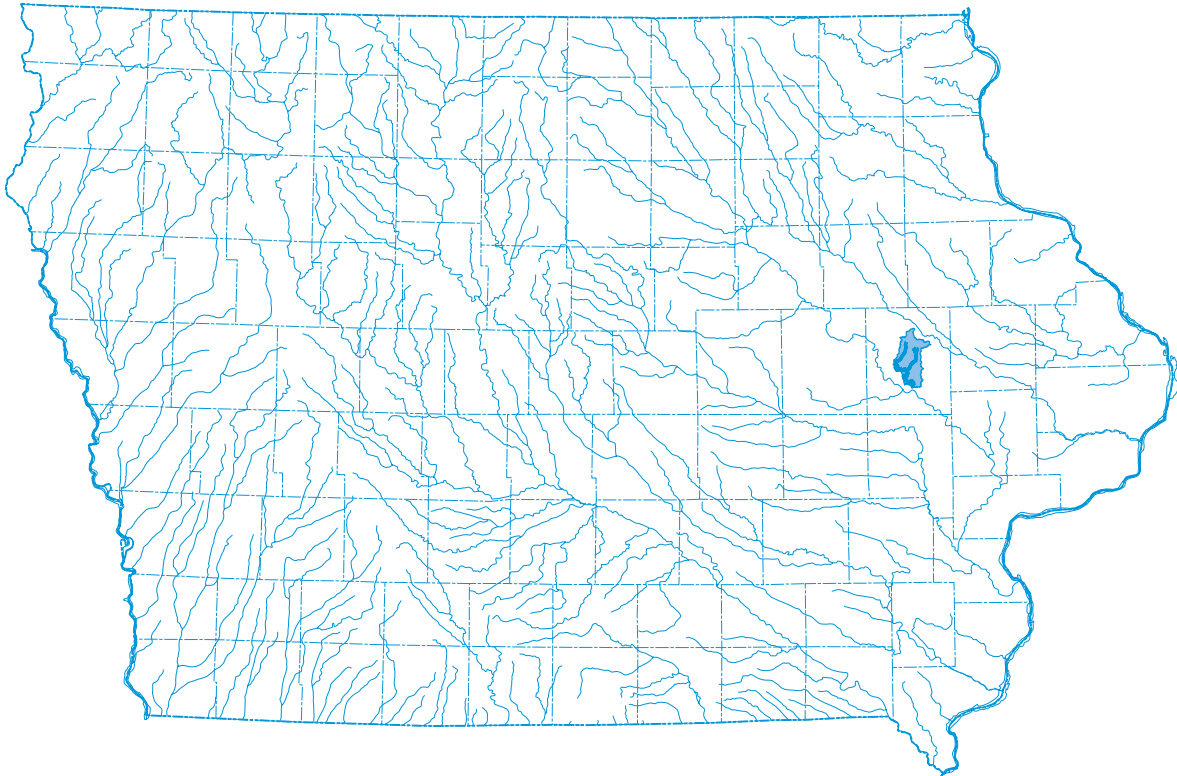


Prepared in cooperation with the Iowa Department of Transportation
and the Iowa Highway Research Board (Project HR-140)

Flood of June 4, 2002, in the Indian Creek Basin, Linn County, Iowa



Open-File Report 2004-1074

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By David A. Eash

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Conversion Factors and Datum

Multiply	By	To obtain
inch (in.)	2.54	centimeter (cm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
square mile (mi ²)	2.590	square kilometer (km ²)
cubic foot per second (ft ³ /s)	0.02832	cubic meter per second (m ³ /s)

NGVD29: In this report, elevation or vertical coordinate information is referenced to the National Geodetic Vertical Datum of 1929.

Water year: In U.S. Geological Survey reports dealing with surface-water supply is the 12-month period October 1 through September 30. The water year is designated by the calendar year in which it ends and which includes 9 of the 12 months. Thus, the year ending September 30, 2003, is called the "2003 water year."

Flood of June 4, 2002, in the Indian Creek Basin, Linn County, Iowa

By David A. Eash

Abstract

Severe flooding occurred on June 4, 2002, in the Indian Creek Basin in Linn County, Iowa, following thunderstorm activity over east-central Iowa. The rain gage at Cedar Rapids, Iowa, recorded a 24-hour rainfall of 4.76 inches at 6:00 p.m. on June 4th. Radar indications estimated as much as 6 inches of rain fell in the headwaters of the Indian Creek Basin. Peak discharges on Indian Creek of 12,500 cubic feet per second at County Home Road north of Marion, Iowa, and 24,300 cubic feet per second at East Post Road in southeast Cedar Rapids, were determined for the flood. The recurrence interval for these peak discharges both exceed the theoretical 500-year flood as computed using flood-estimation equations developed by the U.S. Geological Survey. Information about the basin and flood history, the 2002 thunderstorms and associated flooding, and a profile of high-water marks are presented for selected reaches along Indian and Dry Creeks.

Introduction

Thunderstorms caused severe flooding in east-central Iowa in June 2002 in the area roughly bounded by Cedar Rapids, Dubuque, and Davenport, Iowa (fig. 1). New maximum peak discharge records were set at five U.S. Geological Survey (USGS) streamflow-gaging stations in the Maquoketa and Little Maquoketa River Basins and in the Duck Creek Basin in Scott County (fig. 1A). Flooding occurred in several cities and towns where many homes and businesses were damaged and where hundreds of people were forced to evacuate their homes. Many highways and roads were closed and several bridges were damaged as a result of the flooding. The Iowa Department of Natural Resources reported that sewage treatment facilities in about 10 cities and a mobile home park were forced to bypass their wastewater-treatment plants and to discharge directly into rivers and streams to avoid sewage backup into homes (Pitt, *Waterloo-Cedar Falls Courier*, June 5, 2002; Gersema, Associated Press, *Cedar Rapids Gazette*, June 6, 2002).

A State disaster emergency was declared within days of the flood for eight counties that included Clayton, Clinton, Delaware, Dubuque, Jackson, Jones, Linn, and Scott. A Federal disaster proclamation followed including 17 counties; in addition to the above counties, the counties of Allamakee, Benton, Buchanan, Cedar, Fayette, Iowa, Johnson, Muscatine, and Winneshiek also were included. The flooding damaged an estimated 1,004 homes in eight counties; including 22 homes with major damage and eight homes destroyed (U.S. Department of Commerce, National Oceanic and Atmospheric Administration, and National Weather Service, National Climate Data Center, at uniform resource locator (URL) <http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~storms>). Public property damage in eastern Iowa due to flooding was at least \$7.2 million, for which the greatest damage occurred in Linn County (\$3.2 million), Dubuque County (\$2.1 million), and Jones County (\$1.3 million). Table 1 shows private property damage claims reported for residential and non-residential buildings in eight selected counties in eastern Iowa (Bonnie Shepard, Federal Emergency Management Agency, National Flood Insurance Program Bureau and Statistical Agent, written commun., March 2004).

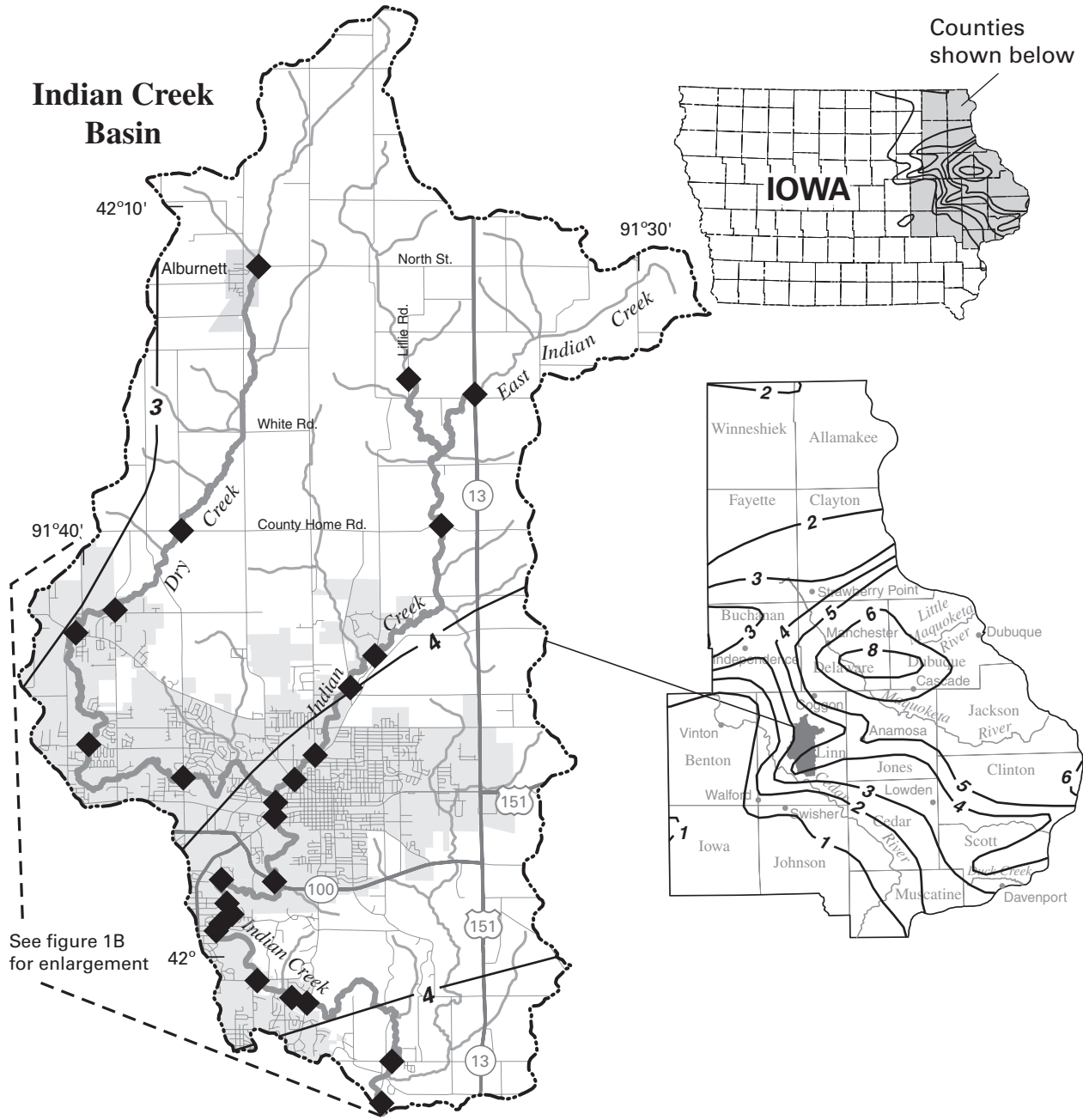
This report provides information about the June 2002 thunderstorms and ensuing flood in the Indian Creek Basin. Flood elevations at selected sites along Indian and Dry Creeks in Linn County are presented as flood profiles.

This report was prepared in cooperation with the Iowa Department of Transportation (IDOT) and the Iowa Highway Research Board. A list of other Iowa flood-profile reports published by the USGS can be obtained from the World Wide Web at URL <http://ia.water.usgs.gov/projects/profiles/>.

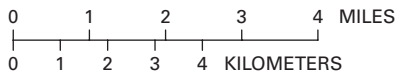
Acknowledgments

The author expresses his gratitude to the following: Ken Bickner, Stormwater Management, City of Cedar Rapids Engineering Department, for providing the survey data used to compute the indirect discharge measurements for Indian Creek at East Post and County Home Roads and for providing additional high-water mark elevations for the June 4, 2002, flood

2 Flood of June 4, 2002, in the Indian Creek Basin, Linn County, Iowa



Base from U.S. Geological Survey digital data; 1:100,000, 1985
 Universal Transverse Mercator projection, Zone 15



EXPLANATION

- Municipal area in Linn County within basin
- Drainage-basin boundary
- Stream reach profiled in this report
- 4 Line of equal rainfall— 48 hours ending 7 a.m. June 5, 2002, in inches. Contour interval, variable (Harry Hillaker, State Climatologist, Iowa Department of Agriculture and Land Stewardship, written commun., 2002)
- Primary highway
- Ungaged bridge site used in profile

Figure 1A. Indian Creek Basin showing location of bridge sites used in June 4, 2002, flood profiles and lines of equal rainfall for 48 hours ending at 7:00 a.m., June 5, 2002.

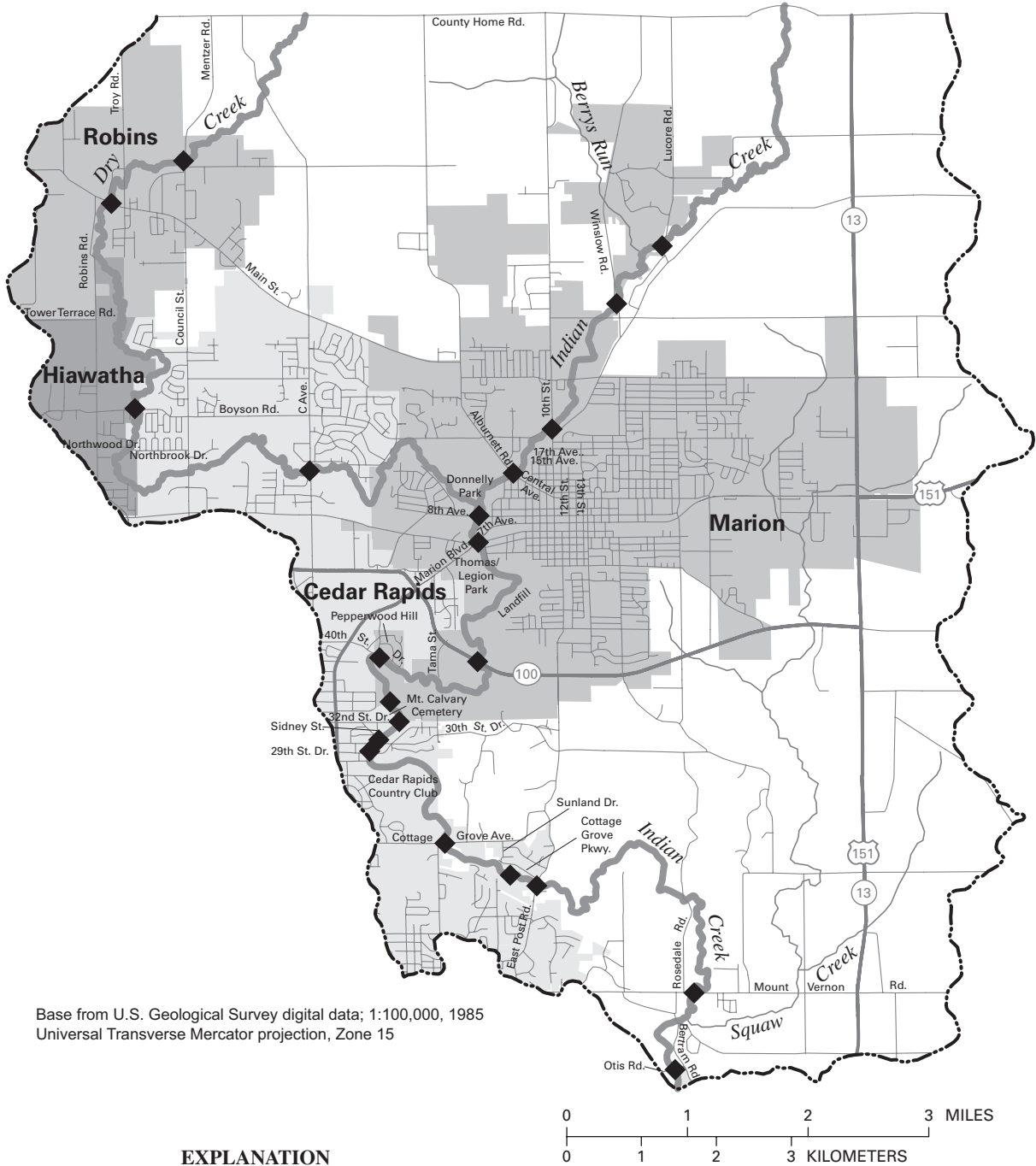


Figure 1B. Indian Creek Basin showing metropolitan area south of County Home Road and location of bridge sites used in June 4, 2002, flood profiles.

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along Indian Creek; Ken Miller, Engineering Surveyor Supervisor, City of Cedar Rapids Engineering Department; Russ Stutt, Linn County Engineer's Office; and Peter Dallman, IDOT, for providing elevation data for temporary bench marks at bridges; Marv Houg, Hall and Hall Engineers, Inc.; the City of Marion; and Doug Wilson, Snyder and Associates, Inc., for providing additional high-water mark elevations for the June 4, 2002, flood along Indian and Dry Creeks; A. Dean Wheatley, Long-Range Planning Manager, City of Cedar Rapids Department of Development, for providing information on development in the Indian Creek Basin and a geographic information system (GIS) data layer of municipal boundaries in the metropolitan area; Stephen Cooper, Public Works GIS Specialist, City of Cedar Rapids Engineering Department, for providing an inundation map of the June 4, 2002, flood and information on the creation of the map; Maryann Shinrock, Assistant City Engineer, City of Marion, for providing high-water mark eleva-

tions and information on the July 5, 1993, flood along Indian Creek in Marion; Nichole Brown, Linn County Secondary Roads Department, for providing information on damage to secondary roads in Linn County; Beverly Redford, Linn County Historical Society, for providing information on historic floods in the Indian Creek Basin; Harry Hillaker, State Climatologist, Iowa Department of Agriculture and Land Stewardship, for providing an isohyetal map of rainfall for the 48-hour period ending at 7:00 a.m. on June 5, 2002; and Bonnie Shepard, National Flood Insurance Program Bureau and Statistical Agent, Federal Emergency Management Agency, for providing private property damage claims for eight counties in Iowa. The author also expresses gratitude to the following USGS employees: Gina Renzi, Greg Littin, Jason Smith, and Dan Christiansen for collecting field data for the determination of water-surface and bench-mark elevations listed in this report, and Ed Fischer for computing the indirect measurements.

Table 1. National Flood Insurance Program Bureau and Statistical Agent Iowa loss report for selected counties, June 4-5, 2002, as of December 31, 2003.

[Source: Bonnie Shepard, Federal Emergency Management Agency, National Flood Insurance Program Bureau and Statistical Agent, written commun., March 2004. ND, no data]

County	Occupancy	Buildings with damage	Building damage (dollars)	Contents damage (dollars)
Clayton	Single-family residential	ND	ND	ND
Clayton	Multiple occupancy	ND	ND	ND
Clayton	Non-residential	ND	ND	ND
Clinton	Single-family residential	5	34,652	0
Clinton	Multiple occupancy ¹	1	5,377	0
Clinton	Non-residential	1	2,480	0
Delaware	Single-family residential	28	278,639	17,062
Delaware	Multiple occupancy	ND	ND	ND
Delaware	Non-residential	ND	ND	ND
Dubuque	Single-family residential	11	55,444	20,154
Dubuque	Multiple occupancy	ND	ND	ND
Dubuque	Non-residential	ND	ND	ND
Jackson	Single-family residential	ND	ND	ND
Jackson	Multiple occupancy	ND	ND	ND
Jackson	Non-residential	1	2,644	0
Jones	Single-family residential	6	21,693	2,159
Jones	Multiple occupancy	ND	ND	ND
Jones	Non-residential	2	49,328	69,776
Linn	Single-family residential	11	77,033	4,241
Linn	Multiple occupancy	ND	ND	ND
Linn	Non-residential	2	28,057	0
Scott	Single-family residential	26	224,635	27,737
Scott	Multiple occupancy ²	5	70,521	0
Scott	Non-residential	3	18,874	4,289

¹Two to four family residential.

²Other residential.

Basin Description

The Indian Creek Basin is located in east-central Iowa, in central Linn County, and drains as a left-bank tributary to the Cedar River southeast of the city of Cedar Rapids (fig. 1). The basin is oriented in a general north-south direction and drains 93.0 mi² (Larimer, 1957). Indian Creek flows through the cities of Marion and Cedar Rapids. Dry Creek, a major tributary to Indian Creek with a drainage area of 31.0 mi² (Larimer, 1957), flows through the cities of Alburnett, Robins, Hiawatha, Cedar Rapids, and Marion.

The majority of the Indian Creek Basin lies within the Iowan Surface landform region; the extreme southern portion of the basin lies within the Southern Iowa Drift Plain landform region (Prior, 1991) (landform regions not shown in fig. 1). The topography of the basin changes from relatively flat in the northwest area draining to Dry Creek to gently rolling in the majority of the basin to moderately steep in the southwest area of the basin. Land use in the northern part of the basin is predominately agricultural and in the southern part of the basin is predominately urban with some agricultural and wooded areas.

Development in the Indian Creek Basin dates from the earliest years of metropolitan area growth; however, development has accelerated over the past 20 years in northern Cedar Rapids, Marion, and Robins (A. Dean Wheatley, City of Cedar Rapids Department of Development, Long-Range Planning Manager, written commun., February 2003). The vast majority of this recent growth has been residential in the form of urban-scale single-family development. Also over the past 20 years, metropolitan area stormwater management practices to control rainfall runoff have become increasingly sophisticated and comprehensive.

Flood History

While numerous floods have been reported in the Indian Creek Basin, few floods have been documented. Table 2 lists four crest-stage gaging stations that were operated in the basin by the USGS during the early to mid 1960's and early 1970's. Flood data were collected at these gages during 1961, 1962, and 1970. Table 3 lists known historic floods in the Indian Creek Basin that were compiled from a review of records from the City of Marion Engineer, Federal Emergency Management Agency (FEMA) flood insurance studies (FEMA, 1981, 1982a, 1982b, 1991), Linn County Engineer, Linn County Historical Society, and USGS. For some of the floods listed in table 3, the day or month of occurrence was not noted in the historical records.

The City of Marion reported the following information for the flood of July 5, 1993 (Maryann Shinrock, Assistant City Engineer, written commun., December 2003). Damage from the 1993 flood to Marion infrastructure exceeded \$133,000 (includes costs for debris removal and protective measures).

Although total damage to private property from the flood is unknown, the City of Marion bought-out nine private homes in the Indian Creek flood plain for \$1.2 million following the 1993 flood with the assistance of funding provided by FEMA.

Storm Description

The June 4, 2002, flood in the Indian Creek Basin was the result of a series of thunderstorms that deluged northeast and east-central Iowa on June 3rd-4th. Radar estimates indicated total rainfall amounts were as high as 8 to 10 inches in Delaware and Dubuque Counties, with over 10 inches in western Dubuque County (U.S. Department of Commerce, National Oceanic and Atmospheric Administration, and National Weather Service, June 2002, WS Form E-5). Figure 2 shows hourly rainfall amounts for June 3-4, 2002, at four selected rain gages located in northeast and east-central Iowa (fig. 1A, Waterloo not shown). Although the two nearest rain gages shown in figure 2 to the Indian Creek Basin are located about 30 miles (Cascade) and 35 miles (Lowden) away from the basin, hourly data collected at these stations (figs. 2A and 2B) may provide a general indication of the timing and intensity of the rainfall in the Indian Creek Basin. The greatest intensity of rainfall at Cascade occurred between 11:00 p.m. and midnight on June 3rd during which 1.6 inches of rain fell in an hour. The greatest intensity at Lowden occurred between 6:00 and 7:00 a.m. on June 4th during which 1.3 inches of rain fell in an hour. The majority of the rainfall at Cascade (6.0 inches of the total 6.5 inches shown in fig. 2A) occurred during a 14-hour period ending at noon on June 4th. The majority of the rainfall at Lowden (2.9 inches of the total 3.5 inches shown in fig. 2B) occurred during a 7-hour period ending at noon on June 4th. Data from the four rain gages (fig. 2) indicate that the majority of the rainfall occurred during about a 15-hour period from 9 p.m. on June 3rd to noon on June 4th.

Rainfall in the Cedar Rapids area was reported to have started at 2:00 a.m. on June 4th and continued until noon, with downpours during the morning commute time (Gravelle, *Cedar Rapids Gazette*, June 5, 2002). Figure 1A shows an isohyetal map of the areal distribution of rainfall for the 48-hour period ending at 7:00 a.m. on June 5, 2002; data provided by Harry Hillaker, State Climatologist, Iowa Department of Agriculture and Land Stewardship (written commun., June 2002). Due to the 7:00 a.m. observation time used to collect 24-hour rainfall data, a 48-hour time period is shown in figure 1A to indicate total rainfall for the storm because the majority of the rainfall occurred during two 24-hour collection periods. Table 4 lists each 24-hour rainfall amount for June 3-5, 2002, for the nine rain gages nearest to the Indian Creek Basin (U.S. Department of Commerce, National Oceanic and Atmospheric Administration, and National Climatic Data Center, 2002; and Iowa Department of Agriculture and Land Stewardship, State Climatologist Office, 2002). Table 4 indicates that minor amounts of rain (between about 0.2 to 0.5 inches) fell in the vicinity of the

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Indian Creek Basin within the 24-hour time period preceding rainfall observations on June 3rd. A 72-hour time period and rainfall total is listed in table 4 for June 3-5 to include all rainfall that could be considered contributing to the June 4th flood.

The National Weather Service, using radar indications, estimated up to 6 inches of rain fell in northern Linn County in the headwaters of the Indian Creek Basin (Gravelle, *Cedar Rapids Gazette*, June 5, 2002). An unofficial rainfall estimate of 8 inches of rain in 12 hours was reported for the Indian Creek Basin (Smith, *Cedar Rapids Gazette*, June 13, 2002). The *Rainfall Frequency Atlas of the Midwest* (Huff and Angel, 1992) provides isohyetal maps of the spatial distribution of theoretical rainfall amounts in Iowa for selected rain periods and recurrence intervals. Table 5 lists the magnitude and frequency of theoretical rainfall amounts for selected rain periods (durations)

interpolated from Huff and Angel (1992) for the Indian Creek Basin.

Tables 5 and 2 list recurrence intervals for two different components of a hydrologic event—rainfall and runoff, respectively. Recurrence interval is the average interval of time within which a given rainfall or flood will be equalled or exceeded once. 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 of being exceeded during any particular year. This flood, commonly termed the 100-year flood, is the theoretical peak discharge against which actual flood-peak discharges are compared. Although the recurrence interval represents the long-term average period between rainfalls or floods of a specific magnitude, rare rainfalls or floods could occur at shorter intervals or even within the same year.

Table 2. Maximum water-surface elevations and discharges, and the corresponding recurrence intervals, at selected sites in the Indian Creek Basin, Linn County, Iowa.

[**boldfaced type**, flood profile included in this report; mi², square miles; ft³/s, cubic feet per second; >, greater than; --, not determined; <, less than]

Site	Period of flood record (water years)	Drainage area (mi ²)	Date	Peak water-surface elevation ¹ (ft)	Peak discharge (ft ³ /s)	Recurrence interval (years)
Misc. measurement at ungaged site Indian Creek at County Home Road (County Road E34) near Marion	2002	19.8	6/04/2002	818.04	² 12,500	³ >500
Crest-stage gage 05464695 Indian Creek near Marion (Winslow Road)	1961-66, 1970-71	32.0	9/13/1961 7/03/1962 6/04/2002	794.38 795.22 801.41	⁴ 1,630 -- --	³ 3-4 -- --
Crest-stage gage 05464685 Dry Creek near Alburnett (White Road)	1961-66, 1970	14.0	9/13/1961 7/03/1962 3/02/1970	862.43 864.14 862.77	-- 1,740 --	-- ³ 7 --
Crest-stage gage 05464690 Dry Creek near Marion (C Avenue)	1961-62, 1965, 1970	25.9	9/14/1961 7/03/1962 3/02/1970 6/04/2002	796.38 797.63 799.29 798.59	-- -- -- --	-- -- -- --
Misc. measurement at ungaged site Indian Creek at East Post Road at Cedar Rapids	2002	75.1	6/04/2002	737.83	² 24,300	⁵ >500
Crest-stage gage 05464720 Indian Creek below Cedar Rapids (Rosedale Road)	1961-62, 1964-67, 1970	76.2	9/13/1961 7/03/1962 3/02/1970	711.55 711.00 714.14	-- ⁴ 1,400 --	-- ⁵ <2 --

¹Elevation (NGVD29) at downstream side of bridge.

²Discharge computed from indirect measurement.

³Computed using rural flood-estimation equations (Eash, 2001).

⁴Discharge measurement made within 0.3 feet of peak water-surface elevation.

⁵Computed using urban flood-estimation equations (Sauer and others, 2002).

Table 3. Chronology of known historic floods in the Indian Creek Basin, Linn County, Iowa.[**boldfaced type**, high-water marks included in flood profile in this report]

Flood date	Remarks
Spring 1859	Washed-out bridge over Indian Creek near present-day Alburnett Road bridge.
Spring 1867	Washed-out bridge over Indian Creek near present-day Marion Boulevard bridge.
1929	(FEMA, 1982b)
Feb. 20, 1937	High-water marks collected along Indian Creek by Linn County Engineer's Office.
July 17, 1939	High-water marks collected along Indian Creek by Linn County Engineer's Office.
1940	High-water marks collected along Indian Creek by Linn County Engineer's Office.
1945	(FEMA, 1982b)
Jan. 6, 1946	High-water marks collected along Indian Creek by Linn County Engineer's Office.
June 1947	Flood along Indian and Dry Creeks (FEMA, 1981, 1982a, 1982b, 1991).
1953	High-water marks collected along Indian Creek by Linn County Engineer's Office.
Mar. 20, 1959	High-water marks collected along Indian Creek by Linn County Engineer's Office.
Jan. 1960	(FEMA, 1981, 1982a)
April 1960	(FEMA, 1981, 1982a)
March 1961	(FEMA, 1981, 1982a)
Nov. 1961	(FEMA, 1981, 1982a)
Sept. 13-14, 1961	High-water marks collected along Indian and Dry Creeks by U.S. Geological Survey.
July 3, 1962	High-water marks collected along Indian and Dry Creeks by U.S. Geological Survey.
Aug. 5, 1968	4.5 inch rainfall in Marion; Indian Creek inundated Thomas and Donnelly Parks.
July 18, 1969	Indian Creek inundated Legion Memorial swimming pool in Marion; fourth time pool inundated in 45-day period.
Aug. 1969	Estimated discharge of 6,700 ft ³ /s for Indian Creek flood near Marion Boulevard bridge (FEMA, 1982b, 1991).
Mar. 2, 1970	High-water marks collected along Indian and Dry Creeks by U.S. Geological Survey.
July 10, 1971	6.8-7 inch rainfall in Marion; many areas inundated along Indian and Dry Creeks including Legion Memorial swimming pool in Marion and Cedar Rapids Country Club.
May 16, 1974	Indian Creek inundated Legion Memorial swimming pool in Marion.
1977	Estimated discharge of 7,900 ft ³ /s for Indian Creek flood near Alburnett Road bridge (FEMA, 1982b, 1991)
July 5, 1993	High-water marks collected along Indian Creek by City of Marion Engineer's Office; 7.0 inch rainfall in Marion; many areas inundated along Indian Creek including the 10th Street bridge in Marion and the Cedar Rapids Country Club; Fire Dept. rescues; washed-out bridge on Sac and Fox Trail downstream of East Post Road; and more than 300 homes in Marion had sewer backup in their basements.

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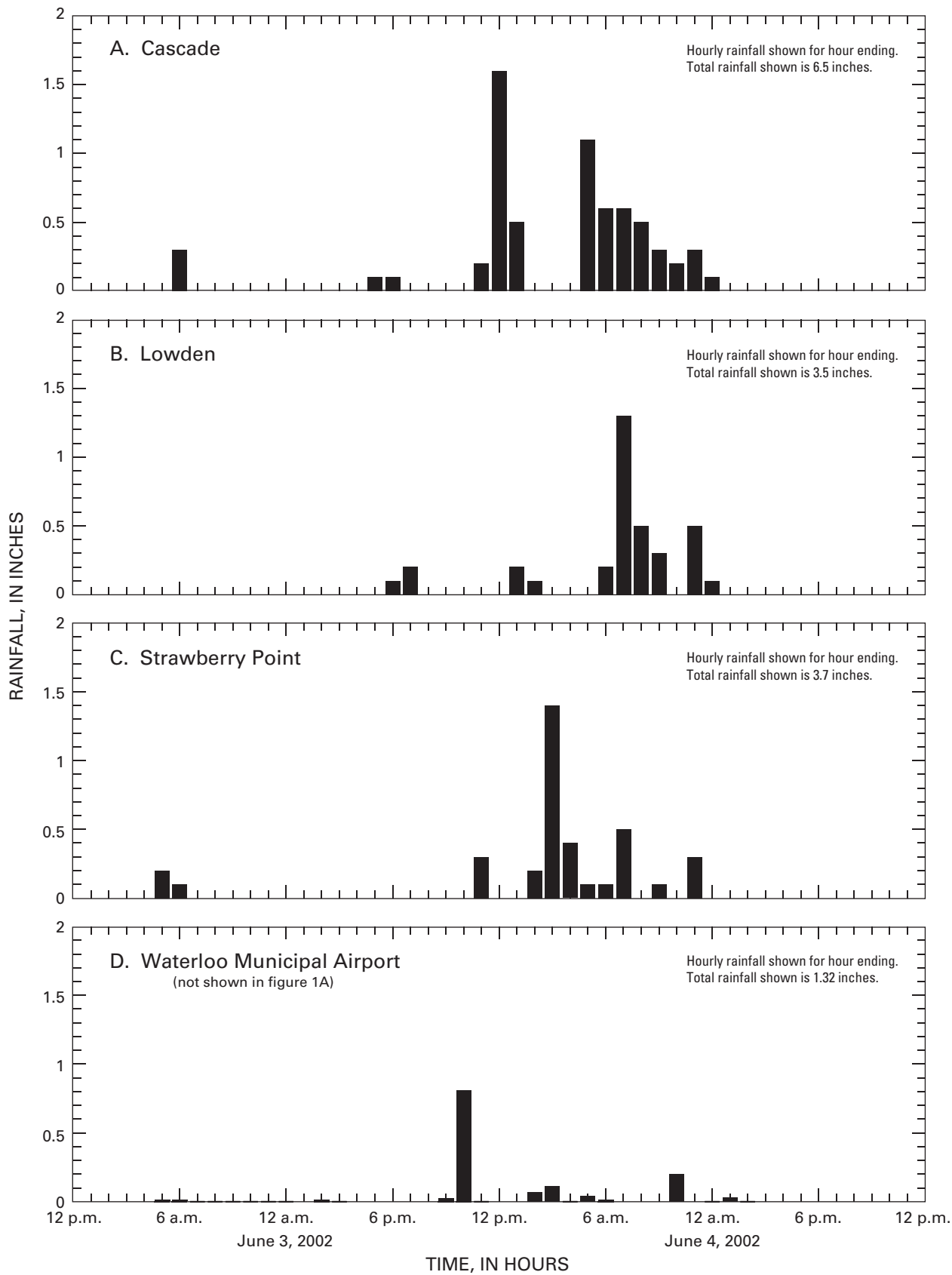


Figure 2. Hourly rainfall for June 3-4, 2002, at selected rain gages in northeast and east-central Iowa (U.S. Department of Commerce, National Oceanic and Atmospheric Administration, and National Climatic Data Center, 2002).

Table 4. Twenty four-hour rainfall amounts at selected rain gages in east-central Iowa during June 3-5, 2002.

[ND, no data]

Rain gage	Observation time	24-hour rainfall, in inches ^{1,2}			72-hour rainfall total, in inches
		June 3, 2002	June 4, 2002	June 5, 2002	
Anamosa 1 WNW	7 a.m.	0.25	2.00	1.50	3.75
Cedar Rapids No. 1	6 p.m.	0.21	4.76	ND	4.97
Cedar Rapids Airport	Midnight	0.21	0.95	ND	1.16
Coggon	6 a.m.	0.34	1.98	3.08	5.40
Independence	7 a.m.	0.26	2.30	0.95	3.51
Manchester No. 2	7 a.m.	0.38	4.03	1.51	5.92
Swisher	7 a.m.	0.45	0.17	0.71	1.33
Vinton	7 a.m.	0.30	0.20	0.82	1.32
Walford 2 SE	7 a.m.	0.26	0.22	0.87	1.35

¹Climatological Data, Iowa (U.S. Department of Commerce, National Oceanic and Atmospheric Administration, and National Climatic Data Center, 2002).

²Iowa Climate Review (Iowa Department of Agriculture and Land Stewardship, State Climatologist Office, 2002).

Table 5. Magnitude and frequency of theoretical rainfall amounts for selected storm periods for the Indian Creek Basin, Linn County, Iowa.

[Rainfall amounts interpolated from the *Rainfall Frequency Atlas of the Midwest*, Huff and Angel, 1992]

Duration (hours)	Rainfall (inches) for indicated recurrence interval (years)		
	25	50	100
6	4.1	4.2	5.1
12	4.7	5.1	6.2
24	5.3	6.2	7.1
48	6.1	7.1	8.1
72	6.2	7.4	8.1

Flood Description

As a result of the intense rainfall, severe flooding occurred throughout the Indian Creek Basin. Peak water-surface elevations and discharges, and the corresponding recurrence intervals, are listed in table 2 for selected sites in the Indian Creek Basin. Peak discharges for the flood of June 4, 2002, on Indian Creek of 12,500 ft³/s at County Home Road north of Marion

(fig. 1B), and 24,300 ft³/s at East Post Road in southeast Cedar Rapids, were determined for the flood. The recurrence interval for these peak discharges both exceed the theoretical 500-year flood as computed using flood-estimation equations developed by the USGS (Eash, 2001; Sauer and others, 2002). Figure 3 shows the approximate boundary of the area inundated by the flood of June 4, 2002, along Indian Creek in Cedar Rapids and the 100- and 500-year flood boundaries as defined by FEMA (FEMA, 1991) (map provided by Stephen Cooper, Public Works GIS Specialist, City of Cedar Rapids Engineering Department, written commun., December 2003). The inundation map shown in figure 3 was created and provided by the City of Cedar Rapids using high-water marks collected by the City of Cedar Rapids, aerial photography of the flood, and two-foot elevation-contour maps of the Indian Creek flood plain. The approximate area inundated by the flood was delineated by projecting the high-water mark elevations perpendicular from the alignment of the channel to where they met corresponding land-surface elevation contours.

The June 4, 2002, flood damaged many secondary roads, bridges, culverts, and ditches in Linn County; damages were almost \$318,000 (Nichole Brown, Linn County Secondary Roads Department, written commun., February 2003). The following flood description information presented in this section was obtained from newspaper articles in the *Cedar Rapids Gazette* (Gravelle, June 5 and June 6, 2002; Hadish, June 21, 2002; Hogan, June 5 and June 6, 2002; and Smith, June 6, June 13, and July 4, 2002).

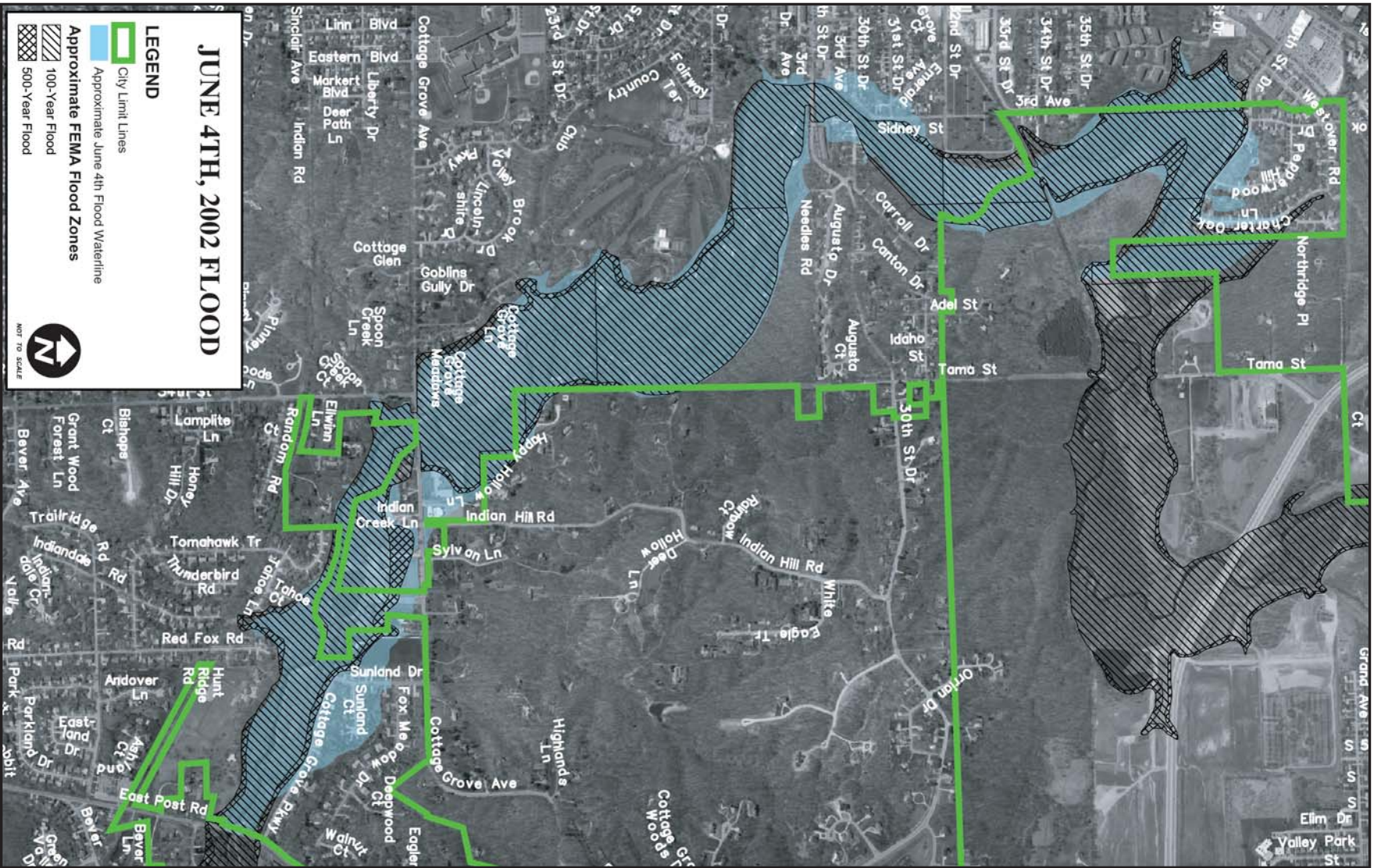


Figure 3. Approximate boundary of area inundated by the flood of June 4, 2002, along Indian Creek in Cedar Rapids, Iowa, and 100- and 500-year flood boundaries as defined by Federal Emergency Management Agency (1991). (Map provided by Stephen Cooper, Public Works GIS Specialist, City of Cedar Rapids Engineering Department, written commun., December 2003.)

While the majority of the damage from the flood occurred in the Cedar Rapids, Marion, and Hiawatha municipal areas within the Indian Creek Basin (fig. 1B), some of the worst damage occurred along the lower reach of Indian Creek south-east of Cedar Rapids. Along Rosedale Road near Mount Vernon Road and the Sac and Fox Trail, a bridge was severely damaged and a short stretch of road was washed-out. As a result of the flood, about 400 people called the Linn County Emergency Management Agency to report damage.

In Cedar Rapids, an estimated 500 homes were damaged by the flooding, with hundreds of homes in many parts of the city experiencing sewer damage. Of the 500 homes damaged, 14 suffered major damage and six were destroyed. Some of the worst residential damage occurred along areas of Cottage Grove Parkway and 30th Street Drive. In Sun Valley, in south-east Cedar Rapids (not shown in fig. 1), about 25 homes were flooded. Along Mount Vernon Road in the 6900 block, an estimated 45 homes were affected by flooding or sewer damage. Residents along Indian Creek reported the creek rose with startling swiftness. In the area of East Post Road, it was estimated that the creek crested around 4:30 p.m. Damage to Cedar Rapids infrastructure was estimated at \$800,000. The flood washed-out two bridges over Indian Creek on the Sac and Fox Trail (not shown in fig. 1) and caused damage to the trail alongside the creek between East Post Road and Mount Vernon Road. Damage to the trail was estimated at \$150,000.

In Marion, the flood along Indian Creek caused about \$2.5 million in damage to about 300 homes and businesses of which approximately 250 homes experienced sewer damage and approximately 15 homes experienced water damage. Several homes were flooded to their first-floor windows in the area between 15th and 17th Avenues and 12th and 13th Streets. Damage to Marion infrastructure, including extensive damage to parks, was estimated at more than \$1 million. Thomas Park suffered some of the most serious damage. During the peak of the flood, West Eighth Avenue, Alburnett Road, and 10th Street bridges crossing Indian Creek were closed and only one bridge in Marion, Marion Boulevard/Seventh Avenue, was open. The flood damaged the Alburnett and Winslow Road bridges (the Winslow Road bridge was under construction and was not open to traffic at the time of the flood).

In the Hiawatha area, flooding on Dry Creek closed Northwood and Northbrook Drives and Robins Road north of Tower Terrace Road. Floodwaters also cut-off access of residents to the Oakbrook Mobile Home Court (not shown in fig. 1). An estimated 20 to 25 homes in Hiawatha had sewer damage. In Robins, the Main Street bridge was closed during the flood.

During the flood along Indian Creek, Cedar Rapids firefighters used boats to rescue about 50 residents, including 35 to 45 people from homes between Cottage Grove Avenue and East Post Road. During the rescue effort, strong currents near 30th Street Drive capsized three firefighters in an inflatable rubber boat. Two additional firefighters went to their rescue in a 16-ft boat, but the current pinned it against a tree and it also capsized. All five firefighters clung to trees in the floodwaters for about five minutes until an 18-ft boat with a larger motor could be

launched and maneuvered in the strong current to rescue them. The firefighters situation was perilous while they awaited rescue because downstream of them floodwaters were within inches of the low-chord of the 29th Street Drive bridge and anyone losing their grip could have been swept beneath the bridge.

Flood Profile

To develop a flood profile, the USGS measured the elevation of high-water marks (HWM's) at selected bridge sites along Indian and Dry Creeks. River miles were determined for the bridge sites using a geographic information system to measure the distance along each stream from the mouth using 1:24,000-scale topographic-map data. Most of the HWM's were measured at Federal and State Highway bridges and at primary municipal and county road bridges. Additional HWM's were measured at secondary municipal and county road bridges to keep the maximum distance between points in the metropolitan area at about 3 river mi and in the rural areas at about 5 river mi. The flood profiles were determined using HWM's generally located immediately downstream and one bridge-length upstream from selected bridges. The HWM's were surveyed to temporary bench marks at bridges within three weeks of the flood peak and were later referenced to the National Geodetic Vertical Datum of 1929 by differential leveling or differential positioning using a global positioning system (GPS). The line connecting the marks on the profiles (figs. 4-16) is a linear interpolation and, therefore, only approximates the flood elevation between marks; the line does not depict the effects on the profile caused by intermediate bridges or flood-plain and channel features. Additional HWM's were provided by Marv Houg, Hall and Hall Engineers, Inc. (written commun., July 2002), for Indian Creek near 40th Street Drive, 8th Avenue, Alburnett Road, 10th Street, and Lucore Road in Marion; Ken Bickner, Stormwater Management, City of Cedar Rapids Engineering Department (written commun., December 2003), for Indian Creek near Cottage Grove Parkway, Sidney Street, and Mt. Calvary Cemetery in Cedar Rapids; and by Doug Wilson, Snyder and Associates, Inc. (oral commun., December 2003), for Dry Creek near Mentzer Road in Robins. The HWM's used to profile the June 4, 2002, flood in the Indian Creek Basin are listed in tables 6-7 and are plotted by river mile in figures 4-16 (following references).

The June 2002 flood along Indian Creek is profiled from Otis Road upstream to Lillie Road, located about 1mi west of State Highway 13 and about 3 mi southeast of Alburnett. The State Highway 13 bridge crossing East Indian Creek also is included with the Indian Creek profile as a single profile point. The 21.8-mi stream reach that was profiled along Indian Creek is shown in figures 1 and 4-10; a single profile point for East Indian Creek is included in figure 11. The 19 stream sites along Indian Creek and the single site along East Indian Creek where HWM's were measured are listed in table 6 and follow the East

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Indian Creek profile shown in figure 11. Low-water profiles measured on November 13, 2002, also are shown for each stream. The low-water profiles were obtained for the purpose of indicating the range in stage along the stream and to define the low-water slope.

The June 2002 flood along Dry Creek is profiled from Eighth Avenue in Marion upstream to North Street in Alburnett. The 17.1-mi stream reach that was profiled along Dry Creek is shown in figures 1 and 12-16, and the seven stream sites where HWM's were measured are listed in table 7 and follow the Dry Creek profile.

For comparison purposes, unpublished profiles for high-water events on September 13-14, 1961, and July 3, 1962, are shown for Indian Creek in figures 4-8 and for Dry Creek in figures 12-15. The 1961 and 1962 high-water events were profiled along Indian Creek from near the mouth to Winslow Road in Marion and along Dry Creek from about 1 mi upstream of the mouth to White Road, located about 2.5 mi south of Alburnett. Low-water profiles measured on September 26, 1961, also are shown for each stream.

Summary

Severe flooding occurred on June 4, 2002, in the Indian Creek Basin in Linn County following intense thunderstorms over east-central Iowa. Twenty four-hour rainfall recorded at Cedar Rapids at 6:00 p.m. on June 4th was 4.76 inches. Radar indications estimated as much as 6 inches of rain fell in the headwaters of the Indian Creek Basin. Peak discharges on Indian Creek of 12,500 ft³/s at County Home Road and 24,300 ft³/s at East Post Road were determined for the flood. The recurrence interval for peak discharges at County Home and East Post Roads both exceed the 500-year flood as computed using flood-estimation equations developed by the USGS.

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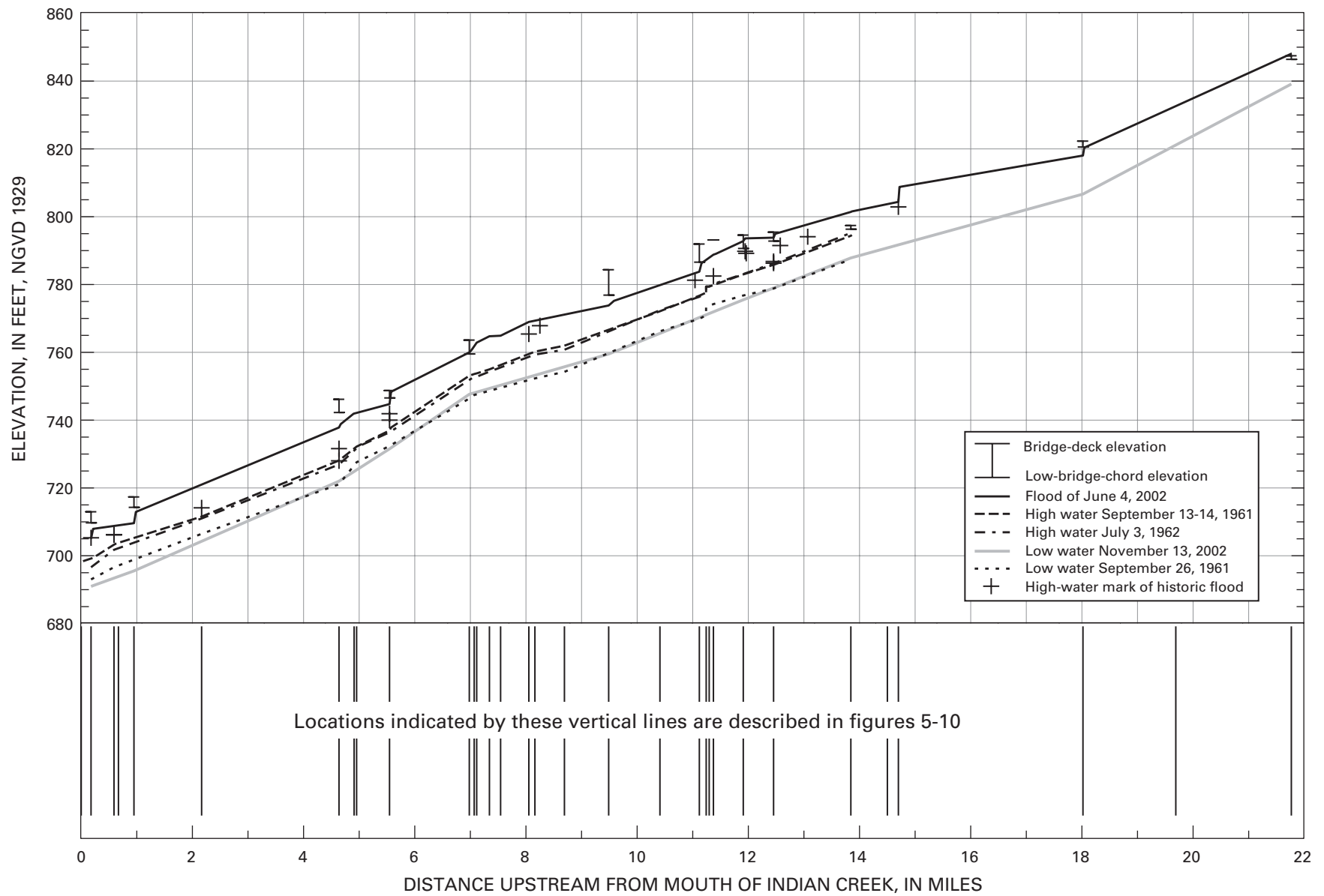


Figure 4. Profile of the June 2002 flood for Indian Creek, Linn County, Iowa; river miles 0 to 22.

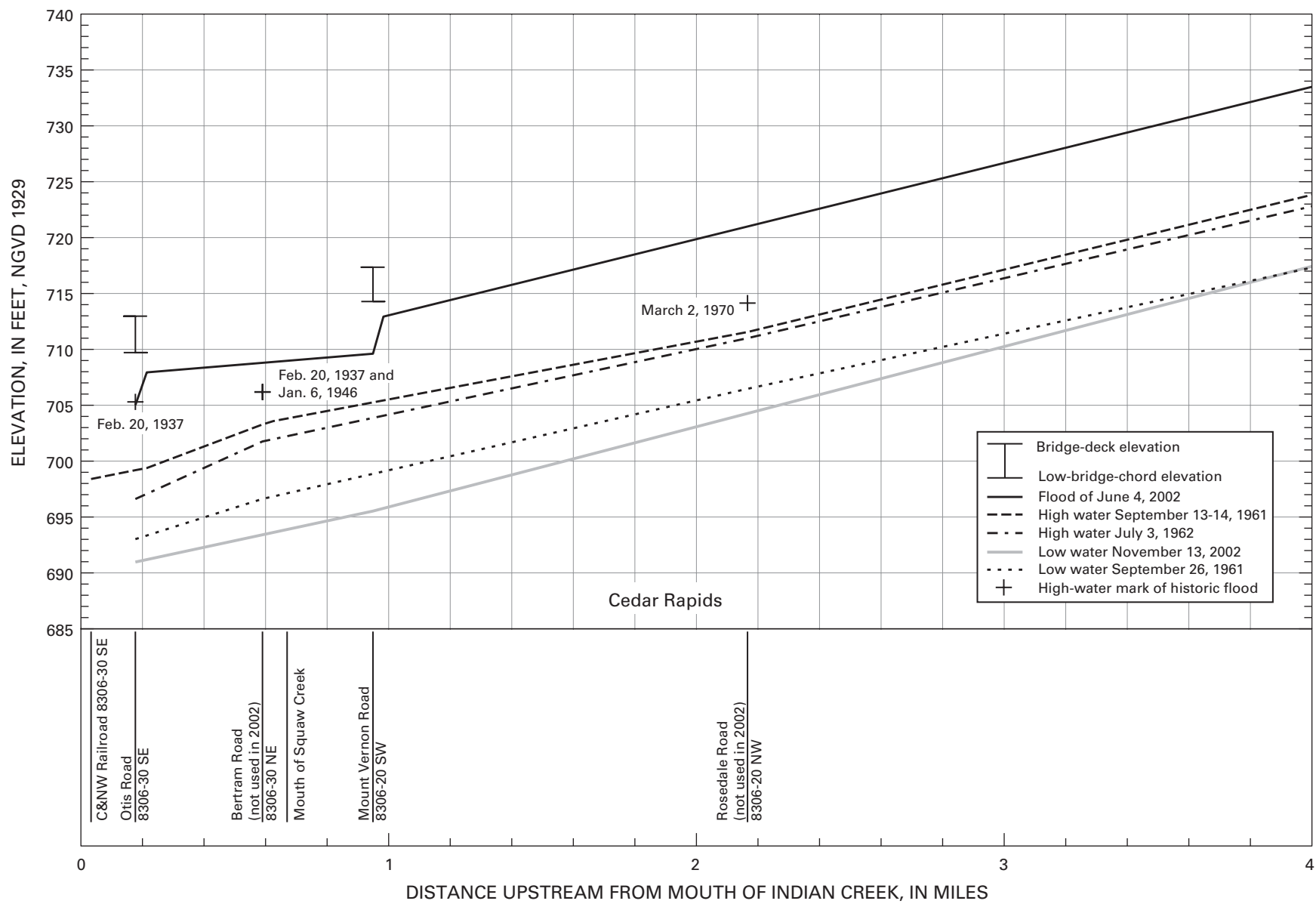


Figure 5. Profile of the June 2002 flood for Indian Creek, Linn County, Iowa; river miles 0 to 4.

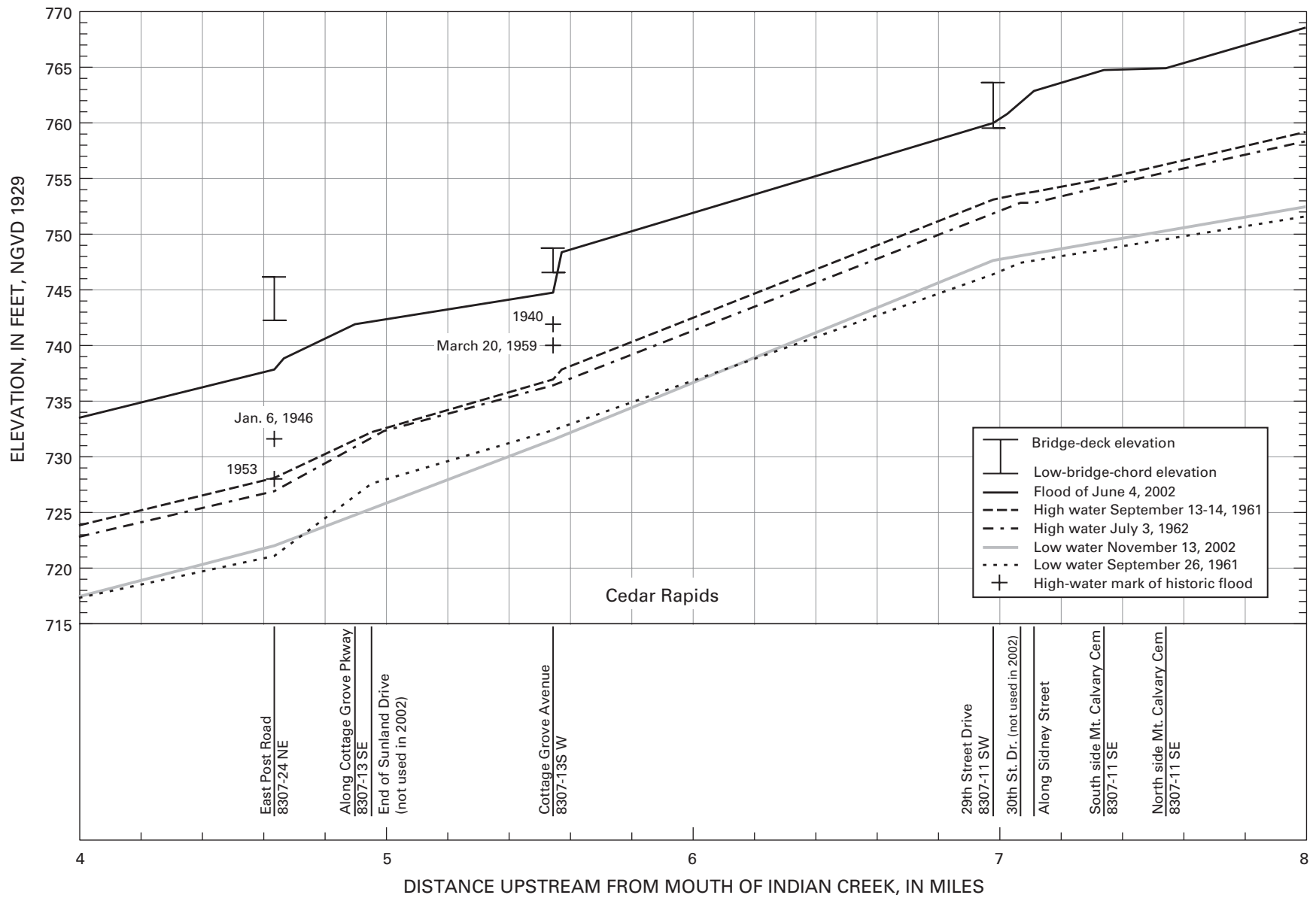


Figure 6. Profile of the June 2002 flood for Indian Creek, Linn County, Iowa; river miles 4 to 8.

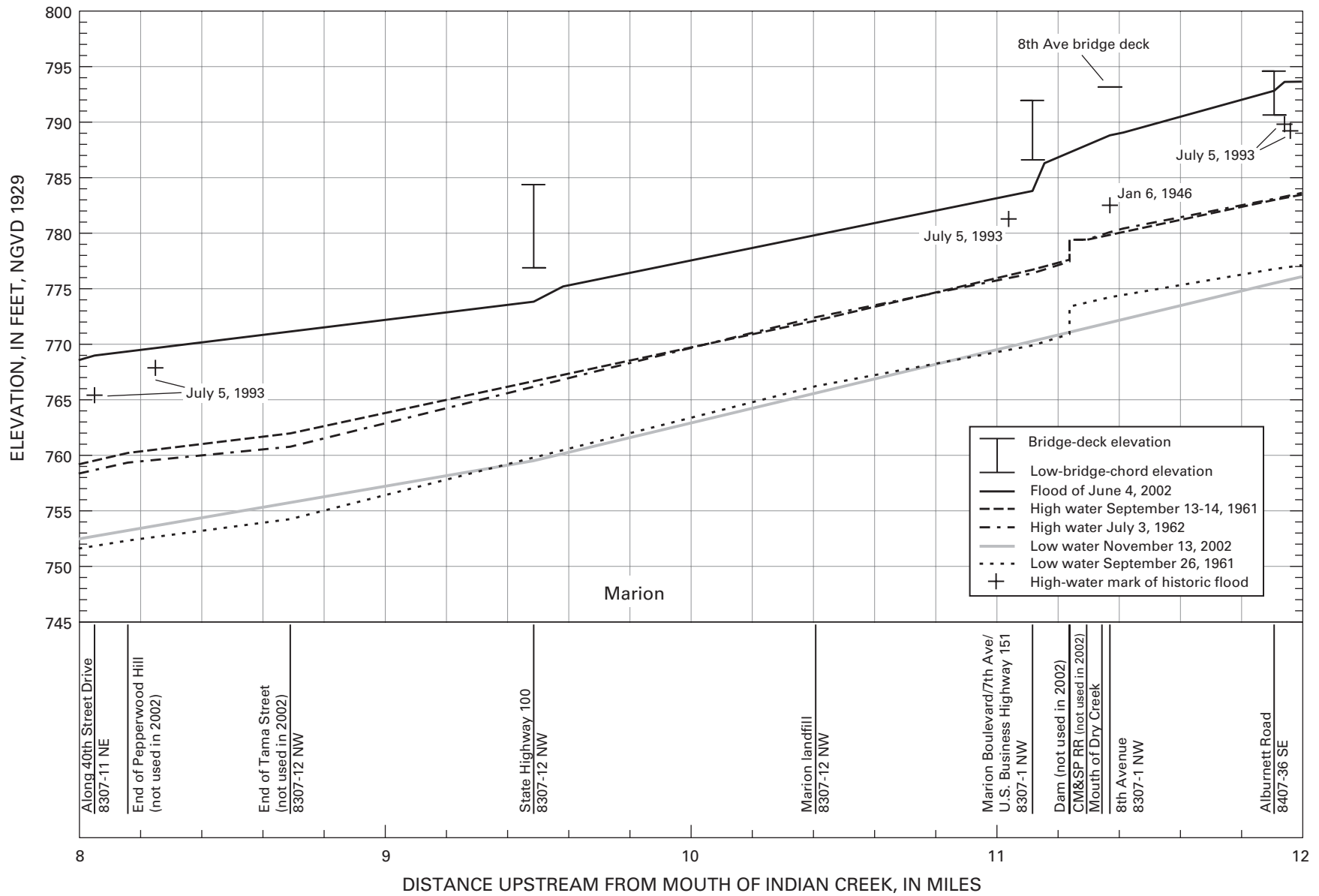


Figure 7. Profile of the June 2002 flood for Indian Creek, Linn County, Iowa; river miles 8 to 12.

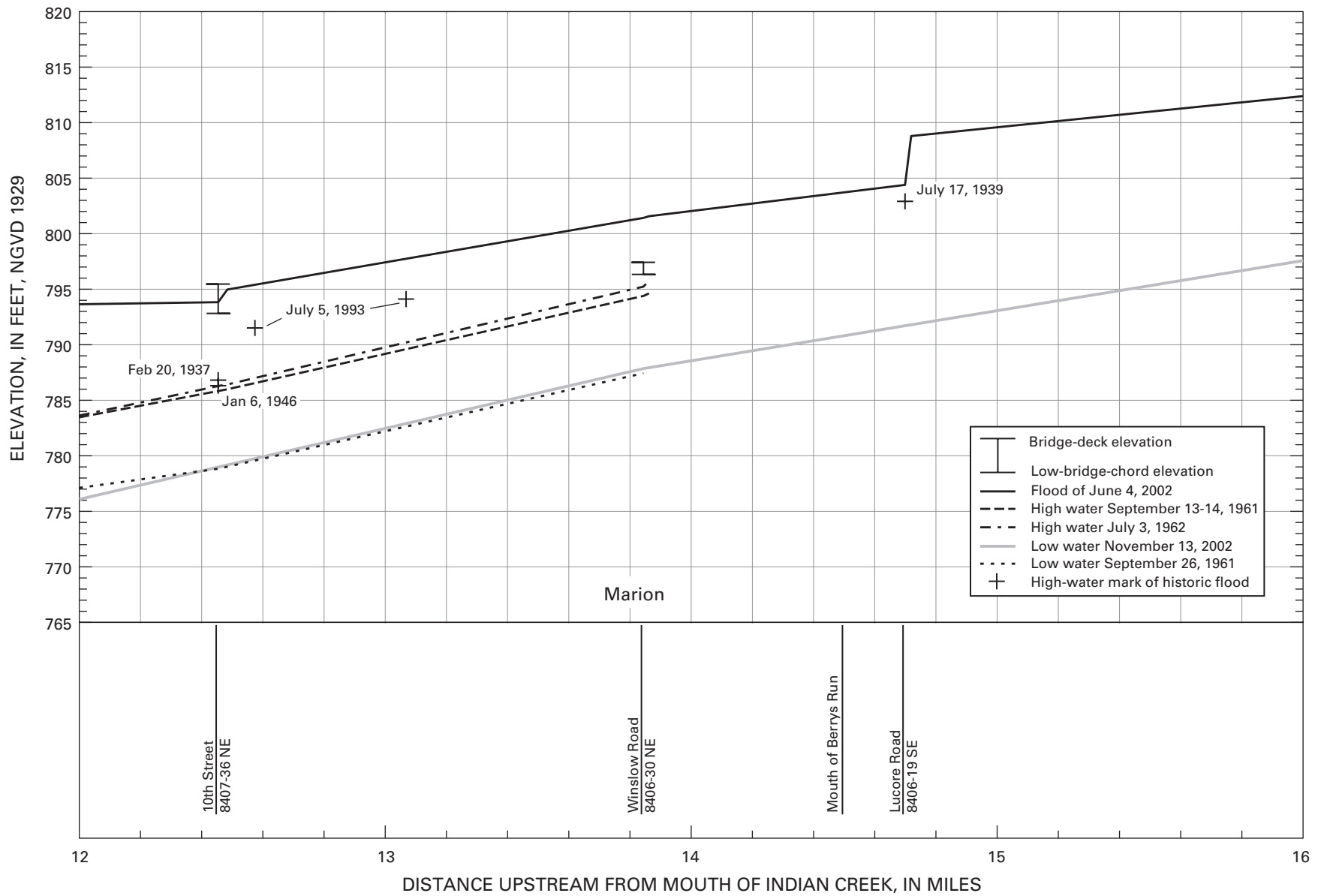


Figure 8. Profile of the June 2002 flood for Indian Creek, Linn County, Iowa; river miles 12 to 16.

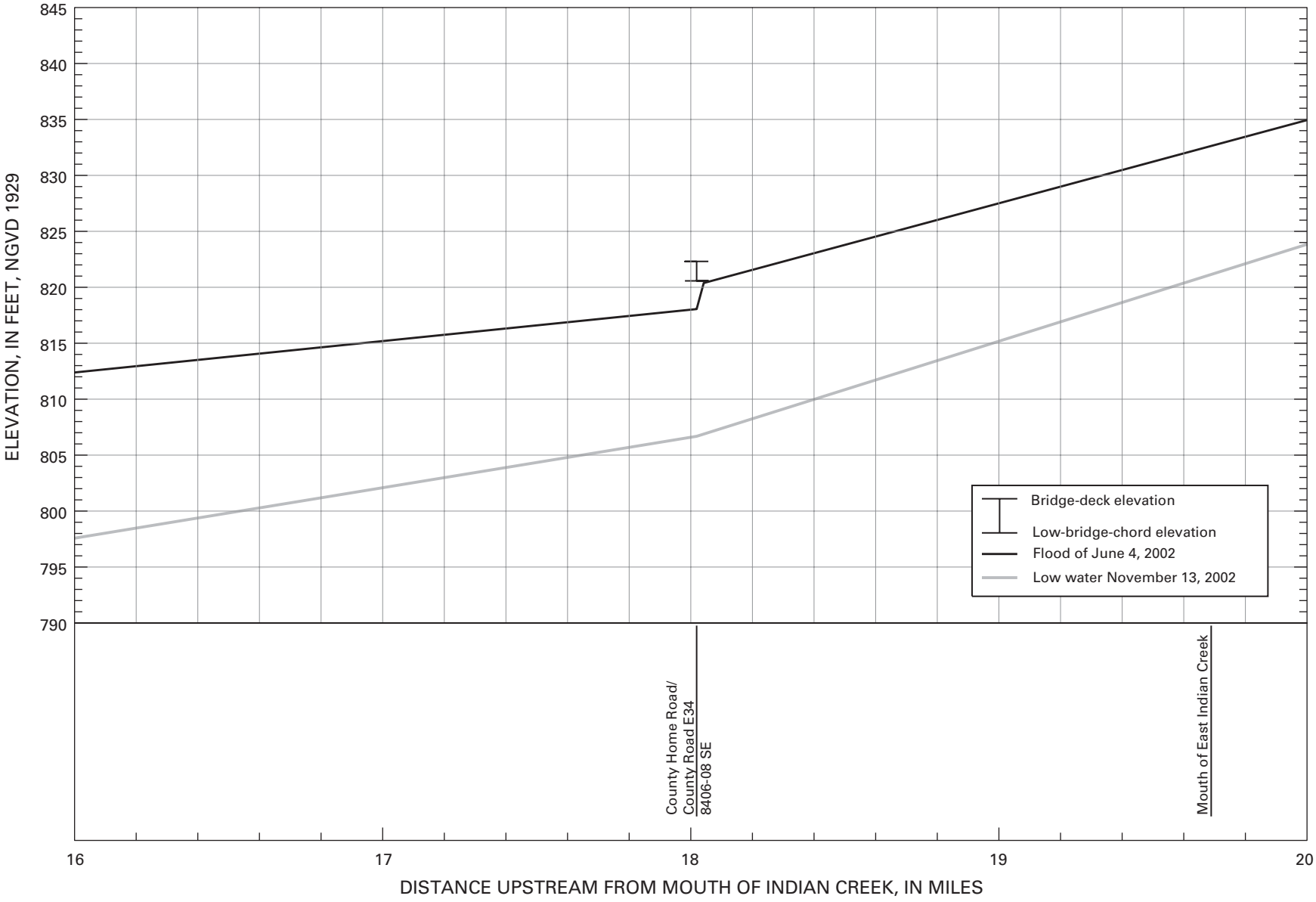


Figure 9. Profile of the June 2002 flood for Indian Creek, Linn County, Iowa; river miles 16 to 20.

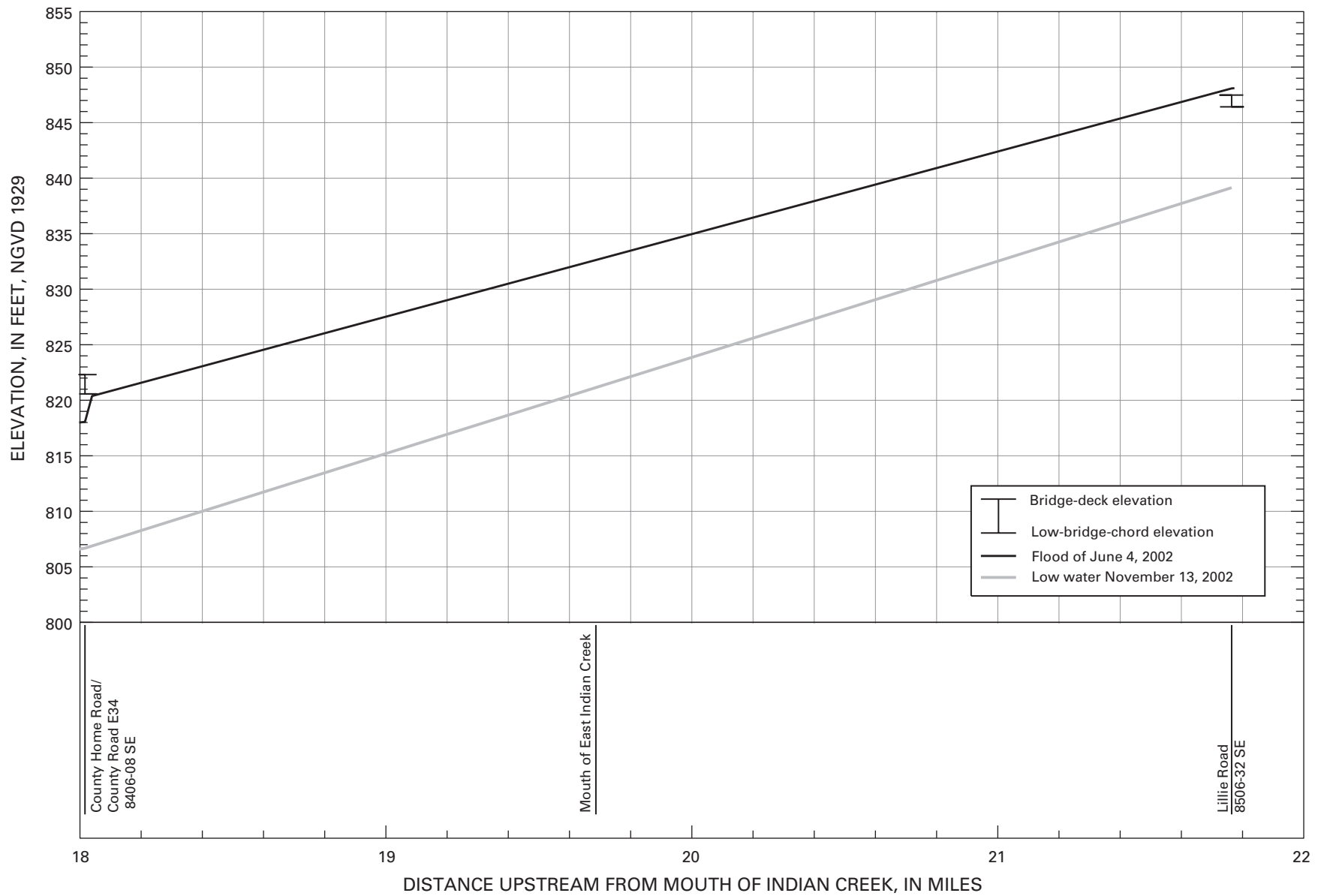


Figure 10. Profile of the June 2002 flood for Indian Creek, Linn County, Iowa; river miles 18 to 22.

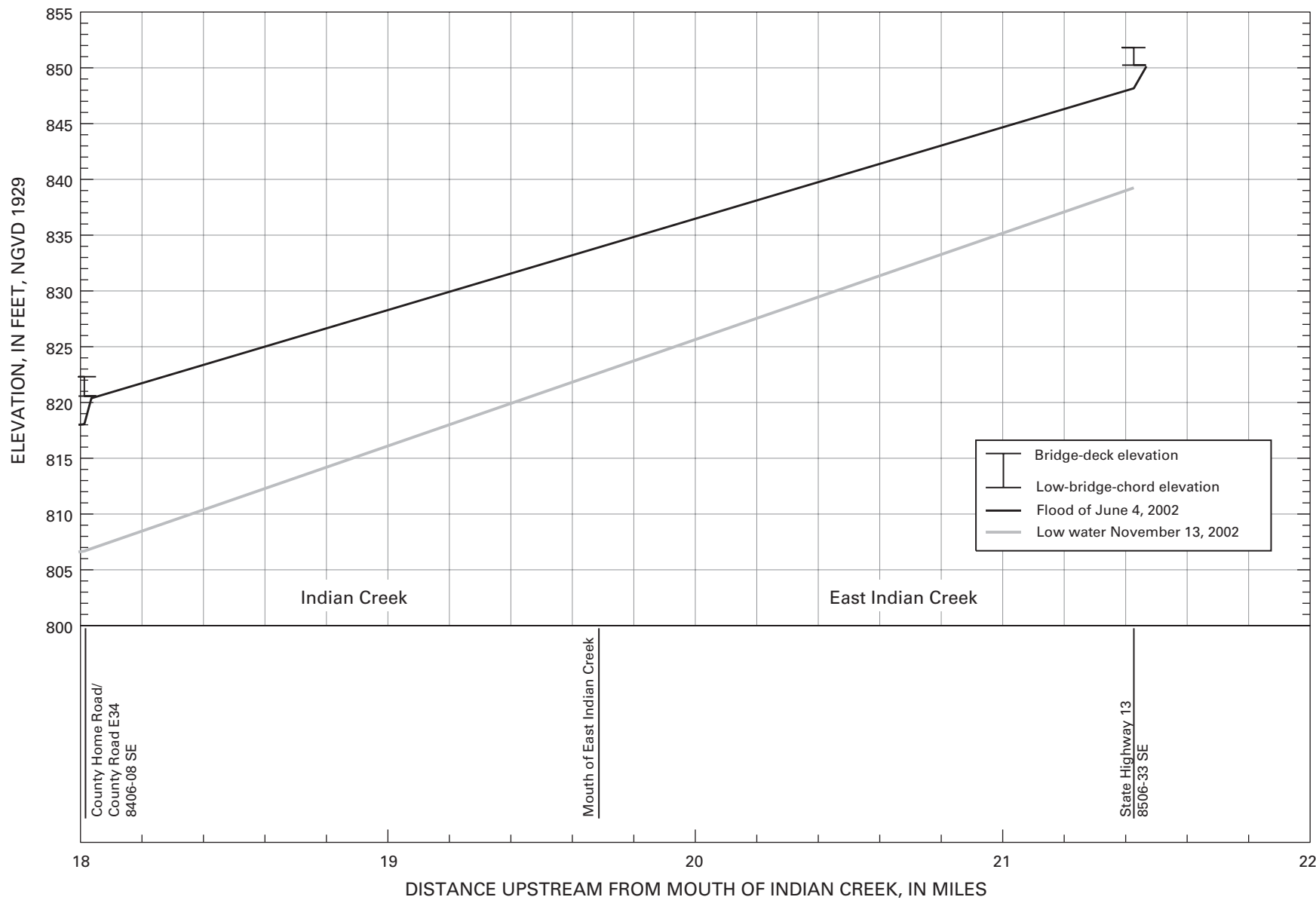


Figure 11. Profile of the June 2002 flood for Indian and East Indian Creeks, Linn County, Iowa; river miles 18 to 22.

Table 6. Elevations of high-water marks used in the June 2002 flood profile for Indian and East Indian Creeks, Linn County, Iowa.

[HWM, high-water mark; NGVD, elevation data is referenced to the National Geodetic Vertical Datum of 1929; **boldfaced type**, temporary bench mark and reference point included in appendix; NA, not applicable]

Distance upstream from mouth of Indian Creek (river miles)	Site description	Downstream HWM (feet, NGVD 1929)	Upstream HWM (feet, NGVD 1929)
0.18	Otis Road bridge , SE of Cedar Rapids	705.01	707.94
0.95	Mount Vernon Road bridge , SE of Cedar Rapids	709.61	712.93
4.64	East Post Road bridge , Cedar Rapids	737.83	738.83
4.90	Along Cottage Grove Parkway, Cedar Rapids	¹ 741.9	NA
5.55	Cottage Grove Avenue bridge , Cedar Rapids	744.74	748.37
6.98	29th Street Drive bridge , Cedar Rapids	759.98	760.80
7.11	Along Sidney Street	¹ 762.86	NA
7.34	South side of Mt. Calvary Cemetery, Cedar Rapids	¹ 764.74	NA
7.54	North side of Mt. Calvary Cemetery, Cedar Rapids	¹ 764.9	NA
8.05	Along 40th Street Drive, Marion	² 768.97	NA
9.49	State Highway 100 bridge , Marion	773.82	775.19
11.12	Marion Boulevard/Seventh Avenue/Business U.S. Highway 151 bridge , Marion	783.79	786.59
11.37	8th Avenue bridge, Marion	² 788.8	² 789.05
11.91	Alburnett Road bridge , Marion	² 792.81	793.61
12.45	10th Street bridge, Marion	² 793.82	² 794.96
13.84	Winslow Road bridge , Marion	801.41	801.56
14.70	Lucore Road bridge, Marion	² 804.38	² 808.78
18.02	County Home Road/County Road E34 bridge , N of Marion	818.04	820.37
21.77	Lillie Road bridge , SE of Alburnett	848.07	848.09
	East Indian Creek		
21.43	State Highway 13 bridge , SE of Alburnett	848.15	850.12

¹High-water mark elevation provided by City of Cedar Rapids.

²High-water mark elevation provided by Hall and Hall Engineers, Inc., and the City of Marion.

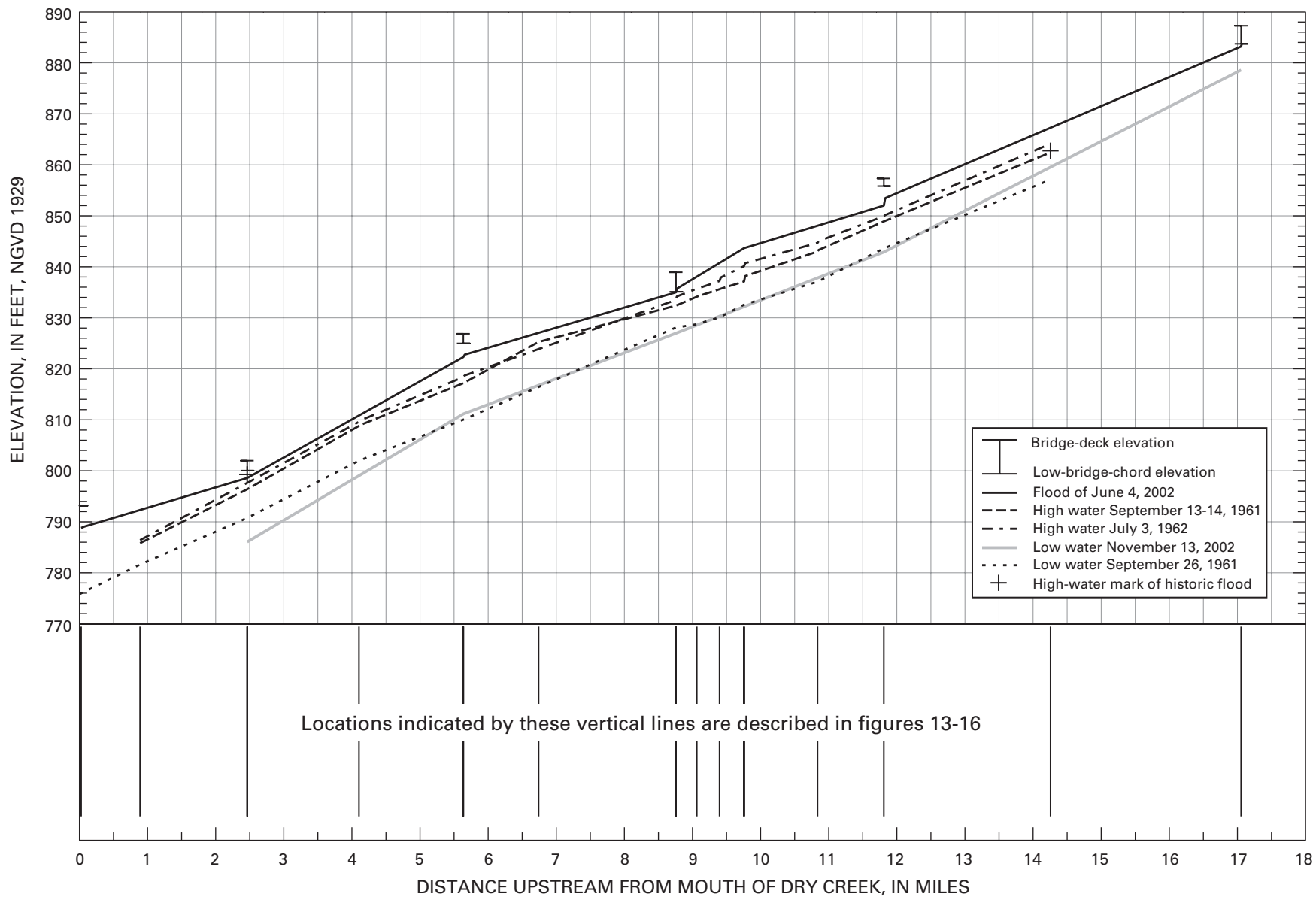


Figure 12. Profile of the June 2002 flood for Dry Creek, Linn County, Iowa; river miles 0 to 17.

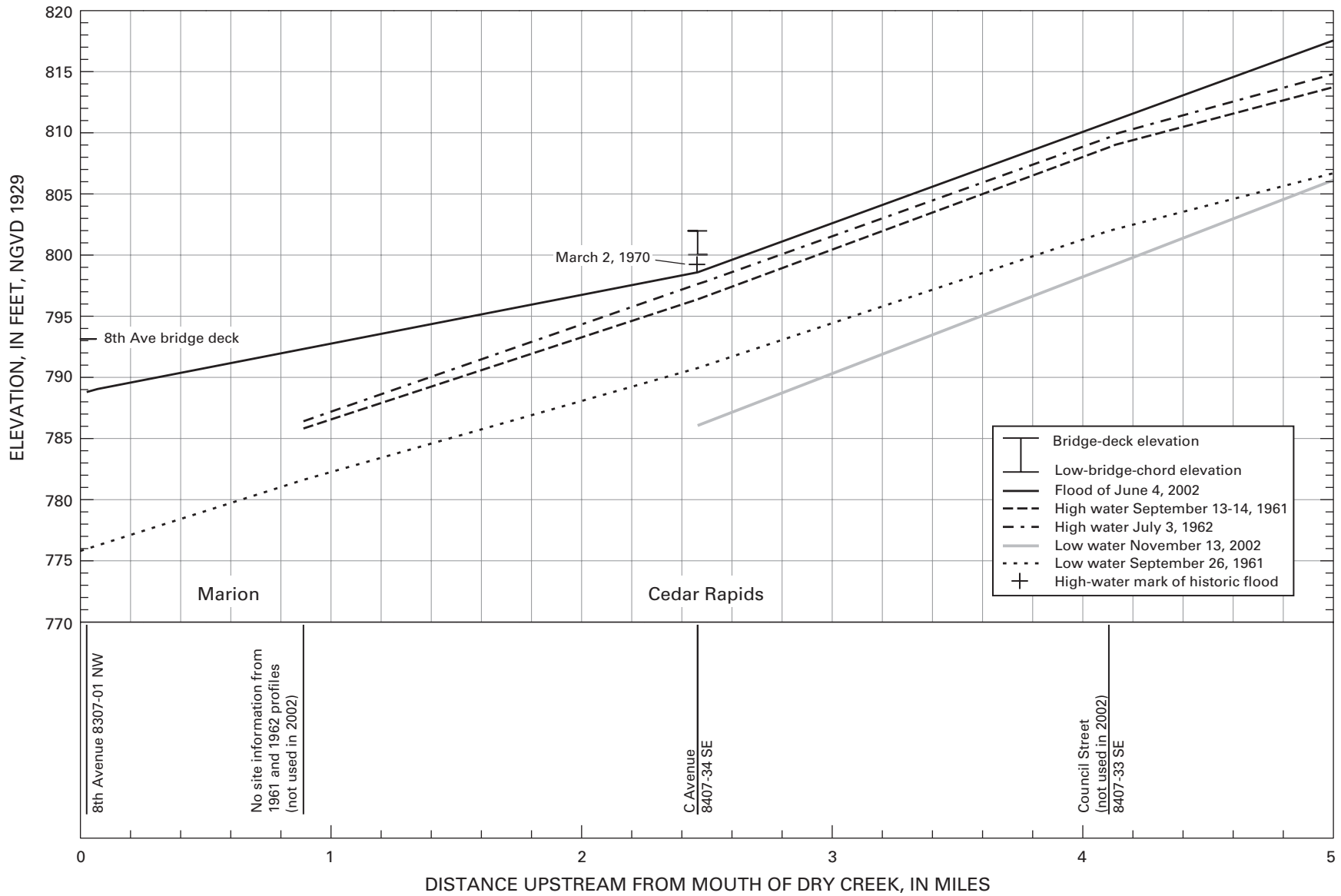


Figure 13. Profile of the June 2002 flood for Dry Creek, Linn County, Iowa; river miles 0 to 5.

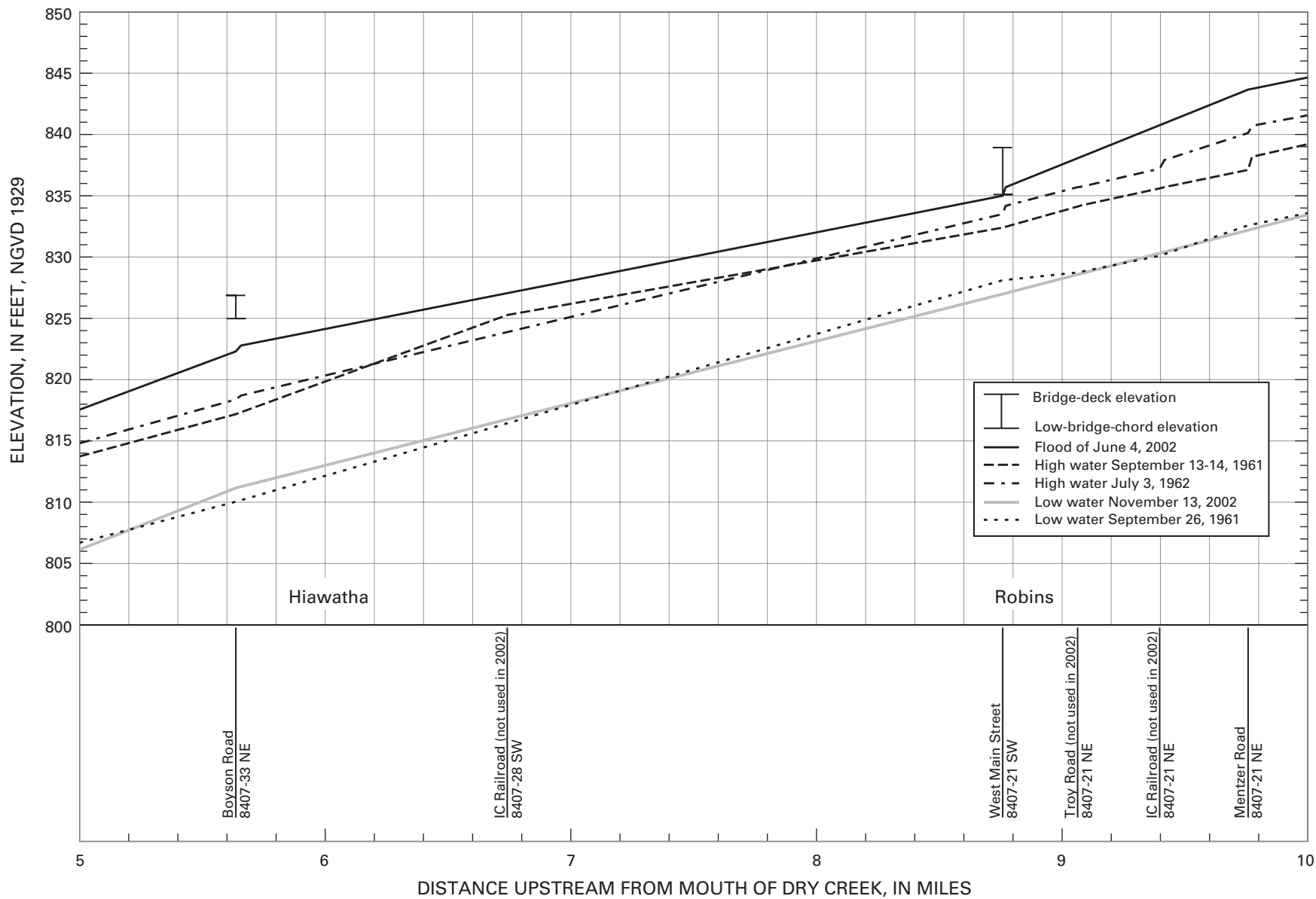


Figure 14. Profile of the June 2002 flood for Dry Creek, Linn County, Iowa; river miles 5 to 10.

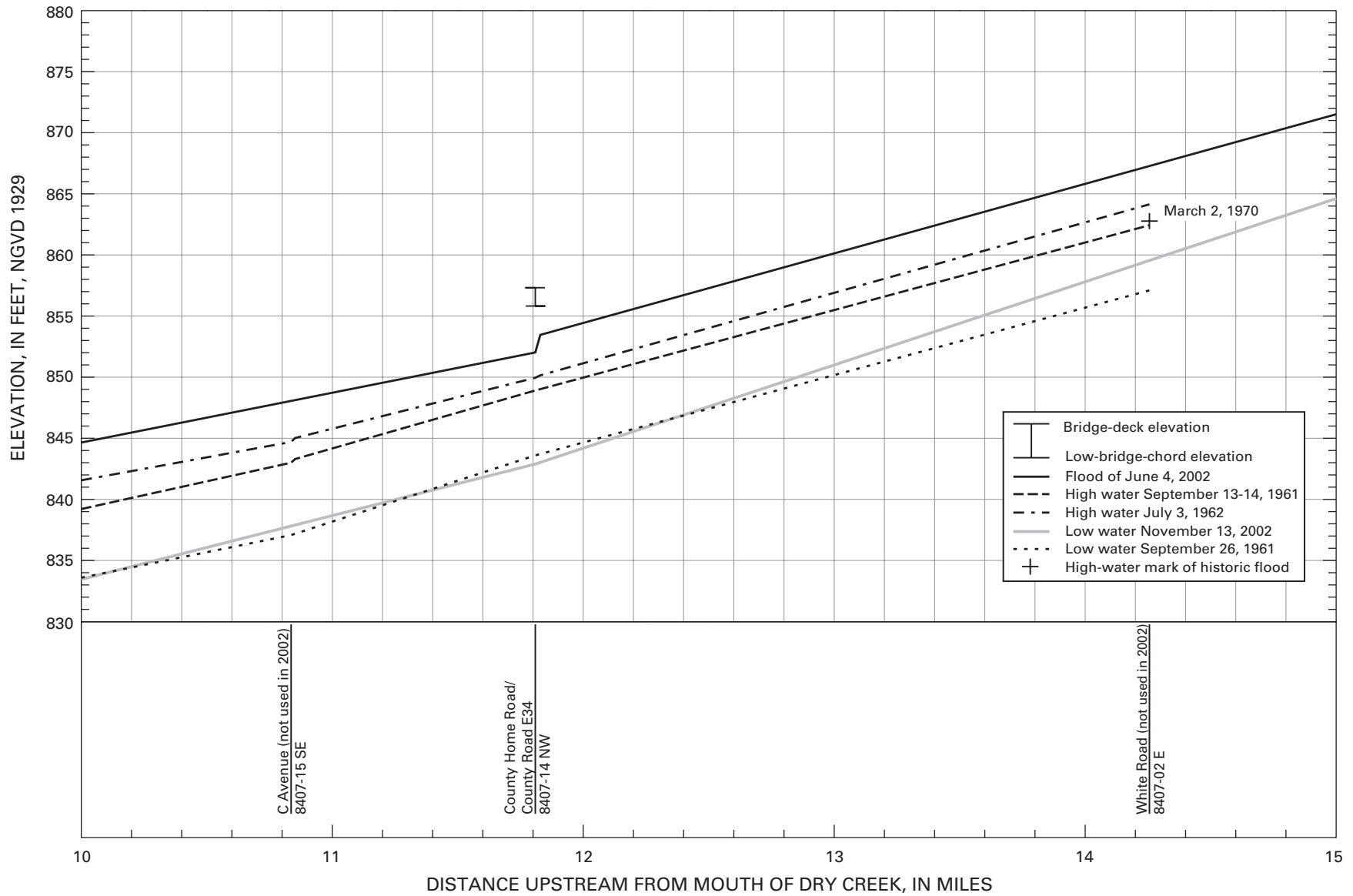


Figure 15. Profile of the June 2002 flood for Dry Creek, Linn County, Iowa; river miles 10 to 15.

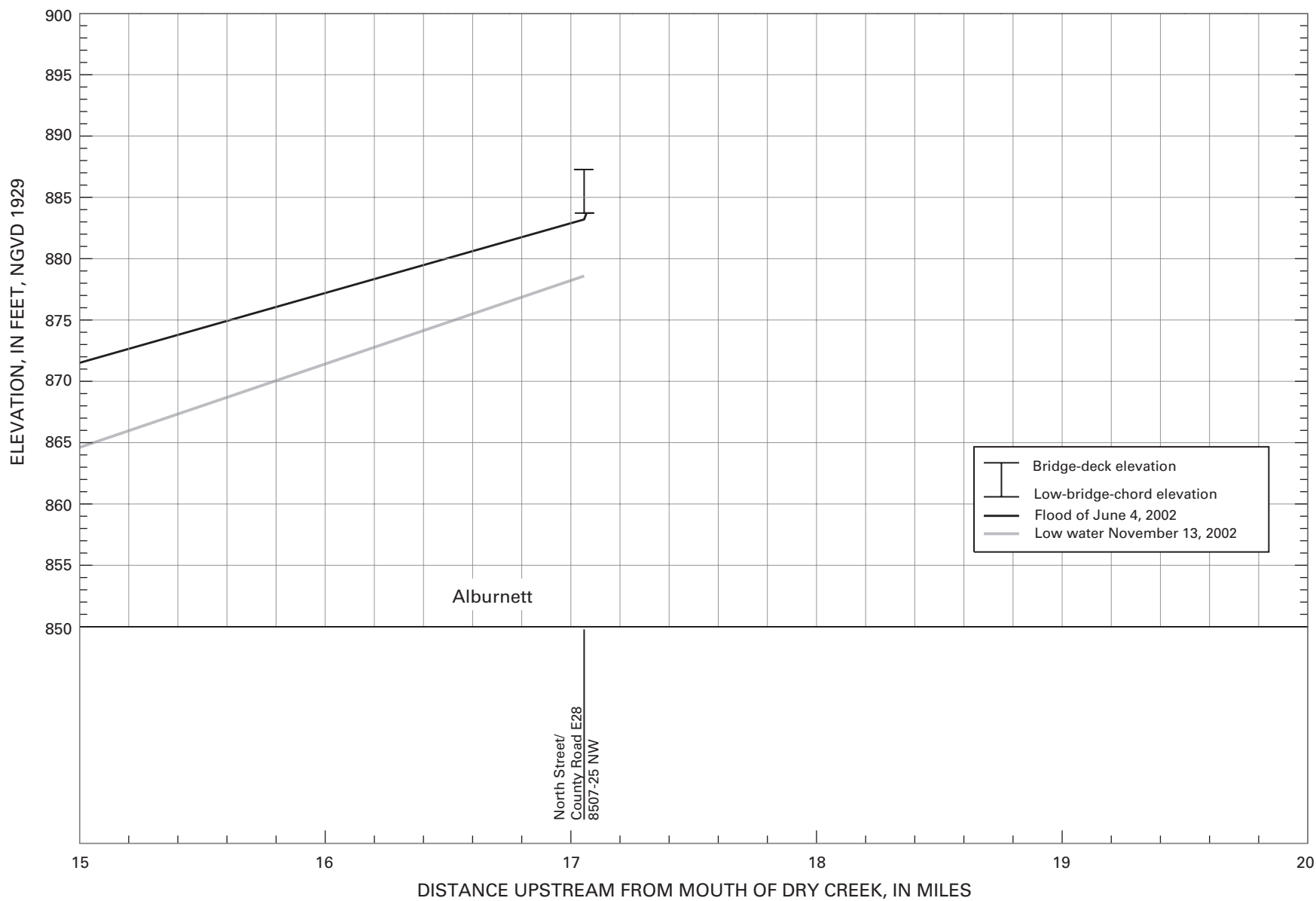


Figure 16. Profile of the June 2002 flood for Dry Creek, Linn County, Iowa; river miles 15 to 17.

Table 7. Elevations of high-water marks used in the June 2002 flood profile for Dry Creek, Linn County, Iowa.

[HWM, high-water mark; NGVD, elevation is referenced to the National Geodetic Vertical Datum of 1929; **boldfaced type**, temporary bench mark and reference point included in appendix; --, not determined]

Distance upstream from mouth of Dry Creek (river miles)	Site description	Downstream HWM (feet, NGVD 1929)	Upstream HWM (feet, NGVD 1929)
0.25	8th Avenue bridge, Marion	¹ 788.8	¹ 789.05
2.46	C Avenue bridge , Cedar Rapids	798.59	--
5.64	Boyson Road bridge , Hiawatha	822.30	822.78
8.76	West Main Street bridge , Robins	835.00	835.70
9.72	Mentzer Road, Robins (HWM measured about 100 feet downstream of bridge)	² 843.66	--
11.81	County Home Road/County Road E34 bridge , NE of Robins	852.02	853.46
17.05	North Street/County Road E28 bridge , Alburnett	883.20	883.68

¹High-water mark elevation provided by Hall and Hall Engineers, Inc., and the City of Marion.

²High-water mark elevation provided by Snyder and Associates, Inc.

Appendix: Temporary Bench Marks and Reference Points

To facilitate measuring and referencing the high-water marks (HWM's) used in the flood profiles to a common datum, temporary bench marks (TBM's) and reference points (RP's) were found or established by the USGS at most of the bridges along the profiled stream reaches. All TBM and RP elevations listed in this tabulation are referenced to the National Geodetic Vertical Datum of 1929. TBM's and RP's are presented for 17 of the 21 bridge sites listed in tables 6 and 7; these 17 sites are where the USGS measured HWM's for the June 2002 flood profile. For 12 of these 17 sites, TBM's and corresponding elevations were established by other agencies and these agencies are noted in the descriptions of the TBM's. Elevations for six of the TBM's established by other agencies are listed as North American Vertical Datum of 1988 (NAVD88). These elevations were converted to National Geodetic Vertical Datum of 1929 (NGVD29) using the Corpscon program (U.S. Army Corps of Engineers, URL <http://crunch.tec.army.mil/software/corpscon/corpscon.html>). The USGS established TBM's at five sites and RP's at 16 sites during 2002. TBM and RP elevations established by the USGS were determined from differential leveling, with the exception of TBM's at three bridges, where elevations were determined from post-processed differential positioning using a global positioning system (GPS). Elevations determined using GPS are noted in the TBM and RP descriptions. Level lines or GPS networks, used to establish the third-order accuracy of the five TBM's established by the USGS shown herein, were surveyed or configured from bench marks established and adjusted by the National Mapping Division of the USGS and National Geodetic Survey or from bench marks listed in the 1982 Linn County Flood Insurance Study (Federal Emergency Management Agency, 1982c). GPS networks also were supplemented with GPS-control sites established by Linn County and the City of Cedar Rapids. Errors of closure in the USGS level work were adjusted along level lines to balance TBM and RP elevations. Specific GPS-network and satellite-constellation configurations, equivalent hours of data collection with multiple GPS receivers, and post-processing quality controls were used to control the effects of error in GPS-derived elevations.

The TBM's and RP's are designated by an index number or legal description derived from their respective locations using Public Land Survey System coordinates (township, range, section). Within the section, the quarter section in which the TBM or RP is located is designated by NE, SE, NW, and SW. For Example, 8306-30 SE refers to a location in Township 83 North, Range 6 West, southeast quarter of section 30. A number in parentheses following the quarter-section designation indicates the number of the TBM or RP in that particular quarter section. The index number serves to describe the legal description of the mark without further reference in the body of the description. The physical location of the TBM on a bridge

dictates the appropriate legal description. An RP is listed with the related TBM and is identified by the same legal description though, at times, it is in a different section, range, or township as determined by upstream or downstream location.

Standard marks, such as squares, crosses, marks, or arrows were chiseled or filed on concrete or metal; or existing bolts on bridges were used as TBM's or RP's. RP's are distinguished from TBM's by the notation "(REFERENCE POINT)" following the legal description. RP's were established to permit water-surface elevations to be determined by use of a tape and weight. The terms "right" and "left" in the descriptions are determined as viewed while facing in the downstream direction.

The TBM's and RP's are listed in a downstream to upstream order with respect to their correspondence to bridges over Indian, East Indian, and Dry Creeks. The user of this information is cautioned that TBM's and RP's listed herein might have been disturbed, destroyed, or moved since elevations were established. It is the responsibility of the user to determine the condition and the suitability of the TBM or RP.

Indian Creek

8306-30 SE (1) --At southeast edge of Cedar Rapids, on Otis Road bridge over Indian Creek, on right downstream wingwall; a Linn County bench mark stamped "1031 715.28." Elevation provided by Linn County Engineer's Office.

Elevation 715.28 ft

8306-30 SE (2)--(REFERENCE POINT) At southeast edge of Cedar Rapids, on Otis Road bridge over Indian Creek, on guard-rail and approximately 1 ft right of 11th guardrail post from left downstream end of bridge; three filed marks.

Elevation 715.90 ft

8306-20 SW (1)--At Cedar Rapids, on Mount Vernon Road bridge over Indian Creek, on end of right upstream concrete wall; a Linn County bench mark. Elevation provided by Linn County Engineer's Office.

Elevation 721.69 ft

8306-20 SW (2)--(REFERENCE POINT) At Cedar Rapids, on Mount Vernon Road bridge over Indian Creek, on 11th guard-rail post from right downstream end of bridge; a filed arrow.

Elevation 721.02 ft

8307-24 NE (1)--At Cedar Rapids, on East Post Road bridge over Indian Creek, on right upstream concrete wall; a Linn County aluminum cap bench mark stamped "2346." Elevation of 749.06 ft (NAVD88) provided by City of Cedar Rapids, elevation converted to NGVD29.

Elevation 749.14 ft

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8307-24 NE (2)--(REFERENCE POINT) At Cedar Rapids, on East Post Road bridge over Indian Creek, on 9th metal guardrail post from right downstream end of bridge; three filed marks.

Elevation 748.55 ft

8307-13 SW (1)--At Cedar Rapids, on Cottage Grove Avenue bridge over Indian Creek, on end of left downstream concrete wingwall, at sidewalk level near cyclone fence; a chiseled square. Elevation of 749.28 (NAVD88) provided by City of Cedar Rapids, elevation converted to NGVD29.

Elevation 749.36 ft

8307-13 SW (2)--At Cedar Rapids, on Cottage Grove Avenue bridge over Indian Creek, on end of right upstream concrete wingwall, at sidewalk level near cyclone fence; a chiseled square.

Elevation 748.61 ft

8307-13 SW (3)--(REFERENCE POINT) At Cedar Rapids, on Cottage Grove Avenue bridge over Indian Creek, on downstream side of cyclone fence centered between 10th and 11th fence posts from right downstream end of bridge; edge of concrete sidewalk.

Elevation 748.98 ft

8307-11 SW (1)--At Cedar Rapids, on 29th Street Drive bridge over Indian Creek, on end of left upstream wingwall curb; a chiseled cross. Elevation of 764.30 ft (NAVD88) provided by City of Cedar Rapids, elevation converted to NGVD29.

Elevation 764.38 ft

8307-11 SW (2)--At Cedar Rapids, on 29th Street Drive bridge over Indian Creek, roadside end of sidewalk on right upstream end of bridge; a chiseled cross.

Elevation 766.53 ft

8307-11 SW (3)--(REFERENCE POINT) At Cedar Rapids, on 29th Street Drive bridge over Indian Creek, on 12th guardrail post from right downstream end of bridge; three filed marks.

Elevation 768.56 ft

8307-12 NW (1)--At Marion, on State Highway 100 bridge over Indian Creek, on right downstream wingwall; an Iowa Department of Transportation bench mark. Elevation of 789.57 ft (NAVD88) provided by Iowa Department of Transportation, elevation converted to NGVD29.

Elevation 789.65 ft

8307-12 NW (2)--(REFERENCE POINT) At Marion, on State Highway 100 bridge over Indian Creek, on downstream concrete barrier wall approximately 224 ft from right end of bridge; a chiseled square.

Elevation 787.12 ft

8307-1 NW (1)--At Marion, on Marion Boulevard/Seventh Avenue/Business U.S. Highway 151 bridge over Indian Creek, on concrete walkway at end of fence on left downstream end of

bridge; a chiseled cross. Elevation of 793.74 (NAVD88) provided by City of Cedar Rapids, elevation converted to NGVD29.

Elevation 793.82 ft

8307-1 NW (2)--(REFERENCE POINT) At Marion, on Marion Boulevard/Seventh Avenue/Business U.S. Highway 151 bridge over Indian Creek, on 8th guardrail post from right end of bridge; three filed marks.

Elevation 797.20 ft

8407-36 SE (1)--At Marion, on Alburnett Road bridge over Indian Creek, between angled corner intersection of sidewalks on right upstream end of bridge; top of stake level with concrete sidewalk. Elevation of 794.68 (NAVD88) provided by City of Cedar Rapids, elevation converted to NGVD29.

Elevation 794.76 ft

8407-36 SE (2)--(REFERENCE POINT) At Marion, on Alburnett Road bridge over Indian Creek, on downstream concrete barrier wall approximately 84 ft from right end of bridge; a chiseled square.

Elevation 797.96 ft

8406-30 NE (1)--At Marion, on Winslow Road bridge over Indian Creek, on outer bolt head on left downstream abutment; a filed cross. Elevation determined using GPS.

Elevation 799.17 ft

8406-30 NE (2)--(REFERENCE POINT) At Marion, on Winslow Road bridge over Indian Creek, on 9th guardrail post from left downstream end of bridge, on nut to bolt on back of guardrail post; a filed cross. Elevation determined using GPS.

Elevation 800.35 ft

8406-08 SE (1)--Approximately 3 mi north of Marion, on County Home Road/County Road E34 bridge over Indian Creek, on left upstream wingwall; a Linn County bench mark. Elevation provided by Linn County Engineer's Office.

Elevation 827.17 ft

8406-08 SE (2)--(REFERENCE POINT) Approximately 3 mi north of Marion, on County Home Road/County Road E34 bridge over Indian Creek, on downstream concrete barrier wall approximately 58 ft from left end of bridge; a chiseled square.

Elevation 825.93 ft

8506-32 SE (1)--Approximately 3 mi southeast of Alburnett, on Lillie Road bridge over Indian Creek, on right upstream wood wingwall/abutment; a Linn County bench mark stamped "1032 1996."

Elevation 847.00 ft

8506-32 SE (2)--(REFERENCE POINT) Approximately 3 mi southeast of Alburnett, on Lillie Road bridge over Indian Creek, on guardrail between 3rd and 4th guardrail posts from left downstream end of bridge; three filed marks.

Elevation 849.88 ft

East Indian Creek

8506-33 SE (1)--Approximately 4 mi southeast of Alburnett, on northbound lane of State Highway 13 bridge over East Indian Creek (upstream bridge), on left upstream wingwall; an Iowa Department of Transportation bench mark.

Elevation 857.66 ft

8506-33 SE (2)--Approximately 4 mi southeast of Alburnett, on southbound lane of State Highway 13 bridge over East Indian Creek (downstream bridge), on left upstream wingwall; an Iowa Department of Transportation bench mark.

Elevation 854.71 ft

8506-33 SE (3)--(REFERENCE POINT) Approximately 4 mi southeast of Alburnett, on southbound lane of State Highway 13 bridge over East Indian Creek (downstream bridge), on concrete platform behind 3rd drain from left downstream end of bridge; a chiseled square.

Elevation 855.64 ft

Dry Creek

8407-34 SE (1)--At Cedar Rapids, on C Avenue bridge over Dry Creek, on curb on right upstream abutment; a Linn County bench mark. Elevation provided by Linn County Engineer's Office.

Elevation 805.20 ft

8407-34 SE (2)--(REFERENCE POINT) At Cedar Rapids, on C Avenue bridge over Dry Creek, on 12th guardrail post from right downstream end of bridge; three filed marks.

Elevation 806.89 ft

8407-33 NE (1)--At Cedar Rapids near Hiawatha municipal boundary, on Boyson Road bridge over Dry Creek, at end of cyclone fence at left downstream end of bridge, on top of left downstream bolt; a filed cross. Elevation determined using GPS.

Elevation 826.60 ft

8407-33 NE (2)--(REFERENCE POINT) At Cedar Rapids near Hiawatha municipal boundary, on Boyson Road bridge over Dry Creek, on downstream side of cyclone fence centered between 6th and 7th fence posts from left downstream end of bridge; edge of concrete sidewalk. Elevation determined using GPS.

Elevation 826.70 ft

8407-21 SW (1)--At Robins, on West Main Street bridge over Dry Creek, on concrete handrail at right downstream wingwall; a Linn County bench mark stamped "2332 1941." Elevation provided by Linn County Engineer's Office.

Elevation 841.87 ft

8407-21 SW (2)--(REFERENCE POINT) At Robins, on West Main Street bridge over Dry Creek, on guardrail between 4th and 5th guardrail posts from right downstream end of bridge; three filed marks.

Elevation 841.70 ft

8407-14 NW (1)--Approximately 2 mi northeast of Robins, on County Home Road/County Road E34 bridge over Dry Creek, on right downstream wingwall; a Linn County bench mark stamped "2313 858.07." Elevation provided by Linn County Engineer's Office.

Elevation 858.07 ft

8407-14 NW (2)--(REFERENCE POINT) Approximately 2 mi northeast of Robins, on County Home Road/County Road E34 bridge over Dry Creek, on concrete platform behind barrier wall at 1st drain from right downstream end of bridge; a chiseled square.

Elevation 858.12 ft

8507-25 NW (1)--At Alburnett, on North Street/County Road E28 bridge over Dry Creek, on right downstream edge of culvert headwall near reflector post; a chiseled square. This bench mark can also be used as a reference point. Elevation determined using GPS.

Elevation 885.78 ft