

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION



FLOODS IN THE
UPPER DES MOINES RIVER BASIN, IOWA

By

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Prepared in cooperation with the
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ABSTRACT

Data on flood stages, discharges, and frequency are used in the design of bridges and other structures and the conduct of various operations on the flood plains of streams. This report provides these data in the form of flood-peak records, gaging-station records, frequency curves, and flood profiles. Information is provided for 253 miles of streams from near Boone on the main stem to the Iowa-Minnesota state line on the East and West Forks of the Des Moines River.

Flood profiles on the main stem include those for the notable flood of 1954, the lesser flood of 1947, and the computed 25- and 50-year floods. On the West Fork, profiles are shown for the outstanding flood of April 1969; lesser floods in April 1965, July 1964, and September 1964; and the computed 25- and 50-year floods. On the East Fork, profiles are shown for the April 1965 flood from the mouth to Algona and for the April 1969 flood from Algona to Tuttle Lake; for a lesser flood in October 1968; and for the computed 25- and 50-year floods. Low-water profiles are shown for all reaches.

Tabulations of flood stages and discharges at gaging stations contained in this report can be used for volumetric studies. They can also be used to study the time distribution of stage and discharge above a selected level.

INTRODUCTION

Purpose and Scope

The purpose of this report is to provide flood information for the upper Des Moines River basin. This information can be used for planning, designing, and operating structures and conducting other activities on or across the flood plain and for assessing the severity of floods. The report provides data on (1) basin characteristics, (2) flood history with brief descriptions of the meteorology of storms causing outstanding floods, (3) flood stages and discharges, (4) flood frequency, and (5) profiles of several major floods and of the 25- and 50-year frequency floods. Streams covered by the report are the main stem Des Moines River from below the junction of the Boone River upstream to the junction of the East and West Forks, and the East and West Forks to the Iowa-Minnesota line. Some flood data are given for a gaging station on the West Fork in Minnesota. Two prior reports published by the U.S. Geological Survey contain information on the floods in 1953 and 1954 (see selected references). The discussion section of this report outlines some possible uses and limitations of the data presented.

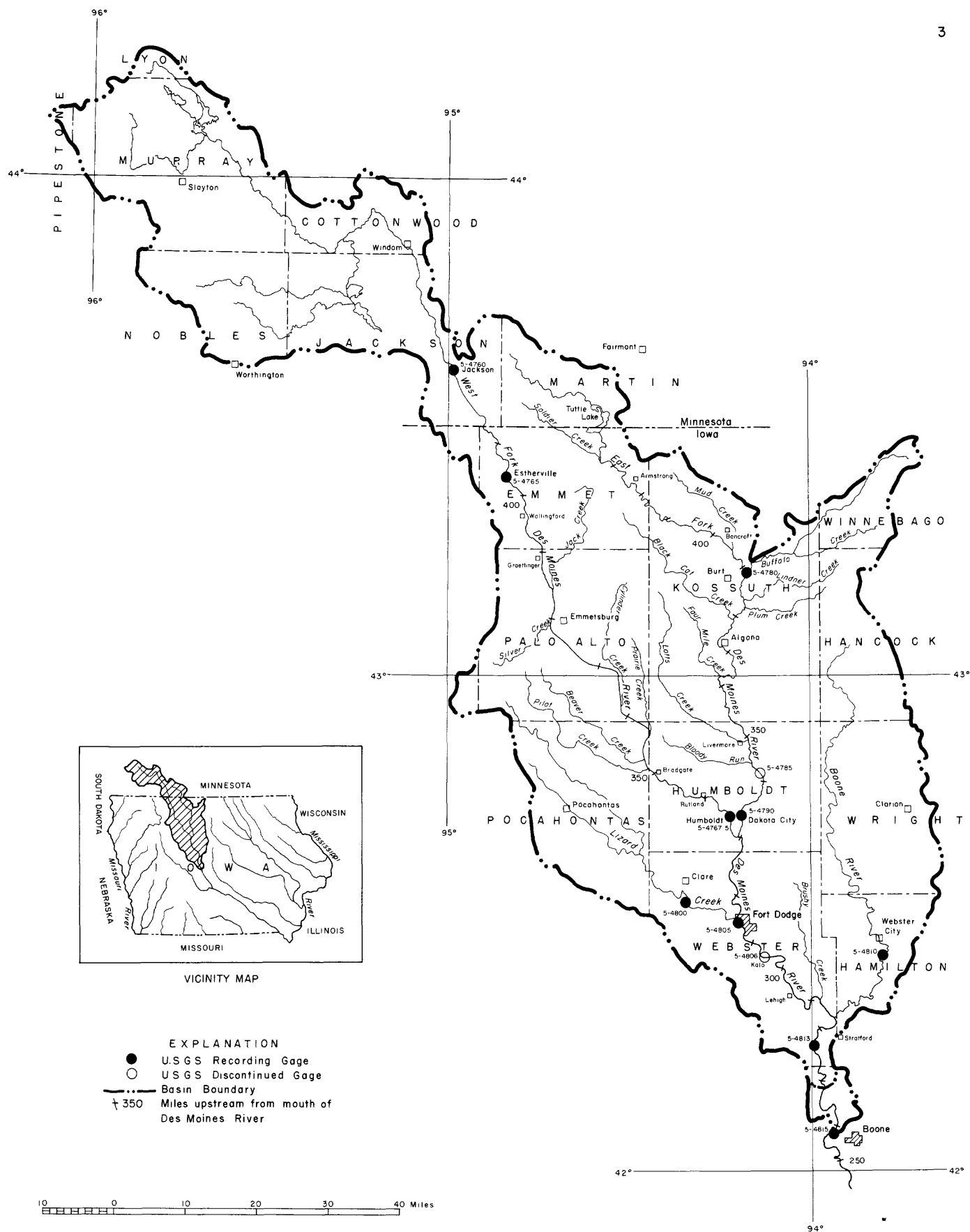


Plate I. Map of upper Des Moines River basin upstream from gaging station near Boone, Iowa.

Acknowledgments

This report is the fourth of a series resulting from a cooperative project with the Iowa State Highway Commission through the Iowa Highway Research Board. Collection of the basic information was generally by the Geological Survey. Profiles of the main stem of the Des Moines River were prepared from flood-elevation data furnished by the Corps of Engineers. Records for stream-gaging stations were obtained as a part of the cooperative program with many city, state and Federal agencies. This cooperation is explained in the U.S. Geological Survey annual publications, "Water Resources Data for Iowa, Part 1, Surface Water Records", after 1960 and in U.S. Geological Survey Water-Supply Papers prior to 1961.

BASIN DESCRIPTION

This report covers that part of the Des Moines River basin upstream from mile 269 (15 miles downstream from Boone River) to the Minnesota State line. Plate 1 shows the outline of the basin above this location and also the basin outline above the gaging station near Boone. At this latter point, the area drained is about 38 percent of the total drainage area of the Des Moines River at its mouth.

Two major tributaries join at mile 330.4 to form the main stem of the Des Moines River. The West Fork Des Moines River, the larger of the two, has its sources in Pipestone, Lyon, and Murray Counties, Minnesota, and flows easterly and southeasterly to the confluence with the East Fork. The source of the East Fork is in Jackson County,

Minnesota, from which it flows southeasterly and southerly to join the West Fork. The main stem of the river flows generally southeasterly and southerly to and past the gaging station near Boone, Iowa.

The topography of the area is the result of several glaciations modified by subsequent erosion. Above the confluence of the East and West Forks the area is flat with shallow stream channels and extremely wide valleys. The East and West Forks flow through many lakes, particularly in Minnesota. From points a short distance upstream of the confluence of the forks to the lower end of the report area, the valley narrows and the stream channel becomes deeper. The surficial materials covering the area were deposited by the Wisconsin Glacier.

A number of cities and towns lie on or near the flood plains of the Des Moines River and the two Forks. If not directly affected by flooding, they are indirectly affected by the closing of roads, interruption of trade with flooded areas, and other effects which accompany major floods. The 1960 population of 14 cities and towns along the main stem and the two forks is given in table 1.

The climate of the basin is temperate. Average yearly temperature (1931-60) of the basin in Iowa ranges from about 47°F to about 50°F from north to south. Normal annual precipitation (1931-60) over the drainage area in Iowa and Minnesota averages about 28.3 inches and ranges from 25 to 31 inches from north to south.

Table 1. Population of cities and towns on or near East and West Forks and main stem Des Moines Rivers, above Boone River.

W. Fk. Des Moines R.		E. Fk. Des Moines R.		Des Moines R.	
Community	1960 Population	Community	1960 Population	Community	1960 Population
Estherville	7,927	Armstrong	958	Fort Dodge	29,654
Wallingford	228	Bancroft	1,000	Lehigh	846
Graettinger	879	Algona	5,977		
Emmetsburg	3,887	Livermore	545		
Bradgate	166	Dakota City	706		
Rutland	221				
Humboldt	4,497				

FLOOD HISTORY

Virtually nothing is known of the flood stages and discharges of the Des Moines River basin above the Boone River prior to the establishment of the gaging station near Boone. Precipitation records indicate the possibility of several great floods between 1850 and 1902. At the gaging station near Boone (fig. 1, 5-4815) a flood of 43,600 cfs (cubic feet per second) occurred in May 1903. From that time until June 1947 no flood exceeding a 10-year recurrence interval (37,000 cfs) flood occurred at the station. Floods of relatively great magnitude have occurred on some streams in the drainage basin above the station near Boone in 1918 and subsequent years. These are listed in table 3.

Major floods in the upper Des Moines River basin generally result from heavy rainfall during the summer months or from snowmelt, often with accompanying rain, in the late winter or early spring. Summer floods occurred in 1918, 1938, 1947, 1953, and 1954. Snowmelt floods occurred in 1951, 1961, 1962, 1965, and 1969. Brief descriptions of the causes of these floods in and after 1938 follow.

During two periods in September 1938, heavy rainfall caused flooding in the upper Des Moines River basin. In the first period, September 5-8, rain amounting to nearly six inches at places in the basin upstream from Fort Dodge saturated the ground. The second period, September 11-14, had a somewhat lesser amount of rain which fell on wet earth and caused extensive flooding. At East Fork Des Moines River near Hardy (about 8 miles upstream from Dakota City) the peak discharge

TABLE 2. Flood peaks at gaging stations in the upper Des Moines River basin for selected years and floods

Station number	Mile	Gaging station	Period of flood record	Drainage area (sq. mi.)	Flood peaks					
					1918			1938		
					Date	Gage height (ft)	Dis-charge (cfs)	Date	Gage height (ft)	Dis-charge (cfs)
5-4760	426.0	West Fork Des Moines R. at Jackson, Minnesota	1909-13, 1931-	1,220	---	---	---	4/8-10	10.01	2,200
5-4765	404.2	West Fork Des Moines R. at Estherville	1952-	1,372	---	---	---	---	---	---
5-4767.5	334.3	West Fork Des Moines R. at Humboldt	1940-	2,256	---	---	---	---	---	---
5-4780	389.7	East Fork Des Moines R. near Burt	1952-	462	---	---	---	---	---	---
5-4790	333.6	East Fork Des Moines R. at Dakota City	1938, 1940	1,308	---	---	---	9/-	^a 17.4	^a 22,000
5-4800	---	Lizard Creek near Clare	1940-	257	---	---	---	---	---	---
5-4805	314.6	Des Moines R. at Fort Dodge	1905-06, 1914-27, 1947-	4,190	6/4	^b 10.1	^d 11,400	---	---	---
5-4810	---	Boone R. near Webster City	1918, 1932, 1940-	844	6/10	^c 19.1	21,500	---	---	---
5-4815	256.8	Des Moines R. near Boone	1903, 1905-29, 1931	5,511	6/6	20.5	31,400	9/18	16.0	24,500

Station number	Flood peaks											
	1947			1951			1953			1954		
	Date	Gage height (ft)	Dis-charge (cfs)	Date	Gage height (ft)	Dis-charge (cfs)	Date	Gage height (ft)	Dis-charge (cfs)	Date	Gage height (ft)	Dis-charge (cfs)
5-4760	7/4	4.29	2,100	4/10	14.73	4,380	6/8	17.43	8,360	3/25 6/16	7.95 6.07	1,160 602
5-4765	---	---	---	---	---	---	6/6	15.53	10,800	6/21	5.66	1,360
5-4767.5	6/23	12.2	11,000	4/5	11.30	8,960	6/13	9.64	6,280	6/22	11.33	9,490
5-4780	---	---	---	---	---	---	6/13	10.36	1,060	6/21	12.67	3,670
5-4790	6/23	^a 15.4	^a 11,800	4/9	^a 14.95	^a 10,800	6/9	^a 7.33	^a 1,340	6/21 6/21	^a 16.95 24.02	^a 18,800 17,400
5-4800	6/23	16.0	10,000	3/26	10.42	3,620	6/28	6.54	1,190	6/20	13.21	6,210
5-4805	6/23	19.7	34,000	4/8	12.13	22,300	6/13	7.14	8,850	6/21	19.28	35,400
5-4810	6/25	12.75	9,340	3/29 4/7	13.00 11.00	9,800 7,070	5/1	5.72	1,760	6/22	18.55	20,300
5-4815	6/24	19.8	37,100	3/30 4/9	16.82 16.44	28,200 27,200	6/15	6.03	9,080	6/22	25.35	57,400

Station number	Flood peaks											
	1961			1962			1965			1969		
	Date	Gage height (ft)	Dis-charge (cfs)	Date	Gage height (ft)	Dis-charge (cfs)	Date	Gage height (ft)	Dis-charge (cfs)	Date	Gage height (ft)	Dis-charge (cfs)
5-4760	3/24	10.78	2,140	4/5	14.97	5,350	4/9	---	9,530	4/11	19.45	15,700
5-4765	3/25	12.03	5,350	4/6	12.22	5,610	4/10	15.61	10,200	4/12	17.68	16,000
5-4767.5	3/29	11.56	9,280	4/1	11.12	8,500	4/8	13.90	14,400	4/14	15.40	16,000
5-4780	3/27	12.05	2,800	4/1	11.86	2,600	4/6 4/9	14.21 13.46	5,000 4,930	4/8	12.09	3,280
5-4790	3/28	19.12	9,440	4/1	20.48	11,400	4/9	23.13	15,700	4/9	16.21	5,990
5-4800	3/26	9.08	2,900	3/28	9.55	3,360	4/7	11.10	4,760	4/5	6.96	1,490
5-4805	3/28	12.83	20,500	4/1	13.34	21,800	4/8	17.79	35,600	4/15	12.83	22,900
5-4810	3/28	9.80	5,860	3/31	13.15	10,600	4/6	15.91	15,200	4/6	7.30	3,460
5-4815	3/29	15.47	26,200	4/2	17.04	30,000	4/9	22.89	51,600	4/16	14.43	24,000

a - At site 7.6 miles upstream until 1955.
 b - At Kalo 7 miles downstream, 1914-27.
 c - Maximum stage known since 1896, from flood marks, from information by local resident--date approximate.

of 22,000 cfs (see table 2) has not been exceeded to date. Other gages in the area were not in operation during 1938.

June 1947 was cool and wet with rainfall in the upper Des Moines River basin on 19 of the 30 days and monthly precipitation totals from 8 to 12.5 inches. As shown in table 2, major floods were extensive in that part of the upper basin in Iowa with the peak flows occurring during the period of June 23-25.

In 1951 the month of March was cold with record snowfall. Late in the month rains and warm weather hastened the snowmelt and caused flooding. Flood discharges were large although not of record proportions in the upper Des Moines River basin.

The floods of June 1953 and June 1954 were caused by exceptionally heavy rainfall. Most of the heavy rainfall in 1953 occurred west of the Des Moines basin and, as shown in table 3, only the West Fork Des Moines River at Estherville had a flood of outstanding size. Water-Supply Paper 1320-A of the U.S. Geological Survey (see references) contains a description of the causes and details of the 1953 floods. In 1954 the center of the heavy June rains was near the eastern boundary of the basin with 8-day totals exceeding 12 inches. All of the basin above Fort Dodge received rainfall in excess of 6 inches. Record peak discharges occurred on the East Fork and on the main stem downstream as far as Des Moines. A detailed report of the flood is published (Yost, 1958).

The snowmelt floods of 1961, 1962, 1965, and 1969 were caused by conditions similar to those that produced the 1951 flood. All

were notable floods, although, those in 1961 and 1962 were generally smaller than that of 1951. The 1965 floods were about equal to or slightly smaller than the 1954 summer flood (table 2). The 1969 flood produced the peak discharge of record along the West Fork. The flood on the East Fork was less severe so that the combination of flows from the two forks was not sufficient to produce an outstanding flood at Fort Dodge and other downstream places.

An appendix to this report contains tabulations of time, gage height, and discharge for the 1965 and 1969 floods. Similar data for the floods in 1953 and 1954 are contained in Water-Supply Papers 1320-A and 1370-A. These data may be used to plot hydrographs of either gage height or discharge and to compute flood volumes.

The data and time of occurrence of peak discharges in 1954, 1965, and 1969 are summarized in table 3.

BASIC DATA

Gaging-station Records

Nine complete-record gaging stations are operated by the U.S. Geological Survey within the basin above the gaging station near Boone (mile 258.8). This latter station will be in the pool of the Saylorville Dam and has been moved to a site at mile 276.7 near Stratford (no. 5-4813, plate 1). Records at the two sites are considered equivalent. Records at the old site are used in this report. Five of the other eight gages are located on rivers having profiles in this report. Data for one of the other stations in Minnesota and two stations in Iowa on tributaries of the main stem are included in the flood records (table 2) and in the descriptive data in the appendix.

TABLE 3. Summary of date and time of peaks of the 1954, 1965, and 1969 floods at gaging stations in upper Des Moines River basin.

Gaging station	Mile	Drainage area sq.mi.	June 1954		April 1965		April 1969	
			Day	Hour	Day	Hour	Day	Hour
West Fork Des Moines R. at Jackson, Minnesota	426.0	1,220	18	1300	9	2100-2300	11	1600
West Fork Des Moines River at Estherville	404.2	1,372	21	1600	10	1900	12	0300
West Fork Des Moines R. at Humboldt	334.3	2,256	22	1200	8	1400	14	2000
East Fork Des Moines R. near Burt	389.7	462	21	0600	6	2100	8	0215
East Fork Des Moines R. near Hardy ^a	341.4	1,230	21	1500	--	--	--	--
East Fork Des Moines R. at Dakota City	333.8	1,308	21	1900	9	0500	9	2400
Lizard Creek near Clare	--	257	20	0400	7	1530	5	0645
Des Moines R. at Fort Dodge	314.6	4,190	21	1100	8	0630	15	0145
Boone R. near Webster City	--	844	22	1400	6	2200	6	2130
Des Moines R. near Boone	258.8	5,490	22	1600	9	0400	16	2030

a - Discontinued 1955

Ice cover prevailed at many places along the streams during the first few days of April 1965 and 1969. The backwater effect caused by ice cover is highly variable particularly during rising stages. During the period of this effect at gaging stations, only daily mean discharges were computed. During open-water periods, the days of flood discharges have been subdivided and the gage height and discharge tabulated with the gaging-station data. These tabulations permit the plotting of detailed hydrographs over the peak period of the floods.

Profile Data

High-water marks of the individual floods furnish the elevation data for plotting the flood profiles. These marks were obtained as soon as possible after the peak. Marks were set at bridges to define the peak water-surface elevation upstream and downstream. Additional marks were set between bridges where necessary in order to define water-surface elevations along the stream. High-water marks were tied to mean sea level using the datum of the 1929 general adjustment. Elevations of the 1953 and 1954 floods were obtained from Water-Supply Papers 1320-A and 1370-A.

Data on low-water elevation and discharge were obtained along the streams and are shown on the profile sheets. These data indicate the approximate range in stage and, to some extent, in discharge along the rivers. Discharge at the time of measurement was not the lowest of record.

Flood-discharge measurements were made at several locations in the basin to supplement data obtained at gaging stations.

Drainage area at selected points along the streams are tabulated on the profiles. The location of the mouths of major tributaries are also shown on the profiles. Drainage area of these tributaries can be computed from the tabulated drainage areas on the profile sheets.

Mileage System

River mileages on the basin map and profiles are in miles upstream of the mouth of the Des Moines River. They are based upon the mileage system of the Corps of Engineers modified slightly to account for changes in the stream alignment. Bridges, creeks, and other easily identified points are indicated on the profiles. The mileages between these points can be adjusted proportionately if they do not agree with the users map mileage. An index number, such as 8828-6SW, is shown at bridges and other points to aid in identifying the map location. The number 8828-6SW indicates a location in Twp. 88N., R.28 W., the the southwest quarter of section 6.

Flood-frequency Information

The computation of the flood discharges tabulated on the profiles (pls. 2-15) for the 25- and 50-year recurrence interval floods is based upon the report by Schwob (1966).

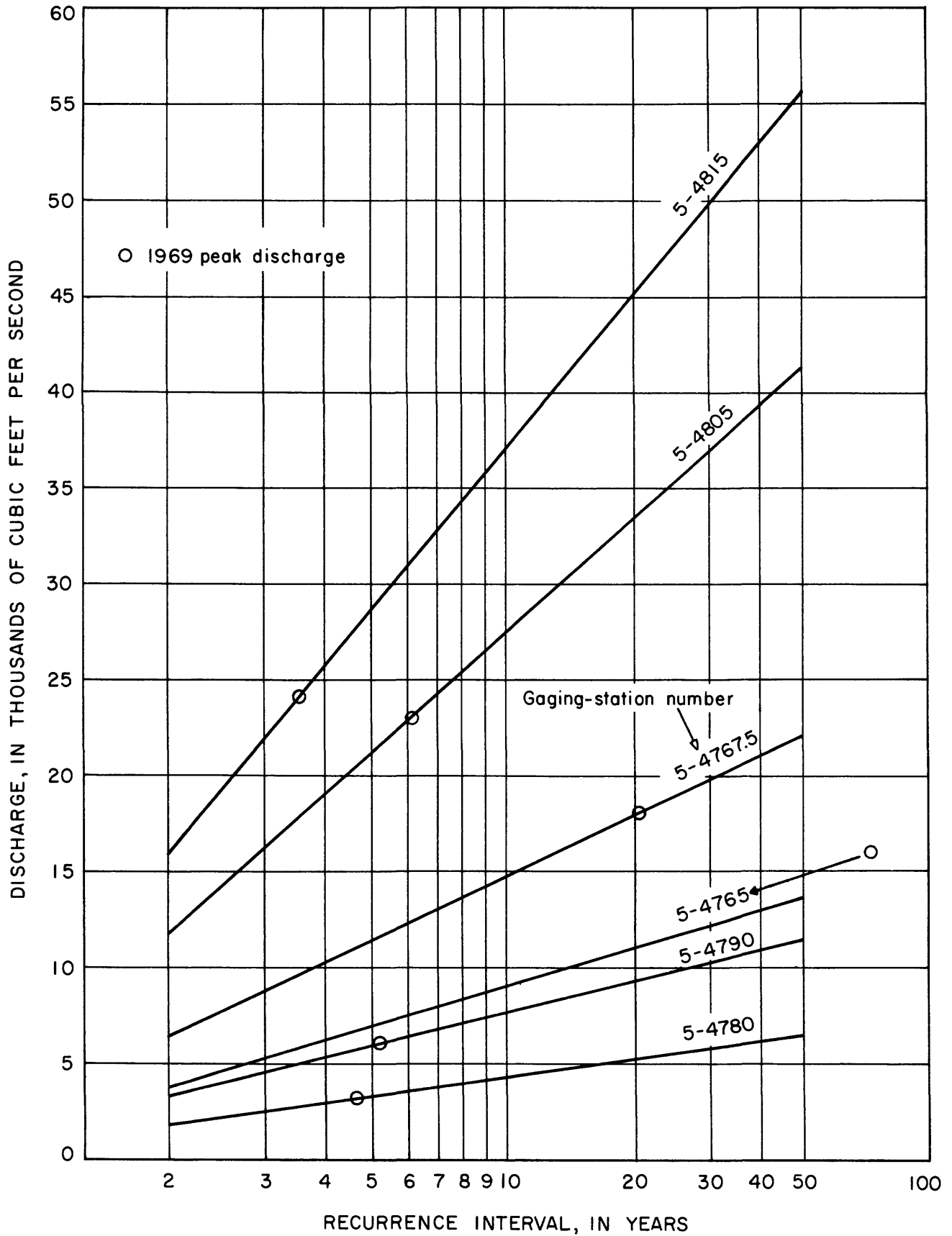


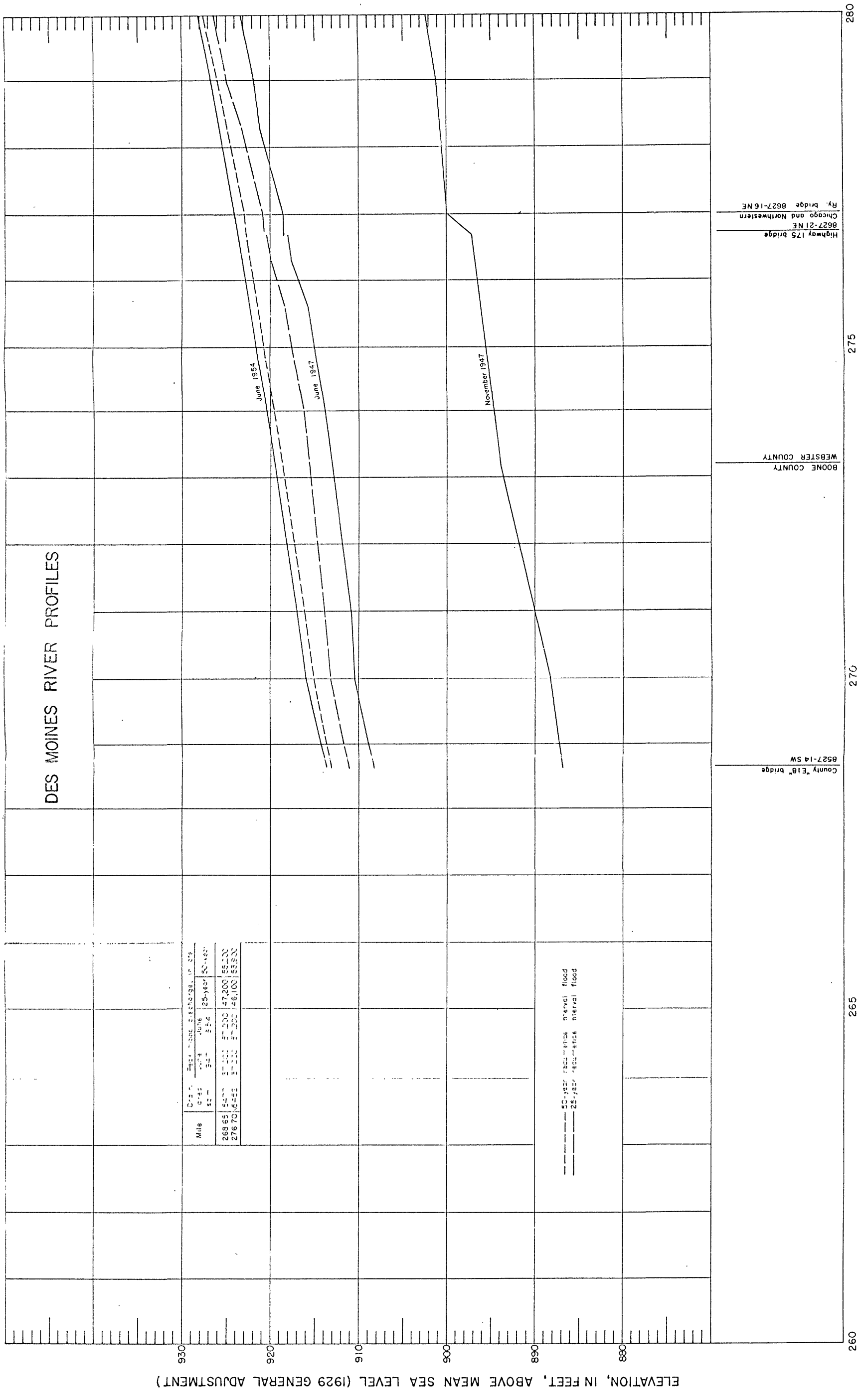
Figure 1. Flood-frequency curves and 1969 flood peaks for selected gaging stations upper Des Moines River basin.

Flood-frequency curves for six selected gaging stations in the report area are shown in figure 1. These curves show the peak discharge for recurrence intervals from 2 to 50 years. They can also be used to determine the recurrence interval for any annual peak discharges in the record for each station shown (1969 flood peak is indicated on each curve).

FLOOD PROFILES

The basic data described were used to prepare flood profiles along the streams. High-water marks defined the known peak elevations for each profile. The gaging-station records and supplemental discharge measurements provided the peak discharges tabulated on the profile sheets (plates 2-15). The computed discharges and elevations for the 25- and 50-year recurrence interval floods have been used to prepare profiles for these two floods.

The profile elevations and the tabulated discharges provide the data for preparation of a partial elevation-discharge relation curve. Such a curve may be prepared for any point on the stream--the only requirement being that the profile elevations and the tabulated discharges are sufficient in number and distribution to adequately define the curve within the range of interest.



ELEVATION, IN FEET, ABOVE MEAN SEA LEVEL (1929 GENERAL ADJUSTMENT)

DES MOINES RIVER PROFILES

Mile	DISCHARGE, CFS			
	June '54	June '47	June '47	25-year '50-'60
268.65	54,000	57,000	57,000	47,200
276.70	64,500	57,000	57,000	46,100

--- 50-year return period interval flood
 --- 25-year return period interval flood

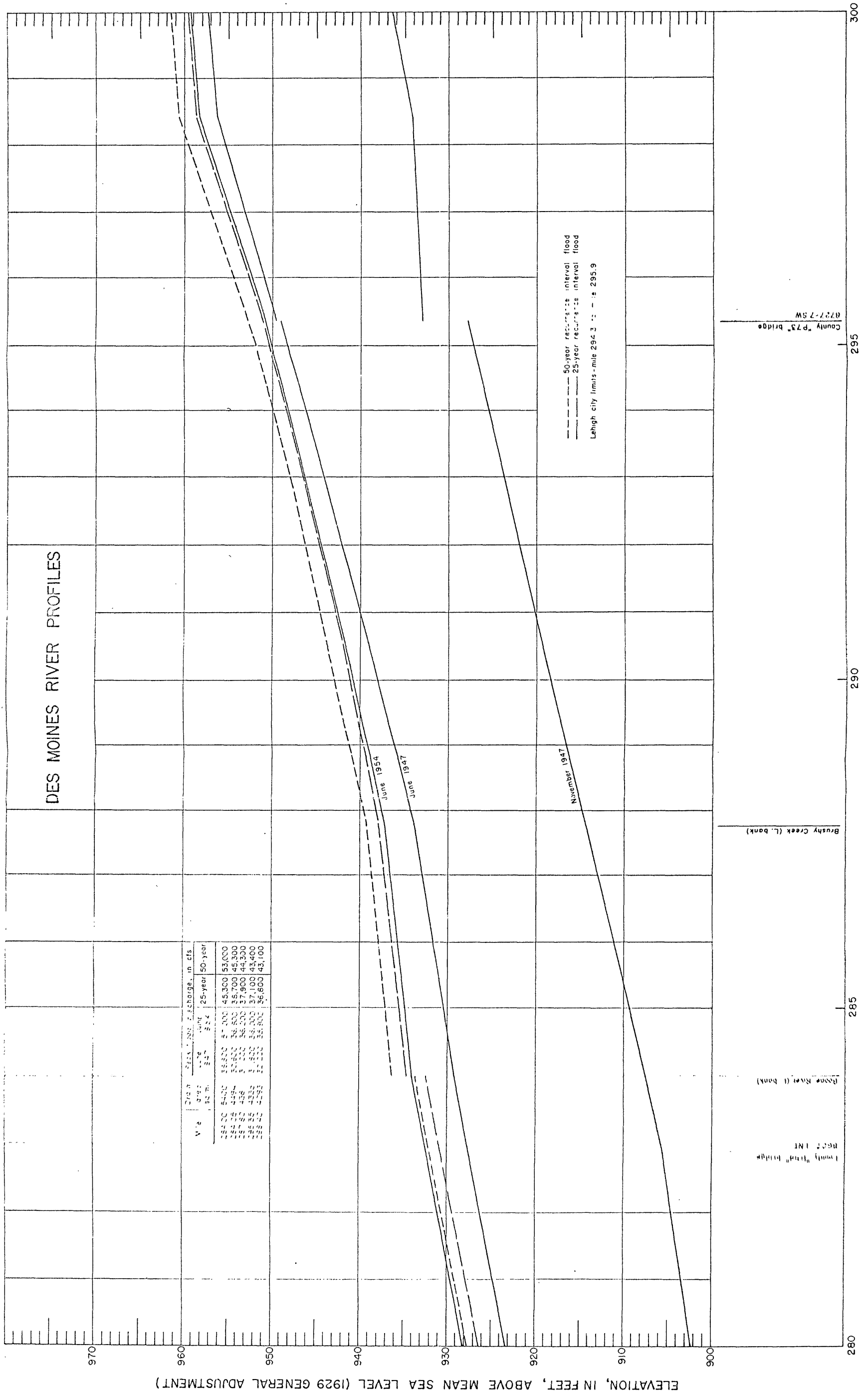
DISTANCE, IN MILES, UPSTREAM FROM MOUTH OF DES MOINES RIVER

BOONE COUNTY
 WEBSTER COUNTY

County "E1B" bridge
 6527-14 SW

Highway 175 bridge
 8627-21 NE
 Chicago and Northwestern
 Ry. bridge 8627-16 NE

Plate 2. Main stem Des Moines River profiles, miles 263.6 to mile 280.



DES MOINES RIVER PROFILES

ELEVATION, IN FEET, ABOVE MEAN SEA LEVEL (1929 GENERAL ADJUSTMENT)

Dist. from mouth, miles	Discharge, in cfs		
	June 1947	June 1954	50-year
280	11,000	11,000	11,000
281	11,000	11,000	11,000
282	11,000	11,000	11,000
283	11,000	11,000	11,000
284	11,000	11,000	11,000
285	11,000	11,000	11,000
286	11,000	11,000	11,000
287	11,000	11,000	11,000
288	11,000	11,000	11,000
289	11,000	11,000	11,000
290	11,000	11,000	11,000
291	11,000	11,000	11,000
292	11,000	11,000	11,000
293	11,000	11,000	11,000
294	11,000	11,000	11,000
295	11,000	11,000	11,000
296	11,000	11,000	11,000
297	11,000	11,000	11,000
298	11,000	11,000	11,000
299	11,000	11,000	11,000
300	11,000	11,000	11,000

--- 50-year recurrence interval flood
 - - - 25-year recurrence interval flood
 Lehigh city limits - mile 294.3

Brushy Creek (L. bank)

Lehigh River (L. bank)

Lehigh 'Frank' bridge

Lehigh 'Frank' bridge

Lehigh 'Frank' bridge

Lehigh 'Frank' bridge

Lehigh 'Frank' bridge

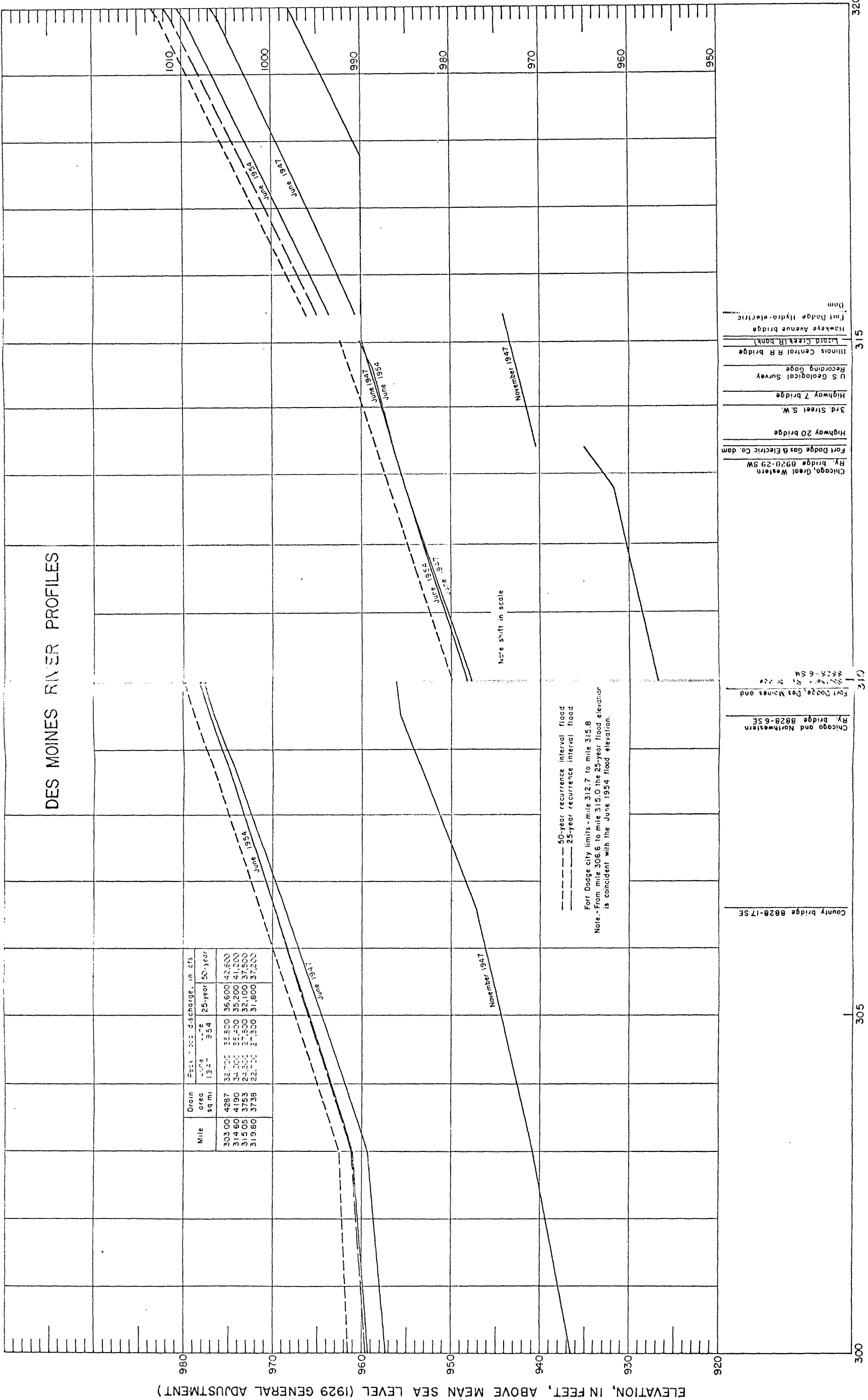
Lehigh 'Frank' bridge

Lehigh 'Frank' bridge

Lehigh 'Frank' bridge

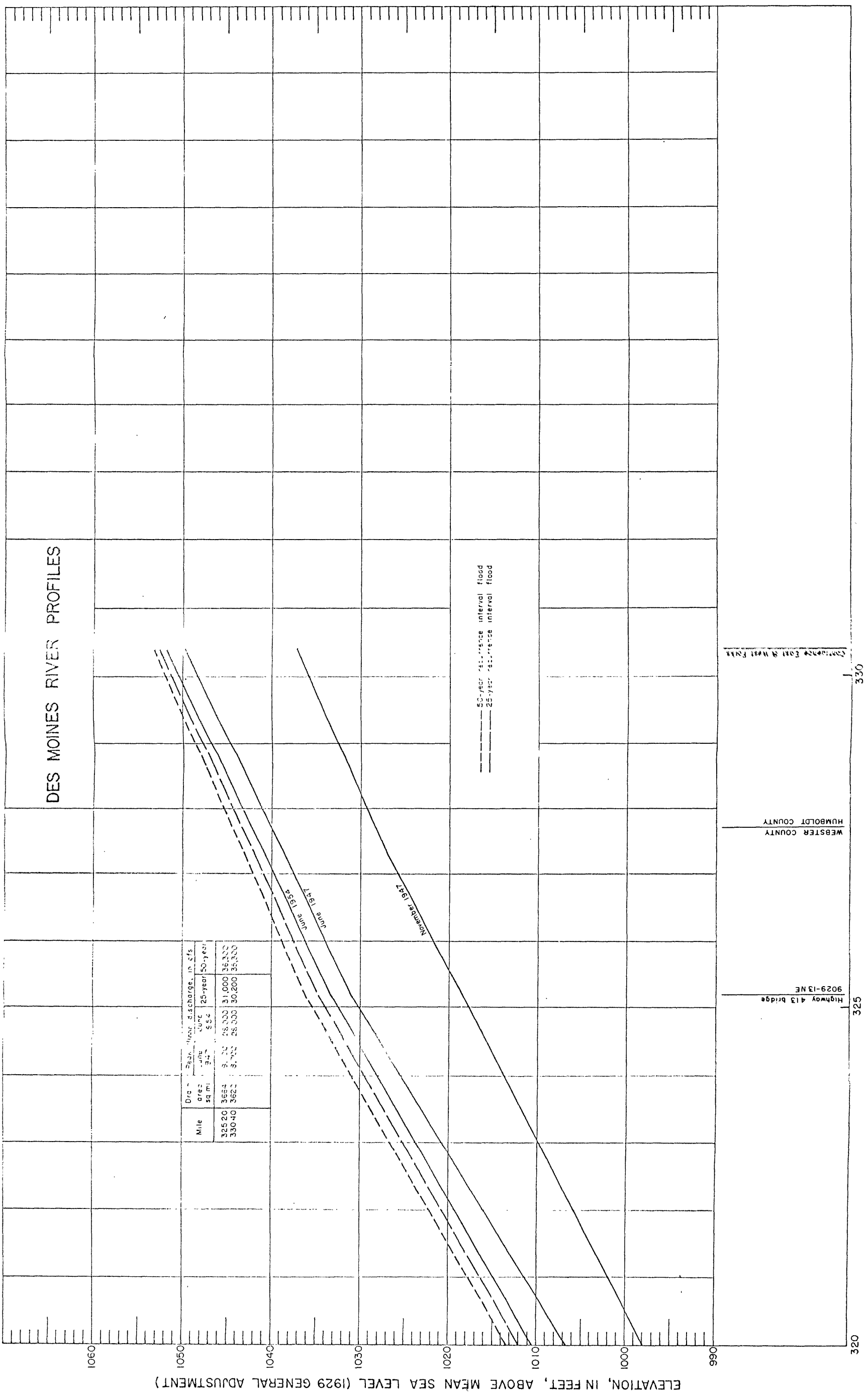
DISTANCE, IN MILES, UPSTREAM FROM MOUTH OF DES MOINES RIVER

Plate 3. Main stem Des Moines River profiles, mile 280 to mile 300.



DISTANCE, IN MILES, UPSTREAM FROM MOUTH OF DES MOINES RIVER

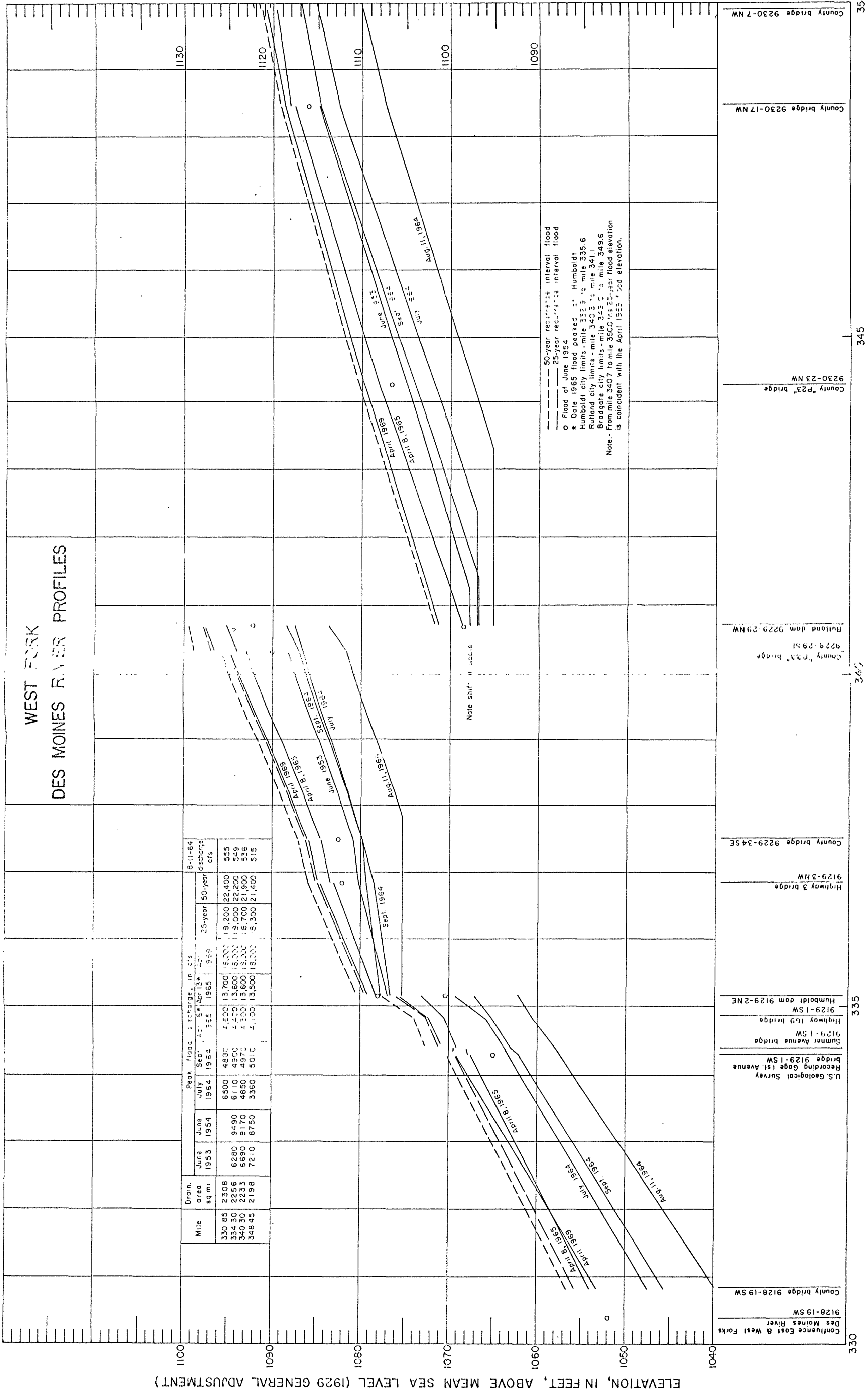
Plate 4. Main stem Des Moines River profiles, mile 300 to mile 320.



DISTANCE, IN MILES, UPSTREAM FROM MOUTH OF DES MOINES RIVER

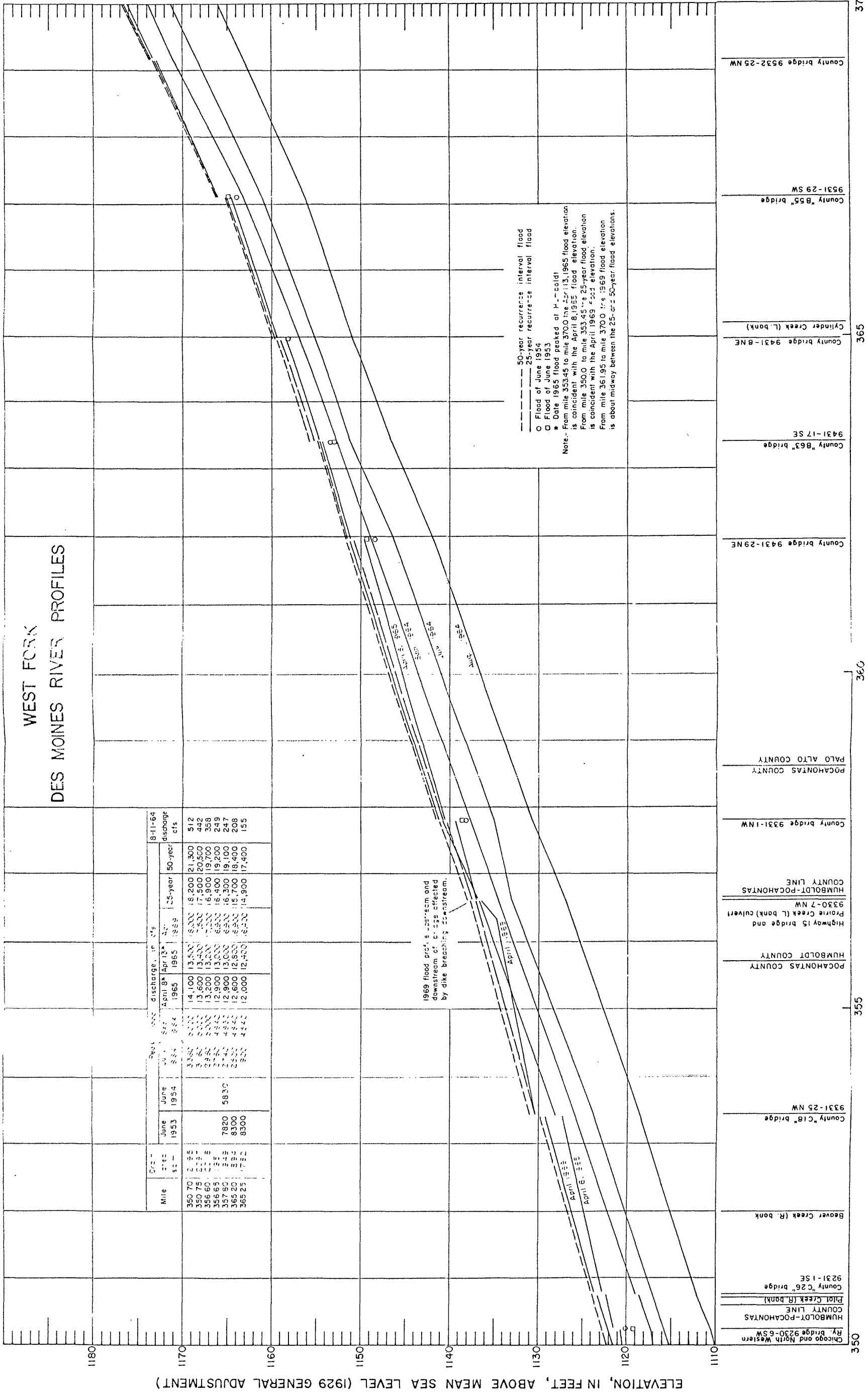
Plate 5. Main stem Des Moines River profiles, miles 320 to mile 330.4.

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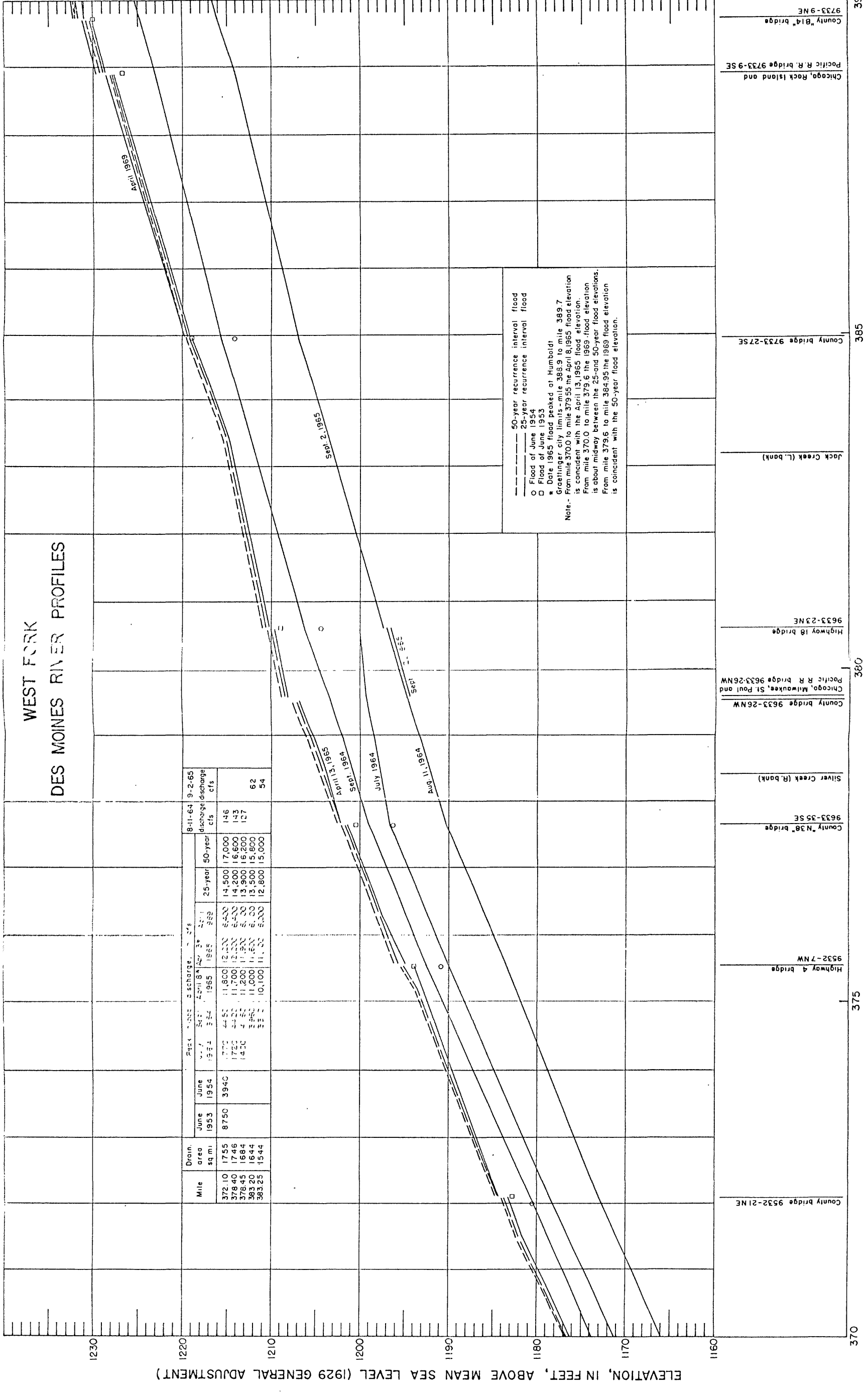
DISTANCE, IN MILES, UPSTREAM FROM MOUTH OF DES MOINES RIVER

Plate 6. West Fork Des Moines River profiles, mile 330.4 to mile 350.



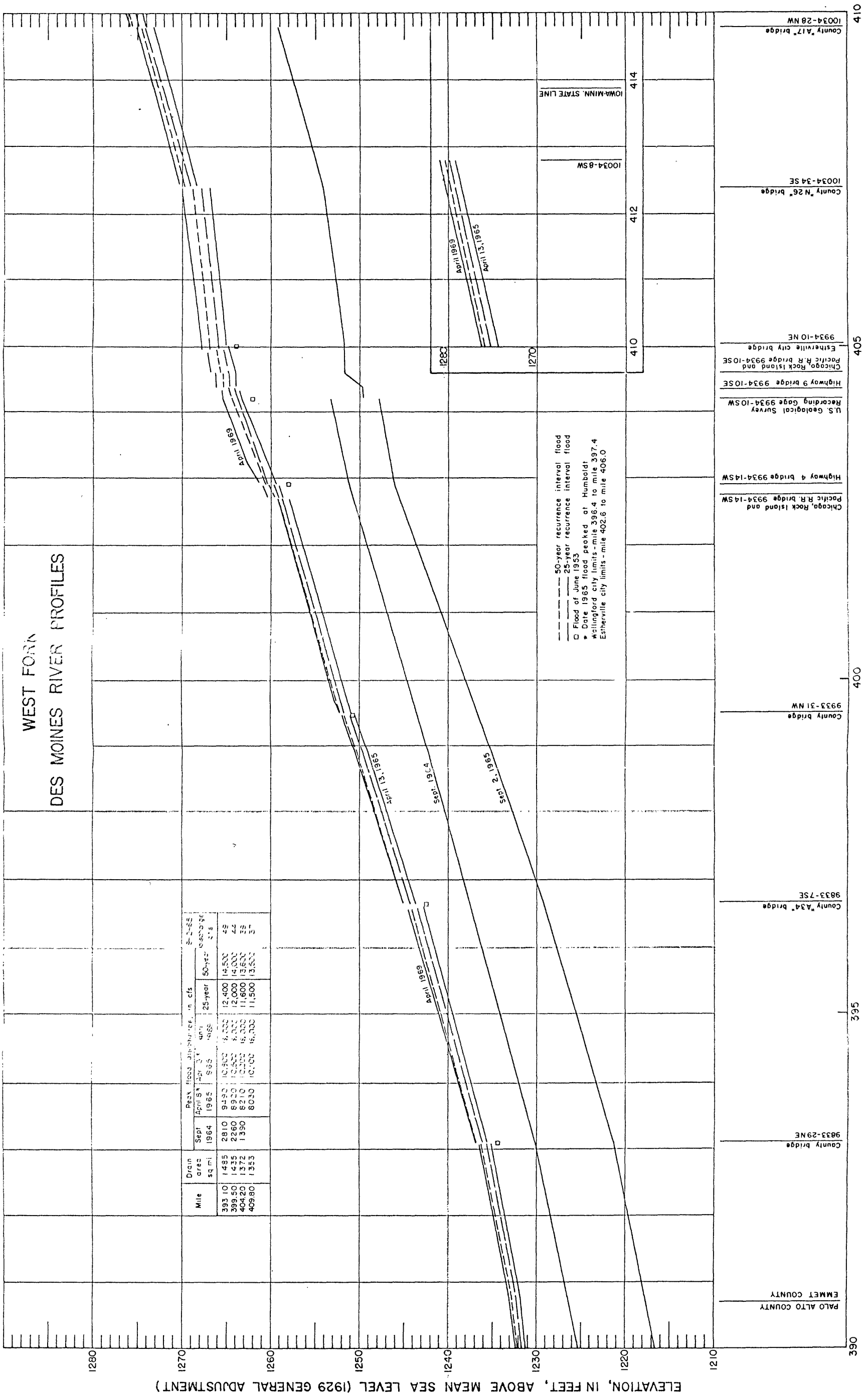
DISTANCE, IN MILES, UPSTREAM FROM MOUTH OF DES MOINES RIVER

Plate 7. West Fork Des Moines River profiles, mile 350 to mile 370.



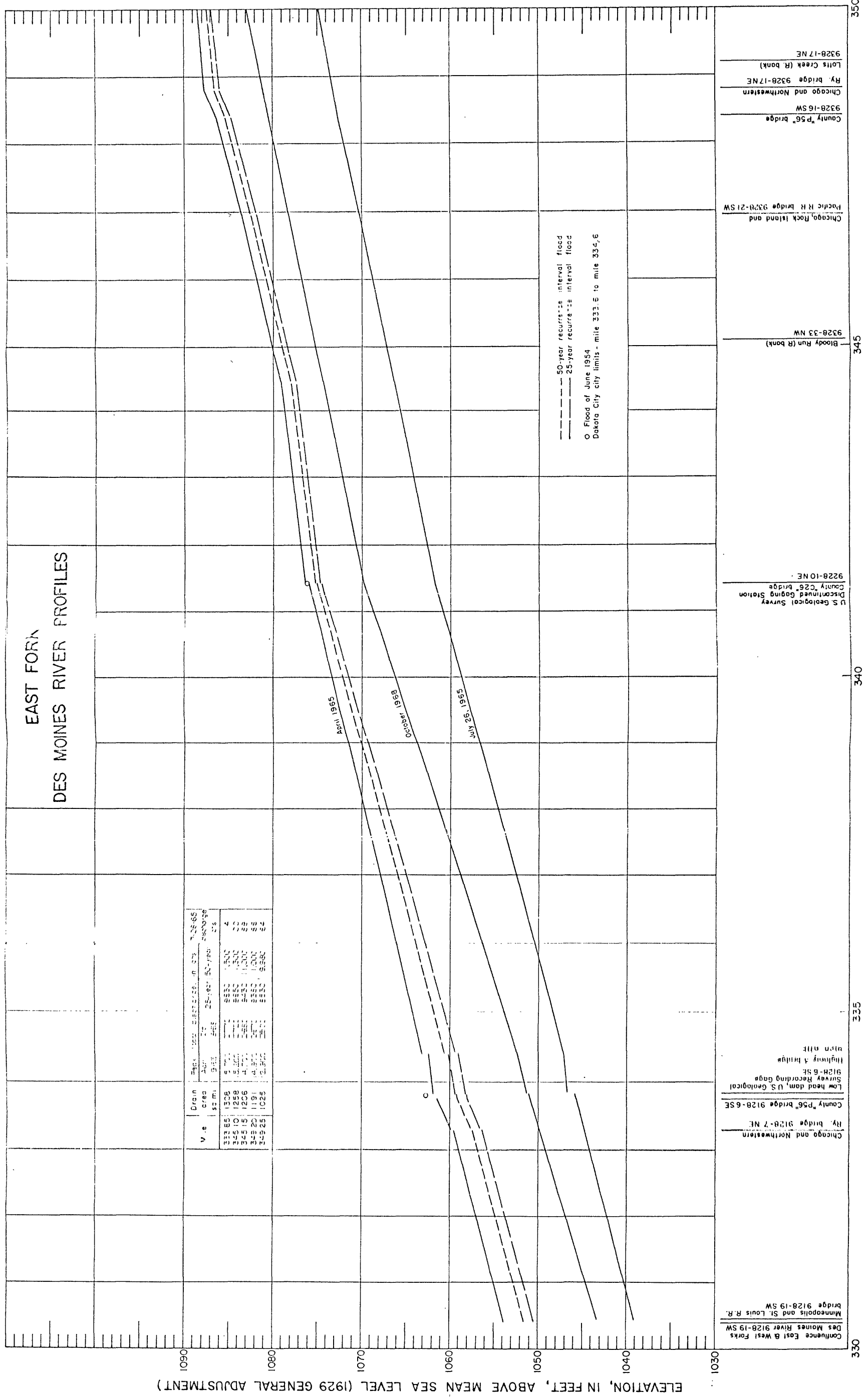
DISTANCE, IN MILES, UPSTREAM FROM MOUTH OF DES MOINES RIVER

Plate 8. West Fork Des Moines River profiles, mile 370 to mile 390.



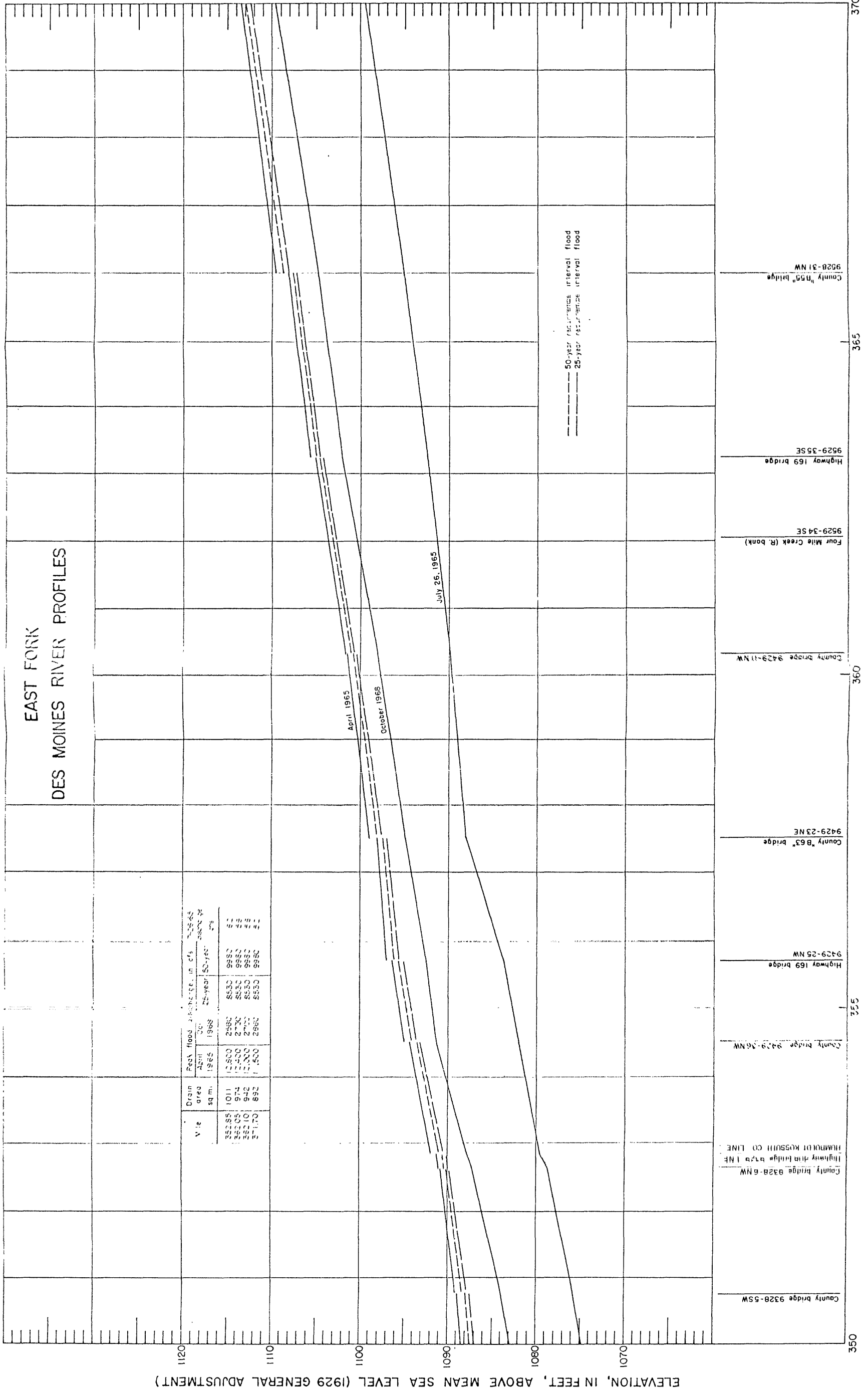
DISTANCE, IN MILES, UPSTREAM FROM MOUTH OF DES MOINES RIVER

Plate 9. West Fork Des Moines River profiles, mile 390 to mile 412.8.



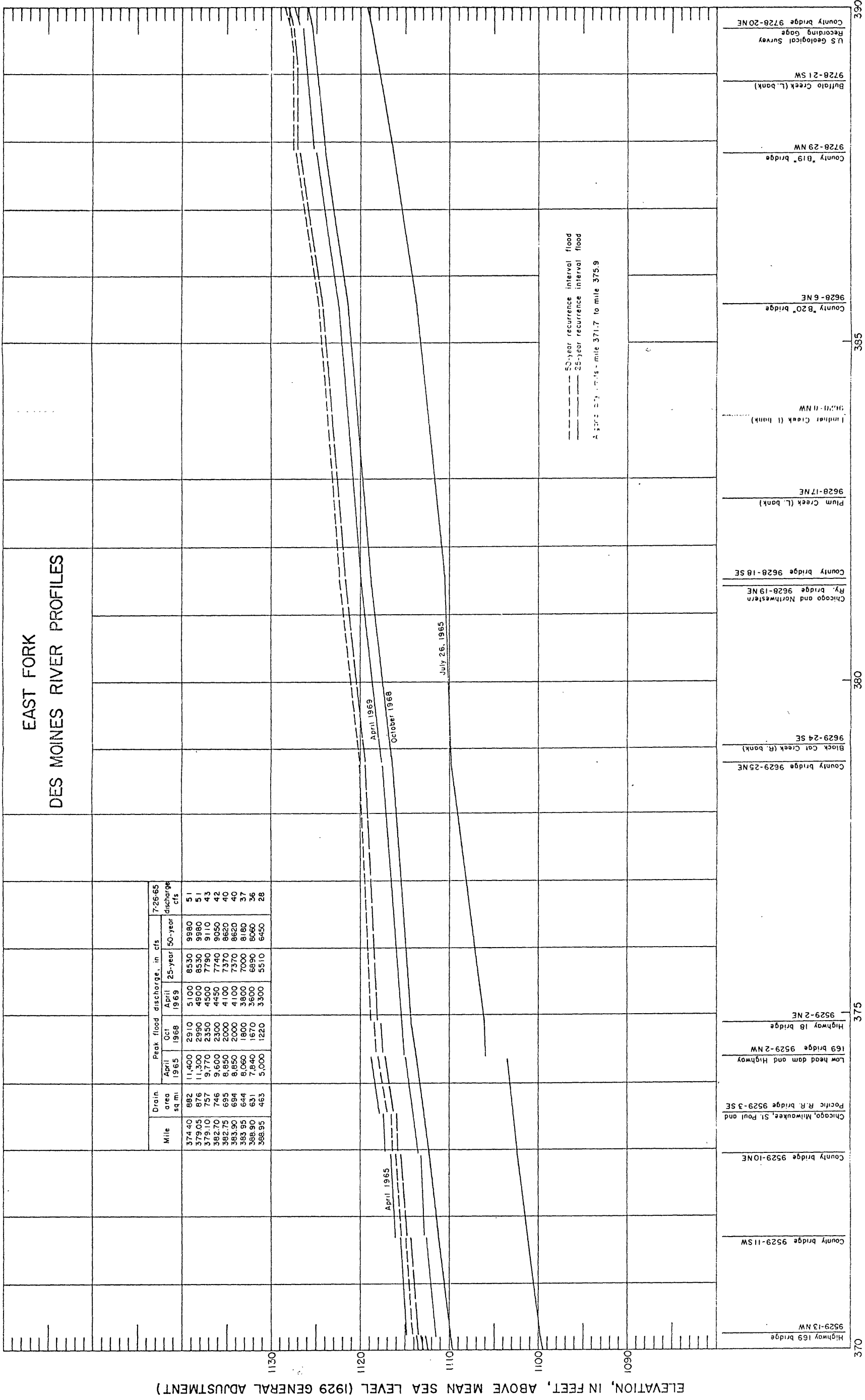
DISTANCE, IN MILES, UPSTREAM FROM MOUTH OF DES MOINES RIVER

Plate 10. East Fork Des Moines River profiles, mile 330.4 to mile 350.



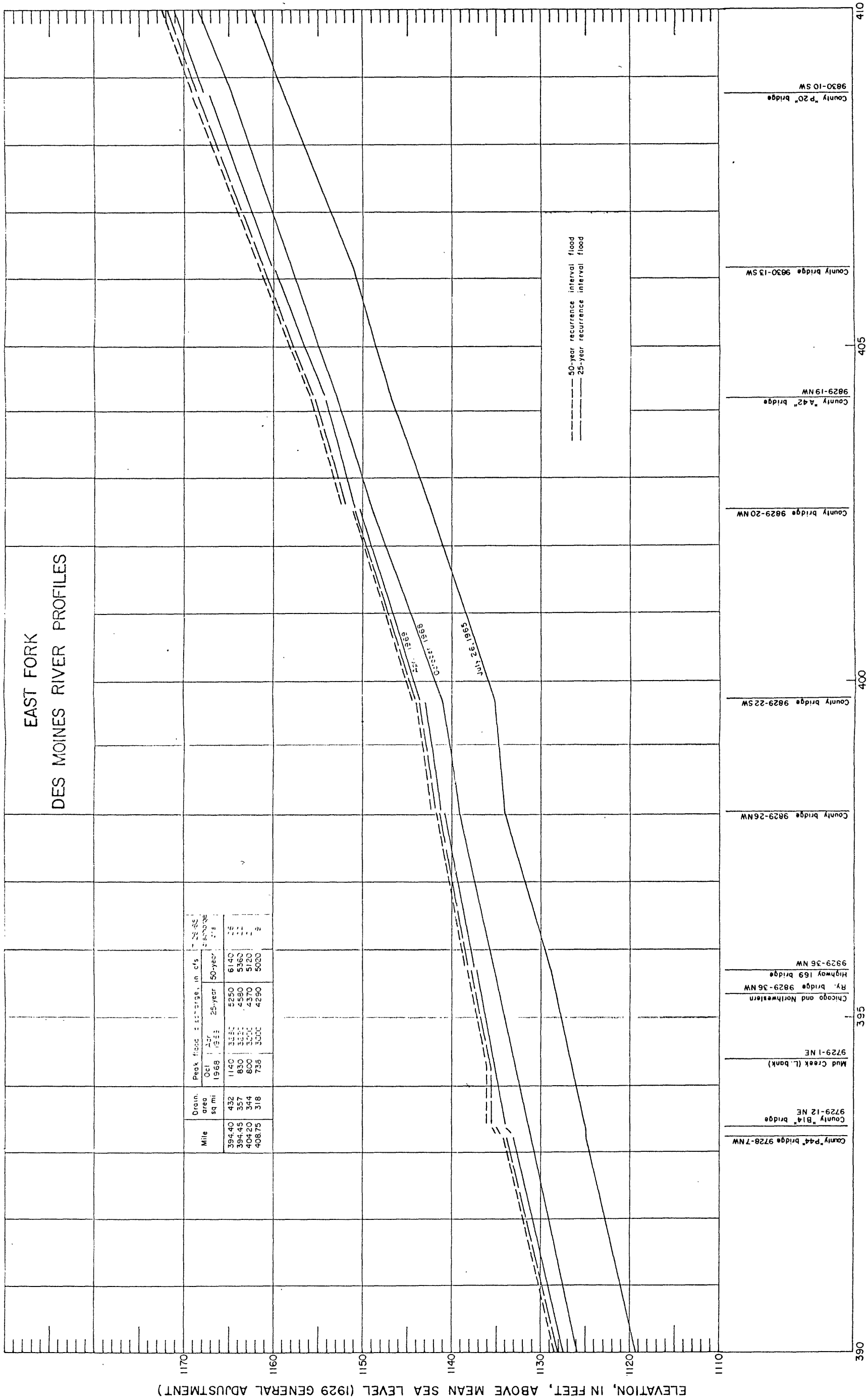
DISTANCE, IN MILES, UPSTREAM FROM MOUTH OF DES MOINES RIVER

Plate 11. East Fork Des Moines River profiles, mile 350 to mile 370.



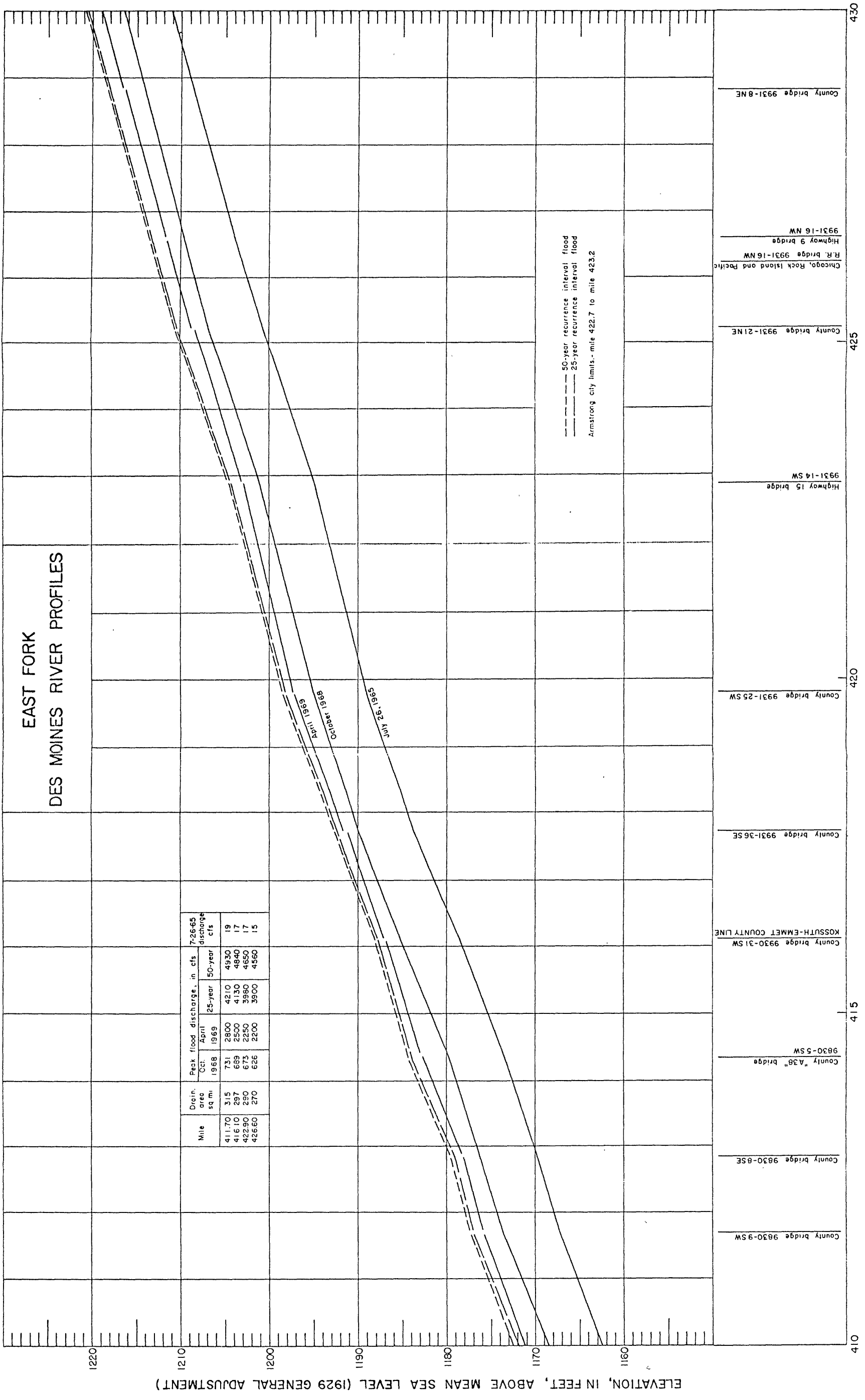
DISTANCE, IN MILES, UPSTREAM FROM MOUTH OF DES MOINES RIVER

Plate 12. East Fork Des Moines River profiles, mile 370 to mile 390.



DISTANCE, IN MILES, UPSTREAM FROM MOUTH OF DES MOINES RIVER

Plate 13. East Fork Des Moines River profiles, mile 390 to mile 410.



DISTANCE, IN MILES, UPSTREAM FROM MOUTH OF DES MOINES RIVER

Plate 14. East Fork Des Moines River profiles, mile 410 to mile 430.

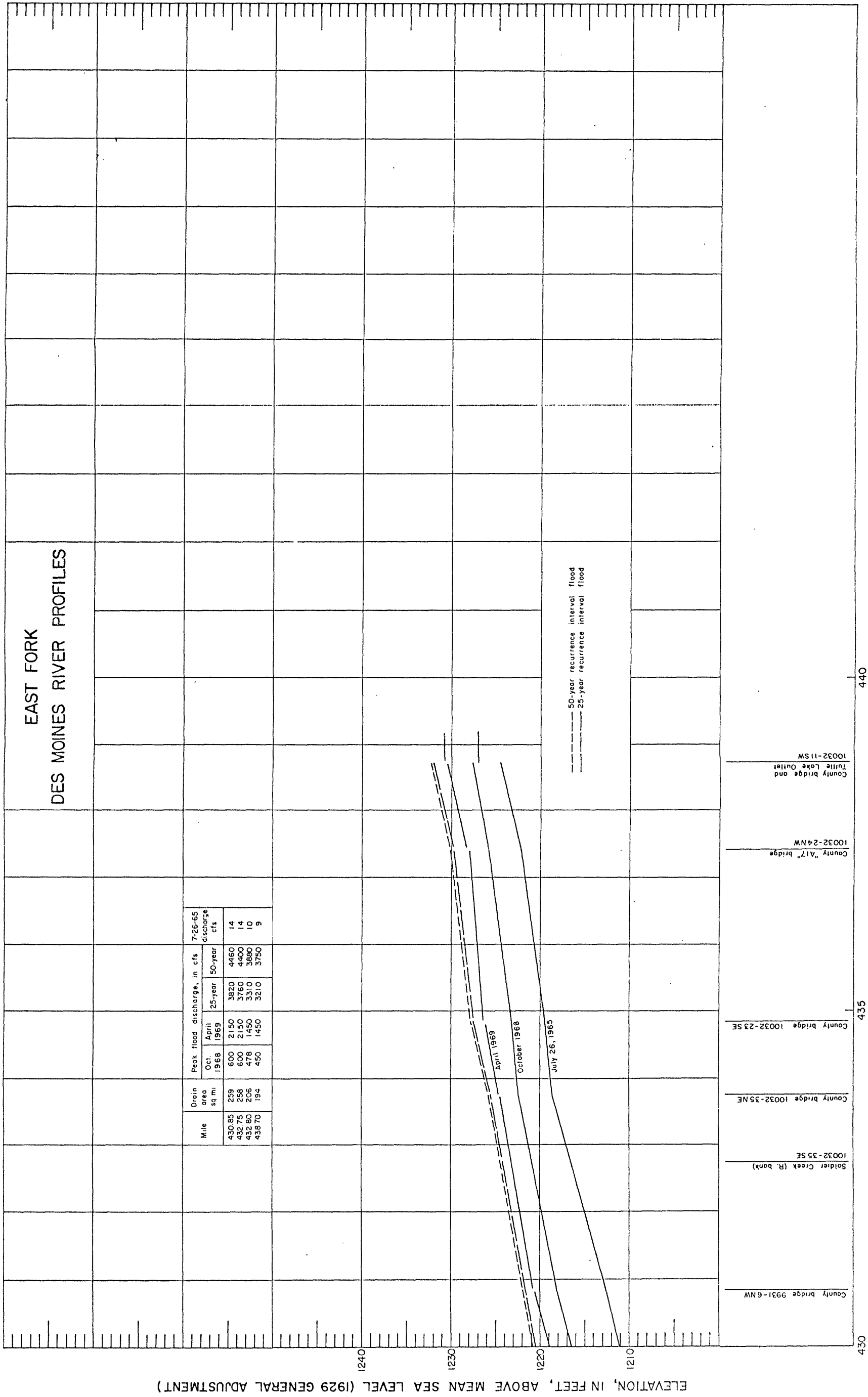


Plate 15. East Fork Des Moines River profiles, mile 430 to mile 438.7.

DISCUSSION

Data for 10 notable flood years in the upper Des Moines River basin are included in this report. These data in combination with the computed 25- and 50-year flood discharges and profiles provide flood information along 253 miles of streams in the basin. Information of this type can benefit nearly all activities of man occurring on the flood plain. For example, the report can furnish data on (1) the past record of flood heights and discharges, (2) the time distribution of flood elevations and discharges (for certain floods) above a selected elevation, (3) flood volumes, and (4) the frequency of past and future floods. Information for (1) is presented in the gaging-station records and on the profile sheets, for (2) and (3) in the tabulated time and discharge data in the gaging station records, (and additional references) and for (4) from the frequency data on the profile sheets and frequency curves in the report.

The elevation and discharge data on the profile sheets can be used to prepare rating curves. Such curves will represent the conditions at the time of the floods that were profiled. Significant changes in the conditions at or downstream from the selected point can change this relation. Permanent changes such as channel straightening, construction of levees, or dams will all affect the relation of elevation to discharge. Temporary changes in the relation will be caused by ice jams or debris jams that are not predictable. The effect of these jams is to cause flood elevations upstream to be higher than those for normal conditions. At many places there is only a small difference in

elevation between the 25- and 50-year flood--often only a few tenths of a foot. This small spread in elevation occurs where a flood plain is wide and flat and relatively large changes in flood discharge cause only small changes in flood elevation.

Stage-frequency curves can be prepared from the data included in this report. The stage for a discharge of known frequency can be derived from the rating curves described in the previous paragraph. Several such determinations will furnish the data from which a stage-frequency curve can be plotted.

REFERENCES

- Iowa Natural Resources Council, 1953, An inventory of water resources and water problems Des Moines River basin, Iowa: Bull. no. 1, 63 p.
- Larimer, O. J., 1957, Drainage areas of Iowa streams: Iowa Highway Research Board Bull. no. 7, 440 p.
- Schwob, H. H., 1966, Magnitude and frequency of Iowa floods: Iowa Highway Research Board Bull. no. 28, pt. 1, 47 p., pt. 2, 376 p.
- U.S. Geol. Survey, issued annually, Water resources data for Iowa--part 1, surface water records: open-file reports.
- _____, 1955, Floods of June 1953 in northwestern Iowa: U.S. Geol. Survey Water-Supply Paper 1320-A, 68 p.
- _____, issued annually to 1960, Surface Water Supply of the United States, part 5, Hudson Bay and Upper Mississippi River basin: U.S. Geol. Survey Water-Supply Papers.
- Yost, I. D., 1958, Floods of June 1954 in Iowa: U.S. Geol. Survey Water-Supply Paper 1370-A, 106 p.

APPENDIX

The flood data which follow are for the 1965 and 1969 floods at gaging stations in the upper Des Moines River basin. Some of these data are not available in other publications.

Gaging-station records are arranged in the downstream order used by and explained in the annual reports of the U.S. Geological Survey. Since 1961 these reports have been published on an annual basis for each state. The annual reports contain much information that supplements data in this report. In particular, the reports for 1965 and 1969 will be needed in any studies involving the stream discharges of the antecedent and post flood periods.

Each gaging-station record has the assigned permanent station number preceding the station name. These numbers are also used on plate 1 and in table 2. Below the name are the station description followed by (for 5 stations) the tabulated daily mean discharges and stage-discharge hydrograph data. Four of the stations have no tabulated stage or discharge data because data were not available or the flood was small.

During periods of ice effect only daily mean discharges have been computed. Stages for specific times are tabulated for the hydrographs for these days and the discharge column is left blank. The daily mean discharge will be found in the table preceding the hydrograph tabulation.

5-4760 West Fork Des Moines River at Jackson, Minnesota

Location.--Lat 43°37'10", long 94°59'10", in SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec.24, T.102 N., R.35 W., on right bank in storage room of city powerplant in Jackson.

Drainage area.--1,220 sq mi, approximately.

Gage-height record.--Water-stage recorder graph. Datum of gage is 1,287.75 ft above mean sea level, datum of 1929. April 1938 chain gage at site 7 miles upstream at datum 17.10 ft higher. Oct. 1, 1944 to Oct. 26, 1949, wire-weight gage at site 600 ft upstream at datum 10.64 ft higher. Oct. 27, 1942, to December 15, 1965, water-stage recorder graph 200 ft downstream at same datum.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--April 1969: Discharge, 15,700 cfs April 11 (gage height, 19.45 ft).

Period of flood record, 1935-69 (1969 flood excluded): Discharge, 9,530 cfs, Apr. 9, 1965, maximum gage height, 18.62 ft Apr. 6, 1965 (backwater from ice).

5-4765 West Fork Des Moines River at Estherville, Iowa

Location.--Lat 43°24'00", long 94°50'40", in SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec.10, T.99 N., R.34 W., on right bank in city park, 1,200 ft downstream from bridge on State Highway 9 at Estherville, 2.5 miles upstream from Brown Creek, and at mile 404.2 upstream from mouth of Des Moines River.

Drainage area.--1,372 sq mi.

Gage-height record.--Digital-recorder tape punched at 15-minute intervals. Datum of gage is 1,247.55 ft above mean sea level, datum of 1929. Prior to Mar. 27, 1966, graphic water-stage recorder chart for same site and datum.

Discharge record.--Stage-discharge relation defined by current-meter measurements. Backwater from ice Apr. 4-8, 1965, and Apr. 1-3, 1969.

Maxima.--March-May 1965: Discharge, 10,200 cfs Apr. 10 (gage height, 15.61 ft).

March-May 1969: Discharge, 16,000 cfs Apr. 12 (gage height, 17.68 ft).

Period of flood record 1951-69 (excluding 1965 and 1969): Discharge, 10,800 cfs June 8, 1953 (gage height, 15.53 ft).

Remarks.--Tables of daily discharges and detailed hydrographs for flood of June 1953 contained in U.S. Geological Survey Water-Supply Paper 1320-A.

Tables of daily discharges and detailed hydrograph for flood of June 1954 contained in U.S. Geological Survey Water-Supply Paper 1370-A.

Mean discharge in cubic feet per second, 1965

Day	April	May	Day	April	May	Day	April	May
1....	490	1,810	11....	9,490	2,090	21....	3,100	1,960
2....	1,120	1,670	12....	8,300	1,790	22....	2,760	2,110
3....	1,340	1,540	13....	7,000	1,620	23....	2,490	1,940
4....	1,660	1,490	14....	6,060	1,670	24....	2,360	1,800
5....	3,000	1,660	15....	5,530	1,880	25....	2,340	1,980
6....	5,700	1,400	16....	4,980	2,070	26....	2,390	2,180
7....	7,200	1,390	17....	4,380	1,930	27....	2,410	2,160
8....	7,600	1,790	18....	3,960	1,800	28....	2,320	2,010
9....	7,860	1,760	19....	3,680	1,730	29....	2,140	1,880
10....	9,660	1,900	20....	3,380	1,730	30....	1,940	1,860
						31....	---	1,850
Monthly mean.....							4,221	1,821
Runoff, in inches.....							3.43	1.53

West Fork Des Moines River at Estherville, Iowa--Continued

Gage height, in feet, and discharge in cubic feet per second
at indicated time, 1965

Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge
<u>Mar. 30</u>			<u>Apr. 5</u>			<u>Apr. 13</u>		
2400	1.96	34	0800	12.45		1200	13.47	6,970
			1400	12.72		2400	13.07	6,450
<u>Mar. 31</u>			1800	12.72		<u>Apr. 14</u>		
1200	2.06	45	2200	12.60		0800	12.84	6,130
1400	2.16	58	2400	12.83		2400	12.51	5,750
1500	2.35	89	<u>Apr. 6</u>			<u>Apr. 15</u>		
1700	2.55	132	1200	13.50		1400	12.32	5,510
2000	2.65	155	2000	14.41		2400	12.09	5,280
2100	2.83	200	2300	14.53		<u>Apr. 16</u>		
2200	2.95	235	2400	14.52		2400	11.59	4,680
2400	3.12	292	<u>Apr. 7</u>			<u>Apr. 17</u>		
<u>Apr. 1</u>			0900	14.11		2400	10.95	4,080
0200	3.36	384	1500	14.52		<u>Apr. 18</u>		
1000	3.35	380	2400	14.79		0400	10.88	4,070
1200	3.40	400	<u>Apr. 8</u>			2400	10.57	3,800
1600	3.70	530	0100	14.80		<u>Apr. 19</u>		
2000	4.06	680	2400	13.84		0200	10.53	3,800
2400	4.36	805	<u>Apr. 9</u>			1000	10.39	3,690
<u>Apr. 2</u>			1000	13.85	7,450	1400	10.35	3,660
1000	4.79	995	2000	14.55	8,500	2400	10.19	3,530
1400	5.37	1,210	2400	14.67	8,710	<u>Apr. 20</u>		
1800	5.80	1,380	<u>Apr. 10</u>			2400	9.76	3,240
2000	5.83	1,390	0400	14.87	8,960	<u>Apr. 21</u>		
2400	5.68	1,330	0800	15.22	9,590	1500	9.50	3,080
<u>Apr. 3</u>			1800	15.55	10,100	2400	9.24	2,930
1200	5.33	1,200	1900	15.61	10,200	<u>Apr. 22</u>		
2400	6.51	1,640	2400	15.56	10,100	2400	8.59	2,600
<u>Apr. 4</u>			<u>Apr. 11</u>			<u>Apr. 23</u>		
0800	6.87		0600	15.38	9,870	1200	8.34	2,480
1000	7.25		1800	14.95	9,100	2400	8.16	2,400
1200	8.37		2400	14.79	8,910	<u>Apr. 24</u>		
1400	9.50		<u>Apr. 12</u>			2400	7.96	2,310
1600	10.42		0600	14.62	8,620			
1800	11.00		1200	14.41	8,270			
2400	11.55		1800	14.21	8,030			
			2400	13.95	7,610			

West Fork Des Moines River at Estherville, Iowa--Continued

Mean discharge, in cubic feet per second, 1969

Day	April	Day	April	Day	April	Day	April
1.....	485	8....	7,250	15....	10,500	23....	4,200
2.....	630	9....	10,700	16....	9,370	24....	3,730
3.....	900	10....	13,700	17....	8,160	25....	3,520
4.....	1,920	11....	15,600	18....	7,120	26....	3,320
5.....	3,010	12....	15,800	19....	6,290	27....	3,150
6.....	4,150	13....	14,400	20....	5,660	28....	2,950
7.....	5,620	14....	12,200	21....	5,160	29....	2,760
				22....	4,730	30....	2,580
Monthly mean discharge, in cubic feet per second.....							6,320
Runoff, in inches.....							5.14

Gage height, in feet, and discharge, in cubic feet per second
at indicated time, 1969

Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge
<u>Apr. 2</u>			<u>Apr. 7</u>			<u>Apr. 12</u>		
2400	4.37		0600	12.62	5,530	0300	17.68	16,000
			1200	12.78	5,710	0600	17.67	16,000
<u>Apr. 3</u>			1800	12.84	5,770	1200	17.65	15,900
1200	4.50		2400	12.98	5,930	1800	17.58	15,700
1800	4.94					2400	17.48	15,300
2400	5.64	1,300	<u>Apr. 8</u>			<u>Apr. 13</u>		
			0600	13.66	6,790	0600	17.37	14,900
<u>Apr. 4</u>			1200	14.08	7,370	1200	17.22	14,400
0600	6.38	1,600	1800	14.32	7,730	1800	17.06	13,900
1200	7.09	1,920	2400	14.80	8,500	2400	16.87	13,200
1800	7.83	2,250						
2400	8.42	2,520	<u>Apr. 9</u>			<u>Apr. 14</u>		
			0600	15.48	9,810	1200	16.51	12,100
<u>Apr. 5</u>			1200	15.99	10,800	2400	16.17	11,300
0600	8.79	2,710	1800	16.32	11,600			
1200	9.07	2,850	2400	16.56	12,300	<u>Apr. 15</u>		
1800	9.97	3,380				1200	15.81	10,500
2400	10.30	3,610	<u>Apr. 10</u>			2400	15.56	9,970
			0600	16.82	13,100			
<u>Apr. 6</u>			1200	17.02	13,700	<u>Apr. 16</u>		
0600	10.21	3,550	1800	17.20	14,400	1200	15.27	9,390
1200	11.08	4,160	2400	17.35	14,900	2400	14.93	8,730
1800	11.69	4,650						
2400	12.13	5,020	<u>Apr. 11</u>			<u>Apr. 17</u>		
			0600	17.47	15,300	1200	14.59	8,140
			1200	17.57	15,600	2400	14.25	7,620
			1800	17.63	15,900			
			2400	17.67	16,000			

5-4767.5 West Fork Des Moines River at Humboldt, Iowa

Location.--Lat 42°43'10", long 94°13'10", in SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec.1, T.91 N., R.29 W., at First Avenue Bridge in City of Humboldt, about 700 ft below dam, 3.9 miles upstream from confluence with East Fork Des Moines River, and at mile 334.3 upstream from mouth of Des Moines River.

Drainage area.--2,256 sq mi.

Gage-height record.--Digital-recorder tape punched at 15-minute intervals. Prior to Oct. 3, 1966, wire-weight gage at same site and datum.

Discharge record.--Stage-discharge relation defined by current-meter measurements. Prior to Oct. 3, 1966, discharges computed from graph of wire-weight gage readings.

Maxima.--March-May 1965: Discharge, 14,400 cfs Apr. 8 (gage height, 13.90 ft).

March-May 1969: Discharge, 18,000 cfs Apr. 14, 1969 (gage height 15.40 ft).

Period of flood record, 1940-69 (excluding 1965 and 1969 floods): Discharge, 11,000 cfs June 23, 1947 (gage height 12.2 ft).

Remarks.--Tables of daily discharges and detailed hydrograph for flood of June 1953 contained in U.S. Geological Survey Water-Supply Paper 1320-A.

Detailed hydrograph for flood of June 1954 contained in U.S. Geological Survey Water-Supply Paper 1370-A. Daily discharge not published for June 1954 flood because of extreme regulation of streamflow by Iowa Public Service Company power dam 700 ft upstream from gage. Power generation and streamflow regulation discontinued August 1964.

Mean discharge in cubic feet per second, 1965

Day	April	May	Day	April	May	Day	April	May
1....	1,520	3,610	11....	12,700	3,100	21....	6,370	2,740
2....	2,150	3,340	12....	12,200	3,010	22....	5,740	2,660
3....	2,920	3,040	13....	13,400	2,850	23....	5,210	2,680
4....	4,600	2,830	14....	12,800	2,730	24....	4,910	2,860
5....	7,330	2,600	15....	11,700	2,610	25....	4,670	3,140
6....	9,340	2,510	16....	10,500	2,790	26....	4,460	3,440
7....	12,500	2,540	17....	9,260	3,160	27....	4,410	3,360
8....	14,300	2,560	18....	8,420	3,280	28....	4,160	3,560
9....	14,000	2,560	19....	7,650	3,170	29....	3,920	3,530
10....	13,700	2,860	20....	6,980	2,950	30....	3,780	3,360
						31....	---	3,170
Monthly mean.....							7,853	2,987
Runoff, in inches.....							3.88	1.53

West Fork Des Moines River at Humboldt, Iowa--Continued

Gage height, in feet, and discharge in cubic feet per second
at indicated time, 1965

Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge
<u>Mar. 30</u>			<u>Apr. 7</u>			<u>Apr. 16</u>		
2400	3.47	276	0600	12.52	12,000	0800	11.78	10,700
			1000	12.57	12,100	2400	11.33	9,770
<u>Mar. 31</u>			2400	13.64	14,000			
1000	3.60	335	<u>Apr. 8</u>			<u>Apr. 17</u>		
1400	3.87	478	1200	13.88	14,400	1200	11.02	9,220
1800	4.09	609	1400	13.90	14,400	2400	10.80	8,820
2200	4.40	820	1800	13.89	14,400	<u>Apr. 18</u>		
2400	4.56	932	2400	13.76	14,200	2400	10.36	8,030
<u>Apr. 1</u>			<u>Apr. 9</u>			<u>Apr. 19</u>		
0400	4.99	1,260	0800	13.60	13,900	1600	10.07	7,510
0600	5.12	1,370	2400	13.65	14,000	2400	9.96	7,310
1200	5.38	1,570	<u>Apr. 10</u>			<u>Apr. 20</u>		
1800	5.56	1,730	0800	13.62	13,900	1600	9.71	6,860
2400	5.71	1,870	1200	13.55	13,800	2400	9.62	6,700
<u>Apr. 2</u>			2400	13.23	13,200	<u>Apr. 21</u>		
1200	6.00	2,130	<u>Apr. 11</u>			2400	9.24	6,040
2400	6.35	2,470	1400	12.82	12,500	<u>Apr. 22</u>		
<u>Apr. 3</u>			2400	12.68	12,300	2400	8.86	5,440
1200	6.73	2,850	<u>Apr. 12</u>			<u>Apr. 23</u>		
2400	7.33	3,490	0800	12.56	12,100	1200	8.69	5,190
<u>Apr. 4</u>			1200	12.57	12,100	2400	8.58	5,030
1200	8.24	4,570	2000	12.73	12,400	<u>Apr. 24</u>		
2400	9.06	5,760	2400	12.86	12,600	2400	8.41	4,790
<u>Apr. 5</u>			<u>Apr. 13</u>			<u>Apr. 25</u>		
1200	9.90	7,200	1000	13.44	13,600	2400	8.23	4,560
1600	10.15	7,650	1500	13.43	13,600	<u>Apr. 26</u>		
1800	11.10	9,360	2400	13.33	13,400	0600	8.17	4,480
2000	10.60	8,460	<u>Apr. 14</u>			2400	8.10	4,400
2400	10.55	8,370	1000	13.10	13,000	<u>Apr. 15</u>		
<u>Apr. 6</u>			2400	12.58	12,100	1200	12.33	11,700
0400	10.59	8,440	<u>Apr. 15</u>			2400	12.08	11,200
1200	10.96	9,110	1200	12.33	11,700			
1800	11.52	10,100	2400	12.08	11,200			
2400	11.85	10,800						

West Fork Des Moines River at Humboldt, Iowa--Continued

Mean discharge, in cubic feet per second, 1969

Day	April	Day	April	Day	April	Day	April
1.....	2,680	8....	5,860	15....	17,600	23....	7,740
2.....	2,570	9....	6,110	16....	16,400	24....	7,080
3.....	2,930	10....	6,650	17....	14,900	25....	6,700
4.....	4,140	11....	8,160	18....	13,400	26....	6,360
5.....	4,700	12....	12,600	19....	11,800	27....	5,940
6.....	5,410	13....	16,400	20....	10,700	28....	5,540
7.....	5,720	14....	17,800	21....	9,310	29....	5,130
				22....	8,440	30....	4,860
Monthly mean discharge, in cubic feet per second.....							8,454
Runoff, in inches.....							4.18

Gage height, in feet, and discharge, in cubic feet per second
at indicated time, 1969

Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge
<u>Apr. 2</u>			<u>Apr. 8</u>			<u>Apr. 14</u>		
2400	6.46	2,680	1200	8.95	5,830	0600	15.27	17,700
			2400	9.04	5,960	1200	15.35	17,900
<u>Apr. 3</u>						2000	15.40	18,000
0600	6.43	2,650	<u>Apr. 9</u>			2400	15.38	18,000
1200	6.70	2,940	1200	9.13	6,100			
1800	6.90	3,160	2400	9.20	6,200	<u>Apr. 15</u>		
2400	7.14	3,430				0600	15.31	17,800
			<u>Apr. 10</u>			1200	15.22	17,600
<u>Apr. 4</u>			1200	9.48	6,620	1800	15.12	17,400
0600	7.61	4,000	2400	9.82	7,130	2400	14.99	17,000
1200	7.95	4,450						
1800	7.84	4,300	<u>Apr. 11</u>			<u>Apr. 16</u>		
2400	7.82	4,280	0600	10.08	7,520	0600	14.85	16,700
			1200	10.38	8,020	1200	14.70	16,400
<u>Apr. 5</u>			1800	10.81	8,770	1800	14.53	16,100
0600	7.97	4,470	2400	11.34	9,700	2400	14.33	15,700
1200	8.17	4,730						
1800	8.34	4,950	<u>Apr. 12</u>			<u>Apr. 17</u>		
2400	8.48	5,130	0600	12.02	11,000	1200	13.97	14,900
			1200	12.83	12,700	2400	13.58	14,200
<u>Apr. 6</u>			1800	13.55	14,100			
1200	8.67	5,410	2400	14.02	15,000	<u>Apr. 18</u>		
2400	8.81	5,620				1200	13.21	13,400
			<u>Apr. 13</u>			2400	12.81	12,600
<u>Apr. 7</u>			0400	14.32	15,600			
1200	8.89	5,740	0800	14.56	16,100	<u>Apr. 19</u>		
2400	8.92	5,780	1200	14.76	16,500	1200	12.38	11,800
			1800	14.98	17,000	2400	12.11	11,100
			2400	15.14	17,400			

5-4780 East Fork Des Moines River near Burt, Iowa

Location.--Lat 43°12'35", long 94°10'40", in NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec.20, T.97 N., R.28 W., on right bank 30 ft downstream from highway bridge, 0.8 mile upstream from Buffalo Creek, 2.5 miles northeast of Burt, 5.3 miles downstream from Mud Creek, and at mile 389.7 upstream from mouth of Des Moines River.

Drainage area.--462 sq mi.

Gage-height record.--Digital-recorder tape punched at 15-minute intervals. Datum of gage is 1,114.42 ft above mean sea level, datum of 1929. Prior to Sept. 30, 1966, graphic water-stage recorder chart for same site and datum.

Discharge record.--Stage-discharge relation defined by current-meter measurements. Backwater from ice Mar. 1 to Apr. 9, 1965 (no gage-height record Mar. 1-15, 18-30, 1965).

Maxima.--March-May 1965: Discharge, 5,000 cfs Apr. 6 (gage height, 14.21 ft).

March-May 1969: Discharge, 3,280 cfs Apr. 8 (gage height, 12.09 ft).

Period of flood record, 1952-69 (excluding 1965 and 1969 floods): Discharge 3,870 cfs June 21, 1954 (gage height, 12.67 ft).

Remarks.--Tables of daily discharge and detailed hydrographs for flood of June 21, 1954, published in U.S. Geological Survey Water-Supply Paper 1370-A.

Mean discharge, in cubic feet per second, 1965

Day	April	May	Day	April	May	Day	April	May
1....	400	1,000	11....	3,110	1,110	21....	1,550	682
2....	470	960	12....	2,920	1,020	22....	1,450	650
3....	660	888	13....	2,680	920	23....	1,340	625
4....	1,100	828	14....	2,480	844	24....	1,270	610
5....	2,000	858	15....	2,340	814	25....	1,250	625
6....	3,900	1,110	16....	2,190	883	26....	1,310	744
7....	3,600	1,180	17....	2,090	876	27....	1,260	884
8....	3,900	1,230	18....	1,980	837	28....	1,230	848
9....	4,500	1,120	19....	1,820	828	29....	1,170	807
10....	3,490	1,040	20....	1,700	762	30....	1,090	741
						31....	---	688
Monthly mean.....							2,008	871
Runoff, in inches.....							4.85	2.17

East Fork Des Moines River near Burt, Iowa--Continued

Gage height, in feet, and discharge, in cubic feet per second
at indicated time, 1965

Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge
<u>Mar. 30</u>			<u>Apr. 4</u>			<u>Apr. 9</u>		
2400	7.31		1600	11.98		0800	13.46	4,930
			2400	12.32		1500	13.37	4,810
<u>Mar. 31</u>			<u>Apr. 5</u>			2000	13.12	4,360
1000	7.45		0300	12.65		2400	12.85	3,700
1400	7.65		0600	12.98		<u>Apr. 10</u>		
1600	8.09		2400	13.53		1200	12.74	3,480
1800	8.89		<u>Apr. 6</u>			2400	12.54	3,280
2000	9.39		1200	13.90		<u>Apr. 11</u>		
2400	9.83		1600	14.14		1200	12.40	3,100
<u>Apr. 1</u>			2100	14.21	5,000	2400	12.28	2,980
1200	10.33		2400	14.19		<u>Apr. 12</u>		
1600	10.47		<u>Apr. 7</u>			2400	12.17	2,860
2100	10.97		1200	13.74		<u>Apr. 13</u>		
2400	10.89		2400	13.64		2400	11.95	2,500
<u>Apr. 2</u>			<u>Apr. 8</u>					
1200	10.69		0400	13.64				
2400	10.72		1800	13.96				
<u>Apr. 3</u>			2400	13.84				
1200	10.76							
1500	10.97							
1600	11.15							
1700	11.35							
1900	11.65							
2400	11.80							

5-4790 East Fork Des Moines River at Dakota City, Iowa

Location.--Lat 42°43'25", long 94°11'30", in NW¼SE¼ sec.6, T.91 N., R.28 W., on right bank 50 ft upstream from old mill dam, in city park at east edge of Dakota City, 500 ft upstream from county highway bridge, 0.6 mile downstream from bridge on State Highway 3, 3.4 miles upstream from confluence with West Fork Des Moines River and at mile 333.85 upstream from mouth of Des Moines River.

Drainage area.--1,308 sq mi. At site used prior to Oct. 1, 1954, 1,268 sq mi.

Gage-height record.--Water-stage recorder graph. Datum of gage is 1,038.71 ft above mean sea level, datum of 1929. Prior to Oct. 1, 1954, wire-weight gage at site 8 miles upstream at different datum.

Discharge record.--Stage-discharge relation defined by current-meter measurements. Backwater from ice Mar. 1 to Apr. 6, 1965.

Maxima.--March-May 1965: Discharge, 15,700 cfs Apr. 9 (gage height, 23.13 ft).

March-May 1969: Discharge, 5,990 cfs Apr. 9 (gage height, 16.21 ft).

Period of flood record, 1938, 1940-69 (excluding 1965 and 1969 floods): Discharge 18,800 cfs June 21, 1954 (gage height 16.95 ft, from floodmark, site and datum then in use). Flood of June 21, 1954, reached a stage of 24.02 ft (discharge 17,400 cfs) at present site.

Remarks.--Tables of daily discharges and detailed hydrograph for flood of June 20, 1954, published in U.S. Geological Survey Water-Supply Paper 1370-A.

Mean discharge, in cubic feet per second, 1965

Day	April	May	Day	April	May	Day	April	May
1....	1,020	2,420	11....	10,600	1,770	21....	3,380	1,720
2....	1,520	2,250	12....	8,520	1,760	22....	3,090	1,630
3....	3,000	2,070	13....	7,460	1,690	23....	2,850	1,550
4....	4,700	1,910	14....	6,660	1,650	24....	2,650	1,470
5....	7,000	1,780	15....	6,000	1,720	25....	2,560	1,460
6....	10,800	1,680	16....	5,410	1,890	26....	2,570	2,120
7....	14,400	1,570	17....	4,930	1,960	27....	2,580	2,250
8....	15,400	1,540	18....	4,450	1,880	28....	2,550	1,990
9....	15,400	1,600	19....	4,050	1,810	29....	2,560	1,900
10....	13,200	1,710	20....	3,700	1,780	30....	2,540	1,970
						31....	---	1,970
Monthly mean.....							5,852	1,822
Runoff, in inches.....							4.99	1.61

East Fork Des Moines River at Dakota City, Iowa--Continued

Gage height, in feet, and discharge, in cubic feet per second
at indicated time, 1965

Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge
<u>Mar. 30</u>			<u>Apr. 4</u>			<u>Apr. 8</u>		
2400	9.03		1200	15.75		1200	22.88	15,300
			1700	18.31		2400	23.07	15,600
<u>Mar. 31</u>			1900	17.60		<u>Apr. 9</u>		
0600	9.00		2400	17.87		0500	23.13	15,700
1200	9.25					1200	23.03	15,600
1400	9.63		<u>Apr. 5</u>			2400	22.42	14,500
1700	10.26		0900	19.02				
2400	11.12		2400	21.00		<u>Apr. 10</u>		
<u>Apr. 1</u>			<u>Apr. 6</u>			2400	20.81	11,900
1200	12.13		0400	21.50				
1800	12.75		0800	20.13		<u>Apr. 11</u>		
2400	12.93		1200	20.36	11,200	2400	19.07	9,400
			2400	21.85	13,600			
<u>Apr. 2</u>			<u>Apr. 7</u>			<u>Apr. 12</u>		
0800	13.12		0400	22.09	14,000	0600	18.67	8,870
2400	14.10		0800	21.80	13,500	1800	18.09	8,120
			1200	22.38	14,400	2400	17.84	7,810
<u>Apr. 3</u>			2400	22.97	15,400			
2400	15.16							

Mean discharge, in cubic feet per second, 1969

Day	April	Day	April	Day	April	Day	April
1.....	3,770	8....	5,560	15....	4,580	23....	2,620
2.....	3,480	9....	5,890	16....	4,410	24....	2,390
3.....	3,210	10....	5,890	17....	4,240	25....	2,190
4.....	3,700	11....	5,480	18....	4,190	26....	2,040
5.....	4,190	12....	5,060	19....	3,870	27....	1,930
6.....	4,650	13....	4,870	20....	3,520	28....	1,820
7.....	5,060	14....	4,750	21....	3,180	29....	1,730
				22....	2,890	30....	1,640
Monthly mean discharge, in cubic feet per second.....							3,760
Runoff, in inches.....							3.21

5-4800 Lizard Creek near Clare, Iowa

Location.--Lat 42°32'40", long 94°20'45", in NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec.11, T.89 N., R.30 W., on right bank 20 ft downstream from county highway bridge, 3 miles south of Clare, 8 miles northwest of Fort Dodge, and 8.9 miles upstream from South Lizard Creek.

Drainage area.--257 sq mi.

Gage-height record.--Digital-recorder tape punched at 15-minute intervals since July 18, 1967. Concrete control since Oct. 11, 1956. Datum of gage 1,079.30 ft above mean sea level, datum of 1929. Prior to May 6, 1953, wire-weight gage and May 6, 1953, to July 18, 1967, water-stage recorder graph at same site and datum.

Discharge record.--Stage-discharge relation defined by current-meter measurements and by logarithmic plotting above 4,500 cfs.

Maxima.--April 1969: Discharge, 1,490 cfs Apr. 5 (gage height, 6.96 ft).

Period of flood record, March 1940-69: Discharge, 10,000 cfs June 23, 1947 (gage height, 16.0 ft from floodmark).

Remarks.--Tables of daily discharge and detailed hydrograph for flood of June 20, 1954, (second highest of record) published in U.S. Geological Survey Water-Supply Paper 1370-A.

5-4805 Des Moines River at Fort Dodge, Iowa

Location--Lat 42°30'25", long 94°12'00", in NW¼SW¼ sec.19, T.89 N., R.28 W., on right bank 400 ft upstream from Soldier Creek, 1,800 ft downstream from Illinois-Central Railroad bridge in Fort Dodge, 2,000 ft downstream from Lizard Creek, and at mile 314.6.

Drainage area--4,190 sq mi.

Gage-height record--Water-stage recorder graph since Dec. 8, 1949. Datum of gage is 969.38 ft above mean sea level, datum of 1929. Apr. 22, 1905, to July 19, 1906, chain gage at bridge, 3,000 ft downstream, at different datum. Oct. 18, 1913, to Oct. 20, 1921, June 20 to Sept. 30, 1927, chain gage, and Oct. 21, 1921, to June 19, 1927, water-stage recorder, at site 7 miles downstream at Kalo, at different datum. Oct. 1, 1946, to Dec. 7, 1949, wire-weight gage at bridge 1,800 ft upstream from present site, at present datum.

Discharge record--Stage-discharge relation defined by current-meter measurements.

Maxima--March-May 1965: Discharge, 35,600 cfs Apr. 8, 1965 (gage height, 17.79 ft).

March-May 1969: Discharge, 22,900 cfs Apr. 15, 1969 (gage height, 12.83 ft).

Period of flood record, 1905-06, 1914-27, 1947-69 (excluding 1965 and 1969 floods): Discharge, 35,400 cfs June 21, 1954 (gage height, 19.28 ft).

Remarks--Tables of daily discharges and detailed hydrograph for flood of June 1954 published in U.S. Geological Survey Water-Supply Paper 1370-A.

Mean discharge, in cubic feet per second, 1965

Day	April	May	Day	April	May	Day	April	May
1....	3,300	6,770	11....	26,200	5,380	21....	11,300	4,980
2....	7,000	6,260	12....	22,800	5,350	22....	10,400	4,870
3....	9,600	5,750	13....	21,900	5,020	23....	9,620	4,800
4....	12,000	5,290	14....	20,900	4,800	24....	8,860	4,960
5....	17,000	5,020	15....	19,000	4,810	25....	8,560	5,920
6....	23,500	4,890	16....	17,200	5,320	26....	8,470	9,920
7....	30,600	4,650	17....	15,500	5,830	27....	8,220	8,420
8....	35,100	4,560	18....	14,200	5,840	28....	7,760	7,340
9....	34,000	4,560	19....	13,100	5,600	29....	7,460	6,740
10....	30,900	5,000	20....	12,200	5,310	30....	7,180	6,470
						31....	---	6,130
Monthly mean.....							15,790	5,695
Runoff, in inches.....							4.21	1.57

Des Moines River at Fort Dodge, Iowa--Continued

Gage height, in feet, and discharge in cubic feet per second
at indicated time, 1965

Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge	Hour	Gage height	Dis-charge
<u>Mar. 30</u>			<u>Apr. 7</u>			<u>Apr. 13</u>		
2400	4.79		1300	15.96	30,300	2000	13.03	22,000
			1800	16.97	33,200	2400	12.99	21,900
<u>Mar. 31</u>			2000	17.16	33,800			
0830	6.61		2400	17.35	34,300	<u>Apr. 14</u>		
1200	4.28					1200	12.62	20,900
2400	8.11		<u>Apr. 8</u>			2400	12.26	19,900
			0400	17.55	34,900			
<u>Apr. 1</u>			0600	17.67	35,200	<u>Apr. 15</u>		
1200	8.11		0630	17.79	35,600	1200	11.94	19,000
2400	9.37		1600	17.70	35,300	2400	11.63	18,200
			1700	17.60	35,000			
<u>Apr. 2</u>			2400	17.58	35,000	<u>Apr. 16</u>		
1200	8.41					1800	11.06	16,700
2400	9.36		<u>Apr. 9</u>			2400	10.89	16,200
			1200	17.29	34,100			
<u>Apr. 3</u>			2400	16.90	33,000	<u>Apr. 17</u>		
0730	9.17					0800	10.69	15,700
1200	9.46		<u>Apr. 10</u>			1000	10.58	15,400
2400	10.20		1200	16.21	31,000	1200	10.59	15,500
			2400	15.38	28,600	2400	10.35	14,900
<u>Apr. 4</u>						<u>Apr. 18</u>		
1200	10.68		<u>Apr. 11</u>			1200	10.08	14,200
2400	11.97		1200	14.47	26,000	2400	9.85	13,600
			2400	13.88	24,300			
<u>Apr. 5</u>			<u>Apr. 12</u>			<u>Apr. 19</u>		
1200	12.53		1200	13.27	22,600	0800	9.71	13,300
1700	14.98		1800	13.09	22,100	1200	9.65	13,100
2400	12.52		2400	12.98	21,800	2400	9.46	12,700
<u>Apr. 6</u>								
0600	12.82	21,400						
1000	13.38	22,900						
2400	14.83	27,000						

Mean discharge, in cubic feet per second, 1969

Day	April	Day	April	Day	April	Day	April
1.....	7,930	8....	13,000	15....	22,600	23....	11,500
2.....	7,600	9....	13,400	16....	21,700	24....	10,400
3.....	7,750	10....	13,700	17....	20,400	25....	9,580
4....	11,400	11....	14,200	18....	19,400	26....	8,860
5.....	12,300	12....	16,900	19....	17,500	27....	8,280
6.....	12,500	13....	20,700	20....	15,800	28....	7,620
7.....	12,700	14....	22,600	21....	14,200	29....	7,130
				22....	12,800	30....	6,750
Monthly mean discharge, in cubic feet per second.....							13,370
Runoff, in inches.....							3.56

5-4810 Boone River near Webster City, Iowa

Location.--Lat 42°26'00", long 93°48'15", in NW¼SE¼ sec.18, T.88 N., R.25 W., on right bank 10 ft upstream from bridge on State Highway 17, 2 miles south of Webster City, and 4.5 miles downstream from White Fox Creek.

Drainage area.--844 sq mi.

Gage-height record.--Digital-recorder tape punched at 15-minute intervals. Datum of gage is 989.57 ft above mean sea level, datum of 1929.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--April 1969: Discharge, 3,460 cfs Apr. 6 (gage height, 7.30 ft).

Period of flood record 1940-April 1969: Discharge, 20,300 cfs June 22, 1954 (gage height, 18.55 ft).

Maximum stage known since 1896, 19.1 ft about June 10, 1918, from floodmarks, from information by local resident (discharge, 21,500 cfs).

Remarks.--Tables of daily discharges and detailed hydrograph for flood of June 1954 in U.S. Geological Survey Water-Supply Paper 1370-A.

5-4815 Des Moines River near Boone, Iowa

Location.--Lat 42°04'38", long 93°56'06", in NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec.24, T.84 N., R.27 W., on left bank 30 ft upstream from Boone Water Department dam, 2 miles northwest of Boone, 2.2 miles upstream from Bluff Creek, and at mile 258.8.

Drainage area.--5,511 sq mi.

Gage-height record.--Water-stage recorder graph since Feb. 7, 1935. Concrete control since Oct. 20, 1932. Datum of gage is 872.16 ft above mean sea level, adjustment of 1929 (levels by Corps of Engineers). Chain gage at site 2.5 miles downstream at datum 7.87 ft lower in 1918.

Discharge record.--Stage-discharge relation defined by current-meter measurements.

Maxima.--March-May 1969: Discharge, 24,000 cfs April 16 (gage height, 14.43 ft).

Period of flood record 1903, 1905-29, 1931-69: Discharge, 57,400 cfs June 22, 1954 (gage height, 25.35 ft, from graph based on hourly gage readings).

Remarks.--Tables of daily discharges and detailed hydrograph for flood of June 1954 published in U.S. Geological Survey Water-Supply Paper 1370-A.