PREPARED IN COOPERATION WITH THE
STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES

FLOODS ON ROCK RIVER IN SOUTHWESTERN JEFFERSON COUNTY, WISCONSIN

Many flood plains in the Nation are being used uneconomically, and potential flood losses are increasing despite costly structures built to control floods. To enhance economical utilization of the flood plains in Wisconsin, the Wisconsin legislature incorporated flood-plain zoning legislation in the Wisconsin Water Resources Act (Section 31, Chapter 614, Laws of Wisconsin, 1965). This legislation gave the counties, cities, and villages the responsibility of enacting, administering, and enforcing reasonable and effective flood-plain regulations.

The Water Resources Act also delegated to the Wisconsin Department of Natural Resources the responsibility for guiding and coordinating the efforts of the local units of government. One phase of this responsibility was establishing and upgrading minimum statewide standards for flood-plain regulations. Minimum standards adopted in the Wisconsin Administrative Code, Chapter RD 16, require that flood-plain regulations be based on sound technical evaluation of potential flooding (Wis. Dept. of Resource Development, 1968). To accomplish this goal for the entire State, the Department of Natural Resources (formerly Department of Resource Development) is coordinating the utilization of technical resources available from the U.S. Geological Survey and from several other Federal, State, and private agencies.

Past flood damages in the Rock River valley have been less severe than those along many other Wisconsin streams. This can be attributed to the irregular distribution of flood events and to the type of flood-plain development. However, much more severe floods may occur on the Rock River. Also, if additional uses of the flood plain are incompatible with nature's requirements for flood plains, flood hazards will increase considerably.

Purpose and scope.—The purposes of this report are to present computed water-surface elevations and to define the areal limits of flood inundation for the regional flood (defined in flood-frequency section); and to discuss briefly the depths, durations, and velocities of floodwaters. The areal limits of flooding on the flood map and the water-surface elevations on the flood profile are intended to aid local units of government in formulating flood-plain regulations compatible with the Department of Natural Resources standards. This information is also useful in the planning and design of any facility located on the flood plain.

The report discusses a reach of the Rock River from the inlet of Lake Koshkonong to the confluence of Johnson Creek, a distance of about 19 river miles. It is the first of two reports on potential Rock River flooding in Jefferson County. All analyses necessary to define potential flood conditions for the 19-mile study reach were made in accordance with minimum statewide standards and in accordance with accepted U.S. Geological Survey techniques.

Cooperation and acknowledgment.—This report is part of a cooperative agreement between the U.S. Geological Survey and the Wisconsin Department of Natural Resources. It was prepared by the U.S. Geological Survey, Water Resources Division, under the administrative direction of C. L. R. Holt, Jr., district chief.

Some of the information contained in this report came from the following sources: the Wisconsin Division of Highways, the Wisconsin Power and Light Company, Jefferson County, the cities of Fort Atkinson and Jefferson, and local residents. Their helpfulness is appreciated.

Basin characteristics.—The Rock River originates near Fond du Lac in east-central Wisconsin and flows southward through Wisconsin and Illinois until it empties into the Mississippi River. The Rock River north of the Wisconsin-Illinois State line is more than 160 miles long and drains 3,410 square miles. Figure 1 shows the location of the Rock River basin within Wisconsin.

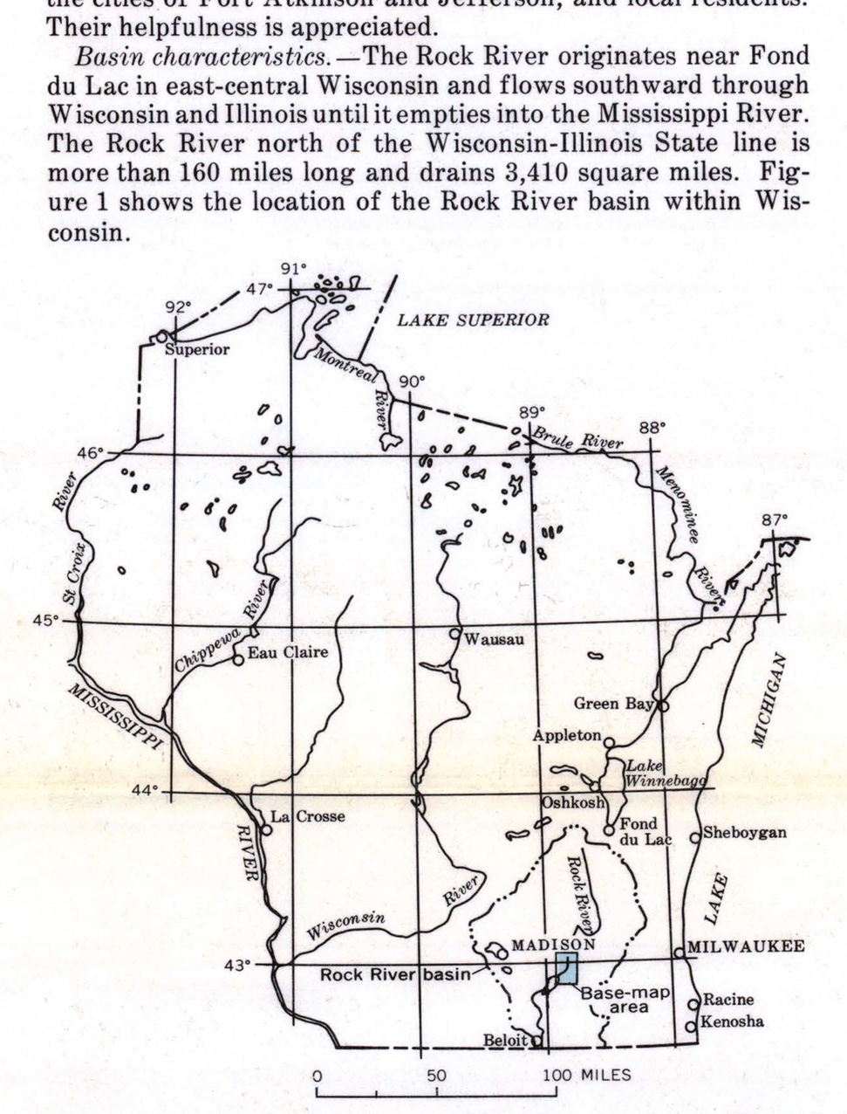


FIGURE 1.—*Location of Rock River basin and base-map area in Wisconsin.*

Characteristics of the basin include gently rolling topography, several marshy areas bordering the drainage network, and many natural lakes. The Rock River basin was described in detail by Cotter and others (1969).

The reach of the Rock River studied for this report is shown in figure 2. The drainage area for the reach increases from 1,010 square miles above Johnson Creek, which enters the Rock River just upstream from County Highway B, to 2,240 square miles at the inlet of Lake Koshkonong.

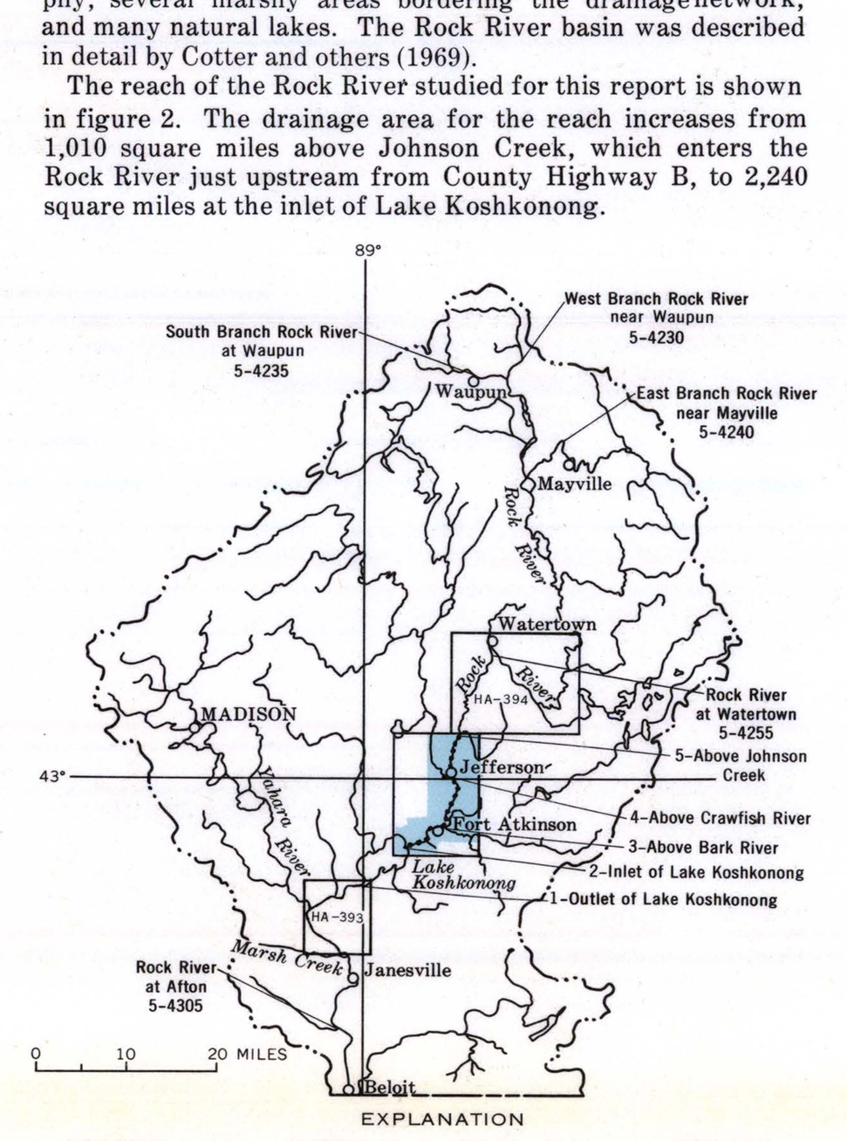


FIGURE 2.—*Rock River basin in Wisconsin. Flood maps in this study area indicated by* HA *number.* HA-413 *shaded.*

Many basin characteristics affect flood discharges. Among the more important are the size of the drainage basin, the slope of the main channel, and the amount of storage in lakes and reservoirs. These characteristics are summarized in the following table for the areas above five selected gaging stations within the Rock River basin.

Rock River basin characteristics

Basin characteristics above station	Gaging-station, number and location (fig. 2)				
	5-4305 Afton	5-4255 Watertown	5-4240 Mayville	5-4235 Waupun	5-4230 Waupun
Drainage area (square miles)	3,300	971	179	62.8	41.4
Main-channel slope (feet per mile)*	1.28	1.38	3.21	8.33	9.58
Lake and reservoir surface area (percent)*	2.71	1.94	0.06	0.00	0.00

*From Ericson (1961).

In general, steeper slopes create higher flood peaks and increased storage reduces flood peaks. Also, an increase in drainage area usually increases flood discharges, although there may be a decrease in the discharge per square mile of drainage area.

In addition to the above factors, areas of permeable sand and gravel, undrained depressions in the glaciated surface (kettles and marshes), and a generally immature drainage system tend to reduce local flood runoff.

Flood history.—The maximum flood for the period of record at each of five stream-gaging stations in the Rock River basin (fig. 2) is tabulated below. Of these gaging stations, those at Afton and Watertown are most closely related to the study reach by location and basin characteristics. Figures 3 and 4 show the highest discharge for each year of record that floodflows exceeded a base discharge of 2,500 and 8,000 cfs (cubic feet per second) at Watertown and Afton, respectively. During their common period of record (1931-66), these stations have a very similar pattern of flood events. Therefore, the records at Afton and Watertown were used to estimate flood discharges within the study reach where there are no streamflow data. Also shown on each figure is the regional-flood discharge for that station.

Maximum recorded floods

Flood data	Gaging-station, number and location (fig. 2)				
	5-4305 Afton	5-4255 Watertown	5-4240 Mayville	5-4235 Waupun	5-4230 Waupun
Period of record	1914-66	1931-66	1949-66	1948-66	1949-66
Date of maximum flood	3-23,24-29	4-4-59	4-3-59	4-3-59	3-27-50
Maximum flood discharge (cubic feet per second)	13,000	5,030	3,400	1,500	949

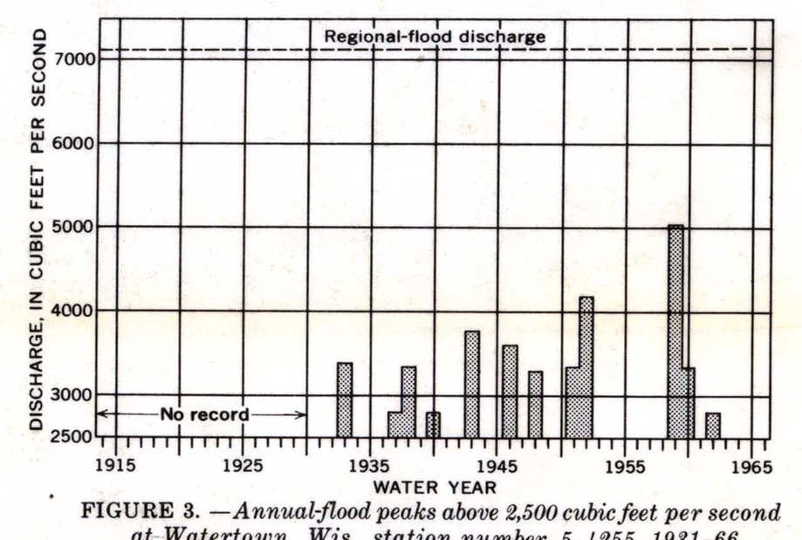


FIGURE 3.—*Annual-flood peaks above 2,500 cubic feet per second at Watertown, Wis., station number 5-4255, 1931-66.*

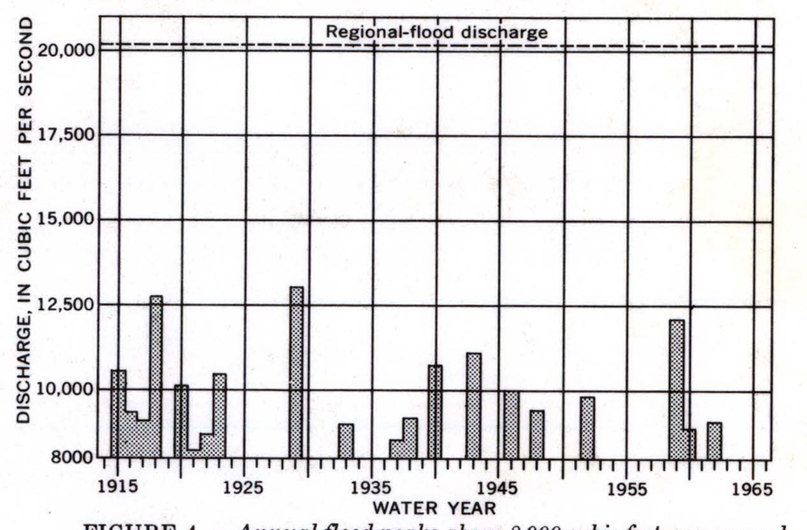


FIGURE 4.—*Annual-flood peaks above 8,000 cubic feet per second at Afton, Wis., station number 5-4305, 1914-66.*

Elevations of the Rock River have been recorded on a daily basis by the city of Ft. Atkinson since 1932. The maximum elevation of the 1929 flood was also recorded. The measuring site is located at the waterplant on the north bank of the Rock River east of the Chicago and Northwestern Railroad bridge. Bankfull stage at this point is 780.5 feet msl (above mean sea level). Figure 5 shows the elevation of annual floods that exceeded bankfull stage at this point. Also shown in figure 5 is the estimated water-surface elevation at this point for the regional flood.

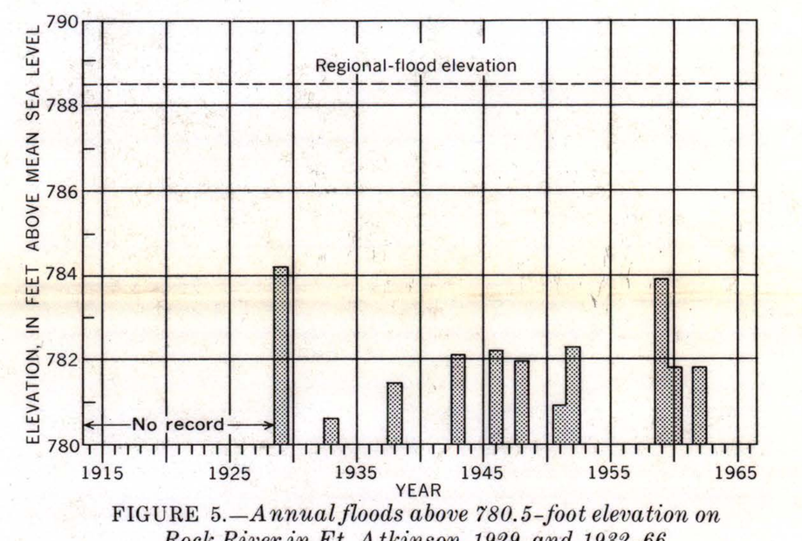


FIGURE 5.—*Annual floods above 780.5-foot elevation on Rock River in Ft. Atkinson, 1929, and 1932-66.*

Flood frequency.—Flood frequencies are stated in terms of their recurrence intervals or in terms of their probabilities of occurrence. The probability of occurrence is virtually the reciprocal of the recurrence interval for floods greater than the 10-year flood. For example, a flood with a recurrence interval of 25 years (25-year flood) will be equaled or exceeded on the average of once in 25 years. Such a flood has a 4-percent probability of occurring in any given year.

Flood-plain regulations in Wisconsin are to be based on flooding caused by the regional-flood discharge. The regional flood is defined as "...a flood determined by the Division of Resource Development[1] which is representative of large floods known to have occurred generally in Wisconsin and reasonably characteristic of what can be expected to occur on a particular stream." (Wis. Dept. of Resource Development, 1968, p. 94). The regional-flood discharge has an average frequency of occurrence of once in 100 years.

Reliable estimates of flood frequency can be made by statistical analysis of data covering a sufficient period of time. Flood-frequency analyses for this study were made in accordance with the recommendations of the U.S. Water Resources Council (1967) and Beard (1962). This method of analysis conforms with Department of Natural Resources standards.

Relations between the discharge and recurrence interval at Afton and Watertown are shown in figure 6. Flood discharges for the 100-year recurrence interval (fig. 6) represent the regional-flood discharges at the Afton and Watertown gages.

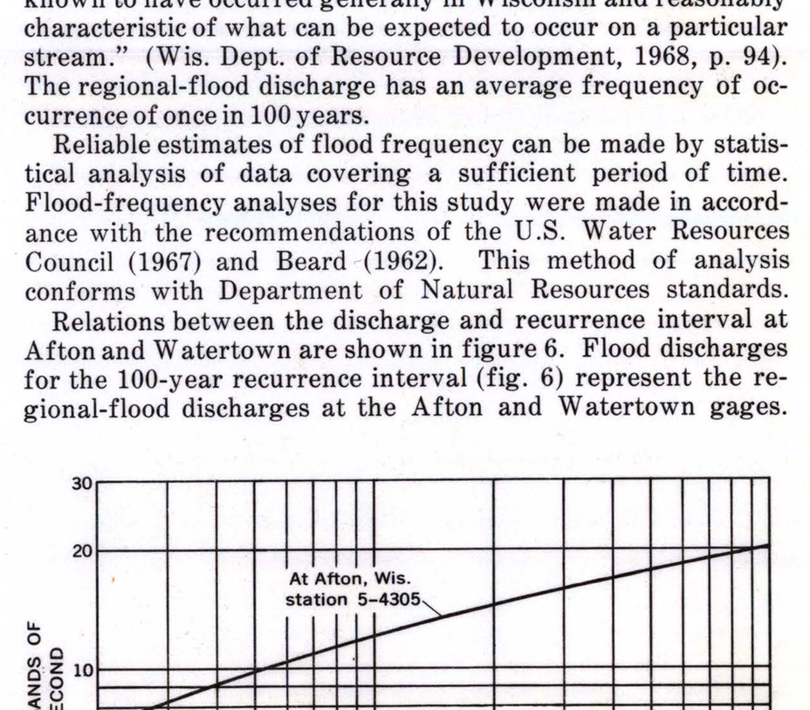
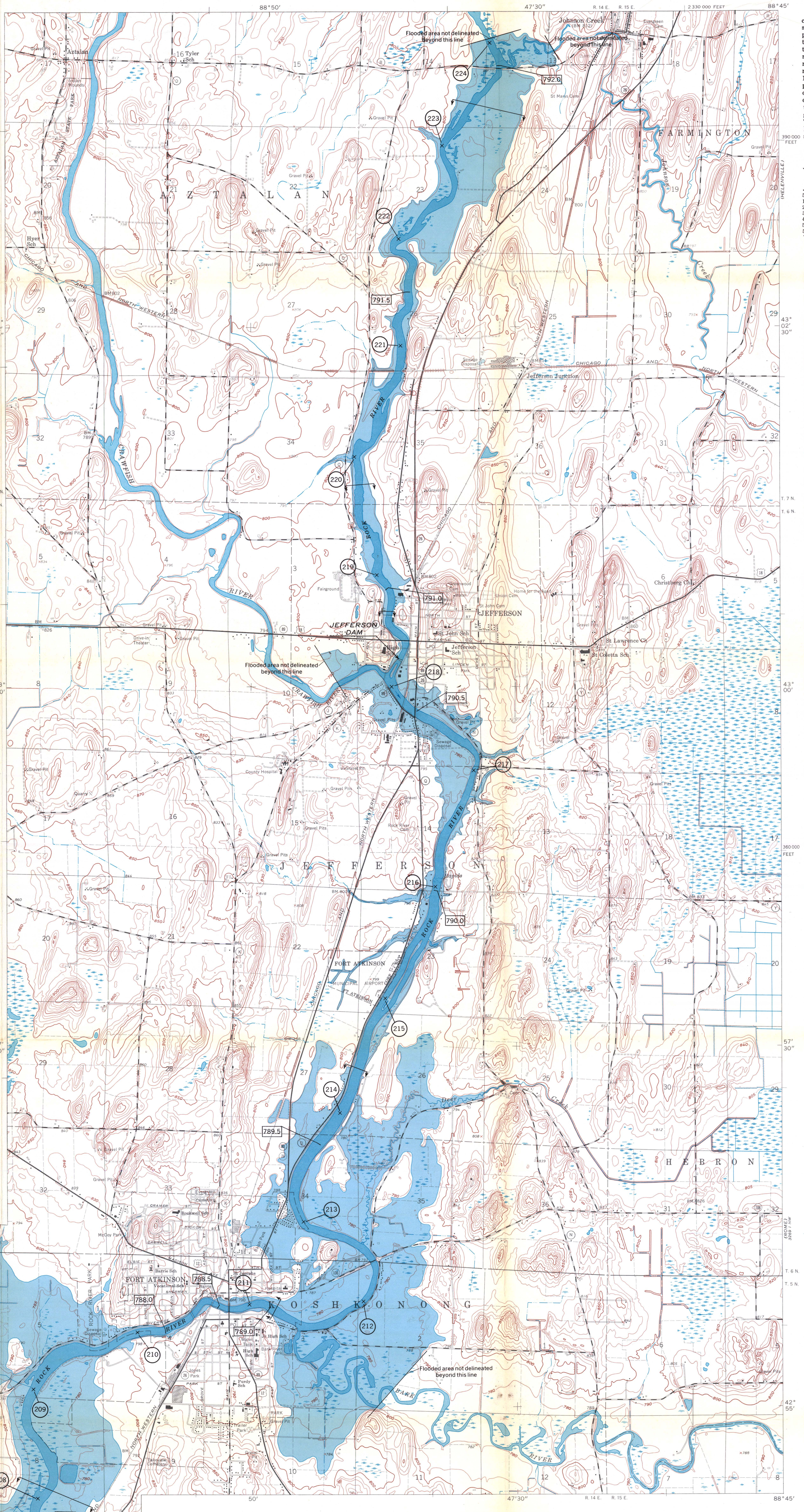
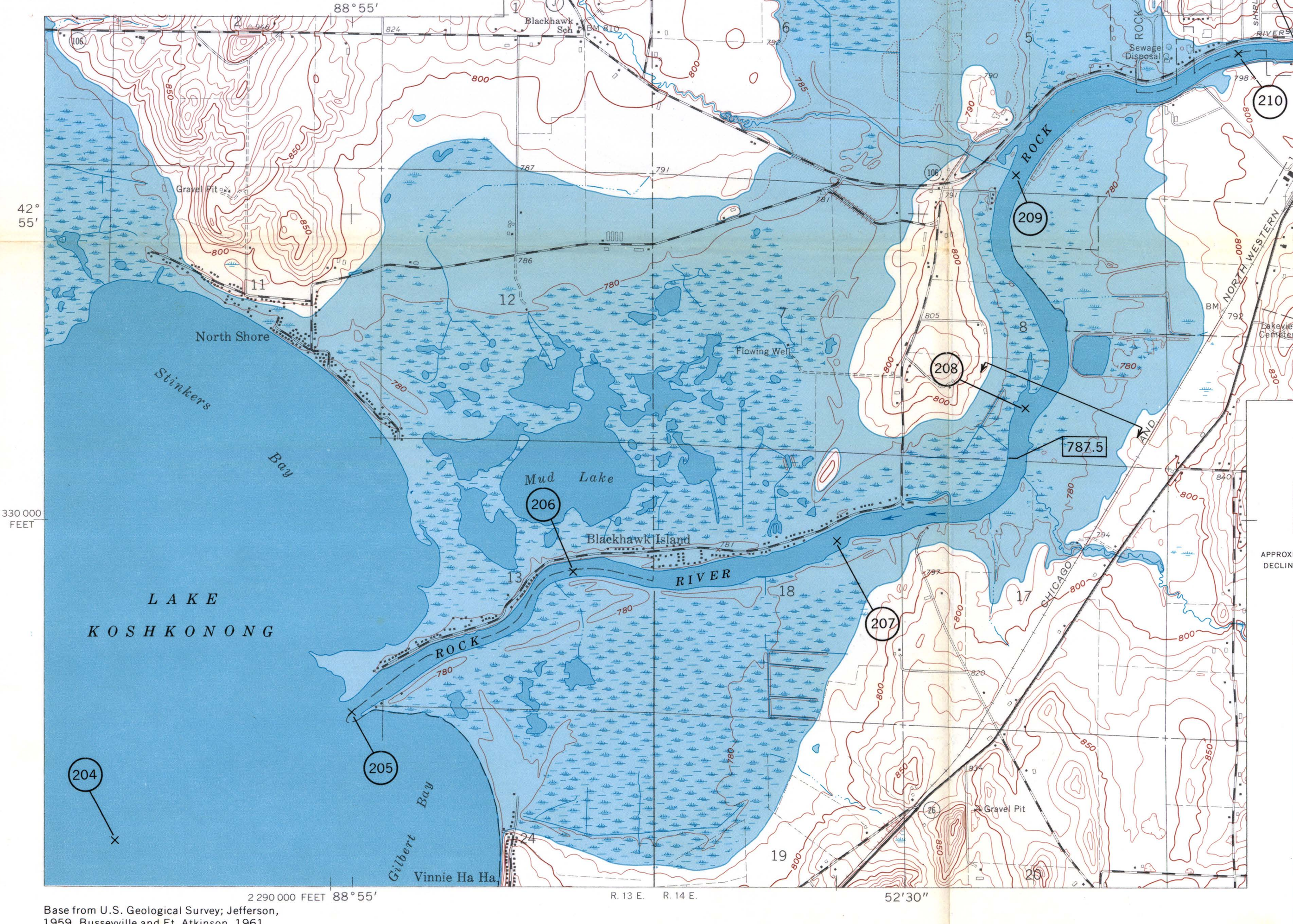


FIGURE 6.—*Frequency of flood discharges on Rock River.*

Floods are irregularly distributed in time as indicated by the 53-year record at Afton (fig. 4). The 5-year flood at Afton has a peak discharge of 9,700 cfs as determined by the frequency analysis. In a 9-year period, 1915-23, this flow was equaled or exceeded four times. In a 10-year period, 1930-39, the annual-flood peaks did not reach this magnitude. However, for the 53-year period of record, 1914-66, the 5-year flood has been equaled or exceeded 10 times. This is close to the expected long-term average of once in 5 years.

[1] Now the Division of Environmental Protection.





Base from U.S. Geological Survey, Jefferson, 1959, Busseyville and Ft. Atkinson, 1961

SCALE 1:24 000
1 MILE
1 KILOMETER
CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL

EXPLANATION

Area that would be inundated by the regional flood	River mile upstream from Mississippi River measured along the stream channel (208)
Boundary of inundated area	Water-surface elevation for the regional flood, in feet above mean sea level (787.5)
Location of typical flood-plain cross section	

Regional-flood discharge.—Estimates of regional-flood discharges within the study reach must reflect the effects of storage and of tributary inflows. Examination of records of past floods on the Rock River and its tributaries indicates that the most reliable estimate of regional-flood discharges at intermediate sites can be made on the basis of drainage-area ratios. Therefore, at key intermediate sites along the study reach between Watertown and the inlet of Lake Koshkonong, regional-flood discharges were estimated by increasing the 100-year flood discharge at Watertown (fig. 6) in direct proportion to the drainage-area ratio. Regional-flood discharges downstream from Lake Koshkonong were estimated by reducing the 100-year flood at Afton (fig. 6) in direct proportion to the drainage-area ratio (Shearman, 1970). A table of regional-flood discharges at specific sites is presented below. The decrease in the regional-flood discharge through Lake Koshkonong is attributed to temporary storage in the lake and surrounding marshes.

Regional-flood discharges on Rock River

Gaging stations and key intermediate sites (fig. 2), number and name	Drainage area (sq mi)	River miles upstream from Mississippi River	Regional-flood discharge (cubic feet per second)
5-4305: Afton gage	3,300	173.0	20,200
1: Outlet of Lake Koshkonong	2,500	198.7	15,300
2: Inlet of Lake Koshkonong	2,240	205.0	16,400
3: Above Bark River	1,850	211.5	13,600
4: Above Crawfish River	1,060	218.1	7,800
5: Above Johnson Creek	1,010	223.8	7,400
5-4255: Watertown gage	971	237.7	7,130

Regional-flood profile and flood map.—The regional-flood profile and the area that would be flooded at the time of the regional-flood discharge are the basic technical information upon which flood-plain regulations are to be based. The flood profile was determined by hydraulic-engineering analyses, and is the basis for constructing the flood map.

To determine the regional-flood profile, more than 70 flood-plain cross sections and supplemental data were obtained by field surveys. Figure 7 shows six typical flood-plain cross sections to illustrate the differences in cross-section geometry in the study reach. Field data were supplemented by information from topographic maps, bridge plans, and plans of Jefferson Dam. Roughness coefficients were estimated by field inspection. These data were used to determine the regional-flood profile by standard step-backwater computations.

The regional-flood profile for the study reach was determined in three parts: 1) from mile 210.8 to the upstream end of the study reach; 2) from mile 207 to mile 210.8; and 3) downstream from mile 207. The regional-flood elevation at the waterplant (mile 210.8) in Ft. Atkinson was determined graphically. Excellent correlation exists between flood discharge at Afton and flood height at Ft. Atkinson for coincident floods. There is somewhat less correlation between flood discharge at Watertown and flood height at Ft. Atkinson for coincident floods. Both of these relationships indicate a regional-flood elevation of 788.5 feet msl at mile 210.8. Therefore, 788.5 feet was the initial water-surface elevation for computation of the regional-flood profile upstream from mile 210.8. Between miles 207 and 210.8, a series of profiles were computed by assigning different elevations at mile 207. The two profiles having water-surface elevations above and below 788.5 feet msl at mile 210.8 were used to interpolate for the regional-flood profile in this reach. Downstream from mile 207, standard step-backwater computations are not applicable due to the extremely wide marshy areas. Therefore, the computed water-surface elevations at mile 198.45 (Shearman, 1970) and mile 207 were connected with a straight line to obtain an estimate of the regional-flood profile downstream from mile 207. The regional-flood profile for the study reach is shown in figure 8.

Regional-flood elevations within the study reach range from 10.7 to 13.6 feet higher than low-water elevations downstream from Jefferson Dam and from 7.7 to 9.0 feet higher than low-water elevations upstream from the dam. A low-water profile for April 1968 is shown in figure 8.

Regional-flood elevations exceed 1959 flood elevations by 3.9 to 4.5 feet within the study reach. The 1959 flood is the highest discharge of record at Watertown and the third highest discharge of record at Afton. The 1959 flood is the second highest flood stage of record at Ft. Atkinson, the 1929 flood being about 0.3 foot higher. The regional-flood profile for the study reach is consistent with the 1959 flood elevations and with the computed regional-flood profile in Rock County (Shearman, 1970).

The regional flood would affect numerous manmade structures within the study reach. Lower bridge members at seven of the ten bridge crossings would be submerged (fig. 8). Also, approach grades at the State Highway 106 bridge east of Ft. Atkinson and at the State Highway 26 and 89 bridge in Jefferson would be inundated by the regional flood. Except for Highway 106, where about 1,500 cfs will flow across the east approach grade, there will not be significant approach-grade overflow. As shown on the flood map, many other streets, roads, and highways will be inundated. At Jefferson Dam, the flood-gate structure would be overflowed by the regional flood.

The flood map shows the area that would be inundated by the regional flood. It was prepared by transferring the water-surface elevations from the regional-flood profile (fig. 8) to the topographic map. River miles on figure 8 correspond to the river miles on the flood map. The base map is a composite of U.S. Geological Survey 7½-minute topographic maps. Flood boundaries on the topographic map between surveyed cross sections were located by interpolating between the contour lines. Large scale topographic maps of Ft. Atkinson and Jefferson were useful in the interpolation. At some cross sections there are significant discrepancies between field-surveyed elevations and contour lines on the base map. Because National Map Accuracy Standards require accuracy to only one-half the contour interval, field-surveyed elevations were used. If greater accuracy is required at a specific site, the flood boundary should be determined by leveling from a point of known elevation.

Depth of flooding.—Depth of flooding at any site can be estimated by subtracting the ground elevation from the flood-profile elevation (fig. 8) at the same river mileage. To aid the reader in this estimation, regional-flood elevations of half foot intervals are indicated on the flood map. Approximate ground elevations can be determined by interpolating between the contour lines on the topographic map. Accurate depths of flooding can be obtained if ground elevations are determined by leveling from a point of known elevation to the site of interest.

Duration of flooding.—Duration of flooding in the study reach will vary depending on the cause of the flood. Floods caused by rainfall will recede about twice as fast as those caused by snowmelt, or rainfall and snowmelt. For example, the flood of September 1938 is the only recorded rainfall flood at Ft. Atkinson that exceeded bankfull stage. This flood remained above bankfull stage for about 12 days. On the other hand, the 1959 flood was caused by a combination of rainfall and snowmelt. This flood remained above bankfull stage at Ft. Atkinson for 23 days.

About 90 percent of the annual floods exceeding bankfull stage at Ft. Atkinson since 1932 occurred from January through May. A flood as large as the regional flood probably would occur in these months and exceed bankfull stage for about 30 days. Ice jams or bridges plugged with debris can considerably lengthen flood duration.

Floodwater velocities.—Computed average floodwater velocities for the regional-flood discharge range between 0.3 and 4.5 fps (feet per second). Downstream from Ft. Atkinson (mile 207 to 209.5), the average floodwater velocities would be about 0.7 fps. In Ft. Atkinson (mile 209.5 to the Bark River), velocities would range from 0.3 to 4.5 fps with the low of 0.3 fps occurring at the confluence of the Bark River and the high of 4.5 fps occurring through the U.S. Highway 12—State Highway 89 bridge. Between Ft. Atkinson and Jefferson (Bark River to mile 217), velocities would range from 1.1 to 2.4 fps, the highest velocities being in the vicinity of the rapids (mile 216). Through Jefferson (mile 217 to 219), velocities would range from 1.1 to 3.0 fps, the highest velocities being in the vicinity of the dam and the bridges. Upstream from Jefferson, velocities would range from 1.0 to 1.8 fps (mile 219 to 222) and from 0.4 to 0.7 fps (upstream from mile 222), with the exception of County Highway B where a velocity of 3.1 fps would occur through the bridge.

Future conditions.—The results of this study are based on conditions existing in 1968. Some factors that might cause deviations from the estimated potential flooding are:

1. Changes in land-use patterns. Such changes could alter runoff patterns and flood-frequency relations.
2. Changes in channel conditions. Such changes could result in a different water-surface profile for any given discharge.
3. Additional flood records may improve flood-frequency estimates.

The flood profile and flood map in this report should not be regarded as a representation of the most severe flooding that might occur in the study reach. It is possible that the regional-flood discharge could be exceeded. Also, ice jams or bridges plugged with debris can cause abnormally high stages that may far exceed stages caused by a much greater but unobstructed discharge.

Additional information.—Detailed information on data in this report and information pertinent to floods throughout Wisconsin can be obtained from the U.S. Geological Survey, Water Resources Division, Madison, Wis.

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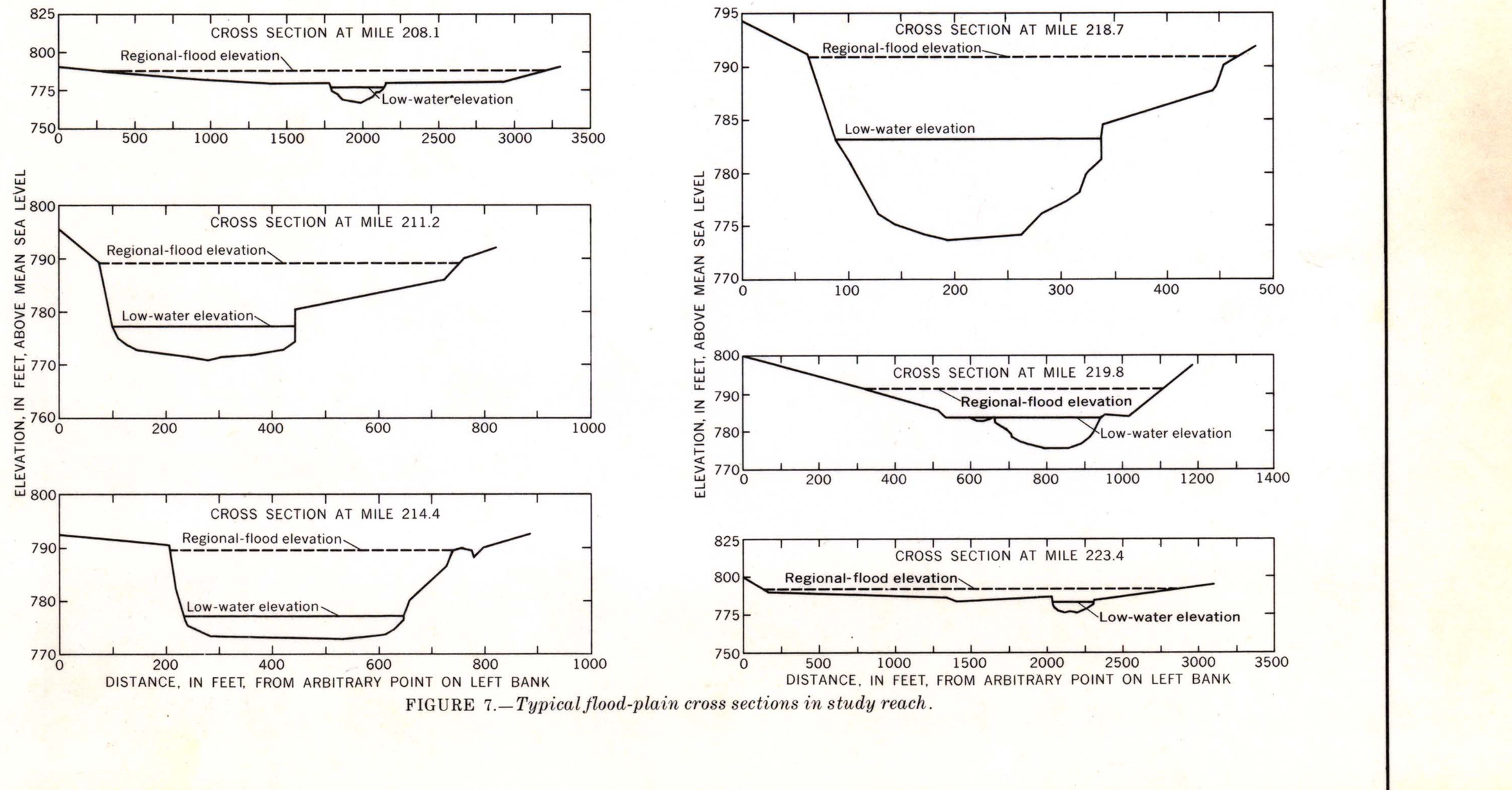

FIGURE 7.—*Typical flood-plain cross sections in study reach.*

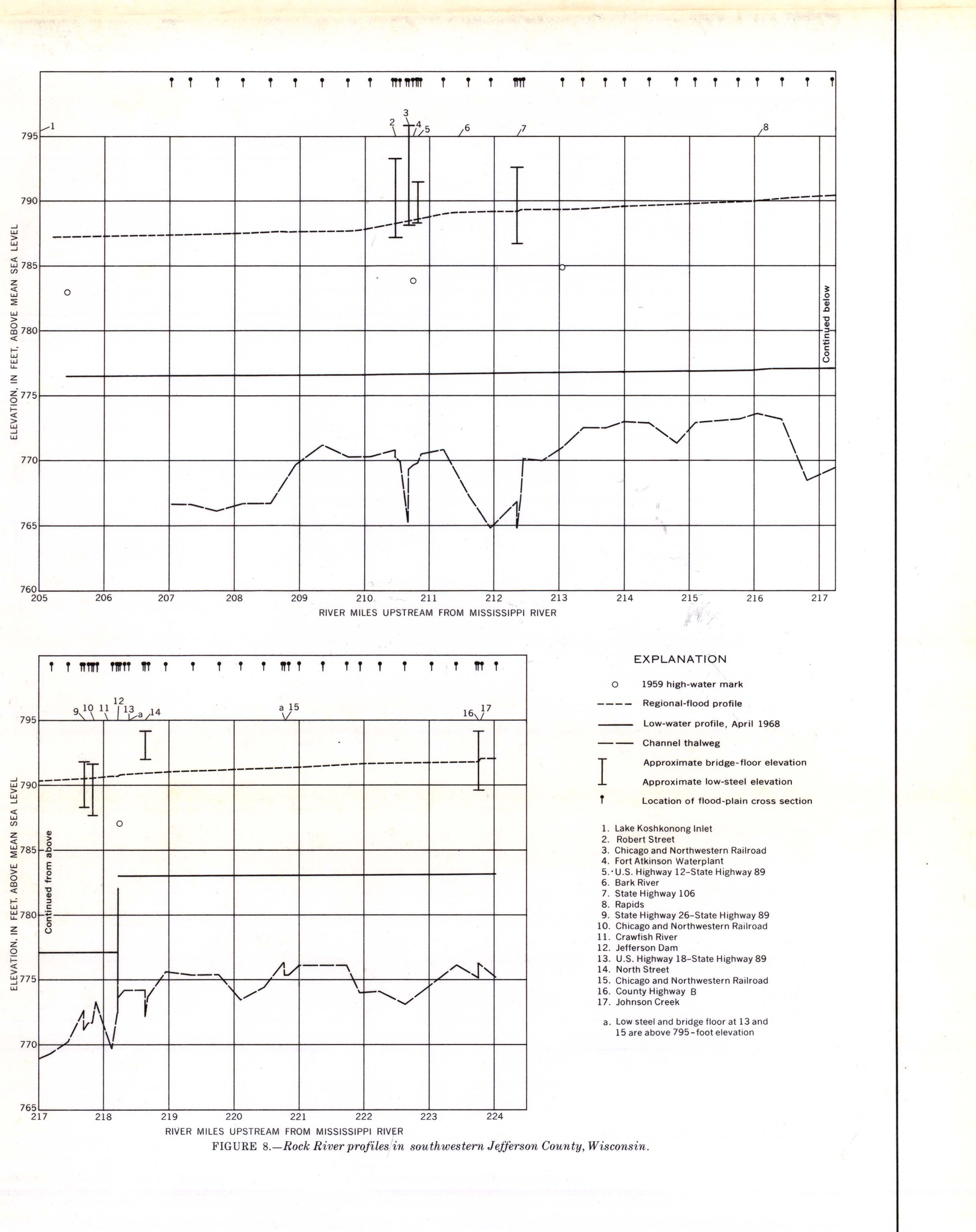

FIGURE 8.—*Rock River profiles in southwestern Jefferson County, Wisconsin.*

Photograph provided by Wisconsin Department of Natural Resources

Flooding at the dam in Jefferson, Wisconsin, during the March 1929 flood on the Rock River.

Photograph by U.S. Geological Survey

Same location during low-flow conditions, December 1969.

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By
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1971

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