Summary of Floods in the United States During 1961

By J. O. ROSTVEDT

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SUMMARY OF FLOODS IN THE UNITED STATES DURING 1961

By J. O. Rostvedt

ABSTRACT

This report describes the most outstanding floods in the United States during 1961. The most damaging floods during the year were those caused by snowmelt in March and April in the upper Mississippi River basin and those accompanying Hurricane Carla in September.

Hurricane Carla traveled northward along the east edge of Texas and then northeastward through southeastern Oklahoma, northwestern Arkansas, southeastern Missouri, and central Illinois. Heavy rains and floods occurred east of the hurricane's path in Texas and west of its path for the remainder of its journey.

Mississippi, Alabama, and Georgia had moderate to severe floods in February and March from a series of large-area rainstorms. Many maximum peak discharges occurred, and streams remained at high stages for periods longer than any known before. Property damage was high and four lives were lost.

Extensive flooding took place in May from southeastern Kansas and northeastern Oklahoma through northern Arkansas, southern Missouri, northern Kentucky, and the southern parts of Illinois, Indiana, and Ohio. Maximum discharges occurred at many sites throughout the area.

Heavy flooding was experienced on Kootenai River at Bonners Ferry, Idaho, in May and June. These floods were noteworthy for their duration.

The most tragic flood of the year was in July in Charleston, W. Va. A small-area cloudburst flood caused 22 deaths and damage of more than $1 million.

Severe flooding occurred in December in the Tombigbee River, Pearl River, and Pascagoula River basins in Mississippi, Louisiana, and Alabama. Much damage resulted, and from two to three thousand persons were evacuated from large flooded areas.

In addition to the floods mentioned above, 19 others of lesser magnitude are considered important enough to be included in this annual summary.

INTRODUCTION

This report summarizes information on outstanding floods in the United States during 1961. The floods selected were unusual hydrologic events in which large areas were affected, great damage resulted, or record-high discharges or stages occurred.

The areas for which flood events in 1961 are described are shown in figure 1 along with the months in which the floods occurred; figure 1 therefore gives the location and the time distribution of floods during the year. Of the 26 floods during the year, 13 are small-area floods in July and August.

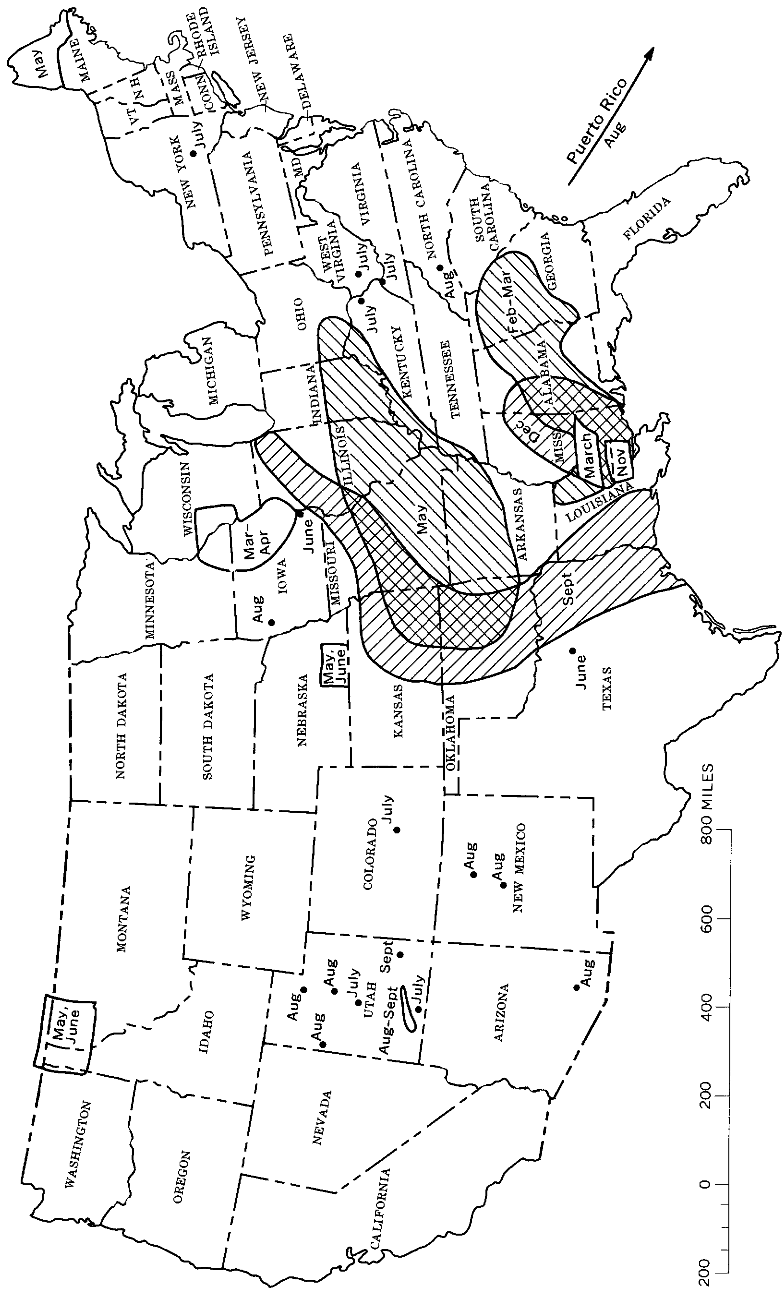

FIGURE 1.—Map of conterminous United States showing areas and months of occurrence of outstanding floods in 1961.

A flood is any high streamflow which overtops natural or artificial banks of a stream. By popular definition a flood is a newsworthy discharge or a stage of extremely high magnitude inundating large areas and causing 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 often be 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 physiographic characteristics of a basin. The principal physiographic factors affecting floodflows are: drainage area, altitude, geology, and basin shape, slope, aspect, and vegetative cover. With the exception of vegetative cover, which varies seasonally, the factors are fixed for any area.

Meteorological factors, of which precipitation is the principal one, are variable with respect to both place and time. Other meteorological factors influencing floods are: form of the precipitation, whether rain, snow, hail, or sleet; amount and intensity of the precipitation; moisture conditions of the soil antecedent to the flood-producing precipitation; and temperature which may cause frozen soil or determine the rate of snowmelt.

In general, meteorological conditions determine when and where the floods will be. The combination of magnitude and intensity of meteorological factors and the effect of inherent physiographic features on runoff determine what the magnitude of a flood will be.

Many different and variable factors form innumerable combinations to produce floods of all degrees of severity. Of two floods with equal peak discharges from different size drainage areas, if both sites are assumed to have similar runoff and climatologic characteristics, the one from the smallest drainage area would be the rarer or more outstanding flood. Also, of two floods having equal discharges from equal drainage areas, the rarer flood would be that at the site having geographic and climatologic characteristics which normally produce the smaller flood peak.

The severity and prevalence of floods are not wholly determined by the absolute values of the contributing factors—amount and intensity of rainfall, peak discharge in cubic feet per second (cfs), volume of runoff, ratio of runoff to rainfall, and many others—but are greatly influenced by the values of these factors relative to normal conditions.

Although losses from floods in the United States during 1961 ($154 million) were relatively small, they were about 65 percent greater than in 1960 ($93 million) and slightly greater than in 1959 ($141 million). They were about 45 percent of the national annual average of $350 million, based on the 10-year period 1949–58, adjusted to the 1958 price index.

Total loss of life owing to floods in 1961 was 52 compared with 32 in 1960 and 25 in 1959. It was much less than the national annual average of 81 lives during the 37-year period 1925–61.

Many of the flood reports give the amount of rainfall and the duration of the storm producing the rain. Recurrence intervals of these storms may be determined from the U.S. Weather Bureau (1961), or from a simplified set of isopluvial maps and charts contained in a report by Rostvedt (1965).

Continuing investigation of surface-water resources in the areas covered by 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 were obtained from U.S. Weather Bureau publications.

Collection of data, 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.

DETERMINATION OF FLOOD STAGES AND DISCHARGES

Data concerning peak stages and discharges at discharge stations in this report are those which are obtained and compiled in regular procedures 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 a known stage. The relation at a station is usually defined by current-meter measurements through as much of the range of stage as possible. However, 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 which are greatly above the range of the stage-discharge relation at gaging stations, and peak discharges at miscellaneous sites are generally determined by various methods of indirect measurement. During major floods adverse conditions often make it impossible to obtain current-meter measurements at some sites. Peak discharges are then measured by indirect methods, after the flood has subsided, based on detailed surveys of selected channel reaches. A general description of these indirect methods is given by Corbett and others (1943), and more detailed descriptions with illustrated examples are contained in reports by Johnson (1936) and Dalrymple (1937, 1939).

EXPLANATION OF DATA

The floods described herein are in chronological order. Because characteristics and amount of information differ for each flood, no consistent form is used to report each event.

The data include: a description of the storm, the flood, and the flood damage; a map of the flood area showing the location of flood-determination points, and for some storms the location of precipitation stations or isohyets; rainfall amounts and intensities; and flood-peak stages and discharges of 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 show daily or storm totals. When sufficient data are available to determine the pattern and distribution of rainfall, an isohyetal map may be shown.

A summary table of peak stages and discharges is given for each flood unless the number of stations in the report is small, and then 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 1961 floods. This period does not necessarily correspond to that in which continuous records of discharge were obtained, but many periods extend 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. A second period of known floods is then 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 1961 floods.

The last column gives recurrence intervals for the 1961 peak discharges. The recurrence interval is the average interval, in years, in which a flood of a given magnitude (the 1961 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 tables were obtained from U.S. Geological Survey reports on flood magnitude and frequency.

In nearly all the flood-frequency reports used, the data available limit the determination of recurrence intervals to periods of 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 1961

FLOODS OF FEBRUARY TO MARCH IN THE SOUTHEASTERN STATES

A succession of low pressure systems originating in the Gulf of Mexico moved northward and northeastward during the period February 16–26. Associated squall lines caused extreme variations in intensity and in total precipitation during the storm periods.

On February 17, rain in the amount of 7–9 inches fell in an area from Bogalusa, La., northeastward through Purvis, Hattiesburg, and Shubuta, Miss., and into southwestern Alabama. During the period February 18–20, following this heavy burst of rain, 1–3 inches of rain fell rather steadily over a wider area. Totals for February 17–20 are shown on the isohyetal map, (fig. 2).

On February 21 and 22 up to 8 inches of rain fell in a band parallel to that of the February 17 burst and roughly 50–100 miles north of it. The band extended from Amite, La., through Columbia, Collins, and Meridian, Miss., and through Tuscaloosa and Birmingham, Ala., into the northeastern part of Alabama. Small amounts of rain fell following this second intense burst. Totals for February 20–23 are shown on the isohyetal map, (fig. 3).

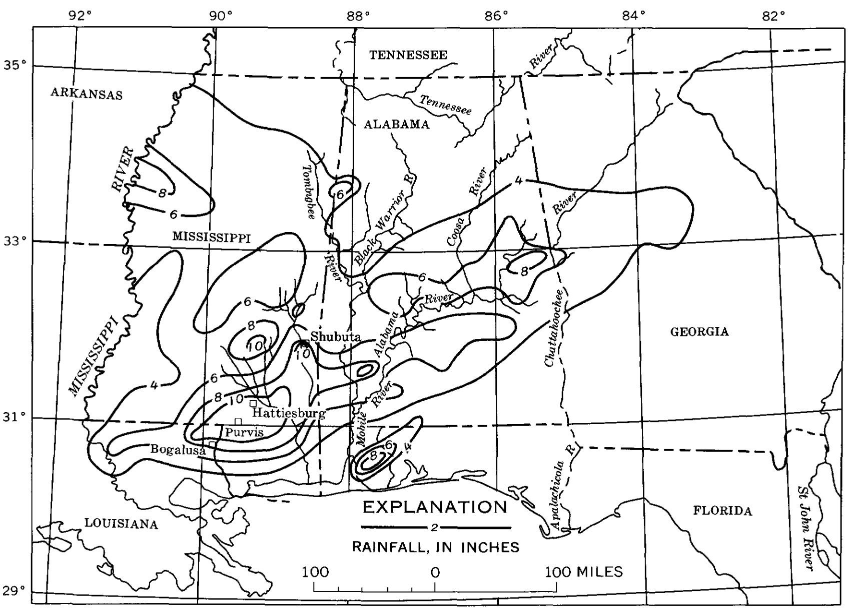

FIGURE 2.—Isohyetal map of Southeastern States showing storm rainfall, February 17–20.

On February 24 and 25 heavy rains centered along a line parallel to the first two storm areas but east of them. The band extended from southwestern Alabama through Greenville, Montgomery, and Lafayette, Ala., to Atlanta, Ga. Totals for February 23–26 are shown on the isohyetal map (fig. 4).

The rapid succession of three heavy storms totaled more than 18 inches of rain in southeastern Lousiana and Mississippi and in central and southern Alabama (fig. 5).

The isohyetal maps are necessarily generalized because of the extreme variations of intensity and accumulation. They serve, however, to emphasize the features of the three storms in relation to the resulting floods.

Prior to the floods, January streamflow was appreciably below the median in a wide band in central Mississippi, in most of Alabama, and in northern Georgia. Louisiana runoff was almost normal or above.

Figure 6 shows the area of flooding and the points at which peak stages and discharges were determined. Table 1 is a summary of the peak stages and discharges.

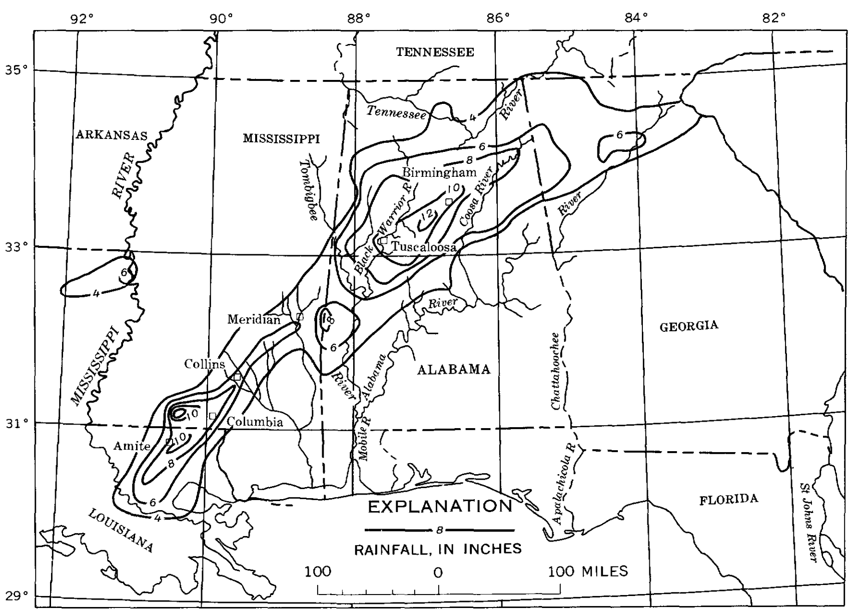

FIGURE 3.—Isohyetal map of Southeastern States showing storm rainfall, February 20–23.

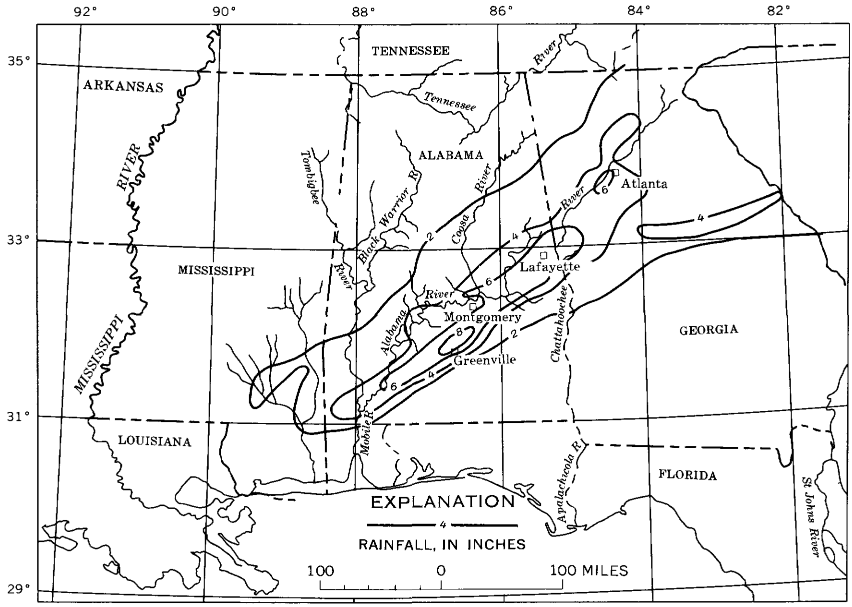

FIGURE 4.—Isohyetal map of Southeastern States showing storm rainfall, February 23–26.

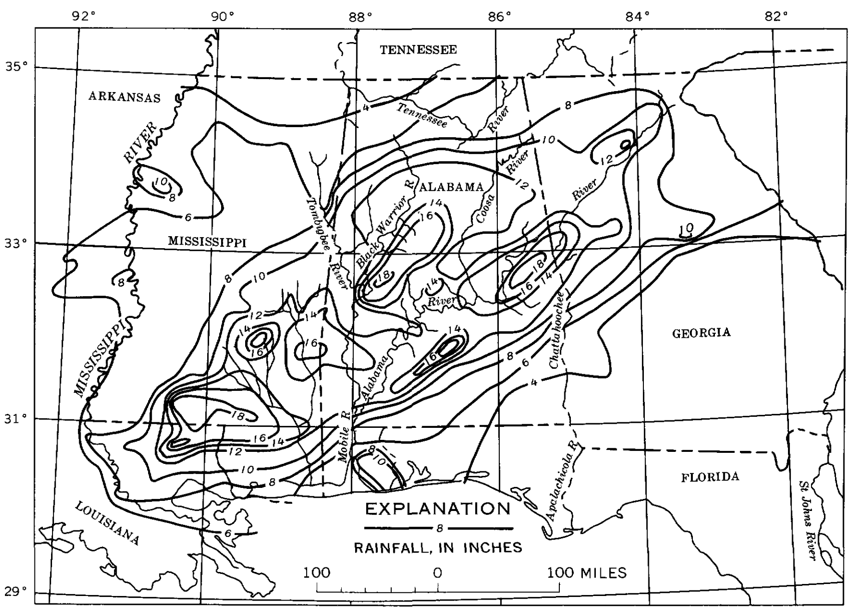

FIGURE 5.—Isohyetal map of Southeastern States showing storm rainfall, February 17–26.

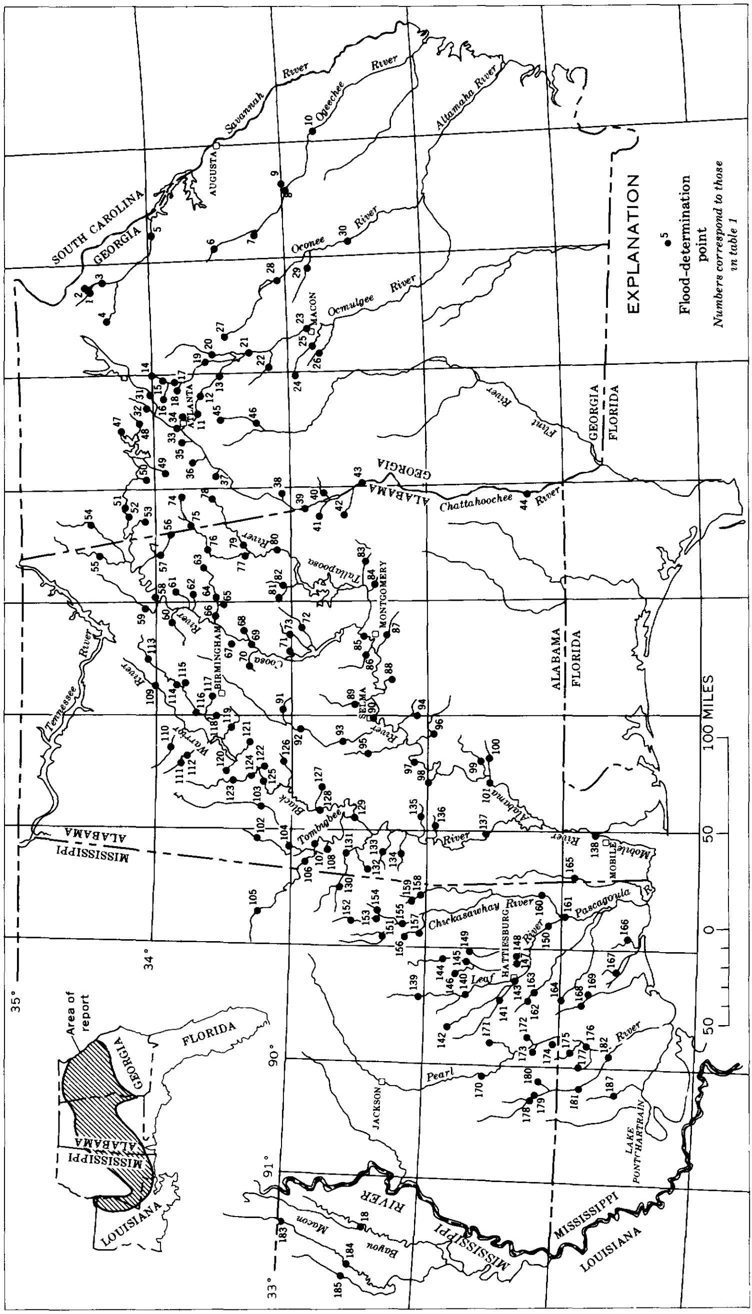

FIGURE 6.—Location of flood-determination points, floods of February to March in the Southeastern States.

TABLE 1.—*Flood stages and discharges, February to March in Southeastern States*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to February 1961: Period	Prior to February 1961: Year	February–March 1961	Gage height (feet)	Discharge: Cfs	Discharge: Recurrence interval (years)
	Savannah River basin							
1	North Fork Broad River near Lavonia, Ga.	42.0	1933	1933		17.5	[1]	
			1954–61	1955		11.80	1,500	
					Feb. 21	11.5	1,770	2
2	Toms Creek near Martin, Ga.	10.3	1954–61	1956		8.41	726	
					Feb. 21	8.40	1,180	
3	North Fork Broad River near Carnesville, Ga.	119	1942–44, 1954–61	1943		7.6	4,700	
					Feb. 21	14.6	11,400	13
4	Hudson River at Homer, Ga.	46	1950–61	1954		11.04	3,170	
					Feb. 21	12.2	3,750	5
5	Broad River near Bell, Ga.	1,430	1926–32, 1937–61	1929		34.8	79,400	
					Feb. 23	23.0	24,300	2
	Ogeechee River basin							
6	South Fork Ogeechee River near Crawfordville, Ga.	33	1948	1948		17.13	[1]	
			1951–61	1953		13.72	2,380	
					Feb. 25	14.25	2,580	7
7	Little Ogeechee River near Hamburg, Ga.	55	1951–61	1953		6.13	2,340	
					Feb. 25	7.37	4,070	[2] 1.21
8	Ogeechee River near Louisville, Ga.	800	1929	1929		21.3	46,000	
			1937–61	1940		17.6	20,600	
					Feb. 25	17.0	17,000	6
9	Big Creek near Louisville, Ga.	95.8	1951–61	1960		5.27	640	
					Feb. 25	4.46	426	1
10	Ogeechee River at Scarboro, Ga.	1,940	1929	1929		17.0	[1]	
			1937–61	1940		12.8	24,600	
				1944				
					Mar. 3,4	11.2	15,500	3
	Altamaha River basin							
11	South River at Atlanta, Ga.	41.5	1951–61	1960		9.79	5,700	
					Feb. 25	11.09	8,000	[2] 1.58
12	South River near Atlanta, Ga.	99	1951–61	1956		13.71	6,930	
					Feb. 25	21.30	12,500	[2] 1.48
13	South River near McDonough, Ga.	456	1940–61	1946		24.7	34,500	
					Feb. 25	25.4	29,500	[2] 1.7
14	Wildcat Creek near Lawrenceville, Ga.	1.59	1954–61	1956		8.20	806	
					Feb. 25	4.96	330	
15	Pew Creek near Lawrenceville, Ga.	2.23	1954–61	1956		6.96	615	
					Feb. 25	6.35	532	
16	Shetley Creek near Norcross, Ga.	.98	1954–61	1956		7.00	610	
					Feb. 21	10.4	[3] 2,320	
17	Yellow River near Snellville, Ga.	134	1942–61	1948		19.4	9,500	
					Feb. 25	19.1	9,080	14
18	Garner Creek near Snellville, Ga.	5.54	1954–61	1956		3.09	754	
					Feb. 25	4.3	1,630	
19	Yellow River near Covington, Ga.	378	1936	1936		29.9	[1]	
			1945–61	1948		20.3	16,200	
					Feb. 26	19.1	13,100	9
20	Alcovy River below Covington, Ga.	244	1887	1887		27.2	12,400	
			1919, 1929–32, 1936, 1945–61.	1919		23.0	9,460	
					Feb. 26	16.88	5,540	3
21	Ocmulgee River near Jackson, Ga.	1,420	1919	1919		26.8	69,000	
			1906–15, 1939–61.	1948		23.9	56,600	
					Feb. 25	20.1	43,100	9
22	Towaliga River near Forsyth, Ga.	315	1929–31	1929		[1]	[4] 15,900	
			1945–61	1949		20.9	13,200	
					Feb. 26	17.99	9,500	5
23	Ocmulgee River at Macon, Ga.	2,240	1893–1913, 1929–61.	1948		28.0	83,500	
					Feb. 26	24.1	48,200	5

See footnotes at end of table.

TABLE 1.—*Flood stages and discharges, February to March in Southeastern States*—Continued

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to February 1961: Period	Maximum floods: Prior to February 1961: Year	Maximum floods: February–March 1961	Maximum floods: Gage height (feet)	Maximum floods: Discharge: Cfs	Maximum floods: Discharge: Recurrence interval (years)
	Altamaha River basin—Continued							
24	Little Tobesofkee Creek near Forsyth, Ga.	16.8	1953	1953		10.7	(1)	
					Feb. 25	10.6	3,970	
25	Tobesofkee Creek near Macon, Ga.	182	1937–61	1944		23.2	9,830	
					Feb. 25	20.3	7,390	8
26	Echeconnee Creek near Macon, Ga.	147	1938–43, 1951–61	1953		15.0	15,000	
					Feb. 25	13.4	9,840	32
27	Murder Creek near Monticello, Ga.	24	1952–61	1959		7.64	2,510	
					Feb. 25	6.95	2,060	6
28	Oconee River at Milledgeville, Ga.	2,950	1886	1886		46.7	(1)	
			1903–61	1928		38.7	95,000	
					Feb. 25	42.9	122,000	[2] 1.02
29	Commissioner Creek at Toomsboro, Ga.	191	1928	1928		22.5	(1)	
			1949–61	1949		19.5	5,950	
					Feb. 25	19.0	5,100	30
30	Oconee River at Dublin, Ga.	4,400	1893–1961	1936		32.97	96,700	
					Feb. 28	28.4	60,400	5
	Apalachicola River basin							
31	Chattahoochee River near Roswell, Ga.	1,320	1941–61	1946		23.4	56,000	
					Feb. 25	10.4	[5] 12,300	
32	Big Creek near Alpharetta, Ga.	72			Feb. 21	12.54	5,800	22
33	Chattahooche River at Atlanta, Ga.	1,450	1928–31, 1936–61	1946		28.0	59,000	
					Feb. 25	18.3	[5] 24,900	
34	Peachtree Creek at Atlanta, Ga.	86.8	1958–61	1959		14.2	4,300	
					Feb. 25	17.1	5,860	16
35	Sweetwater Creek near Austell, Ga.	246	1916	1916		20.0	12,600	
			1904–05, 1913, 1937–61.	1948		18.4	10,400	
					Feb. 26	18.2	10,100	10
36	Dog River near Douglasville, Ga.	43	1951–61	1956		14.36	7,360	
					Feb. 25	16.15	9,910	[2] 1.90
37	Snake Creek near Whitesburg, Ga.	37	1954–61	1956		12.8	6,110	
					Feb.. 25	14.4	7,690	[2] 1.59
38	Yellowjacket Creek near La Grange, Ga.	182	1951–61	1956			7,140	
				1957		13.36		
					Feb. 25	22.5	21,600	[2] 1.71
39	Chattahoochee River at West Point, Ga.	3,550	1896–1961	1919		29.25	134,000	
					Feb. 26	24.9	94,400	12
40	MountainCreek near Hamilton, Ga.	61.7	1943–61	1948		(1)	11,800	
					Feb. 25	6.80	5,200	22
41	Osanippa Creek near Fairfax, Ala.	101	1953–61	1956		11.7	7,100	
					Feb. 25	16.08	12,800	[2] 1.17
42	Phelps Creek near Opelika, Ala.	7.47	1958–61	1960		8.13	509	
					Feb. 24	8.81	680	
43	Chattahoochee River at Columbus, Ga.	4,670	1912, 1929–61	1929		53.2	198,000	
					Feb. 26	47.8		
					Feb. 26		145,000	18
44	Chattahoochee River at Columbia, Ala.	8,040	1928–61	1929		56.05	203,000	
					Mar. 1	47.9	110,000	6
	Flint River basin							
45	Camp Creek near Fayetteville, Ga.	17.2			Feb. 25	9.90	4,000	
46	Flint River near Griffin, Ga.	272	1929	1929		17.9	15,300	
			1937–61	1948		18.0	13,200	
					Feb. 26	16.18	11,100	13

See footnotes at end of table.

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TABLE 1.—*Flood stages and discharges, February to March in Southeastern States*—Continued

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to February 1961 — Period	Maximum floods: Prior to February 1961 — Year	Maximum floods: February–March 1961	Maximum floods: Gage height (feet)	Maximum floods: Discharge — Cfs	Maximum floods: Discharge — Recurrence interval (years)
	Mobile River basin							
47	Etowah River at Canton Ga.	605	1891–1961	1946	--------	26.7	[6] 29,800	--------
					Feb. 26	23.2	19,300	8
48	Little River near Roswell, Ga.	60.5	1946–61	1946	--------	18.0	5,000	--------
					Feb. 21	15.6	4,040	15
49	Pumpkinvine Creek below Dallas, Ga.	40	1951–61	1954	--------	15.64	2,970	--------
					Feb. 21	20.28	6,800	[2] 1.18
50	Hills Creek near Taylorsville, Ga.	26	1959–61	1960	--------	7.98	624	--------
					Feb. 21	10.40	3,000	12
51	Etowah River at Rome, Ga.	1,810	1904–21, 1938–61.	1919	--------	([1])	55,000	--------
					Feb. 22	--------	[5] 23,700	--------
					Feb. 25	30.39	--------	--------
52	Coosa River near Rome, Ga.	4,040	1886	1886	--------	43	100,000	--------
			1914–61	1916	--------	([1])	65,500	--------
					Feb. 26	30.2	39,000	2
53	Cedar Creek near Cedartown, Ga.	109	1886–1961	1948	--------	16.4	[6] 8,820	--------
					Feb. 21	16.2	8,400	9
54	Chattooga River at Summerville, Ga.	193	1937–61	1951	--------	21.0	24,500	--------
					Feb. 23	16.4	8,220	3
55	Little River near Jamestown, Ala.	120	1929–32, 1936–61.	1948	--------	12.9	21,800	--------
					Feb. 22	7.55	7,470	1
56	Little Terrapin Creek near Borden Springs, Ala.	15.9			Feb. 21	8.24	1,620	--------
57	Terrapin Creek near Piedmont, Ala.	115	1944–61	1948	--------	13.3	21,000	--------
					Feb. 21	12.00	14,000	15
58	Coosa River at Gadsden, Ala.	5,800	1886	1886	--------	37.9	115,000	--------
			1926–61	1936	--------	31.13	76,900	--------
					Feb. 26	30.61	74,800	17
59	Big Willis Creek near Crudup, Ala.	185	1884	1884	--------	16.3	([1])	--------
			1943–61	1951	--------	14.5	14,800	--------
					Feb. 23	11.56	6,310	2
60	Big Canoe Creek near Gadsden, Ala.	256	1937–61	1942	--------	29.1	37,900	--------
					Feb. 23	23.58	19,400	7
61	Ohatchee Creek at Reads, Ala.	44.2	1957–61	1957	--------	9.1	2,290	--------
					Feb. 21	11.88	([1])	--------
62	Tallahatchee Creek near Wellington, Ala.	88.6	1956–61	1958	--------	15.2	3,480	--------
					Feb. 21	17.06	([1])	--------
63	Choccolocco Creek at Choccolocco, Ala.	129	1956–61	1957	--------	11.95	6,860	--------
					Feb. 21	10.88	4,400	2
64	Choccolocco Creek near Jenifer, Ala.	281	1903–08, 1929–32, 1935–61.	1936	--------	17.2	21,900	--------
					Feb. 22	15.12	15,800	4
65	Cheaha Creek near Talladega, Ala.	72	1951–53, 1955–61	1951	--------	20.2	16,000	--------
					Feb. 22	16.32	7,000	16
66	Choccolocco Creek near Lincoln, Ala.	499	1886	1886	--------	27.5	([1])	--------
			1939–61	1951	--------	25.5	49,300	--------
					Feb. 22	22.09	25,700	13
67	Kelly Creek near Vincent, Ala.	192	1951–61	1955	--------	20.86	10,500	--------
					Feb. 22	27.08	30,900	34
68	Talladega Creek at Alpine, Ala.	148	1939–61	1951	--------	16.6	39,000	--------
					Feb. 22	14.63	10,200	2
69	Coosa River at Childersburg, Ala.	8,390	1914–61	1951	--------	30.1	146,000	--------
					Feb. 23	30.41	140,000	27
70	Yellowleaf Creek near Wilsonville, Ala.	97.2	1950–61	1951	--------	23.85	19,300	--------
					Feb. 21	25.2	26,700	[2] 1.59
71	Paint Creek near Marble Valley, Ala.	13.5	1959–61	1960	--------	4.26	424	--------
					Feb. 25	5.13	816	--------
72	Hatchet Creek near Rockford, Ala.	244	1944–61	1946	--------	24.9	22,800	--------
					Feb. 25	17.83	9,660	2
73	Weogufka Creek near Weogufka, Ala.	73.6	1951–61	1951	--------	16.8	24,200	--------
					Feb. 25	10.92	3,130	--------
74	Little River near Buchanan, Ga.	18	1959–60	1960	--------	6.05	780	--------
					Feb. 21	12.47	3,710	--------

See footnotes at end of table.

TABLE 1.—*Flood stages and discharges, February to March in Southeastern States*—Continued

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to February 1961: Period	Maximum floods: Prior to February 1961: Year	Maximum floods: February-March 1961	Maximum floods: Gage height (feet)	Maximum floods: Discharge: Cfs	Maximum floods: Discharge: Recurrence interval (years)
	Mobile River basin—Continued							
75	Tallapoosa River at Tallapoosa, Ga.	237	1936, 1948, 1951–61.	1948		27.4	20,000	
					Feb. 21	24.70	11,500	36
76	Tallapoosa River near Heflin, Ala.	444	1952–61	1957		21.4	9,140	
					Feb. 22	26.39	19,300	9
77	Tallapoosa River near Ofelia, Ala.	787	1939–58, 1960–61.	1948		16.2	24,500	
					Feb. 23	15.42	22,400	4
78	Little Tallapoosa River at Carrollton, Ga.	89	1936, 1938–61	1948		19.3	6,010	
					Feb. 25	14.5	3,580	5
79	Little Tallapoosa River near Wedowee, Ala.	592	1941–61	1948		20.8	20,800	
					Feb. 25	22.58	25,500	11
80	Tallapoosa River at Wadley, Ala.	1,660	1923–61	1936		(1)	52,800	
					Feb. 25	25.35	45,500	6
81	Harbuck Creek near Hackneyville, Ala.	6.7	1950–61	1955		8.9	(1)	
					Feb. 25	3.80	745	
82	Hillabee Creek near Hackneyville, Ala.	196	1952–61	1957		25.7	15,600	
					Feb. 25	20.97	9,270	2
83	Uphapee Creek and Tuskegee, Ala.	330	1929	1929		29.3	(1)	
			1939–61	1943		27.33	29,600	
					Feb. 25	25.82	25,500	7
84	Calebe Creek near Tuskegee, Ala.	126	1952–61	1958		17.4	23,000	
					Feb. 25	16.54	14,200	10
85	Alabama River near Montgomery, Ala.	15,100	1886	1886		62.7	(1)	
			1888	1888		60.6	274,000	
			1927–61	1929		59.6	256,000	
					Feb. 26		283,000	[2] 1.08
					Feb. 27	60.65		
86	Autauga Creek at Prattville, Ala.	109	1919, 1939–61	1919		18.8	23,000	
					Feb. 25	6.03	3,800	4
87	Catoma Creek near Montgomery, Ala.	298	1948	1948		27.5	32,000	
			1952–61	1958		25.7	25,600	
					Feb. 25	28.65	48,600	22
88	Big Swampy Creek near Lowndesboro, Ala.	247	1937–38, 1940–61	1948		21.3	37,000	
					Feb. 25	20.10	30,300	6
89	Mulberry Creek at Jones, Ala.	208	1938–61	1938		33.6	48,000	
					Feb. 25	9.99	5,340	1
90	Alabama River at Selma, Ala.	17,100	1886	1886		57.0	221,000	
			1900–13, 1928–61	1929			204,000	
				1948		56.0		
					Mar. 1	57.97	284,000	[2] 1.28
91	Little Cahaba River near Brierfield, Ala.	148	1957–61	1958		12.10	3,860	
					Feb. 21	21.07	10,000	3
92	Cahaba River at Centerville, Ala.	1,029	1901–08, 1929–32,	1938		36.63		
			1935–61	1951			83,600	
					Feb. 23	35.35	82,200	36
93	Cahaba River near Marion Junction, Ala.	1,780	1939–54	1939		42.95	83,400	
					Feb. 24	43.80	(1)	
94	Cedar Creek at Minter, Ala.	217	1952–61	1956		21.5	14,100	
					Feb. 25	24.58	45,600	[2] 2.55
95	Bogue Chitto Creek near Browns, Ala.	104	1942	1942		20.7	(1)	
			1944–61	1951		19.0	14,200	
					Feb. 22	15.75	5,540	1
96	Prairie Creek near Oakhill, Ala.	9.73	1959–61	1960		12.32	1,320	
					Feb. 24	14.15	1,690	
97	Alabama River near Millers Ferry, Ala.	20,700	1929	1929		56.8	238,000	
			1937–54	1938		56.6	237,000	
					Mar. 3	60.0	284,000	[2] 1.07
98	Turkey Creek at Kimbrough, Ala.	114	1958–61	1960		19.90	7,310	
					Feb. 18	19.64	7,200	10
99	Flat Creek at Fountain Ala.	245	1944–61	1948		23.2	26,000	
					Feb. 25	22.00	21,300	11
100	Limestone Creek near Monroeville, Ala.	117	1929	1929		22	(1)	
			1951–61	1955		11.50	9,770	
					Feb. 25	16.28	30,600	

See footnotes at end of table.

TABLE 1.—*Flood stages and discharges, February to March in Southeastern States*—Continued

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to February 1961: Period	Maximum floods: Prior to February 1961: Year	Maximum floods: February–March 1961	Maximum floods: Gage height (feet)	Maximum floods: Discharge: Cfs	Maximum floods: Discharge: Recurrence interval (years)
	Mobile River basin—Continued							
101	Alabama River at Claiborne, Ala.	22,000	1929–61	1929	--------	54.6	270,000	--------
					Mar. 7	55.15	--------	--------
					Mar. 7	--------	267,000	[2] 1.04
102	Lubbub Creek near Carrollton, Ala.	116	1954–61	1960	--------	9.27	2,720	--------
					Feb. 22	11.97	8,210	3
103	Sipsey River near Elrod, Ala.	518	1928–32, 1939–61	1950	--------	18.1	21,000	--------
				1951	--------	--------	--------	--------
					Feb. 23	18.83	27,800	10
104	Sipsey River near Pleasant Ridge, Ala.	753	1939–59	1951	--------	[1]	21,900	--------
					Feb. 25	[1]	31,700	8
105	Noxubee River near Brooksville, Miss.	440	1940–61	1951	--------	23.88	55,000	--------
					Feb. 22	20.53	12,800	--------
106	Noxubee River near Geiger, Ala.	1,140	1939–40, 1944–61	1951	--------	42.7	37,600	--------
					Feb. 24	40.33	24,100	--------
107	Tombigbee River at Gainesville, Ala.	8,700	1938–61	1949	--------	53.9	168,000	--------
					Feb. 2[illegible]	--------	115,000	6
					Feb. 28	50.90	--------	--------
108	Jones Creek near Epes, Ala.	11.7	1959–61	1959	--------	13.11	1,530	--------
					Feb. 21	21.46	5,160	--------
109	Mulberry Fork near Garden City, Ala.	368	1928–61	1936	--------	24.0	46,600	--------
					Feb. 22	18.54	28,500	4
110	Blackwater Creek near Manchester, Ala.	188	1938–61	1946	--------	11.49	8,050	--------
					Feb. 23	13.10	10,600	2
111	Lost Creek near Jasper, Ala.	112	1950–61	1951	--------	24.8	11,600	--------
					Feb. 23	24.75	11,500	4
112	Lost Creek near Oakman, Ala.	130	1951–61	1957	--------	24.9	7,350	--------
					Feb. 22	30.73	19,400	13
113	Locust Fork below Snead, Ala.	147	1950–61	1954	--------	25.1	7,750	--------
					Feb. 22	29.65	12,100	3
114	Locust Fork at Trafford, Ala.	625	1908	1908	--------	60	[1]	--------
			1930–61	1949	--------	59.1	60,700	--------
					Feb. 23	53.38	47,000	6
115	Turkey Creek at Morris, Ala.	81.5	1944–61	1948	--------	23.1	14,300	--------
					Feb. 21	21.88	13,000	10
116	Locust Fork at Sayre, Ala.	887	1928–32, 1942–61	1949	--------	47.9	55,300	--------
					Feb. 23	48.60	54,700	4
117	Fivemile Creek at Ketona, Ala.	22.8	1953–61	1959	--------	6.5	1,300	--------
					Feb. 21	10.37	[1]	--------
118	Village Creek near Adamsville, Ala.	84.1	1953–61	1955	--------	13.38	6,020	--------
					Feb. 22	19.04	13,800	12
119	Valley Creek near Oak Grove, Ala.	145	1936, 1953–61	1954	--------	20.7	8,570	--------
					Feb. 21	28.86	23,000	20
120	Blue Creek near Oakman, Ala.	5.7	1959–61	1959	--------	4.50	887	--------
					Feb. 21	7.16	3,820	--------
121	Davis Creek below Abernant, Ala.	45.2	1956–61	1957	--------	11.1	2,630	--------
					Feb. 21	18.30	5,800	--------
122	Hurricane Creek near Holt, Ala.	108	1951–61	1951	--------	19.6	[1]	--------
			1952–61	1956	--------	14.64	8,380	--------
					Feb. 21	22.33	16,800	12
123	North River near Samantha, Ala.	220	1936	1936	--------	31	[1]	--------
			1939–61	1951	--------	30.7	18,000	--------
					Feb. 22	30.32	17,600	6
124	North River near Tuscaloosa, Ala.	366	1916	1916	--------	30.9	[1]	--------
			1951–61	1955	--------	18.43	--------	--------
				1960	--------	--------	11,500	--------
					Feb. 22	33.10	27,200	18
125	Black Warrior River at Tuscaloosa, Ala.	4,828	1889–1905, 1928–61	1900	--------	67.7	--------	--------
				1951	--------	--------	223,000	--------
					Feb. 21	--------	224,000	50
					Feb. 22	66.81	--------	--------
126	Big Sandy Creek at Duncanville, Ala.	56	1951	1951	--------	15.8	[1]	--------
			1956–61	1958	--------	11.7	956	--------
					[1]	14.38	7,000	--------
127	Fivemile Creek near Greensboro, Ala.	72.2	1954–61	1956	--------	8.37	3,540	--------
					Feb. 22	9.84	7,200	--------
128	Black Warrior River near Eutaw, Ala.	5,797	1932–57	1951	--------	59.1	183,000	--------
					[1]	60.32	213,000	47

See footnotes at end of table.

TABLE 1.—*Flood stages and discharges, February to March in Southeastern States*—Continued

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to February 1961: Period	Maximum floods: Prior to February 1961: Year	Maximum floods: February–March 1961	Maximum floods: Gage height (feet)	Maximum floods: Discharge: Cfs	Maximum floods: Discharge: Recurrence interval (years)
Mobile River basin—Continued								
129	Tombigbee River at Demopolis lock and dam near Coatopa, Ala.	15,400	1928–61	1951	--------	(1)	217,000	--------
					Feb. 28	35.66	250,000	38
130	Ponta Creek at U.S. Highway 45 at Lauderdale, Miss.	60			Feb. 21	42.50	12,100	--------
131	Sucarnoochee River at Livingston, Ala.	606	1938–61	1951	--------	27.6	21,500	--------
					Feb. 22	29.35	31,500	20
132	Alamuchee Creek near Cuba, Ala.	63	1954–61	1956	--------	15.98	4,220	--------
					Feb. 22	18.03	12,000	--------
133	Kinterbish Creek near York, Ala.	91.4	1954–61	1958, 1959	--------	17.3	2,330	--------
					Feb. 22	22.23	14,400	[2]1.52
134	Tuckabum Creek near Butler, Ala.	112	1954–61	1956	--------	17.25	4,570	--------
					Feb. 22	20.13	6,830	9
135	Horse Creek near Sweetwater, Ala.	52.8	1958–61	1960	--------	14.65	1,940	--------
					Feb. 25	14.39	3,820	--------
136	Bashi Creek near Campbell, Ala.	86.3	1959–61	1960	--------	23.09	4,240	--------
					Feb. 25	21.36	3,370	--------
137	Tombigbee River near Leroy, Ala.	19,100	1874	1874	--------	51.8	280,000	--------
			1900	1900	--------	50.6	269,000	--------
			1928–61	1929	--------	46.0	--------	--------
				1951	--------	--------	201,000	--------
					Mar. 4, 5	48.24	252,000	43
138	Mobile River at U.S. Highway 90 near Mobile, Ala.	--------			Mar. 10	--------	533,000	--------
Pascagoula River basin								
139	Leaf River near Raleigh, Miss.	143	1939–44, 1957–61	1940	--------	26.2	7,000	--------
					Feb. 21	26.99	14,500	--------
140	Leaf River near Collins, Miss.	752	1856	1856	--------	33	(1)	--------
			1900	1900	--------	32	(1)	--------
			1938–61	1950	--------	31.14	38,100	--------
					Feb. 23	31.85	48,500	50
141	Bowie Creek near Hattiesburg, Miss.	304	1938–61	1943	--------	25.70	20,100	--------
					Feb. 22	26.92	34,800	[2]1.76
142	Okatoma Creek at State Highway 28, 2¾ miles east of Magee, Miss.	38			Feb. 21	364.17	9,000	--------
143	Leaf River at Hattiesburg, Miss.	1,760	1900	1900	--------	33.6	(1)	--------
			1938–61	1943	--------	28.91	71,300	--------
					Feb. 23	31.53	72,200	30
144	East Tallahalla Creek at State Highway 528 near Bay Springs, Miss.	100			Feb. 22	46.18	11,200	--------
145	Tallahalla Creek at Laurel, Miss.	233	1880–1961	1919	--------	26	(1)	--------
			1939–61	1947	--------	20.29	13,700	--------
					Feb. 23	22.32	19,100	[2]1.33
146	Tallahoma Creek at State Highway 15, 7 miles northwest of Laurel, Miss.	149	1941–61	1947	--------	247.55	9,410	--------
					Feb. 22	248.71	12,600	--------
147	Tallahalla Creek near Runnelstown, Miss.	612	1865–1961	1900	--------	30.5	(1)	--------
			1939–61	1947	--------	21.70	19,300	--------
					Feb. 24	25.07	32,800	[2]1.16
148	Buck Creek near Runnelstown, Miss.	19.1	1951–61	1951	--------	94.54	3,800	--------
					Feb. 18	94.89	3,900	[2]1.32
149	Bogue Homo Creek at U.S. Highway 84, 6 miles east of Laurel, Miss.	117			Feb. 22	7.19	11,500	--------

See footnotes at end of table.

TABLE 1.—*Flood stages and discharges, February to March in Southeastern States*—Continued

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods					
			Prior to February 1961		February–March 1961	Gage height (feet)	Discharge	
			Period	Year			Cfs	Recurrence interval (years)
	Pascagoula River basin—Continued							
150	Leaf River near McLain, Miss.	3,510	1900	1900		31.8	(1)	
			1939–61	1943		27.76	88,300	
					Feb. 26	31.64	128,000	[2] 1.04
151	Chunky Creek near Chunky, Miss.	368	1938–61	1950		25.08	30,700	
					Feb. 22	25.75	30,800	[2] 1.04
152	Okatibbee Creek at county highway, 2 miles west of Center Hill, Miss.	110			Feb. 22	440.87	11,600	
153	Okatibbee Creek near Meridian, Miss.	289	1938–50	1938		29.5	(1)	
			1939–50	1950		24.85	16,300	
					Feb. 22	26.14	27,000	[2] 1.09
154	Sowashee Creek at Meridian, Miss.	51.9	1900–61	1936		26.5	(1)	
			1950–61	1951		20.09	8,030	
					Feb. 21	19.63	7,680	25
155	Chickasawhay River at Enterprise, Miss.	913	1900	1900		37.2	(1)	
			1938–61	1950		33.10	33,500	
					Feb. 23	37.94	61,700	[2] 1.05
156	Souinlovey Creek at State Highway 504, 5 miles northeast of Rose Hill, Miss.	104			Feb. 22	36.79	14,100	
157	Pachuta Creek at Pachuta, Miss.	23	1951–61	1957		267.6	4,400	
					Feb. 22	268.32	6,000	[2] 1.59
158	Bucatunna Creek at State Highway 18, 9½ miles east of Quitman, Miss.	120			Feb. 22	40.76	9,300	
159	Long Creek at State Highway 18, 8 miles northeast of Quitman, Miss.	75			Feb. 22	44.54	5,710	
160	Chickasawhay River at Leakesville, Miss.	2,680	1938–61	1938		34.12	68,800	
					Feb. 28	33.52	73,600	[2] 1.07
161	Pascagoula River at Merrill, Miss.	6,600	1900	1900		32.5	(1)	
			1916	1916		31	(1)	
			1930–61	1938		29.71	154,000	
					Feb. 27	30.66	178,000	50
162	Black Creek at State Highway 589, 7½ miles northwest of Purvis, Miss.	113			Feb. 18	47.61	10,500	
163	Black Creek near Purvis, Miss.	(1)	1956–61	1959		26.30	7,300	
					Feb. 18	28.20	15,700	
164	Red Creek at U.S. Highway 11 at Lumberton, Miss.	15.6	1951–61	1953		97.70	2,280	
					Feb. 18	98.7	3,500	
165	Escatawpa River near Wilmer, Ala.	506	1945–61	1959		24.66	30,000	
					Feb. 25	21.81	17,400	2
	Tchoutacabouffa River basin							
166	Tuxachanie River near Biloxi, Miss.	92.4	1907	1907		23.2		
			1952–61	1957		22.22	17,700	
					Feb. 19	15.10	4,810	3
	Biloxi River basin							
167	Biloxi River at Wortham, Miss.	98.2	1948	1948		23.3	(1)	
			1952–61	1957		21.08	7,740	
					Feb. 19	18.85	6,540	6

See footnotes at end of table.

TABLE 1.—*Flood stages and discharges, February to March in Southeastern States*—Continued

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to February 1961: Period	Year	February–March 1961	Gage height (feet)	Discharge: Cfs	Recurrence interval (years)
	Wolf River basin							
168	Wolf River near Poplarville, Miss.	71	1952–61	1960		189.45	5,000	
					Feb. 18	191.67	8,800	[2] 1.21
169	Murder Creek near Poplarville, Miss.	21.6	1952–61	1953		15.44	2,030	
					Feb. 18	13.94	1,450	3
	Pearl River basin							
170	Pearl River near Monticello, Miss.	5,040	1902	1902		33	100,000	
			1938–61	1950		29.44	59,300	
					Mar. 7	26.61	42,000	3
171	Holiday Creek at State Highway 35 near Bassfield, Miss.	21			Feb. 21	15.67	3,940	
172	Upper Little Creek at U.S. Highway 98 near Columbia, Miss.	45			Feb. 21	48.54	7,570	
173	Tenmile Creek near Columbia, Miss.	39.9	1952–61	1955		19.0	11,300	
					Feb. 22	17.7	7,800	[2] 1.34
174	Hurricane Creek near Columbia, Miss.	12.8			Feb. 21	27.77	11,600	
175	Pushepatapa Creek at Varnado, La.	158	1949–61	1950		44.69	8,800	
					Feb. 22	49.14	(1)	
176	Pearl River near Bogalusa, La.	6,630	1938	1938		21	(1)	
			1939–61	1947			60,000	
				1950		20.32		
					Feb. 23	21.70	88,200	50
177	Bogue Lusa Creek near Franklinton, La.	12.1	1948–61	1948		11.0	4,020	
					Feb. 21	11.90	7,400	[2] 1.14
178	Bogue Chitto near Tylertown, Miss.	502	1936	1936		34.7	(1)	
			1944–61	1950		33.50	45,700	
					Feb. 22	22.20	15,400	2
179	Middle Fork Hickory Flat near Tylertown, Miss.	1.37	1953–61	1953		24.9	2,300	
					Feb.	16.28	370	
180	McGees Creek at Tylertown, Miss.	130	1952–61	1955		26.54	12,400	
					Feb. 22	26.5	12,300	40
181	Bogue Chitto at Franklinton, La.	985	1928–31, 1938–57	1943		18.46	50,000	
					Feb. 22	18.5	50,000	30
182	Bogue Chitto near Bush, La.	1,210	1937–61	1943		15.9	51,200	
					Feb. 23	17.04	57,000	14
	Lower Mississippi River basin							
183	Boeuf River near Arkansas-Louisiana State line.	785	1946–61	1948		22.8	(1)	
			1957–61	1958		22.56	14,700	
					Feb. 22		16,200	
					Feb. 23	22.64		
184	Boeuf River near Girard, La.	1,226	1927	1927		29.5	(1)	
			1938–61	1958		19.31	3,070	
					Feb. 25		2,140	
					Feb. 26	15.08		
185	Bayou Lafourche near Crew Lake, La.	361	1938–61	1958		27.50	26,800	
					Feb. 23		23,700	
					Feb. 24	26.42		
186	Bayou Macon near Delhi, La.	782	1882	1882		37.5	(1)	
			1935–61	1947			5,460	
				1958		26.00		
					Feb. 24	23.39	5,020	4
187	Tchefuncta River near Folsom, La.	95.5	1943–61	1953		22.26	18,300	
					Feb. 22	22.07	24,600	[2] 1.58

[1] Not determined.
[2] Ratio of peak discharge to 50-yr flood.
[3] Affected by dam failure upstream.
[4] Daily mean.
[5] Affected by extensive regulation.
[6] Not necessarily maximum discharge for the period.

LOUISIANA

In northeastern Louisiana, Boeuf River near the Arkansas-Louisiana State line exceeded the peak discharge of the 1958 flood, the previous maximum of a short period of record. Downstream, at Girard, the Boeuf River flood was less than a 2-year event. Just west of Girard, the peak discharge of Bayou Lafourche near Crew Lake substantially exceeded a 25-year flood. Other streams in the vicinity had peaks less than a 4-year flood.

In the Florida parishes of southeastern Louisiana, Pearl River at Bogalusa reached a 50-year peak discharge to set a new maximum in 23 years of record. Flood stages persisted well into April. Smaller streams in the vicinity—Bogue Chitto, Tchefuncta, and Tangipahoa Rivers—reached peaks not greater than a 13-year flood. Floods west of the Tangipahoa River basin were minor.

MISSISSIPPI

Peak discharges were outstanding in southern Mississippi and were high in the delta area of northwestern Mississippi. Because there were two principal concentrations of rainfall, small streams with short concentration times peaked twice, while the large streams—such as the Leaf, Chickasawhay, and Pascagoula Rivers—peaked once with runoff accumulating from both storms. For this reason the peaks of large streams were more unusual events than those of the small streams.

The February 21 storm was intense in the vicinity of Columbia, about 25 miles northwest of Purvis, and extended over the upper reaches of Black Creek, the middle reaches of Bowie Creek, and the upper reaches of Leaf and Chickasaw Rivers. Near Columbia, Silver Creek overtopped the highway and flooded much of the town of Foxworth. Floods on Silver Creek and adjacent Ten Mile Creek were about equal to the flood of 1955, the greatest since April 1900. Black Creek overtopped Mississippi State Route 589 between Purvis and Sumrall. The earlier peak downstream at Brooklyn had receded before this peak reached the area.

Leaf River near Collins peaked at 48,500 cfs (a 50-year flood), the greatest since the 1900 flood and about equal to that historic flood. Water flooded a quarter of a mile of U.S. Highway 84 east of Collins.

Bowie Creek at Hattiesburg flowed over about a mile of U.S. Highway 49.

Leaf River at Hattiesburg reached a peak equivalent to a 30-year flood. A stage and discharge hydrograph (fig. 7) for February 17 to March 1 shows the prolonged peak at Hattiesburg. The discharge was largely from Bowie River whose crest reached Hattiesburg about 24 hours ahead of the upper Leaf River crest. Had the crests been synchronized, a peak discharge with a recurrence interval more in agreement with the others in the area might have occurred. Flood

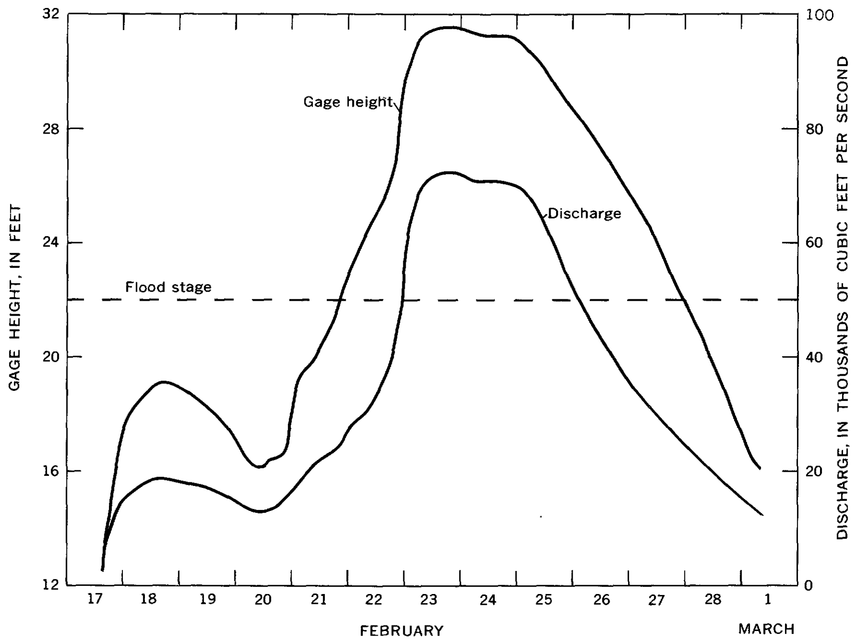

FIGURE 7.—Gage height and discharge of Leaf River at Hattiesburg, Miss., February 17 to March 1.

damage was heavy in Hattiesburg, and 5,000 persons were evacuated from the inundated eastern part of the city.

The peak discharge in Tallahalla Creek exceeded the 50-year flood at Laurel and near Runnelstown.

The Leaf River inundated about 90 percent of McLain. U.S. Highway 98 in McLain and Mississippi State Route 57 south of town were overtopped. The runoff of the two storms coincided to produce one peak and the flood crest tended to flatten out downstream.

The crest on the Chickasawhay River came about 2 days later than the crest on the Leaf River, and the peak discharge in the Pascagoula River just below their confluence was slightly greater than a 50-year flood.

Pearl River peak discharges ranged from a 3-year flood at Monticello and Columbia to a 50-year flood at Bogalusa, La.

ALABAMA

Moderate peak discharges of small streams in southwestern Alabama during February 18–21 were the highest recorded at many short-term gaging stations. No outstanding unit runoff was noted in that area. Moderately high peaks occurred similarly in the Tuscaloosa and Birmingham areas following the February 21–22 storm. The three storms produced few outstanding floods on small streams. The rainfall and stage records for Jones Creek near Epes (11.7 sq mi), figure 8, indicate the complex rainfall occurrence and discharge variations typical of small streams in the area.

The recurring storms generated large volumes of runoff that produced outstanding floods on large streams. The peak discharge of Alabama River near Montgomery was greater than a 50-year flood and exceeded the previous maximum discharge on March 30, 1888. The peak stage was about equal to the 1888 peak and about 2.1 feet lower than the peak of April 1, 1886. Alabama River at Selma had a

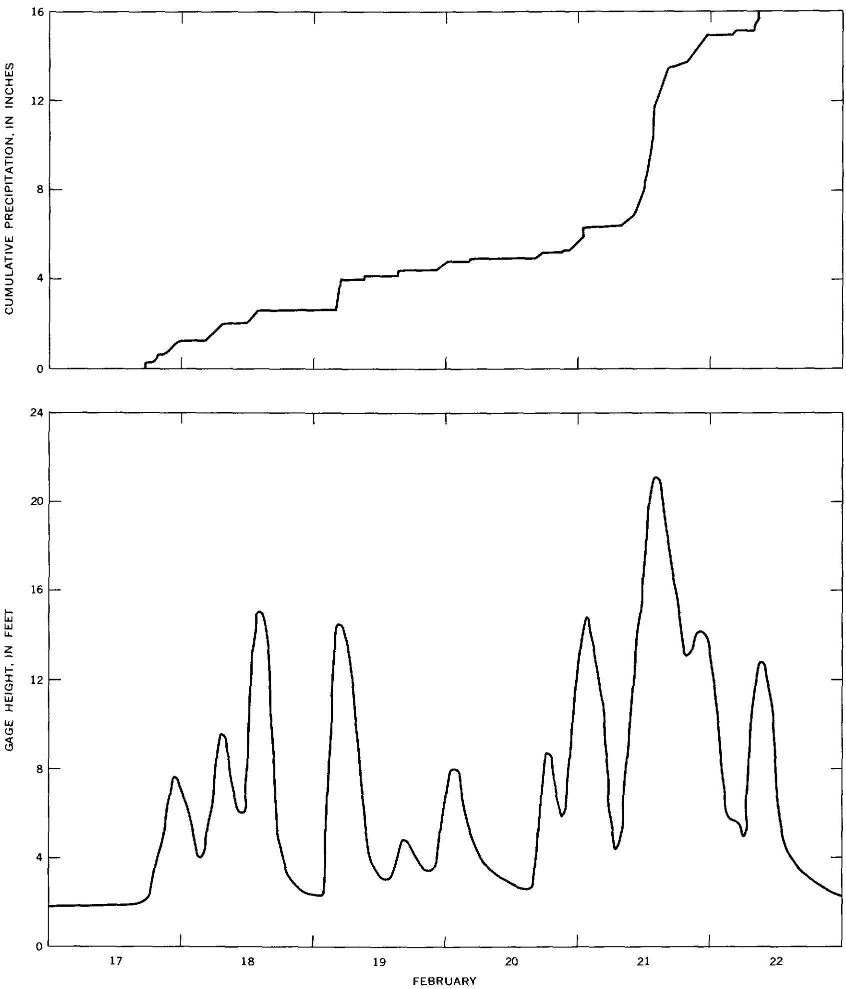

FIGURE 8.—Accumulated rainfall and gage height at Jones Creek near Epes, Ala., February 17–22.

maximum discharge 1.28 times a 50-year flood and continued above flood stage well into March. The Coosa, upper Alabama, Black Warrior, and Tombigbee Rivers had the highest peaks of recent years. Mobile River near Mobile exceeded the record maximum discharge.

The February to March floods of the Alabama River were not only record-breaking discharges but remained above flood stages for longer periods than ever known before. The Alabama River was above flood stage at Montgomery for 19 consecutive days, at Selma for 17 days, at Miller Ferry for 28 days, and at Claiborne for 29 days. The Coosa River remained above flood stage at Wetumpka for 9 days, at Childersburg for 10 days, and at Gadsden for 14 days.

GEORGIA

General moderate flooding occured in the northern half of the State; scattered extreme floods occurred on some streams. Several small streams near Atlanta reached peaks greater than 50-year floods. The Chattahoochee River rose rapidly responding to the heavier concentration of rain in the western part of the State. Little flooding occurred above Newman. At Columbus the flood was about the fourth greatest of record and the greatest since March 1929. Flood stages persisted for about 3 days.

The upper part of the Flint River reached stages 4–9 feet above flood stage. The Apalachicola River reached stages higher than any since 1948 and 1929 at some points.

FLOOD DAMAGE

Louisiana.—One person drowned at Walker. Damage was light, confined mostly to highways, railroads, and agriculture. About one-eighth of the total damage in the Bogue Chitto and Pearl River basins occurred in Louisiana.

Mississippi.—Three persons lost their lives at Hattiesburg. Damage to municipalities, roads, and agriculture was extensive. Damage to county roads was much greater than that to the State Highway system. The municipalities of Hattiesburg, Petal, Foxworth, McLain, Laurel, Waynesboro, Shubuta, Quitman, and Enterprise had heavy damage.

Alabama.—No lives were lost, but about 8,000 families sustained flood losses. The Alabama State Civil Defense Department estimated a total of $36 million flood damage in the State.

Georgia.—No lives were lost, and no buildings were destroyed. The American National Red Cross estimates 25 buildings had major damage and 461 had minor damage.

Table 2 shows an incomplete estimate of damage in the flood area by the Louisiana and the Mississippi Highway Departments, the Alabama State Civil Defense Department, the U.S. Army Corps of

Engineers, the U.S. Weather Bureau, and the U.S. Soil Conservation Service.

TABLE 2.—*Estimates of flood damage, February to March 1961 in the Southeastern States*

Louisiana:	
State and Federal highways	$30,000
Northeastern Louisiana:	
Crop	85,000
Noncrop	15,000
Louisiana-Mississippi:	
Bogue Chitto River basin:	
Agricultural	37,500
Roads and railroads	17,000
Pearl River basin:	
Agricultural	344,200
Roads and railroads	268,800
Mississippi:	
State highways	150,000
County and municipal roads	2,300,000
Agricultural	2,000,000
Alabama:	
Highways	1,000,000
Other public property	10,000,000
Private	12,000,000
Industrial	5,000,000
Agricultural	8,000,000
Georgia:	
All types	500,000
TOTAL	41,747,500

FLOOD OF FEBRUARY 21–22 IN COEUR d'ALENE RIVER BASIN, IDAHO

A flood caused by heavy rainfall on snow occurred in the Coeur d'Alene River basin on February 21–22. During the period beginning January 29, temperatures averaged at least 6° F above the long-term mean, and the precipitation was more than 200 percent of normal. For example, precipitation falling as rain and snow at Wallace, between January 29 and February 19, totaled 8.33 inches, or about 0.40 inch per day compared with an average mean of 0.15 inch per day for this period. During 4 days, February 19–22, an additional 3.29 inches fell; the 1.79 inches that fell on February 21 was accompanied by rising temperature. Figure 9 shows the weather conditions at Wallace during February and the snow depths at Mullan, 6 miles upstream.

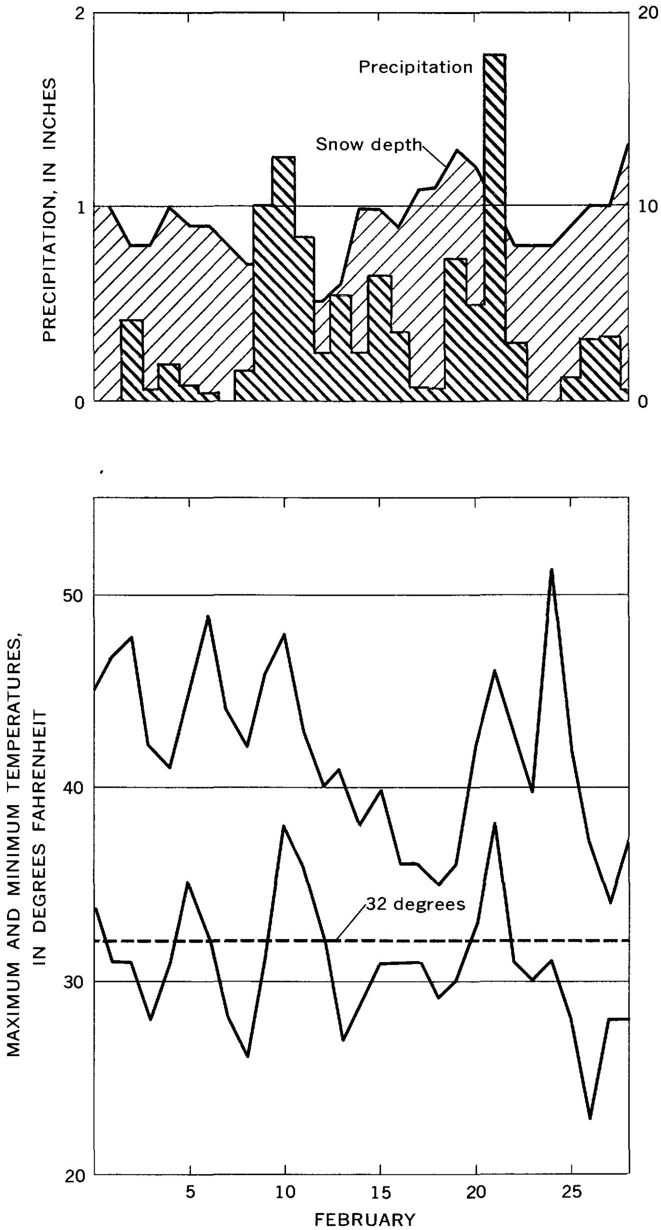

FIGURE 9.—Weather conditions for February 1961 at Wallace, Idaho. Snow depth is that at Mullan, 6 miles upstream.

Heavy runoff came from large areas in the lower parts of the basin. Stages rose rapidly on February 21, and peaked about midnight on February 21 in the tributaries and early in the morning of February 22 in the main stem of the Coeur d'Alene River. Discharges at gaging stations on Coeur d'Alene River near Cataldo and at Enaville were exceeded only by the floods of 1933 and 1938 in 43 years of record.

Coeur d'Alene River above Shoshone Creek near Prichard was the highest in 11 years of record. Figure 10 shows location of the flood-determination points. Floods at Coeur d'Alene River main-stem stations may be expected to be equaled or exceeded on the average of only once in about 50 years at Enaville and Cataldo. Floods in the St. Joe and St. Maries Rivers were of a lower order of magnitude. Peak discharges at six gaging stations are given in table 3.

The principal damage was to roads, railroads, and bridges. The Coeur d'Alene River overtopped the Union Pacific Railroad and U.S. Highway 10 at Cataldo. Pine Creek, which enters South Fork Coeur d'Alene River a few miles above the confluence with the Coeur d'Alene River, was exceptionally high. Several bridges on county roads across Pine Creek were washed out or severely damaged, and traffic was stopped for several days. Other county roads and bridges were washed out or sustained extensive damage.

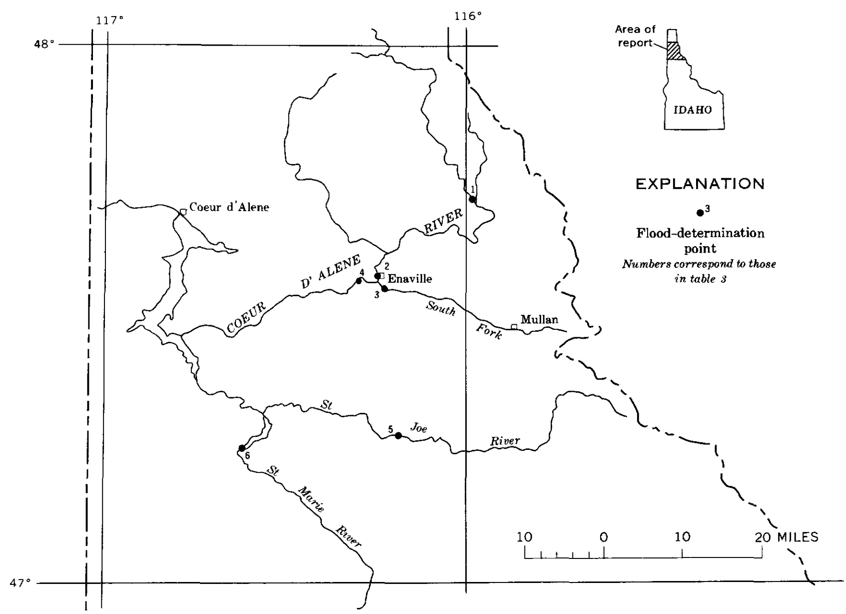

FIGURE 10.—Location of flood-determination points, floods of February 21–22 in Coeur d'Alene River basin, Idaho.

TABLE 3.—*Flood stages and discharges, February 21–22 in Coeur d'Alene River basin, Idaho*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to February 1961 — Period	Year	February 1961	Gage height (feet)	Discharge (cfs)
	Spokane River basin						
1	Coeur d'Alene River above Shoshone Creek, near Prichard.	335	1951–61	1951			9,610
				1957		[1] 9.09	
					22	7.83	11,000
2	Coeur d'Alene River at Enaville.	895	1933	1933		79.47	(2)
			1940–61	1946			28,100
				1951		74.93	
					22	76.33	31,500
3	South Fork Coeur d'Alene River at Enaville.	310			21		9,440
4	Coeur d'Alene River near Cataldo.	1,220	1911–12, 1921–61	1933		56.9	67,000
					22	52.71	41,400
5	St. Joe River at Calder	1,030	1911–12, 1921–61	1933			53,000
				1938		93.1	
					22	87.13	14,200
6	St. Maries River at Lotus	437	1912, 1921–61	1933			23,800
				1951		[1] 13.4	
					22	7.45	9,420

[1] Affected by backwater from ice.
[2] Not determined.

FLOODS OF MARCH 25 TO APRIL 2 IN ADJOINING AREAS OF MINNESOTA, WISCONSIN, AND IOWA

Floods in southeastern Minnesota, southwestern Wisconsin, and northeastern Iowa (fig. 11) were caused by snowmelt from a sudden warmup about March 25 in the basins of tributaries to the Mississippi River south of the Zumbro River in Minnesota to the Cedar River in Iowa.

Low temperatures during the preceding December and January produced frost as deep as 51 inches by mid-February at Zumbrota, Minn. Water from the melting of the snowfall of February 18 was absorbed in the upper crust of the soil and was refrozen. Heavy snow fell March 4–8. The depth of the March snow cover was maximum on March 8 or 9—Hatfield Dam, Wis., had 16 inches, and Austin, Minn., had 14 inches. Eleven-inch snow covers at Rochester, Minn., and at La Crosse, Wis., had water equivalents of 2.9 and 1.1 inches, respectively.

The U.S. Weather Bureau reported that the March snowfall in southeastern Minnesota equaled or exceeded the total accumulated snowfall for the preceding months of the 1960–61 snow season. The heaviest snowfall during March was 29 inches at Harmony, on the headwaters of the South Fork Root River near the Iowa State line, and it had a water equivalent of 4.79 inches. After March 9 the depth of the snow cover slowly decreased.

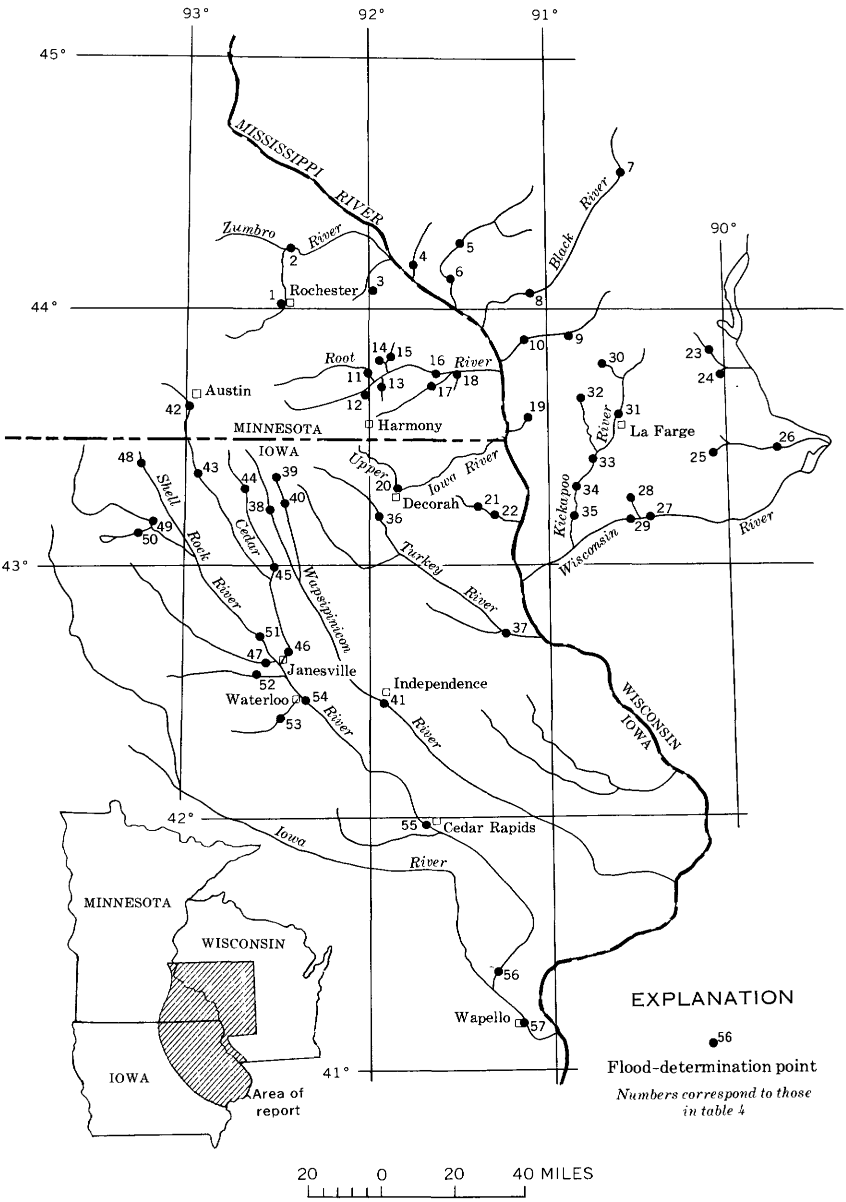

FIGURE 11.—Location of flood-determination points, floods of March 25 to April 2 in adjoining areas of Minnesota, Wisconsin, and Iowa.

The month of March was unusually wet in Iowa, and in many localities it was the wettest March of record. In the northeast and north central division the total monthly rainfall was about 2 inches greater than the long term mean for March. The monthly total at Waterloo was 5.43 inches and that at Charles City was 4.93 inches. There were four periods of precipitation during the month, and much of the precipitation in the first three periods was snow.

Daytime temperatures rose significantly about March 20 and began to melt the snow. Rainfall on March 21–23 and 26–28 exceeded 1 inch in the entire flood area and exceeded 1.5 inches in the central part. A more rapidly warming trend began March 23 and continued through March 27. The combined rain and snowmelt caused rapid runoff which resulted in floods beginning March 25.

Floodflows occurred which were maximum of record since 1952 on South Fork Zumbro River near Rochester, Minn., and since 1953 on Root River below South Fork near Houston, Minn. Flood damage was mainly to inundated croplands, highways, and basements. Extensive riverbank erosion in the Root River damaged the gaging station below the South Fork. The recorder well was exposed and the cableway was destroyed when the right bank was eroded about 30 feet to the A-frame footings. The U.S. Army Corps of Engineers estimated the damage at $380,000 in Rochester, Minn., and $530,000 in the Root River basin.

The Kickapoo River, which meanders between high bluffs and through a narrow valley, had maximum peaks of record at La Farge and Steuben, Wis. Most of the valley was inundated from La Farge to the mouth of the river. Basements and ground floors of buildings were flooded in the villages of Soldiers Grove and Gay Mills, Wis., and water in the main streets rose to 2½ feet.

Extensive flooding of the lowland occurred along the Trempealeau River. At Dodge, Wis., the peak stage was about 1 foot below that of 1956, maximum in 35 years of record, but little damage resulted.

The peak stage on the Lemonweir River at New Lisbon, Wis., was only 0.7 foot below the maximum peak in 18 years of record but little or no damage occurred.

Record breaking floods occurred on the Cedar River and several of its main tributaries above Janesville, Wis., and on other streams in the northeastern part of the State during the last few days in March and the first few days in April.

Tributary discharges into the Cedar River were very small below the mouth of the West Fork—Beaver Creek and Blackhawk Creek

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had peak discharges equal to 3- and 1-year floods, respectively. The crest in the Cedar River, however, attenuated only moderately in its 4-day travel from Waterloo, Iowa, to Conesville. The discharge from Cedar River accounted for virtually the entire rise in the Iowa River at Wapello, Iowa, which crested on April 3 (fig. 12).

The peak discharge (73,000 cfs) in Cedar River at Cedar Rapids, Iowa, was maximum during a period of record which began in 1902 and exceeded that of the historical flood (65,000 cfs) of 1851. Many unusually high discharges occurred. Many of the upper gaging stations had peak discharges greater than any previously known, and most of them had recurrence intervals greater than 50 years.

Flood damage was high. Approximately 40 percent of Charles City, Iowa, was inundated by waters from Cedar River, and at least a hundred families evacuated their homes. Five hundred houses were flooded in Waterloo and five thousand persons were evacuated at Cedar Rapids. Damage at Waterloo was estimated at $60 million.

Peak stages and discharges at gaging stations and other sites throughout the flood area are given in table 4.

Recurrence intervals, shown in table 4, were computed from three flood-frequency reports relating to this area (Prior and Hess, 1961, Ericson, 1961, and Schwob, 1953).

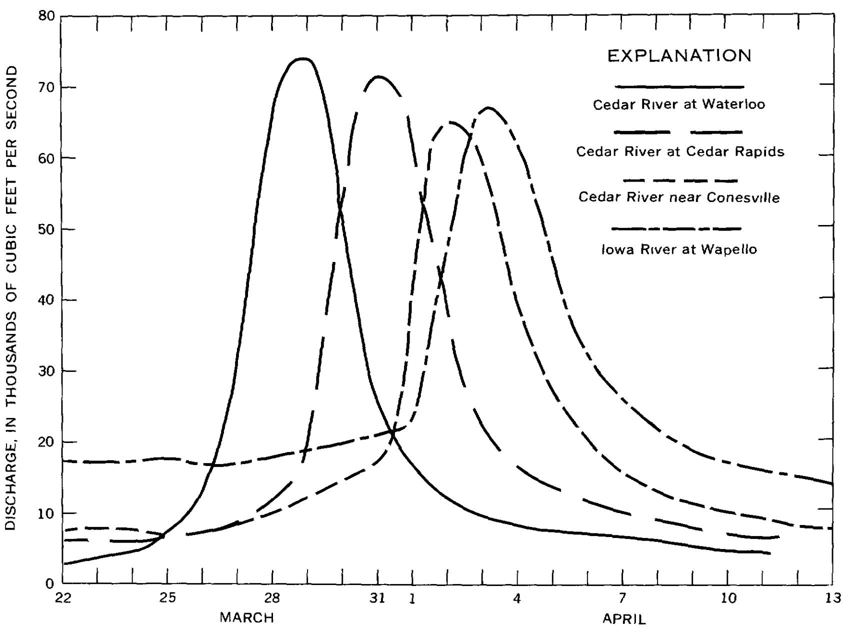

FIGURE 12.—Hydrograph of daily discharge at three gaging stations on the Cedar River and on the Iowa River at Wapello, Iowa. Floods of March 25 to April 2 in adjoining areas of Minnesota, Wisconsin, and Iowa.

TABLE 4.—*Flood stages and discharges, March 25 to April 3 in adjoining areas of Minnesota, Wisconsin, and Iowa*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to March 1961: Period	Maximum floods: Prior to March 1961: Year	Maximum floods: March–April 1961	Maximum floods: Gage height (feet)	Maximum floods: Discharge: Cfs	Maximum floods: Discharge: Recurrence interval (years)
	Zumbro River basin							
1	South Fork Zumbro River near Rochester, Minn.	304	1908–61	1951		17.5	(1)	
			1952–61	1952			8,670	
				1958		13.54		
					Mar. 26	15.43	10,900	22
2	Zumbro River at Zumbro Falls, Minn.	1,130	1859	1859		(2)	(1)	
			1909–17, 1929–61	1951		30.80	30,700	
					Mar. 26	21.69	15,400	3
	Whitewater River basin							
3	South Fork Whitewater River near Altura, Minn.	76.8	1939–61	1947		10.61	5,460	
					Mar. 25	9.65	4,530	40
	Waumandee Creek basin							
4	Eagle Creek near Fountain City, Wis.	26.8			Mar. 25	14.32	930	
	Trempealeau River basin							
5	Trempealeau River at Arcadia, Wis.	552			Mar. 26	6.85	7,840	20
6	Trempealeau River at Dodge, Wis.	643	1913–19, 1934–61	1956		10.35	17,400	
					Mar. 26	9.20	11,100	45
	Black River basin							
7	Black River at Neillsville, Wis.	756	1905–09, 1913–61	1938		23.8	48,800	
					Mar. 27	13.40	13,700	3
8	Black River near Galesville, Wis.	2,120	1931–61	1938		14.31	58,000	
					Mar. 29	13.38	30,800	3
	La Crosse River basin							
9	Little La Crosse River near Leon, Wis.	77.1	1934–61	1935		14.43	4,620	
					Mar. 25	10.5	3,000	10
10	La Crosse River near West Salem, Wis.	398	1913–61	1935		12.2	8,200	
					Mar. 27	10.33	4,490	6
	Root River basin							
11	Root River near Lanesboro, Minn.	615	1910–17, 1940–61	1950		15.55	20,500	
					Mar. 26	15.26	19,500	26
12	Trout Creek tributary near Lanesboro, Minn.	4.08	1959–61	1960		17.74	561	
					Mar. 25	15.41	307	
13	Whalan Creek near Whalan, Minn.	7.85	1959–61	1960		22.17	4,880	
					Mar. 25	16.83	770	
14	Big Springs Creek near Arendahl, Minn.	.14	1959–61	1960		10.67	40	
					Mar. 25	8.85	18	
15	Pine Creek near Arendahl, Minn.	28.1	1959–61	1960		14.16	1,790	
					Mar. 25	14.42	2,020	4
16	Root River near Houston, Minn.	1,270	1909–17, 1929–61	1952		13.90	37,000	
					Mar. 27	15.10	31,400	37

See footnotes at end of table.

TABLE 4.—*Flood stages and discharges, March 25 to April 3 in adjoining areas of Minnesota, Wisconsin, and Iowa*—Continued

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to March 1961: Period	Year	March-April 1961	Gage height (feet)	Discharge: Cfs	Recurrence interval (years)
	Root River basin—Continued							
17	South Fork Root River near Houston, Minn.	275	1950	1950	...	12.81	(1)	...
			1953–61	1960	...	12.30	3,770	...
					Mar. 26	12.87	6,980	3
18	Root River below South Fork near Houston, Minn.	1,560	1938–61	1952	...	17.58	38,700	...
					Mar. 27	17.75	38,200	50
	Bad Axe River basin							
19	North Fork Bad Axe River near Genoa, Wis.	80	1959–61	1959	...	17.59	(1)	...
					Mar. 27	16.12	(1)	...
	Upper Iowa River basin							
20	Upper Iowa River at Decorah, Iowa.	511	1913–61	1941	...	(1)	[3] 28,500	...
			1951–61	1954	...	10.12	13,600	...
					Mar. 27	13.08	20,200	33
	Paint Creek basin							
21	Paint Creek at Waterville, Iowa.	42.8	1950–61	1951	...	17.35	(1)	...
			1952–61	1953	...	8.53	2,840	...
					Mar. 25	8.96	3,420	(1)
22	Paint Creek near Waterville, Iowa.	56.0			Mar. 25	13.53	5,740	(1)
	Wisconsin River basin							
23	Lemonweir River at New Lisbon, Wis.	500	1944–61	1960	...	12.94	6,880	...
					Mar. 29	12.24	5,480	27
24	One Mile Creek near Mauston, Wis.	30.4	1958–61	1960	...	15.58	(1)	...
					Mar. 26	16.16	(1)	...
25	Narrows Creek at Loganville, Wis.	40.0	1958–61	1960	...	15.90	(1)	...
					Mar. 26	14.32	(1)	...
26	Baraboo River near Baraboo, Wis.	600	1913–22, 1942–61	1917	...	[4] 17.5	7,900	...
					Mar. 30	21.10	5,640	10
27	Wisconsin River at Muscoda, Wis.	10,300	1913–61	1938	...	11.48	80,800	...
					Apr. 3	7.34	35,800	2
28	Richland Creek near Plugtown, Wis.	19.1	1958–61	1959	...	17.02	750	...
					Mar. 26	16.86	(1)	...
29	Crooked Creek near Boscobel, Wis.	13.1	1959–61	1960	...	17.55	(1)	...
					Mar. 26	13.09	(1)	...
30	Morris Creek tributary near Norwalk, Wis.	4.67	1960–61	1960	...	13.10	(1)	...
					Mar. 27	12.44	(1)	...
31	Kickapoo River at La Farge, Wis.	266	1938–61	1956	...	12.35	6,750	...
					Mar. 26	12.70	7,040	25
32	Knapp Creek near Bloomingdale, Wis.	8.47	1954–61	1959	...	8.76	3,710	...
					Mar. 27	4.08	825	...
33	Kickapoo River at Readstown, Wis.	485			Mar. 27	39.2	(5)	...
34	Kickapoo River at Gays Mills, Wis.	616	1913–34, 1950,	1913	...	[6] 15.2	...	...
			1960.	1917	...	15.05	9,800	...
					Mar. 27	16.32	(7)	...
35	Kickapoo River at Steuben, Wis.	690	1913–61	1951	...	13.66	10,300	...
					Mar. 28	12.33	10,800	35
	Turkey River basin							
36	Turkey River at Spillville, Iowa.	177	1947	1947	...	18.4	10,000	...
			1956–61	1959	...	[6] 11.48	...	...
				1960	...	...	3,220	...
					Mar. 27	14.37	6,420	>50
37	Turkey River at Garber, Iowa.	1,545	1890–1961	1922	...	28.06	[8] 32,300	...
					Mar. 26	22.84	19,700	3

See footnotes at end of table.

TABLE 4.—*Flood stages and discharges, March 25 to April 3 in adjoining areas of Minnesota, Wisconsin, and Iowa*—Continued

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to March 1961: Period	Maximum floods: Prior to March 1961: Year	Maximum floods: March-April 1961	Maximum floods: Gage height (feet)	Maximum floods: Discharge: Cfs	Maximum floods: Discharge: Recurrence interval (years)
	Wapsipinicon River basin							
38	Wapsipinicon River near Elma, Iowa.	95.2	1958–61	1960		13.44	2,980	
					Mar. 27	14.19	4,970	50
39	Little Wapsipinicon River tributary near Riceville, Iowa.	.90			Mar. 26	4.79	100	(1)
40	Little Wapsipinicon River near Acme, Iowa.	7.76			Mar. 27	7.19	700	(1)
41	Wapsipinicon River at Independence, Iowa.	1,048	1901–61	1947		18.74	[8] 21,500	
					Mar. 29	16.11	15,700	20
	Iowa River basin							
42	Cedar River near Austin, Minn.	425	1909–14, 1944–61	1950		17.81	8,800	
					Mar. 26	17.03	8,290	24
43	Cedar River at Mitchell, Iowa.	826			Mar. 26		17,900	[9] 1.17
44	Little Cedar River at New Haven, Iowa.	193			Mar. 26		10,200	[9] 1.82
45	Little Cedar River near Ionia, Iowa.	306	1954–61	1954		11.37	4,600	
					Mar. 27	15.58	10,800	[9] 1.33
46	Cedar River at Janesville, Iowa.	1,661	1905–06, 1914-27, 1932–42, 1945–61.	1945		16.2	34,300	
					Mar. 28	16.33	37,000	[9] 1.39
47	West Fork Cedar River at Finchford, Iowa.	846	1945–61	1951		17.28	31,900	
					Mar. 27	15.40	17,400	50
48	Shell Rock River near Northwood, Iowa.	300	1945–61	1951		[6] 11.38		
				1951			2,430	
					Mar. 26	[6] 11.68	3,000	3
49	Winnebago River at Mason City, Iowa.	526	1932–61	1933		15.7	10,800	
					Mar. 27	14.80	10,500	25
50	Willow Creek at Mason City, Iowa.	79			Mar. 27		2,820	(1)
51	Shell Rock River at Shell Rock, Iowa.	1,746	1856	1856		17.7	(1)	
			1954–61	1954		14.00	21,300	
					Mar. 28	16.26	33,500	[9] 1.13
52	Beaver Creek at New Hartford, Iowa.	347	1945–61	1947		13.5	18,000	
					Mar. 26	9.52	3,440	3
53	Blackhawk Creek at Hudson, Iowa.	303	1952–61	1960		[6] 16.93	9,000	
					Mar. 26	11.88	1,320	1
54	Cedar River at Waterloo, Iowa.	5,146	1929	1929		20	65,000	
			1940–61	1951		18.83	56,400	
					Mar. 29	21.86	76,700	[9] 1.27
55	Cedar River at Cedar Rapids, Iowa.	6,510	1851	1851		20	65,000	
			1902–61	1929		20.0	64,000	
					Mar. 31	19.66	73,000	50
56	Cedar River near Conesville, Iowa.	7,785	1900–61	1929		15.8	(1)	
			1939–61	1947			60,000	
				1960		15.60		
					Apr. 2	16.62	70,800	30
57	Iowa River at Wapello, Iowa.	12,499	1914–61	1947			94,000	
				1960		17.02		
					Apr. 3	16.85	68,000	7

1 Not determined.
2 Greater than 30.5 ft.
3 At site 4 miles downstream.
4 At site 2.3 miles upstream at datum 7.6 ft higher.
5 Peak discharge not determined; discharge measurement of 6,070 cfs made at gage height of 37.5 ft.
6 Affected by backwater from ice.
7 Peak discharge not determined; discharge measurement of 8,300 cfs made at gage height of 15.20 ft.
8 Not necessarily maximum discharge for period.
9 Ratio of peak discharge to 50-yr flood.

FLOODS OF MARCH 28–31 IN SOUTH-CENTRAL MISSISSIPPI

Heavy rainfall occurred March 28–30 in south-central Mississippi (fig. 13). Most of this rain fell in about a 6-hour period early on March 28 and in a similar period on the night of March 30–31. There was lighter precipitation between these heavy rains. The following rainfall amounts, in inches, were reported by the U.S. Weather Bureau:

Station	*March 28*	*March 31*	*March 27–31*
Natchez	5.75	0.84	8.02
Brookhaven	3.58	3.69	9.29
Monticello	4.64	3.87	10.82
Prentiss	6.04	------	-------
Collins	6.10	3.69	11.49
Laurel	4.00	5.45	11.21
Shubuta	1.67	6.47	8.14
D'Lo	------	4.65	-------
Hickory	------	4.49	-------

Peak rates of runoff on March 28 were outstanding on streams draining up to 1,000 square miles in the area from Collins to Natchez.

The Mississippi Highway Department reported inundation of the following highways:

U.S. Highway 84 at Prentiss by Whitesand Creek.

U.S. Highway 84 at Jefferson Davis-Covington County line by small tributary to Bowie Creek.

U.S. Highway 84 at Lucas (Jefferson Davis County) by Hooker Hollow Creek.

State Highway 556 near Meadville by Homochitto River.

State Highway 570 near Smithdale by Amite River.

State Highways 42 and 43 near New Hebron by small streams.

Indicated frequency, in years, for each peak discharge in table 5 shows that peak discharges were of rare occurrence.

As a result of the heavy rainfall on the night of March 30–31, unusual floods occurred on many of the same streams which were flooded March 28. The heaviest rain during the storm fell along a line from Monticello to Shubuta. The most severe flooding occurred on tributaries to the Leaf River and on Shubuta Creek. The Shubuta Creek was higher, and the crest of Bogue Homo east of Laurel was about the same as the February 1961 crest. The effect of Bogue Homa Lake on the crests is unknown.

TABLE 5.—*Flood stages and discharges, March to April in south-central Mississippi*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to March 1961: Period	Maximum floods: Prior to March 1961: Year	Maximum floods: March–April 1961	Maximum floods: Gage height (feet)	Maximum floods: Discharge: Cfs	Maximum floods: Discharge: Recurrence interval (years)
	Pascagoula River basin							
1	Leaf River near Collins	752	1856	1856		33	[1]	
			1938–61	1961		31.85	48,500	
					Apr. 1	27.18	26,900	7
2	Bowie Creek 13 miles west of Collins.	57	1939–44, 1961	1961		345.85	4,800	
					Mar. 28	346.91	8,000	40
3	Tallahoma Creek 7 miles northwest at Laurel	149	1941–61	1961		248.71	12,600	
					Mar. 31	247.15	8,000	25
4	Bogue Homa 6 miles east of Laurel.	117	1961	1961		7.19	11,500	
					Mar. 31	7.36	13,400	50
5	Shubuta Creek 4 miles northwest of Shubuta.	95	1961	1961		202.8	8,040	
					Mar. 31	202.52	7,310	15
	Pearl River basin							
6	Strong River at D'Lo	429	1928–61	1950		33.0	24,800	
					Mar. 31	29.52	15,100	5
7	Copiah Creek 6 miles east of Hazelhurst.	47.5	1948–61	1950		20.14	[1]	
					Mar. 28	14.8	4,300	2
8	Small Pine ditch 9 miles west of Monticello.	.16	1955–61	1955		6.39	213	
					Mar. 28	6.89	245	3
9	Roadside Park ditch 3 miles east of Monticello.	.25	1955–61	1955		4.17	138	
					Mar. 30	5.31	217	3
10	Silver Creek at Silver Creek.	94			Mar. 28		20,000	50
11	Jay Bird Creek 4 miles south of Prentiss.	38			Mar. 28	29.24	7,130	30
12	White Sand Creek at Oakvale.	125	1879–1961	1900		296.5	[1]	
					Mar. 28, 29	293.34	15,900	25
13	Bogue Chitto 2½ miles southwest of Brookhaven.	30	1951–61	1955		17.96	6,200	
					Mar. 29	18.6	9,000	50
14	Big Creek at Bogue Chitto.	55.2	1951–61	1955		27.06	10,600	
					Mar. 28	24.02	6,520	4
	Bayou Pierre basin							
15	Bayou Pierre at Carpenter.	371	1944–61	1953		25.95	24,400	
					Mar. 31	23.55	19,300	2
	Homochitto River basin							
16	Homochitto River at Eddiceton.	180	1938–61	1939			30,900	
				1953		16.37		
					Mar. 28	15.56	20,500	2
17	McCalls Creek 1.2 miles east of Lucien.	60	1951–61	1955		89.44	14,500	
					Mar. 28	91.83	21,000	10
18	Homochitto River at Rosetta.	750	1949–61	1949		37.80	[1]	
			1951–61	1953		36.03		
				1959			65,300	
					Mar. 28	31.20	97,000	50

[1] Unknown.

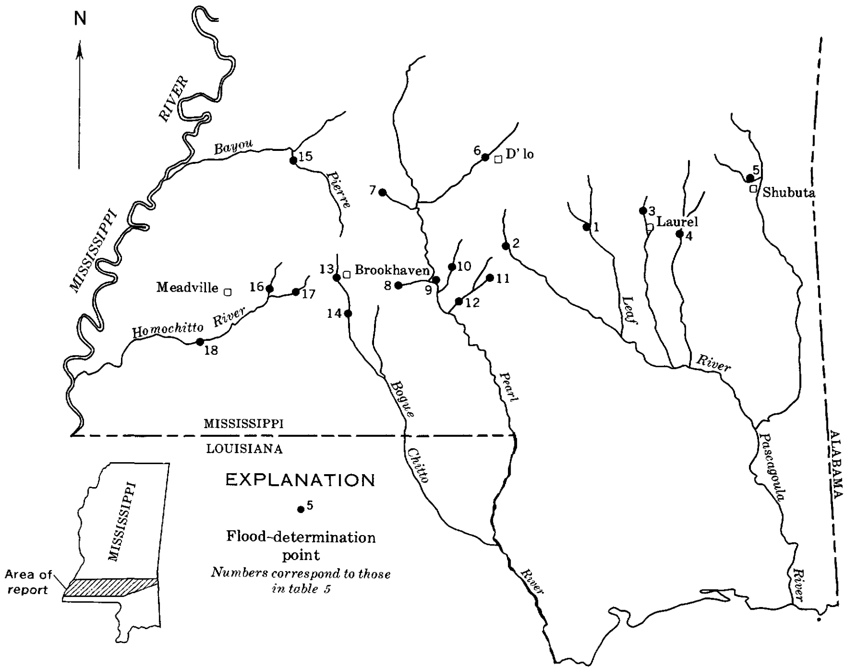

FIGURE 13.—Location of flood-determination points, floods of March 28–31 in south-central Mississippi.

FLOODS OF MAY 5–21, OHIO TO OKLAHOMA

Torrential rains and violent thunderstorms accompanied by high winds swept over parts of eight States (fig. 14) on May 4–9 and caused various degrees of flooding over an unusually large area.

All States shown in figure 14 except Illinois, Indiana, and Ohio had received fairly heavy rainfalls during May 1 and 2 and later received heavy flood-producing rainfall from May 4 to 9. The flood-producing rainfall in Illinois, Indiana, and Ohio fell from May 5 to 9.

The greatest amount of rain fell in a hundred-mile-wide band north of the Ohio River from the center of Indiana to the mouth of the Ohio River. This band extended along the entire Missouri-Arkansas State line (fig. 14).

The flood area consisted of the southwest corner of Ohio, the southern parts of Indiana, Illinois, and Missouri, the southeast corner of Kansas, the northern part of Oklahoma, the northern and southwestern parts of Arkansas, and the north-central part of Kentucky. The flood area is approximately that area inside the 4-inch isohyet shown on figure 14.

The floods were particularly damaging in southern Illinois and Indiana. Flooding was heavy in north-central Kentucky but was

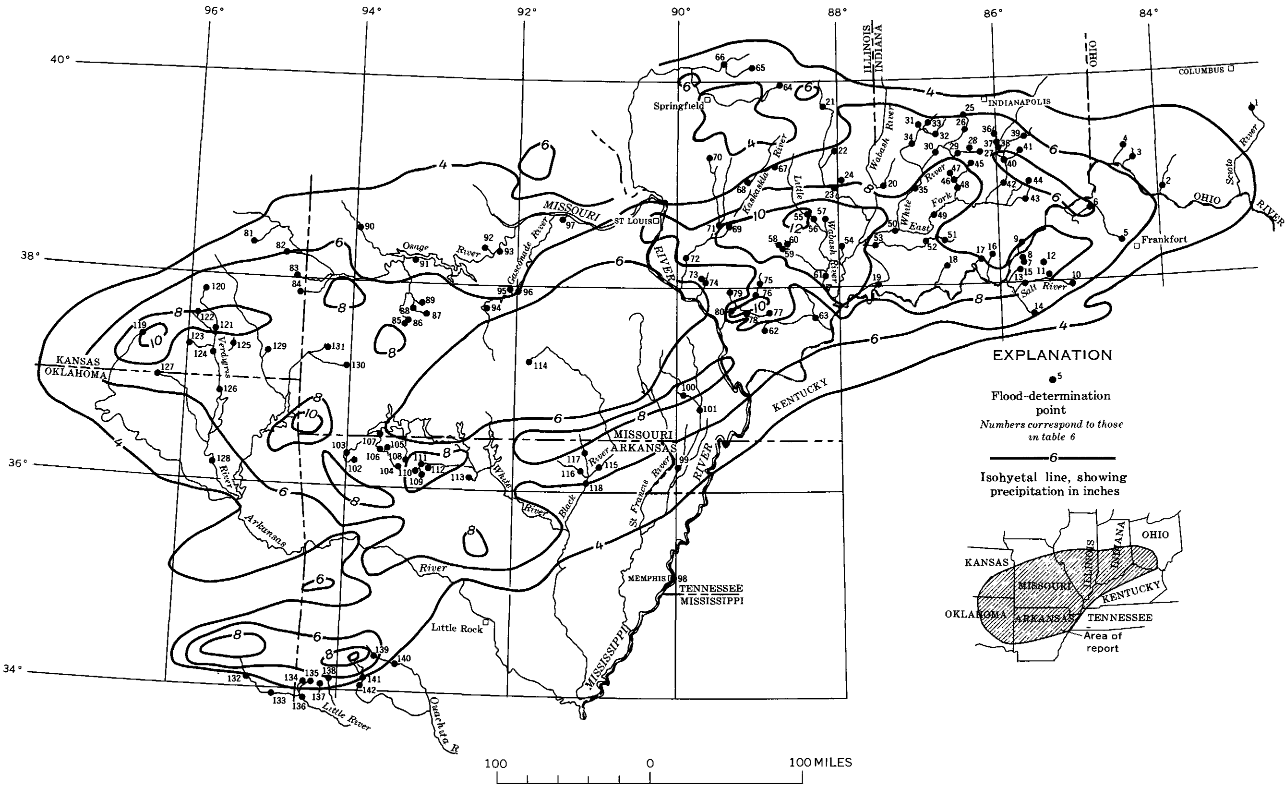

FIGURE 14.—Location of flood-determination points and isohyets for May 4–9 in Kansas, Oklahoma, Missouri, and Arkansas and for May 5–9 in Illinois, Indiana, Ohio, and Kentucky. Floods of May 5–21, Ohio to Oklahoma.

confined mostly to small area streams adjacent to the Ohio River. The floods were severe in Missouri and Kansas, and caused considerable damage in Arkansas and Oklahoma. Some flood damage was caused along the lowlands of the Mississippi River in Tennessee and some high flows, but no serious flooding occurred in Ohio.

KENTUCKY

The major part of the rainfall in May in western and northern Kentucky occurred on May 5–9 and resulted in heavy flooding in tributary streams in the north-central and northeastern parts of the State.

Precipitation in the north-central part of the State for April was between 0.5 and 2.7 inches above normal, and 1.5–4.0 inches fell during the last 10 days of the month. The above-normal precipitation during the antecedent period and the above-normal streamflow at the end of April coupled with the intense rainfall of May 5–9 caused severe flooding on many streams. The greatest rainfall reported for a single day was 5.40 inches at Louisville on May 7, and the highest rainfall reported for the 5-day period was 9.76 inches at La Grange.

Extreme floodflows were confined to a narrow band along the Ohio River (table 6). For example, the peak discharge for Eagle Creek at Glencoe had a frequency of 26 years, whereas that on Big Eagle Creek at Sadieville, 15 miles southeast, had a frequency of only 6 years. Similarly, the peak discharge for Salt River at Shepherdsville had a frequency of 50 years, whereas that upstream at Van Buren had 4 years, and that for Rolling Fork at Boston, about 15 miles south, had 2 years even though the stage was second only to the flood of 1937. The peak discharge for the flood on Middle Fork Beargrass Creek in Louisville was 1.13 times that of the 50-year flood.

Table 6 summarizes flood stages and discharges for selected floods in north-central Kentucky.

TABLE 6.—*Flood stages and discharges, May 5–21, Ohio to Oklahoma*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods					
			Prior to May 1961		May 1961	Gage height (feet)	Discharge	
			Period	Year			Cfs	Recurrence interval (years)
	Scioto River basin							
1	Salt Creek at Tarlton, Ohio.	10.6	1946–61	1947		6.4	2,780	
					8	6.3	2,710	
	Whiteoak Creek basin							
2	Whiteoak Creek near Georgetown, Ohio.	221	1923–35, 1939–61	1933		20.87	20,500	
					8	12.20	16,400	

TABLE 6.—*Flood stages and discharges, May 5–21, Ohio to Oklahoma*—Con.

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to May 1961: Period	Maximum floods: Prior to May 1961: Year	Maximum floods: May 1961	Maximum floods: Gage height (feet)	Maximum floods: Discharge: Cfs	Maximum floods: Discharge: Recurrence interval (years)
	Little Miami River basin							
3	East Fork Little Miami River at Perintown, Ohio.	477	1915–20, 1925–61	1945	--------	23.42	39,400	--------
					8	20.43	28,900	--------
	Mill Creek basin							
4	Mill Creek at Reading, Ohio.	73.1	1938–61	1945	--------	20.00	5,780	--------
					7	16.13	3,820	--------
	Kentucky River basin							
5	Big Eagle Creek at Sadieville, Ky.	42.9	1932	1932	--------	22	(1)	--------
			1941–61	1943	--------	21.96	9,870	--------
					7	17.20	6,620	6
6	Eagle Creek at Glencoe, Ky.	437	1915–20, 1928–31, 1938–61	1943	--------	23.60	32,900	--------
					8	21.60	30,500	26
	Beargrass Creek basin							
7	South Fork Beargrass Creek at Louisville, Ky.	17.2	1939–40, 1943–61	1943	--------	15.1	(1)	--------
				1945	--------	13.62	--------	--------
				1960	--------	--------	2,220	--------
					7	10.76	1,870	27
8	Middle Fork Beargrass Creek at Cannons Lane at Louisville, Ky.	18.9	1943–61	1943	--------	8.1	(1)	--------
		[2] 18.4		1960	--------	5.83	3,300	--------
					7	5.31	2,400	[3] 1.13
	Silver Creek basin							
9	Silver Creek near Sellersburg, Ind.	188	1954–61	1959	--------	30.89	19,600	--------
					9	28.17	14,800	7
	Salt River basin							
10	Salt River near Van Buren, Ky.	196	1928	1928	--------	22.2	20,000	--------
		[2] 192	1938–61	1948	--------	19.3	14,700	--------
					7	18.62	13,600	4
11	Plum Creek at Waterford, Ky.	31.8	1954–61	1960	--------	11.84	13,200	--------
					7	9.03	8,170	44
12	Floyds Fork at Fisherville, Ky.	138	1937	1937	--------	16.8	(1)	--------
			1944–61	1960	--------	13.7	11,800	--------
					8	14.7	15,800	19
13	Salt River at Shepherdsville, Ky.	1,197	1937–61	1937	--------	[4] 47.3	(1)	--------
				1943	--------	--------	50,000	--------
				1945	--------	[4] 38.04	--------	--------
					9	40.84	57,700	50
14	Rolling Fork near Boston, Ky.	1,299	1937–61	1937	--------	[5] 55.2	(1)	--------
				1948	--------	--------	41,300	--------
				1950	--------	46.6	--------	--------
					9	--------	32,000	2
					10	47.15	--------	--------
15	Pond Creek near Louisville, Ky.	64.0	1937–61	1937	--------	[4] 19	--------	--------
			1944–61	1948	--------	17.78	--------	--------
					--------	--------	3,260	--------
					8	17.11	3,080	11

See footnotes at end of table.

TABLE 6.—*Flood stages and discharges, May 5–21, Ohio to Oklahoma*—Con.

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods					
			Prior to May 1961		May 1961	Gage height (feet)	Discharge	
			Period	Year			Cfs	Recurrence interval (years)
	Big Indian Creek basin							
16	Big Indian Creek near Corydon, Ind.	129	1815–1961	1943	--------	22.4	(1)	--------
			1943–61	1959	--------	22.22	23,800	--------
					8	18.13	10,800	6
	Blue River basin							
17	Blue River near White Cloud, Ind. [5]	461	1930–61	1959	--------	23.07	28,500	--------
					9	21.81	25,600	15
	Anderson River basin							
18	Middle Fork Anderson River at Bristow, Ind.	41.9	1905–61	1959	--------	20.0	15,000	--------
					8	18.10	6,680	--------
	Pigeon Creek basin							
19	Pigeon Creek at Evansville, Ind.	326			10	27.94	12,100	--------
	Wabash River basin							
20	Busseron Creek near Carlisle, Ind.	228	1943–61	1950	--------	20.05	8,800	--------
					9	20.30	8,580	30
21	Embarrass River near Camargo, Ill.	185			9	14.39	5,200	--------
22	Range Creek near Casey, Ill.	7.60	1950–61	1960	--------	10.79	2,790	--------
					8	10.45	2,200	--------
23	Embarrass River at Ste. Marie, Ill.	1,513	1909–12, 1914–61	1950	--------	--------	44,800	--------
				1957	--------	25.54	--------	--------
					9	25.08	37,800	10
24	North Fork Embarrass River near Oblong, Ill.	319	1940–61	1950	--------	22.38	27.100	--------
					9	21.00	20,800	28
25	White Lick Creek at Mooresville, Ind.	212	1957-61	1957	--------	22.5	(1)	--------
				1960	--------	21.21	11,400	--------
					8	21.56	14,100	25
26	White River near Centerton, Ind.	2,435	1913–61	1913	--------	[6] 22.8	90,000	--------
					8	15.45	37,000	5
27	Bean Blossom Creek at Bean Blossom, Ind.	14.6	1951–61	1960	--------	11.78	8,140	--------
					8	10.83	3,000	--------
28	Bear Creek near Trevlac, Ind.	7.00	1952–61	1957	--------	7.62	1,830	--------
					8	6.07	1,400	--------
29	Bean Blossom Creek at Dolan, Ind.	100	[7] 1946–61	1947	--------	--------	9,420	--------
				1949	--------	17.9	--------	--------
					8	16.86	6,430	8
30	White River at Spencer, Ind.	2,980	1913–61	1913	--------	28.5	100,000	--------
					9	23.06	49,500	8
31	Big Walnut Creek near Reelsville, Ind.	338	1949–61	1957	--------	18.63	30,700	--------
					8	17.46	18,400	22
32	Mill Creek near Cataract, Ind.	241	1949–61	1960	--------	22.58	11,400	--------
					9	22.20	10,700	7
33	Deer Creek near Putnamville, Ind.	59.0	1954–61	1960	--------	13.53	7,450	--------
					8	13.73	7,710	[3] 1.08
34	Eel River at Bowling Green, Ind.	844	1875–1961	1875	--------	30.0	(1)	--------
			[8] 1931–61	1950	--------	23.53	34,000	--------
					8,9	22.25	26,700	10
35	White River at Newberry, Ind.	4,696	1875–1961	1913	--------	27.5	130,000	--------
					11	23.47	69,300	10

See footnotes at end of table.

TABLE 6.—*Flood stages and discharges, May 5-21, Ohio to Oklahoma*—Con.

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to May 1961: Period	Maximum floods: Prior to May 1961: Year	Maximum floods: May 1961	Maximum floods: Gage height (feet)	Maximum floods: Discharge: Cfs	Maximum floods: Discharge: Recurrence interval (years)
	Wabash River basin—Continued							
36	Youngs Creek near Edinburg, Ind.	109	1942-61	1952		13.4	10,700	
					8	12.62	8,690	21
37	Sugar Creek near Edinburg, Ind.	462	1942-61	1956		18.38	27,600	
					9	16.12	16,100	7
38	Driftwood River near Edinburg, Ind.	1,054	1913-61	1913		20.3	(1)	
			1940-61	1956		16.80	37,500	
					9	15.84	24,300	5
39	Flatrock River at St. Paul, Ind.	298	1848-1961	1913		20.5	(1)	
			1930-61	1949			18,500	
				1959		11.34		
					8	9.60	11,000	5
40	East Fork White River at Columbus, Ind.	1,692	1913	1913		17.9	100,000	
			1947-61	1952		16.00	48,700	
					9	15.12	46,500	14
41	Clifty Creek at Hartsville, Ind.	88.8	1897-1961	1913		25.1	(1)	
			1948-61	1959		14.29	11,300	
					8	11.27	6,120	9
42	East Fork White River at Seymour, Ind.	2,333	1897-1961	1913		21.0	120,000	
					9	18.88	59,400	16
43	Muscatatuck River near Deputy, Ind.	296	1947-61	1959		33.1	52,200	
					8	24.54	24,300	5
44	Vernon Fork at Vernon, Ind.	201	1939-61	1959		32.83	56,800	
					7	22.43	20,600	5
45	North Fork Salt Creek near Belmont, Ind.	120	1913	1913		25.7	(1)	
			1946-61	1960		23.10	13,300	
					8	21.41	9,580	4
46	Salt Creek near Harrodsburg, Ind.	441	1913	1913		[9] 38.1	(1)	
			1955-61	1960		[9] 32.76	22,000	
					9	35.35	20,200	17
47	Clear Creek at Harrodsburg, Ind.	55.2	1960-61	1960		16.47	10,200	
					8	12.89	6,190	32
48	Salt Creek near Peerless, Ind.	582	1937	1937		34.3	(1)	
			1939-50, 1957-61	1949		33.06	20,400	
					10	35.33	25,100	19
49	East Fork White River at Shoals, Ind.	4,954	1847-1961	1913		42.2	160,000	
					13	33.53	76,800	8
50	White River at Petersburg, Ind.	11,139	1913-61	1913		29.5	235,000	
					13	26.14	132,000	11
51	Patoka River near Ellsworth, Ind.	171	1913	1913		19.1	18,000	
					8	18.9	16,400	[3] 1.12
52	Patoka River at Jasper, Ind.	257	1913-61	1913		[10] 15.9	16,000	
					10	[10] 14.96	13,700	[3] 1.33
53	Patoka River near Princeton, Ind.	815	1934-61	1937		[11] 26.80	18,700	
					16	20.58	12,900	26
54	Bonpas Creek at Browns, Ill.	235	1940-61	1945		20.40	5,490	
					9	24.04	7,500	40
55	Little Wabash River tributary at Clay City, Ill.	.47	1959-61	1959		14.96		
					8	17.28		
56	Little Wabash River below Clay City, Ill.	1,130	1914-61	1950		26.67	47,000	
					10	26.61	46,200	45
57	Madden Creek near West Salem, Ill.	1.54	1956-61	1960		17.52	1,060	
					8	17.78	1,550	
58	White Feather Creek near Marlow, Ill.	.45	1956-61	1958		13.82	214	
					8	14.46	271	
59	Horse Creek near Keenes, Ill.	96.8	1959-61	1959		18.82	2,220	
					8	26.98	17,100	
60	Skillet Fork at Wayne City, Ill.	475	1908-12, 1914-21, 1928-61.	1950		22.16	20,000	
					8	26.68		
					9		51,000	[3] 2.21
61	Little Wabash River at Carmi, Ill.	3,090	1937	1937		36.23	(1)	
			1939-61	1950		35.23	39,400	
					12		46,900	[3] 1.14
					13	36.70		

See footnotes at end of table.

TABLE 6.—*Flood stages and discharges, May 5–21, Ohio to Oklahoma*—Con.

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to May 1961: Period	Maximum floods: Prior to May 1961: Year	Maximum floods: May 1961	Maximum floods: Gage height (feet)	Maximum floods: Discharge: Cfs	Maximum floods: Discharge: Recurrence interval (years)
	Saline River basin							
62	Little Saline Creek tributary near Goreville, Ill.	0.54	1959–61	1959		14.77	(1)	
					7	15.08	(1)	
63	Saline River near Junction, Ill.	1,040	1937, 1939–61	1937		[4] 55.8		
				1945			37,400	
					10		25,300	7
					16	39.40		
	Illinois River basin							
64	Sangamon River near Oakley, Ill.	750	1943–61	1943		21.85	(1)	
			1951–61	1959		18.45	13,700	
					9	18.85	15,300	
65	Salt Creek near Rowell, Ill.	334	1926	1926		(12)	(1)	
			1942–61	1943		[13] 24.77	12,400	
				1959		24.84		
					8	23.72	10,300	18
66	Kickapoo Creek near Lincoln, Ill.	306	1929–61	1929		17.4	(1)	
			1944–61	1950		13.66		
				1956			7,800	
					8	13.50	7,600	9
	Kaskaskia River basin							
67	Wolf Creek near Beecher City, Ill.	48.0	1958–61	1959		11.59	2,290	
					8	12.53	5,250	
68	Kaskaskia River at Vandalia, Ill.	1,980	1908–12,	1951		27.39		
			1914–61	1957			62,700	
					9	24.9	35,000	13
69	Kaskaskia River at Carlyle, Ill.	2,680	1908–12, 1914–15, 1938–61.	1943		33.69	54,400	
					10	31.12	34,400	11
70	Blue Grass Creek near Raymond, Ill.	17.2	1960–61	1960		11.42	332	
					8	12.24	364	
71	Shoal Creek near Breese, Ill.	760	1909–12, 1914, 1943–61.	1943		25.6	52,000	
					10	21.33	17,600	7
72	Kaskaskia River at New Athens, Ill.	5,220	1902–12, 1914–21, 1934–61.	1943		[13] 39.35	83,000	
					13	35.87	66,600	17
73	Lick Branch near Eden, Ill.	1.26	1959–61	1959		13.21	(1)	
					7	14.18	(1)	
74	Marys River near Sparta, Ill.	17.8	1949–61	1958		15.04	5,320	
					8	13.66	1,700	
	Big Muddy River basin							
75	Big Muddy River near Benton, Ill.	498	1945–61	1946			28,200	
				1946		24.02		
					9		38,600	
					9	24.94		
76	Big Muddy River at Plumfield, Ill.	753	1908–12,	1946			26,100	
			1914–61	1946		28.22		
					10		42,900	[3] 2.30
					10	29.67		
77	Crab Orchard Creek near Marion, Ill.	31.9	1951–61	1957		11.55	3,380	
					7	11.62	3,500	
78	Crab Orchard Lake near Carbondale, Ill.		1952–61	1957		8.30		
					8	8.20		
79	Beaucoup Creek near Matthews, Ill.	291	1945–61	1946		23.24	18,100	
					9	23.41	18,800	[3] 1.04
80	Big Muddy River at Murphysboro, Ill.	2,170	1916–61	1916			28,000	
				1949		36.01	28,000	
					11		33,300	18
					12	37.97		

See footnotes at end of table.

TABLE 6.—*Flood stages and discharges, May 5–21, Ohio to Oklahoma*—Con.

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to May 1961: Period	Maximum floods: Prior to May 1961: Year	Maximum floods: May 1961	Maximum floods: Gage height (feet)	Maximum floods: Discharge: Cfs	Maximum floods: Discharge: Recurrence interval (years)
	Osage River basin							
81	Pottawatomie Creek near Garnett, Kans.	334	1887–1928, 1939–61.	1951		32.30	45,300	
					6	31.15	27,400	16
82	Big Sugar Creek at Farlinville, Kans	198	1875–1961	1899		31	(1)	
			1929–32, 1948–61	1951		29.2	24,000	
					6	29.88	30,000	30
83	Little Osage River at Fulton, Kans.	295	1948–61	1954		28.93	18,200	
					6	29.38	20,700	7
84	Marmaton River near Fort Scott, Kans.	411	1904–61	1915		42.34	(1)	
			1921–25, 1929–61	1935		37.30	37,400	
					6	42.67	38,100	16
85	Franca Branch near Brighton, Mo.	(1)	1955–61	1955		14.35	298	
					5	15.67	(1)	
86	Pomme de Terre River near Bolivar, Mo.	225	1950–61	1958		17.30	17,600	
					5	17.15	17,300	12
87	Olinger Creek near Buffalo, Mo.	1.96	1957–61	1959		10.65	770	
					5	16.4	3,250	
88	Lindley Creek near Polk, Mo.	112	1914	1914		25.2	(1)	
			1957–61	1958		19.16	12,000	
					5	23.60	28,000	[3] 1.83
89	North Fork Ingalls Creek near Louisburg, Mo.	.32	1958–61	1960		6.13	(1)	
					7	6.44	166	
90	Brushy Creek near Blairstown, Mo.	1.15			5	9.90	1,270	
91	Little Turkey Creek tributary near Warsaw, Mo.	.18	1959–61	1959		10.50	112	
					5	11.10	(1)	
92	Jack Buster Creek at Eugene, Mo.	.17			5	9.10	290	
93	Osage River near St. Thomas, Mo.	14,500	1931–61	1943		43.8	216,000	
					13	37.10	149,000	5
	Gasconade River basin							
94	Laquey Branch near Hazelgreen, Mo.	1.58	1959–61	1959		4.92	519	
					5	6.44	825	
95	Prewett Hollow near Dixon, Mo.	.46			5	14.33	500	
96	Gasconade River at Jerome, Mo.	2,840	1897	1897		29.0	120,000	
			1903–06, 1923–61	1945		27.7	101,000	
					10	23.90	62,800	6
	Bon Homme Creek basin							
97	Shotwell Creek near Ellisville, Mo.	.81			7	20.69	718	
	Mississippi River main stem							
98	Mississippi River at Memphis, Tenn.	932,800	1933–61	1937			1,980,000	
				1937		48.69		
					20, 21		1,451,000	
					22	40.18		
	St. Francis River basin							
99	Little River ditch 1 near Kennett, Mo.	235	1926–61	1937		16.80		
				1950			7,660	
					7	14.2	5,690	50
100	Castor River at Aquilla, Mo.	175	1945–61	1957		14.00	4,100	
					7	14.43	4,700	[3] 1.14
101	Little River ditch 1 near Morehouse, Mo.	450	1945–61	1958		18.26	7,660	
					10	19.35	8,250	21

See footnotes at end of table.

TABLE 6.—*Flood stages and discharges, May 5–21, Ohio to Oklahoma*—Con.

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to May 1961: Period	Year	May 1961	Gage height (feet)	Discharge: Cfs	Recurrence interval (years)
	White River basin							
102	War Eagle Creek near Hindsville, Ark.	262	1943–61	1943		28.1	50,000	
					7	23.10	31,600	4
103	White River near Rogers, Ark.	1,020	1892–1961	1943		52.9	100,000	
					8	40.60	53,600	7
104	Osage Creek at Osage, Ark.	45.4			7		34,100	[3] 1.85
105	Osage Creek tributary at Berryville, Ark.	.3			7	7.58	406	
106	Osage Creek near Berryville, Ark.	164			7		40,000	50
107	Kings River near Berryville, Ark.	532	1927–61	1927		38.0	62,000	
					7	35.98	55,900	15
108	Long Creek at Alpena, Ark.	67.3			7		30,000	[3] 1.27
109	Crooked Creek tributary near Marble Falls, Ark.	4.3			7		2,980	
110	West Fork Crooked Creek near Harrison, Ark.	20.1			7		25,400	[3] 2.25
111	Crooked Creek at Harrison, Ark.	73			7		54,100	[3] 2.18
112	Hussar Creek at Bellefonte, Ark.	5.7			7		5,570	
113	Buffalo River near Rush, Ark.	1,091	1915–61	1915		45.5	164,000	
					6	27.55	61,700	3
114	Big Creek near Yukon, Mo.	8.36	1945	1945		10.5	(1)	
			1949–61	1956		6.15	4,860	
					7	5.8	4,780	45
115	Black River at Pocahontas, Ark.	4,843	1927	1927		25.9	(1)	
			1936–61	1945		24.32	59,600	
					12	24.18	52,300	11
116	Spring River at Imboden, Ark.	1,162	1915	1915		32.1	(1)	
			1936–61	1949		28.42	78,500	
					7	27.75	72,500	30
117	Eleven Point River near Ravenden Springs, Ark.	1,123	1929–33, 1935–61	1958		20.83	37,600	
					8	20.47	35,800	30
118	Black River at Black Rock, Ark.	7,323	1915	1915		31.9	160,000	
			1929–31, 1939–61	1949		28.5	103,000	
					8	28.0	96,300	15
	Arkansas River basin							
119	Grouse Creek tributary near Cambridge, Kans.	1.8	1957–61	1959		13.87	1,020	
					5	[13] 17.12	1,300	
120	Sandy Creek near Yates Center, Kans.	6.8	1957–61	1959		19.60	2,800	
					5	18.29	2,000	
121	Verdigris River near Altoona, Kans.	1,138	1938–61	1951		31.09	71,000	
					5	27.01	29,600	4
122	Salt Creek near Severy, Kans.	7	1957–61	1958		19.03	5,400	
					5	19.24	6,500	
123	Elk River near Elk City, Kans.	575	1869–1961	1951		30.65	81,500	
					6	33.90	100,000	[3] 1.3
124	Verdigris River at Independence, Kans.	2,892	1885–1961	1943			117,000	
				1943		47.60		
					6	47.03	110,000	19
125	Big Hill Creek near Cherryvale, Kans.	37	1951	1951		18.92	(1)	
			1957–61	1959		17.45	3,180	
					5	17.75	3,530	
126	Verdigris River near Lenapah, Okla.	3,639	1938–61	1943		40.44	137,000	
					8	39.78	121,000	17
127	Caney River near Elgin, Kans.	445	1938–61	1944		29.80	35,500	
					6	31.86	49,600	32

See footnotes at end of table.

TABLE 6.—*Flood stages and discharges, May 5-21, Ohio to Oklahoma*—Con.

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to May 1961: Period	Maximum floods: Prior to May 1961: Year	Maximum floods: May 1961	Maximum floods: Gage height (feet)	Maximum floods: Discharge: Cfs	Maximum floods: Discharge: Recurrence interval (years)
	Arkansas River basin—Continued							
128	Verdigris River near Inola, Okla.	7,911	1943-61	1943		54.93	224,000	
					11	53.67		
					12		118,000	
129	Lightning Creek near McCune, Kans.	197	1938-46, 1959-61	1943		17.81	23,000	
					6	17.46	19,000	4
130	Spring River at Larussell, Mo.	306	1957-61	1957		13.50	8,190	
					8	15.30	16,300	7
131	O'Possum Creek at Jasper, Mo.	9.67	1955-61	1955		14.12	(1)	
					8	14.20	(1)	
	Red River basin							
132	Little River near Wright City, Okla.	645	1929-31, 1944-61	1950		45.77	75,400	
					6	45.60		
					6		78,200	
133	Little River below Lukfata Creek near Idabel, Okla.	1,226	1938	1938		39.7	86,000	
			1946-61	1949		39.22	76,000	
					7	36.30		
					7		53,800	
134	Rolling Fork near De Queen, Ark.	181	1947-61	1947		25.6	110,000	
					6	20.11	20,500	4
135	Pepper Creek near De Queen, Ark.	6.5			5	7.03	1,440	
136	Little River near Horatio, Ark.	2,674	1915-61	1915		38	124,000	
					9	31.08	46,200	2
137	Cossatot River near De Queen, Ark.	361	1938-61	1947		20.47	46,900	
					6	20.70	62,000	50
138	Saline River near Dierks, Ark.	124	1920-61	1920		21.9	42,000	
					6	22.50	52,000	[3] 1.78
139	Caddo River at Glenwood, Ark.	192	1939-61	1945		27.0	65,000	
					6	27.95	(1)	
140	Caddo River near Alpine, Ark.	312	1927-61	1945		30.2	64,200	
					6	27.15	55,800	48
141	Little Missouri River at Narrow Dam, Ark.	237	1951-61	1952		405.4	[14] 5,260	
					6		[15] 72,300	[3] 1.56
142	Little Missouri River near Murfreesboro, Ark.	380	1927-61	1927		21.0	(1)	
			1928-61	1945		19.84	120,000	
					6	12.28	[14] 13,000	

[1] Not determined.
[2] Contributing drainage area.
[3] Ratio of peak discharge to 50-yr flood.
[4] Affected by backwater from Ohio River.
[5] At site 1,400 ft upstream at same datum.
[6] At different site and datum.
[4] Flow regulated since 1953 by Lake Lemon, 8.1 miles upstream.
[8] Flow regulated since 1952 by Cagles Mill Reservoir.
[9] At site 3,500 ft upstream at datum 2.41 ft higher.
[10] At supplementary gage site; gage height at gaging station on May 10, 1961, 20.62 ft.
[11] At site 3 miles downstream at datum 6.94 ft lower.
[12] Exceeded that of 1943 by about 1½ ft, 6½ miles downstream.
[13] Affected by backwater from ice.
[14] Regulated.
[15] Computed reservoir inflow.

INDIANA

Storms of May 5-6 soaked the ground, and continuing heavy rains of May 7-9 produced the floods in the south half of Indiana. Precipitation during May 5-9 in this area ranged from 3.21 to 11.18 inches. The greatest amount was recorded at Mount Vernon, in the southwest corner of the State.

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Peak discharges of this flood exceeded previous maximum peaks at five gaging stations (table 6) in southern Indiana.

Flooding was particularly heavy in the basins of Pigeon Creek and upper Patoka River. Pigeon Creek reached a stage of 27.94 feet at the recently established gaging station at Evansville, and had the greatest headwater flood known to local residents, although backwater from the flooding Ohio River has caused higher stages at times. Because of overbank flow from Pigeon Creek and the inability of city storm sewers to carry away the runoff, 400 families were evacuated from their houses, and heavy industrial damage resulted. The stages of the Patoka River at the recently established gaging station near Ellsworth and at the gaging station at Jasper were the highest known to local residents since the floods of 1913.

Flooding on other southern Indiana streams was severe, and damage occurred throughout the valleys of the East Fork White River and the lower White River. About 200 persons were evacuated at Columbus. Trinity Springs and Indian Springs were isolated by floodwaters, and Williams was accessible only by back roads. Forty families in Shoals and 50 families in Spencer were evacuated. Damage to roads and bridges was heavy, and many State and Federal roads were closed by high water.

ILLINOIS

During May 5–9, rain in the amount of 4–8 inches fell in the central part of Illinois. A maximum of 15.7 inches, of which 14.25 inches fell in 24 hours, was recorded in Clinton, De Witt County. In the area south of a line extending northeast across the State from above East St. Louis, on the Mississippi River, to the Wabash River near Terre Haute, Ind., the rainfall ranged from 7 to 12 inches for the 5-day period (fig. 14). The isohyets for Illinois are based on a map prepared by the Illinois State Water Survey Division.

Hundreds of National Guardsmen were called to active duty along with Civil Defense and American Red Cross personnel to aid in the evacuation and care of thousands of persons who were forced from their homes. Nearly every major highway and secondary road was affected by the floodwater which isolated towns and inundated hundreds of thousands of acres of farmland.

Fifteen southern counties were designated major disaster areas by the Small Business Administration, Washington, D.C. One death was caused by the flood, and damage in the State was estimated at $5 million.

In the central part of the State, farmlands were flooded and many major highways were closed to traffic. The floodwaters of an unnamed creek at Clinton (population, 7,300) overturned automobiles in the main streets of the business district. The rushing water closed traffic on U.S. Highways 51 and 54, on Illinois Highway 10, and on the Illinois Central Railroad. A bridge was washed out west of Clinton, and 1,400 homes were flooded causing damage estimated at $300,000. The flood was reported to be the worst since 1943 in Lincoln. Many families were routed from their homes by the water from Salt Creek. A levee on a tributary to the Sangamon River broke near Monticello. The upper Embarrass River south of Champaign spread out over flat fields forming a broad lake. A levee topped by 20,000 sand bags held the water out of Lawrenceville, near the mouth of the Embarrass River, but 15,000 acres of land outside of the town was inundated.

U.S. Highway 51 near Vandalia was under water from the Kaskaskia River, and six levee breaks caused flooding of 40,000 acres of cropland.

Centralia was almost isolated. The city's sewage-disposal plant was destroyed by a fire which could not be fought because the water-supply pumps were submerged in floodwater. National Guardsmen manned the levees nearby.

The flood peak on the Kaskaskia River at New Athens was the maximum since 1946 (table 6) and had a recurrence interval of 17 years. (See Mitchell, 1954.) Floodwaters poured down the main streets and were 4 feet deep in the business district. A farmer searching for his cattle drowned when he apparently waded into deep water.

In the East St. Louis area, 500 volunteers sandbagged a drainage ditch levee east and south of Cahokia for 2 days, but 75 families were left homeless by the overflowing waters. Mass typhoid-fever innoculations were given in the Cahokia Village Hall. Several hundred race horses were evacuated from nearby Cahokia Downs race track. About 60 families from an East St. Louis subdivision and hundreds of persons in the surrounding areas were evacuated.

In the Big Muddy River basin a similar pattern of damage and flooding continued. At the gaging station at Plumfield the flood was the maximum in about 50 years of record and had a recurrence interval much greater than 50 years. (See Mitchell, 1954.) At Mount Vernon 30 families were evacuated, and the Louisville and Nashville Railroad tracks were washed out. Elsewhere in Jefferson County, a dozen highway bridges were washed out, and an estimated one-third of the strawberry, peach, and wheat crops were ruined. A man was injured in Benton when he drove down a flooded road and plunged into a creek where the bridge had washed out. In Marion, 200 families were affected when the southern part of town was covered with 2 feet of water. Damage to crop and farm equipment in Jefferson County was estimated at $4 million.

In the Wabash River basin, the crest stage and discharge at the gaging station on Bonpas Creek at Browns was the highest in 21 years of record and had a recurrence interval of 40 years (See Mitchell, 1954.) The entire town of Browns (population, 251) was evacuated. The Little Wabash River gaging station below Clay City had a crest stage and discharge which were exceeded only once in 47 years (slightly higher in 1950) and had a recurrence interval of 45 years. Skillet Fork at Wayne City, which had the greatest discharge in 43 years of record and had a recurrence interval much greater than 50 years, washed out a section of the Southern Railroad tracks about a mile below the gaging station. Near the mouth of the Little Wabash River, at Carmi, the peaks exceeded the previously known maximum stage of January 1937 and the peak discharge for 22 years of record and had a recurrence interval greater than 50 years. The National Guard helped evacuate nearly one-third of the 5,000 residents of Carmi. A Baptist orphanage became an island. Total damage in White County was estimated by the American Red Cross to be from $8 to $10 million, and nearly 60 percent of the county was under water.

KANSAS

Local heavy rains in southeastern Kansas started on April 30 and were followed by intermittent light rains which increased the soil moisture. Unusually heavy rains on May 5 caused excessive flooding, particularly in the Elk River basin. Rainfall totals were large. At Grenola, on May 5, the rainfall was 7.07 inches; the average for a 5-hour period was more than 1 inch per hour, and the maximum intensity was 2.05 inches per hour. The peak discharge (table 6) at the gaging station on Elk River near Elk City was 1.3 times the discharge of the 50-year flood and was the highest flood since at least 1869. Local residents described the flood as the worst since 1885. Several families, stranded in river bottom homes, were rescued by boat. Small drainage areas had heavy runoff. At the crest-stage station on Grouse Creek tributary near Cambridge, the peak discharge was 1,300 cfs, or 723 cfs per sq mi from 1.8 square miles. In the Fall River basin at the crest-stage station on Salt Creek near Severy, the peak discharge was 6,500 cfs, or 929 cfs per sq mi from 7 square miles. Regulation by flood-control reservoirs on the Verdigris River above Altoona and on the Fall River above Fredonia reduced the recurrence intervals of the peak discharges to only 4 years. Downstream from the mouth of the Elk River, the Verdigris River at Independence had a peak discharge of 110,000 cfs, which has a recurrence interval of 19 years. The flood stage at Independence was 0.57 foot below the maximum stage known since at least 1885.

The U.S. Army Corps of Engineers estimated the total inundated area on the Elk River at 30,700 acres, the rural property losses at $358,000, urban property losses at $37,000, and crop losses at $355,000.

MISSOURI

Flooding was prevalent throughout Missouri on May 5–10 in a band approximately 150 miles wide extending from the southwest corner of the State diagonally in a generally northeast direction toward the city of St. Louis. Rainfall amounts were heaviest in the southwestern part of the State, as shown on figure 14. However, generally heavy rains fell across all Missouri during the period, and heaviest concentrations were south of the Missouri River. Rains were general throughout the State during the 5-day period, and there were only a few rains of high intensities. The rainfall was flood producing owing to the quantity of rainfall. All streams were high in the area, and several exceeded previous maximums (table 6) of which many were on small-area stations having rather short-term records. Some record peaks occurred on longer term large stations.

Stages on the Osage River were the highest since 1943 and the third highest during the period of record beginning in 1931. Stages on the lower Gasconade River were the highest since 1946. In the southeastern part of the State, the Little River ditches were generally about a foot lower than the previous maximum of record, and the stage on Castor River at Aquilla exceeded the previous maximum. The Spring River in the southwestern part of the State was the highest since 1943.

The broad, general coverage in the flood area resulted in damage estimated at more than $2 million, by the U.S. Army Corps of Engineers. No loss of life due to the flood and few concentrations of heavy damage were reported.

ARKANSAS

Heavy rains during the night of May 5–6 caused severe flooding on Cossatot, Saline, Little Missouri, and Caddo Rivers in southwestern Arkansas. Slightly more than 9 inches of rain fell during a 24-hour period at Langley on the headwaters of the Little Missouri River. The greatest discharges for period of record, beginning in 1938, were recorded on Cossatot River near De Queen and Saline River near Dierks. The peak stage on Saline River exceeded that for the historic flood of 1920 by 0.6 foot. Discharge on Caddo River near Alpine was second greatest since at least 1927 and was exceeded by the flood of 1945. The stage on Caddo River at Glenwood was the highest known and exceeded that of the 1945 flood by about 1 foot. The peak discharge on the Cossatot River had a recurrence interval of 50 years, whereas peak discharges on the Saline River and upper Little Missouri River greatly exceeded the 50-year flood. Flooding on Little Missouri River below Lake Greason was prevented by impounding flood waters in the reservoir. More than 200 cattle were drowned and considerable damage was caused to growing crops.

During the night of May 6–7 heavy rains shifted to the northwestern part of the State, and the storm was centered south and southwest of Harrison. Rain-gage records and a bucket survey show that 4–6 inches of rain fell on headwaters of War Eagle Creek, Kings River, Long Creek, and Crooked Creek. The storm was characterized by its intensity, as most of the rainfall occurred during a 2- to 3-hour period. Heavy rainfall began about midnight and, in the Harrison area, ended at about 3 a.m., May 7.

Harrison, on Crooked Creek, the only urban area seriously damaged, had the most devastating flood in its history. About 80 percent of its business district was inundated and four persons were drowned. Water went over the levee protecting the city and reached a depth of 12–14 feet in the business district. Several downtown buildings collapsed. Thirty houses near Crooked Creek were either moved from their foundations or washed away. More than a hundred automobiles were damaged or destroyed. The U.S. Soil Conservation Service and U.S. Corps of Engineers, estimated the damage in the city of Harrison at more than $5 million, and rural damage in Crooked Creek basin at about $66,000. Considerable damage also occurred in rural areas outside the Crooked Creek basin, particularly along Osage Creek, tributary to Kings River. The Arkansas Highway Department estimated damage to State highways in the area to be $120,000, of which $55,000 was in Madison County. County roads in the area were considerably damaged. Extremely high rates of runoff occurred on headwaters of the streams. No gaging stations are in the area of greatest runoff, but indirect measurements of peak discharge were made at five miscellaneous sites and at two crest-stage gages in the area. Peak discharges on Crooked Creek and Osage Creek had recurrence intervals considerably greater than 50 years.

FLOODS OF MAY 15–18, 27–30, IN MAINE

March and April were cooler than normal throughout Maine. This cold weather accounted for a heavy accumulation of snow in the northern part of the State owing to below normal rate of snowmelt. The Weather Bureau estimated there was 2 or 3 feet of "ripe" snow cover in the upper St. John River basin in the beginning of May. Water equivalent of the snow cover was high—3.5 inches near Rangeley Lake in west central Maine, 9.8 inches at Telos Lake in the upper part of Penobscot River basin, and about 2 inches in the wooded areas in central Maine.

Temperatures increased considerably on May 10 and increased again very abruptly on May 13. During this warm period, general light rains occurred throughout the State.

The rains, in themselves, did not cause flooding, but the runoff in the area of rapidly melting snow caused the most outstanding floods. Maximum peak discharge of record occurred at many gaging stations in the St. John River basin (fig. 15).

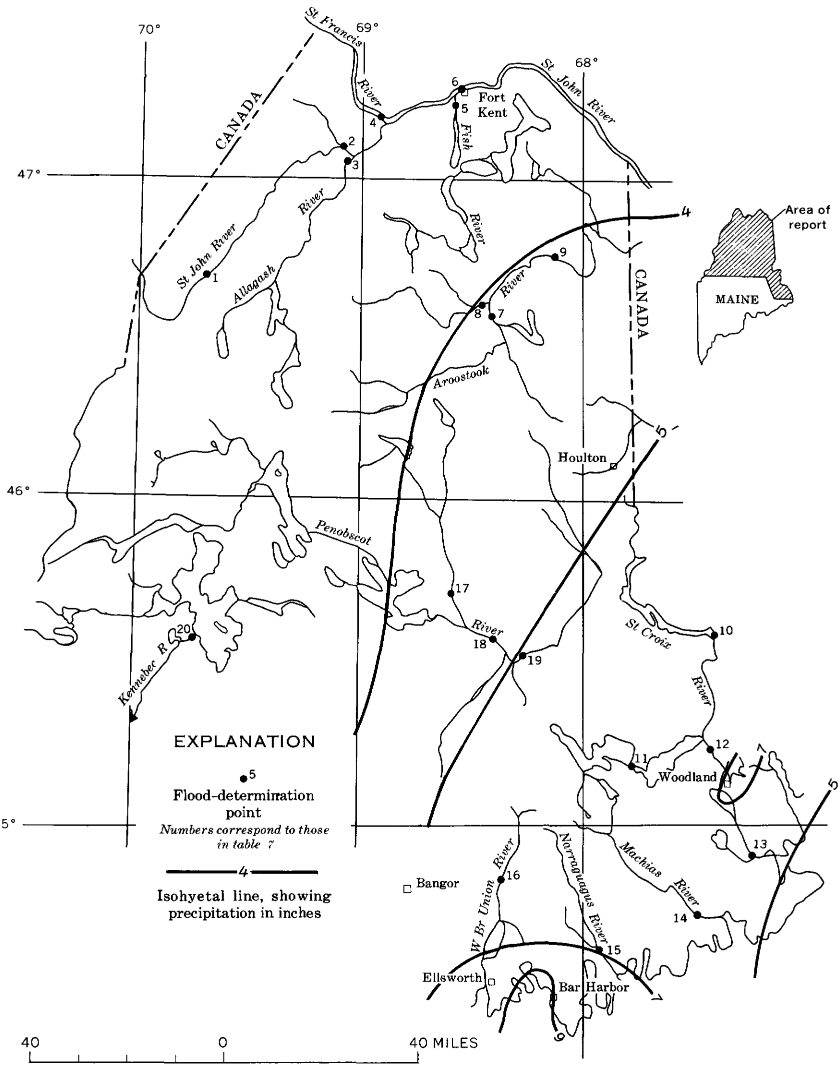

Figure 15.—Location of flood-determination points and isohyets for May 26–29, floods of May 15–18, 27–30 in Maine.

The peak discharge in Fish River near Fort Kent was about 10 percent greater than the previous maximum discharge during 38 years of record.

St. John River at Fort Kent reached a stage of 25.30 feet on May 15 which is 0.2 foot greater than the previous maximum of record which occurred in 1933. This stage is about 9 feet above the flood plain and about 5 feet above the stage at which the business district of Fort Kent begins to flood. At the crest, from one-third to one-half of Fort Kent was inundated; a great amount of damage was caused. Other towns along the St. John River were flooded to various degrees.

Minor flooding occurred along the Aroostook River. Unusually heavy rains fell in eastern Maine during May 26–29 (fig. 15). The entire area from the Aroostook River south to the coastal areas received 4 or more inches of rain. The triangular area south of a line from Houlton to Bangor received 5 or more inches. Small areas near Ellsworth and Woodland had 7 inches, and Bar Harbor had 9 inches. For May 27 the Weather Bureau station at Bar Harbor reported 6.30 inches of rainfall, which is about equal to the 24-hour rainfall of a 100-year storm.

Most of the flooding was in the St. Croix River and small parallel streams to the west. Flooding was not particularly severe in any of the areas which received less than 5 inches of rain, but in areas of heavier rainfall the runoff was maximum of record. Two gaging stations had peak discharges greater than those for 100-year floods (table 7).

TABLE 7.—*Flood stages and discharges, May in Maine*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to May 1961: Period	Year	May 1961	Gage height (feet)	Discharge: Cfs	Recurrence interval (year)
			St. John River basin					
1	St. John River at Nine-mile Bridge.	1,290	1950–61	1958		10.97	34,200	
					15	10.45	31,300	30
2	St. John River at Dickey	2,700	1910–11, 1946–61	1953		[1] 19.88		
				1958			71,200	
					15	16.63	71,700	100
3	Allagash River near Allagash.	1,250	1910–11, 1931–61	1933			23,400	
				1960		[1] 14.16		
					17	12.21	28,800	[2] 1.20
4	St. Francis River at Outlet of Glazier Lake, near Connors, New Brunswick.	520	1951–61	1958		13.21	10,800	
					16	13.31	11,500	12
5	Fish River near Fort Kent.	871	1903–08, 1911, 1929–61.	1958		10.81	12,000	
					16	11.49	13,400	
6	St. John River below Fish River at Fort Kent.	5,690	1926–61	1933		25.1	121,000	
					16	25.30	131,000	[2] 1.26

See footnotes at end of table.

TABLE 7.—*Flood stages and discharges, May in Maine*—Continued

No	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to May 1961: Period	Prior to May 1961: Year	May 1961	Gage height (feet)	Discharge: Cfs	Discharge: Recurrence interval (years)
	St. John River basin—Continued							
7	Aroostook River near Masardis.	888	1957–61	1957		[1] 16.44		
				1958			21,500	
					16	16.03	20,600	18
8	Machias River near Ashland.	330	1951–61	1954		11.94	16,600	
					16	8.12	9,540	30
9	Aroostook River at Washburn.	1,652	1930–61	1936			37,800	
				1951		[1] 15.78		
					16	12.67	37,000	27
	St. Croix River basin							
10	St. Croix River at Vanceboro.	417	1928–61	1959		(3)	4,830	
					30	9.65	[4] 4,980	
11	Grand Lake Stream at Grand Lake Stream.	224	1928–61	1952		6.35	2,840	
					29	5.78	[4] 2,080	
12	St. Croix River near Baileyville.	1,320	1919–61	1923		13.90	23,300	
					28, 29	11.68	[4] 21,900	
	Dennys River basin							
13	Dennys River at Dennysville.	92.4	1955–61	1959		5.85	1,640	
					27	7.61	2,700	14
	Machias River basin							
14	Machias River at Whitneyville.	457	1905–21, 1929–61	1936		[1] 16.18		
				1950			11,800	
					29	16.92	14,800	[2] 1.21
	Narraguagus River basin							
15	Narraguagus River at Cherryfield.	232	1948–61	1950		15.81	7,250	
					28	17.40	10,400	[2] 1.37
	Union River basin							
16	West Branch Union River at Amherst.	148	1909–19, 1929–61	1940			4,140	
				1942		[1] 10.41		
					27	7.59	2,240	3
	Penobscot River basin							
17	East Branch Penobscot River at Grindstone.	1,070	1902–61	1923		16.9	37,000	
					29	11.58	[4] 17,100	
18	Penobscot River near Mattawamkeag.	3,310	1940–61	1945		11.09	40,200	
					29	13.12	[4] 43,300	
19	Mattawamkeag River near Mattawamkeag.	1,418	1934–61	1936		15.34	29,200	
					31	11.11	18,200	3
	Kennebec River basin							
20	Kennebec River at Moosehead.	1,266	1919–61	1947		9.94	15,600	
					18	9.55	[4] 14,500	

[1] Affected by backwater from ice.
[2] Ratio of peak discharge to 100-yr flood.
[3] Not determined.
[4] Regulated by reservoir.

Major damage occurred along the small rivers. Some bridges were washed out or badly damaged, and washouts in roads and railroads isolated many communities. Flash floods struck many towns, and many basements were flooded. Several families were evacuated from their homes in Machias. Some pulpwood was lost owing to the breaking of large log booms on the St. Croix and Machias Rivers. The released logs badly damaged the Union Mills bridge on the St. Croix River and the Machias bridge on the Machias River. The damage from the two May floods totaled about $1.3 million.

FLOODS OF MAY AND JUNE IN SOUTHEASTERN NEBRASKA

Southeastern Nebraska received fairly heavy rains in two 5-day periods, May 3–7 and 13–17, during which more than 3 inches of rainfall was recorded at many U.S. Weather Bureau stations. After a respite of 1 day, the rain continued on May 19 and 20. The antecedent rains did not produce high discharges, but they saturated the ground. Additional heavy rains on May 21 and 22 (table 8) in the south central plains (fig. 16) caused noteworthy rates of discharge in two small drainage areas in two widely separated regions.

Peak discharges in the School Creek basin (table 9) southeast of Harvard were from two to three times as much as the previous maximums in 9 years of record and were 1.2 times that of 25-year floods.

TABLE 8.—*Daily precipitation, in inches, associated with floods of May and June in in south-central Nebraska*

[Data from U.S. Weather Bur.]

Station	Time of observation	May				
		19	20	21	22	Total
Aurora	8 a.m.	0.09	0.07	0.45	1.91	2.52
Blue Hill, 3 SW	7	.52	.55	1.07	1.45	3.59
Bruning	7	.26	----------	.58	3.74	4.58
Clay Center	5 p.m.	----------	.18	4.10	1.75	6.03
Deweese, 4 SE	8 a.m.	.56	.20	1.65	3.70	6.11
Fairmont	7	Trace	.08	.30	1.10	1.48
Hastings	5 p.m.	.21	.24	1.90	1.13	3.48
Hebron	8 a.m.	.32	.10	1.11	1.93	3.46
Hubbell	8	.06	.35	.82	1.06	2.29
Kearney	8	.44	.31	1.24	1.91	3.90
Minden	6 p.m.	.45	.20	2.65	.60	3.90
Nelson	7	.43	.42	2.98	.90	4.73
Western	7 a.m.	.15	.11	.52	1.07	1.85
		June				
		3	4	5	6	Total
Aurora	8 a.m.	----------	----------	0.73	0.27	1.00
Blue Hill, 3 SW	7	0.10	Trace	.59	.32	1.01
Clay Center	5 p.m.	----------	----------	1.95	1.45	3.40
Deweese, 4 SE	8 a.m.	----------	----------	.65	1.20	1.85
Fairmont	7	Trace	----------	.45	.34	.79
Hastings	5 p.m.	----------	1.11	.65	.01	1.77

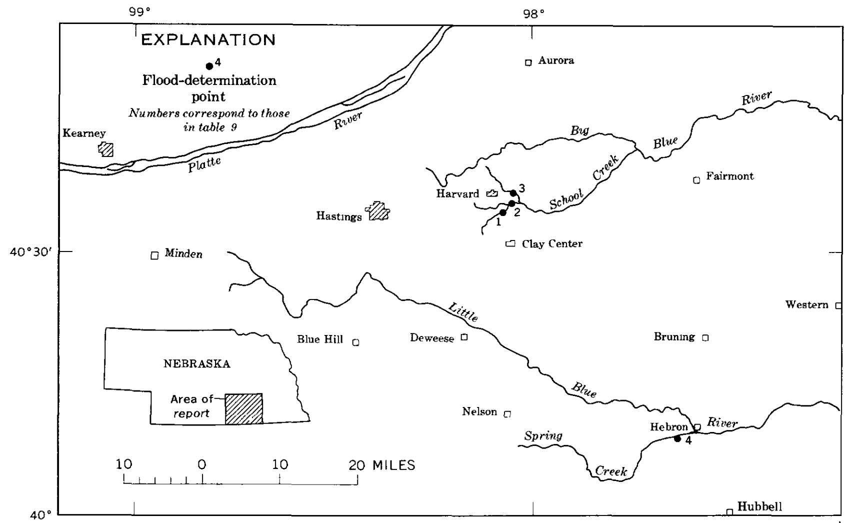

FIGURE 16.—Location of flood-determination points and of precipitation observation, floods of May and June in southeastern Nebraska.

TABLE 9.—*Flood stages and discharges, May and June in southeastern Nebraska*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods					
			Prior to May 1961		May–June 1961	Gage height (feet)	Discharge	
			Period	Year			Cfs	Ratio to 25-yr flood
	Kansas River basin							
1	School Creek tributary near Harvard.	13.1	1953–61	1960	----------	12.17	300	--------
					May 21	13.16	999	1.2
2	School Creek near Harvard.	55.1	1953–61	1960	----------	17.11	1,240	--------
					May 21	17.64	2,690	1.2
3	School Creek tributary 2 near Harvard.	14.0	1953–61	1960	----------	16.83	584	--------
					June 6	18.80	1,120	1.3
4	Spring Creek near Hebron.	17.0	1957–61	1960	----------	--------	754	--------
					May 22	--------	2,340	2.3

The 5 inches of rain which fell during May 19–22 in the headwaters of Spring Creek west of Hebron produced a high-peak discharge which was more than three times the previous maximum in 4 years of record and was 2.3 times that of a 25-year flood.

Only 2 weeks after the storm of May 19–22 in the School Creek basin, another intense storm on June 5 and 6 in the same area produced more than 3 inches of rain at Clay Center (table 8). Greater amounts than this may possibly have fallen over the small basin of School Creek tributary 2 north of Harvard. The peak discharge from the basin on June 6 was almost two times as large as the previous maximum in 9 years of record and was 1.3 times that of a 25-year flood.

No large areas were affected by the flood and no great damage resulted, but the probability of the recurrence of a discharge 1.2 or more times a 25-year flood at any given point in southeastern Nebraska is very low.

FLOODS OF MAY TO JUNE IN THE COLUMBIA RIVER BASIN

High discharges occurred in late May and early June on the Kootenai, the upper Flathead, and the Pend Oreille Rivers (fig. 17). Flooding was most extreme on the Kootenai River, particularly at Bonners Ferry, Idaho.

Peak flow estimates on April 1 indicated moderate flooding would probably occur on Kootenai River at Libby, Mont., and at Bonners Ferry, Idaho. But the unusual weather pattern after April 1 produced the highest stage ever to occur at Bonners Ferry.

The temperatures in the Columbia River basin during April were persistently below normal. During May 2–8 they were the coldest (relative to normal) of the entire year, and they continued subnormally cold until May 18. Snow accumulated in the upper

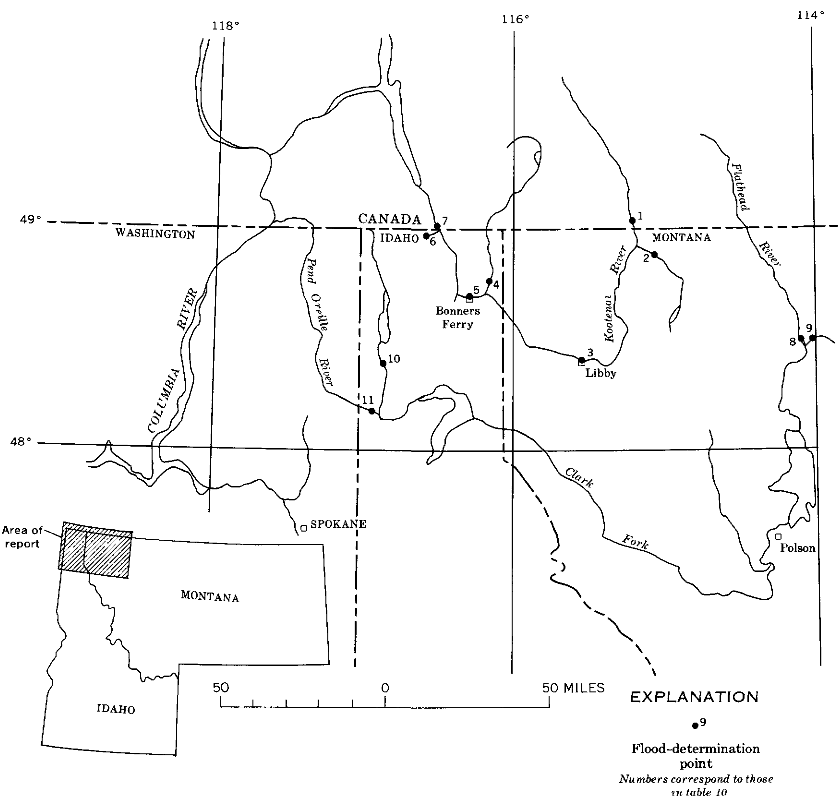

FIGURE 17.—Location of flood-determination points, floods of May to June in the Columbia River basin.

Columbia River and Kootenai River basins in Canada, and measurements of water content showed a steady increase from April 1 to May 15. Snowmelt was at a minimum, and streamflow was below average.

On May 18 temperatures suddenly increased to as high as 70° F in some parts of the Columbia River basin, and succeeding days were progressively warmer. The high temperatures acting on the excessive snowpack in the upper Columbia River and Kootenai River in Canada caused sharp rises in the headwater streams which produced moderate rises in the main-stem tributaries. The discharge in Kootenai River at Libby, Mont., increased from about 25,000 cfs during the middle of May to a peak of 96,000 cfs on May 29. In this same period the stage at Bonners Ferry increased from about 1,760 to 1,780.13 feet, the maximum stage of record since 1927 and 0.04 foot higher than the previous maximum of 1956. The peak discharges at selected sites in the basins of the Kootenai, Flathead, and Pend Oreille Rivers are shown in table 10.

TABLE 10.—*Flood stages and discharges, May to June in the Columbia River basin*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to May 1961: Period	Year	May–June 1961	Gage height (feet)	Discharge: Cfs	Recurrence interval (years)
	Kootenai River basin							
1	Kootenai River at Newgate, British Columbia.	7,660	1930–61	1948		15.02	98,200	
					May 28	14.31	91,800	40
2	Tobacco River near Eureka, Mont.	440	1948	1948		(1)	2,810	
			1958–61	1959		6.10	1,700	
					May 27	7.12	2,300	
3	Kootenai River at Libby, Mont.	10,240	1910–61	1916		20.7	121,000	
					May 29	18.23	96,000	32
4	Moyie River at Eileen, Idaho.	755	1916	1916		(1)	12,000	
			1925–61	1954		6.99	11,000	
					May 27	6.66	10,100	25
5	Kootenai River at Bonners Ferry, Idaho.	13,000	1927–61	1948			139,000	
				1956		80.09		
					May 29	80.13	(1)	
6	Boundary Creek near Porthill, Idaho.	97	1928–61	1955		5.80	3,280	
					May 26	5.69	3,170	[2] 1.14
7	Kootenai River at Porthill, Idaho.	13,700	1894	1894		72.7	(1)	
			1928–61	1948			[3] 125,000	
				1956		67.53		
					May 29		[3] 117,000	
					June 7	67.61		
	Pend Oreille River basin							
8	Flathead River near Columbia Falls, Mont.	1,553	1910–17, 1929–61	1954		12.25	31,500	
					May 28	11.83	29,900	50
9	Middle Fork Flathead River near West Glacier, Mont.	1,128	1939–61	1954		13.01	34,500	
					May 27	10.58	27,100	23
10	Priest River near Coolin, Idaho.	611	1948–61	1956		8.15	8,130	
					June 6	8.02	7,970	20
11	Pend Oreille River at Newport, Wash.	24,200	1894	1894		64	(1)	
			1903–41, 1952–61	1913, 1933		(1)	136,000	
					June 8	49.50	115,000	

[1] Not determined. [2] Ratio of peak discharge to 50-yr flood. [3] Mean daily.

Lower temperatures prevailed on May 26–30 and curtailed the rate of snowmelt; the stage at Bonners Ferry dropped almost 2 feet by June 2. High temperatures after May 31 once more accelerated the snowmelt, and the crest at Bonners Ferry on June 6 came within 0.2 foot of the maximum stage on May 29. The stage on June 7–9 may have exceeded even that of May 29 had not some dikes failed; this failure lowered the stage of the river and flooded several thousand acres of land.

Damage from the flood in Kootenai Valley near Bonners Ferry was reported by the U.S. Army Corps of Engineers, to have been about $3.4 million. Of this, $750,000 was to lands and crops, $360,000 was to improvements and equipment, about $1.3 million was cost of fighting the flood including evacuation costs, and $1 million was estimated damage to the levees. More than 7,000 acres, or about 21 percent of the productive bottomland, was flooded. It is estimated by the Corps of Engineers that total damage from the flood would have been $6.4 million without the extensive flood fight. About 3,100 persons and 340 pieces of equipment assisted in maintenance, sandbagging, patrolling, and other flood-fighting operations.

The 1961 flood at Bonners Ferry was the greatest of record not only in stage but also in duration above critical stage (fig. 18). During the two rises, the stage of the river remained within 1 foot of the peak gage height for about 9 days and within 2 feet for 14 days.

Two other floods in 1894 and 1948 were outstanding. The stage in 1894 reached 1,777.2 feet, but the magnitude of the flood cannot be compared with the 1961 flood because of the less effective levee system at the time of the earlier flood.

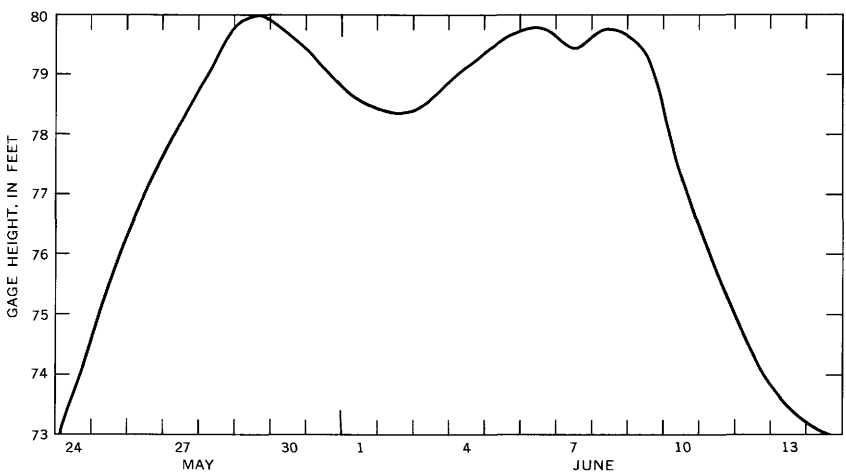

FIGURE 18.—Hydrograph of gage height of Kootenai River at Bonners Ferry, Idaho, May 24 to June 14.

Much of the information on the floods in the Columbia River basin was abstracted from a report by the U.S. Inter-Agency Committee on the Columbia River basin (1961).

FLOODS OF JUNE 25 IN FORT WORTH, TEX.

Flash floods occurred on small tributary streams in the Fort Worth area in the early morning of June 25. The most damaging flood was on Big Fossil Creek over which the intense rainfall was centered and which flows through Richland Hills, a northeastern suburb of Fort Worth.

Figure 19 is a map of the flood area showing the locations of peak discharge determination points and the location rainfall determination sites and the amounts of rainfall.

Three rain gages in the area showed rainfalls ranging from 3.64 to 4.71 inches, but the gages were too sparse to show significant amounts of rainfall or the distribution. A bucket survey by the U.S. Army Corps of Engineers covered the area (fig. 19) well enough so that the pattern of the storm's intensity could be determined. The greatest rainfall reported by the bucket survey was in a triangular area centered directly over the upper part of Big Fossil Creek and one of its tributaries where 7.7, 8.0, and 8.7 inches of rain were recorded.

The amount of the rainfall decreased southward, and about 1 mile upstream from the gaging station on Fossil Creek at Haltom City it was 4.1 inches. The recording rain gage at the gaging station measured 4.71 inches of rain and shows that most of the rain occurred in two periods (fig. 20). About 1.2 inches fell in half an hour in the first period, 8:30 p.m. to 9:00 p.m., June 24; 2.5 inches fell in the second period, 3:00 a.m. to 5:30 a.m., June 25; and 0.6 inch fell during the interval between the two periods.

The first period of rain produced a small rise of about 1,000 cfs in Fossil Creek, and the light rains following this kept the discharge up. The second period of heavy rain, which followed the initial soaking of the soil, produced the sharp rise to 18,300 cfs at 10 a.m.

Figure 20 shows that the rains (2 in. at the recording rain gage) preceding the second intense storm generated less than 0.5 inch of runoff from the Big Fossil Creek basin, whereas the rains of the second storm (2.7 in. at the recording rain gage) generated about 1.8 inches of runoff.

The peak stage at the gaging station on Fossil Creek at Haltom City was 23.06 feet, and the peak discharge was 18,300 cfs from 52.8 square miles of drainage area, or 347 cfs per sq mi. This flood was 2 feet higher than any other flood (12,600 cfs) in the short period since the gaging station was established in 1959. It is the fourth highest known flood since at least 1900. The maximum known flood at the

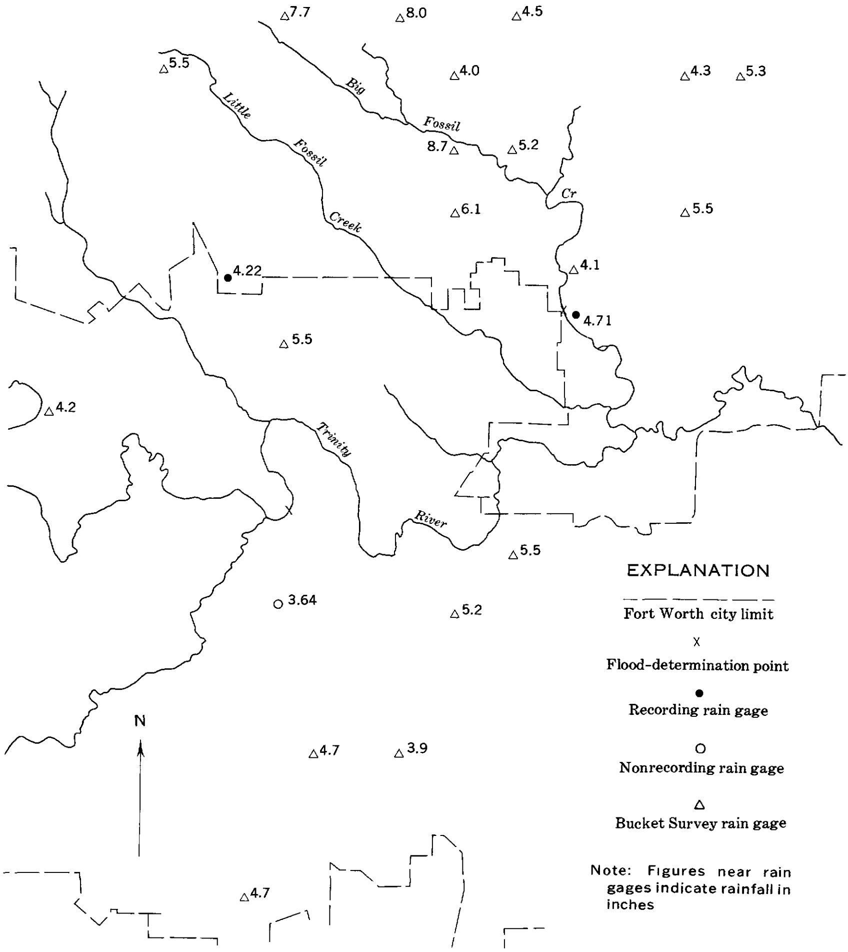

FIGURE 19.—Location of flood-determination points and rainfall data sites, floods of June 25 in Fort Worth, Tex.

station occurred in 1942 and had a peak stage of 24.8 feet. Floods in 1922 and 1949 had peak stages of 24.0 feet and 23.8 feet, respectively.

This small-area storm, although of high intensity, had little effect on the large streams in the area. The peak discharge on June 25 on West Fork Trinity River at Fort Worth (drainage area, 2,627 sq mi) was only 7,850 cfs.

The U.S. Weather Bureau estimated the flood damage at more than $1 million, most of which was to residential property. About 120 houses were flooded in Richland Hills. Two persons were

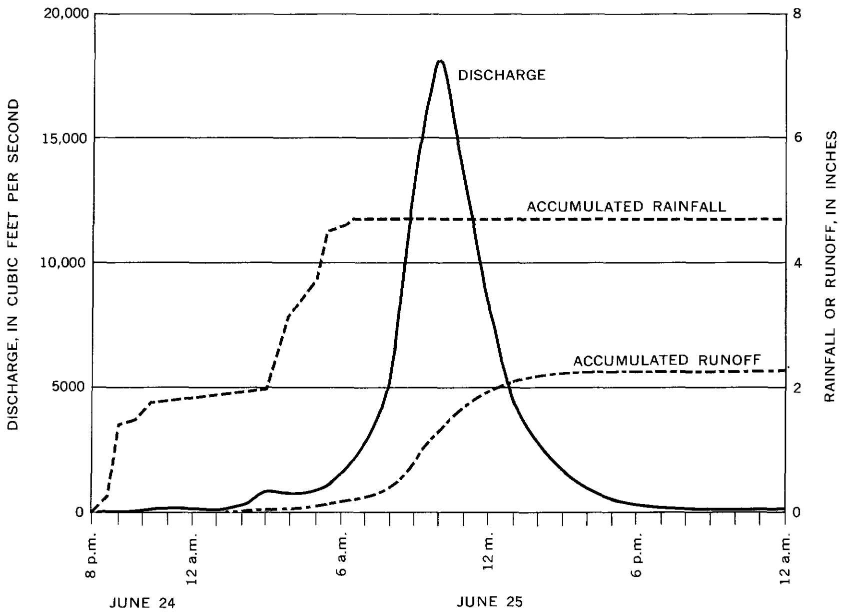

FIGURE 20.—Rainfall-runoff hydrograph for Big Fossil Creek at Haltom City, floods of June 25 at Fort Worth, Tex.

drowned when a truck in which they were riding dropped off a culvert into the floodwaters.

FLOOD OF JUNE 30 AT MUSCATINE, IOWA

A storm at Muscatine, Iowa, on June 30 resulted in a flash flood on Mad Creek, which was outstanding because of the loss of life and great property damage from a small drainage basin. Three lives were lost in a house which was swept away by the floodwaters and smashed against a concrete bridge. The U.S. Army Corps of Engineers estimated the property damage at $920,000. Rainfall lasted about 4 hours in the early morning; an unofficial 6.75 inches was reported at one location. Three regularly operated rain gages in the area, two operated by the U.S. Weather Bureau and one by the Corps of Engineers, recorded amounts of precipitation from 3.70 to 6.42 inches. A bucket survey was conducted by the Corps of Engineers, Rock Island District. Figure 21 is an isohyetal map derived from the results of the bucket survey.

Most damage was to commerical property including warehouses and industrial and retail buildings. A section of the Corps of Engineers Mississippi River flood protection wall along Mad Creek was washed out. Residential loss was a small percentage of the total damage.

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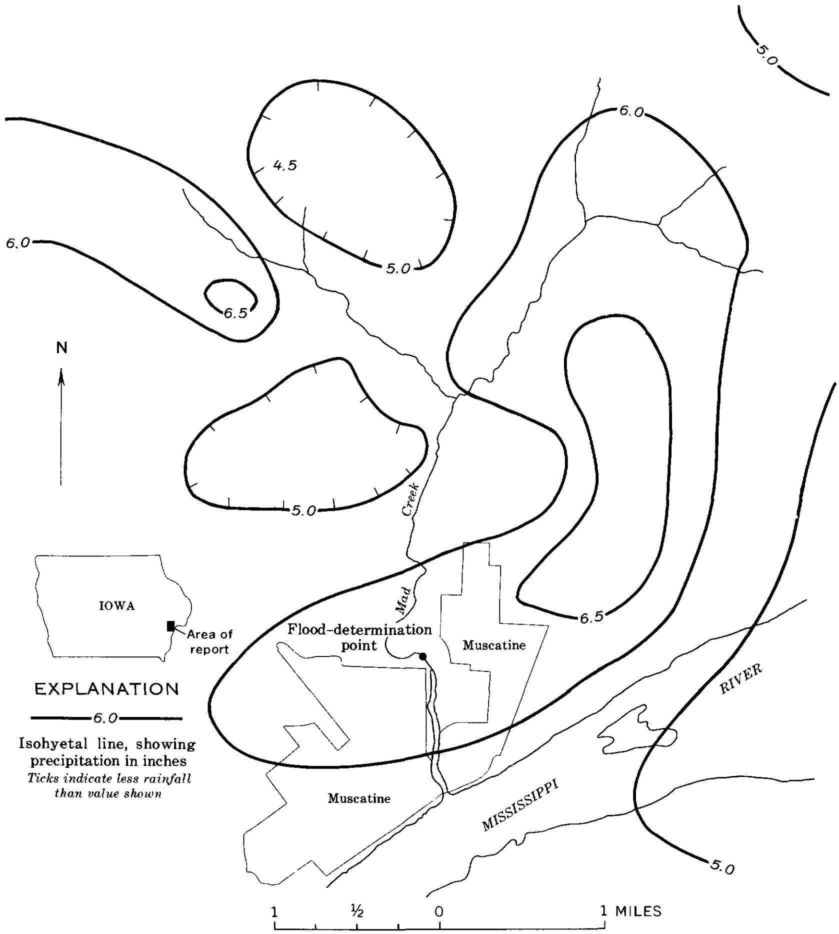

FIGURE 21.—Flood area and isohyets for June 30, floods of June 30 at Muscatine, Iowa.

An indirect measurement of the peak flow (8,460 cfs) of Mad Creek was made about a mile above its mouth, where the drainage area of 16.5 square miles yielded 512 cfs per sq mi. The Corps of Engineers computed the mean rainfall as 5.4 inches over the basin above the site of the measurement. The flood was outstanding not only because of the loss of life and excessive property damage, but also because of the very large discharge from the small drainage area.

FLOOD OF JULY 20 IN CHARLESTON, W. VA.

July was noted for large amounts of rain in central West Virginia and to the south and west in adjoining areas in bordering States. Flash floods were numerous but the most devastating of the month

TABLE 11.—*Peak discharges, July 27 near Parkdale, Colo.*

No.	Stream and place of determination	Drainage area (sq mi)	Peak discharge	
			Cfs	Csf per sq mi
1	Arkansas River tributary 2 at Parkdale	0.16	284	1,780
2	Arkansas River tributary 1 at Parkdale	.84	930	1,110
3	McIntyre Gulch near Parkdale	4.80	8,500	1,770

Canon City and Pueblo, 45 miles east of Parkdale. (See Follansbee and Jones, 1922, p. 21.) The floods of 1921 were the most outstanding ones in this part of the State, and the discharges from small areas were extremely high. A comparison between the most outstanding small-area floods of 1921 and those of July 27, 1961, is shown in figure 24.

Recurrence intervals cannot be computed for either the floods of 1921 or 1961, but because the floods of 1921 were apparently of very rare occurrence, the floods of 1961 must have also been of very rare occurrence. A discharge such as that in McIntyre Gulch (1,770 cfs per sq mi from a drainage area of 4.80 sq mi) will seldom be equaled.

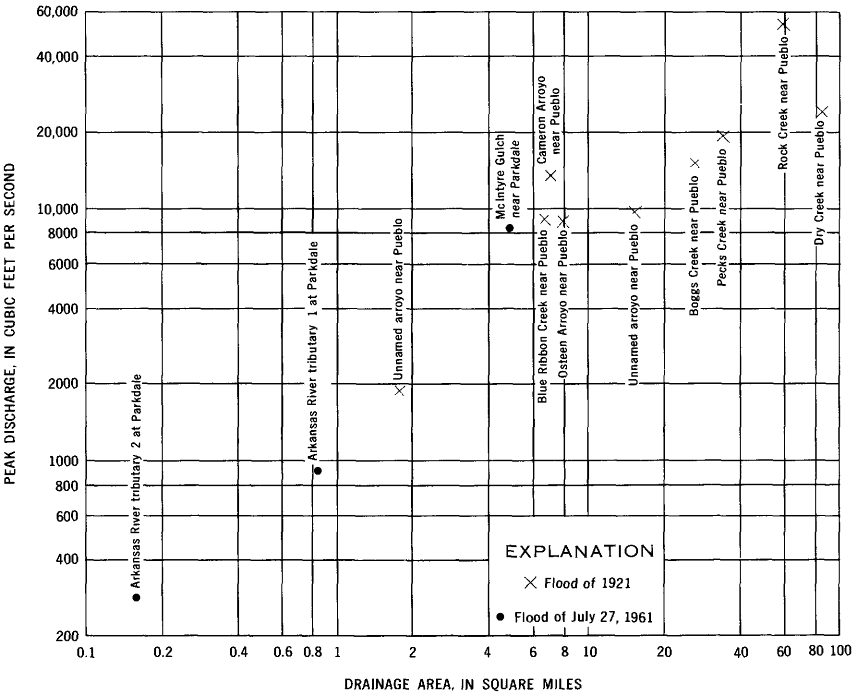

FIGURE 24.—Relation between drainage area and peak discharges for floods of July 27, 1961 and June 1921 in the Arkansas River basin, Colorado.

FLASH FLOOD OF JULY 29 IN THE VICINITY OF UNADILLA, N.Y.

For the second time in little more than 7 years, the village and vicinity of Unadilla, in south-central New York (fig. 25), was severely damaged by flooded streams. The storm began on July 29 at about

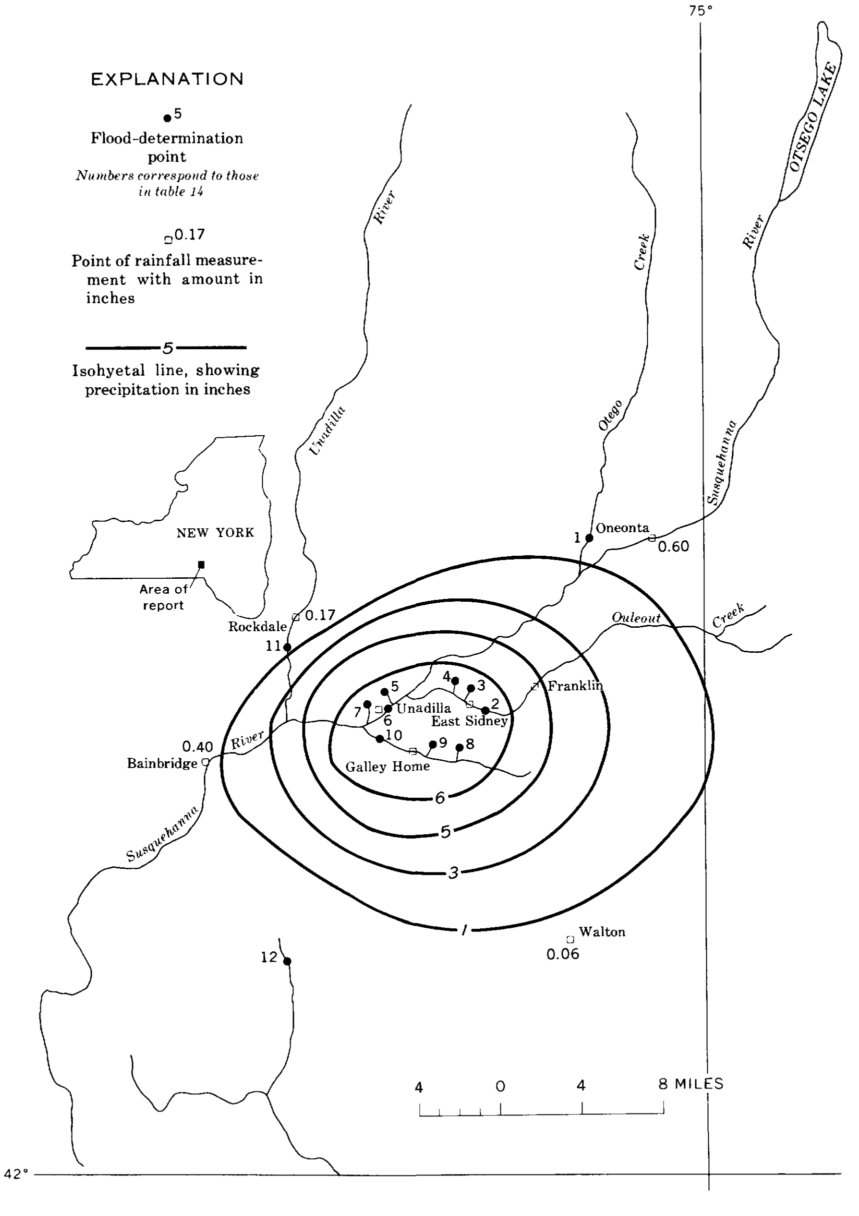

FIGURE 25.—Location of flood-determination points and isohyets for July 29, floods of July 29 in Unadilla, N.Y.

6:15 a.m., and by 10 a.m. nearly 7 inches of rain had been recorded at the U.S. Weather Bureau gage at the East Sidney Dam.

The early morning storm did not alarm residents immediately, but it soon became evident that a storm of more than ordinary proportions was in progress.

The U.S. Weather Bureau gage at East Sidney Dam produced an excellent record of the intensity and duration of the rainfall (fig. 26). The most intense rainfall was 2.25 inches from 7:00 a.m. to 7:30 a.m.

In spite of the very small storm area, the combined readings of official and unofficial observers furnished a better-than-average picture of the storm rainfall. Table 12 shows the official and unofficial observations of rainfall in the vicinity of Unadilla. Figure 25 shows the total rainfall for the storm period.

The rate of rainfall during the storm period 7:00 a.m. to 9:15 a.m. can be expected to recur on an average of once in more than 100 years. (U.S. Weather Bur., 1961.) Table 13 is a comparison

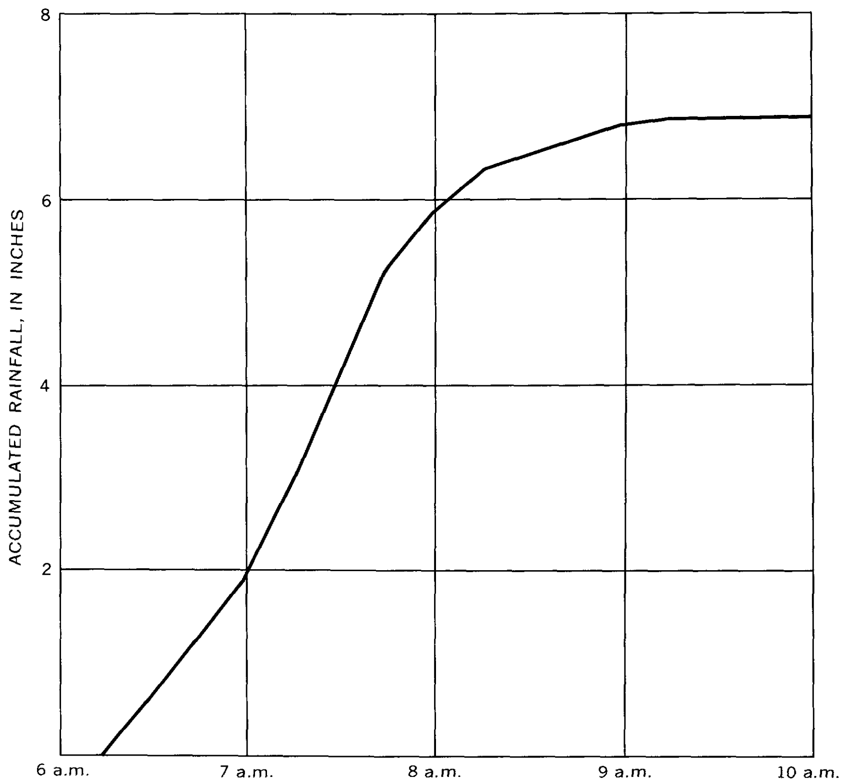

FIGURE 26.—Mass rainfall curve at East Sidney, N.Y., July 29.

of probable 100-year rainfall rates with the measured rainfall rates at East Sidney.

The normally small streams from the hills to the Susquehanna River soon became raging torrents, overflowing their banks and gouging new channels into the hillsides.

Martin Brook, as in the 1954 flood, was the principal source of flooding in the village of Unadilla. A bridge which normally passes the flow of the stream under the Delaware and Hudson Railroad became partially plugged by debris. The railroad embankment then caused the brook to divide and flow, in part east and in part west, until the water escaped through underpasses at each end of the village and thus flooded Main Street to depths of 2–4 feet.

TABLE 12.—*Measured rainfall for storm of July 29 in vicinity of Unadilla, N.Y.*

[Data from U.S. Weather Bur.]

Locality	Inches	Remarks
Official observations		
Bainbridge	0.40	
Delhi	Trace	
East Sidney	6.89	
Oneonta	.61	
Rockdale	.17	
Unadilla	5.60	
Walton	.06	
Nonofficial observations		
Franklin	5.05	Standard U.S. Weather Bur. rain gage. Was formerly official station.
Galley Home at Sidney Center.	6+	6-in. plastic gage overflowed.
Unadilla	6.61	8-in. standard rain gage. Observation by Dr. Ward, who is the official observer for the local newspaper, the Unadilla Times.

TABLE 13.—*Comparison of probable rainfall (100-year occurrence) and measured rainfall at East Sidney, N.Y.*

Duration	Probable rainfall with return period of 100 years [1] (inches)	Measured rainfall July 29, 1961	
		Inches	Hours (a.m.)
30 min	2.0	2.25	7–7:30.
1 hr	2.5	4.00	7–8.
2 hr	3.1	5.47	6:45–8:45.
3 hr	3.5	6.85	6:15–9:15.

[1] From U.S. Weather Bur. (1961).

Indirect measurements or estimates of disharge were made at sites on seven streams in the area (fig. 25). Peak discharges at the seven sites and those at nearby gaging stations are shown in table 14.

The measured peak discharge on Galley Brook represents the greatest rate of runoff per square mile ever documented for streams in New York State. On Hamilton Creek and Kilkenny Creek, where the terrain makes accurate measurements practically impossible, the discharges were estimated and also exceeded the previously known maximums for the State.

TABLE 14.—*Flood stages and discharges, July 29, vicinity of Unadilla, N.Y.*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods				
			Prior to July 1961		July 1961	Gage height (feet)	Discharge (cfs)
			Period	Year			
	Susquehanna River basin						
1	Otego Creek near Oneonta	108	1940–61	1942		14.10	6,000
					29	2.38	113
2	Ouleout Creek at East Sidney.	102	1935–61	1935		(1)	16,700
					29	4.80	2,440
3	Hamilton Creek at East Sidney.	1.55			29		[2] 4,500
4	McKown Creek near East Sidney.	.24			29		319
5	Martin Brook near Unadilla	2.21			29		2,530
6	Susquehanna River at Unadilla.	984	1938–61	1942			21,500
				1960		14.25	
					29	8.55	7,320
7	Kilkenny Creek at Unadilla	.48			29		[2] 2,300
8	Galley Brook at Sidney Center.	1.02			29		3,200
9	Smokey Kill near Sidney Center.	.38			29		376
10	Carrs Creek at South Unadilla.	29.6	1954	1954		(1)	7,730
					29	(1)	4,690
11	Unadilla River at Rockdale	518	1929–33, 1937–61	1942		12.98	17,400
					29	4.59	522
	Delaware River basin						
12	Cold Spring Brook at China	1.51	1934–61	1935		4.5	335
					29	1.73	1.2

[1] Unknown.
[2] Estimated.

Table 14 and figure 25 reveal the highly localized extent of the flood. The only streams producing unusual or record breaking rates of runoff were those with very small drainage areas which were confined to an area within a radius of about 5 miles from the confluence of Ouleout Creek and the Susquehanna River. The total contributions of these small streams did not cause a significant increase in the discharge of the Susquehanna River. Unadilla River at Rockdale and Otego Creek near Oneonta, although only about 10 miles from East Sidney, where the maximum rainfall was recorded, showed almost no effect of the storm.

All seven discharges from small drainage areas exceeded the 50-year flood values, as computed by the method developed by the U.S. Bureau of Public Roads (1961).

Because most of the drainage areas were less than 10 square miles, determinations of the recurrence intervals, based on a study by Robison (1961), were possible only for Carrs Creek at South Unadilla. At this site the flood also exceeded the 50-year recurrence interval.

The gates of the flood-control dam maintained by the U.S. Army Corps of Engineers on Ouleout Creek at East Sidney were closed at about 9:30 a.m. The reservoir level peaked at about 6 p.m. at a stage of 1,146.02 feet, which represents a rise of 30 feet and a storage of more than 800 million gallons. After the danger of flooding was over, the reservoir gates were partly opened at 2 p.m., and fully opened at 6 p.m. The peak discharge of Ouleout Creek below the dam at 6 p.m. was only 23.9 cfs per sq mi.

The most concentrated damage to private property occurred in the village of Unadilla, where the water from Martin Brook flowed along the railroad embankment and flooded commercial property and many homes and garages.

In the townships of Unadilla, Franklin, and Sidney, highways and bridges were badly damaged. Minor washouts along State Routes 7 and 12 caused traffic delays. Washout of some Delaware and Hudson Railroad roadbed caused train service to be interrupted for several hours. Many cellars were flooded, and many homes in the three townships sustained other damage. The damage to lawns, pastures, and croplands was extensive but difficult to appraise. In the villages of Franklin and Sidney damage was slight including some flooding of basements.

Total damage, as appraised by the U.S. Army Corps of Engineers, exceeded $750,000. This figure includes damage occurring in the village and town of Franklin, the village and town of Sidney, and the village and town of Unadilla. It does not, however, include the considerable damage done to agricultural and railroad properties outside the village of Unadilla. The Small Business Administration approved designation of Unadilla as a disaster area to provide assistance to the residents in borrowing money for repairing and rebuilding flood-damaged property.

FLOODS OF JULY 29-30 IN EASTERN KENTUCKY

Two thunderstorms occurred during late July 29 and early July 30, 1961, in eastern Kentucky. These storms were brief but extremely intense and produced unusually high flood flows in many streams in Johnson, Morgan, and Magoffin Counties.

The area of eastern Kentucky over which the storms occurred is shown in figure 27. The topography is marked by fairly sharp relief. Stream channels are narrow and have low banks which are overgrown with trees and brush. Flood plains are narrow and are in cultivation or pasture. Hillsides are in timber or in pasture at lower elevations, and areas at higher elevations and in the vicinity of ridges are mostly covered by second-growth timber.

Soils are generally shallow in the area, and there are many rock outcrops along hillsides. Approximately 80 percent of the area is in timber.

The topography and other factors, such as the thin soil mantle, in the area influenced runoff and probably contributed to the high peak flows.

Precipitation in July prior to the storm had been above normal. Rain had fallen on most of the days during the month, and temperatures were below normal.

Table 15 lists precipitation amounts recorded at four Weather Bureau stations in the vicinity during July and early August and the storm precipitation at five sites in the Weather Bureau early flood-warning network. Prior to the intense storms of July 29–30, there

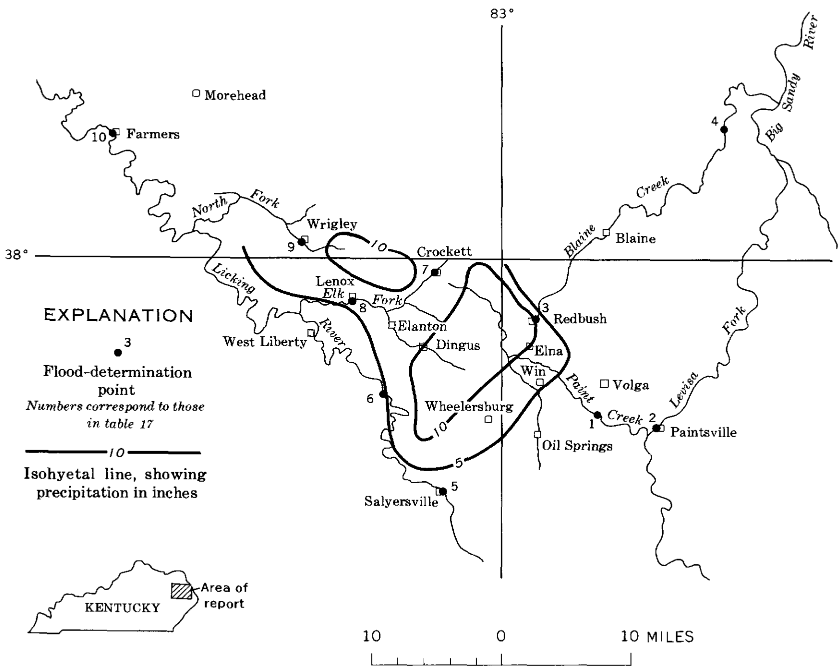

FIGURE 27.—Location of flood-determination points and isohyets for July 29–30, floods of July 29–30 in eastern Kentucky.

TABLE 15.—*Precipitation, in inches, at U.S. Weather Bureau stations in vicinity of storm area, July 1 to August 3, 1961, in eastern Kentucky*

[The first four stations listed are full-time Weather Bur. stations, and precipitation is measured at 7 a.m., except at Blaine, where it is measured at 8 a.m.]

Location	June			July					August		
	3-9	12-22	23-27	1-27	29	30	31	1-31	1	2	3
Blaine	1.63	6.08	1.24	8.95	0	3.25	0	12.20	0.05	0.25	0.05
Farmers [1]	.96	2.55	.20	3.71	.87	.43	.13	5.14	.23	0	.49
Paintsville	.37	4.27	.96	5.60	0	1.45	.80	7.85	.70	0	.52
Salyersville	.46	5.74	.36	6.56	0	.58	2.68	9.82	0	.08	.06

[1] The long-term mean precipitation for July is 4.55 in.

NOTE.—Points in early flood-warning network and storm totals, in inches, for July 29–30 are as follows:

Oil Springs	2.5	Redbush	2.5	West Liberty	2.44
Volga	4.5	Morehead	2.15		

had been considerable storm activity during the month, and rain was recorded at the four stations on practically every day during the periods July 3–9, 12–22, and 23–27.

There were two severe thunderstorms during the storm period on July 29–30; the first between 9:30 p.m. and midnight, July 29, and the second between 4 a.m. and 7 a.m., July 30. None of the rain gages listed in table 15 were in the areas of highest precipitation.

The first storm that struck the area (fig. 27) was most severe in the area between Fannins Fork and the headwaters of North Fork Licking River. Rainfall was intense between 9:30 p.m. and 10:00 p.m., July 29. The second storm covered about the same area as the first one, but was most intense in the area outlined by Crockett, Redbush, Wheelersburg, and Dingus.

The results of bucket surveys made by personnel of the Geological Survey and other agencies during the week following the storm are shown in table 16. The data represents precipitation from the evening of July 29 to the morning of July 30, and is the total from the two intense storms based on interviews with local residents and examination of containers. Some receptacles had overflowed. The total rainfall for the two storms ranged from 4.75 to 14 inches.

The four Weather Bureau stations and five early flood-warning stations, shown in table 15, recorded the precipitation for both thunderstorms on July 30. The greatest amount of precipitation recorded at any of these stations was 4.5 inches at Volga, whereas the next greatest, 2.5 inches, occurred at two points each about 6 miles away—an indication of the local nature of the disturbances.

The floods of July 29–30 in Johnson, Morgan, and Magoffin Counties were the result of intense rainfall, unseasonably high antecedent base streamflow, and saturated soil.

TABLE 16.—*Results of bucket survey, storm of July 29–30 in eastern Kentucky*

Location	Rainfall (inches)	Remarks
Wheelersburg [1]	8+	12-qt pail spilled.
Win	4.75	1-gal can.
Wheelersburg, 3½ miles west [2]	11	No. 2 washtub.
Elna [1]	7.25	Water pail.
Do	[3] 10	10-in. pail filled.
Crockett, 4 miles east southeast	12	In metal container.
Crockett	[3] 8	Iron kettle.
Dingus, 2 miles northeast	8	
Do	14	
Do	8.5	
Elamton	6.5	5-gal container.
Lenox, 2 miles northeast [1]	[3] 12	Washtub spilled.
Wrigley [2]	8	

[1] Collected by U.S. Army Corps of Engineers.
[2] Collected by U.S. Weather Bur.
[3] Not corrected for shape of container.

A maximum discharge of 17,400 cfs occurred at the gaging station, Paint Creek at Staffordsville; it greatly exceeded the previous maximum of 11,700 cfs in 1950 and 1952. The peak stage of 31.41 feet was 6.4 feet higher than that in 1939, the greatest previously known.

Peak discharges were determined at five miscellaneous sites (table 17) on small headwater or tributary streams. At three of these, the stage was the highest known to local residents, and the discharges of all five sites were particularly noteworthy.

Ratios of the peak discharge to the 50-year flood at the five sites ranged from 3.84 to 12.1 on the basis of analyses of flood frequency and magnitude in the region. At the sites ranging from 2.65 to 13.0 square miles in drainage area, the peak discharges were between 884 and 1,990 cfs per sq mi. The Paint Creek gaging station, drainage area 103 square miles, had a peak discharge of 169 cfs per sq mi and even this was 1.27 times the 50-year flood.

A longtime resident of Lenox stated that the flood on Elk Fork was second only to the flood of 1927. Generally, small drainage areas of less than about 100 square miles were more affected than large areas because of the localized extent of the storms Also, the storm and flood area was mainly limited to small headwater streams, and there was some indication that the storm precipitation was greater at higher elevations, where the small tributaries are likely to be found. Steeper gradients probably contributed to the greater peak flows of the small streams. At downstream locations with larger drainage areas, channel storage tended to reduce the magnitude of the peaks.

The area that produced the highest peak discharges during the first storm is rectangular, about 3–5 miles wide and 8 miles long from

TABLE 17.—*Summary of flood stages and discharges in eastern Kentucky*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to July 1961: Period	Maximum floods: Prior to July 1961: Year	Maximum floods: July–August 1961	Maximum floods: Gage height (feet)	Maximum floods: Discharge: Cfs	Maximum floods: Discharge: Recurrence interval (years)
	Big Sandy River basin							
1	Paint Creek at Staffordsville.	103	1939	1939		25	(1)	
			1950–61	1950			11,700	
				1952		24.11	11,700	
					July 30	31.41	17,400	[2] 1.27
2	Levisa Fork at Paintsville.	2,143	1862	1862		46.6	(1)	
			1915–20, 1928–61	1957		45.92	69,700	
					Aug. 2	23.77	21,000	7
3	Upper Laurel Creek at Redbush.	4.21			July 30		5,960	[2] 10.5
4	Blaine Creek at Yatesville.	217		(3)		27.6	(1)	
			1915–18, 1938–61	1939		26.55	15,500	
					July 31	18.49	5,690	2
	Licking River basin							
5	Licking River near Salyersville.	140	1938–61	1939		25.4	14,300	
					July 30	17.78	2,040	1
6	Rockhouse Creek at Matthews.	13.0			July 30		11,500	[2] 6.67
7	Fannins Fork at Crockett.	2.65			July 30		4,100	[2] 8.12
8	Elk Fork at Lenox	59.4			July 30		22,200	[2] 3.84
9	North Fork Licking River at Wrigley.	5.20	1939	1939		(4)	(1)	
					July 29		10,000	[2] 12.1
10	Licking River at Farmers.	831	1915–20	1918		[5] 31.1		
			1928–31	1939		24.8	22,200	
					Aug. 1	18.40		
					Aug. 1		8,830	3

[1] Unknown.
[2] Ratio of peak discharge to 50-yr flood.
[3] Prior to 1915; date unknown.
[4] 1.2 ft lower than on July 29, 1961.
[5] Result of ice jam, at site 400 ft downstream at datum 0.21 ft lower.

east to west, and lies east of Wrigley along the south side of the ridge that forms the Elliott-Morgan County line. One resident of Wrigley said that the peak stage of North Fork, Licking River at about midnight on July 29 was 15 inches higher than it was in 1939. Scour around bridge abutments and across fields along northern tributaries of Elk Fork indicated very high water velocities.

During the second storm, higher runoff occurred in an area about 14 miles square lying northwest of Wheelersburg along the divide between Paint Creek and Licking River basin and northeast of the tributaries of Elk Fork. This area is approximately the area of intense rainfall during the second storm period and partly explains why peak discharges on the smaller headwater steams were greater than those on the larger streams.

Indirect measurements of peak flow were made at six locations: at the Paint Creek gaging station and at the five miscellaneous sites.

The peak flows at other gaging stations in the vicinity were very small and were within the range of the stage-discharge relation.

The hydrographs in figure 28 include the one gaging station, Paint Creek at Staffordsville, that reflected extreme peak flow during the flood. Other gaging stations surrounding the flood area had relatively small discharges at downstream locations on larger drainage areas. The disparity between peak discharges at the miscellaneous sites and the gaging stations is accounted for by the localized extent of the storms and by the fact that the heaviest precipitation occurred mostly at higher elevations over small tributaries.

No loss of life is directly attributable to the flood, although one person was drowned on July 30 while wading in a drainage ditch near Blane Creek in Lawrence County.

The greatest damage caused by the flood was in Johnson, Magoffin, and Morgan Counties. Less damage was caused in the adjacent counties, Lawrence and Elliott.

Damage in Johnson, Magoffin, and Morgan Counties exceeded $6.5 million (table 18). The floods occurred during the growing season, and the greatest damage was to crops. In some localities, wind and heavy rains severely damaged crops, even though they were not inundated. Crop damage totaled $2½ million. Roads and bridges of the State and of the secondary highway systems sustained the next largest amount of damage. The Kentucky Department of Highways reported that in addition to washed out fills and damaged or destroyed bridges, several roads were blocked by earthslides. Damage to dwellings and other buildings including farm and business structures exceeded $1 million.

Because most of the communities, farms, and highways are on the flood plains, the amount of damage was great. The small tributaries which drain ridge areas of the basins drop several hundred feet in a few miles. These drops in elevation caused high stream velocities which, no doubt, aggravated damage by washing away some buildings that would otherwise have been only submerged.

The Chesapeake and Ohio Railroad bridge over Paint Creek at Paintsville was damaged by drift. A county highway bridge spanning Paint Creek upstream from Staffordsville was carried away by floodwaters. A 100-barrel crude-oil storage tank was washed off its foundation and carried several miles downstream.

At Wrigley, on the North Fork Licking River, water 6 feet deep washed two large residences from their foundations. Several outbuildings were torn from concrete foundations to which they were bolted and carried downstream. Stacks of lumber at small sawmills were floated downstream in Fannins Fork and in other streams in the flood area.

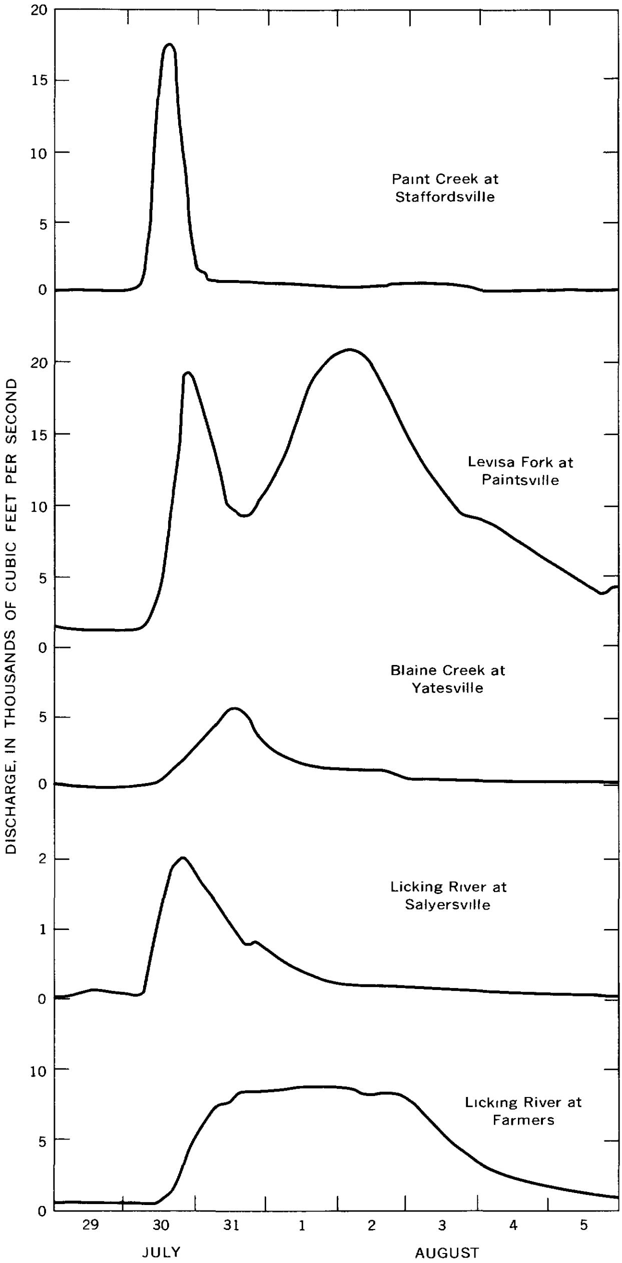

FIGURE 28.—Discharge hydrographs at selected gaging stations, July 29 to August 5, floods of July 29–30 in eastern Kentucky.

TABLE 18.—*Flood damage in Johnson, Magoffin, and Morgan Counties, Ky.*

[Data for Johnson County compiled by Paintsville-Johnson County Office of Civil Defense, and that for other counties compiled by the Corps of Engineers, Dept. of the Army, Louisville, Ky., district]

	County		
	Johnson	Magoffin	Morgan
	Number		
Buildings destroyed:			
Dwellings	7	7	15
Farm buildings	5	30	50
Others	25	20	15
Buildings damaged:			
Dwellings	35	52	45
Farm buildings	40	(1)	(1)
Others	25	4	3
	Thousands of dollars		
Buildings	9	615	450
Tobacco	120	250	1,325
Other crops	30	125	325
Gardens	17	150	300
Harvest crops and livestock	0	190	165
Tractors and vehicles	0	10	20
Utilities:			
Telephone	10	25	10
Power	1	40	80
Railroad bridge	250	0	0
State and county road and bridges	170	320	1,500
Total	607	1,725	4,175

[1] Not determined.

Two dwellings were destroyed at Staffordsville. Damage to dwellings and other buildings was reported along most of the small tributary streams in the area, such as Upper Laurel Creek, Rockhouse Creek, and Elk Fork and its tributaries from the south and east.

FLOODS OF JULY 31 IN HAYSI, VA., AND VICINITY

Heavy rains on July 30 and 31 in the Haysi area produced severe floods from small drainage areas on Russell Prater Creek and Barts Lick Creek (fig. 29). Rainfall totaled 5.85 inches at Haysi; 2.09 inches at Clinchco, 5 miles southwest; 3.60 inches near Grundy, 12 miles northeast; 2.46 inches at Jewell Ridge, 28 miles east; and 2.41 inches at Honaker, 23 miles southeast. Up to 8 inches of rainfall was unofficially estimated in Barts Lick Creek basin from a rainfall catch in a tub.

Although 5 feet of water poured through the main street of Haysi (State Route 83) causing much damage, even greater damage was caused by earthslides from the steep slopes on two sides of the town. All persons except those engaged in emergency work and cleanup were evacuated for a short time. The police chief of Haysi estimated the damage at several hundred thousand dollars.

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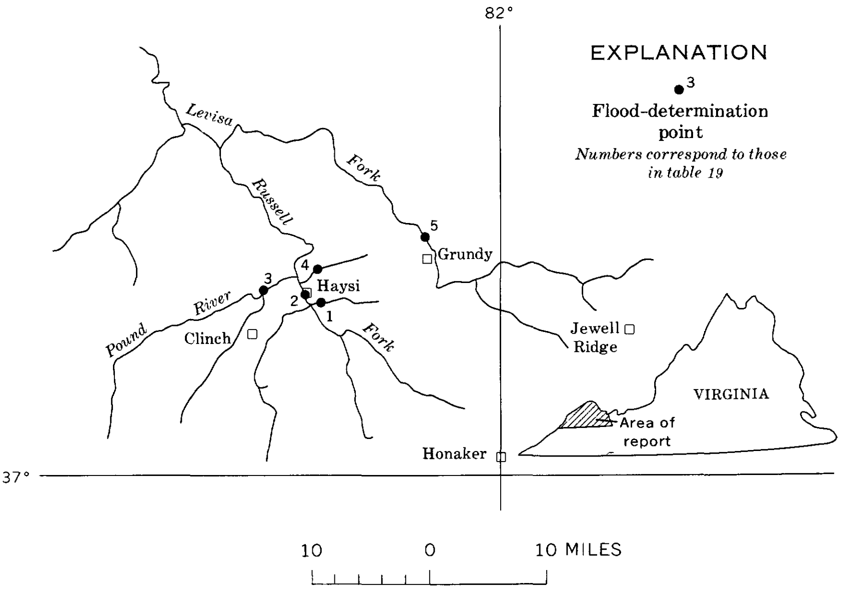

FIGURE 29.—Location of flood-determination points, floods of July 31 in Haysi, Va., and vicinity.

About 50 persons were evacuated in the Barts Lick Creek area, 4 miles north of Haysi. Several houses and two stores were washed away. High water and earthslides closed many roads and highways.

High runoff occurred only on small streams near Haysi. Runoff was extremely high in Barts Lick Creek and Russell Prater Creek (table 19), tributaries to Russell Fork, but the discharge in Russell

TABLE 19.—*Flood stages and discharges, Haysi, Va., and vicinity*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to July 1961: Period	Maximum floods: Prior to July 1961: Year	Maximum floods: July 1961	Maximum floods: Gage height (feet)	Maximum floods: Discharge: Cfs	Maximum floods: Discharge: Cfs per sq mi
	Big Sandy River basin							
1	Russell Prater Creek at Haysi.	25.4			31	--------	7,180	283
2	Russell Fork at Haysi----	286	1926–61----------	1957	----------	23.17	46,600	--------
					31	14.88	24,200	84.5
3	Pound River near Haysi-	212	1926–61----------	1929	----------	16.5	30,000	--------
					31	--------	[1] 1,470	6.9
4	Barts Lick Creek above Little Lick Creek near Haysi.	10.7			31	--------	4,020	376
5	Levisa Fork near Grundy.	235	1941–61----------	1957	----------	21.06	33,200	--------
					31	11.01	7,700	32.8

[1] Daily mean discharge.

Fork (drainage area, 286 sq mi, including that of Russell Prater Creek) was not particularly high. The daily mean discharge on July 31 at the gaging station on Pound River (drainage area, 212 sq mi), about 5 miles west of Haysi, was only 1,470 cfs. The peak discharge on Levisa Fork near Grundy (drainage area, 235 sq mi) was 7,700 cfs.

FLOODS OF JULY TO SEPTEMBER IN UTAH

Many floods caused by cloudbursts occurred throughout Utah from late July to the middle of September. The annual floods in Utah are usually caused by thunderstorms during late summer and early fall. The moisture in these storms is normally carried from the Gulf of Mexico by unstable airmasses. Small-area high-intensity storms often cover only a part of a drainage area. These storms cause peak discharges which are very high from the small areas affected but which attenuate very rapidly while traveling downstream.

Because of the sparsity of rain gages in Utah and the small areas involved by the thunderstorms, the reported rainfall figures very often have no true relation to the intensity of a storm which may have produced a sizeable flood.

Damage from the widely scattered floods is usually light or nonexistant because of the absence of destructible property on the flood plains. The suddenly formed flood peaks may have high recurrence intervals and will seldom reoccur at the same sites, but equivalent floods can be expected to occur at many other scattered sites.

The most noteworthy floods in Utah from late July through September are described in chronological order and their peak discharges are listed in regular downstream order in table 20.

General rain occurred over most of Utah on July 4, and high intensities in isolated areas caused floods on several streams. Although

TABLE 20.—*Flood stages and discharges, July to September in Utah*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods					
			Prior to July 1961		July–September 1961	Gage height (feet)	Discharge	
			Period	Year			Cfs	Recurrence interval (years)
	White Canyon basin							
1	Farley Canyon near Hite	12.5	1959–61	1961		13.86	2,010	
					Sept. 8	22.4	7,350	(1)
	Escalante River basin							
2	East Fork Deer Creek near Boulder.	1.9	1950–55, 1959–61	1955		(2)	350	
					Aug. 3	12.36	224	(2)

TABLE 20.—*Flood stages and discharges, July to September in Utah*—Continued

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to July 1961: Period	Maximum floods: Prior to July 1961: Year	Maximum floods: July–September 1961	Maximum floods: Gage height (feet)	Maximum floods: Discharge: Cfs	Maximum floods: Discharge: Recurrence interval (years)
	Paria River basin							
3	Henrieville Creek at Henrieville.	34	1959–61	1960		13.98	([2])	
					Aug. 4	15.6	7,360	[3]3.0
4	Paria River at Cannonville.	96	1959–61	1959		11.55	([2])	
					Aug. 3	12.28	4,830	[3]1.3
	Kanab Creek basin							
5	Hog Canyon near Kanab.	18.5			July 4		6,580	([1])
	Virgin River basin							
6	Muddy Creek near Mount Carmel.	37			Aug. 25		8,190	[3]3.0
7	Mineral Gulch near Mount Carmel.	7.6	1959–61	1959		12.08	262	
					Sept. 17	15.00	1,680	([2])
8	Crystal Creek near Cedar City.	10.2	1956–61	1959		5.23	1,300	
					Sept. 17	4.94	1,120	([2])
9	North Fork Virgin River near Springdale.	350	1913–14, 1923, 1925–61.	1938		12.29	7,000	
					Sept. 17	10.25	5,880	[3].9
10	Blacks Canyon at Springdale.	0.9			Aug. 8		1,030	([2])
11	Coalpits Wash near Rockville.	20.8			Sept. 17		8,350	([2])
12	Virgin River at Virgin	934	1909–61	1938		([2])	13,500	
					Sept. 17	13.29	13,500	[3].9
	Weber River basin							
13	Cottonwood Creek near Hoytsville.	2.4			Aug. 12		351	([1])
14	Echo Cliff Wash near Echo.	1.2			Aug. 12		1,080	([1])
	Jordan River basin							
15	Phelps Canyon near Alpine.	.41			Aug. 25		1,500	([2])
	Great Salt Lake Desert							
16	Deep Creek near Ibapah.	460			Aug. 25		1,250	([2])
17	Bar Creek near Ibapah	12			Aug. 25		2,690	([1])
	Sevier River basin							
18	Chalk Creek near Fillmore.	60	1914, 1944–61	1952			509	
					July 31		1,850	[3]1.2
19	South Fork Coal Creek near Mount Pleasant.	1.2			Aug. 25		3,310	([1])
20	Pleasant Creek near Mount Pleasant.	16	1946	1946			2,060	
			1954–61	1955			([2])	
					Aug. 25		200	
	Cedar City Valley							
21	Coal Creek near Cedar City.	80.9	1915–19, 1935–61	1936		([2])	2,910	
					Aug. 10	6.50	2,000	[3]1.8

[1] Probably exceeds 50-yr flood.
[2] Not determined.
[3] Ratio of peak discharge to 50-yr flood.

only 0.85 inch of precipitation was recorded at Kanab on July 4, one of the streams in the area, Hog Canyon near Kanab (fig. 30), had a peak discharge of 6,580 cfs from 18.5 square miles. (See table 20.) Flood-frequency relations in this part of Utah are not defined for drainage areas of less than 30 square miles, but the flood of Hog Canyon undoubtedly had a recurrence interval greater than 50 years.

Heavy and intense local rains in the Pavant Range on July 31 caused a flood on Chalk Creek near Fillmore; however, only a trace of

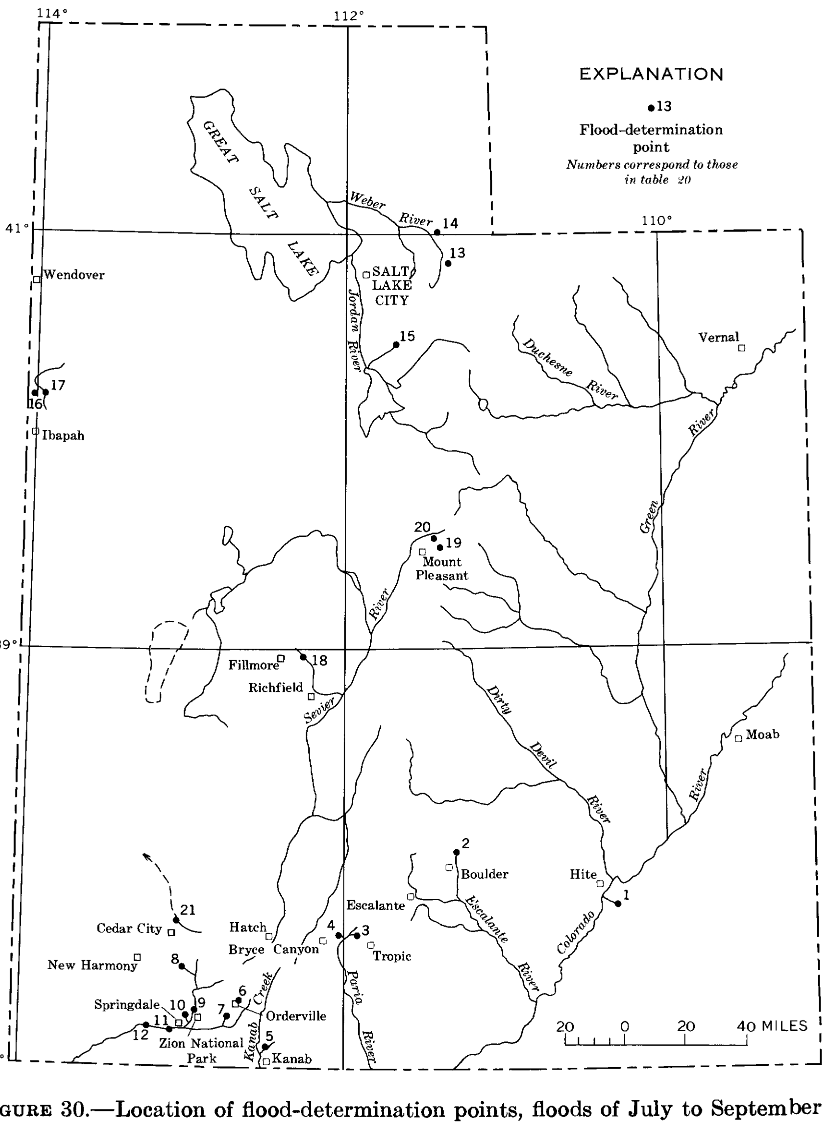

FIGURE 30.—Location of flood-determination points, floods of July to September in Utah.

rain was recorded at the Weather Bureau gage at Fillmore near the edge of the mountains. The peak discharge from the drainage area of 60 square miles was 1,850 cfs, which is about 3.6 times the previous maximum in 18 years of record and about 1.2 times the discharge of a 50-year flood. The floodwaters inundated a few acres of farmland, overtopped U.S. Highway 91, and deposited mud and debris in the yards of several homes in Fillmore.

Recorded rainfall at Bryce Canyon National Park, Boulder, Escalante, and Tropic was between 0.84 inch and 1.43 inches for August 3 and 4, but the flood peaks on several streams in southern Utah were obviously caused by unrecorded heavy rains of high intensity in small areas.

Peak discharges were determined for three small streams. The flood on East Fork Deer Creek near Boulder (drainage area, 1.9 sq mi) was the second highest in 9 years of record. The peak discharge on Henrieville Creek at Henrieville was about three times the discharge of a 50-year flood, and that of Paria River at Cannonville was 1.3 times that of a 50-year flood. The flood-frequency relations are undefined for drainage areas of less than 15 square miles in this area. Henrieville Creek destroyed a short section of State Highway 54, 6 miles north of Henrieville.

Severe thunderstorms in southwestern Utah on August 8 and 10 caused flash floods on several streams. Widely scattered rain gages did not record any precipitation, but the flood on August 8 in Blacks Canyon at Springdale had a peak discharge of 1,030 cfs from a 0.9-square mile drainage basin—a discharge which is 1,140 cfs per sq mi. The probability of a flood of this magnitude occurring in Utah is very small. Water overtopped State Highway 15 at Springdale and flooded the yards of several homes. Coal Creek near Cedar City peaked on August 10 at 1.8 times the discharge of a 50-year flood. Weather Bureau records at Cedar Breaks National Monument and at Cedar City Airport showed only 0.18 and 0.25 inch of precipitation, respectively, on August 10. Damage to crops, fences, roads, and irrigation systems from sediment depositions was light and was estimated at $750.

Intense rains on August 12 caused unusually large floods in Cottonwood Creek near Hoytsville and in Echo Cliff Wash near Echo. U.S. Weather Bureau rain gages at Echo Dam and Coalville recorded 0.55 and 0.41 inch of precipitation, respectively. Rainfall between 1 p.m. and 2 p.m. was 70 percent of the daily amount.

The peak discharges of 351 cfs from 2.4 square miles on Cottonwood Creek and 1,080 cfs from 1.2 square miles on Echo Cliff Wash were probably greater than those for 50-year floods.

On August 24, rainfall at Zion National Park totaled 1.37 inches, but only 0.38 inch of rain was measured at Orderville, less than 3 miles from Mount Carmel where Muddy Creek (drainage area, 37 sq mi) peaked on August 25 at 8,190 cfs. This discharge was estimated on the basis of a field survey and is about three times that of a 50-year flood.

A high-intensity rain on August 25 caused a flood in Phelps Canyon, near Alpine, 20 miles south of Salt Lake City. At Alpine, 2½ miles southwest, 0.60 inch of precipitation was recorded. The peak discharge of 1,500 cfs, estimated on the basis of a field survey, from 0.41 square mile is 3,660 cfs per sq mi. A fire on July 2 destroyed much of the brush on the upper part of the basin which may have contributed to the high rate of runoff. Flood-frequency relations are not defined for drainage areas of less than 2 square miles in this area. The flood destroyed a concrete retaining wall near the powerplant, two automobiles, a tool shed with its equipment, and a small pipeline. The damage was estimated at $5,000, which included the cost of removing debris from the powerplant premises.

A cloudburst north of Ibapah caused floods in Deep Creek and Bar Creek on August 25. The greatest intensity of rainfall took place over the Bar Creek drainage basin. Official weather stations at Ibapah and at Wendover, 50 miles north of Ibapah, recorded insignificant amounts of 0.02 and 0.01 inch of precipitation, respectively. The floods destroyed a $10,000 dam 5 miles north of the Bar Creek measurement site. The peak discharge from approximately 12 square miles in Bar Creek near Ibapah was 2,690 cfs. The flood in Deep Creek was 1,250 cfs from 460 square miles and was a more common occurrence. Flood-frequency relations are not defined in this part of Utah.

Rains of high intensities occurred on August 25 in isolated areas and caused a flood on South Coal Fork near Mount Pleasant. The peak discharge of 3,310 cfs on August 25 from 1.2 square miles is probably greater than a 50-year flood. At the gaging station on Pleasant Creek about 2 miles downstream, this very sharp peak had attenuated to 200 cfs. In the Pleasant Creek Pilot Watershed project which includes South Coal Fork, the U.S. Soil Conservation Service reported the following precipitation for August 25 from recording gages:

	Precipitation (inches)		*Precipitation (inches)*
Upper Twin Creek	Trace	Upper Straight Fork	[1].375
Lower Twin Creek	0.10	Middle Straight Fork	[1].65
Upper Coal Creek	0	Lower Straight Fork	.44
Lower Coal Creek	[1].50		

[1] Precipitation occurred in 10 min.

The precipitation at Middle Straight Fork was at the rate of 3.90 inches per hour, and the peak discharge in South Coal Fork near

Mount Pleasant was at the rate of 4.27 inches per hours; thus rains of higher intensities probably occurred but were not recorded. Considerable overland and channel erosion occurred, and large deposits of rock and debris were left in the Coal Fork channel below the mouth of South Coal Fork.

Intense thunderstorm activity caused a flood on September 8 in Farley Canyon near Hite. A discharge of 7,350 cfs occurred from a drainage area of 12.5 square miles. Flood-frequency relations are not defined for drainage areas of this small size in this part of Utah, but the recurrence interval of this flood was probably well in excess of 50 years. The discharge about 10 miles north, at the gaging station on Dirty Devil River, had a recurrence interval of about 5 years. At Hite, 0.81 inch of precipitation was recorded on September 8 and 0.69 inch, on September 9. The floodwater was about 2 feet deep in the store, Post Office, and residence—the only inhabited buildings in the canyon—about 500 feet downstream from the gage. Mud and debris were deposited in the buildings and yards.

Extensive thunderstorm activity in southwestern Utah on September 17 produced moderate amounts of rainfall at Cedar Breaks National Monument, Hatch, New Harmony, and Zion National Park. Long-time residents near Zion National Park said the rainstorm was the heaviest in the area in nearly 25 years. The flash flood on North Virgin River at the gaging station near Springdale reached a peak discharge which has a recurrence interval of 38 years. The flood trapped a party of 26 hikers in the Narrows—a nearly vertical walled gorge—in Zion National Park, and five of the party were drowned. A part of the park highway, a tractor, fencing, and three diversion structures were destroyed. Debris was deposited on 250 acres of cultivated land, and the damage was estimated at $68,000. The flood on Coalpits Wash near Rockville probably had a recurrence interval well in excess of 50 years. Flood-frequency relations are not defined for drainage areas of less than 45 square miles in this part of Utah.

FLOODS OF AUGUST 9, NEAR WASHTA, IOWA

Torrential rains fell from 6 p.m. to midnight on August 8, causing streams near Washta, Iowa, to produce high rates of runoff. Precipitation up to 12 inches in the 6-hour period was determined from a bucket survey made by the Iowa Natural Resources Council.

Figure 31 shows the location and general area affected by the storm and the isohyetal map furnished by the Iowa Natural Resources Council from the data collected by their bucket survey.

An estimate of 11,000 cfs of runoff on Stratton Creek from a drainage area of 1.90 square miles is an indication of the unusually high rate of

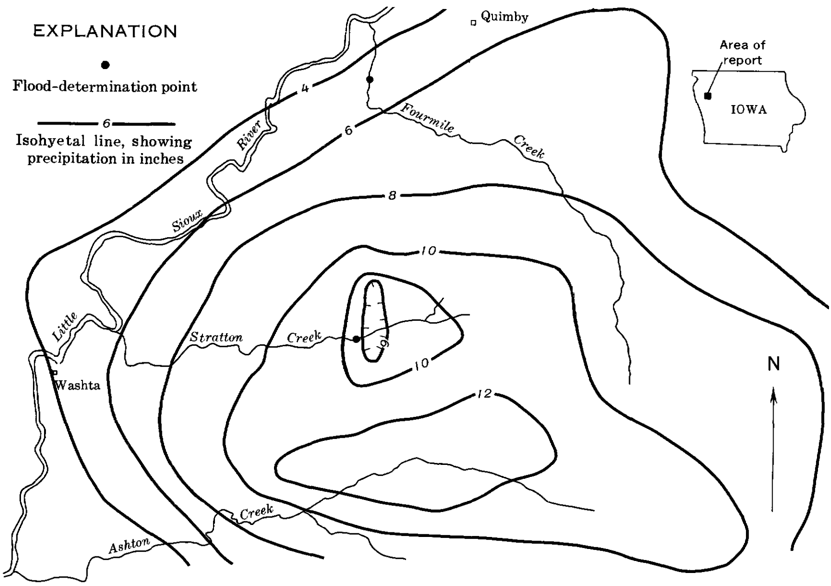

FIGURE 31.—Location of flood-determination points and isohyets for August 8, floods of August 9 near Washta, Iowa. Isohyets from Iowa Natural Resources Council.

runoff produced by this storm. An indirect measurement of 7,460 cfs of discharge from a drainage area of 8.28 square miles was made on Fourmile Creek at the State Highway 31 bridge south of Quimby, Iowa. The heaviest precipitation fell on Ashton Creek about 1.5 miles south of the measurement site.

Two men were killed when Ashton Creek swept them and their automobile from a road crossing the creek. Heaviest property damage was to bridges and roads. Bridges that were not capable of carrying the floodwaters were washed from their abutments, and road fills were washed out. The Soil Conservation Service estimated the total damage at $140,000 in an area of about 50 square miles.

The localized extent of the storm is indicated by the small peak discharge on Little Sioux River at Correctionville, about 10 miles southwest of the Stratton Creek estimate site. The crest occurred at this station at 9 p.m., August 9, and had a discharge of only 7,800 cfs from a drainage area of 2,500 square miles, which is about 1.3 times the mean annual flood.

FLOODS OF AUGUST 11 AT ALBUQUERQUE, N. MEX.

Heavy rain late in the afternoon of August 11 caused flooding in the northeastern part of Albuquerque. Data from privately maintained rain gages showed rainfall amounts in the flooded area ranging from 2.79 to 4.1 inches. The Weather Bureau station at the airport, in the southeastern part of the city about 4 miles from the flood area, reported only 0.75 inches of rain for the day.

Indirect measurements of peak discharge were made on Hahn Arroyo near the mouth, on a tributary to Arroyo del Embudo, and on three sites on Arroyo del Embudo (fig. 32).

An area of about 40 blocks in the city was inundated, and about 100 families were evacuated from their homes. Several automobiles were swept downstream from arroyo crossings—an indication of the very high velocities of the floodwater—but no lives were lost. Flood-control structures built in 1957 prevented damage that would have otherwise occurred. Less damage resulted than from the flood of July 27, 1955, even though the magnitude of the 1961 flood was greater. The discharge for the 1955 flood on Arroyo del Embudo is included in table 21 for comparison with the 1961 peak.

The discharge pattern shows that the heavy rain was confined to a small area consisting of an appreciable part of the Hahn Arroyo basin and that part of the Arroyo del Embudo basin from near the mouth of the tributary at Wyoming Boulevard downstream to below the measurement site of Arroyo del Embudo between San Pedro Drive and Paloma Drive. The drainage areas at the two discharge stations

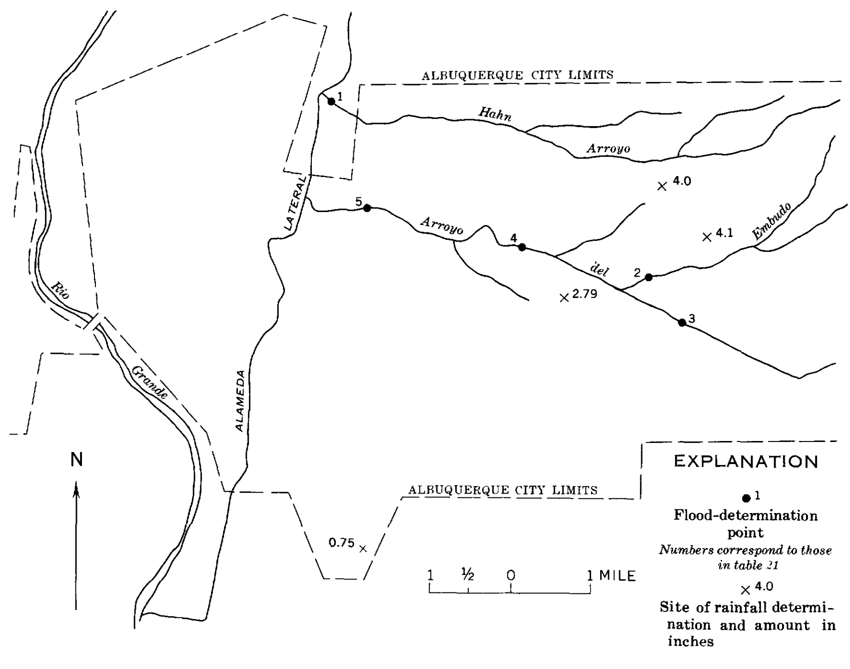

FIGURE 32.—Location of flood-determination points and precipitation gages, floods of August 11 at Albuquerque, N. Mex.

TABLE 21.—*Flood stages and discharges, August 11 at Albuquerque, N. Mex.*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to August 1961: Period	Maximum floods: Prior to August 1961: Year	Maximum floods: August 1961	Maximum floods: Gage height (feet)	Maximum floods: Discharge: Cfs	Maximum floods: Discharge: Recurrence interval (years)
1	Hahn Arroyo	7.6			11	--------	935	[1] 1.2
2	Arroyo del Embudo between Hendola Drive and Pennsylvania Street.	14.6			11	--------	518	4
3	Arroyo del Embudo tributary at Wyoming Boulevard.	7.7			11	--------	572	11
4	Arroyo del Embudo between San Pedro Drive and Palomos Drive.	27.5	1955	1955	--------	--------	[2] 2,360	--------
					11	--------	3,590	[1] 2.6
5	Arroyo del Embudo downstream from Princeton Drive.	34.1			11	--------	3,620	[1] 2.4

[1] Ratio of peak discharge to 50-yr flood.
[2] At site downstream; drainage area, 28.6 sq mi.

in the upper part of the drainage basin of Arroyo del Embudo totaled 22.3 square miles, and the peak discharge at each site was moderate. The drainage area which contributed most of the discharge in Arroyo del Embudo near Palomas Drive was not more than 5 square miles of the total of 27.5 square miles above the site. As the crest moved downstream to Princeton Drive, apparently out of the area of heavy rainfall, the drainage area increased by 6.6 square miles but the peak discharge remained virtually unchanged.

The flood-frequency data computed at each of the five sites of peak-discharge determinations indicate the relative magnitude at the sites. At the two sites in the upper basin of Arroyo del Embudo, the recurrence intervals of the peaks were 4 and 11 years—events which can be expected to occur rather frequently—whereas the peak discharge in Hahn Arroyo had a recurrence interval of more than 50 years. The peak discharges in the lower part of Arroyo del Embudo were so great that recurrence intervals for them cannot be reliably determined, although they may be defined as about 2½ times as great as 50-year floods.

Part of Arroyo del Embudo is a concrete-lined channel in the median strip of the east-west Coronado Freeway in Albuquerque. The Corps of Engineers estimated the peak flow was about 25 percent of the design capacity of the paved channel.

The arroyos draining the flood area are intercepted by Alameda Lateral, which empties into the Rio Grande below the gaging station at Albuquerque. Because of the small storm area only a minor peak was recorded at the station.

FLOODS IN AUGUST AND SEPTEMBER IN SOUTHERN IDAHO

Thunderstorms occurred in widely scattered areas of southern Idaho on several days in August and September (fig. 33).

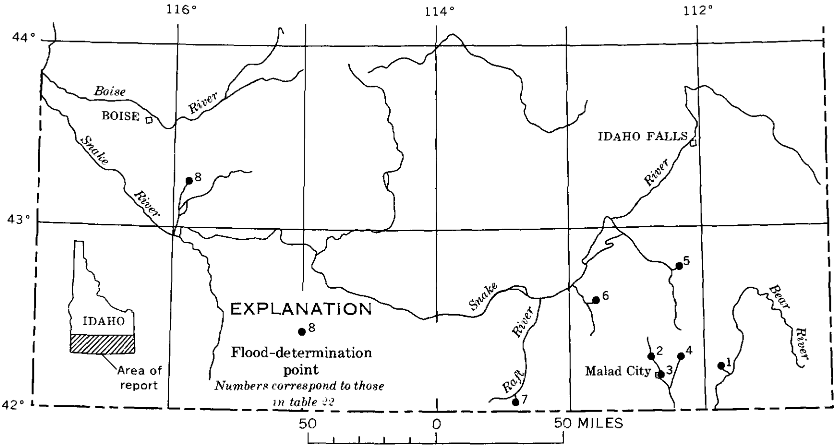

FIGURE 33.—Location of flood-determination points, floods of August and September in southern Idaho

Precipitation was about 200 percent of the long-term mean over large areas of southern Idaho in both August and September. Although rain occurred at nearby weather stations on the days of the floods, no records of intensities or total precipitation were available for any of the flooded basins. Soil moisture increased sufficiently over large areas to decrease demand for irrigation water, and several projects stopped water withdrawals several weeks earlier than usual. Flow in the larger streams, however, rose only nominally. Unusually high rates of discharge were measured, by indirect methods, from eight small basins (table 22). Other small basins had similarly high unit discharges, but the extent of flooding was not definitely defined. Areas of high unit runoff were localized and relatively small.

According to local residents, Battle Creek tributary and Green Canyon tributary were the highest in more than 40 and 50 years, respectively. Devil Creek above Campbell Creek, near Malad City, was the highest in 23 years of record. The peak flow of Little Malad River below Sand Ridge damsite, near Malad City, was about three times the previous maximum in 6 years of record. No previous records were available for the other sites of measurements, but these occurrences are probably rare. Damage was relatively light and was confined to small bridges, light buildings, and short reaches of highways.

TABLE 22.—*Flood stages and discharges, August and September in southern Idaho*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to August 1961, Period	Year	August-September 1961	Gage height (feet)	Discharge, Cfs	Ratio to $Q_{2.33}$
	Bear River basin							
1	Tributary to Battle Creek near Banida.	8.1			Aug. 12	--------	1,600	--------
2	Little Danish Canyon near Malad City.	1.25			Aug. 25	--------	1,170	--------
3	Little Malad River below Sand Ridge damsite near Malad City.	223	1948-------------	1948	----------	9.6	240	--------
					Aug. 25	12.9	706	--------
4	Devil Creek above Campbell Creek near Malad City.	13	1939–61----------	1943	----------	--------	160	--------
					Aug. 25	3.65	194	--------
	Snake River basin							
5	Tributary to Green Canyon near Inkam.	2.82			Aug. 12	--------	3,060	--------
6	Tributary to Spring Canyon near Rockland.	.77			Aug. 18	--------	152	--------
7	One-mile Creek at mouth, near bridge.	25			Aug. 13	--------	155	--------
8	Sqaw Creek near Mountain Home.	61.5			Sept. 16	--------	368	--------

FLOODS OF AUGUST 22 NEAR ESPANOLA, N. MEX.

Heavy rain in the Espanola and Pojoaque Valleys on August 22 produced outstanding floods on some tributaries to the Rio Grande (fig. 34). Precipitation measured at 10 Weather Bureau gages in the area ranged from 0.56 to 2.02 inches. Greater amounts probably fell in the storm centers.

Discharges from small tributaries to the Rio Ojo Caliente, north of Chamita, caused moderate damage to U.S. Highway 285 and blocked the highway for more than 12 hours. At Hernandez, homes, businesses, farmland, and roads were damaged. Tributaries west of Rio Chama carried high discharges and heavy sediment loads that severely damaged irrigation headworks and ditches near Chamita. On Rio Chama near Chamita, 3.4 feet of fill was deposited in the channel during the flood. Damage in the Pojoaque Valley was estimated at $49,000 by the Soil Conservation Service.

Indirect measurements of peak discharge were made at three miscellaneous sites. A summary of peak stages and discharges and frequency data for the flood area is given in table 23.

The runoff pattern indicates that the heavy rain occurred in a fairly small area over the lower part of the Rio Chama basin and in a narrow band southward which includes the lower part of the Pojoaque River basin. Rio Chama near Chamita was in the area of heavy rainfall,

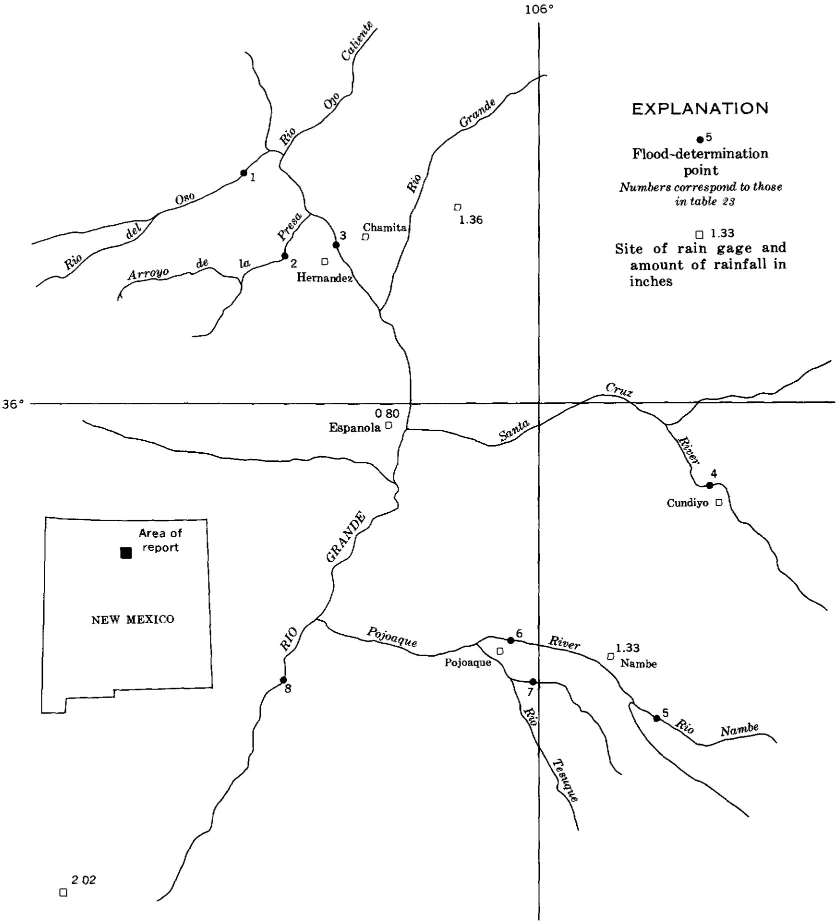

FIGURE 34.—Location of flood-determination points and precipitation gages, floods of August 22 near Espanola, N. Mex.

but the discharge at the station was relatively low because only a small part of the drainage basin was affected. Santa Cruz River at Cundiyo and Rio Nambe near Nambe were near the area of heavy rainfall, but the drainage areas were outside of it. The discharge on the Santa Cruz River was much less than the mean annual flood and that on Rio Nambe was about equal to a 10-year flood.

The peak discharges at four sites, whose drainage areas were entirely or in large part in heavy rainfall, were extremely high and of very rare occurrence. All four peaks exceeded those of 50-year floods by ratios of as much as 14. Of the 92 square miles of drainage area above Pojoaque Creek near Pojaque, at least 38 square miles (the area above Rio Nambe near Nambe) contributed practically no flow. Although

TABLE 23.—*Flood stages and discharges, August 22 near Espanola, N. Mex.*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to August 1961: Period	Maximum floods: Prior to August 1961: Year	Maximum floods: August 1961	Maximum floods: Gage height (feet)	Maximum floods: Discharge: Cfs	Maximum floods: Discharge: Recurrence interval (years)
	Rio Grande basin							
1	Rio del Oso near Hernandez.	41.2			22	....	11,600	[1] 7.2
2	Arroyo de la Presa near Hernandez.	11.0			22	....	12,300	[1] 14
3	Rio Chama near Chamita.	3,200	1912–61........	1920	....	....	15,000	....
				1941	....	8.33	....	....
					22	10.45	8,000	....
4	Santa Cruz River at Cundiyo.	86	1930–61........	1931	....	7.8	2,420	....
					23	2.65	136	1
5	Rio Nambe near Nambe.	38.2	1931–61........	1955	....	9.39	5,580	....
					22	4.17	695	11
6	Pojoaque Creek near Pojoapue.	92	1936–61........	1955	....	....	11,000	[1] 4.7
					22	....	(2)	....
7	Arroyo Cuyamungue near Pojoaque.	3.86			22	....	5,770	[1] 10
8	Rio Grande at Otowi bridge, near San Ildefanso.	[3] 14,300	1884–1961......	1904	....	14.5	....	....
				1920	....	....	24,400	....
					23	7.85	8,700	3

[1] Ratio of peak discharge to 50-yr flood.
[2] Slightly smaller than that of the 1955 flood.
[3] Includes 2,940 sq mi in closed basin in San Luis Valley, Colo.

the peak discharge of Pojoaque Creek was not determined, residents in the vicinity stated that it was slightly less than that of the flood of 1955, which was the maximum discharge during a period of record beginning in 1936.

The high discharges were apparently of short duration. The peak discharges near the mouths of Rio del Oso and Arroyo de la Presa were each about 12,000 cfs, and an undetermined amount of water discharged into Rio Chama from Rio Ojo Caliente. The result of the timing of these tributary crests entering Rio Chama and the effect of channel storage in Rio Chama produced a relatively small peak near Chamita of 8,000 cfs. Peaks that occurred at the regular gaging stations in the area were not outstanding but are shown in table 23 for comparison.

FLOODS OF AUGUST 22–23 IN TUCSON, ARIZ.

A record-breaking flood occurred in Tucson (fig. 35) as a result of intense rainfall on the night of August 22–23. The Weather Bureau reported 2.48 inches of rain at the Tucson airport during a 4-hour period. Maximum intensities were 2.22 inches in 1 hour and 1.17 inches in 15 minutes. The total rainfall for a storm of this duration has been exceeded only once at Tucson, July 29, 1958, when 3.93 inches fell.

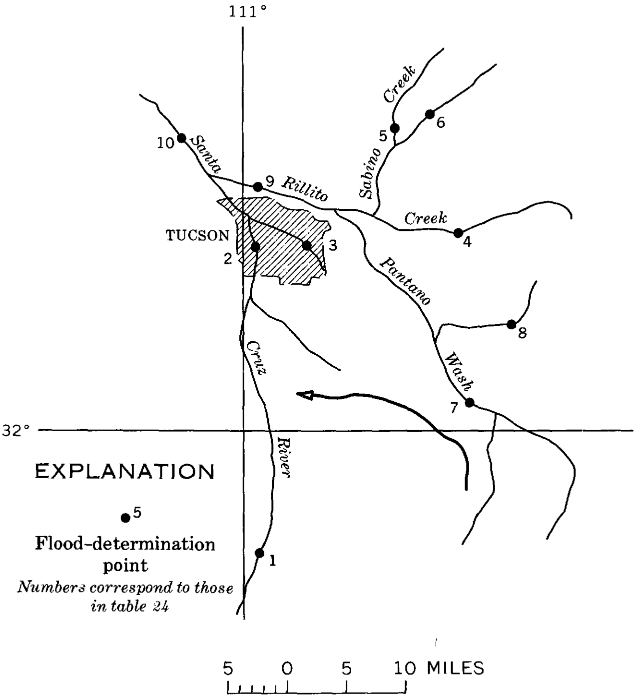

FIGURE 35.—Location of flood-determination points, floods of August 22–23 in the Tucson, Ariz., area.

Thunderstorm activity was widespread over much of Arizona following inflow of a deep moist current of air, originating over the Gulf of Mexico, into the State from the southeast. Rainfalls of 2½–3 inches were reported within a radius of 60–100 miles, east, north, and southwest of Tucson. At the north end of the Santa Rita Mountains, 25 miles south of Tucson, 2.30 inches was measured. Reported precipitation was somewhat less in Tucson and ranged from ½ inch to nearly 2 inches.

The heavy runoff following the cloudburst rapidly filled all the arroyos in the city, flooded many streets, and filled underpasses with water. Many business houses and residences were flooded to a depth of 2–3 feet. Floodwaters closed the main highways south and east of Tucson for several hours. Bridge approaches were washed out, but no bridges were damaged.

Many vehicles were stalled on flooded streets, and several were swept off roads into the swollen arroyos. Three persons were drowned when they were unable to escape from their submerged automobiles, and many other persons narrowly escaped the same fate.

The flooding in Tucson was possibly the costliest in the city's history. Estimates of damage ran as high as $1 million. However, the Weather Bureau estimate is as follows: $100,000 to city streets; $200,000 to county roads; $25,000 to personal property, principally automobiles; and $25,000 wind damage to structures.

Tucson Arroyo, which drains the southern part of Tucson, had a peak discharge of 5,000 cfs at 10 p.m. August 22 (fig. 36), which was the maximum discharge for the period of record, which has been continuous since 1944. The normally dry Santa Cruz River at Tucson reached a peak discharge from local runoff at 12 p.m., August 22; however, a higher peak discharge, 16,600 cfs, occurred at 4:30 a.m., August 23. The second peak was the result of extremely high runoff from the west side of the Santa Rita Mountains and was the maximum of record at the gaging station, where records are continuous since 1905.

Table 24 shows that Santa Cruz River at Continental had only a moderate rise and that only minor inflow to the Santa Cruz River occurred between Tucson and the gaging station at Cortaro. The

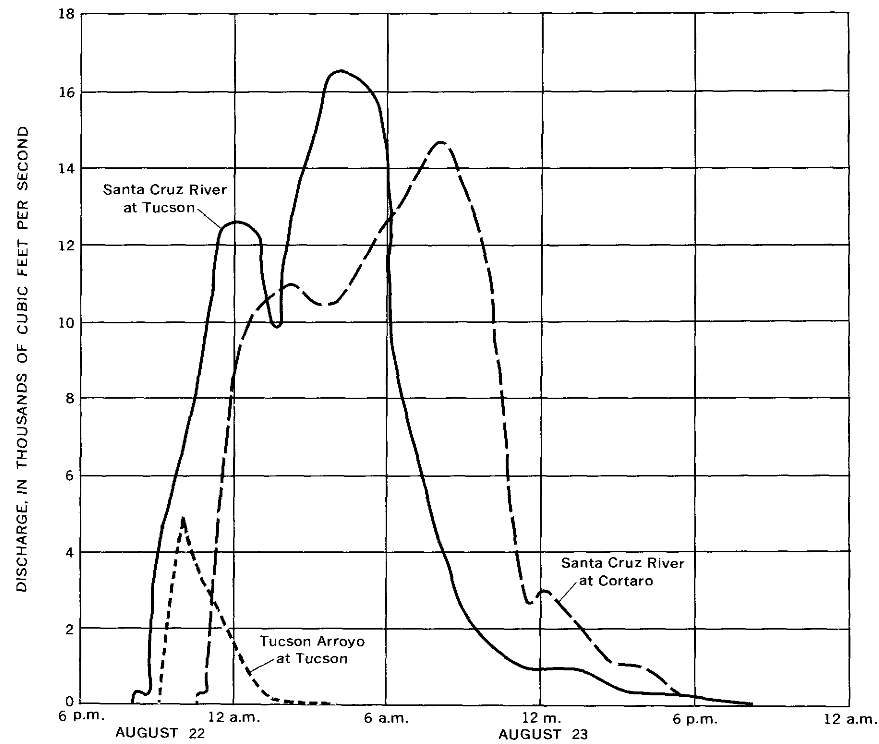

FIGURE 36.—Discharge hydrographs for selected stations in the Tucson, Ariz., area.

peak discharge at Cortaro was less than that at Tucson owing to channel losses between the stations and has been exceeded twice before.

TABLE 24.—*Flood stages and discharges, August 22–23 in Tucson, Ariz.*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods					
			Prior to August 22, 1961		August 1961	Gage height (feet)	Discharge	
			Period	Year			Cfs	Recurrence interval (years)
	Santa Cruz River basin							
1	Santa Cruz River at Continental.	1,662	1940–46, 1951–61	1955		11.34	17,500	
					23	5.80	4,820	2
2	Santa Cruz River at Tucson.	2,222	1905–61	1914		(1)	15,000	
					23	15.60	16,600	11
3	Tucson Arroyo at Vine Avenue, Tucson.	(2)	1944–61	1948		9.9	4,100	
					22	10.35	5,000	15
4	Tanque Verde Wash near Tucson.	43.0	1959–61	1960		2.83	789	
					22	2.32	394	1
5	Sabino Creek near Tucson.	35.5	1932–61	1954		8.43	5,110	
					23	2.49	46	1
6	Bear Creek near Tucson	16.3	1959–61	1960		2.30	575	
					22–23		0	
7	Pantano Wash near Vail	457	1958–61	1958		24	38,000	
					22	5.75	3,850	2
8	Rincon Creek near Tucson.	44.8	1952–61	1955		9.90	8,250	
					22	6.92	2,600	6
9	Rillito Creek near Tucson.	918	1908–61	1929		(1)	24,000	
					22	6.32	2,350	1
10	Santa Cruz River at Cortaro.	3,503	1939–47, 1950–61	1940		(1)	17,000	
					23	9.00	14,700	5

1 Not determined.
2 23.4 sq mi, 1948; 8.2 sq mi, August 1961.

FLOODS OF AUGUST 24–26 IN UPPER FRENCH BROAD RIVER BASIN, NORTH CAROLINA

Rainfall over the upper French Broad River basin was slightly above normal in 3 of the 5 months preceding August. August was particularly wet and total rainfall for the month ranged from 7 or 8 inches near Asheville to nearly 29 inches at Rosman. Showers fell daily from August 1 to 13 and general rains fell from August 18 to 22. Heavy rains began over the basin at 9 p.m. or 10 p.m. on August 23 and by early morning of August 25 the total rainfall averaged 6.7 inches for 17 stations in the basin above Hominy Creek. Additional rain fell in the late morning and early afternoon. Figure 37 shows the amounts and the distribution of the rainfall for the period August 24–25. The heaviest rain fell along the Blue Ridge divide, along the South Carolina State line, and near Rosman and Hendersonville. Figure 38 shows that the flood producing rains came in three periods. Light to heavy showers from late August 25 to August 27 served to keep the stages up.

Three outstanding floods had occurred in this area in 1916, 1940, and 1949. The flood of 1916 was the most severe (table 25) and that

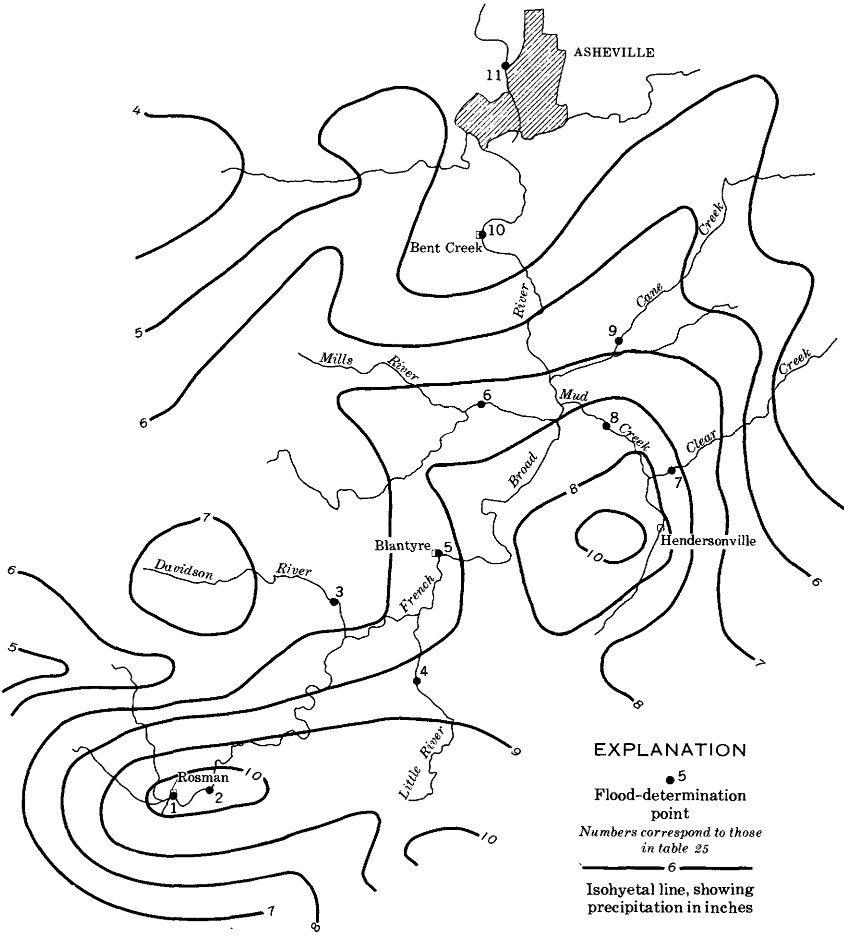

FIGURE 37.—Location of flood-determination points and isohyets for August 24-25, floods of August 24-26 in upper French Broad River basin.

of 1949 was the least severe of the three. The flood in August 1961 was similar to that in 1949. On the French Broad River, the 1961 discharge was about equal to the 1949 discharge as Asheville at the north end of the flood area; it was slightly less than that of 1949 in the headwater area near Rosman and Calvert; it greatly exceeded that of 1949 at Bent Creek, and exceeded the stage and almost equaled the discharge at Blantyre.

The difference in stage pattern along the French Broad River is shown in figure 39. The intense rains near Rosman caused the river to rise sharply and to crest at less than a foot above bankfull stage during the early morning on August 24. The river then quickly receded and again suddenly rose to flood stage during the afternoon

TABLE 25.—*Flood stages and discharges, August 24–26, upper French Broad River basin, North Carolina*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to August 24, 1961: Period	Maximum floods: Prior to August 24, 1961: Year	Maximum floods: August 24–26, 1961	Maximum floods: Gage height (feet)	Maximum floods: Discharge: Cfs	Maximum floods: Discharge: Recurrence interval (years)
	Tennessee River basin							
1	French Broad River at Rosman.	67.9	1916	1916		13.9	[1]	
			1907–09, 1935–61	1940		11.86	9,410	
					24	8.72	3,260	2
2	French Broad River at Calvert.	103	1916	1916		13.5	[1]	
			1924–55	1928		13.0	16,100	
						8.5	[1]	
3	Davidson River near Brevard.	40.4	1869–1961	1876		11.9	[1]	
			1920–61	1928		11.8	8,400	
					24	5.67	2,580	2
4	Little River near Penrose.	41.4	1916	1916		14	[1]	
			1942–55	1952		10.72	3,280	
					[1]	9.85	2,910	5
5	French Broad River at Blantyre.	296	1791–1961	1916		27.1	[1]	
			1920–61	1928		22.9	26,500	
					26	[2] 20.01	7,830	2
6	Mills River near Mills River.	66.7	1876–1961	1940		13.62	[3] 13,400	
					24	8.04	3,330	3
7	Clear Creek near Hendersonville.	42.2	1916	1916		16	[1]	
			1945–55	1949		10.50	4,020	
					[1]	8.97	2,440	3
8	Mud Creek at Naples	109	1916	1916		21	[1]	
			1907, 1938–55	1940		13.07	10,800	
					24	12.60	5,650	4
9	Cane Creek at Fletcher	63.1	1916	1916		14.8	[1]	
			1942–58	1957		8.73	3,340	
					[1]	8.96	3,340	3
10	French Broad River at Bent Creek.	676	1916	1916		27.3	[1]	
			1933–61	1940		12.6	23,600	
					25	10.86	16,800	6
11	French Broad River at Asheville.	945	1791–1961	1916		23.1	[3] 110,000	
					25	9.01	19,000	4

[1] Not determined.
[2] Not at time of peak discharge.
[3] Not necessarily maximum discharge for the period.

and again receded in a few hours. At Blantyre, where the drainage area is about four times that at Rosman, the storms produced a smooth rapid rise to about 6 feet above bankfull stage. The stage remained above bankfull stage from the morning of August 24 to about noon on August 29. Flooding at Bent Creek and at Asheville was less severe than at Blantyre. The crests at Bent Creek and at Asheville were about 3 feet and 1 foot above bankfull stage, respectively, and bankfull stages remained 3 days at Bent Creek and about 2 days at Asheville.

The crest on Mud Creek near Naples was 1.1 feet higher than it was in 1949, although the discharge was less. The flood on Mud Creek was not exceptional in either stage or discharge, but it was probably the most destructive of any flood on the creek. This was due to intensive use of highly productive bottom lands for truck farming and to increased commercial development on the flood plains in Hendersonville. Water remained for 5 days on fields below Hendersonville.

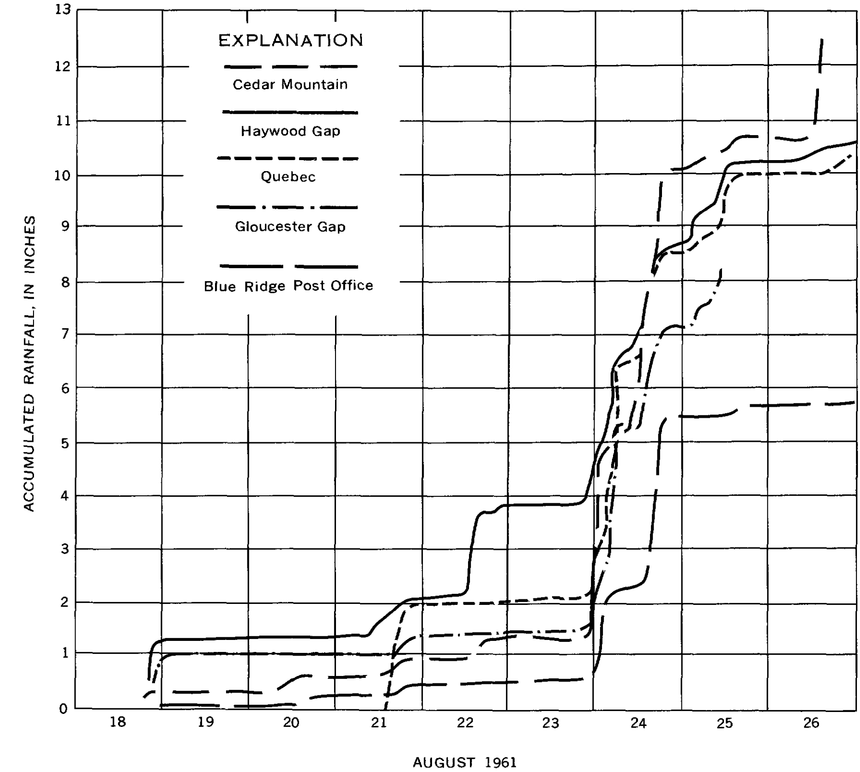

FIGURE 38.—Cumulative precipitation at five precipitation stations in upper French Broad River basin, August 18–26.

The flood on Cane Creek exceeded that in 1949. There was broad inundation of land in corn, hay, and pastureland, and water remained over fields and roads for 2 days.

Tributaries on the right bank of the French Broad River, heading in the Blue Ridge, had moderate floods. The stage on Little River was 1.1 feet above that of the 1949 flood and caused wide overflow along the lower reach of the river. Tributaries on the left bank had only small rises.

The flood caused damage of more than $1 million in the upper French Broad River basin. Damage was mostly on the flood plains of the French Broad River, and most of that was to crops much of which was in the harvesting stage. Substantial damage also occurred to crops along Mud Creek. Table 26 summarizes the amount of damage to crops in the entire flood area. Damage to business establishments and residences in Hendersonville was about $40,000.

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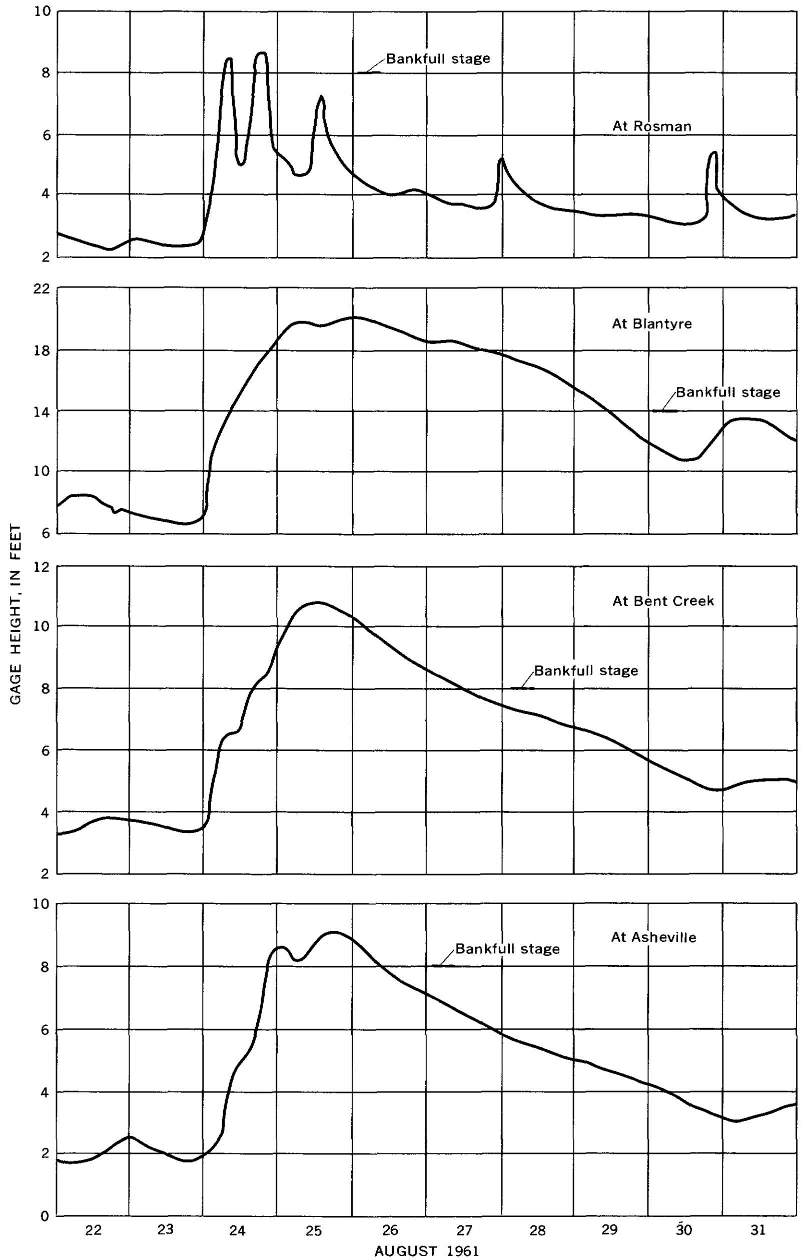

FIGURE 39.—Stage hydrographs on French Broad River, August 22–31.

TABLE 26.—*Crop damage, floods of August 24–25 in upper French Broad River basin*

River	Truck	Farm	Gladioli	Total
French Broad River:				
Acres affected	1, 771	4, 406	116	6, 293
Value of crop	$570, 600	$84, 400	$117, 450	$772, 450
Little River:				
Acres affected	104	354	----------	458
Value of crop	$42, 550	$4, 550	----------	$47, 100
Mud Creek:				
Acres affected	648	967	----------	1, 615
Value of crop	$154, 000	$14, 150	----------	$168, 150
Boylston Creek:				
Acres affected	----------	54	16	70
Value of crop	----------	$650	$6, 000	$6, 650
Cane Creek:				
Acres affected	129	41	----------	170
Value of crop	$7, 750	$550	----------	$8, 300
Totals:				
Acres affected	2, 652	5, 822	132	8, 606
Value of crop	$774, 900	$104, 300	$123, 450	$1, 002, 650

FLOODS OF AUGUST 27 IN PUERTO RICO

Severe floods occurred in many rivers in the eastern two-thirds of Puerto Rico (fig. 40), mostly on the morning of August 27 but continued into the afternoon in the western part of the flood area. The greatest floods were in a broad zone extending across the island from the south-

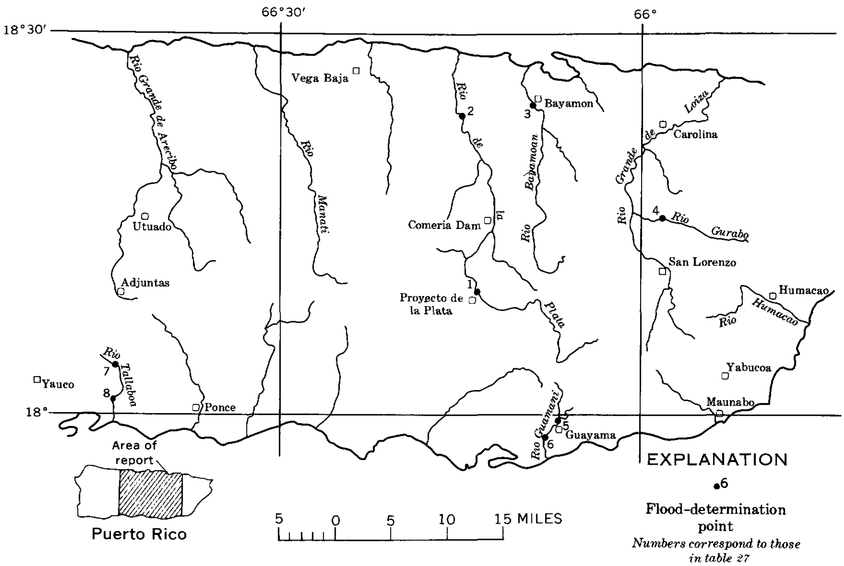

FIGURE 40.—Location of flood-determination points, floods of August 27 in Puerto Rico.

east cape to Bayamón and Vega Baja on the north coast. Maximum runoff apparently occurred in the upper basins of Rio de la Plata, Rio Bayamón, Rio Grande de Loiza and in the adjoining smaller basins to the southeast and south.

Rio Guamani, in the vicinity of Guayama, had the highest flood known to lifetime residents. The three hydro-electric plants in the mountainous part of the basin were damaged and put out of service. At the edge of the coastal plain, part of an 80-year old irrigation canal was destroyed, and Rio Guamani cut new channels at several places.

The floods in the upper and middle reaches of Rio de la Plata were higher than the flood from Hurricane Donna in September 1960. At Proyecto La Plata the flow was 80,000 cfs from 63.1 square miles (table 27) a unit rate of 1,270 cfs per sq mi. Once more, as in the 1960 floods, the hydroelectric plant below Comerio Dam was damaged, and the entire city of Vega Baja in the coastal plain was inundated.

Although the flood in Rio Bayamón was lower than the previous great flood in 1945, the water stages and damage in the vicinity of Bayamón attracted much attention because sections of some of the extensive new urban developments were inundated. Floodwater in the Bayamón coastal plain also inundated an extensive slum area at Cataño and caused many people to be evacuated.

At Humacao this flood was lower than the disastrous flood of 1960, but some of the same areas were swept by the water. A temporary river crossing of concrete pipe and fill was washed out again, but it was quickly restored to service.

TABLE 27.—*Flood stages and discharges, August 27 in Puerto Rico*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to August 1961: Period	Year	August 1961	Gage height (feet)	Discharge: Cfs	Cfs per sq mi
1	Rio de la Plata at Proyecto La Plata.	63.1	1959–61	1960		30.5	54,500	864
					27	32.2	80,000	1,270
2	Rio de la Plata at Toa Alta.	204	1960–61	1960		35.8	95,500	468
					27	33.2	68,700	337
3	Rio Bayamón at Bayamón.	76	1959–61	1959		35.7	15,000	197
					27	[1] 38.11	36,000	474
4	Rio Gurabo at Gurabo	59.6	1960–61	1960		27.7	(2)	
					27	16.7	11,000	185
5	Rio Guamani at Guayama.	8.25			27	[3] 13.7	(2)	
6	Rio Guamani near Guayama.	12.5			27	11.9	(2)	
7	Rio Tallaboa at Peñuelas.	24.9	1959–61	1960		8.3	5,920	238
					27	8.8	6,570	264
8	Rio Tallaboa at Tallaboa.	30.6	1959–61	1960		12.5	5,000	163
					27	13.6	6,700	219

[1] Highest since 1945.
[2] Not determined.
[3] Highest known.

Other large community areas damaged by floods were Carolina, San Lorenzo, Yabucoa, Maunabo, and Ponce. Moderately high floods occurred in the south coastal streams from Guayama to Yauco and in the Adjuntas-Utuado area.

Three people were reported to have died in the floods, and several were reported missing. Many thousands of persons were temporarily evacuated. Total damage was probably $1 or $2 million. Greatest rainfall reported was 13.80 inches in the upper Rio de la Plata basin, north of Guayama, and the rainfall was generally heaviest in the southeast quarter of the island, where many places reported 6–12 inches.

FLOODS OF SEPTEMBER FROM HURRICANE CARLA

Hurricane Carla was one of the largest, most intense, and most destructive hurricanes ever to strike the gulf coast and was classified by the Weather Bureau as one of the eight most intense storms to strike the Texas coast in 200 years. It caused 46 deaths and, according to estimates by the Corps of Engineers, damage amounted to more than $400 million mostly from the high-velocity winds and high tides; how much of this damage was due to stream flooding is unknown.

The hurricane center moved inland between Galveston and Corpus Christi, Tex., on September 11, accompanied by gusts of wind up to 175 miles per hour and by tides from 15 to 18 feet above normal. The hurricane moved northward (fig. 41) to near Denison, Okla., veered to the right and passed just south of the northwest corner of Arkansas, passed near St. Genevieve, Mo., and just south of the northwestern corner of Indiana, and left the United States near Cheyboygan, Mich.

Rains produced by the hurricane were spotty in Texas and Louisiana. Rainfall for September 10–12 ranged from 1.22 inches at Corpus Christi to 15.32 inches at Galveston and was 11.66 inches at Conroe, Tex., 80 miles inland. The heaviest rain in Louisiana, September 11–13, was 13.90 inches at Many, of which 8.93 inches fell on September 12; this rainfall greatly exceeded the previous maximum of record in this area. The resulting floods were not particularly outstanding except in Bayou Toro near Toro, La., where the peak discharge had a recurrence interval of 46 years.

Floods at other stations in western Louisiana had recurrence intervals of less than 10 years. The highest discharges in Texas and Louisiana occurred east of the hurricane's path.

As the hurricane moved northward through Texas and north-eastward through Oklahoma, no floods of consequence followed. Moderately heavy rains fell northwest of the hurricane's path as it passed over northeastern Oklahoma, southeastern Kansas, central Missouri, and central Illinois. The area of floods was a band almost parallel

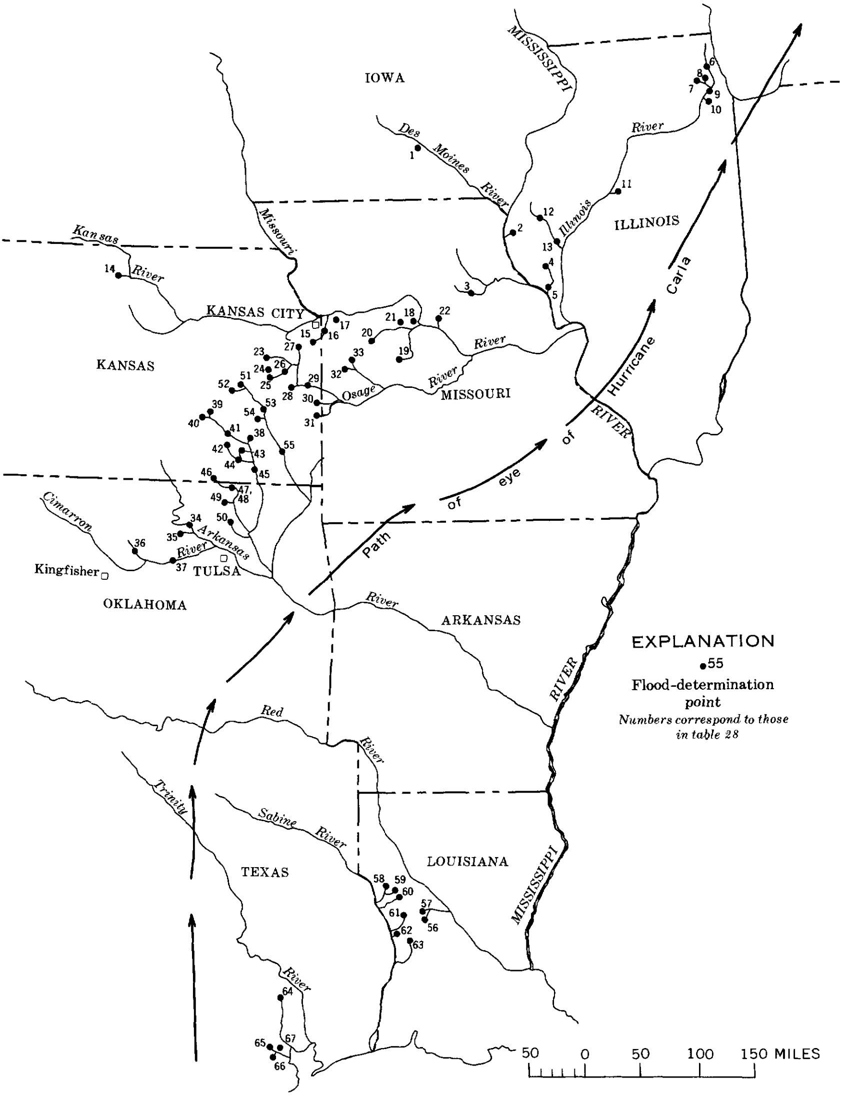

FIGURE 41.—The path of Hurricane Carla and location of flood-determination points, floods of September from Hurricane Carla.

to the hurricane's path (fig. 41). The farther edge of the band was from 150 to 200 miles to the left of the direction of movement of the hurricane path, and the nearer edge was about 80 miles left of the path.

The direction of flow of all large streams and of most of the small streams was across the band of flooding rather than parallel to it. The discharges in the upper and in the lower reaches of large streams, therefore, were relatively small.

Up to 9 inches of rain fell in 24 hours in central Oklahoma, but runoff was generally not high because of newly plowed fields and a preceding dry period. Flooding occurred on some of the small streams tributary to the Arkansas River above Tulsa, Okla. (table 28). About 150 blocks of residential area in Kingfisher, Okla., was flooded.

TABLE 28.—*Flood stages and discharges in September from Hurricane Carla*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods					
			Prior to September 1961		September 1961	Gage height (feet)	Discharge	
			Period	Year			Cfs	Recurrence interval (years)
	Des Moines River basin							
1	Cedar Creek near Bussey, Iowa.	374	1946	1946		(1)	31,500	
			1947–61	1950			29,300	
				1958		28.06		
					13	27.54	20,800	40
	Bear Creek basin							
2	Bear Creek near Marcelline, Ill.	348	1944–61	1951		26.07	21,200	
					14	23.60	17,200	
	Salt River basin							
3	Middle Fork Salt River at Paris, Mo.	356	1939–61	1958		29.94	23,100	
					15	25.37	13,400	25
	Sny River basin							
4	Bay Creek at Pittsfield, Ill.	39.6	1926	1926		18.4	(1)	
			1939–61	1945		13.25	8,300	
					13	13.89	10,000	
5	Bay Creek at Nebo, Ill.	162	1939–61	1946		19.31	23,500	
					14	15.05	10.600	19
	Illinois River basin							
6	Weller Creek at Des Plaines, Ill.	13.1	1950–61	1957		12.37	668	
					14	11.48	596	6
7	Salt Creek at Western Springs, Ill.	122	1945–61	1948			1,920	
				1954		8.27		
					14	8.08	1,430	3
8	Addison Creek at Bellwood, Ill.	18.2	1950–61	1954		9.48	598	
					14	8.93	588	
9	Des Plaines River at Riverside, Ill.	635	1914–61	1919		(1)	7,450	
			1943–61	1948			6,510	
				1960		[3] 8.89		
					14	6.98	4,690	
10	Flag Creek near Willow Springs, Ill.	16.2	1951–61	1959		7.53	1,550	
					14	9.98	2,680	
11	Ackerman Creek at Farmdale, Ill.	11.8	1953–61	1954		8.81	1,110	
					13	9.25	1,310	4
12	La Moine River at Colmar, Ill	655	1944–61	1948		23.75	20,300	
					15	22.60	14,900	13
13	La Moine River at Ripley, Ill.	1,310	1921–61	1944		26.03	17,100	
					14	26.35	15,600	6
	Kansas River basin							
14	Buffalo Creek near Jamestown, Kans.	330	1898–1961	1948		18.5	(1)	
			1959–61	1960		17.80	4,800	
					12	19.31	18,800	50

See footnotes at end of table.

TABLE 28.—*Flood stages and discharges in September from Hurricane Carla*—Con.

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to September 1961, Period	Prior to September 1961, Year	September 1961	Gage height (feet)	Discharge: Cfs	Discharge: Recurrence interval (years)
	Blue River basin							
15	Blue River near Stillwell, Kans.	48.6			13		24,900	[2] 1.7
16	Blue River near Kansas City, Mo.	188	1928–60	1928		39	(1)	
			1939–61	1951		38.30	31,100	
					13	44.46	41,000	[2] 2.43
17	Little Blue River near Lake City, Mo.	184	1948–61	1951		26.1	6,400	
					14	27.94	9,460	9
	Slough Creek basin							
18	Burge Branch near Arrow Rock, Mo.	.33	1959–61	1960		3.38	47.8	
					13	4.38	134	
	Lamine River basin							
19	Flat Creek near Sedalia, Mo.	148	1958–61	1960		16.7	12,200	
					13	17.80	14,100	9
20	Blackwater River at Valley City, Mo.	547	1958–61	1960		30.4	66,500	
					14	31.75	55,000	[2] 1.69
21	Shiloh Branch near Marshall, Mo.	2.87	1952–61	1958		7.04	880	
					13	7.58	934	
	Moniteau Creek basin							
22	Moniteau Creek near Fayette, Mo.	81	1944–61	1944		22.9	(1)	
			1948–61	1955		19.47	4,180	
					13	19.6	4,330	10
	Osage River basin							
23	Marais des Cygnes River near Ottawa, Kans.	1,250	1864–1961	1951		42.50	[4] 142,000	
					14	34.95	26,800	6
24	Middle Creek near Princeton, Kans.	50	1957–61	1959		18.42	2,650	
					13	29.73	10,000	
25	Pottawatomie Creek near Garnett, Kans.	334	1928, 1939–61	1951		32.3	[4] 45,300	
					13	35.38	57,000	[2] 1.34
26	Pottawatomie Creek at Lane, Kans.	513	1928–32	1928		32.84	(1)	
				1931		25.25	7,670	
					14	33.9	75,000	[2] 1.35
27	Big Bull Creek near Hillsdale, Kans.	147	1958–61	1959		18.20	12,000	
					13	20.85	39,600	[2] 1.18
28	Big Sugar Creek at Farlinville, Kans.	198	1875–1961	1898		31	(1)	
				1961		29.88	30,000	
					13	30.28	37,600	50
29	Marais des Cygnes River near Kansas-Missouri State line, Kans.	3,230	1928, 1951, 1958–61	1951		41.2	148,000	
					16	33.93	57,400	6
30	Little Osage River at Fulton, Kans.	295	1948–61	1961		29.38	20,700	
					14	27.08	11,600	3
31	Marmaton River near Fort Scott, Kans.	393	1904–61	1915		50.0	(1)	
				1961		42.67	38,100	
					14	42.15	26,800	9
32	South Grand River at Urich, Mo.	670			15	26.84	29,200	21
33	Big Creek at Blairstown, Mo.	414			14	25.40	24,400	32

See footnotes at end of table.

TABLE 28.—*Flood stages and discharges in September from Hurricane Carla*—Con.

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to September 1961: Period	Year	September 1961	Gage height (feet)	Discharge: Cfs	Recurrence interval (years)
	Arkansas River basin							
34	Arkansas River at Ralston, Okla.	54,465	1923	1923		23.8	[1]	
			1925–61	1944		23.65	179,000	
					14	18.50	114,000	4
35	Black Bear Creek at Pawnee, Okla.	576	1944–61	1959		31.43	30,200	
					14	27.16	15,400	16
36	Skeleton Creek near Lovell, Okla.	410	1949–61	1957		34.58	75,200	
					13	29.95	28,300	[2] 1.53
37	Cimarron River at Perkins, Okla.	17,852	1939–61	1957		19.53	149,000	
					14	13.45	70,000	4
38	Verdigris River near Altoona, Kans.	1,138	1938–61	1951		31.09	71,000	
					14	26.96	29,600	4
39	Fall River near Eureka, Kans.	307	1923, 1946–61	1951		29.60	91,800	
					13	25.66	56,300	[2] 1.19
40	Otter Creek at Climax, Kans.	129	1946–61	1951		23.73	15,400	
					13	28.50	44,000	[2] 1.31
41	Fall River near Fall River, Kans.	585	1939–61	1945		31.15	45,600	
					15		[5] 3	
42	Salt Creek near Severy, Kans.	7	1957–61	1961		19.24	6,500	
					13	19.03	5,400	
43	Fall River at Fredonia, Kans.	827	1904–61	1945		36.17	49,000	
					13	30.93	24,000	4
44	Elk River near Elk City, Kans.	575	1869–1961	1961		33.90	100,000	
					13	32.93	87,000	[2] 1.13
45	Verdigris River at Independence, Kans.	2,892	1885–1961	1943		47.60		
				1945			117,000	
					15	42.98	59,700	6
46	Caney River near Elgin, Kans.	445	1938–61	1944		29.80	35,500	
					13	34.70	62,000	[2] 1.08
47	Hulah Reservoir near Hulah, Okla.	732	1950–61	1957		764.87	[6] 293.4	
					17		[6] 165.1	
48	Caney River near Hulah, Okla.	736	1937–61	1944		[1]	51,000	
					13		[5] 100	
49	Sand Creek at Okesa, Okla.	139	1959–61	1959		23.37	10,400	
					13	27.7	14,700	5
50	Bird Creek at Avant, Okla.	364	1945–61	1959		31.40	32,400	
					13	27.72	24,600	11
51	Neosho River at Burlington, Kans.	3,042	1951	1951		41.53	[1]	
					13	31.53	26,200	3
52	North Big Creek near Burlington, Kans.	46	1957–61	1957		21.31	5,800	
					13	23.81	9,200	
53	Neosho River near Iola, Kans.	3,818	1855–1961	1951		43.0	436,000	
					15	29.65	43,900	5
54	Owl Creek near Piqua, Kans.	177	1959–61	1961		20.42	11,800	
					13	21.78	22,000	23
55	Neosho River near Parsons, Kans.	4,905	1921–61	1951		40.20	410,000	
					19	26.95	40,000	3
	Red River basin							
56	Little Sandy Creek at Kisatchie, La.	21.4	1949–61	1953		15.36	5,880	
					13	11.45	4,080	11
57	Horsepen Creek near Provencal, La.	5.27	1949–61	1953		11.88	1,910	
					13	10.26	1,220	
	Sabine River basin							
58	Bayou San Miguel near Zwolle, La.	111	1948–61	1950		15.75	15,000	
					14	13.06	6,900	6
59	Blackwell Creek at Many, La.	3.16	1959–61	1960		7.27	188	
					13	13.20	865	
60	Bayou La Nana near Zwolle, La.	130	1955–61	1958		21.34	5,700	
					14	22.45	8,960	8
61	Bayou Toro near Florien, La.	74.1	1950–61	1953		50.54	18,500	
					13	50.12	17,000	
62	Bayou Toro near Toro, La.	144	1955–61	1958		17.53	3,350	
					13	24.24	20,500	46
63	Bayou Anacoco near Leesville, La.	118	1948–61	1953		19.39	26,200	
					13	16.42	10,000	5

See footnotes at end of table.

TABLE 28.—*Flood stages and discharges in September from Hvrricane Carla*—Con.

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to September 1961: Period	Maximum floods: Prior to September 1961: Year	Maximum floods: September 1961	Maximum floods: Gage height (feet)	Maximum floods: Discharge: Cfs	Maximum floods: Discharge: Recurrence interval (years)
	San Jacinto River basin							
64	Caney Creek near Splendora, Tex.	105	1885–1961	1940		22.0	(1)	
			1943–61	1945		18.19	14,900	
					13	15.01	7,000	
65	Whiteoak Bayou at Houston, Tex.	84.7	1919–61	1935		51.5	[4] 14,750	
					12	40.37	5,700	
66	Brays Bayou at Houston, Tex.	88.4	1936–61	1945		51.70		
				1960			12,600	
					11	41.62	6,320	
67	Halls Bayou at Houston, Tex.	24.7	1952–61	1953			2,410	
				1954		60.65		
					12	60.50	3,400	

[1] Not determined.
[2] Ratio of peak discharge to 50-yr flood.
[3] Result of ice jam.
[4] Not necessarily maximum discharge for the period.
[5] Flow regulated by reservoir; daily mean discharge.
[6] Contents in thousands of acre-feet.

General rains and low temperatures in early September had produced high soil-moisture content in Kansas. As a result of the hurricane more than 8 inches of rain fell in the headwaters of the Blue River, and 5 inches or more fell on a large area in the southwestern corner of Kansas and in central Missouri. The most outstanding flood occurred in the Blue River and was 1.7 times as large as the 50-year flood at Stillwell, Kans., and 2.4 times as large at Kansas City, Mo. Kansas had record-breaking floods on tributaries to the Verdigris, Neosho, and lower Marais des Cygnes Rivers. Buffalo Creek near Jamestown, Kans., had the highest stage in at least 70 years.

Tributaries of the Marais des Cygnes River downstream from Ottawa, Kans., had floods with recurrence intervals of 50 years or more. The flood on Pottawatomie Creek near Garnett, Kans., crested 3.1 feet higher than the 1951 flood which had been the highest flood since at least 1887. On Big Sugar Creek at Farlinville, Kans., the peak stage was only 0.7 foot less than that for the flood of 1898 and the second highest since 1875. Because of the relatively low flows upstream from Ottawa, the flood peak on the Marais des Cygnes River near the Kansas-Missouri State line had a recurrence interval of only about 7 years.

The third highest stage in 58 years recorded on Marmaton River near Fort Scott, Kans., has a recurrence interval of 9 years.

Heavy rainfall between Madison, Kans., and Toronto Reservoir caused an inflow rate of 61,600 cfs to Toronto Reservoir during the 24 hours ending at midnight on September 13. Virtually all the flood inflow was stored in Toronto Reservoir. The streamflow record on Verdigris River near Coyville, Kans. (drainage area, 747 sq mi), indicates a cut in the releases from Toronto Dam on September 12, some inflow from the intervening drainage area on the 13th, and then daily flows of only 507, 101, and 366 cfs, respectively, on September 14, 15, and 16, while downstream channels carried uncontrolled floodflows from intervening areas of 391 square miles. On September 14 near Altoona, Kans., the Verdigris River peaked at 29,600 cfs.

The upper end of the Fall River was in the area of high rainfall, and the resulting peak discharge was 1.2 times that of the 50-year flood as was that in Otter Creek at Climax, Kans. Inflow to Fall River Reservoir for September 13 was at the rate of 47,500 cfs. The flood-control capacity of Fall River Reservoir was sufficient to store all the flood runoff. Releases were 5 cfs or less during September 13–16. The highest unit discharge measured was 771 cfs per sq mi from 7 square miles on Salt Creek near Severy, Kans. Inflow from 242 square miles below Fall River Dam produced a peak discharge of 24,000 cfs on Fall River at Fredonia, Kans., on September 13.

On Elk River near Elk City, Kans., the peak discharge was 1.1 times that of the 50-year flood, and the peak stage and discharge were the second highest since at least 1869. The highest flood occurred on May 6, 1961. Channel storage and flow through an area of less rainfall reduced the flood peak on Verdigris River at Independence, Kans., to a recurrence interval of 6 years.

Caney River near Elgin, Kans., had a peak discharge whose recurrence interval was slightly more than 50 years and was the maximum during the 24-year period, 1938–61.

Floods on the main stem of the Neosho River between Council Grove and Parsons, Kans., and on Cottonwood River had recurrence intervals of 5 years or less. Owl Creek drains part of the high rainfall area near Yates Center, Kans., and the peak discharge near Piqua, Kans., had a recurrence interval of 23 years.

Widespread damage was caused by the wind and high tides, particularly in the coastal region of Texas and Louisiana. Great damage from flooding streams occurred in several areas farther north. Newspaper articles mentioned that two cars in Kansas and one car in Missouri were swept from roads by overflowing water in which six persons were drowned.

The Topeka Daily Capital of September 14 reported inundation and closing of 15 State highways and 7 U.S. highways in southeastern Kansas.

Kansas county officials estimated that 123,000 acres of land was inundated and that almost $3 million damage was caused in seven counties in the Verdigris River and Neosho River basins. The Kansas City Star of September 30 reported that 40,000 acres of land was inundated and about $1.8 million damage occurred in Miami County, in the Marais des Cygnes River basin.

The greatest concentration of damage was in the Blue River Valley. Damage in Kansas City was estimated at more than $9 million.

FLOODS OF NOVEMBER 13–15 IN SOUTHEASTERN LOUISIANA

Heavy rains on November 13–14 in the eastern section of the Florida Parishes, in Louisiana, caused extreme floods on streams in the vicinity of Bogalusa. During the 4-day period November 13–16, the greatest measured rainfall was 15.62 inches at Sheridan Fire Tower, of which 10.58 inches was recorded on November 14, and more than 10 inches fell over a 600-square mile area (fig. 42).

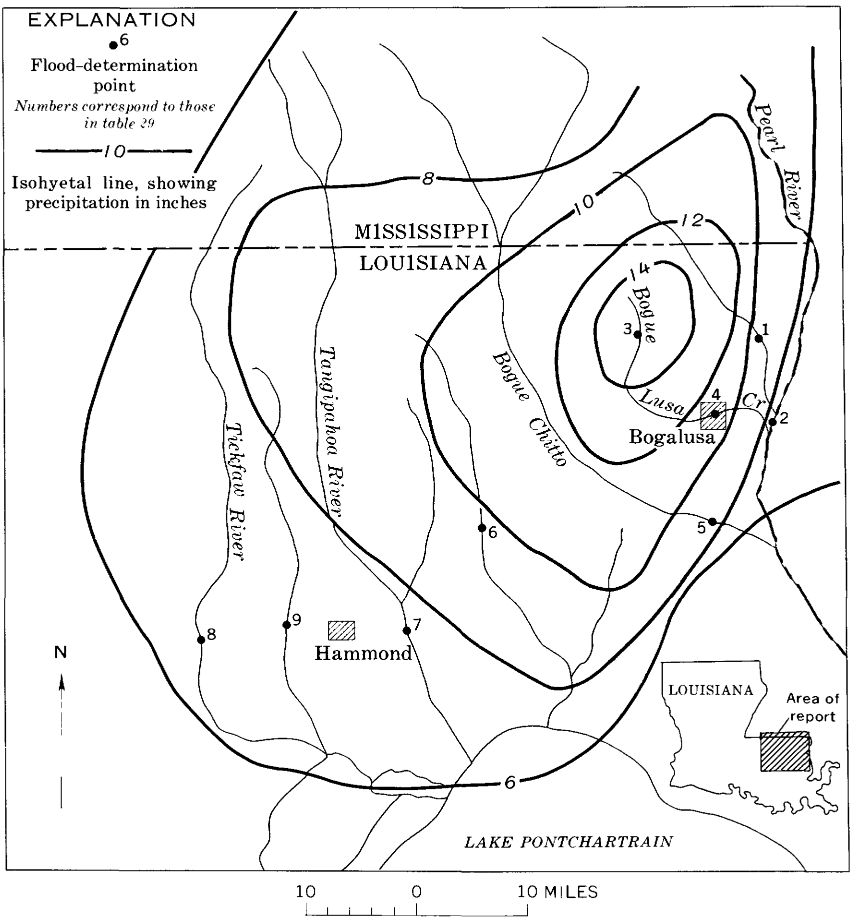

FIGURE 42.—Location of flood-determination points and isohyets for November 13–16, floods of November 13–15 in southeastern Louisiana.

Homes and businesses on the flood plains of creeks in the area were flooded. Overflow from Bogue Lusa Creek entered homes and businesses in Bogalusa. State Highway 21 and many city streets in the town were blocked. At Sun, a small town 10 miles south, the floodwater damaged homes and a gravel industry. Damage in the area was estimated by the Corps of Engineers at $572,000, of which 85 percent was in Bogue Lusa Creek basin. Damage in Bogalusa totaled $460,000.

This flood was the highest of record on Bogue Lusa Creek (table 29). Residents stated that the February 1961 flood on Bogue Lusa Creek at Bogalusa was the highest since at least 1900. The peak stage of November 14 exceeded that of the February 1961 flood by 1.5 feet. The frequency of this flood exceeded 50 years in the Bogalusa area but decreased rapidly in areas 20 miles from the storm center.

High rates of discharge came from small drainage areas which lie mostly in the area of intense rainfall, northwest of Bogalusa. Pearl River near Bogalusa has a large drainage area of which a very small percentage lies in the storm area. As a consequence, the increase in discharge at the station, due to the storm, was very small and was equivalent to a 2-year flood.

TABLE 29.—*Flood stages and discharges, November 13–15, in southeastern Louisiana*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to November 1961: Period	Prior to November 1961: Year	November 1961	Gage height (feet)	Discharge: Cfs	Discharge: Recurrence interval (years)
	Pearl River basin							
1	Pushepatapa Creek at Vornado.	158	1949–61	1961		49.14	55,700	
					13	47.71	30,600	[1] 1.4
2	Pearl River near Bogalusa.	6,630	1938–61	1961		21.70	88,200	
					14	19.75	42,400	2
3	Bogue Lusa Creek near Franklinton.	12.1	1948–61	1961		11.90	7,400	
					13	12.63	9,750	>50
4	Bogue Lusa Creek at Bogalusa.	75			14		24,800	[1] 1.9
5	Bogue Chitto near Bush.	1,210	1937–61	1961		17.04	57,000	
					15	14.10	31,500	3
	Mississippi River Delta							
6	Tchefuncta River near Folsom.	95.5	1943–61	1953		22.26	29,200	
					14	22.11	25,500	[1] 1.6
7	Tangipahoa River at Robert.	646	1921	1921		27.1	([2])	
			1938–61	1953		23.13	50,500	
					14	20.03	30,100	23
8	Tickfaw River at Holden.	247	1940–61	1943		19.75	9,680	
					17	11.65	1,990	
9	Natalbany River at Baptist.	79.5	1943–61	1953		19.73	9,550	
					13	14.75	4,200	4

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

FLOODS OF DECEMBER IN MISSISSIPPI AND ADJOINING STATES

A series of weather fronts associated with low-pressure systems, migrating northeastward from northern Mexico and the lower Rio Grande Valley, moved over Louisiana, Mississippi, and Alabama during the period December 5–18. Collision of these systems with cold airmasses moving southeastward from the Rocky Mountain area produced a prolonged storm period during which 19 inches of rain fell.

During the period December 5–9, rainfall was light over much of the area; average accumulation was approximately 1½ inches. This precipitation produced no appreciable rises on the streams, but it soaked the ground so thoroughly that high percentages of runoff resulted from precipitation that fell later.

On December 10, heavy rain fell on a narrow belt extending from Bogalusa, La., northeastward through southern Mississippi and into southwestern Alabama where as much as 11 inches of precipitation was measured. At Bogalusa, 9.78 inches was measured. Immediately to the east of Bogalusa, 10.52 inches fell early on December 10. Other areas of heavy precipitation were at Beaumont, in southeastern

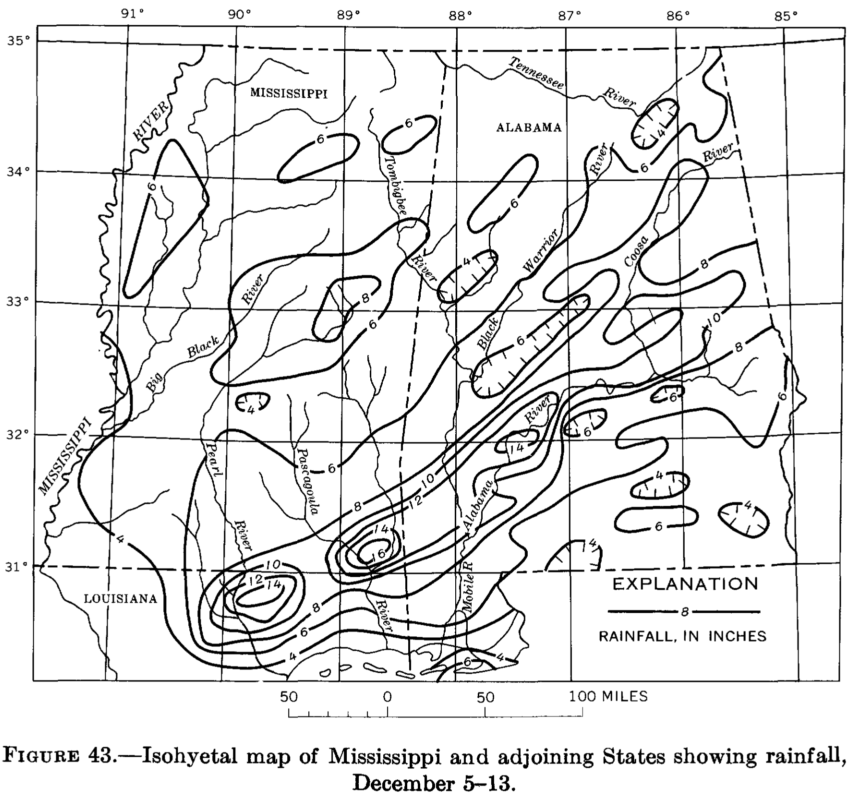

FIGURE 43.—Isohyetal map of Mississippi and adjoining States showing rainfall, December 5–13.

Mississippi, where 11.42 inches of rain fell and at Pinehill, Millers Ferry, and Selma in Alabama, where more than 7 inches of rain fell.

Precipitation continued on December 11 and 12, and was heaviest in central Mississippi over the Pearl and Big Black River basins. Figure 43 shows storm rainfall for the period December 5–13. During the second storm period, December 14–18, heavy rains again fell over the Pearl and Big Black River basins (fig. 44). The isohyetal map for the entire period, December 5–18, is shown on fig. 45. These isohyetal maps are based on rainfall data furnished by the U.S. Weather Bureau and by the Mississippi Forestry Commission.

In general, the flood peaks exceeded previous maximums only on small streams or on streams with short records of streamflow. A few small streams, notably in the Pearl and Pascagoula River basins, reached peaks having recurrence intervals of 50 years or more (fig. 46).

Peak discharges along the main stem of the Pearl River had a 12-year recurrence interval at Edinburg, a 25-year recurrence interval at Jackson, and then an 8-year recurrence interval at Columbia. At Jackson, Miss., the Pearl River reached the highest stage known and

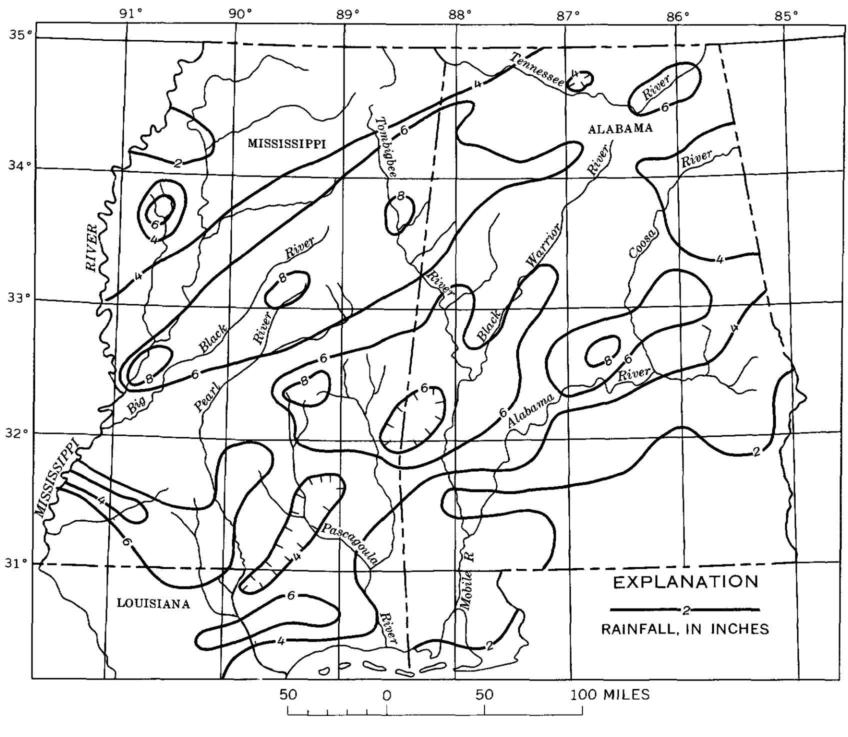

FIGURE 44.—Isohyetal map of Mississippi and adjoining States showing rainfall December 14–18.

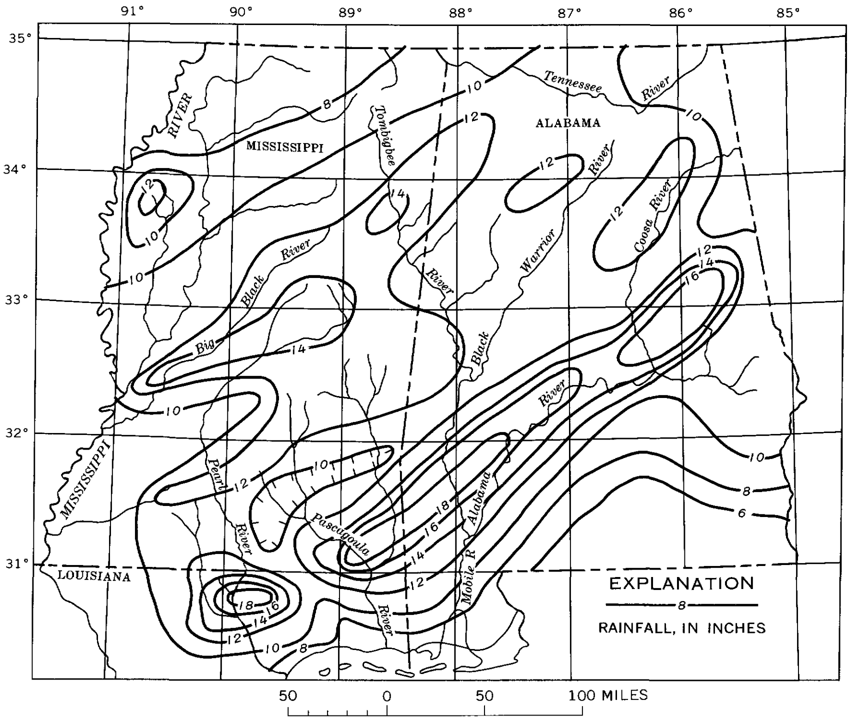

FIGURE 45.—Isohyetal map of Mississippi and adjoining States showing rainfall, December 5–18.

was slightly higher than the previous maximum in 1902, although the peak discharge was less (table 30).

The east flood plain at Jackson has an extensive network of ring levees north of U.S. Highway 80 that protect commercial and industrial property in the area known as Flowood. Some of the levees were overtopped, and only through coordinated efforts of municipal, county, and State agencies were some levees raised high enough to prevent the entire area from being flooded. Two gates in the spillway section of a partially completed dam on the Pearl River, approximately 10 miles upstream from Jackson, were closed late on December 20 to reduce the anticipated flood crest in the Flowood area. The crest at the gaging station at Jackson was reduced an estimated 0.2 foot as a result of this action.

U.S. Highway 80, linking Jackson and Flowood, was overtopped, but traffic was maintained by sandbagging critical points along the westbound lane. U.S. Highway 51, railroads, some principal streets, and commercial and residential property in southeast Jackson were flooded.

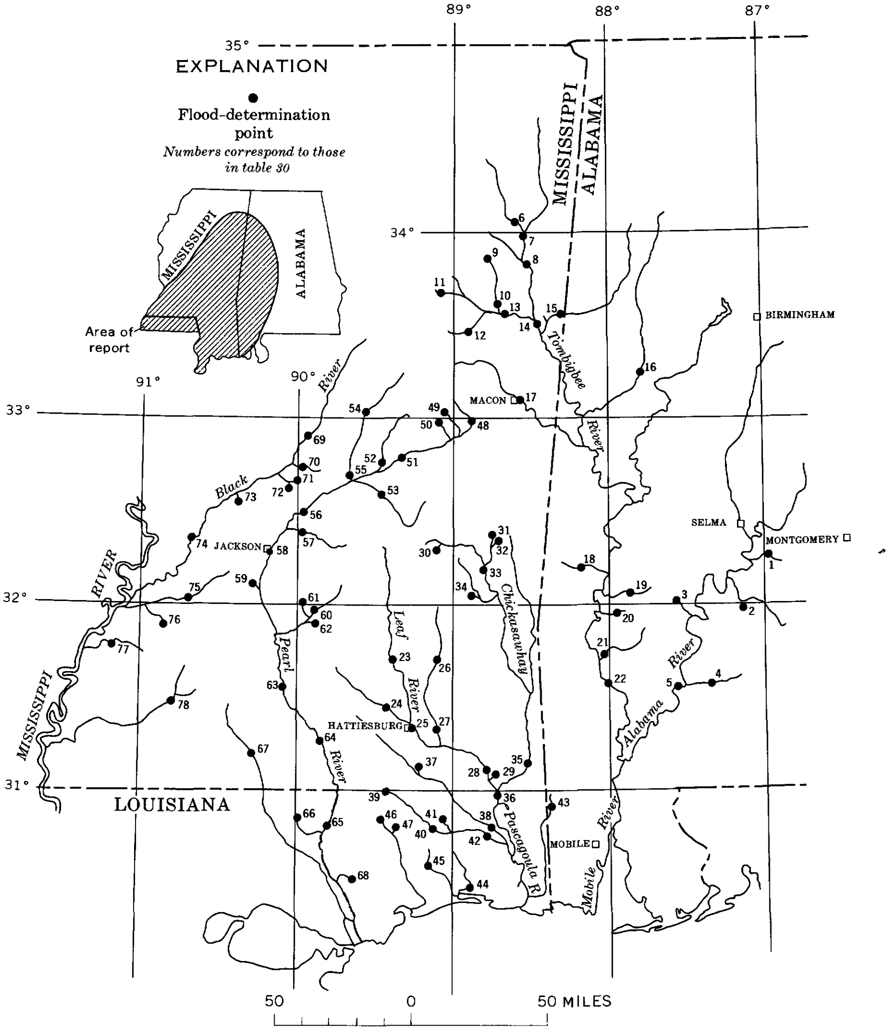

FIGURE 46.—Location of flood-determination points, floods of December in Mississippi and adjoining States.

The duration of flooding on the Pearl River is noteworthy. At Jackson the Pearl River reached flood stage (18 ft) on December 11, 1961, and remained above this point for 65 days, until February 13, 1962, as a result of the storm and subsequent rainfall. Prolonged high stages—32 days above a stage of 28 feet—delayed repairs to the damaged levee system. From February 19, 1961, to February 13, 1962, Pearl River at Jackson was above flood stage for 127 days.

Pearl River at Bogalusa, La., reached a peak discharge of 55,600 cfs on December 20 as a result of heavy rainfall during the period

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TABLE 30.—*Flood stages and discharges, December in Mississippi and adjoining States*

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to December 1961: Period	Year	December 1961	Gage height (feet)	Discharge: Cfs	Recurrence interval (years)
	Mobile River basin							
1	Mush Creek near Selma, Ala.	45.4	1951–61	1955		20.1	22,100	
					14	19.11	19,000	
2	Prairie Creek near Oakhill, Ala.	9.73	1959–61	1961		14.15	1,690	
					12		748	
3	Turkey Creek at Kimbrough, Ala.	114	1958–61	1961		24.23	10,300	
					10	25.02	(1)	
4	Limestone Creek near Monroeville, Ala.	117	1951–61	1929		22	(1)	
				1961		16.28	30,600	
					10	9.64	4,040	2
5	Alabama River at Claiborne, Ala.	22,000	1930–61	1961		55.15	267,000	
					26	48.83	179,000	5
6	West Fork Tombigbee River near Nettleton, Miss.	617	1892–1961	1955		33.88	[2] 151,000	
					18	29.08	30,100	3
7	Tombigbee River near Amory, Miss.	1,941	1937–61	1955		34.47	126,000	
					19	30.01	52,700	8
8	Tombigbee River at Aberdeen, Miss.	2,210	1928–61	1955		42.9	106,000	
					20	40.93	60,000	12
9	Chookatonchee Creek near Egypt, Miss.	170	1951–61	1955		11.23	28,300	
					18	9.26	14,500	7
10	Chookatonchee Creek near West Point, Miss.	514	1943–61	1951		23.55	45,800	
					18	21.3	28,800	5
11	Line Creek near Maben, Miss.	6.5	1952–61	1955		18.38	1,600	
					17	15.31	660	2
12	Trim Cane Creek near Starkville, Miss.	39.6	1952–61	1952		26.9	10,900	
					17	26.29	9,800	25
13	Tibbee Creek near Tibbee, Miss.	928	1926	1926		31.5	(1)	
			1928–30, 1939–61	1951		30.82	75,200	
					18	29.51	56,000	8
14	Tombigbee River at Columbus, Miss.	4,490	1892	1892		[3] 44.1	(1)	
			1899–1912, 1928–61.	1949		39.32	148,000	
					20	38.40	127,000	21
15	Luxapalila Creek at Steens, Miss.	309	1943–61	1949		19.2	16,000	
					20	17.94	9,800	4
16	Sipsey River near Elrod, Ala.	518	1928–32, 1939–61	1961		18.83	27,800	
					20	16.82	15,800	2
17	Noxubee River at Macon, Miss.	812	1928–32, 1938–61	1951		32.97	52,000	
					19	30.97	29,000	8
18	Tuckabum Creek near Butler, Ala.	112	1954–61	1961		20.13	6,830	
					19	17.13	4,480	3
19	Horse Creek near Sweetwater, Ala.	52.8	1959–61	1961		16.80	17,400	
					10	17.5	25,800	
20	Bashi Creek near Campbell, Ala.	86.3	1959–61	1961		24.22	6,340	
					10	25.94	21,100	
21	Satilpa Creek near Coffeeville, Ala.	166	1956–61	1956		18.37	25,600	
					10	16.53	13,100	6
22	Tombigbee River near Leroy, Ala.	19,100	1874	1874		51.8	280,000	
			1928–61	1961		48.24	252,000	
					29	(1)	198,000	12
	Pascagoula River basin							
23	Leaf River near Collins, Miss.	752	1856	1856		33	(1)	
			1938–61	1961		31.85	48,500	
					19	25.08	20,300	3
24	Bowie Creek near Hattiesburg, Miss.	304	1938–61	1961		26.92	34,800	
					18	20.80	10,500	7
25	Leaf River at Hattiesburg, Miss.	1,760	1900	1900		33.6	(1)	
			1938–61	1961		31.53	72,200	
					20	25.92	37,200	4
26	Tallahala Creek at Laurel, Miss.	233	1919	1919		26	(1)	
			1938–61	1961		22.32	19,100	
					19	18.75	10,400	14
27	Tallahala Creek near Runnelstown, Miss.	612	1865–1961	1900		30.5	(1)	
			1939–61	1961		25.07	32,800	
					21	19.08	12,800	4

See footnotes at end of table.

TABLE 30.—*Flood stages and discharges, December in Mississippi and adjoining States*—Continued

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to December 1961: Period	Year	December 1961	Gage height (feet)	Discharge: Cfs	Recurrence interval (years)
	Pascagoula River basin—Continued							
28	Leaf River near McLain, Miss.	3,510	1900	1900		32	[1]	
			1939–61	1961		31.64	128,000	
					21	25.56	57,500	4
29	Waterfall Branch near McLain, Miss.	.65	1955–61	1959		10.89	683	
					10	7.48	398	4
30	Tarlow Creek near Newton, Miss.	15.9	1952–61	1961		18.29	4,300	
					18	17.56	1,900	4
31	Okatibbee Creek near Meridian, Miss.	239	1938	1938		29.5	[1]	
			1939–61	1961		26.14	27,000	
					18	25.23	17,000	25
32	Sowashee Creek at Meridian, Miss.	51.9	1900–61	1936		26.5	[1]	
			1950–61	1951		20.09	8,030	
					18	18.04	5,640	9
33	Chickasawhay River at Enterprise.	913	1938–61	1961		37.94	61,700	
					19	33.78	38,800	12
34	Pachuta Creek near Pachuta, Miss.	23	1952–61	1961		268.32	6,000	
					18	267.86	4,600	[4] 1.26
35	Chickasawhay River at Leakesville, Miss.	2,680	1900	1900		38	[1]	
			1938–61	1961		33.52	73,600	
					24	29.88	39,500	7
36	Pascagoula River at Merrill, Miss.	6,600	1900	1900		32.5	[1]	
			1930–61	1961		30.66	178,000	
					22	25.76	90,000	6
37	Walls Creek near Brooklyn, Miss.	22.3	1951–61	1959		98.16	5,700	
					10	97.47	4,800	[4] 1.20
38	Black Creek near Benndale, Miss.	710	1958–61	1959		62.89	24,300	
					13	63.02	24,500	35
39	Red Creek at Lumberton, Miss.	15.6	1951–61	1961		98.7	3,500	
					10	98.7	2,640	15
40	Red Creek near Wiggins, Miss.	168	1952–61	1960		147.49	13,500	
					10	148.82	17,000	[4] 1.13
41	Flint Creek near Wiggins, Miss.	24.8	1957–61	1957		16.17	3,320	
					10	14.83	2,120	4
42	Red Creek at Vestry, Miss.	416	1958–61	1961		18.40	18,500	
					12	18.56	20,000	30
43	Escatawpa River near Wilmer, Ala.	506	1945–61	1959		24.66	30,000	
					13	22.60	20,100	3
	Biloxi River basin							
44	Tuxachanie Creek near Biloxi, Miss.	92.4	1907–09	[1]		23	[1]	
			1952–61	1957		22.22	17,700	
					11	10.78	2,720	2
45	Biloxi River near Wortham, Miss.	98.3	1948	1948		23.3	[1]	
			1952–61	1957		21.08	7,740	
					10	14.46	4,540	3
	Wolf River basin							
46	Wolf River near Poplarville, Miss.	71	1952–61	1961		191.67	8,800	
					10	193.42	13,000	[4] 1.86
47	Murder Creek near Poplarville, Miss.	21.6	1952–61	1961		16.50	2,850	
					10	19.20	6,760	[4] 1.80
	Pearl River basin							
48	Nanawaya Creek at Handle, Miss.	90	1938	1938		10.64	[1]	
					12	12.3	7,000	12
49	Tallahaga Creek near Noxapater, Miss.	53	1953–61	1953		93.9	4,900	
					12	94.26	6,400	[4] 1.03
50	Noxapater Creek near Noxapater, Miss.	33.1	1952–61	1961		94.62	4,100	
					12	94.82	5,000	50
51	Pearl River at Edinburg, Miss.	898	1902	1902		29.0	[1]	
			1928–61	1935			31,400	
				1961		26.73		
					20	26.53	25,200	12

See footnotes at end of table.

TABLE 30.—*Flood stages and discharges, December in Mississippi and adjoining States*—Continued

No.	Stream and place of determination	Drainage area (sq mi)	Maximum floods: Prior to December 1961: Period	Maximum floods: Prior to December 1961: Year	Maximum floods: December 1961	Maximum floods: Gage height (feet)	Maximum floods: Discharge: Cfs	Maximum floods: Discharge: Recurrence interval (years)
	Pearl River basin—Continued							
52	Lobutcha Creek near Carthage, Miss.	313	1938–61	1951		18.00	19,100	
					18	17.28	11,000	6
53	Tuscolameta Creek at Walnut Grove, Miss.	411	1938–61	1950		23.00	34,600	
					19	18.66	16,800	4
54	Yockanookany River near Kosciusko, Miss.	314	1938–61	1951		18.72	19,300	
					18	17.64	15,300	13
55	Yockanookany River near Ofahoma, Miss.	484	1943–61	1951		20.28	20,700	
					20	19.40	13,800	9
56	Pearl River at Meeks Bridge near Canton, Miss.	2,780	1932	1932		26.4	(1)	
			1938–61	1951		26.30	57,800	
					20	27.77	66,000	20
57	Pelahatchie Creek near Fannin, Miss.	205	1880–1961	1950		23.7	(1)	
			1951–61	1955		22.08	13,500	
					18	22.30	13,600	12
58	Pearl River at Jackson, Miss.	3,100	1901–13, 1928–61	1902		37.2	80,800	
					21	37.29	66,000	25
59	Rhodes Creek near Terry, Miss.	20.9	1948–61	1953		24.5	4,470	
					12	20.77	2,090	2
60	Strong River at D'lo, Miss.	429	1928–61	1950		33.0	24,800	
					18	28.00	11,800	3
61	Dobbs Creek near D'lo, Miss.	55.1	1948–61	1955		24.65	7,950	
					18	22.48	2,260	1
62	Riles Creek near Mendenhall, Miss.	25.3	1948–61	1950		26.29	9,050	
					18	19.33	2,260	2
63	Pearl River at Monticello, Miss.	5,040	1902	1902		33	100,000	
			1938–61	1950		29.44	59,300	
					25	29.97	63,500	9
64	Pearl River near Columbia, Miss.	5,690	1874	1874		31	(1)	
			1928–50	1938		26.40	72,600	
					27	25.15	60,800	8
65	Pearl River at Bogalusa, La.	6,630	1938–61	1938		21.0	(1)	
			1939–61	1947			60,000	
				1950		20.32		
					29	20.98	70,800	14
66	Bogue Lusa Creek near Franklinton, La.	12.1	1948–61	1948		11.0	4,020	
					11	7.84	915	
67	Bogue Chitto near Tylertown, Miss.	502	1936	1936		(5)	(1)	
			1944–61	1950		33.50	45,700	
					18	20.71	12,900	2
68	East Hobolochitto Creek at Picayune, Miss.	108	1957–61	1958		87.08	6,200	
					10	87.54	6,800	5
	Lower Mississippi River basin							
69	Big Black River at Pickens, Miss.	1,460	1926	1926		23.7	(1)	
			1936–61	1951		22.20	49,400	
					18	21.52	42,000	9
70	Doaks Creek near Canton, Miss.	161	1948–61	1951		18.46	13,000	
					18	17.42	9,300	8
71	Tilda Bogue near Canton, Miss.	24.4	1948–61	1953		19.0	8,800	
					17	17.91	4,000	5
72	Bacheler Creek at Canton, Miss.	3.1	1953	1953		17.78	1,000	
					17	15.86	550	3
73	Bogue Chitto near Flora, Miss.	124	1953–61	1953		20.88	21,000	
					18	19.45	13,800	7
74	Big Black River near Bovina, Miss.	2,810	1936–61	1951			58,600	
				1958		39.74		
					20	40.53	63,500	25
75	Bayou Pierre near Carpenter, Miss.	371	1945–61	1953		25.95	24,400	
					18	26.17	25,000	4
76	Clarks Creek near Pattison, Miss.	75			17	20.80	9,800	3
77	Coles Creek near Fayette, Miss.	150			17	25.20	39,500	10
78	Homochitto River at Eddiceton, Miss.	180	1938–61	1939			30,900	
				1953		16.37		
					17	12.12	16,700	2

[1] Not determined.
[2] Discharge not necessarily maximum for the period.
[3] At site 1,100 ft upstream same datum as in 1961.
[4] Ratio of peak discharge to 50-yr flood.
[5] 1.2 ft higher than flood of 1950, ¼ mile downstream.

December 5–13. The river fell slightly but rose again as the upstream crest approached and reached a peak discharge of 70,800 cfs (a recurrence interval of about 14 yr) on December 29.

Floods on small streams immediately east of Bogalusa were outstanding. East Hobolochitto Creek at White Sand flooded many houses in the community, and reached a stage 0.3 foot higher than the peak stage in February 1961 and a peak discharge greater than a 50-year flood.

Peak discharges on the upper Tombigbee River reflected the long duration and fairly even distribution of rainfall in northeastern Mississippi during the entire storm period. At Columbus, Miss., the runoff from several rainstorms coincided to produce a peak discharge of about a 21-year recurrence interval. Upstream from Columbus the peaks were of progressively lower recurrence interval—12 years at Aberdeen and 8 years near Amory—whereas on the tributaries upstream from Amory the peak discharges had recurrence intervals ranging generally from 1 to 3 years. Recurrence intervals of peak discharges indicate flood peaks of smaller frequencies at sites on the tributary streams than at sites on streams having larger drainage areas where precipitation time was longer.

The multicrest response of small streams to the time distribution of storm rainfall compared with the single crest of long duration on large streams is illustrated by figures 47 and 48.

Damage from the flood was limited mostly to highways and to municipal and industrial property in the Jackson, Miss., area. Because the flood occurred in the winter, agricultural damage was light. Two persons were drowned in Mississippi.

Pearl River County, Miss., sustained very heavy damage to roads and bridges, especially on the secondary road system. About 1,000 feet of newly constructed road was washed out. The county engineer estimated the damage to roads and bridges at about a quarter of a million dollars.

The Mississippi Highway Department estimated the total damage to all secondary roads in the State at $1 million. Estimates of damage to major highways in the State by districts were as follows:

District and area in State	*Amount of damage*	*District and area in State*	*Amount of damage*
1. Northeast	$25, 000	6. Southeast	$35, 000
2. Northwest	6, 000	7. Southwest	36, 300
3. West central	30, 000		
5. East central	20, 000	Total	152, 300

The Alabama Highway Department reported damage to highways in at least 10 counties, principally in southwestern Alabama. In Marengo County there was appreciable damage to six bridges or fills, and nine sections of highway were inundated. In Clarke County two

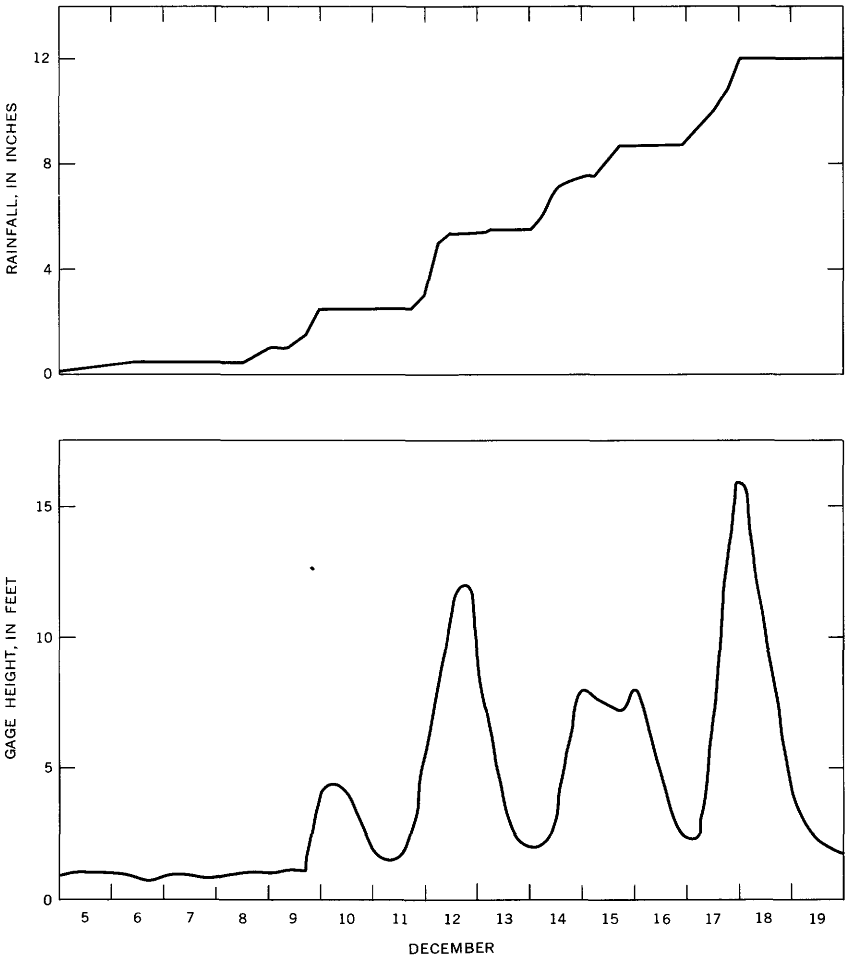

FIGURE 47.—Accumulated rainfall and stages on Sowashee Creek at Meridian, Miss. (drainage area, 51.9 sq mi), December 5–19, 1961.

bridges were damaged. In Fayette County the Sipsey River overtopped a county road near Hubbertville and caused damage estimated at $15,500. In Wilcox County there was extensive damage to State and county roads along Goose and Turkey Creeks in the vicinity of Kimbrough.

Industrial damage and cost of flood protection in the Flowood area east of Jackson, Miss., was estimated at $160,000 by the mayor of Flowood. According to incomplete figures furnished by the American National Red Cross, 567 residences in the Jackson, Miss., area and about 45 at Columbus, Miss., were flooded. These floods have been described in more detail in a report by Shell (1962).

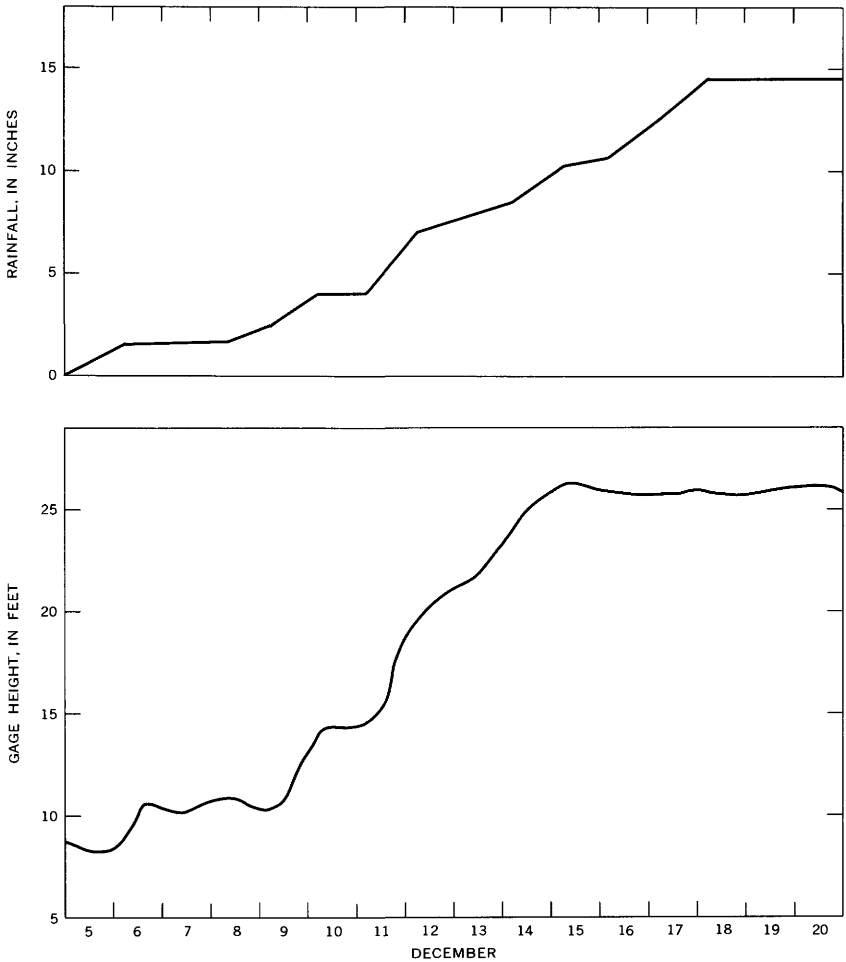

FIGURE 48.—Accumulated rainfall and stages on Pearl River at Edinburg, Miss. (drainage area, 898 sq mi), December 5–20, 1961.

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