Summary of Floods in the United States During 1960

By J. O. ROSTVEDT

FLOODS OF 1960 IN THE UNITED STATES

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Prepared in cooperation with Federal, State, and local agencies

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SUMMARY OF FLOODS IN THE UNITED STATES DURING 1960

By J. O. ROSTVEDT

ABSTRACT

This report describes the most outstanding floods in the United States during 1960. No major floods occurred during the year, although two floods caused severe damage—the first in March and April in eastern Nebraska and adjacent areas, and the second in September in Puerto Rico.

Unseasonal rains in mid-March caused extensive flooding in north-central Florida. Several thousand persons were evacuated from their homes, and damage to homes, roads, and crops was extensive.

The most widespread flooding ever known in Nebraska occurred late in March and early in April as a result of rapid melting of a heavy snow cover. Most of the flood damage, estimated at about $3 million, was to roads and bridges. The flood area extended into South Dakota, Iowa, Kansas, Missouri, and Wisconsin.

Snowmelt in April supplemented by rains and later heavy rains in early May caused severe flooding in northern Wisconsin and in Michigan Upper Peninsula.

The most destructive flood of the year was in eastern Puerto Rico as the result of hurricane Donna. More than one hundred persons died, and considerably more than one hundred persons were injured; property damage was about $7 million. Hurricane Donna also caused severe flooding as it passed over Florida and along the Atlantic coastline.

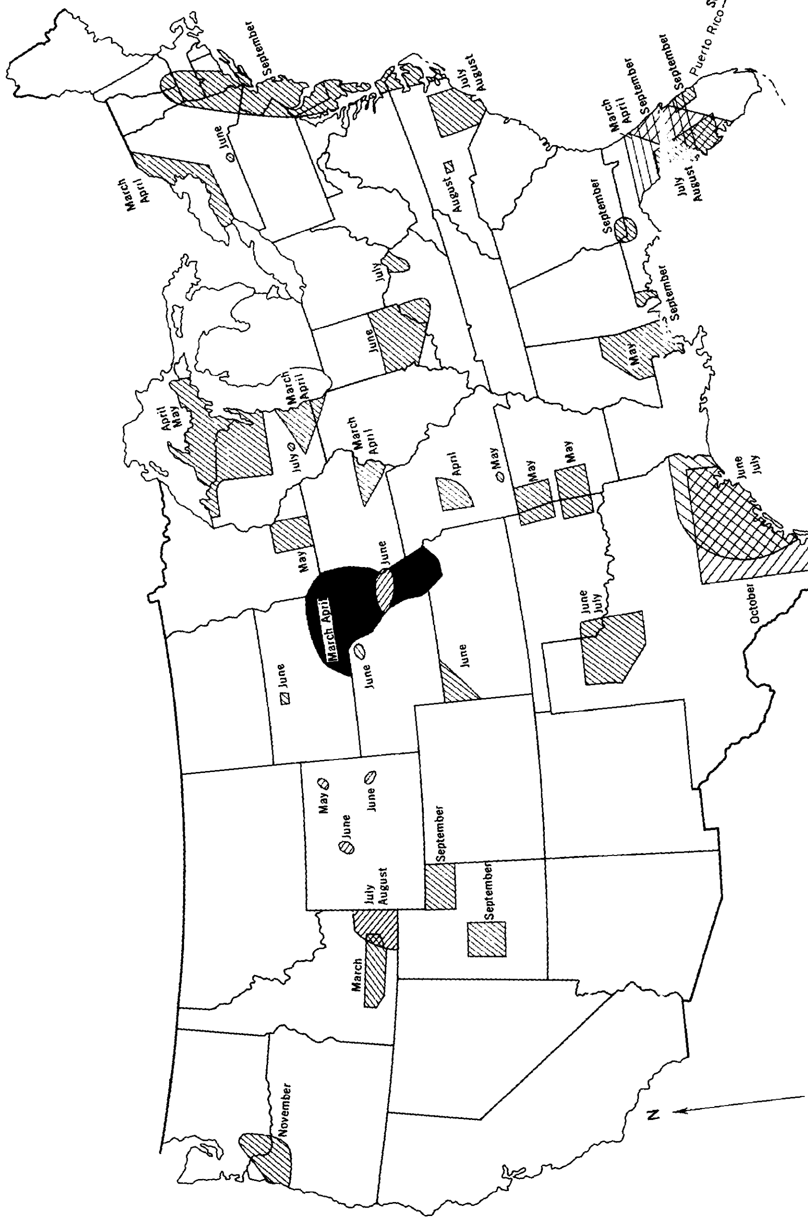
In addition to these floods mentioned, 31 others of lesser magnitude were significant enough to report in this annual summary.

INTRODUCTION

The purpose of this summary chapter in the series "Floods of 1960" is to assemble into a single volume information relating to outstanding floods in the United States during 1960. The floods described in this summary chapter were selected because they were unusual hydrologic events in which large areas were affected, great amounts of damage resulted, or extremely high discharges or stages occurred.

Water-Supply Paper 1790–A, "Floods of March–April 1960 in Eastern Nebraska and Adjacent Areas," is a special report that describes floods in these areas in detail.

The areas for which flood reports have been prepared for 1960 are shown in figure 1. The area discussed in the special flood report is



...are prepared in this summary. Solid pattern indicates the area for which a indicated by a solid pattern, and other areas discussed in this summary chapter are shown by a line pattern. The months in which the floods occurred are shown; the map thereby gives both the location and the time distribution of floods during the year.

Of the 35 reports for the year, 20 are for floods in the 3 months May–July, and 9 of these are for floods in June.

A flood is the occurrence of high streamflow that overtops the natural or artificial banks in any reach of a stream. By popular definition, a flood is a discharge or a stage of extremely high magnitude that allows the writing or telling of a striking story about large areas inundated, much damage, or great loss of life. In a hydrologic sense, an outstanding flood need not be newsworthy and may be one of which only a few or possibly no persons are aware. An outstanding flood is a rare flood; one which will not be often duplicated at a given site. An unusually rare flood on an unoccupied or nonutilized flood plain would be little noticed by the public, but to the hydrologist it could be an event of great interest.

Floods result from the combined effects of meteorological events and the physiographic characteristics of a basin. The principal physiographic factors affecting flood flows from a basin are drainage area, altitude, geology, shape, slope, directional alinement, and ground cover. With the exception of ground cover, which varies seasonally, the factors are fixed for any area.

The meteorological factors, of which precipitation is the principal one, are variable with respect to both place and time. Other meteorological factors influencing floods are the form of the precipitation—whether rain, snow, hail, or sleet—the amount and intensity of the precipitation, the moisture conditions of the soil before the flood-producing precipitation, and the temperature, which may freeze the soil or may cause variation in rate of snowmelt.

In general, meteorological events determine when and where the floods will be. The magnitude and intensity of meteorological events combined with the effect on runoff of physiographic features inherent in the drainage basin determine what the magnitude of a flood will be. The many different and variable factors form innumerable combinations to produce floods of all degrees of severity.

If two floods have equal peak discharges but originate from different size drainage areas having similar runoff and climatologic characteristics, the one from the smallest drainage area would be the rarer or more outstanding flood. Also, if two floods have equal discharges and originate from equal drainage areas, the flood from the drainage area having geographic and climatologic characteristics that normally produce a smaller flood peak would be considered the rarer.

The severity and prevalence of floods are not determined by the

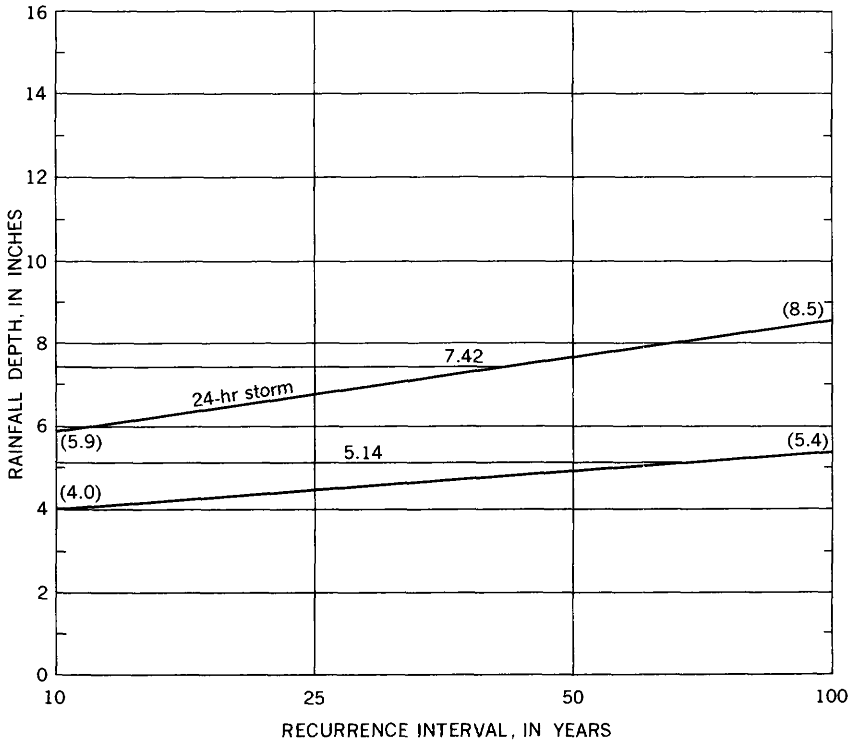


FIGURE 2.—Graph of rainfall depth versus recurrence interval of storms.

absolute values of the contributing factors such as amount and intensity of rainfall, peak discharge (in cubic feet per second), volume of runoff, and ratio of runoff to rainfall but are determined by the value of these factors relative to normal conditions.

Many of the flood reports give the amount of rainfall and the duration of the storm producing it. These data may be used to determine the recurrence interval of the storm.

Rainfall depths were computed by the U.S. Weather Bureau [1] for the 2-year storm and for the 100-year storm at 1-hour and at 24-hour durations throughout the conterminous United States. Isopluvial lines (lines representing rainfall of equal frequency) were drawn on each of four maps. It was established that the rainfall depths for recurrence intervals other than 2 and 100 years could be determined from a straight line between the relationships of rainfall depth versus recurrence interval for the 2-year and 100-year storms. Figure 2 is a graph for determining the approximate rainfall depths for storms having recurrence intervals of 10–100 years.

[1] U.S. Weather Bureau, 1961, Rainfall Frequency Atlas of the United States: Technical Paper 40, 115 p.

It was also established that the relationship of rainfall depth to duration of storm was a straight line between 1 hour and 24 hours on a graph such as the one shown in figure 3.

Four maps (figs. 4–7) show isopluvial lines for the limiting conditions of 1-hour and 24-hour durations at 10-year and 100-year recurrence intervals. By use of the two graphs (figs. 2, 3) and the four maps (figs. 4–7), the recurrence interval between 10 and 100 years of any storm having a duration of 1–24 hours can be determined

The method of using the maps and graphs is best explained through illustration: on July 29, 1960, 7.42 inches of rain fell in 24 hours at Wilson, N.C. From figures 5 and 7, the 10-year 24-hour rainfall and the 100-year 24-hour rainfall are 5.9 inches and 8.5 inches, respectively. The recurrence interval of 7.42 inches of rain in 24 hours is obviously between 10 and 100 years. The two hypothetical storms, 5.9 inches and 8.5 inches of rain in 24 hours, are plotted in figure 2 at 10 years and 100 years, respectively. A straight line between the two points represents a 24-hour storm at Wilson for any recurrence interval from 10 to 100 years. The given rainfall of 7.42 inches in 24 hours on the line represents about a 40-year storm. This same method can be used for a 1-hour storm by using figures 4 and 6.

For a duration between 1 and 24 hours, figure 3 must be used first to determine the hypothetical rainfalls for 1-hour and 24-hour storms which in turn are applied to figure 2: on June 23, 1960, 5.14 inches of rain fell in 12 hours at Louisville, Ky. From figures 4–7, four hypothetical storms are determined as follows: 10-year 1-hour storm = 2.04 inches; 10-year 24-hour storm = 4.50 inches; 100-year 1-hour

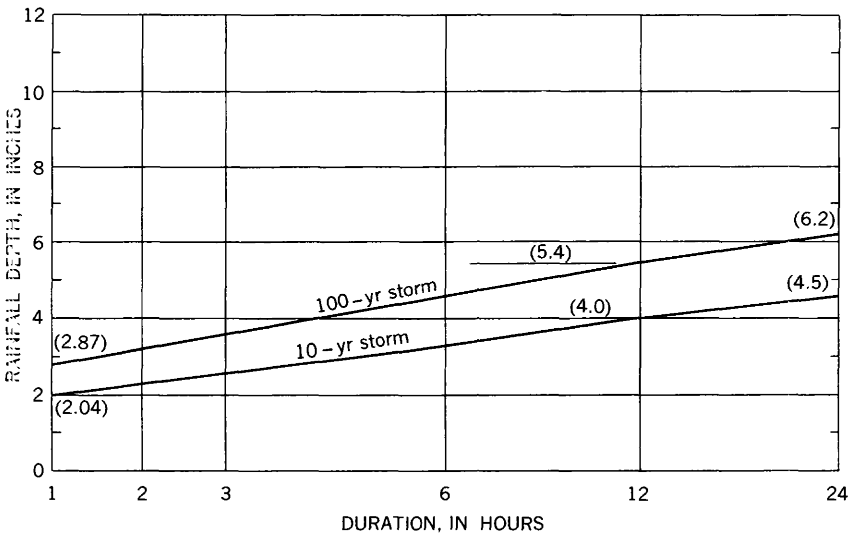


FIGURE 3.—Graph of rainfall depth versus duration of storms.

storm = 2.87 inches; 100-year 24-hour storm = 6.20 inches. These points are plotted in figure 3, and the two (10- and 100-year) recurrence interval lines are drawn. From these lines the rainfall for the 12-hour storm of the 10- and the 100-year recurrence intervals is determined to be 4.0 inches and 5.4 inches, respectively. These two values of the 12-hour storm are plotted in figure 2 as the range of a 12-hour rainfall. The given rainfall of 5.14 inches plots at a recurrence interval of about 65 years.

The continuing investigation of surface-water resources in the areas discussed in this report is performed by the U.S. Geological Survey in cooperation with State agencies, the U.S. Army Corps of Engineers, the Bureau of Reclamation, and other Federal or local agencies. Some data in this report were obtained from U.S. Weather Bureau publications.

The collection of data, the computations, and some of the preparation of text were made by the district offices of the Surface Water Branch in whose district the floods occurred.

The complete report was assembled and prepared in the Floods Section, Water Resources Division: Tate Dalrymple, chief.

DETERMINATION OF FLOOD STAGES AND DISCHARGES

The data for peak stages and discharges at gaging stations and at miscellaneous sites presented in this chapter are those which are obtained and compiled in the regular procedure of surface-water investigation by the Geological Survey.

The usual method of determining stream discharges at gaging stations is the application of a stage-discharge relation to the known stage. The relationship at a station is usually defined by current-meter measurements through the maximum range of stage. However, the peak discharge at a station may be above the range of the stage-discharge relation, and short extensions may be made to the graph of relation by logarithmic extrapolation, by velocity-area studies, or by use of other measurable hydraulic factors.

Peak discharges that are greatly above the range of the defined stage-discharge relation at gaging stations and peak discharges at miscellaneous sites are generally determined by various methods of indirect measurements at the sites. During major floods, adverse conditions often make current-meter measurements impossible to obtain at some sites; during such conditions, peak discharges are measured by indirect methods based on detailed surveys of selected channel reaches. A general description of these indirect methods is given in Water-Supply Paper 888. Water-Supply Papers 773–E, 796–G, and 816 contain more detailed descriptions and illustrated examples.

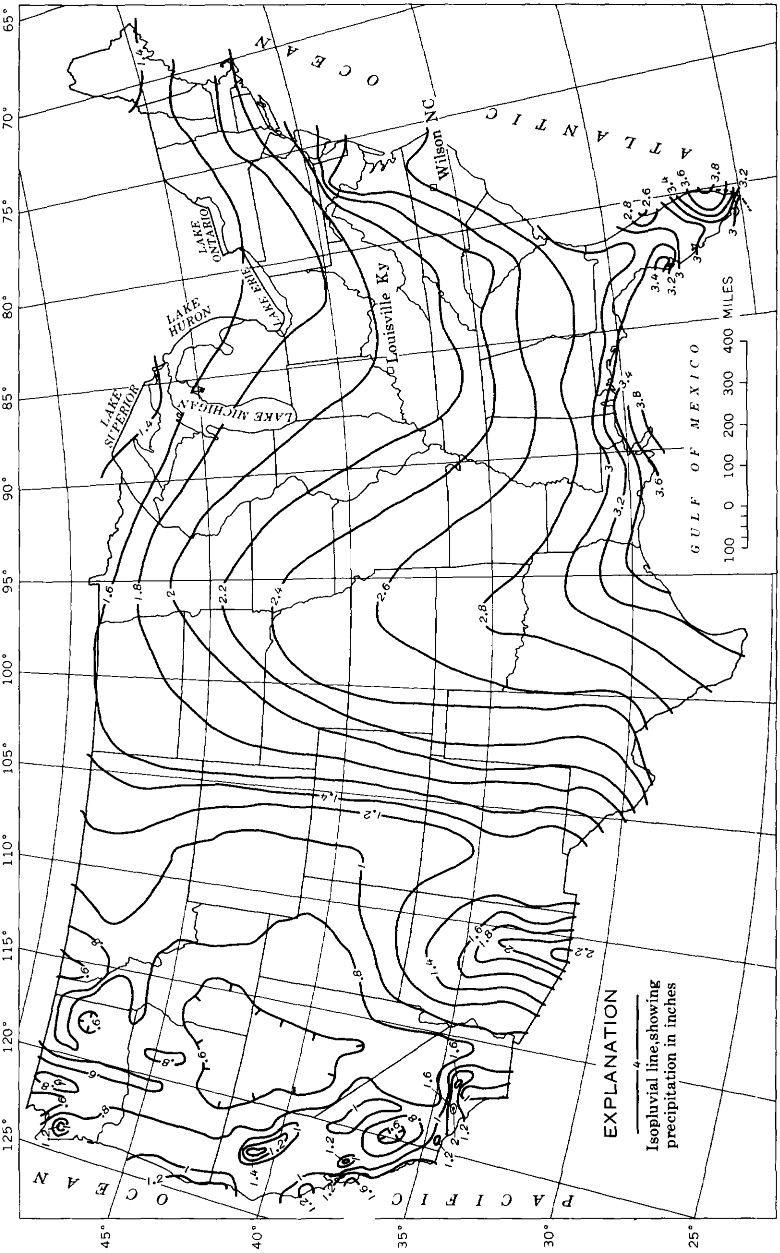


FIGURE 4.—Isopluvial map for a 10-year 1-hour storm in the conterminous United States. From the U.S. Weather Bureau, Technical Paper 40.

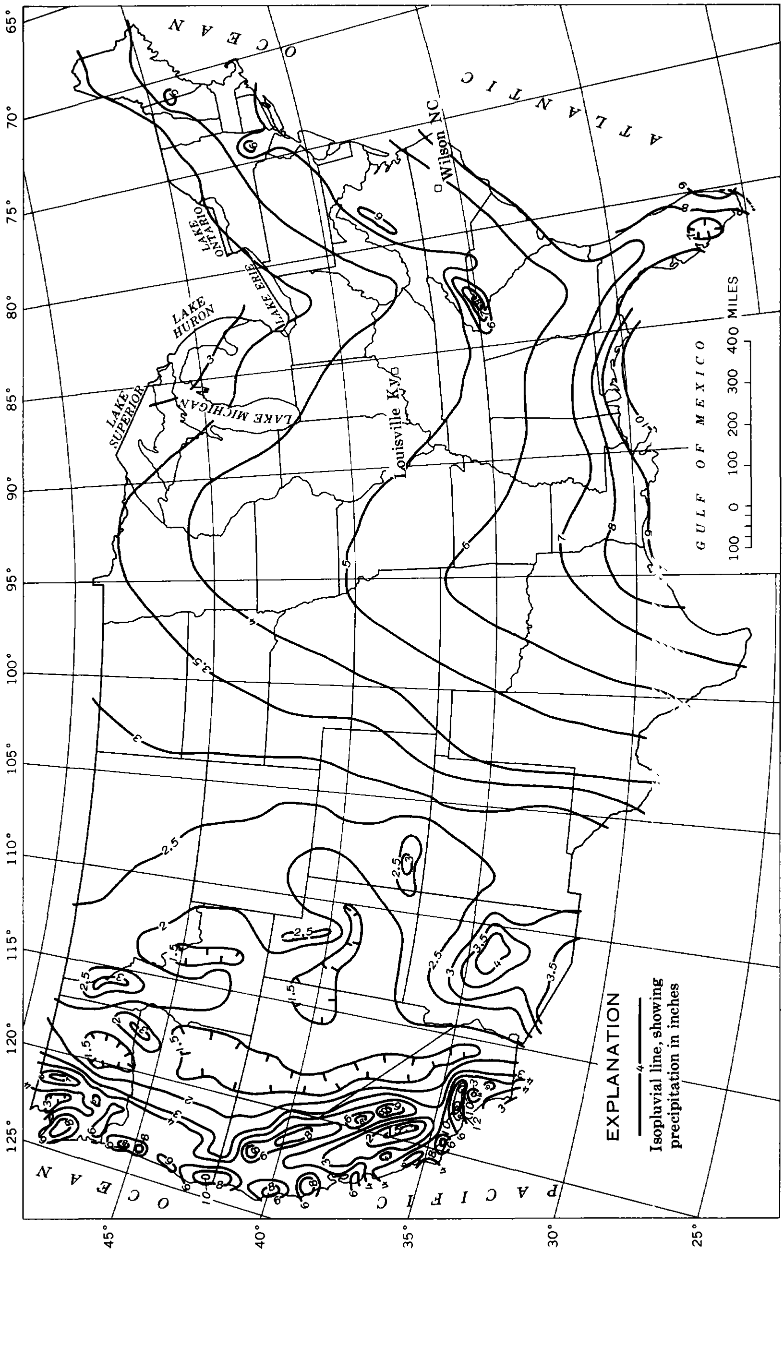


FIGURE 5.—Isopluvial map for a 10-year 24-hour storm in the conterminous United States. From the U.S. Weather Bureau, Technical Paper 40.

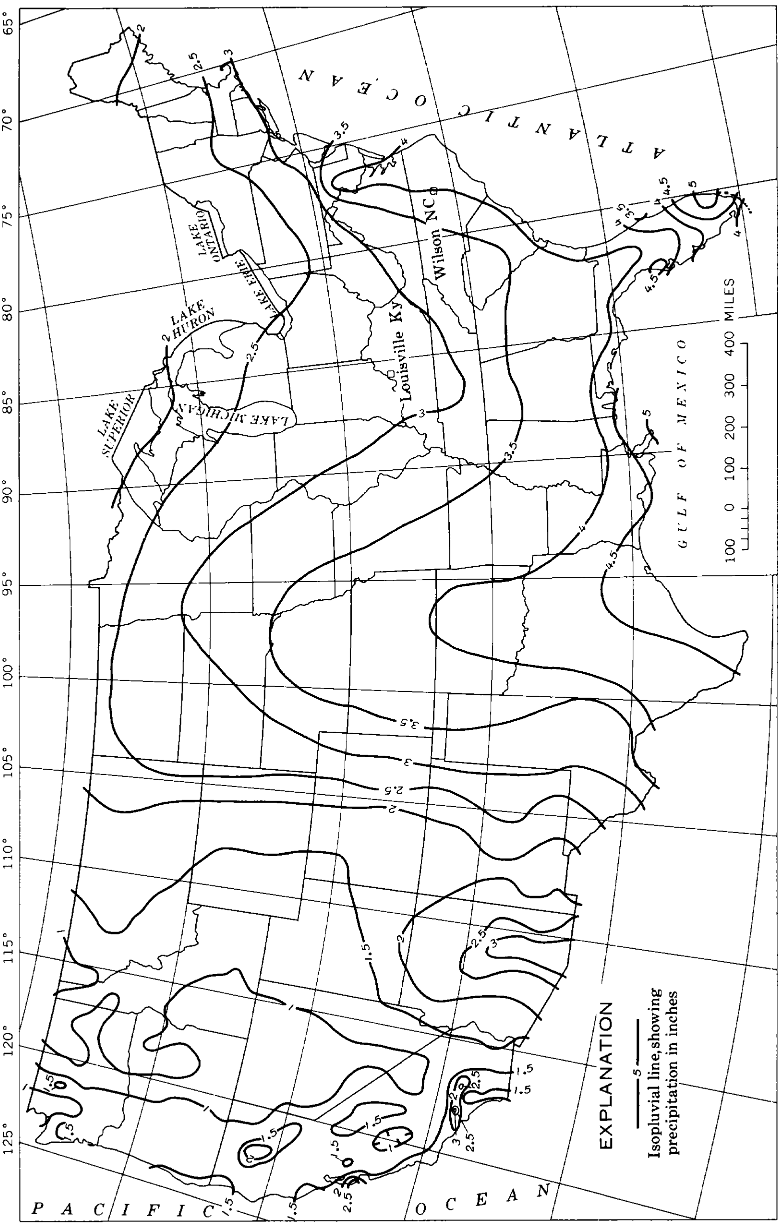


FIGURE 6.—Isopluvial map for a 100-year 1-hour storm in the conterminous United States. From the U.S. Weather Bureau, Technical Paper 40.

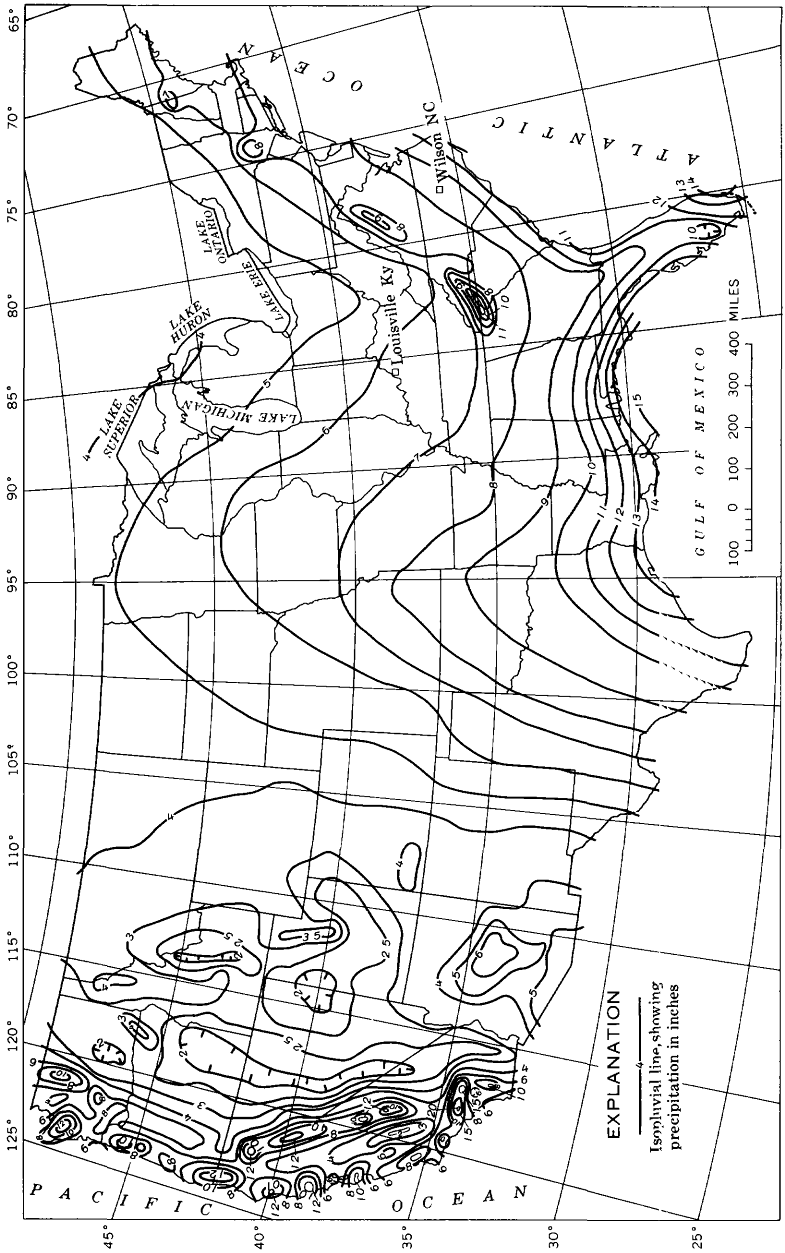


FIGURE 7.—Isopluvial map for a 100-year 24-hour storm in the conterminous United States. From the U.S. Weather Bureau, Technical Paper 40.

EXPLANATION OF DATA

The floods described herein are presented in chronological order. Because each flood has characteristics peculiar to itself and because amounts of information available are different for each flood, no consistent format is used in reporting the events.

The data include (1) a description of the storm, flood, and flood damage, (2) a map of the flood area showing the location of flood-determination points and, on some maps, isohyets or the location of precipitation-measuring stations, (3) rainfall data, and (4) peak stages and discharges during floods in the streams affected.

Usually, some rainfall amounts are included in the description of the flood. When considerable rainfall data are available, they are presented in tabular form and may include daily or storm totals. When sufficient data are available to determine the pattern and distribution of rainfall, an isohyetal map may be shown.

A table summarizing peak stages and discharges is given for each flood unless the number of stations reported is small; if the number is small, the information is included in the text description.

In the summary table, the first column under "Maximum floods" shows the period of known floods prior to the 1960 floods. This period does not necessarily correspond to that in which continuous records of discharge were obtained, but for many stations it extends back to an earlier date. More than one period of known floods are shown for some stations: periods are shown whenever maximum stages can be associated with them, even though the corresponding discharge may not be known, and a second period of known floods is given in which maximums of both discharge and stage are known.

The second column under "Maximum floods" shows the year, within the period of known floods, in which the maximum stage or discharge occurred. The third column gives the date of the peak stage or discharge during the 1960 floods.

The last column generally gives the recurrence intervals for the 1960 peak discharges. The recurrence interval is the average interval, in years, in which a flood of a given magnitude (the 1960 peak) will be equaled or 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 in the table were obtained from U.S. Geological Survey reports on flood magnitude and frequency (Statewide reports or from Water-Supply Papers referring to a specific part (principal river basins) of the United States.

757-337 O—65——2

In nearly all the flood-frequency reports referred to, the definition of the recurrence interval is limited to 50 years. When the recurrence interval of a flood exceeds 50 years, the severity of the flood is expressed as the ratio by which the peak discharge exceeded the 50-year flood.

SUMMARY OF FLOODS OF 1960

FLOODS OF FEBRUARY 8-10 IN NORTHERN CALIFORNIA

Heavy rainfall over northern California in early February brought floods to many lowland communities and caused major stream rises in all coastal basins north of San Francisco Bay and in the Sacramento Valley (fig. 8). Most of the precipitation was associated with a cold front that moved northeastward across the California coast early on February 8. Heavy orographic rains preceding the passage of the cold front started before noon on February 7 and continued for about 24 hours. During this time, the freezing level was generally at 8,000 feet.

The generalized isohyets in figure 8 show that precipitation totals of more than 10 inches were not unusual for the 5-day storm period February 6-10. Several precipitation stations received more than 6 inches of rainfall in 24 hours. Cloverdale (11W), in the Coast Range, reported 9.24 inches in 24 hours, and Blue Canyon, in the Sierra Nevada, reported 8.30 inches during a similar period. No hourly rainfall totals of more than 0.75 inch were reported.

The most damaging floods occurred in the coastal basins. The Eel and South Fork Eel Rivers, rising in some reaches at a rate of 3 feet per hour, surged over their banks and forced the evacuation of more than 200 residents from the lumber and resort communities of Weott, Pepperwood, and Myers Flat. In this same area, high water and slides blocked north-south highway U.S. 101. The peak discharge of 117,000 cfs (cubic feet per second) recorded at the gaging station on South Fork Eel River near Miranda has been exceeded only by the flood peak of December 1955 since the establishment of the station in 1940. The discharge hydrograph for this station is shown in figure 9.

The greatest damage in the Russian River basin occurred in the summer-resort communities along the 16-mile reach of river upstream from Duncan Mills. Commercial and residential areas were inundated, and highways were severely damaged. Agricultural loss was heavy throughout the basin, primarily as a result of deposition of river-borne silt on fields and orchards.

Farther south, in Marin County, widespread flooding of lowland communities occurred along Corte Madera Creek. The residents of more than 50 homes in Kentfield were evacuated by rowboat, and the General Hospital in Ross was marooned for several hours.

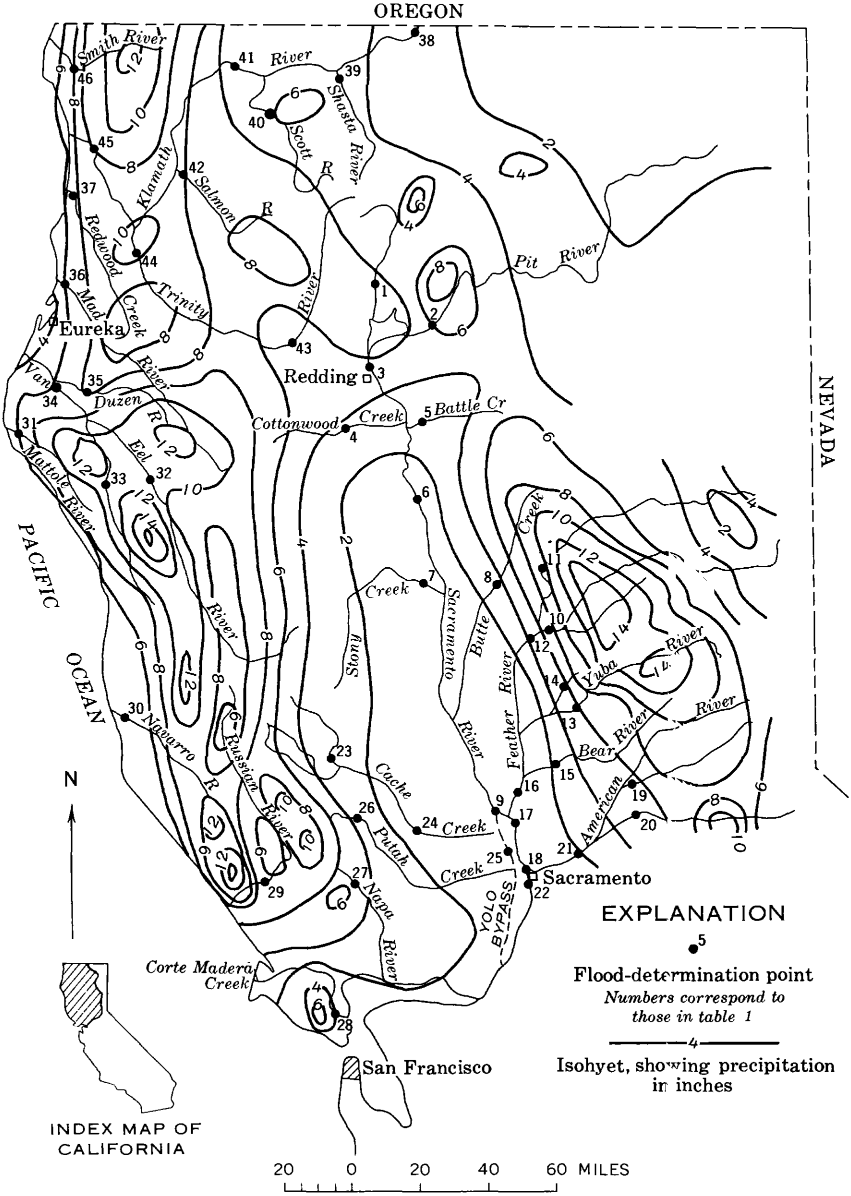


FIGURE 8.—Flood area; location of selected flood-determination points and isohyets for February 6–10 are shown. Floods of February 8–10 in northern California.

The Sacramento River Flood Control Project, an extensive system of dams, levees, and floodways, functioned very effectively. As a

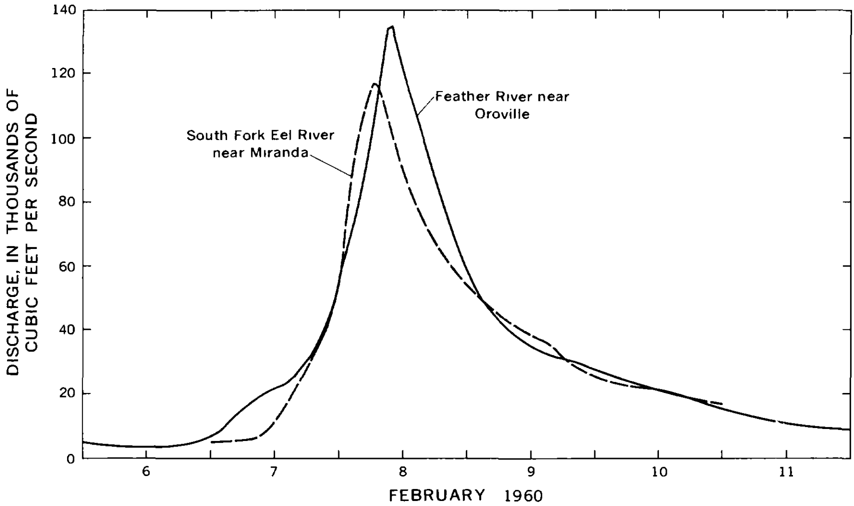


FIGURE 9.—Discharge hydrographs for South Fork Eel River near Miranda, Calif., and for Feather River near Oroville, Calif., February 6–11.

result of operations at Shasta Reservoir, the discharge of the upper Sacramento River at Keswick did not exceed 8,830 cfs. Farther downstream, overflow occurred at all relief weirs except Sacramento Weir, and project floodways carried substantial flows. Folsom Lake was effective in limiting the peak discharge to 5,260 cfs about 7 miles downstream in the American River at Fair Oaks. Some flooding, however, occurred in the Little Holland tract in the Sacramento River delta area.

The most noteworthy peak discharges in the Sacramento River basin occurred on the Feather River and its tributaries. The peak discharges exceeded those of the flood of February 1958, and the discharge of 9,730 cfs on Dry Creek at Virginia Ranch was greater than that of the flood of December 1955. The discharge hydrograph for Feather River near Oroville is shown in figure 9. Table 1 lists peak discharges for 46 selected gaging stations shown in figure 8.

Stream bank erosion was the principal source of flood damage in the Sacramento River basin, and other damage was relatively light. In the coastal basins, one life was lost and damage totalled about $2 million, of which three-fourths was agricultural and highway damage. Table 2 summarizes flood damage in the coastal basins under six categories as compiled by the Corps of Engineers, San Francisco District.

TABLE 1.—*Flood stages and discharges, February 8–10, in northern California*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods				
			Prior to Feb. 1960		February	Gage height (ft)	Discharge (cfs)
			Period	Year			
	Sacramento River basin						
1	Sacramento River at Delta	427	1944–60	1955		19.50	37,000
					8	13.05	16,300
2	Pit River near Montgomery Creek.	5,170	1944–60	1955		14.12	[1] 37,100
					8	9.04	[1] 17,000
3	Sacramento River at Keswick	6,710	1938–60	1940		(2)	186,000
					9	12.36	[1] 8,830
4	Cottonwood Creek near Cottonwood.	945	1940–60	1941		15.4	52,300
					8	12.78	26,100
5	Battle Creek near Cottonwood	362	1937	1937		15.8	35,000
			1940–60	1942		11.85	12,800
					7	8.48	5,410
	Sacramento River near Red Bluff	9,300	1892–1960	1940		38.9	291,000
					8	17.29	[1] 77,600
7	Stony Creek near Hamilton City	764	1941–60	1958		18.31	[1] 39,900
					8	12.63	[1] 10,800
8	Butte Creek near Chico	148	1930–60	1955		13.35	18,700
					8	7.75	6,490
9	Sacramento River at Knight Landing.		1940–60	1942		41.83	
				1958			[1] 29,600
					10	37.76	[1] 24,900
10	Feather River at Bidwell Bar	1,353	1862	1862		32.1	(2)
			1911–60	1955		25.5	104,000
					8	20.50	62,800
11	North Fork Feather River at Big Bar.	1,945	1910–60	1955		35.60	[1] 72,400
					8	25.10	[1] 34,300
12	Feather River near Oroville	3,611	1901–60	1907		(2)	230,000
					8	63.80	[1] 135,000
13	Yuba River at Englebright Dam	1,104	1941–60	1955		(2)	[1] 148,000
					8	(2)	[1] 86,000
14	Dry Creek at Virginia Ranch	71.3	1948–60	1955		9.85	9,120
					8	10.08	9,730
15	Bear River near Wheatland	295	1928–60	1955		19.30	[1] 33,000
					8	16.80	[1] 27,500
16	Feather River at Nicolaus	5,920	1943–60	1955		51.60	[1] 357,000
					9	46.06	136,000
17	Sacramento River at Verona		1926–60	1940		41.20	[1] 79,200
					9	35.45	[1] 64,500
18	Sacramento Weir near Sacramento		1926–60	1928			[1] 118,000
				1950		32.92	
					10	(2)	[1,3] 264
19	Middle Fork American River near Auburn.	619	1911–60	1955		33.9	79,000
					8	22.74	36,700
20	South Fork American River near Lotus.	678	1862–1960	1955		21.37	[3] 71,800
					8	10.15	8,890
21	American River at Fair Oaks	1,889	1904–60	1950		31.85	180,000
					8	3.99	[1] 5,260
22	Sacramento River at Sacramento		1948–60	1950		30.14	[1] 104,000
					10	21.39	[1] 69,600
23	North Fork Cache Creek near Lower Lake.	198	1930–60	1937		13.98	20,300
					8	11.03	11,500
24	Cache Creek near Capay	1,052	1942–60	1958		20.90	[1] 51,600
					8	13.08	[1] 18,400
25	Yolo bypass near Woodland		1939–60	1942		32.00	[1] 272,000
					9	27.06	[1] 73,600
26	Putah Creek near Guenoc	112	1904–06, 1930–60	1937		22.7	32,000
					8	17.90	18,600
	Coastal basins						
27	Napa River near St. Helena	81.3	1929–32, 1939–60	1955		16.17	12,600
					8	14.48	11,600
28	Corte Madera Creek at Ross	18.3	1951–60	1955		17.45	3,620
					8	14.87	2,610
29	Russian River near Guerneville	1,342	1939–60	1955		49.7	90,100
					8	40.80	63,100

TABLE 1.—*Flood stages and discharges, February 8–10, in northern California*—Con.

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to Feb. 1960: Period	Maximum floods: Prior to Feb. 1960: Year	Maximum floods: February	Maximum floods: Gage height (ft)	Maximum floods: Discharge (cfs)
	Coastal basins—Continued						
30	Navarro River near Navarro	304	1950–60	1955		40.60	64,500
					8	30.98	24,800
31	Mattole River near Petrolia	242	1911–13, 1950–60	1955		29.60	90,400
					8	25.34	62,000
32	Eel River at Alderpoint	2,079	1955–60	1955		72.5	376,000
					8	55.70	220,000
33	South Fork Eel River near Miranda.	537	1940–60	1955		42.7	173,000
					8	34.61	117,000
34	Eel River at Scotia	3,113	1910–60	1955		61.90	541,000
					8	51.45	343,000
35	Van Duzen River near Bridgeville	214	1950–60	1955		21.3	43,500
					8	17.60	30,000
36	Mad River near Arcata	485	1910–13, 1950–60	1955		27.30	77,800
					8	17.85	48,000
37	Redwood Creek at Orick	278	1911–13, 1953–60	1953, 1955.		23.95	50,000
					8	18.70	24,900
38	Klamath River below Fall Creek near Copco.	4,370	1923–60	1955		8.15	[1] 12,000
					8	5.36	[1] 5,110
39	Shasta River near Yreka	796	1933–41, 1944–60	1955		9.43	6,090
					9	6.02	1,740
40	Scott River near Fort Jones	662	1941–60	1955		21.40	38,500
					8	10.79	8,220
41	Klamath River near Seiad Valley	6,980	1912–25, 1951–60	1955		29.2	122,000
					8	11.90	[1] 19,600
42	Salmon River at Somesbar	746	1911–15, 1927–60	1955		28.80	84,000
					8	12.97	25,900
43	Trinity River at Lewiston	726	1911–60	1955		27.3	71,600
					8	13.88	17,900
44	Trinity River near Hoopa	2,846	1911–14, 1916–18, 1931–60.	1955		36.90	190,000
					8	24.78	85,700
45	Klamath River near Klamath	12,100	1910–26, 1950–60	1955		49.7	425,000
					8	30.08	195,000
46	Smith River near Crescent City	613	1913–60	1955		41.20	165,000
					8	28.13	74,300

[1] Affected by storage or diversion.
[2] Not determined.
[3] Not necessarily the maximum for the period.

TABLE 2.—*Flood damage in coastal basins of California in February*

[Compiled by Corps of Engineers, San Francisco District]

Stream basin	Flood damage: Agricultural	Flood damage: Highways and public facilities	Flood damage: Residential	Flood damage: Commercial	Flood damage: Public utilities	Flood damage: Emergency aid	Flood damage: Total in basin
Eel River	$528,800	$412,200	$35,800	$136,500	$62,800	$11,000	$1,187,100
Russian River	365,900	205,900	25,500	107,300	3,600	0	708,200
Subtotal	894,700	618,100	61,300	243,800	66,400	11,000	1,895,300
Corte Madera Creek							50,000
Total							1,945,300

Flooding occurred in several low altitude basins in southern Idaho (fig. 10) as a result of the melting of shallow snow by high temperatures accompanied by rain. Blackfoot River near Blackfoot, Idaho, reached the highest discharge in 18 years of summer record and in 29 years of complete record. Big Wood River basin below Magic and Little Wood Reservoirs had the highest rate of runoff since 1922. Since 1922 several floods have been higher at the gaging station Big Wood River near Gooding, but all came from the basin above Magic Reservoir. The peak discharge on Clover Creek near Bliss was nearly twice the previous maximum in the 8 years of record. (See table 3.)

Considerable damage at Blackfoot was averted by recently constructed or improved dikes. Damage was limited to flooded farmlands and roads. Areas flooded were all in rural areas that were not extensively developed. Crops were not yet planted, and damage was relatively light.

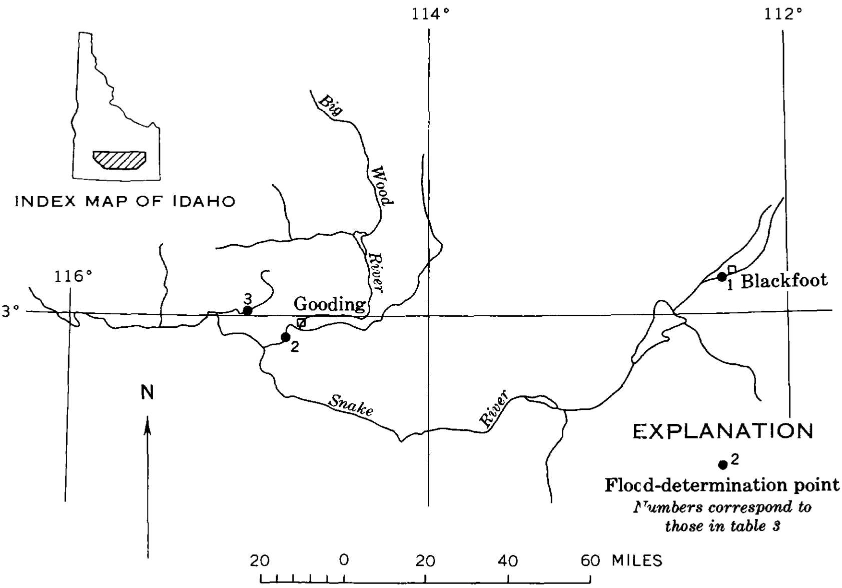


FIGURE 10.—Flood area; location of flood-determination points is shown. Floods of March 7-9 in southern Idaho.

TABLE 3.—*Flood stages and discharges, March 7–9, in southern Idaho*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods					
			Prior to Mar. 1960		March	Gage height (ft)	Discharge (cfs)	Recurrence interval (yrs)
			Period	Year				
	Snake River basin							
1	Blackfoot River near Blackfoot.	1,295	1913–60	1957		7.04	1,040	
					9	6.42	1,070	30
2	Big Wood River below Magic and Little Wood reservoirs near Gooding.	[1] 1,110	1916–60	1922		9.00	3,680	
					8	8.30	3,190	30
					9	[2] 8.82		
3	Clover Creek near Bliss	140	1938–43, 1957–60	1942		6.68	1,560	
					7	7.57	2,700	[3] 1.55

[1] Does not include area above reservoir.
[2] Caused by ice jam.
[3] Ratio of peak discharge to that of 50-year flood.

FLOODS OF MARCH 17–APRIL 5 IN CENTRAL FLORIDA

Unusually heavy and unseasonal rains on March 15–18 centered in an area 25 miles north of Tampa and extended across the north-central part of the peninsula (fig. 11). More than 15 inches of rain was measured north of Tampa in the 4 days, and unofficial reports indicate as much as 20 inches may have fallen at scattered points. The greatest 1-day precipitation recorded was 6.96 inches at Lakeland on March 16, and 12.81 inches fell at Bay Lake on March 16 and 17. The greatest 4-day total recorded was 15.60 inches at Saint Leo.

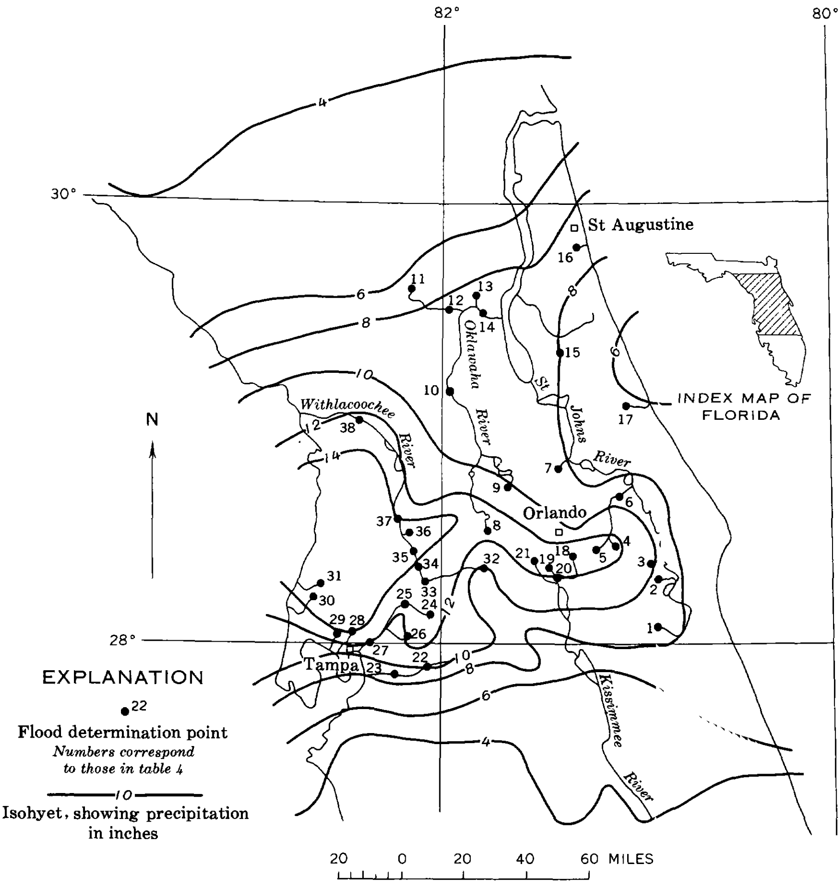


Figure 11.—Flood area; location of flood-determination points and isohyets for March 15–18 are shown. Floods of March 17–April 5 in central Florida.

The intense rains caused most streams in the area to go out of their banks by March 18 or 19, and some streams reached peak stages and discharges higher than any previously known (table 4).

Several thousand persons were evacuated from homes in low-lying and poorly drained areas. Damage to homes, roads, and crops was extensive, and 12 counties in central Florida were declared a disaster area.

TABLE 4.—*Flood stages and discharges, March 17–April 5, in central Florida*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to March 1960: Period	Prior to March 1960: Year	March–April	Gage height (ft)	Discharge (cfs)	Recurrence interval (yrs)
	St. Johns River basin							
1	Jane Green Creek near Deer Park.	248	1953–60	1956		10.95	18,400	
					Mar. 19	9.58	10,700	25
2	Wolf Creek near Deer Park	26.3	1956–60	1956		7.93	7,700	
					Mar. 17	7.99	2,700	48
3	Jim Creek near Christmas	22.7			do	9.18	3,750	[1] 1.50
4	Econlockhatchee River near Bithlo.	119			do	20.51	7,840	50
5	Little Econlockhatchee River near Union Park.	27.1			do	11.64	1,640	10
6	Econlockhatchee River near Chuluota.	260	1935–60	1948		18.09	10,000	
					Mar. 18	[2] 18.69	11,000	23
7	Wekiva River near Sanford.		1935–60	1945		5.60	2,060	
					Mar. 18	5.48	1,950	
8	Big Creek near Clermont	68	1958–60	1958		5.64	283	
					Mar. 18	6.14	628	
9	Apopka-Beauclair Canal near Astatula.	180	1958–60	1959		68.07		
				1959			[3] 478	
					Mar. 17	68.2		
					Mar. 19		[3] 754	
10	Oklawaha River near Ocala.	1,100	1930–60	1933		5.52		
				1934			1,810	
					Mar. 18	5.68	2,270	
11	Lochloosa Creek at Grove Park.	34.7			do	7.90	920	30
12	Orange Creek at Orange Springs.	431	1941–52, 1955–60	1941		10.6	2,400	
					Mar. 18	8.52	1,230	10
13	Deep Creek near Rodman	54.3			do	14.16	1,280	
14	Oklawaha River at Riverside Landing near Orange Springs.	2,100	1943–60	1950		9.50	7,320	
					Mar. 20	9.80	7,830	
15	Little Haw Creek near Seville.	120	1951–60	1953		8.72	1,490	
					Mar. 19	8.58	1,600	
	Moultrie Creek basin							
16	Moultrie Creek near St. Augustine.	23.3	1939–60	1941		9.31	1,370	
					Mar. 18	8.37	936	5
	Spruce Creek basin							
17	Spruce Creek near Samsula	32	1951–60	1953		15.49	798	
					Mar. 17	13.56	501	

See footnotes at end of table.

TABLE 4.—*Flood stages and discharges, March 17–April 5, in central Florida*—Con.

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to Mar. 1960 — Period	Year	March–April	Gage height (ft)	Discharge (cfs)	Recurrence interval (yrs)
	Lake Okeechobee and the Everglades							
18	Boggy Creek near Taft	83.6			Mar. 18	13.64	3,680	10
19	Shingle Creek near Vineland.	45.1			Mar. 17	12.61	40.8	5
20	Shingle Creek at Airport near Kissimmee.	86.4	1958–60	1958		9.17	1,250	
					Mar. 18	11.00	3,320	7
21	Cypress Creek at Vineland.	30.3	1945–60	1945			181	
				1959		3.88		
					Mar. 18	4.45	276	[1] 1.32
	Alafia River basin							
22	North Prong Alafia River at Keysville.	175	1950–60	1959		13.47	5,580	
					Mar. 17	14.50	7,000	14
23	Alafia River at Lithia	335	1933–60	1933		25.6	19,300	
					Mar. 18	17.20	7,250	5
	Hillsborough River basin							
24	Blackwater Creek near Knights.	110	1951–60	1959		8.70	2,220	
					Mar. 18	9.70	5,400	18
25	Hillsborough River near Zephyrhills.	220	1939–60	1947			5,920	
				1950		13.80		
					Mar. 18	15.33	12,600	[1] 1.02
26	Pemberton Creek near Dover.	24	1957–60	1959		6.6	330	
					Mar. 17	8.78	1,400	8
27	Hillsborough River near Tampa.	650	1933	1933			16,500	
			1938–60	1945			9,690	
				1950		22.76		
					Mar. 19	22.62		
					Mar. 21		14,600	
	Sweetwater Creek basin							
28	Sweetwater Creek near Sulphur Springs.	6.4	1951–60	1959		14.23	1,380	
					Mar. 17	4.25	438	
	Rocky Creek basin							
29	Rocky Creek near Sulphur Springs.	35	1953-60	1959		14.23	1,380	
					Mar. 17	16.09	2,340	

See footnotes at end of table.

TABLE 4.—*Flood stages and discharges, March 17–April 5, in central Florida*—Con.

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to March 1960: Period	Maximum floods: Prior to March 1960: Year	Maximum floods: March–April	Maximum floods: Gage height (ft)	Maximum floods: Discharge (cfs)	Maximum floods: Recurrence interval (yrs)
	Lake Tarpon basin							
30	Brooker Creek near Tarpon Springs.	30	1950–60	1950	----------	12.80	1,030	------
					Mar. 17	13.32	1,600	------
	Anclote River basin							
31	Anclote River near Elfers	72.5	1945–60	1945	----------	27.7	5,000	------
					Mar. 18	26.05	3,850	------
	Withlacoochee River basin							
32	Withlacoochee River near Eva.	130	1958–60	1959	----------	--------	836	------
				1959	----------	6.25	----------	------
					Mar. 17	6.90	2,160	------
33	Withlacoochee-Hillsborough overflow near Richland.[4]	----------	----------	------	Mar. 19	6.87	1,880	------
34	Withlacoochee River near Dade City.	390	1930–33, 1958–60	1959	----------	--------	2,740	------
					Mar. 21	14.28	5,900	------
35	Withlacoochee River at Trilby.	580	1928–60	1934	----------	[5] 20.5	8,840	------
					Mar. 23	19.38	6,920	38
36	Little Withlacoochee River at Rerdell.	160	1958–60	1959	----------	10.74	1,940	------
					Mar. 19	12.32	3,400	------
37	Withlacoochee River at Croom.	880	1934	1934	----------	15.2	([6])	------
			1939–60	1950	----------	12.71	8,450	------
					Mar. 23	13.78	8,650	30
38	Withlacoochee River near Holder.	1,710	1928–60	1934	----------	--------	6,740	------
				1934	----------	11.63	----------	------
					Apr. 5	13.28	8,660	19

[1] Ratio of peak discharge to that of 50-year flood.
[2] Maximum stage since at least 1928.
[3] Daily mean discharge.
[4] High-water diversion from Withlacoochee River basin to Hillsborough River basin.
[5] At site 1½ miles downstream at datum 0.12 ft. lower.
[6] Not determined.

FLOODS OF MARCH–APRIL IN THE SKUNK RIVER AND LOWER IOWA RIVER BASINS, IOWA

As the result of heavy snowfalls that accumulated during the winter and melted rapidly under warm temperatures and sunny skies, Iowa streams were in flood at the end of March. At many points the snowfall amounts exceeded any previously recorded, and nearly all of it remained on the ground. Snow surveys made in March indicated water contents of more than 5 inches in some places.

Because the snow melted rapidly, it produced floods on all streams in the State. The most outstanding of these floods were in the southeastern corner of the State (fig. 12). The peaks on the smaller streams were not of record-breaking proportion; however, the concentration produced in the larger streams resulted in much greater floods. The floods on the Lower Skunk River was the greatest in a period of 48 years of record at the gaging station at Augusta (table 5) and greatly exceeded a 50-year flood in the lower Iowa River basin, in Bear River at Ladora, and in English River at Kalona. In the lower Cedar River on April 4, the peak almost equaled the maximum

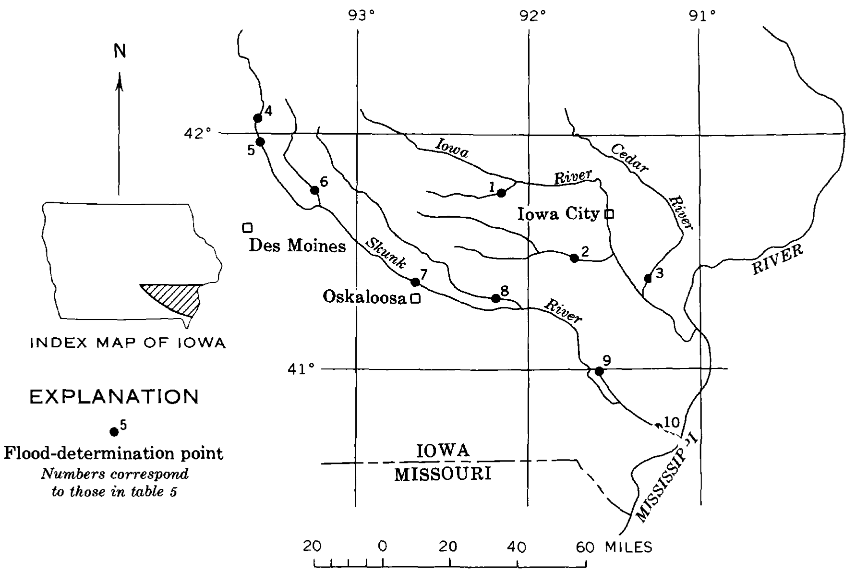


FIGURE 12.—Flood area; location of flood-determination points is shown. Floods of March–April in Skunk River and lower Iowa River basins, Iowa.

discharge and slightly exceeded the maximum stage since 1939, and the peak stage was only 0.2 foot lower than the maximum stage since 1900. Discharge hydrographs (fig. 13) for two stations in the Skunk River basin show the high discharges that occurred and illustrate the great degree by which the peak discharge on North Skunk River near Sigourney exceeded the previous maximum discharge of record.

Damage was not heavy because of protective works and the adequate forewarning provided. No loss of life or serious injury from the flood was reported.

TABLE 5.—*Flood stages and discharges, March–April, in Iowa*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to Mar. 1960: Period	Year	March–April	Gage height (ft)	Discharge (cfs)	Recurrence interval (yrs)
	Iowa River basin							
1	Bear Creek at Ladora	189	1945–60	1946			9,050	
				1958		13.78		
					Mar. 30	14.60	10,500	[1] 1.8
2	English River at Kalona	573	1930	1930		19.9	18,500	
			1939–60	1946		19.74	16,400	
					Mar. 31	19.89	18,500	[1] 1.4
3	Cedar River near Conesville.	7,785	1900–60	1929		15.8	(2)	
			1939–60	1947		15.35	60,000	
					Apr. 4	15.60	58,800	13
	Skunk River basin							
4	Skunk River near Ames	315	1920–27, 1932–60	1944		13.90		
				1954			8,630	
					Mar. 30	10.33	6,210	17
5	Skunk River below Squaw Creek near Ames.	556	1944	1944		13	10,000	
			1952–60	1954			8,700	
				1958		12.82		
					Mar. 30	13.20	9,260	17
6	Indian Creek near Mingo	276	1944	1944		21.4	(2)	
			1958–60	1959		13.50	2,710	
					Mar. 30	15.07	5,860	16
7	Skunk River near Oskaloosa.	1,635	1944–60	1944		25.8	37,000	
					Apr. 3	20.56	14,800	7
8	North Skunk River near Sigourney.	730	1944–60	1944		22.8	14,500	
					Mar. 31	25.33	27,500	[1] 1.8
9	Big Creek near Mount Pleasant.	106	1948	1948		27	(2)	
			1955–60	1958			1,600	
				1959		10.77		
					Mar. 29	15.30	4,460	[1] 1.2
10	Skunk River at Augusta	4,303	1903	1903		21	45,000	
			1913–60	1944		23.04	44,800	
					Apr. 3	25.00	51,000	40

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

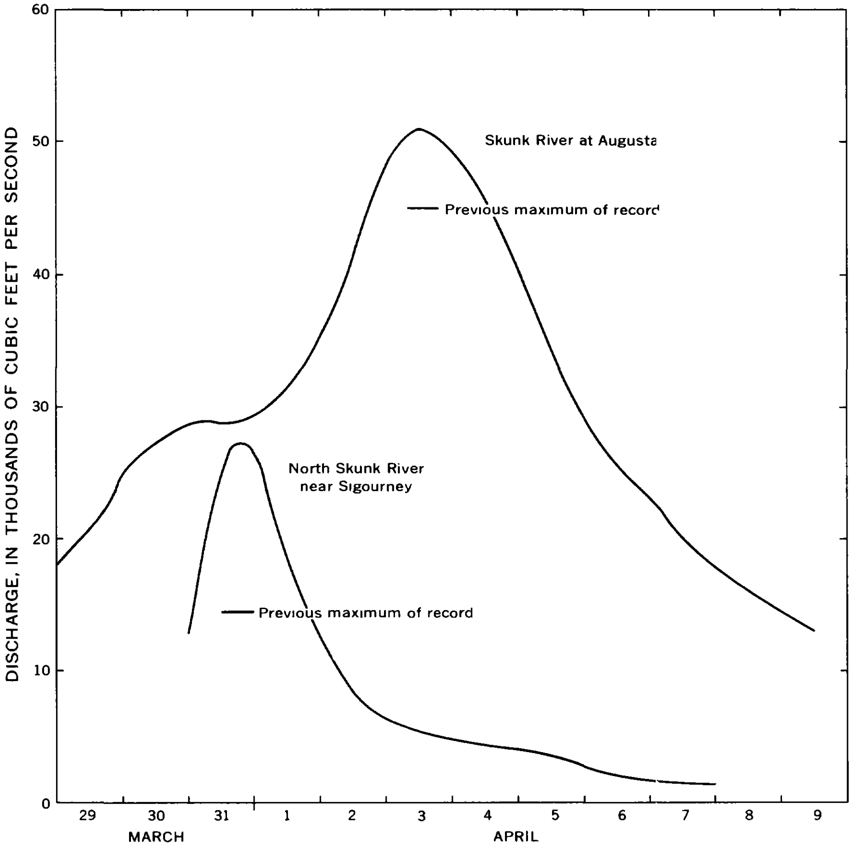


FIGURE 13.—Discharge hydrographs, Skunk River basin. Floods of March-April in Iowa.

FLOODS OF MARCH 29–APRIL 6 IN SOUTHEASTERN WISCONSIN AND NORTHEASTERN ILLINOIS

The southeastern part of Wisconsin and the northern part of Illinois received excessive snowfall during the winter of 1959–60. March 1960 was the coldest March of record, and record amounts of snow lay on the ground at the end of the month. General rains of long duration fell in the area March 30–31. The rain varied in intensity, and Milwaukee received 2.57 inches in 24 hours, a record for such a storm in March. The heavy snow cover and ice-covered ground, high temperatures, and rain caused many of the major rivers to go out of their banks (fig. 14). High water from the Milwaukee, Kinnickinnic, and Root Rivers and from other waterways in and around Milwaukee was the highest in 40 years; that from rivers and waterways in northeastern Illinois was less extreme.

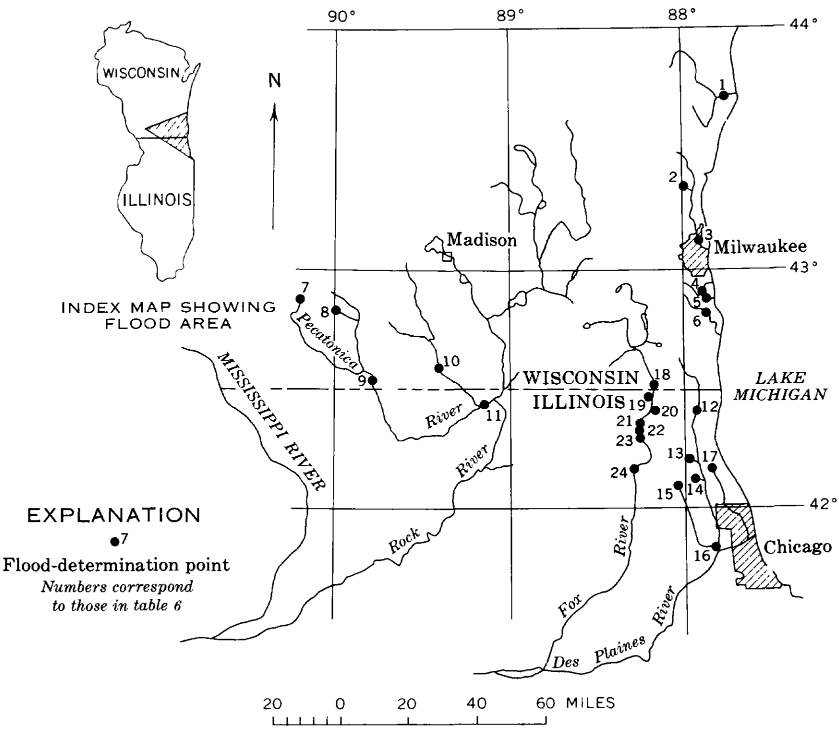


FIGURE 14.—Flood area; location of flood-determination points is shown. Floods of March 29–April 6 in southeastern Wisconsin and northeastern Illinois.

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Flood damage was extensive. Large sections of industrial areas in Milwaukee were inundated. Many families were evacuated, and many basements were flooded. New housing developments in low-lying areas were inundated, and major traffic arteries were blocked by the high water. Ice jams aggravated conditions at many stream constrictions. Suburban areas north of Chicago near the Des Plaines and the North Branch Chicago Rivers were flooded. Rises on the Pecatonica and Rock Rivers caused evacuation of residents from low-lying areas in Freeport and Rockford, Ill., and some farmland was flooded.

The Milwaukee River had the highest discharge since 1929. Cedar Creek near Cedarburg, Fox River at Wilmot, and Yellowstone River near Blanchardville, Wis., had peak flows of record (table 6). Less extreme floods occurred in the Sheboygan River near Sheboygan, Wis., the Sugar River near Brodhead, Wis., and the Rock and Pecatonica Rivers.

Crest-stage gages in southeastern Wisconsin recorded moderate to high stages; the highest unit discharges were at Oak Creek near South Milwaukee (79.1 cfs per sq mi) and at Rock Branch near Mineral Point (230 cfs per sq mi). Stages in the Fox Chain-of-Lakes were record breaking at all five stations. The peak discharge on Fox River at Algonquin, Ill., was the greatest in 45 years of record.

TABLE 6.—*Flood stages and discharges, March 29–April 6, in southern Wisconsin and northern Illinois*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to Mar. 1960: Period	Maximum floods: Prior to Mar. 1960: Year	Maximum floods: March–April	Maximum floods: Gage height (ft)	Maximum floods: Discharge (cfs)	Maximum floods: Recurrence interval (yrs)
	Streams tributary to Lake Michigan							
1	Sheboygan River at Sheboygan, Wis.	432	1916–24, 1950–60	1920		[1] 9.40	7,140	
					Mar. 30	10.65	6,300	13
2	Cedar Creek near Cedarburg, Wis.	121	1930–60	1952		11.40	3,500	
					Mar. 30	12.25	3,600	50
3	Milwaukee River at Milwaukee, Wis.	686	1914–60	1918, 1924		[1] 9.00	15,100	
					Mar. 31	8.05	9,300	15
4	Oak Creek near South Milwaukee, Wis.	13.9			Mar. 30	17.49	1,100	
5	Kinnickinnic River at 27th St., Milwaukee, Wis.	17.6			do		1,780	
6	Root River at State Highway 100, near Milwaukee, Wis.	49.0			do		5,130	

See footnotes at end of table.

TABLE 6.—*Flood stages and discharges, March 29–April 6, in southern Wisconsin and northern Illinois*—Continued

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods					
			Prior to Mar. 1960		March–April	Gage height (ft)	Discharge (cfs)	Recurrence interval (yrs)
			Period	Year				
	Rock River Basin							
7	Rock Branch near Mineral Point, Wis.	5.04			Mar. 29	16.14	1,160	
8	Yellowstone River near Blanchardville, Wis.	29.1	1954–60	1959		10.00	2,000	
					Mar. 29	10.47	2,240	
9	Pecatonica River at Martintown, Wis.	1,040	1939–60	1959		20.23	14,200	
					Apr. 1	19.55	12,800	7
10	Sugar River near Brodhead, Wis.	527	1914–60	1915		11.4	14,800	
					Mar. 31	9.72	10,2[illegible]	11
11	Pecatonica River at Shirland, Ill.	2,540	1939–60	1959		17.45	16,000	
					Apr. 3	17.08	16,000	5
	Illinois River Basin							
12	Des Plaines River near Gurnee, Ill.	215	1945–60	1948		9.21	2,620	
					Apr. 2	10.64	4,070	
13	Buffalo Creek near Wheeling, Ill.	19.4	1952–60	1957		6.26	430	
					Mar. 29	5.60	457	
14	Des Plaines River near Des Plaines, Ill.	359	1938–60	1938		9.7	5,5[illegible]	
					Apr. 2	8.56	4,670	10
15	Salt Creek near Arlington Heights, Ill.	33.7	1950–60	1957		9.82	572	
					Mar. 30	9.37	721	
16	Des Plaines River at Riverside, Ill.	635	1914–60	1919		(2)	7,450	
			1943–60	1960		[3] 8.89		
					Apr. 3	7.46	5,500	6
17	North Branch Chicago River at Deerfield, Ill.	20.7	1952–60	1959		9.63	292	
					Mar. 30	9.59	234	
18	Fox River at Wilmot, Wis.	880	1939–60	1943		8.7	5,700	
					Mar. 31	9.25	7,520	50
19	Channel Lake near Antioch, Ill.		1939–60	1948		5.23		
					Apr. 6	6.08		
20	Fox Lake near Lake Villa, Ill.		1939–60	1948		5.07		
					Apr. 6	5.92		
21	Nippersink Lake at Fox Lake, Ill.		1939–60	1948		5.16		
					Apr. 5	5.99		
22	Fox River at Johnsburg, burg, Ill.		1939–60	1948		4.57		
					Apr. 6	5.39		
23	Fox River near McHenry, Ill.		1941–60	1948		3.76		
					Apr. 5	4.29		
24	Fox River at Algonquin, Ill.	1,364	1915–60	1916		4.50	5,850	
					Apr. 6	4.01	6,6[illegible]	9

1 At different datum.
2 Not determined.
3 Affected by ice jam.

FLOODS OF MARCH–APRIL IN EASTERN NEBRASKA AND ADJACENT AREAS

Record-breaking or outstanding floods occurred in late March and early April in Missouri River tributaries over a large area (fig. 15) consisting of southeastern South Dakota, eastern Nebraska, northeastern Kansas, a narrow strip of western Iowa, and the northwest corner of Missouri.

Precipitation as rain and snow over the flood area from October 1959 through March 1960 was 137 percent of normal. Most of the October precipitation fell as rain, and snow fell over most of the area during November. Sioux City, Iowa, had 15.1 inches of snow, which was its greatest November snowfall in 70 years. Both rain and snow fell in December, and above-normal temperatures were prevalent. January precipitation was mostly snow and was about twice the normal amount in the southern half of the flood area.

February precipitation was freezing rain early in the month, and snow after the eighth of the month; it was above normal in about the same area that had above-normal precipitation in January. More

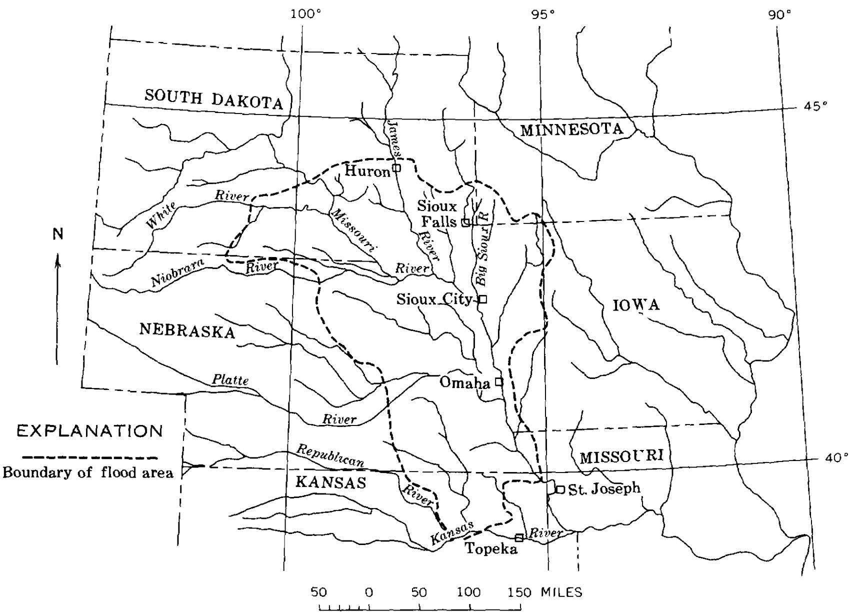

FIGURE 15.—Area of floods of March–April in eastern Nebraska and adjacent areas.

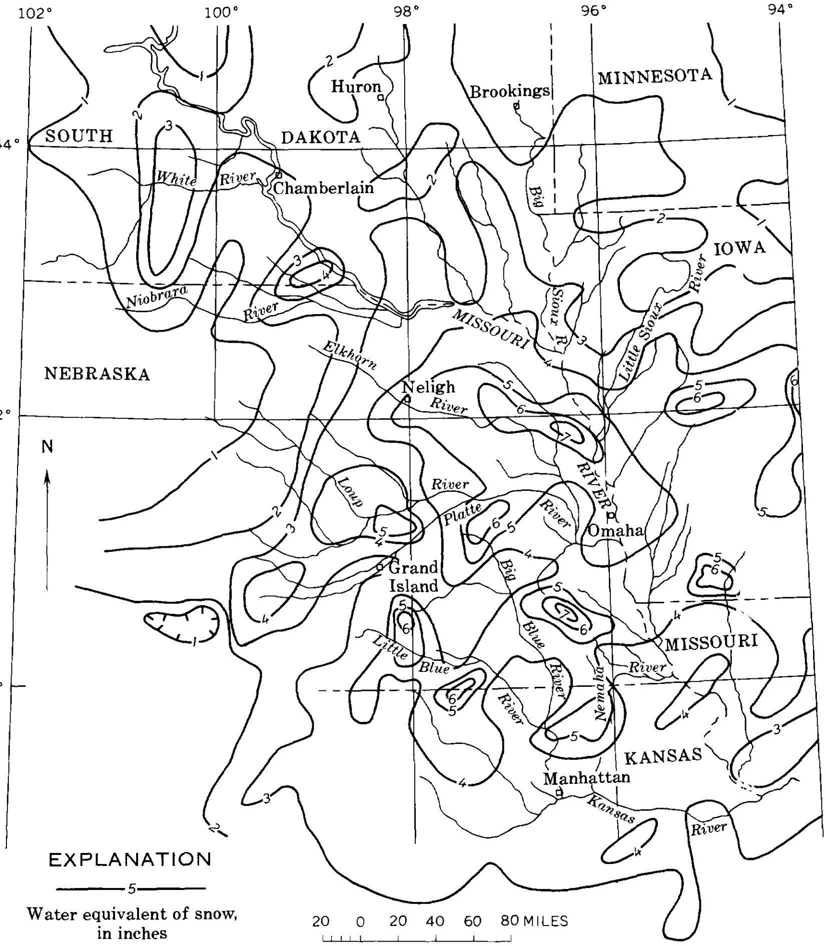

FIGURE 16.—Water equivalent of snow on ground on March 18 in eastern Nebraska and adjacent areas.

snow fell in northeastern Kansas during February 1960 than in any other February since 1930. At the end of the month, the accumulated snow on the ground ranged from 7 inches in southeastern South Dakota to 22 inches in eastern Nebraska.

Frequent light to moderate snow fell over most of the flood area during early March, and a storm on March 12–16 brought heavy snows (fig. 16). The snowfall in eastern Nebraska from December 27 to March 26 was about twice the annual average.

Except in December, monthly mean temperatures throughout the flood area were below normal. The antecedent precipitation and the low temperatures produced a snowpack having the potential to cause a major flood when a rapid rise of temperature occurred. (See fig. 17.)

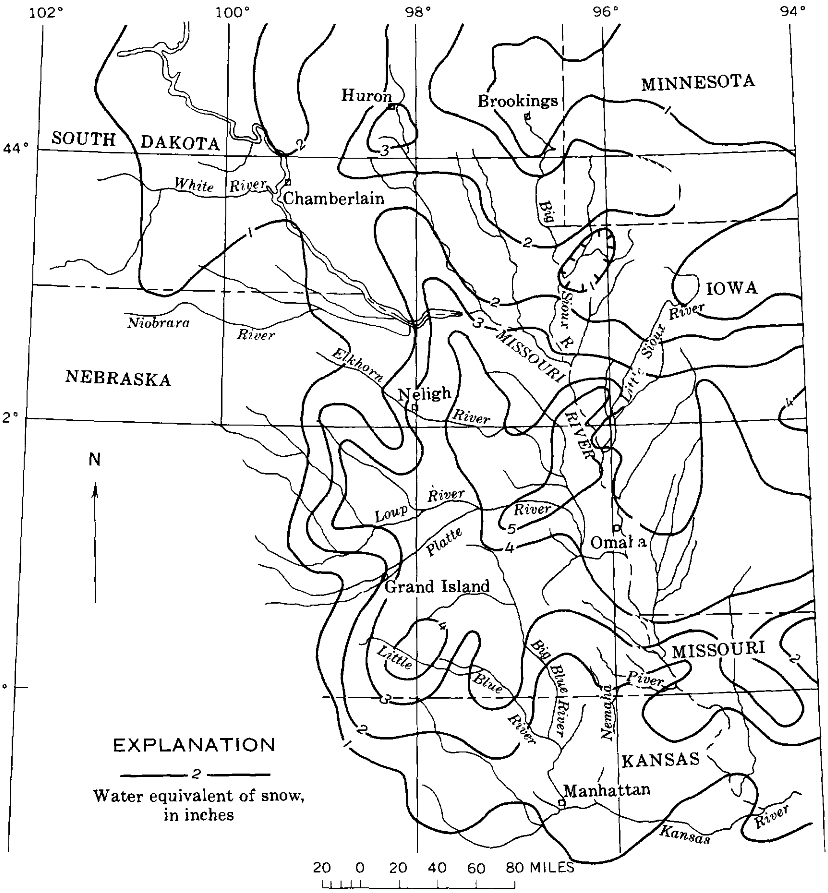

Figure 17.—Water equivalent of snow on ground on March 25 in eastern Nebraska and adjacent areas.

The period of low temperatures ended on March 25, and precipitation in the two periods, March 26–31 and April 1–3 (figs. 18, 19) was mostly rain. The accumulated and compacted snow had 3–4 times the average water content of newly-fallen snow, and that near Lincoln, Nebr., had 3.6 inches of water per foot of snow depth.

The temperature rise started in the western part of the flood area about March 18 and progressed eastward. Most tributaries of the Missouri River in South Dakota and Nebraska flow eastward; therefore, the breakup took place in the headwaters of the streams several days before it did in the downstream reaches. Ice jams formed at the downstream end of flood crests at the upstream edges of the solid ice cover. When a jam was halted temporarily by bends or constrictions in the channel, water and ice were impounded upstream

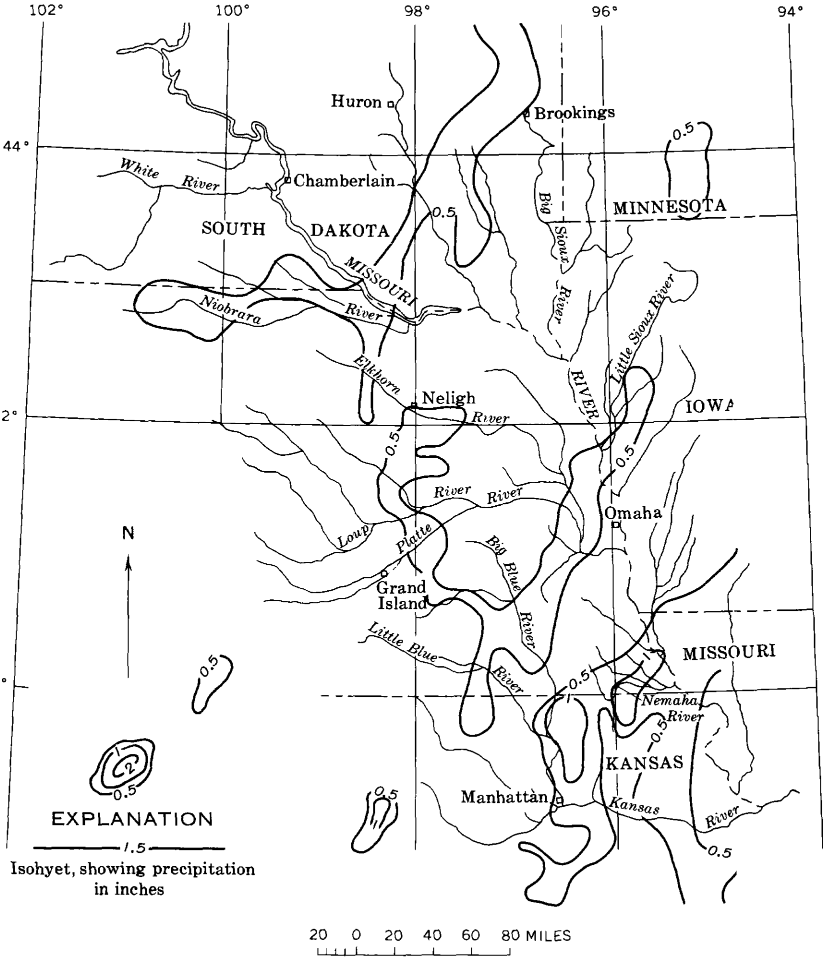

FIGURE 18.—Total precipitation, March 26-31, in eastern Nebraska and adjacent areas.

from the jam, and the increased depth of backwater often caused inundation of the flood plains.

Selected points in the flood area at which peak stages and discharges have been determined are shown in figure 20.

Flooding in south-central South Dakota generally began on March 21. The rapid rise in temperature started on March 18 and caused rapid rises from snowmelt and some ice jams on small streams west of the Missouri River. Moderate flooding of lowlands occurred along Medicine Creek, the South Fork White River, and the Keya Paha River. The peak discharge of South Fork White River below White River, S. Dak., was slightly more than the peak discharge during the

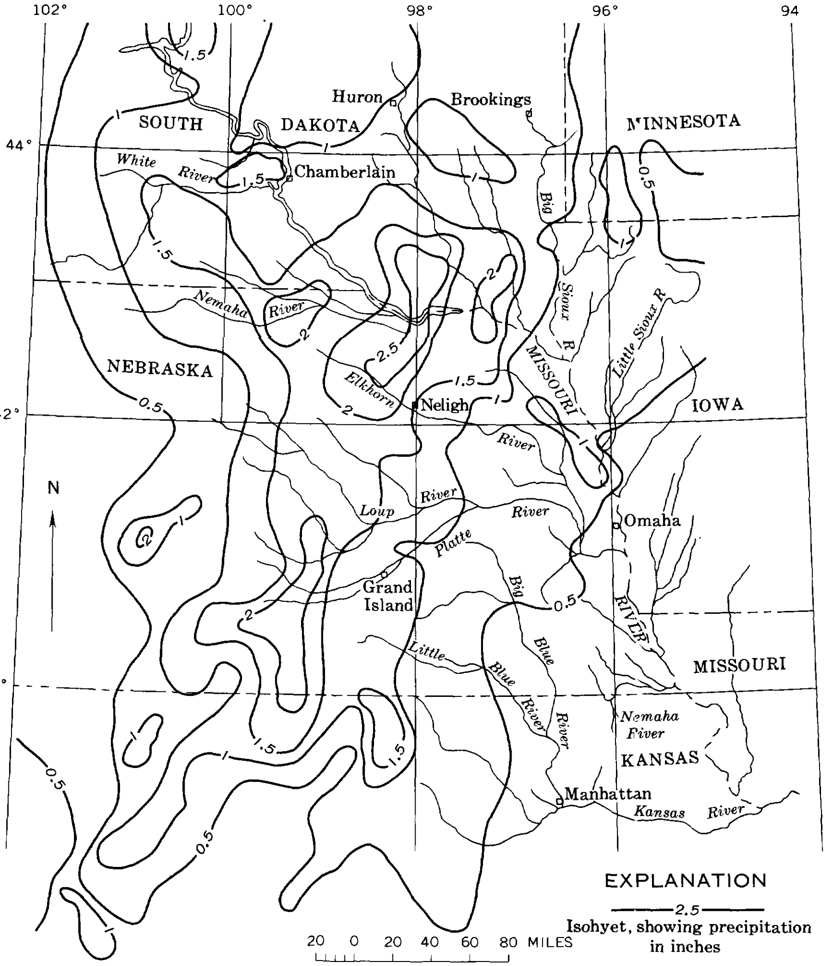

FIGURE 19.—Total precipitation, April 1-3, in eastern Nebraska and adjacent areas.

record snowmelt flood of March–April 1952. Only minor flooding occurred along the White River downstream from the South Fork because of relatively little runoff in the White River upstream from the South Fork. All streams in south-central South Dakota were back within their banks by March 28. Ponca Creek at Anoka, Nebr., reached a peak discharge that was 45 percent higher than the previous maximum in April 1950. Maximum stages and discharges at 87 selected points are given in table 7.

By March 26 the ice cover on the Niobrara River was completely broken, and large ice jams occurred. An ice jam 2 miles long formed near the mouth of the river and caused flooding of the State park and State Highway 12 near Niobrara, Nebr. A similar ice jam

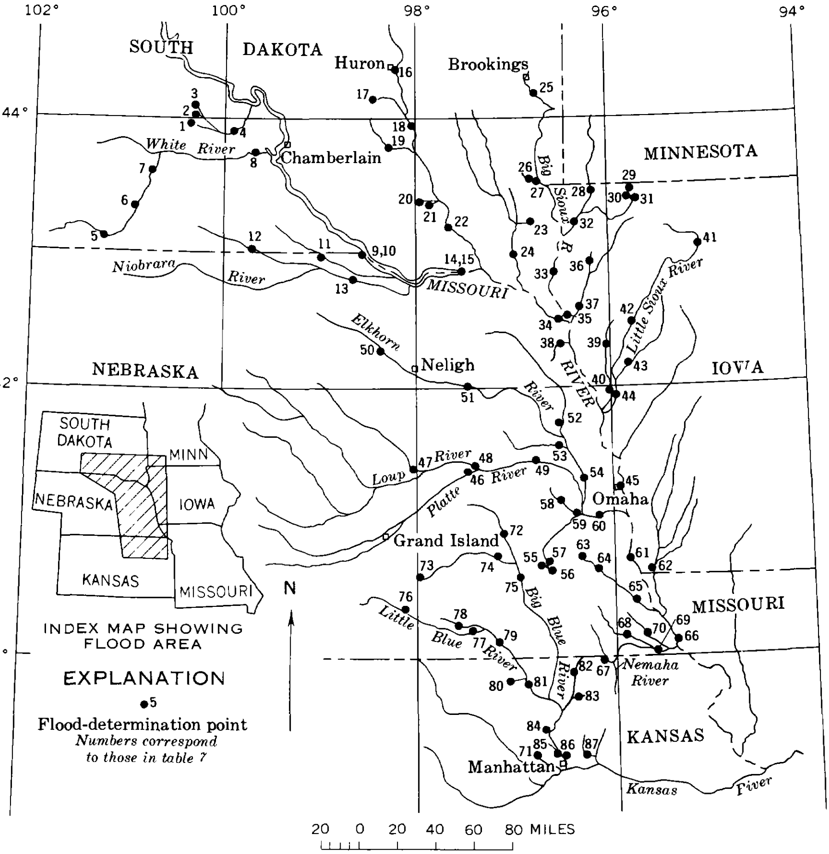

FIGURE 20.—Flood area; location of flood-determination points is shown. Floods of March–April in eastern Nebraska and adjacent areas.

caused lowland flooding near Pishelville. The peak discharge of 39,000 cfs near Verdel, Nebr., was caused by the release of water stored behind an ice jam. The peak discharge of Keya Paha River at Wewela, S. Dak., was only 77 percent of the 1952 peak.

The principal streams in South Dakota east of the Missouri River are the James, Vermillion, and Big Sioux Rivers. These streams flow from north to south, and only their southern reaches, in the area of heavy snow cover, were subjected to extreme flooding. Many small streams tributary to the Redfield-Huron reach of the James River and to the Watertown-Brookings reach of the Big Sioux River went out of their banks during the afternoon of March 27. Snowmelt runoff from many small streams accumulated in the main rivers, which were still partly or completely ice covered, until March 29, when the main rivers left their banks. Ice jams caused widespread flooding during the rising stages of the flood.

TABLE 7.—*Flood stages and discharges, March and April, in eastern Nebraska and adjacent areas*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to Mar. 1960: Period	Year	March-April	Gage height (ft)	Discharge: cfs	Recurrence interval (yrs)
	Medicine Creek basin							
1	North Fork Medicine Creek near Vivian, S. Dak.	45.9	1956–60	1957		3.83	195	
					Apr. 3	7.05	1,080	
2	Medicine Creek tributary near Vivian, S. Dak.	.30	1956–60	1959		8.03	214	
					Apr. 3	5.78	106	
3	Medicine Creek tributary No. 2 near Vivian, S. Dak.	8.62	1956–60	1957		4.58	340	
					Mar. 26	4.80	475	
4	Medicine Creek at Kennebec, S. Dak.	465	1952	1952		17.0	(1)	
			1954–60	1955		13.54	1,840	
					Mar. 28	16.71	8,970	17
	White River basin							
5	South Fork White River near Vestal, S. Dak.	[2] 590			Mar. 24	7.12	1,120	9
6	South Fork White River near Rosebud, S. Dak.	[2] 1,020	1943–60	1944		13.92	4,470	
					Mar. 21	[3] 10.27	2,370	[4] 1.1
7	South Fork White River below White River, S. Dak.	[2] 1,570	1930–32, 1939–40, 1949–60.	1952		[3] 10.90	5,850	
					Mar. 21	[3] 8.86		
					do		6,050	3
8	White River near Oacoma, S. Dak.	10,200	1928–60	1950		(1)		
				1952			51,900	
					Mar. 21	[3] 17.07		
					Mar. 27		23,400	12
	Missouri River main stem							
9	Fort Randall Reservoir at Pickstown, S. Dak.	263,500	1952–60	1959		1,359.3	[5] 4,607	
					Apr. 14, 15		[5] 5,034	
					Apr. 20	1,364.06		
10	Missouri River below Fort Randall Dam, S. Dak.	263,500	1881	1881		21.5	(1)	
			1947–60	1952		20.82	447,000	
					Apr. 28		[6] 16,600	
	Ponca Creek basin							
11	Ponca Creek at Anoka, Nebr.	410	1949–60	1950		15.0	6,770	
					Mar. 27	16.86	9,810	[4] 1.1
	Niobrara River basin							
12	Keya Paha River at Wewela, S. Dak.	1,070	1937–40	1950		[3] 13.5		
			1947–60	1952			5,430	
					Mar. 24	10.56	4,210	[4] 1.7
13	Niobrara River near Spencer, Nebr.	10,400	1913–14, 1927–36, 1940–60.	1955		(1)	27,400	
					Mar. 27	8.6	23,400	4

See footnotes at end of table.

TABLE 7.—*Flood stages and discharges, March and April, in eastern Nebraska and adjacent areas*—Continued

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to Mar. 1960: Period	Maximum floods: Prior to Mar. 1960: Year	Maximum floods: March-April	Maximum floods: Gage height (ft)	Maximum floods: Discharge: cfs	Maximum floods: Discharge: Recurrence interval (yrs)
	Missouri River main stem							
14	Lewis & Clark Lake near Yankton, S. Dak.	279,500	1955–60	1958		1,208.7	[5] 499.4	
					Apr. 1	1,210.72	[5] 565.4	
15	Missouri River at Yankton, S. Dak.	279,500	1881	1881		[3] 30.5	(1)	
			1930–60	1952		15.5	480,000	
					Mar. 29	3.59	[7] 34,700	
	James River basin							
16	James River at Huron, S. Dak.	16,800	1881	1881		19.8	(1)	
			1928–32, 1943–60.	1952		15.23	5,580	
					Apr. 6	15.42	6,050	20
17	Sand Creek near Alpena, S. Dak.	240	1950–60	1950		[3] 14.1		
				1952			1,130	
					Mar. 28	13.35	2,240	[4] 1.7
18	James River near Forestburg, S. Dak.	18,600	1920	1920		18	(1)	
			1922	1922		18	(1)	
			1950–60	1952		15.46	6,290	
					Apr. 2	16.27	10,900	[4] 1.4
19	Firesteel Creek near Mount Vernon, S. Dak.	540	1955–60	1957		6.60	539	
					Mar. 28	15.13	5,780	[4] 3.0
20	North Branch Dry Creek near Parkston, S. Dak.	37.0	1956–60	1958		4.50	146	
					Mar. 27	8.55	1,470	
21	Dry Creek near Parkston, S. Dak.	76.8	1956–60	1958		5.62	234	
					Mar. 27	12.70	4,210	
22	James River near Scotland, S. Dak.	21,550	1928–60	1942			10,800	
				1952		16.23		
					Apr. 6	18.66	13,900	[4] 1.4
	Vermillion River basin							
23	Saddlerock Creek near Canton, S. Dak.	14.8	1956–60	1957		5.38	77	
					Apr. 1	7.83	710	
24	Vermillion River near Wakonda, S. Dak.	1,680	1945–60	1947		16.63		
				1954			3,790	
					Apr. 1	16.94	7,300	16
	Big Sioux River basin							
25	Big Sioux River near Brookings, S. Dak.	[2] 4,420	1953–60	1957		11.67	5,320	
					Mar. 30	12.28	9,620	19
26	Skunk River near Sioux Falls, S. Dak.	520	1948–60	1957		17.78	29,400	
					Mar. 30	13.64	8,200	[4] 1.9
27	Big Sioux River at Sioux Falls, S. Dak.	[2] 5,750	1882–1960	1957		[8] 16.01	[8] 16,100	
					Mar. 30	[8] 15.56	[8] 14,300	18
28	Rock River at Rock Rapids, Iowa.	788			do	8.86	15,500	[4] 2.0
29	Schutte Creek near Sibley, Iowa.	1.43	1952–60	1952		4.49	175	
					Mar. 30	4.17	100	
30	Otter Creek at Sibley, Iowa.	29.9	1952–60	1953		9.82	5,400	
					Mar. 30	7.74	554	

See footnotes at end of table.

TABLE 7.—*Flood stages and discharges, March and April, in eastern Nebraska and adjacent areas*—Continued

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to Mar. 1960: Period	Year	March-April	Gage height (ft)	Discharge: cfs	Recurrence interval (yrs)
	Big Sioux River basin—Continued							
31	Wagner Creek near Ashton, Iowa.	7.09	1952–60	1953		5.37	2,840	
					Mar. 30	4.53	475	
32	Rock River near Rock Valley, Iowa.	1,600	1897	1897		17.0	(1)	
			1948–60	1953		15.99		
				1954			19,200	
					Mar. 31	15.38	16,700	[4] 1.5
33	Big Sioux River at Akron, Iowa.	[2] 9,030	1928–60	1952			33,000	
				1954		19.95		
					Apr. 1	21.56	49,500	[4] 2.2
	Missouri River main stem							
34	Missouri River at Sioux City, Iowa.	314,600	1928–31, 1938–60	1952		24.28	441,000	
					Apr. 3	10.52	[7] 101,000	
	Perry Creek basin							
35	Perry Creek at 38th Street, Sioux City, Iowa.	65.1	1944, 1946–60	1944		25.5	9,600	
					Apr. 1	13.05	3,020	
	Floyd River basin							
36	West Branch Floyd River near Struble, Iowa.	181	1956–60	1957		11.32	840	
					Mar. 29	14.72	3,880	20
37	Floyd River at James, Iowa.	882	1935–60	1953		25.3	71,500	
					Mar. 29	21.93	15,100	[4] 1.8
	Omaha Creek basin							
38	Omaha Creek at Homer, Nebr.	170	1920–60	1940		32.5	(1)	
			1945–60	1958		23.62	14,400	
					Apr. 2	6.45	1,460	1
	Monona-Harrison Ditch basin							
39	West Fork ditch at Holly Springs, Iowa.	399	1939–60	1954		(1)	7,860	
					Mar. 30	22.43	10,000	[4] 1.7
40	Monona-Harrison ditch near Turin, Iowa.	900	1958–60	1959		14.72	9,120	
					Mar. 30	16.32	10,400	[4] 1.2
	Little Sioux River basin							
41	Little Sioux River at Gillett Grove, Iowa.	1,334	1953, 1958–60	1953		17.87	15,000	
					Mar. 30	13.78	5,140	3
42	Little Sioux River at Correctionville, Iowa.	2,500	1891	1891		29.34	(1)	
			1918–25, 1928–32, 1936–60.	1954		23.36	20,900	
					Mar. 29	22.57	16,000	[4] 1.2

See footnotes at end of table.

TABLE 7.—*Flood stages and discharges, March and April, in eastern Nebraska and adjacent areas*—Continued

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to Mar. 1960: Period	Year	March–April	Gage height (ft)	Discharge: cfs	Recurrence interval (yrs)
	Little Sioux River basin—Continued							
43	Maple River at Mapleton, Iowa.	669	1941–60	1950		22.1		
				1954			15,600	
					Mar. 30	17.90	11,400	[4] 1.6
44	Little Sioux River near Turin, Iowa.	3,526	1958–60	1959		21.80	14,000	
					Mar. 30	25.08	73,900	[4] 1.6
	Missouri River main stem							
45	Missouri River at Omaha, Nebr.	322,800	1928–60	1952		30.20	396,000	
					Apr. 1		[7] 120,000	
					Apr. 4	16.96		
	Platte River basin							
46	Platte River near Duncan, Nebr.	61,600	1895–1909, 1912–15, 1928–60.	1905		(1)	44,100	
					Mar. 28	6.36	25,400	[4] 1.1
47	Cedar River near Fullerton, Nebr.	[2] 1,220	1931–32, 1940–60	1950		9.64	10,100	
					Mar. 28	[3] 11.75	4,300	4
48	Loup River at Columbus, Nebr.	[2] 15,200	1894–1915, 1931, 1933–60.	1947		12.0	85,000	
					Mar. 28	10.50	52,000	7
49	Platte River at North Bend, Nebr.	77,800	1949–60	1952		[3] 8.17		
				1957			44,200	
					Mar. 29	[3] 8.04	112,000	[4] 1.7
50	Elkhorn River at Ewing, Nebr.	[2] 1,400	1947–60	1947		11.32		
				1949			7,280	
					Mar. 28	[3] 10.97		
					Mar. 29		6,440	20
51	Elkhorn River near Norfolk, Nebr.	[2] 2,790	1945–60	1947			12,600	
				1949		(1)		
					Mar. 30	8.60	13,500	7
52	Logan Creek near Uehling, Nebr.	1,030	1940–60	1940		18.6	20,000	
					Apr. 2	15.20	9,400	8
53	Maple Creek near Nickerson, Nebr.	450	1944, 1951–60	1944		16.28	35,000	
					Mar. 31	13.40	6,280	11
54	Elkhorn River at Waterloo, Nebr.	[2] 6,900	1880–1960	1944		16.6	100,000	
					Apr. 2	14.11	46,900	13
55	Olive Branch below Sprague, Nebr.	81	1956–60	1958		16.02	4,380	
					Mar. 27	17.12	5,700	3
56	Hickman Branch at Hickman, Nebr.	32	1956–60	1958		19.31	(1)	
					Mar. 27	14.75	3,600	3
57	Salt Creek at Roca, Nebr.	174	1909–60	1950		26.0	67,000	
					Mar. 27	20.85	5,900	2
58	Wahoo Creek at Ithaca, Nebr.	270	1910–60	1959		(1)	45,300	
					Mar. 29	21.68	5,080	2
59	Salt Creek near Ashland, Nebr.	1,640	1947–60	1947		15.13		
				1951			46,200	
					Mar. 29		23,100	6
					Mar. 30	[9] 13.85		
60	Platte River at Louisville, Nebr.	85,500	1953–60	1957		10.35	71,000	
					Mar. 30	12.45	[10] 124,000	[4] 1.4
	Missouri River main stem							
61	Missouri River at Nebraska City, Nebr.	414,400	1929–60	1952		27.66	414,000	
					Apr. 5	21.43	178,000	

See footnotes at end of table.

TABLE 7.—*Flood stages and discharges, March and April, in eastern Nebraska and adjacent areas*—Continued

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to March 1960: Period	Year	March-April	Gage height (ft)	Discharge: cfs	Recurrence interval (yrs)
	Nishnabotna River basin							
62	Nishnabotna River above Hamburg, Iowa.	2,806	1922–23, 1928–60	1947	----------	26.03	55,500	------
					Mar. 31	24.56	23,900	9
	Little Nemaha River basin							
63	Hooper Creek near Palmyra, Nebr.	57.5	1950–60	1950	----------	23.0	47,600	------
					Mar. 27	18.42	2,340	2
64	Little Nemaha River near Syracuse, Nebr.	218	1950–60	1950	----------	36.7	225,000	------
					Mar. 28	14.77	8,270	3
65	Little Nemaha River at Auburn, Nebr.	801	1949–60	1950	----------	27.65	164,000	------
					Mar. 27	24.2	48,000	[4] 1.4
	Missouri River main stem							
66	Missouri River at Rulo, Nebr.	418,905	1881, 1949–60	1952	----------	25.60	358,000	------
					Apr. 6	22.36	181,000	------
	Nemaha River basin							
67	Turkey Creek near Seneca, Kans.	276	1949–60	1958	----------	24.20	18,000	------
					Mar. 28	22.73	11,700	7
68	North Fork Nemaha River at Humboldt, Nebr.	531	1952–60	1958	----------	31.70	51,000	------
					Mar. 27	24.20	36,200	1.6
69	Nemaha River at Falls City, Nebr.	1,340	1944–60	1949	----------	28.8	----------	------
				1954		----------	51,400	------
					Mar. 28	27.75	46,900	15
70	Muddy Creek at Verdon, Nebr.	188	1952–60	1958	----------	31.50	31,900	------
					Mar. 27	23.90	20,000	12
	Kansas River basin							
71	Wild Cat Creek at Riley, Kans.	13	1957–60	1958	----------	18.00	1,400	------
					Mar. 27	19.85	2,050	------
72	Big Blue River at Seward, Nebr.	1,070	1954–60	1957	----------	22.34	15,300	------
					Mar. 30	19.70	8,200	5
73	School Creek near Saronville, Nebr.	89.4	1952–60	1952	----------	17.6	1,280	------
					Mar. 27	19.29	3,720	[4] 1.2
74	West Fork Big Blue River near Dorchester, Nebr.	1,210	1950	1950	----------	24.8	49,400	------
			1958–60	1959	----------	14.66	2,890	------
					Mar. 30	20.28	11,200	8
75	Big Blue River near Crete, Nebr.	2,680	1945–60	1950	----------	28.74	27,600	------
					Mar. 30, 31	28.00	23,000	8
76	Little Blue River near Deweese, Nebr.	1,140	1951	1951	----------	(1)	16,000	------
			1953–60	1957	----------	15.00	13,000	------
					Mar. 27	14.45	11,800	11
77	Little Blue River near Gilead, Nebr.	1,400	----------	------	Mar. 28	17.30	25,600	[4] 1.5
78	South Fork Big Sandy Creek near Hebron, Nebr.	81.9	1952–60	1952	----------	21.8	3,160	------
					Mar. 27	21.90	3,220	[4] 1.1
79	Little Blue River near Fairbury, Nebr.	2,320	1908–15, 1928–60	1951	----------	(1)	36,800	------
					Mar. 28	15.80	31,700	[4] 1.0

See footnotes at end of table.

TABLE 7.—*Flood stages and discharges, March and April, in eastern Nebraska and adjacent areas*—Continued

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to Mar. 1960: Period	Year	March-April	Gage height (ft)	Discharge: cfs	Recurrence interval (yrs)
	Kansas River basin—Continued							
80	Mill Creek at Washington, Kans.	344	1903-60	1941	----------	36	(1)	------
					Mar. 28	25.58	9,690	8
81	Little Blue River at Waterville, Kans.	3,330	1922-25, 1928-60	1941	----------	(1)	50,400	------
					Mar. 29	23.90	38,800	11
82	Robidoux Creek at Beattie, Kans.	40	1957-60	1958	----------	20.23	3,600	------
					Mar. 27	22.46	6,200	------
83	Black Vermillion River near Frankfort, Kans.	412	1948	1948	----------	30.2	(1)	------
			1953-60	1959	----------	29.40	38,300	------
					Mar. 28	28.52	25,100	23
84	Big Blue River at Randolph, Kans.	9,100	1897-1960	1941	----------	30.81	98,000	------
					Mar. 30	----------	74,000	14
					Apr. 2	[11] 36.48	----------	------
85	Big Blue River near Manhattan, Kans.	9,560	1903	1903	----------	35.85	(1)	------
			1951, 1954-60	1951	----------	33.04	93,400	------
					Apr. 5	23.05	[7] 31,400	------
86	Cedar Creek near Manhattan, Kans.	14	1957-60	1958	----------	18.97	3,000	------
					Mar. 27	11.63	460	------
87	Rock Creek near Louisville, Kans.	128	1958-60	1959	----------	27.8	6,040	------
					Mar. 27	27.70	5,960	6

1 Not determined.
2 Part of drainage area does not contribute to runoff.
3 Affected by backwater from ice.
4 Ratio of peak discharge to that of 25-year flood.
5 Contents, in thousands of acre-feet.
6 Daily discharge; flow completely regulated.
7 Flow fully or partly regulated.
8 In main channel only; part of flow bypasses gage at high stages.
9 Affected by backwater from Platte River.
10 Maximum discharge known since at least 1881.
11 Affected by backwater from Tuttle Creek dam.

Severe flooding occurred along the James River just upstream from Huron, where the extremely flat gradient is not conducive to rapid downstream movement of water, and the flat crest did not reach Huron until April 6. The peak stages in 1881 and 1922 were higher than the peak stage in 1960, and the peak discharge in 1960 exceeded the previous maximum discharge in 21 years of record by 8 percent. Downstream from Huron, tributary inflow was greater and more rapid than upstream, and the crest on April 2 near Forestburg was only 1.7 feet lower than that of the floods of 1920 and 1922. The magnitude of the flood increased rapidly downstream from Forestburg, but local residents believed the 1960 flood was somewhat lower than the great flood of 1881 in the Forestburg-Mitchell reach and slightly higher than that flood between Milltown and the mouth. The crest reached the gaging station near Scotland on April 6, where the stage was 2.4 feet higher and the discharge was 29 percent greater than those of any other flood that had occurred since 1928. Some areas in the lower James River valley were under water until mid-April.

According to long-time residents, the flood on the Vermillion River from the confluence of the East and West Forks near Parker to the mouth near Vermillion was the greatest in about 80 years. The peak discharge at the gaging station near Wakonda on April 1 was almost twice that of the previous maximum in a 15-year record.

The Big Sioux River, in flood from near Brookings, S. Dak., to the mouth at Sioux City, Iowa, had severe flooding downstream from Sioux Falls, S. Dak. The gradient of the Big Sioux River is steeper than those for other streams in eastern South Dakota; therefore the time of concentration was shorter, and the flood peak moved downstream more rapidly.

A flood-control project recently constructed by the Corps of Engineers at Sioux Falls appreciably reduced the crest height and prevented much damage in outlying areas that had been inundated by lesser floods in the past. The flood-control project consists of high dikes along the river and a bypass channel that diverts part of the flow across the loop of the river inside which the city of Sioux Falls is located. The 1960 peak discharge, 14,300 cfs, in the main channel at Sioux Falls exceeded the combined discharges, 13,500 cfs, of the main channel and the bypass channel during the snowmelt flood in April 1952 but was 1,900 cfs less than the combined discharges in June 1957

The peak discharge on April 1 at Akron, Iowa, where discharge records were started in 1928, was 50 percent greater than that in 1952, and the stage was 1.6 feet higher than the previous maximum in 1954. The large increase in the peak discharge between Brandon and Akron was due to heavy tributary inflow from an area of snowpack having a higher water content than the snowpack upstream. The increase of about 11 cfs per square mile from 3,220 square miles gave a unit runoff that is generally associated with snowmelt floods from much smaller areas.

Below Akron, the Big Sioux River flood plain contains a great many dikes, and nearly all dikes were overtopped. Because of temporary storage of the flood water on the flood plain and the absence of major tributaries, the flood crest did not reach Sioux City, Iowa, 50 miles downstream from Akron, until April 3. The river was 2 miles wide in most of this reach, and residents reported that the flood was the greatest since 1881.

Rain and snow on April 1–3 caused minor rises on the Big Sioux River and prolonged the flooding for several days. The Big Sioux River did not recede into its normal channel at Sioux City until April 18.

The flood on the Floyd River at James, Iowa, was the second highest in 26 years of record and exceeded the 1952 snowmelt-flood peak by 9 percent. Floods from summer thunderstorms in this area are much more prevalent and severe than snowmelt floods, and peak discharges on small Missouri River tributaries in Nebraska north of Omaha were only 2–15 percent of maximums of record.

The Little Sioux River in Iowa had less than maximum peak discharges upstream from Correctionville and greater than previous maximum discharges downstream from there. Smaller streams such as the Soldier River and the Boyer River in Iowa had peak discharges much less than those of previous floods.

The Platte River has no major tributaries other than the Wood River for almost 200 miles upstream from Duncan, Nebr. The water equivalent of the snow on the ground and the precipitation during the flood decreased very rapidly west along the Platte River, and the peak discharge near Duncan was a modest 25,400 cfs on March 28. The Loup and Cedar Rivers, Shell Creek, and other streams drain areas that had snow of higher water content. The inflow from these streams raised the peak discharge of the Platte River at North Bend to 112,000 cfs on March 29. Areas having snow of still higher water content and 0.5–2.5 inches of precipitation during April 1–3 are drained by the Elkhorn River and Salt Creek. Floods on lower reaches of each of these Platte River tributaries had recurrence intervals of 6–13 years, but the timing of the peaks was such that the Platte River at Louisville crested on March 30 at 124,000 cfs, which was the greatest discharge since at least 1881 and was 1.4 times the discharge of a 25-year flood.

The larger floods in the Kansas River basin occurred on School Creek near Saronville, Nebr., the Little Blue River near Gilead, Nebr., and South Fork Big Sandy Creek downstream from Davenport, Nebr.; they equaled or exceeded the 25-year floods. Most Kansas streams east of the Republican River were bankfull or higher. Tuttle Creek Reservoir in Kansas was under construction, but its maximum storage of 358,100 acre-feet reduced the 74,000 cfs peak on the Big Blue River at Randolph to 31,400 cfs near Manhattan.

The flood on the main stem of the Missouri River was quite different from any previous flood. The last major flood was in 1952, but the flood in June 1953 was almost as high as that in 1960 at Omaha, Nebr. Between 1952 and 1960, four large dams were built on the Missouri River, and these effectively controlled all runoff entering the reservoirs in 1960.

Fort Randall Reservoir, the reservoir farthest downstream near the north end of the flood area, reduced the maximum daily inflow of 64,000 cfs to a maximum daily outflow of 1,530 cfs while uncontrolled

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tributaries were creating a flood hazard downstream. The peak discharge increased to 34,700 cfs at Yankton, S. Dak., 82 miles downstream from the Fort Randall Dam, to 101,000 cfs at Sioux City, Iowa, to 120,000 cfs at Omaha, Nebr., to 178,000 cfs at Nebraska City, Nebr., and to 181,000 cfs at Rulo, Nebr. In contrast, the 1952 flood was generated mainly in the area upstream from the area discussed in this report, and peak discharges in the Missouri River decreased from 480,000 cfs at Yankton to 358,000 cfs at Rulo.

Ice jams on the Elkhorn and Niobrara Rivers in Nebraska produced high stages which inundated large areas along these streams.

Most of the damage along the James River in South Dakota occurred to rural roads, fields, crops, and fences. The river near Scotland was above bankfull stage until near the end of April, and the flood delayed crop planting about 1 month.

Although floodwaters of the Vermillion River inundated about 50,000 acres of land, only one community, Davis, S. Dak., was flooded. Principal damage was erosion of fields, dikes, and roads, and lesser damage was sediment deposition on land behind overtopped dikes. The river remained out of its banks for about 3 weeks.

Severe damage was caused by the Big Sioux River because its valley is the most populous in southeastern South Dakota. Heavy rural damage resulted, and several hundred persons were evacuated from North Sioux City, S. Dak., and from Riverside, a suburb of Sioux City, Iowa. About 80,000 acres of land was flooded in the valley, and damage exceeded half a million dollars.

Another severely flooded section was the Platte River valley in Nebraska between the mouths of the Loup and Elkhorn Rivers. North Bend was completely inundated, and many dikes failed between North Bend and South Bend. The flooding was the worst since 1912.

In eastern Nebraska, 24 cities and towns were flooded to various degrees.

Table 8 lists by river basins the estimates of damage, in dollars, as compiled by the Weather Bureau. These figures do not include damage from erosion and sedimentation or intangible losses. Table 9, compiled by the Corps of Engineers, lists the damage by types and by river basin.

Five persons were drowned in the flood area.

This flood is more thoroughly described in Water-Supply Paper 1790–A, "Floods of March-April 1960 in Eastern Nebraska and Adjacent States."

TABLE 8.—*Summary of damage, in thousands of dollars, of floods of March and April 1960 in eastern Nebraska and adjacent areas*

[Data furnished by U.S. Weather Bureau]

Stream basin	Urban property					Rural property					Other property		Miscel-laneous	Total loss
	Residential		Commercial		Public	Crops		Live-stock	Other		Rail-roads, bridges, high-ways, etc.	Public utilities		
	Fixed	Movable	Fixed	Movable		Growing	Stored		Fixed	Movable				
Minor tributaries in South Dakota and Nebraska	28.0	50.0	20.0	20.0	135.0	34.0			50.0		300.0	10.0	50.0	697.0
James River	40.0	12.0	45.0	15.0	150.0	75.0	250.0		90.0		280.0	9.0	70.0	1,036.0
Vermillion River	15.0		5.0		30.0	150.0	60.0		50.0		350.0		45.0	705.0
Big Sioux River	450.0	75.0	125.0	35.0	260.0	110.0	275.0	13.0	285.0	40.0	950.0	15.0	118.0	2,751.0
Floyd River	30.0	25.0	25.0	210.0	16.0		38.0		42.0	4.0	30.0	7.0	67.0	494.0
Little Sioux River	[1] 38.0					23.0			310.0		83.0			454.0
Loup River	[1] 87.0					7.0		1.5	151.5		80.0			327.0
Elkhorn River	200.0	75.0	50.0	10.5	250.0	42.5	85.0	9.2	106.0	17.5	261.4	58.9	138.1	1,304.1
Salt Creek						6.0			62.0		14.0			82.0
Platte River	[1] 484.0					54.0		32.0	1,218.0		731.0			2,519.0
Nishnabotna River						12.0			61.0		182.0			255.0
Missouri River above Rulo, Nebr						680.0		5.0	1,321.0		265.0			2,271.0
Nemaha River	.7					51.0					54.4			106.1
Little Blue River	2.5	2.4			42.7	11.0	.5	.1	8.5		91.4		6.2	165.3
Big Blue River	44.0	3.0	81.1	4.0	52.5	14.5	5.0	24.5	18.5	1.0	22.7	16.5	6.2	293.5
Kansas River and minor tributaries	3.0	.1	2.0	.5	.5	15.0	1.0	.5	4.0	.5	5.0	.5	2.0	34.6
Total	1,422.2	242.5	353.1	295.0	936.7	1,285.0	714.5	85.8	3,777.5	63.0	3,699.9	116.9	502.5	13,494.6

[1] Includes all urban property.

TABLE 9.—*Summary of damage, by type, of floods of March and April 1960 in eastern Nebraska and adjacent areas*

[Data furnished by U.S. Army Corps of Engineers]

Stream basin	Buildings destroyed or damaged			Bridges destroyed or damaged	Persons reported evacuated	Lives lost	Acres flooded (thousands)
	Residences	Commercial and other	Farm				
Niobrara River and Ponca Creek	65	7	----	----	(1)	0	----
James River	48	10	135	(1)	(1)	0	45
Vermillion River	24	0	0	Many	(2)	1	49.5
Big Sioux River	718	74	360	6	600	1	80
Floyd River	56	37	----	4	160	0	11
Little Sioux River	71	28	2	4	60	0	38.8
Loup River	151	----	----	(1)	15	1	29.8
Elkhorn River	700	20	5	17	712	0	96.2
Platte River	768	60	370	19	1,519	2	71.9
Nishnabotna River	0	0	0	5	0	0	11.5
Missouri River, Omaha to Rulo, Nebr	181	21	325	----	(1)	0	----

[1] No report.
[2] Nine families.

FLOODS OF MARCH 30–APRIL 6 IN NEW YORK

Water content of the mid-March snow pack varied throughout the State from about 2 inches in southeastern New York to 18 inches in the Tug-Hill area near Watertown. Warm spring temperatures caused this snow to melt and combine with intermittent rainfall to produce flooding throughout the State. Flooding occurred in different areas during the period March 30–April 6 (fig. 21). The earlier floods, on March 31 and April 1, occurred generally in western counties, and the later floods, on April 4–6, occurred in the eastern part of the State.

Most streams in western New York overflowed low-lying farm areas and adjacent roads. Buffalo Creek, Ellicott Creek, Tonawanda Creek, and Clear Creek all inundated some land in the Buffalo area. Canaseraga Creek, Oatka Creek, Black Creek, and Allen Creek flooded low-lying areas near Rochester. The peak discharges on Oatka Creek at Garbutt and on Black Creek at Churchville were each greater than that for a 50-year flood, and the peak discharge on Ellicott Creek at Williamsville was about equal to that of a 40-year

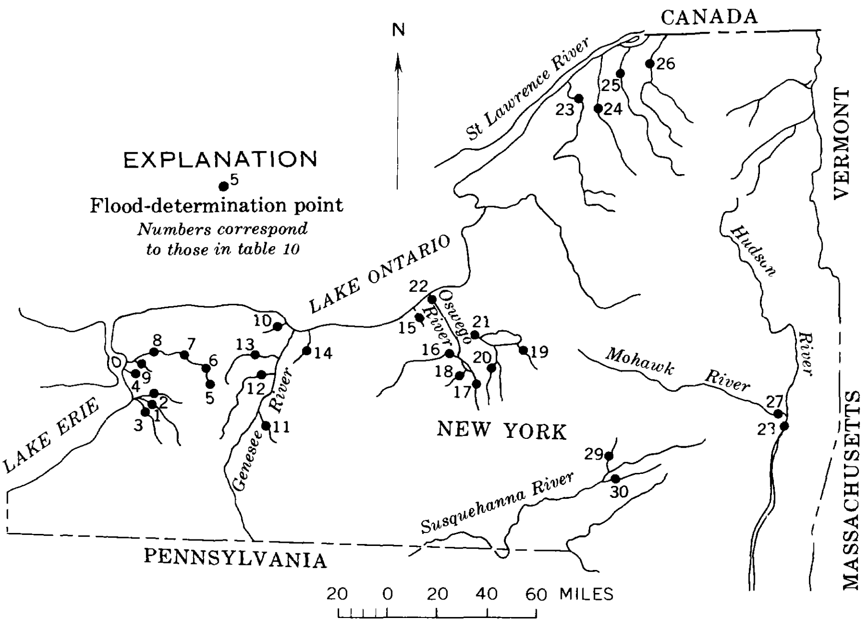

FIGURE 21.—Flood area; location of flood-determination points is shown. Floods of March 30–April 6 in New York

flood. The peak discharges at the stations in the flood area are given in table 10.

Flooding occurred on tributaries of the Oswego River near Syracuse. Limestone and Onondaga Creeks flooded low areas and caused subsequent inconvenience due to closed roads and interrupted services. The Seneca River flooded low-lying areas and caused much damage to houses near Baldwinsville, Cold Springs, and Phoenix.

Discharges of streams flowing into the St. Lawrence River in northern New York were high and caused floods near Ogdensburg. The peak discharge of 19,600 cfs on Oswegatchie River near Heuvelton was the greatest in a period of record that began in 1916. The floods in this area broke water mains and inundated roads and farmlands. Some roadbed of the Ogdensburg-DeKalb branch of the New York Central Railroad was washed out. Tributaries to the St. Lawrence River—the Grass, Raquette, St. Regis, and Salmon Rivers—flooded much area of lowlands.

TABLE 10.—*Flood stages and discharges, March 30–April 6, in New York*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods					
			Prior to Mar. 1960		March-April	Gage height (ft)	Discharge (cfs)	Recurrence interval (yrs)
			Period	Year				
	Streams tributary to Lake Erie							
1	Buffalo Creek at Gardenville.	145	1938–60	1942		[1] 11.90		
				1955		7.07	13,000	
				1956		7.07	13,000	
					Mar. 30	[1] 7.45		
					do	7.07	7,530	2
2	Cayuga Creek near Lancaster.	93.3	1938–60	1942		[1] 12.36		
				1959		10.09	8,750	
					Mar. 30	[1] 12.58		
					do	9.10	7,070	5
3	Cazenovia Creek at Ebenezer.	136	1940–60	1955		15.82	13,500	
					Mar. 30	10.82	7,160	2
	Streams tributary to Niagara River							
4	Scajaquada Creek at Buffalo.	15.7	1957–60	1959		7.98	1,150	
					Mar. 29	6.49	848	2
5	Little Tonawanda Creek at Linden.	22.0	1912–60	1956		16.04	2,700	
					Mar. 30	11.74	1,840	13
6	Tonawanda Creek at Batavia.	172	1942	1942		14.5	(2)	
			1944–60	1947		13.85		
				1956			6,480	
					Mar. 31	12.70	7,200	6
7	Tonawanda Creek near Alabama.	230	1955–60	1959		15.95	9,000	
					Mar. 31	14.28	7,980	4
8	Tonawanda Creek at Rapids.	358	1955–60	1957		15.46	5,210	
					Apr. 1	16.96	6,280	2
9	Ellicott Creek at Williamsville.	76.3	1955–60	1956		10.44	2,510	
					Mar. 31	8.99	5,960	42

See footnotes at end of table.

TABLE 10.—*Flood stages and discharges, March 30–April 6, in New York*—Con.

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to Mar. 1960: Period	Year	March–April	Gage height (ft)	Discharge (cfs)	Recurrence interval (yrs)
	Streams tributary to Lake Ontario							
10	West Creek near Hilton	31.0	1957–60	1959		9.89	1,170	
					Mar. 30	10.67	1,480	2
11	Canaseraga Creek near Dansville.	153	1910–12, 1915–60	1940			8,380	
				1956		13.68		
					Mar. 30	11.26	5,170	3
12	Oatka Creek at Garbutt	208	1945–60	1950		8.52	6,080	
					Mar. 31	8.64	6,920	[3] 1.12
13	Black Creek at Churchville.	123	1945–60	1950		8.83	4,750	
					Mar. 31	9.44	4,880	[3] 1.34
14	Allen Creek near Rochester	28.0			Mar. 30	6.06	5,040	[3] 1.75
15	Sterling Creek at Sterling	44.4	1957–60	1959		4.15	770	
					Apr. 4	5.13	1,490	12
16	Seneca River at Baldwinsville.	3,130	1949–60	1956		8.84	[4] 16,700	
					Apr. 4	9.21		
					do		[4] 17,200	
17	Onondaga Creek at Syracuse.	88.9	1951–60	1959		4.92	1,960	
					Mar. 31	5.06	2,130	
18	Harbor Brook at Syracuse	947			Mar. 30	6.97	354	
19	Oneida Creek at Oneida	112	1949–60	1950		13.78	7,440	
				1959		[1] 14.30		
					Mar. 30	12.71	5,130	6
20	Limestone Creek at Fayetteville.	85.7	1939–60	1950		7.78	7,010	
					Mar. 30	7.60	6,060	30
21	Oneida River at Caughdenoy.	1,377	1947–60	1950			[4] 9,160	
					Apr. 7		[4] 8,580	
22	Oswego River at Oswego	5,121	1933–60	1936			37,500	
				1940		13.46		
					Apr. 4	12.26	31,200	
	Streams tributary to St. Lawrence River							
23	Oswegatchie River near Heuvelton.	973	1916–60	1947		9.26	15,800	
					Apr. 6	10.36	19,600	8
24	Grass River at Pyrites	335	1924–60	1927		13.0	8,300	
					Apr. 4	12.58	4,800	2
25	Raquette River at Raymondville.	1,131	1943–60	1954		[1] 9.24		
				1954		7.60	11,000	
					Apr. 4	6.71	8,720	
26	St. Regis River at Brasher Center.	616	1910–60	1937		[1] 15.3		
				1937		12.82	16,800	
					Apr. 4	10.59	9,330	3
	Hudson River basin							
27	Mohawk River at Cohoes	3,456	1918–60	1936		22.57	130,000	
					Apr. 4	20.15	83,300	
28	Hudson River at Green Island.	8,090	1946–60	1948		27.05	181,000	
					Apr. 5	24.41	134,900	
	Susquehanna River basin							
29	Susquehanna River at Colliersville.	351	1924–60	1936		8.13	8,740	
					Apr. 5	7.91	7,870	13
30	Charlotte Creek at West Davenport.	167	1938–60	1938			14,000	
					Apr. 4	10.66	9,840	33

[1] Affected by backwater from ice.
[2] Not determined.
[3] Ratio of peak discharge to that of 50-year flood.
[4] Daily mean discharge.

Floodwaters from the Mohawk and Hudson Rivers on April 4–5, inundated the flood plains—much of which are built up with homes and business establishments—in Waterford, Troy, Green Island, and Albany. A five-block area in Waterford was covered with as much as 5 feet of water, and 22 families were evacuated.

Widespread flooding from Charlotte Creek occurred in and near Oneonta. About 200 families in the area were evacuated, and several roads were impassable owing to high water. The peak discharge at West Davenport on April 4 was the greatest in 23 years; every house along Charlotte Creek was flooded, and several sections of the county road that followed the stream were washed out.

FLOODS OF APRIL 15–19 IN WEST-CENTRAL MISSOURI

During the period April 13–16, rain totaling more than 10 inches fell in west-central Missouri. One U.S. Weather Bureau rain gage in this area recorded 8.10 inches of rain in a 24-hour period, and another Weather Bureau recording gage nearby measured 5.63 inches of rain in a 6-hour period. This precipitation caused outstanding floods on some of the streams in this part of the State (fig. 22).

At West Branch Crawford Creek near Lee's Summit, a crest-stage gage station, a runoff of 1,050 cfs per square mile came from a drainage area of 0.80 square mile. Damage from the storm was not great as it was wholly in rural areas. Local damage to crops was small; because of the early date, few crops had been planted. A summary of flood stages and discharges for streams in this area is given in table 11.

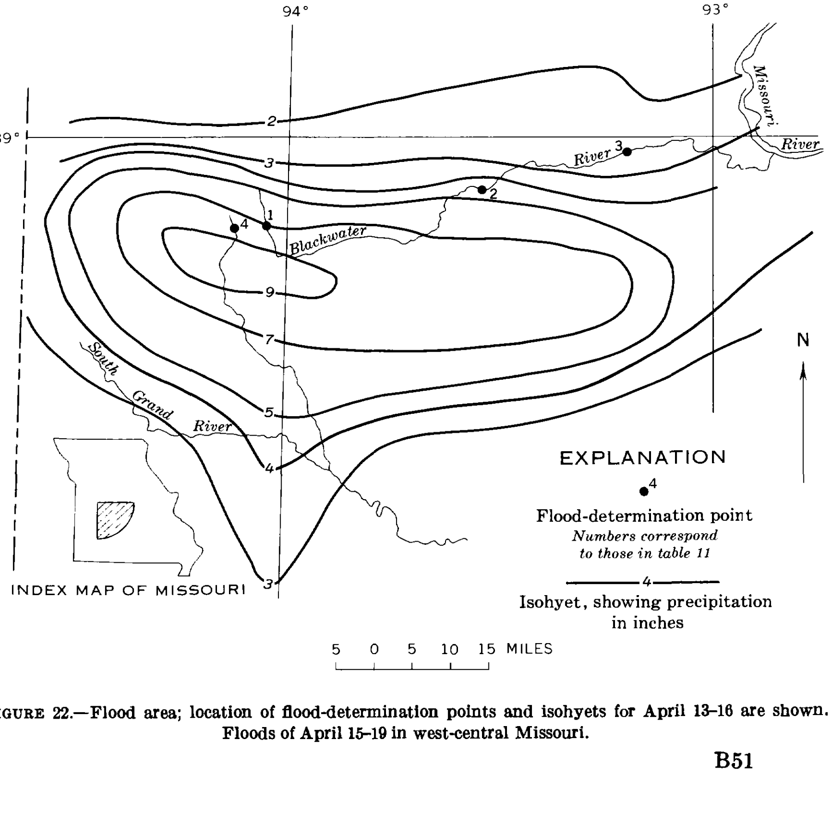

FIGURE 22.—Flood area; location of flood-determination points and isohyets for April 13–16 are shown. Floods of April 15–19 in west-central Missouri.

TABLE 11.—*Flood stages and discharges, April 15–19, in west-central Missouri*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to Apr. 1960: Period	Maximum floods: Prior to Apr. 1960: Year	Maximum floods: April (ft)	Maximum floods: Gage height (ft)	Maximum floods: Discharge (cfs)	Maximum floods: Recurrence interval (yrs)
	Lamine River basin							
1	East Branch South Fork Blackwater River near Elm.	16.4	1951	1951	----------	14.8	(1)	------
			1954–60	1955	----------	8.50	2,380	------
					15	12.0	5,600	[2] 1.5
2	Blackwater River at Valley City.	547	1958–60	1959	----------	22.92	5,760	------
					16	20.4	66,500	[2] 2.0
3	Blackwater River at Blue Lick.	1,120	1922–33, 1938–60	1928	----------	41.25	54,000	------
					19	33.0	16,200	3
	Osage River basin							
4	West Branch Crawford Creek near Lee's Summit.	0.80	1955–60	1956	----------	13.47	345	------
					16	15.57	839	------

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

FLOODS OF APRIL AND MAY IN NORTHERN WISCONSIN AND MICHIGAN UPPER PENINSULA

Below freezing temperatures during most of March and in early April maintained the heavy snow cover that had been laid down previously in the Upper Peninsula of Michigan and in northern Wisconsin. Moderate amounts of precipitation fell over the northern part of the two States on April 15–17. Rising temperatures on about April 20 rapidly melted much of the snow, and runoff increased sharply. Record or near-record amounts of rain on April 22–25 in this area, where the streams were already high, resulted in one of the worst floods in years in several basins (fig. 23). On April 23, precipitation at Gurney, Wis., was 6.67 inches of rain.

Roads, highway, and railroads were damaged, and many culverts were washed out, grades were overtopped, and bridge approaches were swept away. Traffic was rerouted for several days until the water receded and repairs were made.

Water 4 feet deep flowed through Odanah, Wis., on the flood plain of the Bad River. Nearly all the inhabitants were evacuated—the water reached the second-story windows in some houses. About 2 miles of U.S. Highway 2 near Odanah was inundated. High velocities

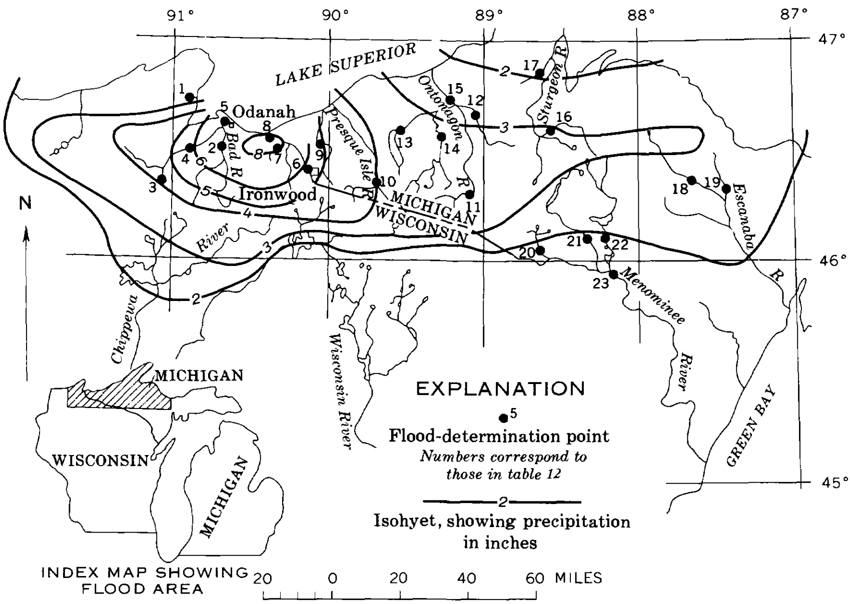

FIGURE 23.—Flood area; location of flood-determination points and isohyets for April 22-25 are shown. Floods of April 24-28 in northern Wisconsin and Michigan Upper Peninsula.

of water across the road caused extensive erosion to the downstream shoulders, and some sections of concrete slabs were undermined.

The peak discharge of the Bad River at Odanah was 45,600 cfs, and according to residents the stage was 6–10 inches lower than that of the flood of 1946. The discharge of the flood cannot be compared with that of 1946, as flow conditions have been altered because extensive changes were made to a nearby railroad grade since then.

The Montreal River in the Hurley, Wis., to Ironwood, Mich., area was out of its banks and flooded some stores and houses. The flood was the worst in this area in the memory of long-time residents. The Presque Isle River flooded the village of Marenisco, Mich.

The maximum discharge of record occurred at many stations in the flood area (table 12).

Reservoirs in the upper Wisconsin and Chippewa River basins stored most of the runoff and prevented flooding of these streams farther to the south.

The floods of May 7–12 in northern Wisconsin and the Upper Peninsula of Michigan were in and southwest of an area adjoining that of the floods of April 1960 (fig. 24). They occurred at the time when most streams were still high from recent storms and snowmelt.

Nearly the entire area received precipitation on the last 1 or 2 days in April and on each day for the first 10 days in May. As much as 6 inches of rain fell in the central part of the Upper Peninsula of Michigan during the first 10 days in May.

Heavy rain on May 5–7, added to that at the end of April and the beginning of May, caused severe flooding, especially in the Upper Peninsula.

Maximum discharges of record occurred generally in the upper Wolf River basin and in the lower Menominee River basin in Wisconsin and in the lower Escanaba River and all other tributaries to Lake Michigan in the Michigan Upper Peninsula (table 13). Reservoirs in the Wisconsin and Chippewa River basins were at 120 percent of their average content and attenuated the flood peaks in these basins. However, the maximum discharge of record (1944–60) occurred at one station in the Wisconsin River basin—Lemonwier River at New Lisbon, Wis., had a peak discharge that was about equal to that of a 50-year flood.

Many county roads throughout the flood area were closed owing to high-water damage. U.S. Highway 41 near Rapid River, Mich., was under 6 inches of water, and streets were flooded and houses were damaged in Rapid River. High water in inland lakes in the eastern part of Michigan Upper Peninsula flooded lakeshore property and caused considerable damage to dwellings, especially on Indian Lake and Manistique Lakes.

TABLE 12.—*Flood stages and discharges, April 24–28, in northern Wisconsin and Michigan Upper Peninsula*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to Apr. 1960, Period	Maximum floods: Prior to Apr. 1960, Year	Maximum floods: April	Maximum floods: Gage height (ft)	Maximum floods: Discharge (cfs)	Maximum floods: Recurrence interval (yrs)
	Streams tributary to Lake Superior							
1	Sioux River near Washburn, Wis.	17.5			24	17.48	1,620	
2	Bad River near Odanah, Wis.	611	1946	1946		22.2	(1)	
			1914–22, 1948–60	1949		17.3	16,500	
					24	21.7	27,700	45
3	Pearl Creek at Grandview, Wis.	15.9			24	12.99	278	
4	White River near Ashland, Wis.	269	1948–60	1953		7.90	6,270	
					24	6.40	4,630	4
5	Bad River at Odanah, Wis.	1,010			24	49.63	45,600	
6	Montreal River at Ironwood, Mich.	66.0	1918–22, 1925, 1950–54.	1952		5.10	1,810	
					24	(2)	3,400	
7	Boomer Creek near Saxon, Wis.	6.73			24	16.60	349	
8	Montreal River near Saxon, Wis.	262	1938–60	1942		6.93	[3] 5,700	
					24	7.50	[3] 6,600	
9	Black River near Bessemer, Mich.	202	1954–60	1957		9.76	5,420	
					24	14.27	14,800	
10	Presque Isle River at Marenisco, Mich.	175	1945–60	1952		9.90	2,670	
					25	11.25	3,520	[4] 1.18
11	Middle Branch Ontonagon River near Paulding, Mich.	175	1942–60	1951		10.0	2,050	
					25	10.07	1,700	10
12	East Branch Ontonagon River near Mass, Mich.	265	1942–60	1953		10.57	4,590	
					24	10.65	4,410	
13	West Branch Ontonagon River near Bergland, Mich.	160	1942–60	1951		5.73		
				1954			[3] 1,300	
					26	5.98	[3] 1,400	
14	South Branch Ontonagon River at Ewen, Mich.	320	1942–60	1946		18.86		
				1952			6,710	
					24	22.07	13,500	
15	Ontonagon River near Rockland, Mich.	1,290	1942–60	1942		28.6	[3] 42,000	
					24	20.82	[3] 22,400	
16	Sturgeon River near Sidnaw, Mich.	171	1912–15, 1943–60	1951			3,670	
				1957		10.40	3,670	
					24	11.63	4,630	
17	Otter River neat Elo, Mich.	165	1942–60	1952		13.52	4,540	
					24	12.08	3,160	
	Streams tributary to Lake Michigan							
18	Middle Branch Escanaba River near Ishpeming, Mich.	128	1954–60	1955		9.56	1,510	
					25	12.55	2,680	
19	East Branch Escanaba River at Gwinn, Mich.	125	1954–60	1955		12.01	1,030	
					25	14.44	1,920	
20	Iron River at Caspian, Mich.	84	1948–60	1953		10.20	1,430	
					24	9.24	1,040	12
21	Paint River at Crystal Falls, Mich.	616	1944–60	1953		9.70	10,700	
					25	9.82	10,900	
22	Michigamme River near Crystal Falls, Mich.	670	1944–60	1954		10.11	6,340	
					28	10.73	7,260	
23	Menominee River near Florence, Wis.	(1)	1950–60	1953		13.81	18,800	
					26	14.15	19,500	

[1] Not determined.
[2] At least 8 feet.
[3] Affected by regulation.
[4] Ratio of peak discharge to that of 50-year flood.

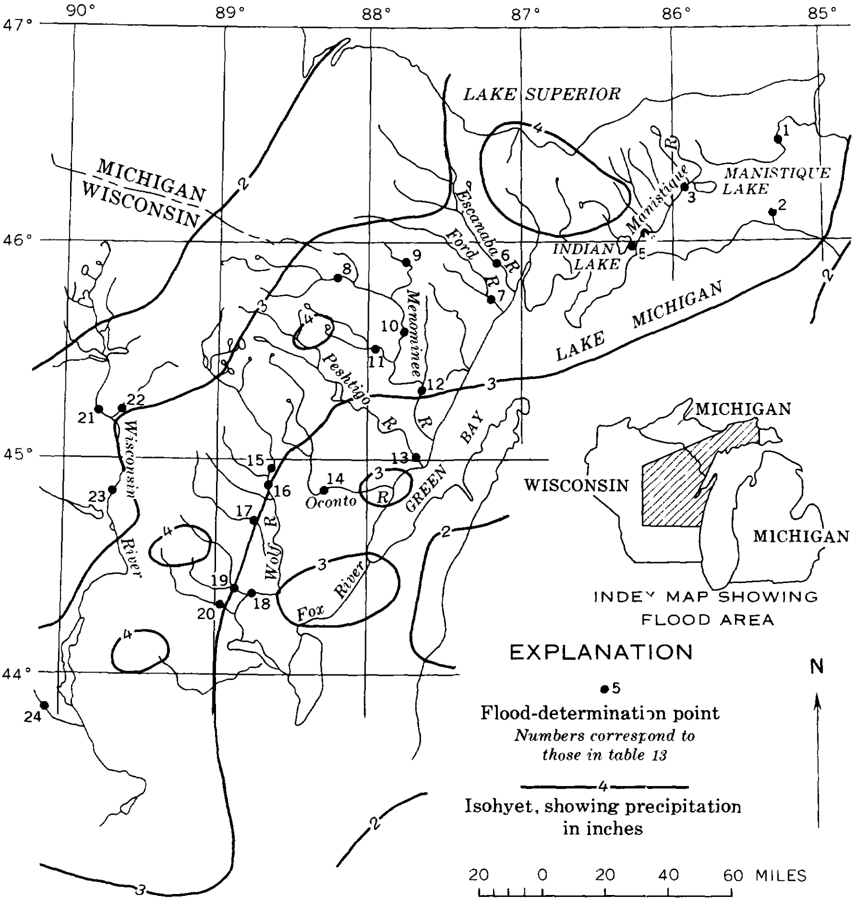

FIGURE 24.—Flood area; location of flood-determination points and isohyets for May 5–7 are shown. Floods of May 7–12 in northern Wisconsin and in Michigan Upper Peninsula.

TABLE 13.—*Flood stages and discharges, May 7–12, in northern Wisconsin and Michigan Upper Peninsula*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods					
			Prior to May 1960		May	Gage height (ft)	Discharge (cfs)	Recurrence interval (yrs)
			Period	Year				
	Streams tributary to Lake Superior							
1	Tahquamenon River near Tahquamenon Paradise, Mich.	790	1953–60	1957		9.43	5,740	
					10	10.26	6,990	

TABLE 13.—*Flood stages and discharges, May 7–12, in northern Wisconsin and Michigan Upper Peninsula*—Continued

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to May 1960: Period	Prior to May 1960: Year	May	Gage height (ft)	Discharge (cfs)	Recurrence interval (yrs)
	Streams tributary to Lake Michigan							
2	Black River near Garnet, Mich.	28	1951–60	1957		7.95	690	
					7	8.55	860	
3	Manistique River at Germfask, Mich.	341	1938–60	1938		[1] 8.50	2,130	
					10	8.64	2,250	
4	Manistique River near Manistique, Mich.	1,100	1938–60	1939		12.59	15,400	
					11	12.85	16,900	
5	Indian River near Manistique, Mich.	302	1938–60	1943		7.79	1,550	
					11	7.56		
					12		[2] 2,030	
6	Escanaba River at Cornell, Mich.	870	1903–12, 1950–60	1952			10,000	
				1956		[3] 5.72		
					7	4.90	10,500	
7	Ford River near Hyde, Mich.	450	1954–60	1955		5.89	3,120	
					7	8.27	7,590	
8	Pine River at Pine River Powerplant near Florence, Wis.	528	1923–60	1929			[2] 4,380	
					7		[2] 3,220	
9	Sturgeon River near Foster City, Mich.	244	1954–60	1955			[2] 1,400	
					8	10.35	2,570	
10	Menominee River near Pembine, Wis.	3,240	1949–60	1953		13.06	[4] 25,500	
					8	13.90	[4] 26,900	18
11	Pike River at Amberg, Wis.	253	1914–60	1922		[1] 7.8	2,800	
					7	7.00	2,290	8
12	Menominee River near McAllister, Wis.	4,020	1945–60	1951		17.83	[4] 25,700	
					9	20.00	[4] 32,500	35
13	Peshtigo River at Peshtigo, Wis.	1,124	1953–60	1959		7.90	4,400	
					9	11.59	9,790	
14	Oconto River near Gillett, Wis.	678	1906–9, 1913–60	1922		11.2	[5] 8,400	
					10	6.37	4,340	17
15	Wolf River above West Branch Wolf River, Wisc.	633	1927–60	1929		6.20	2,640	
					8	6.60	3,120	
16	Wolf River at Keshena Falls, Wis.	812	1907–60	1922		7.30	4,390	
				1943		[3] 13.83		
					7	9.67	4,830	20
17	Embarrass River near Embarrass, Wis.	395	1919–60	1922		11.6	6,920	
					7	9.72	4,890	6
18	Wolf River at New London, Wis.	2,240	1888	1888		11.6	([6])	
			1896–1960	1922			[2] 15,500	
					12	10.52	13,300	[7] 1.10
19	Little Wolf River at Royalton, Wis.	485	1914–60	1943		8.00	6,950	
				1950		[3] 11.95		
					8	5.82	4,260	
20	Waupaca River near Waupaca, Wis.	305	1916–60	1948		6.90	2,520	
					7	3.55	980	
	Wisconsin River basin							
21	New Wood River near Merrill, Wis.	83	1952–60	1959		6.00	1,370	
				1955		[3] 8.40		
					7	5.53	1,090	
22	Prairie River near Merrill, Wis.	181	1914–31, 1939–60	1941		9.45	5,800	
					7	6.70	2,620	25
23	Wisconsin River at Rothschild, Wis.	4,000	1941	1941		22.3	75,000	
			1944–60	1959		17.81	47,000	
					7	17.05	42,900	6
24	Lemonweir River at New Lisbon, Wis.	486	1944–60	1956		12.60	5,580	
					8	12.94	6,880	[7] 1.09

[1] At different site or datum.
[2] Daily mean discharge.
[3] Affected by ice jam.
[4] Affected by regulation.
[5] Caused by failure of dam 4 miles upstream.
[6] Not determined.
[7] Ratio of peak discharge to that of a 50-year flood.

FLOODS OF MAY 4–6 IN NORTHWESTERN ARKANSAS AND EAST-CENTRAL OKLAHOMA

Heavy rainfall of May 4–6 caused record-breaking floods on tributaries of the Arkansas and White Rivers in northwestern Arkansas. The heaviest rainfall occurred in the Ozark Mountain area about 40 miles north of Fort Smith, where a bucket survey showed that as much as 8 inches of rain fell (fig. 25).

Peak discharges exceeding that of the 50-year flood occurred in Arkansas at the discontinued gaging stations on West Fork White

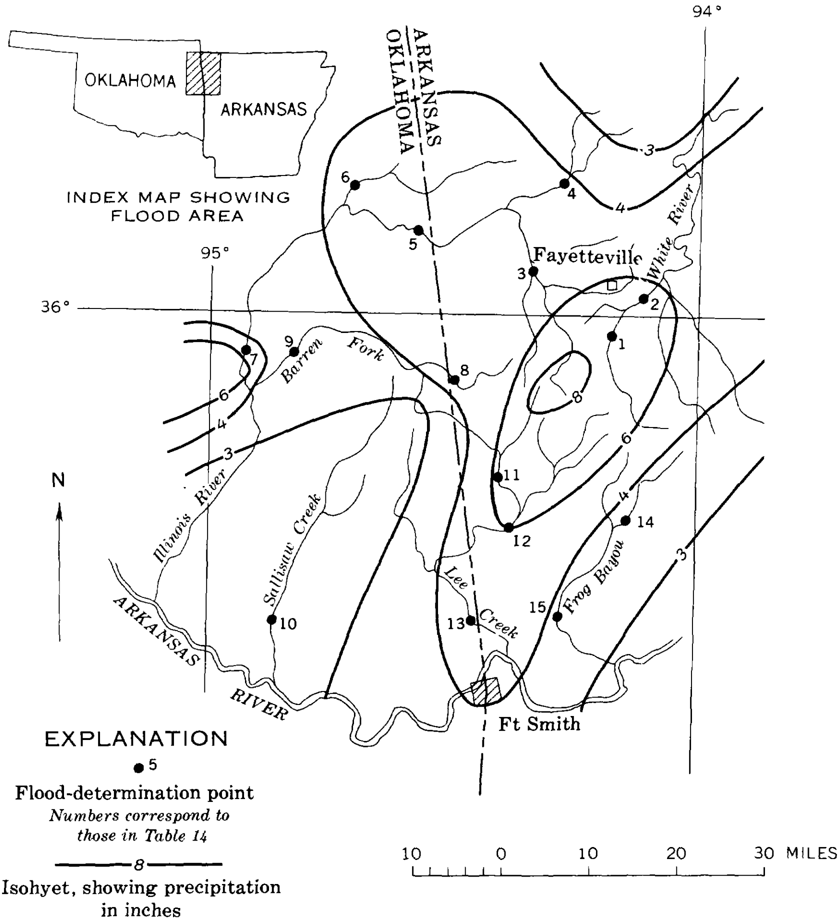

FIGURE 25.—Flood area; location of flood-determination points and isohyets for May 4–6 are shown. Floods of May 4–6 in northwestern Arkansas and east-central Oklahoma.

TABLE 14.—*Flood stages and discharges, May 4–7, in northwest Arkansas and east-central Oklahoma*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to May 1960: Period	Maximum floods: Prior to May 1960: Year	Maximum floods: May	Maximum floods: Gage height (ft)	Maximum floods: Discharge (cfs)	Maximum floods: Recurrence interval (yrs)
	White River basin							
1	West Fork White River at Greenland, Ark.	83	1946–60	1946		13.71		
				1957			27,700	
					6	14.50	34 700	32
2	West Fork White River near Fayetteville, Ark.	118	1938–60	1945		21.50	53 000	
					6	21.6	54 000	[1]1.12
	Arkansas River basin							
3	Illinois River near Prairie Grove, Ark.	53			5		39,800	[1]1.37
4	Osage Creek near Elm Springs, Ark.	129	1950–60	1950		16.7	22,500	
					6	8.46	3,270	1.5
5	Illinois River near Watts, Okla.	635	1955–60	1957		24.73	49 000	
					6	21.56	31,600	4
6	Flint Creek near Kansas, Okla.	110	1955–60	1958		12.55	12,000	
					6	12.47	11,700	8
7	Illinois River near Tahlequah, Okla.	959	1916–60	1950		27.94	150,000	
					7	17.19	25,000	2.3
8	Barren Fork at Dutch Mills, Ark.	43	1958–60	1958		12.8	14,800	
					5	12.12	12,800	
9	Barren Fork near Eldon, Okla.	307	1945–60	1945		23.8		
				1957		20.33	37,600	
					6	17.18	24 000	7
10	Sallisaw Creek near Sallisaw, Okla.	182	1942–60	1945		[2]11.25	110,000	
					6	12.27	10,200	1.5
11	Cove Creek near Lee Creek, Ark.	36.9	1950–60	1957		13.50	20,500	
					5	15.60	33,600	[1]1.96
12	Lee Creek at Natural Dam, Ark.	168	1890–1960	1957			51,800	
					6		90,300	[1]1.95
13	Lee Creek near Van Buren, Ark.	427	1931–60	1945		35.0	112,000	
					6	30.30	80,600	44
14	Frog Bayou near Mountainburg, Ark.	74	1937–60	1945		31.06	17,300	
					6	28.08	6,210	2.3
15	Frog Bayou at Rudy, Ark.	217	1945–60	1945		18.5	39 500	
					6	14.60	20,400	6

[1] Ratio of peak discharge to that of a 50-year flood.
[2] At site 400 feet upstream at datum 13.22 feet higher.

River near Fayetteville and Cove Creek near Lee Creek, at miscellaneous sites on the upper Illinois River near Prairie Grove, and at Lee Creek at Natural Dam. The peak on West Fork White River near Fayetteville was the greatest since at least 1938. According to local residents, the flood on Lee Creek at Natural Dam was the greatest since at least 1890. The flood at the downstream station on Lee Creek near Van Buren was the second highest since at least 1931. Table 14 gives a summary of peak stages and discharges in the flood area.

Several small bridges were washed out, and considerable damage was done to early crops.

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FLOODS OF MAY 5-9 IN SOUTHERN MISSISSIPPI

Heavy rains of May 4, 5, and 6 in southern Mississippi caused extensive flooding on smaller streams in the lower Pascagoula and Pearl River basins. The rainfall at the selected stations listed in the following table represents 24-hour totals ending at 7 a.m. on the date indicated:

Station	*May 5*	*May 6*	*May 7*	*Total, May 5-7*
Meridian	2.66	2.10	0.15	4.91
Laurel	.88	.37	6.18	7.43
Columbia	4.20	1.98	2.58	8.76
Tylertown	7.90	3.00	.40	11.30
Purvis	4.07	1.59	4.46	10.12
Merrill	.52	.72	4.79	6.03

The rainfall was heavy and intense in the Columbia-Tylertown-Purvis area on May 5. As much as 2.14 inches fell in a 1-hour period at Purvis during the height of the storm, and a maximum 1-hour rainfall of 2.07 inches was reported at Tylertown. Peak runoff from small drainage areas in the Columbia-Tylertown area was almost as high as that of April 12, 1955, which was the greatest known in that area. The peak discharge of McGee Creek at Tylertown (drainage area, 130 sq mi) was less than that of April 12, 1955, but was the highest flood since that time.

During the afternoon of May 6, rainfall similar to that of May 5 fell in a relatively narrow band extending from Purvis through the Beaumont-Merrill area into Alabama. Maximums of 2.10 inches in 1 hour and 1.80 inches in 1 hour were recorded at Tylertown and Purvis, respectively. The resulting runoff indicated that the short-duration rain was even more intense near McLain. During the night of May 6-7, State Highway 13 was overtopped between Columbia and Lumberton (near Pinesboro) by a tributary to Lower Little Creek. Beaver Dam Creek overtopped U.S. Highway 49 near Maxie. Floodwaters from a tributary to Big Oktibbee Creek near McLain (drainage area, 3.87 sq mi) washed two cars off U.S. Highway 98. Flooding was severe along both Black and Red Creeks. Figure 26 shows the total amounts and distribution of rainfall of the May 5-7 storm and the points at which peak discharges were determined. A summary of flood stages and discharges at 37 sites is given in table 15. The peak discharges of May 5-7 are probably the annual maximums at each of these sites.

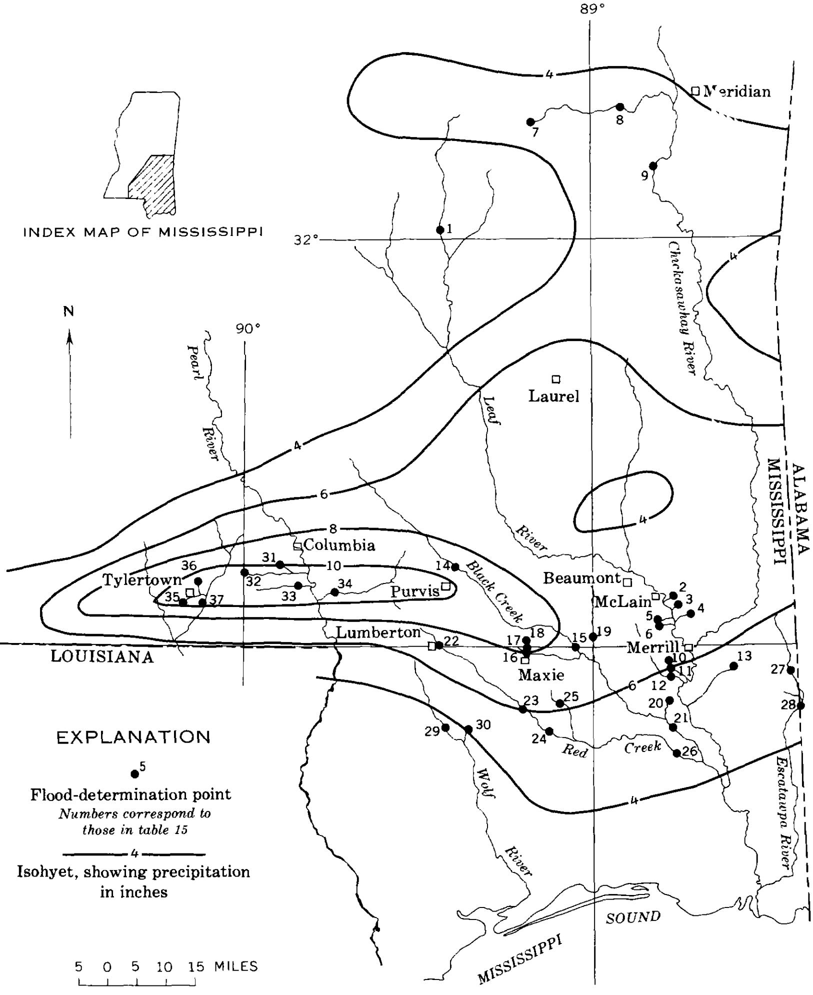

FIGURE 26.—Flood area; location of flood-determination points and isohyets for May 5–7 are shown. Floods of May 5–9 in southern Mississippi.

A peak discharge of 2,750 cfs per square mile was measured at Holy Creek near McLain (drainage area, 1.30 sq mi). Peak discharges of 1,700 and 1,500 cfs per square mile were measured from a tributary to McMillan Creek near McLain (drainage area, 1.39 sq mi) and from a tributary to Beaver Dam Creek near Maxie (drainage area, 0.9 sq mi), respectively. Unusual floods also occurred on Lower Little Creek at Hub, Red Creek near Wiggins, and the Wolf River near Poplarville and were larger than any other floods in recent years. The drainage areas at these sites range from 71 to 168 square miles.

TABLE 15.—*Flood stages and discharges, May 5–9, in southern Mississippi*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to May 1960: Period	Maximum floods: Prior to May 1960: Year	Maximum floods: May	Maximum floods: Gage height (ft)	Maximum floods: Discharge (cfs)	Maximum floods: Recurrence interval (yrs)
	Pascagoula River basin							
1	Leaf River near Raleigh	143	1940–43, 1957–60	1957		296.11	2,000	
					7	296.55	2,150	1
2	Waterfall Branch near McLain.	.68	1955–60	1959		10.99	764	
					7	8.93	541	
3	Tributary to Big Oktibee Creek near McLain.	3.87			6	21.9	6,390	(1)
4	Holy Creek near McLain	1.30			7	22.50	3,580	(1)
5	Tributary to McMillan Creek near McLain.	1.39			6	16.67	2,370	(1)
6	McLeod Branch near McLain.	2.35			6	17.55	2,670	(1)
7	Tarlow Creek near Newton	15.9	1952–60	1953		18.08	3,700	
					7	17.42	1,720	3
8	Chunky Creek near Chunky.	368	1938–60	1950		25.08	30,700	
					8	12.30	4,890	1
9	Chickasawhay River at Enterprise.	913	1900	1900		37.2	(2)	
			1938–60	1950		33.10	33,500	
					8	18.17	7,660	1
10	Cowart Branch near McLain.	2.5			7	20.04	2,400	(1)
11	Green Creek near Benndale	6.0			7	27.22	1,290	8
12	Whiskey Creek near Benndale.	42.0			7	51.91	11,000	(1)
13	Big Creek near Lucedale	22.1	1952–60	1959		95.77	7,000	
					7	90.41	2,100	1
14	Black Creek near Purvis	154	1957–60	1959		25.10	5,200	
					6	26 30	7,300	10
15	Black Creek near Janice	471			7	114.10	14,400	9
16	Beaver Dam Creek at Maxie.	7			7	19.42	2,890	(1)
17	Tributary to Beaver Dam Creek near Maxie.	.9			5	22.03	1,370	(1)
18	Bowens Bay near Maxie	1.2			5	19.51	893	(1)
19	Cypress Creek near Janice	52.2	1910–60	1959		54.30	22,800	
					7	43.25	4,700	2
20	Mosquito Branch at Benndale.	.22	1955–60	1955		8.26	314	
					7	2.82	61	
21	Black Creek near Benndale	710			9	38.99	18,400	12
22	Red Creek at Lumberton	15.6	1951–60	1953		97.70	2,720	
					6	97.26	2,400	10
23	Red Creek near Wiggins	168	1952–60	1953		144.65	8,400	
					7	147.49	13,600	10
24	Red Creek at Perkinston	218			7	119.2	13,800	25
25	Flint Creek near Wiggins	24.8	1957–60	1957		16.17	3,320	
					7	15.51	2,760	7
26	Red Creek at Vestry	416	1958–60	1959		15.30	8,600	
					9	16.42	13,000	10
27	Brushy Creek near Lucedale.	49.6	1907–60	1959		27.34	13,800	
					7	23.20	4,220	3
28	Escatawpa River near Wilmer.	506	1945–60	1959		24.66	30,000	
					7	20.76	14,600	7

See footnotes at end of table.

TABLE 15.—*Flood stages and discharges, May 5–9, in southern Mississippi*—Con.

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to May 1960, Period	Prior to May 1960, Year	May	Gage height (ft)	Discharge (cfs)	Recurrence interval (yrs)
	Wolf River basin							
29	Wolf River near Poplarville.	71	1952–60	1957		187.2	2,400	
					7	189.45	5,000	12
30	Murder Creek near Poplarville.	21.6	1952–60	1953		15.44	2,160	
					7	14.72	1,760	4
	Pearl River basin							
31	Elmers Draw near Columbia.	0.91	1955–60	1955		12.21	1,150	
					7	11.72	1,080	40
32	Kokomo Draw at Kokomo	1.26	1955–60	1955		8.43	1,320	
					7	7.25	1,030	20
33	Tenmile Creek near Columbia.	39.9	1952–60	1955		19.0	11,300	
					7	17.49	7,700	[3] 1.37
34	Lower Little Creek at Hub	117			7		14,100	([1])
35	Middle Fork Hickory Flat near Tylertown.	1.37	1953–60	1953		24.90	2,300	
					7	18.08	832	40
36	Union Creek near Tylertown.	12.6	1953–60	1953		19.2	12,800	
					6	16.97	3,230	[3] 1.06
37	McGees Creek at Tylertown.	130	1952–60	1955		26.54	12,400	
					6	23.56	6,900	7

[1] Greater than 50; ratio to 50-year flood not determined.
[2] Not determined.
[3] Ratio of peak discharge to that of a 50-year flood.

FLOODS OF MAY 6 IN SOUTH-CENTRAL MISSOURI

A thunderstorm on May 6 produced 2.81 inches of rain at Forsyth and 1.44 inches in less than an hour at a nearby site. This rainfall caused small streams in this area (fig. 27) to exceed flood stage.

The floods overtopped some roads and caused scour at culvert outlets. Indirect measurements of this flood flow at two sites show that the discharges were extremely unusual. The peak discharge on Cedar Hollow at a culvert under State Highway 76 about 0.8 mile southwest of Bradleyville was 1,160 cfs from a drainage area of 0.83 square mile. On Ingenthron Hollow at a culvert under county road H 2 miles north of Forsyth the peak discharge was 1,190 cfs from a drainage area of 0.646 square mile. The runoff at these sites was 1,400 and 1,840 cfs per sq mi, respectively.

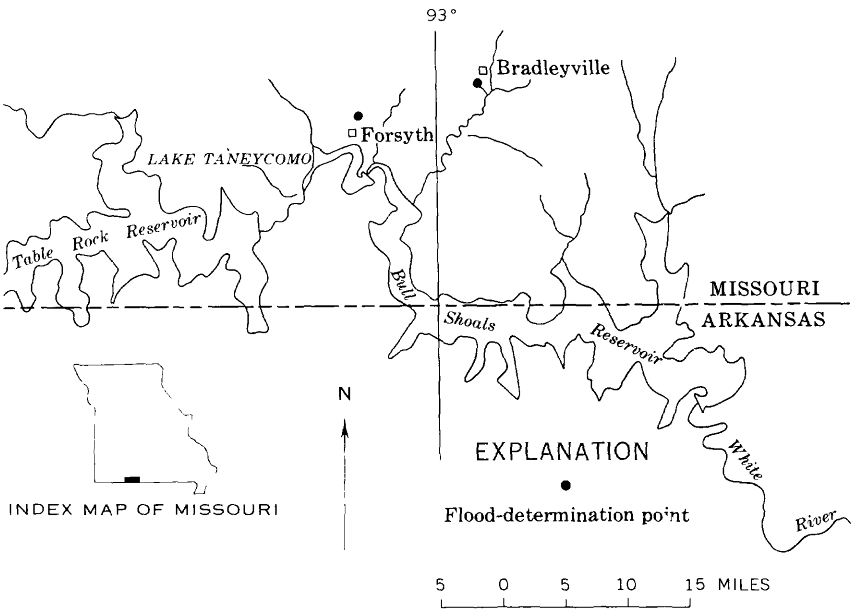

FIGURE 27.—Flood area; location of flood-determination points is shown. Floods of May 6 in south-central Missouri.

FLOODS OF MAY 19-22 IN SOUTHWESTERN ARKANSAS AND SOUTHEASTERN OKLAHOMA

Floods of unusual magnitude occurred in tributary streams of the Arkansas and Red Rivers during May 19–22 in an area immediately north of the area in which the record-breaking floods of May 4–6, 1960, occurred. A 24-hour rainfall of 7.19 inches was recorded at Wilberton, Okla., on Fourche Maline, a tributary to the Poteau River, and a rainfall of slightly more than 6 inches occurred at several other points. Total rainfall for the storm period exceeded 10 inches over a large area.

Peak discharges were determined at 16 gaging stations and 1 miscellaneous site in the flood area (fig. 28). New maximum discharges and stages for period of gaging station record occurred on Dutch Creek and the Fourche La Fave River in Arkansas River basin and on the Mountain Fork River, Ouachita River, and South Fork Ouachita River in the Red River basin. Floods having recurrence intervals of 50 years or more occurred on Fourche Maline, the

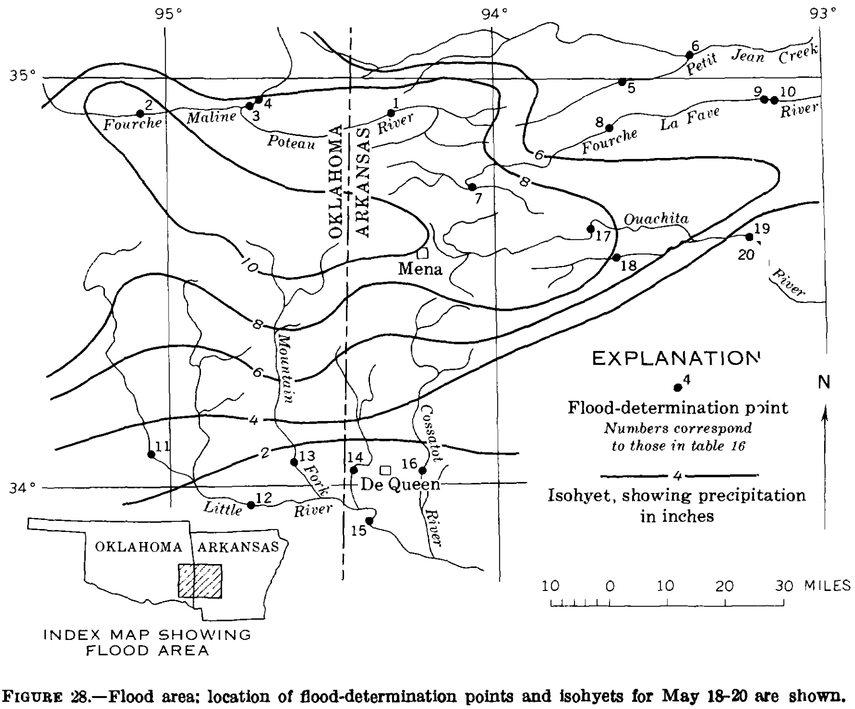

FIGURE 28.—Flood area; location of flood-determination points and isohyets for May 18-20 are shown. Floods of May 19-22 in southwest Arkansas and southeast Oklahoma.

TABLE 16.—*Flood stages and discharges, May 19–22, in southwestern Arkansas and southeastern Oklahoma*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to May, 1960: Period	Year	May	Gage height (ft)	Discharge (cfs)	Recurrence interval (yrs)
	Arkansas River basin							
1	Poteau River at Cauthron, Ark.	200	1935–60	1935		27.4	(1)	
			1939–60	1949		23.34	31,000	
					20	23.76	32,200	38
2	Fourche Maline near Red Oak, Okla.	122	1935–60	1935		25.4	(1)	
			1939–60	1942		22.34	26,300	
					19	24.79	41,500	[2] 1.25
3	Wister Reservoir near Wister, Okla.	993	1949–60	1957		505.73	[3] 507	
					23	502.98	[3] 441	
4	Poteau River near Wister, Okla.	993	1935–60	1935		[4] 38.5	(1)	
			1938–60	1945		[4] 37.16	78,600	
					20–21		13	
5	Dutch Creek at Waltreak, Ark.	74	1927–60	1927		19.5	(1)	
			1945–60	1949		18.45	13,700	
					20	19.36	14,300	17
6	Petit Jean Creek at Danville, Ark.	741	1916–60	1939		31.82	70,800	
					21	25.16	15,800	1.4
7	Mill Creek near Boles, Ark.	55.0			20		16,700	34
8	Fourche La Fave River near Gravelly, Ark.	413	1939–60	1949		28.86	54,000	
					20	30.30	69,400	[2] 1.04
9	Nimrod Reservoir near Nimrod, Ark.	680	1942–60	1945		374.80	[3] 370	
					24–25	364.91	[3] 208	
10	Fourche La Fave River near Nimrod, Ark.	680	1927–60	1935		28.8	39,000	
					20	3.82	656	
	Red River basin							
11	Little River near Wright City, Okla.	645	1930–31, 1945–60	1950		45.77	75,400	
					20	44.71	69,100	16
12	Little River below Lukfata Creek near Idabel, Okla.	1,226	1930–60	1938		39.7	86,000	
					21		57,900	8
					22	36.65		
13	Mountain Fork River near Eagletown, Okla.	787	1915–60	1915		26.4	92,500	
					20	26.73	101,000	50
14	Rolling Fork near De Queen, Ark.	181	1947–60	1947		25.6	110,000	
					20	15.50	6,070	1.2
15	Little River near Horatio, Ark.	2,674	1915–60	1915		38.0	124,000	
					22	31.99	55,500	2.1
16	Cossatot River near De Queen, Ark.	361	1938–58	1947		20.47	46,900	
					20	19.12	32,600	4
17	Ouachita River near Mt. Ida, Ark.	410	1942–60	1949		[5] 30.8	54,800	
					21	32.18	57,300	24
18	South Fork Ouachita River at Mt. Ida, Ark.	64	1950–60	1952		13.24	10,800	
					20	13.69	17,900	30
19	Lake Ouachita near Hot Springs, Ark.	1,105	1952–60	1957		584.01	[3] 2,402	
					22	581.47	[3] 2,294	
20	Ouachita River at Blakely Mountain Dam, Ark.	1,105			26		9,140	

[1] Not determined.
[2] Ratio of peak discharge to that of a 50-year flood.
[3] Contents in thousands of acre-feet.
[4] At site and datum used 1939–47.
[5] At former site; about 31.8 ft at present site.

Fourche La Fave River, and the Mountain Fork River. A summary of flood peaks is given in table 16.

Several small bridges were washed out, and considerable crop damage occurred.

FLOODS OF MAY 21–28 IN SOUTH-CENTRAL MINNESOTA

Flooding in south-central Minnesota was caused by rains that fell during May 16–21 in the basins of the Blue Earth River, the Le Sueur River, and Sand Creek. Precipitation was heaviest in the Sand Creek basin (fig. 29).

The greatest rainfall reported for the storm in the Le Sueur River basin occurred on May 21 at Matawan and Waldorf; 24-hour totals were 5.00 inches and 4.80 inches, respectively. The storm accumulations at these two sites were 9.13 inches and 8.80 inches, respectively. The greatest 24-hour rainfall reported in the Sand Creek basin was 6.15 inches at Jordan and 6.00 inches at New Prague. The storm accumulations for these two sites were 9.14 inches and 9.80 inches, respectively. The U.S. Weather Bureau was able to supplement the rainfall data by collecting and evaluating information from many unofficial rain gages in the area. The isohyetal map (fig. 29) was prepared from Weather Bureau maps.

The peak on Le Sueur River near Rapidan was the maximum of record. The water-stage recorder was inundated for two days to a depth of 4 feet. Readings from a temporary staff gage and a reference point determined high-water marks and insured the continuity of the record. The gage observer, who has lived near the gage site since 1924, stated that this flood had the highest stage since that time. According to relatives of the observer, the flood may have been the highest since 1888.

No daily discharge records have been collected in the Sand Creek basin, although peak discharges were determined at four crest-stage gage sites and at two miscellaneous sites. Residents in the basin reported the flood to be the highest in at least 50 years. The peak discharge on Sand Creek tributary near Jordan was high, even though it was reduced by storage upstream from the culvert at which the discharge was measured.

The location of all sites where peak flows were obtained are shown on the map (fig. 29). A summary of flood stages and discharges is given in table 17. Composite flood-frequency curves for this area, taken from Prior and Hess,[2] were used to compute the recurrence intervals given in table 17. Recurrence intervals were not computed for some of the sites due to lack of information on flood flows on small drainage basins in the area.

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[2] Prior, C. H., and Hess, J. H., 1961, Floods in Minnesota, magnitude and frequency: Minnesota Department of Conservation, Division of Waters, 141 p.

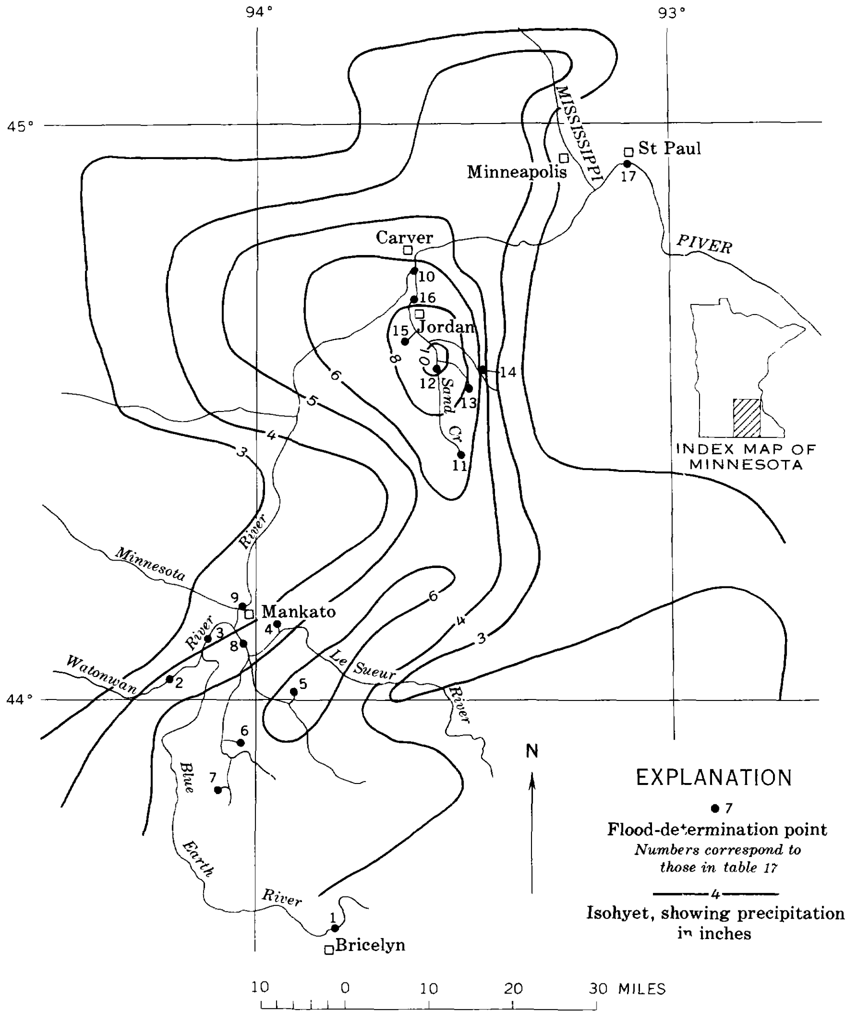

FIGURE 29.—Flood area; location of flood-determination points and isohyets for May 16–21 are shown. Floods of May 21–28 in south-central Minnesota.

Flood damage in the areas consisted mainly of inundated croplands, highways, and basements. Many minor landslides, triggered by heavy local rainfall, blocked township roads and highways. No formal report is available for damage in the Le Sueur River basin, but the bridge on State Highway 256 over the Le Sueur River, about 0.6 mile below the gage, failed. The Corps of Engineers made a letter report of damage in the Sand Creek basin and determined the

TABLE 17.—*Flood stages and discharges, May 21–28, in south-central Minnesota*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to May 1960: Period	Maximum floods: Prior to May 1960: Year	Maximum floods: May	Maximum floods: Gage height (ft)	Maximum floods: Discharge (cfs)	Maximum floods: Recurrence interval (yrs)
	Minnesota River basin							
1	East Branch Blue Earth River near Bricelyn.	132	1951–60	1951		10.68	1,320	
					23	10.36	935	5
2	Watonwan River near Garden City.	812	1940–45	1944		9.84	5,620	
			1953	1953		18.6	17,700	
					22	9.3	5,000	5
3	Blue Earth River near Rapidan.	2,430	1909–10, 1939–45, 1949–60.	1951		14.97	26,100	
					24	11.52	16,600	10
4	Le Sueur River tributary near Mankato.	.07	1959–60	1959		23.72	33	
					21	23.02	33	
5	Cobb River tributary near Mapleton.	7.23	1959–60	1959		18.09	258	
					21	22.24	526	
6	Maple River tributary near Mapleton.		1959–60	1959		15.89	(1)	
					21	23.26	445	
7	Maple River tributary near Amboy.		1959–60	1959		[2] 12.26	(1)	
					21	19.51	1,110	
8	Le Sueur River near Rapidan.	1,100	1939–45, 1949–60	1951		19.73	13,200	
					22	22.72	21,200	[3] 1.5
9	Minnesota River at Mankato.	14,900	1881	1881		29.9	90,000	
			1903–60	1951		26.20	66,600	
					23	20.41	34,300	9
10	Minnesota River near Carver.	16,200	1934–60	1951		27.71	64,100	
				1952		[2] 28.31		
					25	24.58	36,400	10
					26	[4] 24.87		
11	Rice Lake tributary near Montgomery.				21	13.72	279	
12	Sand Creek near New Prague.	65			21	14.84	1,160	
13	Raven Stream tributary near New Prague.	23			21	17.34	929	
14	Porter Creek near Lydia	58.6			21	17.96	725	
15	Sand Creek tributary near Jordan.	2.62			21	19.66	558	
16	Sand Creek at Jordan	238			21	13.71	8,650	[3] 3.9
17	Mississippi River at St. Paul.	36,800	1870–1960	1952		22.02	125,000	
					28	10.50	43,300	2

[1] Unknown.
[2] Backwater from ice.
[3] Ratio of peak discharge to that of a 30-year flood.
[4] Backwater from Mississippi River.

damage to be $817,000; they indicated that the heaviest damage was at and near Jordan (population 1,479, census of 1960). A large part of the residential area of the city was inundated to depths as much as 5 feet. About 110 families were evacuated from the flood area. In addition to damage to private property, damage occurred to streets, bridges, sidewalks, parks, fairgrounds, and water and sewer facilities in Jordan. Highways, highway bridges, railroad facilities, growing crops, and cropland in the area were also severely damaged.

Showers in Wyoming during the summer are frequently light, but occasionally they are associated with thunderstorms and are very heavy over areas of a few square miles. One thunderstorm in May and several in June produced unusually large floods in three widely scattered areas in the State. No gaging stations were in the areas of high discharge.

Floods occurred in a small area east of Moorcroft (fig. 30) on May 24. Two indirect measurements of peak discharge were made on tributaries of Rush Creek at culverts under U.S. Highway 16 southeast of Moorcroft. One, at a site 1.9 miles from Moorcroft, measured 336 cfs from a drainage area of 0.47 square mile (table 18). Flood damage was light in this sparsely populated area.

A cloudburst centered over North Elkhorn Creek northwest of Glendo (fig. 30) on the afternoon of June 7. Residents near the area reported rainfall intensities ranging from 1 to 6 inches in 1½ hours. An unusually high peak discharge of 9,940 cfs from a drainage area

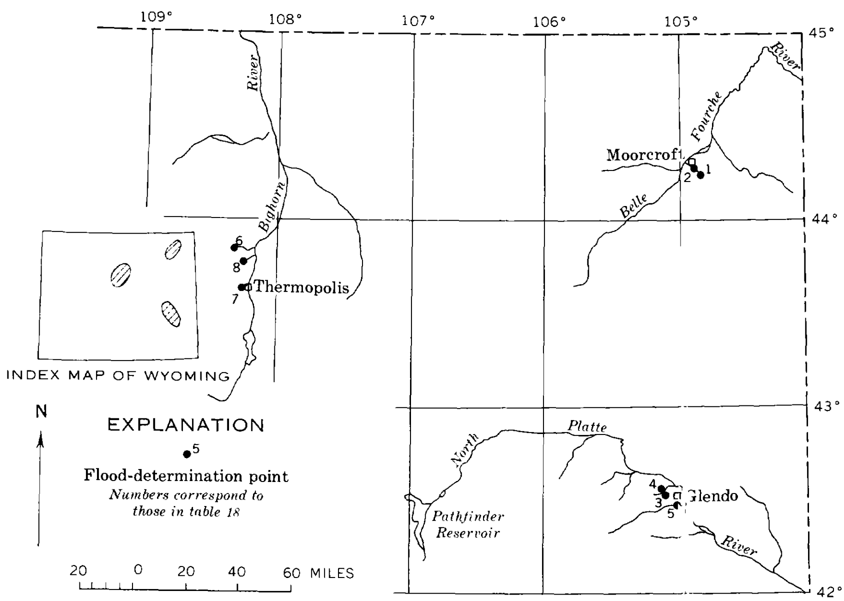

FIGURE 30.—Flood area; location of flood-determination points is shown. Floods of May and June in Wyoming.

TABLE 18.—*Flood stages and discharges, May and June 1960, in Wyoming*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods	
			May-June	Discharge (cfs)
	Cheyenne River basin			
1	Rush Creek tributary 1.9 miles southeast of Moorcroft.	0.47	May 24	336
2	Rush Creek tributary 1.6 miles southeast of Moorcroft.	.16	do	136
	Platte River basin			
3	Elkhorn Creek near Glendo	27.2	June 7	3,670
4	North Elkhorn Creek near Glendo	20.1	do	9,940
5	Horseshoe Creek 1.8 miles south of Glendo.	[1] 194	do	680
	Yellowstone River basin			
6	Sand Draw 19 miles northwest of Thermopolis.	6.3	June 9	2,490
7	Unnamed creek 1.4 miles west of Thermopolis.	.44	June 16	361
8	Coal Draw tributary 12 miles northwest of Thermopolis.	3.8	do	1,740

[1] Area contributing to peak discharge on June 7 is unknown.

of 20.1 square miles was indirectly measured on North Elkhorn Creek 2 miles upstream from U.S. Highway 87 and 6.3 miles northwest of Glendo. Moderate damage was caused to the abutments and embankments of the bridge on U.S. Highway 87 and to the Chicago, Burlington, and Quincy Railroad bridge. Damage reported by ranchers was slight and was mostly to stock ponds and small losses of livestock. No dwellings are within the drainage basin. Horseshoe Creek had a peak discharge of only 680 cfs on June 7 at a site 0.2 mile upstream from U.S. Highway 87 and 1.8 miles south of Glendo. The storm apparently covered only a small part of the drainage area of 194 square miles above this site. At the gaging station (drainage area, 211 sq mi) about 3 miles southeast of the site, the peak discharge was reduced to 370 cfs.

Local flooding caused by scattered thunderstorms occurred June 9 and 16 near Thermopolis (fig. 30). A flash flood occurred on Sand Draw 19 miles northwest of Thermopolis about 7 p.m. on June 9. The peak discharge at a box culvert under State Highway 120 was 2,490 cfs from a drainage area of 6.3 square miles.

After scattered thunderstorms on June 16, the unnamed creek that flows through the southwestern part of Thermopolis overflowed its banks and flooded areas between 8th and 11th Streets. One residence had to be evacuated, and several basements were flooded. A high peak discharge of 1,740 cfs occurred in an unnamed tributary of Coal Draw at a culvert under State Highway 120 about 12 miles northwest of Thermopolis from a drainage area of 3.8 square miles. Other heavy rains east of Thermopolis on June 16 caused flash floods on Kirby Creek and Sand Draw (not the same stream mentioned at the beginning of the paragraph). A county bridge was washed out, and damage to hay fields, fence lines, and canals was estimated at $55,000 by the Soil Conservation Service.

FLOODS OF JUNE AND JULY ON THE TEXAS HIGH PLAINS

Heavy rains occurred in early June and early July and caused severe localized flooding and the formation of many "wet-weather" lakes, which inundated large areas on the level High Plains of Texas. Rainfall for the two storm periods totaled as much as 18 inches. Normal rainfall for this area is about 20 inches per year.

The June storm occurred between the 5th and 12th and produced local flooding in the upper reaches of the Red River (fig. 31). Hall County in the southeastern Panhandle of Texas was declared a disaster area. Heavy damage to grounds and facilities in the Palo Duro State Park near Canyon was caused primarily by the failure of a partly completed earthen dam on Prairie Dog Town Fork of the Red River upstream from the park. The resulting flood was reported to be the greatest known in the park. Historic floods were not exceeded at any gaging station (table 19).

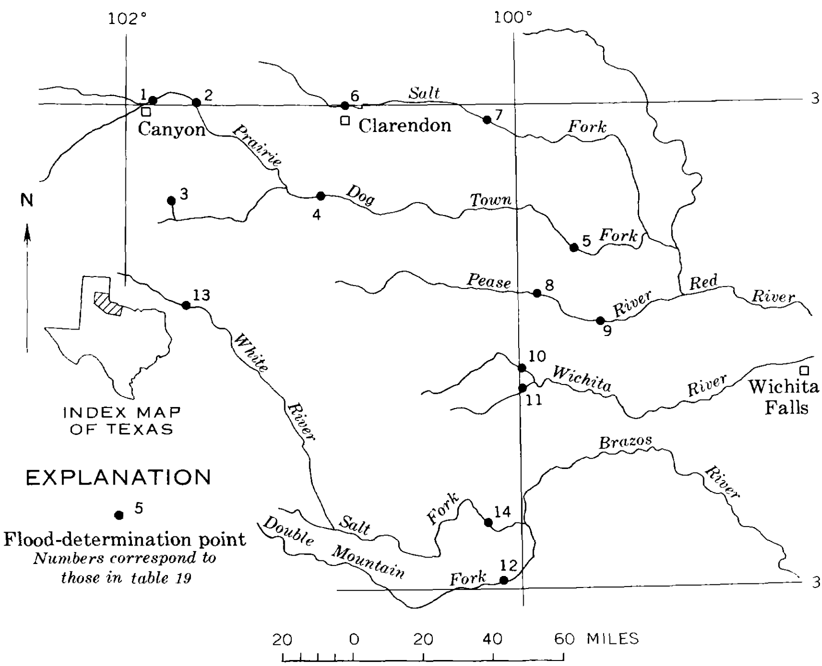

FIGURE 31.—Flood area; location of flood-determination points is shown. Floods of June and July on the Texas High Plains.

TABLE 19.—*Flood stages and discharges, June and July, on the Texas High Plains*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to June 1960: Period	Maximum floods: Prior to June 1960: Year	Maximum floods: June–July	Maximum floods: Gage height (ft)	Maximum floods: Discharge (cfs)	Maximum floods: Recurrence interval (yrs)
	Red River basin							
1	Prairie Dog Town Fork Red River near Canyon.	3,369	1905–60	1951		20.31	15,200	
		[1] 2,658			June 10	15.25	5,000	2
2	Prairie Dog Town Fork Red River in Palo Duro Canyon State Park.	([2])	1951–60	1951			18,500	
					June 10	([3])	52,700	
3	North Tule Draw at reservoir near Tolia.	189	1939–60	1951			[4] 5,430	
		[1] 124			July 8		[4] 3,010	11
4	Prairie Dog Town Fork Red River near Brice.	6,082	1906–60	1933		[5] 14.8	([2])	
		[1] 4,501		1957		[6] 19.5	([2])	
					June 7	12.20	49,000	19
5	Red River near Quanah	8,321	1891–1960	1896		([7])	([2])	
		[1] 4,769		1957		27.2	([2])	
					June 9	15.00	64,000	8
6	Salt Fork Red River near Clarendon.	457	1910–60	1954		32	([2])	
		[1] 191			June 8	15.50	28,000	[8] 1.60
7	Salt Fork Red River near Wellington.	1,222	1952–60	1957		19.00	146,000	
		[1] 209			June 9	8.80	16,300	3
8	Pease River near Childress	2,747	1909–60	1957		22	([2])	
		[1] 559			June 9	13.59	19,000	2
9	Pease River near Vernon	3,488	1890–1960	1891		24.0	([2])	
		[1] 559			June 9	13.30	19,000	2
10	North Fork Wichita River near Truscott.	937	1900–60	1954		([2])	([2])	
					July 7	15.88	6,100	1
11	South Fork Wichita River near Benjamin.	584	1903–60	1919		([2])	([2])	
					July 7	12.27	2,500	1
	Brazos River basin							
12	Double Mountain Fork Brazos River near Aspermont.	7,980	1899–1960	1955		27.50	[9] 91,400	
		[1] 6,470			July 7	16.00	35,200	
13	White River at Plainview	([2])	1880–1960	1890		([10])	([2])	
				1941		8.75	12,000	
					July 8	9.38	9,130	
14	Salt Fork Brazos River near Aspermont.	4,830	1900–60	1955		14.92	[9] 52,200	
		[1] 2,770			July 7	7.98	11,400	

[1] Noncontributing drainage area.
[2] Not determined.
[3] About 7.8 feet higher than the flood peak of 1951.
[4] Computed on basis of change in reservoir contents.
[5] At site 2 miles upstream at different datum.
[6] Gage height at present site, 19.2 feet.
[7] About 2 feet higher than the flood peak of 1957.
[8] Ratio of peak discharge to that of a 50-year flood.
[9] Discharge not necessarily maximum for period.
[10] Slightly lower than 1960 flood.

The greatest peak discharge on Prairie Dog Town Fork Red River near Brice during the June storms was 49,000 cfs on June 7, whereas the greatest discharge upstream in Palo Duro Canyon State Park after the failure of the partly completed dam was 52,700 cfs on June 10. The heavy rain of June 10 and the record-breaking discharge in the park combined to produce a peak discharge near Brice of 45,000 cfs on June 10, a discharge that was almost as large as that of June 7.

During the period July 5–8, heavy rainfall again occurred on the High Plains; the greatest amounts fell on the southern part. Heavy damage occurred in Slaton, Levelland, Littlefield, Hale Center, and surrounding areas owing to the formation of large "wet-weather" lakes that inundated low-lying areas in cities and towns and submerged parts of roads, highways, and farmlands. The overflow of normally dry creeks and draws caused heavy damage in many rural areas. Plainview suffered damage estimated at $1.2 million from the normally dry White River when it reached its highest stage since at least 1880 and flooded many business and residential properties. Moderate flooding also occurred on several other streams in the upper Red and Brazos River basins; these streams are listed in table 19.

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FLOODS OF JUNE 11 IN NORTHWESTERN KANSAS

Prolonged rains in early June caused heavy flooding on Beaver Creek in northwestern Kansas (fig. 32). Rainfall in the area started on June 4 and continued through June 15 (table 20). Individual precipitation amounts were not excessive, but at times the intensity of precipitation was very great. At Goodland a maximum intensity of 0.85 inch per hour was recorded on June 10. At Colby rainfall in 2 successive hours was 1.17 and 1.16 inches per hour. The peak discharge of Beaver Creek at Cedar Bluffs (drainage area, 1,710 sq mi) was 7,940 cfs on June 11. This discharge was 1.7 times the previous maximum discharge of a 15-year record that occurred in 1957; it was 10.6 times the mean annual flood and 1.2 times the 50-year flood. Neighboring streams had minor flows. Sappa Creek near Oberlin (drainage area, 1,040 sq mi) had a peak discharge on the morning of June 11 of only 1,120 cfs, which has a recurrence interval of 3 years. The peak discharge on the evening of June 12 of South Fork Sappa Creek near Achilles (drainage area, 434 sq mi) was 1,140 cfs, which has a recurrence interval of only 4 years.

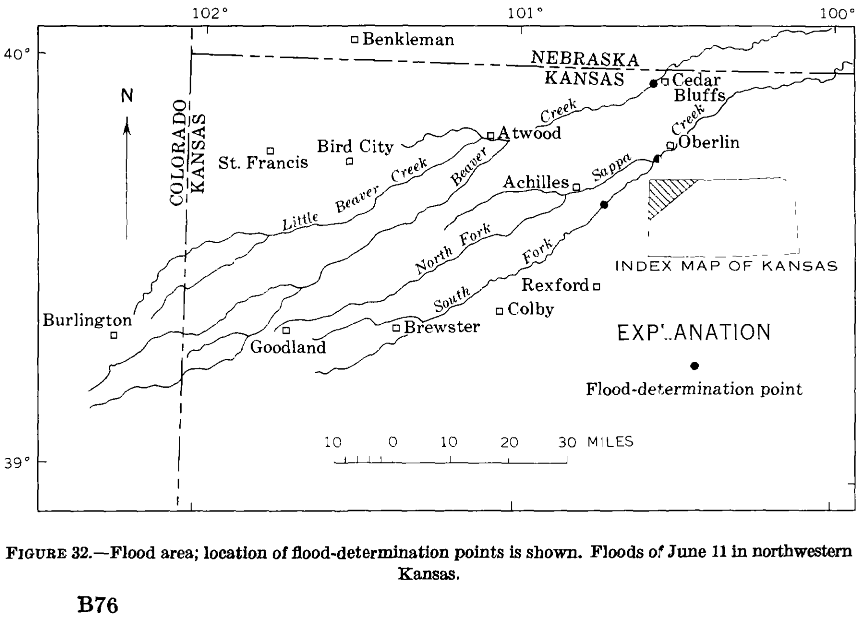

FIGURE 32.—Flood area; location of flood-determination points is shown. Floods of June 11 in northwestern Kansas.

TABLE 20.—*Daily rainfall, in inches, at selected rain-gage stations in northwestern Kansas, June 4–15*

[Tr., trace]

Station	June												Total
	4	5	6	7	8	9	10	11	12	13	14	15	
Saint Francis	------	0.19	0.41	0.03	0.05	0.27	0.45	0.07	0.21	Tr.	Tr.	Tr.	1.68
Atwood	Tr.	.07	.25	.05	.08	.07	.77	1.04	.07	0.04	Tr.	Tr.	2.44
Oberlin	0.02	------	.26	------	.06	.15	.19	3.16	.02	.41	Tr.	------	4.27
Bird City	------	------	.26	------	.12	1.26	1.68	.24	.46	------	------	------	4.02
Goodland	------	.10	.07	.01	.41	.32	1.10	.08	Tr.	------	0.01	Tr.	2.10
Brewster	------	Tr.	------	Tr.	.18	.03	.14	2.50	.29	------	------	0.14	3.28
Colby	Tr.	Tr.	.02	.01	.36	.15	.09	2.91	.02	.21	Tr.	.28	4.05
Rexford	Tr.	------	------	.10	.22	1.10	.08	.72	Tr.	.08	Tr.	Tr.	2.30
Burlington, Colo	.07	.27	.05	------	1.20	.52	.24	------	------	------	------	------	2.35

FLOODS OF JUNE 17 NEAR BINGHAMTON, N.Y.

A series of severe thunderstorms in the Endicott-Johnson City-Union area on June 17 produced heavy concentrated rainfall. Total rainfall at the Binghamton Airport stations was 3.04 inches in 2 hours (fig. 33). The intensity of this rainfall exceeded all previous records at this station, and has a recurrence interval greater than 100 years.[3]

The intense rain produced a very destructive flash flood in a small area on the night of June 17. Damage was caused primarily from flooding of the Little Choconut, Patterson, and Burious Creeks (fig. 34). These streams, which flow through heavily populated areas of Endicott, Endwell, and Johnson City, overflowed their banks and caused widespread flooding of homes, roads, and commercial establishments.

Millions of dollars of damage occurred to the large industries of Endicott Johnson and International Business Machines, and loss to individuals was very large. The total loss in the flood area was estimated at $5 million.

No gaging stations are operated by the Geological Survey on the streams affected by the flood, however, an indirect measurement of peak flow was made on Little Choconut Creek near Choconut Center north of Johnson City. The discharge of 8,200 cfs came from a drainage area of 6.94 square miles and has a recurrence interval much greater than 50 years.

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[3] U.S. Department of Commerce, 1961, Rainfall-Frequency Atlas of the United States: Tech. Paper 40, 115 p.

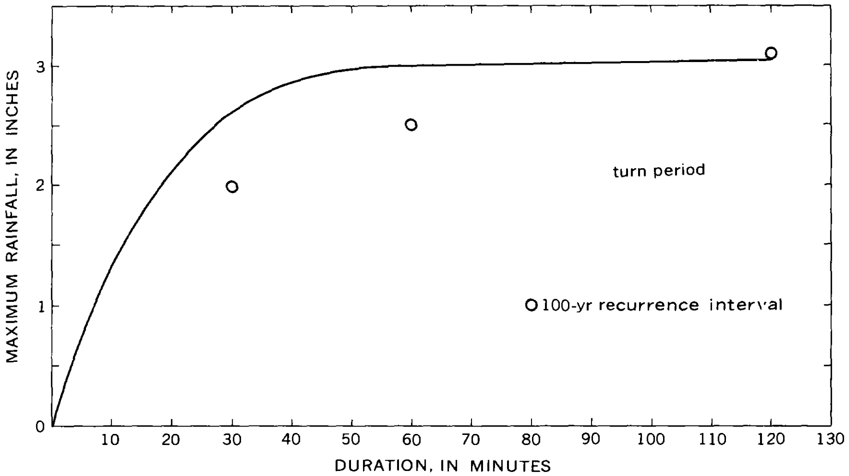

FIGURE 33.—Maximum rainfall depth-duration diagram; Binghamton, N.Y., Airport station, June 17.

FIGURE 34.—Location of area of floods of June 17 near Binghamton, N.Y.

FLOODS OF JUNE 19 NEAR TIMBER LAKE, S. DAK.

On June 19, a severe thunderstorm about 7 miles south of Timber Lake caused a flash flood on a small unnamed tributary to the Little Moreau River (fig. 35). The storm swept across the relatively small drainage area (21.5 sq mi) in the middle of the afternoon.

According to local residents, 5–6 inches of rain fell in about 45 minutes. The buildings on a farm about three-quarters of a mile above the mouth of the creek were swept away, and some livestock and fowl were drowned.

The storm was very localized. A peak discharge of 10,600 cfs was measured 1 mile upstream from the mouth of the unnamed tributary to the Little Moreau River. This discharge is 493 cfs per sq mi of drainage area (table 21). After passing through Whitehorse Lake, the peak discharge was only about half the mean annual flood at the Moreau River station near Whitehorse.

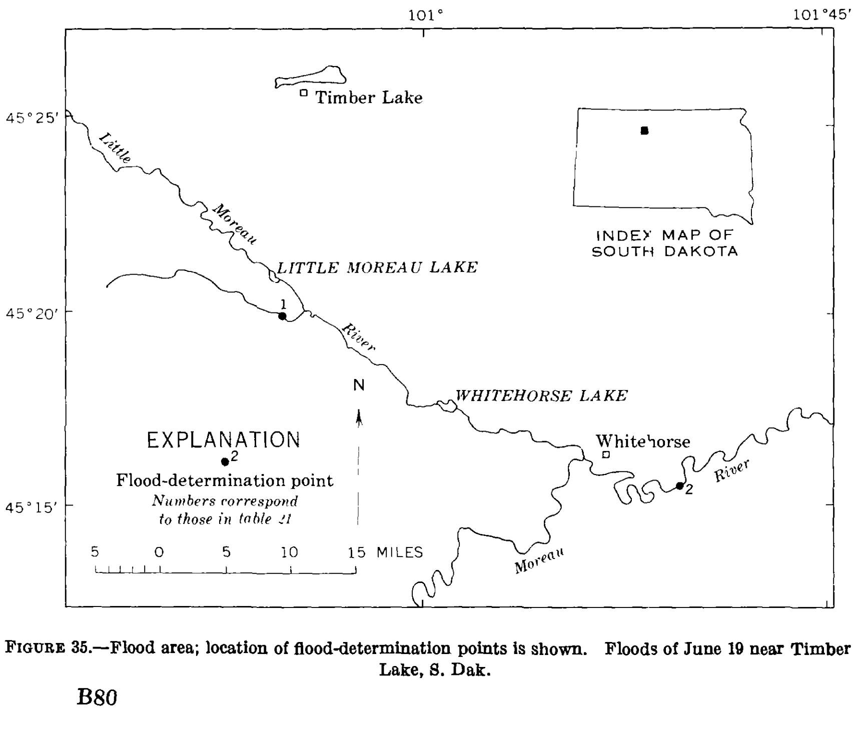

FIGURE 35.—Flood area; location of flood-determination points is shown. Floods of June 19 near Timber Lake, S. Dak.

TABLE 21.—*Flood stages and discharges, June 19, near Timber Lake, S. Dak.*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods				
			Prior to June 1960		June	Gage height (ft)	Discharge (cfs)
			Period	Year			
	Moreau River basin						
1	Little Moreau River tributary near Timber Lake.	21.5			19		10,600
2	Moreau River near Whitehorse	4,880	1953–60	1953		[1] 26.2	[2]
				1957		15.7	15,300
					20	9.36	3,550

[1] Was probably exceeded by flood of March 1947.
[2] Not determined.

The most devastating floods in the memory of local residents occurred on many small streams in east-central Nebraska on June 20 and 21. Torrential rains on June 20 followed moderate rains June 15–19 (table 22). Unofficial reports stated that as much as 6 inches of rain fell in the headwaters of Papillion Creek near Blair (fig. 36). Crops and buildings near Blair were damaged, and hundreds of acres of cropland in the Kennard area were flooded. Many new homes on the flood plain of Papillion Creek in western Omaha were inundated; families were evacuated by Omaha firemen in boats, and a helicopter airlift rescued two emergency patients south of Omaha. Extensive flooding near Omaha occurred near 114th and Dodge Streets, 87th and Center Streets, and 72d and Q Streets and in the Rainbow Addition south of Center Street and east of 88th Street.

TABLE 22.—*Daily rainfall, in inches, at selected rain-gage stations in east-central Nebraska, June 15–20*

[Type of gage: R, recording; NR, nonrecording. Tr., trace]

Station	Type of gage	Time of observation	June						Total
			15	16	17	18	19	20	
Albion (7WNW)	R	12 p.m.	0.04	0.07	1.63	0.01	0.97	0.30	3.02
Albion (9 NE)	R	do	.07		.48	.03	.13	3.64	4.35
Albion	NR	8 a.m.	Tr.	.21	.06	.97		1.91	3.15
Bartlett (7 NNE)	NR	6 p.m.		.02	.22	.20	.11	1.05	1.60
Blair	NR	9 a.m.	.88			.21		2.89	3.98
Clarkson	NR	6 p.m.	.05	.65	.34			1.60	2.64
Creston	R	12 p.m.			.55	.14	2.66	1.66	5.01
Dodge	NR	8 a.m.		2.78	.31	Tr.		2.43	5.52
Ericson (6 WNW)	NR	7 p.m.		.21		1.40	Tr.	1.08	2.69
Fremont	NR	6 p.m.		.66		.18		3.12	3.96
Genoa	R	12 p.m.	.10		.37	.01		.90	1.38
Greeley	NR	8 a.m.	.10	.52		1.65	.02	.74	3.03
Gretna (3 NE)	R	12 p.m.	.51		.03	.28		2.33	3.15
Herman	NR	8 a.m.		1.27		.32		2.23	3.82
Madison	NR	5 p.m.		.17		.27	.11	5.79	6.34
Malmo (1 E)	R	12 p.m.	.29		.07	.28	.11	1.88	2.63
Meadow Grove	NR	7 a.m.	.02	.41	.07	.10		2.97	3.57
Norfolk WB	R	12 p.m.	.12	.02	.08		.58	1.10	1.90
North Omaha Airport	R	do	.83	.02	.01	.18	.02	4.32	5.38
Pender	R	do	.08	.02	.05	.02	.18	.41	.76
Pilger	NR	7 a.m.	Tr.	.12	Tr.	.31	.06	2.57	3.06
Schuyler	NR	do		.69		.25		1.45	2.39
Scribner	R	12 p.m.	1.46		.11	.13	.05	4.76	6.51
Spalding	R	do	.08		.75		1.78	.07	2.68
Spiker	R	do	1.00	.05	.09	.17		1.38	2.69
Spiker (4 N)	NR	8 a.m.	1.45			.36		2.86	4.67
Stanton	NR	Sunset	Tr.	.07		.16	.30	3.65	4.18
Tarnov	R	12 p.m.	.08		.43	.01	.84	1.05	2.41
Tekamah	NR	8 a.m.		1.15	.06	.34		1.42	2.97
Valparaiso	NR	6 p.m.		.60		.51		2.00	3.11
Wahoo	NR	8 a.m.	Tr.	.33	.02	.38	Tr.	2.80	3.53
Waterloo	NR	do	Tr.	.60		.32		3.06	3.98
West Point	NR	7 p.m.		.97		.35	Tr.	1.50	2.82

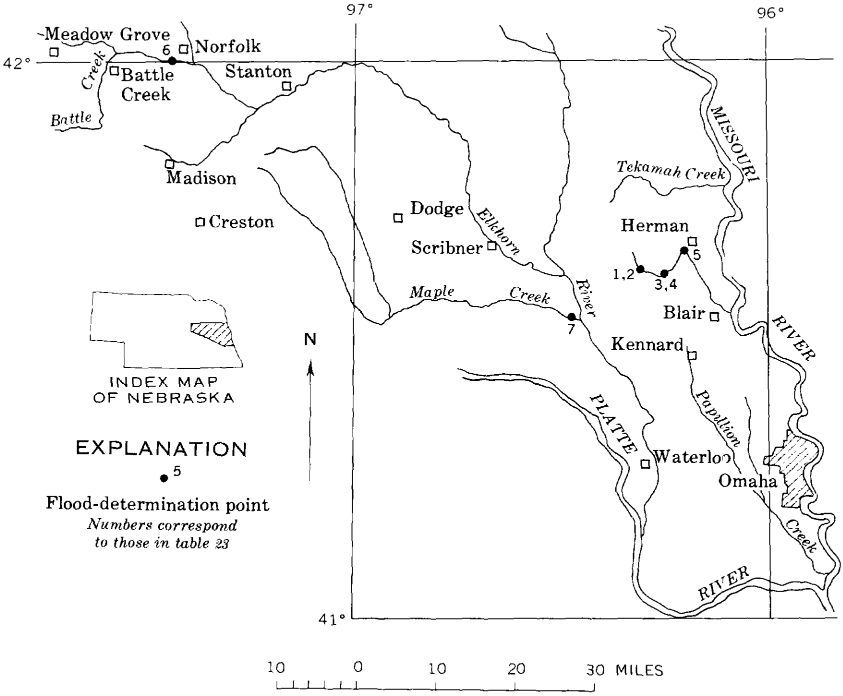

Figure 36.—Flood area; location of flood-determination points is shown. Floods of June 20–21 in east-central Nebraska.

The highest stages and discharges in 10 or 11 years of record occurred at three of the five stream gaging stations in the New York Creek basin (table 23). The upper stations had peak discharges, the recurrence intervals of which were 21 years and slightly more than 25 years, and the stations north and east of Spiker had peak discharges about 1.2 and 2.0 times as great as those of a 25-year flood. The peak discharge in New York Creek at Herman, at some distance from the center of the heavy rainfall, was less than half that east of Spiker and had about a 10-year recurrence interval. Floods in Tekamah Creek, just north of New York Creek, had recurrence intervals of only 4–6 years.

The discharge of Elkhorn River near Norfolk increased from a mean daily of 517 cfs on June 19 to a peak of 8,820 cfs on June 20. Most of this rise was due to inflow from Battle Creek. Unofficial reports were made of more than 2 inches of rain at the town of Battle Creek during the night of June 19–20. U.S. Weather Bureau records show that 2.97 inches of rain fell at Meadow Grove, northwest of Battle Creek, and 5.79 inches fell at Madison, southeast of Battle Creek. Damage to the town of Battle Creek was extensive. North of the railroad tracks, homes were flooded, the Chicago and North Western Railway depot was surrounded by water, and part of a side track was washed out. A lumberyard was inundated on June 20; although the water had receded by the following day, the town's sewer system was still inoperative.

Maple Creek near Nickerson had a peak discharge early on June 21 about 1.2 times as great as that of a 25-year flood. The Middle Fork flooded Clarkson, and Maple Creek washed out railroad tracks and halted traffic on U.S. Highway 77 north of Fremont.

TABLE 23.—*Flood stages and discharges, June 20–21, in east-central Nebraska*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to June 1960, Period	Year	June	Gage height (ft)	Discharge (cfs)	Recurrence interval (yrs)
	New York Creek basin							
1	New York Creek near Spiker.	1.75	1952–60	1957		16.19	1,380	
					20	16.60	1,700	[1] 1.05
2	New York Creek tributary near Spiker.	1.55	1951–60	1957		17.80	1,580	
					20	17.52	1,370	21
3	New York Creek north of Spiker.	6.50	1951–60	1957		23.40	3,160	
					20	24.07	3,620	[1] 1.18
4	New York Creek east of Spiker.	13.9	1950–60	1951		24.14	6,020	
					20	25.03	9,250	[1] 2.02
5	New York Creek at Herman.	25.4	1944	1944		20.8		
			1946–60	1950			5,500	
					20	19.93	4,420	9
	Platte River basin							
6	Elkhorn River near Norfolk.	1,790	1945–60	1960		8.60	13,500	
					20	7.04	8,820	4
7	Maple Creek near Nickerson.	450	1944, 1951–60	1944		16.28	35,000	
					21	14.67	10,800	[1] 1.18

[1] Ratio of peak discharge to that of 25-year flood.

FLOODS OF JUNE 21-29 IN INDIANA

Several days of severe thunderstorms in June caused flooding over a large part of central and southern Indiana (fig. 37). On the night of June 20 and early morning of June 21, a small storm centered approximately 3 miles west of Rockville and caused heavy local flooding. Rainfall at Rockville totaled 3.87 inches, and unofficial amounts ranging from 4 to 5 inches were collected near the storm center. Indirect measurements of peak discharge made on small drainage areas of 1.58 and 0.18 square miles showed discharges of 1,150 and 1,010 cfs per sq mi, respectively.

Precipitation ranged from 3 to 7.7 inches over a large part of central and southern Indiana on the night of June 22 and the morning of

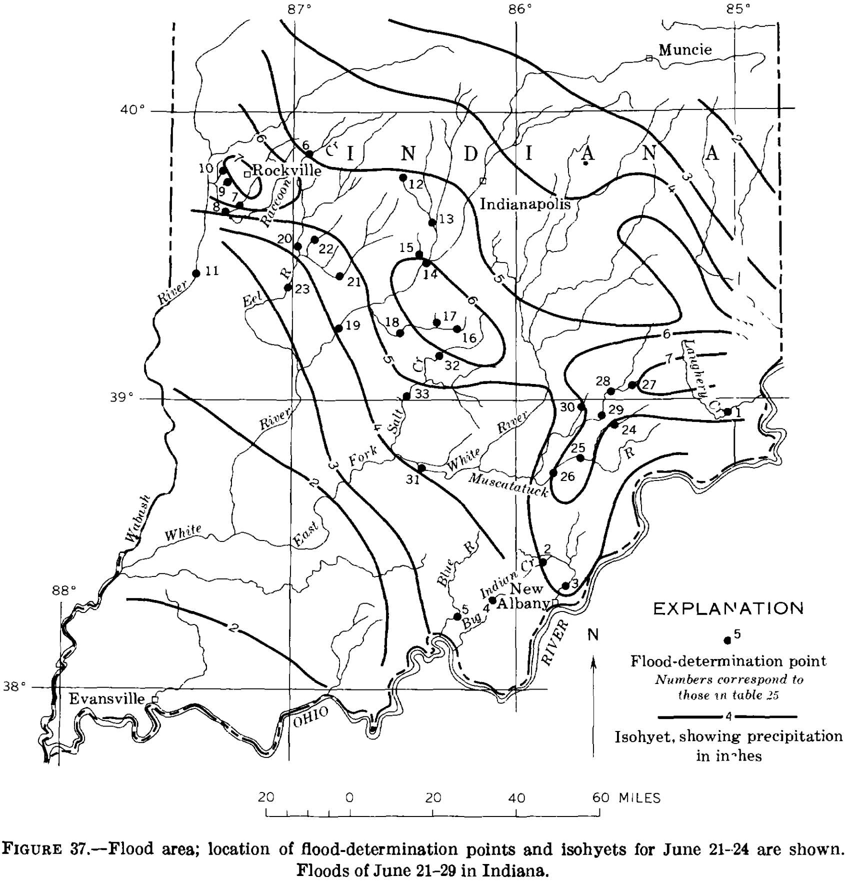

FIGURE 37.—Flood area; location of flood-determination points and isohyets for June 21-24 are shown. Floods of June 21-29 in Indiana.

June 23. Rainfall data for selected rainfall stations for the period June 21–24 are listed in table 24. Although discharges were high in the areas of concentrated rainfall on basins of some tributaries to the Wabash River above Terre Haute, the peak discharge was not particularly great by the time it passed Terre Haute (table 25). Considerable flood damage occurred in areas where streams overtopped their banks and inundated newly planted crops.

TABLE 24.—*Rainfall, in inches, at selected stations in Indiana, June 21–24*

[Tr., trace (less than 0.01 in.)]

Station	Date				Total
	21	22	23	24	
Crawfordsville Power Plant	1.35	0.17	3.01	0.12	4.65
Lafayette (5S)	.96	Tr.	2.06	.06	3.08
Rockville	3.87	Tr.	3.88	Tr.	7.75
Terre Haute (8S)	.49	0	1.74	.49	2.72
Spencer	.20	0	3.45	.89	4.54
Bloomington University	.25	0	4.85	.30	5.40
Indianapolis WB Airport	1.42	.80	2.81	Tr.	5.03
Rushville sewage plant	.25	.03	4.43	.59	5.30
Martinsville	.60	0	5.02	.80	6.42
Seymour (2N)	Tr.	Tr.	3.70	.90	4.60
Richmond waterworks	.55	.01	.75	.07	1.38
Brookville (1S)	.12	.03	1.90	1.55	3.60
Greensburg (3SW)	.66	0	3.09	.73	4.48
Greenfield	.70	.10	2.35	.12	3.27
Columbus	.20	0	3.97	1.43	5.60
Henryville State Forest	.13	.18	4.99	.23	5.53
Newberry Highway bridge	.22	0	1.60	.86	2.68
Paoli	.10	Tr.	2.45	.53	3.08
Princeton (1N)	Tr.	Tr.	.32	1.21	1.53
Salem	.10	Tr.	4.05	0	4.15
Scottsburg	.16	0	5.50	.47	6.13
Crane Naval Depot	.19	0	2.34	1.26	3.79
Shoals Highway 50 bridge	.20	0	1.10	.91	2.21
Bedford (4SW)	.22	0	2.76	1.21	4.19
North Vernon (2SW)	.13	.01	6.50	.02	6.66
Madison Sewage plant	.19	0	4.00	.06	4.25
Evansville WB Airport	.04	0	3.01	.04	3.09
Milan waterworks	.28	.35	6.63	.43	7.69
Whitestown	1.08	Tr.	3.02	.05	4.15

Peak discharges for the flood on June 23–24 equaled or exceeded previous maximum peaks at seven gaging stations. Indirect measurements were made at three miscellaneous sites.

The location of the gaging stations and miscellaneous sites in the storm area affected by the rains of June 21 and June 23–24 are shown in figure 37, and their peak discharges are listed in table 25.

TABLE 25.—*Flood stages and discharges, June 21–29, in Indiana*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to June 1960 — Period	Prior to June 1960 — Year	June	Gage height (ft)	Discharge (cfs)	Recurrence interval (yrs)
	Laughery Creek basin							
1	Laughery Creek near Farmers Retreat.	248	1897–1960	1959		21.13	47,800	
					23	18.23	29,000	35
	Silver Creek basin							
2	Persimmon Run near Carwood.	3.23	1959–60	1959			874	
					23		1,590	
3	Silver Creek near Sellersburg.	188	1954–60	1959		30.89	19,600	
					24	29.1	16,400	9
	Big Indian Creek basin							
4	Big Indian Creek near Corydon.	129	1815–1960	1943		22.4	(1)	
			1943–60	1959		22.22	23,800	
					23	18.62	10,500	5
	Blue River basin							
5	Blue River near White Cloud.	461	1930–60	1959		23.07	28,500	
					24	18.33	19,400	6
	Wabash River basin							
6	Raccoon Creek near Fincastle.	132	1957–60	1957		19.10	39,900	
					23	11.46	3,780	2
7	Little Raccoon Creek near Catlin.	133	1956–60	1957		18.27	53,400	
					23	14.00	9,300	18
8	Raccoon Creek at Coxville	440	1956–60	1957		21.23	108,000	
					23	14.99	15,500	7
9	Rock Run near Coloma	1.58			21		1,820	
10	Rocky Run tributary at Coloma.	0.18			21		182	
11	Wabash River at Terre Haute.	12,200	1828–1960	1913		31.1	245,000	
					25	21.26	47,900	1
12	West Fork White Lick Creek at Danville.	28.9	1957–60	1957		16.0	6,660	
					23	7.73	1,620	2
13	White Lick Creek at Mooresville.	212	1957–60	1957		22.5	(1)	
				1959		21.17	11,400	
					23	21.21	11,400	11
14	White River near Centerton.	2,435	1913	1913		22.8	90,000	
			1930–32, 1946–60	1950		[2] 17.2	43,000	
					24	14.29	27,000	2
15	Sycamore Creek near Centerton.	17.2			23		7,690	[3] 2.4
16	Bean Blossom Creek at Bean Blossom.	14.6	1951–60	1951		11.42	5,040	
					23	11.78	8,140	[3] 2.7
17	Bear Creek near Trevlac	7.00	1952–60	1957		7.62	1,830	
					23	7.08	1,520	22
18	Bean Blossom Creek at Dolan.	100	1946–60	1947			9,420	
				1949		17.9		
					23	[4] 17.80	8,530	23
19	White River st Spencer	2,980	1913–60	1913		28.5	100,000	
					25	21.01	34,000	3

See footnotes at end of table.

TABLE 25.—*Flood stages and discharges, June 21–29, in Indiana*—Continued

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to June 1960, Period	Maximum floods: Prior to June 1960, Year	Maximum floods: June	Maximum floods: Gage height (ft)	Maximum floods: Discharge (cfs)	Maximum floods: Recurrence interval (yrs)
	Wabash River Basin—Continued							
20	Big Walnut Creek near Reelsville.	338	1949–60	1957		18.63	30,700	
					23	17.12	16,000	12
21	Mill Creek near Cataract	241	1949–60	1950		21.35	9,480	
					24	22.58	11,400	8
22	Deer Creek near Putnamville.	59.0	1954–60	1958		11.92	5,210	
					23	13.53	7,450	60
23	Eel River at Bowling Green	844	1875–1960	1875		30.0	(1)	
			1931–60	1950		23.53	34,000	
					24	[5] 20.45	16,500	2
24	Graham Creek near Vernon	77.6	1955–60	1959		19.13	15,700	
					23	21.37	18,600	22
25	Muscatatuck River near Deputy.	296	1947–60	1959		33.1	52,200	
					23	28.57	31,800	10
26	Muscatatuck River near Austin.	365	1932–60	1959		29 20	53,900	
					24	26 36	26,900	12
27	Brush Creek near Nebraska	11.7	1955–60	1959		10 30	2,730	
					23	10 03	2,540	
28	North Fork of Vernon Fork near Butlerville.	87.3	1942–60	1959		25 41	26,200	
					23	17.68	10,400	3
29	Vernon Fork at Vernon	201	1939–60	1959		32.83	56,800	
					23	28 13	35,300	27
30	Sixmile Creek at Hayden	20.8	1959–60	1959			6,080	
					23		7,010	
31	East Fork White River near Bedford.	3,870	1913–57	1913		[6] 47.5	155,000	
					27	28.25	42,300	2
32	North Fork Salt Creek near Belmont.	120	1913–60	1913		25.7	(1)	
			1946–60	1952		22.55	11,800	
					23	22.10	13,300	11
33	Salt Creek near Harrodsburg.	441	1913	1913		38.1	(1)	
			1955–60	1959		31.88	17,900	
					25	32.76	22,000	24

1 Not determined.
2 At site ⅜ mile upstream at same datum.
3 Ratio of peak discharge to that of a 50-year flood.
4 Flow regulated since 1953 by Lake Lemon 8.1 miles upstream.
5 Flow regulated since 1952 by Cagles Mill Reservoir.
6 At site 9.7 miles downstream at datum 4.39 feet lower.

General rains accompanied by severe thunderstorms occurred over most of Kentucky between June 21 and July 3 following near-drought conditions during May and early June.

Scattered thunderstorms that began during the night of June 20 ended with torrential rains on June 24 in the north-central and eastern section of the State. Many precipitation stations reported total rainfall in excess of 3 inches during the 4-day period. Louisville recorded 5.14 inches of rain for a 12-hour period ending the morning of June 23, which was a new record for that location. The maximum discharges of record occurred at one gaging station in the Elkhorn Creek basin, at two gaging stations in the Beargrass Creek basin, and at seven gaging stations on northern tributaries of the Salt River basin (see table 26). Figure 38 shows the location of sites where peak stages and discharges were determined for this flood and isohyets for the period June 21–24.

No rain fell on June 25–26. Scattered afternoon thundershowers on June 27 became torrential rains that lasted through June 29 or 30 in central and western Kentucky.

Dunmor, in Muhlenberg County, reported a record 10.40 inches of rain for the 24-hour period ending the morning of June 28. These

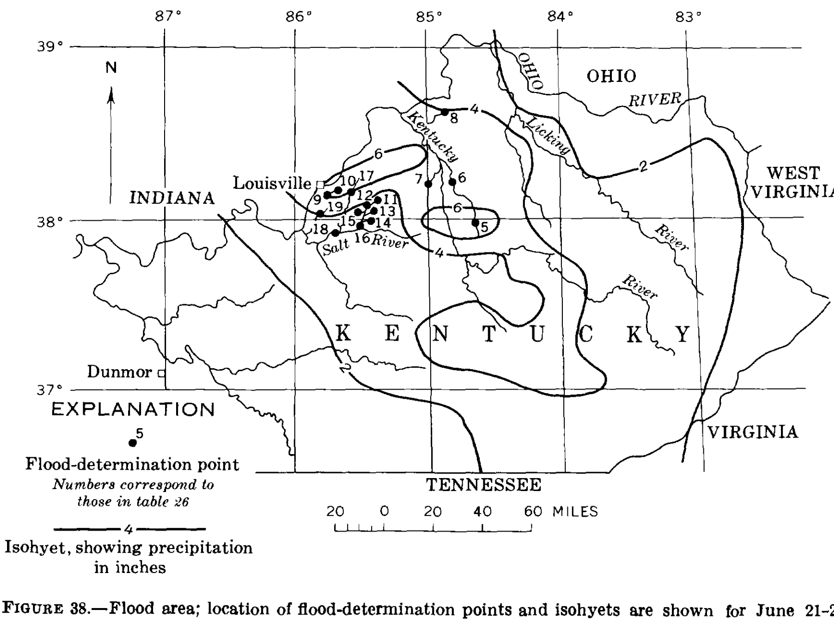

FIGURE 38.—Flood area; location of flood-determination points and isohyets are shown for June 21–24 in central Kentucky.

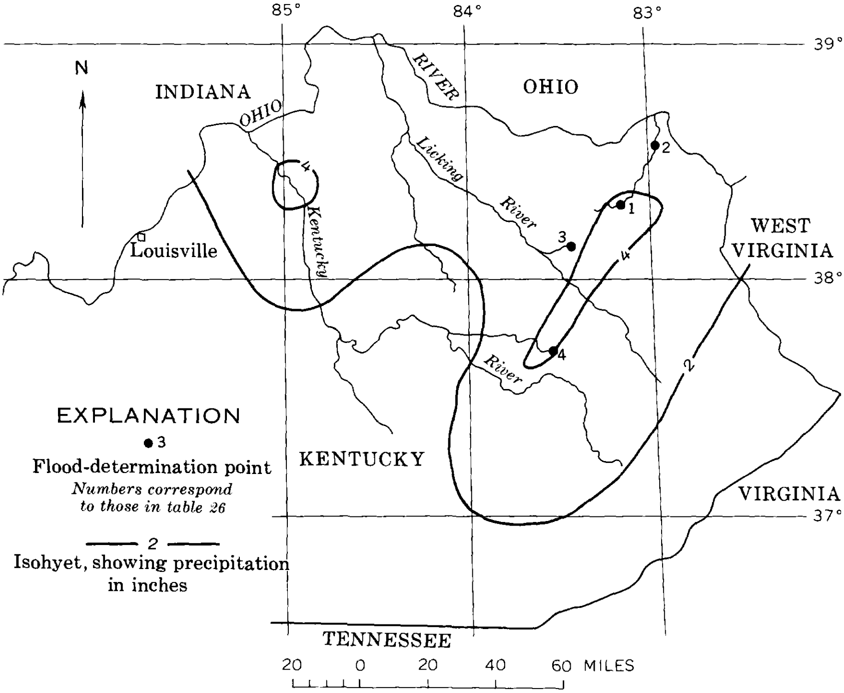

FIGURE 39.—Flood area: location of flood-determination points and isohyets are shown for July 1–4 in northeastern Kentucky.

rains, although intense in some areas, did not produce floods of much significance.

More thunderstorms occurred on July 1 and 3 in northeastern Kentucky. Storm activity was greatest in the Triplett Creek basin east of Morehead (fig. 39). Many long-time residents of the Morehead area reported that the storm and resultant flood of July 3 was the worst since 1939. State Police reported that 6.61 inches of rain fell at their barracks 1 mile east of Morehead between the time of their reading on June 30 and that on July 3 and that 3.50 inches fell between 1:00 p.m. and 2:30 p.m. on July 3. The maximum stage and peak discharge for the period of record occurred at the stream-gaging station on Triplett Creek at Morehead. Figure 39 shows the isohyets for the period July 1–4, based on total rainfall and the location of reporting stream-gaging stations in the storm area. Table 26 compares maximum stages and peak discharges of this flood with those of floods during the period of record for selected stations.

Severe crop damage occurred in many areas of the State as a result of the flash floods caused by the heavy rainfall of late June and early July.

TABLE 26.—*Flood stages and discharges, June and July, in Kentucky*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to June 1960: Period	Maximum floods: Prior to June 1960: Year	June-July	Gage height (ft)	Discharge (cfs)	Recurrence interval (yrs)
	Tygarts Creek basin							
1	Tygarts Creek at Olive Hill.	59.6	1957-60	1958		14.20	2,930	
					July 3	12.32	6,190	[1]1.3
2	Tygarts Creek near Greenup.	242	1940-60	1948		20.35	12,800	
					July 4	17.77	7,900	3
	Licking River basin							
3	Triplett Creek at Morehead.	47.9	1939	1939		18.9	(2)	
			1941-60	1950		13.10	11,400	
					July 3	14.83	18,600	[1]1.4
	Kentucky River basin							
4	Stillwater Creek at Stillwater.	24.0	1954-60	1956		12.91	3,890	
					July 1	9.53	1,980	10
5	South Elkhorn Creek at Fort Spring.	24.0	1950-60	1952		8.0	1,280	
					June 23	9.15	1,890	30
6	Elkhorn Creek near Frankfort.	473	1932	1932		17.5	(2)	
			1915-20, 1939-60	1948		14.5	22,400	
					June 24	12.24	13,000	4
7	Flat Creek near Frankfort	5.63	1951-60	1955		11.50	7,100	
					June 23	9.30	2,240	
8	Eagle Creek at Glencoe	437	1915-20, 1928-31, 1938-60.	1943		23.1	32,900	
					June 23	20.6	26,500	14
	Beargrass Creek basin							
9	South Fork Beargrass Creek at Louisville.	17.2	1943	1943		15.1	(2)	
			1939-40, 1944-60	1945		13.62	1,890	
					June 23	11.82	2,220	[1]1.1
10	Middle Fork Beargrass Creek at Cannons Lane at Louisville.	18.9	1943	1943		8.1	(2)	
			1944-60	1950		5.14	2,120	
					June 23	5.83	3,300	[1]1.6
	Salt River basin							
11	Plum Creek Subwatershed 4 near Simpsonville.	1.55	1954-60	1957			[3]620	
					June 23		[3]655	
12	Plum Creek near Wilsonville.	19.1	1954-60	1958		6.59	4,180	
					June 23	7.92	5,180	
13	Plum Creek Subwatershed 15 (Little Plum Creek) near Wilsonville.	1.03	1957-60	1957			[3]434	
					June 23		[3]1,630	
14	Plum Creek Subwatershed 17 near Waterford.	.52	1957-60	1958			[3]705	
					June 23		[3]721	
15	Little Plum Creek near Waterford.	5.15	1954-60	1957		4.81	1,320	
					June 23	6.12	3,810	
16	Plum Creek at Waterford	31.8	1953-60	1957		7.66	7,760	
					June 23	11.84	13,200	[1]1.6
17	Floyds Fork at Fisherville	138	1937	1937		16.8	(2)	
			1944-60	1950		13.12	11,500	
					June 23	13.7	11,800	5
18	Salt River at Shepherdsville.	1,197	1937-60	1937		[4]47.3	(2)	
			1938-60	1943			50,000	
				1945		[4]38.04		
					June 24	29.02	29,300	2
19	Pond Creek near Louisville.	64.0	1937-60	1937		[4]19	(2)	
				1948		17.78		
				1959			3,260	
					June 23	15.17	2,490	4

[1] Ratio of peak discharge to that of a 50-year flood.
[2] Not determined.
[3] Computed maximum inflow.
[4] Affected by backwater from the Ohio River.

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FLOODS OF JUNE 25–JULY 1 ON THE TEXAS COAST

Many floods, some having record-high levels, occurred on many streams and bayous along the gulf coast following extremely heavy rains on June 24–26. Rainfall totals of more than 30 inches were recorded at places during the 3-day period, and general rains of 8 inches or more extended over approximately 20,000 square miles (fig. 40). The rainfall was the result of a tropical storm moving inland.

Flooding was caused not only by overflowing streams but also by ponding on the level coastal plain. Damage to crop and grazing lands and to urban property was heavy; total damage was estimated at more than $3.5 million. More than 500 families were temporarily evacuated from flooded areas. At least eight deaths were directly attributed to the floods.

Residential, business, and farm and ranch properties in and around Houston were considerably damaged primarily owing to poor drainage in level and low-lying areas. Sims Bayou at Houston reached record stage and discharge. Reservoirs in the San Jacinto River basin were at record-high storage levels. Floodwaters temporarily stored in Barker and Addicks Reservoirs in the Buffalo Bayou watershed reduced the flood on Buffalo Bayou in Houston.

Flooding occurred in the lower reaches of the Brazos River from Hempstead to the mouth. At the stream-gaging station Big Creek near Needville, the maximum discharge since at least 1952 occurred; however, because of channel rectification, the peak stage was exceeded by about 0.2 foot in 1959. Flooding also occurred in the lower reaches of the San Bernard, Colorado, Lavaca, Guadalupe and Mission Rivers; however, no historic peaks were exceeded at any gaging stations in these basins. Port Lavaca, center of the area of heaviest rainfall, was considerably damaged when several bayous overflowed. Damage in Victoria caused by overflow of the Guadalupe River was light. Flooding in the Guadalupe River basin extended as far inland as Luling, where the San Marcos River had a peak discharge of 37,900 cfs (gage-height 33.56 ft) on June 25, the greatest since 1952. A summary of flood stages and discharges for this flood period is given in table 27.

A more comprehensive report on the storm and associated floods during the period June 25–July 1 is available from the Texas Water Commission, Austin, Texas.

TABLE 27.—*Flood stages and discharges, June 25–July 1, on the Texas coast*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to June 25, 1960 — Period	Year	June–July	Gage height (ft)	Discharge (cfs)	Recurrence interval (yrs)
	San Jacinto River basin							
1	West Fork San Jacinto River near Conroe.	809	1913–60	1940		25.85	[1] 110,000	
					June 27	17.98	25,800	5
2	Spring Creek near Spring	409	1879–1960	1929		29.3	[1] 48,300	
					June 27	24.70	20,700	6
3	Cypress Creek near Westfield.	285	1875–1960	1929		34	[1] 26,000	
					June 28	29.13	10,600	4
4	East Fork San Jacinto River near Cleveland.	325	1900–60	1940		24	[1] 59,000	
					June 28	16.65	7,960	3
5	Caney Creek near Splendora.	117	1885–1960	1940		22.0	(2)	
			1943–60	1945		18.19	14,900	
					June 27	15.90	9,680	8
6	Lake Houston near Sheldon	2,811	1954-60	1959		47.0	[3] 101,000	
					June 28	47.54	[3] 200,000	
7	Barker Reservoir near Addicks.	150	1945–60	1945		90.4	[3] 11,240	
					June 28	93.54	[3] 28,830	
8	Addicks Reservoir near Addicks.	129	1948–60	1954		94.3	[3] 9,180	
					June 28	95.23	[3] 12,190	
9	Buffalo Bayou at Houston	359	1835–1960	1935		54.4	[1] 40,000	
					June 26	23.30		
					June 28		7,270	2
10	Whiteoak Bayou at Houston.	84.7	1919–60	1935		51.5	[1] 14,750	
					June 26	40.58	4,380	5
11	Brays Bayou at Houston	88.4	1911–60	1919		[5] 56.0	(2)	
			1936–60	1945		[5] 51.70		
				1943			8,120	
					June 26	49.72	12,600	[6] 1.44
12	Sims Bayou at Houston	64.0	1952–60	1957			5,050	
				1959		23.91		
					June 26	29.76	8,030	[6] 1.15
13	Greens Bayou near Houston	72.7	1952–60	1954		64.75	7,000	
					June 26, 27	63.92	2,530	2
14	Halls Bayou at Houston	24.7	1952–60	1953			2,410	
				1954		60.65		
					June 26	58.79	2,230	8
	Chocolate Bayou basin							
15	Chocolate Bayou near Alvin.	88.1	1939–60	1939		22.9	(2)	
			1947–60	1949		21.80	7,400	
					June 27	18.46	2,920	2
	Brazos River basin							
16	Brazos River near Hempstead.	[7] 42,640	1899–1960	1913		56.1	(2)	
			1938–60	1957		44.21	143,000	
					June 26	23.65	43,300	
17	Brazos River at Richmond	[7] 44,020	1852–1960	1913		48.2	(2)	
			1922–60	1929		40.6	123,000	
					June 27	24.45	58,100	
18	Brazos River near Juliff	[7] 44,100	1884–1960	1913		64.0	(2)	
					June 27		72,700	
					June 28	52.30		
19	Big Creek near Needville	37.6	1913–60	1945		14.4	(2)	
			1952–60	1959		14.03	8,900	
					June 26	13.81	10,400	[6] 2.13

See footnotes at end of table.

TABLE 27.—*Flood stages and discharges, June 25–July 1, on the Texas coast*—Con.

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods					
			Prior to June 25, 1960		June–July	Gage height (ft)	Discharge (cfs)	Recurrence interval (yrs)
			Period	Year				
	San Bernard River basin							
20	San Bernard River near Boling.	720	1900–60	1913		43.5	(2)	
			1954–60	1957		40.50	15,400	
					June 28	42.41	21,200	8
	Colorado River basin							
21	Colorado River at Wharton	[8] 41,380	1869–1960	1913		38.9	(2)	
				1935		38.2	159,000	
					June 27	27.50	53,200	
22	Colorado River near Bay City.	[8] 41,650	1869–1960	1913		56.1	(2)	
			1940, 1946–60	1940		46.6	83,300	
					June 26	46.43	84,100	
	Lavaca River basin							
23	Navidad River near Ganado.	1,116	1876–1960	1936		39.8	[1] 94,000	
					June 27	33.46	34,000	6
	Guadalupe River basin							
24	San Marcos River at Luling.	833	1859–1960	1869 or 1870		40.4	(2)	
			1939–60	1952		34.95	57,000	
					June 25	33.56	37,900	5
25	Peach Creek below Dilworth.	462	1840–1960	1940		35.3	(2)	
					June 27	28.52	8,400	
26	Guadalupe River at Victoria.	5,161	1833–1960	1936		31.22	179,000	
					July 1	29.06	23,700	3
	Mission River basin							
27	Mission River at Refugio	643	1899–1960	1942		33.3	41,700	
					June 27	24.55	6,440	2

[1] Discharge not necessarily maximum for the period.
[2] Unknown.
[3] Contents in acre-feet.
[4] Affected by backwater from Whiteoak Bayou.
[5] At site 0.8 mile downstream.
[6] Ratio of peak discharge to that of a 50-year flood.
[7] About 9,240 sq mi probably noncontributing.
[8] About 11,900 sq mi probably noncontributing.

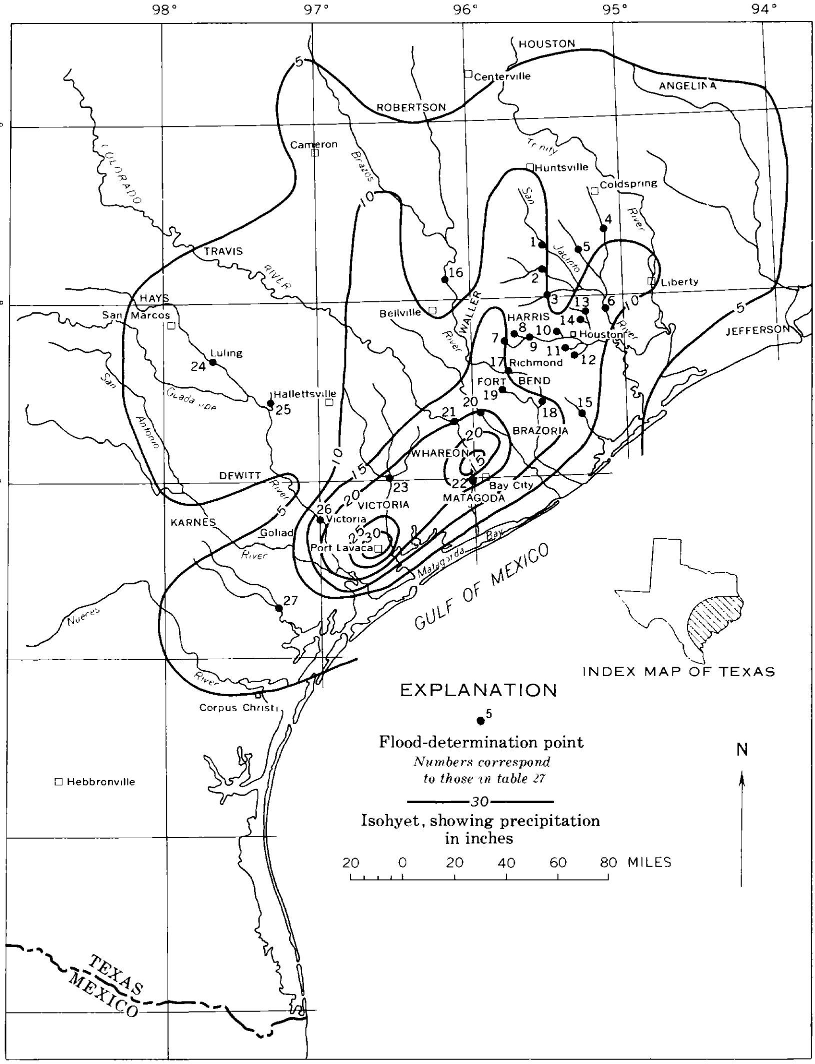

FIGURE 40.—Flood area; location of flood-determination points and isohyets for June 24–26 are shown. Floods of June 25–July 1 on the Texas coast.

FLOODS OF JUNE 27 IN THE NIOBRARA RIVER BASIN, NEBRASKA

Flash floods occurred in the Bone Creek basin, tributary to Niobrara River, near Ainsworth (fig. 41) on the evening of June 27. Rainfall reports are lacking for that immediate area, but a total of 2.40 inches was measured at Ainsworth for the 24-hour period ending 6 p.m. on June 27. An unofficial report from Bassett, about 18 miles east of Ainsworth, stated that 1.30 inches of rain fell there in 15 minutes on the evening of June 27. A report for Ainsworth also stated that 0.96 inch of rain fell on June 28; this rain, or a part of the rain, likely fell during the evening of June 27 after the 6-p.m. observation had been made and thus contributed to the flood of June 27.

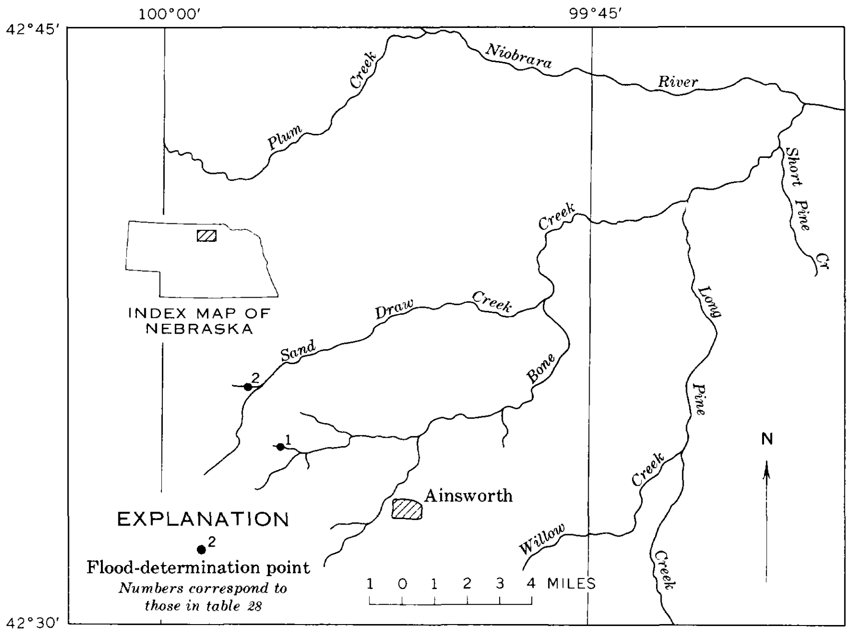

FIGURE 41.—Flood area; location of flood-determination points is shown. Floods of June 27 in the Niobrara River basin, Nebraska.

Amounts of rain falling on the small tributary basins of Sand Draw and Bone Creek are not known, but the peak discharges of the June 27 flood were the highest since the crest-stage gages were installed in 1955 (table 28). Flood-frequency relations for small areas in Nebraska are defined to recurrence intervals of 25 years. The peak discharge on Bone Creek tributary was 2.7 times that of a 25-year flood, and that on Sand Draw tributary was 4.7 times the discharge of a 25-year flood. The local newspapers did not report these floods; hence property damage was apparently little.

TABLE 28.—*Flood stages and discharges, June 27, in the Niobrara River basin, Nebraska*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods					
			Prior to June 1960		June	Gage height (ft)	Discharge	
			Period	Year			(cfs)	Ratio to Q_{25}
1	Bone Creek tributary near Ainsworth.	0.39	1956–60	1959		12.11	150	
					27	12.35	202	2.7
2	Sand Draw tributary near Ainsworth.	1.07	1956–60	1959		12.54	126	
					27	13.75	710	4.7

FLOOD OF JULY 2 IN MADISON, WIS.

Locally heavy rains with high winds and hail on July 2 in Madison, Wis., and the immediate surrounding area caused high runoff in a small area. Precipitation varied from almost 5 inches on the west side of Madison to about 3 inches on the east side. The flooding in the city was the worst in the city's history, and the damage was estimated to be about $500,000. Of three gaging stations located within 20 miles to the south and west of Madison, two—on Black Earth Creek and on the Yahara River—recorded the greatest peak discharge for the year during this flood; however, the discharges were much less than the maximum discharges recorded at these stations (table 29).

Lakes Mendota (surface area, 15.2 sq mi) and Monona (surface area, 5.3 sq mi) showed rises in lake levels of 0.6 and 0.8 foot, respectively, as a result of the heavy rain.

Severe thunderstorms with high winds and hail also occurred in southwest Wisconsin on July 2, but no flooding was reported in the area.

TABLE 29.—*Flood stages and discharges, July 2 in Madison, Wis.*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods				
			Prior to July 1960		July	Gage height (ft)	Discharge (cfs)
			Period	Year			
	Wisconsin River basin						
1	Black Earth Creek at Black Earth, Wis.	45.9	1954–60	1954		6.58	1,750
					3		1,020
	Rock River basin						
2	Yahara River near McFarland, Wis.	351	1934–60	1950		6.33	
				1959			867
					3, 4	5.29	580

FLOODS OF JULY 29–AUGUST 3 IN CENTRAL-WESTERN FLORIDA

Frequent thunderstorms occurred throughout July over the Florida peninsula. The moisture content of the soil was fairly high when tropical-storm Brenda moved up the west coast and across the State in the Big Bend area during the last week in July. The intense rains (fig. 42) accompanying Brenda produced heavy flooding in the central-western coastal part of the State.

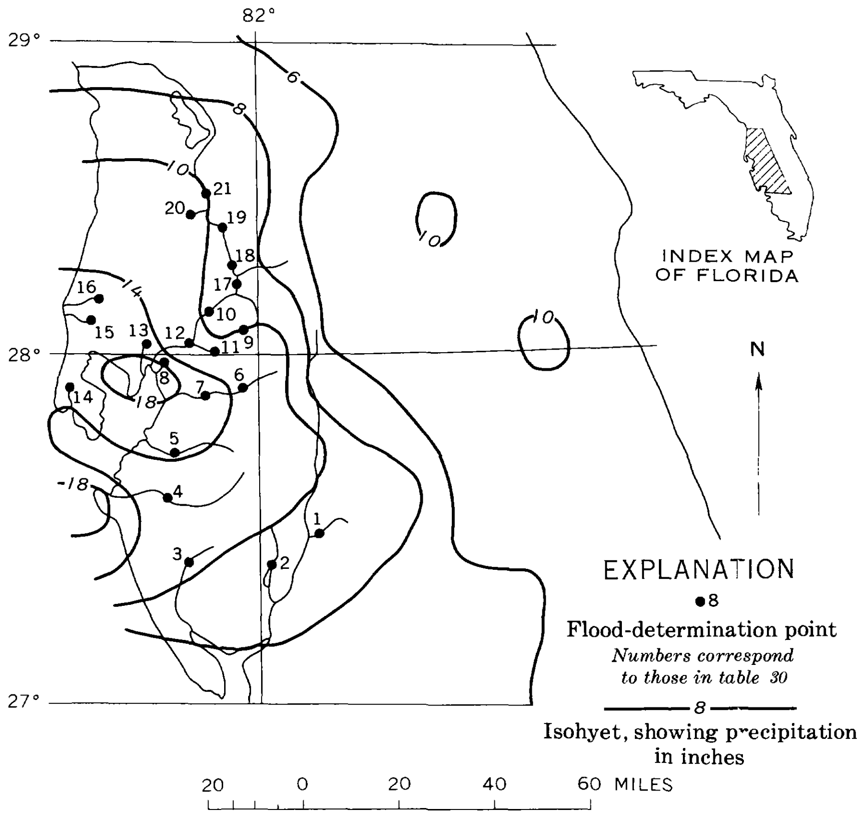

FIGURE 42.—Flood area; location of flood-determination points and isohyets for July 23–31 are shown. Floods of July 29–August 3 in central-western Florida.

A severe local thunderstorm produced more than 8 inches of rain in a 4-hour period at Orlando on July 25. High ground-water levels impeded surface drainage. Many lakes overflowed their banks and flooded houses; many streets were damaged and closed to traffic.

The tropical storm produced nearly 14 inches of rain in the Tampa-Saint Petersburg area; the storm in conjunction with high tides caused widespread flooding and extensive damage to streets and roads.

Lakes throughout the flood area were at high levels. The flow of Silver Springs was at a record high for July and was 142 percent of average.

The greatest floods were in the area south of Tampa. The peak discharge of Horse Creek near Arcadia was equal to that of a 50-year flood, and the peak discharge of Alafia River at Lithia was slightly greater than that of a 50-year flood (see table 30).

TABLE 30.—*Flood stages and discharges, July 29–August 3, in central-western Florida*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to July 1960: Period	Maximum floods: Prior to July 1960: Year	Maximum floods: July-August	Maximum floods: Gage height (ft)	Maximum floods: Discharge (cfs)	Maximum floods: Recurrence interval (yrs)
	Peace River basin							
1	Charlie Creek near Gardner	330	1928	1928		24.2	(1)	
			1950–60	1953		17.85	6,640	
					Aug. 1	18.77	8,160	
2	Horse Creek near Arcadia	205	1948	1948		17.8	(1)	
			1950–60	1951		16.84	6,680	
					Aug. 1	17.94	11,700	50
	Myakka River basin							
3	Myakka River near Sarasota.	235	1936–60	1947		10.78	6,620	
					Aug. 1	11.58	8,670	18
	Manatee River basin							
4	Manatee River near Bradenton.	90	1939–60	1947		24.51	6,170	
					July 29	25.09	7,500	10
	Little Manatee River basin							
5	Little Manatee River near Wimauma.	145	1939–60	1945			9,450	
				1959		15.68		
					July 30	15.28	8,660	6
	Alafia River basin							
6	North Prong Alafia River at Keysville.	175	1950–60	1959		13.47	5,580	
					July 30	14.42	6,860	13
7	Alafia River at Lithia	335	1933–60	1933		25.6	19,300	
					July 31	19.97	17,200	[2] 1.05

See footnotes at end of table.

TABLE 30.—*Flood stages and discharges, July 29–August 3, in central-western Florida*—Continued

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to July 1960: Period	Maximum floods: Prior to July 1960: Year	Maximum floods: July–August	Maximum floods: Gage height (ft)	Maximum floods: Discharge (cfs)	Maximum floods: Recurrence interval (yrs)
	Palm River basin							
8	Sixmile Creek at Tampa	28	1956–60	1959	----------	9.92	1,150	------
					July 29	11.04	1,170	4
	Hillsborough River basin							
9	Blackwater Creek near Knights.	110	1951–60	1959	----------	8.70	2,220	------
					July 30	8.89	2,700	4
10	Hillsborough River near Zephyrville.	220	1939–60	1947	----------	--------	5,920	------
				1950	----------	13.80	----------	------
					July 30	13.76	6,280	7
11	Pemberton Creek near Dover.	24	1957–60	1959	----------	6.6	330	------
					July 29	8.42	940	4
12	Hillsborough River near Tampa.	650	1933	1933	----------	25.6	----------	------
				1933	----------	--------	16,500	------
			1938–60	1945	----------	--------	9,690	------
				1950	----------	22.76	----------	------
					Aug. 2	22.86	----------	------
					Aug. 3	--------	11,200	------
	Rocky Creek basin							
13	Rocky Creek near Sulphur Springs.	35	1953–60	1959	----------	14.23	1,380	------
					July 29	17.03	2,840	------
	Long Bayou basin							
14	Seminole Lake Outlet near Largo.	14	1950–60	1950	----------	7.44	539	------
					July 29, 30	7.38	522	------
	Lake Tarpon basin							
15	Brooker Creek near Tarpon Springs.	30	1950–60	1950	----------	12.80	1,080	------
					July 30	13.27	1,550	------
	Anclote River basin							
16	Anclote River near Elfers	72.5	1945–60	1945	----------	27.7	5,000	------
					July 30	26.09	3,890	15
	Withlacoochee River basin							
17	Withlacoochee-Hillsborough overflow near Richland.[3]	----------	----------	------	Aug. 1	6.27	1,180	------
18	Withlacoochee River near Dade City.	390	1930–33, 1958–60	1959	----------	--------	2,740	------
					August	13.40	4,060	------
19	Withlacoochee River at Trilby.	580	1928–60	1934	----------	(1)	8,840	------
					Aug. 5	16.48	4,310	9
20	Little Withlacoochee River at Perdell.	160	1958–60	1959	----------	10.74	1,910	------
					Aug. 3	10.22	1,470	------
21	Withlacoochee River at Croom.	880	1934	1934	----------	15.2	(1)	------
			1939–60	1950	----------	12.71	8,450	------
					Aug. 7	11.55	5,320	7

1 Not determined.
2 Ratio of peak discharge to that of a 50-year flood.
3 High-water diversion from Withlacoochee River basin to Hillsborough River basin.

FLOODS OF JULY 29–AUGUST 2 IN SOUTHEASTERN NORTH CAROLINA

Tropical-storm Brenda originated in the northeastern Gulf of Mexico on July 27. After moving up the west coast of Florida and crossing the State in the Big Bend area, it moved northeastward to and across the eastern part of the Coastal Plain of North Carolina on July 29 (fig. 43). The passage of this storm was preceded by local thunderstorm activity in North Carolina.

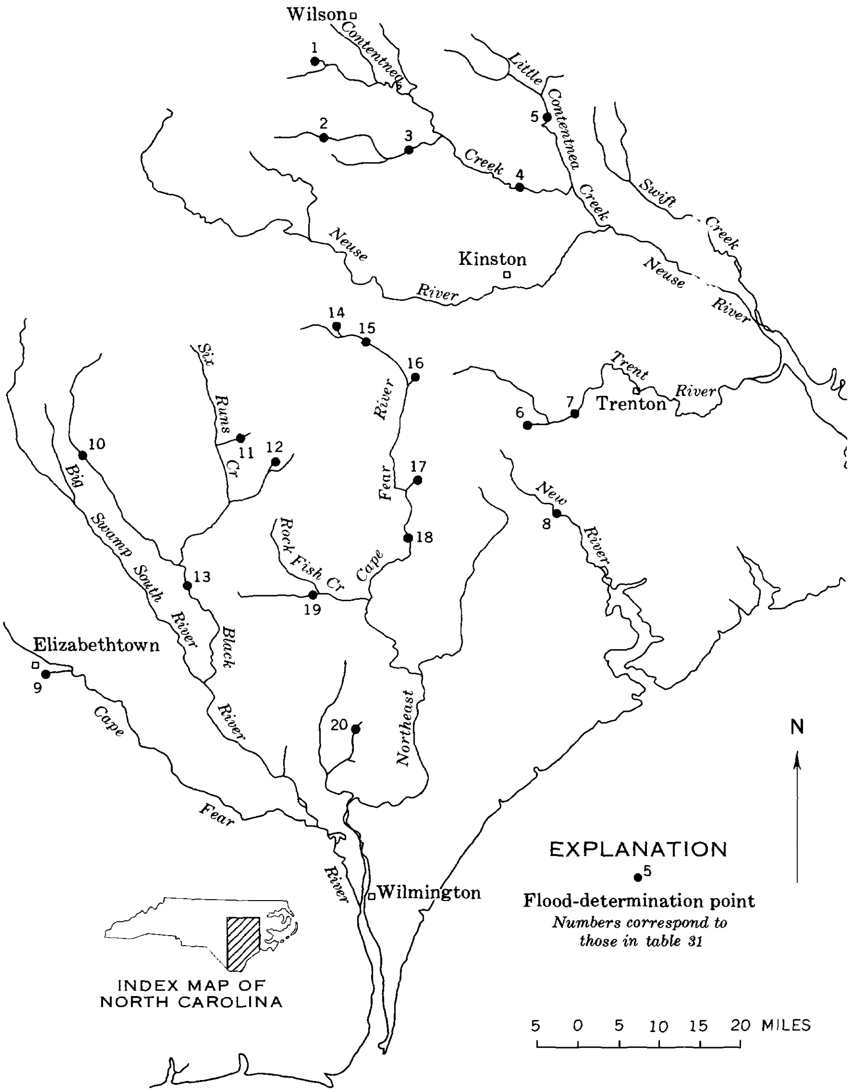

FIGURE 43.—Flood area; location of flood-determination points is shown. Floods of July 29–August 2 in eastern North Carolina.

Rainfall totals during the storm period ranged from 3 to 8 inches over most of the Coastal Plain, and the greatest 1-day rainfall reported was 7.42 inches at Wilson on July 29. A rainfall such as this has a recurrence interval of about 35 years. Property damage from the resulting flood was slight, and no lives were lost.

Record breaking floods occurred at several short-term gaging stations and partial-record stations (table 31) and the peak discharge at many of them equaled or exceeded that of a 50-year flood. Although the peak discharges of this flood were of rare occurrence, the peak discharges at many of the stations were even greater during the floods following hurricane Ione in September 1955.

TABLE 31.—*Flood stages and discharges, July 29–August 2, in southeastern North Carolina*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods					
			Prior to July 1960		July-August	Gage height (ft)	Discharge (cfs)	Recurrence interval (yrs)
			Period	Year				
	Neuse River basin							
1	Lee Swamp tributary near Lucama.	2.83			July 30	25.96	508	
2	Nahunta Swamp near Pikeville.	18.6	1953–60	1954		17.96	365	
					July 30	20.38	1,070	[1] 1.69
3	Nahunta Swamp near Shine.	77.6	1954–60	1955		12.37	2,050	
					July 30	12.21	2,910	[1] 1.37
4	Contentnea Creek at Hookerton.	729	1928–60	1928		23.3	([2])	
			1929–60	1929		18.90	11,100	
					Aug. 2	17.53	10,600	22
5	Little Contentnea Creek near Farmville.	93.3	1955–60	1955		18.9	([2])	
			1956–60	1958		14.33	1,380	
					July 31	16.27	2,490	50
6	Rattlesnake Branch near Comfort.	3.35			July 29	24.07	685	
7	Trent River near Trenton	168	1951–60	1955		17.84	9,100	
					Aug. 1	14.78	2,840	19
	New River basin							
8	New River near Gum Branch.	74.5	1949–60	1955		19.99	7,900	
					July 30	16.44	3,030	[1] 1.49

See footnotes at end of table.

FLOODS OF AUGUST 22–23 IN RANDOLPH COUNTY, N.C.

Several thunderstorms, variable with respect to locality and intensity, occurred in Randolph County, N.C., on August 22 and produced floods from small areas that were the greatest known. The two U.S. Weather Bureau precipitation stations in the area reported 3.42 inches of rain 2 miles west of Asheboro for the storm and 6.31 inches at Randleman. A survey in the Back Creek basin determined the total storm rainfall at the six places shown in table 32. The letters in the table designate sites of rainfall determinations and correspond to those in figure 45.

Newspapers reported that the two hardest rains occurred soon after 4 p.m. and at about 6:45 p.m. and that the rain continued sporadically through the night of August 22–23.

The flood area is in the central part of the Piedmont Plateau and is characterized by rolling hills.

Two gaging stations, Deep River near Randleman and Deep River at Ramseur, were operated in the flood area during the floods, and two other gaging stations had been operated in the area prior to the floods. Only a small part of the drainage area of Deep River at Ramseur was in the flood area. The other three stations were outside the flood area (figure 45), and peak discharges at these stations were relatively small. Peak discharges at miscellaneous sites on small streams were exceptionally great. Recurrence intervals of the discharge of three small streams are known to have greatly exceeded 50 years (table 33); the intervals were also great on two other streams having drainage areas too small to make recurrence-interval computations possible.

Other great floods have occurred in this section of the Piedmont Plateau. On August 4, 1924, a flood on Morgan Creek near Chapel Hill (45 miles east of Asheboro) had a peak discharge of about 30,000 cfs from 29.1 square miles of drainage area. On July 20, 1956, a flood on Bear Creek at Robbins (25 miles southeast of Asheboro) had a peak discharge of 43,600 cfs from 134 square miles of drainage

TABLE 32.—*Rainfall totals, in inches, in Randolph County, N.C., on August 22*

Station	*Rainfall*	*Station*	*Rainfall*
A	7	D	8½
B	4¾	E	8
C	9½	F	2¾

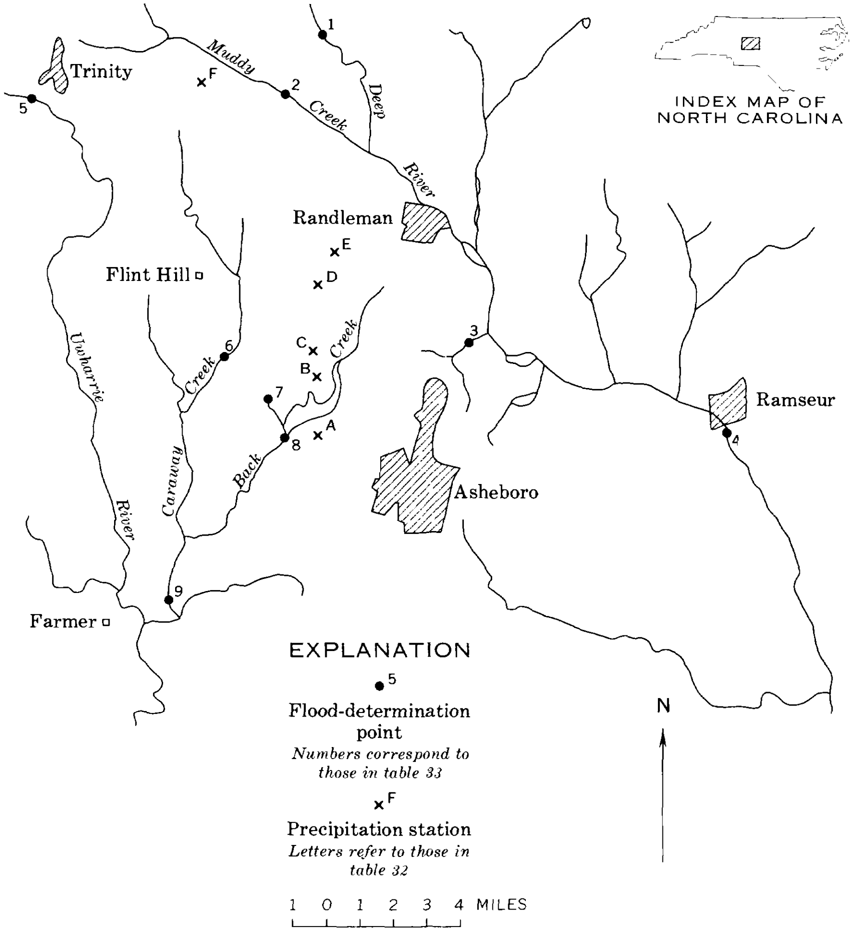

FIGURE 45.—Flood area: location of flood-determination points and precipitation sites is shown. Floods of August 22–23 in Randolph County, N.C.

area. The peak discharges of these two floods are 8.4 and 2.7 times as great as that of a 50-year flood, respectively.

Flood damage was high according to the North Carolina Department of Water Resources and the Corps of Engineers. The greatest damage was to industrial plants. One textile mill in Randleman reported $750,000 damage. About $1,500 damage occurred to the Asheboro sewer plant, and State highways in the Asheboro area received $40,000 damage. Damage to three bridges near Randleman was about $25,000. Agricultural damage near Asheboro totaled about $30,000, and damage to crops, mostly corn and tobacco, in other areas was heavy. Many farm ponds were destroyed.

TABLE 33.—*Flood stages and discharges, August 22–23, in Randolph County, N.C.*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods					
			Prior to Aug. 1960		August	Gage height (ft)	Discharge (cfs)	Recurrence interval (yrs)
			Period	Year				
	Cape Fear River basin							
1	Deep River near Randleman.	124	1928–60	1947		32.2	20,000	
					23	16.62	3,840	1
2	Muddy Creek near Archdale.	16.2	1934–41	1938		10.46	2,180	
					22	9.1	1,650	2
3	Haskett Creek at Central Falls.	10.6			22		6,300	[1] 1.51
4	Deep River at Ramseur	346	1922–60	1945		34.04	43,000	
					22	24.37	20,400	7
	Pee Dee River basin							
5	Uwharrie River near Trinity.	11.3	1934–41	1941		7.0	2,190	
					22	6.05	1,720	12
6	Caraway Creek tributary near Flint Hill.	.08			22		245	
7	Molers Branch near Asheboro.	.59			22		1,580	
8	Back Creek at Back Creek Lake near Asheboro.	15.7			22		12,500	[1] 3.54
9	Caraway Creek near Farmer.	79.3			22		17,300	[1] 1.44

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

FLOODS OF EARLY SEPTEMBER IN UTAH

A series of intense thunderstorms September 2, 5, and 6 in the northeastern and in the central parts of Utah caused floods that were unusually high for the areas in which they occurred. Although cloudburst floods are common in these parts of Utah, those of September 1960 were much larger than those commonly occurring.

Severe thunderstorm activity on September 2 caused flash floods on several streams near Hanna and Duchesne (fig. 46). Rainfall, which fell in less than 1 hour, at Hanna, 5 miles northwest of Farm Creek, was 1.27 inches. A small tributary of Farm Creek carried a peak discharge of 4,300 cfs from a drainage area of 8.1 square miles; flood-frequency studies show that the discharge was about 10 times that of a 50-year flood (table 34). Basements of several ranch homes were flooded, and about 100 acres of hay land was damaged by erosion and by deposition of debris. Local residents stated that this flood was the greatest since at least 1930.

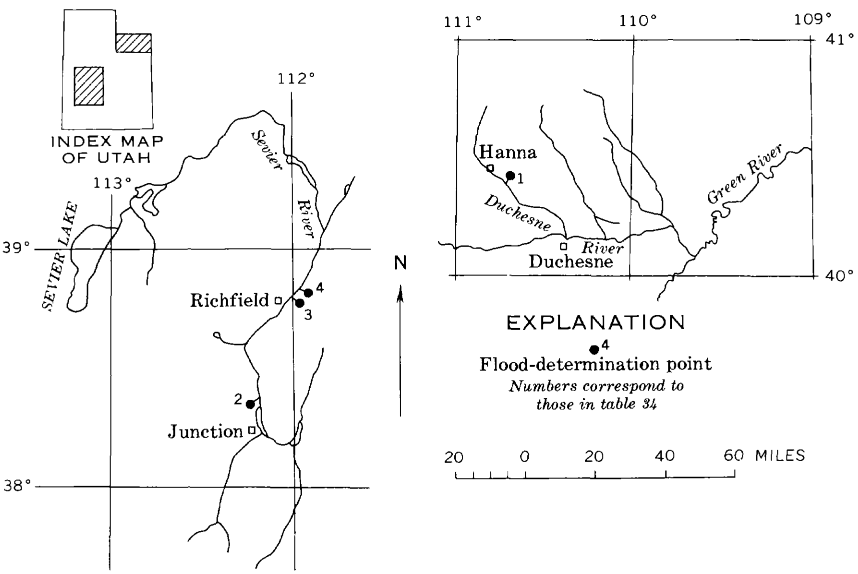

FIGURE 46.—Flood area; location of flood-determination points is shown. Floods of early September in Utah.

TABLE 34.—*Flood discharges in early September, in Utah*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods		
			September	Discharge	
				cfs	Ratio to Q_{50}
	Green River basin				
1	Farm Creek tributary near Hanna	8.1	2	4,300	10
	Sevier River basin				
2	Tenmile Creek near Marysvale	9.9	6	937	>1
3	Mill Canyon near Glenwood	12	5	3,620	5.3
4	Peterson Creek near Sigurd	27	5	2,150	2.1

An intense thunderstorm caused a flood on September 5 in Mill Canyon near Glenwood (fig. 46). The drainage area at the site of the indirect measurement is 12 square miles; however, the U.S. Soil Conservation Service reported that the peak discharge of 3,620 cfs came from only about 4 square miles of the drainage area. This peak discharge, if it had occurred from the entire drainage area of 12 square miles, would have been 5.3 times that of a 50-year flood. Flood-frequency relations are not defined in this part of Utah for drainage areas less than about 10 square miles. However, from a drainage area of 4 square miles, the probability of such a flood occurring in any one year is obviously very small. Most of the flood runoff was stored in a flood-control reservoir; thus, serious damage to the town of Glenwood was prevented.

Heavy rains over 2.2 square miles about 5 miles southeast of Sigurd caused a flash flood on Peterson Creek (fig. 46) on September 5. Although the drainage area is 27 square miles at the crest-stage gage near Sigurd, only 1.6 square miles contributed to the runoff. The peak discharge is 2.1 times that of a 50-year flood from the entire drainage area of 27 square miles. The probability of a flood of this magnitude from only 1.6 square miles occurring in any one year is extremely small. A bridge on State Highway U–119 was destroyed, and State Highway U–24 was damaged.

A flood on Tenmile Creek near Marysvale (fig. 46) on September 6 was caused by another thunderstorm. The peak discharge was high for this part of Utah and had a recurrence interval of more than 50 years. Water covered U.S. Highway 89 and delayed traffic.

FLOODS OF SEPTEMBER 6 IN EASTERN PUERTO RICO

On September 2, Hurricane Donna was about 1,200 miles east-southeast of Puerto Rico. By the evening of September 5, Donna had moved through the northern Leeward Islands to a position about 100 miles north of San Juan. Beginning about 9 p.m. on September 5 and continuing until 3 or 4 a.m. on September 6, rains of very high intensity fell over parts of eastern Puerto Rico. Light rains continued until daybreak.

Precipitation intensities were outstanding at many of the weather stations during the period of heavy rain. At Carite Dam, 25 miles south of San Juan, 6.10 inches of rain was measured in 2 hours between 9 and 11 p.m. Gages in the eastern section of the island at El Yungue, Rio Blanco, and Fajardo recorded 3 inches in 1 hour during the night.

The largest rainfall total reported was 18.76 inches on the northeast slope of the Luqillo Mountains near Sabana. Naguabo and Cayey reported 24-hour totals of 14.60 and 14.07 inches, respectively. High-intensity rain amounting to 10 inches or more fell over an area about 15 by 40 miles extending from Barranquitas, in the central interior, to the east coast of the island.

An isohyetal map of the storm rainfall for September 5–7 is shown in figure 47. Inconclusive reports suggest that the total rainfall during the storm period in the mountainous areas between Cayey and Humacao may have been considerably higher than that indicated by the map.

Damaging floods were widespread on both large and small streams throughout the eastern half of Puerto Rico. At Humacao, near the southeast coast, 90 persons were drowned as floodwaters of the Rio Humacao swept through the low-lying areas of the city during the predawn hours of September 6. The rate at which the level of the unprecedented flood rose was so rapid that victims were unable to reach safety even after being warned of the danger.

Many landslides occurred on the cultivated slopes of the island's mountainous interior. Highways along the mountainsides were blocked in many places and dangerously undermined or destroyed in others. Large amounts of soil, rock, and bamboo were dumped into the streams by the landslides and by channel erosion.

Bamboo is used rather extensively throughout the island to check roadside erosion and protect streambanks. The dislodged bamboo that was swept away by streams proved to be a menace to bridges

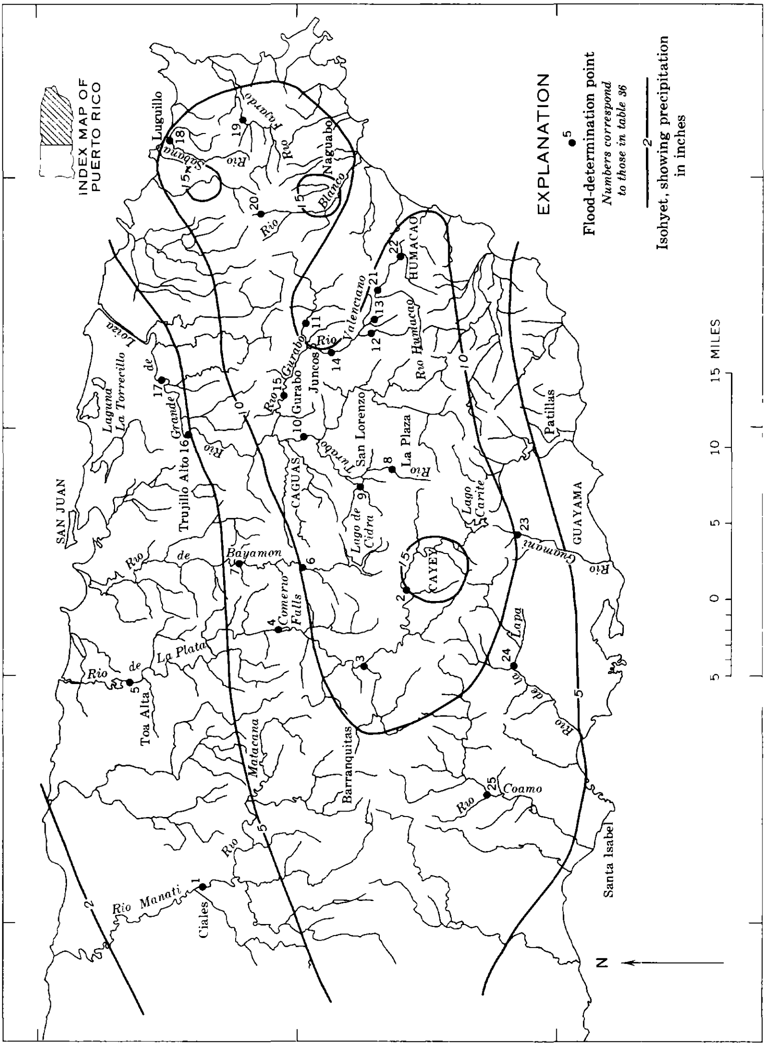

FIGURE 47.—Flood area; location of flood-determination points and isohyets for September 5–7 are shown. Floods of September 6 in eastern Puerto Rico.

and culverts. In many places, bridge and culvert openings were completely blocked by the debris; the blockage forced floodwaters over or around the structures and resulted in large washouts.

In the upper reaches of the Rio Turabo, deposition of rock and gravel raised the riverbed above the highway and bridge level at points between Caguas and La Plaza. Sharply angled fresh rock, in addition to the common rounded and bleached-out boulders, was particularly noticeable in the channels. Several of the older citizens living along the Rio Turabo north of La Plaza indicated that the flood on September 6 was the greatest known.

Floods along the small tributaries in upper reaches of the Rio Grande de Manati were high but were not particularly outstanding. However, downstream at Ciales the peak stage exceeded the previous maximum of record by 3 feet and destroyed the gaging station.

At Comerio Dam, the Rio de la Plata produced a peak discharge of 101,000 cfs from a drainage basin of 140 square miles. The design head for the dam was exceeded by more than 3 feet, and water poured over the abutments of the spillway. The generation of hydroelectric power was interrupted when the powerhouse was flooded prior to the peak. Farther downstream at the Toa Alta gaging station, the river rose 29.1 feet; 15 feet of the rise occurred in 1 hour.

Peak discharges or stages were determined at 25 sites on streams in eastern Puerto Rico (fig. 47).

The peak discharges in the middle reaches of the Rio Valenciano rank among the highest known for streams that have drainage areas of 6–15 square miles. At Juncos, the floodwall protecting the city along the left bank of the river was overtopped and extensively damaged. Downstream from the mouth of Rio Valenciano, floodwaters of Rio Gurabo overtopped the bridge handrails at Highways 185 and 181 and washed out the bridge approaches. The gaging station at Gurabo was damaged and put out of action. The railroad bridge 1 mile downstream was destroyed.

At San Lorenzo the floodwaters of Rio Grande de Loiza destroyed nearly all houses and buildings in its path. The only evidence left of some previous habitation was partly exposed foundations along the boulder- and debris-littered banks.

The gaging station on the Rio Grande de Loiza at Highway 30 recorded a rise of 12 feet in 1 hour. Shortly after 5 a.m. on September 6, the river crested at a stage of 31.2 feet. Local residents reported that the floodwaters rose 42 feet just below Loiza Dam at Trujillo Alto. At Carolina the peak discharge through the bridge on Highway 3 was 197,000 cfs from a contributing area of 239 square miles. Below this point, floodwaters, in their rush to the sea, broke out of the Loiza's canalized main channel and found outlet through Laguna La Torrecilla, about 8 miles to the west. Practically the entire coastal plain between Highway 3 and the low ridge at the Atlantic beach became a large lake about 10 miles long. Highway 3 was under water at several places.

The Rio Sabana and the Rio Fajardo, draining the northern and eastern slopes of the Sierra de Luquillo, produced notable floods.

Along the coastal highway from Naguabo, at the eastern end of Puerto Rico, to Santa Isabel, on the south-central coast, almost every principal stream overtopped the highway. Floods on the Rio Blanco and Rio Guayanes were particularly destructive. Residents along the coast northeast of Yabucoa stated that the magnitude of flooding on streams of this area was less than that for the floods of 1928.

The damage caused by the floods of September 6 exceeded $7 million (table 35).

TABLE 35.—*Summary of flood damage, September 6, in eastern Puerto Rico*

[Adapted from Civil Defense Corps data

Public property:	
Department of Public Works (roads and bridges)	$3, 201, 000
Aqueduct and Sewer Authority	247, 000
Land Authority	600, 000
Water Resources Authority (power)	104, 000
Communication Authority	20, 000
Total	4, 172, 000
Private property:	
Houses	1, 496, 000
Agriculture:	
Crops	924, 000
Livestock and poultry	91, 000
Facilities	298, 000
Other	74, 000
Utilities	26, 000
Total	2, 909, 000
Total damage	7, 081, 000

Human suffering was great—117 deaths occurred, 30 persons were missing, and 136 persons were injured. Emergency housing, medical attention, food, and clothing were provided for thousands, because 484 houses were destroyed and about 3,600 others were damaged. The Civil Defense Corps and the American Red Cross assisted more than 30,000 persons in 33 towns.

Damage to agriculture was high—8,300 acres of sugar cane, coffee, bananas, and other crops was damaged. More than 800 head of livestock were killed.

Total damage to roads and bridges exceeded $3 million. During the floods, all main highways and most secondary roads were impassable for a short period. At Humacao, the highway bridge over Rio Humacao was destroyed, and traffic was not restored for more than 3 weeks.

Hydrologic information indicates that the floods of September 6, 1960, were the greatest known over much of eastern Puerto Rico. The only previous flood in the area with which they may be compared occurred September 13–14, 1928, during the San Felipe hurricane. M. A. Quinones' study of the 1928 flood at Comerio Falls Dam [4] indicates that the peak discharge was slightly higher than that of the 1960 flood.

The peak discharges for the floods of September 6, 1960, were determined at 24 sites. Peak discharges, expressed in cubic feet per second per square mile, are plotted against drainage area in figure 48. Comparison of these floods with outstanding floods that have occurred in other places indicates that the floods on the Rio Humacao, Rio Valenciano, and Rio Turabo (drainage areas of 6–15 sq mi) rank among the highest known.

The peak discharges at nine sites had a Myers rating in excess of 80 percent; the discharge at four of these sites exceeded 100 percent. Compilations of record peak discharges of streams in the United States and of some foreign streams [5,6] reveal only 14 known events (from drainage areas of less than 250 sq mi) in which the Myers rating exceeded 80 percent.

Significantly each of the high-yield streams mentioned heads on the northern slope of the Sierra de Cayey between Cayey and Humacao. During the storm, U.S. Weather Bureau radar units tracked the northeastward movement of the most intense rainstorm over this area. The orographic influence of the mountain range that rises abruptly from the south coastal plain is indicated by the rainfall pattern (fig. 47).

Peak discharges at stream-gaging stations and at other points in eastern Puerto Rico are summarized in table 36. The reference numbers in the table apply to figures 47 and 48.

Five gaging stations were operated by the Geological Survey in the flood area—four recording gages and one nonrecording. During the flood the gaging station on Rio Grande de Manati at Ciales was completely destroyed. The station on Rio Gurabo at Gurabo was ex-

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[4] Quinones, M. A., 1953, High intensity rainfall and major floods in Puerto Rico: Am. Soc. Civil Engineering Proc., v. 79, Separate 364.

[5] Lindsey, R. K., Kohler, M. A., and Paulhus, J. C. H., 1949, Applied hydrology: New York, McGraw-Hill Book Co., Inc., 689 p.

[6] Creager, W. P., Justin. J. D., and Hinds, J., 1954, Engineering for dams: New York, John Wiley & Sons, v. 1, 245 p.

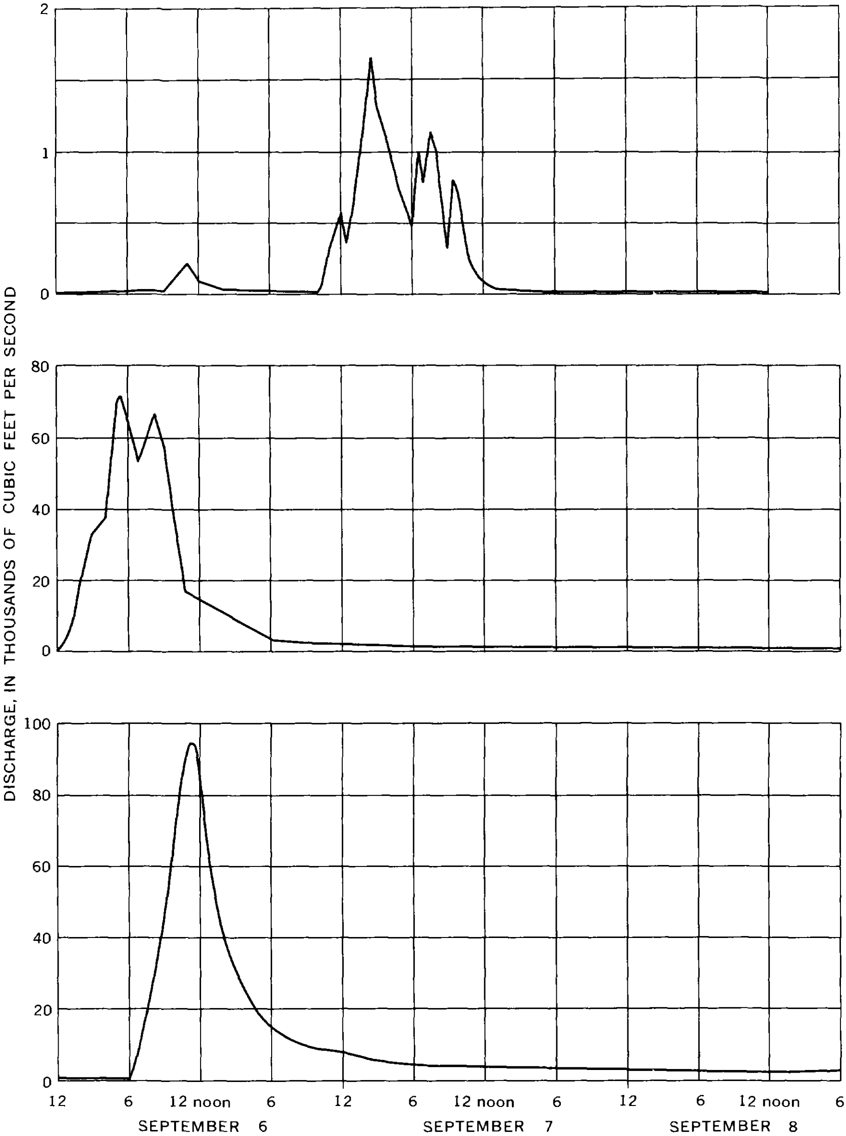

FIGURE 49.—Discharge hydrographs for three gaging stations, September 6–8. Floods of September 6 in eastern Puerto Rico. Top curve: Rio Hicaco near Naquabo; drainage area, 1.24 sq mi. Middle curve: Rio Grande de Loiza at Caquas; drainage area, 89.7 sq mi. Bottom curve: Rio de la Plata at Toa Alta: drainage area, 204 sq mi.

This flood was reported earlier, in Circular 451, "Floods of September 6, 1960, in Eastern Puerto Rico," by Harry H. Barnes, Jr., and Dean B. Bogart.

FLOODS OF SEPTEMBER 11–14 IN EASTERN UNITED STATES CAUSED BY HURRICANE DONNA

Hurricane Donna, which left the Puerto Rico area on September 5, hit the middle Florida Keys on the night of September 9. It moved up the southwest side of Florida, turned inland at Fort Myers on September 10, and proceeded northward to Lakeland and thence northeastward into the Atlantic Ocean. Heavy rainfall, high tides, and severe winds caused great damage. Tides at Everglade City, Fort Myers, and Naples were 4–7 feet above normal.

Rainy weather preceded hurricane Donna over most of Florida, and generally the areas that received the heaviest rain in the early part of the month also received the heaviest rain during the passage of the hurricane. Substantial rain had also fallen in the late part of August.

Heavy rainfall in Florida ranged from 5 to 10 inches in a belt 80–100 miles wide extending 50–75 miles to the right and 30–40 miles to the left of the storm track. The heaviest rainfall was on the extreme south end of the State. In the Miami and Dade County area, the storm totals were mostly 7–10 inches; a few totals were 12 inches.

Although the rainfall accompanying the hurricane was not unusually great for Florida, the high antecedent moisture conditions contributed to considerable flooding. Maximum peak discharge occurred in a few streams in the western and the central parts of the State (fig. 50).

Many millions of dollars of damage was done in Florida, mostly due to the high winds and to inundation by high tides along the coastal area.

Hurricane Donna entered North Carolina late on September 11. The eye was about 60 miles in diameter, and the center moved in a rather straight line near Swansboro, New Bern, Belhaven, and Elizabeth City and thence back into the ocean near the North Carolina–Virginia State line.

Little damage resulted from flooding; most of the damage was due to wind and high tides at beach areas. Damage in North Carolina was probably about one-third of that caused by hurricane Hazel in 1954.

The heaviest rainfall associated with this storm was along and some distance to the west of the path of the eye, where total rainfall ranged from 4 to 7 inches in a period of 24 hours or less.

Flooding occurred on small streams in eastern North Carolina (fig. 51), and large streams originating outside the flood area were

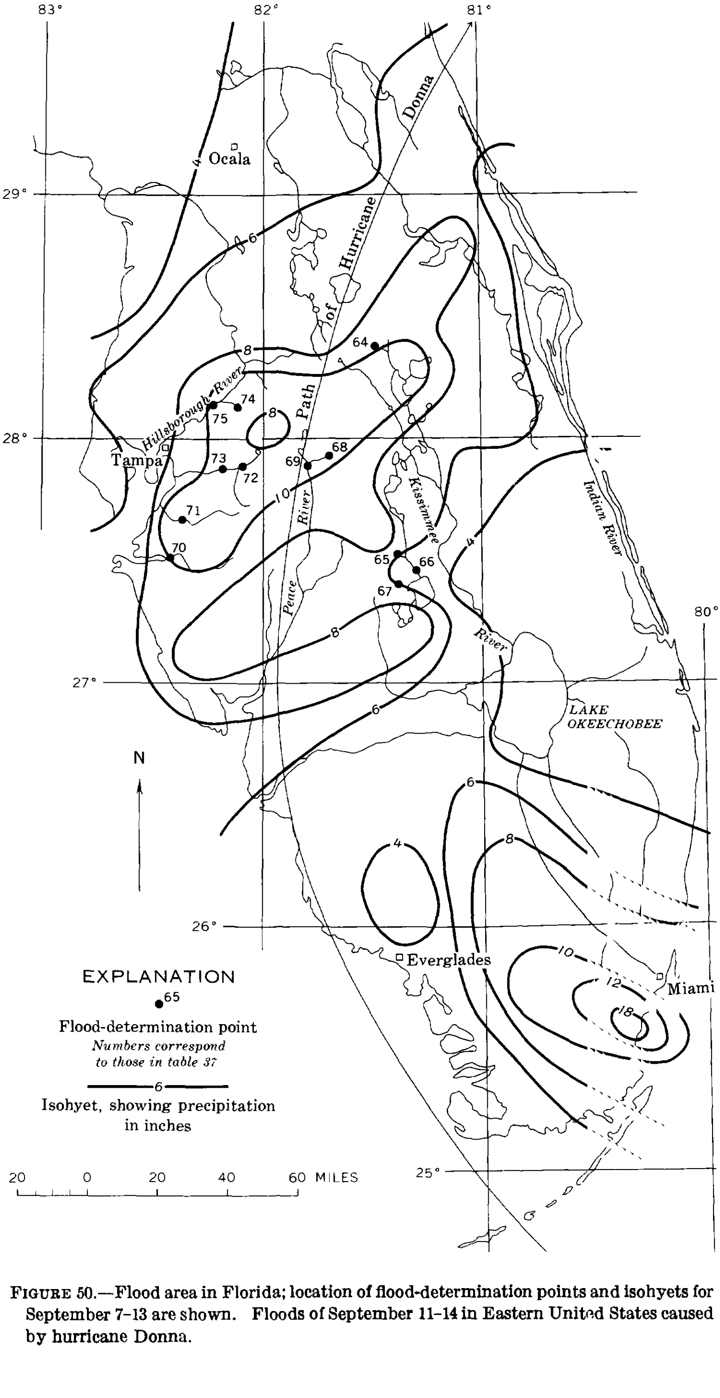

FIGURE 50.—Flood area in Florida; location of flood-determination points and isohyets for September 7–13 are shown. Floods of September 11–14 in Eastern United States caused by hurricane Donna.

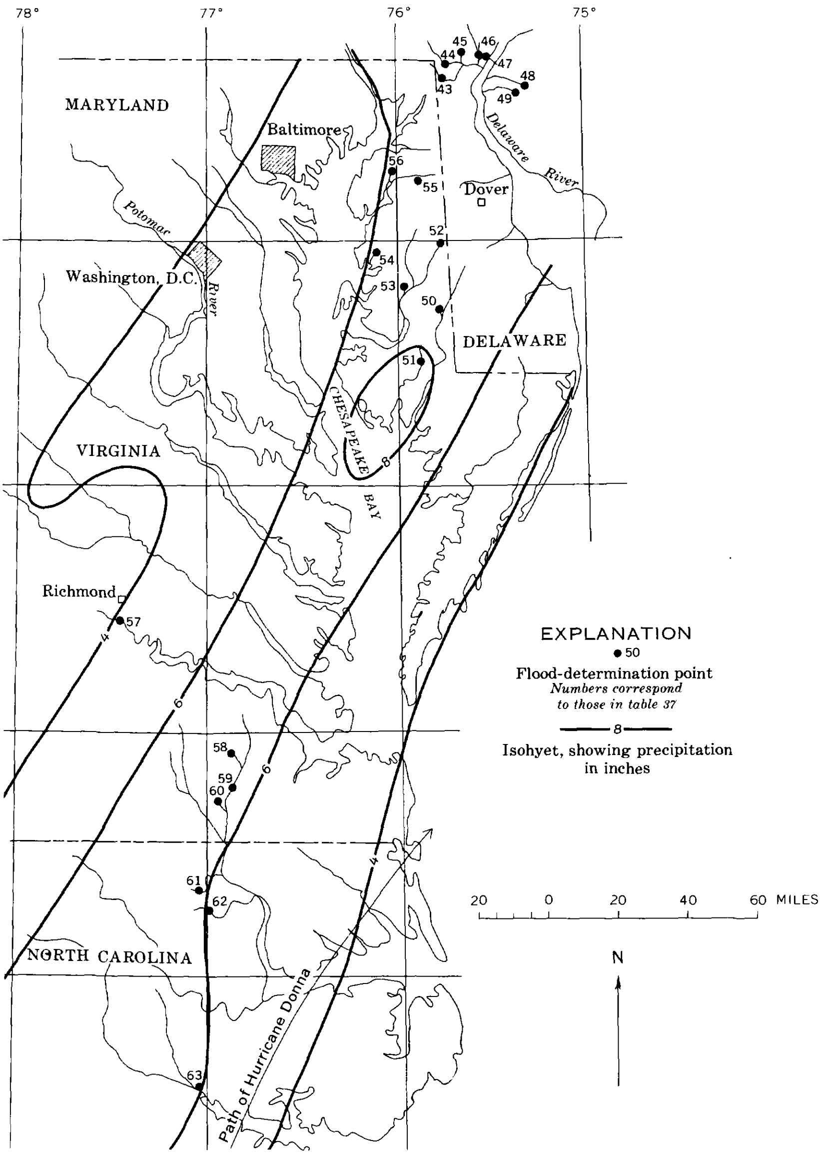

FIGURE 51.—Flood area, North Carolina to Delaware; location of flood-determination points and isohyets for September 9–13 are shown. Floods of September 11–14 in Eastern United States caused by Hurricane Donna.

little affected. Several short-period gaging stations had flood peaks greater than those of record. Nearly all stations had peak discharges smaller than those of floods in 1955. Crest-stage partial-record gaging stations in the flood area have been operated for the most part since 1952, and peak discharges for this flood at some stations for small drainage areas exceeded the maximum peak of record.

The eye of the hurricane skirted the Virginia coast on the morning of September 12. The rain was heaviest in the eastern part of the State, and 6.65 inches fell in 24 hours at Sunnybank, at the mouth of the Potomac River.

Major flooding in Virginia occurred in the Blackwater River basin in the southeastern part of the State, and the peak discharge on the Blackwater River at Franklin was the maximum in a period of record beginning in 1944 (table 37).

The hurricane continued in a northeasterly path along the coast of the Maryland peninsula, Delaware, and New Jersey, and by the evening of September 12 was north of Boston; it passed over northern Maine early on September 13.

The eye of the hurricane was so close to Delaware that winds as strong as 110 miles per hour were reported from the coast. Winds of hurricane force extended as far as 30 miles inland, and rainfall ranged generally from 4 to 6 inches in this belt. From 3 to 4 inches of rain fell as far as 100 miles inland. At Wilmington, Del., the rainfall of 5.62 inches was the greatest 24-hour amount since 6.24 inches fell in July 1952. The greatest reported daily total from the hurricane, outside of Florida, was 8.29 inches at Denton, Md.

Serious flooding occurred in northern Delaware on White Clay Creek near Newark and on Red Clay Creek at Wooddale, where the peak discharges were maximum since at least 1943. High discharges occurred in the Baltimore City area. The peak discharge of Weasel Brook at Clifton, N.J. (4.45 sq mi) was maximum since at least 1937.

The southeastern corner of Pennsylvania received as much as 6 inches of rain. Many small streams inundated low-lying areas, but flooding in general was not serious (fig. 52). Many streets in Philadelphia were under water.

The heaviest rains in the New England States fell west of the storm path. From 6 to 7 inches fell at a distance of about 40 miles west of the path, and only about 1 inch fell at Cape Cod, east of the path. Moderate to substantial rises occurred on small streams, but no outstanding floods occurred. In general, the rainfall abated considerably in Maine, and no flooding of consequence followed.

The State of New York was seriously affected by hurricane Donna, which crossed Long Island about noon on September 12; the eye of the hurricane covered most of the island. The storm lashed southeastern

TABLE 37.—*Flood stages and discharges, September 11–14, in Eastern United States*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to Sept. 1960 — Period	Maximum floods: Prior to Sept. 1960 — Year	September	Gage height (ft)	Discharge (cfs)	Recurrence interval (yrs)
	Merrimack River basin							
1	Contoocook River at Peterboro, N.H.	68.1	1945–60	1950		6.35	2,640	
					12	5.93	2,260	10
	Connecticut River basin							
2	Saxtons River at Saxtons River, Vt.	72.2	1938	1938		17.9	(1)	
			1940–60	1952		11.37	5 430	
					12	11.57	5 610	5
	Streams on Long Island							
3	Mill Neck Creek at Mill Neck, N.Y.		1937–60	1938		[2] 4.85		
				1955		1.58	135	
					12	1.60	137	
4	Nissequogue River near Smithtown, N.Y.		1943–60	1955		1.96	324	
					12	1.62	231	
5	Peconic River at Riverhead, N.Y.		1942–60	1953		.97	140	
					13	.60	50	
6	Carmans River at Yaphank, N.Y.		1942–60	1954		1.25	83	
					12	.98	57	
7	Champlin Creek at Islip, N.Y.		1948–60	1955		1.41	91	
					12	1.05	58	
8	Penataquit Creek at Bay Shore, N.Y.		1945–60	1955		2.31	64	
					12	1.66	56	
9	Sampawams Creek at Babylon, N.Y.		1944–60	1955		1.67	110	
					12	2.11	136	
10	Carlls Creek at Babylon, N.Y.		1944–60	1955		1.74	132	
					12	2.20	166	
11	Santapoque River at Lindenhurst, N.Y.		1947–60	1948		1.15		
				1954			42	
					13	.91	41	
12	East Meadow Brook at Freeport, N.Y.		1903, 1937–60	1955		3.66	355	
					12	4.38	835	
13	Pines Brook at Malverne, N.Y.		1936–60	1955		2.76	191	
					12	4.51	346	
	Hudson River basin							
14	North Branch Hoosic River at North Adams, Mass.	39.0	1927	1927		(1)	9,980	
			1931–60	1938		12.05	8,950	
					12	9.95	3,520	
15	Little Hoosic River at Petersburg, N.Y.	56.1	1948	1948		9.4	7,470	
			1951–60	1952		6.80	2,910	
					12	8.28	4,760	20
16	Schoharie Creek at Hunter, N.Y.	39.5	1951	1951		1,578.2	13,800	
					12	1,572.1	5,600	3
17	East Kill near Jewett Center, N.Y.	35.2	1955	1955		1,469.8	9,920	
					12	1,468.1	8,100	5
18	West Kill near West Kill, N.Y.	26.8	1955	1955		94.90	4,880	
					12	94.19	3,600	2
19	Batavia Kill at Hensonville, N.Y.	13.5	1955	1955			5,000	
					12		5,000	7
20	Nauvo Stream at Windham, N.Y.	3.88	1955	1955			1,700	
					12		1,690	
21	Mad Brook near Windham, N.Y.	6.88			12		4,550	
22	Batavia Kill at Ashland, N.Y.	62.1	1955	1955		1,404.5	15,500	
					12	1,408.2	24,000	23
23	Schoharie Creek at Prattsville, N.Y.	236	1902–60	1955		19.14	55,200	
					12	18.35	49,900	16
24	Fox Creek near West Berne, N.Y.	74.6	1955	1955			6,470	
					12		8,000	2

See footnotes at end of table.

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TABLE 37.—*Flood stages and discharges, September 11–14, in Eastern United States*—Continued

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to Sept. 1960: Period	Prior to Sept. 1960: Year	September	Gage height (ft)	Discharge (cfs)	Recurrence interval (yrs)
	Hudson River basin—Continued							
25	Schoharie Creek at Burtonsville, N.Y.	883	1939–60	1955		12.39	76,500	
					13	7.03	28,700	7
26	Normans Kill near Slingerlands, N.Y.	169	1955	1955		114.7	13,300	
					12	114.1	12,800	16
27	Catskill Creek at Preston Hollow, N.Y.	47.5	1955	1955		94.6	3,980	
					12	93.8	(1)	
28	Durham Kill at Oak Hill, N.Y.	5.82	1955	1955		94.9	2,860	
					12	92.9	(1)	
29	Catskill Creek at Oak Hill, N.Y.	98.0	1910–60	1950		14.08	12,500	
					12	13.75	11,900	12
30	Ten Mile Creek at Oak Hill, N.Y.	35.3	1952	1952		91.3	1,990	
					12	92.5	2,800	4
31	Shingle Kill at Cairo, N.Y.	13.9	1955	1955			3,100	
					12		2,170	8
32	Esopus Creek at Cold Brook, N.Y.	192	1914–60	1951		20.70	59,600	
					12	11.78	11,700	
	Passaic River basin							
33	Weasel Brook at Clifton, N.J.	4.45	1937–60	1953		3.35	450	
					12	3.53	496	
	Elizabeth River basin							
34	Elizabeth River at Elizabeth, N.J.	20.2	1921–60	1938			2,720	
				1954		15.02		
					12	12.42	2,130	
	Rahway River basin							
35	Robinson Branch Rahway River at Rahway, N.J.	21.6	1939–60	1953		5.36	1,490	
					12	5.20	1,190	
	Manasquan River basin							
36	Manasquan River at Squankum, N.J.	43.4	1931–60	1938		(1)	2,940	
					13	12.13	2,040	
	Mollica River basin							
37	Batsto River at Batsto, N.J.	70.5	1927–60	1933			[3] 1,310	
					14		[3] 1,060	
	Delaware River basin							
38	Pequest River at Pequest, N.J.	108	1921–60	1936		4.97	1,810	
					13	4.44	1,290	
39	Tohickon Creek near Pipersville, Pa.	97.4	1935–60	1955		11.26	16,000	
					12	11.07	15,500	25
40	Crosswicks Creek at Extonville, N.J.	83.6	1940–60	1940		12.05	3,360	
					13	11.99	3,200	[4] 1.42
41	North Branch Rancoeas Creek at Pemberton, N.J.	111	1921–60	1939		(1)	1,730	
					13	3.81	1,420	28
42	Chester Creek near Chester, Pa.	61.1	1931–60	1950		16.21	14,400	
					12	13.89	9,940	[4] 1.50
43	Christina River at Coochs Bridge, Del.	20.5	1943–60	1947		12.41	2,620	
					12	11.33	1,980	
44	White Clay Creek near Newark, Del.	87.8	1931–36, 1943–60	1933		16.05	6,230	5
					12	16.11	6,340	15
45	Red Clay Creek at Wooddale, Del.	47.0	1943–60	1955		8.38	3,650	
					12	9.93	6,000	[4] 1.13

See footnotes at end of table.

TABLE 37.—*Flood stages and discharges, September 11–14, in Eastern United States*—Continued

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to Sept. 1960: Period	Prior to Sept. 1960: Year	September	Gage height (ft)	Discharge (cfs)	Recurrence interval (yrs)
	Delaware River basin—Continued							
46	Brandywine Creek at Wilmington, Del.	314	1946–60	1955		13.89	17,800	
					13	11.42	15 600	30
47	Shellpot Creek at Wilmington, Del.	7.46	1945–60	1952		8.6	4,080	
					12	6.12	1,930	46
48	Salem River at Woodstown, N.J.	14.6	1940–60	1940		7.98	22,000	
					12	3.01	1,630	[4] 1.13
49	Alloway Creek at Alloway, N.J.	21.9	1952–60	1956		3.46	1,110	
					12	4.24	1,860	
	Nanticoke River basin							
50	Faulkner Branch at Federalsburg, Md.	7.10	1950–60	1958		4.12	440	
					12	4.73	672	[4] 2.31
	Transquaking River basin							
51	Chicamacomico River near Salem, Md.	15.0	1951–60	1952		3.92	326	
					12	4.23	419	17
	Choptank River basin							
52	Choptank River near Greensboro, Md.	113	1948–60	1958		11.74	4 380	
					13	12.45	5 040	[4] 1.75
53	Beaverdam Branch at Matthews, Md.	5.85	1950–60	1958		7.24	1,050	
					12	10.24	2,200	[4] 4.70
	Wye River basin							
54	Sallie Harris Creek near Carmichael, Md.	8.09			12	7.43	1,240	[4] 1.93
	Chester River basin							
55	Unicorn Branch near Millington, Md.	22.3	1948–60	1956		5.49	630	
					12	7.17	1,060	10
56	Morgan Creek near Kennedyville, Md.	10.5	1951–60	1958		7.11	834	
					12	8.88	1,530	[4] 1.93
	James River basin							
57	Falling Creek near Drewrys Bluff, Va.	54	1942–60	1945		(1)	7,270	
					12	10.40	5 010	
	Chowan River basin							
58	Seacock Creek near Ivor, Va.	27.4	1950–60	1958		6.33	700	
					12	7.26	4,000	
59	Blackwater River near Franklin, Va.	613	1940	1940		22	21,000	
			1944–60	1958		13.47	5 450	
					14	17.14	9 420	
60	Cypress Swamp near Burdette, Va.	8.55	1950–60	1958		6.17	197	
					12	9.85	(1)	
61	Potecasi Creek near Union, N.C.	191	1929	1929		19.1	4 050	
			1958–60	1958		19.12	4,050	
					14	18.80	4,000	36
62	Ahoskie Creek at Ahoskie, N.C.	64.3	1940	1940		11.1	(1)	
			1950–60	1955		8.77	1,420	
					14	10.11	2,560	[4] 1.39

See footnotes at end of table.

TABLE 37.—*Flood stages and discharges, September 11–14, in Eastern United States*—Continued

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to Sept. 1960: Period	Year	September	Gage height (ft)	Discharge (cfs)	Recurrence interval (yrs)
	Pamlico River basin							
63	Herring Run near Washington, N.C.	15	1946	1946		17	(1)	
			1950–60	1955		14.77	548	
					12	13.00	334	15
	Lake Okeechobee and the Everglades							
64	Cypress Creek at Vineland, Fla.	30.3	1945–60	1945			181	
				1959		3.88		
					11	4.66	354	[4] 1.73
65	Carter Creek near Sebring, Fla.	38.8	1954–60	1959		10.49	315	
					11	11.05	552	
66	Arbuckle Creek near DeSoto City, Fla.	385	1939–60	1948		(1)	7,380	
					12	9.45	4,900	
67	Josephine Creek near DeSoto City, Fla.	109	1946–60	1948		(1)	1,780	
					11	8.43	1,110	
	Peace River basin							
68	Peace Creek drainage canal near Alturas, Fla.	150	1928	1928		13.3	2,540	
			1947–60	1949		11.67	1,740	
					12	12.80	1,620	
69	Peace River at Bartow, Fla.	390	1939–60	1947			4,140	
				1959		6.73		
					13,14	8.01	3,470	
	Manatee River basin							
70	Manatee River near Bradenton, Fla.	90	1939–60	1947		2[illegible] 51	6,170	
					11	2[illegible] 67	8,410	
	Little Manatee River basin							
71	Little Manatee River near Wimauma, Fla.	145	1939–60	1945			9,450	
				1959		15.68		
					11	17.59	14,000	30
	Alafia River basin							
72	North Prong Alafia River at Keysville, Fla.	175	1950–60	1959		13.47	5,580	
					11	15.86	9,570	36
73	Alafia River at Lithia, Fla.	335	1933–60	1933		25.6	19,300	
					12	2[illegible].12	20,300	[4] 1.24
	Hillsborough River basin							
74	Blackwater Creek near Knights, Fla.	110	1951–60	1960		9.70	5,400	
					11	9.52	4,680	
75	Hillsborough River near Zephyrhills, Fla.	220	1939–60	1960		15.33	12,600	
					12	14.68	9,620	

[1] Not determined.
[2] Affected by hurricane wave.
[3] Mean daily discharge.
[4] Ratio of peak discharge to that of a 50-year flood.

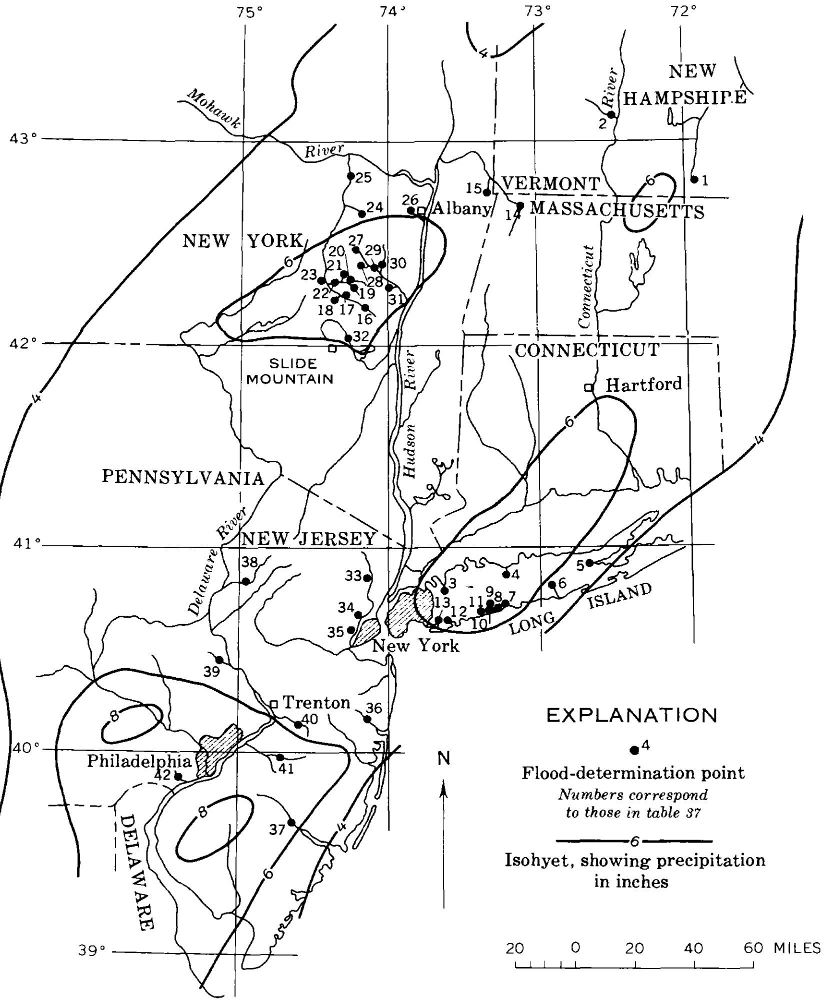

FIGURE 52.—Flood area, New Jersey to New England States; location of flood-determination points and isohyets for September 9–13 are shown. Floods of September 11–14 in Eastern United States caused by hurricane Donna.

New York State with winds as great as 100 miles per hour and produced rainfall exceeding 7 inches at several stations. The greatest recorded rainfall in New York for this storm and some of the most concentrated damage occurred in Greene County on the north edge of the Catskills. The rainfall record at Windham, near the storm center, was lost when the Weather Bureau rain gage was washed away.

The Catskill area is normally subject to heavy rainfall because of the orographic influence of the mountains. Slide Mountain (highest mountain in the Catskills; on the north edge) was on the south

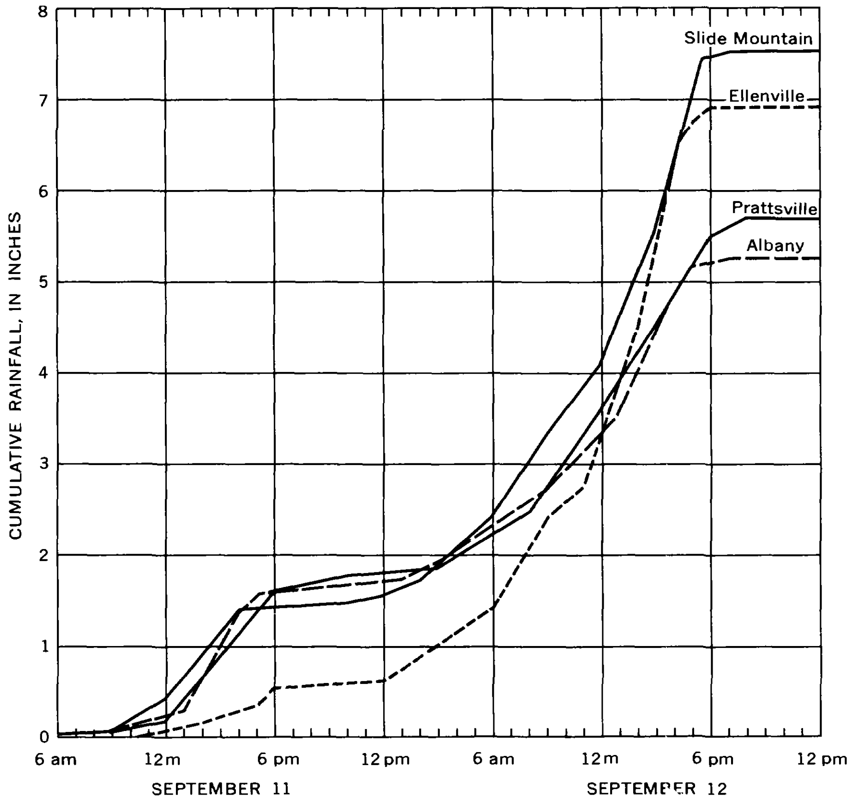

FIGURE 53.—Accumulated rainfall on September 11-12 at four weather stations in southeastern New York.

edge of the flood area of September 1960; rainfall of high intensity often occurs on the mountain. The greatest rainfall in the storm of September 11–12, 1960, was more than 7 inches, and this fell in the Slide Mountain area. The rain began before 8 a.m. on September 11 and continued almost unabated until the early evening of September 12, the intensity increasing during September 12. The maximum recorded rainfall for the storm in New York was 7.75 inches at North Settlement. The graph indicating the hourly accumulation of the rain at four weather stations (fig. 53) shows that the most intense rain was from the early afternoon to about 6 p.m. on September 12.

As the rain fell on the mountain slopes, many of which are covered with nonretentive rock and boulders, small streams became raging torrents. Mad Brook, for example, which is normally a placid stream, increased in volume and piled trees and other debris against the opening under a small bridge in Windham; the opening was blocked, and nearly all the stream's flow (more than 4,500 cfs) was over the banks. The stream flooded Main Street to depths as great as 4½ feet.

FLOODS OF SEPTEMBER 16–28 IN FLORIDA

After the passage of hurricane Donna in early September, tropical storms Ethel and Florence entered Florida during the last half of the month.

Ethel grazed the extreme western tip of the State, and rains on September 15–16 produced a flash flood on the West Fork Big Coldwater Creek at Cobbtown. Although the flood was greater than a 40-year flood and was a major hydrologic event, damage was minor; little housing, agriculture, and industry are on the flood plain of the stream.

Florence entered the State from the south on September 21, drifted slowly to the northwest, and left the State on September 25. This storm caused widespread flooding in the eastern coastal areas and some local flooding in the northwest (fig. 54). The heaviest rainfall occurred in the Palm Bay area, where 14 inches of rain fell September 21–25; total rainfall decreased rapidly away from the center of the area.

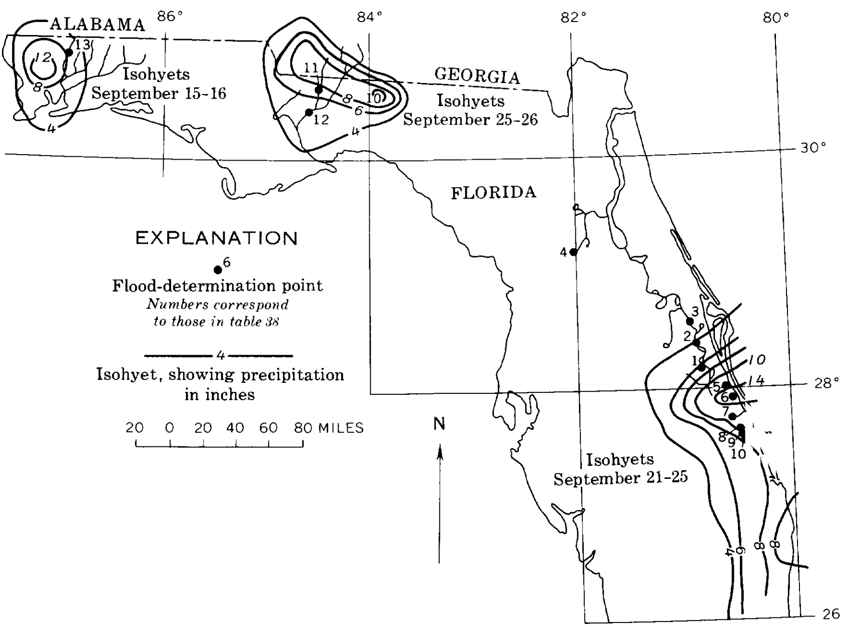

FIGURE 54.—Flood area; location of flood-determination points and isohyets in three flood areas are shown. Floods of September 16–28 in Florida.

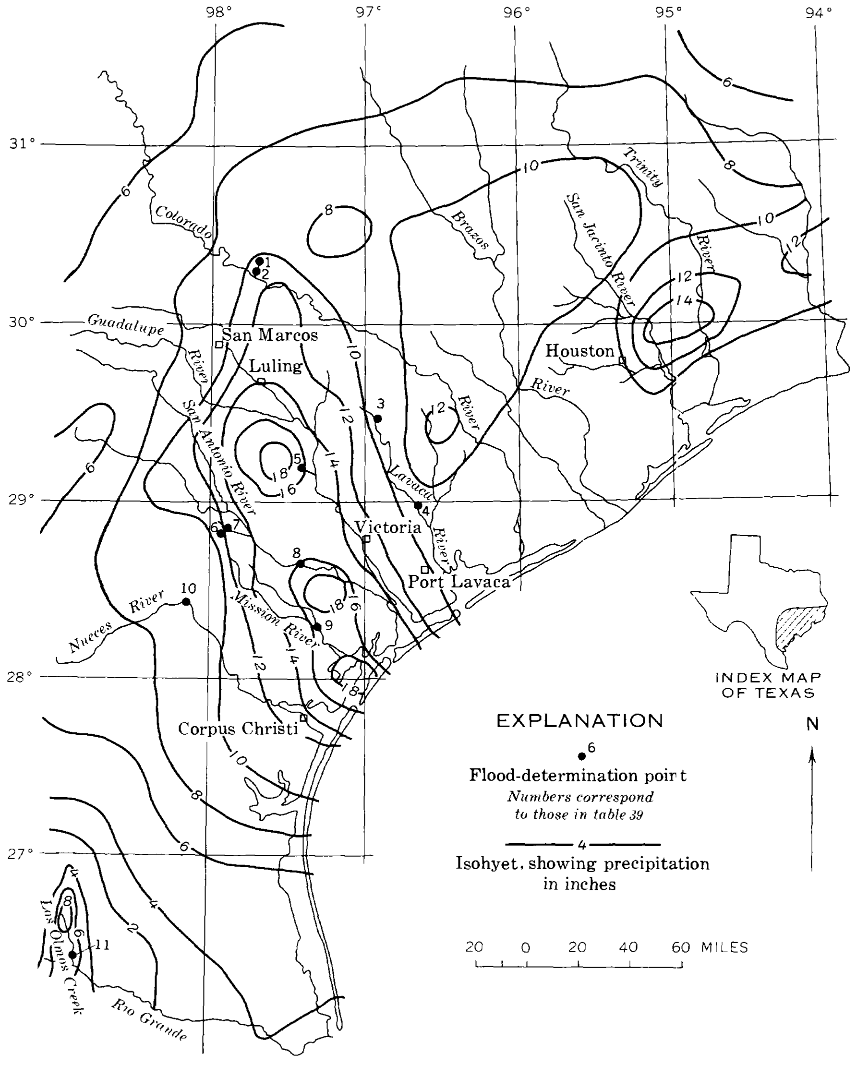

FIGURE 55.—Flood area; location of flood-determination points and isohyets for October are shown. Floods of October 16-30 in southern and south-central Texas.

The International Boundary and Water Commission estimated that the peak discharge of Los Olmos Creek at U.S. Highway 83 was between 15,000 and 16,000 cfs at about 6 p.m. on October 24. No flooding occurred on the main stream of the Rio Grande.

Exceptionally heavy high-intensity rains on October 25 preceded by several days of general rainfall produced flash flooding of local creeks in Bee and Karnes County in south-central Texas.

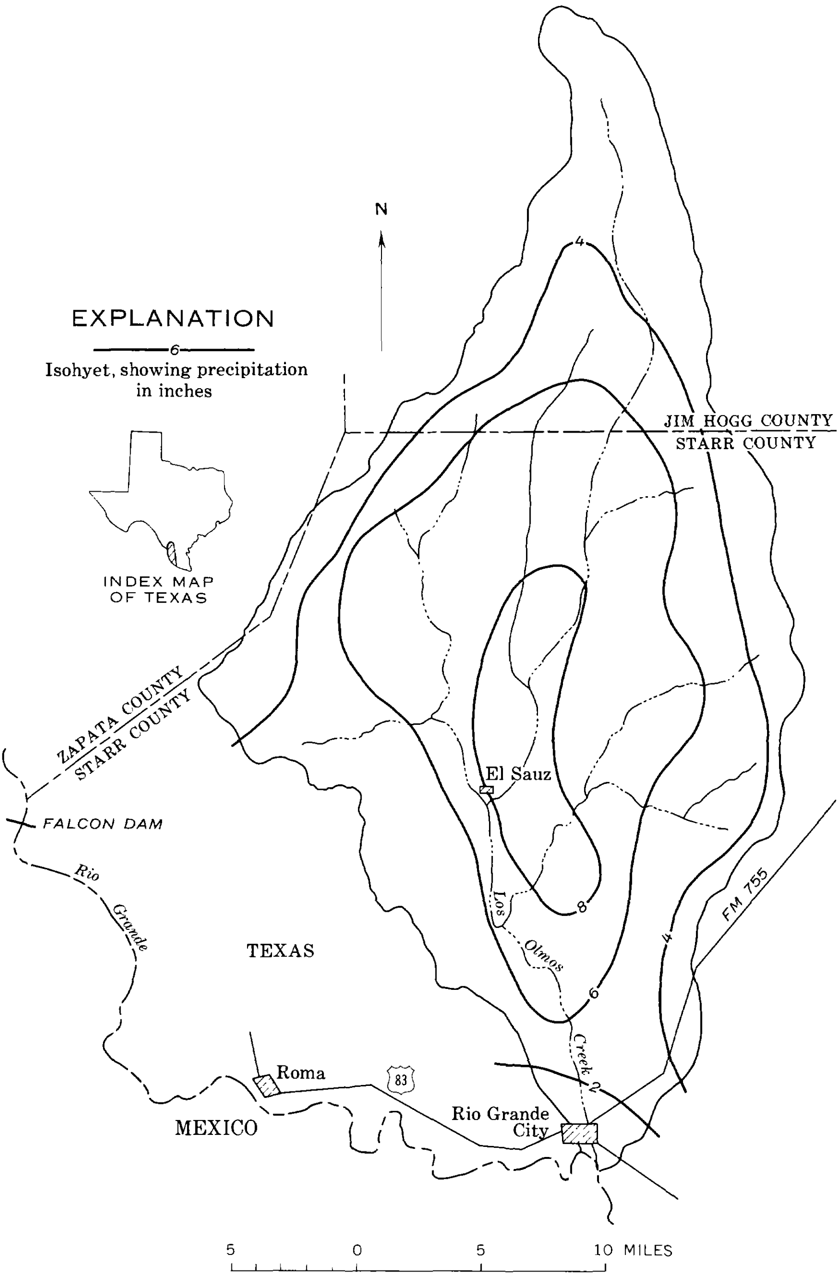

FIGURE 56.—Isohyets for October 23-24 in Los Olmos Creek watershed.

TABLE 39.—*Flood stages and discharges, October 17–29, in Texas*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to Oct. 1960: Period	Prior to Oct. 1960: Year	October	Gage height (ft)	Discharge (cfs)	Recurrence interval (yrs)
	Colorado River basin							
1	Waller Creek at 38th Street, Austin.	2.31	1955–60	1957		5.75	596	
					29	7.77	1,970	
2	Waller Creek at 23rd Street, Austin.	4.13	1955–60	1957		5.85	2,050	
					29	7.96	3,710	
	Lavaca River basin							
3	Lavaca River at Hallettsville.	101	1840–1960	1940		40.60	93,100	
					18	28.37	29,500	43
4	Lavaca River near Edna	887	1880–1960	1936		33.8	83,400	
					20	27.50	25,100	5
					27	27.30	23,900	5
	Guadalupe River basin							
5	Sandies Creek near Westhoff.	560	1864–1960	1936		33.1	93,300	
					27	24.78	13,300	2
6	Escondido Creek subwatershed 1 near Kenedy.	3.29	1954–60	1957			[1] 2,100	
					25		[2] 4,990	
7	Escondido Creek at Kenedy	82.2	1887–1960	1946		24.2	12,300	
					25	23.55	10,700	[3] 1.10
8	San Antonio River at Goliad.	3,918	1800–1960	1869		([4])	([5])	
			1869–1960	1942		44.9	33,800	
					29	31.62	11,300	3
	Mission River basin							
9	Mission River at Refugio	643	1899–1960	1942		33.3	41,700	
					17	26.60	7,440	2
					28	25.38	6,420	2
	Nueces River basin							
10	Nueces River at Three Rivers.	15,600	1875–1960	1919		46.0	85,000	
					26	29.04	7,610	
	Rio Grande basin							
11	Los Olmos Creek at Rio Grande City.	540			24		[6] 15,500	

[1] Inflow computed on basis of change in contents plus outflow for 15-minute interval—unadjusted for rainfall on pool surface.
[2] Inflow computed on basis of change in contents plus outflow for 15-minute interval—adjusted for rainfall on pool surface.
[3] Ratio of peak discharge to that of a 50-year flood.
[4] Several feet higher than for 1942 flood.
[5] Not determined.
[6] Estimated by International Boundary and Water Commission.

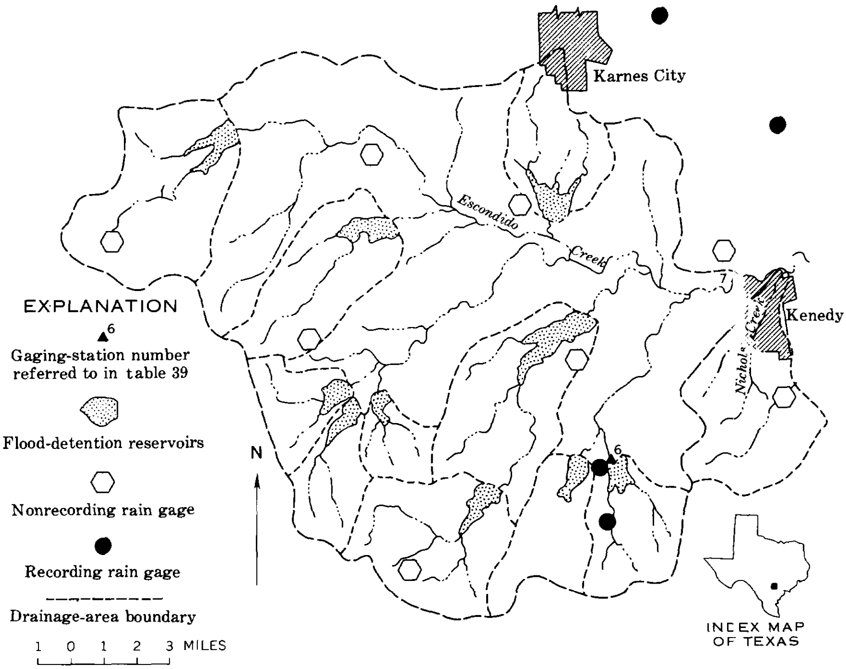

FIGURE 57.—Escondido Creek basin; location of flood-detention reservoirs and hydrologic instrument installations is shown.

The town of Kenedy in Karnes County was very heavily damaged when Escondido Creek and Nichols Creek overflowed and flooded almost the entire business district and numerous homes. Water was as much as 5 feet deep in some business establishments. Two persons were drowned. The flood was described by local residents as the most disastrous in the history of the town. Estimates of damage ranged from one-half to one million dollars.

Most of the damage in Kenedy was caused by Nichols Creek, a small ungaged tributary of Escondido Creek. Nichols Creek drains approximately 3.4 square miles and runs through the center of Kenedy; it enters Escondido Creek about 1.4 miles below the Geological Survey stream-gaging station on Escondido Ceek.

Escondido Creek, which runs along the outskirts of Kenedy, caused considerable damage when it reached its second highest stage since at least 1887. Escondido Creek at Kenedy has a drainage area of 82.2 square miles, of which 36.5 square miles is partly controlled by 10 flood-detention reservoirs. This flood would probably have exceeded the previous historical flood had not the present flood-detention reservoirs been in place. The watershed is well instrumented, as is shown in figure 57, and considerable rainfall and

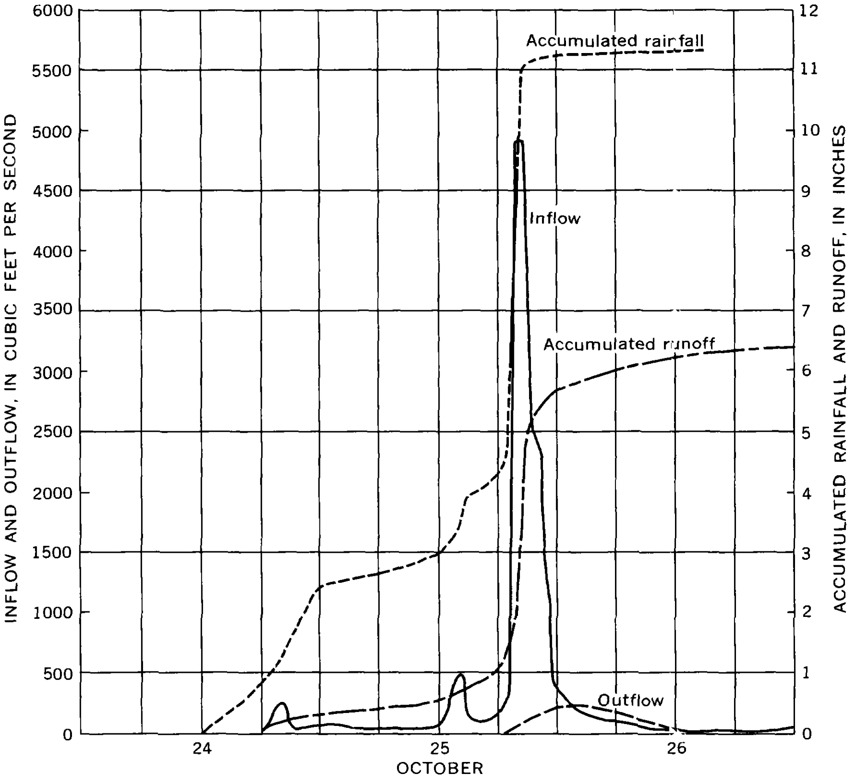

FIGURE 58.—Rainfall-runoff hydrographs for Escondido Creek subwatershed 1 near Kenedy, Tex., for October 24–26.

runoff data are available for this flood. Figures 58 and 59 illustrate the intensity and accumulation of rainfall, the resulting discharges, and total storm runoff.

The storm at Kenedy was centered near the San Antonio River–Mission River basin divide. Heavy rainfall from this storm fell on the headwaters of Medio Creek, an ungaged tributary to the Mission River. The resulting flash flood on Medio Creek flooded the town of Pettus in Bee County. Damage was caused to 20 business firms and 70 homes and to 1 mile of railroad track. Long-time residents stated that this flood was the most severe since at least 1903. Only minor flooding occurred on the Mission River farther downstream (table 39).

Heavy rains averaged 7–10 inches during the night of Ocotober 28–29 in south-central Texas, and they caused flash floods on many small streams. Heaviest amounts fell in the Austin area, where about 300 families were evacuated when creeks sent 4–6 feet of floodwater into homes and business establishments in low-lying sections. Damage in Austin was estimated at $2.5 million by the U.S. Weather Bureau. Waller Creek at Austin had its highest stage in 5 years of record, after the storm produced approximately 7.5 inches of rain in 7 hours. No damage was caused by the Waller Creek flood.

Eleven persons were drowned in the south-central Texas area when the flash floods swept cars from low-water crossings. Rises on main streams were moderate, and only minor flooding occurred.

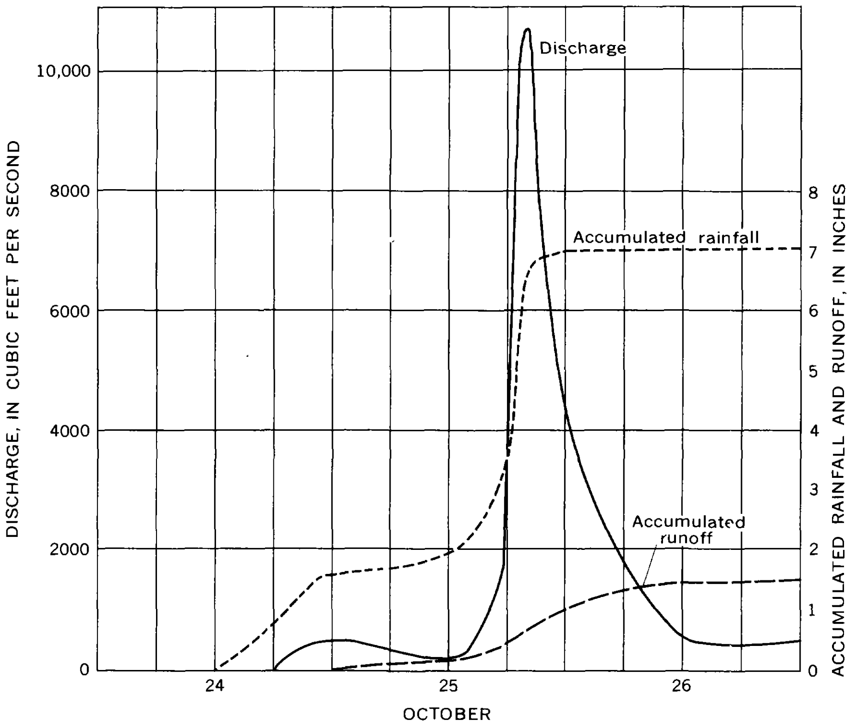

FIGURE 59.—Rainfall-runoff hydrographs for Escondido Creek at Kenedy, Tex., for October 24-26.

FLOODS OF NOVEMBER 24–25 IN NORTHWESTERN OREGON AND SOUTHERN WASHINGTON

Heavy general rains fell over western Oregon and Washington during November; monthly totals were as much as 33 inches. During the period November 23–25, amounts as much as 10.22 inches fell and caused severe flooding on November 24–25 in northwestern Oregon, principally in the Molalla, Clackamas, and Alsea River basins. High peaks also occurred in the Little White Salmon, Wind, and upper Lewis River basins of Washington (fig. 60). The peaks in the Lewis River basin were preceded by high peaks on November 17 and November 20

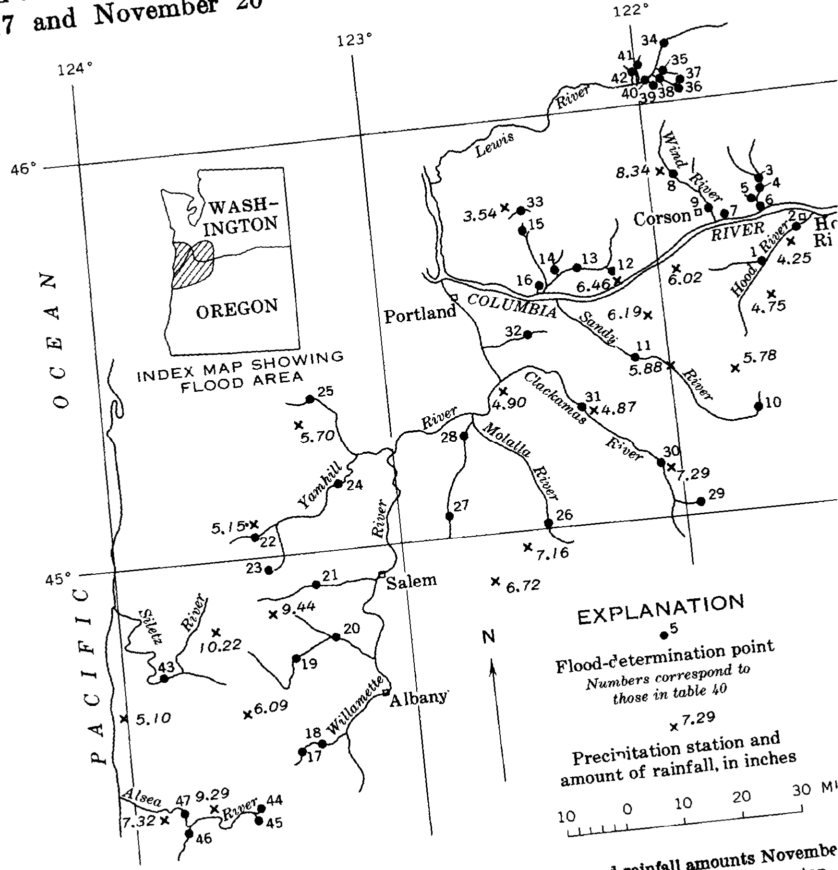

FIGURE 60.—Flood area; location of flood-determination points and rainfall amounts November shown. Floods of November 24-25 in northwestern Oregon and southern Washington.

Stages at Wind River near Carson, Molalla River above Pine Creek near Wilhoit, and Johnson Creek at Sycamore were the highest since records began in 1934, 1935, and 1940, respectively. Peak discharges on the Clackamas River were the highest since 1931 and the second or third highest of record. Alsea River near Tidewater was the highest since at least 1939. Several other gaging stations having short-term records had significant flood peaks and were the highest known to local residents (table 40).

Flooding was general along the Molalla and Clackamas Rivers. The town of Shady Dell in the Molalla River basin was designated a disaster area, and residents of 150 homes were temporarily evacuated. Johnson Creek, a small tributary to the Willamette River in Portland, Oreg., overflowed its banks, and 20 families east of 95th Street were evacuated from homes along the creek. The Molalla River cut the approaches to a bridge on U.S. Highway 99–E south of Canby, and many highways were closed or limited to one-way traffic because of overflow or slides.

No appreciable flood damage occurred in Washington, as most of the streams affected by this flood are confined to fairly deep canyons that are not subject to overflow.

TABLE 40.—*Flood stages and discharges, November 24–25, in Oregon and Washington*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to Nov. 1960: Period	Year	November	Gage height (ft)	Discharge (cfs)	Recurrence interval (yrs)
	Hood River basin							
1	West Fork Hood River near Dee, Oreg.	96	1913–16, 1932–60	1933		12.4	12,900	
						11.17	10,800	7
2	Hood River near Hood River, Oreg.	329	1913–60	1923		[1] 11.1	34,000	
					24		17,000	7
	Little White Salmon River basin							
3	Little White Salmon River at Willard, Wash.	114	1903–06, 1944–60	1946		9.50	4,140	
					24	9.38	3,930	10
4	Little White Salmon River above Lapham Creek near Willard, Wash.	117	1949–60	1953		5.98	3,610	
					24	6.28	4,330	13
5	Rock Creek near Willard, Wash.	4.10	1948–60	1949		13.16	428	
					24	11.32	283	3
6	Little White Salmon River near Cook, Wash.	134	1956–60	1957		5.78	2,170	
					24	7.51	5,210	
	Columbia River basin							
7	Columbia River tributary near Home Valley, Wash.	0.54	1949–60	1956		22.58	75.4	
					24	21.48	69	10

See footnotes at end of table.

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TABLE 40.—*Flood stages and discharges, November 24–25, in Oregon and Washington*—Continued

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to Nov. 1960: Period	Maximum floods: Prior to Nov. 1960: Year	Maximum floods: November	Maximum floods: Gage height (ft)	Maximum floods: Discharge (cfs)	Maximum floods: Recurrence interval (yrs)
	Wind River basin							
8	Wind River above Trout Creek near Carson, Wash.	108	1944–60	1945		15.5	8,880	
					24	15.23	8,400	17
9	Wind River near Carson, Wash.	225	1934–60	1937		17.30	20,000	
					24	18.78	26,400	35
	Sandy River basin							
10	Salmon River near Government Camp, Oreg.	8.7	1910–12, 1926–60	1956		3.95	682	
					24	4.04	447	6
11	Sandy River near Marmot, Oreg.	262	1911–60	1923		[2] 17.5	29,200	
					24	11.70	27,500	40
	Washougal River basin							
12	Canyon Creek near Washougal, Wash.	2.74	1948–60	1949		9.51	281	
					24	8.49	215	2
13	Washougal River near Washougal, Wash.	108	1944–60	1953		15.56	17,700	
					24	13.50	14,200	6
14	Little Washougal River near Washougal, Wash.	23.8	1951–60	1953		7.73	1,620	
					24	8.22	1,960	8
15	Shanghai Creek near Hockinson, Wash.	2.14	1949–60	1956		20.24	124	
					24	20.31	126	13
	Groeneveld Creek basin							
16	Groeneveld Creek near Camas, Wash.	0.51	1957–60	1958		4.72	46	
					24	4.79	47	7
	Willamette River basin							
17	Rock Creek near Philomath, Oreg.	14.6	1945–60	1955		6.82	2,190	
					24	5.32	1,360	8
18	Marys River near Philomath, Oreg.	159	1940–60	1955		20.83	8,660	
					24	20.75	8,380	6
19	Luckiamute River at Pedee, Oreg.	115	1940–60	1949		18.46	13,500	
					24	16.24	9,960	12
20	Luckiamute River near Suver, Oreg.	240	1905–11, 1937–60	1937		33.5	25,000	
					25	30.42	16,100	8
21	Rickreall Creek near Dallas, Oreg.	26.5	1957–60	1957		5.81	2,610	
					24	7.05	4,610	50
22	South Yamhill River near Willamina, Oreg.	133	1934–60	1949		14.80	15,200	
					24	13.47	13,500	6
23	Mill Creek near Willamina, Oreg.	27.4	1958–60	1959		7.77	2,560	
					24	9.38	4,160	30
24	South Yamhill River near Whiteson, Oreg.	502	1940–60	1955		45.25	36,800	
					25	43.50	29,500	13
25	North Yamhill River at Pike, Oreg.	66.8	1948–60	1955		12.42	9,530	
					24	8.87	4,810	7
26	Molalla River above Pine Creek near Wilhoit, Oreg.	97.0	1935–60	1948			12,200	
				1955		16.04		
					24	14.85	17,700	50
27	Pudding River near Mount Angel, Oreg.	204	1939–60	1949		30.38	15,000	
					25	29.75	10,800	15
28	Pudding River at Aurora, Oreg.	479	1923–60	1923		25.0	27,900	
					25	20.78	11,800	6
29	Clackamas River at Big Bottom, Oreg.	136	1920–60	1931, 1946.			6,750	
				1955		8.96		
					24	8.45	5,040	7

See footnotes at end of table.

TABLE 40.—*Flood stages and discharges, November 24–25, in Oregon and Washington*—Continued

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to Nov. 1960: Period	Maximum floods: Prior to Nov. 1960: Year	Maximum floods: November	Maximum floods: Gage height (ft)	Maximum floods: Discharge (cfs)	Maximum floods: Recurrence interval (yrs)
	Willamette River basin—Continued							
30	Clackamas River above Three Lynx Creek, Oreg.	479	1909–13, 1921–60	1931	----------	15.5	34,800	------
					24	15.18	[3] 34,600	15
31	Clackamas River at Estacada, Oreg.	671	1908–60	1931	----------	[4] 24.5	60,800	------
					24	14.82	55,200	28
32	Johnson Creek at Sycamore, Oreg.	28.2	1940–60	1949	----------	13.77	2,110	------
					24	13.78	2,180	26
	Lake River basin							
33	Salmon Creek near Battleground, Wash.	18.3	1943–60	1954	----------	4.02	1,500	------
					24	3.76	1,380	10
	Lewis River basin							
34	Lewis River near Trout Lake, Wash.	127	1958–60	1959	----------	23.63	4,610	------
					24	24.84	6,600	4
35	Big Creek below Skookum Meadow near Trout Lake, Wash.	13.2	1927–31, 1955–60	1931	----------	[5] 5.1	766	------
					24	4.92	696	5
36	Rush Creek above Meadow Creek near Trout Lake, Wash.	5.87	1955–60	1958	----------	3.08	640	------
					17	3.15	790	17
37	Meadow Creek below Lone Butte Meadow near Trout Lake, Wash.	11.7	1927–31, 1955–60	1956	----------	2.20	330	------
					24	2.70	435	19
38	Rush Creek above Falls near Cougar, Wash.	26.0	1927–31, 1955–60	1956	----------	3.69	846	------
					24	----------	995	10
					24	4.97	----------	------
39	Curly Creek near Cougar, Wash.	11.6	1955–60	1955	----------	3.25	417	------
					24	4.64	1,870	25
40	Lewis River above Muddy River near Cougar, Wash.	227	1927–34, 1954–60	1933	----------	10.6	27,000	------
					24	9.54	13,100	4
41	Muddy River below Clear Creek near Cougar, Wash.	131	1927–34, 1954–60	1933	----------	[5] 14.5	17,500	------
					24	6.88	5,980	4
42	Pine Creek near Cougar, Wash.	22.4	1957–60	1959	----------	4.06	921	------
					24	4.36	1,170	4
	Siletz River basin							
43	Siletz River at Siletz, Oreg.	202	1905–60	1921	----------	[5] 31.6	40,800	------
					24	22.12	29,100	5
	Alsea River basin							
44	North Fork Alsea River at Alsea, Oreg.	63.0	1955–60	1955	----------	13.30	12,000	------
					24	11.80	8,820	30
45	South Fork Alsea River near Alsea, Oreg.	49.5	1957–60	1959	----------	7.38	3,050	------
					24	9.33	4,340	8
46	Five Rivers near Fisher, Oreg.	114	1958–60	1959	----------	14.24	7,820	------
					24	20.06	15,700	18
47	Alsea River near Tidewater, Oreg.	334	1890–1960	1890	----------	29.5	(6)	------
			1939–60	1955	----------	23.80	32,200	------
					24	24.02	32,800	11

[1] At site within ½ mile at same datum.
[2] At site 1 mile upstream at different datum.
[3] Slightly affected by storage in Timothy Lake.
[4] At site 6.3 miles upstream at different datum.
[5] At different site and datum.
[6] Not determined.

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