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Floods of May and June 2008 in Iowa

Open-File Report 2010–1096

U.S. Department of the Interior
U.S. Geological Survey

Cover photograph. The Cedar River and urban flooding in Cedar Rapids, Iowa, June 12, 2008.

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KEN SALAZAR, Secretary

U.S. Geological Survey
Marcia K. McNutt, Director

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Conversion Factors and Datums

Inch/Pound to SI

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
foot (ft)	0.3048	meter (m)
	Area	
square mile (mi^2)	2.590	square kilometer (km^2)
	Flow rate	
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)

Elevation or vertical coordinate information is referenced to the National Geodetic Vertical Datum of 1929 (NGVD 1929). Elevation refers to distance above or below NGVD 1929. NGVD 1929 can be converted to the North American Vertical Datum of 1988 (NAVD 88) by using the National Geodetic Survey conversion utility available at *http://www.ngs.noaa.gov/TOOLS/Vertcon/vertcon.html*.

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Water year is the 12-month period from October 1 through September 30. The water year is designated by the calendar year in which the water year ends and that includes 9 of the 12 months. Thus, the water year ending September 30, 2008, is called the “2008 water year.”

Floods of May and June 2008 in Iowa

By Robert C. Buchmiller and David A. Eash

Abstract

An unusually wet winter and spring of 2007 to 2008 resulted in extremely wet antecedent conditions throughout most of Iowa. Rainfall of 5 to 15 inches was observed in eastern Iowa during May 2008, and an additional 5 to 15 inches of rain was observed throughout most of Iowa in June. Because of the severity of the May and June 2008 flooding, the U.S. Geological Survey, in cooperation with other Federal, State, and local agencies, has summarized the meteorological and hydrological conditions leading to the flooding, compiled flood-peak stages and discharges, and estimated revised flood probabilities for 62 selected streamgages.

Record peak discharges or flood probabilities of 1 percent or smaller (100-year flooding or greater) occurred at more than 60 streamgage locations, particularly in eastern Iowa. Cedar Rapids, Decorah, Des Moines, Iowa City, Mason City, and Waterloo were among the larger urban areas affected by this flooding. High water and flooding in small, headwater streams in north-central and eastern Iowa, particularly in June, combined and accumulated in large, mainstem rivers and resulted in flooding of historic proportions in the Cedar and Iowa Rivers. Previous flood-peak discharges at many locations were exceeded by substantial amounts, in some cases nearly doubling the previous record peak discharge at locations where more than 100 years of streamflow record are available.

Introduction

An unusually wet winter and spring of 2007 to 2008 resulted in extremely wet antecedent conditions throughout most of Iowa. Spring rains beginning in April 2008 caused record flooding in some areas. Rainfall was exceptionally plentiful from May through June 2008. During this time, record high discharges or flood probabilities of 1 percent or smaller (100-year flooding or greater) occurred at more than 60 streamgage locations, particularly in eastern Iowa. High water and flooding in small, headwater streams in north-central and eastern Iowa, particularly in June, combined and accumulated in large, mainstem rivers and resulted in flooding of historic proportions in the Cedar and Iowa Rivers. Previous flood-peak discharges at many locations were exceeded by substantial amounts, in some cases nearly doubling the previous record peak discharge at locations where more than 100 years of streamflow record are available.

Because of the severity of the May and June 2008 flooding, the U.S. Geological Survey (USGS), in cooperation with other Federal, State, and local agencies, has summarized the meteorological and hydrological conditions leading to the flooding, compiled flood-peak stages and discharges, and estimated revised flood probabilities for 62 selected streamgages.

Purpose and Scope

This report presents hydrologic and flood-probability information related to the flooding that occurred in Iowa (fig. 1) during May and June 2008. Additional maximum-peak discharges occurred at several streamgages in Iowa during April, July, and September 2008, but this flooding was not widespread and was separate from the May and June flooding time frame by several weeks and is not included in this report.

Meteorologic conditions contributing to the flooding are discussed. Peak-stage and peak-discharge data are presented for 62 active continuous-record and partial-record streamgages in Iowa. Recalculated flood-probability statistics that include the 2008 flood peaks also are presented for most of the 62 streamgages.

Conditions Leading to the Floods

Antecedent conditions in Iowa prior to the spring and summer of 2008 were wet. Precipitation from December 2007 through May 2008 was the second wettest on record from 1895 to 2008. Notably, the precipitation in eastern Iowa and southern Wisconsin was characterized by extremely wet conditions that normally occur less than 2.5 percent of the time (National Climatic Data Center, 2008). New monthly precipitation records were set across Iowa during this period. New records were set at seven sites in December, six sites in April, one site in May, eight sites in June, and one site in July. The precipitation records at all but two of the sites were greater than 100 years (Hillaker, 2008). The monthly statewide precipitation amounts and comments by the Iowa State Climatologist for December 2007 to June 2008 are tabulated in table 1.

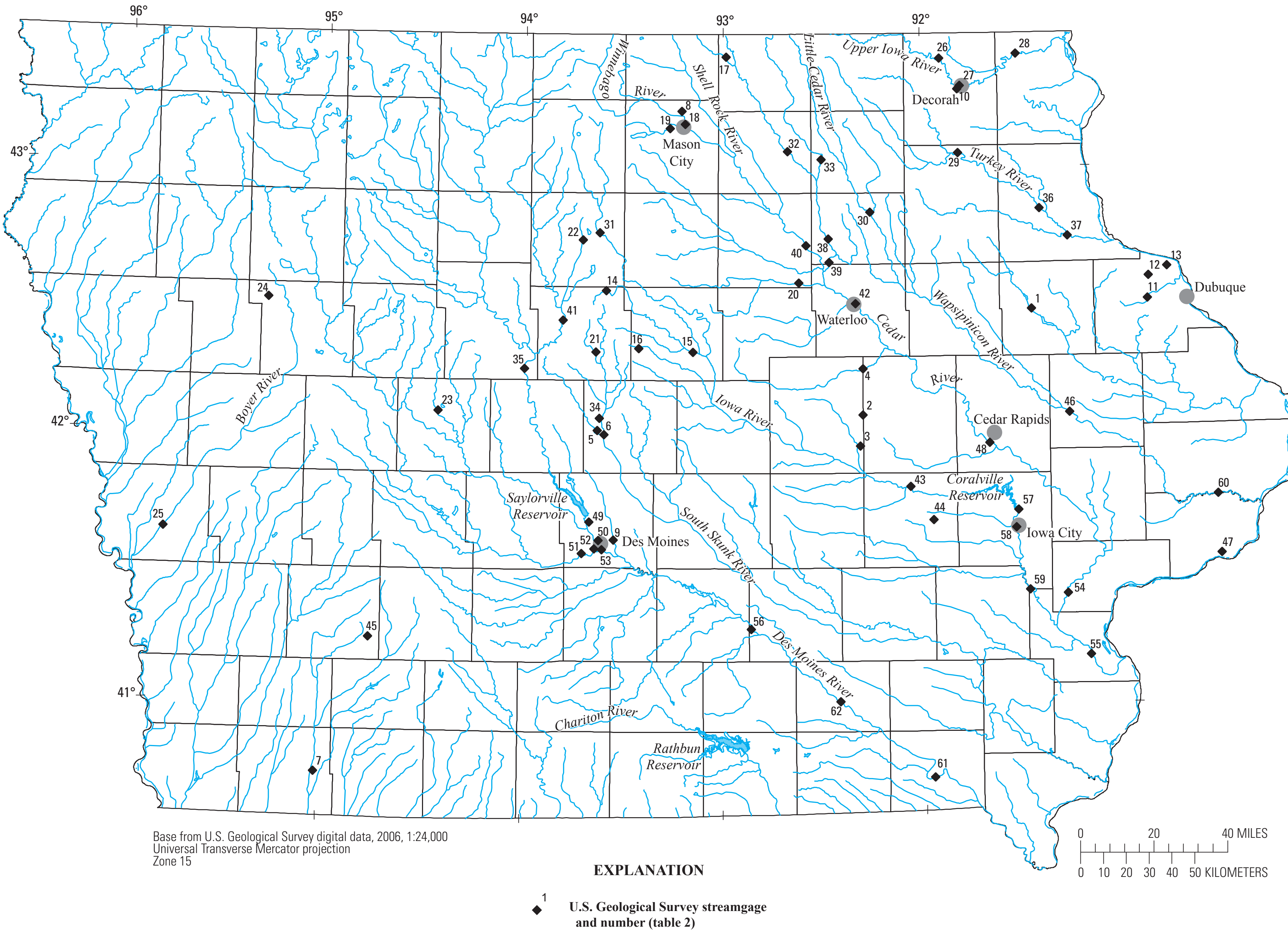


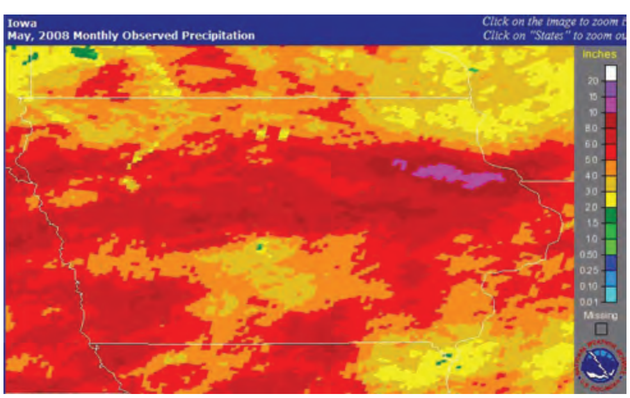
Figure 1. Location of Iowa streamgages with new peak discharges or where the flood probability was estimated to be 1 percent or less, May and June 2008.

Table 1. Iowa statewide precipitation, December 2007 through June 2008.

[+, greater than normal; −, less than normal]

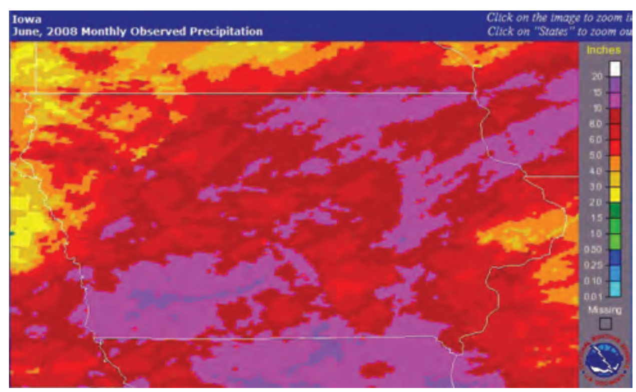
Date	Iowa statewide precipitation (inches)	Departure from normal precipitation (inches)	Comments by the State Climatologist (Hillaker, 2008)
December 2007	2.57	+1.34	"Second wettest December in 135 years of state records. Much of the precipitation was freezing rain and snow."
January 2008	.70	− .25	"Precipitation was frequent during January but lacked the major winter storm events seen in December."
February 2008	1.79	+ .81	"Measurable snow fell somewhere in the State on all but 8 days of the month."
March 2008	1.25	− .96	"Precipitation was well below normal over most of the State. The result was that snow melt flooding, though widespread, did not reach severe proportions in most areas. Nevertheless, frequent light precipitation events, and cooler than usual weather, kept soils very soggy and made for poor driving conditions on many unpaved roadways."
April 2008	5.88	+2.55	"Second wettest April in 136 years of state records. Three storm systems each dropped an average of over an inch of rain statewide. Major flooding followed the third, and largest, storm of the series."
May 2008	5.84	+1.61	"The heaviest rains of the month fell on the 29th and 30th, when a statewide average of 2.04 inches fell. Flooding was widespread during this event from west-central to northeast Iowa."
June 2008	9.01	+4.37	"Iowa endured an exceptionally wet period from May 29 through June 12 when a statewide average of 9.03 inches of rain fell (normal for the period is 2.45 inches). Daily statewide average rain statistics are not available very far back in time but it is doubtful that a larger amount of rain has been recorded in Iowa in only 15 days."

Statewide observed precipitation for Iowa during May 2008 is shown on figure 2. Rainfall ranged from about 2 inches (in.) along the northern border and in south-central areas near Des Moines to more than 10 in. in northeast Iowa west of Dubuque. Rainfall in excess of 5 in. fell across much of the northern one-third of Iowa. June 2008 statewide observed precipitation for Iowa is shown on figure 3. Rainfall exceeded 5 in. across most of the State, with amounts commonly exceeding 10 in. in northeast and southwest Iowa. Some areas, particularly in southwest Iowa, received more than 15 in. of rain.



Data from the National Weather Service, 2009

Figure 2. Statewide observed precipitation for Iowa, May 2008.



Data from the National Weather Service, 2009

Figure 3. Statewide observed precipitation for Iowa, June 2008.

Methods

Estimation of Magnitudes

Peak discharges documented in this report were determined by use of the rating curve (the relation between river height and flow) for each streamgage. Rating curves at streamgages are developed by relating stage to discharge for a range of flows (Rantz and others, 1982). Discharge data points used to develop a rating are determined most commonly by direct measurement at the gage; or, if direct measurement is not possible, by indirect methods. No indirect methods were used for the data in this report. The rating curve is interpolated between discharge data points and can be extrapolated beyond the highest discharge data point; however, excessive extrapolation of the rating at high stages can result in large errors in discharge (Sherwood and others, 2007).

Peak-stage data were obtained either from electronic data recorders or from surveyed high-water marks where recorders or stage sensors were destroyed or malfunctioned. The rating curve was used to compute peak discharge from peak stage. Direct discharge measurements served as data points at or near the respective flood peaks for rating-curve verification and extrapolation.

Estimation of Flood Probablility

Flood probability for a specific discharge is the probability or chance of that discharge being equaled or exceeded in any particular year. For example, a probability of 0.01 means there is a 1 percent chance of that flow magnitude being equaled or exceeded in any particular year. Stated another way, the chances are 1 in 100 that the flow will be equaled or exceeded in any particular year. A 0.2-percent flood probability has a 1 in 500 chance of occurring during any year. The traditional concept of flood-recurrence interval is directly related to flood probability and is the reciprocal of the flood probability. For example, if a specific flood magnitude has a 1 in 100 chance of occurring in a given year (a 1-percent flood probability), then the average recurrence interval between floods of this magnitude is 100 years. This flood magnitude is referred to as the 100-year flood.

Flood probabilities allow city planners, highway engineers, and water managers to assess the likelihood of when another flood of similar magnitude might occur. Flood probabilities are estimated using a variety of techniques. All techniques ultimately are based on the history of actual annual peak discharges measured at one or more streamgages.

The method described in Bulletin 17B of the Interagency Advisory Committee on Water Data (1982) was used to estimate flood probabilities for streamgages in Iowa to indicate the relative magnitude of the May and June 2008 floods. Discharge estimates for selected flood-probability percentages (20, 10, 4, 2, 1, and 0.2) were computed by fitting annual peak-discharge data for streamgages to a log-Pearson Type III distribution.

The accuracy and reliability of Bulletin 17B flood-probability estimation is dependent on several assumptions (Interagency Advisory Committee on Water Data, 1982)—most notably that previous flood discharges are accurate and reliable indicators of future flood discharges. Bulletin 17B flood-probability estimation also assumes that the flood record is an accurate depiction of previous floods, and that the flood process can be represented mathematically as a sequence of independent annual maximum discharges that are randomly sampled from a population of all possible flood discharges. Bulletin 17B flood-probability estimates have substantial uncertainties (Subcommittee on Hydrology, 2008). Flood probabilities are reported as a range, except for those less than the 0.2 percent, to indicate the considerable amount of uncertainty in these estimates. If two independent estimates of flood probability are available, computing a weighted average of the two estimates will lower the uncertainty of either independent estimate (Interagency Advisory Committee on Water Data, 1982). Therefore, the method outlined in Bulletin 17B, appendix 8 was used where possible to achieve lower uncertainty in the estimation of flood probabilities. The weighted average was computed as the inverse of the respective variances of the two independent estimates.

For Iowa, the second independent estimate for each rural streamgage was obtained by use of regional-regression equations (Eash, 2001, 2003). At some locations, the regional-regression equations were not applied because the streamgages were in urban areas or were controlled by upstream reservoir releases. For streamgages without a second independent estimate for flood probabilities, Bulletin 17B estimates were used with no weighting method applied. For streamgages with less than 10 years of record, regional-regression equations were used.

The USGS uses U.S. Army Corps of Engineers (USACE) flood-probability estimates at sites where a river is controlled by upstream major impoundments. Interior stream segments in Iowa that are controlled by major impoundments are the Iowa River downstream from Coralville Reservoir, the Des Moines River downstream from Saylorville Reservoir, and the Chariton River downstream from Rathbun Reservoir. Flood-probability estimates for the affected streamgages on the Iowa and Des Moines Rivers are provided by USACE (2009) and the Hydrologic Engineering Center (2002). Flood-probability estimates for the affected streamgages on the Chariton River are provided by the St. Louis District USACE.

Theoretical flood-probability estimates computed for Iowa streamgages from two independent estimates, Bulletin 17B estimates or USACE estimates for controlled sites, can then be used to estimate the range of flood probabilities for 2008 floods by means of two approaches. The upper and lower bounds for the range of probability were determined by comparing a particular flood discharge directly to discharge estimates for selected flood probabilities. This method failed to consider the uncertainty of the discharge estimates for the selected probabilities. An alternative approach is to determine the 95-percent confidence intervals for discharges of the selected probabilities and to compare the particular flood discharge to these confidence intervals. Because of the uncertainty of estimating flood probabilities, the 95-percent confidence-interval range also was considered to be a likely estimate for the particular peak. In cases where the flood peak was within the confidence interval for multiple probabilities, the estimated flood probability was reported as a range.

Floods of May and June 2008

Flooding occurred at various times and places throughout Iowa during 2008 in response to major rainfall events or a series of rainfall events. New flood-peak discharges were recorded at many streamgages. Peak-discharge and peak-stage data and estimated flood probabilities for the May and June 2008 floods at 62 selected USGS streamgages in Iowa are presented in table 2. Streamgages with new peak-discharge records established during May and June 2008 or where flood probability based on an estimate were 1 percent or smaller were selected for table 2. The locations of the 62 streamgages listed in table 2 are shown on figure 1.

New record high discharges of the floods of May and June 2008 in Iowa began in late May at two streamgages (05451955, map no. 2 and 05464220, map no. 4) south of Waterloo following more than 3 in. of rainfall in the area on May 26 (National Weather Service, 2009). Beginning on June 5, new record peak discharges were recorded for 11 of 12 consecutive days. Sixteen new record peak discharges were recorded on June 8, across a considerable area of the northern one-half of Iowa, mainly from central Iowa to near Dubuque. Flooding in the Mason City area was particularly noteworthy in early June after more than 4 in. of rain fell across northern Iowa (National Weather Service, 2009), with the Winnebago River at Mason City streamgage (05459500, 76 years of record, map no. 18) exceeding its previous high discharge [10,800 cubic feet per second (ft^3/s)] by more than 21 percent (13,100 ft^3/s) and the Shell Rock River at Shell Rock streamgage (05462000, 56 years of record, map no. 40) exceeding its previous high discharge (45,000 ft^3/s) by more than 33 percent (60,400 ft^3/s). The estimated flood probabiliy for these two streamgages was 0.2 to 1 (500 to 100 years) and less than 0.2 (more than 500 years), respectively. Water from the Winnebago and Shell Rock Rivers flows into the Cedar River upstream from Waterloo.

On June 9, 2008, seven new record high discharges were recorded mainly in the Decorah area in response to the June 8 rainfall. The Upper Iowa River at Decorah (05387500, 57 years of record, map no. 27) exceeded its previously record high discharge (20,500 ft^3/s) by about 66 percent (34,100 ft^3/s). The estimated flood probability for this streamgage is 0.2 to 1 (500 to 100 years).

Beginning on June 10, new record peak discharges were recorded in the upstream reaches of the Cedar River. Streamflow from the Winnebago and Shell Rock Rivers described previously combined with streamflow from the upstream reaches of the Cedar River at Charles City (05457700, map no. 32) and the Little Cedar River near Ionia (05458000, map no. 33). This combined flow resulted in a new record peak discharge (112,000 ft^3/s), 46 percent larger (flood probability 0.2 to 1) than the previous peak discharge at the Cedar River at Waterloo streamgage (05464000, 72 years of record, map no. 42) on June 11. An additional 3 in. or more of rain fell in the Cedar Rapids area as the discharge in the river was peaking (National Weather Service, 2009). The new record peak discharge at Cedar Rapids (05454500, 140,000 ft^3/s, map no. 48) on June 13 was nearly 92 percent larger than the previous record. The estimated flood probability at Cedar Rapids is less than 0.2 (more than 500 years). The annual peak discharges for the period of record for the Cedar Rapids streamgage are shown on figure 4.

Record peak discharges were recorded on the middle reaches of the Des Moines (05481650, map no. 49), Iowa (05453100, map no. 43), and Wapsipinicon (05421740, map no. 46) Rivers on June 12 through 13. The downstream reaches of the Cedar, Iowa, and Wapsipinicon Rivers recorded new record high discharges from June 14 to 16. A new record peak discharge (41,100 ft^3/s) was measured at the Iowa River

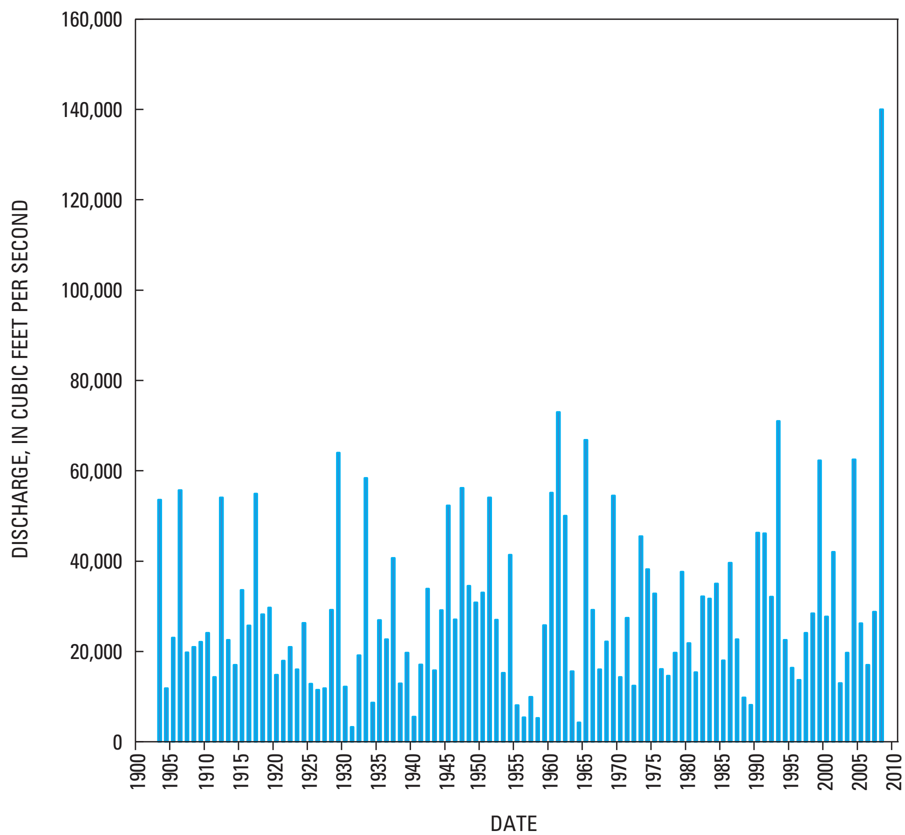


Figure 4. Historic annual peak discharges for the Cedar River at Cedar Rapids (05464500) streamgage, 1903 to 2008.

Table 2. Flood-peak stage and discharge for selected Iowa streamgages where a new peak-discharge record was recorded or where the flood-probability was estimated to be 1 percent or less during May and June 2008.

[Peak of record shown in bold. mi², square miles; ft, feet; ft³/s, cubic feet per second; ND, not determined; RRE, regional-regression equations from Eash (2001); <, less than; WIE, flood probabilities calculated using weighting of independent estimates method (Interagency Advisory Committee on Water Data, 1982, appendix 8; C. Berenbrock and T. Cohn, U.S. Geological Survey, written commun., 2008); >, more than; B17B, Bulletin 17B method for calculating flood probabilities (Interagency Advisory Committee on Water Data, 1982); USACE, U.S. Army Corps of Engineers]

					Maximum prior to 2008 flood			Maximum for 2008 flood					
											Estimated flood-probability range		
Map number (fig. 1)	Streamgage number	Streamgage name and location	Drainage area (mi²)	Period of peak-flow record (water years)	Date	Peak stage (ft)	Peak discharge (ft³/s)	Date	Peak stage (ft)	Peak discharge (ft³/s)	Based on estimate[a] (percent)	Based on 95-percent confidence intervals[b] (percent)	Probability calculation method
1	05416900	Maquoketa River at Manchester	275	2001–08	5/23/2004	21.66	**26,000**	5/26/2008	20.80	22,100	0.2–1	ND	RRE
2	05451955	Stein Creek near Clutier	23.4	1972–2008	6/15/1982	77.92	11,400	5/30/2008	78.02	**12,200**	<.2	<.2–1	WIE
3	05452000	Salt Creek near Elberon	201	1944, 1946–2008	7/9/1993	20.85	**36,600**	5/30/2008	19.75	22,400	.2–1	<.2–4	WIE
4	05464220	Wolf Creek near Dysart	299	1996–98, 2002–08	5/23/2004	17.39	14,500	5/30/2008	18.25	**15,700**	2–4	.2–10	WIE
5	05470500	Squaw Creek at Ames	204	1918, 1920–27, 1965–2008	7/9/1993	18.54	**24,300**	5/30/2008	15.85	12,600	1–2	.2–4	WIE
6	05471000	South Skunk River below Squaw Creek near Ames	556	1944, 1953–79, 1990–2008	7/9/1993	[c]25.57	**26,500**	5/30/2008	24.70	19,800	.2–1	<.2–4	WIE
7	06817000	Nodaway River at Clarinda	762	1918–25, 1936–2008	6/13/1947[d]	25.30	31,100	6/5/2008	26.61	**47,900**	<.2	<.2–1	WIE
8	05459490	Spring Creek near Mason City	29.3	1966–2008	5/22/2004	91.15	**5,340**	6/6/2008	92.91	4,680	1–2	<.2–10	WIE
9	05485640	Fourmile Creek at Des Moines	92.7	1972–2008	6/18/1998	15.00	5,600	6/6/2008	[c]15.14	**6,810**	2–4	.2–10	WIE
10	05387490	Dry Run Creek near Decorah	21	1978, 1980, 1984–85, 1987–2008	8/16/1993	20.80	4,620	6/8/2008	21.53	**5,820**	1–2	1–2	WIE
11	05414350	Little Maquoketa River near Graf	39.6	1951–2008	6/4/2002	15.93	7,700	6/8/2008	16.47	**8,370**	2–4	.2–10	WIE
12	05414450	North Fork Little Maquoketa River near Rickardsville	21.6	1951–2008	8/2/1972	14.02	7,180	6/8/2008	12.58	**8,040**	.2–1	<.2–4	WIE
13	05414605	Bloody Run Tributary near Sherrill	.59	1991–2008	6/15/1991	19.27	[e]692	6/8/2008	22.71	**1,110**	2–4	1–>10	B17B
14	05451080	South Fork Iowa River near Blairsburg	12	2006–08	3/12/2007	11.79	227	6/8/2008	12.50	**762**	.2–1	ND	RRE
15	05451210	South Fork Iowa River northeast of New Providence	224	1996–2008	6/23/2007	[c]11.59	3,910	6/8/2008	13.84	**7,390**	2–4	1–10	WIE
16	0545129280	Honey Creek Tributary near Radcliffe	3.29	1991–93, 1995–2008	5/10/1995	100.14	[e]510	6/8/2008	100.23	**[e]511**	>10	4–>10	WIE
17	05457440	Deer Creek near Carpenter	91.6	1973–2008	7/6/2004	85.75	4,150	6/8/2008	87.86	**11,800**	<.2	<.2–1	WIE
18	05459500	Winnebago River at Mason City	526	1933–2008	3/30/1933	15.70	10,800	6/8/2008	18.74	**13,100**	.2–1	<.2–4	WIE
19	05460100	Willow Creek near Mason City	78.6	1966–89, 1991–2008	5/22/2004	92.21	1,270	6/8/2008	93.28	**2,380**	.2–1	<.2–2	WIE
20	05463000	Beaver Creek at New Hartford	347	1946–2008	6/13/1947	13.50	18,000	6/8/2008	15.71	**25,900**	.2–1	<.2–2	WIE

Table 2. Flood-peak stage and discharge for selected Iowa streamgages where a new peak-discharge record was recorded or where the flood-probability was estimated to be 1 percent or less during May and June 2008.—Continued

[Peak of record shown in bold. mi², square miles; ft, feet; ft³/s, cubic feet per second; ND, not determined; RRE, regional-regression equations from Eash (2001); <, less than; WIE, flood probabilities calculated using weighting of independent estimates method (Interagency Advisory Committee on Water Data, 1982, appendix 8; C. Berenbrock and T. Cohn, U.S. Geological Survey, written commun., 2008); >, more than; B17B, Bulletin 17B method for calculating flood probabilities (Interagency Advisory Committee on Water Data, 1982); USACE, U.S. Army Corps of Engineers]

Map number (fig. 1)	Streamgage number	Streamgage name and location	Drainage area (mi²)	Period of peak-flow record (water years)	Maximum prior to 2008 flood			Maximum for 2008 flood					
					Date	Peak stage (ft)	Peak discharge (ft³/s)	Date	Peak stage (ft)	Peak discharge (ft³/s)	Estimated flood-probability range: Based on estimate[a] (percent)	Estimated flood-probability range: Based on 95-percent confidence intervals[b] (percent)	Probability calculation method
21	05469860	Mud Lake Drainage Ditch 71 at Jewell	65.4	1966–2008	7/9/1993	91.32	**3,700**	6/8/2008	91.87	3,120	1–2	<0.2–4	WIE
22	05480930	White Fox Creek at Clarion	13.3	1966–2008	7/9/1993	[c]93.77	1,400	6/8/2008	93.85	**1,480**	1–2	<.2–10	WIE
23	05482900	Hardin Creek near Farlin	101	1951–93, 1995–2008	7/9/1993	13.97	3,010	6/8/2008	13.40	**3,030**	1–2	.2–10	WIE
24	0660683710	Halfway Creek at Schaller	1.74	1990–2008	5/6/2007	94.64	486	6/8/2008	97.31	**1,010**	4–10	2–>10	WIE
25	06609500	Boyer River at Logan	871	1881, 1918–25, 1938–2008	6/17/1990	[c]25.22	30,800	6/8/2008	24.75	**33,600**	1–2	<.2–4	WIE
26	05387440	Upper Iowa River at Bluffton	367	2003–08	8/22/2007	12.66	8,440	6/9/2008	15.49	**16,600**	2–4	ND	RRE
27	05387500	Upper Iowa River at Decorah	511	1952–2008	8/17/1993	[e]14.35	[e]20,500	6/9/2008	17.90	**34,100**	[f].2–1	[f]<.2–1	WIE
28	05388250	Upper Iowa River, at Dorchester	770	1941, 1976–95, 1997–2008	5/31/1941	21.80	30,400	6/9/2008	22.46	**31,200**	.2–1	.2–4	WIE
29	05411850	Turkey River near Eldorado	641	1991, 2001–08	5/23/2004	19.61	19,700	6/9/2008	21.46	**50,100**	<.2	ND	RRE
30	05420680	Wapsipinicon River near Tripoli	346	1997–2008	7/21/1999	18.50	**19,400**	6/9/2008	18.24	18,300	1–2	.2–10	WIE
31	05449500	Iowa River near Rowan	429	1941–76, 1978–2008	6/21/1954	14.88	**8,460**	6/9/2008	15.89	7,890	1–2	.2–10	WIE
32	05457700	Cedar River at Charles City	1,054	1946–53, 1961–62, 1965–2008	7/21/1999	22.81	31,200	6/9/2008	25.33	**34,600**	.2–1	<.2–4	WIE
33	05458000	Little Cedar River near Ionia	306	1954–2008	8/16/1993	18.99	14,000	6/9/2008	21.32	**24,700**	.2–1	<.2–2	WIE
34	05470000	South Skunk River near Ames	315	1921–27, 1930, 1933–2008	7/17/1996[g]	15.89	[e]**14,000**	6/9/2008	16.93	11,000	1–2	.2–4	WIE
35	05481300	Des Moines River near Stratford	5,452	1968–2008	4/2/1993	25.68	42,300	6/9/2008	27.32	**50,300**	[h]1–2	[h].2–4	WIE
36	05412020	Turkey River above French Hollow Creek at Elkader	903	1991, 2002–08	6/15/1991	27.32	38,300	6/10/2008	27.77	**40,500**	.2–1	ND	RRE
37	05412500	Turkey River at Garber	1,545	1902, 1914–16, 1919–27, 1930, 1933–2008	5/23/2004	32.80	**66,700**	6/10/2008	29.13	45,500	1–2	.2–4	WIE
38	05458300	Cedar River at Waverly	1,547	2001–08	4/14/2001	[c]13.16	25,600	6/10/2008	19.33	**52,600**	[i]<.2	[i]ND	RRE
39	05458500	Cedar River at Janesville	1,661	1905–06, 1915–21, 1923–27, 1933–42, 1945–2008	7/22/1999	17.15	42,200	6/10/2008	19.45	**53,400**	.2–1	<.2–1	WIE

Table 2. Flood-peak stage and discharge for selected Iowa streamgages where a new peak-discharge record was recorded or where the flood-probability was estimated to be 1 percent or less during May and June 2008.—Continued

[Peak of record shown in bold. mi², square miles; ft, feet; ft³/s, cubic feet per second; ND, not determined; RRE, regional-regression equations from Eash (2001); <, less than; WIE, flood probabilities calculated using weighting of independent estimates method (Interagency Advisory Committee on Water Data, 1982, appendix 8; C. Berenbrock and T. Cohn, U.S. Geological Survey, written commun., 2008); >, more than; B17B, Bulletin 17B method for calculating flood probabilities (Interagency Advisory Committee on Water Data, 1982); USACE, U.S. Army Corps of Engineers]

Map number (fig. 1)	Streamgage number	Streamgage name and location	Drainage area (mi²)	Period of peak-flow record (water years)	Maximum prior to 2008 flood			Maximum for 2008 flood					
											Estimated flood-probability range		
					Date	Peak stage (ft)	Peak discharge (ft³/s)	Date	Peak stage (ft)	Peak discharge (ft³/s)	Based on estimate[a] (percent)	Based on 95-percent confidence intervals[b] (percent)	Probability calculation method
40	05462000	Shell Rock River at Shell Rock	1,746	1856, 1954–2008	1/29/1905	[j]17.70	[e]45,000	6/10/2008	20.36	**60,400**	<0.2	<0.2–1	WIE
41	05481000	Boone River near Webster City	844	1918, 1932, 1941–2008	6/10/1918	19.10	21,500	6/10/2008	17.74	[k]**20,500**	.2–1	<.2–4	WIE
42	05464000	Cedar River at Waterloo	5,146	1929, 1933, 1941–2008	3/29/1961	21.86	76,700	6/11/2008	27.01	**112,000**	.2–1	<.2–4	B17B
43	05453100	Iowa River at Marengo	2,794	1957–2008	7/19/1993	20.31	38,000	6/12/2008	21.38	**51,000**	.2–1	<.2–2	WIE
44	05454180	Clear Creek tributary near Williamsburg	.37	1990–2008	6/22/2007	49.18	328	6/12/2008	49.37	**346**	4–10	2–>10	B17B
45	06816290	West Nodaway River at Massena	23.4	1966–2008	2/1/1973	82.39	[e]4,700	6/12/2008	80.54	**4,850**	2–4	.2–10	WIE
46	05421740	Wapsipinicon River near Anamosa	1,575	2003–08	5/26/2004	22.73	22,000	6/13/2008	26.18	**31,800**	[l]2–4	ND	B17B
47	05422600	Duck Creek at Duck Creek Golf Course at Davenport	57.3	1994–2008	6/4/2002	16.34	7,310	6/13/2008	16.60	**7,570**	4–10	1–>10	B17B
48	05464500	Cedar River at Cedar Rapids	6,510	1851, 1903–2008	3/31/1961	[c]20.00	73,000	6/13/2008	31.12	**140,000**	<.2	<.2–1	B17B
49	05481650	Des Moines River near Saylorville	5,841	1954, 1962–2008	7/21/1993[m]	[c]24.22	[n]45,700	6/13/2008	24.03	[n]**50,500**	[o]<.2	ND[o]	USACE
50	05482000	Des Moines River at 2nd Avenue at Des Moines	6,245	1902–03, 1906, 1915–61, 1997–2008	4/17/2001[m]	[c]20.72	[p]18,500	6/13/2008	31.57	[p]**47,300**	[o].2–1	ND[o]	USACE
51	05484650	Raccoon River at 63rd Street at Des Moines	3,529	1992–2008	7/11/1993	40.77	**66,000**	6/13/2008	41.31	52,000	1–2	.2–4	WIE
52	05484900	Raccoon River at Fleur Drive at Des Moines	3,625	1984–87, 1989–2008	7/11/1993	26.80	**67,900**	6/13/2008	24.66	56,300	1–2	<.2–4	WIE
53	05485500	Des Moines River below Raccoon River at Des Moines	9,879	1903, 1940–2008	7/11/1993[m]	34.29	**116,000**	6/13/2008	35.55	104,000	[o].2–1	ND[o]	USACE
54	05465000	Cedar River near Conesville	7,787	1929, 1940–2008	4/6/1993	17.11	74,000	6/14/2008	23.40	**127,000**	.2–1	<.2–2	B17B
55	05465500	Iowa River at Wapello	12,500	1903–2008	7/8/1993[m]	[c]29.53	111,000	6/14/2008	32.15	**188,000**	[q]<.2	ND[q]	USACE
56	05488500	Des Moines River near Tracy	12,479	1903, 1920–2008	7/12/1993[m]	24.16	[r]**109,000**	6/14/2008	23.70	104,000	[o].2–1	ND[o]	USACE
57	05453520	Iowa River below Coralville Dam, Coralville	3,115	1993–2008	7/19/1993	63.95	25,800	6/15/2008	68.09	**39,900**	[q].2–1	ND[q]	USACE
58	05454500	Iowa River at Iowa City	3,271	1851, 1881, 1903–2008	8/10/1993[m]	28.52	[s]28,200	6/15/2008	31.53	[s]**41,100**	[q].2–1	ND[q]	USACE
59	05455700	Iowa River at Lone Tree	4,293	1944, 1957–2008	7/7/1993[m]	22.94	**57,100**	6/15/2008	23.10	53,700	[q].2–1	ND[q]	USACE

Table 2. Flood-peak stage and discharge for selected Iowa streamgages where a new peak-discharge record was recorded or where the flood-probability was estimated to be 1 percent or less during May and June 2008.—Continued

[Peak of record shown in bold. mi², square miles; ft, feet; ft³/s, cubic feet per second; ND, not determined; RRE, regional-regression equations from Eash (2001); <, less than; WIE, flood probabilities calculated using weighting of independent estimates method (Interagency Advisory Committee on Water Data, 1982, appendix 8; C. Berenbrock and T. Cohn, U.S. Geological Survey, written commun., 2008); >, more than; B17B, Bulletin 17B method for calculating flood probabilities (Interagency Advisory Committee on Water Data, 1982); USACE, U.S. Army Corps of Engineers]

Map number (fig. 1)	Streamgage number	Streamgage name and location	Drainage area (mi²)	Period of peak-flow record (water years)	Maximum prior to 2008 flood			Maximum for 2008 flood					
											Estimated flood-probability range		
					Date	Peak stage (ft)	Peak discharge (ft³/s)	Date	Peak stage (ft)	Peak discharge (ft³/s)	Based on estimate[a] (percent)	Based on 95-percent confidence intervals[b] (percent)	Probability calculation method
60	05422000	Wapsipinicon River at DeWitt	2,336	1935–2008	5/30/2004	[c]14.19	31,500	6/16/2008	14.13	**36,400**	2–4	0.2–10	WIE
61	05490500	Des Moines River at Keosauqua	14,038	1851, 1903–06, 1912–2008	7/12/1993[m]	32.66	[t]**111,000**	6/16/2008	30.49	106,000	[o].2–1	ND[o]	USACE
62	05489500	Des Moines River at Ottumwa	13,374	1903, 1917–2008	7/12/1993[m]	22.15	[u]**112,000**	6/17/2008	20.60	102,000	[o].2–1	ND[o]	USACE

[a] Estimated flood-probability range based on estimate: The flood probability for a specific streamflow magnitude is the probability or chance of that streamflow being equaled or exceeded in any particular year. For example, a 1-percent-chance flood has a 1 in 100 chance of occurring in any particular year. Flood-recurrence interval, which is the reciprocal of the flood probability, is the statistical average number of years between exceedances of a specific streamflow magnitude. If a specific flood magnitude has a 1 in 100 chance of occurring in a particular year (a 1-percent chance flood), then the average recurrence interval between floods of this magnitude is 100 years. This flood magnitude is referred to as the 100-year flood. Based on direct comparison of flood-peak discharge to the discharge estimates for various flood probabilities (traditional approach). Flood probabilities are reported as a range because of uncertainty in estimating flood-discharge probabilities. The reporting ranges are (ordered by decreasing probability): more than 10, 4–10, 2–4,1–2, 0.2–1, and less than 0.2 percent.

[b] Estimated flood-probability range based on 95-percent confidence intervals: Based on comparison of flood-peak discharge to the lower and upper bounds of the 95-percent confidence limits for discharge estimates for multiple probabilities (alternative approach). Flood probabilities from 95-percent confidence intervals also are reported as a range because of uncertainty in estimating flood-discharge probabilities.

[c] Maximum peak stage occurred on a different date than the maximum peak discharge.

[d] Peak discharge of 31,100 ft³/s also occurred during 2007 at a stage of 23.82 ft.

[e] Estimated.

[f] Flood-probability estimates are based on inclusion of additional area-weighted annual-peak discharges from discontinued downstream gage (05388000).

[g] Maximum occurred at a different site and datum of streamgage.

[h] Flood-probability estimates are based on inclusion of additional annual-peak discharges from discontinued downstream gage (05481500).

[i] Flood-probability estimates are based on logarithmic interpolation of weighted flood-probabillty discharge estimates between upstream gage (05421000) and downstream gage (05422000).

[j] Stage measured at bridge 400 ft downstream, from information provided by U.S. Army Corps of Engineers

[k] Record peak of systematic record: discharge of historic 1918 peak was 21,500 ft³/s.

[l] Flood-probability estimates are based on weighted estimates from nearby downstream gage (05458500) and regional-regression estimates for this gage (05458300) (Eash, 2001, equation 4).

[m] Maximum during post-regulation period of record. Post regulation on the Iowa River downstream from the Coralville Lake since September 17, 1958; on the Des Moines River downstream from Lake Red Rock since March 12, 1969; and on the Des Moines River downstream from Saylorville Lake since April 12, 1977.

[n] Record peak during regulated period of record (1977–2008): discharge of historic 1954 peak was 60,000 ft³/s.

[o] Hydrologic Engineering Center (2002).

[p] Record peak during regulated period of record (1997–2008): discharge of 1954 peak was 60,200 ft³/s.

[q] U.S. Army Corps of Engineers (2009).

[r] Record peak during regulated period of record (1969–2008): discharge of 1947 peak was 155,000 ft³/s.

[s] Record peak during regulated period of record (1959–2008): discharge estimate of historic 1851 peak was 70,000 ft³/s.

[t] Record peak during regulated period of record (1969–2008): discharge of 1903 peak was 146,000 ft³/s.

[u] Record peak during regulated period of record (1969–2008): discharge estimate of historic 1903 peak was 140,000 ft³/s.

at Iowa City streamgage (05454500, 108 years of record, map no. 58) on June 15 that was 46 percent larger than the previous record set in 1993. The flood-probability estimate at Iowa City was 0.2 to 1 (500 to 100 years). The combined flow of the Cedar and Iowa Rivers was measured at the Iowa River at Wapello streamgage (05465500, 106 years of record, map no. 55). The peak discharge at this streamgage in June 2008 was 188,000 ft^3/s (69 percent larger than the previous peak) with a flood-probability estimate of less than 0.2 (more than 500 years). Although no new historic peak discharges were established on the Des Moines River downstream from Des Moines, flood probabilities of 0.2 to 1 (500 to 100 years) were common.

Summary

An unusually wet winter and spring of 2007 to 2008 resulted in extremely wet antecedent conditions throughout most of Iowa. Rainfall of 5 to 15 inches was observed in eastern Iowa during May 2008 and an additional 5 to 15 inches of rain was observed throughout most of Iowa in June. Because of the severity of the May and June 2008 flooding, the U.S. Geological Survey, in cooperation with other Federal, State, and local agencies, has summarized the meteorological and hydrological conditions leading to the flooding, compiled flood-peak stages and discharges, and estimated revised flood probabilities for 62 selected streamgages.

Record peak discharges or flood probabilities of 1 percent or smaller (100-year flooding or greater) occurred at more than 60 streamgage locations, particularly in eastern Iowa. Cedar Rapids, Decorah, Des Moines, Iowa City, Mason City, and Waterloo were among the larger urban areas affected by this flooding. High water and flooding in small, headwater streams in north-central and eastern Iowa, particularly in June, combined and accumulated in large, mainstem rivers and resulted in flooding of historic proportions in the Cedar and Iowa Rivers. Previous flood peaks at many locations were exceeded by substantial amounts, in some cases nearly doubling the previous record peak at locations where more than 100 years of streamflow record are available.

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