UNITED STATES

DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

FLOODS IN THE BIG CREEK BASIN, LINN COUNTY, IOWA

Open-File Report 77-209

Prepared in cooperation with

Linn County, Iowa

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By

Albert J. Heinitz

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Iowa City, Iowa
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Floods in the Big Creek basin Linn County, Iowa

by
Albert J. Heinitz

ABSTRACT

Flood information is given for the Big Creek basin which will be of use to those concerned with the design of bridges and other structures, and with various other activities on the flood plains of the streams. Water-surface profiles for the flood of May 1974 are given for Big Creek and its major tributaries, East Big, Crabapple, Elbow, and Abbe Creeks. The May 1974 flood was at least a 50-year flood on East Big Creek and along certain reaches of Big and Abbe Creeks. Also included for Big Creek are a profile of the December 1971 medium-stage flow and a partial profile for the minor flood of July 1971. Profiles for the low-water condition of October 26, 1972, are shown for all reaches. Water-surface profiles for the 25- and 50-year floods are estimated in relation to the May 1974 flood.

INTRODUCTION

Purpose and Scope

The purpose of this report is to provide flood information for the Big Creek basin. This information can be used in connection with planning, designing, and operating

structures, and conducting other activites on or across the flood plain and for assessing the severity of floods. The report provides data on (1) basin characteristics--drainage area and stream-channel slope, (2) flood stages and discharges, (3) flood frequency, and (4) water-surface profiles for streamflow ranging from low to flood flows.

This report was prepared in cooperation with Linn County, Iowa, as part of a program to collect and analyze hydrologic data in the county.

Conversion factors for converting English units published herein to the International System of units (SI) are given in table 1.

Table 1.--Conversion factors for converting English units to the International System of units (SI)

Multiply English unit	By	To obtain SI unit
inches (in)	25.4	millimeters (mm)
inches (in)	2.54	centimeters (cm)
feet (ft)	0.3048	meters (m)
miles (mi)	1.609	kilometers (km)
square miles (mi^2)	2.590	square kilometers (km^2)
cubic feet (ft^3)	0.02832	cubic meters (m^3)
cubic feet per second (ft^3/s)	0.02832	cubic meters per second (m^3/s)

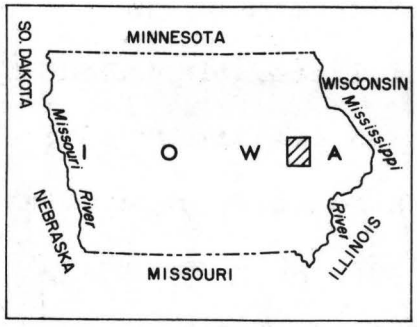
Basin Description

The Big Creek basin, shown in figure 1, lies about 5 miles (8.05 km) east of Cedar Rapids and is almost entirely in Linn County. The basin area contains 111 square miles (287 km^2) and is approximately 13 miles (20.9 km) long and 9 miles (14.5 km) wide and drains into the Cedar River.

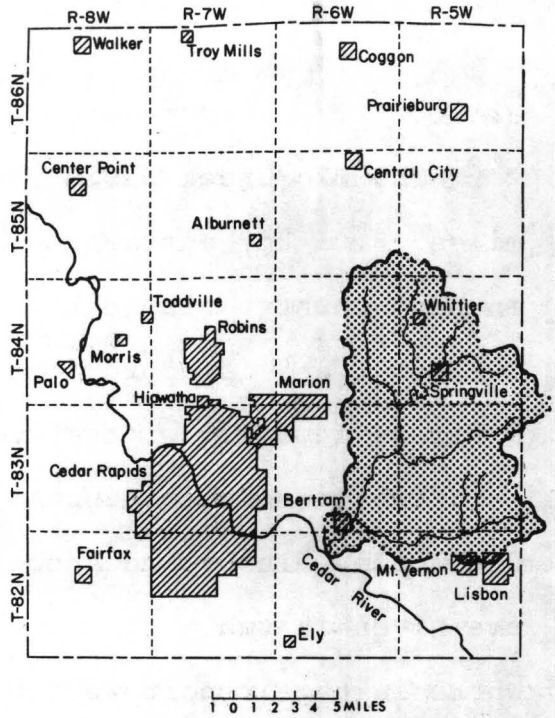
The principal tributaries of Big Creek are East Big, Crabapple, Elbow, and Abbe Creeks for which drainage areas are given in table 2. Drainage areas in table 2 and elsewhere in this report were determined from Larimer (1957).

Land use in the basin is predominantly agricultural. The uplands are cultivated for row crops, primarily corn and soybeans, whereas the land along the creeks and adjoining hills is used for pasture. Many new homesites have been established along the rural roads by people who commute primarily to the Cedar Rapids area for employment.

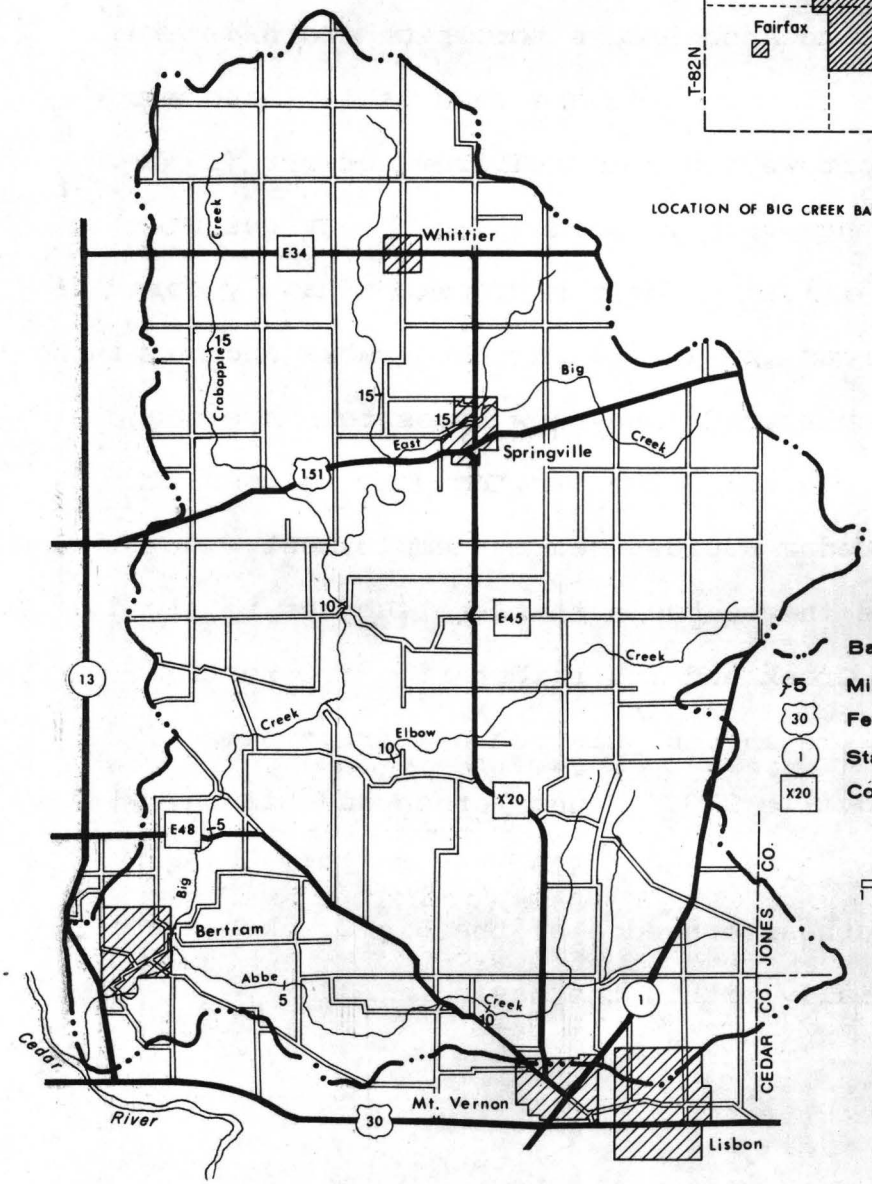
The two towns in the basin that are subject to flood problems from Big Creek and its tributaries are Bertram and Springville. The 1970 population of Bertram was 177 and that of Springville 970. Mount Vernon and Lisbon, with 1970 populations of 3,018 and 1,329, respectively, are located at the southeastern edge of the Big Creek basin and are only partially within the basin.



LOCATION OF LINN COUNTY



LOCATION OF BIG CREEK BASIN AND CITIES AND TOWNS IN LINN COUNTY



EXPLANATION

- Basin boundary
- 5 Mileage upstream from mouth of Big Creek
- 30 Federal highway
- 1 State highway
- X20 County highway

1 0 1 2 3 4MILES

Figure 1. Map of Big Creek basin in Linn County, Iowa.

Table 2.--Drainage areas of the principal tributaries of Big Creek and of the main stem Big Creek

Stream	Distance upstream from mouth of Big Creek, in miles	Bank of entry	Drainage area, in square miles	Total area, in percent	Drainage area of main stem downstream from tributary, in square miles
Big Creek at County Road E-34	17.20	----	5.74	5.2	----
East Big Creek. . .	14.00	Left	13.6	12.3	23.5
Crabapple Creek. . .	10.75	Right	14.1	12.7	40.0
Elbow Creek. . .	8.20	Left	13.9	12.5	65.0
Abbe Creek. . .	2.82	Left	26.4	23.8	108
Big Creek at mouth .	0	----	111	100	----

The average annual temperature at Cedar Rapids is 49.3° Fahrenheit (9.6°Celsius) and is considered to be representative of the Big Creek basin. July is the warmest month and January the coldest with average temperatures of 74.9° and 21.5°F (23.8° and minus 5.8°C), respectively. Total average annual precipitation at Cedar Rapids is 33.3 inches (846 mm). The highest monthly average 4.8 inches (122 mm) occurs during the month of June and the minimum monthly average, 1.1 inches

(28 mm) occurs in February. The average annual snowfall is 29.9 inches (759 mm) with the highest monthly mean of 7.7 inches (196 mm) occurring in March.

Mileage System

All stream mileages shown for the streams in the Big Creek basin were measured from the mouth of Big Creek. The mileages were measured along the stream channels shown on the U.S. Geological Survey topographic maps, where available, and on the U.S. Department of Agriculture soil maps. Mileages for highway crossings, mouths of tributaries, and other easily identified points are indicated on the profiles. An index number, such as 8206-4NE, is shown at bridges and other points to aid in identifying the land-line location. The number 8206-4NE indicates a location in township 82 north, range 6 west, the northeast quarter of section 4.

FLOOD INFORMATION

The first data obtained for the Big Creek basin were that for the minor flood of July 1971. This flood was the result of scattered showers that produced discharges less than one half those of a 50-year flood. Water-surface elevations were obtained at all bridges for 13.8 miles (22.2 km) of Big Creek and discharges were obtained at selected bridge

sites. Additional data were obtained for the medium-stage flow of December 1971 for the reach of Big Creek covered in this study. These data were used for additional definition of the profiles and stage-discharge relations on Big Creek.

Flood of May 16, 1974

The one major flood for which data are available for this report is that of the May 16, 1974, flood. Rainfall records for this flood are not available in the Big Creek basin, however, National Weather Service rain gages are located in the Cedar Rapids area nearby. Rainfall recorded there on the 16th was about 2.5 inches (64 mm) with total antecedent rainfall of about 3.5 inches (89 mm) on the 9 days preceding the flood. Peak flood discharges on streams in the Big Creek basin indicate a local storm producing much heavier rainfall amounts occurred along the eastern part of the Big Creek Basin.

DETERMINATION OF DISCHARGE

Discharges usually are determined by development of stage-discharge relation curves from current-meter measurements made at various stages and application of this relation to the stage or peak flood elevation. Peak discharges for Big Creek at miles 3.10, 7.32, and 13.80 (kilometers 4.99,

11.78, and 22.20), tabulated in table 3, were determined from the stage-discharge relations (rating curves) shown in figure 2. Discharges listed in table 3 show how closely the May 1974 flood compares to the computed 50-year flood for all but the uppermost reach of Big Creek. A 50-year flood is one that would, over a very long time, occur on the average of once in 50 years or, in terms of probability, would have a 2 percent chance of occurring in any one year.

Indirect methods of determining peak discharge were used to compute the discharges at mile 17.20 (kilometer 27.67) on Big Creek and at the six sites on the Big Creek tributaries which are indicated in table 4. Indirect methods are based on hydraulic equations which relate the discharge to the water-surface profile and the physical characteristics and geometry of the channel and flood plain. A field survey is made to determine the characteristics of the channel and flood plain which are required for the computations.

Discharges for the low-water condition of October 26, 1972, were determined on the basis of nine current-meter measurements; five on Big Creek, two on Crabapple Creek, and one each on Elbow and Abbe Creeks.

Table 3.--Drainage area and discharges at selected sites on Big Creek

Bridge location (mi)	Drainage area (mi^2)	Discharge, in cubic feet per second					
		July 1971 flood	Dec. 1971 flow	May 1974 flood	Computed 25-year flood	Computed 50-year flood	Low-water Oct. 26 1972
1.16	109	----	----	----	9,500	11,600	102
2.48	108	----	----	----	9,500	11,600	102
3.10	81.3	4,500	1,700	10,100	8,200	10,000	76
4.97	75.0	----	----	----	8,000	9,800	70
5.97	72.8	----	----	----	8,000	9,800	68
7.32	67.0	3,700	1,500	9,800	7,800	9,600	63
9.98	41.5	----	----	----	6,300	7,800	39
13.80	23.4	2,200	580	6,200	4,900	6,200	22
14.45	9.84	----	----	----	3,000	3,800	9
*17.20	5.74	----	----	2,100	2,400	3,100	5

* Site of indirect measurement of flood discharge.

Table 4.--Drainage area and discharges at selected sites on Big Creek tributaries

Bridge location (mi)	Drainage area (mi^2)	Discharge, in cubic feet per second: May 1974 flood	Computed 25-year flood	Computed 50-year flood	Low-water Oct. 26 1972
		East Big Creek			
14.00	13.6	----	3,400	4,300	12
15.35	12.0	*5,000	3,200	4,100	12
		Crabapple Creek			
11.20	14.1	----	3,500	4,400	16
12.30	13.0	----	3,300	4,300	14
12.75	----	----	----	----	--
13.90	10.7	*2,150	3,000	3,900	12
15.40	7.0	----	2,500	3,200	8
16.40	5.3	----	2,200	2,900	7
		Elbow Creek			
11.58	11.0	*2,700	3,100	4,000	13
12.95	9.2	----	2,800	3,700	11
13.30	8.3	----	2,700	3,500	10
		Abbe Creek			
2.94	26.3	----	4,600	5,800	28
5.15	23.6	*3,500	4,400	5,500	26
8.40	20.0	----	4,100	5,100	21
8.95	19.6	----	4,000	5,100	21
11.10	15.4	*5,450	3,600	4,600	17
12.26**	3.6	1,140	1,900	2,400	--

* Indirect measurement of flood discharge.
** Not on profile sheet.

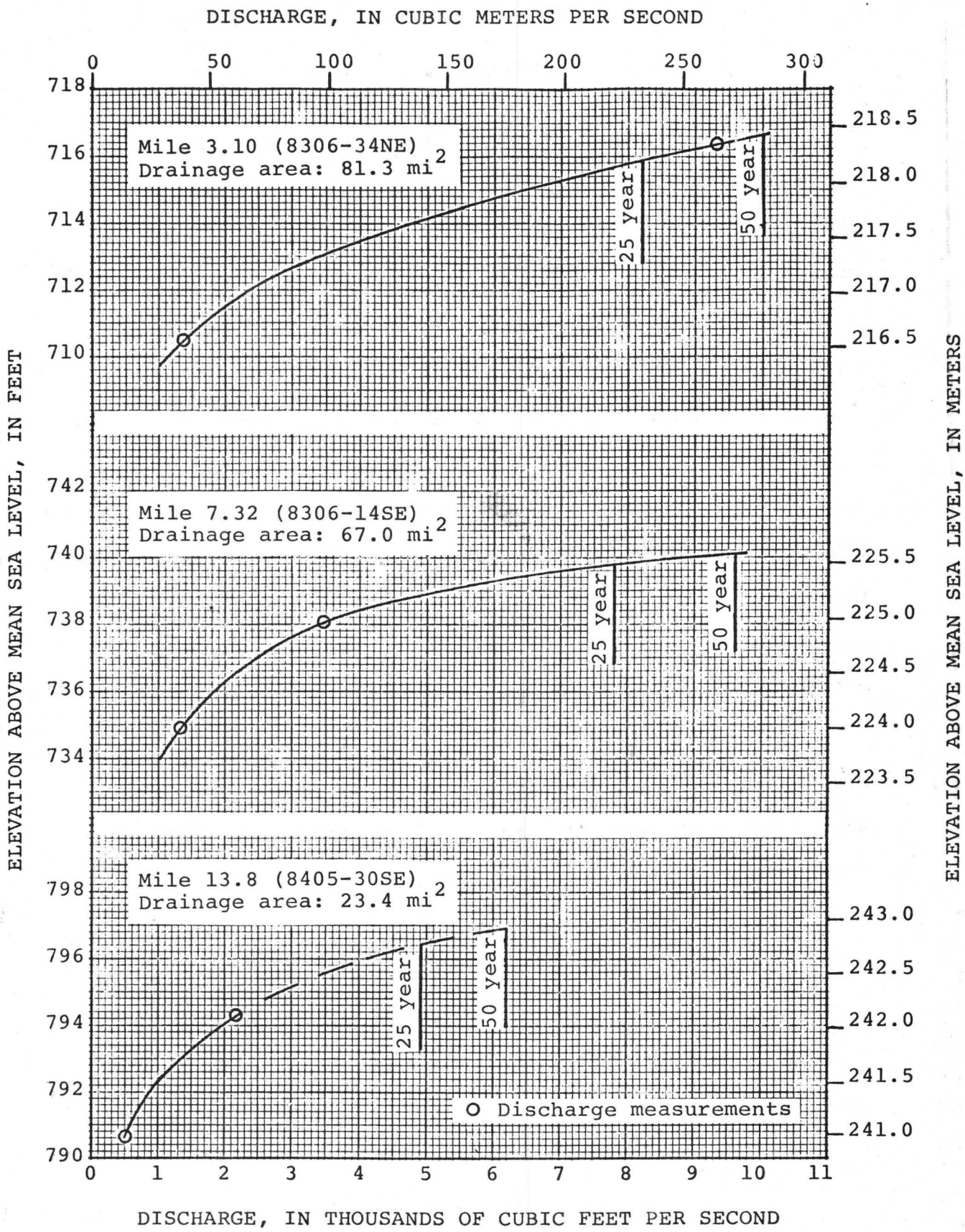


Figure 2.--Stage-discharge relationship for downstream side of selected bridges on Big Creek.

STREAM PROFILES

Profiles for Big Creek include those for July and December 1971, May 1974, and the low-water condition of October 26, 1972. The July 1971 profile covers only the reach up to mile 13.8 (kilometer 22.20).

Profiles for the Big Creek tributaries of East Big, Crabapple, Elbow, and Abbe Creeks include the flood of May 1974 and the low-water condition of October 26, 1972.

The 25- and 50-year flood profiles are not shown on the profile sheets. They are referenced on the profile sheets to the May 1974 flood profile. The relation between the 25- and 50-year floods to the May 1974 flood was estimated on the basis of the relations found at the sites where discharges were computed.

On East Big Creek, on Big Creek downstream from East Big Creek, and on the upstream reach of Abbe Creek, the May 1974 flood is about equivalent to a 50-year flood and the 25-year flood is from 0.3 to 0.9 foot (0.09 to 0.27 meter) lower in elevation. Elsewhere the May 1974 flood is generally slightly greater than a 10-year flood.

Water-surface elevations for the profiles shown in figures 4 to 8 were generally obtained within one to two days after the occurrence of the peak stage. Elevations of high-water marks were obtained at the upstream and down-

stream sides of bridges and at intermediate points in some cases in order to adequately define the water-surface profiles. All profile elevations were referenced to mean sea level, datum of 1929, by leveling. Descriptions and elevations of bench marks established in this work are contained in table 5.

FLOOD FREQUENCY

The 25- and 50-year flood discharges shown in tables 3 and 4 were computed by regional methods outlined by Lara (1973). For Big Creek, the discharges were computed using the equations requiring the drainage area and slope for the selected site. The channel slope is determined from elevations at points 10 and 85 percent of the distance along the channel from the point of interest to the basin divide. The slope curve for Big Creek, shown in figure 3, was computed utilizing the best available topographic maps. These maps, however, are not adequate for defining slopes for most of the smaller tributary streams in the basin. Therefore, for East Big, Crabapple, Elbow, and Abbe Creeks, the 25- and 50-year flood discharges were computed using the equations requiring only the drainage area for the selected site.

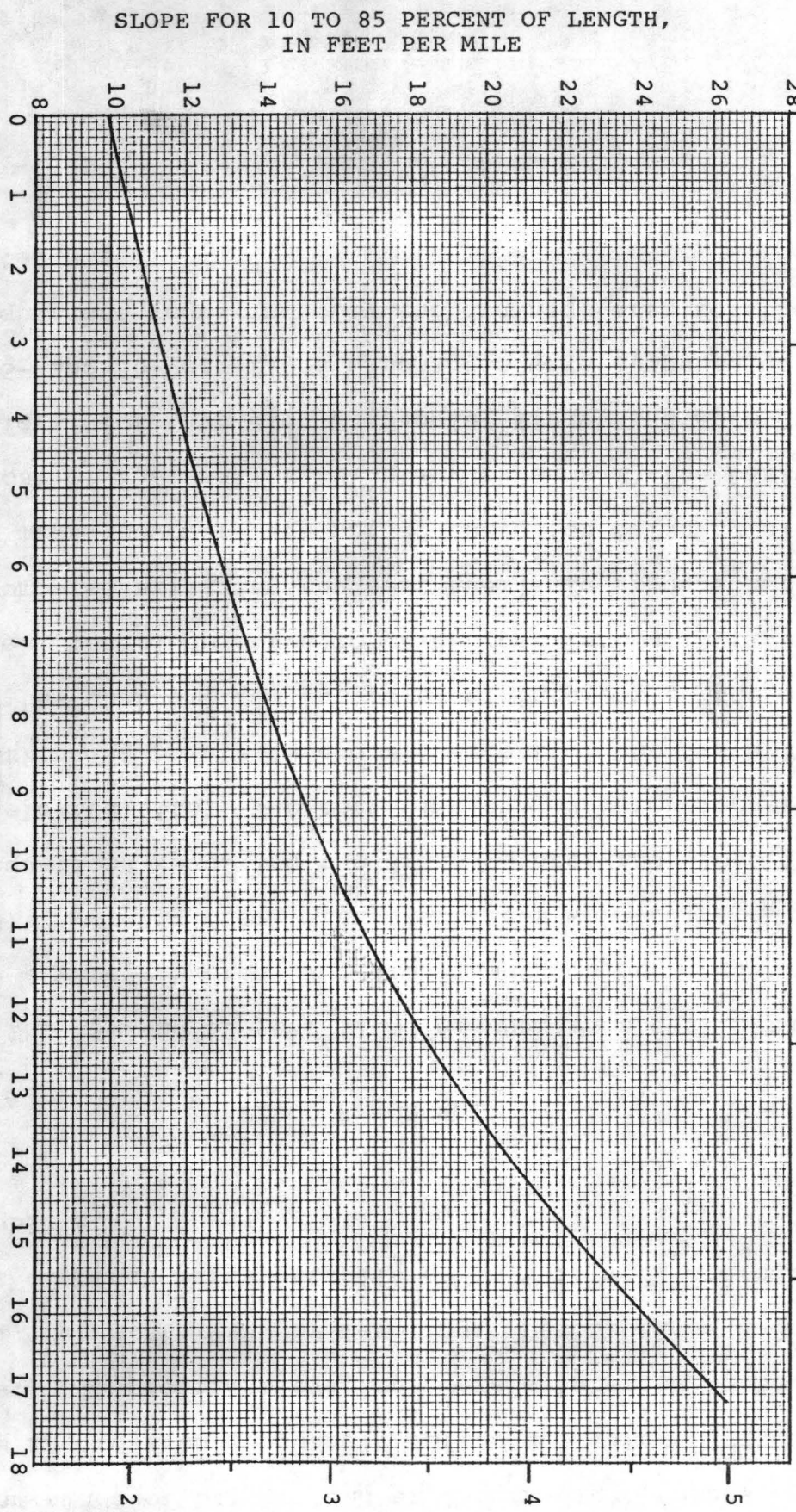


Figure 3.--Slope curve for Big Creek.

DISCUSSION

The data for this report were collected over a period of only a few years. Fortunately, flood data equivalent to a 50-year flood were obtained over part of the basin. These data should be very useful for planning purposes at locations where this flood took place.

Flood data on other streams in the basin would be desirable but rather than wait for a large flood to occur, which could take many years, the decision was made to publish the report and supplement it with data determined by indirect methods of computation.

The user of this report should be aware that the 50-year flood profiles, except where they are coincident with the May 1974 flood, are estimated on the basis of computations at relatively few sites. The fall or backwater condition at the bridges for the 50-year flood is also not available except where the 50-year flood is coincident with the May 1974 flood. Even though the 25- and 50-year flood profiles are not precisely defined, they should still serve satisfactorily for planning and preliminary design.

Elevations shown on the profile sheets are indicative of that particular flood discharge at the time of the occurrence, including the fall through the bridges. Elevations for other flood discharges of the same magnitude are subject to changes dependent on several factors, primarily

the following: (1) seasonal changes due to vegetative growth, particularly crops on cultivated lands, (2) blockage of flow in the channel, bridges, or culverts, and (3) encroachments in the form of dikes or developments on the flood plain.

REFERENCES

Lara, O. G., 1973, Floods in Iowa - Technical manual for estimating their magnitude and frequency: Iowa Natural Resources Council Bull. 11, 56 p.

Larimer, O. J., 1957, Drainage areas of Iowa streams: Iowa Highway Research Board Bull. 7, 439 p.

National Oceanic and Atmospheric Administration, National Weather Service, Environmental Data Service, issued monthly, Climatological data for Iowa.

U.S. Bureau of the Census, 1970, 1970 Census of population, final population counts: U.S. Dept. of Commerce advance report, PC(V1)-17, Iowa.

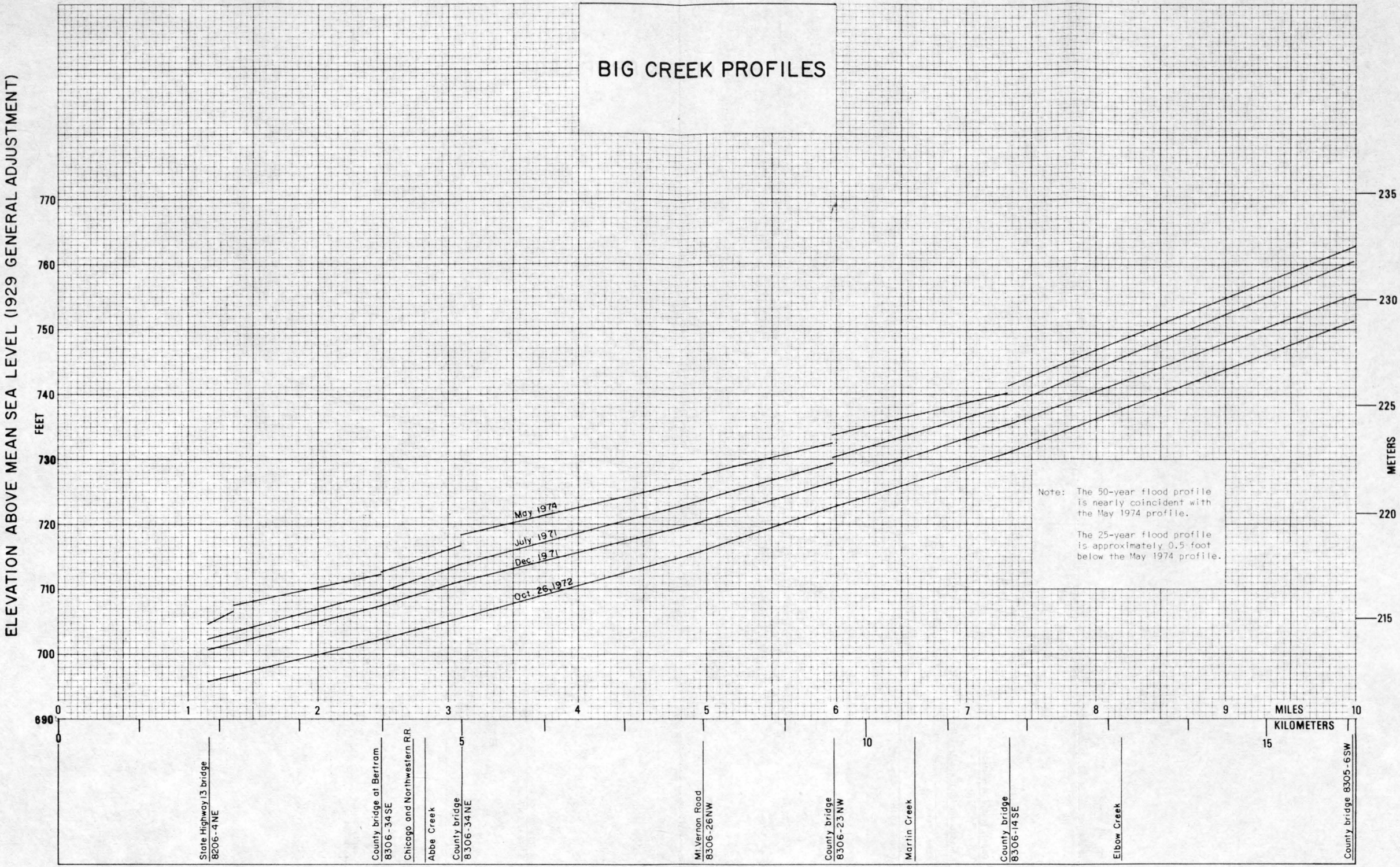


Figure 4. Big Creek profiles.

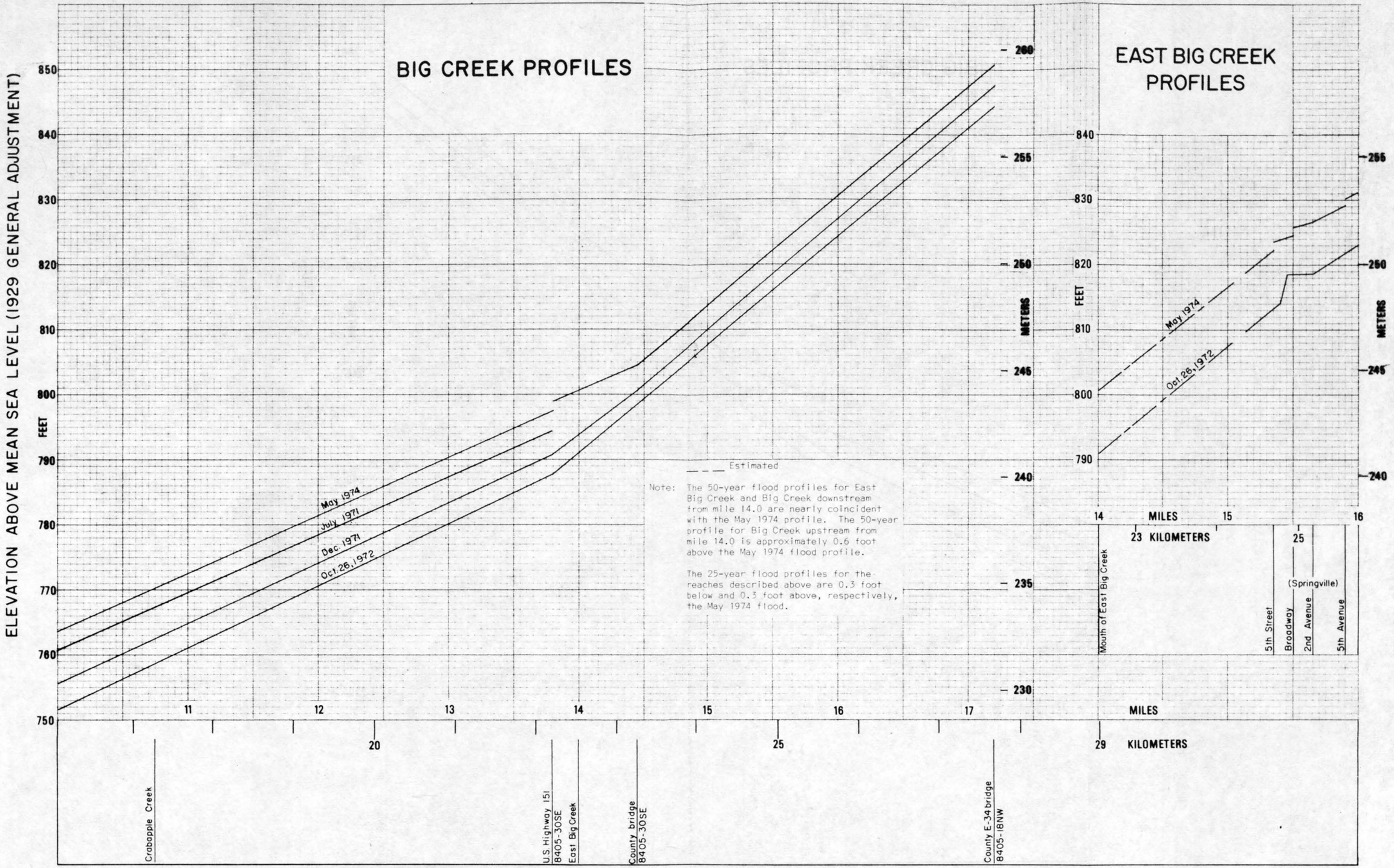


Figure 5. Big Creek and East Big Creek profiles.

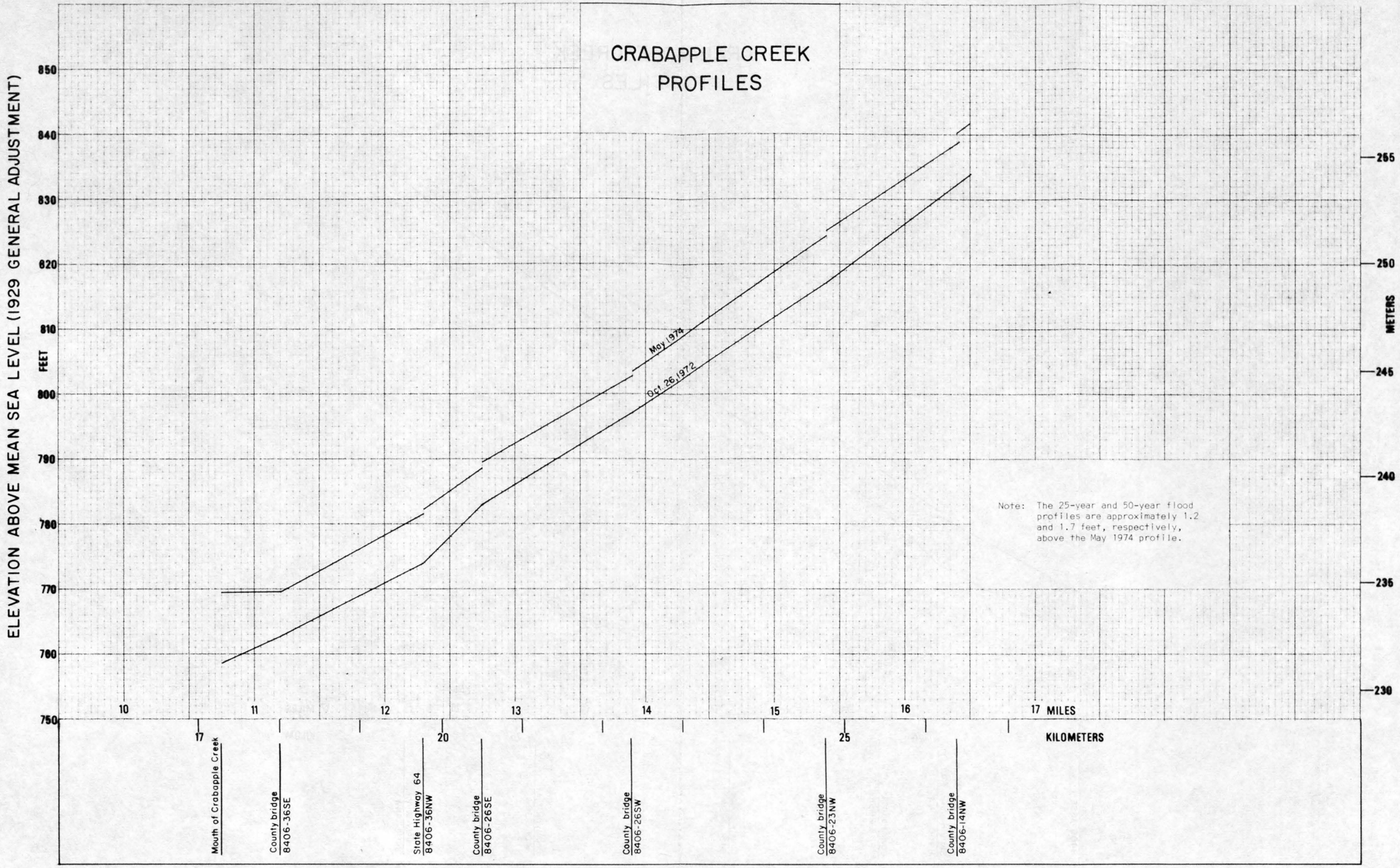


Figure 6. Crabapple Creek profiles.

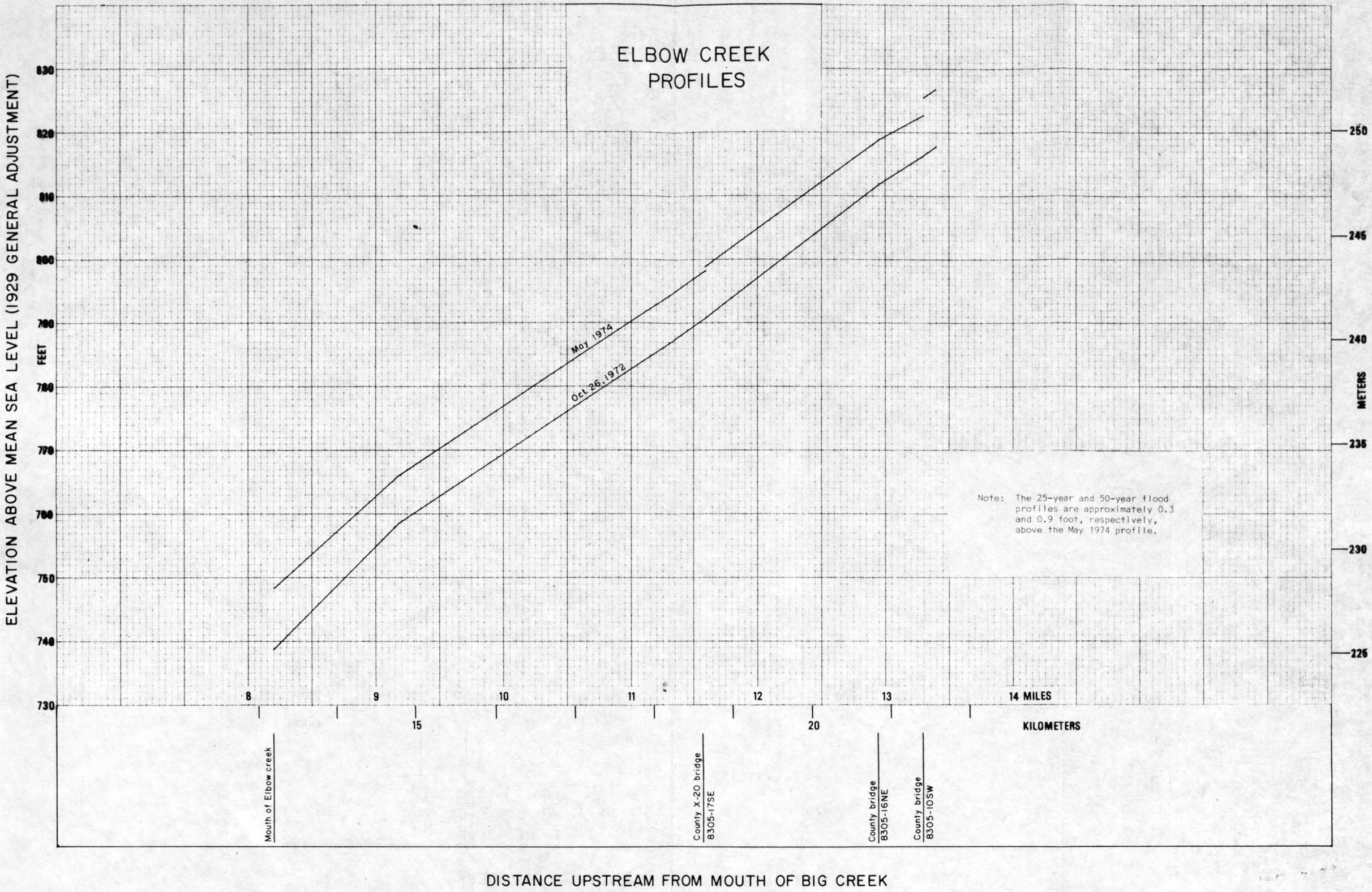


Figure 7. Elbow Creek profiles.

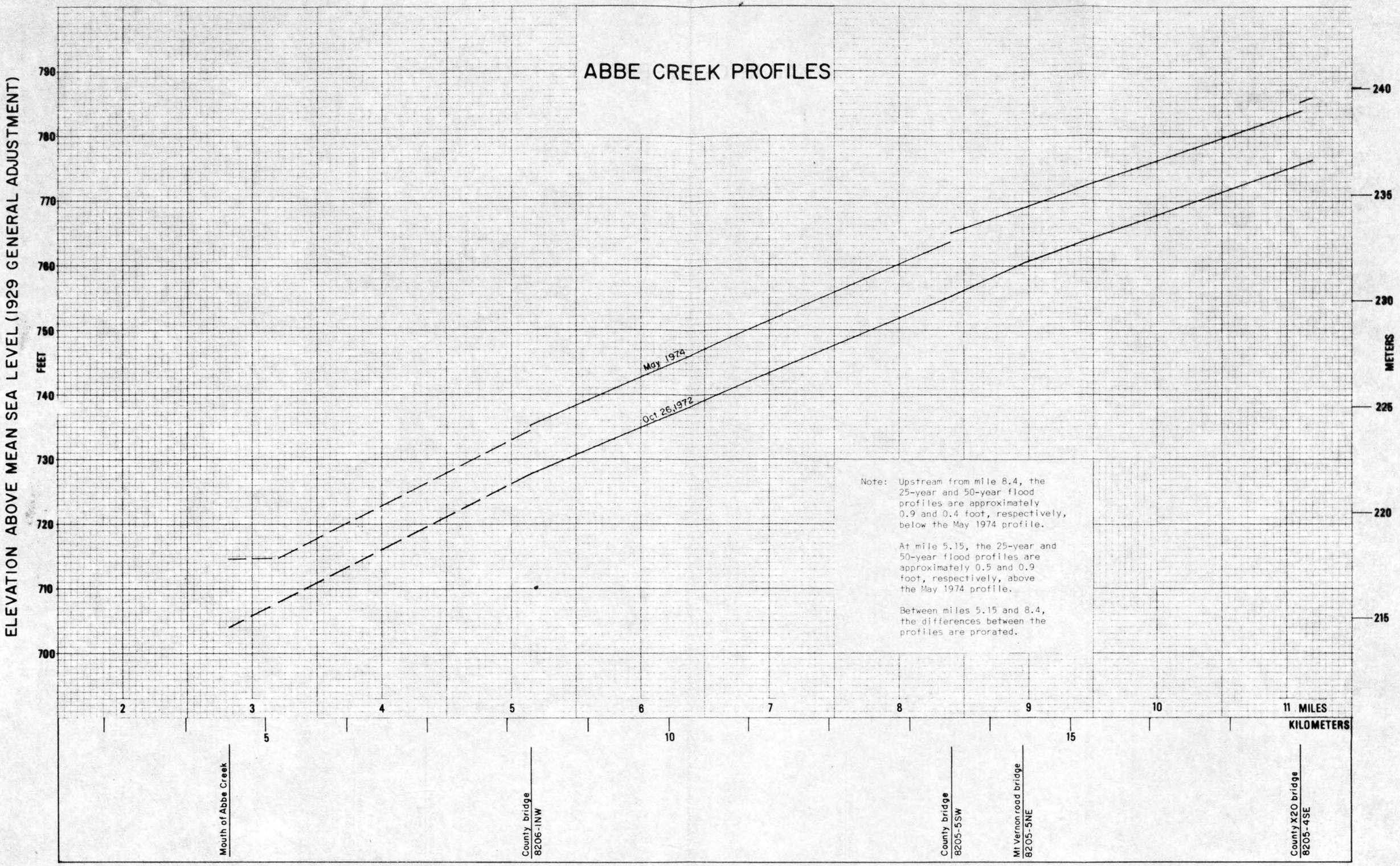


Figure 8. Abbe Creek profiles.

TABLE 5

TEMPORARY BENCH MARKS

BIG CREEK BASIN
(Linn County, Iowa)

The temporary bench marks listed in this tabulation have been compiled by the Iowa District of the U.S. Geological Survey. Elevations for the bench marks were established by the U.S. Geological Survey except for some of the bench marks designated as Linn County bench marks. Elevations for these bench marks were furnished by the Linn County Engineering Department.

That part of the Big Creek basin covered by the level work includes the major tributaries of Abbe Creek, Elbow Creek, Crabapple Creek, and East Big Creek.

Level lines run by the U.S. Geological Survey were commenced and terminated at first or second order bench marks established and adjusted by the U.S. Coast and Geodetic Survey or the U.S. Geological Survey. Elevations are in mean sea level datum, 1929 general adjustment. The elevations of the temporary bench marks established by the Survey are of third order accuracy.

The bench marks have been identified by an index number which is composed of the Congressional township, range, section number, and the quarter-section in which they are located. The township and range numbers have been combined into a four-digit number, such as 8205 for Township 82 North and Range 05 West. This is followed by a dash and the section, the quarter in which the mark is located is designated by NE, SE, NW, or SW. 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 land-line 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 and steel. On trees or poles a 20-penny pole spike driven horizontally through a short piece of 1/8-inch galvanized pipe 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.

In the descriptions of the bench marks at the bridges, the directions "right" and "left" are used quite frequently. These directions are determined as viewed facing in the direction of the flow of the stream.

8205-4 SE (1) (Abbe Cr) - About 1 mile north of Mt. Vernon, at county road X20 over Abbe Creek, on top of wingwall at left downstream end of bridge; Linn Co. Engr. Dept. BM #1699 1960. Elev. 788.90 feet

8205-4 SE (2) (Abbe Cr) - (REFERENCE POINT) - About 1 mile north of Mt. Vernon, at county road X20 bridge over Abbe Creek, on top of downstream guardrail, 3 ft. right of 7th post from left; chiseled arrow. Elev. 790.65 feet

8205-5 NE (1) (Abbe Cr) - About 2 miles northwest of Mt. Vernon, at Mt. Vernon road bridge over Abbe Creek, on top of curb at left downstream end of bridge, at junction of curb with wingwall; chiseled square. Elev. 776.30 feet

8205-5 NE (2) (Abbe Cr) - (REFERENCE POINT) - About 2 miles northwest of Mt. Vernon, at Mt. Vernon road bridge over Abbe Creek, on top of top chord of truss, on downstream side of bridge directly over left vertical beam. Elev. 781.42 feet

8205-5 NE (3) (Abbe Cr) - About 2 miles northwest of Mt. Vernon, at county road bridge over Abbe Creek, first bridge upstream from Mt. Vernon road, in streamward side of sub-floor beam at left downstream end of bridge; pole spike and collar. Elev. 772.36 feet

8205-5 NE (4) (Abbe Cr) - (REFERENCE POINT) - About 2 miles northwest of Mt. Vernon, at county road bridge over Abbe Creek, first bridge upstream from Mt. Vernon road, in downstream side of downstream curb, 3 ft. left of 3rd guardrail post from left; scaffold nail. Elev. 775.27 feet

8205-5 SW (1) (Abbe Cr) - About 2 miles northwest of Mt. Vernon, at county road bridge over Abbe Creek, on top of right downstream wingwall; Linn Co. Engr. Dept. BM #407. Elev. 766.10 feet

8205-5 SW (2) (Abbe Cr) - (REFERENCE POINT) - About 2 miles northwest of Mt. Vernon, at county road bridge over Abbe Creek, on top of top chord of truss, on downstream side of bridge, 2.9 ft. left of 3rd vertical beam from left; chiseled arrow. Elev. 771.08 feet

8205-5 NW (1) (Abbe Cr) - About 2 miles northwest of Mt. Vernon, at county road intersection, near center of section 5, at northwest corner of intersection, in west side of power pole; pole spike and collar. Elev. 791.40 feet

8205-7 NE (1) (Abbe CR) - About 2-1/2 miles west of Mt. Vernon, at culvert under C & NW railroad tracks near north quarter corners of sec. 7, on top of concrete foundation, at northeast corner of culvert foundation, chiseled square with inscription "CE 1909" on north side of headwall. Elev. 773.13 feet

8205-8 NW (1) (Abbe Cr) - About 2 miles west of Mt. Vernon, at intersection of C & NW Ry and county road, at southwest corner of intersection, in west side of power pole, pole spike and collar. Elev. 807.80 feet

8205-8 NW (2) (Abbe Cr) - About 2 miles west of Mt. Vernon, at T road west intersection in the center of sec. 8, at northwest corner of intersection, on top of west headwall of culvert; Linn Co. Engr. Dept. BM # 1084. Elev. 775.18 feet

8206-1 NW (1) (Big Cr) - About 3-1/2 miles northwest of Mt. Vernon, at county road T east intersection, at concrete culvert just south of intersection, on top of west headwall, a disk stamped "Linn Co. Engr. Dept. No. 846 1922". Elev. 744.60 feet

8206-1 NW (2)(Abbe Cr) - About 3-1/2 miles northwest of Mt. Vernon, at county road bridge over Abbe Creek, on sub-floor beam on downstream side of bridge next to left wingwall, a disk stamped "BM Linn Co. Engr. Dept." Elev. 738.56 feet

8206-1 NW (3) (Abbe Cr) - (REFERENCE POINT) - About 3-1/2 miles northwest of Mt. Vernon, at county road bridge over Abbe Creek, on downstream handrail, 0.4 ft. left of 7th handrail post from left; scaffold nail. Elev. 742.52 feet

8206-2 NE (1) (Abbe Cr) - About 1-1/2 miles east of Bertram, at C & NW RR bridge over Abbe Creek, on left downstream wingwall, 1 ft. downstream and 1 ft. right of right downstream corner of anchor plate, chiseled square. Elev. 736.08 feet

8206-2 NE (2) (Abbe Cr) - (REFERENCE POINT) - About 1-1/2 miles east of Bertram, at C & NW RR bridge over Abbe Creek, 3 floor beams from right, at downstream track, on downstream guardrail, chiseled square. Elev. 743.23 feet

8206-4 NE (1) (Big Cr) - About 0.5 mile southwest of Bertram, about 0.2 mile upstream from State Hwy 13 bridge over Big Creek, at abandoned county road bridge over Big Creek, on left downstream pneumatic pier, on landward downstream rivet, chiseled cross. Elev. 708.95 feet

8206-4 NE (2) (Big Cr) - About 0.5 mile southwest of Bertram, at State Hwy 13 bridge over Big Creek, at right upstream end of bridge, on upstream side of abutment; Iowa Highway Commission plug. Elev. 726.20 feet

8206-4 NE (3) (Big Cr) - (REFERENCE POINT) - About 0.5 mile southwest of Bertram, at State Hwy 13 bridge over Big Creek, on downstream curb between 10th and 11th guardrail posts from left; chiseled arrow. Elev. 721.86 feet

8206-4 NE (4) (Big Cr) - (REFERENCE POINT) - About 0.5 mile southwest of Bertram, about 0.2 mile upstream from State Hwy 13 bridge over Big Creek, at abandoned county road bridge over Big Creek, on top of most downstream longitudinal brace, 3 ft. right of first vertical support on left; chiseled mark. Elev. 709.79 feet

8305-6 SW (1) (Big Cr) - About 2-1/2 miles southwest of Springville, at county road bridge over Big Creek, on top of curb at right downstream end of bridge, tablet stamped "BM Linn Co. Engr. Dept., 374, Big Creek 1949, Elev. 773.54". Elev. 773.57 feet

8305-6 SW (2) (Big Cr) - (REFERENCE POINT) - About 2-1/2 miles southwest of Springville, at county road bridge over Big Creek, on top of downstream guardrail, 3.4 ft. right of center guardrail post; chiseled arrow. Elev. 776.42 feet

8305-6 SW (3) (Big Cr) - About 2 miles west of Paralta, at CMStP & P RR bridge Z 790, in top of the south parapet of the west abutment; a USC & GS standard disk stamped "R80 Reset 1946". Elev. 788.077 feet

8305-10 SW (1) (Elbow Cr) - About 3 miles south of Springville and 1.3 miles east of county road X20, at county road bridge over Elbow Creek, on top of left downstream pier, on downstream streamward corner; chiseled square. Elev. 826.48 feet

8305-10 SW (2) (Elbow Cr) - (REFERENCE POINT) - About 3 miles south and 1.3 miles east of county road X20, at county road bridge over Elbow Creek, on top of top chord of truss on downstream side of bridge, 3.8 ft. from left end; chiseled arrow. Elev. 832.80 feet

8305-16 NE (1) (Elbow Cr) - About 3 miles south of Springville and 1 mile east of county road X20, at county road bridge over Elbow Creek, on top of right downstream subfloor beam; Linn Co. Engr. Dept. marker #2122 1952. Elev. 820.67 feet

8305-16 NE (2) (Elbow Cr) - (REFERENCE POINT) - About 3 miles south of Springville and 1 mile east of county road X20 at county road bridge over Elbow Creek, on downstream guardrail, 2.3 ft. right of 6th post from left; scaffold nail. Elev. 824.65 feet

8305-17 SE (1) (Elbow Cr) - About 4 miles south of Springville, at county road X20 culvert on Elbow Creek, at top of downstream headwall of culvert, at center of culvert, Linn Co. Engr. Dept. BM #2 1930. Elev. not run

8305-19 NW (1) (Big Cr) - 4 miles north and 2.8 miles west of Mt. Vernon, near west sixteenth corner between secs. 18 and 19, 13 ft. south and 3 ft. higher than road at culvert, tablet stamped "Linn Co. Engr. Dept. No. 1018 1925". Elev. 782.58 feet

8306-1 NE (1) (Crabapple Cr) - (REFERENCE POINT) - About 2 miles southwest of Springville, at county road bridge over Crabapple Creek, on downstream curb beam, right of 8th gurardail post from right; scaffold nail. Elev. 775.88 feet

8306-13 NE (1) (Big Cr) - About 4-1/2 miles north and 3 miles west of Mt. Vernon, about 0.7 miles north of section corner of secs. 13, 18, 19, and 24, on dead end road, 8 ft. east of fence, in 2 ft. diameter cottonwood tree, in east side of tree and 2 ft. above ground; railroad spike. Elev. 754.58 feet

8306-14 SE (1) (Big Cr) - About 3 miles northeast of Bertram, at county road bridge over Big Creek, on top of left downstream wingwall, tablet stamped "BM Linn Co. Engr. Dept. Br 449, 1959, Elev. 750.46". Elev. 750.48 feet

8306-14 SE (2) (Big Cr) - (REFERENCE POINT) - About 3 miles northeast of Bertram, at county road bridge over Big Creek, on downstream guardrail, midway between 9th and 10th posts from left; chiseled arrow. Elev. 750.66 feet

8306-14 SE (3) (Big Cr) - About 3 miles northeast of Bertram, at corner of road where north road turns east, at north side of corner in line with road running south, Linn Co. BM #352, Elev. 748.647 feet

8306-23 SE (1) (Big Cr) - About 2 miles northeast of Bertram, 0.2 miles north of Mt. Vernon road, top of west headwall of concrete culvert, tablet marked "BM Linn Co. Engr. Dept. 311 1914". Elev. 749.40 feet

8306-23 NW (1) (Big Cr) - About 2-1/2 miles northeast of Bertram, at county road bridge over Big Creek, on left upstream wingwall, at junction of wingwall and headwall; chiseled square. Elev. 743.09 feet

8306-23 NW (2) (Big Cr) - (REFERENCE POINT) - About 2-1/2 miles northeast of Bertram, at county road bridge over Big Creek, on downstream handrail, 8.7 ft. left of bridge center; chiseled arrow. Elev. 745.89 feet

8306-26 NW (1) (Big Cr) - About 2 miles northeast of Bertram, at Mt. Vernon road bridge over Big Creek, top of left downstream wingwall, 2.7 ft. downstream from curb; Chiseled square. Elev. 732.17 feet

8306-26 NW (2) (Big Cr) - (REFERENCE POINT) - About 2 miles northeast of Bertram, at Mt. Vernon road bridge over Big Creek, on downstream vertical truss member, 2nd member from right, on downstream left side of truss member about 0.2 ft. above guardrail; horizontal line marked with arrow. Elev. 735.18 feet

8306-34 NE (1) (Big Cr) - About 1/2 mile northeast of Bertram, at culvert on county road, on top of south headwall; chiseled cross. Elev. 721.22 feet

8306-34 NE (2) (Big Cr) - About 1/2 mile northeast of Bertram, at county road bridge over Big Creek, on right downstream pneumatic pier, on top of right downstream rivet; chiseled cross. Elev. 721.01 feet

8306-34 NE (3) (Big Cr) - (REFERENCE POINT) - About 1/2 mile northeast of Bertram, at county road bridge over Big Creek, on downstream handrail post at center of bridge, 2 ft. below handrail; scaffold nail. Elev. 722.98 feet

8306-34 SE (1) (Big Cr) - At southeast edge of Bertram, at county road bridge over Big Creek, on downstream pneumatic pier, 2nd pier from right, top of right downstream rivet on pier; chiseled cross. Elev. 714.81 feet

8306-34 SE (2) (Big Cr) - (REFERENCE POINT) - At southeast edge of Bertram, at county road bridge over Big Creek, at 2nd vertical member of left truss on downstream side bridge, at right downstream side of vertical member, at bottom of vertical member, chiseled arrow. Elev. 714.94 feet

8306-34 SE (3) (Big Cr) - About 1/2 mile northeast of Bertram, at C & NW RR bridge over Big Creek, on right downstream concrete headwall, 0.8 ft. upstream and 2.4 ft. right of corner of upper surface of headwall, 3/4 inch pipe. Elev. 719.62 feet

8306-34 SE (4) (Big Cr) - (REFERENCE POINT) - About 1/2 mile northeast of Bertram, at C & NW RR bridge over Big Creek, on downstream side of longitudinal beam, 5 ft. left of 2nd vertical beam from right, chiseled arrow. Elev. 718.74 feet

8306-34 SE (5) (Abbe Cr) - About 1/2 mile northeast of Bertram, at C & NW RR bridge over Abbe Creek, on left upstream pier, 1 inch right and 1 inch downstream of left upstream corner of pier; chiseled arrow. Elev. 720.80 feet

8306-34 SE (6) (Abbe Cr) - (REFERENCE POINT) - About 1/2 mile northeast of Bertram, at C & NW RR bridge over Abbe Creek, on top of downstream guardrail, about 11 ft. right of center of pier; chiseled arrow. Elev. 725.26 feet

8405-18 NW (1) (Big Cr) - About 0.5 mile west of Whittier, at county road bridge over Big Creek, on top of right downstream wingwall; tablet inscribed "Linn Co. Engr. Dept. BM 1893 1961". Elev. 858.32 feet

8405-18 NW (2) (Big Cr) - (REFERENCE POINT) - About 0.5 mile west of Whittier, at county road bridge over Big Creek, on top of downstream guardrail between 5th and 6th post from left; chiseled arrow. Elev. 860.51 feet

8405-29 SE(1) (East Big Cr) - In Springville, on concrete culvert north side of Hwy 151, 135 ft. east of county road X20, in shoulder-wall of culvert; chiseled cross. Elev. 865.84 feet

8405-29 SE (2) (East Big Cr) - In Springville, at bridge over East Big Creek, at 1st bridge downstream from bridge on county road X20, on top of right upstream wingwall; chiseled square. Elev. 825.27 feet

8405-29 SE (3) (East Big Cr) - (REFERENCE POINT) - In Springville, at bridge over East Big Creek, first bridge downstream from bridge on county road X20, in downstream handrail post, 8th post from right; scaffold nail. Elev. 829.02 feet

8405-29 SE (4) (East Big Cr) - In Springville, at Broadway St. bridge (road X20) over East Big Creek, on left downstream wingwall; tablet inscribed "Linn Co. Engr. Dept. BM #2152, 1956". Elev. 840.35 feet

8405-29 SE (5) (East Big Cr) - (REFERENCE POINT) - In Springville, at Broadway St. bridge (road X20) over East Big Creek, on top of downstream curb, between 5th and 6th guardrail posts; chiseled arrow. Elev. 836.00 feet

8405-29 SE (6) (East Big Cr) - In Springville, at CMStP & P RR bridge over East Big Creek, at west edge of Springville, in sub-floor beam at right end of bridge, on streamward side of beam; pole spike and collar. Elev. 832.36 feet

8405-29 SE (7) (East Big Cr) - (REFERENCE POINT) - In Springville, at CMStP & P RR bridge over East Big Creek at west edge of Springville, in sub-floor beam, 4 ft. right of 5th floor beam from left; scaffold nail. Elev. 834.76 feet

8405-29 SE (8) (East Big Cr) - In Springville, at bridge over East Big Creek, first bridge upstream from bridge over Broadway St. (road X20), in sub-floor beam at right downstream end of bridge; pole spike and collar. Elev. 825.83 feet

8405-29 SE (9) (East Big Cr) - (REFERENCE POINT) - In Springville, at bridge over East Big Creek, first bridge upstream from bridge over Broadway St. (road X20), in downstream walk at center of bridge; scaffold nail. Elev. 828.38 feet

8405-29 SE (10) (East Big Cr) - In Springville, at CMStP & P RR bridge about 0.2 mile upstream from Broadway St. (road X20), in sub-floor beam at right upstream end of bridge; pole spike and collar. Elev. 831.16 feet

8405-29 SE (11) (East Big Cr) - (REFERENCE POINT) - In Springville, at CMStP & P RR bridge about 0.2 mile upstream from Broadway St. (road X20), in longitudinal beam on downstream side of bridge, ? ft. left of 4th sub-floor beam from left; pole spike and collar. Elev. 833.53 feet

8405-29 SE (12) (East Big Cr) - In Springville, at bridge over East Big Creek, bridge above upper Railroad bridge, on top of right downstream wingwall; chiseled square. Elev. 830.29 feet

8405-29 SE (13) (East Big Cr) - (REFERENCE POINT) - In Springville, at bridge over East Big Creek, bridge above upper railroad bridge, on downstream curb at center of bridge; chiseled arrow. Elev. 830.28 feet

8405-30 NE (1) (Big Cr) - About 1 mile northwest of Springville at culvert on county road about 0.3 mile north of cross-roads with deadend lane to old bridge, top of west head-wall; tablet, Linn Co. BM #738. Elev. 813.51 feet

8405-30 SE (1) (Big Cr) - About 1 mile west of Springville, at intersection of county roads, at southeast corner of intersection (south road of intersection leads to deadend lane of old bridge), in north side of power pole; pole spike and collar. Elev. 817.97 feet

8405-30 SE (2) (Big Cr) - About 1 mile west of Springville, at county road bridge over Big Creek, top of left downstream abutment; chiseled square. Elev. 808.32 feet

8405-30 SE (3) (Big Cr) - (REFERENCE POINT) - About 1 mile west of Springville, at county road bridge over Big Creek, in downstream handrail between 3rd and 4th posts from left; scaffold nail. Elev. 812.20 feet

8405-30 SE (4) (Big Cr) - About 1 mile west of Springville, at Hwy 151 bridge over Big Creek, on top of left downstream wingwall, Iowa Highway Commission Plug. Elev. 812.80 feet

8405-30 SE (5) (Big Cr) - (REFERENCE POINT) - About 1 mile west of Springville, at Hwy 151 bridge over Big Creek, on top of downstream curb, 5 ft. left of bridge center; chiseled arrow. Elev. 812.26 feet

8406-14 NW (1) (Apple Cr) - About 3 miles west of Whittier, at county road intersection, at southeast corner of intersection in southeast side of power pole; pole spike and collar. Elev. 852.13 feet

8406-14 NW (2) (Crabapple Cr) - About 2-1/2 miles west of Whittier, at county road bridge over Crabapple Creek, on top of downstream headwall; tablet inscribed "Linn Co. Engr. Dept. BM 2240 1954". Elev. 842.79 feet

8406-14 NW (3) (Crabapple Cr) - (REFERENCE POINT) - About 2-1/2 miles west of Whittier, at county road bridge over Crabapple Creek, on top of downstream headwall, 3.5 ft from left end headwall; measure from lower edge of bevel. Elev. 842.71 feet

8406-23 NW (1) (Crabapple Cr) - About 3 miles southwest of Whittier, at county road bridge over Crabapple Creek, on subfloor beam at right downstream end of bridge; tablet inscribed "Linn Co. Engr. Dept. BM 2239 1961". Elev. 825.62 feet

8406-23 NW (2) (Crabapple Cr) - (REFERENCE POINT) - About 3 miles southwest of Whittier, at county road bridge over Crabapple Creek, in downstream guardrail 0.3 ft left of 5th post from right; scaffold nail. Elev. 829.77 feet

8406-23 NW (3) - About 3 miles west and 1 mile south of Whittier, at intersection of county roads, at southeast corner of intersection, in north side of power pole; pole spike and collar. Elev. 854.04 feet

8406-25 SW (1) (Crabapple Cr) - (REFERENCE POINT) - About 3 miles west of Springville, at county road bridge over Crabapple Creek, about 0.3 mile north of Hwy 151, on top of top chord of downstream truss above right vertical truss member; chiseled arrow. Elev. 797.47 feet

8406-25 (2) - About 3 miles west of Springville, at county T road west intersection, about 0.9 mile north of Hwy 151, in power pole at east side of intersection, nearest pole; pole spike and collar. Elev. 842.19 feet

8406-25 SW (3) - About 3 miles west of Springville, near the quarter corner between secs. 25 and 26, 28 ft east and 1.9 ft lower and in line with the center of the T-road west, 1 ft north of the T fence east, 2 ft east of the east right-of-way fence, set in top of concrete footing of a concrete corner fence post; a standard tablet stamped "18 DDB 1966". Elev. 841.210 feet

8406-26 SW (1) (Crabapple Cr) - About 3-1/2 miles west of Springville, at county road bridge over Crabapple Creek, on left downstream wingwall pile, on right side of pile and 2 ft up from top of wingwall; railroad spike. Elev. 810.04 feet

8406-26 SW (2) - (REFERENCE POINT) - About 3-1/2 miles west of Springville, at county road bridge over Crabapple Creek, on downstream guardrail post, 5th post from right; scaffold nail. Elev. 812.22 feet

8406-26 SE (1) (Crabapple Cr) - About 3 miles west of Springville, at county road bridge over Crabapple Creek, about 0.3 mile north of Hwy 151, in right upstream subfloor beam; railroad spike. Elev. 790.14 feet

8406-35 NE (1) - About 3 miles west of Springville, at county T road north intersection with Hwy 151, at the northwest corner of intersection, in east side of power pole; pole spike and collar. Elev. 810.79 feet

8406-36 NE (1) - About 2 miles west of Springville, at intersection of county road and Hwy 151, at southwest corner of intersection, in east side of power pole; pole spike and collar. Elev. 858.27 feet

8406-36 SE (1) (Crabapple Cr) - About 2 miles southwest of Springville, at county road bridge over Crabapple Creek, at left upstream end of bridge, on floor beam, 0.5 ft from end; railroad spike. Elev. 771.78 feet

8406-36 SE (3) - About 2 miles southwest of Springville, at culvert on county road bridge 0.6 mile south of Hwy 151, on top of west headwall; chiseled square. Elev. 790.74 feet

8406-36 NW (1) (Crabapple Cr) - About 2-1/2 miles west of Springville, at Hwy 151 bridge over Crabapple Creek, on top of right upstream wingwall; Iowa Highway Commission plug. Elev. 788.83 feet

8406-36 NW (2) (Crabapple Cr) - About 2-1/2 miles west of Springville, at Hwy 151 bridge over Crabapple Creek, on top curb at right upstream end of bridge; chiselled cross. Elev. 789.54 feet

8406-36 NW (3) (Crabapple Cr) - (REFERENCE POINT) - About 2-1/2 miles west of Springville, at Hwy 151 bridge over Crabapple Creek, on top of downstream curb, left side of 5th guardrail post from left; chiselled arrow. Elev. 789.36 feet