FLOODS OF JUNE 17, 1990, AND JULY 9, 1993, ALONG SQUAW CREEK AND THE SOUTH SKUNK RIVER IN AMES, IOWA, AND VICINITY

by Robert F. Einhellig and David A. Eash

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CONTENTS

FIGURES

TABLES

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.

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ABSTRACT

Water-surface-elevation profiles and peak discharges for the floods of June 17, 1990, and July 9, 1993, along Squaw Creek and the South Skunk River, in Ames, Iowa, are presented in this report. The maximum flood-peak discharge of 24,300 cubic feet per second for the streamflow-gaging station on Squaw Creek at Ames, Iowa (station number 05470500) occurred on July 9, 1993. This discharge was 80 percent larger than the 100-year recurrence-interval discharge and exceeded the previous record flood-peak discharge of June 17, 1990, by 94 percent. The July 9, 1993, flood-peak discharge of 26,500 cubic feet per second on the South Skunk River below Squaw Creek (station number 05471000) was also a peak of record, exceeding the previous record flood-peak discharge of June 27, 1975, by 80 percent, and the 100-year recurrence-interval discharge by 60 percent. A flood history describes rainfall conditions for floods that occurred during 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

The City of Ames was established in Story County on the banks of Squaw Creek and the South Skunk River near their point of confluence in central Iowa. Substantial reaches of both streams, as well as their confluence, are contained within the Ames municipal boundary. These two streams, either individually, or together, have been the source of flooding several times during Ames' history. None of these floods, however, can compare in magnitude or damage with the flooding that occurred in Ames, and much of the midwest, during the summer of 1993.

This report presents water-surface-elevation profiles for the floods of June 17, 1990, and July 9, 1993, along Squaw Creek and the South Skunk River in Ames, Iowa. The report provides information on flood stages and discharges, flood-flow frequencies, and bench-mark and reference-point descriptions and elevations for the Squaw Creek and South Skunk River Basins in and around Ames, Iowa. The flood history briefly describes the rainfall conditions for the floods that occurred during 1990 and 1993.

A previous report by Lara and Heinitz (1976), "Flood of June 27, 1975 in City of Ames, Iowa," provides information on flooding that occurred in the Ames area prior to and including the 1975 flood. Water-surface profile data from the 1976 report are included in this report 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 Project Development 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 acknowledg-ment of which is contained in the annual water-data reports of the USGS (U.S. Geological Survey, 1961-95).

STUDY AREA

The South Skunk River originates in Hamilton County in central Iowa (fig. 1). It flows in a general south-east direction to its confluence with the North Skunk River (not shown). The flows from the North and South Skunk Rivers combine to form the Skunk River which continues to follow a general south-east course across Iowa until reaching the Mississippi River.

Squaw Creek enters the South Skunk River as a right-bank tributary in the south-east portion of the City of Ames, Story County, Iowa (fig. 1). The two streams collectively drain 556 mi^2 at their confluence.

The Squaw Creek and South Skunk River Basins upstream of Ames, Iowa, lie within the Des Moines Lobe land-form region of the state. This region was the most recently glaciated part of the state. This last period of glacial activity occurred only 12,000 to 14,000 years ago (Prior, 1991 p. 36). Because of the recent glacial activity, the surface-drainage network of the Des Moines Lobe tends to be immature and poorly defined, with level terrain, potholes, and marshes commonly occurring. As a result, basins in the region tend to have minimal drainage efficiency, leading to lower peak discharges than those that occur on streams in steeper and more mature basins elsewhere within the state (Lara, 1987, p. 2)

Mean annual precipitation for 1961-90 at the Ames 8 WSW weather station (fig. 1) was 32.94 in. The mean annual precipitation at Jewell, Iowa, centrally located in the contributing drainage basin above Ames (fig. 1), was nearly identical at 32.87 in. for the same period (Owenby and Ezell, 1992).

Although the mean annual precipitation has been nearly uniform throughout the contributing drainage basin upstream of Ames, the mean annual runoff for Squaw Creek and the South Skunk River at Ames show considerable variation. Mean annual runoff for the Squaw Creek drainage basin upstream of Ames was 9.43 in. as determined from records at the streamflow-gaging station Squaw Creek at Ames (station number 05470500) for the period 1920-94 (May and others, 1995, p. 113). Mean annual runoff for the South Skunk River drainage basin upstream of Ames was 7.56 in. as determined from records at the streamflow-gaging station South Skunk River near Ames (station number 05470000) for the period 1921-94 (May and others, 1995, p. 112). This variation in mean annual runoff between Squaw Creek and the South Skunk River drainage basins upstream of Ames is reflected in the flood histories and characteristics of these streams at Ames.

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. There are three active USGS continuous-record gaging stations and no crest-stage gaging stations in the vicinity of Ames, Iowa, as 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, 1961-95).

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 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

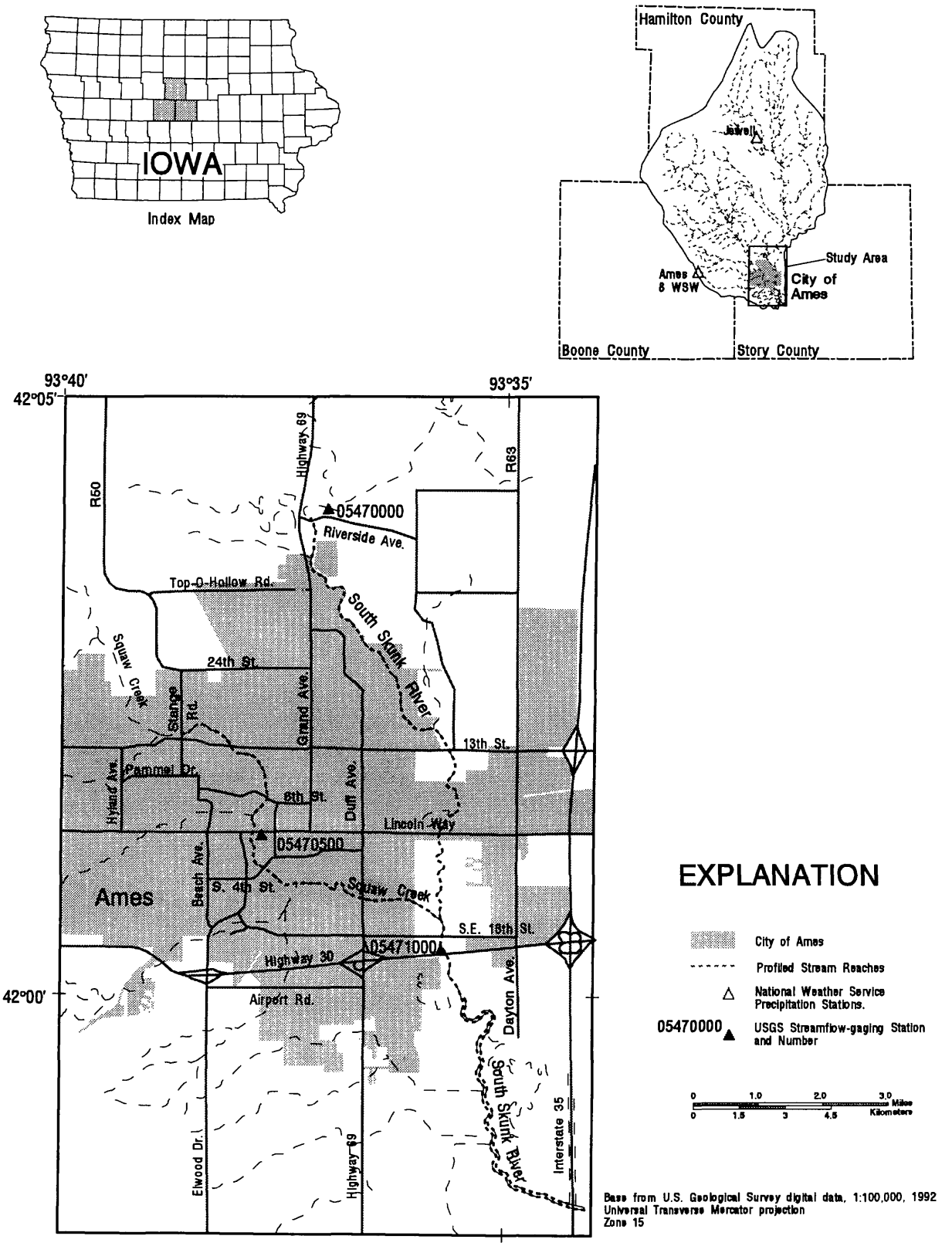

Figure 1. Map showing profiled stream reaches, active U.S. Geological Survey streamflow-gaging stations, and selected roads in the study area.

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 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.

A method for determining floodflow frequencies using streamflow-discharge data 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, 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. 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. These statistics become more reliable as more data are collected and used in the computations. USGS streamflow-gaging stations are the primary source of the stream-flow 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 alternative methods for estimating floodflow frequencies for stream sites in Iowa were developed by Eash (1993). For the first method, 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. For the second method, 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 near Ames, Iowa, are listed in table 1. The discharges determined by the Bulletin 17B method use data collected through the 1994 water year, including available historic flood data. It should be noted that different flood-frequency discharges have been computed for these gaging stations by other agencies using the standard log-Pearson Type-III distribution of Bulletin 17B but with different periods of record, different generalized skew coefficients, and different approaches to the use of historical flood information.

FLOOD HISTORY

Continuous records of streamflow have been collected in the vicinity of Ames, Iowa, from as early as May, 1919, at the USGS streamflow-gaging station Squaw Creek at Ames, Iowa (station number 05470500). Selected flood-peak discharges, including maximum known flood-peak discharges, and recurrence intervals for the three active streamflow-gaging stations in the Ames area are listed in table 2.

The June 27, 1975, and prior floods in Ames are discussed in detail in the report "Flood of June 27, 1975 in City of Ames, Iowa," (Lara and Heinitz, 1976). A discussion of floods throughout the entire Skunk River Basin can be found in the report, "Floods in the Skunk River Basin, Iowa," (Heinitz and Wiitala, 1978).

Table 1. *Floodflow frequencies for active streamflow-gaging stations along Squaw Creek and the South Skunk River in Ames, Iowa, and vicinity*

[17B, Bulletin 17B (Interagency Advisory Committee on Water Data, 1982); Lara, floodflow-frequency equations for hydrologic region 4 (Lara, 1987, p. 28); DB, drainage-basin characteristic floodflow-frequency equation (Eash, 1993, p. 17); CG, channel-geometry characteristic floodflow-frequency equation (Region II, bankfull; Eash, 1993, p. 26)]

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
05470000	South Skunk River near Ames	17B	3,140	4,890	5,990	7,280	8,180	9,010
		Lara	2,600	4,220	5,500	7,250	8,020	9,550
		DB	3,620	6,260	8,210	10,600	12,400	14,300
		CG	2,330	4,280	5,710	7,530	9,080	10,700
05470500	Squaw Creek at Ames	17B	2,680	4,720	6,390	8,870	11,000	13,400
		Lara	1,860	3,080	4,050	5,390	6,020	7,200
		DB	3,150	5,520	7,300	9,530	11,300	13,000
		CG	2,230	4,130	5,540	7,330	8,870	10,400
05471000	South Skunk River below Squaw	17B	6,070	8,750	10,600	13,000	14,900	16,800
	Creek near Ames	Lara	4,030	6,350	8,180	10,700	11,700	13,800
		DB	5,270	8,880	11,500	14,700	17,100	19,200
		CG	4,670	8,310	10,900	14,200	16,900	19,700

Flood of June 17, 1990

Following a wet spring with excessive precipitation in both March and May, persistent and widespread rainfall occurred throughout the State of Iowa in June of 1990 (Hillaker, 1990). On average, 8.05 in. of rain fell over the state, making it the fourth wettest June in the 118 years of state records available at the time (State Climatology Office, 1990). This rainfall, over antecedent wet soil conditions, resulted in flooding across much of central and east-central Iowa. As a result of the widespread flooding, 44 of Iowa's 99 counties received State disaster declarations, with 33 of these counties receiving Federal disaster designations.

Extensive rainfall on June 17 and the preceding few days was responsible for much of the flooding, including the Ames area. For the five-day period of June 13-17, 4.33 and 5.90 in. of rainfall were recorded at the Ames 8 WSW gage and further upstream in the basin at Jewell, respectively (National Oceanic and Atmospheric Administration, 1990), culminating in damaging flooding in Ames on the morning of June 17. This flooding forced the evacuation of approximately 30 households and closed 16 blocks of Duff Avenue (fig. 1) (Des Moines Register, June 18, 1990).

At the Squaw Creek at Ames streamflow-gaging station, the peak discharge recorded on June 17, 1990, was the maximum discharge for the period of record available up to that time. This flood peak of 12,500 ft^3/s had a recurrence interval of approximately 75 years (table 2). The peak stage associated with this flood exceeded the June 27, 1975 peak stage by nearly 2 ft at the Squaw Creek gage.

Flood of July 9, 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. Flood-peak

Table 2. *Selected flood-peak discharges, recurrence intervals, and unit runoff for active streamflow-gaging stations along Squaw Creek and the South Skunk River in Ames, Iowa, and vicinity*

[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]

Station number (fig. 1)	Station name and location	Period of systematic record[1]	Drainage area (mi^2)	Date of flood peak	Gage height[2] (ft)	Discharge (ft^3/s)	Recurrence interval[3] (years)	Unit runoff [$(ft^3/s)/mi^2$]
05470000	South Skunk River near Ames, Iowa	1921-27, 1933-94	315	05-20-44	13.90	8,060	45	25.6
				06-10-54	13.66	8,630	70	27.4
				06-28-75	9.98	5,230	6	16.6
				06-17-90	11.84	6,600	15	21.0
				07-09-93	14.15	11,100	[4]1.2	35.2
				08-16-93	14.23	*11,200	[4]1.2	35.6
05470500	Squaw Creek at Ames, Iowa	1918-27, 1965-94	204	06-27-75	14.00	11,300	55	55.4
				06-17-90	15.97	12,500	75	61.3
				07-09-93	18.54	*24,300	[4]1.8	119
05471000	South Skunk River below Squaw Creek near Ames, Iowa	1953-79, 1992-94	556	06-27-75	25.57	14,700	50	26.4
				06-17-90	[5]25.40	13,000	25	23.4
				07-09-93	[5, 6]25.53	*26,500	[4]1.6	47.7

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

[2]Gage datum in feet above sea level for each 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 recurrence intervals larger than 20 years.

[4]Recurrence intervals for discharges larger than the computed 100-year flood discharge are expressed as a ratio of the given flood discharge to the 100-year flood discharge.

[5]Gage height from high-water mark.

[6]Gage height for 1993 flood at U.S. Highway 30, gage heights for floods prior to October 1991 at S.E. 16th Street.

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). During the two-day period of July 8-9, 1993, the Ames 8 WSW weather station received 5.36 inches of rain, while further upstream in the basin the rainfall gage at Jewell recorded 4.44 inches of rain (National Oceanic and Atmospheric Administration, 1993). On July 9, 1993, floodwaters from Squaw Creek and the South Skunk River inundated large parts of the Ames area, including Interstate 35, U.S. Highway 30, businesses along Duff Avenue, and parts of the Iowa State University campus (Des Moines Register, 1993). The magnitude of this flood was larger than any previous flood on record that had occurred in the City of Ames, exceeding the June 27-28, 1975, and June 17, 1990, floods both in magnitude and damage in the Ames area. New peak-discharge records were set at each of the three USGS continuous-record gages in the Ames area, although the July 9th discharge at the South Skunk River near Ames gage was slightly exceeded later that same summer by a less-damaging flood on August 16. The peak discharge on July 9, 1993, at the Squaw Creek at Ames gage was 24,300 ft^3/s, 1.8 times the computed magnitude of the 100-year flood, and almost 2 times the magnitude of the previous record flood-peak of 12,500 ft^3/s from June 17, 1990. The peak discharge at the South Skunk River below Squaw Creek near Ames gage was 26,500 ft^3/s, 1.6 times the computed magnitude of the 100-year flood, and 1.8 times the magnitude of the previous record flood-peak of 14,700 ft^3/s from June 27, 1975.

FLOOD PROFILE

The water-surface-elevation profiles for the June 27, 1975, June 17, 1990, and July 9, 1993 floods on Squaw Creek and the South Skunk River in Ames, Iowa and vicinity are shown in Appendix B (figs. 2 and 3). Flood elevations located both immediately downstream and 1 bridge-length upstream from selected bridges were identified within a few days of passage of the flood peak. A low-water profile measured on July 31 and August 1, 1995, also is shown in figures 2 and 3 to indicate the approximate low-end of the range of stage that can occur within the profiled reaches. 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.

River miles for the South Skunk River are referenced to the mouth of Skunk River at the Mississippi River. River miles for Squaw Creek are referenced to the mouth of Squaw Creek at the South Skunk River. The river miles presented in this report are consistent with the river miles presented in previously published reports (Lara and Heinitz, 1976; Heinitz and Wiitala, 1978). Measurements of river miles using lower- or higher-resolution data or different technologies such as geographic information systems may yield different values than those contained in this report. Bridges are designated by an index number that helps to identify their location. For example, 8323-30SE refers to a location in Township 83 North, Range 23 West, southeast quarter of section 30.

Differential leveling was performed to reference all the points along the profiles to a common datum, sea level. 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 figures 2 and 3 to indicate the relation between the elevation of important components of the bridges and the elevation of the profiled flood and low-water. For sloping bridges, the profiled bridge-deck and low-bridge-chord elevations represent the lower end of the bridges.

CONSIDERATIONS

The user of this report is cautioned that the stage-discharge data presented 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 can cause the water-surface elevations to plot higher than the normal profile.

SUMMARY

This report provides information on the floods of June 17, 1990, and July 9, 1993, on Squaw Creek and the South Skunk River in Ames, Iowa and vicinity. While the June 17, 1990, flood-peak discharge of 12,500 ft^3/s at the Squaw Creek streamflow-gaging station was the largest recorded discharge up to that time, it was substantially exceeded by the 24,300 ft^3/s peak discharge recorded at the gage on July 9, 1993. The July 9, 1993, flood set new discharge records at all three streamflow-gaging stations in the Ames area on Squaw Creek and the South Skunk River, with peak discharges at the gages ranging from 1.2 to 1.8 times the computed 100-year flood discharges. The July 9, 1993, peak-discharge at the South Skunk River near Ames streamflow-gaging station was subsequently exceeded later that same year on August 16.

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APPENDIX A

PEAK STAGES AND DISCHARGES FOR ACTIVE STREAMFLOW-GAGING STATIONS ALONG SQUAW CREEK AND THE SOUTH SKUNK RIVER IN AMES, IOWA, AND VICINITY, 1918-1994

The peak-stage and discharge data for this report were compiled through September 30, 1994, for the active continuous-record streamflow-gaging stations located in the Squaw Creek and South Skunk River Basins near Ames, Iowa. 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 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 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).

The gaging-station records are arranged in downstream order as explained in the annual streamflow reports of the U.S. Geological Survey (see "References"). The gaging stations are identified by a permanent number that is also used in figure 1 and in tables 1 and 2 of this report. The datum of each gage is sea level. For those gaging stations which are used by the National Weather Service (NWS) as forecast points, the flood stage, as determined by the NWS, is listed. For those gaging stations which are used by the NWS as data points, the bankfull stage, as determined by the NWS, is listed. The flood stage 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, while the bankfull stage is the maximum stage which can occur without overflowing the natural banks of the stream.

The following notations are used in the gaging-station records:

1. A dashed line in the "water year" column denotes a break or gap in the record of peaks.
2. A dashed line beginning at the "date" column and continuing through the "discharge" column indicates a change in site and datum.
3. A dashed line in the "date" and "discharge" columns indicates a change in site without a change in datum.
4. A dashed line in the "gage height" column denotes a change in datum only.

The remainder of the information given is self-explanatory.

05470000 South Skunk River near Ames, Iowa

Location.--Lat 42°04'06", long 93°37'09", in NW1/4 SW1/4 sec.23, T.84 N., R.24 W., Story County, Hydrologic Unit 07080105, on left bank 2.5 mi north of Ames, 3.5 mi downstream from Keigley Branch, 5.2 mi upstream from Squaw Creek, and at mile 228.1 upstream from mouth of Skunk River.

Drainage area.--315 mi^2.

Gage.--Water-stage encoder. Concrete control since July 21, 1934. Datum of gage is 893.61 ft above sea level (Iowa Highway Commission bench mark). Prior to Aug. 25, 1921, nonrecording gage at same site and datum.

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

Flood stage.--9 ft.

Remarks.--Base for partial-duration series, 1,500 ft^3/s.

Peak stages and discharges

[ft, feet above gage datum; ft^3/s, cubic feet per second; (A), discharge not determined; (B), gage height not determined]

Water year	Date	Gage height (ft)	Discharge (ft^3/s)
1921	Sept. 17, 1921	9.20	3,540
1922	Feb. 23, 1922	9.00	3,370
1923	Mar. 28, 1923	6.22	1,670
	Sept. 28, 1923	6.00	1,530
1924	Mar. 30, 1924	6.30	1,680
	June 28, 1924	8.21	3,010
	Aug. 9, 1924	6.00	1,500
1925	Aug. 7, 1925	5.00	905
1926	Sept. 8, 1926	6.50	1,900
	Sept. 19, 1926	8.26	3,120
1927	Feb. 5, 1927	7.40	2,460

1930	Nov. 24, 1929	11.20	5,230

1933	Apr. 1, 1933	6.47	1,990
1934	Jan. 22, 1934	[1]5.39	[2]600
1935	Feb. 15, 1935	[1]7.80	[2]2,490
	Mar. 5, 1935	9.00	3,490
	June 19, 1935	6.50	1,900
	June 25, 1935	8.40	2,960
	July 24, 1935	7.00	2,190
1936	Mar. 10, 1936	7.70	2,580
1937	Mar. 6, 1937	[1]8.40	[2]3,000

05470000 South Skunk River near Ames, Iowa

Peak stages and discharges–Continued

Water year	Date	Gage height (ft)	Discharge (ft^3/s)
1938	May 4, 1938	8.30	2,890
	May 17, 1938	6.50	1,880
	June 29, 1938	5.80	1,540
1939	Mar. 14, 1939	[1]10.50	[2]3,230
1940	Aug. 13, 1940	7.30	2,320
1941	Sept. 8, 1941	8.60	3,050
1942	Nov. 1, 1941	5.90	1,630
	Sept. 14, 1942	8.10	2,530
1943	June 16, 1943	6.50	1,910
	July 31, 1943	10.30	4,500
1944	May 20, 1944	13.90	8,060
	June 12, 1944	8.00	2,840
1945	Mar. 16, 1945	6.30	1,800
	May 22, 1945	7.70	2,620
	June 2, 1945	9.70	4,010
1946	Feb. 5, 1946	7.10	2,270
	Mar. 6, 1946	5.90	1,600
	Mar. 13, 1946	5.90	1,610
1947	June 1, 1947	8.63	3,740
	June 4, 1947	8.18	3,400
	June 13, 1947	11.95	6,550
	June 23, 1947	10.80	5,400
	June 30, 1947	6.40	2,200
1948	Feb. 28, 1948	5.80	1,630
	Mar. 19, 1948	7.35	2,620
	Mar. 27, 1948	7.30	2,600
1949	Mar. 4, 1949	[1]10.52	[2]3,000
1950	Mar. 7, 1950	8.86	3,820
	May 5, 1950	6.00	1,810
	May 9, 1950	7.00	2,410
	June 9, 1950	5.80	1,690
	June 18, 1950	6.60	2,170
1951	Feb. 26, 1951	5.75	1,690
	Mar. 29, 1951	10.90	5,320
	May 2, 1951	6.75	2,290
	June 2, 1951	10.35	4,920
	June 20, 1951	6.25	1,930
	July 4, 1951	7.07	2,470
1952	July 9, 1952	5.73	1,630
1953	May 1, 1953	4.71	980

05470000 South Skunk River near Ames, Iowa

Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft^3/s)
1954	June 1, 1954	7.84	3,180
	June 10, 1954	13.66	8,630
	June 16, 1954	6.37	2,110
	June 22, 1954	5.88	1,770
	Aug. 27, 1954	8.27	3,520
1955	Oct. 15, 1954	5.22	1,340
1956	Sept. 4, 1956	3.49	376
1957	June 16, 1957	8.28	3,540
	July 4, 1957	6.52	2,200
1958	July 2, 1958	6.55	2,270
	July 4, 1958	7.85	3,150
	July 11, 1958	5.78	1,720
1959	Mar. 20, 1959	5.60	1,590
	May 31, 1959	5.83	1,720
1960	Mar. 30, 1960	10.33	6,210
	May 7, 1960	5.59	1,590
1961	Feb. 23, 1961	5.71	1,990
	Mar. 15, 1961	5.51	1,770
	Aug. 2, 1961	5.51	1,770
1962	Mar. 26, 1962	6.91	3,010
	May 7, 1962	7.53	3,510
	May 30, 1962	5.72	1,970
	July 14, 1962	9.02	4,300
	July 22, 1962	5.72	1,970
1963	Apr. 30, 1963	5.65	1,820
1964	May 8, 1964	5.31	1,570
	June 22, 1964	5.91	2,170
1965	Mar. 1, 1965	[1]7.49	[2]3,500
	Apr. 2, 1965	[1]7.25	[2]3,300
	Apr. 6, 1965	9.43	5,260
	May 27, 1965	6.55	2,730
	June 6, 1965	5.75	2,020
	Sept. 20, 1965	6.92	3,030
	Sept. 28, 1965	5.34	1,610
1966	Feb. 9, 1966	[1]6.92	[2]2,900
	May 23, 1966	5.87	1,960
	June 12, 1966	6.26	2,510
1967	June 8, 1967	6.63	2,790
	June 13, 1967	5.87	2,140
	June 18, 1967	6.06	2,320
1968	June 25, 1968	8.74	4,890

05470000 South Skunk River near Ames, Iowa

Peak stages and discharges–Continued

Water year	Date	Gage height (ft)	Discharge (ft^3/s)
1969	Mar. 20, 1969	7.97	3,910
	Mar. 25, 1969	6.27	2,510
	June 7, 1969	6.19	2,440
	June 13, 1969	5.28	1,550
	June 30, 1969	6.88	2,910
	July 10, 1969	8.49	4,380
	July 18, 1969	6.13	2,390
	July 28, 1969	7.32	3,360
1970	May 13, 1970	5.10	1,330
1971	Feb. 19, 1971	[1]9.10	(A)
	Feb. 20, 1971	7.67	3,660
	Mar. 13, 1971	6.03	2,300
1972	Mar. 7, 1972	[1]8.93	(A)
	June 6, 1972	5.34	1,610
	Aug. 3, 1972	5.40	1,670
	Aug. 7, 1972	6.92	3,030
1973	Oct. 24, 1972	5.66	1,930
	Nov. 2, 1972	5.33	1,600
	Nov. 8, 1972	5.67	1,940
	Dec. 30, 1972	[1]7.13	[2]2,790
	Jan. 18, 1973	[1]6.19	[2]2,210
	Feb. 2, 1973	[1]7.94	[2]2,470
	Mar. 1, 1973	5.29	1,560
	Mar. 11, 1973	5.77	2,040
	Mar. 14, 1973	5.53	1,800
	Apr. 16, 1973	7.30	3,340
	May 8, 1973	6.12	2,380
	May 28, 1973	5.38	1,650
	Sept. 27, 1973	5.83	2,100
1974	Oct. 12, 1973	6.70	2,850
	Apr. 22, 1974	5.10	1,730
	May 14, 1974	5.17	1,800
	May 16, 1974	5.37	2,000
	May 19, 1974	5.50	2,130
	May 22, 1974	5.37	2,000
	June 9, 1974	6.35	2,860
	June 19, 1974	8.90	5,100
	June 20, 1974	6.69	3,130
	June 23, 1974	9.61	5,780
1975	Mar. 20, 1975	5.94	2,170
	June 19, 1975	5.09	1,570
	June 22, 1975	6.12	2,290
	June 25, 1975	6.19	2,340
	June 28, 1975	9.98	5,230
1976	June 14, 1976	7.54	3,580

05470000 South Skunk River near Ames, Iowa

Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft^3/s)
1977	Aug. 9, 1977	5.92	2,080
	Aug. 10, 1977	6.03	2,140
	Aug. 16, 1977	9.46	5,300
1978	Apr. 18, 1978	5.83	2,100
	Sept. 14, 1978	5.93	2,240
	Sept. 21, 1978	5.34	1,650
1979	Mar. 19, 1979	9.13	4,980
	Mar. 23, 1979	6.82	2,950
	Mar. 30, 1979	7.48	3,490
	June 13, 1979	5.62	1,880
	July 11, 1979	6.16	2,410
	July 30, 1979	5.39	1,660
	Aug. 21, 1979	5.53	1,800
1980	June 14, 1980	6.54	2,720
	June 19, 1980	5.29	1,560
1981	June 25, 1981	5.61	1,880
1982	Feb. 22, 1982	7.05	3,140
	Mar. 16, 1982	5.35	1,630
	Mar. 20, 1982	6.39	2,600
	June 15, 1982	5.46	1,730
	July 19, 1982	7.53	3,490
1983	Nov. 12, 1982	(B)	[3]1,500
	Dec. 6, 1982	(B)	[3]1,500
	Dec. 28, 1982	5.62	1,790
	Feb. 20, 1983	5.99	2,160
	Mar. 7, 1983	5.59	1,760
	Apr. 2, 1983	5.75	1,970
	Apr. 15, 1983	6.24	2,470
	May 20, 1983	6.59	2,680
	July 3, 1983	9.43	5,150
1984	Feb. 17, 1984	(B)	2,600
	May 1, 1984	5.52	1,790
	June 13, 1984	9.19	5,020
	June 17, 1984	7.71	3,680
	June 22, 1984	5.42	1,680
1985	Mar. 4, 1985	5.75	1,980
1986	Mar. 14, 1986	5.48	1,740
	Mar. 19, 1986	5.95	2,140
	June 30, 1986	8.11	4,040
	Sept. 20, 1986	5.58	1,840
1987	Oct. 5, 1986	5.35	1,610
	Oct. 13, 1986	6.82	2,940
	July 12, 1987	6.84	3,040
	Aug. 26, 1987	6.01	2,290
1988	Nov. 29, 1987	3.98	565

05470000 South Skunk River near Ames, Iowa

Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft^3/s)
1989	Mar. 10, 1989	[1]4.98	[4]370
1990	May 20, 1990	7.37	3,250
	May 25, 1990	5.97	2,120
	June 17, 1990	11.84	6,600
	June 20, 1990	9.36	4,630
	June 23, 1990	6.97	2,890
	July 27, 1990	6.45	2,600
	July 29, 1990	7.55	3,540
1991	Mar. 2, 1991	5.08	1,540
	Mar. 18, 1991	5.56	1,970
	Mar. 23, 1991	5.33	1,780
	Mar. 28, 1991	5.06	1,500
	Apr. 8, 1991	5.24	1,670
	Apr. 13, 1991	7.03	3,260
	Apr. 14, 1991	7.15	3,360
	Apr. 19, 1991	5.50	1,910
	Apr. 27, 1991	5.39	1,820
	May 16, 1991	7.86	4,000
	May 19, 1991	7.30	3,510
	June 4, 1991	8.73	4,700
1992	Mar. 7, 1992	5.70	2,070
	July 16, 1992	6.00	2,350
1993	Mar. 9, 1993	5.63	1,770
	Mar. 27, 1993	5.34	1,520
	Mar. 31, 1993	7.14	3,220
	May 11, 1993	5.34	1,520
	June 9, 1993	5.77	1,900
	June 19, 1993	10.22	6,360
	July 1, 1993	7.10	3,180
	July 9, 1993	14.15	11,100
	July 14, 1993	10.25	6,390
	July 18, 1993	11.66	8,000
	Aug. 11, 1993	5.80	1,930
	Aug. 16, 1993	14.23	11,200
	Aug. 30, 1993	6.86	2,920
1994	Mar. 5, 1994	6.20	2,330
	June 7, 1994	6.20	2,340
	June 23, 1994	5.77	1,940

[1]Affected by ice.
[2]Approximate.
[3]Discharge greater than indicated value.
[4]Discharge due to snowmelt or ice-jam breakup

05470500 Squaw Creek at Ames, Iowa

Location.--Lat 42°01'21", long 93°37'45", in NE1/4 NW1/4 sec.10, T.83 N., R.24 W., Story County, Hydrologic Unit 07080105, on left bank 65 ft downstream from Lincoln Way Bridge in Ames, 0.2 mi downstream from College Creek, and 2.4 mi upstream from mouth.

Drainage area.--204 mi^2.

Gage.--Water-stage recorder and concrete control. Datum of gage is 881.00 ft above sea level (levels by Iowa State University). Prior to Mar. 11, 1925, nonrecording gage at site 0.6 mi upstream at different datum. Mar. 11, 1925, to Apr. 30, 1927, nonrecording gage at site 65 ft upstream at datum about 4 ft higher.

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

Flood stage.--7 ft.

Remarks.--Base for partial-duration series, 1,600 ft^3/s.

Peak stages and discharges

[ft, feet above gage datum; ft^3/s, cubic feet per second; (B), gage height not determined]

Water year	Date	Gage height (ft)	Discharge (ft^3/s)
1918	June 4, 1918	14.50	[1]6,900
1919	Sept. 30, 1919	7.96	[2]1,900
1920	Oct. 4, 1919	8.60	2,260
1921	Sept. 17, 1921	7.40	1,900
1922	July 17, 1922	10.70	4,130
1923	Sept. 28, 1923	6.10	1,340
1924	July 28, 1924	8.80	3,170
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1925	Aug. 7, 1925	4.90	791
1926	Sept. 19, 1926	10.20	3,610
1927	Oct. 4, 1926	5.80	1,060
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1965	Mar. 1, 1965	10.70	4,200
	May 26, 1965	6.06	1,700
	June 4, 1965	8.85	[3]2,680
1966	June 12, 1966	10.15	3,160
1967	June 8, 1967	6.69	1,950
	June 12, 1967	6.92	2,020
1968	June 25, 1968	8.27	2,500

05470500 Squaw Creek at Ames, Iowa

Peak stages and discharges–Continued

Water year	Date	Gage height (ft)	Discharge (ft^3/s)
1969	Mar. 20, 1969	9.59	2,970
	Mar 24, 1969	7.16	2,120
	June 7, 1969	8.34	2,240
	June 30, 1969	9.45	2,580
	July 4, 1969	(B)	[3]1,800
	July 9, 1969	7.84	2,090
1970	May 13, 1970	10.74	3,540
1971	Feb. 19, 1971	10.09	3,650
1972	Aug. 2, 1972	5.84	1,680
1973	Jan. 18, 1973	[4]10.80	[3]2,310
	Feb 2, 1973	[4]9.40	[3]2,540
	Apr. 16, 1973	8.69	2,800
	May 7, 1973	6.65	1,950
	Sept. 27, 1973	5.60	1,610
	Sept. 29, 1973	6.57	1,930
1974	Oct. 12, 1973	8.64	2,750
	May 16, 1974	7.21	2,080
	May 18, 1974	8.14	2,450
	May 22, 1974	5.75	1,620
	June 9, 1974	7.93	2,400
	June 19, 1974	8.02	2,440
	June 22, 1974	8.95	2,900
1975	Mar. 20, 1975	(B)	[3]1,700
	June 18, 1975	5.96	1,720
	June 26, 1975	9.79	3,430
	June 27, 1975	14.00	11,300
1976	June 14, 1976	8.55	2,680
1977	Aug. 8, 1977	7.09	2,070
	Aug. 16, 1977	8.01	2,430
1978	Apr. 18, 1978	7.11	2,060
	June 24, 1978	6.33	1,840
	Sept. 14, 1978	7.51	2,230
	Sept. 20, 1978	5.97	1,720
1979	Mar. 19, 1979	11.81	5,300
	Mar. 23, 1979	6.28	1,800
	Mar. 30, 1979	6.11	1,740
	July 11, 1979	6.05	1,710
	Aug. 10, 1979	7.88	2,320
	Aug. 20, 1979	6.64	1,890
1980	May 30, 1980	4.69	1,250
1981	June 24, 1981	4.26	1,060

05470500 Squaw Creek at Ames, Iowa

Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft^3/s)
1982	Mar. 19, 1982	6.61	1,900
	May 21, 1982	5.85	1,680
	May 26, 1982	6.56	1,910
	June 16, 1982	6.78	1,970
	July 18, 1982	10.30	3,820
1983	Dec. 28, 1982	5.88	1,690
	Feb. 19, 1983	5.81	1,650
	Feb. 20, 1983	6.22	1,790
	Apr. 1, 1983	5.76	1,620
	Apr. 13, 1983	7.19	2,070
	May 19, 1983	7.63	2,260
	June 29, 1983	7.20	2,070
	July 2, 1983	7.55	2,210
	July 4, 1983	7.52	2,190
1984	Apr. 30, 1984	8.40	2,590
	May 29, 1984	8.21	2,500
	June 13, 1984	12.97	7,180
	June 17, 1984	12.77	6,820
1985	Mar. 4, 1985	6.97	2,030
1986	Mar. 3, 1986	5.96	1,680
	June 30, 1986	10.21	3,750
1987	Oct. 12, 1986	7.27	2,120
	July 12, 1987	5.71	1,670
	Aug. 26, 1987	8.03	2,490
1988	Feb. 19, 1988	3.22	656
1989	May 24, 1989	7.01	2,050
1990	May 9, 1990	5.56	1,620
	May 19, 1990	10.61	4,200
	May 25, 1990	9.62	3,420
	June 10, 1990	8.28	2,590
	June 17, 1990	15.97	12,500
1991	Mar. 2, 1'991	5.97	1,620
	Apr. 12, 1991	8.90	2,730
	Apr. 14, 1991	8.79	2,680
	May 16, 1991	7.08	1,970
	May 18, 1991	6.64	1,830
	May 30, 1991	8.56	2,570
	June 4, 1991	9.41	3,000
1992	July 16, 1992	6.88	1,910

05470500 Squaw Creek at Ames, Iowa

Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft^3/s)
1993	Mar. 4, 1993	(B)	[5]2,200
	Mar. 7, 1993	8.07	2,670
	Mar. 30, 1993	5.84	1,800
	June 19, 1993	(B)	2,740
	June 30, 1993	9.85	3,680
	July 9, 1993	18.54	24,300
	July 11, 1993	13.67	8,250
	July 13, 1993	12.32	6,370
	July 17, 1993	15.01	11,000
	Aug. 16, 1993	13.26	7,600
	Aug. 19, 1993	5.77	1,770
	Aug. 29, 1993	7.68	2,510
1994	June 8, 1994	5.40	1,620
	June 24, 1994	8.66	2,920

[1]Historic peak discharge.
[2]Maximum discharge during partial year of record.
[3]Approximate.
[4]Affected by ice.
[5]Discharge due to snowmelt or ice-jam breakup.

05471000 South Skunk River below Squaw Creek near Ames, Iowa

Location.--Lat 42°00'31", long 93°35'57", in SE1/4 NW1/4 sec.13, T.83 N., R.24 W., Story County, Hydrologic Unit 07080105, on right bank 500 ft downstream from bridge on county highway, 0.2 mi downstream from Squaw Creek, 100 ft upstream from bridge on U.S. Highway 30, 2 mi southeast of Ames, and at mile 222.6 upstream from mouth of Skunk River.

Drainage area.--556 mi^2.

Gage.--Water-stage encoder. Datum of gage is 857.10 ft above sea level. Prior to Oct. 1, 1973, at datum 10.00 ft higher. Prior to Oct. 1991, at site 500 ft upstream at same datum.

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

Bankfull stage.--20 ft.

Remarks.--Base for partial-duration series, 2,500 ft^3/s.

Peak stages and discharges

[ft, feet above gage datum; ft^3/s, cubic feet per second; (B), gage height not determined]

Water year	Date	Gage height (ft)	Discharge (ft^3/s)
1944	May19, 1944	13.00	[1]10,000

1953	May 1, 1953	5.47	1,620
1954	June 1, 1954	10.92	6,500
	June 11, 1954	11.92	7,980
	June 16, 1954	7.63	3,200
	June 22, 1954	8.36	3,820
	Aug. 22, 1954	8.53	3,950
	Aug. 26, 1954	9.26	4,700
	Aug. 28, 1954	12.36	8,700
1955	Oct. 14, 1954	6.81	2,680
	July 10, 1955	6.73	2,540
1956	May 13, 1956	3.05	638
1957	June 16, 1957	11.58	6,360
	July 4, 1957	8.54	3,950
1958	June 8, 1958	6.95	2,610
	June 13, 1958	6.93	2,610
	July 2, 1958	11.13	6,120
	July 4, 1958	12.82	8,550
1959	Mar. 20, 1959	8.69	3,860
	May 31, 1959	10.57	5,520
1960	Mar. 30, 1960	13.20	9,260
	May 7, 1960	9.47	4,600

05471000 South Skunk River below Squaw Creek near Ames, Iowa

Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft^3/s)
1961	Feb. 23, 1961	7.98	3,450
	Mar. 15, 1961	8.05	3,380
	June 7, 1961	7.11	2,680
	Aug. 1, 1961	7.97	3,310
	Sept. 30,1961	8.27	3,520
1962	Mar. 26, 1962	10.70	5,900
	May 8, 1962	10.47	5,140
	May 29, 1962	9.32	4,280
	June 9, 1962	7.32	2,820
	July 15, 1962	11.87	6,330
	July 20, 1962	7.96	3,310
1963	Apr. 29, 1963	8.56	3,520
	May 13, 1963	10.20	4,780
1964	May 8, 1964	8.84	3,600
	June 23, 1964	9.80	4,440
1965	Mar. 1, 1965	11.87	6,410
	Apr. 1, 1965	11.82	6,350
	Apr. 6, 1965	12.59	7,340
	June 5, 1965	(B)	[2]3,800
	Sept. 20, 1965	8.36	3,720
1966	May 23, 1966	8.23	3,400
	June 12, 1966	11.45	6,380
1967	June 8, 1967	9.90	4,960
	June 12, 1967	8.57	3,880
	June 18, 1967	6.78	2,600
1968	June 25, 1968	12.07	7,310
	June 29, 1968	6.71	2,550
1969	Mar. 20, 1969	12.15	6,620
	Mar. 25, 1969	(B)	[2]4,400
	June 7, 1969	9.22	3,920
	June 13, 1969	(B)	[2]2,600
	June 27, 1969	(B)	[2]3,600
	June 30, 1969	11.30	5,700
	July 3, 1969	7.80	2,890
	July 10, 1969	11.84	6,260
	July 19, 1969	(B)	[2]3,600
	July 28, 1969	9.50	4,120
1970	May 13, 1970	10.35	4,950
1971	Feb. 20, 1971	12.67	8,610
	Mar. 14, 1971	9.21	4,270
1972	Aug. 2, 1972	8.05	3,340
	Aug. 8, 1972	(B)	[2]3,300

05471000 South Skunk River below Squaw Creek near Ames, Iowa

Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft^3/s)
1973	Oct. 24, 1972	7.50	2,930
	Nov. 2, 1972	7.27	2,770
	Nov. 7, 1972	7.73	3,090
	Dec. 30, 1972	[3]8.97	[2]3,720
	Jan. 18, 1973	[3]9.91	[2]3,800
	Feb. 2, 1973	[3]12.43	[2]5,120
	Mar. 11, 1973	8.12	3,400
	Mar. 14, 1973	7.72	3,080
	Apr. 16, 1973	11.94	6,860
	May 8, 1973	10.09	5,39
	May 28, 1973	6.92	2,730
	Sept. 27, 1973	8.89	3,530
	Sept. 30, 1973	9.60	3,780

1974	Oct. 10, 1973	21.69	5,880
	Apr. 22, 1974	18.15	[2]2,900
	May 16, 1974	19.83	[2]4,000
	May 18, 1974	21.13	[2]5,100
	May 22, 1974	18.67	[2]3,200
	June 9, 1974	21.21	5,210
	June 19, 1974	22.58	[2]6,900
	June 23, 1974	23.19	7,800
1975	Mar. 20, 1975	(B)	[2]3,990
	June 18, 1975	18.23	2,950
	June 22, 1975	18.76	3,240
	June 27, 1975	25.57	14,700
1976	Apr. 18, 1976	17.75	3,170
	Apr. 21, 1976	16.66	2,520
	May 24, 1976	16.80	2,600
	June 14, 1976	22.14	6,410
1977	Aug. 16, 1977	22.43	6,400
1978	Apr. 18, 1978	20.08	4,430
	Sept. 14, 1978	19.97	4,700
	Sept. 30, 1978	18.39	3,590
1979	Mar. 19, 1979	23.68	9,430
	Mar. 23, 1979	20.17	5,160
	Mar. 30, 1979	20.55	5,470
	June 13, 1979	16.86	2,760
	June 27, 1979	16.63	2,620
	July 11, 1979	19.48	4,500
	July 30, 1979	17.22	2,980
	Aug. 10, 1979	17.63	3,220
	Aug. 20, 1979	19.24	4,330

1990	June 17, 1990	[4]25.40	[2]13,000

05471000 South Skunk River below Squaw Creek near Ames, Iowa

Peak stages and discharges--Continued

Water year	Date	Gage height (ft)	Discharge (ft^3/s)
------	----------		--------
1992	Mar. 6, 1992	17.62	3,180
	July 16, 1992	17.96	[2]3,370
1993	Mar. 31, 1993	19.01	4,120
	May 11, 1993	16.85	2,740
	June 9, 1993	18.06	3,510
	June 14, 1993	17.60	3,220
	June 19, 1993	22.32	8,030
	June 21, 1993	17.31	3,060
	July 1, 1993	21.44	6,800
	July 9, 1993	[4]25.53	26,500
	July 11, 1993	23.92	14,300
	July 14, 1993	22.92	10,100
	July 17, 1993	24.20	16,100
	Aug. 1, 1993	18.30	3,840
	Aug. 10, 1993	19.53	4,760
	Aug. 17, 1993	25.25	24,200
	Aug. 24, 1993	18.33	3,980
	Aug. 29, 1993	19.20	4,570
1994	Mar. 5, 1994	17.68	3,400
	June 8, 1994	17.93	3,580
	June 24, 1994	19.96	5,170
	June 30, 1994	18.20	3,760
	July 1, 1994	19.35	4,660

[1]Historic peak discharge.
[2]Approximate.
[3]Affected by ice.
[4]Gage height from high-water mark.

APPENDIX B

WATER-SURFACE-ELEVATION PROFILES FOR SQUAW CREEK AND THE SOUTH SKUNK RIVER

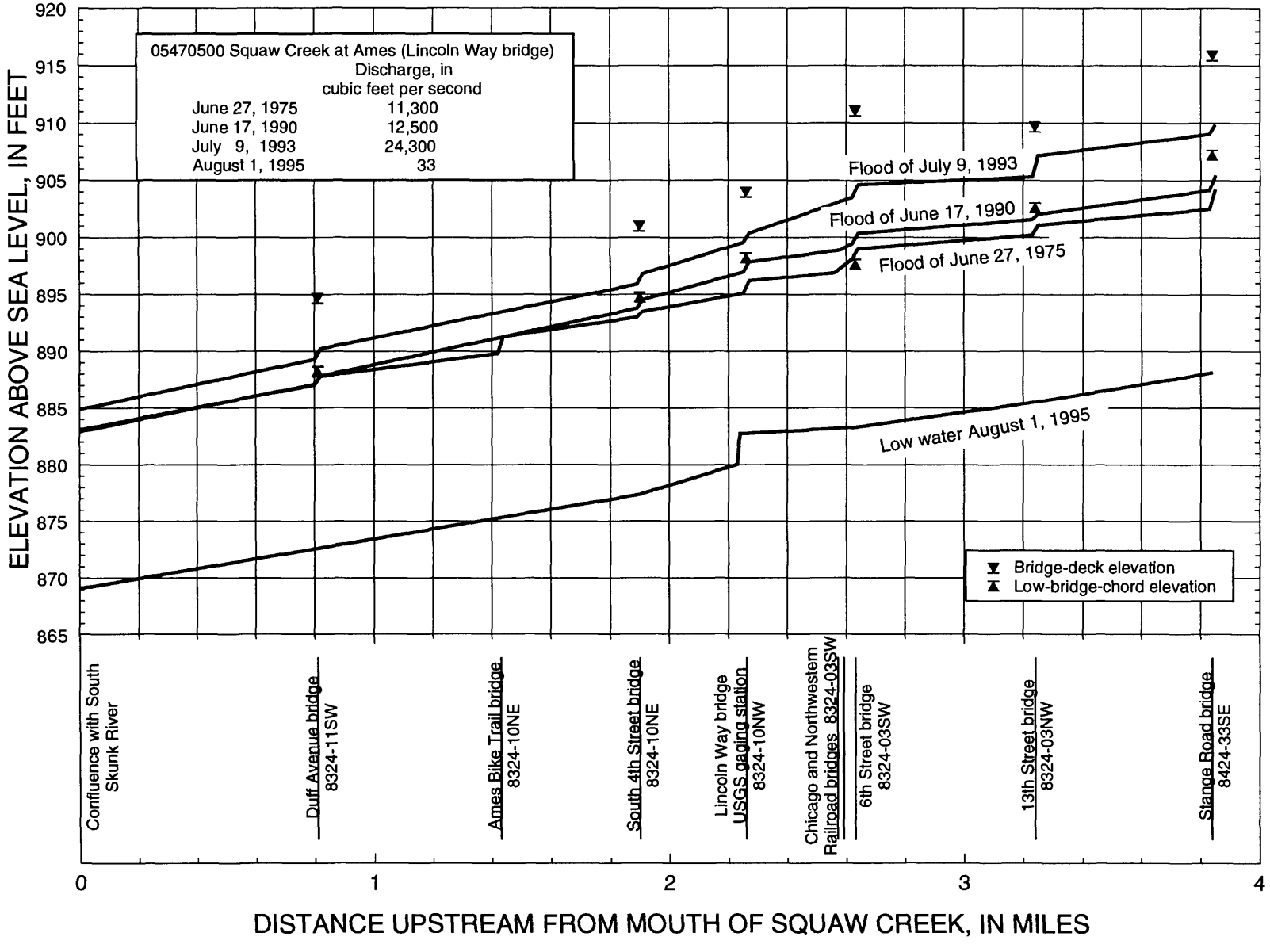

Figure 2. Water-surface-elevation profiles for Squaw Creek.

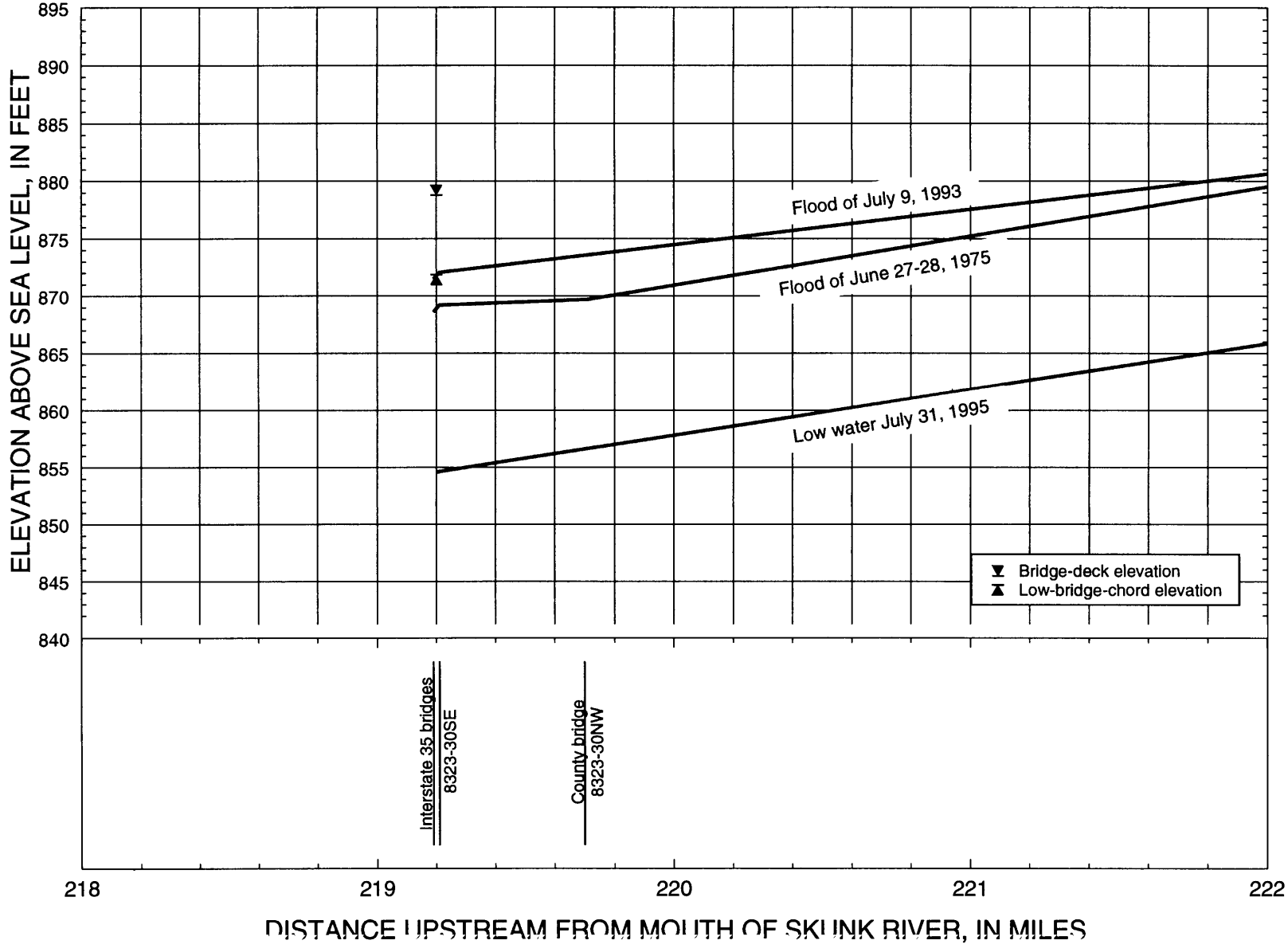

Figure 3. Water-surface-elevation profiles for South Skunk River.

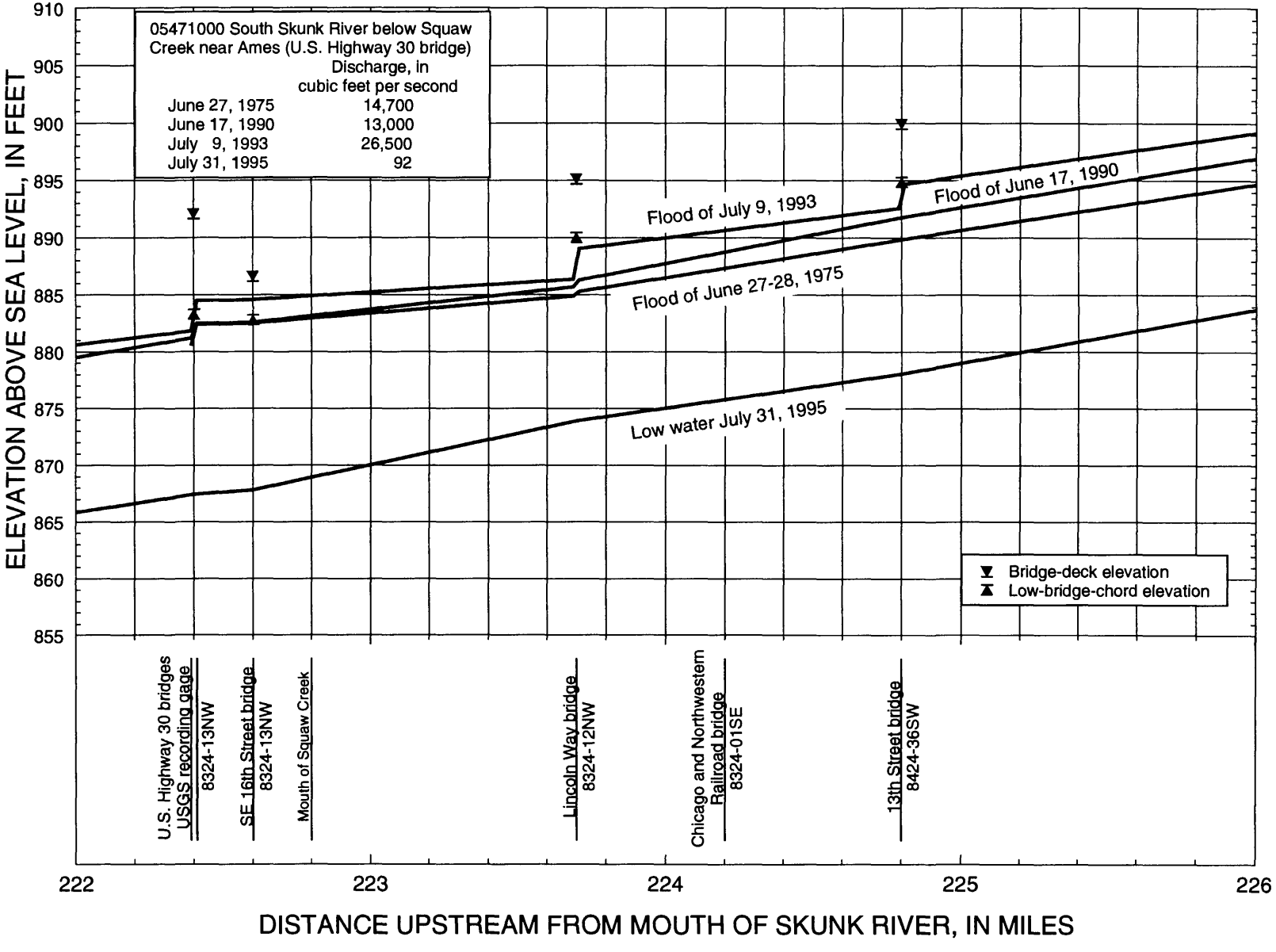

Figure 3. Water-surface-elevation profiles for South Skunk River--Continued

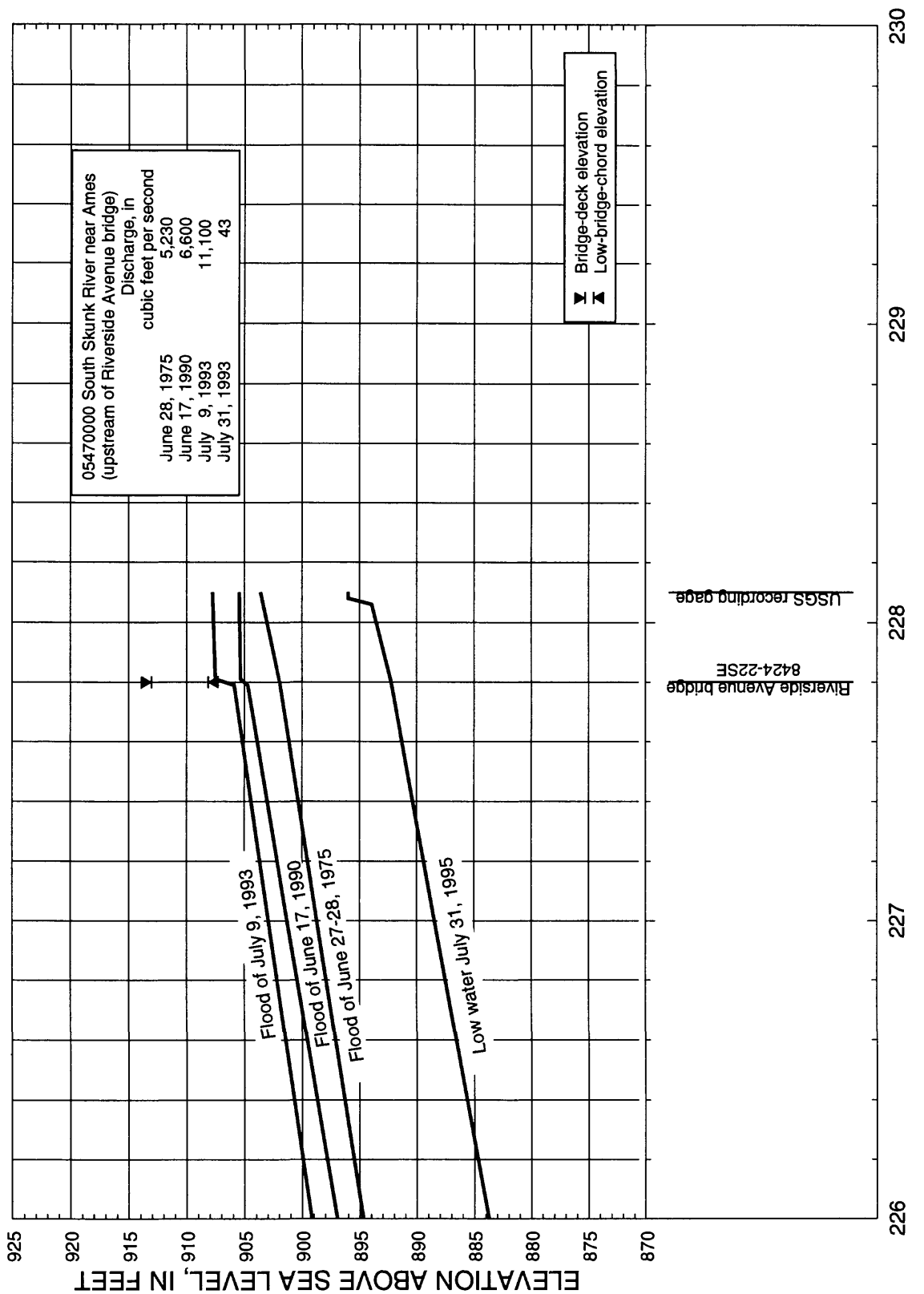

Figure 3. Water-surface-elevation profiles for South Skunk River--Continued

APPENDIX C

DESCRIPTIONS AND ELEVATIONS OF TEMPORARY BENCH MARKS AND REFERENCE POINTS IN THE SQUAW CREEK AND SOUTH SKUNK RIVER BASINS IN AMES, IOWA, AND VICINITY

The temporary bench marks listed in this tabulation were established by the U.S. Geological Survey (USGS). Elevations for the bench marks also were established by the USGS except those for which credit is given in the description of the bench mark. The work was done as a part of a stream profile study jointly funded by both the Highway Research Advisory Board and the Project Development Division of the Iowa Department of Transportation, and the USGS.

The stream reaches included in the level work were Squaw Creek and the South Skunk River near Ames. Bench marks were set at the majority of bridges and at intermediate points to preserve the level lines.

Level lines to establish the third-order accuracy bench marks 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.

The bench marks are identified by an index number, which is composed of the township, range, and section number as mandated by Congress and the quarter section in which they are located. The township and range numbers are combined into a four-digit number, such as 8323 for Township 83 North and Range 23 West. This is followed by a dash and the section number in which the mark is located. Within the section, the quarter in which the mark is located is designated by NE, SE, SW, and NW. A number in parentheses following this letter designation indicates the number of the mark in that particular quarter section. The index number serves to describe the landline location of the mark without further reference in the body of the description.

Standard marks, such as chiseled squares and crosses, were used on concrete or steel. On trees or poles, either a 20-penny pole spike driven horizontally through a short piece of 1/8-in. galvanized pipe or a railroad spike was used. Existing marks were used wherever available, and the agency responsible for the mark, when known, is indicated in the description. Marks indicated as (REFERENCE POINT) following the name of the stream 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 direction of the flow of the stream.

The user of this information is cautioned that the bench marks listed herein may be disturbed, destroyed, or may have moved over time. Many of the marks are located on bridges that may have been repaired, replaced, or destroyed since the original level lines were run. It is the responsibility of the user to determine the condition and the suitability of the bench mark.

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.

TEMPORARY BENCH MARKS AND REFERENCE POINTS

8323-19 SE--About 4 miles southeast of Ames, in southwest wingwall of county road E57 overpass of I-35, between sections 19 and 30; Iowa Highway Commission plug. (Found 6/94)

Elevation 894.19 ft

8323-30 SE (1)--About 4.5 miles southeast of Ames, on downstream I-35 bridge over the South Skunk River, on top of right downstream wingwall; Iowa Highway Commission plug. (Found 7/95)

Elevation 879.53 ft

8323-30 SE (2)--About 4.5 miles southeast of Ames, on upstream I-35 bridge over the South Skunk River, on top of left upstream wingwall; Iowa Highway Commission plug. (Found 7/95)

Elevation 879.20 ft

8323-30 SE (3)--(REFERENCE POINT) About 4.5 miles southeast of Ames, on downstream I-35 bridge over the South Skunk River, on downstream bridge curb 147 ft streamward of right end of bridge deck; chiseled arrow. (Found 7/95)

Elevation 880.17 ft

8323-30 NW (1)--About 4 miles southeast of Ames, on first county road bridge over South Skunk River upstream of I-35, on top of upstream side of left pier; chiseled square.

Elevation 871.87 ft

8323-30 NW (2)--(REFERENCE POINT) About 4 miles southeast of Ames, on first county road bridge over the South Skunk River upstream of I-35, on top of downstream guardrail just right of bridge center; filed arrow.

Elevation 877.91 ft

8323-32 SE (1)--About 6 miles southeast of Ames, on the first bridge over the South Skunk River downstream of I-35, on upstream end of 1 ft by 1 ft beam adjacent to the left abutment, on top of 1/2 in. diameter rod; chiseled cross.

Elevation 862.80 ft

8323-32 SE (2)--(REFERENCE POINT) About 6 miles southeast of Ames, on the first bridge over the South Skunk River downstream of I-35, on left downstream side of first vertical member left of center of left truss; filed arrow.

Elevation 868.85 ft

8323-32 SE (3)--About 6 miles southeast of Ames, on the first bridge over the South Skunk River downstream of I-35, on upstream end of bridge pier; a chiseled cross (set by Iowa Natural Resources Council).

Elevation 862.85 ft

8324-03 SW (1)--At Ames, at 6th Street bridge over Squaw Creek, on top of right downstream wingwall; chiseled square. (Found 7/95)

Elevation 908.41 ft

8324-03 SW (2)--(REFERENCE POINT) At Ames, at 6th Street bridge over Squaw Creek, on downstream handrail at 9th post from left end of bridge; chiseled arrow. (Found 7/95)

Elevation 916.08 ft

8324-03 NW (1)--At Ames, at 13th Street bridge over Squaw Creek, on top of wingpost at right downstream end of bridge; Iowa Highway Commission plug. (Found 7/95)

Elevation 912.44 ft

8324-03 NW (2)--(REFERENCE POINT) At Ames, at 13th Street bridge over Squaw Creek, on downstream handrail post, 15th post from right end of bridge; chiseled arrow. (Found 7/95)

Elevation 912.37 ft

8324-10 NE (1)--At Ames, at 4th Street bridge over Squaw Creek, at left upstream end of bridge, on top of curb; chiseled square. (Found 7/95)

Elevation 900.68 ft

8324-10 NE (2)--(REFERENCE POINT) At Ames, at 4th Street bridge over Squaw Creek, at downstream handrail, on 12th post from left abutment; chiseled arrow. (Found 7/95)

Elevation 903.08 ft

8324-10 NW (1)--At Ames, at Lincoln Way bridge over Squaw Creek, on top of left downstream wingwall; chiseled square. (Found 6/94)

Elevation 903.54 ft

8324-10 NW (2)--At Ames, at Lincoln Way bridge over Squaw Creek, on top of right downstream wingwall; Iowa Highway Commission plug. (Found 6/94)

Elevation 903.34 ft

8324-11 SW--At Ames, at South Duff Avenue bridge over Squaw Creek, at left upstream end of bridge, on top of wingpost; chiseled square. (Found 7/95)

Elevation 897.09 ft

8324-11 SE--(REFERENCE POINT) At Ames, at South Duff Avenue bridge over Squaw Creek, at base of light pole in center of bridge on downstream side of bridge; top of 1/4 inch bolt. (Found 7/95)

Elevation 894.17 ft

8324-12 NW (1)--At Ames, at Lincoln Way bridge over South Skunk River, on top of wingpost at left downstream end of bridge; Iowa Highway Commission plug. (Found 7/95)

Elevation 897.11 ft

8324-12 NW (2)--(REFERENCE POINT) At Ames, at Lincoln Way bridge over South Skunk River, 110 ft streamward of left upstream end of bridge on concrete deck upstream of the guardrail; chiseled square. (Found 7/95)

Elevation 894.95 ft

8324-13 NW (1)--About 2 miles southeast of Ames, on Highway 30 bridge over the South Skunk River, on right downstream curb; Iowa Highway Commission plug. (Found 7/95)

Elevation 891.40 ft

8324-13 NW (2)--About 2 miles southeast of Ames at SE 16th Street bridge over South Skunk River, downstream of mouth of Squaw Creek, on upstream 1 ft by 1 ft pile cap, in top of vertical bolt; a chiseled cross (RM 6). (Found 7/93)

Elevation 882.78 ft

8324-14 NE--About 2.5 miles southeast of Ames, at the southeast corner of the intersection of Highway 69 and Airport Road, on top of the northeast corner of the concrete foundation for traffic light controls; a chiseled square.

Elevation 903.72 ft

8324-24 NE--About 3.5 miles southeast of Ames, on gravel road bridge over South Skunk River, at right upstream end of truss, on top of anchor bolt; filed cross.

Elevation 874.22 ft

8324-24 SE--(REFERENCE POINT) About 3.5 miles southeast of Ames, on gravel road bridge over South Skunk River, on top of downstream tiebar, 1 ft right of center of truss; filed arrow.

Elevation 876.22 ft

8324-24 SW--About 3.75 miles southeast of Ames, near southwest corner of sec. 24, just north of entrance to farmhouse east, on east headwall of concrete culvert; chiseled square.

Elevation 907.07 ft

8324-25 NW (1)--About 4.25 miles southeast of Ames, about 300 ft north of intersection of two county roads, on top center of east headwall of concrete culvert; chiseled square.

Elevation 923.49 ft

8324-25 NW (2)--About 4.5 miles southeast of Ames, 0.3 miles east of intersection of two county roads, on top center of south headwall of concrete culvert; chiseled square.

Elevation 894.22 ft

8424-22 SE (1)--About 3 miles northeast of Ames, at Riverside Road bridge over South Skunk River, on top of guardrail at right upstream end of bridge; Iowa Highway Commission plug. (Found 7/95)

Elevation 914.52 ft

8424-22 SE (2)--(REFERENCE POINT) About 3 miles northeast of Ames, at Riverside Road bridge over South Skunk River, on upstream guardrail 75 ft streamward of the Iowa Highway Commission plug; chiseled square. (Found 7/95)

Elevation 915.24 ft

8424-33 SE (1)--At Ames, at Stange Road bridge over Squaw Creek, on top of bolt at left upstream end of bridge, at left end of handrail; chiseled cross. (Found 7/95)

Elevation 912.56 ft

8424-33 SE (2)--(REFERENCE POINT) At Ames, at Stange Road bridge over Squaw Creek, at downstream side of bridge, on walk at center of bridge; chiseled cross. (Found 7/95)

Elevation 915.82 ft

8424-36 SW (1)--At Ames, at 13th Street bridge over South Skunk River, on top of wingpost at left upstream end of bridge; chiseled square. (Found 7/95)

Elevation 913.94 ft

8424-36 SW (2)--(REFERENCE POINT) At Ames, at 13th Street bridge over South Skunk River, center of 7th vertical handrail support on upstream side of bridge; chiseled arrow. (Established 6/93)

Elevation 913.20 ft

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