65
Macon	(1)	---	---	---	---	---	---	---	---	---	---	3.8	---	---	3.8
Minden	8:00	Tr.	Tr.	.03	.03	.30	---	---	---	---	---	---	2.30	---	2.66
Red Cloud	7:00	---	---	---	1.08	.10	.76	---	---	---	---	---	2.10	---	4.04
Upland	7:00	Tr.	.01	Tr.	---	.11	---	---	---	---	---	---	3.64	.02	3.78

[1] Recording gage.

respectively, of the peak discharge near Pauline on August 31, even though the Gilead and Fairbury peaks had been augmented somewhat by rain that fell over the downstream reaches in the 24-hour period prior to 8:00 a.m., September 1 (table 36).

Local residents reported that the flood crest on Little Blue River 5 miles north of Deshler was the highest in 40 years. The crest, only inches below the all-time local record, reached Hebron about 0145 hours September 2, flooding the southwest section of the city.

Several thousand acres of farmland were flooded, and crop damage was extensive. A dozen or more highway bridges were washed out or damaged. Total damage was estimated at several hundred thousand dollars.

TABLE 37.—*Flood stages and discharges, August 31, September 2, 3 in Little Blue River basin, Nebraska*

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before August 1969: Period of known floods	Known before August 1969: Year	August, September 1969	Gage height (feet)	Discharge: Cfs	Discharge: Recurrence interval (yrs)
	Kansas River basin							
1	06882900, Little Blue River below Pawnee Creek near Pauline	881	1962–69	1965		13.88	17,800	
					Aug. 31	15.73	27,000	[1] 1.8
2	06883000, Little Blue River near Deweese	979	1953–69	1965		15.99	17,100	
					Aug. 31	18.57	25,100	[1] 1.5
3	06883570, Little Blue River near Gilead	1,552	1959–69	1960		17.30	25,600	[1] 1.2
					Sept. 2	16.83	15,200	35
4	06884000, Little Blue River near Fairbury	2,350	1908–15 1928–69	1951			36,800	[1] 1.4
					Sept. 3	12.80	12,300	25

[1] Ratio of peak discharge to that of a 50-year flood.

FLOOD OF SEPTEMBER 14 AT GUADALUPE, ARIZONA

By H. W. HJALMARSON and L. L. WERHO

On the evening of September 14 an intense thunderstorm caused extensive flooding in the small community of Guadalupe (fig. 52), about 3 miles southwest of Tempe.

Precipitation at the University of Arizona Experimental Farm about a mile north of Guadalupe (fig. 52) was 3.87 inches, 3.52

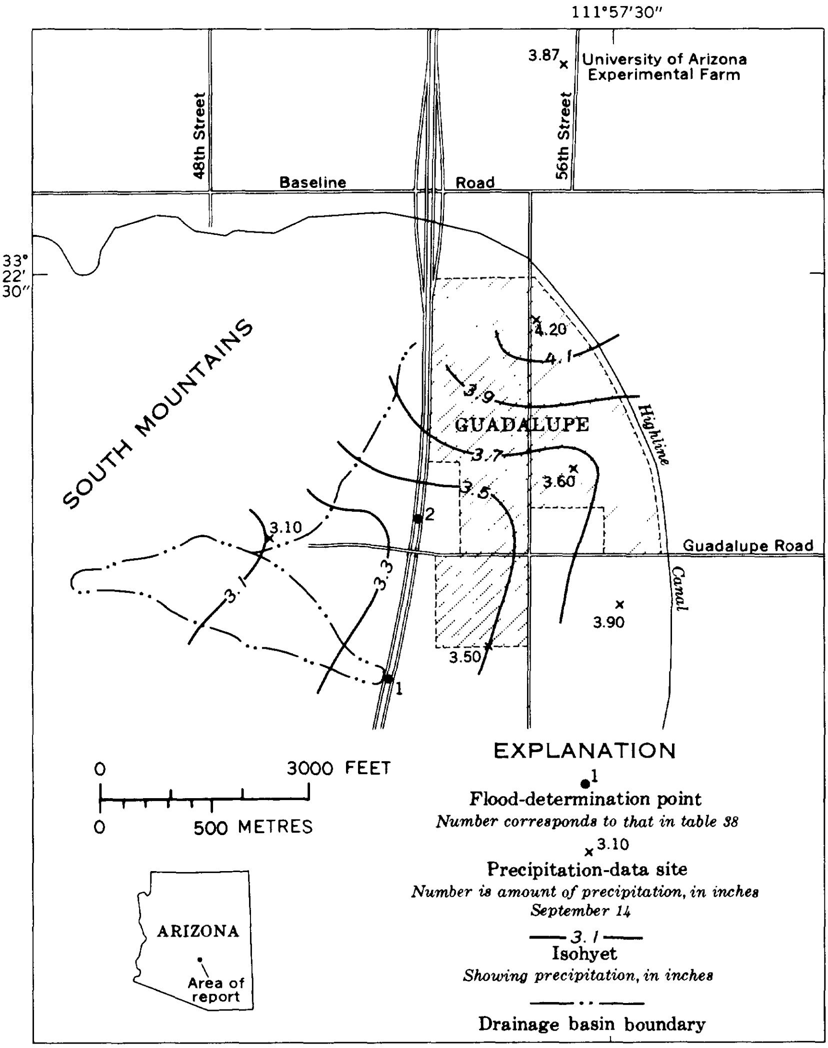


FIGURE 52.—Location of flood-determination points, precipitation-data sites, and isohyets, flood of September 14, at Guadalupe, Ariz. Isohyets by U.S. Geological Survey; from unofficial data.

inches of which fell between 1800 hours and 1900 hours on September 14; this amount is greatly in excess of the 2½ inches given by Hershfield (1961, p 21) for a 1-hour storm with a 100-year recurrence interval. The largest amount of precipitation previously recorded by the U.S. Weather Bureau in Arizona for a 2-hour period was 2.57 inches at Tombstone; however, much larger amounts have been reported unofficially. The isohyetal pattern shown in (fig. 52) is based on unofficial precipitation measurements obtained from a bucket survey.

The runoff that originated on the east slopes of the South Mountains flowed eastward through 12 small culverts under Interstate Highway 10 and entered streets and poorly defined stream channels in Guadalupe, where it was combined with runoff that originated within the community. Many homes were flooded to depths of 1 or 2 feet, and, as the water flowed eastward, it became ponded behind the banks of the Highline Canal and inundated most of the homes and pit privies next to the canal. Although the canal served as an outlet for some of the runoff, most of it flowed over the banks onto the farmland east of Guadalupe.

On the wash at Interstate Highway 10, mile post 157.05, the peak discharge was 228 cfs September 14 from an ungaged drainage area of 0.14 of a square mile equal to unit runoff of 1,630 cubic feet per square mile (table 38). On 12 washes at Interstate Highway 10 between mile post 156.20 and 156.95 the peak discharge was 300 cfs September 14 from a 0.16 of a square mile drainage area, equal to a unit runoff of 1,880 cubic feet per square mile. Flood-frequency relations are undefined for these small drainage areas, thus recurrence intervals were not determined. The Highline Canal, with a capacity of about 60 cfs, was flowing bank full.

Sheetflow flooded many homes and pit privies, destroyed two small adobe buildings, damaged roads, and deposited sediment in homes. The swiftly moving water also damaged the Highline Canal (fig. 52) and irrigation ditches and fields east and south of Guadalupe. No lives were lost.

TABLE 38.—*Flood stages and discharges, September 14, at Guadalupe, Ariz.*

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before September 1969: Period of known floods	Known before September 1969: Year	September 1969	Gage height (feet)	Discharge: Cfs	Discharge: Cfs per sq. mi [1]
	Gila River basin							
1	Wash at Interstate Highway 10, mile post 157.05	0.14		1969	Sept. 14	----	228	1,630
2	Twelve washes at Interstate Highway 10, mileposts 156.20 to 156.95	.16		1969	Sept. 14	----	[2] 300	1,880

[1] Cubic feet per second per square mile.
[2] Combined peak discharge of 12 washes.

FLOODS OF SEPTEMBER 21–23 IN NORTHWESTERN FLORIDA AND SOUTHWESTERN GEORGIA

By Wayne C. Bridges

A tropical storm was nearly stationary for about 48 hours after it hit northwest Florida September 20. Rainfall was most intense over the Quincy area where September 20–23 rainfall exceeded 20 inches (fig. 53). A record 6-hour rainfall of 6 inches September 21 and 48-hour total of 17.71 inches was recorded at Quincy. This 48-hour total rainfall has a recurrence interval well over 100 years. The 72-hour total rainfall of 23.40 inches September 20–23 at Havana was the maximum for this storm. Precipitation data and isohyets shown in figure 54 were furnished by the National Weather Service.

Flood peaks at many measurement sites were the greatest of record, and their recurrence intervals were in excess of 50 years (table 39). At the gaging station, Little River near Quincy, the peak discharge of 45,600 cfs September 22 (gage height 24.65 feet), was 1.8 times the maximum discharge of record for 20 years and nearly three times that of a 50-year flood. At the gaging station on Ochlockonee River near Bloxham, the maximum discharge of 89,400 cfs (gage height 29.2 feet) from 1,720 square miles, on September 23 was 1.6 times the peak discharge of record for 44 years (table 39).

Flood recurrence intervals are not defined for all drainages but are probably well in excess of those for a 50-year flood at all sites listed in table 39.

The Florida Department of Transportation reported 51 sites where roads were closed due to high water levels or to washed out bridges or culverts. Nearly $200,000 was spent on emergency road repair, and $520,000 on reconstruction of four destroyed bridges. Losses to agricultural lands were estimated at $1 million.

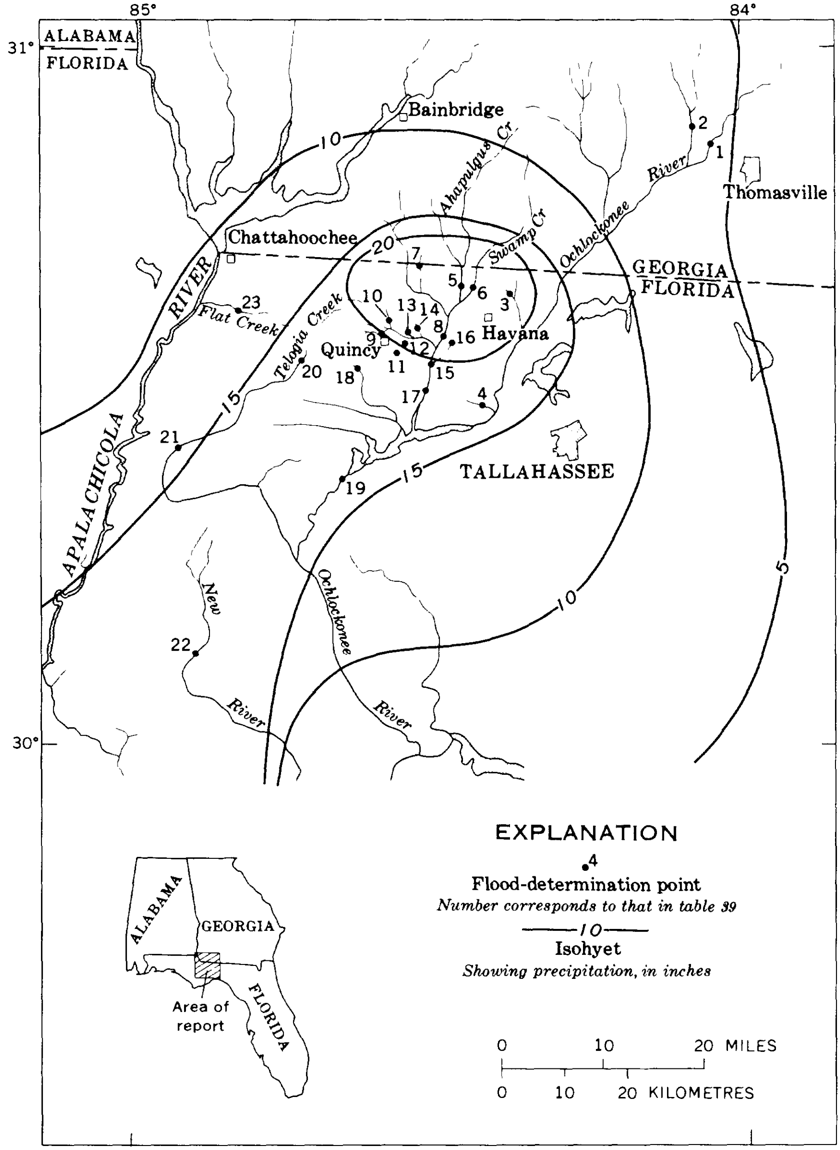


FIGURE 53.—Location of flood-determination points and isohyets for September 20–23, flood of September 21–23, in northwestern Florida and southwestern Georgia. Isohyets from National Weather Service.

TABLE 39.—*Flood stages and discharges, September 21–23, in northwestern Florida and southwestern Georgia*

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before September 1969: Period of known floods	Known before September 1969: Year	September 1969	Gage height (feet)	Discharge: Cfs	Discharge: Recurrence interval (yrs)
	Ochlockonee River basin and coastal area							
1	02327500, Ochlockonee River near Thomasville	550	1937–69	1948	------	[1] 29.1	72,000	----
			--------------		Sept. 23	8.67	872	1.1
2	02327700, Barnetts Creek near Thomasville	104	1951–69	1964	------	[1] 20.4	17,700	----
			--------------		Sept. 22	10.36	680	1.2
3	02328859, Ochlockonee River tributary near Havana	1.34	--------------		Sept. 21	----	1,700	([2])
4	02329260, Midway Branch near Midway	1.38	--------------		Sept. 21	----	2,130	([2])
5	02329352, Attapulgus Creek at Jamieson	96.6	--------------		Sept. 21	----	22,200	[3] 2.28
6	02329404, Swamp Creek at Jamieson	53.0	--------------		Sept. 21	----	18,800	[3] 2.56
7	02329481, Willacoochee Creek tributary near Quincy	1.26	--------------		Sept. 21	----	642	([2])
8	02329500, Little River near Quincy	237	1950–69	1964	------	20.81	25,400	----
			--------------		Sept. 22	[1] 24.65	45,600	[3] 2.99
9	02329516, Quincy Creek near Quincy	6.16	--------------		Sept. 21	----	4,840	([2])
10	02329538, Holman Branch near Quincy	3.09	--------------		Sept. 21	----	1,050	([2])
11	02329546, South Prong Tanyard Branch near Quincy	2.29	--------------		Sept. 21	----	1,480	([2])
12	02329548, Tanyard Branch near Quincy	4.91	--------------		Sept. 21	----	2,430	([2])
13	02329553, Hubbert Branch near Quincy	4.68	--------------		Sept. 21	----	2,360	([2])
14	02329556, Winkley Branch near Quincy	1.64	--------------		Sept. 21	----	1,000	([2])
15	02329565, Little River near Littman	[4] 292	--------------		Sept. 22	----	47,400	2.89

See footnotes at end of table.

TABLE 39.—*Flood stages and discharges, September 21–23, in northwestern Florida and southwestern Georgia*—Continued

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before September 1969: Period of known floods	Year	September 1969	Gage height (feet)	Discharge: Cfs	Recurrence interval (yrs)
	Ochlockonee River basin and coastal area—Continued							
16	02329582, Hurricane Creek near Havana	8.31			Sept. 21		7,450	([2])
17	02329600, Little River near Midway	305	1965–69	1964		83.27	27,800	
					Sept. 22	[1]86.25	49,200	2.85
18	02329700, Rocky Comfort Creek near Quincy	9.45	1964–69	1964		41.00	2,140	
					Sept. 21	[1]42.50	7,610	([2])
19	02330000, Ochlockonee River near Bloxham	1,720	1926–69	1957		32.64	[5]55,000	
					Sept. 23	[1]29.2	89,400	2.19
20	02330050, Telogia Creek near Greensboro	28.1	1965–69	1965		96.86	4,410	
					Sept. 21	[1]99.9	12,000	2.26
21	02330100, Telogia Creek near Bristol	126	1950–69	1964		11.11	8,280	
					Sept. 22	[1]16.65	20,600	1.49
22	02330300, New River near Wilma	81.7	1964–69	1966		46.32	2,720	
					Sept. 22	50.67	8,790	46
	Apalachicola River basin							
23	02358600, Flat Creek near Chattahoochee	24.9	1961–69	1965		11.43	3,990	
					Sept. 21	[1]13.6	8,450	[3]1.70

[1] From floodmark.
[2] Not defined.
[3] Ratio of peak discharge to that of a 50-year flood.
[4] Includes Hurricane Creek.
[5] Maximum daily discharge, caused by failures of earth embankment of Jackson Bluff dam.

FLOODS OF OCTOBER 6–22 IN SOUTH-CENTRAL ALASKA

Drought conditions existed over the entire Kenai Peninsula prior to an October succession of three storms. Rainfall data for Seward showed a total deficiency of 25.63 inches for the water year October 1968 to September 1969. The October 1969 storms were centered in the mountainous areas along the Gulf of Alaska coast of the Kenai Peninsula, missing the northern lowlands of the peninsula where drought conditions continued.

Location of flood determination points, precipitation-data sites, and ice dammed lakes on Kenai Peninsula are shown in figure 54.

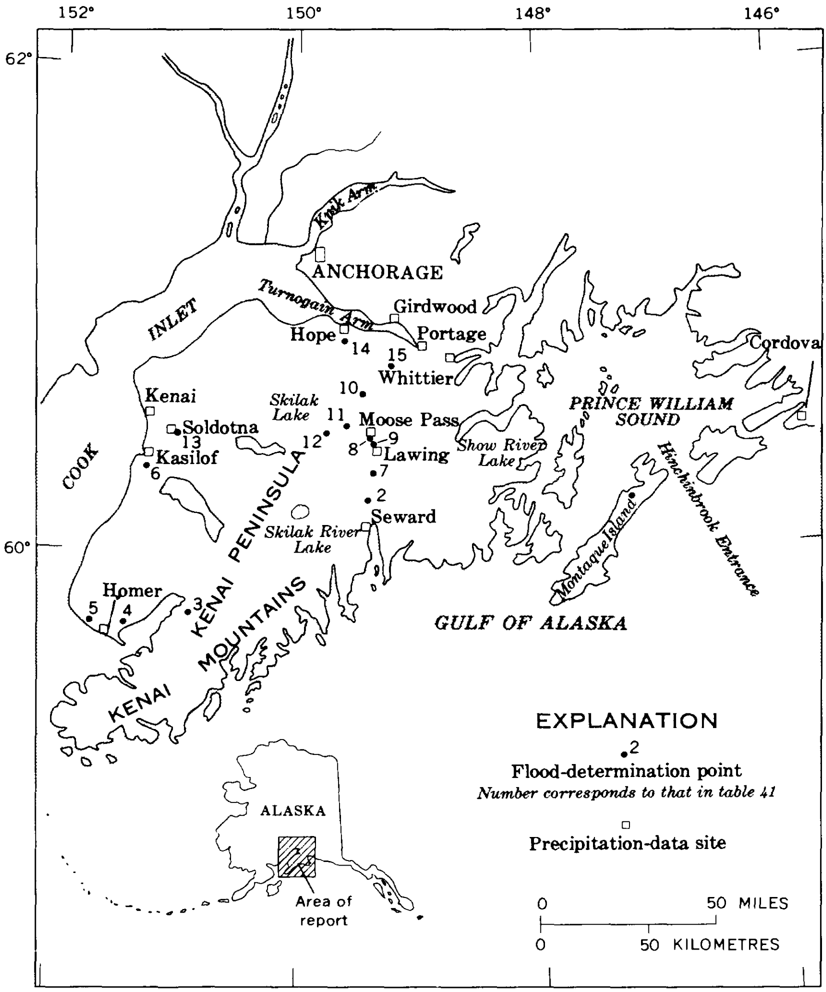


FIGURE 54.—Location of flood-determination points and precipitation-data sites, floods of October 6–22, south-central Alaska.

Rainfall reported by the National Weather Service is shown in table 40. The October total precipitation for Seward is 11.97 inches above the normal for that month.

The first intense storm, on October 6, was concentrated in the upper Kenai River basin and Turnagain Arm area between Moose Pass and Whittier. This storm runoff, combined with high tides, washed out railroad tracks between Girdwood and Portage on Turnagain Arm and inundated several Forest Service campgrounds near Kenai Lake and Moose Pass. Peak discharges at several gaging stations were the highest of record. The flood stages and discharges of streams in the storm areas are shown in table 41.

The second storm, which occurred on October 11, extended along the coastal areas from Seward to Cordova. Peak flows of record occurred in this area also with Chalmers River near Cordova having a unit discharge of 481 cfs per sq mi. Damage consisted mainly of washed out culverts between Moose Pass and Seward and a wash out of the Lowell Creek bridge at Seward.

The third intense storm, on October 13, struck in the Homer area near the tip of the Kenai Peninsula. Peak flows on gaged streams in this area were the highest for as much as 12 years. Ice dammed lakes in the Snow River and Skilak River drainages were observed to be full during the flood period. Had either lake emptied abruptly, as Snow River did on September 1, 1967, or as Skilak River did on January 18, 1969, flood damage in the Kenai River system could have been much greater.

TABLE 40.—*Precipitation, in inches, in south-central Alaska, reported by the National Weather Service*

Location	October			
	6	11	13	Monthly total
Cordova	1.51	1.06	---	15.69
Whittier	6.25	4.49	1.09	37.81
Moose Pass	3.50	2.60	1.05	14.10
Seward	3.96	3.75	1.23	21.97
Homer	1.83	.35	.82	8.55
Kenai	.13	.02	.07	1.48

TABLE 41.—*Flood stages and discharges in October, in south-central Alaska*

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before October 1969: Period of known floods	Known before October 1969: Year	October 1969	Gage height (feet)	Discharge: Cfs	Discharge: Cfs per sq. mi [1]
	Chalmers River basin							
1	15237400, Chalmers River near Cordova	6.32	1967–69	1969		12.23	2,890	457
					Oct. 11	12.31	3,040	481
	Resurrection River basin							
2	15238000, Lost Creek near Seward	7.96	1963–69	1967		11.57	530	66.6
					Oct. 11	11.68	619	77.8
	Bradley River basin							
3	15239000, Bradley River near Homer	54.0	1957–69	1961		8.71	6,430	119
					Oct. 14	9.13	7,690	142
	Fritz Creek basin							
4	15239500, Fritz Creek near Homer	10.4	1963–69	1963		[2] 11.68	107	10.3
					Oct. 6	11.63	181	17.4
	Anchor River basin							
5	15239900, Anchor River near Anchor Point	133	1965–69	1966		4.67	1,660	12.5
					Oct. 14	4.72	1,730	13.0
	Kasilof River basin							
6	15242000, Kasilof River near Kasilof	738	1949–69	1957		7.90	12,300	16.7
					Oct. 22	5.85	7,379	9.99
	Kenai River basin							
7	15243950, Porcupine Creek near Primrose	16.8	1963–69	1966		12.21	1,200	71.4
					Oct. 11	12.58	1,400	83.3
8	15248000, Trail River near Lawing	181	1947–69	1967		11.93	7,480	41.3
					Oct. 7	10.59	6,080	33.6
9	15250000, Falls Creek near Lawing	11.8	1963–69	1966		13.86	693	58.7
					Oct. 6	13.22	491	41.6

See footnotes at end of table.

TABLE 41.—*Flood stages and discharges in October, in south-central Alaska* —Continued

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before October 1969: Period of known floods	Maximum floods: Known before October 1969: Year	Maximum floods: October 1969	Maximum floods: Gage height (feet)	Maximum floods: Discharge: Cfs	Maximum floods: Discharge: Cfs per sq. mi [1]
	Kenai River basin—Continued							
10	15251800, Quartz Creek at Gilpatricks	9.41	1963–69	1967		10.89	350	37.2
					Oct. 6	1.54	633	67.3
11	15254000, Crescent Creek at Cooper Landing	31.7	1949–69	1953		2.55	820	25.9
					Oct. 9	1.73	1,500	47.3
12	15258000, Kenai River at Cooper Landing	634	1947–69	1967		16.25	21,500	33.9
					Oct. 14	15.10	17,460	27.5
13	15266300, Kenai River at Soldotna	2,010	1965–69	1967		11.48	24,900	12.4
					Oct. 15	12.20	30,000	14.9
	Resurrection Creek basin							
14	15267900, Resurrection Creek near Hope	149	1968–69	1968		7.20	1,020	6.85
					Oct. 6	8.40	2,700	18.1
	Sixmile Creek basin							
15	15269500, Granite Creek near Portage	28.2	1967–69	1967		12.26	1,940	68.8
					Oct. 6	12.46	2,040	72.3

[1] Cubic feet per second per square mile.
[2] Different site and datum.

FLOODS OF OCTOBER 12–14 IN EAST-CENTRAL MISSOURI

Severe flooding occurred in east-central Missouri October 12–14 as the result of heavy rains October 10–13. Precipitation in the flood area ranged from 5 to 10 inches.

At seven of the sites shown in figure 55, with drainage areas greater than 50 square miles, the peak discharges are equal to or more than those of a 50-year flood. At 11 stations the October flood equaled or exceeded previous maximums for periods of record ranging from 3 to 48 years (table 42).

One of the more significant floods occurred on South Fork Salt River near Santa Fe, located near the center of the flood area. The maximum discharge, 28,800 cfs from 295 square miles, (98 cfs per sq mi) was 1.8 times that of a 50-year flood and more than double the previous maximum in 31 years of record.

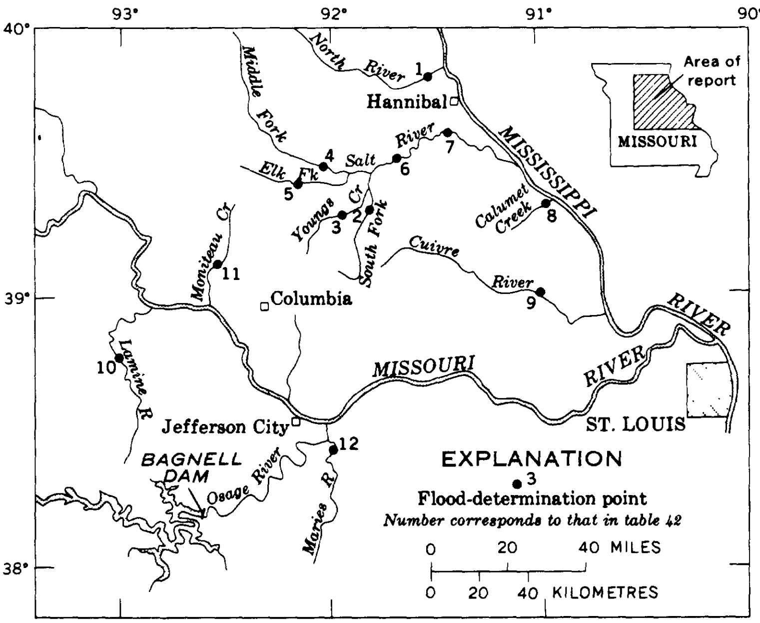


FIGURE 55.—Location of flood-determination points, floods of October 12–14 in east-central Missouri.

TABLE 42.—*Flood stages and discharges, October 12–14 in east-central Missouri*

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before October 1969: Period of known floods	Year	October 1969	Gage height (feet)	Discharge: Cfs	Recurrence interval (yrs)
	North River basin							
1	05501000, North River at Palmyra	313	1934–69	1944	------	22.96	27,400	----
			--------	------	Oct. 13	26.57	26,500	37
	Salt River basin							
2	05504900, South Fork Salt River near Santa Fe	295	1939–69	1944	------	21.10	13,100	----
			--------	------	Oct. 13	28.24	28,800	[1]1.8
3	05506000, Youngs Creek near Mexico	67.4	1936–69	1958	------	16.52	6,530	----
			--------	------	Oct. 13	16.60	6,640	50

See footnotes at end of table.

TABLE 42.—*Flood stages and discharges, October 12–14 in east-central Missouri*—Continued

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before October 1969: Period of known floods	Maximum floods: Known before October 1969: Year	Maximum floods: October 1969	Maximum floods: Gage height (feet)	Maximum floods: Discharge: Cfs	Maximum floods: Discharge: Recurrence interval (yrs)
	Salt River basin—Continued							
4	05506500, Middle Fork Salt River at Paris	356	1939–69	1958		29.94	23,100	
					Oct. 13	26.20	15,300	38
5	05506800, Elk Fork Salt River near Madison	200	1967–69	1967		28.37	13,000	30
6	05507500, Salt River near Monroe City	2,230	1939–69	1958		34.81	71,100	
					Oct. 14	37.40	89,500	[1] 1.3
7	05508000, Salt River near New London	2,480	1922–69	1958		29.92	64,700	
					Oct. 14	30.62	79,500	[1] 1.2
	Calumet Creek basin							
8	05509700, Calumet Creek near Clarksville	15.7	1965–69	1968		11.60	3,900	
					Oct. 13	12.62	5,690	25
	Cuivre River basin							
9	05514500, Cuivre River near Troy	903	1922–69	1941		33.40	120,000	
					Oct. 12	31.20	84,000	[1] 1.4
	Lamine River basin							
10	06907000, Lamine River at Clifton City	598	1922–69	1951		32.50	65,500	
					Oct. 13	31.50	50,000	23
	Moniteau Creek basin							
11	06909500, Moniteau Creek near Fayette	81	1948–69	1961		19.6	4,330	
					Oct. 13	20.79	8,100	1.4
	Osage River basin							
12	06927000, Maries River at Westphalia	257	1947–69	1957		18.21	20,000	
					Oct. 12	20.83	26,000	50

[1] Ratio of peak discharge to that of a 50-year flood.

FLOODS OF DECEMBER 30 AND 31 IN NORTHEASTERN MISSISSIPPI

By K. V. Wilson

A rainstorm that continued from about noon December 29 to noon December 30 resulted in more than 5 inches of rain on a belt 15 to 50 miles wide extending across the State from Vicksburg to Tupelo (fig. 56).

As much as 0.8 of an inch per hour was reported at several sites. When the rain started, the larger streams in the area were already near flood stage due to a rain of about 2 inches on December 25.

The most severe flooding was on the large streams near Tupelo or generally in the upper part of the Tombigbee River basin. At the gaging station on Bull Mountain Creek at State Highway 25 near Smithville, the peak discharge of 34,600 cfs December 31 (gage height 16.50 feet), from 335 square miles, was the second highest in 31 years of record and the recurrence interval was in excess of 50 years (table 43).

Flood damage was limited to agricultural lands and was minor.

Table 43.—*Flood stages and discharges, December 30 and 31 in northeastern Mississippi*

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before December 1969: Period of known floods	Year	December 1969	Gage height (feet)	Discharge: Cfs	Recurrence interval (yrs)
	Mobile River basin							
1	02433000, Bull Mountain Creek at State Highway 25, 1.1 miles north of Smithville	335	1926	1926		15.7	----	----
			1940–69	1955		17.18	40,000	----
					Dec. 31	16.50	34,600	50+
2	02440800, Trim Cane Creek at U.S. Highway 82, 6 miles west of Starkville	39.6	1951–69	1969		27.04	11,300	----
					Dec. 30	26.28	9,200	20

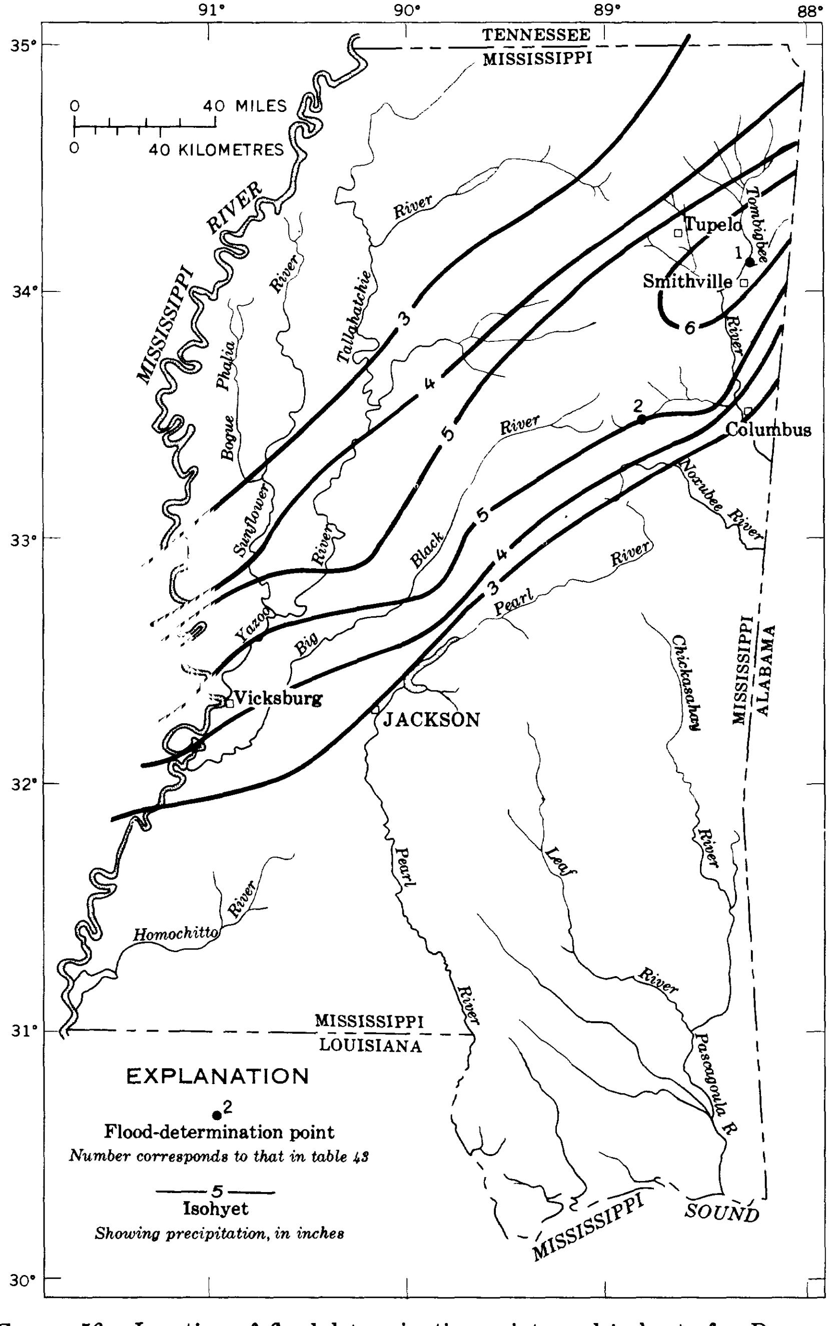


FIGURE 56.—Location of flood-determination points and isohyets for December 29–30, flood of December 30, 31 in northeastern Mississippi. Isohyets by U.S. Geological Survey; data from the National Weather Service.

FLOODS OF DECEMBER 30, 1969, TO JANUARY 2, 1970, IN SOUTHEASTERN KENTUCKY

By CURTIS H. HANNUM

December temperatures were below normal and snowfall totals were much above normal. Snowfall on December 25 was the heaviest for that date over much of the State since the early 1930's. In southeastern Kentucky the depth ranged from 3 to 6 inches with more than a foot reported at some of the higher altitudes. Between December 25 and 28 daily maximum temperatures ranged from below to a few degrees above freezing and daily minimum temperatures were as much as 16° F below freezing in the southeastern part of the State. Heavy rains and rising temperatures began early the morning of December 29 and continued through December 31.

Precipitation ranged from 4.04 inches at Pineville to 5.13 inches at Stearns and 6.43 inches at Middlesboro. Isohyets in figure 57 show the general rainfall distribution for the storm.

The rains and rising temperatures melted the snow cover and caused flooding along the Cumberland River between Harlan and Barbourville and along Yellow Creek downstream from Middlesboro. Stages and discharges at gaging stations on Cumberland River near Harlan and Yellow Creek near Middlesboro were the maximum during 32 years of record (table 44).

The peak discharge of 43,200 cfs on the Cumberland River near Harlan from a 374 square mile drainage area had a recurrence interval of 32 years and the peak discharge of 9,980 cfs on Yellow Creek near Middlesboro from 58.2 square miles had a recurrence interval of 33 years.

One life was lost in Middlesboro as a result of the flood. Much of the business district of Middlesboro was flooded from high water on Little Yellow Creek and Yellow Creek. The Harlan waterplant was closed for a short time and some of the business district was flooded. Many residents of low-lying areas were forced to evacuate their homes because of flooding along Clover Fork and Martins Fork in Harlan.

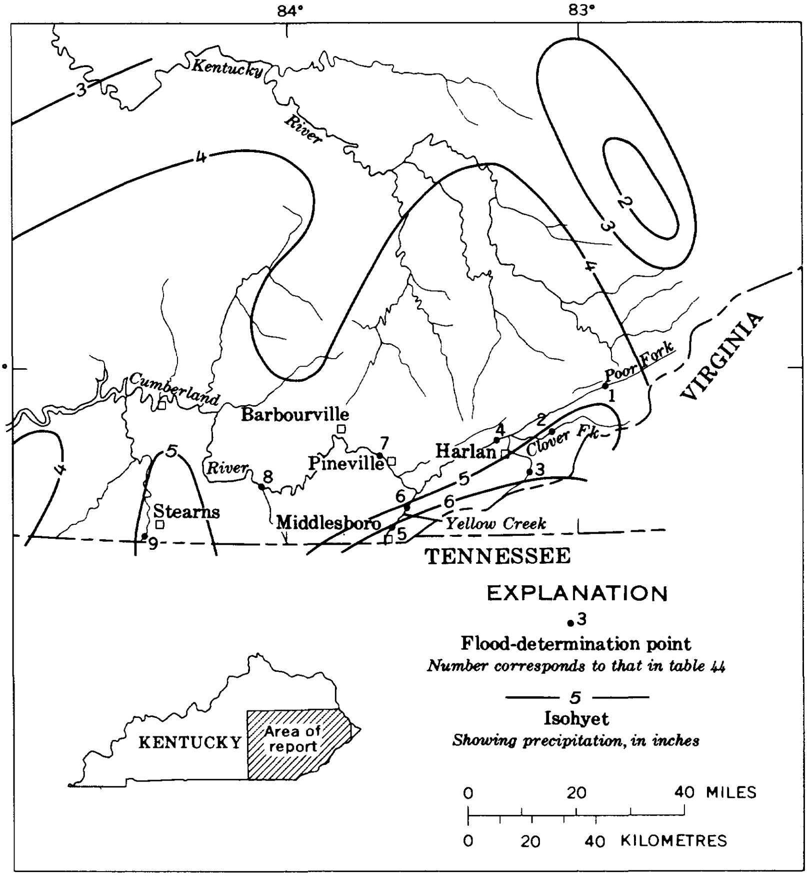


FIGURE 57.—Location of flood-determination points and isohyets for December 29–31, floods of December 30, 1969, to January 2, 1970, in southeastern Kentucky. Isohyets by U.S. Geological Survey; data from the National Weather Service.

TABLE 44.—*Flood stages and discharges, December 30 to January 2 in southeastern Kentucky*

No.	Station number, stream, and place of determination	Drainage area (sq mi)	Maximum floods: Known before December 1969: Period of known floods	Known before December 1969: Year	December 1969	Gage height (feet)	Discharge: Cfs	Discharge: Recurrence interval (yrs)
	Cumberland River basin							
1	03400500, Poor Fork at Cumberland	82.3	1927, 1940–69	1957	------	11.50	11,800	----
			--------------		Dec. 30	14.64	8,560	8
2	03400700, Clover Fork at Everts	82.4	1959–69	1963	------	12.37	14,100	----
			--------------		Dec. 30	10.71	11,500	21
3	03400800, Martins Fork near Smith	56.2	1969	----------	Dec. 30	17.04	8,390	20
4	03401000, Cumberland River near Harlan	374	1918, 1929, 1940–69	1963	------	24.89	43,100	----
			--------------		Dec. 31	24.90	43,200	32
5	03401500, Yellow Creek Bypass at Middlesboro	35.3	1940–69	1965	------	6.16	10,900	----
			--------------		Dec. 30	4.40	5,640	18
6	03402000, Yellow Creek near Middlesboro	58.2	1929, 1939 1940–69	1965	------	20.77	9,660	----
			--------------		Dec. 31	40.99	9,980	33
7	03403000, Cumberland River near Pineville	809	1929, 1938–69	1946	------	49.31	57,900	----
			--------------		Dec. 31	49.77	56,200	10
8	03404000, Cumberland River at Williamsburg	1,607	1918–69,	1946	------	34.2	(1)	----
			1950–69	1957	------	33.78	49,700	----
			--------------		Jan. 2	29.42	37,300	8
9	03410500, South Fork Cumberland River near Stearns	954	1929,	1929	------	52.9	(1)	----
			1942–69	1948	------	38.50	69,600	----
			--------------		Dec. 30	44.00	86,000	9

[1] Not determined.

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