

# **FLOOD OF JULY 9-11, 1993, IN THE RACCOON RIVER BASIN, WEST-CENTRAL IOWA**

*By* David A. Eash *and* Barbara A. Koppensteiner

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## CONVERSION FACTORS, ABBREVIATIONS, AND VERTICAL DATUM

Multiply	By	To obtain
inch (in.)	25.4	millimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
square mile (mi <sup>2</sup> )	2.590	square kilometer
cubic foot per second (ft <sup>3</sup> /s)	0.02832	cubic meter per second
cubic foot per second per square mile [(ft <sup>3</sup> /s)/mi <sup>2</sup> ]	0.01093	cubic meter per second per square kilometer
ton per acre	2.242	megagram per square hectometer

**Sea Level:** In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929--a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

# Flood of July 9-11, 1993, in the Raccoon River Basin, West-Central Iowa

by David A. Eash and Barbara A. Koppensteiner

## ABSTRACT

Water-surface-elevation profiles and peak discharges for the flood of July 9-11, 1993, in the Raccoon River Basin, west-central Iowa, are presented in this report. The profiles illustrate the 1993 flood along the Raccoon, North Raccoon, South Raccoon, and Middle Raccoon Rivers and along Brushy and Storm Creeks in the west-central Iowa counties of Carroll, Dallas, Greene, Guthrie, and Polk. Water-surface-elevation profiles for the floods of June 1947, March 1979, and June 29-July 1, 1986, in the Raccoon River Basin also are included in the report for comparative purposes. The July 9-11, 1993, flood is the largest known peak discharge at gaging stations Brushy Creek near Templeton (station number 05483318) 19,000 cubic feet per second, Middle Raccoon River near Bayard (station number 05483450) 27,500 cubic feet per second, Middle Raccoon River at Panora (station number 05483600) 22,400 cubic feet per second, South Raccoon River at Redfield (station number 05484000) 44,000 cubic feet per second, and Raccoon River at Van Meter (station number 05484500) 70,100 cubic feet per second. The peak discharges were, respectively, 1.5, 1.3, 1.1, 1.2, and 1.3 times larger than calculated 100-year recurrence-interval discharges. The report provides information on flood stages and discharges and floodflow frequencies for streamflow-gaging stations in the Raccoon River Basin using flood information collected through 1996. A flood history summarizes rainfall conditions and damages for floods that occurred during 1947, 1958, 1979, 1986, 1990, and 1993. Information on temporary bench marks and reference points established in the Raccoon River Basin during 1976-79 and 1995-97 also is included in the report.

## INTRODUCTION

Evaluation of flood hazards and the planning, design, and operation of various structures on flood plains require information about floods. Flood-profile reports provide water-surface-elevation profiles and specific information for selected floods and are used by planners and engineers to evaluate the magnitude and frequency of floods in a river basin. This flood-profile report was prepared by the U.S. Geological Survey (USGS) in cooperation with the Iowa Highway Research Board and the Project Development Division of the Iowa Department of Transportation.

## Purpose and Scope

This report presents water-surface-elevation profiles for the flood of July 9-11, 1993, in the Raccoon River Basin in west-central Iowa. Profiles for the floods of June 1947, March 1979, and June 29-July 1, 1986, in the Raccoon River Basin also are presented in this report for comparative purposes. The report provides information on flood stages and discharges and flood-flow frequencies for streamflow-gaging stations in the Raccoon River Basin using flood information collected through 1996. A flood history summarizes rainfall conditions and damages for floods that occurred during 1947, 1958, 1979, 1986, 1990, and 1993. Information on temporary bench marks and reference points established in the Raccoon River Basin during 1976-79 and 1995-97 also is included in the report.

## Acknowledgments

Various Federal, State, and local agencies cooperated in the collection of streamflow records used in this report, the acknowledgment of which is contained

in the annual water-data reports of the USGS (U.S. Geological Survey, 1916-97). The authors express their gratitude to the following: G. F. Grimm, S. G. Hill, R. L. Kopish, R. L. Kuzniar, T. C. Melcher, J. M. Pohl, D. J. Tanko, and K. G. Umstattd for collecting the field data for the 1993 flood and surveying level-lines, and for collecting and processing global-positioning-system data, to establish sea-level elevations for the temporary bench marks and reference points; and T. L. Birkenholtz for preparing the maps for this report.

## STUDY AREA

The Raccoon River Basin is located in west-central Iowa, includes parts of 17 counties, and drains as a right bank tributary to the Des Moines River within the City of Des Moines (fig. 1A). The basin is oriented in a general northwest-southeast direction and covers 3,629 mi<sup>2</sup> (Larimer, 1957, p. 337). Three principal rivers drain the Raccoon River Basin, the North Raccoon, the South Raccoon, and the Middle Raccoon Rivers. The North Raccoon and South Raccoon Rivers, with drainage areas of 2,298 and 1,143 mi<sup>2</sup>, respectively (Larimer, 1957, p. 114-115), join northwest of Van Meter in Dallas County to form the Raccoon River. The Raccoon River proper, consists of a 30.28-mi long reach that flows across eastern Dallas and western Polk Counties. The Middle Raccoon River is a tributary to the South Raccoon River; the mouth of the Middle Raccoon River is south of Redfield in Dallas County. Land use in west-central Iowa is primarily row-crop agriculture with some livestock operations.

In general, the topography of the Raccoon River Basin developed as a result of repeated continental glacial advances across west-central Iowa, during which the land was scoured and thick deposits of glacial till were deposited. Periods of glaciation were followed by interglacial periods of erosion. The majority of the Raccoon River Basin lies within two landform regions of the State, the Des Moines Lobe and the Southern Iowa Drift Plain (fig. 1A) (Prior, 1991, p. 31-34). In the extreme northwest part of the basin, a small part of the basin lies within a third landform region, the Northwest Iowa Plains. The Des Moines Lobe landform region is characteristic of a young, postglacial landscape that is unique with respect to the rest of the State (Prior, 1991, p. 30-47). The Des Moines Lobe outlines the last glacial advance into Iowa, which ended at what is now the

City of Des Moines, and in the process established the present course of the Raccoon River (Prior, 1991, p. 36-37). The Des Moines Lobe generally comprises low-relief terrain, accentuated by natural lakes, pot-holes, and marshes, where surface-water drainage typically is poorly defined and sluggish. Soils of the Des Moines Lobe do not include a loess cover and generally consist of friable, calcareous loam glacial till with thick deposits of compact, uniform pebbly loam (Oschwald and others, 1965, p. 28; Prior, 1991, p. 34 and 39). The Southern Iowa Drift Plain landform region is characteristic of a mature postglacial landscape that has eroded to form a steeply to gently rolling topography and a well-established drainage system; common terrain characteristics are integrated drainage networks, stepped erosional surfaces, and exposed bedrock in the deeper alluvial valleys (Prior, 1991, p. 34 and 58-61; Iowa Natural Resources Council, 1953, p. 3 and 7). Soils of the Southern Iowa Drift Plain in the Raccoon River Basin generally consist of moderately-permeable, silty-clay loam to silty clay that formed from loess-covered glacial till under prairie vegetation; loess deposits in the area range from 100 to 200 in. (8.3 to 16.7 ft) (Oschwald and others, 1965 p. 6, 52-53, and 63-65).

Approximately 78 percent of the Raccoon River Basin, including nearly the entire North Raccoon River Basin, lies within the Des Moines Lobe landform region. The South Raccoon River Basin, upstream from the mouth of the Middle Raccoon River, lies entirely within the Southern Iowa Drift Plain landform region. The Middle Raccoon River generally marks the boundary between the Des Moines Lobe and the Southern Iowa Drift Plain; the Middle Raccoon River Basin lies within both of these landform regions. Thus, the Raccoon River Basin is characterized by two distinct topographic landscapes, the youthful topography of the Des Moines Lobe and the mature topography of the Southern Iowa Drift Plain. The transition between these two landform regions is abrupt on either side of the Middle Raccoon River.

## HYDROLOGIC DATA

Gaging-station records are the primary source of data for analyzing and understanding the flood hydrology of a river basin. Flood information is obtained

from complete-record streamflow-gaging stations, which provide a continuous chronology of streamflow, and from partial-record, crest-stage streamflow-gaging stations, which provide a chronology of annual peak-flows. The location of 19 USGS gaging stations in the Raccoon River Basin are shown in figure 1; 12 are active gaging stations (nine continuous-record gages and three crest-stage gages) and seven are discontinued gaging stations (four continuous-record gages and three crest-stage gages). The specific location, annual peak stages and discharges, and other information pertaining to each gaging station are presented in Appendix A. Discharge records collected during the operation of these gaging stations are published in the annual water-data reports of the USGS (U.S. Geological Survey, 1916-97).

The computation of discharge records at a gaging station is dependent upon the development of a stage-discharge relation, or rating curve, between water-surface elevations (stages) and the corresponding flow rates (discharges). The high-water part of the stage-discharge relation generally remains stable if the channel downstream from the gaging station remains unchanged. Changes in the stage-discharge relation occur from time to time, either gradually or abruptly, due to changes in the stream channel that result from scour, deposition, the growth of vegetation, or the construction of dams, bridges, or levees (Rantz and others, 1982, p. 328-360).

Mean annual precipitation for 1961-90 at rain gages within the Raccoon River Basin are summarized as follows (Owenby and Ezell, 1992, p. 22-25).

Rain gage and mean annual precipitation for 1961-90, in inches			
Carroll	32.89	Perry	31.69
Des Moines Airport	33.12	Rockwell City	31.25
Guthrie Center	33.92	Sac City	31.72
Jefferson	31.56	Storm Lake	31.39

Mean annual runoff at selected locations within the Raccoon River Basin was determined at the following streamflow-gaging stations for the following water years (May and others, 1997, p. 257-275).

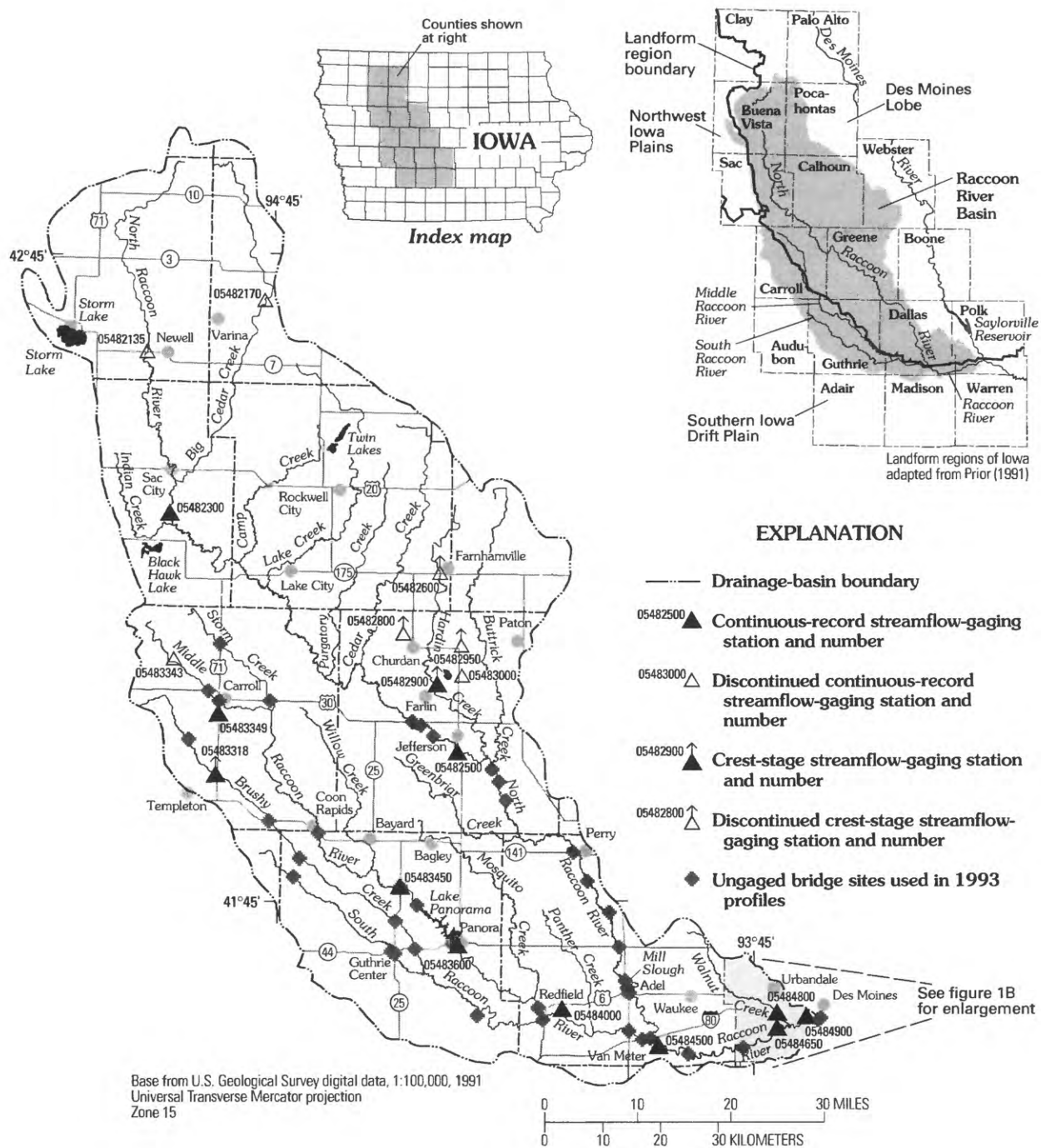
Station number	Station name	Period of record (water years)	Mean annual runoff, in inches
05482300	North Raccoon River near Sac City	1959-96	7.71
05482500	North Raccoon River near Jefferson	1941-96	6.71
05483450	Middle Raccoon River near Bayard	1980-96	9.13
05483600	Middle Raccoon River at Panora	1959-96	7.30
05484000	South Raccoon River at Redfield	1941-96	6.76
05484500	Raccoon River at Van Meter	1916-96	6.01
05484800	Walnut Creek at Des Moines	1972-96	10.94

## FLOODFLOW FREQUENCIES

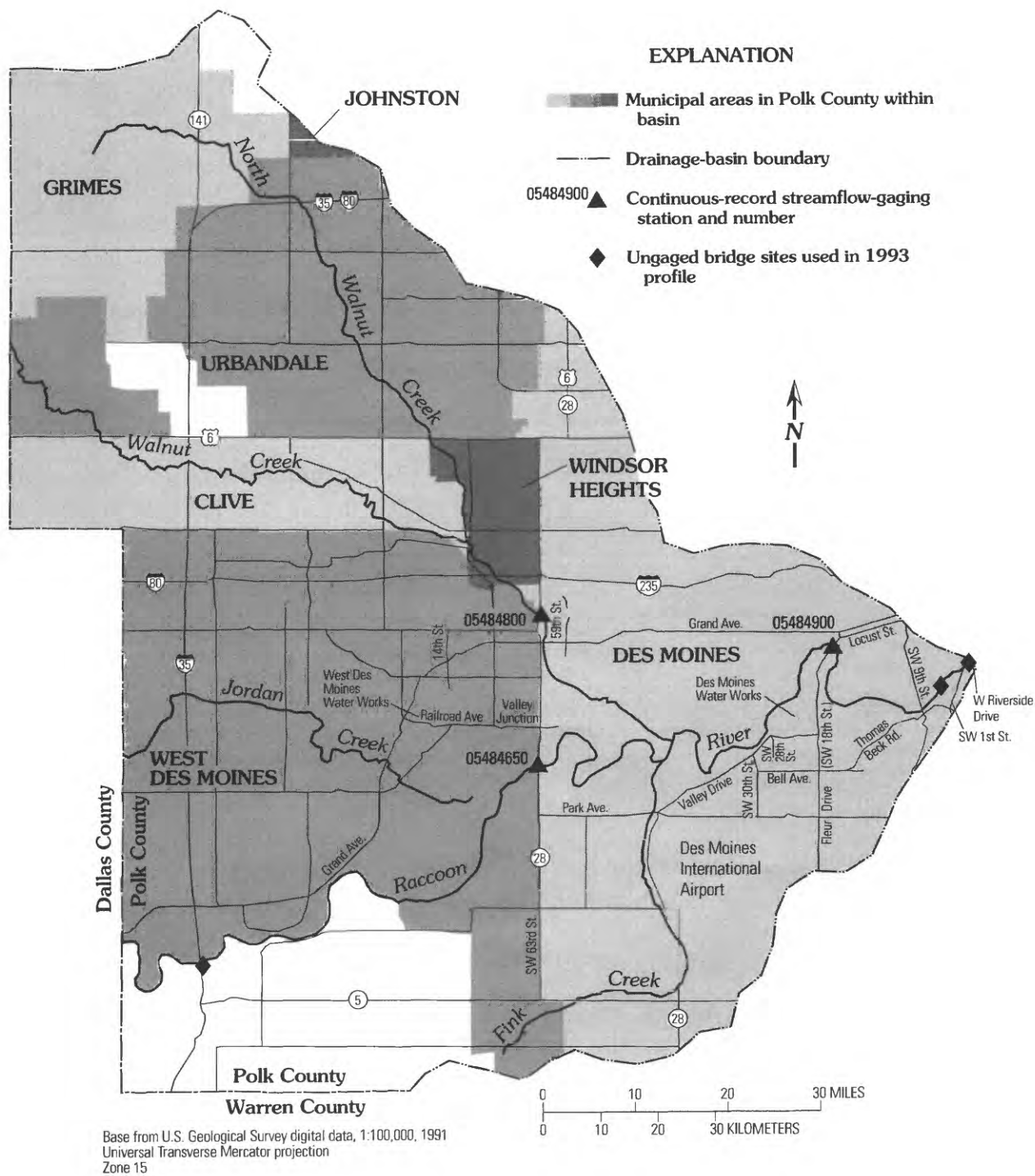
The magnitude and frequency of flood discharges, or floodflow frequencies, for a streamflow-gaging station are determined from a flood-frequency curve which relates observed annual-peak discharges to annual exceedance probability or recurrence interval. Annual exceedance probability is expressed as the chance that a specified flood magnitude will be exceeded in any 1 year. Recurrence interval, which is the reciprocal of the annual exceedance probability, is the statistical average number of years between exceedances of a specified flood magnitude. For example, a flood with a magnitude that is expected to be exceeded on average once during any 100-year period (recurrence interval) has a 1-percent chance (annual exceedance probability = 0.01) of being exceeded during any particular year. This flood, commonly termed the 100-year flood, is the theoretical peak discharge against which actual flood peaks generally are compared. Although the recurrence interval represents the long-term average period between floods of a specific magnitude, rare floods could occur at shorter intervals or even within the same year.

Floodflow frequencies computed for a gaging station, and recurrence intervals determined for selected flood peaks, are statistics that can change as more data become available. Statistics become more reliable as more data are collected and used in the computations. USGS streamflow-gaging stations are the primary source of the streamflow data used in the computations presented in this report.





**Figure 1A.** Raccoon River Basin showing location of bridge sites used in July 9-11, 1993, flood profiles and U.S. Geological Survey streamflow-gaging stations.



**Figure 1B.** Raccoon River Basin showing area within Polk County, location of bridge sites used in the July 9-11, 1993, flood profile, U.S. Geological Survey streamflow-gaging stations, and selected roads in Polk County.

The method used in this report for determining floodflow frequencies from streamflow data is outlined in Bulletin 17B of the Interagency Advisory Committee on Water Data (1982, p. 1-28). The Interagency Advisory Committee recommends using the Pearson Type-III distribution with log transformation of the data, commonly known as the log-Pearson Type-III distribution, as a base method for determining floodflow frequencies. At least 10 years of gaged annual-peak discharges are required to compute floodflow frequencies using this method. In this report, this method for determining floodflow frequencies is referred to as the "Bulletin 17B" method.

Three methods for estimating floodflow frequencies at stream sites in Iowa, including those not gaged, are described by Lara (1987, p. 2-19) and Eash (1993, p. 9-41). Lara (1987) used the physiographic characteristics of Iowa as a guide in defining the boundaries of five hydrologic regions. Regional equations were developed by using the floodflow frequencies for all gaged stations in a hydrologically, homogeneous area, thereby reducing potential errors associated with non-representative, short-term record stations. Eash (1993) developed two other methods for estimating floodflow frequencies for stream sites in Iowa. In one method, significant drainage-basin characteristics were related to the floodflow frequencies for 164 streamflow-gaging stations in Iowa. In the other method, significant onsite channel-geometry characteristics were related to the floodflow frequencies for 157 streamflow-gaging stations in Iowa. Both Lara and Eash used the Bulletin 17B method as the base method for developing their flood-estimation equations.

The floodflow frequencies computed using the Bulletin 17B method, the regional method of Lara (1987), and the drainage-basin and channel-geometry characteristic methods of Eash (1993) are listed in table 1 for the gaging stations in the Raccoon River Basin. Differences in computed discharges between the four flood-estimation methods result from inherent differences between the methods and from differences in the periods of streamflow record that were used in the computation of each method. Flood-frequency discharges computed using the Bulletin 17B method used streamflow data collected through the 1996 water year; the regional method developed by Lara used data collected through the 1984 water year; and the drainage-basin and channel-geometry methods developed by Eash used data collected through the 1990 water year. It is noted that different flood-frequency discharges might

be computed using the Bulletin 17B method if analyses use different periods of record, different approaches to weighting the skewness (asymmetry) of the frequency distribution of the annual peak discharges, or different approaches to incorporating historical flood information.

## FLOOD HISTORY

Continuous records of streamflow have been collected in the Raccoon River Basin since April 1915 at streamflow-gaging station Raccoon River at Van Meter (station number 05484500, fig. 1A). Appendix A contains a complete list of flood peaks for the 19 streamflow-gaging stations in the Raccoon River Basin. Selected flood-peak discharges, including maximum known flood-peak discharges, and recurrence intervals for these gaging stations are listed in table 2.

## Additional Publications

Additional information on floods in the Raccoon River Basin can be found in the following USGS publications. Approximate areas inundated in Des Moines and vicinity by the Raccoon River floods of June 13, 1947, and April 2, 1960, and by Walnut Creek during the flood of June 12, 1947, are described in the hydrologic atlas "Floods at Des Moines, Iowa" (Myers, 1963). Water-surface profiles and rating curves computed for a 4-mi reach of the Raccoon River upstream from the mouth are described in the report "Water-Surface Profiles of Raccoon River at Des Moines, Iowa" (Carpenter and Appel, 1966). The purpose of the 1966 report was to show the effect on water-surface profiles of raising the road-grade elevation of Fleur Drive roadway in Des Moines (fig. 1B). A study to assess the impact of urban development on the magnitude and frequency of flooding in the lower reach of the Walnut Creek Basin (fig. 1B) is described in the report "Effects of Urban Development on the Flood-Flow Characteristics of the Walnut Creek Basin Des Moines Metropolitan Area, Iowa" (Lara, 1978). Water-surface-elevation profiles (including profiles along the North Raccoon River upstream to the Sac-Buena Vista County line) and peak discharges for the March 1979 flood in the Raccoon River Basin, and flood information collected through 1978 for streamflow-gaging stations in the Raccoon River Basin, are presented in the



**Table 1. Floodflow frequencies for streamflow-gaging stations in the Raccoon River Basin**

[Water year, October 1-September 30; mi<sup>2</sup>, square mile; 17B, Bulletin 17B (Interagency Advisory Committee on Water Data, 1982); Lara, hydrologic-region flood-frequency equations (Lara, 1987, p. 28); DB, drainage-basin characteristic flood-frequency equations (Eash, 1993, p. 17); CG, channel-geometry characteristic flood-frequency equations (Eash, 1993, p. 25); --, not determined]

Station number (fig. 1A)	Station name	Drain- age area (mi <sup>2</sup> )	Period of flood record <sup>a</sup> (water year)	Method	Discharge, in cubic feet per second, for indicated recurrence interval, in years					
					2	5	10	25	50	100
05482135	North Raccoon River near Newell	233	1983-93, 1995	17B	1,530	2,380	2,920	3,570	4,030	4,460
				<sup>b</sup> Lara	2,060	3,390	4,450	5,900	6,570	7,850
				DB	1,320	2,430	3,290	4,390	5,240	6,100
				CG	--	--	--	--	--	--
05482170	Big Cedar Creek near Varina	80.0	1960-91	17B	660	1,290	1,750	2,350	2,800	3,250
				<sup>b</sup> Lara	905	1,570	2,110	2,850	3,250	3,920
				DB	691	1,350	1,860	2,540	3,080	3,630
				<sup>c</sup> CG	512	1,000	1,360	1,910	2,330	2,760
05482300	North Raccoon River near Sac City	700	1954, 1958-96	17B	3,930	7,580	10,100	13,400	15,700	17,900
				<sup>b</sup> Lara	4,810	7,490	9,610	12,500	13,600	16,000
				DB	4,010	7,080	9,360	12,200	14,400	16,600
				<sup>d</sup> CG	4,200	7,470	9,810	12,700	15,200	17,700
05482500	North Raccoon River near Jefferson	1,619	1940-96	17B	7,100	12,700	16,600	21,400	24,900	28,300
				<sup>b</sup> Lara	9,170	13,700	17,300	22,100	23,600	27,700
				DB	--	--	--	--	--	--
				<sup>d</sup> CG	6,730	11,700	15,200	19,500	23,100	26,800
05482600	Hardin Creek at Farnhamville	43.7	1952-90	17B	505	981	1,350	1,870	2,290	2,720
				<sup>b</sup> Lara	568	1,020	1,380	1,890	2,180	2,640
				DB	298	592	832	1,160	1,420	1,700
				<sup>d</sup> CG	442	890	1,250	1,740	2,150	2,600
05482800	Happy Run at Churdan	7.58	1951-89	17B	39.0	83.9	120	169	208	248
				<sup>b</sup> Lara	147	288	405	575	685	847
				DB	117	252	368	534	673	822
				CG	--	--	--	--	--	--
05482900	Hardin Creek near Farlin	101	1951-93, 1995-96	17B	676	1,330	1,870	2,630	3,270	3,940
				<sup>b</sup> Lara	1,080	1,860	2,480	3,340	3,790	4,560
				DB	1,050	2,000	2,760	3,770	4,580	5,420
				<sup>d</sup> CG	1,510	2,840	3,840	5,150	6,260	7,410
05482950	East Fork Hardin Creek near Paton	7.57	1952-55	17B	--	--	--	--	--	--
				<sup>b</sup> Lara	147	288	404	574	685	846
				DB	115	258	385	568	725	894
				CG	--	--	--	--	--	--
05483000	East Fork Hardin Creek near Churdan	24.0	1952-91	17B	230	365	456	570	654	737
				<sup>b</sup> Lara	358	660	907	1,260	1,470	1,790
				DB	213	415	575	783	947	1,110
				<sup>d</sup> CG	323	656	922	1,290	1,600	1,930

**Table 1.** Floodflow frequencies for streamflow-gaging stations in the Raccoon River Basin--Continued

Station number (fig. 1A)	Station name	Drain- age area (mi <sup>2</sup> )	Period of flood record <sup>a</sup> (water year)	Method	Discharge, in cubic feet per second, for indicated recurrence interval, in years					
					2	5	10	25	50	100
05483318	Brushy Creek near Templeton	45.0	1966-93, 1996	17B	2,280	4,200	5,800	8,240	10,400	12,700
				<sup>e</sup> Lara	1,370	2,500	3,340	4,500	5,430	6,400
				DB	1,440	2,890	4,100	5,790	7,200	8,710
				<sup>f,g</sup> CG	1,430	2,780	3,880	5,460	6,760	8,130
05483343	Hazelbrush Creek near Maple River	9.22	1991-94	17B	--	---	--	--	--	--
				<sup>b</sup> Lara	171	332	464	657	780	962
				DB	696	1,500	2,210	3,260	4,170	5,160
				CG	--	--	--	--	--	--
05483349	Middle Raccoon River tributary at Carroll	6.58	1966-96	17B	474	1,270	2,100	3,550	4,960	6,660
				<sup>e</sup> Lara	415	805	1,120	1,560	1,920	2,310
				DB	605	1,330	1,970	2,920	3,750	4,650
				<sup>b</sup> CG	386	890	1,340	2,070	2,680	3,440
05483450	Middle Raccoon River near Bayard	375	1973, 1979-96	17B	3,550	6,690	9,340	13,300	16,800	20,600
				<sup>i</sup> Lara	3,550	5,860	7,560	9,870	11,200	13,100
				DB	5,520	9,780	13,000	17,200	20,500	23,900
				<sup>b</sup> CG	3,720	6,990	9,470	13,100	15,700	18,900
05483600	Middle Raccoon River at Panora	440	1953, 1958-96	<sup>j</sup> 17B	4,850	8,380	11,100	14,900	17,900	21,200
				<sup>i</sup> Lara	3,960	6,480	8,340	10,900	12,300	14,400
				DB	5,690	10,000	13,300	17,500	20,800	24,200
				CG	--	--	--	--	--	--
05484000	South Raccoon River at Redfield	994	1940-96	17B	10,500	17,400	22,000	27,800	31,900	36,000
				<sup>i</sup> Lara	7,860	12,700	16,000	20,400	23,200	26,800
				DB	12,000	20,000	25,800	33,000	38,500	44,100
				<sup>b</sup> CG	8,480	14,800	19,300	25,500	29,800	35,000
05484500	Raccoon River at Van Meter	3,441	1915-96	17B	14,500	24,000	30,800	40,000	47,200	54,500
				<sup>i</sup> Lara	17,100	25,200	31,200	39,000	42,000	48,500
				DB	--	--	--	--	--	--
				<sup>d</sup> CG	10,600	17,900	23,000	29,000	34,200	39,200
05484650	Raccoon River at 63rd Street, Des Moines	3,529	1992-96	17B	--	--	--	--	--	--
				<sup>i</sup> Lara	17,500	25,800	31,900	39,900	43,100	49,700
				DB	--	--	--	--	--	--
				CG	--	--	--	--	--	--
05484800	Walnut Creek at Des Moines	78.4	1972-96	17B	2,260	4,670	6,810	10,100	13,100	16,400
				<sup>b</sup> Lara	891	1,550	2,080	2,820	3,200	3,870
				DB	1,950	3,580	4,850	6,510	7,850	9,220
				<sup>d</sup> CG	1,880	3,520	4,760	6,350	7,730	9,140

**Table 1.** Floodflow frequencies for streamflow-gaging stations in the Raccoon River Basin--Continued

Station number (fig. 1A)	Station name	Drain- age area (mi <sup>2</sup> )	Period of flood record <sup>a</sup> (water year)	Method	Discharge, in cubic feet per second, for indicated recurrence interval, in years					
					2	5	10	25	50	100
05484900	Raccoon River at Fleur Drive, Des Moines	3,625	1985-96	17B	--	--	--	--	--	--
				<sup>i</sup> Lara	17,800	26,300	32,500	40,600	43,800	50,500
				DB	--	--	--	--	--	--
				CG	--	--	--	--	--	--

<sup>a</sup>See Appendix A for list of flood peaks.

<sup>b</sup>Flood-frequency equations for hydrologic region 4 were used.

<sup>c</sup>Flood-frequency equations for region 2, active-channel were used.

<sup>d</sup>Flood-frequency equations for region 2, bankfull were used.

<sup>e</sup>Flood-frequency equations for hydrologic region 3 were used.

<sup>f</sup>Flood-frequency equations for region 1, active-channel were used.

<sup>g</sup>Active-channel widths estimated from cross sections plotted from field-survey notes.

<sup>h</sup>Flood-frequency equations for region 1, bankfull were used.

<sup>i</sup>Flood-frequency equations for hydrologic regions 3 and 4 were used based on weighted average, drainage-area ratios.

<sup>j</sup>Flow regulated by Lake Panorama Dam since August 1970. Comparisons of flood-frequency analyses for both the unregulated and regulated periods of record for the Panora gage, and for a consecutive period of record for both the Bayard and Panora gages, indicates that the dam does not appear to significantly affect annual-peak discharges at the Panora gage. Flood frequency was computed using a combined unregulated and regulated period of record that included annual-peak discharges for water years 1953 and 1958-96.

report "Floods in the Raccoon River Basin, Iowa" (Heinitz, 1980). Water-surface-elevation profiles and peak discharges for the flood of June 29-July 1, 1986, in the Raccoon River Basin and for the flood of May 10, 1986, along Walnut Creek, and flood information collected through 1990 for streamflow-gaging stations in the Raccoon River Basin, are presented in the report "Floods of 1986 and 1990 in the Raccoon River Basin, West-Central Iowa" (Baebenroth and Schaap, 1992). Areas inundated in Des Moines and vicinity by the Raccoon River and Walnut Creek floods of 1993 are described in the hydrologic atlas "Delineation of Flooding within the Upper Mississippi River Basin--Flood of June 18 through August 4, 1993, in Des Moines and Vicinity, Iowa" (Schaap, 1996).

## Flood of June 1947

Severe flooding that affected much of Iowa during June 1947 also involved west-central Iowa. Frequent rains and cool, cloudy weather during April and May saturated soils in the area prior to the flooding. Rainfall for June 1947, which averaged 10.33 in. statewide, is the second greatest statewide total for any month of record (surpassed only by the July 1993 statewide average of 10.50 in.) (Harry Hillaker, State Climatologist, Iowa Department of Agriculture and Land Stewardship, written commun., September 1993). The

majority of the flooding in the Raccoon River Basin was caused by four successive thunderstorms over west-central Iowa during May 31-June 1, June 4-5, June 12-13, and June 22-23 (U.S. Department of Commerce, Weather Bureau, and Iowa Department of Agriculture, 1947a, p. 66-67, and 1947b, p. 84; Iowa Natural Resources Council, 1953, p. 37-43). Rainfall amounts recorded during the last three storms are listed below (U.S. Department of Commerce, Weather Bureau, and Iowa Department of Agriculture, 1947a, p. 68-69). The rain gage at Van Meter recorded 18.12 in. during June 1947, which at the time, was the maximum monthly amount of rainfall on record for the location.

Rain gage	Rainfall for the following days during June 1947, in inches		
	June 4-5	June 12-13	June 22-23
Carroll	0.64	2.88	4.78
Des Moines Airport	3.77	5.48	1.24
Guthrie Center	1.20	3.40	0.12
Jefferson	1.68	2.91	0.07
Lake City	0.64	2.40	4.62
Perry	1.59	3.25	0.88
Rockwell City	0.53	2.14	6.65
Sac City	0.34	1.91	2.19
Storm Lake	0.24	1.50	0.68
Van Meter	5.00	5.92	3.07
Wauke	2.66	5.34	2.36

**Table 2.** Selected flood-peak discharges, recurrence intervals, and unit runoff for streamflow-gaging stations in the Raccoon River Basin

[ft, foot; ft<sup>3</sup>/s, cubic foot per second; (ft<sup>3</sup>/s)/mi<sup>2</sup>, cubic foot per second per square mile; \*, maximum flood-peak discharge known for site; --, not determined]

Station number (fig. 1A)	Station name	Date	Gage height <sup>a</sup> (ft)	Discharge (ft <sup>3</sup> /s)	Recurrence interval <sup>b</sup> (years)	Unit runoff [(ft <sup>3</sup> /s)/mi <sup>2</sup> ]
05482135	North Raccoon River near Newell	06-17-84	16.73	*2,850	9	12.2
		06-17-90	16.33	2,380	5	10.2
		07-11-93	16.20	2,420	5	10.4
05482170	Big Cedar Creek near Varina	08-31-62	13.68	*2,080	17	26.0
		03-24-79	<sup>c</sup> 16.29	<sup>d</sup> 2,050	16	25.6
		06-16-84	12.77	1,710	9	21.4
05482300	North Raccoon River near Sac City	09-01-62	<sup>e</sup> 18.12	10,800	12	15.4
		03-23-79	<sup>e</sup> 18.02	*13,100	25	18.7
		06-17-90	20.14	9,930	10	14.2
		07-11-93	17.55	6,550	4	9.36
05482500	North Raccoon River near Jefferson	06-23-47	22.3	*29,100	<sup>f</sup> 1.0	18.0
		06-22-54	19.52	21,300	25	13.2
		03-31-60	19.43	18,600	15	11.5
		03-25-79	17.84	15,300	8	9.45
		06-19-90	18.61	18,400	14	11.4
		07-10-93	19.20	16,900	11	10.4
05482600	Hardin Creek at Farnhamville	08-26-54	10.48	*2,000	30	45.8
		07-26-69	10.45	1,960	30	44.9
		03-19-79	10.29	1,850	25	42.3
		06-16-90	10.39	1,980	30	45.3
05482800	Happy Run at Churdan	03-25-62	8.57	150	18	19.8
		06-13-67	9.37	* <sup>d</sup> 180	30	23.7
		03-19-79	9.36	* <sup>d</sup> 180	30	23.7
05482900	Hardin Creek near Farlin	03-19-79	12.69	2,330	18	23.1
		06-16-90	12.89	2,470	20	24.5
		06-01-91	13.02	2,630	25	26.0
		07-09-93	13.97	*3,010	40	29.8
05482950	East Fork Hardin Creek near Paton	03-24-53	7.77	*68	--	8.98
05483000	East Fork Hardin Creek near Churdan	05-05-60	8.92	413	7	17.2
		03-19-79	7.46	376	5	15.7
		06-30-86	<sup>g</sup> 10.78	737	100	30.7
		06-17-90	10.20	*754	<sup>f</sup> 1.0	31.4
05483318	Brushy Creek near Templeton	06-23-74	<sup>h</sup> 90.96	5,330	8	118
		06-16-90	<sup>h</sup> 90.58	7,550	20	168
		07-09-93	<sup>h</sup> 93.48	* <sup>i</sup> 19,000	<sup>f</sup> 1.5	422
05483343	Hazelbrush Creek near Maple River	07-09-93	14.77	*1,120	--	121

**Table 2.** Selected flood-peak discharges, recurrence intervals, and unit runoff for streamflow-gaging stations in the Raccoon River Basin--Continued

Station number (fig. 1A)	Station name	Date	Gage height <sup>a</sup> (ft)	Discharge (ft <sup>3</sup> /s)	Recurrence interval <sup>b</sup> (years)	Unit runoff [(ft <sup>3</sup> /s)/mi <sup>2</sup> ]
05483349	Middle Raccoon River tributary at Carroll	06-29-86	24.81	<sup>i</sup> 3,350	25	509
		07-09-93	25.79	4,490	40	682
		07-17-96	25.88	* <sup>i</sup> 4,600	45	699
05483450	Middle Raccoon River near Bayard	07-03-73	<sup>g</sup> 21.63	<sup>i</sup> 14,600	35	38.9
		03-19-79	<sup>g</sup> 20.81	9,250	10	24.7
		06-30-86	24.70	12,300	20	32.8
		06-17-90	23.23	9,570	11	25.5
		07-09-93	29.02	*27,500	<sup>f</sup> 1.3	73.3
05483600	Middle Raccoon River at Panora	06-10-53	<sup>g</sup> 14.3	<sup>d</sup> 14,000	20	31.8
		07-02-58	11.87	9,150	6	20.8
		05-19-74	14.80	14,000	20	31.8
		03-19-79	12.95	10,700	9	24.3
		06-30-86	15.50	15,300	30	34.8
		06-18-90	12.77	9,000	6	20.5
		07-09-93	20.04	*22,400	<sup>f</sup> 1.1	50.9
05484000	South Raccoon River at Redfield	06-12-47	<sup>j</sup> 24.3	23,800	14	23.9
		07-02-58	<sup>g,j</sup> 29.04	35,000	90	35.2
		03-19-79	<sup>j</sup> 22.81	20,400	8	20.5
		07-01-86	<sup>j</sup> 25.15	26,300	20	26.5
		06-16-90	19.05	19,100	7	19.2
		07-10-93	26.98	*44,000	<sup>f</sup> 1.2	44.3
05484500	Raccoon River at Van Meter	06-13-47	<sup>g</sup> 21.37	41,200	30	12.0
		07-03-58	21.77	35,200	16	10.2
		03-19-79	20.39	29,900	9	8.69
		07-01-86	22.69	40,200	25	11.7
		06-16-90	21.39	34,600	15	10.1
		07-10-93	26.34	*70,100	<sup>f</sup> 1.3	20.4
05484650	Raccoon River at 63rd Street, Des Moines	07-11-93	<sup>g</sup> 40.77	--	--	--
05484800	Walnut Creek at Des Moines	07-01-73	17.72	9,000	19	115
		06-09-74	17.44	8,160	15	104
		05-10-86	18.32	*12,500	45	159
		06-16-90	18.00	7,780	14	99.2
05484900	Raccoon River at Fleur Drive, Des Moines	07-11-93	<sup>g</sup> 26.8	--	--	--

<sup>a</sup>See Appendix A for datum of gage above sea level for continuous-record streamflow-gaging stations.

<sup>b</sup>Interpolated from Bulletin 17B flood-frequency analysis (Interagency Advisory Committee on Water Data, 1982) and rounded to the nearest 5 years for 20- to 50-year recurrence intervals and to the nearest 10 years above the 50-year recurrence interval.

<sup>c</sup>Affected by ice.

<sup>d</sup>Approximate.

<sup>e</sup>Prior to October 1, 1987, gaging station at different site and datum.

<sup>f</sup>Recurrence interval discharge larger than the computed 100-year flood is expressed as a ratio of the given flood discharge to the 100-year flood discharge.

<sup>g</sup>Gage height determined from floodmarks.

<sup>h</sup>Referenced to previous datum; datum was changed on July 17, 1996.

<sup>i</sup>Discharge computed from indirect measurement.

<sup>j</sup>Prior to October 1, 1986, gaging station at different site and datum.



During the first three weeks of June, the floods were confined to the lower portion of the Raccoon River Basin (U.S. Department of Commerce, Weather Bureau, and Iowa Department of Agriculture, 1947b, p. 85). Excessive rainfall on June 22nd in the upper portion of the basin resulted in flooding from north of Carroll to Des Moines. Additional information on the 1947 flood in the Raccoon River Basin can be found in the report "An Inventory of Water Resources and Water Problems, Des Moines River Basin, Iowa" (Iowa Natural Resources Council, 1953, p. 37-43), which includes maps showing the areal distribution of rainfall and flood hydrographs for the periods June 4-6, June 12-13, and June 17-23, 1947, for the Des Moines River Basin. As a result of the June 22-23 storm, the Raccoon and Des Moines Rivers crested almost simultaneously at Des Moines on June 26th and inundated nearly 7,000 acres or about one-fifth of the total area within the city limits (U.S. Department of Commerce, Weather Bureau, and Iowa Department of Agriculture, 1947a, p. 71). The flooding in Des Moines caused an estimated \$1.25 million of damage, the drowning of two people, and the evacuation of 800 families from their homes (U.S. Department of Commerce, Weather Bureau, and Iowa Department of Agriculture, 1947b, p. 86).

At the South Raccoon River at Redfield stream-flow-gaging station, the peak discharge (23,800 ft<sup>3</sup>/s) for the flood of June 12, 1947 (table 2), is the fourth largest known at this site during 1940-96. The flood-peak discharge of 23,800 ft<sup>3</sup>/s at the Redfield gage has a recurrence interval of approximately 14 years (table 2). At the Raccoon River at Van Meter gaging station, the peak discharge (41,200 ft<sup>3</sup>/s) for the flood of June 13, 1947 (table 2), is the second largest known and the peak stage (21.37 ft) is the sixth largest known at this site during 1915-96. The flood-peak discharge of 41,200 ft<sup>3</sup>/s at the Van Meter gage has a recurrence interval of approximately 30 years (table 2). At the North Raccoon River near Jefferson gaging station, the peak discharge (29,100 ft<sup>3</sup>/s) and stage (22.3 ft) for the flood of June 23, 1947 (table 2), are both the largest known at this site during 1940-96. The flood peak of 29,100 ft<sup>3</sup>/s at the Jefferson gage has a recurrence interval of approximately 100 years (table 2). As a result of the June 22-23 storm, the Raccoon River at Van Meter crested again on June 25th nearly as high as on June 13th, the peak discharge recorded on June 25, 1947, was 38,000 ft<sup>3</sup>/s and the peak stage was 21.1 ft (see Appendix A). At the Raccoon River at Van Meter gaging station, five separate flood crests occurred during June 1947 (see Appendix A) and

the river was above flood stage during June 2-9, June 12-19, and June 21-29. At the Des Moines Waterworks, on Fleur Drive in Des Moines (fig. 1B), flood crests on the Raccoon River of 19.8 and 19.5 ft on June 13, and June 26, 1947, respectively, both exceeded the 1903 flood record (U.S. Department of Commerce, Weather Bureau, and Iowa Department of Agriculture, 1947b, p. 85).

### Flood of July 2-3, 1958

The flood of July 2-3, 1958, occurred as a result of an intense localized thunderstorm on July 2nd in the lower part of the Raccoon River Basin, primarily in the South Raccoon River Basin. Rainfall amounts recorded on July 2-3, 1958, are listed below (U.S. Department of Commerce and Weather Bureau, data obtained through the Midwestern Climate Center Web site). The rain gage at Guthrie Center recorded 6.55 in. on July 2nd.

Rain gage and rainfall for July 2-3, 1958, in inches			
Carroll	1.35	Perry	5.01
Des Moines Airport	3.93	Rockwell City	1.52
Guthrie Center	6.59	Sac City	1.33
Jefferson	2.74	Storm Lake	0.11

At the South Raccoon River at Redfield stream-flow-gaging station, the peak discharge (35,000 ft<sup>3</sup>/s) for the flood of July 2, 1958 (table 2), is the second largest known at this site during 1940-96. The flood-peak discharge of 35,000 ft<sup>3</sup>/s at the Redfield gage has a recurrence interval of approximately 90 years (table 2). At the Raccoon River at Van Meter gaging station, the peak discharge (35,200 ft<sup>3</sup>/s) for the flood of July 3, 1958 (table 2), is the sixth largest known and the peak stage (21.77 ft) is the third largest known at this site during 1915-96. The flood-peak discharge of 35,200 ft<sup>3</sup>/s at the Van Meter gage has a recurrence interval of approximately 16 years (table 2).

### Flood of March 19-25, 1979

The flood of March 19-25, 1979, in the Raccoon River Basin resulted from a rapid snowmelt that occurred over a period of several days prior to the flooding, in combination with rainfall and snowfall. Snow depths for March 16, rainfall amounts for March 18-19

and 22-24, and snowfall amounts for March 23, 1979, are listed below (U.S. Department of Commerce, National Oceanic and Atmospheric Administration, and Iowa Department of Agriculture, 1979, p. 5-13).

Rain gage	Snow on ground on March 16, 1979, in inches	Rainfall for March 18-19, 1979, in inches	Rainfall for March 22-24, 1979, in inches	Snowfall for March 23, 1979, in inches
Carroll	--	0.87	1.16	--
Des Moines Airport	0	0.88	1.43	3.6
Guthrie Center	--	1.84	0.91	--
Jefferson	5	1.90	0.82	2.0
Perry	--	1.36	0.53	--
Rockwell City	16	0.69	1.01	2.5
Sac City	--	1.02	2.82	--
Storm Lake	22	0.67	1.87	0.5

--, not determined

At the Big Cedar Creek near Varina streamflow-gaging station, the peak discharge (2,050 ft<sup>3</sup>/s) for the flood of March 24, 1979 (table 2), is the second largest known at this site during 1960-91. The flood-peak discharge of 2,050 ft<sup>3</sup>/s at the Varina gage has a recurrence interval of approximately 16 years (table 2). At the North Raccoon River near Sac City gaging station, the peak discharge (13,100 ft<sup>3</sup>/s) for the flood of March 23, 1979 (table 2), is the largest known at this site during 1954 and 1958-96. The flood-peak discharge of 13,100 ft<sup>3</sup>/s at the Sac City gage has a recurrence interval of approximately 25 years (table 2).

### Floods of May 10, and June 29-July 1, 1986

The May 10, 1986, flood in the Walnut Creek Basin resulted from a localized thunderstorm that occurred during the evening of May 9th. Intense rainfall ranging from 4 to 7 in. was reported in the Walnut Creek Basin. At Waukee, 6.09 in. of rain fell in about 2.5 hours (U.S. Department of Commerce, National Oceanic and Atmospheric Administration, and Iowa Department of Agriculture and Land Stewardship, 1986a). A flash flood occurred on Walnut Creek in the early-morning hours of May 10th. As a result of the flood, damage to homes and businesses along Walnut Creek was reported to be in the millions of dollars (U.S. Department of Commerce, National Oceanic and Atmospheric Administration, and

National Weather Service, Storm summary report, 1986, p. 5). Rainfall amounts recorded during May 9-10, 1986, are listed below (U.S. Department of Commerce and National Oceanic and Atmospheric Administration, data obtained through the Midwestern Climate Center Web site).

Rain gage and rainfall for May 9-10, 1986, in inches			
Carroll	2.06	Perry	2.22
Des Moines Airport	0.80	Rockwell City	2.27
Guthrie Center	3.62	Sac City	2.35
Jefferson	1.10	Storm Lake	1.68

At the Walnut Creek at Des Moines streamflow-gaging station, the peak discharge (12,500 ft<sup>3</sup>/s) and stage (18.32 ft) for the flood of May 10, 1986 (table 2), are both the largest known at this site during 1972-96. At the Walnut Creek gage, the flood-peak discharge of 12,500 ft<sup>3</sup>/s has a recurrence interval of approximately 45 years (table 2) and the peak stage of 18.32 ft exceeded the flood stage by about 5.3 ft.

The flood of June 29-July 1, 1986, occurred as a result of excessive rainfall over the middle and lower portions of the Raccoon River Basin during June 28-30th. Rainfall amounts of 8 to 12 in. were reported for central and north-central Iowa during June 28-30th, primarily in the Middle Raccoon River Basin (U.S. Department of Commerce, National Oceanic and Atmospheric Administration, and Iowa Department of Agriculture and Land Stewardship, 1986b). Rainfall amounts recorded during June 28-30, 1986, are listed below (U.S. Department of Commerce and National Oceanic and Atmospheric Administration, data obtained through the Midwestern Climate Center Web site).

Rain gage and rainfall for June 28-30, 1986, in inches			
Carroll	2.97	Perry	6.23
Des Moines Airport	3.64	Rockwell City	1.47
Guthrie Center	3.77	Sac City	1.23
Jefferson	6.43	Storm Lake	1.07

At the East Fork Hardin Creek near Churdan gaging station, the peak discharge (737 ft<sup>3</sup>/s) for the flood of June 30, 1986 (table 2), is the second largest known at this site during 1952-91. The flood-peak discharge of 737 ft<sup>3</sup>/s at the Churdan gage has a recurrence interval of approximately 100 years (table 2). At the Middle Rac-



coon River near Bayard gaging station, the peak discharge (12,300 ft<sup>3</sup>/s) for the flood of June 30, 1986 (table 2), is the third largest known and the peak stage (24.70 ft) is the second largest known at this site during 1973 and 1979-96. The flood-peak discharge of 12,300 ft<sup>3</sup>/s at the Bayard gage has a recurrence interval of approximately 20 years (table 2). At the Middle Raccoon River at Panora gaging station, the peak discharge (15,300 ft<sup>3</sup>/s) and stage (15.50 ft) for the flood of June 30, 1986 (table 2), are both the second largest recorded at this site during 1953 and 1958-96. The flood-peak discharge of 15,300 ft<sup>3</sup>/s at the Panora gage has a recurrence interval of approximately 30 years (table 2). At the South Raccoon River at Redfield gaging station, the peak discharge (26,300 ft<sup>3</sup>/s) for the flood of July 1, 1986 (table 2), is the third largest known at this site during 1940-96. The flood-peak discharge of 26,300 ft<sup>3</sup>/s at the Redfield gage has a recurrence interval of approximately 20 years (table 2). At the Raccoon River at Van Meter gaging station, the peak discharge (40,200 ft<sup>3</sup>/s) for the flood of July 1, 1986 (table 2), is the third largest known and the peak stage (22.69 ft) is the second largest known at this site during 1915-96. The flood-peak discharge of 40,200 ft<sup>3</sup>/s at the Van Meter gage has a recurrence interval of approximately 25 years (table 2).

### Flood of June 16-19, 1990

Following a wet spring with excessive precipitation in both March and May, persistent and widespread rainfall occurred throughout the State in June of 1990. On average, 8.02 in. of rain fell over the State, making it the fourth wettest June in the 118 years of state records available at the time (U.S. Department of Commerce, National Oceanic and Atmospheric Administration, and Iowa Department of Agriculture and Land Stewardship, 1990, p. 31-32). Intense thunderstorms that began on June 13th, over antecedent wet soil conditions, resulted in flooding across much of central and east-central Iowa. The majority of the flooding occurred as a result of excessive rainfall during June 16-17th. Nearly 6 in. of rain fell at Van Meter in a little over two hours on June 16th (U.S. Department of Commerce, National Oceanic and Atmospheric Administration, and National Weather Service, Storm summary report, 1990, p. 10). Rainfall amounts recorded during June 16-17, 1990, are listed below (U.S. Department of Commerce, National Oceanic and Atmospheric Administration, and Iowa Department of Agriculture and Land Stewardship, 1990, p. 6-7).

Rain gage and rainfall for June 16-17, 1990, in inches			
Carroll	2.40	Perry	3.44
Des Moines Airport	4.54	Rockwell City	1.97
Guthrie Center	3.45	Sac City	2.78
Jefferson	2.71	Storm Lake	4.19

The intense rainfall caused flash flooding on Walnut Creek in Des Moines. Flooding along Walnut Creek closed streets in a broad area of West Des Moines, from Grand Avenue south to the Raccoon River and from 14th Street in West Des Moines to 59th Street in Des Moines; flooding along the Raccoon River in Des Moines closed Fleur Drive from Bell Avenue to Locust Street (fig. 1B) (Des Moines Register, June 17, 1990). In Des Moines and West Des Moines, more than 1,200 homes were affected by the flooding (Doug Riggs, Red Cross spokesperson, Des Moines Register, June 18, 1990). Agricultural damage, including soil erosion, was extensive as a result of the flooding. In Dallas County, approximately one-half of the county or about 175,000 acres were affected by severe soil erosion and flooding (Beth Grabau, Dallas County Executive Director, Agricultural Stabilization and Conservation Service, Des Moines Register June 20, 1990). The U.S. Soil Conservation Service reported that soil erosion resulting from the June 16-19th storms equalled or exceeded 20 tons per acre on nearly 2.8 million acres of cropland in central and eastern Iowa, including all of Carroll, Dallas, Greene, Guthrie, and Polk Counties; the erosion rate exceeded 40 tons per acre on 350,000 acres of the total affected area (Des Moines Register, June 22, 1990). As a result of the widespread flooding during June 1990, 44 of Iowa's 99 counties received State disaster declarations, with 33 of these counties receiving Federal disaster designations. Flood damage eligible under Presidential and Secretarial Declarations for the period May 18 to July 6, 1990, that includes public, residential, small business, and agricultural damage, exceeded \$14.1 million for the 10-county area of Buena Vista, Calhoun, Carroll, Dallas, Greene, Guthrie, Pocahontas, Polk, Sac, and Webster Counties (information provided by Ellen Gordon, Disaster Services Division, Iowa Department of Public Defense, written commun., April 1991).

At the East Fork Hardin Creek near Churdan streamflow-gaging station, the peak discharge (754 ft<sup>3</sup>/s) for the flood of June 17, 1990 (table 2), is the largest known at this site during 1952-91. The flood-peak discharge of 754 ft<sup>3</sup>/s at the Churdan gage has a recurrence interval of approximately 100 years (table 2). At the Rac-

coon River at Van Meter gaging station, the peak discharge (34,600 ft<sup>3</sup>/s) for the flood of June 16, 1990 (table 2), is the eighth largest known and the peak stage (21.39 ft) is the fifth largest known at this site during 1915-96. The flood-peak discharge of 34,600 ft<sup>3</sup>/s at the Van Meter gage has a recurrence interval of approximately 15 years (table 2). At the Walnut Creek at Des Moines gaging station, the peak discharge (7,780 ft<sup>3</sup>/s) for the flood of June 16, 1990 (table 2), is the fourth largest known and the peak stage (18.00 ft) is the second largest known at this site during 1972-96. At the Walnut Creek gage, the flood-peak discharge of 7,780 ft<sup>3</sup>/s has a recurrence interval of approximately 14 years (table 2) and the peak stage of 18.00 ft exceeded the flood stage by about 5.0 ft.

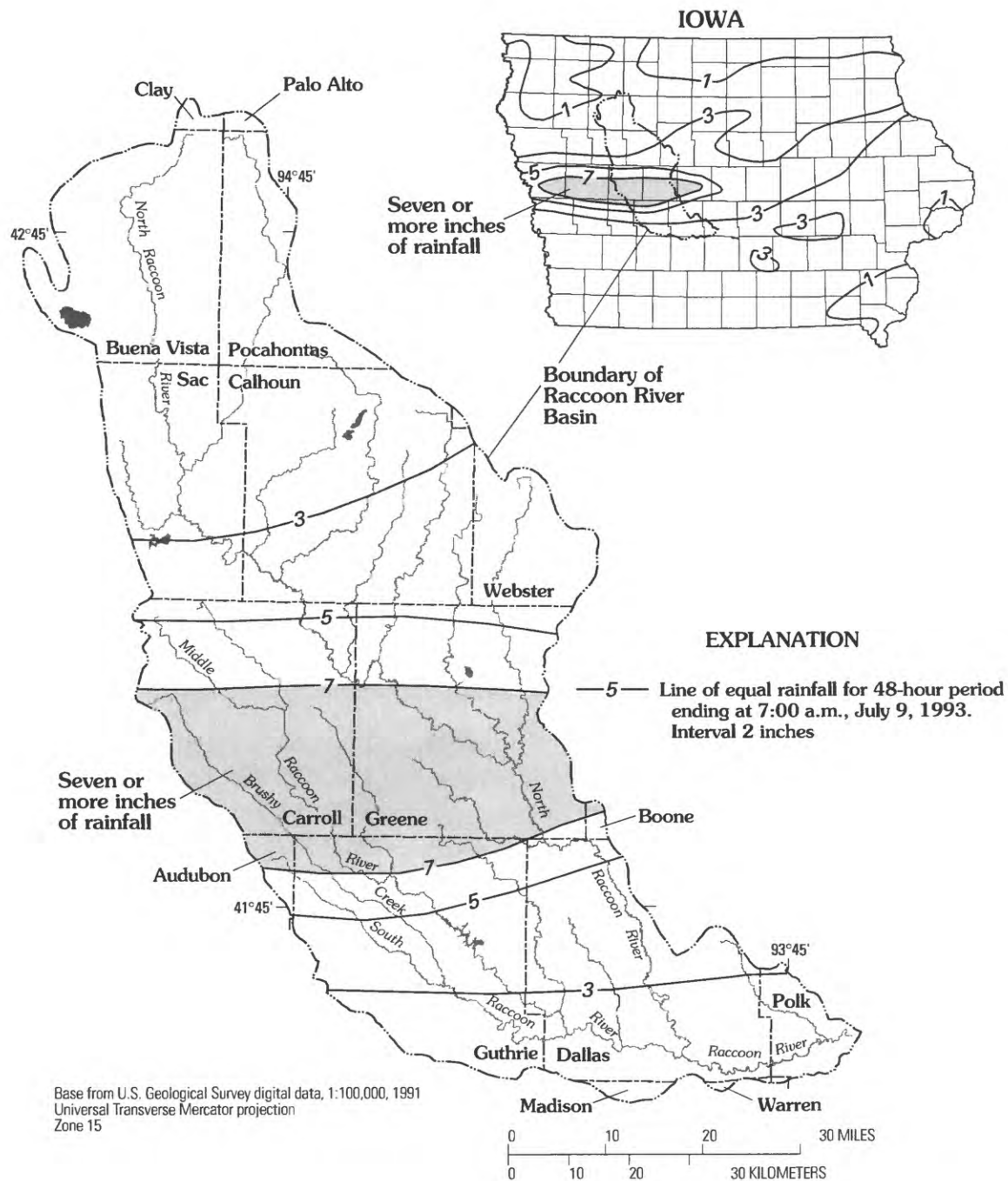
### Flood of July 9-11, 1993

The largest flood on record in the Raccoon River Basin occurred during July 9-11, 1993. From mid-June through early August 1993, severe flooding in a nine-state area of the upper Mississippi River Basin followed an extended period of persistent precipitation that began in January. Following a spring that was wetter than average, weather patterns that persisted from early June through July caused the upper Midwest to be deluged with an excessive amount of rainfall (Wahl and others, 1993, p. 1). The 1993 flood in the upper Midwest is significant with respect to the magnitude and duration of flow. Flood-peak discharges that equalled or exceeded the 10-year recurrence interval were recorded at 154 streamflow-gaging stations in the flooded region during June through August 1993 (Parrett and others, 1993, p. 9-14). Not only were previous maximum peak discharges exceeded at many gaging stations, but flood volumes were significantly higher than previous maximums (Southard, 1995, p. 1). The human and economic costs of the flood were high. Total flood and other related damage in the upper Mississippi River Basin was estimated in the \$10 billion to \$16 billion range, with total Federal expenditures in excess of \$5.4 billion (Scientific Assessment and Strategy Team, 1994, p. 191).

In Iowa, thirty-four streamflow-gaging stations exceeded previous peak discharges in 1993 with the vast majority of peaks occurring in July (Southard and others, 1994, p. 7). Eleven gaging stations in Iowa with 10 or more years of record on unregulated streams had flood recurrence intervals of 100 years or greater and every major reservoir in the State had record pool elevations.

As a result of the magnitude of the 1993 flood, computed flood-frequency discharges increased at the majority of streamflow-gaging stations in Iowa, including the majority of those in the Raccoon River Basin (Eash, in press). Damage from the 1993 flood in Iowa was estimated to exceed \$3.2 billion (Jerry Ostendorf, Iowa Emergency Management Division, written commun., March 1994).

The majority of the following information pertaining to precipitation for the July 9-11, 1993, flood was provided by Harry Hillaker (State Climatologist, Iowa Department of Agriculture and Land Stewardship, written commun., September, 1993; Iowa Department of Agriculture and Land Stewardship, 1993, p. 1; U.S. Department of Commerce, National Oceanic and Atmospheric Administration, and Iowa Department of Agriculture and Land Stewardship, 1993, p. 35-36). The 1993 flood is the most severe natural disaster in Iowa history; flooding struck virtually every county of the State. Only the flood of 1851, which occurred five years after Iowa statehood, appears to be possibly of similar magnitude statewide to the flood of 1993. However, incomplete quantitative historical records make comparison of the two flood years impossible. On average, 10.50 in. of rain fell over the State during July 1993, making it the wettest month ever recorded in Iowa in 121 years of record (1873-1993). The flood of July 9-11, 1993, in west-central Iowa occurred as a result of intense thunderstorms over the area during July 8-9, 1993 (fig. 2). Strong thunderstorms moved into west-central Iowa before sunrise on July 8th and rapidly traversed eastward across the state into Illinois by noon. A second set of stronger thunderstorms developed over west-central Iowa later in the afternoon of July 8th and they slowly moved along the same path as the morning storms. By the time these storms weakened around sunrise on July 9th, a wide area of 3-9 in. of rain fell in an uninterrupted 275-mi long band across the state (see inset map on fig. 2). The greatest rainfall amounts were concentrated in west-central Iowa where rainfall ranging from 3 to more than 7 in. was common over the middle portion of the Raccoon River Basin (fig. 2.) The greatest rainfall was centered over Carroll and Greene Counties and over northern Guthrie County in the headwaters of Brushy Creek (tributary to the South Raccoon River) and in the middle reaches of the North Raccoon and Middle Raccoon Rivers. Unofficial rainfall amounts of nearly 12 in. were reported in some parts of Carroll County (Des Moines Register, July 10, 1993). Official rainfall amounts recorded during July 8-9, 1993, are



**Figure 2.** Areal distribution of rainfall for the July 8-9, 1993, storm in the Raccoon River Basin and in Iowa (lines of equal rainfall, in inches, provided by Harry Hillaker, State Climatologist, Iowa Department of Agriculture and Land Stewardship, Written Commun., September 1993).



listed below (U.S. Department of Commerce, National Oceanic and Atmospheric Administration, and Iowa Department of Agriculture and Land Stewardship, 1993, p. 6-7).

Rain gage and rainfall for July 8-9, 1993, in inches			
Carroll	9.45	Perry	3.30
Des Moines Airport	1.26	Rockwell City	2.63
Guthrie Center	3.00	Sac City	1.77
Jefferson	8.56	Storm Lake	1.64

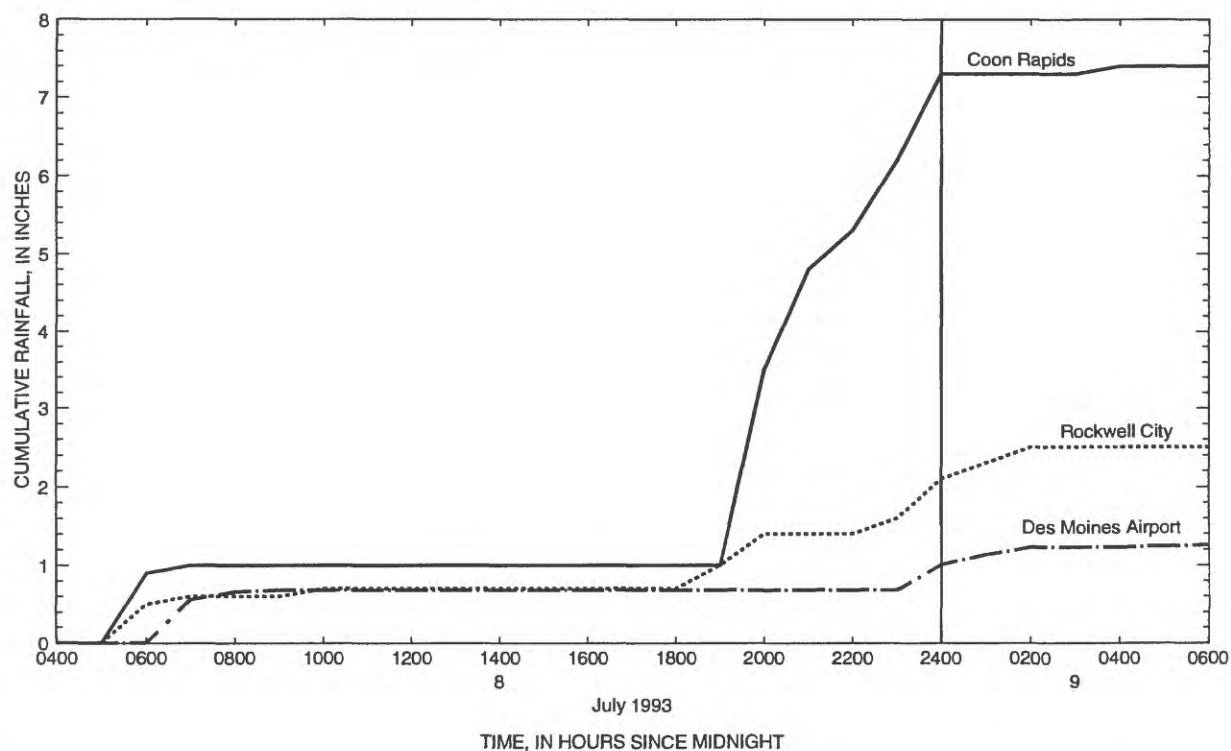
A total of 7.40 in. of rain fell at Coon Rapids between 5:00 a.m. on July 8 and 4:00 a.m. on July 9, 1993 (fig. 3) (U.S. Department of Commerce and National Oceanic and Atmospheric Administration, 1993, p. 7). The majority of the rain (6.30 in.) fell between 7:00 and 12:00 p.m. on July 8th; the average rainfall intensity during this 5-hour period was approximately 1.3 in. per hour. The maximum intensity was 2.5 in. in one hour, which occurred between 7:00 and 8:00 p.m. Twenty-four hour rainfall amounts of 7.40 in. at Coon Rapids and 6.87 in. at Carroll were recorded during July 8-9, 1993; both exceeded the 100-year, 24-hour recurrence-interval rainfall amounts for each area of 6.65 and 6.55 in., respectively (Waite, 1988, p. 34). Runoff from the storm resulted in a catastrophic flood along the Raccoon River. Discharge in the Raccoon River at the Van Meter gaging station tripled (increasing from 23,500 ft<sup>3</sup>/s to 70,100 ft<sup>3</sup>/s) in the 24-hour period ending at 2 p.m. on July 10th (fig. 4).

The following information in this paragraph was obtained from the Des Moines Register (July 11 and 12, 1993, newspaper articles). In West Des Moines, a sandbag levee built along Railroad Avenue (fig. 1B) by hundreds of volunteers and National Guard troops was unable to contain floodwaters of the Raccoon River that were rising nearly a foot every hour; on the evening of July 10th, a break occurred in the West Des Moines levee and floodwaters from the Raccoon River inundated parts of the historic Valley Junction business district (fig. 1B) under more than 5 ft of water. The order to evacuate the Valley Junction area was issued at 8 p.m. At another location a few blocks to the west along Railroad Avenue, 1,000 volunteers built a sandbag levee along the West Des Moines Water Works that successfully protected the water supply for that city during the flood (fig. 1B). At 1 a.m. on July 11th, the Raccoon River flooded the Water Works for the City of Des Moines (fig. 1B), an installation protected by a levee

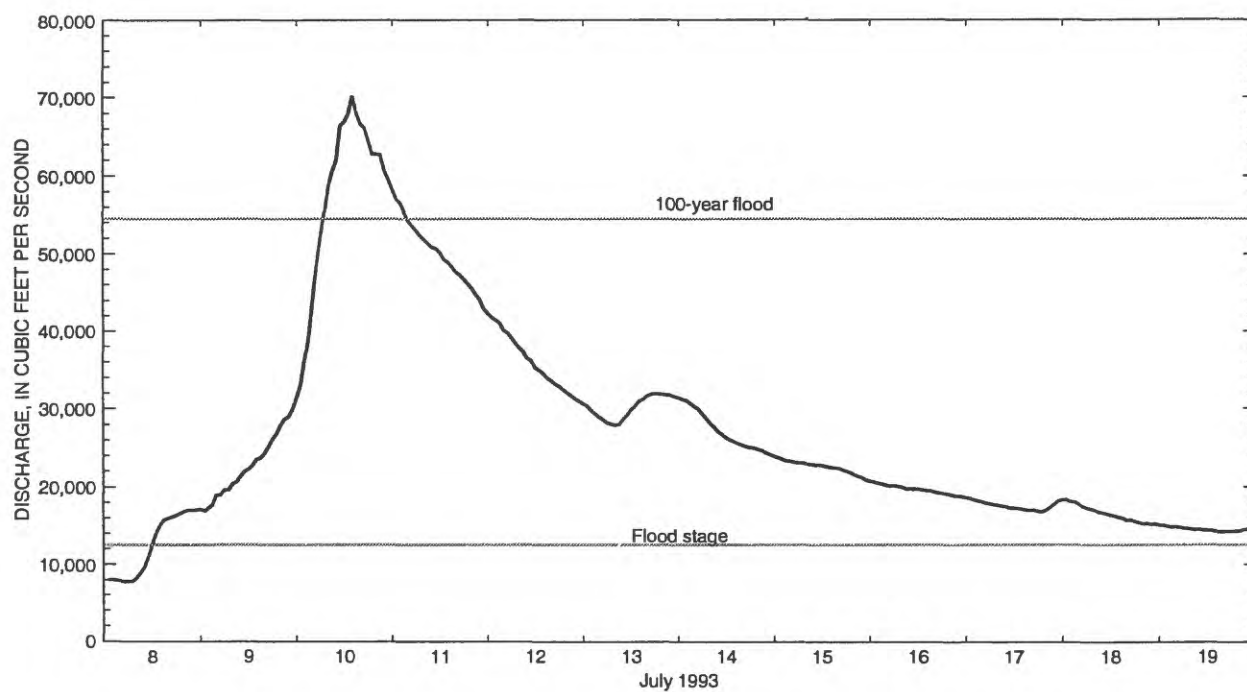
built 6 ft higher than the highest, previously known flood. Because of the inundation of the water treatment plant, water service was cut-off to more than 250,000 Des Moines area residents for 19 days. The Des Moines Fire Department was without water to fight major fires. During the interruption in water service, truckloads of potable water and water suitable for other purposes, such as washing, were hauled to Des Moines and water-distribution centers were established at 29 area grocery stores. The Raccoon River floodwaters combined with a record crest on the Des Moines River inundated several electrical substations, resulting in the loss of power to many areas of Des Moines, including all of the downtown area. As reported in the Des Moines Register newspaper on Monday July 12, 1993:

"The unprecedented extent of flooding and the magnitude of the damage left no area of central Iowa unaffected. Traffic was paralyzed, commerce was reduced to a standstill and basements were flooded. The most basic of human tasks were rendered impossible. For most residents of central Iowa, life Sunday boiled down to two goals: finding safe water and regaining electrical service."

During the flood, officials released water out of Lake Panorama (fig. 1A) on July 10th, according to normal operating procedures, to maintain lake elevation. It was uncertain what effect the release from Lake Panorama had on the rising Raccoon River. Outflow to the Des Moines River from the Saylorville Reservoir (fig. 1A) was increased during July 9-10, according to the prescribed regulation plan. Officials did not believe the increase in outflow from the Saylorville Reservoir affected the Des Moines Water Works (Des Moines Register, July 18, 1993). Flooding on the Raccoon and Des Moines Rivers forced the evacuation of about 5,000 residents in Des Moines and West Des Moines; both cities declared states of emergency (Des Moines Register, July 11, 1993). Numerous streets in Des Moines and West Des Moines were closed as a result of the flood, including Fleur Drive between Park Avenue and Locust Street, S.W. 30th Street between Valley Drive and Bell Avenue, Thomas Beck Road between S.W. 9th Street and Fleur Drive, Valley Drive between Park Avenue and S.W. 28th Street, and West Riverside Drive between Court Avenue and S.W. 1st Street (fig. 1B) (Des Moines Register, July 11, 1993). Des Moines officials estimated flood damage to the city and its residents exceeded \$253 million (Des Moines Register, July 14, 1993). A case study describing the flood



**Figure 3.** Cumulative rainfall for July 8-9, 1993, at Coon Rapids, the Des Moines Airport, and Rockwell City, Iowa (U.S. Department of Commerce and National Oceanic and Atmospheric Administration, 1993, p. 7).



**Figure 4.** Discharge at the Raccoon River at Van Meter streamflow-gaging station (station number 05484500) July 8 through July 19, 1993.

modeling and forecasting response to the July 8-9, 1993, rainfall in the Raccoon River Basin, and the hydrometeorological complexity of the rainfall and runoff events that lead up to the flooding in Des Moines during July 10-12, 1993, is presented in the report "The Great Flood of 1993" (U.S. Department of Commerce and National Oceanic and Atmospheric Administration, 1994, p. 6-27--6-38).

Flooding in the Raccoon River Basin caused many road closures including both the eastbound and westbound lanes of Interstate 80 from west of the Adel exit to the Waukee exit, Interstate 35 from the Interstates 80 and 235 interchange south to the U.S. Highway 34-Osceola interchange, U.S. Highway 71 between Carroll and State Highway 141, State Highway 4 north of State Highway 141 near Jamaica, and State Highway 141 west of Coon Rapids (fig. 1A) (Des Moines Register, July 11, 1993). The record flood on Brushy Creek caused the scour and failure of the U.S. Highway 71 bridge crossing Brushy Creek (site of gaging station Brushy Creek near Templeton, station number 05483318, fig. 1A) (Monk, 1995, p. 38-46). As a result of the 1993 flood, all 99 counties in Iowa were declared Federal disaster areas. Flood damage eligible under the Public Assistance Program of the Federal Emergency Management Agency for flooding that occurred from April 13 to October 1, 1993, that does not include residential and agricultural damage, exceeded \$23.9 million for the 5-county area of Carroll, Dallas, Greene, Guthrie, and Polk Counties (information provided by Jerry Ostendorf, Iowa Emergency Management Division, written commun., April 1997).

The peak discharge and stage for the flood of July 9-11, 1993, are both the largest known at the Brushy Creek near Templeton streamflow-gaging station during 1966-93 and 1996, at the Middle Raccoon River near Bayard gaging station during 1973 and 1979-96, at the Middle Raccoon River at Panora gaging station during 1953 and 1958-96, and at the Raccoon River at Van Meter gaging station during 1915-96 (table 2). At the South Raccoon River at Redfield gaging station, the peak discharge for the flood of July 10, 1993 (table 2), is the largest known at this site during 1940-96. At the Brushy Creek near Templeton gaging station, the July 9, 1993, flood-peak discharge of  $19,000 \text{ ft}^3/\text{s}$  is 1.5 times larger than the 100-year recurrence-interval discharge (table 2). At the Middle Raccoon River near Bayard gaging station, the July 9, 1993, flood-peak discharge of  $27,500 \text{ ft}^3/\text{s}$  is 1.3 times larger than the 100-year recurrence-interval discharge

(table 2). At the Middle Raccoon River at Panora gaging station, the July 9, 1993, flood-peak discharge of  $22,400 \text{ ft}^3/\text{s}$  is 1.1 times larger than the 100-year recurrence-interval discharge (table 2). At the South Raccoon River at Redfield gaging station, the July 10, 1993, flood-peak discharge of  $44,000 \text{ ft}^3/\text{s}$  is 1.2 times larger than the 100-year recurrence-interval discharge (table 2) and the peak stage of 26.98 ft exceeded the flood stage at this site by about 13.0 ft. At the Raccoon River at Van Meter gaging station, the July 10, 1993, flood-peak discharge of  $70,100 \text{ ft}^3/\text{s}$  is 1.3 times larger than the 100-year recurrence-interval discharge (table 2, fig. 4) and the peak stage of 26.34 ft exceeded the flood stage at this site by about 13.3 ft.

## **PROFILES FOR THE FLOOD OF JULY 9-11, 1993, IN THE RACCOON RIVER BASIN, WEST-CENTRAL IOWA**

Water-surface-elevation profiles for the flood of July 9-11, 1993, in the Raccoon River Basin are shown in Appendix B (figs. 5-16). Profiles for the floods of June 1947 (figs. 6-7), March 1979 (figs. 6-11 and 14-15), and June 29-July 1, 1986 (figs. 6-7, 10-11, and 14-15) also are shown in Appendix B for comparative purposes. The flood profiles were determined from high-water marks generally located immediately downstream and 1 bridge-length upstream from selected bridges. The high-water marks were identified within a few days of passage of the flood peak and were later referenced to sea level by differential leveling. Low-water profiles measured on August 8-9, 1979 (figs. 6-8, 10-11, and 14-15), and November 20-21, 1996 (figs. 6-8 and 10-16), in the Raccoon River Basin also are shown in Appendix B to indicate the approximate low-end of the range of stages that can occur within the profiled reaches.

The profiles were defined using data collected by the USGS; with the following two exceptions: (1) the profiles of the flood of July 9-11, 1993, along the Raccoon, North Raccoon, and South Raccoon Rivers (figs. 5-11), were supplemented by water-surface elevations collected by the U.S. Army Corps of Engineers (William Riebe, Chief, Survey Branch, Rock Island District, written commun., February 1997); and (2) the profile of the flood of June 1947 along the Raccoon River (figs. 6-7) was supplemented by water-surface elevations collected by the City of Des Moines Engineer (Myers, 1963). The profiles between the measured



water-surface elevations are represented by straight lines and are therefore only approximations of the actual water-surface elevations between the measurements. Water-surface elevations for ungaged bridge sites used in the 1993 flood profiles were collected at selected primary highway and paved county road bridges (figs. 1 and 5-16). Approximately 77 percent of the bridge sites used in the 1993 profiles were located less than 10 miles apart, about 21 percent were located between 10 and 20 miles apart, and about 2 percent were located between 20 and 30 miles apart. Flood elevations were not collected at both the upstream and downstream sides of all bridges. Water-surface elevations for the 1979 and 1986 floods were collected at the majority of bridges along the profiled reaches. Bridges along the North Raccoon, South Raccoon, and Middle Raccoon Rivers for which flood elevations were collected in 1979 or 1986 but were not collected in 1993 are noted on the profiles in figures 8, 11, and 15.

All river miles used in the profiles (figs. 5-16) were measured from the most current 1:24,000-scale USGS topographic maps. River miles measured for the Raccoon, North Raccoon, South Raccoon, and Middle Raccoon Rivers were referenced to the mouth of the Raccoon River, and river miles measured for Brushy and Storm Creeks were referenced to the mouth of each respective creek. River miles were measured using a geographic information system. Measurements of river miles using larger- or smaller-scale cartographic data or different measurement methods may yield different values than those contained in this report. Bridges are designated by an index number derived from their respective locations using Public Land Survey System coordinates (township, range, section). For example, 7824-10 NW refers to a location in Township 78 North, Range 24 West, northwest quarter of section 10.

A bench mark and a reference point were established at the majority of the bridges in the profiled reaches to reference all the points along the profiles to a common datum. Bench-mark and reference-point descriptions and elevations for bridge sites used in the July 9-11, 1993, flood profiles are listed in Appendix C.

Bridge-deck and low-bridge-chord elevations are shown in figures 6-16 to indicate the relation of the bridge to the high- and low-water surfaces. For sloping bridges, the bridge-deck and low-bridge-chord elevations represent the lower end of each bridge.

## CONSIDERATIONS

The user of this report is cautioned that the stage-discharge data presented herein are representative of the physical conditions of the basin at the time of the floods described. Changes in the basin can alter the flood magnitude for a specific frequency. Examples of these basin changes include, but are not limited to, extensive urbanization, implementation of agricultural conservation practices, and installation of drainage systems. Changes in the channel conditions immediately downstream from a streamflow-gaging station can substantially affect the stage-discharge relation. Examples of such changes include the construction of dams, bridges, or levees; changes in the flood-plain vegetative cover; straightening of the channel; and natural scour and fill. Temporary changes can be caused by ice and debris jams that produce backwater conditions that cause water-surface elevations to be higher than would occur in an unobstructed channel.

## SUMMARY

This report provides information on the flood of July 9-11, 1993, in the Raccoon River Basin in west-central Iowa. Information on the floods of June 1947, March 1979, and June 29-July 1, 1986, in the Raccoon River Basin is included for comparative purposes. The report provides information on flood stages and discharges and floodflow frequencies for streamflow-gaging stations in the Raccoon River Basin using flood information collected through 1996. A flood history summarizes rainfall conditions and damages for floods that occurred during 1947, 1958, 1979, 1986, 1990, and 1993. The July 9-11, 1993, flood is the largest known peak discharge at gaging stations Brushy Creek near Templeton (station number 05483318) 19,000 ft<sup>3</sup>/s, Middle Raccoon River near Bayard (station number 05483450) 27,500 ft<sup>3</sup>/s, Middle Raccoon River at Panora (station number 05483600) 22,400 ft<sup>3</sup>/s, South Raccoon River at Redfield (station number 05484000) 44,000 ft<sup>3</sup>/s, and Raccoon River at Van Meter (station number 05484500) 70,100 ft<sup>3</sup>/s. The peak discharges were, respectively, 1.5, 1.3, 1.1, 1.2, and 1.3 times larger than calculated 100-year recurrence-interval discharges. Information on temporary bench marks and reference points established in the Raccoon River Basin during 1976-79 and 1995-97 also is included in the report.



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## APPENDIX A

### PEAK STAGES AND DISCHARGES FOR STREAMFLOW-GAGING STATIONS IN THE RACCOON RIVER BASIN, WEST-CENTRAL IOWA

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The peak-stage and discharge data for streamflow-gaging stations located in the Raccoon River Basin were compiled through September 30, 1996. The data are listed in chronological order. In general, independent peak discharges above a pre-selected base (partial-duration series) are listed for the continuous-record gaging stations. The magnitude of the selected base discharge, given in the "Remarks" section of the headnote, was determined so that it would be equaled or exceeded on the average about three times per year. Two peak discharges are considered independent if a plot of the recorded stages indicates a well-defined trough between the peaks and if the instantaneous discharge of the trough is 25 percent or more below that of the lower peak (Novak, 1985, p. 93). Only annual peak discharges are listed for the crest-stage gaging stations.

The peak flow lists for each gaging-station are arranged in downstream order as explained in the annual water-data reports of the USGS (see "References"). The gaging stations are identified by a permanent number that also is used in figure 1 and in tables 1 and 2 of this report. The datum of the gage, when given, is above sea level. Flood stage as determined by the National Weather Service, when given, is the stage at which overflow of the natural banks of the stream begins to cause damage in the reach in which the elevation is measured.

Footnotes used throughout this appendix are selected so that each letter has the same meaning. For example, each occurrence of footnote "a" in any of the lists means "Affected by ice." Not all footnotes may appear in every list.

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## 05482135 North Raccoon River near Newell, Iowa

(Discontinued September 30, 1995)

Location.--Lat 42°36'16", long 95°02'42" in NE1/4 NW1/4 sec. 24, T.90 N., R.36 W., Buena Vista County, Hydrologic Unit 07100006, on left bank 40 ft downstream from bridge on State Highway 7, 0.8 mi upstream from Outlet Creek, 2.2 mi west of Newell, and at mile 198.1 upstream from mouth of Raccoon River.

Drainage area.--233 mi<sup>2</sup>.

Gage.--Water-stage recorder. Datum is 1,235.50 ft above sea level.

Stage-discharge relation.--Defined by current-meter measurements.

Remarks.--Base for partial-duration series, 750 ft<sup>3</sup>/s.

### Peak stages and discharges

[Water year, October 1-September 30; ft, feet above gage datum; ft<sup>3</sup>/s, cubic feet per second; --, not determined]

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1983	Oct. 2, 1982	--	1,200
	Oct. 9, 1982	--	1,300
	Feb. 22, 1983	14.51	811
	Mar. 7, 1983	15.40	1,740
	Mar. 17, 1983	13.52	947
	Apr. 2, 1983	14.76	1,400
	Apr. 13, 1983	14.72	1,380
	May 3, 1983	13.95	1,080
	June 14, 1983	13.59	967
	June 21, 1983	16.30	2,450
	June 30, 1983	16.17	2,320
1984	Feb. 17, 1984	<sup>a</sup> --	<sup>b</sup> 1,020
	Apr. 9, 1984	14.20	1,170
	Apr. 13, 1984	14.49	1,290
	Apr. 23, 1984	13.91	1,070
	May 28, 1984	13.36	906
	June 2, 1984	14.83	1,440
	June 6, 1984	--	1,800
	June 12, 1984	--	2,400
	June 17, 1984	16.73	2,850
1985	Dec. 29, 1984	<sup>a</sup> 12.94	--
	May 15, 1985	12.87	776
1986	Mar. 20, 1986	14.76	1,410
	Apr. 5, 1986	13.86	1,060
	Apr. 28, 1986	15.45	1,780
	May 13, 1986	15.61	1,880
	June 5, 1986	13.00	805

# 05482135 North Raccoon River near Newell, Iowa

## Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1987	Oct. 12, 1986	14.22	1,190
	July 12, 1987	14.13	1,160
	July 22, 1987	13.49	974
	Sept. 17, 1987	14.81	1,440
1988	Aug. 22, 1988	12.20	649
1989	Mar. 10, 1989	<sup>a</sup> 13.90	--
	May 24, 1989	11.50	504
1990	June 2, 1990	13.31	917
	June 13, 1990	14.22	1,130
	June 17, 1990	16.33	2,380
1991	Apr. 15, 1991	14.63	1,360
	Apr. 27, 1991	13.96	1,030
	May 6, 1991	14.48	1,290
	May 19, 1991	15.06	1,590
	June 1, 1991	14.37	1,240
	June 4, 1991	15.57	1,910
	June 15, 1991	15.24	1,700
	Aug. 8, 1991	14.18	1,180
1992	Dec. 13, 1991	12.80	793
	Mar. 9, 1992	13.92	1,100
	Apr. 22, 1992	14.77	1,430
	June 17, 1992	13.21	899
	July 12, 1992	14.46	1,280
1993	Oct. 10, 1992	14.43	1,260
	Mar. 29, 1993	16.16	2,380
	Apr. 20, 1993	15.49	1,860
	May 11, 1993	13.58	1,000
	May 31, 1993	13.24	907
	June 14, 1993	15.40	1,800
	June 25, 1993	14.13	1,160
	July 1, 1993	15.66	1,970
	July 11, 1993	16.20	2,420
	July 15, 1993	15.98	2,230
	Aug. 17, 1993	14.91	1,500
	Aug. 30, 1993	13.10	870
1994	--	--	--
1995	Apr. 21, 1995	12.87	826
	May 10, 1995	13.35	969
	May 14, 1995	14.35	1,280
	May 29, 1995	14.19	1,200

<sup>a</sup>Affected by ice.

<sup>b</sup>Approximate.

## 05482170 Big Cedar Creek near Varina, Iowa

(Discontinued September 30, 1991)

Location.--Lat 42°41'16", long 94°47'52", in NE1/4 NE1/4 sec. 24, T.91 N., R.34 W., Pocahontas County, Hydrologic Unit 07100006, on left bank 2 ft downstream from bridge on County Road N33, 2.0 mi downstream from Drainage Ditch 21, 3.5 mi upstream from Drainage Ditch 74, and 5.5 mi northeast of Varina.

Drainage area.--80.0 mi<sup>2</sup>.

Gage.--Water-stage recorder. Datum is 1,225.12 ft above sea level.

Stage-discharge relation.--Defined by current-meter measurements.

Remarks.--Base for partial duration series, 400 ft<sup>3</sup>/s.

### Peak stages and discharges

[Water year, October 1-September 30; ft, feet above gage datum; ft<sup>3</sup>/s, cubic feet per second; --, not determined]

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1960	Mar. 27, 1960	<sup>a</sup> 13.13	--
	Mar. 27, 1960	11.42	1,020
	June 16, 1960	8.27	466
1961	Mar. 2, 1961	--	400
	Mar. 25, 1961	<sup>c</sup> 11.88	1,460
	Mar. 29, 1962	<sup>a</sup> 14.49	--
1962	Mar. 31, 1962	13.68	<sup>b</sup> 1,000
	July 2, 1962	8.91	665
	July 4, 1962	10.15	960
	July 28, 1962	7.89	452
	Aug. 31, 1962	13.68	2,080
1963	Mar. 15, 1963	<sup>a</sup> 7.51	--
	June 2, 1963	6.57	333
1964	May 6, 1964	6.23	291
1965	Apr. 6, 1965	<sup>a</sup> 15.05	--
	Apr. 8, 1965	10.17	1,060
	June 6, 1965	7.00	404
1966	Oct. 1, 1965	<sup>d</sup> 6.31	257
	Mar. 31, 1966	5.84	237
1967	June 10, 1967	7.82	548
	June 15, 1967	9.28	852
1968	July 19, 1968	3.99	45
1969	Mar. 24, 1969	<sup>a</sup> 10.44	<sup>b</sup> 700
	Apr. 4, 1969	8.89	744
	June 23, 1969	8.04	506
	June 25, 1969	10.76	992
	June 29, 1969	7.37	412
	July 27, 1969	10.49	938
1970	May 13, 1970	8.02	554



# 05482170 Big Cedar Creek near Varina, Iowa

## Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1971	Feb. 19, 1971	<sup>a</sup> 11.18	<sup>b</sup> 800
	Mar. 13, 1971	<sup>a</sup> --	<sup>b</sup> 880
	Mar. 28, 1971	8.25	595
	June 7, 1971	10.66	1,010
1972	Aug. 6, 1972	7.37	400
1973	Mar. 11, 1973	7.43	485
	Mar. 14, 1973	7.25	459
	Apr. 16, 1973	6.84	404
	May 28, 1973	7.78	530
	Aug. 23, 1973	9.82	904
	Sept. 26, 1973	9.25	850
1974	Oct. 11, 1973	7.75	573
	Nov. 21, 1973	8.11	642
1975	Apr. 9, 1975	--	<sup>b</sup> 800
	Apr. 12, 1975	--	<sup>b</sup> 600
	Apr. 28, 1975	10.88	1,250
	May 11, 1975	6.78	413
	June 18, 1975	7.04	452
1976	June 29, 1976	4.71	157
1977	Mar. 9, 1977	<sup>a</sup> 3.91	<sup>b</sup> 64
1978	July 6, 1978	10.39	818
	Sept. 14, 1978	10.02	788
1979	Mar. 24, 1979	<sup>a</sup> 16.29	<sup>b</sup> 2,050
	June 27, 1979	8.06	509
	July 30, 1979	8.49	573
	Aug. 20, 1979	7.46	424
	Aug. 21, 1979	12.29	1,220
1980	Mar. 15, 1980	<sup>a</sup> 8.44	--
	Apr. 3, 1980	6.59	385
1981	June 13, 1981	6.87	372
1982	July 6, 1982	7.48	459
	July 10, 1982	7.71	488
1983	Oct. 1, 1982	8.15	551
	Oct. 9, 1982	7.97	533
	Dec. 25, 1982	7.02	449
	Dec. 29, 1982	7.14	468
	Feb. 23, 1983	7.54	535
	Feb. 27, 1983	7.05	454
	Mar. 6, 1983	9.53	937
	Mar. 16, 1983	6.72	404
	Apr. 1, 1983	7.91	603
	Apr. 13, 1983	8.29	678
	Apr. 16, 1983	7.47	523
	May 3, 1983	6.91	432

# 05482170 Big Cedar Creek near Varina, Iowa

## Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1983--Continued	June 20, 1983	11.03	1,180
	June 30, 1983	9.52	868
1984	Feb. 16, 1984	<sup>a</sup> --	<sup>b</sup> 750
	Feb. 23, 1984	<sup>a</sup> --	<sup>b</sup> 860
	Apr. 9, 1984	7.27	457
	Apr. 23, 1984	7.37	472
	May 1, 1984	9.29	834
	June 7, 1984	9.32	841
	June 13, 1984	9.62	910
	June 16, 1984	12.77	1,710
	June 23, 1984	8.15	610
1985	Dec. 28, 1984	<sup>a</sup> 7.24	--
	May 24, 1985	5.90	302
1986	Mar. 3, 1986	--	<sup>b</sup> 550
	Mar. 18, 1986	10.05	1,010
	Apr. 5, 1986	8.21	659
	Apr. 28, 1986	7.58	533
	May 11, 1986	7.07	456
	May 13, 1986	11.80	1,430
	Aug. 13, 1986	7.13	467
1987	Oct. 12, 1986	8.09	632
	May 26, 1987	7.40	528
1988	Mar. 1, 1988	<sup>a</sup> 5.78	--
	Aug. 22, 1988	5.74	316
1989	Mar. 10, 1989	<sup>a</sup> 6.83	--
	May 24, 1989	4.40	168
1990	June 3, 1990	7.07	482
	June 17, 1990	11.50	1,410
	June 19, 1990	12.09	1,580
	Aug. 25, 1990	7.47	538
1991	Mar. 23, 1991	9.19	860
	Apr. 14, 1991	9.65	960
	Apr. 19, 1991	6.47	405
	Apr. 27, 1991	7.71	572
	Apr. 30, 1991	7.49	541
	May 5, 1991	9.21	864
	May 18, 1991	8.07	628
	May 31, 1991	7.72	574
	June 4, 1991	11.32	1,360
	June 15, 1991	8.20	654
	Aug. 8, 1991	6.82	449

<sup>a</sup>Affected by ice.

<sup>b</sup>Approximate.

<sup>c</sup>Gage height determined from floodmark.

<sup>d</sup>Stage decreasing.

## 05482300 North Raccoon River near Sac City, Iowa

Location.--Lat 42°21'16", long 94°59'26", in NW1/4 NW1/4 sec. 13, T.87 N., R.36 W., Sac County, Hydrologic Unit 07100006, on right bank 5 ft downstream from bridge on county road, 2.1 mi upstream from Indian Creek, 0.3 mi upstream from Drainage Ditch 73, 4.6 mi south of Sac City, and at mile 167.1 upstream from mouth of Raccoon River.

Drainage area.--700 mi<sup>2</sup>.

Gage.--Water-stage recorder. Datum is 1,146.03 ft above sea level. Prior to Oct. 1, 1987, at site 1.7 mi downstream, at datum 1.43 ft lower.

Stage-discharge relation.--Defined by current-meter measurements.

Bankfull stage.--13 ft (determined by National Weather Service).

Remarks.--Base for partial-duration series, 2,000 ft<sup>3</sup>/s.

### Peak stages and discharges

[Water year, October 1-September 30; ft, feet above gage datum; ft<sup>3</sup>/s, cubic feet per second; --, not determined]

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1954	June 21, 1954	<sup>c</sup> 15.61	7,000
	(Systematic operation of gage began June 1, 1958.)		
1958	June 4, 1958	13.44	<sup>e</sup> 4,560
1959	May 31, 1959	14.51	5,200
1960	Mar. 30, 1960	16.73	9,020
	May 22, 1960	9.68	2,100
	May 26, 1960	10.94	2,840
	June 19, 1960	10.47	2,640
1961	Mar. 28, 1961	13.16	4,420
1962	Mar. 29, 1962	15.83	7,730
	June 9, 1962	9.96	2,010
	July 5, 1962	10.32	2,160
	Sept. 1, 1962	18.12	10,800
1963	June 3, 1963	9.32	1,910
1964	May 7, 1964	7.47	1,100
1965	Apr. 6, 1965	15.59	6,960
	Sept. 28, 1965	9.82	2,020
1966	June 12, 1966	9.49	1,860
1967	June 9, 1967	12.06	3,230
	June 16, 1967	15.73	7,150
1968	June 25, 1968	4.89	354
1969	Oct. 18, 1968	10.57	2,110
	Mar. 26, 1969	12.94	3,790
	Apr. 5, 1969	14.65	5,370
	June 7, 1969	10.69	2,430
	June 27, 1969	13.93	4,850
	July 28, 1969	12.72	3,780

# 05482300 North Raccoon River near Sac City, Iowa

## Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1970	May 14, 1970	12.75	3,630
1971	Feb. 19, 1971	<sup>a</sup> 14.25	<sup>b</sup> 4,000
	Mar. 14, 1971	13.40	4,200
	Mar. 29, 1971	10.62	2,490
	June 10, 1971	11.82	3,070
	July 17, 1972	13.43	4,140
1972	July 17, 1972	13.43	4,140
1973	Nov. 3, 1972	9.73	2,010
	Mar. 4, 1973	<sup>a</sup> 12.18	<sup>b</sup> 2,680
	Mar. 14, 1973	11.54	2,890
	Mar. 26, 1973	10.46	2,360
	Apr. 16, 1973	10.22	2,240
	May 28, 1973	--	<sup>b</sup> 2,790
	July 2, 1973	13.16	3,930
	July 9, 1973	--	<sup>b</sup> 3,190
	Aug. 24, 1973	12.62	3,550
	Sept. 27, 1973	13.90	4,520
	Oct. 12, 1973	13.33	4,060
	Nov. 21, 1973	12.11	3,250
	May 19, 1974	11.21	2,400
	Apr. 28, 1975	14.35	4,570
	May 12, 1975	10.37	2,160
1975	June 19, 1975	11.12	2,590
	May 25, 1976	5.73	557
	Mar. 12, 1977	<sup>a</sup> 5.94	--
1977	Aug. 9, 1977	5.43	479
	June 18, 1978	11.53	2,890
	July 7, 1978	13.47	4,180
1978	Sept. 14, 1978	15.23	5,880
	Mar. 23, 1979	18.02	13,100
	Mar. 30, 1979	16.64	7,750
1979	June 28, 1979	15.43	5,930
	Aug. 24, 1979	13.22	3,980
	Apr. 4, 1980	8.90	1,720
1980	Apr. 4, 1980	8.90	1,720
1981	June 14, 1981	7.96	1,290
1982	Mar. 20, 1982	10.92	2,610
	May 27, 1982	11.52	2,980
	July 7, 1982	13.64	4,410
	July 11, 1982	12.50	3,560
	July 18, 1982	13.25	4,100
	Sept. 14, 1982	9.66	2,110
	Oct. 3, 1982	12.25	3,360
1983	Oct. 9, 1982	12.95	3,840
	Feb. 23, 1983	<sup>c</sup> 12.22	3,380
	Mar. 7, 1983	<sup>f</sup> 16.16	7,200

# 05482300 North Raccoon River near Sac City, Iowa

## Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1983--Continued	Mar. 16, 1983	<sup>g</sup> 11.98	3,250
	Apr. 2, 1983	13.72	4,510
	Apr. 14, 1983	13.54	4,370
	May 3, 1983	12.50	3,590
	June 15, 1983	10.27	2,400
	June 21, 1983	<sup>g</sup> 17.31	9,390
	June 30, 1983	16.31	7,230
1984	Feb. 17, 1984	10.64	2,580
	Feb. 23, 1984	9.82	2,210
	Apr. 4, 1984	10.25	2,410
	Apr. 9, 1984	12.27	3,460
	Apr. 14, 1984	12.20	3,410
	Apr. 23, 1984	11.87	3,210
	Apr. 27, 1984	11.27	2,890
	May 1, 1984	13.78	4,540
	May 28, 1984	11.94	3,250
	June 8, 1984	16.47	7,790
	June 13, 1984	14.62	5,270
	June 18, 1984	15.70	6,460
1985	May 15, 1985	<sup>b,h</sup> 9.12	<sup>b</sup> 1,800
1986	Mar. 19, 1986	14.82	5,430
	Apr. 5, 1986	12.69	3,690
	Apr. 28, 1986	13.55	4,160
	May 11, 1986	12.52	3,580
	May 13, 1986	14.12	4,790
	Sept. 21, 1986	12.19	3,290
	Sept. 25, 1986	10.45	2,370
1987	Oct. 12, 1986	12.85	3,670
	Apr. 15, 1987	10.61	2,460
	May 27, 1987	11.64	2,930
	July 12, 1987	14.01	4,570
	Sept. 17, 1987	11.25	2,740
(Gage moved to new site and datum October 1, 1987.)			
1988	Feb. 20, 1988	<sup>a</sup> 10.63	--
	Aug. 23, 1988	10.12	1,040
1989	Mar. 11, 1989	<sup>a</sup> 12.67	<sup>b</sup> 1,700
1990	May 20, 1990	14.05	2,890
	May 26, 1990	12.77	2,210
	June 3, 1990	13.68	2,640
	June 14, 1990	14.60	3,280
	June 17, 1990	20.14	9,930
	June 28, 1990	14.41	3,140
	Aug. 26, 1990	15.77	4,430



# 05482300 North Raccoon River near Sac City, Iowa

## Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1991	Mar. 23, 1991	15.11	3,560
	Apr. 15, 1991	16.07	4,330
	Apr. 19, 1991	13.42	2,570
	Apr. 27, 1991	14.96	3,480
	Apr. 30, 1991	14.42	3,150
	May 6, 1991	16.15	4,400
	May 18, 1991	15.23	3,670
	June 1, 1991	15.68	4,010
	June 5, 1991	16.84	4,990
	June 15, 1991	16.59	4,850
	Aug. 8, 1991	12.90	2,190
1992	Jan. 23, 1992	a--	2,770
	Mar. 10, 1992	13.20	2,390
	Apr. 22, 1992	15.21	3,780
	June 18, 1992	12.74	2,140
	July 14, 1992	16.51	4,990
1993	Mar. 30, 1993	17.47	6,450
	Apr. 20, 1993	16.91	5,820
	May 11, 1993	13.95	3,000
	June 17, 1993	14.91	3,690
	June 25, 1993	12.97	2,330
	June 30, 1993	16.02	4,800
	July 11, 1993	17.55	6,550
	July 18, 1993	15.55	4,270
	July 25, 1993	15.69	4,330
	Aug. 31, 1993	12.76	2,150
1994	Mar. 5, 1994	16.13	4,890
	June 13, 1994	13.83	2,820
	June 24, 1994	13.74	2,750
1995	Apr. 21, 1995	12.53	2,200
	May 10, 1995	13.31	2,770
	May 14, 1995	13.79	3,150
	May 28, 1995	15.11	4,310
1996	May 29, 1996	12.72	2,270
	June 17, 1996	13.76	3,050
	June 21, 1996	17.65	6,990
	Aug. 6, 1996	14.66	3,800
	Aug. 12, 1996	12.73	2,260

<sup>a</sup>Affected by ice.

<sup>b</sup>Approximate.

<sup>c</sup>Gage height determined from floodmark.

<sup>e</sup>Peak for 1958 is from June 1 to September 30.

<sup>f</sup>From graph based on outside gage height.

<sup>g</sup>From outside gage.

<sup>h</sup>Affected by backwater.

## 05482500 North Raccoon River near Jefferson, Iowa

Location.--Lat 41°59'17", long 94°22'36", in SW1/4 NW1/4 sec. 20, T.83 N., R.30 W., Greene County, Hydrologic Unit 07100006, on right bank 3 ft downstream from bridge on State Highway 4, 0.1 mi downstream from drainage Ditches 33 and 40, 1.9 mi south of Jefferson, 4.7 mi upstream from Hardin Creek, and at mile 92.0 upstream from mouth of Raccoon River.

Drainage area.--1,619 mi<sup>2</sup>.

Gage.--Water-stage recorder. Datum is 967.09 ft above sea level. Prior to Apr. 22, 1946, nonrecording gage at site 4 mi upstream at different datum. Apr. 22 to June 25, 1946, nonrecording gage; June 26, 1946, to Sept. 30, 1955, water-stage recorder; Oct. 1, 1955 to Apr. 30, 1958, nonrecording gage, at present site and datum.

Stage-discharge relation.--Defined by current-meter measurements.

Flood stage.--10 ft.

Remarks.--Base for partial-duration series, 4,000 ft<sup>3</sup>/s.

### Peak stages and discharges

[Water year, October 1-September 30; ft, feet above gage datum; ft<sup>3</sup>/s, cubic feet per second; --, not determined]

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
(Systematic operation of gage began in March 1940.)			
1940	Aug. 28, 1940	10.9	4,030
1941	June 14, 1941	9.1	2,420
1942	July 15, 1942	10.5	3,590
1943	Aug. 13, 1943	15.5	9,480
1944	May 22, 1944	15.4	9,860
	June 14, 1944	16.2	11,900
1945	Mar. 12, 1945	12.9	6,880
	Apr. 18, 1945	10.6	4,130
	Apr. 25, 1945	14.2	8,700
	May 24, 1945	13.1	7,120
	June 3, 1945	14.3	8,780
	June 10, 1945	13.5	7,630
	Aug. 8, 1945	10.7	4,230
	Mar. 16, 1946	11.5	5,160
(Gage moved to new site and datum on April 22, 1946.)			
	May 28, 1946	13.4	7,310
1947	June 14, 1947	12.4	5,780
	June 23, 1947	22.3	29,100
	July 8, 1947	11.6	5,420
1948	Mar. 20, 1948	13.8	8,630
1949	Mar. 7, 1949	14.8	10,100
1950	June 19, 1950	12.0	6,050
	June 23, 1950	11.1	4,710

# 05482500 North Raccoon River near Jefferson, Iowa

## Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1951	Mar. 29, 1951	17.39	16,000
	May 3, 1951	15.62	11,800
	June 3, 1951	12.88	6,720
	June 21, 1951	12.25	5,800
	July 4, 1951	12.58	6,320
	Aug. 18, 1951	12.41	6,060
	Aug. 30, 1951	12.97	6,860
1952	Apr. 1, 1952	12.80	6,580
	July 11, 1952	12.51	6,190
1953	July 1, 1953	10.10	3,490
1954	June 13, 1954	11.09	4,670
	June 22, 1954	19.52	21,300
	Aug. 29, 1954	14.19	9,360
1955	Apr. 26, 1955	9.78	3,580
1956	May 13, 1956	5.4	650
1957	June 16, 1957	13.49	7,800
1958	June 7, 1958	11.70	4,720
1959	June 3, 1959	15.06	9,800
1960	Mar. 31, 1960	19.43	18,600
	May 28, 1960	13.45	6,960
1961	Mar. 29, 1961	13.19	6,680
1962	Mar. 30, 1962	17.60	14,300
	June 10, 1962	11.90	5,050
	Sept. 4, 1962	16.33	11,700
1963	May 14, 1963	12.34	5,510
1964	May 8, 1964	8.61	2,280
1965	Apr. 5, 1965	15.29	9,890
	May 27, 1965	14.94	9,300
	Sept. 30, 1965	12.38	5,610
1966	June 12, 1966	14.11	7,980
	June 28, 1966	11.47	4,620
1967	June 11, 1967	15.61	10,400
	June 19, 1967	15.61	10,400
	June 24, 1967	12.04	5,200
	June 28, 1967	11.75	4,900
1968	June 26, 1968	9.05	2,620
1969	Oct. 19, 1968	11.06	4,160
	Mar. 26, 1969	15.85	10,800
	Apr. 7, 1969	14.46	8,500
	Apr. 19, 1969	11.06	4,200
	June 30, 1969	12.88	6,110
	July 10, 1969	13.72	7,410
	July 30, 1969	12.16	5,220

# 05482500 North Raccoon River near Jefferson, Iowa

## Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1970	May 16, 1970	<sup>c</sup> 11.64	4,690
1971	Feb. 21, 1971	<sup>a</sup> 15.75	<sup>b</sup> 6,300
	Mar. 15, 1971	13.70	7,160
1972	July 20, 1972	12.25	5,550
1973	Feb. 27, 1973	<sup>a</sup> 13.19	<sup>b</sup> 5,460
	Mar. 4, 1973	<sup>a</sup> 14.37	<sup>b</sup> 7,370
	Mar. 15, 1973	13.34	6,720
	Mar. 27, 1973	11.64	4,940
	Apr. 13, 1973	10.91	4,260
	Apr. 18, 1973	12.56	6,030
	May 4, 1973	11.29	4,720
	May 9, 1973	13.42	6,940
	May 31, 1973	12.78	6,170
	June 19, 1973	10.95	4,260
	July 4, 1973	15.11	9,060
	July 11, 1973	12.38	5,680
	Aug. 26, 1973	11.13	4,150
	Sept. 29, 1973	15.97	10,400
	Oct. 14, 1973	14.06	7,240
	Nov. 23, 1973	12.04	5,340
	Feb. 20, 1974	<sup>a</sup> 15.11	<sup>b</sup> 5,900
1974	May 16, 1974	11.25	4,260
	May 18, 1974	13.35	6,400
	Apr. 28, 1975	12.84	6,060
1975	May 1, 1975	13.82	7,190
	May 24, 1976	10.31	3,330
1976	Feb. 23, 1977	<sup>a</sup> 5.71	--
	Aug. 26, 1977	5.29	404
1977	July 10, 1978	12.21	5,160
	Sept. 17, 1978	14.67	8,200
	Sept. 21, 1978	10.98	4,010
1978	Mar. 20, 1979	16.56	12,300
	Mar. 25, 1979	17.84	15,300
	Mar. 31, 1979	17.5	14,500
	June 30, 1979	13.3	7,000
	Aug. 26, 1979	11.38	4,800
1979	Apr. 5, 1980	8.93	2,550
1980	June 29, 1981	7.35	1,620
1981	Mar. 21, 1982	12.00	5,440
	May 5, 1982	11.30	4,720
	May 6, 1982	10.96	4,400
	May 29, 1982	12.52	6,040
	June 15, 1982	10.53	4,110
	July 9, 1982	10.61	4,190

# 05482500 North Raccoon River near Jefferson, Iowa

## Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1982--Continued	July 13, 1982	10.96	4,490
	July 21, 1982	12.91	6,540
1983	Oct. 11, 1982	10.91	4420
	Feb. 24, 1983	12.80	6,690
	Mar. 9, 1983	15.92	11,600
	Mar. 18, 1983	12.16	5,970
	Apr. 3, 1983	14.11	8,530
	Apr. 16, 1983	14.33	8,850
	May 5, 1983	13.16	7,210
	June 24, 1983	16.39	12,500
	July 2, 1983	17.38	14,500
1984	Feb. 19, 1984	12.05	5,790
	Apr. 6, 1984	11.00	4,840
	Apr. 11, 1984	12.38	6,320
	Apr. 25, 1984	12.58	6,570
	May 1, 1984	15.69	11,300
	May 31, 1984	13.05	7,170
	June 11, 1984	14.94	9,930
	June 17, 1984	15.85	11,500
	June 21, 1984	17.86	15,600
1985	Dec. 31, 1984	<sup>a</sup> 13.10	<sup>b</sup> 2,800
1986	Mar. 21, 1986	14.01	8,260
	Apr. 7, 1986	11.17	4,840
	May 1, 1986	11.31	4,990
	May 13, 1986	13.44	7,520
	June 30, 1986	13.95	8,230
	Sept. 22, 1986	10.86	4,390
	Sept. 28, 1986	10.47	4,010
1987	Oct. 15, 1986	14.03	8,840
	Apr. 17, 1987	11.54	5,420
	May 28, 1987	10.74	4,600
	July 15, 1987	11.46	5,320
	Sept. 18, 1987	10.56	4,250
1988	Feb. 20, 1988	<sup>a</sup> 7.08	--
	May 10, 1988	6.78	1,470
1989	May 24, 1989	8.97	1,740
1990	May 21, 1990	12.22	6,160
	May 25, 1990	13.88	8,370
	June 19, 1990	18.61	18,400
	June 30, 1990	12.09	6,250
	Aug. 27, 1990	10.75	4,440
1991	Mar. 26, 1991	12.58	6,820
	Apr. 17, 1991	14.34	9,400
	Apr. 29, 1991	14.15	9,080



# 05482500 North Raccoon River near Jefferson, Iowa

## Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1991--Continued	May 8, 1991	14.04	8,890
	May 20, 1991	13.60	8,190
	May 29, 1991	11.46	5,480
	June 6, 1991	16.60	13,600
	June 16, 1991	14.15	9,610
1992	Apr. 23, 1992	12.25	6,400
	July 16, 1992	11.12	5,200
1993	Mar. 8, 1993	<sup>a</sup> --	<sup>b</sup> 5,700
	Apr. 2, 1993	14.60	9,580
	Apr. 23, 1993	15.13	10,400
	May 12, 1993	15.21	10,500
	June 20, 1993	13.09	7,480
	July 3, 1993	14.07	8,820
	July 10, 1993	19.20	16,900
	July 27, 1993	11.63	5,600
	Aug. 19, 1993	14.39	9,280
	Sept. 1, 1993	12.12	6,210
	Mar. 5, 1994	<sup>a</sup> 11.93	--
	Mar. 6, 1994	11.66	5,640
1995	Apr. 23, 1995	9.92	4,050
	May 11, 1995	11.59	6,000
	May 15, 1995	10.98	5,250
	May 30, 1995	12.53	7,210
1996	May 30, 1996	10.23	4,020
	June 24, 1996	16.16	11,900
	July 18, 1996	12.66	6,910
	Aug. 7, 1996	10.87	4,700
	Aug. 11, 1996	10.68	4,490

<sup>a</sup>Affected by ice.

<sup>b</sup>Approximate.

<sup>c</sup>Gage height determined from floodmark.

## 05482600 Hardin Creek at Farnhamville, Iowa

(Discontinued September 30, 1991)

Location.--Lat 42°16'01", long 94°25'10", near NE corner sec. 14, T.86 N., R. 31 W., Calhoun County, Hydrologic Unit 07100006, at bridge on State Highway 175, near west city limits of Farnhamville.

Drainage area.--43.7 mi<sup>2</sup>.

Gage.--Crest-stage gage.

Stage-discharge relation.--Defined by current-meter measurements.

Remarks.--Only annual peaks are shown.

### Peak stages and discharges

[Water year, October 1-September 30; ft, feet above gage datum; ft<sup>3</sup>/s, cubic feet per second; --, not determined]

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1952	Mar. 29, 1952	8.09	318
1953	July 14, 1953	8.44	429
1954	Aug. 26, 1954	10.48	2,000
1955	Mar. 11, 1955	8.76	557
1956	Mar. 21, 1956	6.78	118
1957	June 16, 1957	7.90	270
1958	June 7, 1958	7.69	225
1959	June 1, 1959	9.06	700
1960	Mar. 29, 1960	9.75	840
1961	Sept. 30, 1961	7.91	272
1962	July 14, 1962	9.20	812
1963	May 13, 1963	9.55	995
1964	Apr. 13, 1964	8.54	466
1965	May 26, 1965	9.78	1,110
1966	May 23, 1966	7.93	277
1967	June 13, 1967	9.34	854
1968	June 25, 1968	8.79	570
1969	July 26, 1969	10.45	1,960
1970	--	i--	i90
1971	Mar. 12, 1971	<sup>a</sup> 9.38	<sup>b</sup> 480
1972	Oct. 31, 1971	9.09	700
1973	Mar. 17, 1973	9.27	820
1974	June 22, 1974	8.82	570
1975	Apr. 26, 1975	9.56	1,000
1976	--	i--	i90
1977	Aug. 21, 1977	7.85	250
1978	--	i--	i90
1979	Mar. 19, 1979	10.29	1,850
1980	--	i--	i90
1981	July 3, 1981	8.00	255

# 05482600 Hardin Creek at Farnhamville, Iowa

## Peak stage and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1982	May 4, 1982	8.95	580
1983	June 28, 1983	9.90	1,300
1984	June 21, 1984	9.97	900
1985	--	<sup>i</sup> --	<sup>j</sup> 88
1986	May 10, 1986	9.09	430
1987	Oct. 11, 1986	9.17	450
1988	--	<sup>i</sup> --	<sup>j</sup> 87
1989	--	<sup>i</sup> --	<sup>j</sup> 87
1990	June 16, 1990	10.39	1,980
1991	--	--	--

<sup>a</sup>Affected by ice.

<sup>b</sup>Approximate.

<sup>i</sup>Peak did not reach bottom of gage.

<sup>j</sup>Discharge less than indicated value.

# 05482800 Happy Run at Churdan, Iowa

(Discontinued September 1989)

Location.--Lat 42°10'16", long 94°29'39", in SW1/4 sec. 17, T.85 N., R.31 W., Greene County, Hydrologic Unit 07100006, at bridge on county road, 1 mi northwest of Churdan.

Drainage area.--7.58 mi<sup>2</sup>.

Gage.--Crest-stage gage.

Stage-discharge relation.--Defined by current-meter measurements and above 100 ft<sup>3</sup>/s by rating-curve extension.

Remarks.--Only annual peaks are shown.

## Peak stages and discharges

[Water year, October 1-September 30; ft, feet above gage datum; ft<sup>3</sup>/s, cubic feet per second; --, not determined]

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1951	Mar. 29, 1951	7.72	110
1952	Mar. 19, 1952	6.25	54
1953	--	i--	j19
1954	Aug. 26, 1954	7.87	116
1955	July 10, 1955	7.80	113
1956	--	i--	j19
1957	June 17, 1957	7.81	k81
1958	--	i--	j19
1959	June 1, 1959	7.70	77
1960	May 6, 1960	6.50	48
1961	Sept. 30, 1961	6.42	k62
1962	Mar. 25, 1962	8.57	150
1963	--	i--	j19
1964	Apr. 13, 1964	7.27	61
1965	Sept. 27, 1965	7.77	k108
1966	June 12, 1966	7.36	64
1967	June 13, 1967	9.37	b180
1968	--	i--	j19
1969	Mar. 26, 1969	6.29	60
1970	--	i--	j,k25
1971	Mar. 12, 1971	6.74	79
1972	--	i--	j,k25
1973	Apr. 28, 1973	4.87	36
1974	--	i--	j,k25
1975	--	i--	j,k25
1976	--	i--	j,k25
1977	Aug. 21, 1977	4.49	30
1978	--	i--	j,k25
1979	Mar. 19, 1979	9.36	b180
1980	--	i--	j25

# 05482800 Happy Run at Churdan, Iowa

## Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1981	July 3, 1981	5.64	<sup>k</sup> 51
1982	May 4, 1982	6.41	<sup>k</sup> 70
1983	Feb. 20, 1983	5.01	<sup>k</sup> 38
1984	May 1, 1984	4.21	<sup>k</sup> 26
1985	--	<sup>i</sup> --	<sup>j</sup> 25
1986	May 10, 1986	5.52	<sup>k</sup> 48
1987	--	<sup>i</sup> --	<sup>j</sup> 25
1988	--	<sup>i</sup> --	<sup>j</sup> 25
1989	--	<sup>i</sup> --	<sup>j</sup> 25

<sup>b</sup>Approximate.

<sup>i</sup>Peak did not reach bottom of gage.

<sup>j</sup>Discharge less than indicated value.

<sup>k</sup>Revised from previously published value.



# 05482900 Hardin Creek near Farlin, Iowa

Location.--Lat 42°05'34", long 94°25'39", in NW1/4 sec. 14, T.84 N., R.31 W., Greene County, Hydrologic Unit 07100006, at bridge on county road, 1.5 mi northeast of Farlin.

Drainage area.--101 mi<sup>2</sup>.

Gage.--Crest-stage gage.

Stage-discharge relation.--Defined by current-meter and indirect measurements.

Remarks.--Only annual peaks are shown.

## Peak stages and discharges

[Water year, October 1-September 30; ft, feet above gage datum; ft<sup>3</sup>/s, cubic feet per second; --, not determined]

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1951	Mar. 29, 1951	12.97	2,270
1952	Mar. 29, 1952	9.11	472
1953	July 14, 1953	7.96	300
1954	Aug. 27, 1954	12.57	1,810
1955	July 10, 1955	10.03	631
1956	--	i--	j120
1957	June 17, 1957	10.59	743
1958	--	i--	j120
1959	June 1, 1959	11.40	980
1960	Mar. 29, 1960	13.32	1,960
1961	Mar. 27, 1961	8.82	324
1962	Mar. 26, 1962	12.48	2,000
1963	May 13, 1963	10.87	930
1964	Apr. 13, 1964	9.39	615
1965	Sept. 21, 1965	9.79	703
1966	June 12, 1966	9.13	474
1967	June 13, 1967	10.95	1,020
1968	--	i--	j300
1969	July 26, 1969	12.17	1,950
1970	--	i--	j300
1971	Mar. 12, 1971	<sup>a</sup> 12.37	<sup>b</sup> 1,110
1972	May 6, 1972	9.04	570
1973	Mar. 18, 1973	11.32	960
1974	May 28, 1974	9.79	700
1975	--	i--	j300
1976	--	i--	j300
1977	--	i--	j300
1978	Mar. 16, 1978	9.26	510
1979	Mar. 19, 1979	12.69	2,330
1980	--	i--	j300
1981	--	i--	j300
1982	May 4, 1982	9.84	768

# 05482900 Hardin Creek near Farlin, Iowa

## Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1983	Feb. 19, 1983	10.15	835
1984	Apr. 30, 1984	9.55	708
1985	--	i--	j479
1986	May 10, 1986	9.64	726
1987	Oct. 12, 1986	11.29	1,210
1988	--	i--	j479
1989	--	i--	j479
1990	June 16, 1990	12.89	2,470
1991	June 1, 1991	13.02	2,630
1992	Apr. 23, 1992	9.53	600
1993	July 9, 1993	13.97	3,010
1994	--	--	--
1995	--	i--	j435
1996	July 17, 1996	9.00	600

<sup>a</sup>Affected by ice.

<sup>b</sup>Approximate.

<sup>i</sup>Peak did not reach bottom of gage.

<sup>j</sup>Discharge less than indicated value.

**05482950 East Fork Hardin Creek near Paton, Iowa**

(Discontinued September 1955)

Location.--Lat 42°08'15", long 91°23'00', near S1/4 corner, sec. 20, T.85 N., R.30 W., Greene County, Hydrologic Unit 07100006, at bridge on County Road H, 6 mi west of Paton.

Drainage area.--7.57 mi<sup>2</sup>.

Gage.--Crest-stage gage.

Stage-discharge relation.--Defined by current-meter measurements.

Remarks.--Only annual peaks are shown.

**Peak stages and discharges**

[Water year, October 1-September 30; ft, feet above gage datum; ft<sup>3</sup>/s, cubic feet per second; --, not determined]

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1952	July 7, 1952	4.72	39
1953	Mar. 24, 1953	7.77	68
1954	Aug. 26, 1954	7.00	60
1955	July 10, 1955	7.37	64

## 05483000 East Fork Hardin Creek near Churdan, Iowa

(Discontinued September 30, 1991)

Location.--Lat 42°06'27", long 94°22'12", in SE1/4 SW1/4 sec. 5, T.84 N., R.30 W., Greene County, Hydrologic Unit 07100006, on left bank 35 ft upstream from bridge on County Road E26, 1.6 mi upstream from small left-bank tributary, 4.4 mi upstream from mouth, and 6.5 mi southeast of Churdan.

Drainage area.--24.0 mi<sup>2</sup>.

Gage.--Water-stage recorder. Datum is 1,050.90 ft above sea level.

Stage-discharge relation.--Defined by current-meter measurements and above 180 ft<sup>3</sup>/s by theoretical rating-curve extension techniques.

Bankfull stage.--High banks are not subject to overflow.

Remarks.--Base for partial-duration series, 150 ft<sup>3</sup>/s; prior to 1962, peak base was 200 ft<sup>3</sup>/s.

### Peak stages and discharges

[Water year, October 1-September 30; ft, feet above gage datum; ft<sup>3</sup>/s, cubic feet per second; --, not determined]

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
(Systematic operation of gage began July 1, 1952.)			
1952	July 14, 1952	4.33	<sup>1</sup> 79
1953	June 10, 1953	5.17	105
1954	Aug. 26, 1954	7.73	329
1955	Oct. 13, 1954	6.15	250
	July 10, 1955	6.60	252
1956	May 13, 1956	4.42	112
1957	June 14, 1957	6.57	216
	June 16, 1957	8.82	371
1958	July 19, 1958	6.10	186
1959	May 31, 1959	7.36	288
1960	Mar. 29, 1960	<sup>a</sup> 7.63	<sup>b</sup> 300
	Apr. 24, 1960	8.04	350
	May 5, 1960	8.92	413
	May 25, 1960	6.30	231
1961	Feb. 22, 1961	<sup>a</sup> 5.41	<sup>b</sup> 150
1962	Mar. 25, 1962	6.06	231
	May 29, 1962	5.20	160
	July 14, 1962	7.46	315
	July 20, 1962	5.42	173
1963	Apr. 29, 1963	7.78	<sup>b</sup> 300
1964	Apr. 13, 1964	5.36	172
	Apr. 27, 1964	5.18	159
1965	Mar. 31, 1965	<sup>a</sup> 8.28	<sup>b</sup> 300
	Apr. 5, 1965	6.13	214
	Sept. 27, 1965	5.45	170

# 05483000 East Fork Hardin Creek near Churdan, Iowa

## Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1966	June 12, 1966	8.32	367
	June 27, 1966	6.27	180
1967	June 9, 1967	6.40	235
	June 13, 1967	6.83	265
	June 16, 1967	5.57	179
	June 19, 1967	5.21	157
	June 24, 1967	5.80	193
	June 27, 1967	6.70	256
1968	June 25, 1968	4.13	77
1969	Oct. 17, 1968	6.15	191
	Mar. 19, 1969	6.83	297
	Mar. 24, 1969	6.34	248
	May 5, 1969	5.97	215
	June 29, 1969	6.34	201
	July 9, 1969	7.46	306
	July 26, 1969	6.46	211
1970	May 14, 1970	3.89	70
1971	Feb. 19, 1971	7.86	<sup>b</sup> 200
1972	Mar. 6, 1972	<sup>a</sup> 5.86	<sup>b</sup> 160
	Aug. 1, 1972	5.72	195
1973	Feb. 24, 1973	<sup>a</sup> --	<sup>b</sup> 157
	Mar. 1, 1973	<sup>a</sup> --	<sup>b</sup> 152
	Mar. 11, 1973	5.74	208
	Apr. 15, 1973	5.78	199
	May 7, 1973	5.95	205
	July 2, 1973	6.46	248
	Aug. 23, 1973	5.58	177
	Sept. 26, 1973	8.26	385
	Oct. 11, 1973	5.65	197
	Feb. 17, 1974	5.25	159
1974	May 13, 1974	5.58	206
	May 16, 1974	6.13	243
	May 18, 1974	7.71	385
	Mar. 18, 1975	<sup>a</sup> 6.83	--
	Apr. 28, 1975	5.39	195
1976	May 23, 1976	5.11	148
1977	Sept. 30, 1977	6.02	197
1978	July 9, 1978	5.64	180
	Sept. 13, 1978	7.59	225
	Sept. 20, 1978	5.88	191
1979	Mar. 19, 1979	7.46	376
1980	June 4, 1980	5.62	179
1981	July 4, 1981	6.86	207
	Aug. 26, 1981	6.19	169



# 05483000 East Fork Hardin Creek near Churdan, Iowa

## Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1982	Feb. 21, 1982	7.12	237
	May 4, 1982	7.16	282
	May 21, 1982	5.62	175
	May 26, 1982	5.28	155
	July 18, 1982	5.34	158
1983	<sup>m</sup> Feb. 1983	<sup>c</sup> 5.59	173
	Mar. 6, 1983	5.94	194
	June 29, 1983	7.45	237
1984	Feb. 5, 1984	5.32	187
	Apr. 29, 1984	7.10	331
	June 13, 1984	4.93	158
	June 16, 1984	4.98	162
1985	June 2, 1985	4.20	110
1986	June 11, 1986	5.73	197
	June 30, 1986	<sup>c</sup> 10.78	737
1987	Oct. 11, 1986	6.17	260
	July 12, 1987	5.83	152
	Aug. 26, 1987	5.05	171
1988	Dec. 9, 1987	2.64	37
	Jan. 27, 1988	<sup>a</sup> 3.29	--
1989	June 27, 1989	3.81	82
1990	May 19, 1990	7.16	305
	May 25, 1990	6.53	241
	June 13, 1990	5.66	164
	June 17, 1990	10.20	754
	July 13, 1990	5.20	150
	July 26, 1990	7.82	406
	Aug. 25, 1990	6.28	249
1991	Mar. 23, 1991	5.52	208
	Mar. 27, 1991	5.63	216
	Apr. 14, 1991	6.49	288
	Apr. 18, 1991	5.16	179
	Apr. 26, 1991	7.08	343
	May 17, 1991	6.92	327
	June 4, 1991	5.87	233

<sup>a</sup>Affected by ice.

<sup>b</sup>Approximate.

<sup>c</sup>Gage height determined from floodmark.

<sup>l</sup>Peak for 1952 is from July 1 to September 30.

<sup>m</sup>Peak occurred sometime during February 19-21, 1983.

## 05483318 Brushy Creek near Templeton, Iowa

Location.--Lat 41°56'45", long 94°52'45", in NW1/4 sec. 1, T.82 N., R.35 W., Carroll County, Hydrologic Unit 07100007, at bridge on U.S. Highway 71, 4 mi northeast of Templeton.

Drainage area.--45.0 mi<sup>2</sup>.

Gage.--Crest-stage gage. Datum is 1186.30 ft above sea level. Prior to July 9, 1993, at present site at different datum.

Stage-discharge relation.--Prior to 1993 flood, defined by current-meter and indirect measurements; not defined for new bridge.

Remarks.--Only annual peaks are shown.

### Peak stages and discharges

[Water year, October 1-September 30; ft, feet above gage datum; ft<sup>3</sup>/s, cubic feet per second; --, not determined]

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1966	June 12, 1966	88.62	3,400
1967	June 7, 1967	88.70	3,450
1968	--	i--	j700
1969	July 26, 1969	86.99	2,400
1970	May 13, 1970	83.91	1,060
1971	Mar. 13, 1971	<sup>a</sup> 87.78	--
1972	Oct. 30, 1971	86.48	2,100
1973	Sept. 26, 1973	88.62	3,400
1974	June 23, 1974	90.96	<sup>n</sup> 5,330
1975	Apr. 27, 1975	85.72	1,880
1976	--	i--	j940
1977	--	i--	j1,080
1978	Sept. 12, 1978	87.56	<sup>k</sup> 3,640
1979	Mar. 19, 1979	86.58	3,210
1980	--	i--	j1,480
1981	--	i--	j1,480
1982	May 26, 1982	85.60	2,600
1983	--	i--	j1,480
1984	June 13, 1984	83.89	1,960
1985	--	i--	j1,480
1986	June 30, 1986	88.60	4,840
1987	--	i--	j1,480
1988	June 8, 1988	87.82	<sup>n</sup> 4,100
1989	Sept. 8, 1989	78.64	400
1990	June 16, 1990	90.58	7,550
1991	--	i--	j1,480
1992	--	i--	j400

# 05483318 Brushy Creek near Templeton, Iowa

## Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1993	July 9, 1993	93.48	<sup>n</sup> 19,000
	(Bridge destroyed by July 1993 flood.)		
1996	July 17, 1996	<sup>b,c,o</sup> 81.63	--
	(Gage reinstalled on new bridge Sept. 16, 1996, at new datum.)		

<sup>a</sup>Affected by ice.

<sup>b</sup>Approximate.

<sup>c</sup>Gage height determined from floodmark.

<sup>i</sup>Peak did not reach bottom of gage.

<sup>j</sup>Discharge less than indicated value.

<sup>k</sup>Revised from previously published value.

<sup>n</sup>Discharge computed from indirect measurement.

<sup>o</sup>Gage height for July 17, 1996, flood was referenced to the new datum established for the site.

### 05483343 Hazelbrush Creek near Maple River, Iowa

(Discontinued September 30, 1994)

Location.--Lat 42°07'36", long 94°58'32", in SW1/4 SW1/4 sec. 31, T.85 N., R.35 W., Carroll County, Hydrologic Unit 07100007, on right bank 0.26 mi upstream from bridge on 160th Street, 0.40 mi upstream from mouth, and 2.9 mi northeast of Maple River.

Drainage area.--9.22 mi<sup>2</sup>.

Gage.--Water-stage recorder and crest-stage gage. Datum of gage is 1,268.17 ft above sea level.

Remarks.--Only annual peaks are shown.

#### Peak stages and discharges

[Water year, October 1-September 30; ft, feet above gage datum; ft<sup>3</sup>/s, cubic feet per second; --, not determined]

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1991	June 15, 1991	13.59	957
1992	Dec. 12, 1991	4.31	68.0
1993	July 9, 1993	14.77	1,120
1994	Mar. 3, 1994	<sup>a</sup> 6.14	<sup>b</sup> 114

<sup>a</sup>Affected by ice.

<sup>b</sup>Approximate.

### 05483349 Middle Raccoon River tributary at Carroll, Iowa

Location.--Lat 42°02'30", long 94°52'43", in NW1/4 sec. 36, T.84 N., R.35 W., Carroll County, Hydrologic Unit 07100007, at bridge on U.S. Highway 71, 1.5 mi south of Carroll.

Drainage area.--6.58 mi<sup>2</sup>.

Gage.--Crest-stage gage.

Stage-discharge relation.--Defined by current-meter and indirect measurements.

Remarks.--Only annual peaks are shown.

#### Peak stages and discharges

[Water year, October 1-September 30; ft, feet above gage datum; ft<sup>3</sup>/s, cubic feet per second; --, not determined]

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1966	June 12, 1966	90.12	500
1967	June 27, 1967	90.45	550
1968	June 25, 1968	89.69	440
1969	July 26, 1969	90.37	540
1970	--	i--	j80
1971	Mar. 13, 1971	<sup>a</sup> 89.64	<sup>b</sup> 400
1972	Sept. 12, 1972	87.67	200
1973	July 1, 1973	90.58	580
1974	--	i--	j80
1975	Apr. 27, 1975	90.34	530
1976	May 23, 1976	91.06	680
1977	--	i--	j80
1978	--	i--	j80
1979	--	i--	j80
1980	Mar. 20, 1980	19.66	168
1981	June 29, 1981	22.83	694
1982	Mar. 19, 1982	23.07	810
1983	June 27, 1983	22.76	667
1984	June 13, 1984	22.91	726
1985	--	i--	j36
1986	June 29, 1986	24.81	<sup>n</sup> 3,350
1987	Aug. 12, 1987	24.68	3,130
1988	June 8, 1988	22.07	439
1989	June 12, 1989	23.57	1,060
1990	June 13, 1990	23.97	1,580
1991	--	i--	j,k89
1992	--	i--	j89
1993	July 9, 1993	25.79	<sup>k</sup> 4,490
1994	--	i--	j89



# 05483349 Middle Raccoon River tributary at Carroll, Iowa

## Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1995	Mar. 14, 1995	<sup>a</sup> 21.45	--
1996	July 17, 1996	25.88	<sup>n</sup> 4,600

<sup>a</sup>Affected by ice.

<sup>b</sup>Approximate.

<sup>i</sup>Peak did not reach bottom of gage.

<sup>j</sup>Discharge less than indicated value.

<sup>k</sup>Revised from previously published value.

<sup>n</sup>Discharge computed from indirect measurement.

## 05483450 Middle Raccoon River near Bayard, Iowa

Location.--Lat 41°46'43", long 94°29'33", in SW1/4 SW1/4 sec. 32, T.81 N., R. 31 W., Guthrie County, Hydrologic Unit 07100007, on left bank 15 ft downstream from bridge on State Highway 25, 0.2 mi downstream from Battle Run Creek, 1.8 mi upstream from Springbrook Creek, 5.8 mi southeast of Bayard, 10.3 mi upstream from dam at Lake Panorama, and at mile 78.0 upstream from mouth of Raccoon River.

Drainage area.--375 mi<sup>2</sup>.

Gage.--Water-stage recorder. Datum is 1,040.00 ft above sea level. Prior to June 23, 1979, nonrecording gage, at present site and datum.

Stage-discharge relation.--Defined by current-meter measurements.

Bankfull stage.--About 14 ft.

Remarks.--Base for partial-duration series, 1,200 ft<sup>3</sup>/s.

### Peak stages and discharges

[Water year, October 1-September 30; ft, feet above gage datum; ft<sup>3</sup>/s, cubic feet per second; --, not determined]

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1973	July 3, 1973	<sup>c</sup> 21.63	<sup>n</sup> 14,600
1979	Mar. 19, 1979	<sup>c</sup> 20.81	9,250
	(Systematic operation of gage began March 23, 1979.)		
<sup>p</sup> 1979	Mar. 23, 1979	17.68	3,460
	Mar. 30, 1979	14.74	2,520
	May 3, 1979	12.73	1,220
	June 28, 1979	17.65	3,410
	July 23, 1979	16.63	2,770
	July 24, 1979	13.36	1,440
	July 30, 1979	12.79	1,240
1980	Mar. 16, 1980	11.51	859
1981	May 23, 1981	13.73	1,580
	June 30, 1981	15.74	2,370
	July 4, 1981	13.23	1,400
	Aug. 2, 1981	15.34	2,200
1982	Feb. 22, 1982	<sup>a</sup> 18.71	<sup>b</sup> 3,480
	Mar. 12, 1982	13.21	1,390
	Mar. 20, 1982	17.53	3,340
	May 20, 1982	15.16	2,130
	May 22, 1982	13.20	1,390
	May 27, 1982	17.00	2,970
	June 16, 1982	16.14	2,540
1983	Feb. 20, 1983	17.30	3,180
	Mar. 7, 1983	15.79	2,390
	Apr. 1, 1983	15.62	2,320
	Apr. 13, 1983	14.25	1,770
	May 3, 1983	15.44	2,140

# 05483450 Middle Raccoon River near Bayard, Iowa

## Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1983--Continued	June 30, 1983	18.03	3,310
	July 2, 1983	19.79	5,190
1984	Feb. 16, 1984	14.76	1,700
	Apr. 9, 1984	14.24	1,440
	Apr. 22, 1984	16.12	2,150
	Apr. 27, 1984	15.72	2,000
	Apr. 30, 1984	19.99	4,960
	May 25, 1984	14.02	1,420
	May 29, 1984	15.65	2,060
	June 13, 1984	15.14	1,920
	June 15, 1984	16.33	2,400
	June 17, 1984	18.50	3,700
	June 20, 1984	14.85	1,810
1985	Feb. 22, 1985	<sup>a</sup> 14.10	1,170
1986	Feb. 27, 1986	<sup>a</sup> --	1,500
	Mar. 16, 1986	13.08	1,210
	Mar. 19, 1986	18.49	3,630
	May 11, 1986	19.25	4,400
	May 17, 1986	14.88	1,600
	June 14, 1986	15.64	1,800
	June 30, 1986	24.70	12,300
	July 6, 1986	16.43	2,060
	July 12, 1986	14.20	1,290
	Aug. 5, 1986	16.22	2,010
	Aug. 14, 1986	20.24	5,200
1987	Oct. 12, 1986	18.24	3,350
	July 12, 1987	16.12	1,970
	Aug. 13, 1987	14.11	1,310
	Aug. 26, 1987	16.54	2,180
	Sept. 17, 1987	14.35	1,330
1988	June 8, 1988	16.63	2,230
	July 18, 1988	14.52	1,390
1989	Mar. 10, 1989	<sup>a</sup> 18.35	1,450
	May 24, 1989	17.35	2,620
	May 29, 1989	14.68	1,440
	Sept. 8, 1989	18.11	3,090
1990	May 20, 1990	20.20	5,180
	May 25, 1990	18.35	3,290
	June 14, 1990	19.19	4,080
	June 17, 1990	23.23	9,570
	June 23, 1990	17.02	2,370
	June 28, 1990	17.65	2,750

# 05483450 Middle Raccoon River near Bayard, Iowa

## Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1990--Continued	July 11, 1990	16.21	1,910
	July 26, 1990	15.95	1,800
	Aug. 25, 1990	16.41	2,070
1991	Mar. 23, 1991	14.83	1,510
	Apr. 14, 1991	18.97	3,870
	Apr. 19, 1991	15.51	1,730
	Apr. 27, 1991	16.48	2,170
	May 6, 1991	14.66	1,460
	June 16, 1991	19.28	4,170
	Apr. 21, 1992	13.96	1,220
1992	July 25, 1992	16.10	1,940
1993	Mar. 9, 1993	<sup>a</sup> 18.95	3,500
	Mar. 17, 1993	16.44	2,320
	Mar. 24, 1993	14.56	1,520
	Mar. 27, 1993	14.20	1,370
	Apr. 20, 1993	14.05	1,290
	May 12, 1993	17.76	2,940
	June 14, 1993	15.33	1,760
	June 17, 1993	17.99	3,070
	June 19, 1993	15.55	1,850
	June 30, 1993	15.57	1,860
	July 9, 1993	29.02	27,500
	July 18, 1993	15.56	1,940
	July 22, 1993	13.95	1,300
	July 25, 1993	13.83	1,260
	Aug. 11, 1993	17.57	2,930
	Aug. 19, 1993	15.46	1,910
	Aug. 31, 1993	18.20	3,330
1994	Feb. 19, 1994	<sup>a</sup> 19.94	2,000
1995	Mar. 12, 1995	14.24	1,450
	May 10, 1995	14.42	1,510
	May 28, 1995	18.18	3,320
1996	May 28, 1996	14.70	1,540
	June 22, 1996	20.77	5,290
	June 25, 1996	13.89	1,280
	July 18, 1996	20.83	5,370
	July 28, 1996	14.22	1,390
	Aug. 6, 1996	20.63	5,110

<sup>a</sup>Affected by ice.

<sup>b</sup>Approximate.

<sup>c</sup>Gage height determined from floodmark.

<sup>d</sup>Discharge computed from indirect measurement.

<sup>e</sup>Peaks for 1979 are from March 23 to September 30.

## 05483600 Middle Raccoon River at Panora, Iowa

Location.--Lat 41°41'14", long 94°22'15", in NE1/4 NW1/4 sec. 5, T.79 N., R.30 W., Guthrie County, Hydrologic Unit 07100007, on left bank 15 ft downstream from bridge on Soldier Trail, 0.2 mi southwest of Panora, 1.5 mi upstream from Andy's Branch, 1.6 mi downstream from Lake Panorama, 18.1 mi upstream from mouth, and at mile 66.1 upstream from mouth of Raccoon River.

Drainage area.--440 mi<sup>2</sup>.

Gage.--Water-stage recorder and concrete control. Datum is 991.20 ft above sea level.

Stage-discharge relation.--Defined by current-meter and indirect measurements, and by theoretical rating-curve extension techniques.

Remarks.--Base for partial-duration series, 2,500 ft<sup>3</sup>/s. City of Panora diverts approximately 100 acre-ft/yr upstream of station. Flow regulated by dam on Lake Panorama since August 1970.

### Peak stages and discharges

[Water year, October 1-September 30; ft, feet above gage datum; ft<sup>3</sup>/s, cubic feet per second; --, not determined]

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1953	June 10, 1953	<sup>c</sup> 14.3	<sup>b</sup> 14,000
	(Systematic operation of gage began June 24, 1958.)		
<sup>a</sup> 1958	July 2, 1958	11.87	9,150
	July 3, 1958	8.95	4,200
	July 19, 1958	8.07	3,020
1959	June 1, 1959	7.50	2,480
1960	Mar. 31, 1960	9.68	5,320
	May 7, 1960	8.33	3,740
1961	June 16, 1961	7.82	2,730
1962	Mar. 26, 1962	9.29	4,620
	June 10, 1962	8.85	3,940
1963	Aug. 7, 1963	9.05	4,200
1964	June 22, 1964	10.47	6,300
1965	Mar. 2, 1965	<sup>a</sup> 11.54	<sup>b</sup> 4,600
	Mar. 17, 1965	10.87	6,890
	Apr. 2, 1965	8.49	3,540
	Apr. 5, 1965	9.35	4,690
	May 27, 1965	7.90	2,840
1966	June 12, 1966	8.54	3,480
	June 29, 1966	8.79	3,800
1967	June 7, 1967	8.45	3,550
	June 10, 1967	<sup>c</sup> 9.95	5,600
	June 12, 1967	8.37	3,450
	June 25, 1967	<sup>c</sup> 9.53	5,010
1968	June 26, 1968	6.18	1,150
1969	Mar. 20, 1969	<sup>c</sup> 9.84	5,380
	Mar. 24, 1969	10.25	5,950
	July 10, 1969	7.93	2,870



# 05483600 Middle Raccoon River at Panora, Iowa

## Peak stages and discharges—Continued

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1970	May 15, 1970	7.83	2,780
(Flow regulation by operation of Lake Panorama Dam began in August 1970.)			
1971	Feb. 19, 1971	<sup>a</sup> 12.98	<sup>b</sup> 8,900
1972	Mar. 1, 1972	7.63	2,670
	May 7, 1972	7.51	2,550
	June 17, 1972	8.17	3,300
	Aug. 2, 1972	9.64	5,110
1973	Mar. 2, 1973	7.87	2,970
	Apr. 16, 1973	8.35	3,370
	Apr. 26, 1973	8.39	3,380
	May 9, 1973	8.87	4,180
	June 4, 1973	8.04	3,190
	July 3, 1973	13.56	12,000
	July 30, 1973	9.39	4,570
	Sept. 28, 1973	8.99	4,090
1974	May 17, 1974	7.85	2,810
	May 19, 1974	14.80	14,000
	May 21, 1974	9.00	4,240
	May 27, 1974	9.13	4,410
	June 14, 1974	8.13	3,150
1975	Apr. 29, 1975	8.36	3,420
	June 18, 1975	7.88	2,850
	Aug. 27, 1975	7.90	2,870
1976	May 23, 1976	11.05	7,300
1977	Aug. 26, 1977	7.75	2,690
1978	Mar. 20, 1978	8.97	4,180
	Sept. 13, 1978	9.18	4,470
1979	Mar. 19, 1979	12.95	10,700
	Mar. 24, 1979	7.78	2,730
	Mar. 30, 1979	7.58	2,500
	June 28, 1979	8.53	3,630
	July 23, 1979	7.66	2,590
1980	June 4, 1980	8.30	3,350
1981	Aug. 14, 1981	7.46	2,380
1982	Feb. 23, 1982	9.13	4,330
	Mar. 19, 1982	8.21	3,210
	May 27, 1982	8.42	3,580
	June 16, 1982	8.26	3,350
1983	Feb. 16, 1983	7.69	2,620
	Feb. 20, 1983	7.94	2,920
	Mar. 7, 1983	7.82	2,770

# 05483600 Middle Raccoon River at Panora, Iowa

## Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1983--Continued	Apr. 1, 1983	8.29	3,340
	June 28, 1983	8.61	3,730
	July 2, 1983	9.81	5,360
1984	Feb. 16, 1984	7.78	2,730
	Apr. 4, 1984	7.73	2,680
	Apr. 23, 1984	7.85	2,810
	Apr. 30, 1984	11.18	7,530
	June 16, 1984	8.19	3,210
	June 17, 1984	8.89	4,090
1985	Dec. 29, 1984	7.43	2,350
1986	Feb. 28, 1986	8.18	3,200
	Mar. 19, 1986	8.09	3,090
	May 11, 1986	9.08	4,330
	May 25, 1986	8.13	3,140
	June 30, 1986	15.50	15,300
	Aug. 5, 1986	8.55	3,450
	Aug. 14, 1986	9.88	4,970
1987	Oct. 12, 1986	8.42	3,320
	Aug. 26, 1987	8.07	2,960
1988	June 8, 1988	7.40	2,300
1989	Sept. 8, 1989	8.40	3,300
1990	May 20, 1990	9.27	4,520
	May 25, 1990	8.29	3,530
	June 13, 1990	8.66	3,900
	June 18, 1990	12.77	9,000
	June 23, 1990	8.00	3,190
	June 28, 1990	7.72	2,880
	July 11, 1990	7.38	2,520
	Aug. 26, 1990	8.46	3,690
1991	Apr. 15, 1991	8.52	3,420
	Apr. 27, 1991	8.21	3,100
	June 14, 1991	8.83	3,750
	June 16, 1991	8.74	3,660
1992	Sept. 15, 1992	7.21	2,100
1993	Mar. 8, 1993	8.73	3,770
	May 12, 1993	7.79	2,720
	June 30, 1993	7.69	2,610
	July 9, 1993	20.04	22,400
	Aug. 30, 1993	8.01	2,960
1994	Feb. 18, 1994	<sup>a</sup> 7.28	1,300
1995	May 28, 1995	9.20	4,320
	Aug. 6, 1995	10.49	5,920

# 05483600 Middle Raccoon River at Panora, Iowa

## Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1996	May 9, 1996	8.11	3,070
	June 22, 1996	9.28	4,410
	June 24, 1996	8.00	2,950
	July 18, 1996	9.42	4,580
	Aug. 6, 1996	9.26	4,390

<sup>a</sup>Affected by ice.

<sup>b</sup>Approximate.

<sup>c</sup>Gage height determined from floodmark.

<sup>d</sup>Peaks for 1958 are from June 24 to September 30.

## 05484000 South Raccoon River at Redfield, Iowa

Location.--Lat 41°35'22", long 95°09'04", in SW1/4 NE1/4 sec. 2, T.78 N., R.29 W., Dallas County, Hydrologic Unit 07100007, on right bank 20 ft upstream from bridge on H Avenue, 3.4 mi downstream from bridge on U.S. Highway 6, 3.4 mi downstream from mouth of confluence with Middle Raccoon River, 14.3 mi upstream from mouth, and at mile 44.6 upstream from mouth of Raccoon River.

Drainage area.--994 mi<sup>2</sup>.

Gage.--Water-stage recorder. Datum is 888.88 ft above sea level. Prior to June 12, 1946, nonrecording gage, and June 12, 1946, to Sept. 30, 1986, water-stage recorder at site 2.4 mi upstream, at datum 7.55 ft higher.

Stage-discharge relation.--Defined by current-meter measurements.

Flood stage.--14 ft.

Remarks.--Base for partial-duration series, 5,000 ft<sup>3</sup>/s.

### Peak stages and discharges

[Water year, October 1-September 30; ft, feet above gage datum; ft<sup>3</sup>/s, cubic feet per second; --, not determined]

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
(Systematic operation of gage began in March 1940.)			
1940	July 31, 1940	13.3	6,100
1941	June 28, 1941	10.5	3,550
1942	May 11, 1942	13.0	5,740
	Aug. 28, 1942	13.4	6,380
1943	Aug. 25, 1943	14.1	6,610
1944	May 3, 1944	13.2	5,930
	May 20, 1944	23.8	20,000
	May 23, 1944	16.9	9,750
	June 11, 1944	13.7	6,430
1945	May 14, 1945	15.0	7,730
	May 22, 1945	17.2	10,100
	May 30, 1945	15.0	7,730
	June 6, 1945	13.1	5,830
1946	Aug. 24, 1946	18.9	12,000
	Sept. 8, 1946	21.4	15,200
1947	June 2, 1947	19.9	15,000
	June 5, 1947	22.7	20,500
	June 12, 1947	24.3	23,800
	June 24, 1947	16.7	10,500
1948	Mar. 19, 1948	21.3	17,600
1949	Mar. 6, 1949	14.2	7,530
1950	May 5, 1950	14.7	7,990
	June 19, 1950	17.9	11,600
	June 23, 1950	13.8	7,080

# 05484000 South Raccoon River at Redfield, Iowa

## Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1951	Mar. 29, 1951	20.10	15,400
	May 2, 1951	17.70	11,700
	June 2, 1951	18.14	12,200
	June 7, 1951	12.19	5,680
	July 3, 1951	16.26	10,100
1952	Mar. 13, 1952	11.53	5,160
	Mar. 31, 1952	14.39	7,840
	June 21, 1952	12.12	5,680
	June 27, 1952	16.06	9,740
1953	May 24, 1953	12.23	5,680
	June 10, 1953	23.08	21,300
1954	Aug. 22, 1954	13.84	7,200
1955	Apr. 24, 1955	12.86	6,310
1956	Sept. 4, 1956	9.80	3,840
1957	June 17, 1957	17.80	12,700
1958	July 2, 1958	<sup>c</sup> 29.04	35,000
	July 4, 1958	19.28	14,200
	July 19, 1958	15.80	9,580
	Sept. 6, 1958	25.12	25,500
1959	May 30, 1959	10.95	5,420
1960	Mar. 30, 1960	15.29	9,340
	May 7, 1960	15.31	9,340
1961	Feb. 23, 1961	11.23	5,590
	Mar. 27, 1961	10.67	5,160
	June 14, 1961	10.78	5,250
	Sept. 30, 1961	11.00	5,420
1962	Mar. 19, 1962	<sup>a,c</sup> 17.50	--
	Mar. 24, 1962	14.42	8,350
	May 29, 1962	15.46	9,340
	June 9, 1962	13.01	7,090
1963	Mar. 3, 1963	<sup>a</sup> 13.43	<sup>b</sup> 6,300
	Apr. 29, 1963	15.25	9,240
	Aug. 7, 1963	10.85	5,080
1964	Apr. 13, 1964	13.57	7,720
	June 23, 1964	19.69	14,900
1965	Feb. 21, 1965	<sup>a</sup> 11.82	<sup>b</sup> 5,600
	Mar. 2, 1965	17.70	12,800
	Mar. 17, 1965	19.60	15,800
	Apr. 1, 1965	15.14	9,350
	Apr. 5, 1965	16.99	11,800
1966	June 12, 1966	15.17	9,460
1967	June 8, 1967	14.06	8,080
	June 10, 1967	17.12	12,000
	June 12, 1967	15.21	9,430

# 05484000 South Raccoon River at Redfield, Iowa

## Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1968	Sept. 4, 1968	6.27	1,710
1969	Mar. 19, 1969	16.69	11,700
	Mar. 24, 1969	16.08	10,900
	June 29, 1969	11.75	5,990
	July 9, 1969	13.55	7,780
	May 14, 1970	14.50	9,050
1971	Feb. 19, 1971	20.82	17,800
	Mar. 14, 1971	14.61	9,200
	June 6, 1971	17.25	12,500
1972	Aug. 2, 1972	12.82	7,220
	Sept. 11, 1972	13.95	8,410
	Mar. 14, 1973	10.33	5,010
1973	Apr. 1, 1973	10.95	5,650
	Apr. 16, 1973	14.77	9,650
	May 8, 1973	17.63	13,000
	June 5, 1973	10.74	5,260
	July 4, 1973	19.97	16,500
	July 30, 1973	10.96	5,450
	Sept. 26, 1973	14.74	9,310
	Oct. 11, 1973	11.96	6,380
	Apr. 21, 1974	15.58	10,300
	Apr. 28, 1974	12.93	7,380
1974	May 16, 1974	10.64	5,210
	May 19, 1974	21.85	20,000
	May 21, 1974	13.42	8,300
	May 26, 1974	11.52	6,150
	Apr. 28, 1975	15.45	10,200
	June 18, 1975	14.28	8,680
	June 25, 1975	12.40	6,720
1976	Mar. 12, 1976	10.41	5,130
	May 23, 1976	12.71	7,490
1977	Aug. 26, 1977	15.90	11,300
	Aug. 28, 1977	13.76	8,740
	Sept. 3, 1977	12.97	7,870
1978	Mar. 21, 1978	a--	8,640
	Mar. 22, 1978	14.02	8,990
	Apr. 17, 1978	17.13	12,700
	Sept. 13, 1978	13.79	8,770
	Sept. 14, 1978	14.63	9,760
1979	Mar. 13, 1979	10.75	5,550
	Mar. 19, 1979	22.81	20,400
	Aug. 10, 1979	12.10	6,910
1980	June 15, 1980	7.47	2,700
1981	May 23, 1981	7.08	2,430



# 05484000 South Raccoon River at Redfield, Iowa

## Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1982	Feb. 21, 1982	<sup>a</sup> 14.22	<sup>b</sup> 6,150
	Feb. 23, 1982	12.46	5,650
	Mar. 19, 1982	12.85	7,740
	May 28, 1982	11.31	6,110
	June 15, 1982	12.82	7,700
1983	Dec. 28, 1982	11.34	6,130
	Feb. 20, 1983	12.92	7,800
	Mar. 31, 1983	10.96	5,740
	May 19, 1983	12.44	7,280
	June 29, 1983	13.02	7,910
1984	July 3, 1983	11.24	6,020
	Apr. 30, 1984	18.58	14,500
	May 25, 1984	10.22	5,020
	June 15, 1984	10.84	5,630
	June 16, 1984	12.02	6,840
1985	June 17, 1984	12.03	6,850
	Feb. 21, 1985	<sup>a</sup> 16.37	6,200
1986	Feb. 26, 1986	<sup>a</sup> --	5,800
	Mar. 18, 1986	9.67	5,030
	Apr. 30, 1986	10.17	5,640
	May 11, 1986	15.29	11,400
	May 16, 1986	11.99	7,080
	July 1, 1986	25.15	26,300
	July 10, 1986	10.47	5,100
	July 14, 1986	10.51	5,140
	Aug. 6, 1986	10.46	5,070
	Aug. 14, 1986	17.54	13,000
(Gage moved to new site and datum October 1, 1986.)			
1987	July 12, 1987	11.44	7,290
	Aug. 26, 1987	14.30	10,900
	Sept. 16, 1987	11.10	6,340
1988	Jan. 30, 1988	<sup>a</sup> 14.31	8,400
1989	Sept. 8, 1989	13.33	9,380
1990	May 19, 1990	10.92	6,890
	May 25, 1990	10.73	6,660
	June 14, 1990	10.32	6,190
	June 16, 1990	19.05	19,100
	June 23, 1990	9.69	5,240
1991	Apr. 14, 1991	14.70	11,500
	Apr. 18, 1991	11.88	7,350
	Apr. 27, 1991	12.80	8,610
	May 6, 1991	11.44	6,280
	June 14, 1991	16.20	12,000
	June 15, 1991	13.84	8,470

# 05484000 South Raccoon River at Redfield, Iowa

## Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1992	Sept. 16, 1992	15.86	13,300
1993	Mar. 8, 1993	13.00	8,800
	June 18, 1993	11.42	6,660
	July 1, 1993	12.04	7,470
	July 8, 1993	14.48	11,000
	July 10, 1993	26.98	44,000
	July 13, 1993	16.82	15,000
	July 23, 1993	10.12	5,110
	July 25, 1993	10.82	5,920
	Aug. 12, 1993	16.52	14,500
	Aug. 19, 1993	11.55	6,830
	Aug. 29, 1993	20.46	22,400
1994	Mar. 5, 1994	<sup>a</sup> 7.79	2,400
1995	May 28, 1995	14.05	10,400
1996	Feb. 9, 1996	<sup>a</sup> 13.22	--
	May 10, 1996	13.07	8,900
	May 24, 1996	13.51	9,540
	June 21, 1996	15.25	12,300
	June 23, 1996	10.58	5,640
	July 18, 1996	14.86	11,600
	Aug. 5, 1996	13.79	9,960

<sup>a</sup>Affected by ice.

<sup>b</sup>Approximate.

<sup>c</sup>Gage height determined from floodmark.

<sup>f</sup>Peak for 1940 is from March to September 30.

## 05484500 Raccoon River at Van Meter, Iowa

Location.--Lat 41°32'02", long 93°56'59", in SW1/4 SW1/4 sec. 22, T.78 N., R.27 W., Dallas County, Hydrologic Unit 07100006, on right bank 10 ft downstream from bridge on County Road R16, 0.3 mi northeast of Van Meter, 0.7 mi upstream from small left bank tributary, 1.1 mi downstream from confluence of North and South Raccoon Rivers, and 29.1 mi upstream from mouth.

Drainage area.--3,441 mi<sup>2</sup>.

Gage.--Water-stage recorder at present site since Aug. 9, 1934. Datum is 841.16 ft above sea level. Prior to Oct. 1, 1915, chain gage at same site and at datum 2 ft higher. Oct. 1, 1915, to May 30, 1923, chain gage; May 31, 1923, to Sept. 30, 1927, water-stage recorder; and Oct. 1, 1927, to Aug. 8, 1934, chain gage; all at same site and datum.

Stage-discharge relation.--Defined by current-meter measurements.

Flood stage.--13 ft.

Remarks.--Base for partial-duration series, 8,500 ft<sup>3</sup>/s.

### Peak stages and discharges

[Water year, October 1-September 30; ft, feet above gage datum; ft<sup>3</sup>/s, cubic feet per second; --, not determined]

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
(Systematic operation of gage began in April 1915.)			
<sup>s</sup> 1915	May 29, 1915	15.19	21,600
(New datum for gage October 1, 1915, at same site.)			
1916	Mar. 16, 1916	8.4	5,840
1917	June 7, 1917	18.4	35,200
	June 10, 1917	17.0	26,000
1918	June 6, 1918	13.7	14,800
1919	Apr. 24, 1919	12.6	12,400
	May 4, 1919	12.4	12,000
	June 4, 1919	11.7	10,700
	June 11, 1919	11.8	11,000
1920	Mar. 14, 1920	<sup>a</sup> 12.2	<sup>b</sup> 10,000
1921	Sept. 20, 1921	11.1	9,670
1922	Apr. 11, 1922	12.1	11,400
1923	Mar. 27, 1923	11.6	10,300
1924	Oct. 3, 1923	11.2	10,000
	June 8, 1924	12.3	12,400
	June 25, 1924	15.2	20,100
1925	Aug. 7, 1925	10.1	8,060
1926	Sept. 20, 1926	19.0	32,000
1927	Feb. 8, 1927	9.7	6,880
1928	Aug. 27, 1928	10.8	8,480
1929	Mar. 14, 1929	16.2	19,400
1930	May 13, 1930	8.8	5,870
1931	June 21, 1931	8.3	5,270

# 05484500 Raccoon River at Van Meter, Iowa

## Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1932	Nov. 24, 1931	14.6	15,200
	Jan. 1, 1932	12.5	11,400
	Mar. 4, 1932	14.2	14,200
1933	Apr. 5, 1933	10.1	7,550
1934	Apr. 7, 1934	5.0	2,020
1935	Mar. 5, 1935	13.1	11,000
1936	Mar. 5, 1936	13.9	12,200
1937	Mar. 4, 1937	13.9	12,200
1938	June 2, 1938	11.6	8,590
1939	Mar. 12, 1939	<sup>a</sup> 17.85	<sup>b</sup> 14,000
	Mar. 16, 1939	13.0	10,600
1940	July 31, 1940	9.2	5,770
1941	June 2, 1941	10.0	6,920
1942	May 11, 1942	11.7	8,800
1943	June 16, 1943	12.9	10,000
	Aug. 16, 1943	14.7	12,500
1944	May 21, 1944	18.3	23,400
	June 11, 1944	15.1	13,100
	June 16, 1944	17.2	17,900
1945	Mar. 15, 1945	13.7	11,600
	Apr. 28, 1945	12.7	10,200
	May 15, 1945	13.4	11,200
	May 23, 1945	15.7	14,300
	May 31, 1945	15.0	12,900
	June 6, 1945	16.1	15,100
	June 13, 1945	13.0	10,900
1946	Aug. 25, 1946	13.2	10,300
	Sept. 9, 1946	16.1	15,100
1947	June 3, 1947	17.4	19,800
	June 5, 1947	19.3	25,600
	June 13, 1947	<sup>c</sup> 21.37	41,200
	June 23, 1947	16.4	17,300
	June 25, 1947	21.1	38,000
1948	Mar. 19, 1948	19.0	26,700
1949	Mar. 6, 1949	15.7	15,900
1950	Mar. 7, 1950	12.4	11,300
	June 20, 1950	16.1	17,600
	June 24, 1950	14.0	13,700
1951	Mar. 31, 1951	19.15	27,700
	May 2, 1951	17.00	19,900
	June 3, 1951	17.13	20,200
	June 8, 1951	14.47	14,400
	July 4, 1951	15.18	15,800
	July 6, 1951	11.55	10,100

# 05484500 Raccoon River at Van Meter, Iowa

## Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1952	Apr. 1, 1952	14.81	15,100
	June 27, 1952	14.67	14,900
1953	June 11, 1953	19.42	26,000
1954	June 16, 1954	12.46	11,000
	June 25, 1954	17.40	20,800
	Aug. 22, 1954	12.07	10,200
	Aug. 31, 1954	14.14	13,800
1955	Apr. 24, 1955	11.43	8,620
1956	Sept. 4, 1956	7.43	4,150
1957	June 18, 1957	17.27	20,000
1958	July 3, 1958	21.77	35,200
	July 20, 1958	13.73	13,300
	Sept. 6, 1958	17.76	20,900
1959	June 4, 1959	13.22	13,500
1960	Apr. 2, 1960	21.18	32,300
	May 7, 1960	14.62	14,800
	May 26, 1960	11.76	10,400
1961	Mar. 27, 1961	12.35	11,300
1962	Mar. 31, 1962	17.23	19,700
	May 29, 1962	14.33	14,900
	June 11, 1962	12.42	11,900
	Sept. 7, 1962	11.45	10,400
1963	Mar. 4, 1963	<sup>a</sup> 14.38	<sup>b</sup> 10,000
	Mar. 11, 1963	13.85	12,200
	Apr. 29, 1963	12.62	12,200
1964	June 23, 1964	15.92	17,400
1965	Mar. 2, 1965	<sup>a</sup> 14.73	<sup>b</sup> 13,000
	Mar. 17, 1965	<sup>a</sup> 18.20	<sup>b</sup> 20,100
	Apr. 1, 1965	13.93	14,300
	Apr. 6, 1965	18.35	22,300
	May 30, 1965	11.20	10,400
	June 13, 1966	15.15	16,200
1967	June 8, 1967	13.09	12,300
	June 10, 1967	17.04	18,700
	June 12, 1967	18.07	20,600
	June 26, 1967	12.11	10,900
1968	June 27, 1968	7.05	4,360
1969	Mar. 25, 1969	17.60	22,800
	Apr. 9, 1969	12.07	10,900
	June 29, 1969	12.95	12,400
	July 10, 1969	14.18	14,700
	July 18, 1969	11.74	10,400
	May 14, 1970	14.23	14,800

# 05484500 Raccoon River at Van Meter, Iowa

## Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1971	Feb. 20, 1971	<sup>a</sup> 18.85	<sup>b</sup> 23,000
	Mar. 14, 1971	14.55	15,400
	June 6, 1971	13.44	13,300
1972	June 18, 1972	10.74	8,840
	Aug. 2, 1972	10.96	9,140
	Aug. 6, 1972	10.71	8,790
	Sept. 11, 1972	11.33	9,730
1973	Feb. 2, 1973	<sup>a</sup> 15.15	<sup>b</sup> 14,300
	Feb. 25, 1973	11.00	9,200
	Mar. 7, 1973	13.43	13,300
	Mar. 14, 1973	14.80	16,000
	Apr. 1, 1973	13.48	13,400
	Apr. 16, 1973	17.59	22,700
	May 8, 1973	17.55	21,600
	June 1, 1973	10.68	8,750
	June 5, 1973	11.77	10,400
	July 1, 1973	20.74	32,400
	July 4, 1973	21.74	35,600
	Sept. 29, 1973	13.16	12,800
1974	Oct. 1, 1973	15.33	17,100
	Oct. 11, 1973	14.01	14,300
	Oct. 15, 1973	11.87	10,600
	Apr. 21, 1974	13.47	13,400
	Apr. 29, 1974	14.33	15,000
	May 19, 1974	20.13	30,400
	May 27, 1974	11.95	11,000
	May 29, 1974	10.71	9,380
	June 9, 1974	11.87	11,100
1975	Mar. 21, 1975	12.34	11,300
	Apr. 28, 1975	13.90	14,100
	June 18, 1975	14.01	14,300
	June 25, 1975	11.92	10,700
	June 27, 1975	10.59	8,630
1976	Apr. 24, 1976	10.69	8,710
	May 24, 1976	12.84	12,200
1977	Aug. 26, 1977	12.50	11,600
	Aug. 28, 1977	12.79	11,900
1978	Mar. 22, 1978	<sup>a</sup> 17.62	<sup>b</sup> 20,800
	Aug. 18, 1978	14.48	15,300
	Sept. 14, 1978	13.14	12,800
	Sept. 20, 1978	12.63	11,800
1979	Mar. 19, 1979	20.39	29,900
	Apr. 2, 1979	15.80	17,000



# 05484500 Raccoon River at Van Meter, Iowa

## Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1979--Continued	June 29, 1979	11.09	9,340
	Aug. 10, 1979	12.25	11,200
1980	June 15, 1980	7.76	4,870
1981	July 4, 1981	7.12	4,130
1982	Feb. 21, 1982	<sup>a</sup> 14.34	<sup>b</sup> 11,600
	Feb. 23, 1982	12.25	11,500
	Mar. 20, 1982	12.14	11,300
	May 20, 1982	12.86	12,700
	May 26, 1982	12.41	11,800
	June 15, 1982	14.21	15,100
	June 16, 1982	10.92	9,390
1983	Dec. 28, 1982	12.78	12,200
	Feb. 20, 1983	13.66	13,700
	Mar. 11, 1983	14.28	14,900
	Mar. 16, 1983	10.53	8,520
	Apr. 2, 1983	14.00	14,400
	Apr. 10, 1983	12.73	12,000
	Apr. 17, 1983	14.08	14,500
	May 7, 1983	13.64	13,700
	May 19, 1983	11.61	10,200
	June 26, 1983	12.70	12,100
	June 30, 1983	16.25	19,400
	July 3, 1983	18.59	25,500
1984	Feb. 12, 1984	13.61	13,900
	Feb. 19, 1984	11.61	10,800
	Apr. 12, 1984	11.64	10,200
	Apr. 16, 1984	11.21	9,550
	Apr. 30, 1984	19.51	28,500
	May 25, 1984	11.94	10,700
	May 29, 1984	11.39	9,830
	June 8, 1984	10.73	8,790
	June 9, 1984	13.45	13,300
	June 13, 1984	13.31	13,100
	June 17, 1984	18.09	24,000
	June 23, 1984	17.50	22,400
1985	Feb. 22, 1985	<sup>a</sup> 12.70	9,900
1986	May 11, 1986	13.92	14,300
	May 17, 1986	15.20	17,000
	July 1, 1986	22.69	40,200
	July 10, 1986	11.28	9,880
	July 11, 1986	11.07	9,520
	July 14, 1986	11.39	9,990
	Aug. 14, 1986	14.14	14,400

# 05484500 Raccoon River at Van Meter, Iowa

## Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1987	Oct. 12, 1986	12.42	11,500
	July 12, 1987	10.64	8,730
	Aug. 26, 1987	13.97	14,700
1988	Feb. 21, 1988	<sup>a</sup> 11.66	--
	June 9, 1988	7.16	3,920
1989	Mar. 10, 1989	<sup>a</sup> 11.00	--
	Sept. 9, 1989	<sup>c</sup> 9.98	7,640
1990	May 21, 1990	12.27	11,300
	May 28, 1990	13.60	13,600
	June 16, 1990	21.39	34,600
1991	Mar. 27, 1991	11.82	10,900
	Apr. 19, 1991	16.78	21,000
	Apr. 29, 1991	14.10	15,000
	May 9, 1991	12.24	11,600
	May 21, 1991	12.37	11,800
	June 2, 1991	13.36	13,600
	June 7, 1991	16.64	20,600
	June 14, 1991	15.94	18,900
	June 15, 1991	15.67	18,300
1992	Apr. 23, 1992	11.50	10,400
	July 26, 1992	10.49	8,850
	Sept. 16, 1992	12.69	12,400
1993	Mar. 9, 1993	14.01	14,400
	Mar. 30, 1993	14.55	15,500
	Apr. 25, 1993	12.80	12,200
	June 20, 1993	13.62	13,700
	July 1, 1993	13.59	13,600
	July 10, 1993	26.34	70,100
	Aug. 12, 1993	15.48	17,400
	Aug. 18, 1993	14.60	15,600
	Aug. 29, 1993	21.15	33,900
1994	Sept. 25, 1993	12.01	10,800
	Feb. 19, 1994	<sup>a</sup> 12.64	--
	Mar. 7, 1994	10.42	8,750
1995	Apr. 27, 1995	11.38	9,320
	May 11, 1995	12.40	10,800
	May 28, 1995	13.12	12,400
1996	Feb. 9, 1996	<sup>a</sup> 14.92	--
	May 10, 1996	12.82	12,000
	May 24, 1996	16.47	17,400
	May 28, 1996	13.34	12,700

# 05484500 Raccoon River at Van Meter, Iowa

## Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1996--Continued	June 22, 1996	15.73	16,100
	July 18, 1996	13.62	13,100
	Aug. 6, 1996	11.82	10,600

<sup>a</sup>Affected by ice.

<sup>b</sup>Approximate.

<sup>c</sup>Gage height determined from floodmark.

<sup>s</sup>Peak for 1915 is from April to September 30.

### 05484650 Raccoon River at 63rd Street, Des Moines, Iowa

Location.--Lat 41°33'49", long 93°42'13", in SW1/4 NE1/4 sec. 14, T.78 N., R. 25 W., Polk County, Hydrologic Unit 07100006, on left bank, at upstream side of bridge on State Highway 28, 2.9 mi upstream from Walnut Creek, 8.6 mi upstream from mouth.

Drainage area.--3,529 mi<sup>2</sup>.

Gage.--Water-stage recorder. Datum is 774.91 ft above sea level.

Stage-discharge relation.--As of September 30, 1996, stage-discharge relation not defined, only gage heights are published.

Bankfull stage.--36 ft.

Remarks.--Only annual peak stages are shown.

#### Peak stages

[Water year, October 1-September 30; ft, feet above gage datum; --, not determined]

Water year	Date	Gage height (ft)
1992	Sept. 16, 1992	--
1993	July 11, 1993	<sup>c</sup> 40.77
1994	Feb. 19, 1994	<sup>a</sup> 32.82
1995	May 29, 1995	31.00
1996	June 22, 1996	33.12

<sup>a</sup>Affected by ice.

<sup>c</sup>Gage height determined from floodmark.

# 05484800 Walnut Creek at Des Moines, Iowa

Location.--Lat 41°35'14", long 93°42'11", in SW1/4 SE1/4 sec. 2, T.78 N., R. 25 W., Polk County, Hydrologic Unit 07100006, on left bank, 25 ft downstream from bridge on 63rd Street in Des Moines, and 2.2 mi upstream from Raccoon River.

Drainage area.--78.4 mi<sup>2</sup>.

Gage.--Water-stage recorder. Datum is 801.04 ft above sea level (levels by Iowa Natural Resources Council).

Stage-discharge relation.--Defined by current-meter measurements.

Flood stage.--13 ft.

Remarks.--Base for partial-duration series, 600 ft<sup>3</sup>/s.

## Peak stages and discharges

[Water year, October 1-September 30; ft, feet above gage datum; ft<sup>3</sup>/s, cubic feet per second; --, not determined]

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1972	June 20, 1972	9.53	680
	Sept. 10, 1972	8.86	644
1973	Dec. 30, 1972	<sup>a</sup> 10.39	<sup>b</sup> 700
	Feb. 1, 1973	14.00	2,350
	Apr. 16, 1973	11.85	1,610
	May 1, 1973	9.70	942
	May 8, 1973	9.99	878
	July 1, 1973	17.72	9,000
	July 4, 1973	12.56	1,670
1974	Oct. 11, 1973	12.74	1,770
	Apr. 28, 1974	12.73	1,740
	May 19, 1974	12.78	1,760
	June 9, 1974	17.44	8,160
1975	Apr. 27, 1975	9.08	736
	June 15, 1975	8.82	670
	June 18, 1975	11.53	1,440
	Aug. 27, 1975	17.00	5,800
	Aug. 29, 1975	10.19	948
1976	Apr. 18, 1976	14.24	2,470
	Apr. 24, 1976	12.20	1,530
	June 10, 1976	10.13	928
	June 12, 1976	9.82	875
	June 13, 1976	9.05	686
	June 28, 1976	13.41	2,060
1977	Aug. 26, 1977	11.84	1,400
	Aug. 28, 1977	14.48	2,590
	Aug. 31, 1977	9.43	746
	Sept. 17, 1977	8.70	602

# 05484800 Walnut Creek at Des Moines, Iowa

## Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1978	Mar. 20, 1978	8.80	620
	Apr. 17, 1978	9.99	933
	Apr. 17, 1978	10.75	1,180
	Aug. 27, 1978	10.32	965
	Sept. 20, 1978	8.62	616
1979	June 13, 1979	10.30	1,010
	Aug. 10, 1979	9.59	855
	Aug. 19, 1979	8.72	662
	Aug. 21, 1979	8.77	672
1980	June 1, 1980	8.60	674
	June 4, 1980	9.28	827
	Aug. 16, 1980	9.80	954
1981	May 23, 1981	11.93	1,560
	June 24, 1981	11.49	1,420
	July 3, 1981	13.47	2,190
	July 17, 1981	11.44	1,440
	Aug. 14, 1981	12.25	1,700
	Aug. 28, 1981	8.45	643
1982	Feb. 23, 1982	<sup>a</sup> --	<sup>b</sup> 821
	Mar. 19, 1982	8.58	702
	Apr. 16, 1982	8.79	766
	June 15, 1982	9.65	989
	July 6, 1982	9.39	920
	July 18, 1982	11.41	1,440
	July 21, 1982	8.56	668
	Aug. 5, 1982	12.08	1,650
	Dec. 27, 1982	8.84	757
	Apr. 12, 1983	8.67	728
1983	May 7, 1983	9.21	899
	May 19, 1983	8.56	740
	June 9, 1983	8.01	618
	June 29, 1983	11.60	1,490
	July 2, 1983	9.00	771
	July 3, 1983	12.64	1,840
	Aug. 30, 1983	8.30	609
	Nov. 3, 1983	8.41	700
1984	Nov. 19, 1983	8.14	638
	Apr. 29, 1984	9.85	989
	May 25, 1984	10.38	1,130
	May 28, 1984	9.01	774
	June 8, 1984	12.58	1,820
	June 9, 1984	14.63	2,820

# 05484800 Walnut Creek at Des Moines, Iowa

## Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1984--Continued	June 11, 1984	10.75	1,240
	June 14, 1984	10.56	1,180
	July 14, 1984	12.07	1,640
	July 26, 1984	10.77	1,240
1985	Nov. 1, 1984	9.69	946
	Sept. 22, 1985	9.02	776
1986	Apr. 30, 1986	14.37	3,160
	May 8, 1986	8.21	669
	May 10, 1986	18.32	12,500
	May 13, 1986	7.88	687
	May 17, 1986	10.43	1,450
	May 25, 1986	11.46	1,820
	June 4, 1986	10.12	1,340
	June 30, 1986	14.88	3,450
	July 10, 1986	9.75	1,220
	July 29, 1986	7.63	625
	Aug. 13, 1986	12.18	2,090
	Apr. 14, 1987	8.09	740
	June 18, 1987	8.09	735
	June 25, 1987	7.75	645
	July 8, 1987	8.92	964
	July 12, 1987	11.87	1,970
1987	Aug. 8, 1987	8.02	732
	Aug. 25, 1987	9.50	1,150
	Aug. 26, 1987	10.42	1,440
	June 8, 1988	7.58	613
	Aug. 22, 1988	7.95	704
	Nov. 15, 1988	8.69	899
1988	May 24, 1989	8.41	824
	July 18, 1989	8.76	924
1989	Aug. 29, 1989	7.66	642
	Sept. 9, 1989	8.36	822
	Mar. 13, 1990	11.61	2,070
	May 25, 1990	8.19	766
	June 16, 1990	18.00	7,780
	June 19, 1990	9.68	1,200
	June 22, 1990	7.89	689
	June 28, 1990	8.71	907
	July 5, 1990	7.64	628
	July 19, 1990	10.76	1,560
1990	July 26, 1990	7.74	652
	July 27, 1990	10.97	1,640



# 05484800 Walnut Creek at Des Moines, Iowa

## Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1991	Apr. 12, 1991	7.71	652
	Apr. 14, 1991	8.34	806
	Apr. 18, 1991	7.82	677
	May 14, 1991	7.56	621
	May 29, 1991	11.56	1,850
	May 31, 1991	8.66	893
	June 4, 1991	13.95	2,890
	June 11, 1991	7.94	702
	June 14, 1991	8.10	742
	June 15, 1991	8.60	876
	Aug. 8, 1991	12.35	2,160
1992	Nov. 1, 1991	7.08	602
	July 2, 1992	7.38	674
	July 24, 1992	10.10	1,450
	Sept. 9, 1992	7.17	624
1993	Mar. 4, 1993	9.00	1,110
	May 3, 1993	7.52	709
	May 8, 1993	7.34	664
	May 11, 1993	9.07	1,130
	May 29, 1993	7.17	624
	June 19, 1993	7.79	777
	June 29, 1993	8.34	922
	June 30, 1993	9.17	1,160
	July 5, 1993	7.10	607
	July 8, 1993	9.63	1,300
	July 9, 1993	15.74	4,110
	July 11, 1993	12.10	2,140
	July 13, 1993	9.47	1,260
	July 25, 1993	8.98	1,110
	Aug. 10, 1993	10.22	1,490
	Aug. 11, 1993	12.69	2,370
	Aug. 13, 1993	7.50	731
	Aug. 18, 1993	7.06	628
	Aug. 29, 1993	17.56	6,460
	Sept. 25, 1993	12.93	2,460
1994	July 11, 1994	7.46	704
	July 12, 1994	7.48	706
	Aug. 30, 1994	7.89	792
	Sept. 4, 1994	7.39	667
1995	Apr. 26, 1995	7.38	650
	May 9, 1995	10.12	1,450
	June 27, 1995	8.68	1,030

# 05484800 Walnut Creek at Des Moines, Iowa

## Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft <sup>3</sup> /s)
1996	May 8, 1996	6.86	802
	May 10, 1996	12.60	3,430
	May 14, 1996	6.50	684
	May 24, 1996	13.24	3,850
	May 27, 1996	6.97	839
	June 1, 1996	7.49	1,030
	July 17, 1996	11.43	2,750
	Sept. 23, 1996	6.38	645
	Sept. 26, 1996	8.17	1,290

<sup>a</sup>Affected by ice.

<sup>b</sup>Approximate.

### 05484900 Raccoon River at Fleur Drive, Des Moines, Iowa

Location.--Lat 41°34'54", long 93°38'34", in NW1/4 NE1/4 sec. 8, T.78 N., R. 24 W., Polk County, Hydrologic Unit 07100006, on downstream side of Fleur Drive bridge (SW 18th Street) attached to handrail 465 ft from right edge of bridge, 3.0 mi downstream from Walnut Creek, 2.6 mi upstream from mouth.

Drainage area.--3,625 mi<sup>2</sup>.

Gage.--Water-stage recorder. Datum is 780.696 ft above sea level.

Stage-discharge relation.--As of September 30, 1996, stage-discharge relation not defined, only gage heights are published.

Flood stage.--12 ft.

Remarks.--Only annual peak stages are shown.

#### Peak stages

[Water year, October 1-September 30; ft, feet above gage datum; --, not determined]

Water year	Date	Gage height (ft)
1984	June 18, 1984	16.34
1985	Feb. 23, 1985	<sup>a</sup> 7.90
1986	July 2, 1986	19.38
1987	Aug. 27, 1987	12.39
1988	<sup>b</sup> Feb. 22, 1988	--
1989	Sept. 9, 1989	7.85
1990	June 17, 1990	19.42
1991	June 8, 1991	15.36
1992	Sept. 16, 1992	--
1993	July 11, 1993	<sup>c</sup> 26.8
1994	<sup>b</sup> Mar. 7, 1994	--
1995	May 29, 1995	11.34
1996	June 22, 1996	13.67

<sup>a</sup>Affected by ice.

<sup>b</sup>Approximate.

<sup>c</sup>Gage height determined from floodmark.

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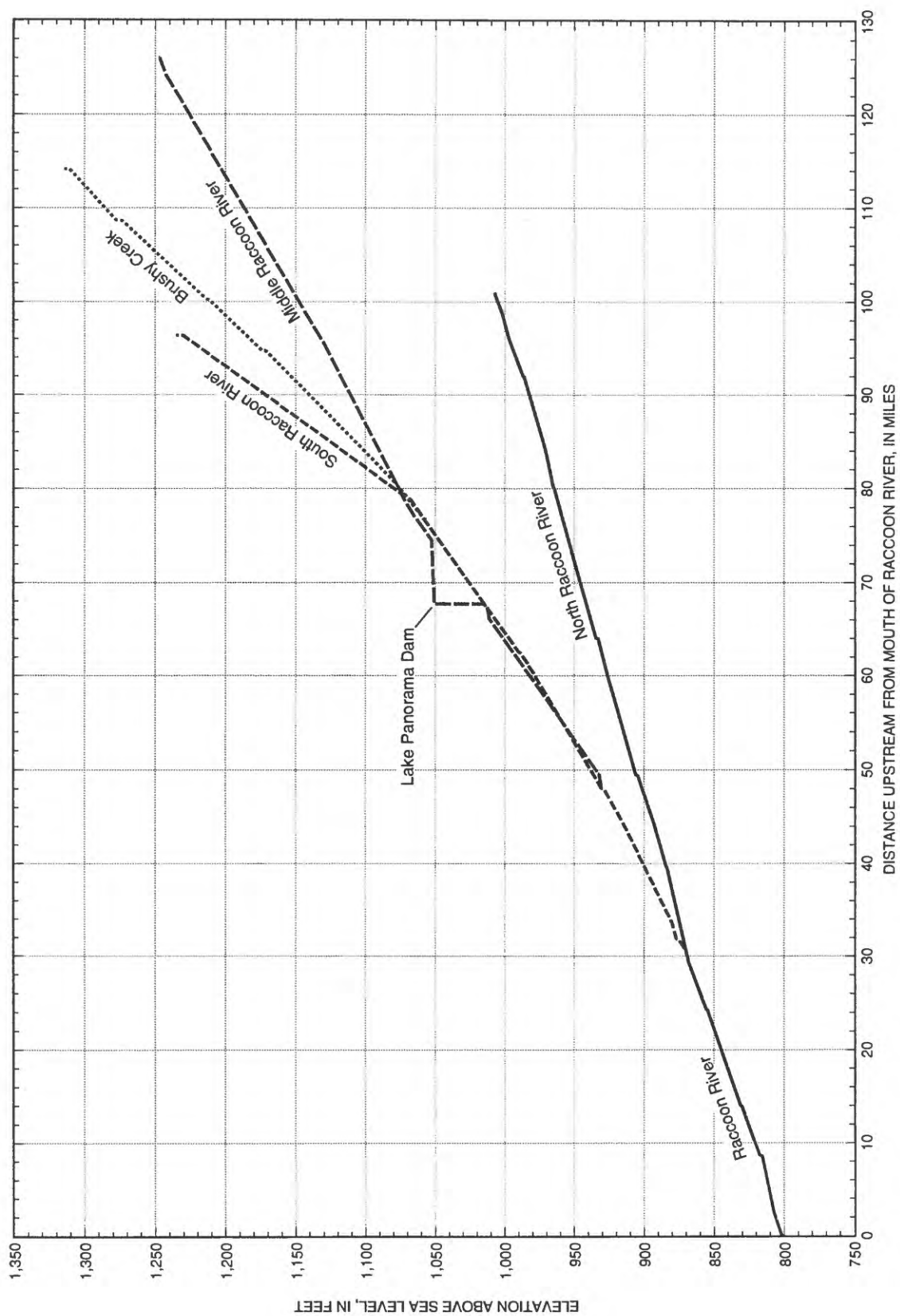
## **APPENDIX B**

### **WATER-SURFACE-ELEVATION PROFILES FOR THE RACCOON RIVER BASIN, WEST-CENTRAL IOWA**

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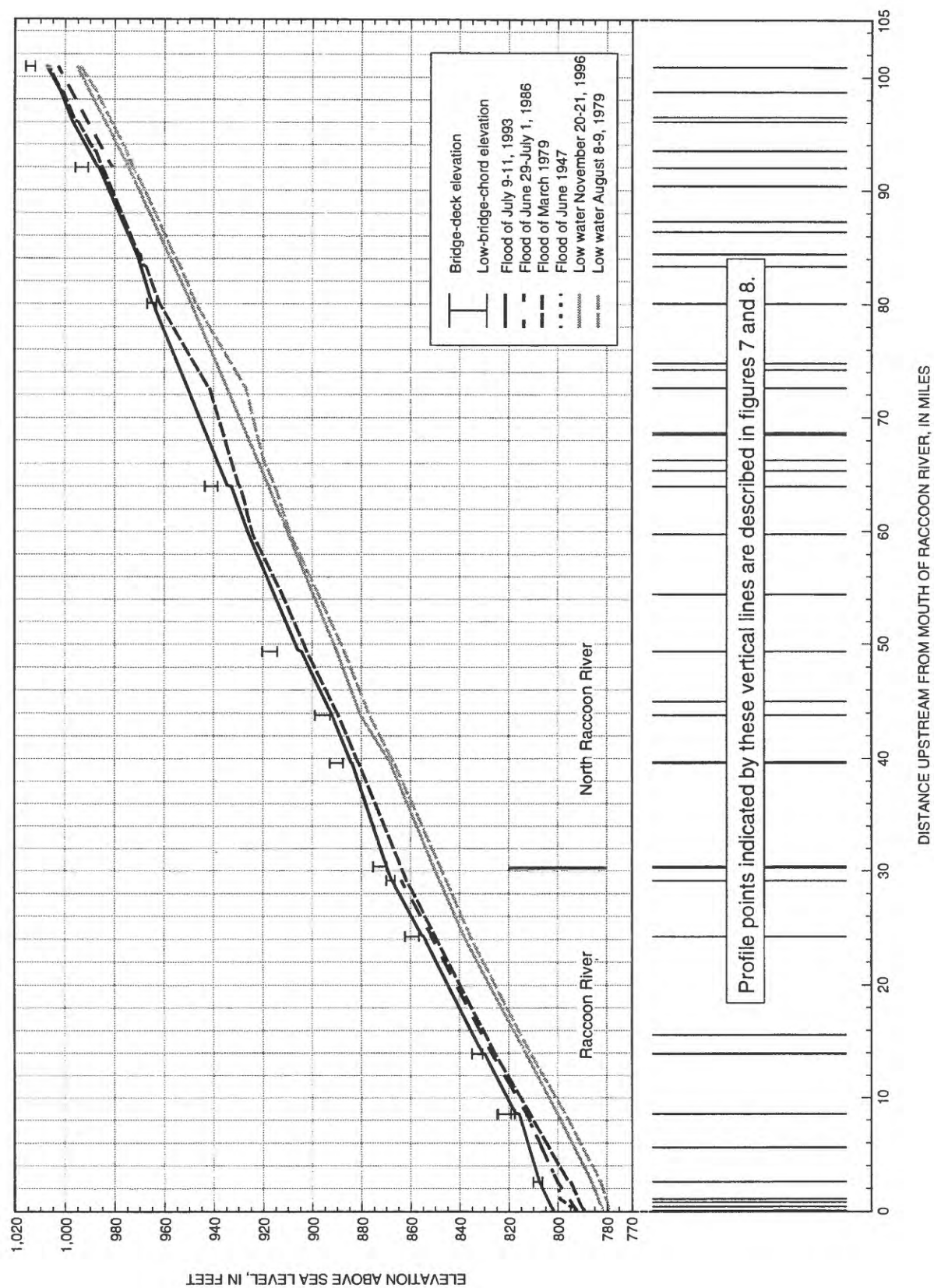
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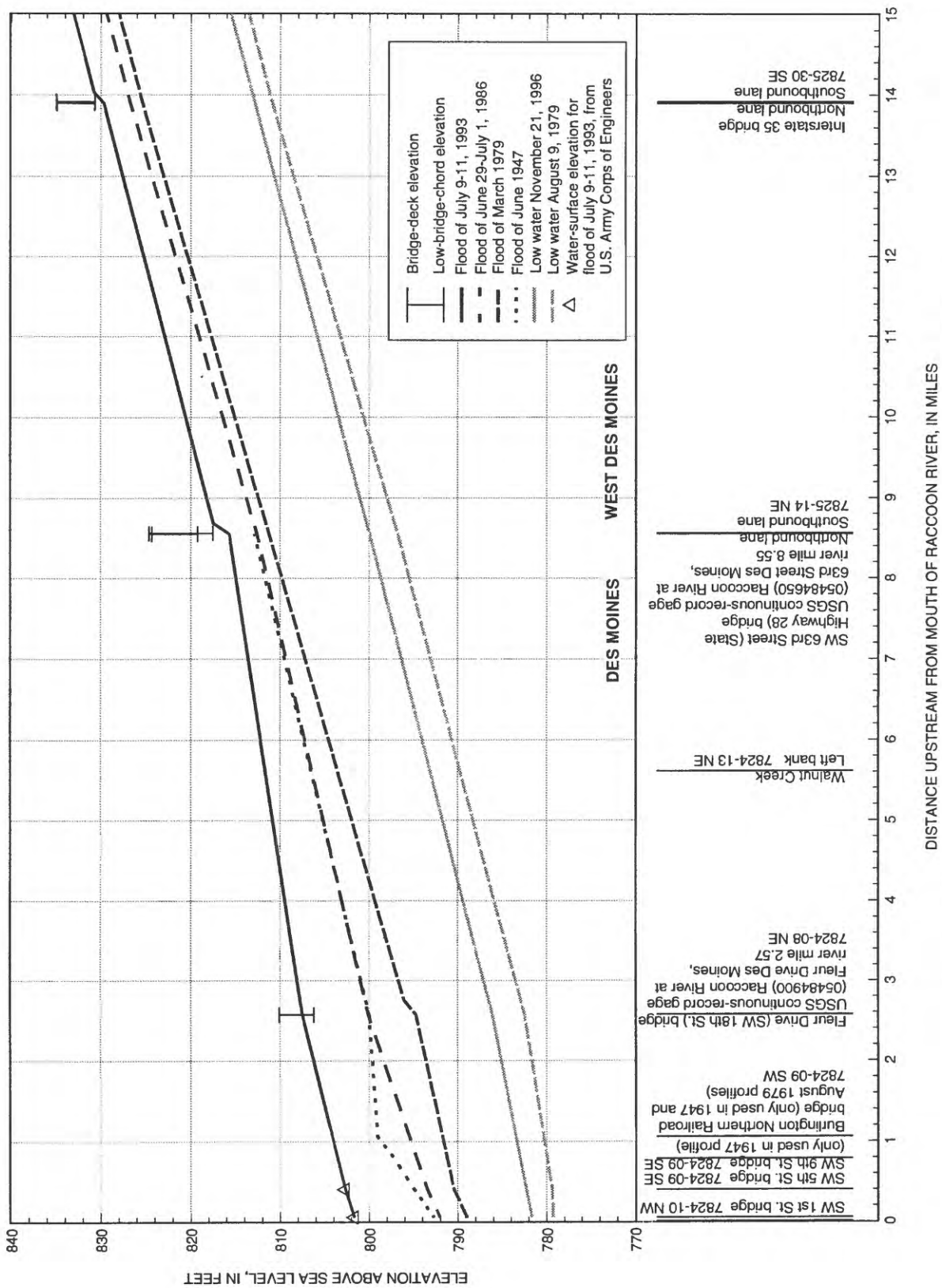


**Figure 5.** Water-surface-elevation profiles for the flood of July 9-11, 1993, along the Raccoon, North Raccoon, South Raccoon, and Middle Raccoon Rivers and Brushy Creek, river miles 0.05-126.03.

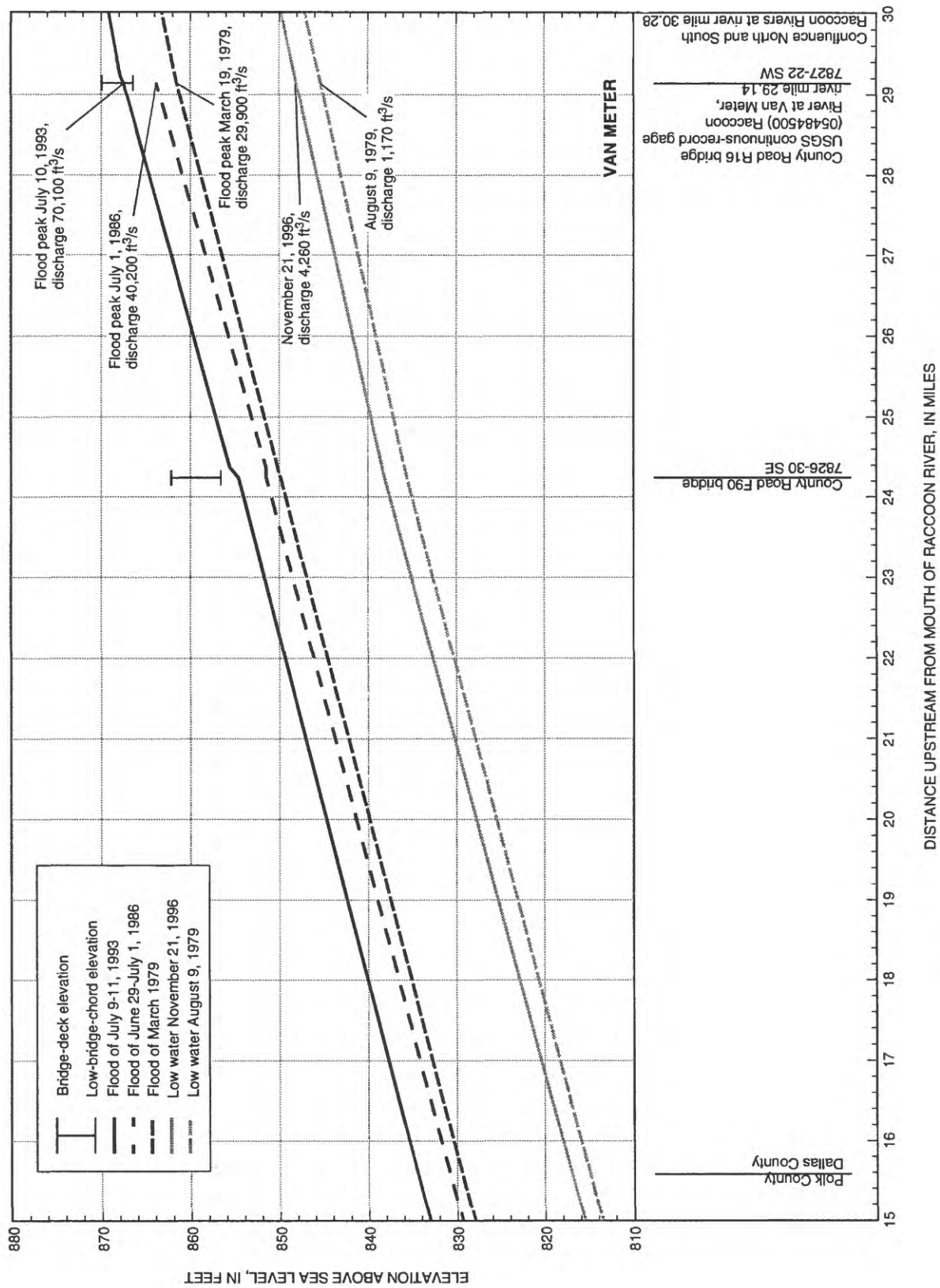




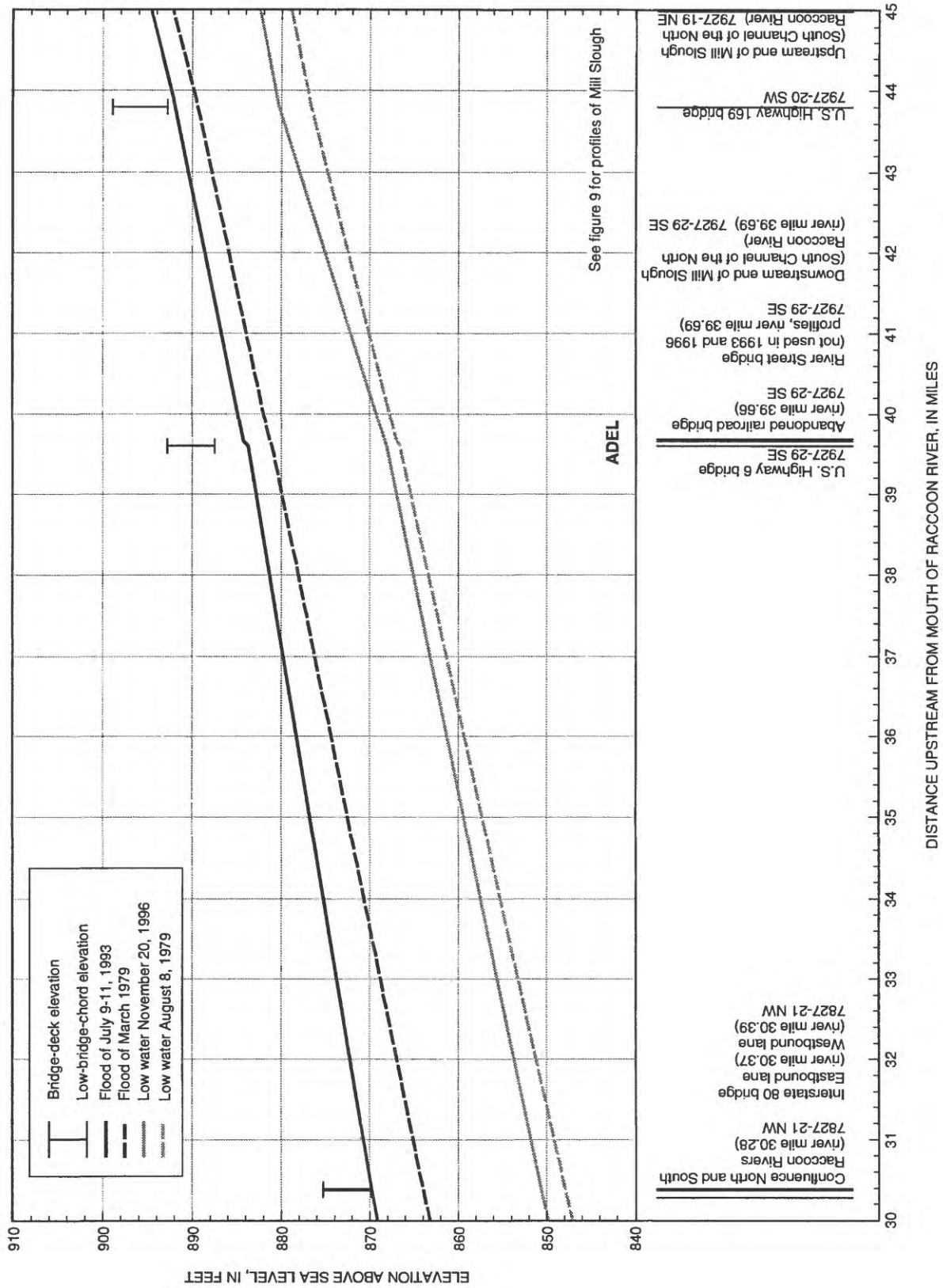
**Figure 6.** Water-surface-elevation profiles for the Raccoon and North Raccoon Rivers, river miles 0.05-100.91.



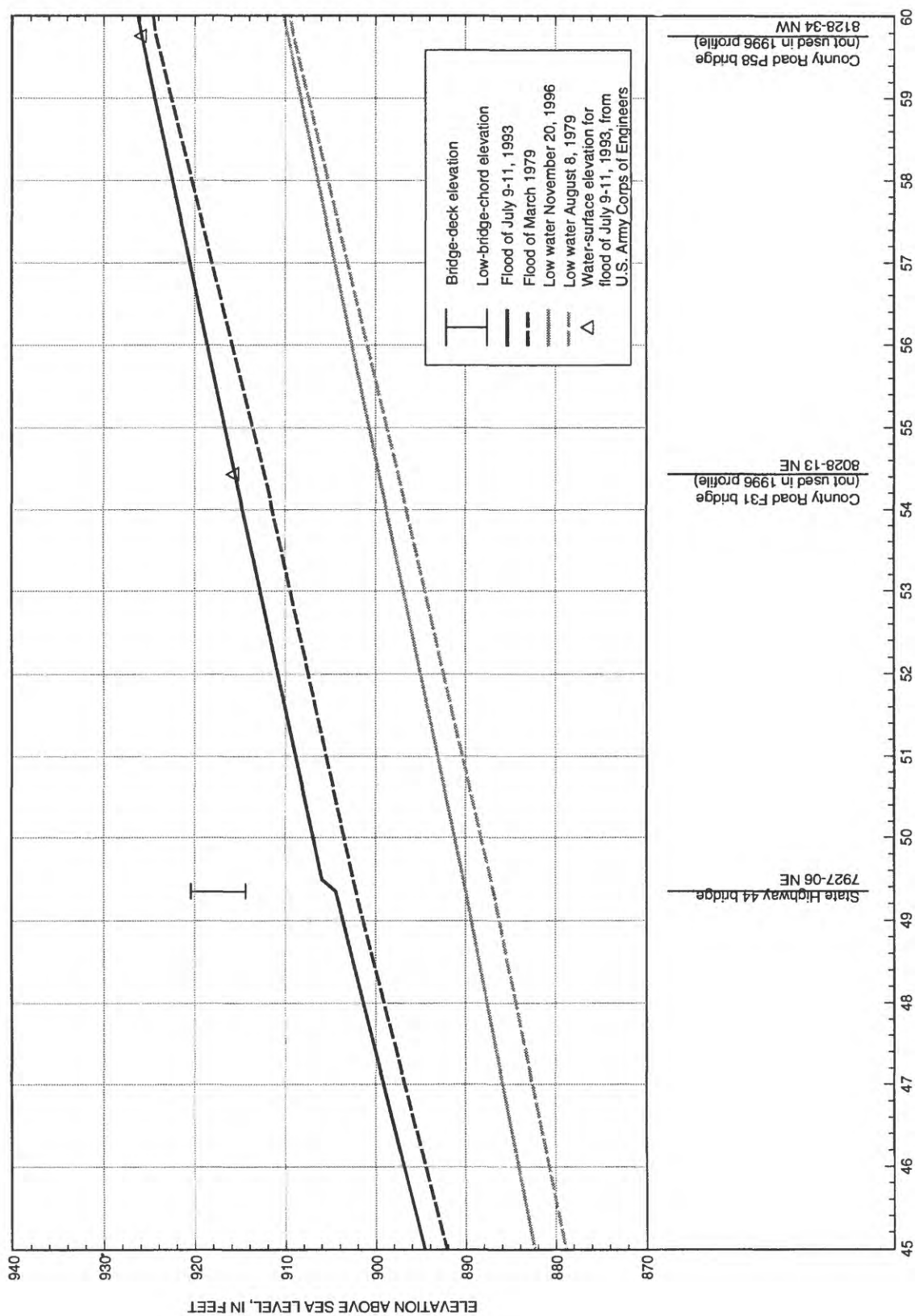
**Figure 7A.** Water-surface-elevation profiles for the Raccoon River, river miles 0.05-15.



**Figure 7B.** Water-surface-elevation profiles for the Raccoon River, river miles 15-30.

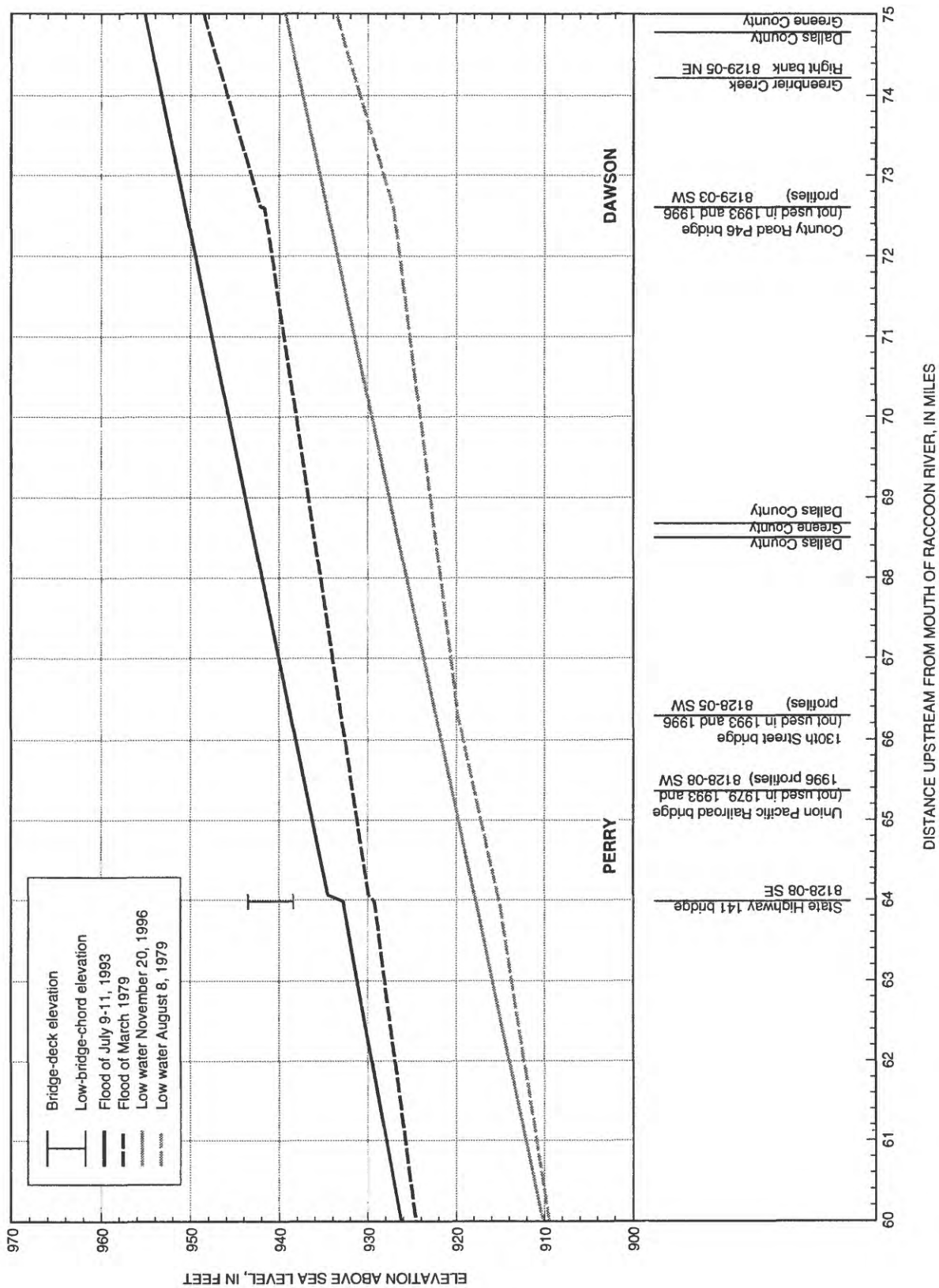


**Figure 8A.** Water-surface-elevation profiles for the North Raccoon River, river miles 30.28-45.



DISTANCE UPSTREAM FROM MOUTH OF RACCOON RIVER, IN MILES

Figure 8B. Water-surface-elevation profiles for the North Raccoon River, river miles 45-60.



**Figure 8C.** Water-surface-elevation profiles for the North Raccoon River, river miles 60-75.



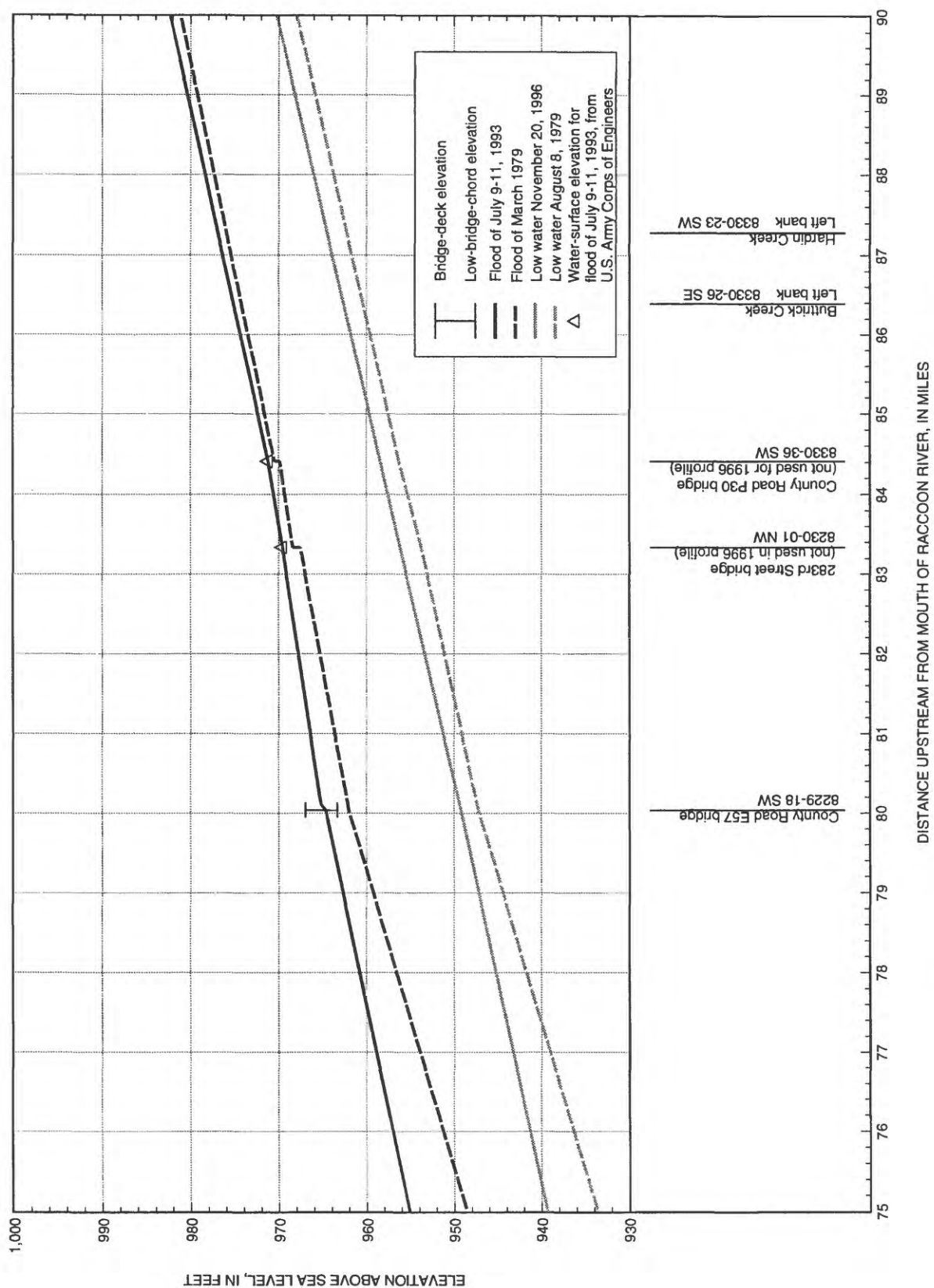


Figure 8D. Water-surface-elevation profiles for the North Raccoon River, river miles 75-90.



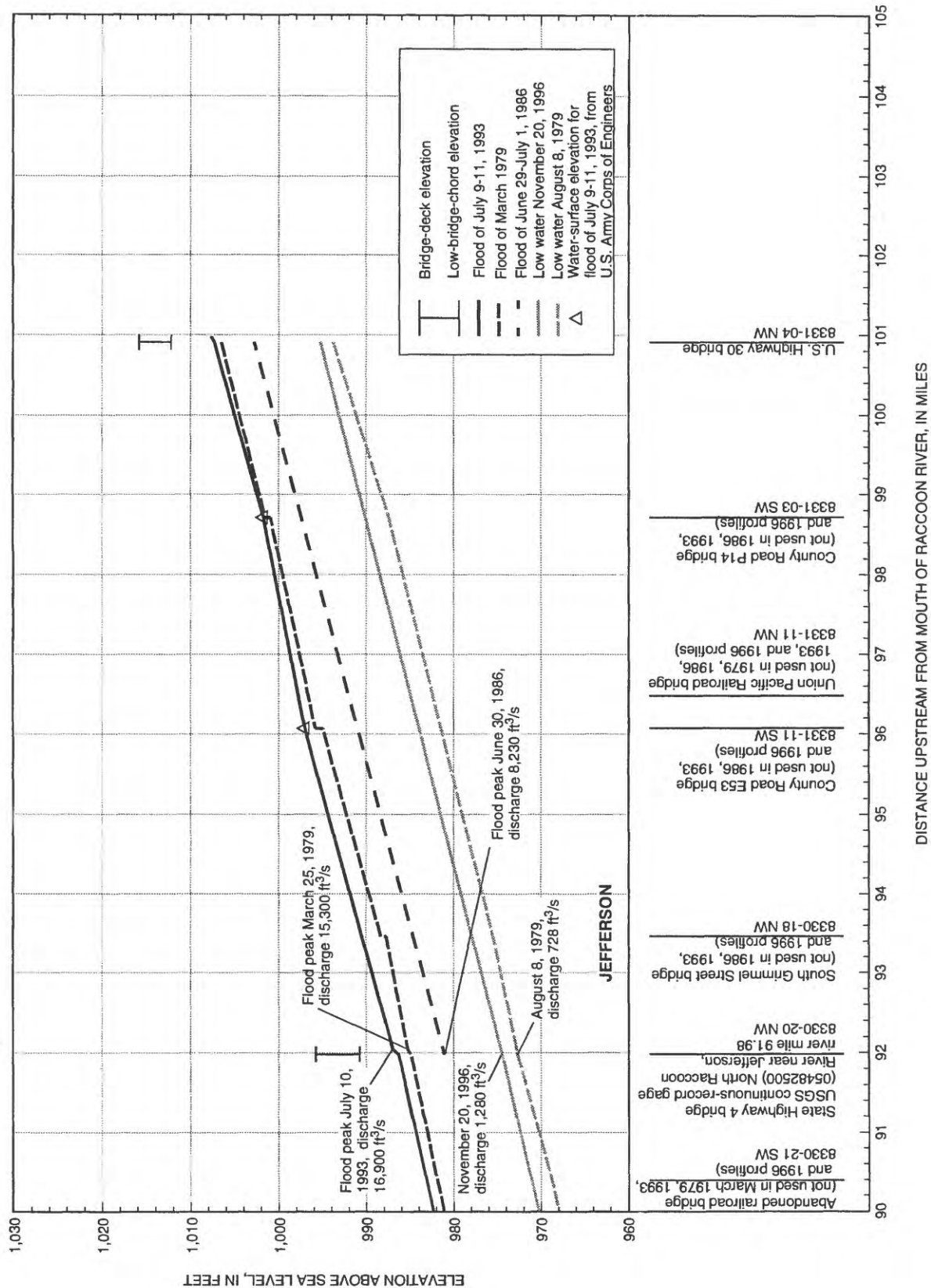
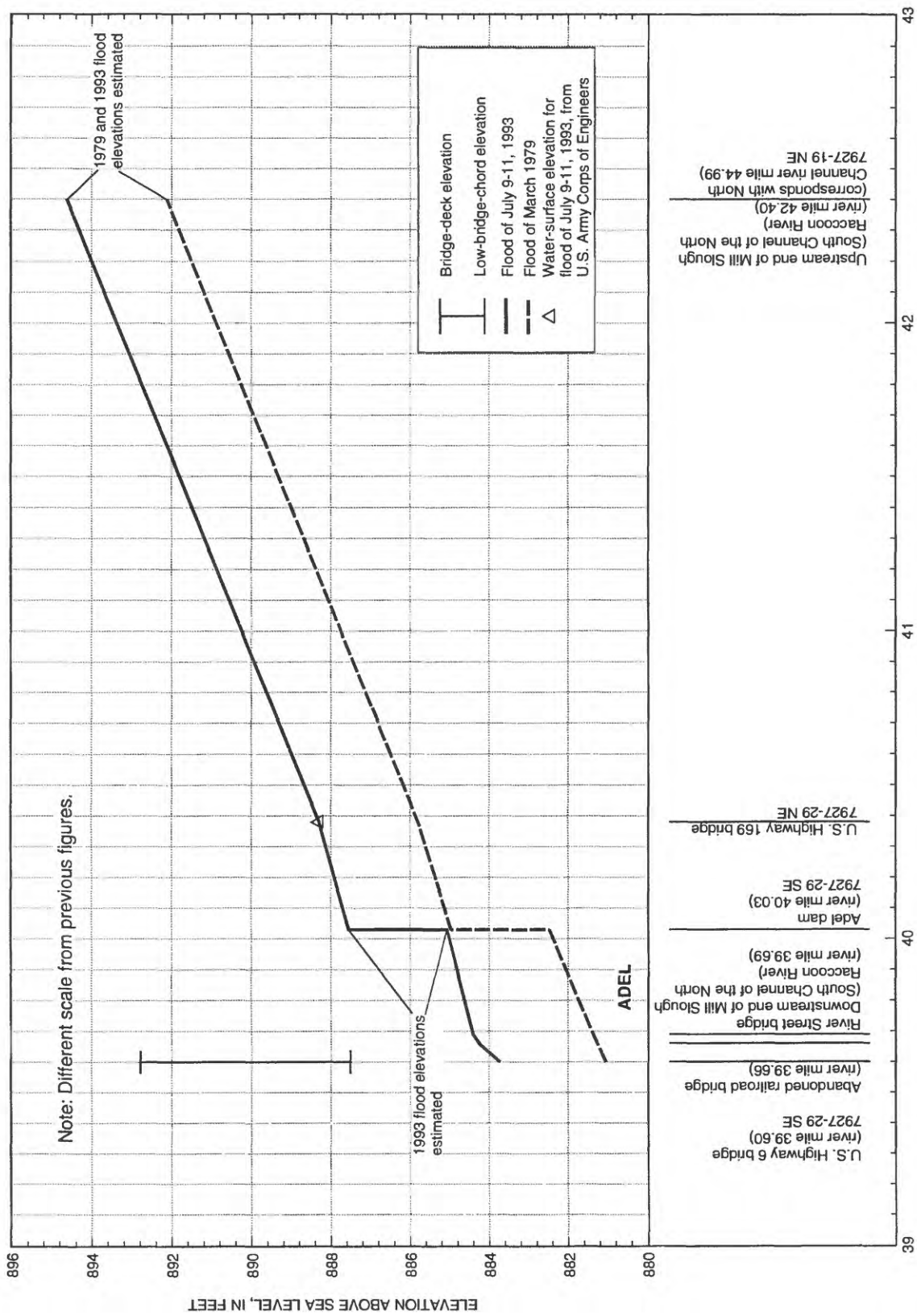
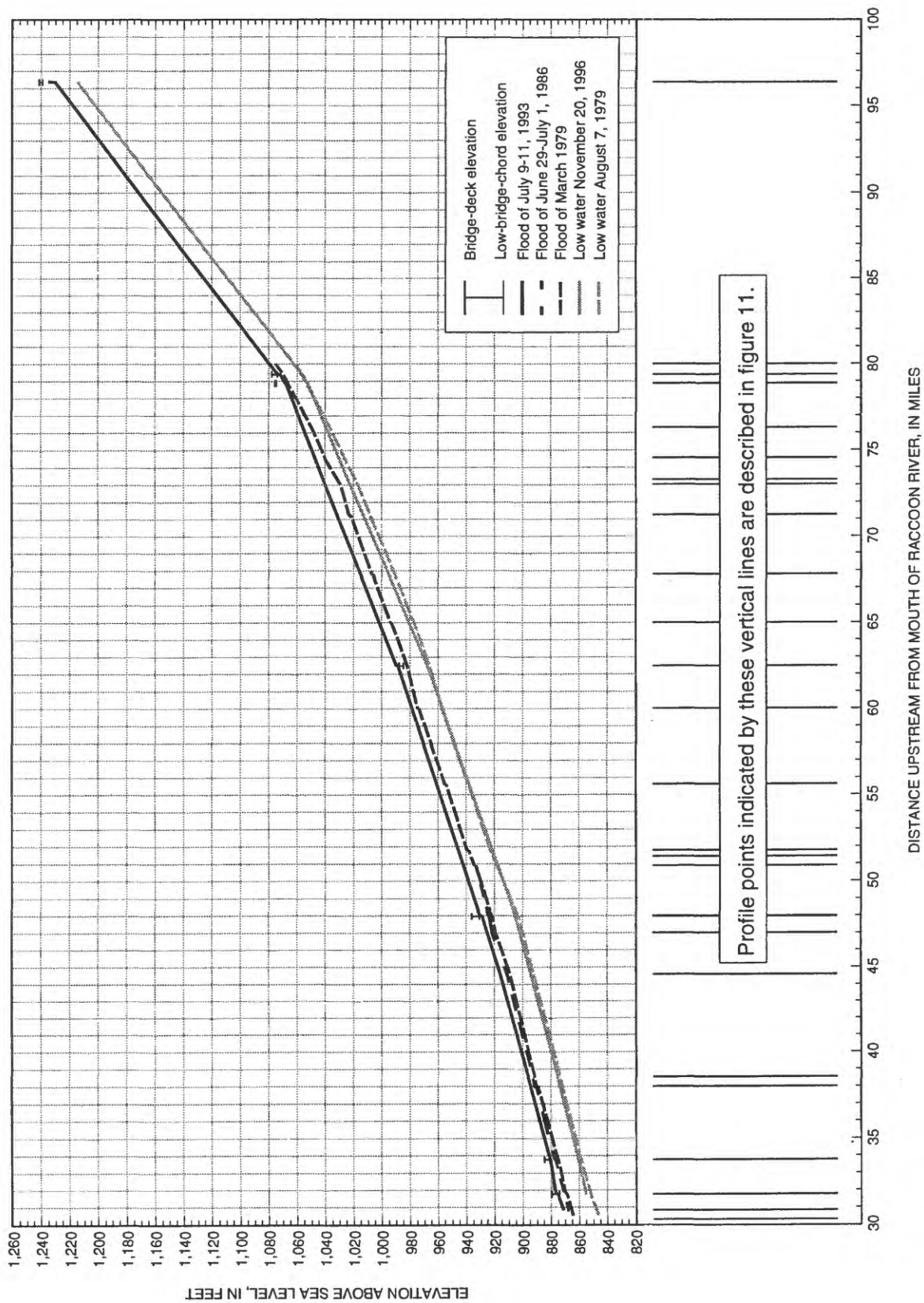


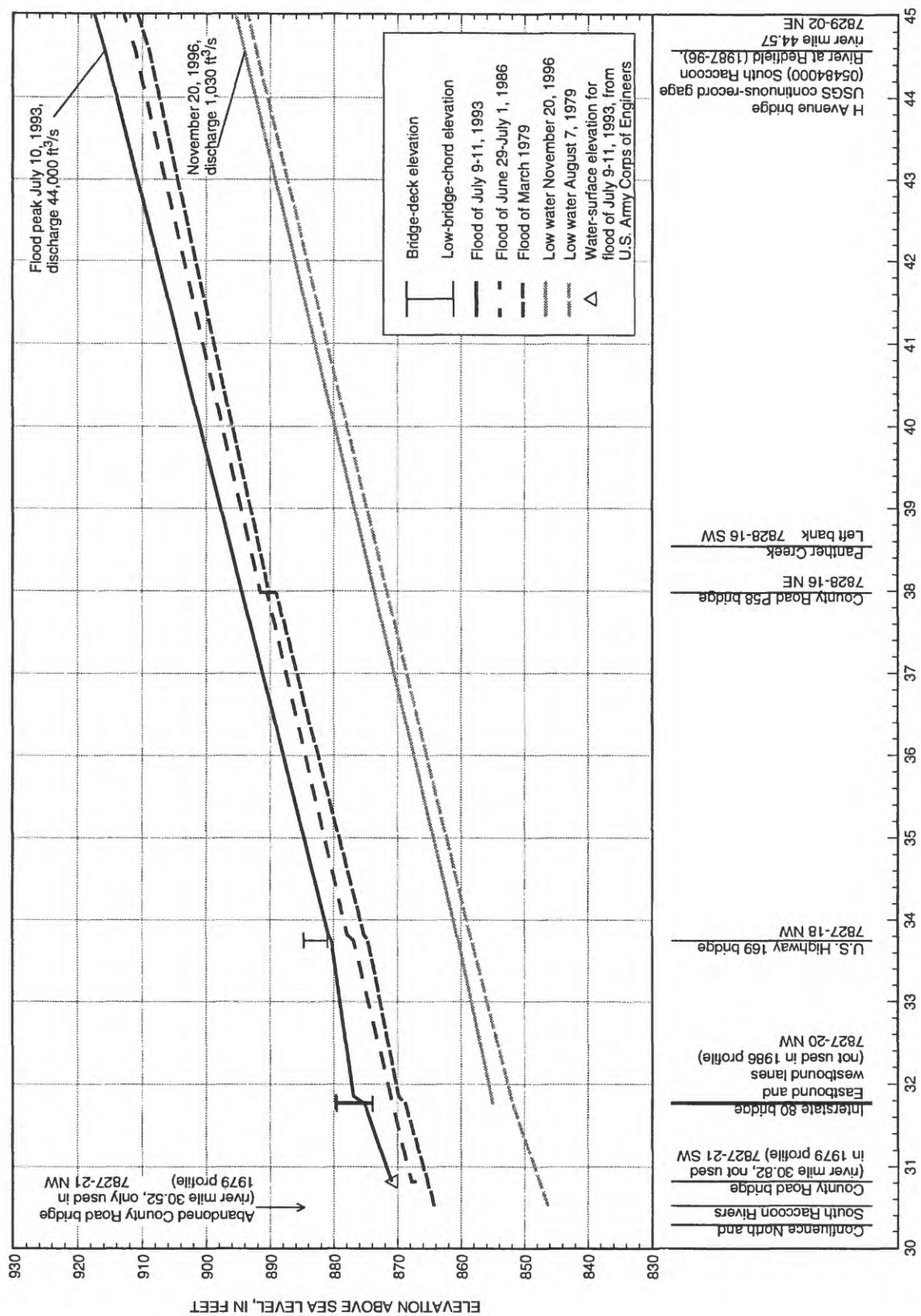
Figure 8E. Water-surface-elevation profiles for the North Raccoon River, river miles 90-100.91.



**Figure 9.** Water-surface-elevation profiles for Mill Slough (South Channel of the North Raccoon River), river miles 39.69-42.40.



**Figure 10.** Water-surface-elevation profiles for the South Raccoon River, river miles 30.28-96.36.



DISTANCE UPSTREAM FROM MOUTH OF RACCOON RIVER, IN MILES

**Figure 11A.** Water-surface-elevation profiles for the South Raccoon River, river miles 30.28-45.



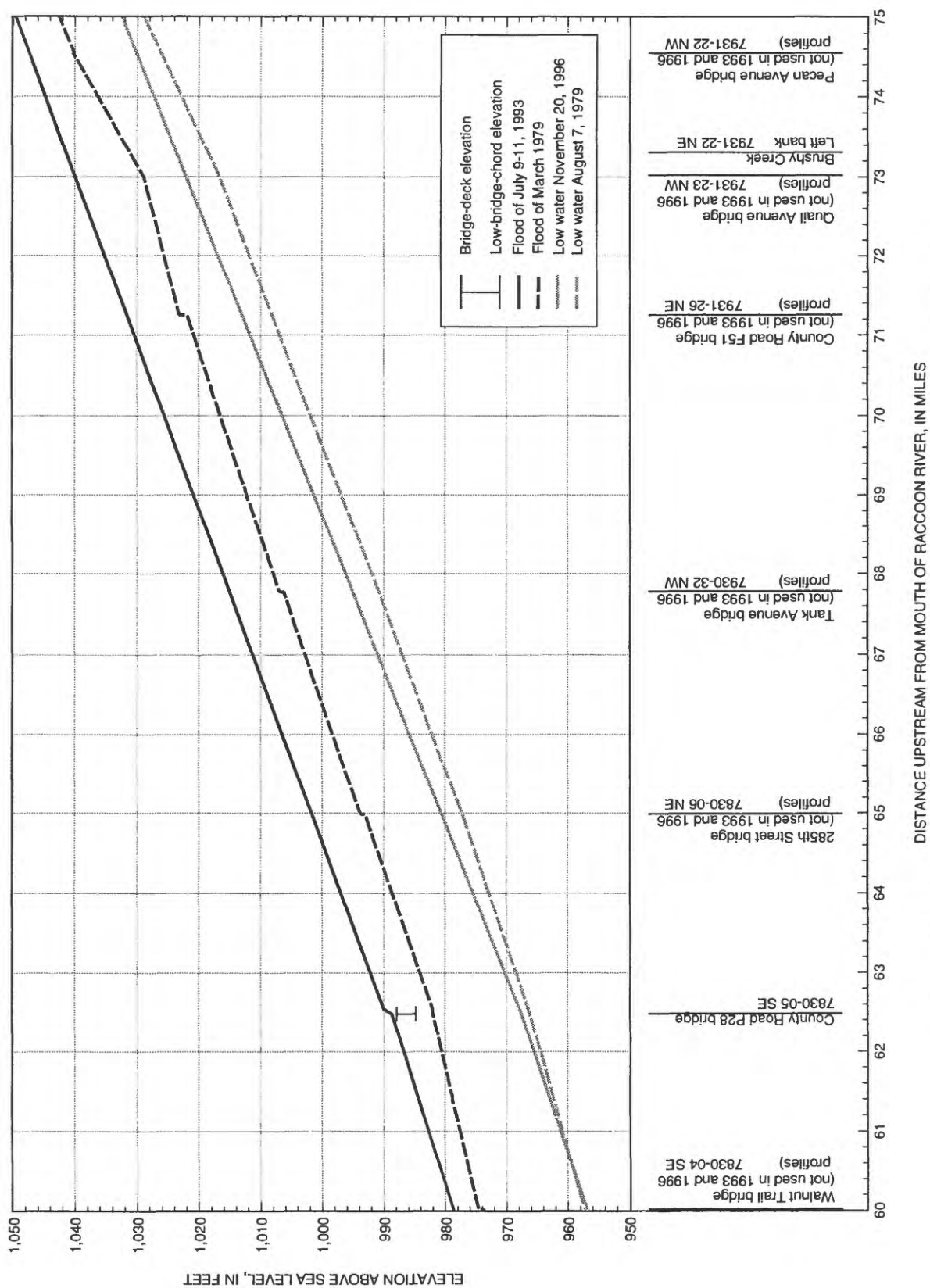
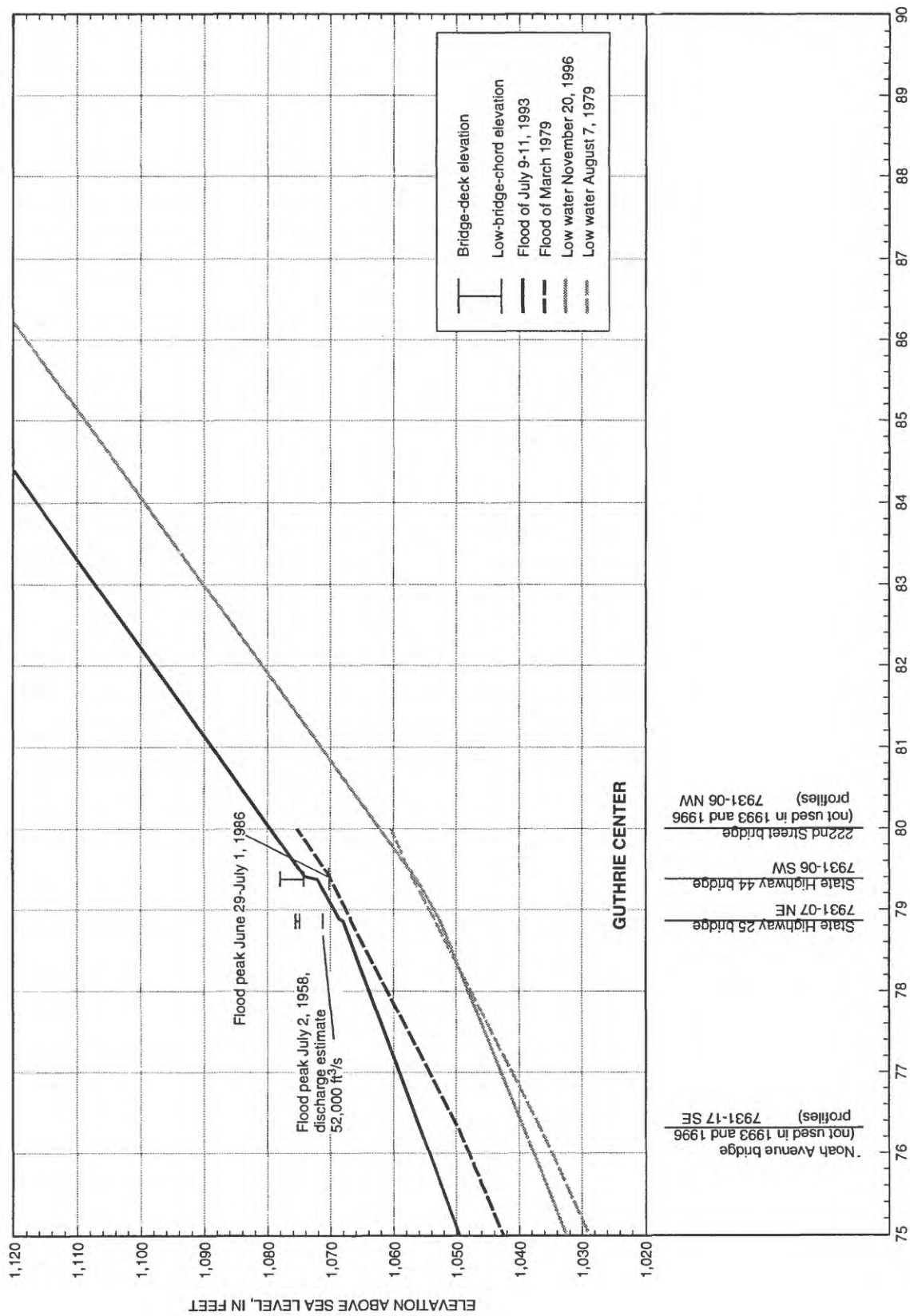


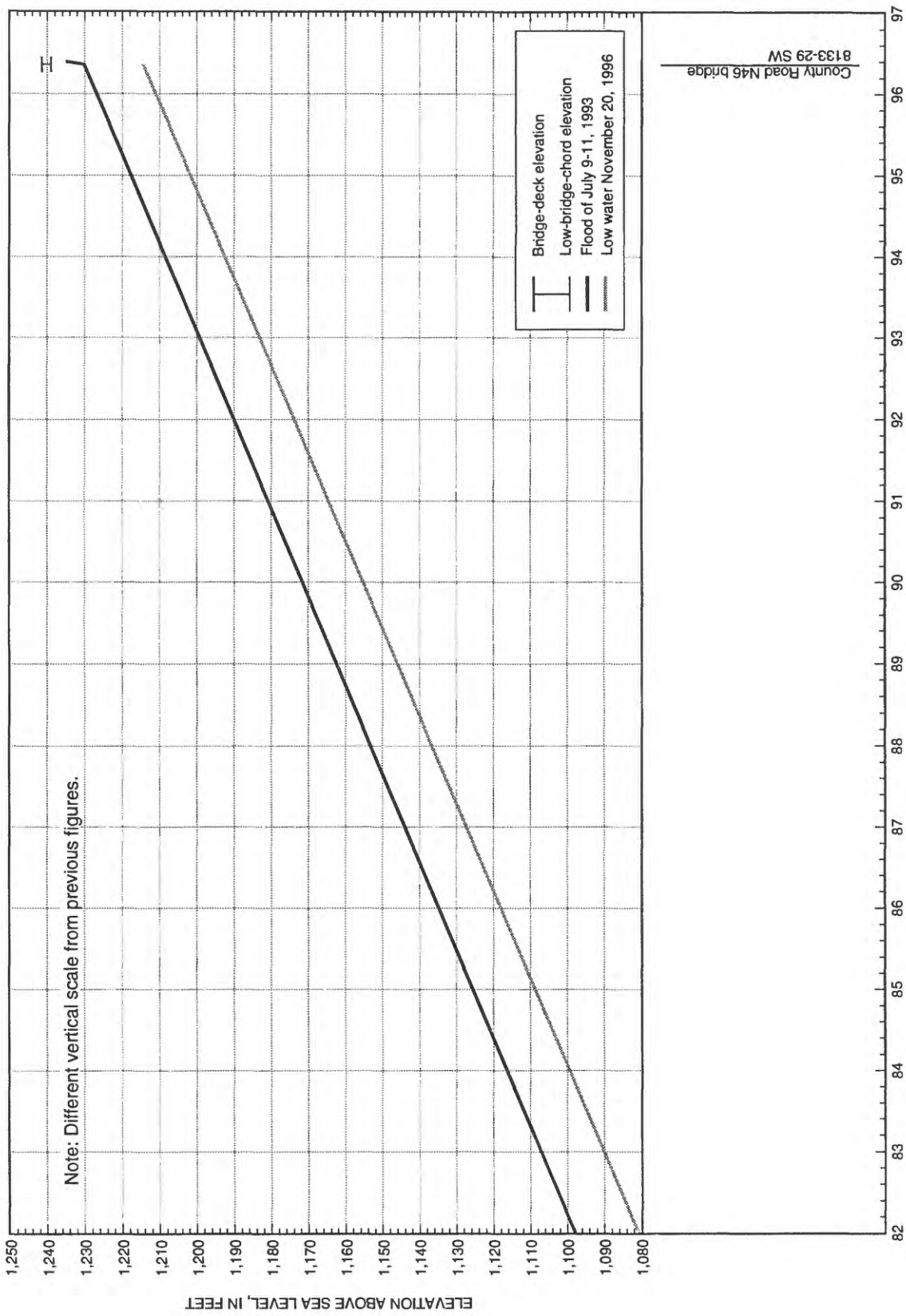
Figure 11C. Water-surface-elevation profiles for the South Raccoon River, river miles 60-75.





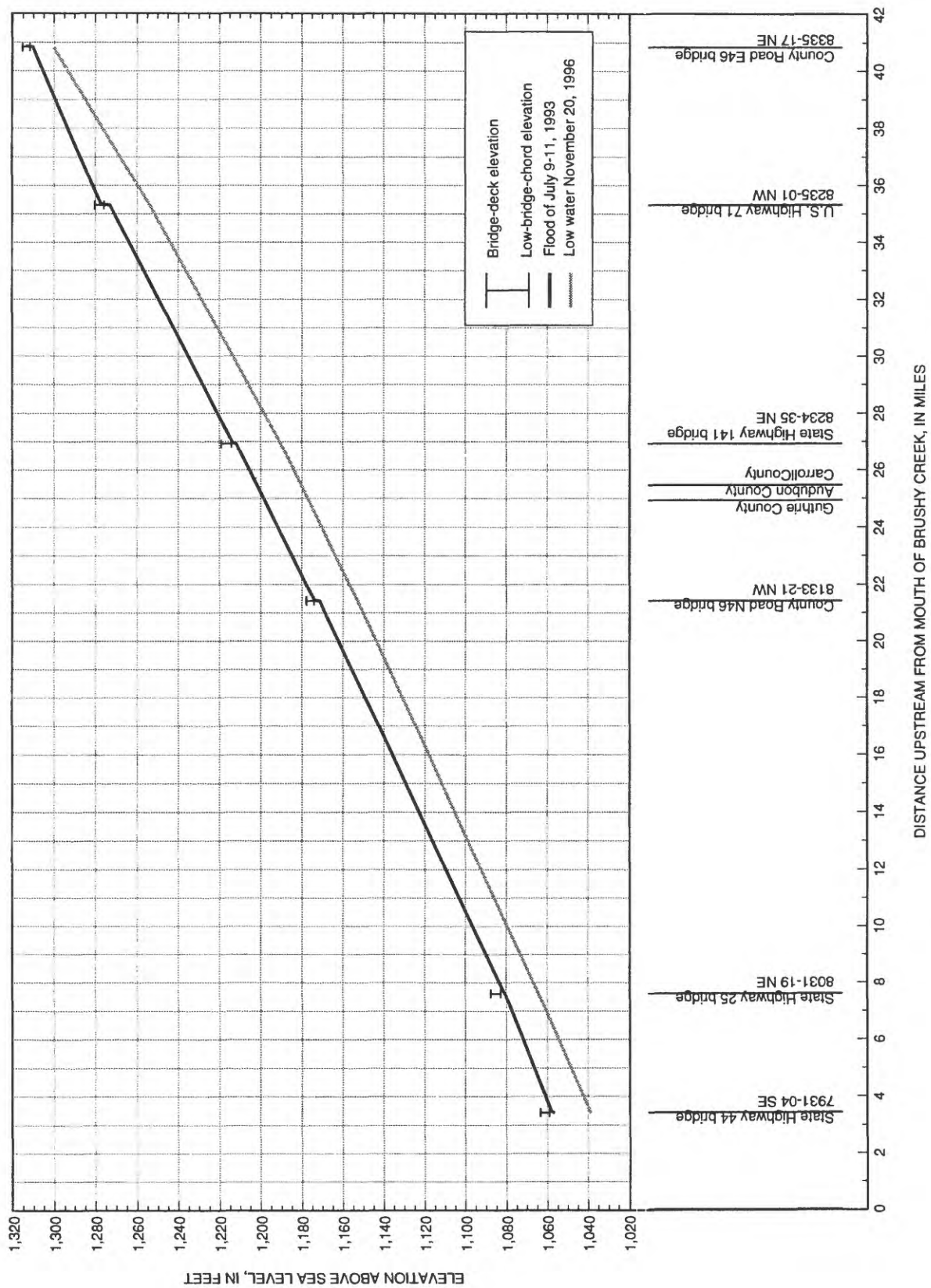
**Figure 11D.** Water-surface-elevation profiles for the South Raccoon River, river miles 75-90.





DISTANCE UPSTREAM FROM MOUTH OF RACCOON RIVER, IN MILES

Figure 11E. Water-surface-elevation profiles for the South Raccoon River, river miles 82-96.36.



**Figure 12.** Water-surface-elevation profiles for Brushy Creek, river miles 3.44-40.84.

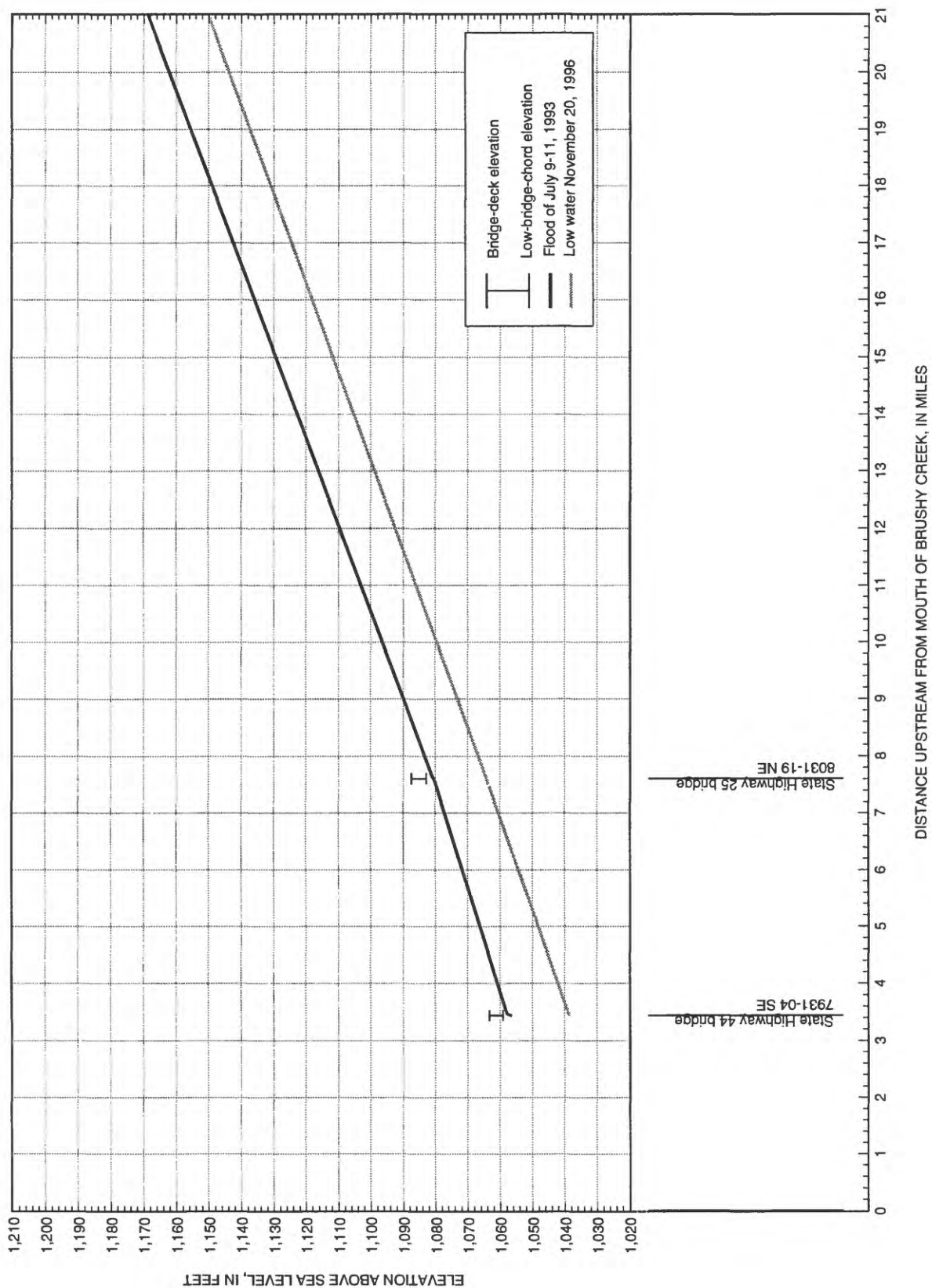
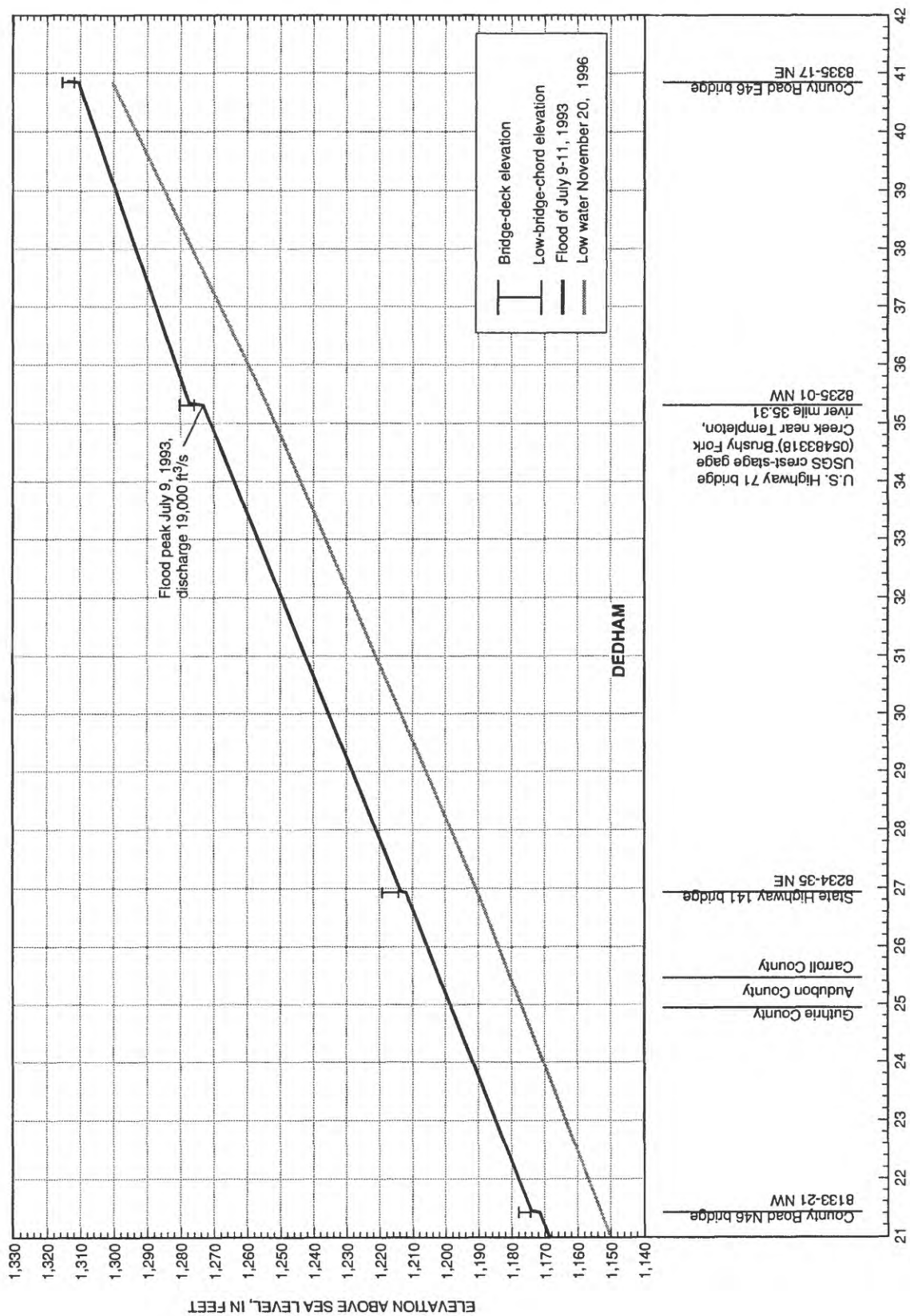
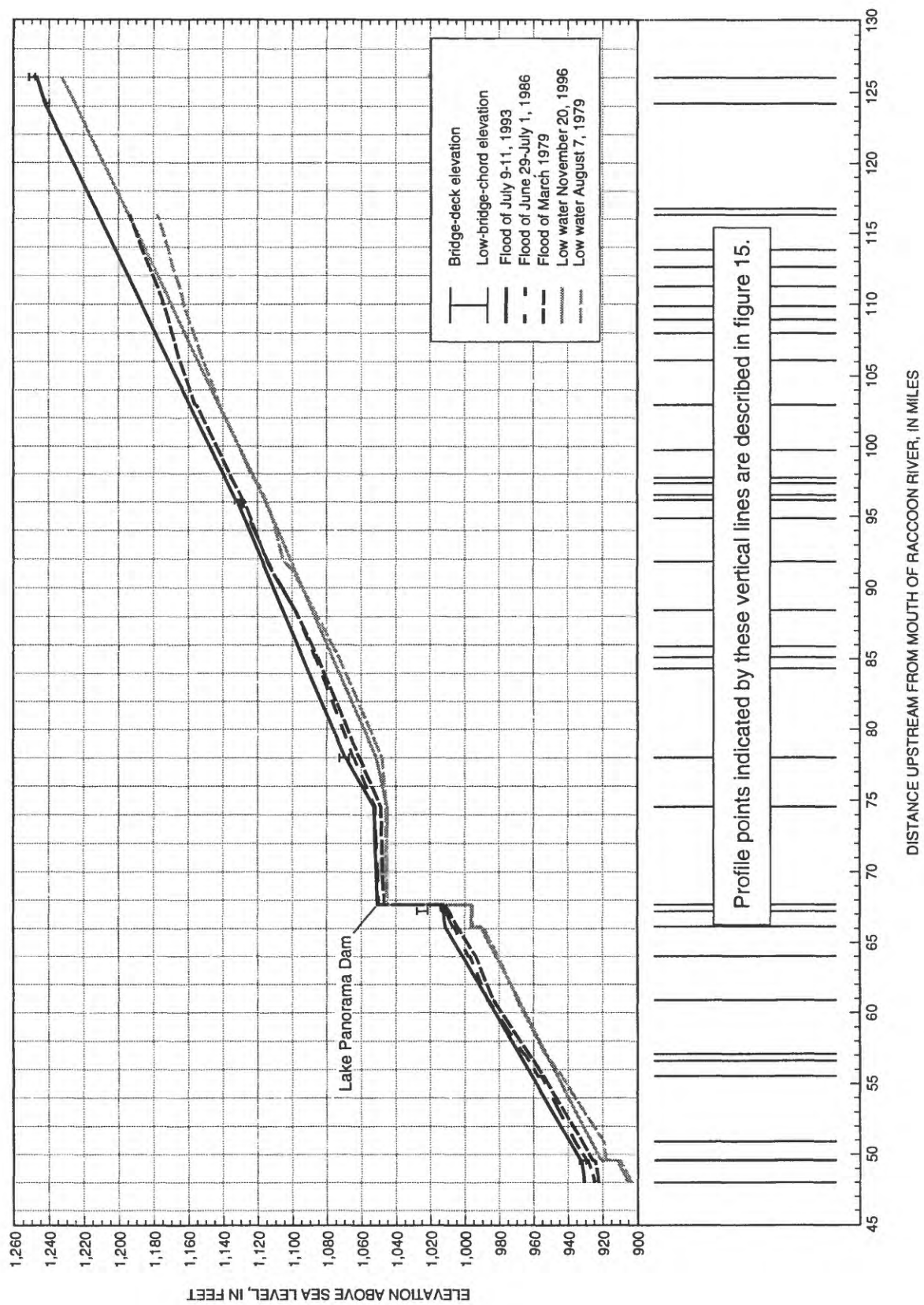


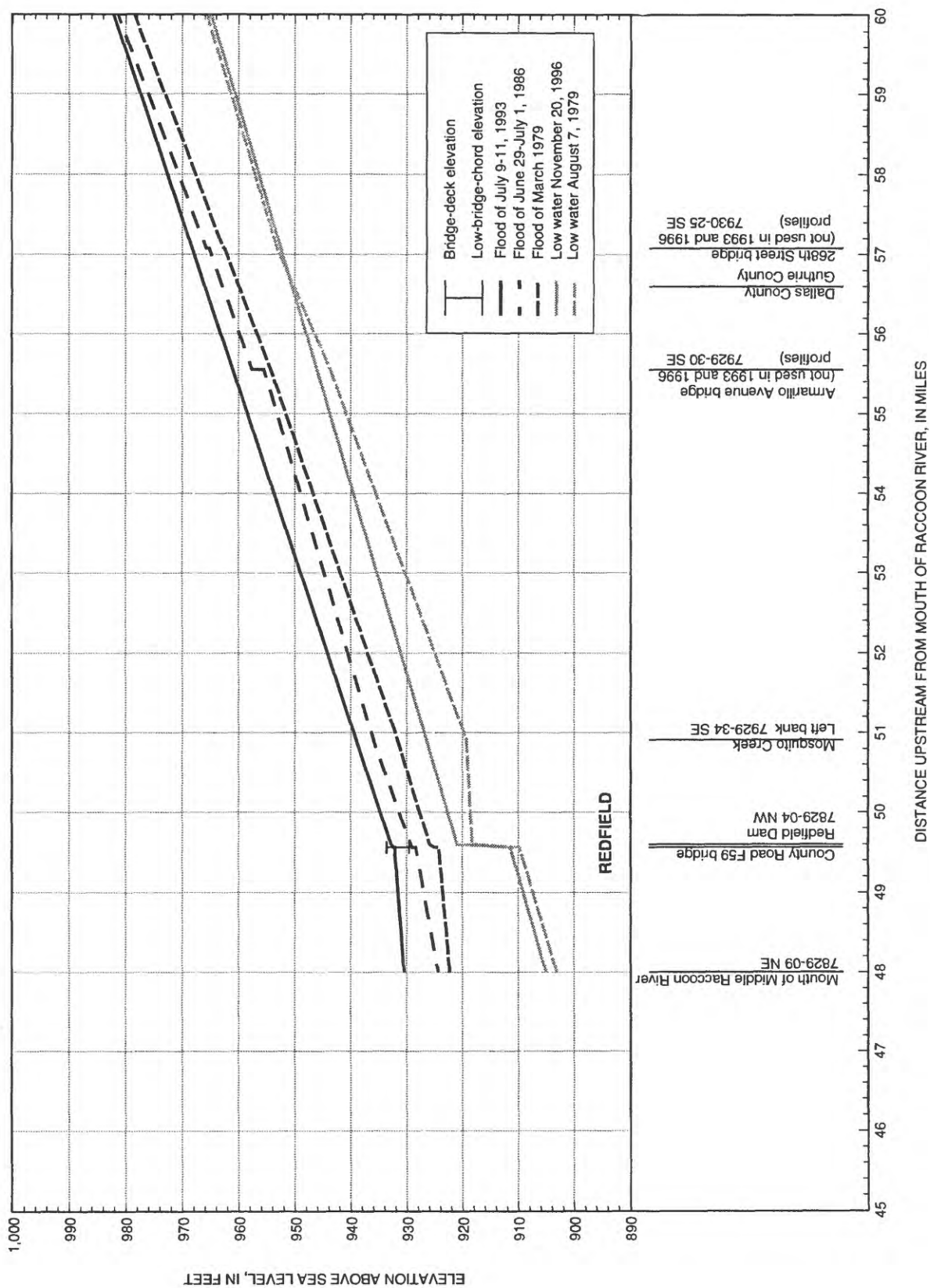
Figure 13A. Water-surface-elevation profiles for Brushy Creek, river miles 3.44-21.



**Figure 13B.** Water-surface-elevation profiles for Brushy Creek, river miles 21-40.84.



**Figure 14.** Water-surface-elevation profiles for the Middle Raccoon River, river miles 48-126.03.



**Figure 15A. Water-surface-elevation profiles for the Middle Raccoon River, river miles 48-60.**



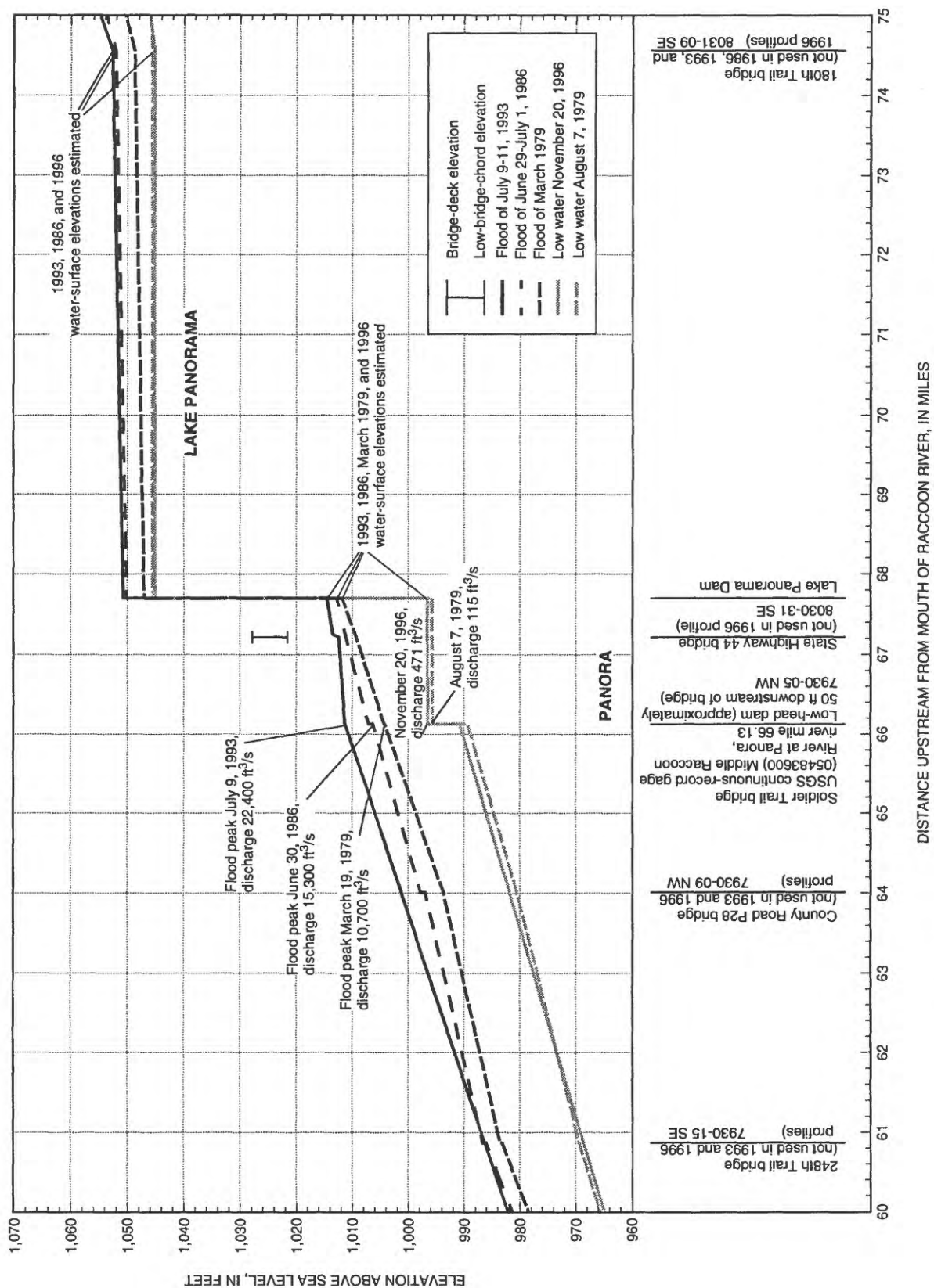
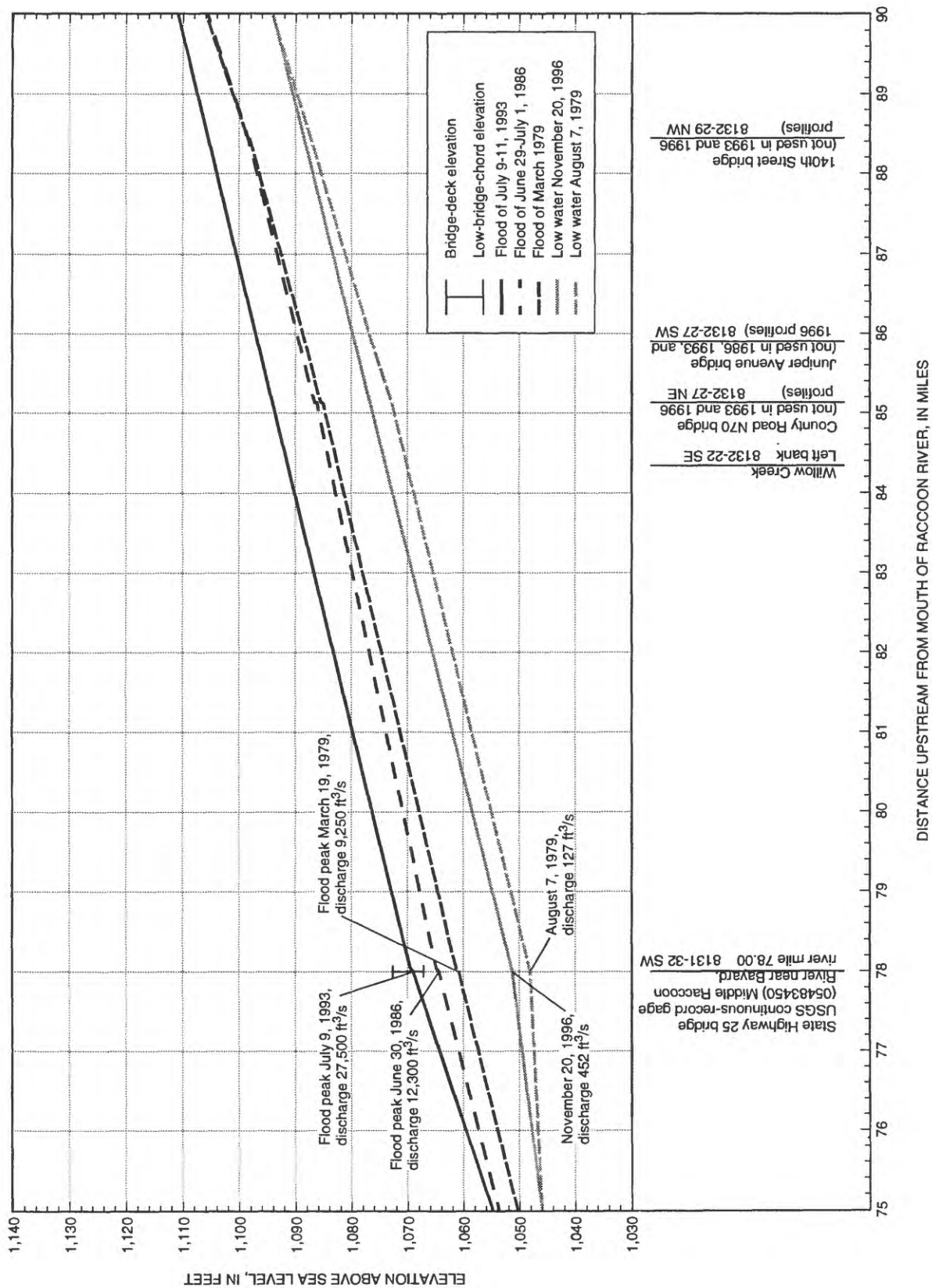


Figure 15B. Water-surface-elevation profiles for the Middle Raccoon River, river miles 60-75.



**Figure 15C.** Water-surface-elevation profiles for the Middle Raccoon River, river miles 75-90.



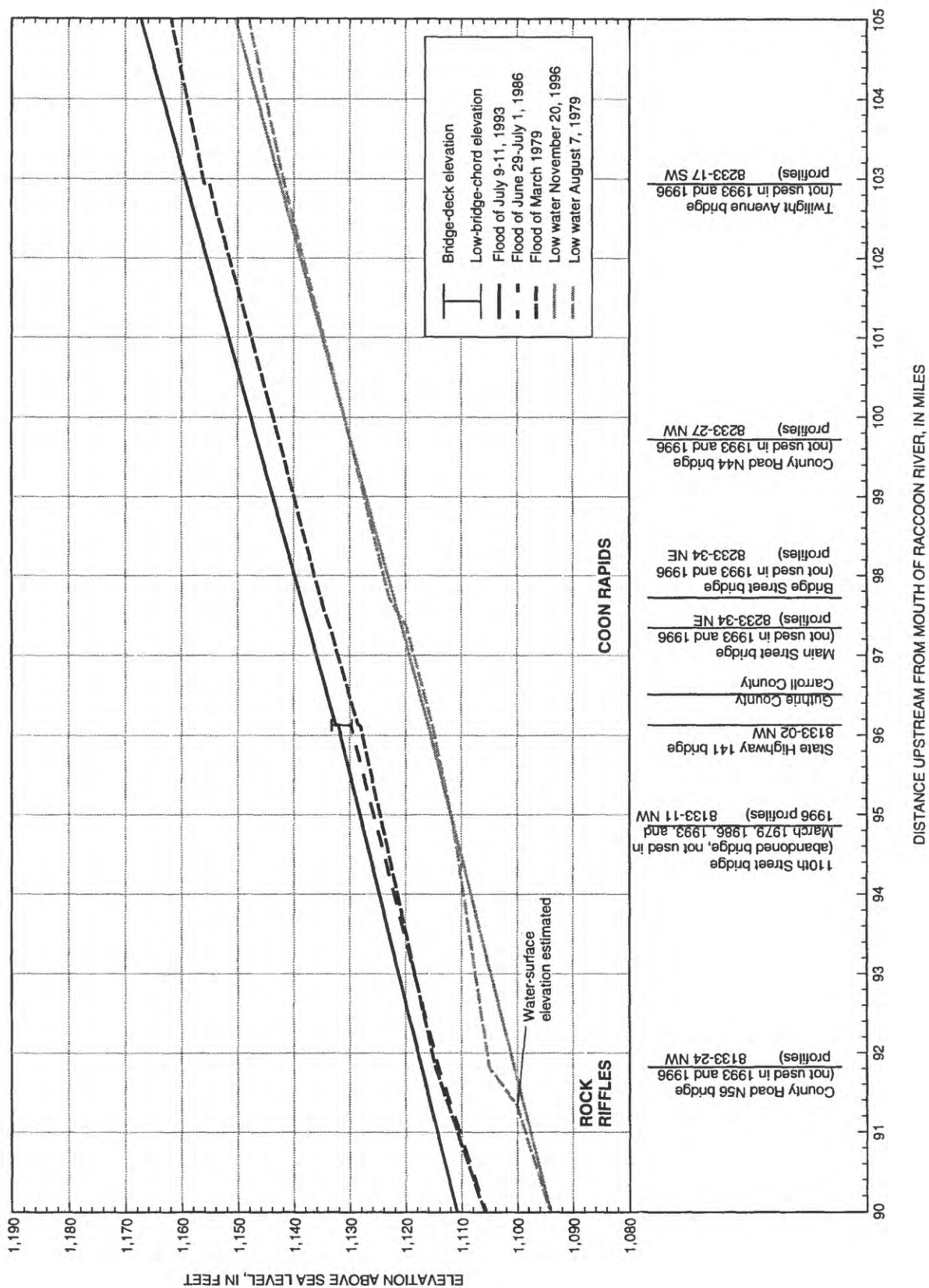
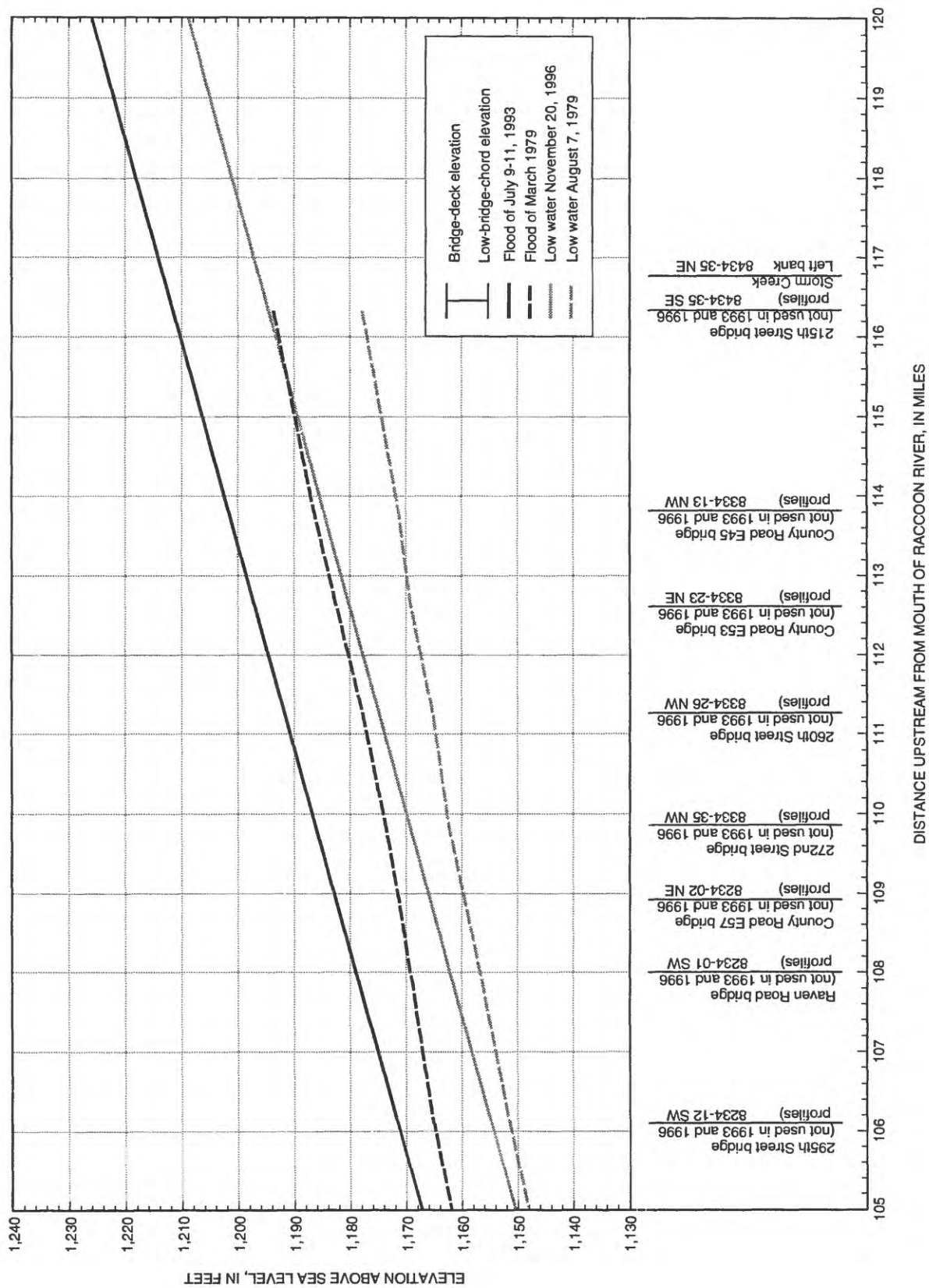
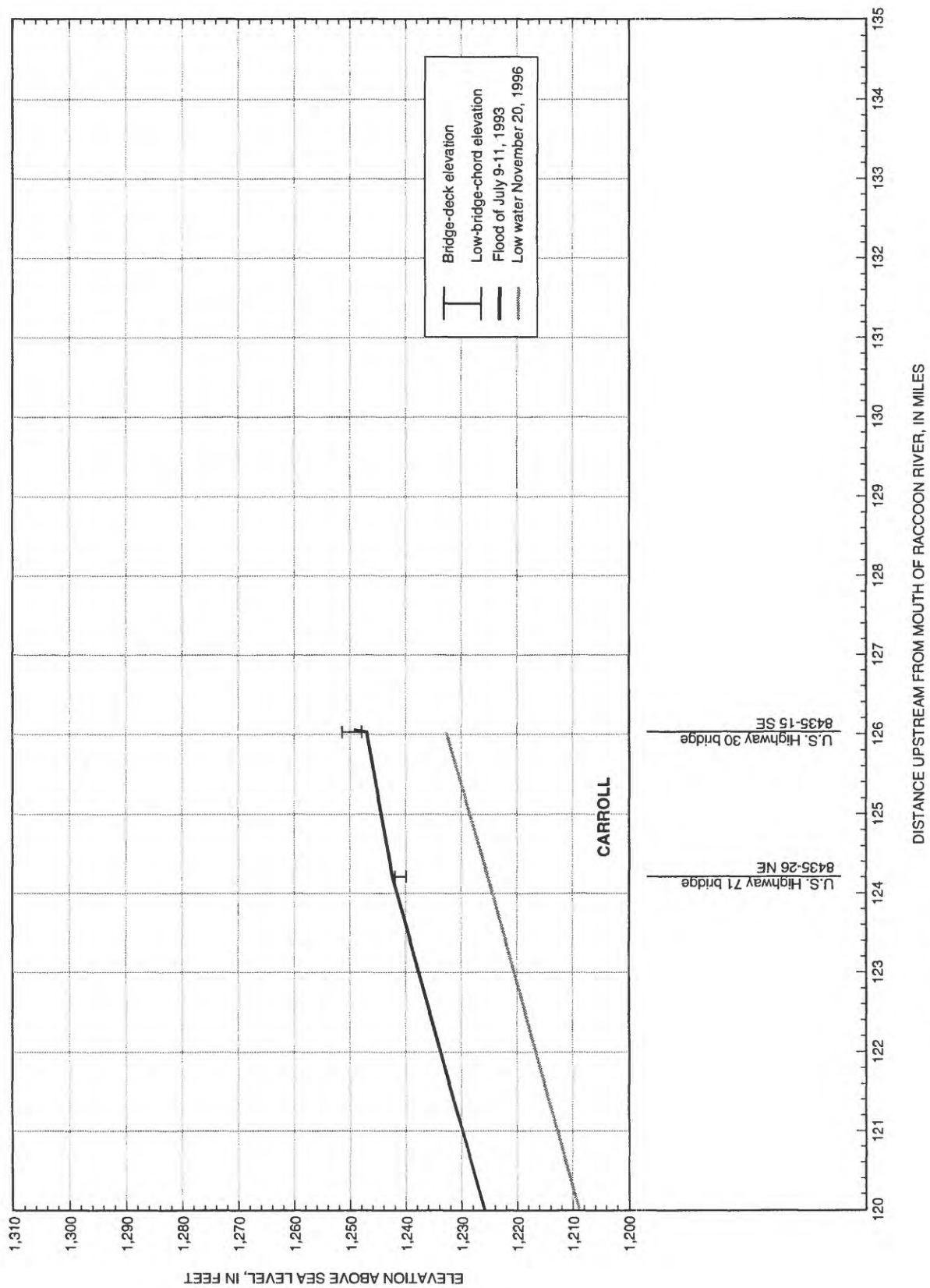


Figure 15D. Water-surface-elevation profiles for the Middle Raccoon River, river miles 90-105.



**Figure 15E.** Water-surface-elevation profiles for the Middle Raccoon River, river miles 105-120.



**Figure 15F.** Water-surface-elevation profiles for the Middle Raccoon River, river miles 120-126.03.

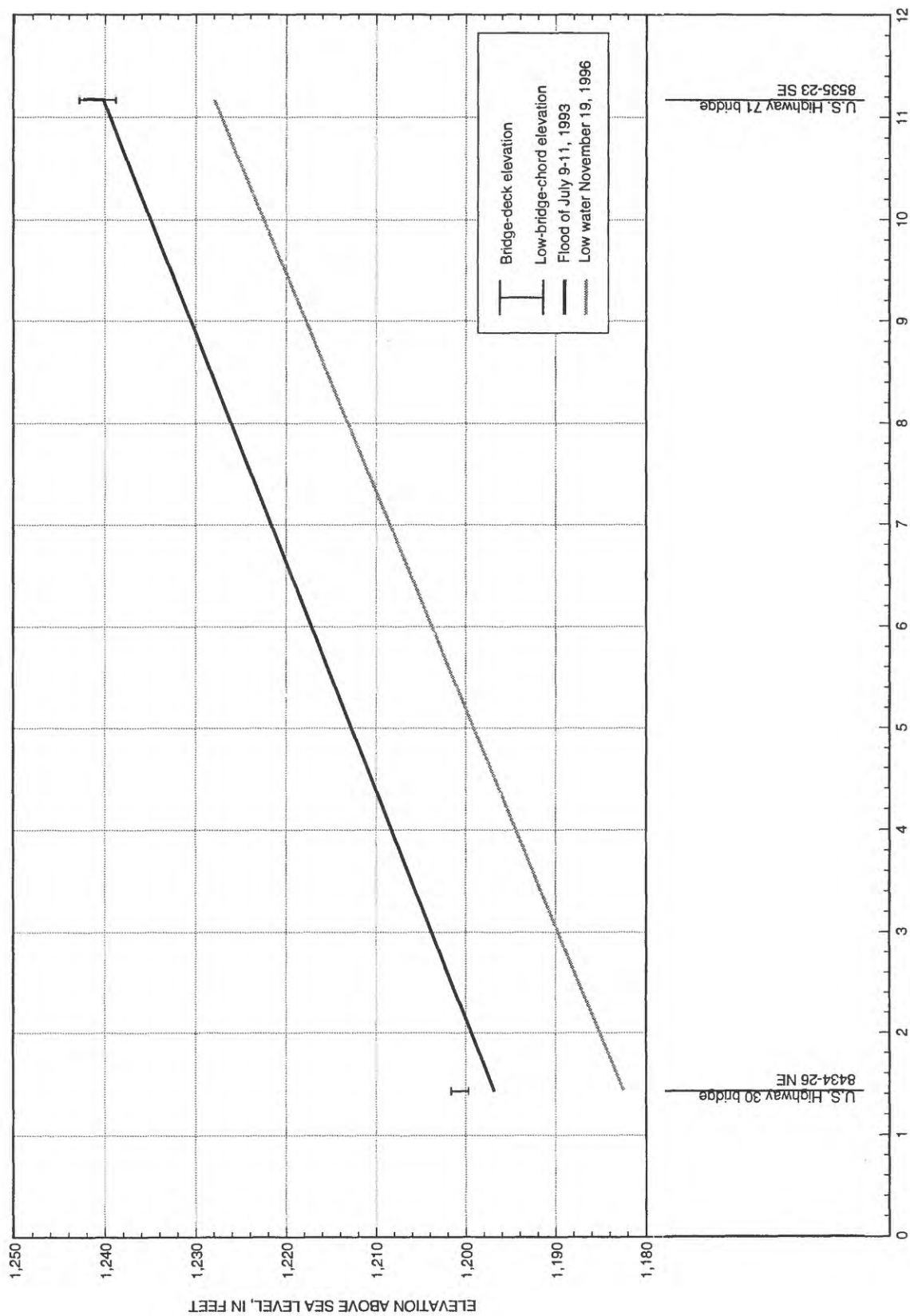


Figure 16. Water-surface-elevation profiles for Storm Creek, river miles 1.43-11.17.



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## APPENDIX C

### TEMPORARY BENCH MARKS AND REFERENCE POINTS IN THE RACCOON RIVER BASIN, WEST-CENTRAL IOWA

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To facilitate measuring and referencing the high-water marks used in the flood profiles to a common datum, temporary bench marks (BM) and reference points (RP) were established by the USGS at many of the bridges along the profiled river reaches. All BM and RP elevations listed in this tabulation are referenced to sea level. BMs and RPs are listed only for those bridges used in the July 9-11, 1993, flood profiles. The BMs and RPs were established in the Raccoon River Basin during 1976-79 and 1995-97, with the exception of BMs and RPs established at USGS streamflow-gaging stations, which are identified in this tabulation with a reference mark (RM) or RP number. BMs and RPs for other bridges used in the 1979 and 1986 flood profiles are listed in the reports "Floods in the Raccoon River Basin, Iowa" (Heinitz, 1980) and "Floods of 1986 and 1990 in the Raccoon River Basin, West-Central Iowa" (Baebenroth and Schaap, 1992). BM and RP elevations were determined from differential leveling, with the exception of the U.S. Highway 71 culvert crossing Storm Creek, where BM and RP elevations were determined using a Global Positioning System (GPS). Level lines to establish the third-order accuracy of the BMs and RPs shown herein were surveyed from bench marks established and adjusted by the National Mapping Division of the USGS and the National Geodetic Survey. Errors of closure in the USGS level work were adjusted along the level lines to balance the BM and RP elevations. BMs and RPs established by other agencies are noted in the bench-mark descriptions where they occur.

The BMs and RPs are designated by an index number derived from their respective locations using Public Land Survey System coordinates (township, range, section). Within the section, the quarter in which the BM or RP is located is designated by NE, SE, SW, or NW. For example, 7824-10 NW refers to a location in Township 78 North, Range 24 West, northwest quarter of section 10. A number in parentheses following the quarter-section designation indicates the number of the BM or RP in that particular quarter section. The index number serves to describe the landline location of the BM or RP without further reference in the body of the description.

Standard BMs and RPs such as chiseled squares, arrows, or crosses on concrete; filed arrows or marks on steel; or existing bolts on bridges were used. Existing BMs or RPs were used wherever available, and the agency responsible for the mark, when known, is indicated in the description. RPs are distinguished from BMs in this tabulation by the notation "(REFERENCE POINT)" following the index number. RPs were established to permit water-surface elevations to be determined by use of a tape and weight. The terms "right" and "left" in the descriptions are determined as viewed while facing in the downstream direction.

The user is cautioned that the BMs and RPs listed herein might have been disturbed, destroyed, or moved since the surveys were made. It is the responsibility of the user to determine the condition and the suitability of the BM or RP.

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## TEMPORARY BENCH MARKS AND REFERENCE POINTS IN THE RACCOON RIVER BASIN, WEST-CENTRAL IOWA

**7824-08 NE (1)** - At Des Moines, on Fleur Drive bridge over Raccoon River, on right upstream wingwall; chiseled square. (RM 2)

**Elevation 813.90 ft.**

**7824-08 NE (2)** - (REFERENCE POINT) At Des Moines, on Fleur Drive bridge over Raccoon River, on downstream guardrail between 1st and 2nd guardrail posts right of 4th pier from right end of bridge; chiseled arrow.

**Elevation 829.05 ft.**

**7825-14 NE (1)** - At Des Moines-West Des Moines municipal boundary, on northbound lane of S.W. 63rd Street (State Highway 28) bridge over Raccoon River (downstream bridge), on right downstream wingwall; Iowa Department of Transportation bench mark. Elevation obtained from Iowa Department of Transportation.

**Elevation 843.85 ft.**

**7825-14 NE (2)** - (REFERENCE POINT) At Des Moines-West Des Moines municipal boundary, on southbound lane of S.W. 63rd Street (State Highway 28) bridge over Raccoon River (upstream bridge), on 15th guardrail post from left downstream end of bridge; chiseled arrow.

**Elevation 831.75 ft.**

**7825-30 SE (1)** - At West Des Moines, on northbound lane of Interstate 35 bridge over Raccoon River (downstream bridge), on left downstream wingwall curb; chiseled cross.

**Elevation 835.70 ft.**

**7825-30 SE (2)** - (REFERENCE POINT) At West Des Moines, on northbound lane of Interstate 35 bridge over Raccoon River (downstream bridge), on 35th guardrail post from left downstream end of bridge; filed arrow.

**Elevation 839.03 ft.**

**7826-30 SE (1)** - Approximately 0.3 mi west of Booneville, on County Road F90 bridge over Raccoon River, on right downstream curb; Iowa Highway Commission bench mark.

**Elevation 863.18 ft.**

**7826-30 SE (2)** - (REFERENCE POINT) Approximately 3.0 mi west of Booneville, on County Road F90 bridge over Raccoon River, on top of 27th guardrail post from right downstream end of bridge; three chiseled marks.

**Elevation 865.69 ft.**

**7827-18 NW (1)** - Approximately 4.0 mi south of Adel, on U.S Highway 169 bridge over South Raccoon River, on right upstream wingwall curb; Iowa Highway Commission bench mark. Elevation obtained from Dallas County Engineer.

**Elevation 885.24 ft.**

**7827-18 NW (2)** - Approximately 4.0 mi south of Adel, on U.S Highway 169 bridge over South Raccoon River, on top of concrete guardrail at left upstream wingwall; Iowa Highway Commission bench mark.

**Elevation 887.02 ft.**

**7827-18 NW (3)** - (REFERENCE POINT) Approximately 4.0 mi south of Adel, on U.S. Highway 169 bridge over South Raccoon River, near 21st old guardrail post hole from left downstream end of bridge; chiseled arrow.

**Elevation 886.02 ft.**

**7827-20 NW (1)** - Approximately 2.0 mi northwest of Van Meter, on westbound lane of Interstate 80 bridge over South Raccoon River (upstream bridge), on left upstream wingwall curb; Iowa Highway Commission bench mark.

**Elevation 879.05 ft.**

**7827-20 NW (2)** - Approximately 2.0 mi northwest of Van Meter, on westbound lane of Interstate 80 bridge over South Raccoon River (upstream bridge), on right upstream curb; chiseled cross.

**Elevation 880.30 ft.**

**7827-20 NW (3)** - (REFERENCE POINT) Approximately 2.0 mi northwest of Van Meter, on eastbound lane of Interstate 80 bridge over South Raccoon River (downstream bridge), on top of 30th guardrail post from left downstream end of bridge; filed arrow.

**Elevation 881.17 ft.**

**7827-21 NW (1)** - Approximately 1.5 mi northeast of Van Meter, on eastbound lane of Interstate 80 bridge over North Raccoon River (downstream bridge), on right downstream wingwall; Iowa Highway Commission bench mark.

**Elevation 875.64 ft.**

**7827-21 NW (2)** - (REFERENCE POINT) Approximately 1.5 mi northeast of Van Meter, on eastbound lane of Interstate 80 bridge over North Raccoon River (downstream bridge), on top of 35th guardrail post from right downstream end of bridge; chiseled arrow.

**Elevation 877.38 ft.**



**7827-22 SW (1)** - Approximately 0.3 mi northeast of Van Meter, on County Road R16 bridge over Raccoon River, on right downstream bridge seat and 10 ft upstream of gage house; chiseled square. (RM 15)

**Elevation 866.11 ft.**

**7827-22 SW (2)** - Approximately 0.3 mi northeast of Van Meter, on County Road R16 bridge over Raccoon River, on right downstream wingwall; chiseled square. (RM 16)

**Elevation 870.34 ft.**

**7827-22 SW (3)** - (REFERENCE POINT) Approximately 0.3 mi northeast of Van Meter, on County Road R16 bridge over Raccoon River, on top of guardrail and 1 ft right of wire weight; two chiseled marks. (RP 3)

**Elevation 872.35 ft.**

**7829-02 NE (1)** - Approximately 2.2 mi east of Redfield, on H Avenue bridge over South Raccoon River, set in concrete 6 in. above ground and 3 ft southwest of gage house; U.S. Geological Survey bench mark. (RM 4)

**Elevation 914.94 ft.**

**7829-02 NE (2)** - Approximately 2.2 mi east of Redfield, on H Avenue bridge over South Raccoon River, on top of left upstream abutment; chiseled square. (RM 1)

**Elevation 924.66 ft.**

**7829-02 NE (3)** - (REFERENCE POINT) Approximately 2.2 mi east of Redfield, on H Avenue bridge over South Raccoon River, on top of 20th guardrail post from left downstream end of bridge; chiseled arrow. (RP 1)

**Elevation 925.96 ft.**

**7829-09 NE (1)** - Approximately 1.0 mi south of Redfield, on U.S Highway 6 bridge over South Raccoon River, on left upstream wingwall; Iowa Highway Commission bench mark.

**Elevation 938.02 ft.**

**7829-09 NE (2)** - Approximately 1.0 mi south of Redfield, on U.S Highway 6 bridge over South Raccoon River, on right downstream wingwall; Iowa Highway Commission bench mark.

**Elevation 938.24 ft.**

**7829-09 NE (3)** - (REFERENCE POINT) Approximately 1.0 mi south of Redfield, on U.S. Highway 6 bridge over South Raccoon River, on top of and at center of 10th concrete guardrail section from left downstream end of bridge; chiseled arrow.

**Elevation 939.28 ft.**

**7830-05 SE (1)** - Approximately 5.5 mi southwest of Linden, on County Road P28 bridge over South Raccoon River, on left upstream wingwall curb; top of nail.

**Elevation 990.46 ft.**

**7830-05 SE (2)** - (REFERENCE POINT) Approximately 5.5 mi southwest of Linden, on County Road P28 bridge over South Raccoon River, on top of and at middle of downstream concrete guardrail (four concrete sections from right and four concrete sections from left ends of bridge); chiseled arrow.

**Elevation 990.75 ft.**

**7927-06 NE (1)** - Approximately 5 mi north of Adel, on State Highway 44 bridge over North Raccoon River, on left downstream wingwall curb; Iowa Highway Commission bench mark.

**Elevation 952.84 ft.**

**7927-06 NE (2)** - Approximately 5 mi north of Adel, on State Highway 44 bridge over North Raccoon River, on left downstream wingwall; Iowa Department of Transportation bench mark.

**Elevation 954.81 ft.**

**7927-06 NE (3)** - (REFERENCE POINT) Approximately 5 mi north of Adel, on State Highway 44 bridge over North Raccoon River, left of 48th old guardrail post hole and 426 ft from right downstream end of bridge; chiseled "⊥".

**Elevation 936.39 ft.**

**7927-20 SW (1)** - Approximately 1.3 mi north of Adel, on U.S. Highway 169 bridge over North Channel of North Raccoon River, on right downstream wingwall; Iowa Highway Commission bench mark.

**Elevation 901.82 ft.**

**7927-20 SW (2)** - (REFERENCE POINT) Approximately 1.3 mi north of Adel, on U.S. Highway 169 bridge over North Channel of North Raccoon River, on curb on outside of guardrail at center of downstream side of bridge and 270 ft from right end of bridge; chiseled arrow.

**Elevation 899.72 ft.**

**7927-29 SE (1)** - At Adel, on U.S. Highway 6 bridge over North Raccoon River, on right upstream wingwall; Iowa Highway Commission bench mark.

**Elevation 895.36 ft.**

**7927-29 SE (2)** - (REFERENCE POINT) At Adel, on U.S. Highway 6 bridge over North Raccoon River, near base of lamppost on downstream guardrail; chiseled arrow.

**Elevation 895.89 ft.**

**7930-05 NW (1)** - Approximately 0.2 mi southwest of Panora, on Soldier Trail bridge over Middle Raccoon River, on top of left downstream abutment pile cap; chiseled square. (RM 5)

**Elevation 1,015.81 ft.**

**7930-05 NW (2)** - Approximately 0.2 mi southwest of Panora, on Soldier Trail bridge over Middle Raccoon River, on top of left upstream abutment pile cap; chiseled square. (RM 6)

**Elevation 1,015.77 ft.**

**7931-04 SE (1)** - Approximately 1.8 mi east of Guthrie Center, on State Highway 44 bridge over Brushy Creek, on right downstream wingwall; chiseled square.

**Elevation 1066.58 ft.**

**7931-04 SE (2)** - Approximately 1.8 mi east of Guthrie Center, on State Highway 44 bridge over Brushy Creek, on left upstream wingwall; chiseled cross.

**Elevation 1066.12 ft.**

**7931-04 SE (3)** - (REFERENCE POINT) Approximately 1.8 mi east of Guthrie Center, on State Highway 44 bridge over Brushy Creek, on downstream guardrail and 73 ft from right end of bridge; chiseled arrow.

**Elevation 1,065.29 ft.**

**7931-06 SW (1)** - At west edge of Guthrie Center, on State Highway 44 bridge over South Raccoon River, on right upstream wingwall; Iowa Highway Commission bench mark.

**Elevation 1,080.05 ft.**

**7931-06 SW (2)** - (REFERENCE POINT) At west edge of Guthrie Center, on State Highway 44 bridge over South Raccoon River, on top of 5th upstream concrete guardrail section and approximately 64 ft from right end of bridge; chiseled arrow.

**Elevation 1,080.63 ft.**

**7931-07 NE (1)** - Near south edge of Guthrie Center, on State Highway 25 bridge over South Raccoon River, on right downstream bridge abutment; Iowa Department of Transportation bench mark.

**Elevation 1,076.98 ft.**

**7931-07 NE (2)** - Near south edge of Guthrie Center, on State Highway 25 bridge over South Raccoon River, on left upstream bridge abutment; Iowa Department of Transportation bench mark.

**Elevation 1,076.95 ft.**

**7931-07 NE (3)** - (REFERENCE POINT) Near south edge of Guthrie Center, on State Highway 25 bridge over South Raccoon River, on downstream concrete guardrail 57 ft from right end of bridge; chiseled arrow.

**Elevation 1,077.18 ft.**

**8030-31 SE (1)** - Approximately 0.7 mi west of Panora, on State Highway 44 bridge over Middle Raccoon River, on right downstream wingwall curb; Iowa Highway Commission bench mark.

**Elevation 1,036.19 ft.**

**8030-31 SE (2)** - Approximately 0.7 mi west of Panora, on State Highway 44 bridge over Middle Raccoon River, on left upstream wingwall curb; Iowa Highway Commission bench mark.

**Elevation 1,029.93 ft.**

**8031-19 NE (1)** - Approximately 2.8 mi north of Guthrie Center, on State Highway 25 bridge over Brushy Creek, on left upstream wingwall; Iowa Highway Commission bench mark.

**Elevation 1,089.88 ft.**

**8031-19 NE (2)** - Approximately 2.8 mi north of Guthrie Center, on State Highway 25 bridge over Brushy Creek, on right downstream wingwall; chiseled square.

**Elevation 1,090.42 ft.**

**8031-19 NE (3)** - (REFERENCE POINT) Approximately 2.8 mi north of Guthrie Center, on State Highway 25 bridge over Brushy Creek, on downstream guardrail 114 ft from right end of bridge; chiseled arrow.

**Elevation 1,090.44 ft.**

**8128-08 SE (1)** - Approximately 1.5 mi west of Perry, on State Highway 141 bridge over North Raccoon River, on left upstream wingwall curb; Iowa Highway Commission bench mark.

**Elevation 944.53 ft.**

**8128-08 SE (2)** - (REFERENCE POINT) Approximately 1.5 mi west of Perry, on State Highway 141 bridge over North Raccoon River, left of 11th old guardrail post hole from left downstream end of bridge; top of bolt.

**Elevation 944.40 ft.**

**8131-32 SW (1)** - Approximately 5.8 mi southeast of Bayard, on State Highway 25 bridge over Middle Raccoon River, on top of left end of downstream concrete barrier of bridge, chiseled square. (RM9)

**Elevation 1,074.84 ft.**

**8131-32 SW (2)** - Approximately 5.8 mi southeast of Bayard, on State Highway 25 bridge over Middle Raccoon River, set 1 ft south of gage house; U.S. Geological Survey bench mark. (RM11)

**Elevation 1,067.67 ft.**

**8133-02 NW (1)** - Approximately 1.0 mi southeast of Coon Rapids, on State Highway 141 bridge over Middle Raccoon River, on left upstream wingwall; Iowa Department of Transportation bench mark.

**Elevation 1,136.13 ft**

**8133-02 NW (2)** - (REFERENCE POINT) Approximately 1.0 mi southeast of Coon Rapids, on State Highway 141 bridge over Middle Raccoon River, on top of 16th guardrail post from right downstream end of bridge; filed arrow.

**Elevation 1,136.10 ft.**

**8133-21 NW (1)** - Approximately 3.7 mi southwest of Coon Rapids, on County Road N46 bridge over Brushy Creek, on left downstream wingwall; chiseled square.

**Elevation 1,180.62 ft.**

**8133-21 NW (2)** - Approximately 3.7 mi southwest of Coon Rapids, on County Road N46 bridge over Brushy Creek, on right upstream wingwall; chiseled cross.

**Elevation 1,180.62 ft.**

**8133-21 NW (3)** - (REFERENCE POINT) Approximately 3.7 mi southwest of Coon Rapids, on County Road N46 bridge over Brushy Creek, on top of 8th concrete guardrail post from right downstream end of bridge; chiseled arrow.

**Elevation 1,180.77 ft.**

**8133-29 SW (1)** - Approximately 5.7 mi southwest of Coon Rapids, on County Road N46 bridge over South Raccoon River, on right upstream wingwall; chiseled square.

**Elevation 1,244.41 ft.**

**8133-29 SW (2)** - Approximately 5.7 mi southwest of Coon Rapids, on County Road N46 bridge over South Raccoon River, on left downstream wingwall curb; chiseled cross.

**Elevation 1,242.37 ft.**

**8133-29 SW (3)** - (REFERENCE POINT) Approximately 5.7 mi southwest of Coon Rapids, on County Road N46 bridge over South Raccoon River, on right side of 4th concrete guardrail post from left downstream end of bridge; chiseled arrow.

**Elevation 1,245.04**

**8229-18 SW (1)** - Approximately 4.0 mi east of Cooper, on County Road E57 bridge over North Raccoon River, on right downstream wingwall; bolt in concrete.

**Elevation 969.03 ft.**

**8229-18 SW (2)** - Approximately 4.0 mi east of Cooper, on County Road E57 bridge over North Raccoon River, on left upstream wingwall; bolt in concrete.

**Elevation 969.00 ft.**

**8229-18 SW (3)** - (REFERENCE POINT) Approximately 4.0 mi east of Cooper, on County Road E57 bridge over North Raccoon River, on top of 21st guardrail post from right downstream end of bridge; chiseled arrow.

**Elevation 970.70 ft.**

**8234-35 NE (1)** - Approximately 3.3 mi southeast of Dedham, on State Highway 141 bridge over Brushy Creek, on left downstream wingwall; Iowa Highway Commission bench mark.

**Elevation 1,221.67 ft.**

**8234-35 NE (2)** - Approximately 3.3 mi southeast of Dedham, on State Highway 141 bridge over Brushy Creek, on left upstream wingwall; chiseled cross.

**Elevation 1,221.60 ft.**

**8234-35 NE (3)** - (REFERENCE POINT) Approximately 3.3 mi southeast of Dedham, on State Highway 141 bridge over Brushy Creek, 111 ft from left downstream end of bridge; chiseled arrow.

**Elevation 1,219.92 ft.**

**8235-01 NW (1)** - Approximately 4 mi northeast of Templeton, on U.S. Highway 71 bridge over Brushy Creek, on left downstream abutment; U.S. Geological Survey brass tablet stamped "41 PJH 1969."

**Elevation 1,286.295 ft.**

**8235-01 NW (2)** - Approximately 4 mi northeast of Templeton, on U.S. Highway 71 bridge over Brushy Creek, on left upstream abutment; chiseled cross.

**Elevation 1,286.34 ft.**

**8235-01 NW (3)** - (REFERENCE POINT) Approximately 4 mi northeast of Templeton, on U.S. Highway 71 bridge over Brushy Creek, on top of downstream concrete guardrail 108 ft from left end of bridge; chiseled arrow.

**Elevation 1,284.15 ft.**

**8330-20 NW (1)** - Approximately 1.9 mi south of Jefferson, on State Highway 4 bridge over North Raccoon River, on top of right downstream guardrail; Iowa Highway Commission bench mark. (RM 12)

**Elevation 1,010.00 ft.**

**8330-20 NW (2)** - Approximately 1.9 mi south of Jefferson, on State Highway 4 bridge over North Raccoon River, set in cement 8 ft east of gage house; U.S. Geological Survey bench mark. (RM 15)

**Elevation 1,006.70 ft.**

**8331-04 NW (1)**- Approximately 4.6 mi northwest of Jefferson, on U.S. Highway 30 bridge over North Raccoon River, on left upstream wingwall curb; chiseled square.

**Elevation 1,020.16 ft.**

**8331-04 NW (2)**- Approximately 4.6 mi northwest of Jefferson, on U.S. Highway 30 bridge over North Raccoon River, on right upstream wingwall curb; chiseled cross.

**Elevation 1,016.40 ft.**

**8335-17 NE (1)** -Approximately 1.2 mi west of Roselle, on County Road E46 bridge over Brushy Creek, on left upstream wingwall; chiseled square.

**Elevation 1,318.21 ft.**

**8335-17 NE (2)** -(REFERENCE POINT) Approximately 1.2 mi west of Roselle, on County Road E46 bridge over Brushy Creek, 26 ft from left upstream end of bridge; chiseled mark.

**Elevation 1,318.10 ft.**

**8434-26 NE (1)** - Approximately 4.1 mi east of Carroll, on U.S. Highway 30 bridge over Storm Creek, on right downstream wingwall; chiseled square.

**Elevation 1,204.55 ft.**

**8434-26 NE (2)** - Approximately 4.1 mi east of Carroll, on U.S. Highway 30 bridge over Storm Creek, on left upstream wingwall curb; chiseled cross.

**Elevation 1,202.27 ft.**

**8434-26 NE (3)** - (REFERENCE POINT) Approximately 4.1 mi east of Carroll, on U.S. Highway 30 bridge over Storm Creek, 50 ft from left downstream end of bridge; chiseled arrow.

**Elevation 1,202.16 ft.**

**8435-15 SE (1)** - At northwest edge of Carroll, on U.S. Highway 30 bridge over Middle Raccoon River, on left upstream wingwall; chiseled cross.

**Elevation 1,255.63 ft.**

**8435-15 SE (2)** - At northwest edge of Carroll, on U.S. Highway 30 bridge over Middle Raccoon River, on right upstream wingwall; chiseled square.

**Elevation 1,253.83 ft.**

**8435-15 SE (3)** -(REFERENCE POINT) At northwest edge of Carroll, on U.S. Highway 30 bridge over Middle Raccoon River, 66 ft from left upstream end of bridge; chiseled arrow.

**Elevation 1,254.70 ft.**

**8435-26 NE (1)** - At southwest edge of Carroll, on U.S. Highway 71 bridge over Middle Raccoon River, on right downstream wingwall; Iowa Highway Commission bench mark.

**Elevation 1,244.28 ft.**

**8435-26 NE (2)** - At southwest edge of Carroll, on U.S. Highway 71 bridge over Middle Raccoon River, on left upstream wingwall; chiseled cross.

**Elevation 1,244.73 ft.**

**8435-26 NE (3)** -(REFERENCE POINT) At southwest edge of Carroll, on U.S. Highway 71 bridge over Middle Raccoon River, 85 ft from left upstream end of bridge; chiseled arrow.

**Elevation 1,244.82 ft.**

**8535-23 SE (1)** - Approximately 1.5 mi east of Mount Carmel, on U.S. Highway 71 culvert over Storm Creek, on top of and at center of upstream culvert headwall; Iowa Highway Commission bench mark. Elevation determined using GPS.

**Elevation 1,241.61 ft.**

**8535-23 SE (2)** - (REFERENCE POINT) Approximately 1.5 mi east of Mount Carmel, on U.S. Highway 71 culvert over Storm Creek, on top of and 6 ft from left end of downstream culvert headwall; chiseled arrow. Elevation determined using GPS.

**Elevation 1,241.06 ft.**