Flood of June 17, 1990, in the Clear Creek Basin, East-Central Iowa

Geological Survey
Open-File Report 94-78

Prepared in cooperation with the
Iowa Highway Research Board and the
Highway Division of the Iowa Department
of Transportation
(Research Project HR-140)

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By KIMBERLEE K. BARNES AND DAVID A. EASH

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Iowa City, Iowa
1994

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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^2)	2.590	square kilometer
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
cubic foot per second per square mile [$(ft^3/s)/mi^2$]	0.01093	cubic meter per second per square kilometer

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 June 17, 1990, in the Clear Creek Basin, East-Central Iowa

By Kimberlee K. Barnes *and* David A. Eash

Abstract

A water-surface-elevation profile for the flood of June 17, 1990, in the Clear Creek Basin, east-central Iowa, is given in this report. The maximum flood-peak discharge of 10,200 cubic feet per second for the streamflow-gaging station on Clear Creek near Coralville, Iowa (station number 05454300), occurred on June 17, 1990. This discharge was approximately equal to the 80-year recurrence-interval discharge. A flood history describes rainfall conditions for floods that occurred during 1982, 1990, and 1993.

INTRODUCTION

Evaluation of flood hazards and the planning, design, and operation of various structures on flood plains require information about floods. Flood reports supply specific information for selected floods and are used by planners and engineers to evaluate the magnitude and frequency of floods in a river basin.

Purpose and Scope

This report presents a water-surface-elevation profile for the flood of June 17, 1990, in the Clear Creek Basin in east-central Iowa. It provides information on flood stages and discharges, flood-flow frequencies, and bench-mark and reference-point descriptions and elevations for the Clear Creek Basin. Rainfall conditions for floods that occurred during 1982, 1990, and 1993 are provided for comparison purposes.

Acknowledgments

This report was prepared by the U.S. Geological Survey (USGS) in cooperation with the Iowa Highway Research Board and the Highway Division of the Iowa Department of Transportation. 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, 1953-93).

STUDY AREA

The Clear Creek Basin is located in east-central Iowa, includes parts of Iowa and Johnson Counties, and drains as a right-bank tributary to the Iowa River within the city of Coralville (fig. 1). The basin is oriented in a general west-east direction and drains 105 mi^2.

The topography of the Clear Creek Basin is characterized by uplands, dissected by tributary streams. The dissected uplands form rolling hills with flat areas on the divides (Schwob, 1964, p. 8-9). The basin has a relatively broad and flat flood plain adjoining Clear Creek, which has a meandering low-water channel except for reaches that have been straightened. Land use in the basin is primarily agricultural with some livestock operations.

Mean annual precipitation for 1961-90 in the Clear Creek Basin was 36.31 in., as determined from rain gages located in Iowa City and Williamsburg (Harry Hillaker, Iowa Department of Agriculture and Land Stewardship, State Climatology Office, oral commun., July 1993). Mean annual runoff for 1953-92 in the basin was 9.18 in. as determined at the Clear Creek near Coralville streamflow-gaging station (station number 05454300) (U.S. Geological Survey, 1993, p. 101).

HYDROLOGIC DATA

Gaging-station records are the primary source of data for analyzing and understanding the flood

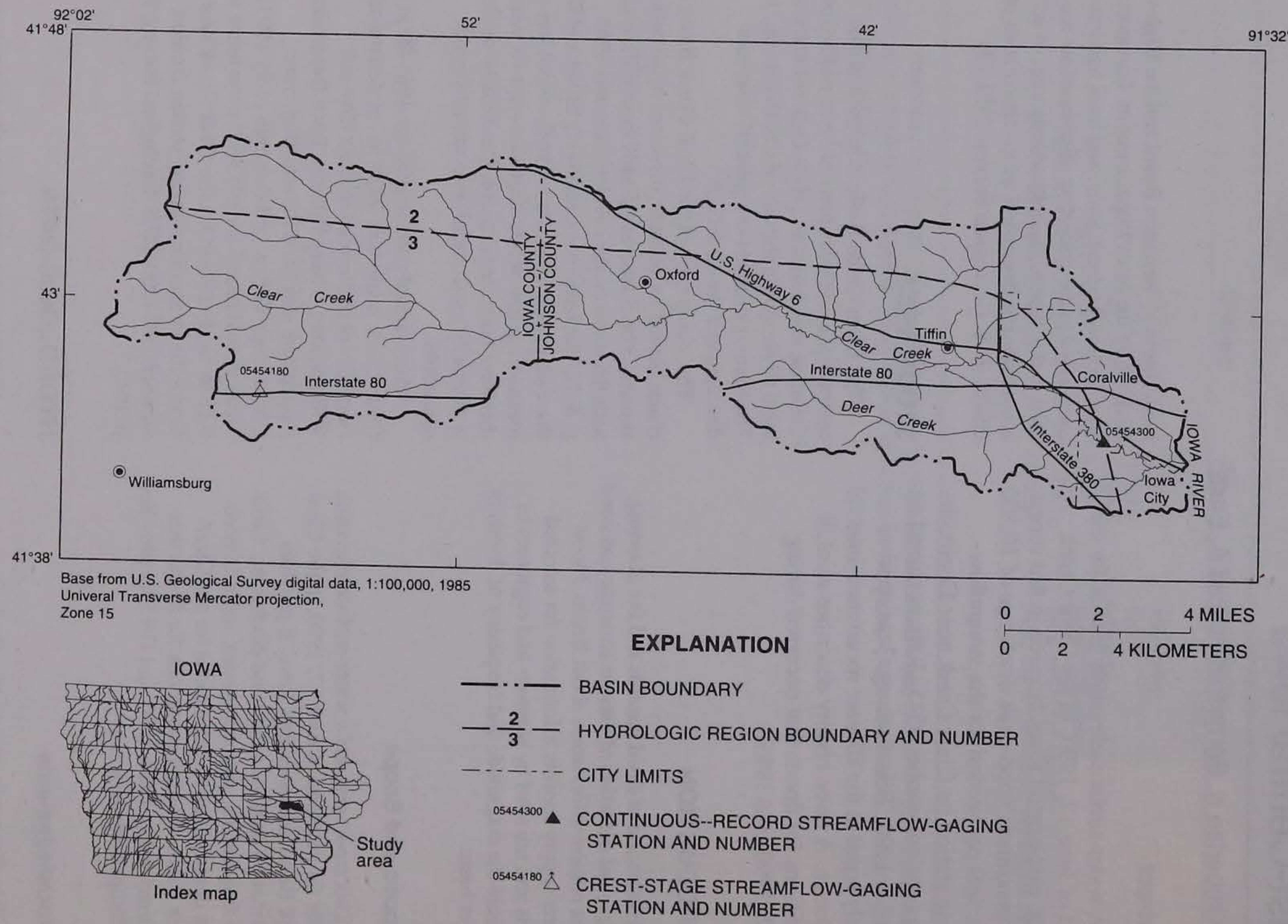

Figure 1. Location of active U.S. Geological Survey streamflow-gaging stations in the Clear Creek Basin.

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 the two active USGS gaging stations in the Clear Creek Basin, one continuous-record and one crest-stage gaging station, are shown in figure 1. The specific location, annual peak stages and discharges, and other information pertaining to each gaging station are presented in Appendix A. Discharge records for these gaging stations are published in the annual water-data reports of the USGS (U.S. Geological Survey, 1953-93).

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 river channel that result from scour, deposition, or the growth of vegetation (Rantz and others, 1982, p. 328-360).

FLOODFLOW FREQUENCIES

The magnitude and frequency of flood discharges, or floodflow frequencies, for a streamflow-gaging station are determined from a flood-frequency curve that relates observed annual-peak discharges to annual exceedance probability or recurrence interval. Annual exceedance probability is expressed as the chance that a given 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 given flood. For example, a flood with a magnitude that is expected to be exceeded once on the average during any 100-year period (recurrence interval) has a 1-percent chance (annual exceedance probability = 0.01) of being exceeded during any 1 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.

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

Floodflow frequencies computed for a gaging station and recurrence intervals determined for selected flood peaks are statistics that can change when recalculated 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.

Other methods for determining 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 nonrepresentative, short-term stations. For this reason, a regional analysis may produce improved estimates of the flood characteristics at gaged sites.

Two new methods for estimating floodflow frequencies for stream sites in Iowa were developed by Eash (1993). Statewide, drainage-basin equations were developed by relating significant drainage-basin characteristics (quantified using a geographic-information-system procedure) to the floodflow frequencies for 164 streamflow-gaging stations in Iowa. Secondly, statewide and regional channel-geometry equations were developed by relating significant channel-geometry characteristics (measured onsite) to the floodflow frequencies for 157 streamflow-gaging stations in

Iowa. Lara (1987) and Eash (1993) both 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) for the active gaging stations in the Clear Creek Basin are listed in table 1. The discharges determined by the Bulletin 17B method use data collected through the 1993 water year.

The Clear Creek Basin has parts of its drainage area in two of the hydrologic regions defined by Lara (1987); approximately 22 percent of the drainage area is in region 2, and 78 percent is in region 3 (fig. 1). Therefore, regional floodflow-frequency estimates for intrabasin sites in the Clear Creek Basin may use more than one regional, flood-frequency equation. Because the Clear Creek near Coralville gaging station has a drainage basin situated in more than one hydrologic region, weighted averages based on drainage-area ratios were used to compute the regional floodflow frequencies listed in table 1 according to Lara (1987).

FLOOD HISTORY

Continuous records of streamflow have been collected since October 1952 at the USGS streamflow-gaging station on Clear Creek near Coralville (station number 05454300). Selected flood-peak discharges, including maximum known flood-peak discharges, and recurrence intervals for active streamflow-gaging stations in the Clear Creek Basin are listed in table 2.

Flood of June 17, 1990

In east-central Iowa, June 1990 was the wettest month on record, with an average of 11.59 in. of rain (previous record, 10.47 in., June 1924) (Harry Hillaker, Iowa Department of Agriculture and Land Stewardship, State Climatology Office, oral commun., October 1993; National Oceanic and Atmospheric Administration, 1990). For June 16-17, 1990, 4.90 and 5.66 in. of rainfall were recorded in Iowa City and Williamsburg, respectively. June 1990 floods affected much of central and east-central Iowa, resulting in State disaster declarations for 44 of Iowa's 99 counties,

Table 1. Floodflow frequencies for active streamflow-gaging stations in the Clear Creek Basin

[17B, Bulletin 17B (Interagency Advisory Committee on Water Data, 1982); Lara, floodflow-frequency equations for hydrologic regions 2 and 3 (Lara, 1987, p. 28). For the Clear Creek near Coralville gaging station with a basin situated in more than one hydrologic region, weighted averages based on drainage-area ratios were used; DB, drainage-basin characteristic floodflow-frequency equation (Eash, 1993, p. 17); CG, channel-geometry characteristic floodflow-frequency equation (Region I, bankfull; Eash, 1993, p. 25); --, not determined]

Station number (fig. 1)	Station name	Method	Discharge, in cubic feet per second, for indicated recurrence interval, in years					
			2	5	10	25	50	100
05454180	Clear Creek tributary near Williamsburg	17B	--	--	--	--	--	--
		Lara	69.6	147	216	321	406	502
		DB	--	--	--	--	--	--
		CG	--	--	--	--	--	--
05454300	Clear Creek near Coralville	17B	1,880	3,610	5,030	7,110	8,840	10,700
		Lara	2,320	4,190	5,620	7,540	9,000	10,600
		DB	2,300	4,170	5,620	7,510	9,020	10,600
		CG	2,150	4,250	5,910	8,380	10,200	12,500

Table 2. Selected flood-peak discharges, recurrence intervals, and unit runoff for active streamflow-gaging stations in the Clear Creek Basin

[mi^2, square mile; ft^3/s, cubic foot per second; $(ft^3/s)/mi^2$, cubic foot per second per square mile; *, maximum flood-peak discharge known for station; --, not determined]

Station number (fig. 1)	Station name and location	Period of flood record[1]	Drainage area (mi^2)	Date of flood peak	Gage height[2] (ft)	Discharge (ft^3/s)	Recurrence interval[3] (years)	Unit runoff [$(ft^3/s)/mi^2$]
05454180	Clear Creek tributary near Williamsburg	1990-93	0.37	06-17-90	48.76	*291	--	786
				07-23-93	48.47	264	--	714
05454300	Clear Creek near Coralville	1953-93	98.1	06-15-82	14.61	[4]6,520	20	66.5
				06-17-90	16.36	*[4]10,200	80	104
				07-06-93	14.74	6,760	20	68.9

[1]Water years (October 1-September 30) listed in Appendix A with flood peaks.

[2]Gage datum in feet above sea level for the Clear Creek near Coralville streamflow-gaging station is listed in Appendix A.

[3]Approximate recurrence interval interpolated from Bulletin 17B 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.

[4]Discharge revised from previously published value.

with 33 of these counties, receiving Federal disaster designations.

In Tiffin, about one-third of the homes had flooded basements, and residents of a south-side neighborhood had to be evacuated when their trailer homes were threatened by the rising water of Clear Creek (Des Moines Register, June 18, 1990). A 2-mi stretch of Interstate 80 near Coralville was closed for about 14 hours because of inundation by Clear Creek floodwaters. Traffic was detoured for 5 mi until Interstate 80 was reopened on the afternoon of June 17.

At the Clear Creek near Coralville streamflow-gaging station, the peak discharge recorded on June 17, 1990, is the maximum discharge for the period of record (table 2). This flood peak of 10,200 ft^3/s had a recurrence interval of approximately 80 years.

Floods of 1982 and 1993

Antecedent wet conditions and intense rains on June 15, 1982, contributed to general flooding over a large area in east-central Iowa (Heinitz, 1986). Floodwaters from Clear Creek inundated Interstate 80 near Coralville. June 15th rainfalls of 4.02 and 6.15 in. were recorded in Iowa City and Williamsburg, respectively (National Oceanic and Atmospheric Administration, 1982). At the Clear Creek near Coralville gaging station, the flood peak of 6,520 ft^3/s on June 15, 1982, had a recurrence interval of approximately 20 years and is the third largest peak discharge on record.

From mid-June through early August 1993, severe flooding in a nine-state area in the upper Mississippi River Basin followed intense and persistent rain from January through July. Flood-peak discharges that 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). On July 6, 1993, floodwaters from Clear Creek again inundated Interstate 80 near Coralville. For July 5-6, 1993, 3.60 and 5.68 in. of rainfall were recorded in Iowa City and Williamsburg, respectively (Harry Hillaker, Iowa Department of Agriculture and Land Stewardship, State Climatology Office, oral commun., September 1993). At the Clear Creek near Coralville gaging station, the flood peak of 6,760 ft^3/s on July 6, 1993, had a recurrence interval of approximately 20 years and is the second largest peak discharge on record.

FLOOD PROFILE

The water-surface-elevation profile for the June 17, 1990, flood on Clear Creek is shown in Appendix B (fig. 2). Flood elevations located both upstream and downstream from bridges were identified within a few days of passage of the flood peak and were referenced to a common datum by leveling. A December 22, 1993, low-water profile also is shown in figure 2 to indicate the approximate range of stage that can occur within the profiled reach. The profiles were defined using data obtained by the USGS. Profiles between the bridges are straight-line interpolations, which provide only an approximation of the water-surface elevations.

For comparison, flood elevations are shown in figure 2 for June 15, 1982, and July 6, 1993, at the Clear Creek near Coralville gaging station. Flood elevations for July 6, 1993, upstream of the Interstate 80 bridge and upstream of the First Avenue and U.S. Highway 6 bridges in Coralville also are shown in figure 2. The reach downstream of the Clear Creek near Coralville gaging station is subject to backwater from the Iowa River. On July 6, 1993, high water from the Iowa River caused the flood elevations at the First Avenue and U.S. Highway 6 bridges to exceed those of the July 17, 1990, flood.

River miles, determined from the most current 1:24,000-scale USGS topographic maps, are referenced to the mouth of Clear Creek. Bridges are designated by an index number that helps to identify their location. For example, 7906-8NE refers to a location in Township 79 North, Range 6 West, northeast 1/4 section 8.

Differential leveling was performed to reference all the points along the profiles to a common datum. A bench mark and a reference point were established at the majority of the bridges in the profiled reach. Bench-mark and reference-point descriptions and elevations are listed in Appendix C.

Bridge-deck and low-bridge-chord elevations are shown in figure 2 to indicate the relation between the elevation of the bridges and the elevation of the profiled flood and the low-water profile. For sloping bridges, the profiled bridge-deck and low-bridge-chord elevations represent the lower ends of the bridges.

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 given 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 and may cause the water-surface elevations to plot higher than the normal profile.

SUMMARY

This report provides information on the flood of June 17, 1990, in the Clear Creek Basin in east-central Iowa. The maximum flood-peak discharge of 10,200 ft^3/s for the Clear Creek near Coralville streamflow-gaging station occurred on June 17, 1990, and this flood peak was approximately equal to the 80-year recurrence-interval discharge. Floodflow frequencies for active gaging stations in the Clear Creek Basin and a flood history describing rainfall conditions for floods that occurred during 1982, 1990, and 1993 also are included in this report.

REFERENCES

Des Moines Register, 1990, June 18 newspaper article.

Eash, D.A., 1993, Estimating design-flood discharges for streams in Iowa using drainage-basin and channel-geometry characteristics: U.S. Geological Survey Water-Resources Investigation Report 93-4062, 96 p.

Heinitz, A.J., 1986, Floods of June-July, 1982, in Iowa: U.S. Geological Survey Open-File Report 85-151, 18 p.

Interagency Advisory Committee on Water Data (IACWD), 1982, Guidelines for determining flood flow frequency: Hydrology Subcommittee Bulletin 17B, U.S. Geological Survey, Office of Water Data Coordination, 28 p. and appendices.

Lara, O.G., 1987, Method for estimating the magnitude and frequency of floods at ungaged sites on unregulated rural streams in Iowa: U.S. Geological Survey Water-Resources Investigation Report 87-4132, 34 p.

National Oceanic and Atmospheric Administration, 1982, Climatologic data, Iowa: Asheville, N.C., monthly summaries, v. 93, no. 6, 28 p.

____1990, Climatologic data, Iowa: Asheville, N.C., monthly summaries, v. 101, no. 6, 27 p.

Novak, C.E., 1985, WRD data reports preparation guide: Reston, Virginia, U.S. Geological Survey, 199 p.

Parrett, Charles, Melcher, N.B., and James, R.W., 1993, Flood discharges in the upper Mississippi River Basin, 1993: U.S. Geological Survey Circular 1120-A, 14 p.

Rantz, S.E., and others, 1982, Measurement and computation of streamflow--Volume 2. Computation of discharge: U.S. Geological Survey Water-Supply Paper 2175, p. 285-631.

Schwob, H.H., 1964, Water resources of the English River, Old Mans Creek, and Clear Creek Basins in Iowa: Iowa City, Iowa, U.S. Geological Survey open-fiie report, 53 p.

U.S. Geological Survey, 1953-93, Water resources data, Iowa, water years 1952-92 (published annually): U.S. Geological Survey Water-Data Reports.

____1993, Water resources data, Iowa, water year 1992: U.S. Geological Survey Water-Data Report IA-92-1, 374 p.

APPENDICES

APPENDIX A. PEAK STAGES AND DISCHARGES FOR ACTIVE STREAMFLOW-GAGING STATIONS IN THE CLEAR CREEK BASIN, EAST-CENTRAL IOWA, 1953-93

The peak-stage and discharge data for this report were compiled through September 30, 1993, for the active streamflow-gaging stations located in the Clear Creek Basin. The floods, designated by calendar date, are in chronological order and grouped by water year (October 1-September 30). In general, independent flood peaks above a preselected base (partial-duration series) are listed for the continuous-record gaging station (Clear Creek near Coralville). 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 of about three times per year. Two flood peaks 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 the annual flood peaks are listed for the crest-stage gaging station (Clear Creek tributary near Williamsburg).

The gaging-station records are arranged in downstream order as explained in the annual streamflow 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 sea level. Flood stage, as determined by the National Weather Service, 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.

05454180 Clear Creek Tributary near Williamsburg, Iowa

Location.--Lat 41°41'16", long 91°57'02", in SE1/4, sec. 36, T.80 N., R.10 W., Iowa County, Hydrologic Unit 07080209, at culvert on county road, 4 mi northeast of Williamsburg, 1 mi south of county highway F35.

Drainage area.--0.37 mi^2.

Gage.--Crest-stage gage.

Stage-discharge relation.--Defined by current-meter measurements and culvert rating.

Remarks.--Only annual peaks are shown.

Peak stages and discharges
[ft, feet above gage datum; ft^3/s, cubic feet per second]

Water year	Date	Gage height (ft)	Discharge (ft^3/s)
1990	June 17, 1990	48.76	291
1991	Mar. 2, 1991	44.82	(1)
1992	July 25, 1992	46.97	131
1993	July 23, 1993	48.47	264

[1] Discharge not determined.

05454300 Clear Creek near Coralville, Iowa

Location.--Lat 41°40'36", long 91°35'55", in NE1/4 SE1/4 sec. 1, T.79 N., R.7 W., Johnson County, Hydrologic Unit 07080209, on left bank 15 ft upstream from bridge on county highway. Prior to September 25, 1992, gage located about 100 ft upstream of bridge. 1.1 mi west of post office in Coralville, 1.5 mi downstream from Deer Creek, and 2.7 mi upstream from mouth.

Drainage area.--98.1 mi^2.

Gage.--Water-stage encoder. Datum is 647.48 ft above sea level. Prior to January 7, 1957, nonrecording gage at same site and datum.

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

Flood stage.--11 ft.

Remarks.--Base for partial-duration series, 1,000 ft^3/s.

Peak stages and discharges
[ft, feet above gage datum; ft^3/s, cubic feet per second]

Water year	Date	Gage height (ft)	Discharge (ft^3/s)
1953	Feb. 20, 1953	[1]11.18	[2]1,800
	May 25, 1953	9.30	1,010
1954	Aug. 26, 1954	8.10	730
1955	Feb. 21, 1955	[1]9.70	[2]850
1956	Aug. 30, 1956	9.52	900
1957	Jan. 22, 1957	6.28	300
1958	Sept. 5, 1958	9.69	1,020
1959	Feb. 27, 1959	[1]11.34	[2]1,500
	Mar. 20, 1959	11.68	2,880
	Mar. 26, 1959	10.22	1,040
	Apr. 28, 1959	10.25	1,040

05454300 Clear Creek near Coralville, Iowa--Continued

Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft^3/s)
1960	Jan. 13, 1960	11.79	3,060
	Mar. 31, 1960	11.63	2,740
	June 2, 1960	10.08	1,150
	June 4, 1960	10.06	1,120
	July 9, 1960	10.27	1,240
	July 14, 1960	10.90	1,840
1961	Mar. 5, 1961	11.84	3,020
	Mar. 14, 1961	[1]10.50	[2]1,180
1962	Nov. 16, 1961	10.99	1,410
	Mar. 20, 1962	12.03	2,740
	May 29, 1962	13.31	5,390
	July 14, 1962	13.10	4,160
1963	Mar. 4, 1963	[1]10.83	[2]700
1964	June 24, 1964	10.47	1,280
1965	Jan. 22, 1965	10.98	1,190
	Apr. 6, 1965	11.12	1,600
	Apr. 24, 1965	12.50	4,060
	July 10, 1965	10.67	1,360
	Sept. 21, 1965	13.47	4,000
1966	Feb. 9, 1966	11.90	2,460
	May 24, 1966	11.91	2,480
1967	June 10, 1967	7.74	648
	Sept. 15, 1967	7.79	(3)
1968	Apr. 20, 1968	7.83	686
1969	Apr. 4, 1969	9.28	1,050
	June 28, 1969	11.65	1,990
	June 30, 1969	12.85	3,180
	July 9, 1969	12.84	3,160
	July 27, 1969	12.14	2,350

05454300 Clear Creek near Coralville, Iowa--Continued

Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft^3/s)
1970	Mar. 3, 1970	13.49	4,900
	May 14, 1970	9.81	1,230
	Sept. 17, 1970	10.31	1,410
1971	Feb. 20, 1971	[1]13.00	[2]1,650
1972	Dec. 15, 1971	9.39	1,170
	Feb. 29, 1972	(4)	[2]1,200
	Apr. 16, 1972	9.00	1,070
	Apr. 21, 1972	8.85	1,020
	July 17, 1972	10.87	1,670
	Aug. 6, 1972	12.29	2,470
1973	Dec. 30, 1972	[1]12.24	[2]1,600
	Apr. 16, 1973	9.87	1,260
	Apr. 21, 1973	12.23	2,430
	May 2, 1973	10.69	1,570
	May 7, 1973	9.27	1,090
	May 27, 1973	11.53	1,920
	June 4, 1973	9.44	1,140
1974	Apr. 29, 1974	9.66	1,230
	May 14, 1974	12.00	2,270
	May 17, 1974	13.93	[5]5,380
	May 29, 1974	11.19	1,770
	June 9, 1974	9.49	1,150
	June 23, 1974	10.02	1,320
	Aug. 13, 1974	11.02	1,700
1975	Mar. 19, 1975	10.71	1,940
	Mar. 22, 1975	9.97	1,620
1976	Apr. 24, 1976	9.06	1,030
1977	Aug. 16, 1977	13.02	3,540
	Sept. 18, 1977	10.82	1,620

05454300 Clear Creek near Coralville, Iowa--Continued

Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft^3/s)
1978	June 29, 1978	12.94	3,360
	July 9, 1978	10.28	1,400
	July 19, 1978	9.77	1,230
	July 22, 1978	11.65	1,990
1979	Mar. 19, 1979	12.41	2,590
	Aug. 20, 1979	10.71	1,570
1980	July 14, 1980	7.23	632
1981	June 24, 1981	9.06	1,040
	June 29, 1981	9.11	1,050
	Aug. 5, 1981	9.06	1,040
1982	Feb. 22, 1982	[1](4)	[2]1,270
	June 15, 1982	14.61	[5]6,520
	July 13, 1982	(4)	[2]1,500
	July 19, 1982	13.23	[5]3,600
	Aug. 8, 1982	12.73	4,050
1983	Dec. 5, 1982	9.17	1,060
	Apr. 2, 1983	9.15	1,130
	June 28, 1983	11.87	1,940
	June 29, 1983	9.10	1,050
	July 2, 1983	9.37	1,120
1984	Feb. 12, 1984	8.80	1,010
1985	Nov. 1, 1984	9.90	1,270
	Feb. 22, 1985	10.70	1,810
	Mar. 4, 1985	9.70	1,260
1986	Apr. 30, 1986	8.65	1,200
	May 17, 1986	13.20	3,640
	May 26, 1986	10.52	1,690
	June 5, 1986	10.73	1,650
	June 30, 1986	13.32	4,100
	July 7, 1986	8.62	1,050

05454300 Clear Creek near Coralville, Iowa--Continued

Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft^3/s)
1987	Aug. 26, 1987	7.73	809
1988	Jan. 19, 1988	[1]10.25	1,660
1989	Sept. 9, 1989	7.99	1,040
1990	June 9, 1990	8.52	1,020
	June 17, 1990	16.36	[5]10,200
	June 20, 1990	9.71	1,270
	July 29, 1990	8.61	1,040
	Aug. 20, 1990	13.09	[5]3,450
	Aug. 25, 1990	11.64	2,060
1991	Mar. 2, 1991	9.30	1,180
1992	July 26, 1992	8.90	1,100
	July 31, 1992	9.47	1,220
1993	Nov. 21, 1992	11.55	2,010
	Nov. 22, 1992	8.63	1,040
	Mar. 3, 1993	11.32	2,210
	Mar. 23, 1992	11.63	2,050
	Apr. 20, 1993	11.05	1,780
	May 4, 1993	10.63	1,610
	May 7, 1993	8.51	1,020
	June 19, 1993	11.37	1,920
	June 25, 1993	9.03	1,130
	June 27, 1993	11.15	1,820
	June 30, 1993	10.82	1,690
	July 6, 1993	14.74	6,760
	July 9, 1993	10.43	1,540
	July 11, 1993	9.71	1,320
	July 24, 1993	12.83	2,960
	July 25, 1993	11.34	1,910
	July 31, 1993	13.45	4,520
	Aug. 10, 1993	13.59	4,350
	Aug. 12, 1993	9.05	1,130
	Aug. 14, 1993	10.58	1,590

05454300 Clear Creek near Coralville, Iowa--Continued

Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft^3/s)
1993	Aug. 16, 1993	13.20	3,500
	Aug. 29, 1993	11.50	1,980
	Sept. 26, 1993	12.77	2,900

[1] Affected by ice.
[2] Approximate.
[3] Discharge not determined.
[4] Gage height not determined.
[5] Discharge revised from previously published value.

Appendix B. WATER-SURFACE-ELEVATION PROFILES FOR CLEAR CREEK

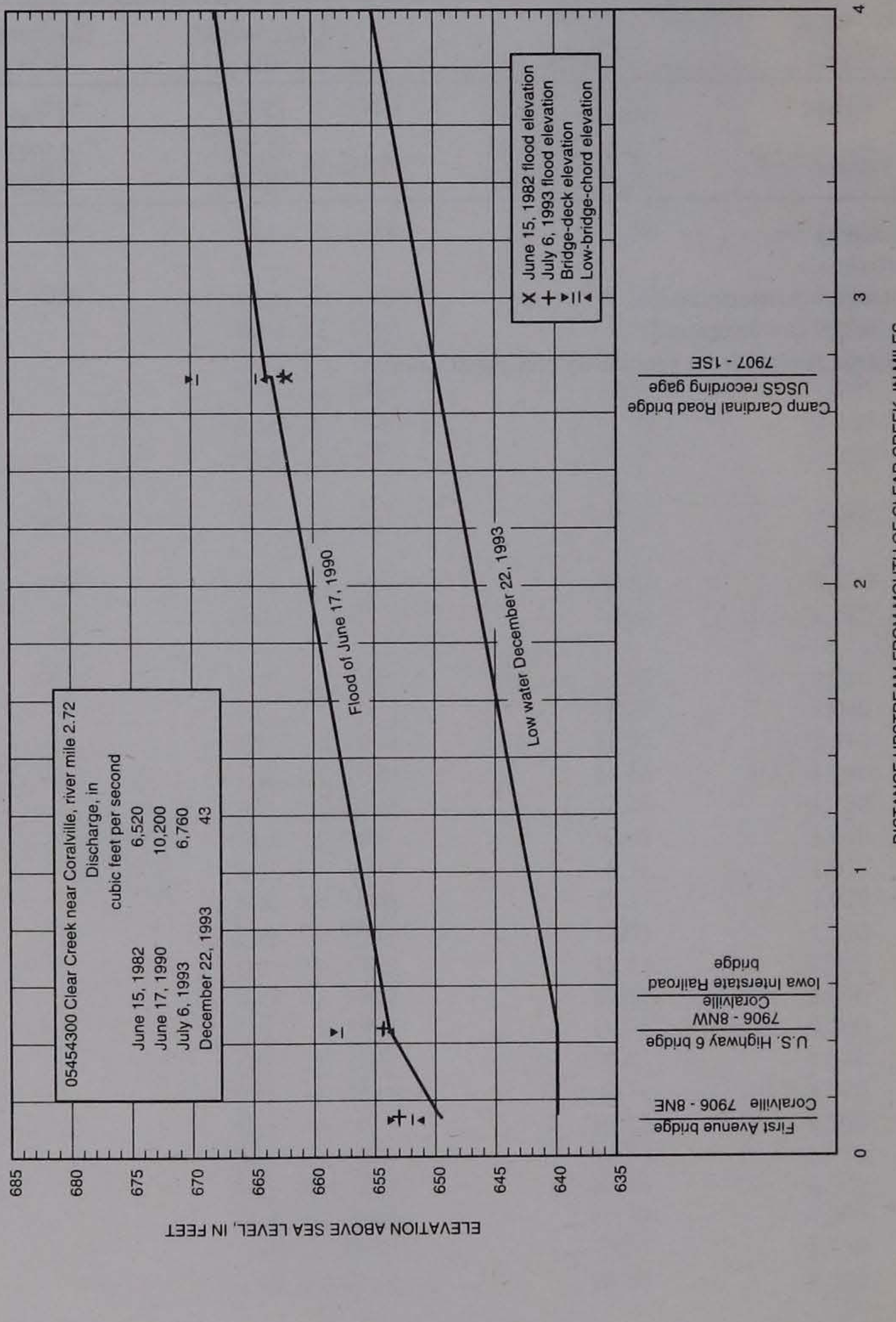

Figure 2. Water-surface-elevation profiles for Clear Creek.

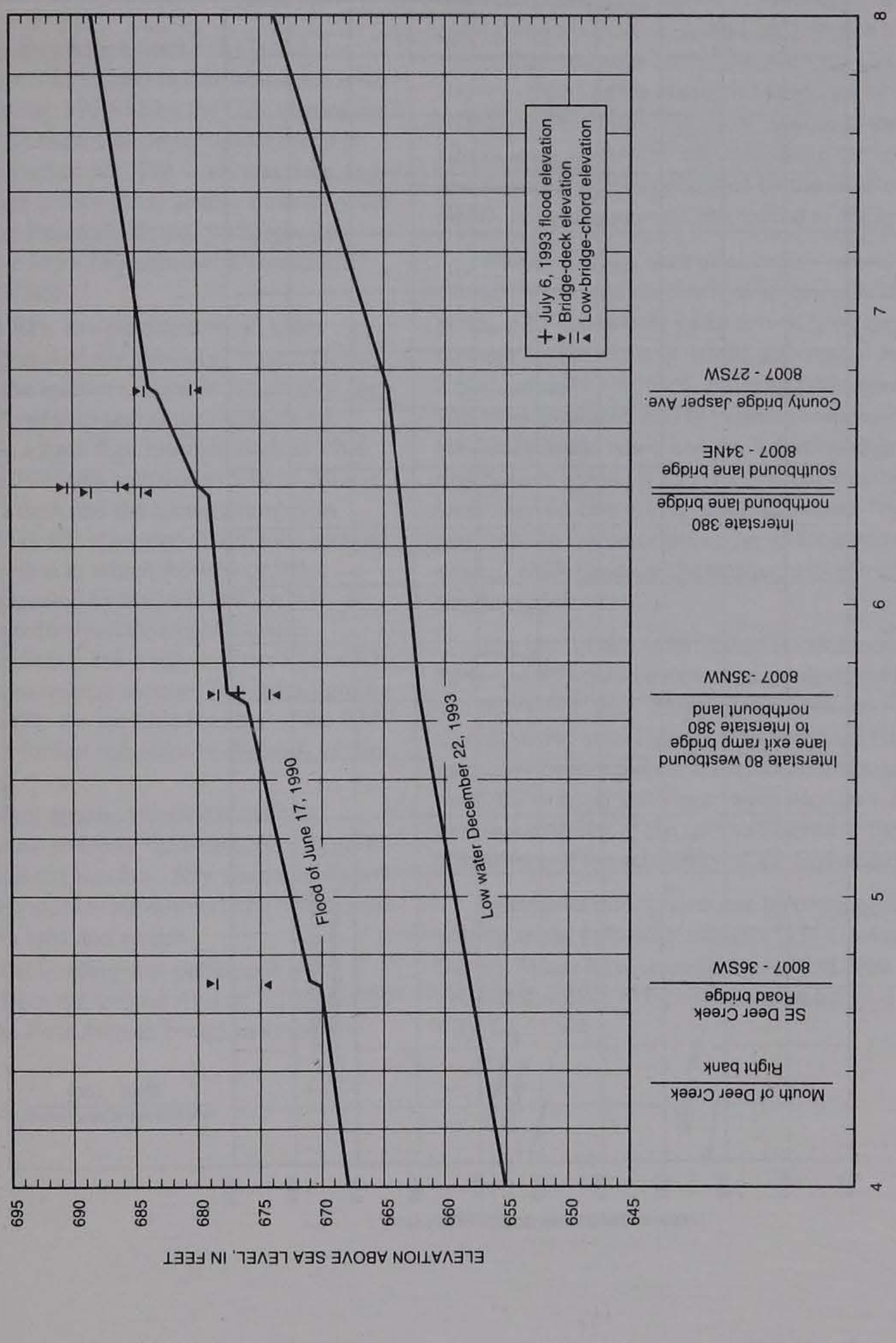

Figure 2. Water-surface-elevation profiles for Clear Creek--Continued

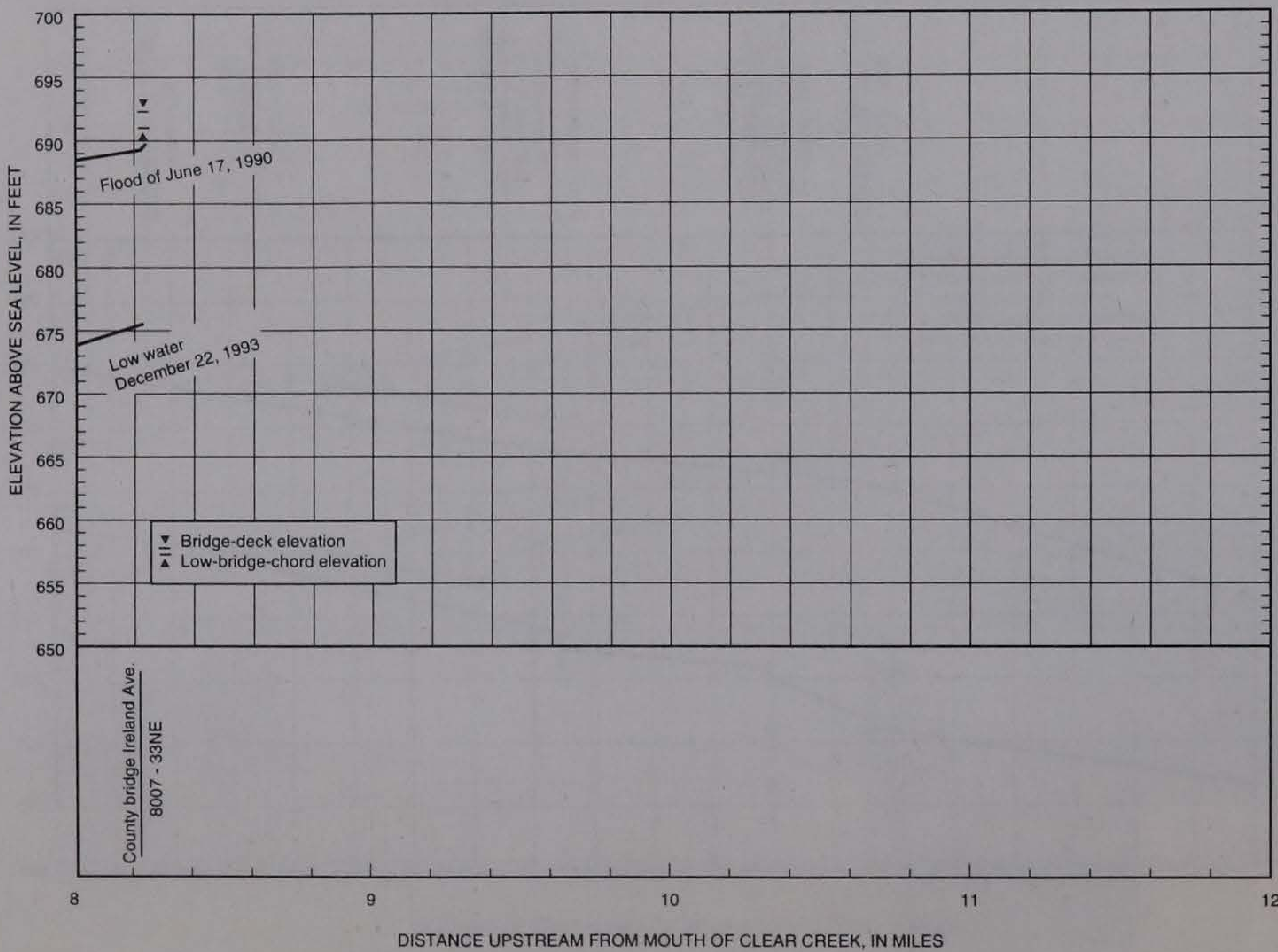

Figure 2. Water-surface-elevation profiles for Clear Creek--Continued

Appendix C. DESCRIPTIONS AND ELEVATIONS OF TEMPORARY BENCH MARKS AND REFERENCE POINTS IN THE CLEAR CREEK BASIN, EAST-CENTRAL IOWA

The temporary bench marks (BM) and reference points (RP) listed in this tabulation were established during 1990-93 by the U.S. Geological Survey (USGS) except those for which credit is given in the descriptions. The work was done as a part of a stream-profile study jointly funded by the Iowa Highway Research Board, the Highway Division of the Iowa Department of Transportation, and the USGS.

BMs and RPs are identified by an index number composed of the township, range, section number, and the quarter section in which they are located. The township and range numbers are combined into a four-digit number, such as 7906 for Township 79 North and Range 6 West. This is followed by a dash and the section number in which the BM or RP is located. Within the section, the quarter section in which the BM or RP is located is designated by NE, SE, SW, or NW. A number in parentheses following this letter 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.

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 the use of a tape and weight.

Differential leveling was performed along Clear Creek from the Ireland Avenue bridge south of Tiffin to the First Avenue bridge in Coralville (figs. 1 and 2). BMs and RPs were established at the majority of bridges and at intermediate points to preserve the level lines.

Level lines to establish the third-order accuracy of the BMs and RPs shown herein were surveyed from first- or second-order bench marks established and adjusted by the National Geodetic Survey (NGS) or the National Mapping Division (NMD) of the USGS. Errors of closure in the USGS level work were adjusted along the level line to the elevations published by the NGS and the NMD. All elevations are referenced to sea level.

Standard BMs, such as chiseled squares and crosses, were used on concrete or steel. On trees or poles, a 20-penny pole spike driven horizontally through a short piece of 1/8-in. galvanized pipe or a railroad spike was used. Existing BMs were used wherever available, and the agency responsible for the bench mark, when known, is indicated in the description. Standard RPs, such as chiseled arrows, were used on concrete or steel. The terms "right" and "left" in the descriptions are determined as viewed while facing in the downstream direction of the flow of the stream.

The user of this information is cautioned that BMs and RPs may be disturbed or destroyed and can move over time. Many of the BMs and RPs that are listed herein are located on bridges that may have been repaired, replaced, or destroyed since the original level lines were surveyed. It is the responsibility of the user to determine the condition and the suitability of the BM or RP.

Additional information can be obtained by writing to the following address: U.S. Geological Survey, Water Resources Division, RM. 269, Federal Building, 400 South Clinton Street, Iowa City, IA 52244.

DESCRIPTIONS AND ELEVATIONS OF TEMPORARY BENCH MARKS AND REFERENCE POINTS IN THE CLEAR CREEK BASIN, EAST-CENTRAL, IOWA

7906-05 SE (1)--At Coralville, along First Avenue about 0.4 mi north of U.S. Highway 6 and about 20 ft south of Iowa River Power Company driveway, 1 ft south of first shrub south of driveway; an Iowa Geodetic Survey standard disk stamped "52-10" and set in the top of a concrete post flush with the ground.

Elevation 656.547 ft.

7906-08 NE (1)--At Coralville, on First Avenue bridge over Clear Creek, on upstream curb, on top of first 3/4-in. bolt from left bridge abutment; chiseled cross.

Elevation 654.36 ft.

7906-08 NE (2)--(REFERENCE POINT) At Coralville, on First Avenue bridge over Clear Creek, on upstream curb, 48 ft from right bridge abutment; chiseled arrow.

Elevation 654.47 ft.

7906-08 NW (1)--At Coralville, on U.S. Highway 6 bridge over Clear Creek, on upstream sidewalk, 1.3 ft north of left wingwall; Iowa Highway Commission bench mark.

Elevation 658.39 ft.

7906-08 NW (2)--(REFERENCE POINT) At Coralville, on U.S. Highway 6 bridge over Clear Creek, on upstream guardrail at 14th upright from left bridge abutment; three chiseled marks.

Elevation 661.01 ft.

7906-08 NW (3)--At Coralville, about 650 ft south of U.S. Highway 6, on Iowa Railroad bridge over Clear Creek, on upstream bridge deck, on top of second 3/4-in. bolt from left side of bridge; chiseled cross.

Elevation 667.39 ft.

7907-01 SE (1)--About 1.1 mi west of post office in Coralville, on Camp Cardinal Road bridge over Clear Creek, on left upstream curb on wingwall of bridge, U.S. Geological Survey bronze bench mark.

Elevation 668.33 ft.

8007-26 SW (1)--About 1.4 mi east of Tiffin and 0.4 mi east of Interstate 380, on north side of U.S. Highway 6, on culvert about 60 ft west of first house east of Farm Service Feeds; Iowa Department of Transportation bench mark.

Elevation 691.71 ft.

8007-27 SE (1)--About 0.9 mi east of Tiffin and about 250 ft west of Interstate 380, on north side of U.S. Highway 6, on culvert about 40 ft east of first house west of Interstate 380; Iowa Department of Transportation bench mark.

Elevation 683.00 ft.

8007-27 SW (1)--About 0.8 mi east of Tiffin, at intersection of U.S. Highway 6 and Jasper Avenue, in center of southwest concrete headwall of a 2- x 4-ft box culvert; U.S. Geological Survey standard tablet stamped "26 FDR 1964 682" painted "BM 682.2."

Elevation 682.155 ft.

8007-27 SW (2)--About 0.8 mi east of Tiffin, on Jasper Avenue bridge over Clear Creek, on top of right downstream wingwall; chiseled square.

Elevation 687.04 ft.

8007-27 SW (3)--(REFERENCE POINT) About 0.8 mi east of Tiffin, on Jasper Avenue bridge over Clear Creek, on downstream guardrail, about one-third of bridge length from right abutment; chiseled arrow.

Elevation 687.28 ft.

8007-33 NW (1)--About 0.25 mi south of Tiffin, on Ireland Avenue bridge over Clear Creek, on curb at left downstream abutment; Iowa Highway Commission bench mark.

Elevation 693.42 ft.

8007-33 NW (2)--About 0.25 mi south of Tiffin, on Ireland Avenue bridge over Clear Creek, on wingwall at left downstream abutment; chiseled square.

Elevation 695.16 ft.

8007-33 NW (3)--(REFERENCE POINT) About 0.25 mi south of Tiffin, on Ireland Avenue bridge over Clear Creek, on upstream guardrail at eighth upright from right bridge abutment; chiseled arrow.

Elevation 694.91 ft.

8007-34 NE (1)--About 1 mi east of Tiffin, on northbound lane of Interstate 380 bridge over Clear Creek (downstream bridge), on top of downstream concrete barrier wall at left end of bridge; Iowa Department of Transportation bench mark. Elevation obtained from Iowa Department of Transportation.

Elevation 694.73 ft.

8007-34 NE (2)--(REFERENCE POINT) About 1 mi east of Tiffin, on northbound lane of Interstate 380 bridge over Clear Creek (downstream bridge), on top of downstream concrete barrier wall approximately 92 ft from Iowa Department of Transportation bench mark 8007-34 NE (1); chiseled arrow.

Elevation 692.62 ft.

8007-35 NW (1)--About 1.7 mi southeast of Tiffin, on exit ramp bridge over Clear Creek of westbound lane of Interstate 80 to northbound lane of Interstate 380 (most upstream bridge), on curb near left upstream bridge abutment; Iowa Highway Commission bench mark.

Elevation 679.17 ft.

8007-35 NW (2)--(REFERENCE POINT) About 1.7 mi southeast of Tiffin, on exit ramp bridge over Clear Creek of westbound lane of Interstate 80 to northbound lane of Interstate 380 (most upstream bridge), on upstream guardrail at 12th upright from left bridge abutment; chiseled arrow.

Elevation 681.54 ft.

8007-36 SW (1)--About 2.3 mi northwest of post office in Coralville and about 300 ft south of U.S. Highway 6, on SE Deer Creek Road bridge over Clear Creek, on top of right upstream wingwall; Iowa Department of Transportation bench mark.

Elevation 681.03 ft.

8007-36 SW (2)--(REFERENCE POINT) About 2.3 mi northwest of post office in Coralville and about 300 ft south of U.S. Highway 6, on SE Deer Creek Road bridge over Clear Creek, downstream side of bridge, on downstream guardrail at 15th upright from right bridge abutment; chiseled arrow.

Elevation 682.27 ft.

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