UNITED STATES DEPARTMENT OF THE INTERIOR
Harold L. Ickes, Secretary

GEOLOGICAL SURVEY
W. C. Mendenhall, Director

Water-Supply Paper 869

FLOOD OF AUGUST 1935 IN THE MUSKINGUM RIVER BASIN, OHIO

BY

C. V. YOUNGQUIST AND W. B. LANGBEIN

WITH SECTIONS ON THE ASSOCIATED METEOROLOGY AND HYDROLOGY

BY

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UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1941

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FLOOD OF AUGUST 1935 IN THE MUSKINGUM RIVER BASIN, OHIO

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ABSTRACT

Heavy rainfall over the entire Muskingum River Basin with unusually intensive precipitation over the central part, where more than 8 inches of rain fell over an area of 400 square miles during a 12-hour period on August 6-7, 1935, resulted in the largest general summer flood known in this basin. On the smaller streams in the region of intensive precipitation the flood was the greatest of record. On the larger streams the flood was generally exceeded by that of March 1913, and on the lower Muskingum River it was exceeded by four known floods, none of which, however, occurred during the summer.

From July 31 to August 4 there had been a series of rather heavy local showers at various places averaging about 2.8 inches over the basin, which raised the streams and which served to decrease the retentive capacity of the ground and vegetation, with significant effect on the volume of run-off that followed the intensive rains of August 6–7. This report presents a detailed discussion of the rainfall and run-off relations in 27 areas in the basin, thus affording a measure of the flood run-off that might be expected in the region under similar meteorologic and hydrologic conditions.

The direct property loss to agriculture, railroads, and highways is believed to approach $6,000,000. The indirect loss due to interruption of industry, damage to industrial plants, and destruction of personal property has not been estimated but is known to be great.

This report presents in more detail than would be practical in the regular surface water supply papers comprehensive factual information on the stage and discharge at 27 points in the basin and the flood crest stage at 193 points together with pertinent data on previous floods, records for which on the main river extend back with decreasing completeness to 1847.

INTRODUCTION

The flood of August 1935 was the direct result of a short intense summer storm that centered over the Muskingum River Basin during the night of August 6. River stages were the highest that had been recorded during the summer and approached previous maximum stages, all of which had resulted from widespread storm disturbances during the winter months. Coming as it did in the height of the growing season, the storm resulted in crop losses that were unusually severe, the reliably estimated loss through agricultural damage alone amounting to about $3,500,000. Hundreds of people in the river towns along the valley were forced to vacate their homes, and the necessary emergency relief activities were conducted by the American Red Cross and the various county and municipal agencies. The total loss due to physical damages was reported to have reached approximately $6,000,000.

The storm of August 6–7 was the culmination of a rainy period which began on July 20 and during which the rainfall in the Muskingum River Basin was about 5.5 inches, nearly 3.3 inches above normal. The maximum rainfall at any Weather Bureau station during the storm of the night of August 6 was 8.70 inches, reported by the observer at Newcomerstown. Unofficial records indicate, however, that during the same 12-hour period a rainfall exceeding 8 inches occurred over an area of more than 400 square miles and that in some smaller areas the rainfall exceeded 12 inches. The average rainfall over the basin in 12 hours was 4.1 inches, and nearly every point in the basin received at least 2 inches.

The resultant flood stages on many of the smaller creeks in the central basin were higher than any previously known. Unfortunately but few quantitative data are available concerning these creeks. Slope-area measurements of crest discharge at two places in the Mill Creek Basin indicate rates of run-off in that area of 1,270 to 3,190 second-feet per square mile, equivalent to 2.0 to 4.9 inches per hour. Peak rates of discharge were materially less at points regularly gaged, the maximum being 63.5 second-feet per square mile (nearly 0.10 inch per hour) for Sugar Creek at Strasburg.

On the larger streams and in the basin generally the flood was exceeded by that of March 1913.[1] On the lower Muskingum River the flood was exceeded by four known floods.

At the time of the flood, plans for extensive flood control had been made by the Muskingum Watershed Conservancy District, and construction work was in progress by the Corps of Engineers, United States Army, on a system of 14 reservoirs.

Although the project for the partial control of flood waters in the river channels was essentially completed in 1939, operation of the plan and plans for the future require knowledge of the outstanding characteristics of major storms and flood run-off. To that end the preparation of this report was begun soon after the flood, but progress was slow because of the crowded program of regular river measurements. The preparation of the report has been completed by means of funds allotted to the Geological Survey in July 1938 for survey of floods and droughts, by the Federal Emergency Administration of

[1] Horton, A. H., and Jackson, H. J., The Ohio Valley flood of March-April 1913, including comparisons with some earlier floods: U. S. Geol. Survey Water-Supply Paper 334, 96 pp., 1913.

Public Works acting in accordance with the National Industrial Recovery Act of 1933.

This report contains all available records of precipitation and all records of discharge during the flood at river-measurement stations of the Geological Survey in the Muskingum River Basin, as well as records of stages and discharges furnished by other agencies. Figures 1 and 2 illustrate typical hydrographs of flood discharge at selected river-measurement stations in the upper and lower basin plotted from data included in this report.

In addition to the presentation of factual information in tabular form, this report contains explanations of the pertinent data and the flood events, brief discussions of the relation between rainfall and run-off, and finally, a review of previous floods in the Muskingum River Basin.

ADMINISTRATION AND PERSONNEL

The field and office work involved in the preparation of this report was performed by the Water Resources Branch of the Geological Survey, under the general administrative direction of N. C. Grover, chief hydraulic engineer, until his retirement on January 31, 1939, and since that time under C. G. Paulsen, Chief, Division of Surface Waters.

The river-measurement program in Ohio and the preliminary preparation of this report was under the immediate supervision of district engineer Lasley Lee until his death in 1937 and since that time under his successor, C. V. Youngquist. The special work and the assembling of the report was carried on under the general technical direction of R. W. Davenport, Chief, Division of Water Utilization, by W. B. Langbein.

ACKNOWLEDGMENTS

The river-measurement program in operation in Ohio at the time of the flood of August 1935 was in cooperation with the Ohio Cooperative Topographic Survey, C. E. Sherman, inspector-director.

Much valuable information regarding the flood was furnished by the Muskingum Watershed Conservancy District, C. C. Chambers, chief engineer; by the Corps of Engineers, United States Army; and by the Soil Conservation Service, Department of Agriculture. The United States Weather Bureau supplied many records of rainfall observations at its first-order and cooperative stations, of which there were 47 within or near the Muskingum River Basin. The data so supplied are included in this report with appropriate acknowledgments.

The section entitled "Meteorologic and hydrologic conditions" was prepared by Waldo E. Smith, hydraulic engineer of the Muskingum Watershed Conservancy District. Special acknowledgments are due Mr. Smith for his helpful and constructive cooperation in the prepara-

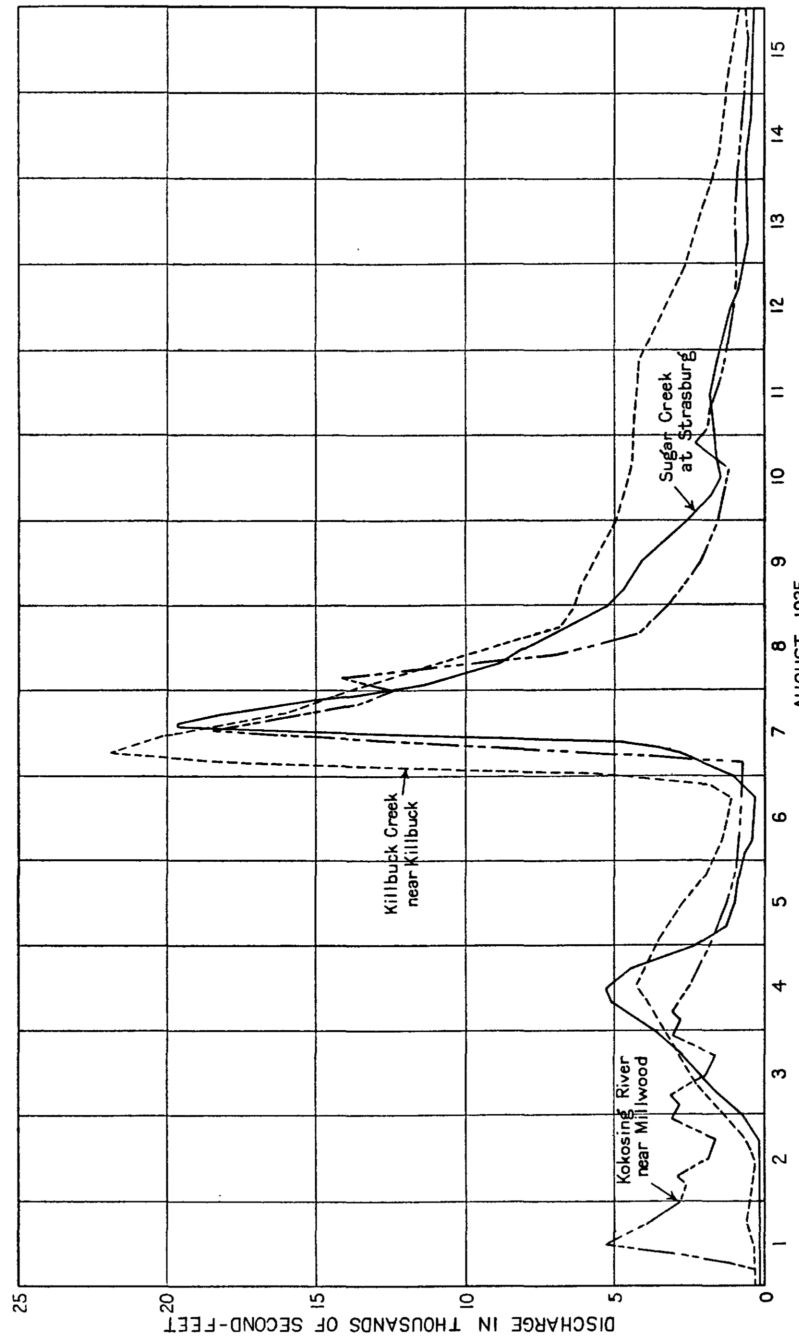

FIGURE 1.—Hydrographs of discharge at river-measurement stations in the upper Muskingum River Basin, August 1-15.

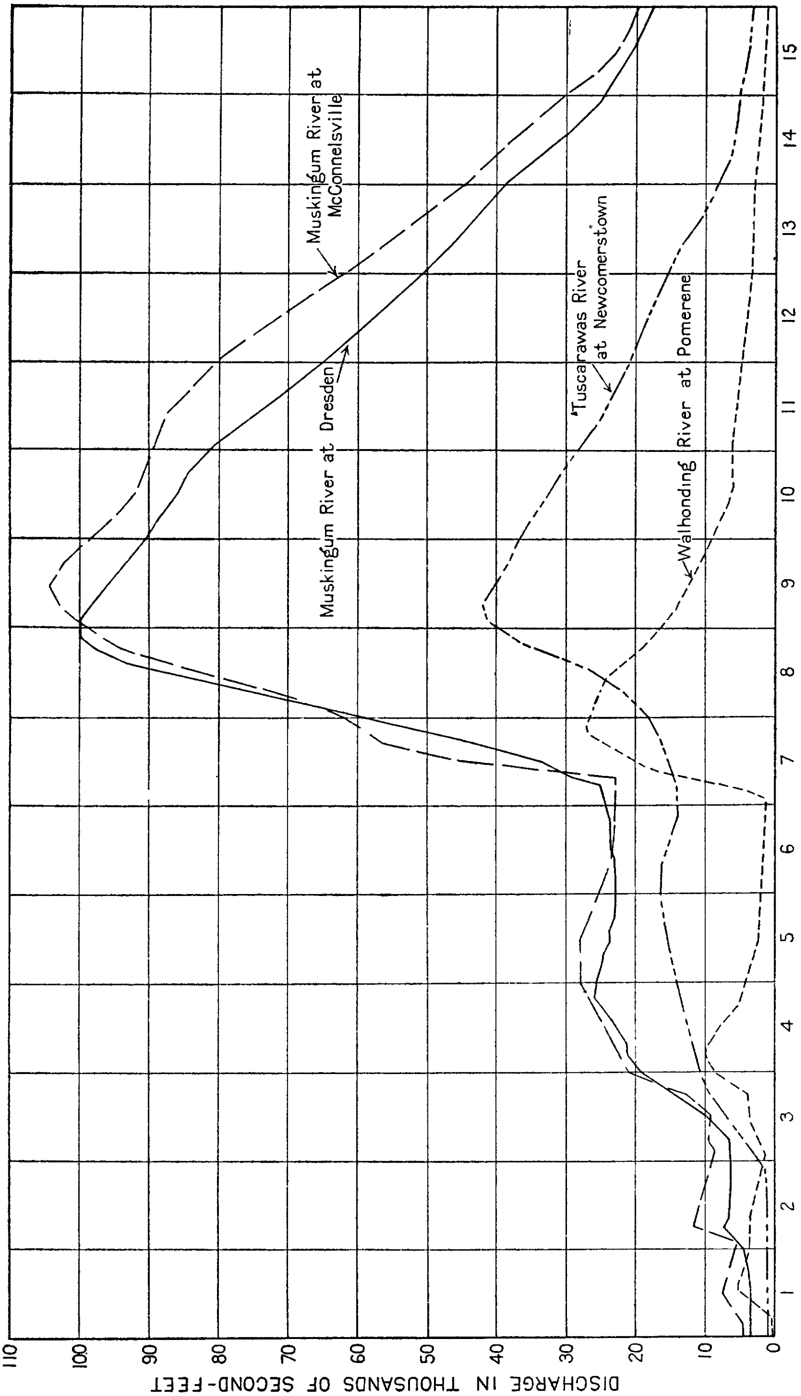

FIGURE 2.—Hydrographs of discharge at river-measurement stations in the lower Muskingum River Basin, August 1-15.

tion of the report. The section "Meteorology of the storm" was prepared by Albert K. Showalter, of the United States Weather Bureau. Acknowledgments are also due Prof. R. W. Powell, Ohio State University, who at the time of the flood was hydraulic engineer for the Muskingum Watershed Conservancy District, for his advice and assistance in collecting data and in preparing the report.

GEOGRAPHY

TOPOGRAPHY, DRAINAGE, AND TRANSPORTATION

The Muskingum River Basin (pl. 1) has an area of 8,038 square miles. It is the largest tributary basin of the Ohio River within the State of Ohio. The basin is within the Allegheny Plateau and may be divided into two general physiographic regions—the glaciated plateau in the western and northern part of the basin and the unglaciated plateau in the southern and eastern part. The glaciated part is characterized by low relief and flat gradients of the hillside slopes and stream channels, whereas the unglaciated area in the southeastern part of the basin presents a more rugged topography with steep slopes and high relief. Many of the valleys in the unglaciated area are believed by geologists to be too wide to be the work of the streams that now occupy them, indicating that they were cut by streams of far greater magnitude.[2] The boundary between the two regions, though obscure, extends across the northern part of Tuscarawas County westward through Holmes County and then in a southerly direction through Perry County.

The Muskingum River proper is formed by the confluence of the Tuscarawas and Walhonding Rivers at Coshocton, from which it flows in a southerly direction 112 miles to its mouth at Marietta, Ohio, with an average slope of 1.45 feet per mile. The Tuscarawas River drains the eastern upper part of the basin and the Walhonding River the western part. The main tributaries below the confluence are Wills Creek from the east, which drains the southeastern part of the basin, and Licking River from the west.

The Tuscarawas River is the largest stream of the Muskingum River Basin. It is about 125 miles long and drains 2,590 square miles in the northeastern part of the basin. The slope of the stream averages 15.3 feet per mile in the upper 15 miles of its length and 2.1 feet per mile from this point to its mouth.

The Walhonding River, formed by the confluence of the Kokosing and Mohican Rivers, has a length of about 24 miles and drains 2,252 square miles in the northwestern part of the basin. The flood plains of the Walhonding River are wide, and the average gradient of the stream is about 3.4 feet per mile. Killbuck Creek, which enters the

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[2] Tight, W. G., Drainage modifications in southeastern Ohio and adjacent parts of West Virginia and Kentucky: U. S. Geol. Survey Prof. Paper 13, 111 pp., 1903.

Walhonding River in its lower reach, has a flatter gradient and flows through a wide valley. The low-water and flood profiles of the Tuscarawas, Muskingum, and Walhonding Rivers are shown in figures 20, 21, and 22, respectively, in the section on "Flood crest stages."

A summary of the drainage areas of the principal tributaries of the Muskingum River follows:

	Square miles
Tuscarawas River	2, 590
Walhonding River	2, 252
Wills Creek	853
Licking River	780
Killbuck Creek	613
Other tributaries	950
Total for Muskingum River	8, 038

The basin is well provided with primary roads, railways, and airports. The Muskingum River is canalized for small barges for a distance of 93 miles above its mouth.

RAINFALL

The mean annual rainfall in the Muskingum River Basin from 1889 to 1935 was 39.17 inches, with a maximum of 56.47 inches in 1890 and a minimum of 25.35 inches in 1930. The rainfall is well distributed over the basin. The mean monthly precipitation for the above period ranged from 2.62 inches for February to 4.45 inches for July; the mean rainfall for August was 3.65 inches.

The Muskingum River Basin lies in the path of rain-producing storms moving from Texas toward the St. Lawrence Valley. It lies south of the main path of storms that frequently move across the continent from west to east over the Great Lakes.

Many of the summer rains in the basin are intense but usually local in extent. Winter rains are not so intense but they are usually of longer duration and occur when the ground is frozen, saturated, or snow-covered, although snowmelt has not been a major constituent of flood run-off. Practically all the major floods have resulted from winter or spring rainstorms, as shown on page 11. The greatest precipitation in 24 hours for each month in the year during the period of record prior to 1929 at Cambridge, in the Muskingum River Basin, as given below, indicates the differences in intensity of winter and summer rainfall.

Maximum precipitation for 24-hour period

	Inches		*Inches*
January	1. 50	July	7. 09
February	2. 17	August	2. 62
March	2. 55	September	4. 25
April	2. 33	October	2. 30
May	2. 26	November	1. 80
June	3. 69	December	1. 62

POPULATION, INDUSTRY, AND MINERAL RESOURCES

The population within the Muskingum Basin as given in the 1930 census was 804,091, of which 403,972 reside in cities and villages of more than 2,500 population. Cities of more than 10,000 population in the basin are Canton (104,906), Zanesville (36,440), Mansfield (33,525), Newark (30,596), Massillon (26,400), Barberton (23,934), Cambridge (16,129), Marietta (14,285), New Philadelphia (12,365), Ashland (11,141), Coshocton (10,908), and Wooster (10,742).

According to the 1930 census about 90,000 people were employed in the manufacturing industries in the basin and about 55,000 were engaged in agriculture.

Agriculture, including stock raising, is the predominant industry in the basin, and the principal crops are corn, wheat, hay, oats, soybeans, potatoes, and garden produce.

The basin also has considerable manufacturing industries, Stark County in the northeastern part of the basin being one of the most highly industrialized sections of the State. Much manufacturing is done throughout the basin. The basin has a large variety of mineral resources, principally bituminous coal, ceramic clays, natural gas, petroleum, sandstone, salt, sand, and gravel.

FLOOD CONTROL

Fourteen reservoirs having a total flood-control capacity of 1,326,400 acre-feet were under construction at the time of the flood in August 1935,[3] but no effective artificial storage was available at the time of the flood.

The dams are of earth-fill type with the exception of Dover Dam, which is concrete. The outlet works are all gate-controlled except at Pleasant Hill Dam, where the principal facility is for automatic operation. Further details regarding these reservoirs are shown in the following table.

[3] The Muskingum flood-control work—a symposium on the $34,500,000 flood-control and water-conservation project in eastern Ohio: Civil Eng., vol. 6, No. 1, p. 1, 1936. Official plan of the Muskingum Watershed Conservancy District, unpublished document, 1934.

TABLE 1.—*Drainage areas and capacities of flood-control reservoirs of Muskingum Watershed Conservancy District*

Reservoir	Location	Drainage area (square miles)	Capacity (acre-feet)		
			Flood control	Water conservation	Total
Wills Creek	Wills Creek	[1] 723	190,000	6,000	196,000
Senecaville	Seneca Fork	121	45,000	43,500	88,500
Mohawk	Walhonding River	[1] 817	285,000	0	285,000
Pleasant Hill	Clear Fork	199	74,200	13,500	87,700
Charles Mill	Black Fork	216	80,600	7,400	88,000
Mohicanville	Lake Fork	269	102,000	0	102,000
Tappan	Little Stillwater Creek	71	26,500	35,100	61,600
Clendening	Brushy Fork	70	26,100	27,900	54,000
Piedmont	Stillwater Creek	84	31,400	33,600	65,000
Beach City	Sugar Creek	300	70,000	1,700	71,700
Dover	Tuscarawas River	[1] 777	202,000	1,000	203,000
Bolivar	Sandy Creek	502	149,600	0	149,600
Atwood	Indian Fork	70	26,100	23,600	49,700
Leesville	McGuire Creek	48	17,900	19,500	37,400

[1] Does not include area tributary to reservoirs upstream.

GENERAL FEATURES OF THE FLOOD

The storm of August 6–7, 1935, was of approximately 12 hours' duration—between the hours of about 7 p. m., August 6 and about 7 a. m. August 7—and was well-centered over the basin. Many unofficial observations in the central part of the basin indicate that 12-hour rainfall intensities were extremely high. The heaviest rains apparently occurred over small local areas, and the intensities will never be known.

The lines on plate 2 showing equal rainfall in the basin during this 12-hour storm are based on all reliable measurements of rainfall. The storm centered over the area immediately adjacent to the confluence of the Walhonding and Tuscarawas Rivers, in such a manner that the resultant run-off from the small streams was discharged directly and promptly into the relatively large Walhonding and Tuscarawas Rivers, which during the early period of the storm were at comparatively low stages. The large conveyance and natural storage of the Walhonding and Tuscarawas Rivers were thus entirely available and effective in reducing the intensiveness of the local run-off. Had the storm been located so that the intensive run-off had been carried by streams of gradually increasing size instead of debouching directly into the Tuscarawas or Walhonding Rivers, the extent of the flooded areas would have been materially greater.

For the purpose of comparing the storm of August 1935 with previous storms, the areas within the various isohyetal lines in the Muskingum River Basin have been measured by planimeter with the results shown in the following table.

Area-depth data for rainfall of Aug. 6–7, 1935

Isohyetal (inches)	Area enclosed (square miles) [1]	Average depth within isohyetal (inches)	Isohyetal (inches)	Area enclosed (square miles)	Average depth within isohyetal (inches)
11	44	11.50	5	1,700	7.25
10	115	10.88	4	3,100	6.00
8	405	9.44	3	5,300	4.97
6	1,500	7.50		[2] 8,038	4.11

[1] Areas shown for depths above 8 inches may be considerably in error.
[2] Total area of Muskingum River Basin.

The last column in the above table gives the computed average precipitation for the area enclosed by each indicated isohyetal line. From a curve determined by plotting these latter depths against the corresponding area, the average depth of rainfall over areas of 1, 500, 1,000, 2,000, 4,000, and 6,000 square miles was obtained. Table 2 gives a comparison of these results with all 1-day storms listed by the Miami Conservancy District [3a] as having the same or greater rainfall over an area of 2,000 square miles.

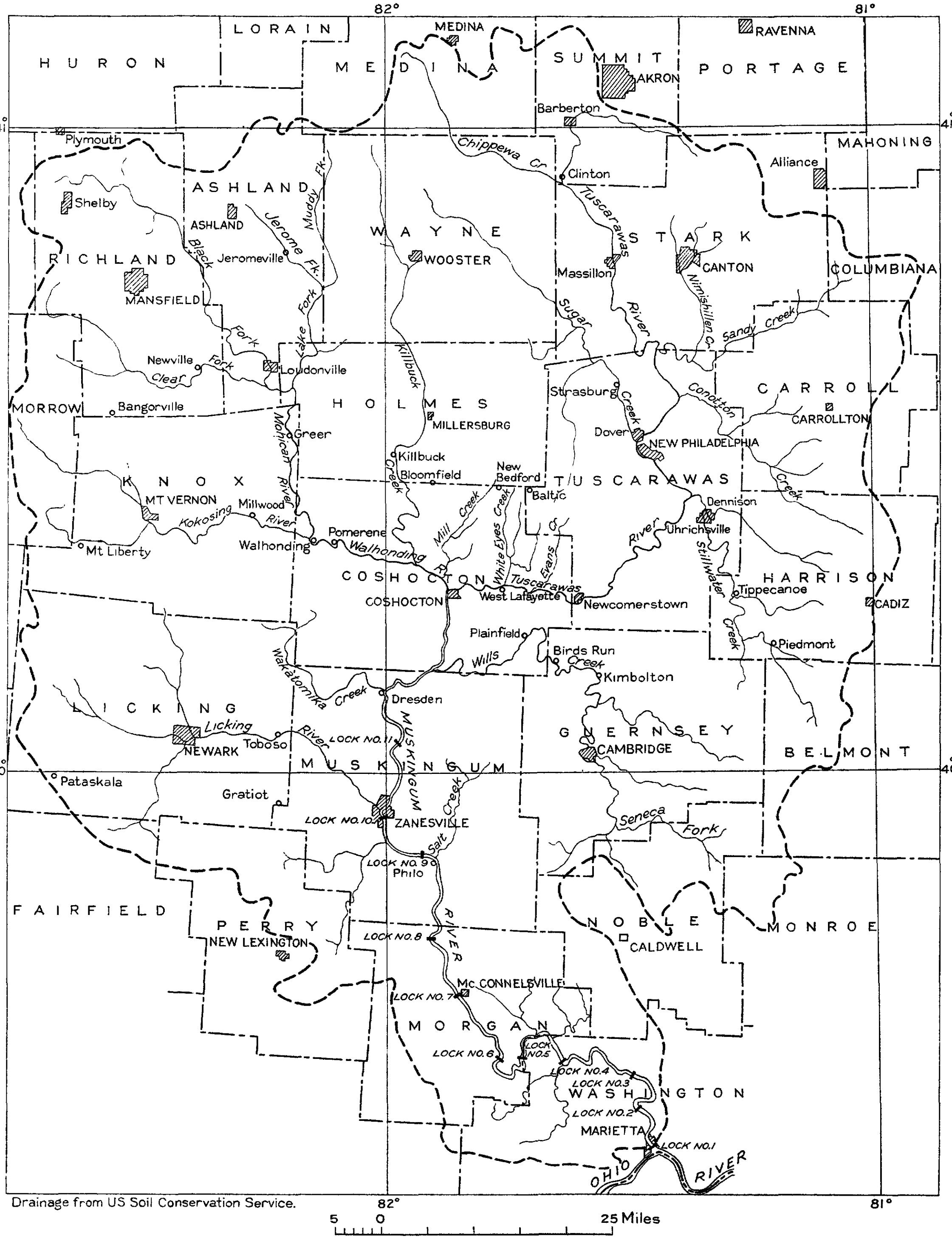
TABLE 2.—*Depth of average 1-day rainfall in relation to areal extent for notable storms in eastern United States, 1889–1935*

Storm			Area, in square miles					
No.	Date	Center	1	500	1,000	2,000	4,000	6,000
268	Sept. 16–17, 1932 [1]	Rhode Island	12.2	11.2	10.4	9.4	8.3	7.8
72	Aug. 27, 1903	Iowa	11.2	10.6	10.0	9.1	7.8	6.8
83	June 9–10, 1905	Iowa	12.1	10.9	10.0	8.9	7.8	6.9
194	July 10, 1922	Missouri	12.2	10.3	9.1	7.6	5.8	5.1
76	Oct. 9, 1903	New Jersey	11.5	9.3	8.4	7.6	6.8	6.3
176	Sept. 18, 1919	Nebraska	8.7	8.1	7.8	7.4	6.7	6.1
c	May 31, 1889	Pennsylvania	8.4	7.8	7.5	7.3	7.1	6.8
237	Aug. 11, 1928	Maryland	8.3	7.8	7.4	6.7	6.0	5.9
	Aug. 6–7, 1935	Ohio	12.7	9.1	8.1	6.9	5.5	4.7

[1] G. V. White, Great storm of Sept. 16 and 17, 1932: New England Water Works Assoc. Jour., vol. 47, no. 2, pp. 164–183, 1932.

The storm of August 6–7, 1935, shows a greater intensity over an area of 1 square mile than any of the others, but it is notable that many unofficial records, as well as official Weather Bureau records, were used in the construction of the isohyetal map of that storm, whereas generally only Weather Bureau or other established records were used for other storms. In storm No. 83, as in the storm of August 1935, the rain fell on 2 calendar days and within a period totaling about 12 hours. The rainfall for each of the other storms is that for 1 calendar day, although the storms lasted 2 days or more; consequently, the duration of precipitation as recorded in the table was probably more than 12 hours. With respect to average depth of rainfall over 2,000 square miles, the storm of August 1935 ranks ninth among 33 intense storms in the northeastern United States, but the records do not disclose any previous storm of comparable intensity in the Muskingum Basin.

[3a] Storm rainfall of eastern United States: Miami Conservancy District Technical Reports, pt. 5 (revised), p. 278, Dayton, Ohio, 1936.



MAP OF MUSKINGUM RIVER BASIN.

EXPLANATION

Boundary of drainage basin

• 7.32 Location of point of measurement of precipitation and amount of storm precipitation in inches August 6-7, 1935

—3— Line of equal rainfall, in inches August 6-7, 1935

ISOHYETAL MAP OF MUSKINGUM RIVER BASIN, OHIO, SHOWING TOTAL RAINFALL IN INCHES, AUGUST 6-7, 1935

Scale 1/500000

10 0 10 20 30 Miles

1940

The flood that followed the storm of August 1935 was the result not only of the extraordinarily intense precipitation but also of the excessive antecedent rainfall, which had decreased the absorptive capacity of the soil and had utilized some of the conveyance capacity of the stream channels for disposing of the storm rainfall. Outstanding floods, it has been frequently observed, are generally the result of an unusual combination of meteorologic and hydrologic conditions. These factors with respect to the flood of August 1935 are described in detail in subsequent sections of this report.

The flood of August 1935 is the only major summer flood of record in the Muskingum Basin. At Zanesville, on the lower Muskingum River, the crest stage had been exceeded only four times during the period of record prior to 1935, as shown below.

	Feet
February 1832	34.8
February 1884	34.5
March 1898	36.8
March 1913	51.8
August 1935	33.6

Figure 3, based on data given in table 17 presented in the section "Records of previous floods," shows the relation between the various known flood stages at Coshocton, at the head of the Muskingum River. It will be noted that the stage of the flood of August 1935 at this location was exceeded three times—in 1913, 1898, and 1884; there is no record of the stage attained in 1832. The 38 floods at Coshocton during the period 1911–36 occurred during the months shown in figure 4. It will be noted that only two occurred during the summer; the first, during August 1919, reached a stage of 15.3 feet, and the second, during August 1935, reached a stage of 24.65 feet. Figure 4 not only shows that a widespread summer flood rarely occurs in the Muskingum River Basin but also aids in an appreciation of the outstanding nature of the flood of August 1935.

On small streams in and near the center of the storm area, the flood stages of August 1935 exceeded those of March 1913 and were undoubtedly the greatest in more than 40 years. The flood stages were especially excessive on the following streams:

Streams showing excessive flood stages in August 1935

Stream	Tributary to—	Location
Beaver Run	Walhonding River	Warsaw.
Mohawk Creek	do	Nellie.
Simmons Run	do	Warsaw.
Mill Creek	do	Coshocton.
White Eyes Creek	Tuscarawas River	West Lafayette.
Evans Creek	do	Between Coshocton and Newcomerstown.
Buckhorn Creek	do	Newcomerstown.
Dunlap Creek	do	East of Newcomerstown.
Birds Run	Wills Creek	Birds Run.
Indian Camp Run	do	Near Birds Run.
Bucklew Run	Killbuck Creek	Near mouth of Killbuck Creek.
Doughty Creek	do	14 miles above mouth of Killbuck Creek.

Unfortunately no data are available as to discharge rates in these creeks during the flood except for two slope-area determinations made by the Soil Conservation Service on Little Mill Creek, tributary to Mill Creek, presented in the section on summary of flood discharges. These determinations indicate rates of run-off of 3,190 second-feet and 1,270 second-feet per square mile on streams of 1.7 and 7.1 square miles of drainage area. Some information concerning data on high-

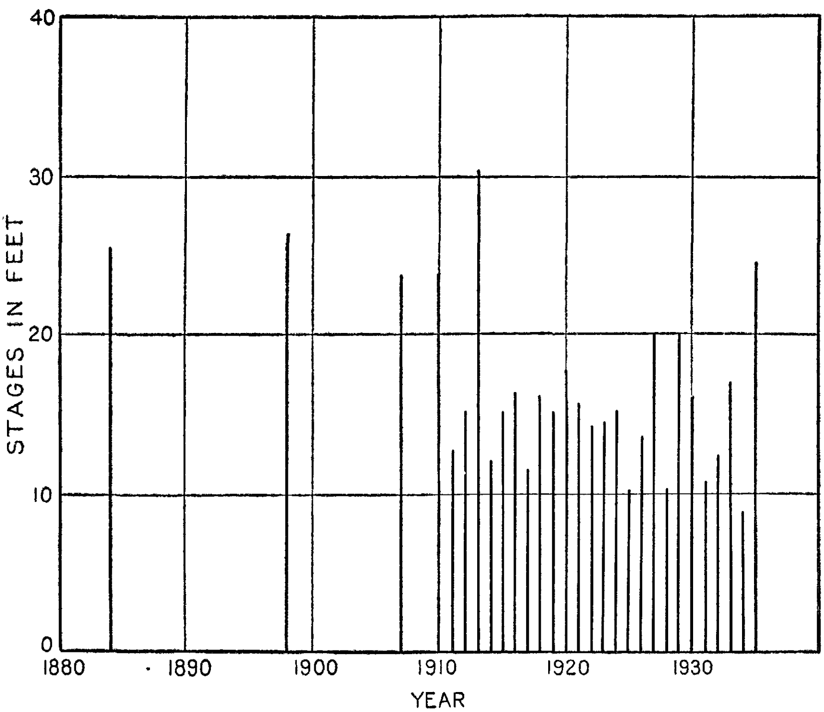


FIGURE 3.—Stages reached by the flood of August 1935 and known previous floods at Coshocton.

water marks in Mill Creek Basin is presented in the section "Flood crest stages" (pp. 94–99).

More specific information is available for larger streams in the basin on which Geological Survey river-measurement stations were in operation during the flood. Complete compilations of stage and discharge throughout the flood period, as well as data on volumes of run-off and maximum stages, are given in later sections of this report.

Figure 5, showing the time of crest stages at various points in the Muskingum River Basin in relation to the distances in miles above

Marietta, is based on records at river-measurement stations, observations of the Corps of Engineers at construction works along the rivers, and other data as listed in table 14 in section on flood crest stages. In this diagram (fig. 5) points on the same stream are connected by full lines; dashed lines indicate estimated progress of the flood.

This diagram indicates that most of the tributaries crested during the morning of August 7. The tributaries of the Mohican River rose to crests more rapidly than the streams in the Tuscarawas Basin although the rain did not fall on the Mohican River catchment area until after it had begun to rain in the northeastern section of the basin. As shown on figure 5 on Black Fork at Loudonville (mile 163) the peak discharge of 5,860 second-feet occurred at about 6 a. m. on

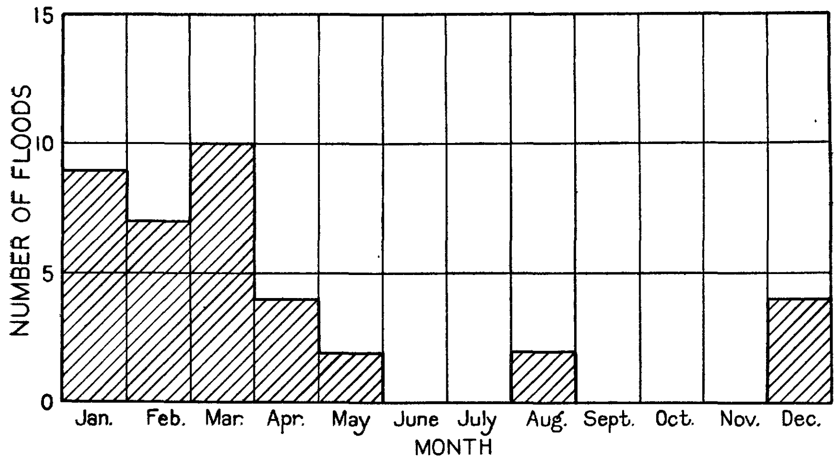


FIGURE 4.—Monthly distribution of 38 floods at Coshocton.

August 7; on Lake Fork near Loudonville (mile 158) the peak discharge was 6,030 second-feet at 11 a. m.; and on Clear Fork at Newville (mile 171), it was 5,680 second-feet at 7 a. m. As shown in figure 5, the crests of Jerome Fork at Jeromeville (mile 176) and Lake Fork at Mohicanville dam site (mile 168) occurred much later than downstream near Loudonville, indicating that the crest of Lake Fork near Loudonville was caused by large run-off from the intervening area below Mohicanville dam site or by backwater from the Mohican River.

Figure 5 indicates that the peak discharges from the Mohican River and from Lake Fork reached the mouth of Lake Fork (at mile 156) almost simultaneously and that the Clear Fork peak arrived soon afterward. The Mohican River crested at Greer (mile 149) with a peak discharge of 17,700 second-feet at 1 p. m. on August 7. The Kokosing River at Millwood (mile 138) crested at the same time with a discharge of 18,500 second-feet. The Mohican and Kokosing

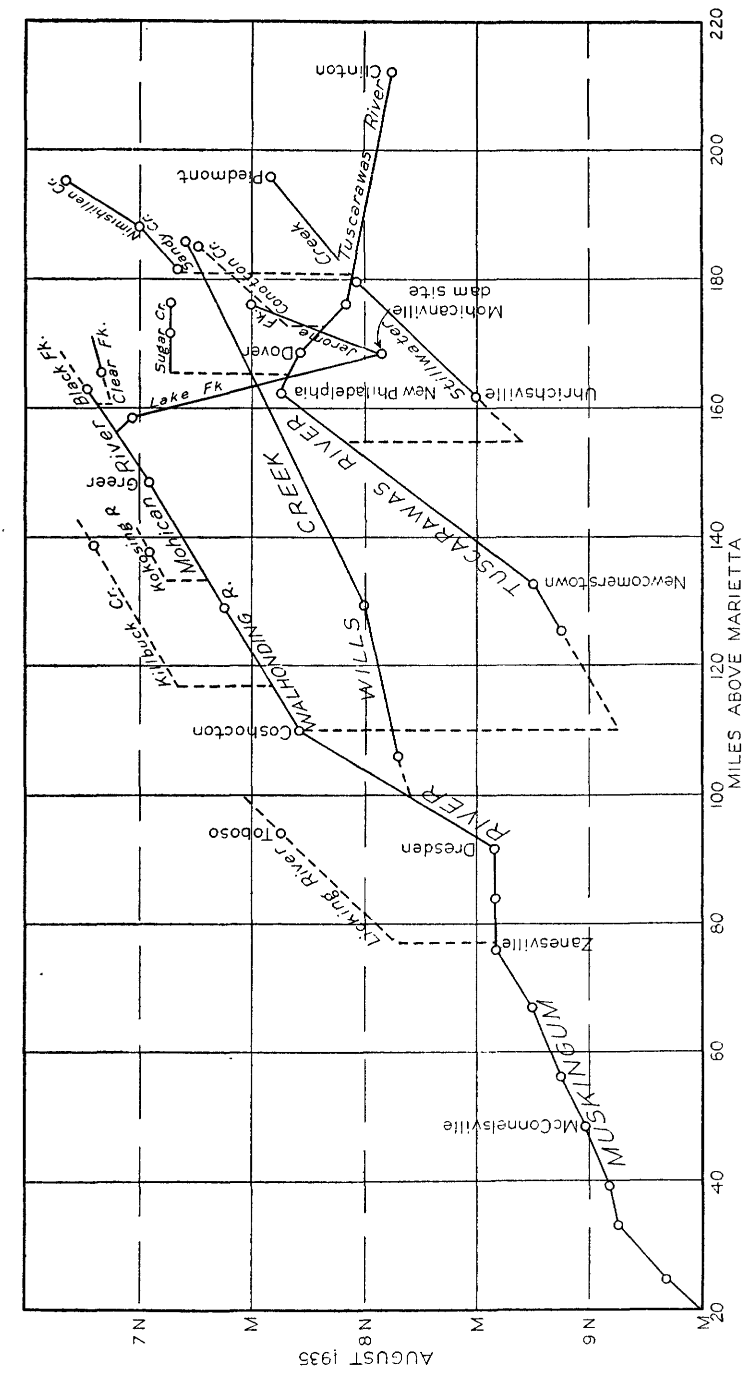


FIGURE 5.—Time of crest, August 7, 8, 9, in relation to distance from Marietta.

Rivers join to form the Walhonding River at mile 133, but apparently the peak of the Mohican River arrived at the confluence 4 hours after the Kokosing River discharged its peak into the Walhonding River. The peak on the Walhonding River at Pomerene (mile 129) occurred at 9 p. m. August 7, with a discharge of 27,100 second-feet, but in this flood the peak flow of Killbuck Creek entered the Walhonding River (at mile 118) 10 hours before the peak occurred in the Walhonding River at that point. As in most floods the Walhonding River crested at its mouth at Coshocton (mile 110) at 5 a. m. August 8, many hours before the peak flow from the Tuscarawas River entered the Muskingum River at this conjunction. The time of crest at this point was advanced by the large flow from local tributaries that drained the area of most intensive rainfall, such as Mill Creek and White Eyes Creek, which were reported locally to have crested between 1 and 3 a. m. on August 7.

In the Tuscarawas Basin, the peak discharge of Nimishillen Creek at North Industry (mile 196) was about 8,240 second-feet at 4 a. m. on August 7, and immediately downstream on Sandy Creek at Sandyville (mile 188) it was 12,600 second-feet at noon August 7. The discharge from this tributary entered the Tuscarawas River and passed downstream before the Tuscarawas River crested at Dover (mile 169). The peak flow at Dover, 22,300 second-feet at 5 a. m. August 8, was apparently produced by inflow from the lower tributaries, including Conotton Creek, added to the large flow still coming from Sandy Creek, as the peak of the Tuscarawas River at Clinton (mile 212) did not occur until 3 p. m. on August 8, or 10 hours after the time of the peak at Dover. The peak discharge of 19,700 second-feet on Sugar Creek at Strasburg (mile 172) occurred about 3 p. m. on August 7. The times of peak discharge along the Tuscarawas River between Clinton and New Philadelphia apparently regressed downstream, owing to the large increments from the tributaries to that reach. The earliest peak on the Tuscarawas River occurred at New Philadelphia (mile 162) at 3 a. m. on August 8. Crest stages occurred progressively later downstream from New Philadelphia and did not arrive at Coshocton until early afternoon of August 9, a day later than the peak discharge of the Muskingum River as produced by the Walhonding River and large inflow from local tributaries. The delay in the discharge of the Tuscarawas River as compared with the discharge of the Walhonding River tended to reduce the maximum flood stage at Coshocton and farther downstream. A study of past floods indicates that this is the usual behavior of these two rivers.

Below Coshocton, Wills Creek is a considerable factor in augmenting flood flow on the Muskingum River. The crest on Seneca Fork at Senecaville (mile 186) in the upper Wills Creek Basin, which occurred at 5 p. m. on August 7, reached Wills Creek at Birds Run (mile 130) at noon on August 8 and the site of the new Wills Creek Dam (mile 106) at about 3:30 p. m. The peak reached the mouth of Wills Creek (mile 100) at about 4 p. m. of August 8, about the same time that the Muskingum crested. Licking River, however, discharged its peak (20,000 second-feet at Toboso) into the Muskingum River at Zanesville (mile 76) between about 2 and 4 p. m. on August 8, 11 hours before the arrival of the peak of the Muskingum River.

On the Muskingum River the crest was reached at Dresden at 2 a. m. on August 9 (peak discharge, 100,000 second-feet), at Zanesville at 2 a. m. August 9, and at McConnelsville at noon on August 9 (peak discharge, 104,000 second-feet). The crest passed lock 2 about 6 miles above the mouth about 6 a. m. on August 10. By this time all streams in the upper basin had materially receded from their peaks, and the flood dangers there were ended.

It should be noted that two factors enter into the determination of the time of crest at a point on a river—the rate of progress of the flood wave downstream and a modifying factor determined by the rate at which water is discharged from nearby tributaries. Whenever the rate of progress is predominant, the river crests at progressively later times as the wave moves downstream, but whenever the local inflow increases materially downstream, then the river may crest at downstream points at a time earlier than upstream. Thus, as shown in figure 5, the large early inflow from Sandy, Sugar, and Conotton Creeks had the effect of producing a crest at Dover and New Philadelphia earlier than that upstream at Clinton. This effect would seemingly indicate that the flood wave moved upstream from New Philadelphia. Such movement is only apparent. In reality the crest at New Philadelphia belonged to a different flood wave from that at Clinton. Below New Philadelphia, the time of occurrence of the crest was largely determined by the time required for the flood wave to move downstream, modified of course by local inflow. Flood waves in the lower reaches of the Muskingum River are proportionately less affected by local inflow, as figure 5 indicates. There is a generally uniform downstream motion of the crest of the flood wave, except that the peak at Zanesville may have been advanced by the discharge of the Licking River. The Wills Creek discharge apparently produced no modification with respect to time, as its crest nearly coincided with the stage of the main stream.

Fourteen flood-control reservoirs under construction by the Corps of Engineers, United States Army, were in such early stages that they had no effect on the flood.

DAMAGE

This flood caused unprecedented crop damage, coming as it did at the peak of the agricultural season. Much wheat, corn, and oats, a large part of which was standing in the valley-bottom fields, remained unharvested. The crop loss has been estimated at $3,500,000 by Prof. Guy Miller, of the College of Agriculture, Ohio State University. Plate 3 shows two views of valley-bottom flooding that resulted in damage to crops. After a survey on August 8 of the flooded region, Mr. C. C. Chambers, chief engineer of the Muskingum Watershed Conservancy District, reported as follows:

> At all points along the main river and tributary valleys were evidences of huge losses to rural property owners, from damages to current crops, buildings, fences, and other improvements, and erosion from flood flows. Owing to an unusually wet season, many fields of wheat were still in shock and practically all of the oats crop was also in shock. All such crops within the flood area were carried away by the floodwaters. Shocks of grain floating down the main rivers were seen at almost every point. A storm of this magnitude at this time of the year is especially damaging to rural property.

After the flood the Muskingum Watershed Conservancy District appraised the damages to farm crops on 914 farms along the Muskingum, Tuscarawas, and Walhonding River Valleys, and along the lower reaches of streams tributary to them. These farms had a total area of 88,835 acres, of which 20,589 acres was in the overflow area of the flood of August 1935. The total appraised damage to crops on the 20,589 acres was $573,606 or $27.87 per acre.

Damages to State roads amounted to $299,000 and to county roads $1,165,000, a total of $1,464,000, as estimated by the Ohio State Highway Department and the various county engineers.

The principal damages to railroads within the basin were those sustained by the Wheeling & Lake Erie Railway of $100,000,[4] principally along White Eyes Creek, the Pennsylvania Railroad of $50,000,[5] and the Baltimore & Ohio Railroad. The damage was largely in the upper basin, where the roadbed was washed out by the floods in small streams and by run-off from the hillsides.

No records are available as to damage incurred by cities and towns along the flooded streams, but the damage must have been rather material, since the newspapers report many individual heavy losses. Among the cities that suffered most are Massillon, Coshocton, and Zanesville.

All the evidence marks this flood as a major disaster. It has been estimated by the Corps of Engineers, United States Army, that total losses of all kinds reached $5,500,000, and several newspapers reported $6,000,000 losses. The Geological Survey has no means of verifying these figures. Selected photographs of the flood incorporated in this report depict the nature of the flood and the resultant damages. It is believed that the damage was largely due to inundation rather than to the dynamic action of the flowing water, although much damage was done by dynamic action in the smaller streams in the center of

[4] Figure furnished by the Corps of Engineers, U. S. Army.

[5] Idem.

the storm area, of which the bridge wash-out shown in plate 4, *A*, is an example. With respect to debris, Mr. Chambers reported as follows:

> Owing to the intensity of the storm and to the fact that short tributary streams dumped heavy discharges into the larger streams before the water in the larger streams reached high stages, an unusual amount of debris was carried by tributaries into the larger channels to form bars and drift barriers in these channels.

Many vivid descriptions of events during the flood appeared in newspapers on August 8, of which those given below are included as a record of the effect of the flood on the normal activities within the flooded region.

> The most terrific cloudburst in local history lashed the county Tuesday night and the rivers began rising at an incredible rate at midnight.
>
> Damage to the city was estimated as high as $50,000. Loss to farmers of Coshocton County was expected to be much higher than to the city. Some observers said that the damage to farms would be greater than that of 1913, since the present flood will cause heavy crop losses while the 1913 flood came before crops were planted.
>
> Relief work was undertaken by the American Legion and city and county authorities. Many rescues from flooded homes were effected by boats. Rescuers reported more people were willing to leave their homes than in 1913, when great difficulty was experienced in convincing some families that they were in danger.
>
> Coshocton was virtually marooned by highway during the afternoon. * * * The Coshocton Water Plant was forced to shut down.[6] [See pl. 4, *B*.]
>
> No deaths due to the flood were reported in Holmes County, but loss to farmers and the county road system will run into at least half a million dollars.
>
> Tuesday [August 6] about 6 p. m., one of the most severe rain and electrical storms in the county broke loose. Rain fell in torrents converting small streams into raging rivers and within a few hours Killbuck Creek had overflowed the lowlands. Rain fell so hard in Millersburg that almost every street was filled with water from curb to curb and gravel and debris was washed from unpaved streets and carried down the gutters and through overtaxed storm sewers.
>
> The downpour was accompanied by the most severe electrical storm in the county's history. Lightning flashed and snapped all night long.[7]

Newspapers also reported many tragedies and disasters. On Mill Creek about 6 miles north of Coshocton on U. S. Highway 76, the water rose over the highway early in the flood, and a car became stalled in this water about midnight on August 6. When the water rose suddenly the driver climbed to the roof of his car in order to reach apparent safety, but the continuously rising waters carried him off to his death.

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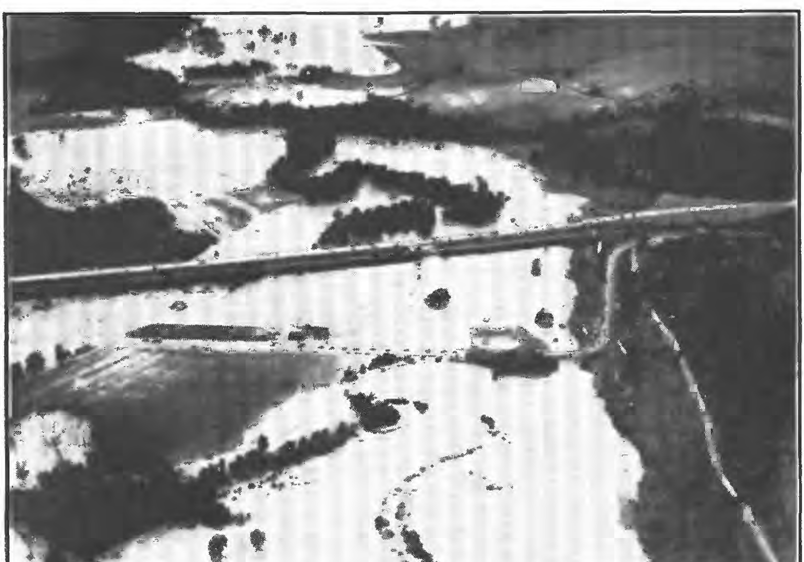
[6] Coshocton Tribune, August 8, 1935.

[7] Holmes County Democrat, August 8, 1935, Millersburg, Ohio.

A. WALHONDING RIVER AT MOUTH OF KILLBUCK CREEK.
Photograph furnished by Corps of Engineers, U. S. Army.



B. U. S. HIGHWAY 40 AT CROOKED CREEK, A MILE WEST OF CAMBRIDGE.
Photograph furnished by Muskingum Watershed Conservancy District.

A. SUGAR CREEK FALLS BRIDGE ON U. S. ROUTE 250, AUGUST 9.
Right abutment washed out. Photograph furnished by Muskingum Watershed Conservancy District.

B. TUSCARAWAS RIVER NEAR ITS MOUTH, LOOKING NORTH DURING FLOOD.
Coshocton municipal waterworks in center, at right of bridge. Photograph furnished by Muskingum Watershed Conservancy District.

Six deaths can be attributed directly to the storm and subsequent flood; two men were electrocuted, one by lightning and the other while attempting to repair an electric pump in his flooded basement; the others were drowned.

METEOROLOGIC AND HYDROLOGIC CONDITIONS

By Waldo E. Smith, Muskingum Watershed Conservancy District

GENERAL FEATURES OF THE STORM

Rains of extraordinary magnitude and extent fell in the Muskingum River Basin on the night of August 6, 1935. As shown by the isohyetal lines on plate 2, the rains were well centered over the basin, almost every part of which received a rainfall in excess of 2 inches. The maximum rainfall according to official records was 8.7 inches at the cooperative Weather Bureau station at Newcomerstown, but measurements made soon after the storm in containers of various shapes indicated a rainfall of more than 12 inches in some places. In general, the precipitation at any one station occurred within a 12-hour period. On the northern headwaters in the vicinity of Akron the rain started about 1 o'clock in the afternoon of August 6 and ended soon after midnight, as shown in table 3. At Parkersburg, W. Va., and Columbus, both just outside the basin, to the south and the west, respectively, the precipitation from the main storm started after midnight and was heaviest after daybreak. The recording gages at Plymouth and Wooster show that the maximum rainfall in 1 hour occurred between 8 and 9 p. m., August 6. No recording gage was located near the center of the storm, but the observers for nonrecording gages stated that the rain started at about 7 p. m., August 6, and ended at about 7 a. m., August 7. (See table 4.)

The residents in the valley of the Tuscarawas River from Newcomerstown to Coshocton said there was almost continual lightning. Most of this lightning appears to have been atmospheric, as in making a survey of the flooded area, Gay[8] found very little damage by lightning, although one death was reported. In general, the greatest precipitation appears to have been along the line of hills extending from Newcomerstown to Killbuck Creek just north of the flood plain of the Tuscarawas and Walhonding Rivers and rising more than 300 feet

[8] Gay, R. W., The storm of August 6-7, 1935, on Muskingum River watershed, in Alexander, W. H., Floods in Ohio: Ohio State Univ., Eng. Exper. Sta. News, vol. 7, No. 4, pp. 21-25, 1935.

TABLE 3.—*Hourly rainfall, in inches, Aug. 6–7*

Hour ending	Akron [1]	Wooster [2]	Plymouth [3]	Gage 5 near Zanesville [4]	Gage 13 near Zanesville [4]	Gage C and S near Hopewell [4]	Columbus [1]	Parkersburg, W. Va.[1]
Aug. 6								
1 p. m.								
2	0.30							
3	.09							
4	.09							
5							0.29	
6	.10	0.05	0.22				.04	
7	.04	.72					.01	0.01
8	Tr.	.09						.01
9	.22	1.06	1.22					
10	.18	.46	.28					
11	.13	.07	.46					
12 midnight	.42	.35	.06	0.26	0.03	0.05		
Aug. 7								
1 a. m.	.17	.50	.68		.07			.09
2	.14	.35	.38	.06	.07	.01		.15
3	Tr.	.08	.12		.11	.01		.42
4		.17	.04	.12	.05	.02		.16
5	.01	.04	.02	.78	.46	.38	Tr.	
6	.01		.05	.88	.46	.13	Tr.	
7			.01	.04	.94	.74	.01	Tr.
8				.25	.22	1.00	1.54	.46
9					.08	.26	.54	.34
10			.03			.04	.26	.40
11			.03				Tr.	.11
12 noon								.01
Total	1.90	3.94	3.60	2.39	2.49	2.72	2.69	2.16
Catch in standard gage		4.44		2.69	2.71			

[1] Furnished by U. S. Weather Bureau.
[2] Furnished by Ohio Agricultural Experiment Station.
[3] Furnished by John A. Root, Plymouth.
[4] Furnished by U. S. Soil Conservation Service.

NOTE.—The above table includes all precipitation that was recorded at the indicated stations on Aug. 5, 6, and 7, with the following exceptions: Wooster, 0.77 inch between 6 and 7 p. m., Aug. 7. Plymouth, 0.18 inch between 6 and 7 p. m., Aug. 5; 0.03 inch between 10 and 11 a. m., Aug. 6; 0.05 inch between 11 a. m. and 12 noon, Aug. 6.

TABLE 4.—*Times of beginning and ending of storm rainfall at nonrecording rain gages, Aug. 6–7*

Station	Time of beginning (Aug. 6, p. m.)	Time of ending (Aug. 7, a. m.)	Station	Time of beginning (Aug. 6, p. m.)	Time of ending (Aug. 7, a. m.)
Alliance	1	During night	Marietta (Phillips)	During night	11
Ashland	5	4	Massillon	1	3
Bucyrus	Midnight	6	McConnelsville	During night	10:30
Caldwell	11	10	Medina	7	1
Cambridge	8	9:30	Millersburg	6:40	7:10
Canton	2:30	During night	Newcomerstown	7:30	8
Coshocton	7	9	Newark	During night	8:15
Demos	8	10	Oberlin	6	6
Dennison	5	7	Philo (2)	[1] 12:41	7:32
Lowell	During night	10	Walhonding	6	8
Mansfield	9	6			

[1] Aug. 7, a. m.

above it. Here the upward deflection of the currents of moist warm air from the south by the dense cold air from the north was possibly aided by topography. There were apparently other local areas of very high precipitation, as shown by the isohyetal map, notably in the middle part of Wills Creek watershed.

The center of the main storm was said by observers to have been a close succession of heavy showers. The rainfall intensities for short periods and the distribution with respect to time will never be known, but the intensities for periods of an hour or so may not have exceeded previous high records.

Fortunately the greater part of the very heavy rain fell near the channels of the Muskingum River and its major tributaries, so that the flood waters traveled only a short distance before entering large channels. Had the storm occurred over headwaters in any part of the basin, the resulting stages on the main stream might have been slightly lower, but the dynamic damage in the smaller valleys would have been much greater and record-breaking stages would have been more widespread.

RECORDS OF PRECIPITATION

Table 5 lists the daily observations of precipitation during the period July 20 to August 11 made by cooperative observers of the United States Weather Bureau and those made by other agencies, as indicated. The rainfall for this storm established new 12-hour and 24-hour maxima at several stations. The highest rainfall record for this region, 8.7 inches at Newcomerstown,[9] however, exceeds the previous 12-hour record, measured at Toboso, July 13–14, 1913, by only 1.3 inches, and in June 1937 was approached about as closely, as shown in table 6. In contrast with the summer storms of relatively short duration listed in table 6, the outstanding winter storm, that of March 23–28, 1913, was of 5 days' duration. The average rainfall in the Muskingum River Basin was 6.94 inches, and the greatest amounts for 1 day were 5.96 inches at Ashland[10] and 5.25 inches at Bangorville. These two were the only 1-day amounts in excess of 5 inches in the basin.

[9] Storm rainfall in eastern United States (revised): Miami Conservancy District, Tech. Rept., pt. 5, p. 84, Dayton, 1936.

[10] Alexander, W. H., Climatological history of Ohio: Ohio State Univ., Eng. Exper. Sta., Bull. 26, p. 138, 1924. According to the United States Weather Bureau office at Columbus, a revised interpretation of the observer's notes indicates that the catch between 12:30 p. m. March 24 and 12:30 p. m. March 25 was 5.60 inches, not 5.96.

TABLE 5.—*Daily precipitation, in inches, July 20 to Aug. 11, 1935*

[Measured in the afternoon except as noted]

Station	July—												August—											Storm of Aug. 6–7 (total)
	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	
U. S. WEATHER BUREAU																								
Akron [1]	0.03	0.01	0.31	0.04	0.88	1.08	0.01		0.23			0.15	0.03	1.90	0.58	0.65		1.57	0.33	0.61		0.22		1.90
Alliance		.05	.14	.11	.50	.70	.22		1.00			.28	.04	.48	1.47	.25		.37	1.07	.23		.20		1.44
Ashland [2]		Tr.	.10	.20	.20	.50	.55	0.30		0.10		Tr.	.20	.60	.85	.05		Tr.	3.40	.03		.03	0.60	3.43
Athens [2]	Tr.	1.27	.06	.22	.02	.84	.10	Tr.		.57		.16	.48	.44	.02	.33			.55	.75	0.45		1.60	1.30
Bangorville		.20	.11	1.50	.12	2.08			.30				2.00	.02	1.76		0.03	.09	1.93	.03		.70		2.02
Bellpoint [2]				.70		.02	.07	Tr.					.78	.11	.56		1.32		1.35	.07			.87	1.42
Beverly [2]		.08	.06	.75		2.14				.51	0.12	.17	2.47	.92	1.24	.86			2.20		.18		.65	2.20
Brecksville [2]	.11		1.47	.39	.08	.61							.79	1.95	.62			1.35		.02	Tr.	.19	.06	1.35
Cadiz	.13		.02	.10	.98	.12	Tr.		.09			.14	.14	.69	2.47	.65		.55	1.20			.49		1.75
Caldwell (near)		.15		.08	.59		Tr.		.63				.83	1.29	1.28	.30			3.90	.07		.56		3.90
Cambridge		.21		Tr.		.53	.01		.97			.04	.55	.66	2.29	.14			5.82	.03		.68		5.82
Canton [2]		.35	.02	.58	.08	2.23				.76		.22	.18		2.36	.29			3.61	.01	.01		.45	3.62
Charlestown		.23	.01	.86	1.01	.51	.42		.34			.07	.87	1.33	.89			.56	.86	.44		.24		1.42
Columbus (1) [1]		.10	Tr.	.06	.04	.03	Tr.		.40			.42		Tr.	.89			.34	2.35		Tr.	.85		2.69
Columbus (2)		.96	.05	.02	Tr.	.15	Tr.	.08	1.40	.03		.06	.31	.01	.46			.20	1.81		Tr.	1.26		2.01
Coshocton [2]		.04	.24	.14	.04	1.52	Tr.	Tr.		.79			.78	.09	.82	.52		.23	7.10	.22	Tr.		.84	7.32
Delaware		.40	Tr.	1.83	Tr.	.15			.57				.40	.05	1.41			.03	1.02	.02		.43		1.04
Demos		.29		.06	.05	.13			.05			.44	.14	.21	4.67	.02		.02	2.30	.30		.35	.02	2.32
Dennison		.17	.07	.20	Tr.	1.33	.10		1.42			.07	.29	.45	1.57				2.65	.01		.31		2.65
Dover [2]	.39	.73		.19	.04	.36				1.01			.48	.08	2.81	1.06			2.38				.29	2.38
Ellsworth		.17	.27	.38	.09	1.50	.12		.08			.19	.39	.50	1.34	.40		.73	.81	.06		.24		1.54
Lancaster		.60	.02	.50	2.31	.18			2.82			.33	.15	.28	1.42			Tr.	2.40	Tr.		.91		2.40
Lake Milton	.03	.10	.83	.21	.71	1.08	.17	.15				.08		1.00	1.91			.51	.66			.21		1.17
Lowell [2]		.20	.05	.02	.05	1.28		.38	.02			.18	2.16	.65	.82	1.08			2.40	.35			.50	2.75
Mansfield	Tr.	.02	.02	.23	.23	.80	Tr.						Tr.	.60	1.00		.02	.33	3.86	Tr.		.33	Tr.	4.19
Marietta (Phillips)		.50		.30	.21	.95	.01		.02			.14	4.60	.60	.13	.65			3.11		.19	.20	.27	3.11
Marietta (2) [2]		.31	.25	.18	.28	.92				.01		.12	4.58	.35	.38	.66			2.21	1.00	.36		.52	3.21
Marion [2]		.16	.20	.10	.22	.94	.66			.10			.95		.12	.73			.82	.33		.02	.05	1.15
McConnelsville		.94		.13	.52	.19	.07		.54			.05	2.03	.89	.97	.07			1.97			.84	.02	1.97
McConnelsville [2]		.92	.02		.13	.70	.01	.07		.54		.05	2.03	.66	.46	.81			1.57	.40			.86	1.97

Medina (near)	Tr.	1.12	.22	2.45	.82	.02			Tr.	.13		.28	.47	.68	1.08			1.05	2.68			.28		3.73
Millersburg		.03	1.04	.43		1.79	.05		1.39				.72	.31	2.31			Tr.	6.79			.76		6.79
Millport		.04	.80	.45		.51			.52			.26	.24	.12	2.03	.56		.92	.68	Tr.		.26		1.60
Mount Vernon (near)		.18		.12	.43	.29			.56				.85	.43	.54	.15			2.67			.42		2.67
Newark		.36	.07	.03	.75	.11			1.16				.30	.12	.91	.02			3.43			1.51		3.43
Newcomerstown [2]	.05	.07	.17	.08	.07	.37				.96			.33	.10	1.72	1.22	Tr.	.33	8.70	.04	.02		.89	8.74
Norwalk		.73	.12	1.20	1.27		Tr.		.02					.11	.79	.02			1.92	.12	.02	.15	.10	1.92
Oberlin				.62	1.03								.15	1.13	.96			.98	1.70			.33	.08	2.68
Ohio State University		.25	Tr.	.07		.12	.01		.49	Tr.		.13	.14	Tr.	.93			.47	2.18		Tr.	1.07		2.65
Philo (1)		.21		.18	.02	.47	.59		.47				1.41	1.05	1.36	.06			2.78			.61		2.78
Philo (2)		.27		.19	Tr.	.60	.80		.60				.92	.27	1.50	.04			3.01			.68	.09	3.01
Plymouth		.01	Tr.	.22	.20	.03	.97						.10	.30	.16		.18	.32	3.36			.33		3.68
Valley Crossing		.42		Tr.	.06	.17	Tr.		.47				.33		.31			.23	1.78			.73		2.01
Walhonding [2]		.05		.30	.13	.80	.10	Tr.		.85			.90	.27	.60			Tr.	4.40	.10	Tr.		.35	4.50
Wooster (1)		.36	.05	.11	.03	3.23			1.60				.55	1.33	.63			.01	4.44	.91		.66		4.44
Wooster (2)		.36	.05	.10	.03	3.15			1.38				.48	1.23	.60			.02	4.08	.98		.53		4.10
Zanesville	.03	.24	.09	Tr.		.50	Tr.	.18		1.07			.74	.38	.37	.64			2.60	.07		Tr.	.92	2.67
OTHER AGENCIES																								
Ellis [2 3]			.60		.25		.80	.30	.70	.25		.35	1.10	.20	.50	.70			2.40				1.05	2.40
Massillon [4]	.51	.37		.34	.78				.45				.41	2.69	.25		.03	4.07	1.61				1.92	5.68
Salt Creek Basin [7]																								
Station 1 [2]	Tr.	.12	.24	.25		.62	.01	.59		.61			1.14	.17	.98	.39			2.94	.03	Tr.		1.13	2.97
Station 2 [2]	Tr.	.14	.50	.15		.54	.15			.53			1.15	.19	.49	.32			3.17		.05		1.20	3.17
Station 3 [2]		.15	.31			1.16		.45		.75			1.67	.03	.25	.52			2.62	.07			.80	2.69
Station 4 [2]	.65	.85	.05	.11		.46		.02		.48			1.24	.02	.39	.85			3.18	.08			1.00	3.26
Station 5 [2]	.56	.17				.78		.10		.52			1.46	.29	.38	.45			2.69		.07		.74	2.69
Station 6 [2]		.20		.07		.79		.02		1.00			1.26	.21	.79	.42			2.95				.98	2.95
Station 7 [2]		.10	.12	.15		1.04		.30		1.22			.58	.25	.59	.34			3.10				1.12	3.10
Station 8 [2]	.36	.24	.25	.16		.68		.15		.50			.99	.03	.63	.72			2.35	.07	.03		.92	2.42
Station 9 [2]		.25			.05	.35				.57			.96	.40	.80	.88			2.53	.06			.78	2.59
Station 10 [2]		.12			.06	.40		.06		1.67			1.26	.12	1.15	.90			2.55	.11			.68	2.66
Station 11 [2]		.15	.01	.01	.12	.52	.01	.47		2.12			1.31	1.10	.64	.70			2.74	.10			.89	2.84
Station 12 [2]		.15		.18	.05	.46	.02			1.44			1.74	2.15	.39	.50			2.40	.35			.75	2.75
Station 13 [2]		.13		.03		.75		.16		1.80			.54	.22	.29	.28			2.71	.05	.08		1.10	2.76
Station 14 [2]	.04	.34				.61				.36			1.19	.15	.43	.51			2.96				.80	2.96
Station 15 [2]		.14	.01			.80		.38		1.24			.53	.18	.50	.29			2.95				1.17	2.95
Station 16 [2 5]	(6)	(6)	(6)	(6)	(6)	1.02		.02		.41				.12	.45	.50			2.49	.05	.07		.92	2.54
Zanesville (Hopewell) [7]		.20			.23	.03	.56		.90				.70	.41	1.18			.04	2.68			1.82		2.72

[1] Recording gage; precipitation is for the 24-hour period midnight to midnight.
[2] Precipitation measured in the morning, amount then recorded is for preceding 24 hours.
[3] Record furnished by Corps of Engineers, U. S. Army. The gage is an 8-inch cylinder, 17½ inches high without receiver or measuring tube.
[4] The gage at Massillon is maintained by the Ohio Water Service Co. The one in use at the time of this record was a glass funnel, graduate type, which gave records of questionable reliability because of splashing and other factors. Supplementary readings: Aug. 6, 1 p. m. to 3:30 p. m., 0.27 in.; 8 p. m. to 11 p. m., 1.46 in.; 11 p. m. to 12:30 a. m., 2.34 in.; Aug. 7, 12:30 a. m. to 3 a. m., 0.95 in.; during afternoon 0.66 in. The gage is read at irregular times during the day.
[5] Station No. 16 established on July 24.
[6] No record.
[7] Furnished by U. S. Soil Conservation Service.

TABLE 6.—*Extraordinary 1-day summer rainfalls of record in or near Muskingum River Basin*

[U. S. Weather Bureau and Ohio State records]

Date	Station	Precipitation (inches)	Period [1]	Nature of storm
July 29, 1879	Wooster	6.56	105 minutes	
June 24, 1884	Vicinity of Canton[2]	[3] 12.	80 minutes	Local cloudburst.
July 18–19, 1889	Logan [4]	5.50	3½ hours	
June 20, 1899	Pataskala	5.58	4 hours	
July 6–7, 1904	Gratiot	6.48	1 day	
Aug. 14–15, 1909	Milfordton	5.53	21 hours	
July 13–14, 1913	Philo (1)	6.48	About 12 hours	General.
	Philo (2)	7.17	8 hours, 42 minutes	Do.
	Toboso	7.40	About 12 hours	Do.
	Zanesville	6.70	do	Do.
July 16, 1914	Cambridge	7.09	90 minutes	Local.
May 28, 1916	Akron	5.13	1 day	
July 19–20, 1919	Bangorville	6.35	13 hours	
Aug. 4–5, 1919	Ashland	5.10	9½ hours	
July 2–3, 1923	Toboso	7.24	1 day	
July 3–4, 1935	Bangorville	5.91	do	General.
Aug. 6–7, 1935	Cambridge	5.82	12 hours	Do.
	Coshocton	7.10	do	Do.
	Millersburg	6.79	do	Do.
	Newcomerstown	8.70	do	Do.
June 20–21, 1937	Bucyrus	7.51	About 12 hours	Do.

[1] No specific information is available for those rains whose duration is given as 1 day. For most rains the actual duration is probably less than 24 hours.
[2] Ohio Meteorological Report, June 1884, pp. 4–5.
[3] Estimated, not well authenticated.
[4] Ohio Meteorological Report, July 1889, p. 4.

Records of hourly precipitation for August 6 and 7 at recording gages in and near the Muskingum River Basin are presented in table 3 and plate 5. The maximum precipitation rate indicated is 1.54 inches per hour at Columbus, in the Scioto River Basin, and 1.22 inches per hour at Plymouth. Since none of the recording gages were within the area of most intense precipitation as delineated on the isohyetal map (pl. 2), their principal value was to indicate the duration and time distribution of the storm precipitation.

A few miscellaneous records of intensity of precipitation are available. The Ohio Water Service Co. at Massillon measured 2.34 inches of rainfall between 11 p. m. August 6 and 12:30 a. m. August 7, an average rate of 1.56 inches per hour. Mr. B. O. Stingel, whose farm is located 5 miles northeast of Coshocton, reported a rainfall of 2.5 inches in less than 1 hour during the storm. Mr. Stingel also reported a total fall of 11.5 inches in 14 hours, an average rate of 0.82 inch per hour.

Gay[11] mentioned in his report on the storm that a funnel-shaped cloud was photographed 4 or 5 miles southeast of Coshocton but that it was not reported elsewhere. There were severe winds at times during the storm. There were also reports, apparently unsupported by scientific observation, of "walls of water" or hydraulic bores coming down some of the tributary valleys.

In using unofficial records of precipitation determined by the quantity of water caught in tubs, earthen jars, fruit jars, and similar

[11] Gay, R. W., op. cit., p. 22.

containers, one is never sure how much adjustment to make for inaccuracy of observation. Such chance interception of storm rainfall in the region of high intensity, and where regular measurements are lacking, furnishes valuable indications of the rainfall. Moreover, these records frequently are the only available evidence of the intense rainfall that produces high run-off and high river stages. Where sufficiently numerous and sufficiently consistent, they provide data that supplement the more trustworthy but numerically deficient official records, which are more systematically obtained. Numerous measurements of the rain caught in various exposed vessels during the night of August 6 were made shortly after the storm. These measurements were all adjusted for the exposed opening of the receptacle. Certain observations that obviously seem to have been in error were discarded. If, however, reports for a given area consistently indicate a given rainfall, and, furthermore, if the vessels receiving the rain seem satisfactorily located and the sources of the reports seem trustworthy, such reports have been taken as authentic and have been used without change. The following is a list of available data of this character, collected by the Corps of Engineers, United States Army, and others:

Miscellaneous records of precipitation, Aug. 6–7, 1935

Coshocton County

No.	Location	Reporter or resident	Rainfall (estimated, in inches)
1	Evans Creek, 2 miles north of Orange	Justin Miller	11.3+
2	Evans Creek, Adams Township, at mouth of Swigert Run	Chester Morris	10.8
3	Mill Creek at Spoon Run	E. D. Porter	7.75
4	Mill Creek, half a mile south of Mound	W. O. Martin	9.00
5	Mill Creek at Keene		10.5 and 9.5
6	Bucklew Run near School No. 5	Donald Howell	12.7
7	Sec. 25, White Eyes Township	B. O. Stingel	11.5
8	West Lafayette	Harry Lewis	9.2
9	State Highway 16, ¾ of a mile east of West Lafayette	Harry Shurtz	9.5
10	State Highway 271, 6 miles northwest of Plainfield and 4½ from Coshocton.	Herb Watson	7.75+
11	State Highway 271, 3½ miles northwest of Plainfield		7.25
12	Plainfield	S. M. Sharock	8.2+
13	2 miles southeast of Plainfield	J. C. Miskimen	6.9+
14	New Bedford	John Kleinknecht	8 and 8.5
15	2 miles east of White Eyes Creek and ¼ of a mile south of Powell crossroads.	Elmer Thomas	10.5
16	Blissfield, on State Highway 1	Floyd Lowe	9
17	Warsaw	H. L. Duling, superintendent of schools.	Between 6.1 and 6.9
18	Northeast corner of Lafayette Township, 1 mile east of West Lafayette Station.	Robert Swigert	9.9
19	½ mile northwest of New Bedford		8.25
20	Along State Highway 76, 2 miles south of Bloomfield and 1,500 feet west of roadway.	Cleophas Conkle	10
21	1 mile south of Bloomfield	Burt Uhl	7.2

Holmes County

No.	Location	Reporter or resident	Rainfall (estimated, in inches)
22	3 miles north of Charm, on State Highway 62 to Berlin		8
23	Charm		7.8+
24	Benton, Salt Creek Township	Mr. Maxwell	5.25
25	1 mile northwest of New Bedford	John Draper	9
26	1¼ miles northwest of Bloomfield	Charles Casey	9.95+

Miscellaneous records of precipitation, Aug. 6–7, 1935—Continued

Tuscarawas County

No.	Location	Reporter or resident	Rainfall (estimated, in inches)
27	Joyce, on Stone Creek	Willis Beaber	6
28	Baltic		7.8+
29	3 miles south of Sugar Creek and ¼ of a mile west of State Highway 93.		6.6
30	Sutler farm on Huff Run near Conotton Creek	Sutler	8+
31	½ mile below confluence of Conotton Creek and Indian Fork.		3.5
32	¾ of a mile south of Bernice and about 2 miles upstream from the mouth of Dunlap Creek, on State Highway 21.	Clyde Kees	9.5+

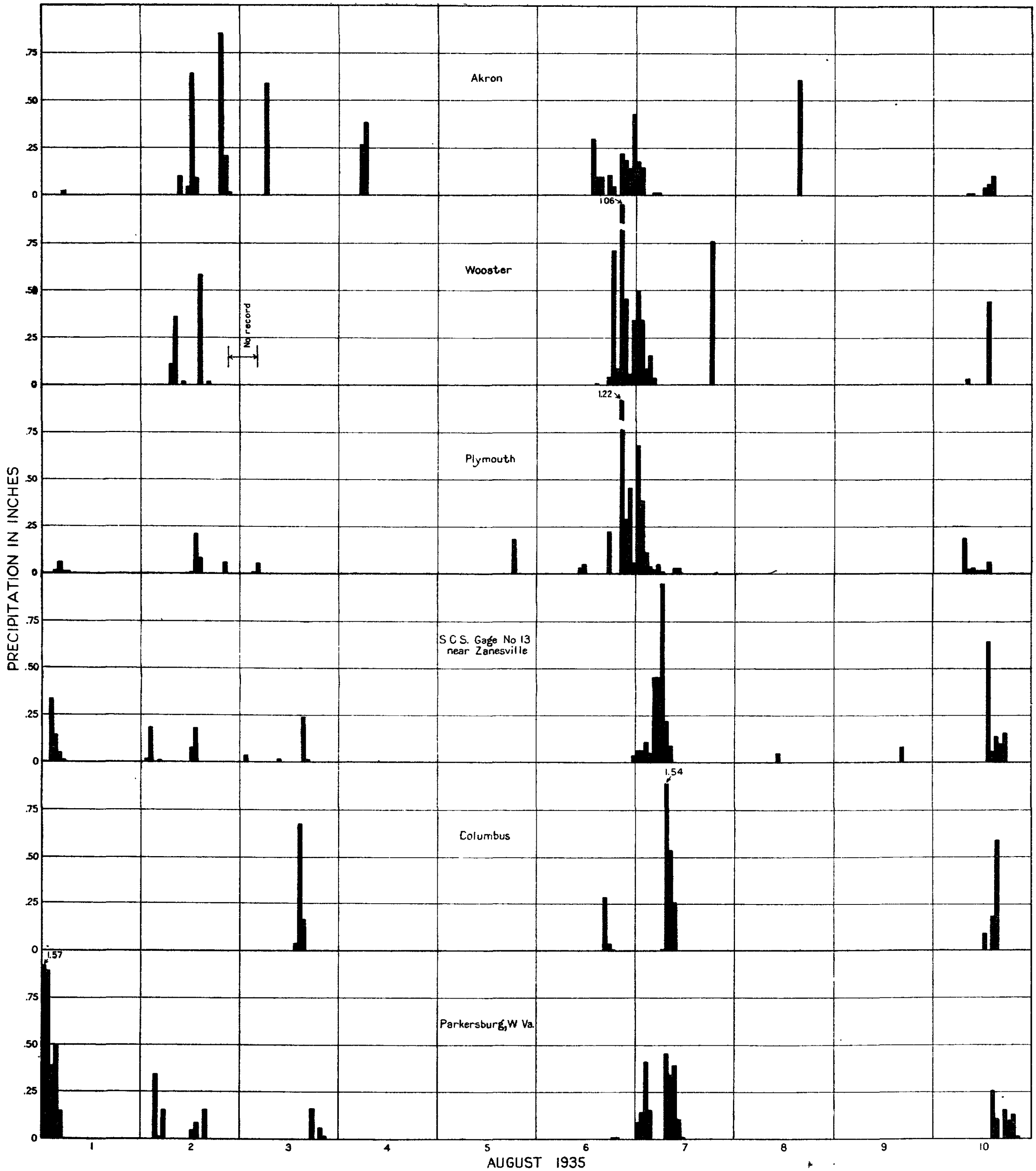
Guernsey County

No.	Location	Reporter or resident	Rainfall (estimated, in inches)
33	3 miles north of North Salem, on State Highway 21		7+
34	5 miles north of North Salem, on State Highway 21		7.25
35	1 mile west of Birds Run, on State Highway 271	J. L. Fourney	8 and 8.75
36	5 miles southeast of Newcomerstown and 1 mile east of Guernsey.	Marshall Nay	12
37	Kimbolton		6.6+

Wayne County

No.	Location	Reporter or resident	Rainfall (estimated, in inches)
38	Mount Eaton	H. B. Graber	7
39	2 miles east of Fredericksburg		6.1

1. Measured in bucket 14½ inches in diameter at top, 12 inches at bottom, and 13½ inches deep, which ran over.
2. Caught 13 inches in a tapered bucket.
3. Exclusive of the first shower.
5. Observations made in two separate straight-sided paint buckets within 1 mile of each other.
6. Caught in a 5-inch quart Mason jar which was filled; diameter of neck 2$^{15}/_{16}$ inches. Estimate of depth made by Mr. Howell.
7. Observed in a 3-inch rain gage between 6 p. m. Aug. 6 and 8 a. m. Aug. 7. 2.5 inches fell during the first shower, which lasted less than an hour. Mr. Stingel also reported 4.05 inches of antecedent rainfall distributed as follows: July 28, 1.45 inches; July 30, 0.10 inch; July 31, 1.00 inch; Aug. 3, 1.50 inches.
8. Measured in a tapered tub 10 inches deep which was empty Tuesday evening Aug. 6 and overflowed about 6 a. m. Aug. 7. The rain continued about 2 hours after that.
9. Measured in a vertical-sided bucket about 10 feet from the house, which may have prevented a correct catch of the rainfall. The house was two stories high and the bucket was somewhat sheltered from the wind, which came from the direction of the house. Mr. Shurtz was certain that no roof drainage reached the bucket.
10. Measured in a bucket that overflowed.
12. Measured in a tub 19⅛ inches across the top, 16¼ inches at bottom, and 9⅝ inches deep that overflowed.
13. Caught in a bucket 11 inches deep, 8⅛ inches in diameter at bottom, and 9⅛ inches at top that overflowed.
14. Measured in a straight-sided crock. Mr. Kleinknecht stated that a neighbor 1 mile south of New Bedford caught 8.5 inches.
16. Measured in a 10-gallon milk can.
17. Caught 7.5 inches in a 10-quart bucket.
18. Measured in a straight-sided tub. Does not include an early shower Aug. 6.
21. Measured in a tub 21⅜ inches across top, 18½ inches across bottom, and 10½ inches deep, which lacked about 2 inches of being full.
22. Measured in a straight-sided crock.
23. Several people reported that 12-quart buckets overflowed.
24. Measured in a straight-sided crock.
26. Caught in a tub 21½ inches in diameter at top, 18½ inches at bottom, and 11½ inches deep that overflowed.
28. Caught in a bucket 8⅜ inches across bottom, 10⅜ inches across top, and 9½ inches deep that overflowed.
29. Measured in a sap bucket 8 inches in diameter at bottom, 11 inches at top, and 9¾ inches deep, which lacked ¾ inch of being full.
31. Measured during the night of Aug. 6 in four straight-sided feed cans standing in the open.
32. Caught in a straight-sided vessel that overflowed.
33. Caught in a bucket that overflowed.
34. Measured in a bucket.
35. Measured in a straight-sided bucket. Mr. Fourney reported that a neighbor 1 mile north in the hills caught 8.75 inches.
36. Caught in a straight-sided 5-gallon bucket 12 inches deep that overflowed. Mr. Nay also reported that it rained from 9 p. m. to early morning, with a light shower before dark that was not caught in the bucket.
37. Caught in a tub 13½ inches across top, 11⅛ inches across bottom, and 8 inches deep that overflowed.
38. Measured in a straight-sided crock.



HOURLY PRECIPITATION AT RECORDING RAIN GAGES AUGUST 1–10.

These miscellaneous records, together with those listed in table 5, have been plotted on a map in their correct location to produce the isohyetal map on plate 2. The isohyetal lines in general are based on the total precipitation between 1 p. m. August 6, when rains in the

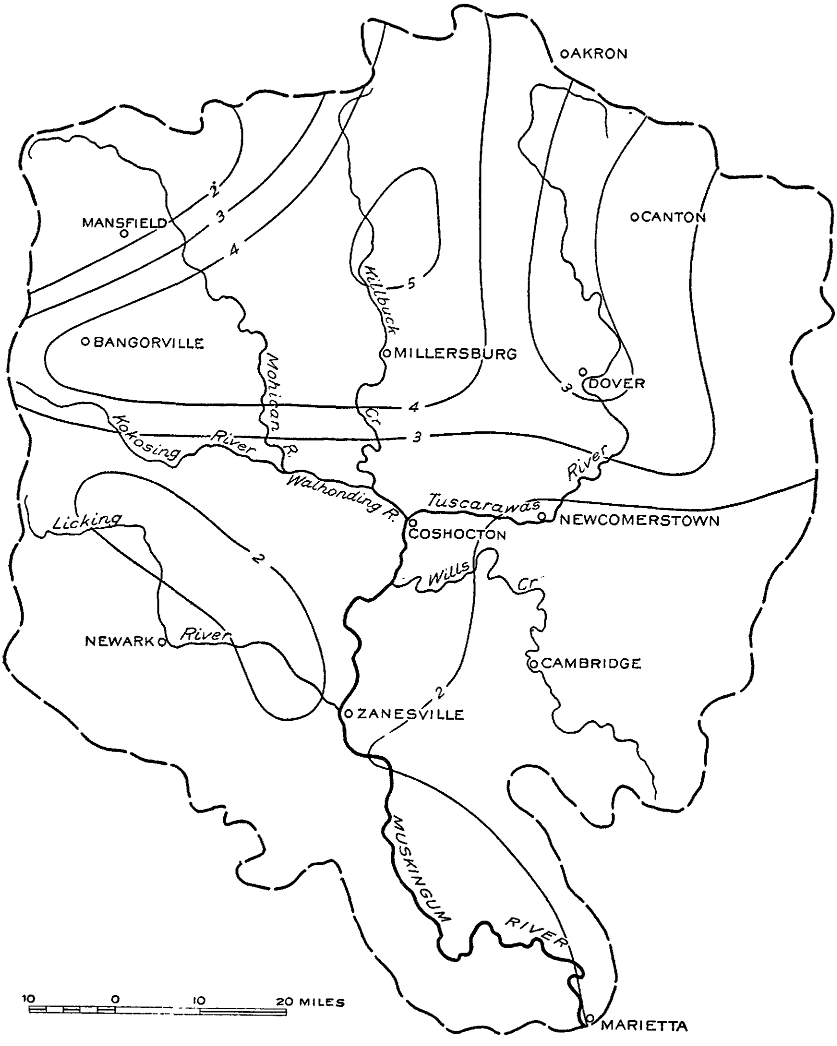


FIGURE 6.—Isohyetal map of Muskingum River Basin showing total rainfall, in inches, July 20–30.

basin began in the vicinity of Akron, and 11 a. m. August 7, when rains ceased along the southwestern divide of the basin. In general, as mentioned previously, storm precipitation was of 12 hours' duration at any one station. In the area where the storm was most severe the rain started between 7 and 8 o'clock of the evening of August 6 and continued until about 8 o'clock of the morning of August 7. For a few of the stations with daily observations, it was impossible to separate light rain immediately preceding or following the storm from that of the main storm. Table 4 lists the time of beginning and ending of

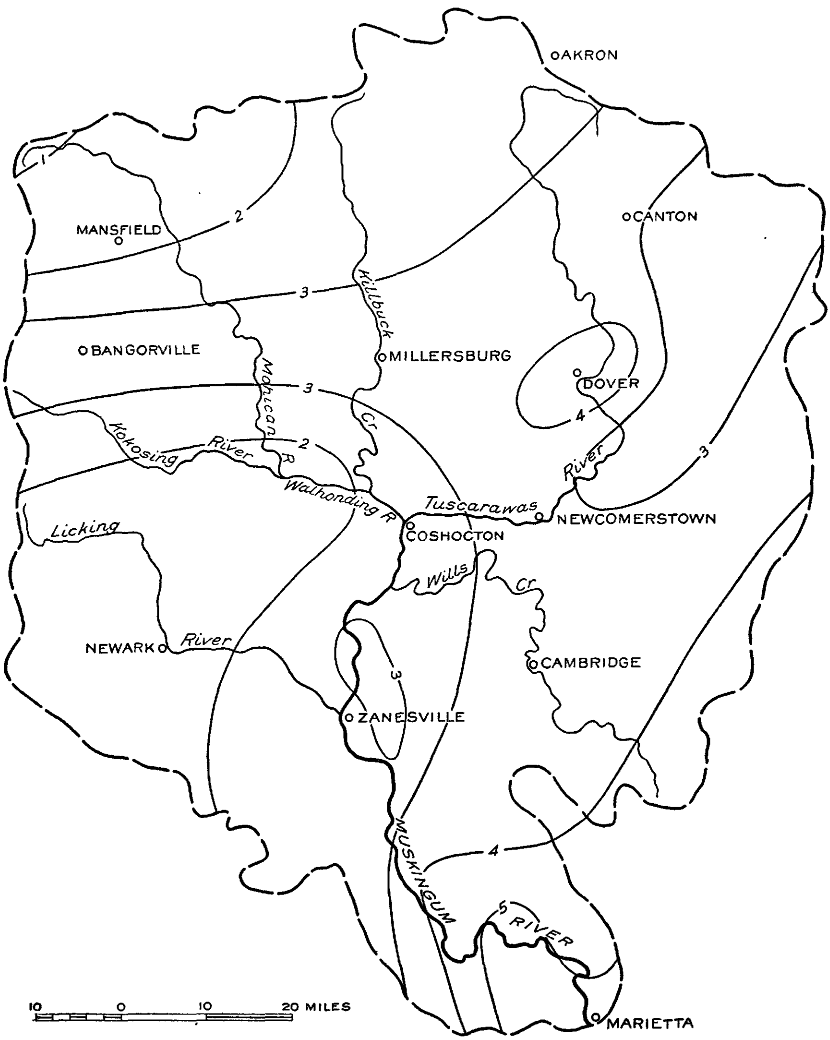


FIGURE 7.—Isohyetal map of Muskingum River Basin showing total rainfall, in inches, July 31 to August 5.

storm rainfall at those Weather Bureau cooperative stations for which this information was available.

Insofar as they were consistent with official records and with each other, the unofficial records have been given full weight in drawing the isohyetal lines shown on plate 2. They have been most valuable in defining the area of heavy rainfall and the center of the storm, where the maximum precipitation was about 12 inches. The depth and areal extent of rainfall of this storm are compared with those of other storms on page 10.

ANTECEDENT RAINFALL

The rain on the night of August 6 seems to have been the culmination of a series of rain periods, each successive rainfall being more intense than the one preceding. Table 5, showing daily precipitation measured in and near the basin from July 20 to August 11, shows this characteristic. These rainy periods caused the ground to be rather wet for the summer season. For this reason exceptionally high rates of discharge resulted from the major storm. From July 21 to 26 there were general moderate rains, which became heavy at a few stations toward the end of the period. Additional rains followed on July 28 and 29. The total precipitation during the period July 20–30, shown on figure 6, averaged about 2.7 inches over the basin above Coshocton and was generally heaviest in the northern part of the basin. The rains from July 31 to August 5 were a series of generally local and rather severe showers that were somewhat scattered and staggered with respect to time. Total precipitation over the basin during this interval as shown on figure 7 averaged 2.85 inches. Almost all stations received heavy precipitation at some time during this interval, and along the east-central part of the basin a few streams reached higher stages than after the more general heavy storm. The total precipitation during the period July 20 to August 5 averaged about 5.5 inches, which was about 3.3 inches above a normal of 2.2 inches for this 16-day period. Channels were flowing nearly full, and with the ground wet, the way was paved for the flood following the torrential rain on the night of August 6.

These conditions are indicated by the general rise in base or groundwater stream flow during the antecedent period July 20 to August 5. On July 20 this flow was estimated to be at the average rate of about 0.22 second-foot per square mile; by July 31 it had risen to 0.38 second-foot per square mile; and as a result of the rains of July 31 to August 4, the base flow increased to an estimated 0.90 second-foot per square mile on August 5, just before the storm. The total stream flow on August 5 was materially greater.

METEOROLOGY OF THE STORM

By Albert K. Showalter, United States Weather Bureau

A careful analysis of the morning and afternoon surface weather maps, in conjunction with daily isentropic charts[12] for the 315-and-319 degree potential temperature surfaces and in addition to a careful

[12] Osmun, J. W. W., An introductory discussion of the isentropic chart: U. S. Dept. Agr., Weather Bur., unpublished manuscript October 1937. Rossby, C. G., Isentropic analyses: Am. Meteorol. Soc. Bull., vol. 18, June–July 1937.

check on the autographic records collected at first-order Weather Bureau stations, indicates the following significant features as being basically contributory to the excessive rains in the vicinity of Newcomerstown, Ohio, on the night of August 6.

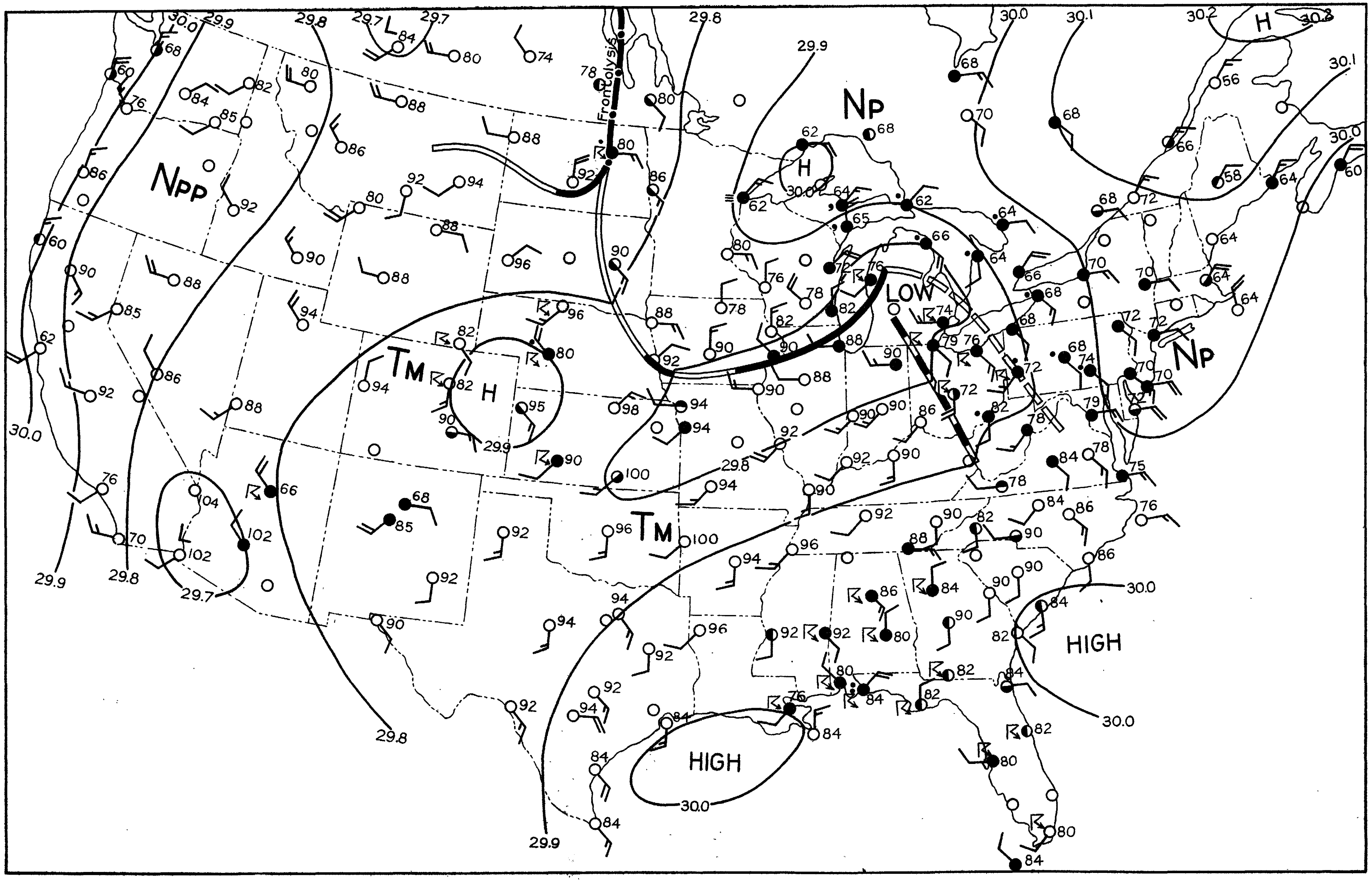
The surface weather map for 8 p. m. August 5 showed the polar front extending from Norfolk, Va., to Spartanburg, S. C., to Dubuque, Iowa, to Huron, S. Dak., to Denver, Colo., to Yellowstone Park, Wyo., to Helena, Mont. Near Helena, Mont., the polar front was occluded and the occluded front extended northeastward and northward into Canada while the cold front extended west-southwestward into Oregon. Scattered thunderstorms had occurred north of the warm sector in the upper Mississippi Valley, indicating the convective instability of the tropical maritime air. By morning of August 6 the principal warm sector had advanced slowly eastward and the apex of the wave was located in central Wisconsin. Heavy rains and thunderstorms had occurred in the vicinity of Wisconsin.

Analysis of the upper-air data for the morning of August 6 revealed a tongue of warm moist air moving upslope from El Paso toward Chicago. This moist tongue was undergoing a clockwise curvature as it advanced northward. A deep dome of cold air, circulating cyclonically aloft over the northeastern United States, was blocking the eastward advance of the moist tongue.

To the south of the moist tongue another dome of cool air was constricting the flow of warm moist air and causing it to converge as if flowing through a valley or mountain pass.

The upslope motion of the moist tongue was producing condensation and precipitation over Wisconsin. During subsequent periods the cold cyclonic dome over the northeastern States remained relatively stationary and caused the moist tongue to undergo a sharp anticyclonic deflection southeastward over Ohio. This stationary cold dome aloft in conjunction with the cooling of the surface layers by evaporation led to the development of a quasi-stationary frontal zone extending north-northwestward across Ohio. This frontal zone was well-defined on the map of 8 p. m. August 6, shown on plate 6. Aloft over the frontal zone cyclonic eddies were developing, which resulted in a series of showers and thunderstorms that moved southward with the general drift of air aloft. By the morning of August 7, the cyclonic eddies along the frontal zone appeared as minor waves along its western edge. Analysis of the upper air showed that both the cold cyclonic dome in the northeastern States and the moist anticyclonic tongue had been displaced slightly eastward. However, the moist tongue was still moving through a well-defined valley, hemmed in by domes of cold air on either side.

The heavy rains near Newcomerstown, Ohio, on the night of August 6 were apparently due to the combination of several factors. The



SURFACE WEATHER CHART OF THE UNITED STATES 8 P. M. AUGUST 6, 1935.

EXPLANATION

Temperature (°F.) at time of observation is shown at right of station circle

State of weather:

- Clear (0 to 0.3 of sky covered by clouds)
- Partly cloudy (0.4 to 0.7 of sky covered by clouds)
- Cloudy (0.8 to all of sky covered by clouds)
- Dense fog
- Drizzle (mist)
- Light rain
- Moderate rain
- Heavy rain
- Thunderstorm within last 12 hours

Wind:

Arrows fly with the wind; only the tail of the arrow is shown. Number of half barbs on tail indicates wind force in Beaufort scale

Wind from west, force 5, partly cloudy

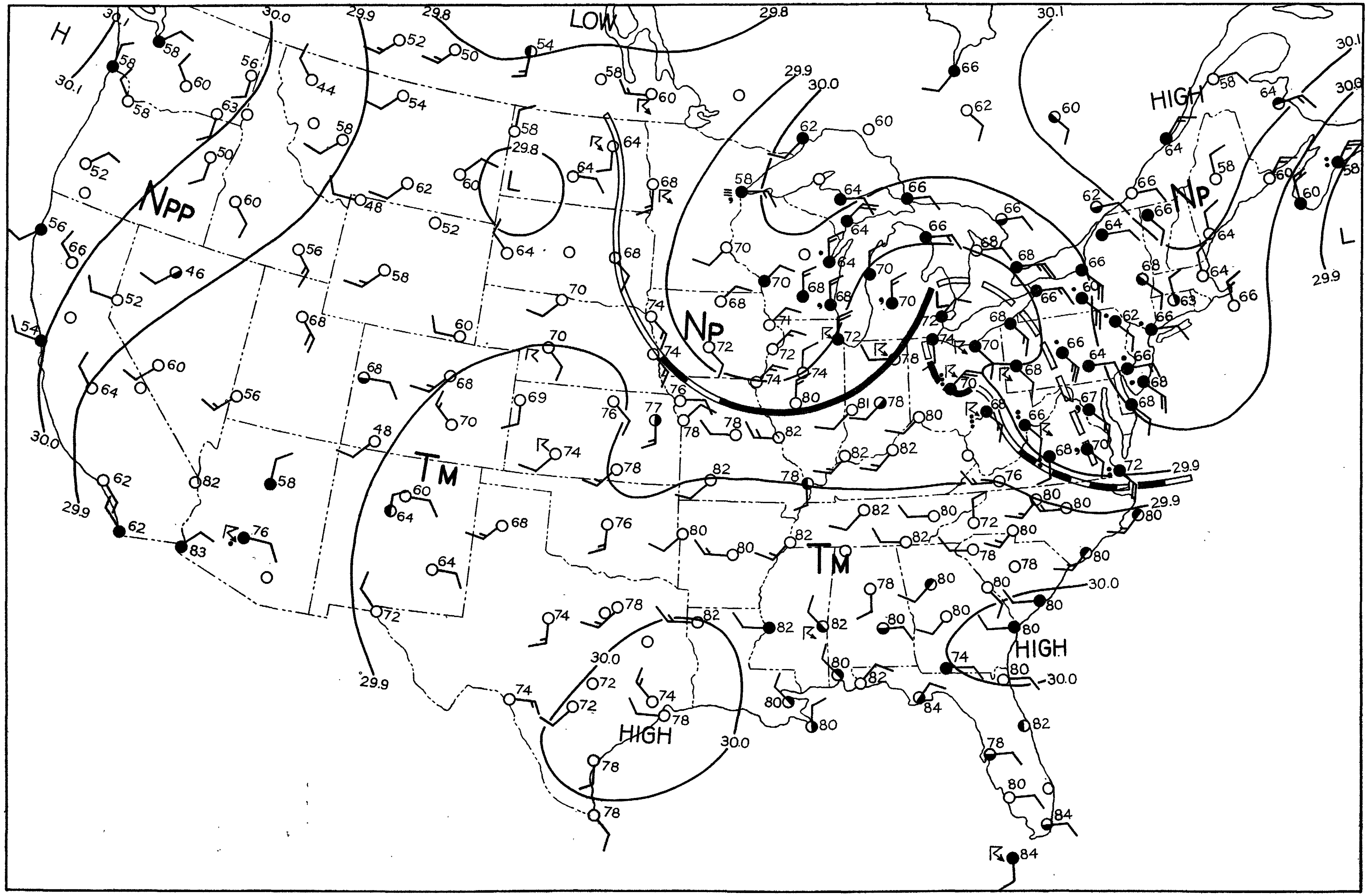
Air masses:

- NPP Transitional polar Pacific
- NP Transitional polar (mixed Pacific and continental)
- TM Tropical marine

Fronts are shown by light or heavy lines—solid, dash, or dot and dash

	Surface	Upper air
Cold		
Warm		
Occluded		
Quasi-stationary		

Isobars are drawn for each 0.10 inch of mercurial pressure



SURFACE WEATHER CHART OF THE UNITED STATES, 8 A. M. AUGUST 7, 1935.

EXPLANATION

Temperature (°F.) at time of observation is shown at right of station circle

State of weather:

- Clear (0 to 0.3 of sky covered by clouds)
- Partly cloudy (0.4 to 0.7 of sky covered by clouds)
- Cloudy (0.8 to all of sky covered by clouds)
- Dense fog
- Drizzle (mist)
- Light rain
- Moderate rain
- Heavy rain
- Thunderstorm within last 12 hours

Wind:

Arrows fly with the wind; only the tail of the arrow is shown. Number of half barbs on tail indicates wind force in Beaufort scale

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	Surface	Upper air
Cold		
Warm		
Occluded		
Quasi-stationary		

Isobars are drawn for each 0.10 inch of mercurial pressure

tongue of moist warm air, which was convectively unstable, moved upward through a gradually narrowing valley in the isentropic surfaces. This tended to cause horizontal convergence. The formation of cyclonic eddies between the high-velocity moist tongue and the slower-moving colder air to the northeast resulted in the development of waves and thunderstorms along the quasi-stationary front. A number of these cyclonic systems moved directly over Newcomerstown, causing the rainfall to be heaviest near that point. The direction of movement of the heavy showers was consistent with the general flow of air aloft and with the direction of displacement of the minor waves at the surface. As some of these minor waves deepened the convergence of air into their troughs helped to increase the intensity of precipitation.

As shown on the map for the afternoon of August 7 (pl. 7), the frontal zone had spread out considerably, and the rains had become light and had moved eastward.

This series was rather unusual in that heavy rains occurred between a warm moist tongue and a cold dry tongue, both of which were flowing southeastward. Most heavy rains occur between two such tongues flowing northeastward or northward. The rains probably would not have been excessive with such a flow pattern if the other features described above had not been present.

RECORDS OF FLOOD STAGE AND FLOOD DISCHARGE

The records of stage and discharge collected during the flood on the principal streams within the Muskingum Basin were exceptionally comprehensive. This satisfactory showing may be largely credited to the effective cooperation of the Muskingum Watershed Conservancy District, the Corps of Engineers, United States Army, and the Geological Survey in the emergency. These records are presented under the classifications shown below:

1. Records of stage and discharge at the regular river-measurement stations of the Geological Survey, 20 in number, are presented in appropriate detail under the heading "Flood discharge" with special acknowledgment for contributions of cooperating agencies.

2. Records of observations of the Weather Bureau at river-stage stations are published by the Weather Bureau in "Daily river stages at river gage stations on the principal rivers of the United States." The records appear in the volume for 1935. The record at the confluence of the Walhonding and Tuscarawas Rivers at the head of the Muskingum River, however, has been included in this report. This record has, moreover, been used in computing the discharge of the Muskingum River at this place on the basis of a stage-discharge relation subsequently defined by the Geological Survey. This com-

puted record is included in the succeeding section "Supplementary records of flood discharge."

3. Records of stage and discharge were collected at the temporary gaging stations established by the Corps of Engineers, United States Army, at or near the sites of the 14 flood-control dams previously described. Six of these records for sites in the eastern part of the basin have been computed by the Geological Survey and are included in this report under the heading "Supplementary records of flood discharge."

4. Observations of stage were made by the Corps of Engineers, United States Army, at the 11 locks and dams on the Muskingum River. The records are given in table 7, "Gage height, in feet, on Muskingum River at Locks 1–11 during August 1935."

FLOOD DISCHARGE

On the following pages there are presented stage and discharge records of the flood at 20 Geological Survey river-measurement stations operated in the Muskingum River Basin. These records consist of a station description, a table giving the daily mean discharge during July and August 1935 and the total run-off for each of these months, and a table of stage and discharge at indicated times during July and August in sufficient number for reasonably reliable delineation of the hydrograph. It should be noted that although the tabulated stages and corresponding discharges under normal conditions follow a direct functional relation (considering the limits to which gage heights are used, as noted), this relation may not apply during brief intervals of time when backwater is present. Notation is made in the station description under "Stage-discharge relation" of factors that affect the normal functional relation, except that changes in rating due to shifts in control or due to the marked effects of vegetation as defined by current-meter measurements are not noted. Pertinent information that will aid in an interpretation of the record is included in the station description under "Remarks."

The data presented in the following pages are based on records of stage and current-meter measurements of discharge made during the flood by the Geological Survey as a part of its regular river-measurement program in Ohio. During the flood emergency, when nearly all rivers in the basin were in flood simultaneously, the Geological Survey received valuable assistance from the field engineers of the Corps of Engineers, United States Army, and of the Muskingum Watershed Conservancy District in inspecting the river-measurement stations within the flood area and in making measurements of flood discharge. As a result, there is virtually no gage-height record missing at any station, and with few exceptions the stage-discharge relations are fairly well defined nearly to the peak discharge.

At a few stations, extensions of rating curves to peak discharge have been based on slope-area measurements of flood discharge. For each record the station description indicates the upper limit to which the rating curve has been defined by current-meter measurements and, where the extension is considerable, mention is made of the basis for the extension. Geological Survey Water-Supply Papers 798–800, The floods of March 1936, contain explanations of the methods employed for extending rating curves to the peak discharge.

TUSCARAWAS RIVER AT CLINTON, OHIO

LOCATION.—Lat. 40°55′39″, long. 81°37′59″, in NW¼ sec. 32, T. 14 N., R. 10 W., 100 feet below highway bridge at Clinton and 1 mile above mouth of Chippewa Creek. Zero of gage is 933.28 feet above mean sea level.

DRAINAGE AREA.—165 square miles.

GAGE-HEIGHT RECORD.—Water-stage recorder graph. Gage heights used to half tenths between 3.4 and 7.0 feet; hundredths below and tenths above these limits.

STAGE-DISCHARGE RELATION.—Defined to 1,760 second-feet by current-meter measurements; extended to peak discharge from area-velocity study. Affected by shifting control and backwater from Chippewa Creek.

MAXIMA.—1935: Discharge, 2,700 second-feet 3 a. m. Aug. 8 (gage height 14.82 feet).

1926–34: Discharge, 2,660 second-feet Mar. 15, 1933 (gage height, 13.53 feet).

Flood of March 1913 reached a stage of 22.2 feet.

Mean discharge, in second-feet, 1935

Day	July	Aug.	Day	July	Aug.	Day	July	Aug.	Day	July	Aug.
1	32	55	9	37	2,020	17	36	124	25	95	80
2	33	83	10	36	1,180	18	34	116	26	88	77
3	34	887	11	35	478	19	29	112	27	68	85
4	67	930	12	37	192	20	43	108	28	65	83
5	50	428	13	58	80	21	54	105	29	53	77
6	39	238	14	36	56	22	43	101	30	50	76
7	39	2,170	15	38	95	23	46	101	31	48	73
8	36	2,660	16	43	124	24	87	95			
Mean monthly discharge, in second-feet										48.0	422
Run-off, in inches										.34	2.95

Gage height, in feet, and discharge, in second-feet, at indicated time, 1935

Time	Feet	Second-feet	Time	Feet	Second-feet	Time	Feet	Second-feet
Aug. 1			*Aug. 3*			*Aug. 5*		
6 a. m.	2.89	55	4 a. m.	8.32	814	6 a. m.	7.29	569
10 a. m.	2.88	54	12 noon	8.57	900	12 noon	6.62	428
12 noon	2.95	59	6 p. m.	8.85	960	6 p. m.	5.90	313
10 p. m.	2.92	57	12 midnight	9.04	1,020	12 midnight	5.32	238
Aug. 2			*Aug. 4*			*Aug. 6*		
6 a. m.	2.80	48	6 a. m.	8.98	1,020	6 a. m.	4.91	170
10 a. m.	2.80	48	12 noon	8.80	960	2 p. m.	4.46	138
2 p. m.	2.88	54	6 p. m.	8.54	870	4 p. m.	4.69	156
5 p. m.	3.09	69	12 midnight	7.96	736	6 p. m.	5.82	249
8 p. m.	4.17	144				8 p. m.	6.51	344
9 p. m.	4.15	144				10 p. m.	7.18	466
10 p. m.	4.40	163				12 midnight	8.65	788
12 midnight	6.60	428						

Gage height, in feet, and discharge, in second-feet, at indicated time, 1935—Continued

Time	Feet	Second-feet	Time	Feet	Second-feet	Time	Feet	Second-feet
Aug. 7			*Aug. 9*			*Aug. 13*		
2 a. m.	10.70	1,300	12 noon	14.03	2 020	6 a. m.	5.32	91
4 a. m.	12.02	1,760	12 midnight	13.09	1,680	10 a. m.	5.10	77
6 a. m.	12.60	1,980	*Aug. 10*			4 p. m.	4.96	67
10 a. m.	13.10	2,180	12 noon	11.92	1,170	12 midnight	4.70	49
2 p. m.	13.70	2,420	12 midnight	10.61	788	*Aug. 14*		
6 p. m.	14.03	2,540	*Aug. 11*			12 noon	4.40	56
12 midnight	14.39	2,700	12 noon	9.28	466	6 p. m.	4.21	43
Aug. 8			12 midnight	8.04	266	*Aug. 15*		
6 a. m.	14.64	2,660	*Aug. 12*			2 a. m.	4.24	101
3 p. m.	14.82	2,700	12 noon	7.07	189	12 noon	4.13	95
12 midnight	14.68	2,660	12 midnight	6.00	112	12 midnight	4.03	86

TUSCARAWAS RIVER NEAR DOVER, OHIO

LOCATION.—Lat. 40°31′49″, long. 81°25′51″, in T. 9 N., R. 2 W., at highway bridge 2½ miles northeast of Dover and 3 miles above mouth of Sugar Creek. Zero of gage is 861.51 feet above mean sea level.

DRAINAGE AREA.—1,398 square miles.

GAGE-HEIGHT RECORD.—Water-stage recorder graph. Gage heights used to half tenths between 2.2 and 4.1 feet; hundredths below and tenths above these limits.

STAGE-DISCHARGE RELATION.—Defined to 18,000 second-feet by current-meter measurements; extended to crest discharge from area-velocity study.

MAXIMA.—1935: Discharge, 22,300 second-feet 4 to 6 a. m. Aug. 8 (gage height, 15.26 feet).

1923–34: Discharge, 20,600 second-feet (revised), Mar. 16, 1933 (gage height, 13.33 feet).

Discharge known, 62,000 second-feet March 1913, computed by Zanesville office of Corps of Engineers, U. S. Army (gage height, about 23.5 feet at present gage and datum, from floodmarks).

REMARKS.—Small amount of water diverted into Cuyahoga River Basin by Ohio Canal at Portage Lakes. There is no appreciable flow in Ohio Canal at this gaging station.

Mean discharge, in second-feet, 1935

Day	July	Aug.	Day	July	Aug.	Day	July	Aug.	Day	July	Aug.
1	428	674	9	706	17,300	17	547	2,170	25	1,100	700
2	368	858	10	589	12,700	18	440	1,720	26	1,380	630
3	362	5,360	11	505	10,300	19	416	1,340	27	1,160	760
4	1,760	8,770	12	458	7,190	20	398	1,160	28	966	858
5	3,020	9,110	13	452	4,080	21	533	1,100	29	1,380	754
6	2,340	6,070	14	422	2,610	22	575	1,200	30	1,020	618
7	1,280	13,700	15	452	1,870	23	547	1,050	31	658	575
8	850	21,500	16	600	2,020	24	554	840			
Mean monthly discharge, in second-feet										847	4,503
Run-off, in inches										0.70	3.71

Gage height, in feet, and discharge, in second-feet, at indicated time, 1935

Time	Feet	Second-feet
July 3		
12 noon	1.22	362
12 midnight	1.26	386
July 4		
7 a. m.	1.36	446
12 noon	2.59	1,470
5 p. m.	3.70	2,610
6 p. m.	4.37	3,440
9 p. m.	4.67	3,810
12 midnight	4.54	3,560
July 5		
8 a. m.	4.02	2,960
8 p. m.	3.90	2,840
July 6		
6 a. m.	3.70	2,610
12 noon	3.53	2,440
6 p. m.	3.20	2,070
July 7		
6 a. m.	2.63	1,520
12 noon	2.36	1,240
8 p. m.	2.10	1,020
July 8		
6 a. m.	1.98	914
6 p. m.	1.83	794
July 24		
4 a. m.	1.57	589
4 p. m.	1.55	575
12 midnight	1.46	512
July 25		
9 a. m.	1.63	634
12 noon	2.18	1,090
4 p. m.	2.66	1,520
8 p. m.	2.80	1,670
July 26		
2 a. m.	2.79	1,670
10 a. m.	2.51	1,380
6 p. m.	2.26	1,160
12 midnight	2.32	1,200
July 27		
4 a. m.	2.37	1,240
12 noon	2.28	1,200
12 midnight	2.09	1,010
July 28		
12 noon	1.98	914
8 p. m.	2.04	966
12 midnight	2.23	1,160
July 29		
6 a. m.	2.60	1,470
12 noon	2.60	1,470
8 p. m.	2.38	1,290
July 30		
4 a. m.	2.30	1,200
12 noon	2.13	1,050
12 midnight	1.79	762
July 31		
6 a. m.	1.71	698
6 p. m.	1.62	626
12 midnight	1.57	589
Aug. 1		
10 a. m.	1.60	610
6 p. m.	1.77	746
12 midnight	1.91	858
Aug. 2		
6 a. m.	1.91	858
2 p. m.	1.89	842
6 p. m.	1.87	826
10 p. m.	1.99	922
12 midnight	2.23	1,160
Aug. 3		
2 a. m.	3.08	1,970
10 a. m.	5.56	5,000
12 noon	5.99	5,560
1 p. m.	6.73	6,550
6 p. m.	7.30	7,480
12 midnight	7.70	8,120
Aug. 4		
6 a. m.	7.99	8,600
10 a. m.	8.00	8,600
4 p. m.	8.19	8,940
12 midnight	8.48	9,450
Aug. 5		
6 a. m.	8.57	9,620
12 noon	8.40	9,280
6 p. m.	8.02	8,600
12 midnight	7.58	7,960
Aug. 6		
6 a. m.	6.96	7,000
12 noon	6.23	5,840
4 p. m.	5.79	5,280
10 p. m.	5.65	5,000
12 midnight	5.83	5,280
Aug. 7		
4 a. m.	7.79	8,280
12 noon	10.93	13,700
4 p. m.	12.11	16,000
6 p. m.	12.95	17,700
8 p. m.	14.00	19,700
10 p. m.	14.71	21,100
12 midnight	15.04	21,700
Aug. 8		
2 a. m.	15.21	22,100
4 a. m.	15.26	22,300
6 a. m.	15.26	22,300
10 a. m.	15.16	22,100
6 p. m.	14.55	20,900
12 midnight	13.97	19,700
Aug. 9		
12 noon	12.74	17,100
12 midnight	11.49	14,800
Aug. 10		
12 noon	10.20	12,500
6 p. m.	9.73	11,600
12 midnight	9.52	11,200
Aug. 11		
6 a. m.	9.38	11,000
6 p. m.	8.79	9,960
Aug. 12		
6 a. m.	7.73	8,120
6 p. m.	6.50	6,260
Aug. 13		
6 a. m.	5.20	4,460
8 a. m.	5.12	4,330
12 noon	4.81	3,940
6 p. m.	4.46	3,560
12 midnight	4.13	3,080
Aug. 14		
12 noon	3.75	2,660
12 midnight	3.25	2,120
Aug. 15		
12 noon	2.99	1,870
12 midnight	2.80	1,670
Aug. 16		
12 noon	3.19	2,070
12 midnight	3.46	2,340
Aug. 17		
12 noon	3.34	2,220
12 midnight	3.10	1,970
Aug. 18		
12 noon	2.87	1,720
12 midnight	2.61	1,470
Aug. 19		
12 noon	2.46	1,340
12 midnight	2.30	1,200
Aug. 20		
12 noon	2.25	1,160
7 p. m.	2.18	1,900

TUSCARAWAS RIVER AT NEWCOMERSTOWN, OHIO

LOCATION.—Lat. 40°16′21″, long. 81°35′32″, in T. 5. N., R. 3 W., at highway bridge three-quarters of a mile east of Newcomerstown. Zero of gage is 780.03 feet above mean sea level.

DRAINAGE AREA.—2,432 square miles.

GAGE-HEIGHT RECORD.—Graph constructed from readings of wire-weight gage made at least twice daily. Prior to July 17, water-stage recorder graph. Gage heights used to half tenths between 5.2 and 7.1 feet; hundredths below and tenths above these limits.

STAGE-DISCHARGE RELATION.—Defined to peak discharge by current-meter measurements. Affected by backwater from Buckhorn Creek on Aug. 7; discharge computed from estimated graph.

MAXIMA.—1935: Discharge, 41,700 second-feet 6 a. m. Aug. 9 (gage height, 21.25 feet).

1921–34: Discharge 32,900 second-feet Mar. 17, 1933 (gage height, 13.55 feet).

Discharge known, 83,000 second-feet March 1913, computed by Zanesville office of Corps of Engineers, U. S. Army (gage height, 26.5 feet from floodmarks).

REMARKS.—Records for August supersede those published in Water Supply Paper 783. Gage-height record collected in cooperation with U. S. Weather Bureau. Some discharge measurements furnished by Muskingum Watershed Conservancy District.

Mean discharge, in second-feet, 1935

Day	July	Aug.	Day	July	Aug.	Day	July	Aug.	Day	July	Aug.
1	875	1,110	9	3,580	40,000	17	1,160	4,520	25	1,690	1,540
2	757	1,390	10	1,950	32,600	18	890	3,840	26	3,330	1,390
3	695	6,920	11	1,340	24,000	19	709	3,030	27	1,900	1,300
4	2,880	12,300	12	1,070	18,300	20	1,250	2,440	28	1,840	1,440
5	8,360	15,300	13	913	11,400	21	1,050	2,110	29	2,910	1,490
6	8,000	15,300	14	844	6,330	22	1,490	2,270	30	2,380	1,250
7	6,490	15,600	15	786	4,240	23	1,250	2,500	31	1,390	1,070
8	5,090	27,600	16	905	3,450	24	1,250	2,060			
Mean monthly discharge, in second-feet										2,227	8,648
Run-off, in inches										1.06	4.10

Gage height, in feet, and discharge, in second-feet, at indicated time, 1935

Time	Feet	Second-feet
July 3		
8 a. m.	4.71	695
7 p. m.	4.62	635
12 midnight	5.16	1,040
July 4		
2 a. m.	5.64	1,490
4 a. m.	5.74	1,590
8 a. m.	5.45	1,300
10 a. m.	5.54	1,390
12 noon	5.93	1,790
4 p. m.	7.44	3,450
8 p. m.	8.66	5,240
July 5		
2 a. m.	9.98	7,310
8 a. m.	10.68	8,540
12 noon	10.84	8,720
4 p. m.	10.80	8,720
12 midnight	10.62	8,360
July 6		
12 noon	10.40	8,000
12 midnight	10.02	7,310
July 7		
12 noon	9.57	6,650
12 midnight	9.00	5,690
July 8		
12 noon	8.56	5,090
12 midnight	8.12	4,380
July 9		
12 noon	7.60	3,710
12 midnight	6.71	2,610
July 10		
12 noon	6.01	1,840
12 midnight	5.71	1,540
July 11		
12 noon	5.49	1,340
12 midnight	5.36	1,200
July 12		
12 noon	5.20	1,070
12 midnight	5.12	1,000
Aug. 1		
8 a. m.	5.23	1,110
6 p. m.	5.26	1,110
Aug. 2		
8 a. m.	5.36	1,200
6 p. m.	5.63	1,490
10 p. m.	5.96	1,790
12 midnight	6.53	2,440
Aug. 3		
6 a. m.	8.37	4,800
12 noon	9.94	7,140
6 p. m.	11.12	9,290
12 midnight	11.79	10,600
Aug. 4		
12 noon	12.65	12,300
12 midnight	13.38	14,000
Aug. 5		
12 noon	14.00	15,300
12 midnight	14.43	16,300
Aug. 6		
8 a. m.	14.29	16,100
4 p. m.	13.67	14,700
6 p. m.	13.54	14,200
10 p. m.	14.00	14,000
12 midnight	15.00	14,000
Aug. 7		
4 a. m.	16.70	14,200
8 a. m.	17.33	14,700
12 noon	16.90	15,300
4 p. m.	16.15	16,300
6 p. m.	15.85	16,800
12 midnight	15.25	18,300
Aug. 8		
6 a. m.	16.30	21,200
8 a. m.	16.75	22,700
10 a. m.	17.28	24,300
12 noon	17.88	26,400
2 p. m.	18.44	28,400
4 p. m.	19.00	30,800
6 p. m.	19.72	34,000
8 p. m.	20.23	36,300
12 midnight	20.89	40,000
Aug. 9		
2 a. m.	21.08	41,100
4 a. m.	21.22	41,700
6 a. m.	21.25	41,700
8 a. m.	21.17	41,700
12 noon	20.97	40,500
6 p. m.	20.65	38,400
12 midnight	20.27	36,900
Aug. 10		
8 a. m.	19.68	34,000
12 noon	19.39	32,600
6 p. m.	18.95	30,800
12 midnight	18.39	28,400
Aug. 11		
8 a. m.	17.50	25,000
6 p. m.	16.67	22,400
12 midnight	16.20	20,900
Aug. 12		
8 a. m.	15.55	19,300
6 p. m.	14.70	17,000
12 midnight	14.03	15,300
Aug. 13		
8 a. m.	12.98	13,100
6 p. m.	11.35	9,860
12 midnight	10.50	8,180
Aug. 14		
8 a. m.	9.65	6,650
6 p. m.	8.95	5,690
12 midnight	8.56	5,090
Aug. 15		
8 a. m.	8.08	4,380
6 p. m.	7.66	3,840
12 midnight	7.49	3,580
Aug. 16		
8 a. m.	7.34	3,450
6 p. m.	7.35	3,450
Aug. 17		
8 a. m.	8.19	4,520
12 noon	8.29	4,660
6 p. m.	8.22	4,660
Aug. 18		
8 a. m.	7.84	4,100
6 p. m.	7.51	3,710
Aug. 19		
8 a. m.	7.11	3,210
6 p. m.	6.90	2,910
Aug. 20		
8 a. m.	6.57	2,500
6 p. m.	6.44	2,380

MUSKINGUM RIVER AT DRESDEN, OHIO

LOCATION.—Lat. 40°07′14″, long. 82°00′02″, at highway bridge half a mile east of Dresden, Muskingum County, and half a mile below Wakatomika Creek. Zero of gage is 693.15 feet above mean sea level.

DRAINAGE AREA.—5,982 square miles.

GAGE-HEIGHT RECORD.—Water-stage recorder graph except July 12 to Aug. 11, when record was obtained from hourly readings at Dam 11 and gage relation. Gage heights used to half tenths between 4.2 and 6.6 feet; hundredths below and tenths above these limits.

STAGE-DISCHARGE RELATION.—Defined to 92,600 second-feet by current meter measurements. Extended to peak discharge on basis of area-velocity study.

MAXIMA.—1935: Discharge, 100,000 second-feet 2 a. m. Aug. 9 (gage height, 31.6 feet).

1921–34: Discharge, 63,300 second-feet Mar. 23, 1927 (gage height, 26.0 feet).

Discharge known, 228,000 second-feet March 1913, computed by Zanesville office of Corps of Engineers, U. S. Army (gage height, 46.0 feet from high-water mark).

REMARKS.—Records for August supersede those published in Water-Supply Paper 783.

Mean discharge, in second-feet, 1935

Day	July	Aug.	Day	July	Aug.	Day	July	Aug.	Day	July	Aug.
1	2,240	3,760	9	8,350	96,000	17	2,840	11,300	25	5,260	4,280
2	2,180	6,230	10	6,070	86,600	18	2,480	10,300	26	9,490	3,680
3	1,960	11,200	11	4,320	73,200	19	2,120	8,540	27	6,400	3,530
4	4,350	23,000	12	3,220	57,600	20	2,180	6,910	28	4,600	3,680
5	21,700	23,900	13	2,900	44,600	21	2,180	5,870	29	5,910	4,130
6	24,100	23,300	14	2,600	31,500	22	2,240	5,370	30	5,910	4,280
7	15,200	36,000	15	2,600	20,600	23	2,720	5,530	31	4,320	3,680
8	11,700	84,500	16	2,600	14,900	24	3,350	5,050			
Mean monthly discharge, in second-feet										5,745	23,320
Run-off, in inches										1.11	4.50

Gage height, in feet, and discharge, in second-feet, at indicated time, 1935

Time	Feet	Second-feet
July 3		
4 a. m.	5.00	2,010
12 noon	4.90	1,900
8 p. m.	4.87	1,840
July 4		
4 a. m.	5.10	2,120
12 noon	6.08	3,350
6 p. m.	7.60	5,460
12 midnight	11.30	12,300
July 5		
6 a. m.	13.80	18,600
12 noon	15.18	22,700
6 p. m.	16.22	25,700
12 midnight	17.03	28,300
July 6		
3 a. m.	17.25	28,900
8 a. m.	16.73	27,300
4 p. m.	14.70	21,200
12 midnight	13.56	18,100
July 7		
6 a. m.	12.90	16,200
12 noon	12.30	14,700
8 p. m.	12.02	14,000
July 8		
4 a. m.	11.54	12,800
12 noon	11.02	11,700
12 midnight	10.03	9,680
July 9		
12 noon	9.24	8,170
12 midnight	8.65	7,090
July 10		
12 noon	7.96	6,070
12 midnight	7.28	5,020
July 11		
12 noon	6.80	4,320
12 midnight	6.28	3,620
July 24		
2 a. m.	5.94	3,160
10 a. m.	6.00	3,220
12 noon	6.12	3,350
6 p. m.	6.12	3,350
12 midnight	6.47	3,900
July 25		
6 a. m.	6.86	4,460
12 noon	7.43	5,160
6 p. m.	7.75	5,760
12 midnight	9.20	8,170
July 26		
6 a. m.	10.62	10,900
12 noon	10.00	9,680
4 p. m.	9.60	8,920
12 midnight	9.11	7,990
July 27		
8 a. m.	8.44	6,740
12 noon	8.30	6,570
6 p. m.	7.74	5,610
12 midnight	7.39	5,160
July 28		
6 a. m.	7.19	4,880
8 a. m.	7.04	4,600
2 p. m.	6.99	4,600
6 p. m.	6.85	4,320
12 midnight	6.96	4,600
July 29		
10 a. m.	7.96	6,070
3 p. m.	8.30	6,570
12 midnight	8.32	6,570
July 30		
8 a. m.	8.08	6,230
2 p. m.	7.71	5,610
6 p. m.	7.74	5,610
12 midnight	7.48	5,310
July 31		
6 a. m.	7.03	4,600
12 noon	6.80	4,320
6 p. m.	6.48	3,900
12 midnight	6.33	3,620
Aug. 1		
8 a. m.	6.30	3,620
12 noon	6.12	3,350
2 p. m.	6.30	3,620
6 p. m.	6.30	3,620
12 midnight	7.00	4,600
Aug. 2		
6 a. m.	8.68	7,270
8 a. m.	8.46	6,910
2 p. m.	8.10	6,230
6 p. m.	8.10	6,230
12 midnight	8.10	6,230
Aug. 3		
6 a. m.	8.48	6,910
12 noon	10.10	9,870
12 midnight	13.88	18,900
Aug. 4		
5 a. m.	14.70	21,200
8 a. m.	14.72	21,200
2 p. m.	15.42	23,300
8 p. m.	16.30	26,000
12 midnight	16.20	25,700
Aug. 5		
6 a. m.	15.75	24,500
8 a. m.	15.75	24,500
12 noon	15.44	23,300
2 p. m.	15.60	23,900
6 p. m.	15.26	23,000
12 midnight	15.22	22,700
Aug. 6		
10 a. m.	15.30	23,000
12 noon	15.46	23,600
8 p. m.	15.48	23,600
Aug. 7		
6 a. m.	15.96	25,100
8 a. m.	17.10	28,600
12 noon	18.70	33,900
6 p. m.	21.53	44,200
12 midnight	24.90	58,000
Aug. 8		
6 a. m.	27.65	72,600
12 noon	29.75	87,300
3 p. m.	30.58	93,100
6 p. m.	31.22	97,500
10 p. m.	31.54	99,800
Aug. 9		
2 a. m.	31.60	100,000
12 noon	31.04	96,000
6 p. m.	30.63	93,100
12 midnight	30.25	90,200
Aug. 10		
6 a. m.	29.98	88,700
12 noon	29.60	85,900
6 p. m.	29.35	84,400
12 midnight	28.95	81,600
Aug. 11		
12 noon	27.66	73,200
12 midnight	26.31	65,200
Aug. 12		
12 noon	24.80	57,600
12 midnight	23.25	50,700
Aug. 13		
12 noon	21.58	44,600
12 midnight	20.09	39,000
Aug. 14		
12 noon	18.05	31,500
12 midnight	15.85	24,500
Aug. 15		
12 noon	14.50	20,600
12 midnight	13.35	17,500
Aug. 16		
12 noon	12.36	14,900
12 midnight	11.29	12,300
Aug. 17		
6 a. m.	10.95	11,700
6 p. m.	10.70	11,100
Aug. 18		
12 noon	10.28	10,300
12 midnight	9.90	9,490
Aug. 19		
12 noon	9.35	8,540
12 midnight	8.87	7,630
Aug. 20		
12 noon	8.50	6,910
12 midnight	8.17	6,380

MUSKINGUM RIVER AT McCONNELSVILLE, OHIO

LOCATION.—Lat. 39°38′40″, long. 81°51′00″, in SE¼ sec. 11, T. 10 N., R. 12 W., above Dam 7, at McConnelsville. Zero of gage is at elevation of crest of dam, which is 650.31 feet above mean sea level.

DRAINAGE AREA.—7,411 square miles.

GAGE-HEIGHT RECORD.—Water-stage recorder graph. Gage heights used to half tenths between 1.6 and 3.6 feet; hundredths below and tenths above these limits.

STAGE-DISCHARGE RELATION.—Defined to peak discharge by current-meter measurements.

MAXIMA.—1935: Discharge, 104,000 second-feet 10 a. m. to 1 p. m. Aug. 9 (gage height, 17.02 feet).

1921–34: Discharge, 75,100 second-feet revised Mar. 19, 1933 (gage height, 12.29 feet).

Discharge known, 270,000 second-feet Mar. 27, 1913, computed by Zanesville office of Corps of Engineers, U. S. Army (gage height, 33.5 feet, present datum).

Mean discharge, in second-feet, 1935

Day	July	Aug.	Day	July	Aug.	Day	July	Aug.	Day	July	Aug.
1	2,810	6,110	9	9,550	102,000	17	3,260	15,000	25	4,330	4,840
2	2,470	9,610	10	7,220	92,900	18	3,130	12,700	26	9,310	4,250
3	2,340	11,700	11	5,230	86,000	19	2,700	10,400	27	7,850	4,230
4	2,900	25,100	12	4,250	71,600	20	2,550	7,960	28	5,460	6,730
5	19,100	27,200	13	3,650	53,500	21	2,650	6,700	29	7,210	4,540
6	27,200	23,700	14	3,130	38,600	22	2,780	5,620	30	6,900	4,540
7	19,600	41,100	15	3,130	23,900	23	2,860	5,460	31	5,460	4,250
8	13,900	81,800	16	2,800	17,100	24	3,300	5,460			
Mean monthly discharge, in second-feet										6,420	26,280
Run-off, in inches										1.00	4.09

Gage height, in feet, and discharge, in second-feet, at indicated time, 1935

Time	Feet	Second-feet
July 25		
6 a. m.	1.63	3,820
12 noon	1.80	4,250
6 p. m.	2.06	5,000
12 midnight	2.20	5,460
July 26		
6 a. m.	2.82	7,740
2 p. m.	3.54	11,100
4 p. m.	3.56	11,100
12 midnight	3.23	9,720
July 27		
12 noon	2.82	7,740
12 midnight	2.42	6,140
July 28		
12 noon	2.13	5,300
6 p. m.	2.08	5,150
12 midnight	2.37	5,960
July 29		
12 noon	2.78	7,740
12 midnight	2.73	7,520
July 30		
12 noon	2.61	6,900
12 midnight	2.40	6,140
July 31		
12 noon	2.16	5,300
12 midnight	1.92	4,540
Aug. 1		
4 a. m.	1.96	4,690
12 noon	2.79	7,740
12 midnight	2.18	5,460
Aug. 2		
2 a. m.	2.20	5,460
7 a. m.	3.73	11,800
12 noon	3.46	10,600
6 p. m.	3.30	9,950
12 midnight	3.03	8,820
Aug. 3		
3 a. m.	2.98	8,600
6 a. m.	3.18	9,500
12 noon	3.12	9,050
6 p. m.	3.90	12,700
12 midnight	5.36	21,000
Aug. 4		
12 noon	5.90	24,400
12 midnight	6.35	27,900
Aug. 5		
6 a. m.	6.37	27,900
12 noon	6.35	27,900
12 midnight	6.04	25,100
Aug. 6		
12 noon	5.74	23,000
12 midnight	5.70	23,000
Aug. 7		
8 a. m.	5.70	23,000
12 noon	8.50	44,500
2 p. m.	9.12	49,900
6 p. m.	9.90	56,700
12 midnight	10.54	61,500
Aug. 8		
6 a. m.	11.62	70,200
12 noon	13.40	82,400
6 p. m.	15.20	93,200
12 midnight	16.25	99,200
Aug. 9		
6 a. m.	16.86	103,000
12 noon	17.02	104,000
6 p. m.	16.70	102,000
12 midnight	16.10	98,600
Aug. 10		
6 a. m.	15.54	95,000
12 noon	15.00	92,000
6 p. m.	14.76	90,800
12 midnight	14.64	89,600
Aug. 11		
6 a. m.	14.40	88,400
12 noon	14.06	86,600
6 p. m.	13.60	83,600
12 midnight	13.06	80,600
Aug. 12		
12 noon	11.84	71,600
12 midnight	10.50	61,500
Aug. 13		
12 noon	9.50	53,500
6 p. m.	9.00	49,000
12 midnight	8.60	45,400
Aug. 14		
12 noon	7.85	38,600
12 midnight	6.68	30,000
Aug. 15		
6 a. m.	6.13	25,800
12 noon	5.74	23,000
6 p. m.	5.42	21,000
12 midnight	5.17	19,800
Aug. 16		
12 noon	4.70	16,800
6 p. m.	4.50	15,700
12 midnight	4.40	15,200
Aug. 17		
6 a. m.	4.43	15,200
12 noon	4.38	15,200
12 midnight	4.12	13,700
Aug. 18		
12 noon	3.90	12,700
12 midnight	3.73	11,800
Aug. 19		
12 noon	3.40	10,400
12 midnight	3.10	9,050
Aug. 20		
12 noon	2.84	7,960
12 midnight	2.65	7,100

SANDY CREEK AT SANDYVILLE, OHIO

LOCATION.—Lat. 40°38'04", long. 81°22'28", in sec. 8, T. 10 N., R. 1 W., 100 feet below highway bridge, a third of a mile below mouth of Nimishillen Creek and half a mile south of Sandyville. Zero of gage is 913.25 feet above mean sea level.

DRAINAGE AREA.—481 square miles.

GAGE-HEIGHT RECORD.—Water-stage recorder graph except for period Aug. 3–5, when record was based on floodmarks and record at Bolivar dam site. Gage heights used to half tenths between 3.0 and 5.0 feet; hundredths below and tenths above these limits.

STAGE-DISCHARGE RELATION.—Defined to 10,300 second-feet by current-meter measurements; extended to peak discharge from area-velocity study.

MAXIMA.—1935: Discharge, 12,600 second-feet noon Aug. 7 (gage height, 13.84 feet).

1923–34: Discharge, 11,600 second-feet Feb. 26, 1929 (gage height, 13.0 feet).

Flood of March 1913 reached stage of approximately 14.8 feet on present gage.

REMARKS.—Records for August supersede those published in Water-Supply Paper 783; see Water-Supply Paper 803 for complete revised record.

Mean discharge, in second-feet, 1935

Day	July	Aug.	Day	July	Aug.	Day	July	Aug.	Day	July	Aug.
1	133	278	9	150	3,500	17	134	848	25	448	258
2	120	494	10	144	1,910	18	116	588	26	275	252
3	118	4,470	11	126	1,870	19	123	476	27	202	316
4	615	4,180	12	116	1,220	20	110	422	28	277	390
5	458	2,870	13	166	975	21	122	410	29	321	322
6	286	1,600	14	114	810	22	157	434	30	190	256
7	204	9,900	15	124	622	23	212	334	31	174	235
8	164	6,510	16	227	1,070	24	188	294			
Mean monthly discharge, in second-feet										204	1,552
Run-off, in inches										0.49	3.72

Gage height, in feet, and discharge, in second-feet, at indicated time, 1935

Time	Feet	Second-feet
July 31		
8 a. m.	1.75	150
10 a. m.	1.95	205
10 p. m.	1.90	190
Aug. 1		
2 a. m.	1.82	168
8 a. m.	1.95	205
1 p. m.	2.50	397
4 p. m.	2.30	319
8 p. m.	2.35	338
12 midnight	2.37	346
Aug. 2		
8 a. m.	2.19	280
4 p. m.	2.23	294
8 p. m.	3.95	1,080
10 p. m.	4.06	1,130
12 midnight	5.80	2,200
Aug. 3		
2 a. m.	7.50	3,570
6 a. m.	8.39	4,380
12 noon	9.00	4,920
4 p. m.	9.38	5,300
8 p. m.	8.88	4,830
12 midnight	8.00	4,020
Aug. 4		
3 a. m.	7.42	3,480
6 a. m.	7.70	3,750
10 a. m.	8.55	4,560
1 p. m.	8.70	4,650
6 p. m.	8.40	4,380
12 midnight	7.92	3,930
Aug. 5		
12 noon	6.80	2,950
12 midnight	5.29	1,860

Time	Feet	Second-feet
Aug. 6		
6 a. m.	4.72	1,490
12 noon	4.31	1,260
4 p. m.	4.15	1,190
6 p. m.	4.25	1,240
8 p. m.	5.32	1,860
12 midnight	7.40	3,480
Aug. 7		
4 a. m.	10.56	6,640
8 a. m.	13.13	11,100
12 noon	13.84	12,600
6 p. m.	13.11	11,100
10 p. m.	12.38	9,700
Aug. 8		
6 a. m.	11.23	7,520
12 noon	10.34	6,260
6 p. m.	9.56	5,500
12 midnight	8.92	4,830
Aug. 9		
12 noon	7.42	3,480
12 midnight	5.86	2,270
Aug. 10		
6 a. m.	5.23	1,800
2 p. m.	4.70	1,490
8 p. m.	5.90	2,270
12 midnight	5.71	2,130
Aug. 11		
2 a. m.	5.83	2,200
12 noon	5.32	1,860
6 p. m.	4.95	1,670
12 midnight	4.69	1,490
Aug. 12		
12 noon	4.20	1,210
12 midnight	3.88	1,050

Time	Feet	Second-feet
Aug. 13		
6 a. m.	3.75	975
10 a. m.	3.87	1,020
12 noon	3.92	1,050
4 p. m.	3.71	950
12 midnight	3.65	925
Aug. 14		
12 noon	3.43	826
6 p. m.	3.31	754
12 midnight	3.15	682
Aug. 15		
6 a. m.	3.04	636
12 noon	2.95	590
9 p. m.	2.92	577
12 midnight	3.05	636
Aug. 16		
6 a. m.	3.90	1,050
8 a. m.	4.05	1,130
12 noon	4.12	1,160
2 p. m.	4.20	1,210
10 p. m.	4.10	1,160
Aug. 17		
2 a. m.	3.85	1,020
12 noon	3.48	850
12 midnight	3.15	632
Aug. 18		
12 noon	2.95	590
12 midnight	2.80	523
Aug. 19		
12 noon	2.68	471
12 midnight	2.65	458
Aug. 20		
12 noon	2.54	413
12 midnight	2.50	397

NIMISHILLEN CREEK AT NORTH INDUSTRY, OHIO

LOCATION.—Lat. 40°44'01", long. 81°21'08" in SW¼ sec. 35, T. 10 N., R. 8 W., just below railroad bridge 1 mile southeast of North Industry and 3 miles below mouth of Sherrie Run. Zero of gage is 970.77 feet above mean sea level.

DRAINAGE AREA.—175 square miles.

GAGE-HEIGHT RECORD.—Water-stage recorder graph. Gage heights used to half tenths between 2.6 and 6.3 feet; hundredths below and tenths above these limits.

STAGE-DISCHARGE RELATION.—Defined to 1,240 second-feet by current-meter measurements; extended to crest stage on basis of slope-area determination of peak discharge; affected by weed growth Aug. 3–6.

MAXIMA.—1935: Discharge, about 8,240 second-feet 4 a. m. Aug. 7 (gage height, 9.51 feet).

1921–34: Discharge, about 9,000 second-feet (revised) Feb. 26, 1929 (gage height, 9.9 feet).

REMARKS.—Records for August supersede those published in Water-Supply Paper 783.

Mean discharge, in second-feet, in 1935

Day	July	Aug.	Day	July	Aug.	Day	July	Aug.	Day	July	Aug.
1	34	93	9	43	570	17	51	125	25	309	64
2	39	482	10	38	440	18	44	104	26	101	66
3	94	1,810	11	38	468	19	38	92	27	49	68
4	324	961	12	68	262	20	36	83	28	186	65
5	87	346	13	55	196	21	54	90	29	76	66
6	54	635	14	36	154	22	60	80	30	44	63
7	47	5,570	15	117	130	23	77	71	31	53	65
8	46	1,320	16	98	135	24	97	66			
Mean monthly discharge, in second-feet										80.4	475
Run-off, in inches										0.53	3.12

Gage height, in feet and discharge, in second-feet, at indicated time, 1935

Time	Feet	Second-feet	Time	Feet	Second-feet	Time	Feet	Second-feet
Aug. 1			*Aug. 4*			*Aug. 8*		
6 a. m.	1.06	51	4 a. m.	2.76	532	6 a. m.	4.80	1,630
8 a. m.	1.78	221	7 a. m.	3.43	812	12 noon	4.10	1,180
11 a. m.	1.38	110	8 a. m.	3.26	732	6 p. m.	3.65	962
4 p. m.	1.62	171	12 noon	4.37	1,270	12 midnight	3.30	812
12 midnight	1.35	104	4 p. m.	4.70	1,460	*Aug. 9*		
			12 midnight	3.00	632	6 a. m.	3.01	692
Aug. 2						2 p. m.	2.38	446
			Aug. 5			4 p. m.	2.64	552
8 a. m.	1.17	69	7 a. m.	2.45	420	12 midnight	2.25	397
10 a. m.	.87	25	12 noon	2.18	317	*Aug. 10*		
11 a. m.	1.15	66	12 midnight	1.85	198	12 noon	2.05	321
2 p. m.	1.34	101	*Aug. 6*			3 p. m.	3.09	732
4 p. m.	3.65	962	8 a. m.	1.70	154	5 p. m.	2.70	572
6 p. m.	2.35	435	1 p. m.	1.64	138	8 p. m.	2.55	512
8 p. m.	2.38	446	4 p. m.	2.55	458	12 midnight	2.92	652
10 p. m.	5.75	2,440	6 p. m.	3.80	962	*Aug. 11*		
12 midnight	5.34	2,060	12 midnight	6.55	3,180	12 noon	2.41	458
Aug. 3			*Aug. 7*			12 midnight	2.03	313
						Aug. 12		
4 a. m.	5.70	2,240	2 a. m.	8.50	6,400	8 a. m.	1.92	272
8 a. m.	6.68	3,310	4 a. m.	9.51	8,240	10 a. m.	1.98	294
10 a. m.	6.43	3,060	8 a. m.	9.10	7,480	2 p. m.	1.90	264
4 p. m.	3.90	1,010	12 noon	8.50	6,400	6 p. m.	1.87	253
6 p. m.	3.77	962	6 p. m.	6.75	3,710	12 midnight	1.79	225
12 midnight	3.23	732	12 midnight	5.63	2,340			

SUGAR CREEK AT STRASBURG, OHIO

LOCATION.—Lat. 40°35′12″, long. 81°31′28″, in NW¼ sec. 1, T. 9 N., R. 3 W., at highway bridge three-quarters of a mile southeast of Strasburg and three-quarters of a mile above Broad Run. Zero of gage is 898.24 feet above mean sea level.

DRAINAGE AREA.—310 square miles.

GAGE-HEIGHT RECORD.—Staff gage read twice daily or oftener; graph constructed from gage readings and floodmarks Aug. 2–19. Gage heights used to half tenths between 1.7 and 3.1 feet; hundredths below and tenths above these limits.

STAGE-DISCHARGE RELATION.—Defined to 8,380 second-feet by current-meter measurements; extended to peak discharge from area-velocity study.

MAXIMA.— 1935: Discharge, about 19,700 second-feet 2 to 4 p. m. Aug. 7 (gage-height, 12.70 feet).

1931–33: Discharge, 6,940 second-feet (revised) Mar. 15, 1933 (gage-height, 9.56).

Mean discharge, in second-feet, 1935

Day	July	Aug.	Day	July	Aug.	Day	July	Aug.	Day	July	Aug.
1	58	91	9	120	3,970	17	66	223	25	830	61
2	45	166	10	98	1,700	18	48	203	26	375	61
3	44	2,070	11	76	1,640	19	44	163	27	142	61
4	1,050	4,290	12	66	950	20	43	144	28	192	193
5	1,570	1,090	13	61	495	21	47	126	29	900	92
6	510	319	14	61	463	22	70	108	30	570	73
7	179	10,200	15	58	281	23	76	92	31	120	64
8	102	8,090	16	216	223	24	120	84			
Mean monthly discharge, in second-feet										257	1,219
Run-off, in inches										0.96	4.53

Gage height, in feet, and discharge, in second-feet, at indicated time, 1935

Time	Feet	Second-feet
Aug. 2		
6 a. m	1.58	126
12 noon	1.72	154
6 p. m	1.88	204
12 midnight	3.70	725
Aug. 3		
6 a. m	5.60	1,480
12 noon	6.60	2,010
6 p. m	7.58	2,730
12 midnight	8.41	3,650
Aug. 4		
8 a. m	9.20	5,050
12 noon	9.30	5,270
6 p. m	8.89	4,450
12 midnight	7.00	2,250
Aug. 5		
6 a. m	5.02	1,210
12 noon	4.36	970
6 p. m	4.01	830
12 midnight	3.45	630
Aug. 6		
2 a. m	3.20	570
6 a. m	2.43	346
2 p. m	2.34	319
6 p. m	2.28	306
12 midnight	4.40	970
Aug. 7		
6 a. m	7.50	2,650
8 a. m	8.20	3,370
Aug. 7—Con.		
10 a. m	9.12	4,830
12 noon	11.72	14,500
2 p. m	12.69	19,700
3 p. m	12.70	19,700
6 p. m	12.40	18,000
8 p. m	12.08	16,500
10 p. m	11.73	14,500
12 midnight	11.40	13,000
Aug. 8		
2 a. m	11.05	11,300
4 a. m	10.80	10,500
8 a. m	10.40	8,890
12 noon	10.17	8,090
6 p. m	9.75	6,670
12 midnight	9.34	5,270
Aug. 9		
6 a. m	9.00	4,610
12 noon	8.66	4,130
6 p. m	8.16	3,370
12 midnight	7.40	2,550
Aug. 10		
8 a. m	6.24	1,640
12 noon	5.90	1,460
6 p. m	5.98	1,520
12 midnight	6.13	1,580
Aug. 11		
11 a. m	6.40	1,760
6 p. m	6.14	1,580
12 midnight	5.84	1,400
Aug. 12		
8 a. m	5.45	1,190
6 p. m	4.50	780
Aug. 13		
8 a. m	3.73	495
6 p. m	3.67	495
Aug. 14		
8 a. m	3.81	527
6 p. m	3.44	403
Aug. 15		
8 a. m	3.00	294
6 p. m	2.91	268
Aug. 16		
8 a. m	2.70	223
6 p. m	2.70	223
Aug. 17		
8 a. m	2.81	244
6 p. m	2.65	213
Aug. 18		
8 a. m	2.60	203
6 p. m	2.59	203
Aug. 19		
8 a. m	2.45	173
6 p. m	2.41	163

STILLWATER CREEK AT UHRICHSVILLE, OHIO

LOCATION.—Lat. 40°22′31″, long. 81°20′10″, at waterworks pumping station 1 mile south of Uhrichsville and Dennison, in Tuscarawas County. Zero of gage is 839.37 feet above mean sea level.

DRAINAGE AREA.—367 square miles.

GAGE-HEIGHT RECORD.—Staff gage read twice daily or oftener. Gage heights used to half tenths between 2.4 and 3.1 feet; hundredths below and tenths above these limits.

STAGE-DISCHARGE RELATION.—Defined to 7,350 second-feet by current-meter measurements; extended to peak discharge.

MAXIMA.—1935: Discharge, 7,650 second-feet 8 p. m. Aug. 8 to 4 a. m. Aug. 9, (gage height, 14.2 feet).

1922–34: Discharge, about 4,960 second-feet (revised) Dec. 16, 1927 (gage height, 11.8 feet).

The flood of March 1913 reached a stage corresponding to approximately 17.5 feet, present gage datum.

REMARKS.—Municipal water supply for Dennison and Uhrichsville diverted at gage not included in records except in monthly means as indicated. Records for August supersede those published in Water Supply Paper 783.

Mean discharge, in second-feet, 1935

Day	July	Aug.	Day	July	Aug.	Day	July	Aug.	Day	July	Aug.
1	85	184	9	1,900	7,380	17	121	1,080	25	166	184
2	81	198	10	410	6,180	18	85	625	26	515	152
3	34	1,020	11	166	4,370	19	55	385	27	652	152
4	1,480	2,270	12	198	2,780	20	310	242	28	735	152
5	3,080	2,770	13	184	1,790	21	488	220	29	460	130
6	3,880	3,080	14	166	652	22	460	845	30	265	108
7	4,040	4,300	15	152	680	23	211	542	31	139	108
8	3,240	7,300	16	152	960	24	130	242			
Mean monthly discharge, in second-feet (observed)										775	1,648
Mean monthly discharge, in second-feet (adjusted for diversion)										777	1,650
Run-off, in inches (adjusted)										2.44	5.19

Gage height, in feet, and discharge, in second-feet, at indicated time, 1935

Time	Feet	Second-feet	Time	Feet	Second-feet	Time	Feet	Second-feet
Aug. 2			*Aug. 8*			*Aug. 13*		
6 a. m.	2.20	220	4 a. m.	13.32	6,890	8 a. m.	5.40	2,030
6 p. m.	2.11	180	2 p. m.	14.00	7,480	4 p. m.	4.56	1,570
Aug. 3			8 p. m.	14.20	7,650	12 midnight	4.02	1,200
6 a. m.	2.83	542	*Aug. 9*			*Aug. 14*		
12 noon	3.52	900	4 a. m.	14.20	7,650	8 a. m.	3.20	735
12 midnight	4.96	1,900	12 noon	13.95	7,420	6 p. m.	2.90	570
Aug. 4			6 p. m.	13.70	7,220	*Aug. 15*		
12 noon	5.92	2,260	12 midnight	13.49	7,030	8 a. m.	2.90	570
12 midnight	6.70	2,520	*Aug. 10*			6 p. m.	3.30	790
Aug. 5			6 a. m.	13.00	6,600	*Aug. 16*		
12 noon	7.45	2,770	12 noon	12.62	6,280	8 a. m.	3.50	900
12 midnight	8.00	3,000	6 p. m.	11.86	5,640	6 p. m.	3.70	1,020
Aug. 6			12 midnight	11.43	5,300	*Aug. 17*		
12 noon	8.27	3,150	*Aug. 11*			8 a. m.	3.90	1,140
6 p. m.	8.14	3,070	8 a. m.	10.63	4,680	6 p. m.	3.70	1,020
12 midnight	8.20	3,110	12 noon	10.25	4,410	*Aug. 18*		
Aug. 7			6 p. m.	9.80	4,100	8 a. m.	3.10	680
4 a. m.	8.40	3,230	12 midnight	9.20	3,700	6 p. m.	2.90	570
8 a. m.	8.80	3,460	*Aug. 12*			*Aug. 19*		
2 p. m.	10.60	4,660	8 a. m.	8.00	3,000	8 a. m.	2.60	410
8 p. m.	12.18	5,910	6 p. m.	7.10	2,630	6 p. m.	2.50	360

BLACK FORK AT LOUDONVILLE, OHIO

LOCATION.—Lat. 40°38′08″, long. 82°14′19″, in NW¼ sec. 1, T. 19 N., R. 16 W., at highway bridge at Loudonville, 1½ miles below mouth of Big Run. Zero of gage is 928.46 feet above mean sea level.

DRAINAGE AREA.—342 square miles.

GAGE-HEIGHT RECORD.—Chain gage read two or more times daily. Gage heights used to half tenths between 3.1 and 3.8 feet; hundredths below and tenths above these limits.

STAGE-DISCHARGE RELATION.—Defined to 4,050 second-feet by current-meter measurements; extended to peak discharge on basis of area-velocity study.

MAXIMA.—1935: Discharge observed, 5,860 second-feet 6:15 a. m. Aug. 7 (gage height, 12.29 feet).

1931–34: Discharge observed, 3,500 second-feet Mar. 21, 1933 (gage height, 9.96 feet).

Stage known, about 20.5 feet, present site and datum, March 1913 (discharge 11,700 second-feet at Charles Mill dam site, about 16 miles above gage, computed by Zanesville office of Corps of Engineers, U. S. Army).

REMARKS.—Discharge for August 4 and monthly computations supersede those published in Water-Supply Paper 783.

Mean discharge, in second-feet, 1935

Day	July	Aug.	Day	July	Aug.	Day	July	Aug.	Day	July	Aug.
1	64	72	9	192	1,920	17	69	229	25	601	91
2	61	82	10	155	1,770	18	61	192	26	138	84
3	60	1,620	11	155	1,870	19	58	167	27	95	95
4	447	322	12	91	1,570	20	55	153	28	95	153
5	447	179	13	77	1,090	21	55	131	29	117	98
6	447	138	14	65	634	22	58	122	30	82	87
7	390	4,220	15	85	390	23	82	110	31	65	89
8	229	3,580	16	117	268	24	64	102			
Mean monthly discharge, in second-feet										153	698
Run-off, in inches										0.52	2.35

Gage height, in feet, and discharge, in second-feet, at indicated time, 1935

Time	Feet	Second-feet
Aug. 2		
8 a. m.	2.66	65
6 p. m.	2.97	124
12 midnight	3.46	242
Aug. 3		
8 a. m.	4.47	537
12 noon	5.70	966
2 p. m.	6.55	1,340
4 p. m.	8.30	2,200
5 p. m.	8.48	2,320
6 p. m.	8.15	2,140
12 midnight	5.55	927
Aug. 4		
8 a. m.	3.96	390
6 p. m.	3.49	255
Aug. 5		
6 a. m.	3.30	204
2 p. m.	3.20	179
12 midnight	3.12	155
Aug. 6		
12 noon	3.03	138
6 p. m.	2.98	126
8 p. m.	3.05	143
10 p. m.	4.30	476
12 midnight	6.70	1,390
Aug. 7		
2 a. m.	9.12	2,710
4 a. m.	11.60	5,020
6 a. m.	12.28	5,860
8 a. m.	11.97	5,500
10 a. m.	11.20	4,580
12 noon	10.58	3,960
2 p. m.	10.40	3,760
4 p. m.	10.52	3,860
6 p. m.	10.67	4,060
12 midnight	10.99	4,360
Aug. 8		
7 a. m.	10.86	4,260
8 a. m.	10.74	4,060
10 a. m.	10.50	3,860
12 noon	10.23	3,580
6 p. m.	9.42	2,920
12 midnight	8.72	2,440
Aug. 9		
8 a. m.	8.00	2,020
6 p. m.	7.50	1,770
12 midnight	7.31	1,670
Aug. 10		
6 a. m.	7.34	1,670
12 noon	7.49	1,770
8 p. m.	7.74	1,870
Aug. 11		
8 a. m.	7.70	1,870
6 p. m.	7.65	1,820
12 midnight	7.50	1,770
Aug. 12		
12 noon	7.10	1,570
12 midnight	6.59	1,340
Aug. 13		
12 noon	6.00	1,090
12 midnight	5.37	849
Aug. 14		
12 noon	4.79	634
12 midnight	4.32	476
Aug. 15		
12 noon	3.98	390
12 midnight	3.69	308
Aug. 16		
8 a. m.	3.60	281
6 p. m.	3.50	255
Aug. 17		
8 a. m.	3.41	229
6 p. m.	3.37	216
Aug. 18		
8 a. m.	3.32	204
6 p. m.	3.20	179
Aug. 19		
8 a. m.	3.16	167
8 p. m.	3.12	155

MOHICAN RIVER AT GREER, OHIO

LOCATION.—Lat. 40°30′55″, long. 82°11′48″, in NW¼ sec. 10, T. 8 N., R. 10 W., 3,000 feet below highway bridge at Greer. Zero of gage is 872.91 feet above mean sea level.

DRAINAGE AREA.—942 square miles.

GAGE-HEIGHT RECORD.—Water-stage recorder graph except for periods July 20–22, 27–31, and Aug. 18–21 when it was based on comparative hydrograph. Gage heights used to half tenths between 3.2 and 4.6 feet; hundredths below and tenths above these limits.

STAGE-DISCHARGE RELATION.—Defined to 13,400 second-feet by current-meter measurements; extended to peak discharge by area-velocity study.

MAXIMA.—1935: Discharge, 17,700 second-feet 1 p. m. Aug. 7 (gage height, 13.63 feet).

1921–34: Discharge observed, 15,400 second-feet, March 21, 1927 (gage height, 12.7 feet at highway bridge above present gage).

Discharge known, 55,000 second-feet, March 1913 (gage height, 27.0 feet, from floodmarks from slope area study).

Mean discharge, in second-feet, 1935

Day	July	Aug.	Day	July	Aug.	Day	July	Aug.	Day	July	Aug.
1	201	553	9	668	8,780	17	319	717	25	3,710	302
2	184	510	10	518	5,210	18	264	650	26	1,390	280
3	184	3,710	11	415	4,160	19	296	570	27	900	253
4	2,590	3,450	12	338	3,020	20	300	500	28	640	280
5	5,040	1,510	13	422	2,060	21	240	440	29	760	280
6	1,720	1,290	14	603	1,380	22	300	388	30	460	264
7	1,660	12,800	15	338	1,000	23	807	362	31	430	258
8	913	12,600	16	650	807	24	610	331			
Mean monthly discharge, in second-feet										899	2,217
Run-off, in inches										1.10	2.71

Gage height, in feet, and discharge, in second-feet, at indicated time, 1935

Time	Feet	Second-feet	Time	Feet	Second-feet	Time	Feet	Second-feet
July 4			*Aug. 3*			*Aug. 9*		
7 a. m.	1.72	215	6 a. m.	3.48	1,940	6 a. m.	9.04	9,900
9 a. m.	3.70	2,180	9 a. m.	3.90	2,430	2 p. m.	8.16	8,620
10 a. m.	2.74	1,040	1 p. m.	3.65	2,120	12 midnight	7.06	6,950
11 a. m.	2.57	860	4 p. m.	5.46	4,580			
1 p. m.	2.68	978	10 p. m.	7.80	8,000	*Aug. 10*		
2 p. m.	3.13	1,500						
4 p. m.	5.08	4,020	*Aug. 4*			12 noon	5.75	5,000
5 p. m.	5.32	4,300				12 midnight	5.42	4,440
6 p. m.	6.30	5,750	4 a. m.	6.77	6,500			
9 p. m.	6.66	6,350	8 a. m.	4.80	3,600	*Aug. 11*		
12 midnight	7.85	8,000	12 noon	3.88	2,430			
July 5			12 midnight	3.31	1,700	12 noon	5.20	4,160
						12 midnight	4.74	3,470
3 a. m.	9.22	10,200	*Aug. 5*					
8 a. m.	5.90	5,150				*Aug. 12*		
10 a. m.	4.87	3,740	12 noon	3.11	1,470			
2 p. m.	4.60	3,340	12 midnight	3.05	1,400	12 noon	4.35	3,020
6 p. m.	4.50	3,210				12 midnight	3.95	2,500
July 6			*Aug. 6*					
						Aug. 13		
6 a. m.	3.63	2,120	12 noon	2.94	1,270			
4 p. m.	3.08	1,440	12 midnight	3.00	1,340	12 noon	3.57	2,000
10 p. m.	2.98	1,320				12 midnight	3.27	1,640
July 7			*Aug. 7*					
						Aug. 14		
2 a. m.	3.20	1,580	2 a. m.	3.30	1,700	12 noon	3.03	1,380
5 a. m.	3.89	2,430	8 a. m.	11.15	13,500	12 midnight	2.85	1,170
12 noon	3.23	1,640	10 a. m.	12.65	15,900			
12 midnight	2.87	1,190	12 noon	13.48	17,500	*Aug. 15*		
Aug. 1			1 p. m.	13.63	17,700			
			2 p. m.	13.56	17,700	12 noon	2.70	1,000
4 a. m.	1.95	338	4 p. m.	13.18	17,000	12 midnight	2.58	870
2 p. m.	1.96	344	8 p. m.	12.16	15,200			
5 p. m.	2.90	1,220	12 midnight	12.12	15,100	*Aug. 16*		
12 midnight	2.37	659				12 noon	2.52	807
Aug. 2			*Aug. 8*			12 midnight	2.47	756
12 noon	2.09	428	2 a. m.	12.05	14,900	*Aug. 17*		
10 p. m.	2.14	465	12 noon	10.48	12,400			
12 midnight	2.55	838	12 midnight	9.32	10,400	12 noon	2.42	707

WALHONDING RIVER AT POMERENE, OHIO

LOCATION.—Lat. 40°21′20″, long. 82°06′19″, at highway bridge at Pomerene, Coshocton County, a third of a mile above mouth of Honey Run. Zero of gage is 805.53 feet above mean sea level.

DRAINAGE AREA.—1,488 square miles.

GAGE-HEIGHT RECORD.—Water-stage recorder graph. Gage heights used to half-tenths between 2.7 and 4.6 feet; hundredths below and tenths above these limits.

STAGE-DISCHARGE RELATION.—Defined to 20,300 second-feet by current-meter measurements; extended to peak discharge from area-velocity study.

MAXIMA.—1935: Discharge, 27,100 second-feet, 9 p. m., Aug. 7 (gage height, 15.97 feet).

1921–34: Discharge, 27,800 second-feet, Feb. 26, 1929 (gage height, 15.5 feet).

Discharge known, 80,000 second-feet (estimated) in March 1913 (gage height, 21.6 feet, from high-water mark).

Mean discharge, in second-feet, 1935

Day	July	Aug.	Day	July	Aug.	Day	July	Aug.	Day	July	Aug.
1	409	3,190	9	1,590	12,400	17	743	1,590	25	6,360	658
2	356	2,910	10	1,280	7,060	18	566	1,810	26	3,360	604
3	341	3,720	11	1,050	5,640	19	797	1,430	27	1,760	581
4	8,290	7,430	12	865	4,110	20	658	1,180	28	1,380	760
5	15,000	2,810	13	751	3,200	21	507	1,040	29	1,640	635
6	4,600	1,860	14	1,050	2,360	22	612	919	30	1,080	536
7	3,590	17,000	15	760	1,760	23	1,430	811	31	856	507
8	2,220	22,400	16	1,270	1,640	24	1,430	717			
Mean monthly discharge, in second-feet										2,148	3,654
Run-off, in inches										1.66	2.84

Gage height, in feet, and discharge, in second-feet, at indicated time, 1935

Time	Feet	Second-feet	Time	Feet	Second-feet	Time	Feet	Second-feet
July 3			*July 6*					
						July 23		
6 a. m.	1.60	320	2 a. m.	6.22	5,640			
12 noon	1.60	320	4 a. m.	6.28	5,790	2 a. m.	3.12	1,590
6 p. m.	1.63	336	6 a. m.	6.32	5,790	6 a. m.	2.86	1,330
12 midnight	1.79	428	12 noon	5.50	4,640	12 noon	2.68	1,160
			6 p. m.	4.76	3,720	8 p. m.	3.47	1,980
July 4			12 midnight	4.40	3,200			
						July 24		
2 a. m.	1.98	558						
			July 7					
4 a. m.	2.23	760						
6 a. m.	2.81	1,280				2 a. m.	3.05	1,540
8 a. m.	3.03	1,540	6 a. m.	4.86	3,850	6 a. m.	3.16	1,640
10 a. m.	3.50	2,040	9 a. m.	5.19	4,240	3 p. m.	2.88	1,380
12 noon	6.10	5,490	12 noon	5.00	3,980	12 midnight	2.72	1,180
2 p. m.	8.75	10,300	6 p. m.	4.50	3,330			
4 p. m.	9.85	12,400	12 midnight	4.22	2,940			
						July 25		
6 p. m.	11.30	15,700						
8 p. m.	12.40	18,300						
			July 8					
10 p. m.	13.20	20,200				5 a. m.	3.12	1,590
12 midnight	13.40	20,700				8 a. m.	6.36	5,940
			12 noon	3.63	2,220	12 noon	7.42	7,600
July 5			12 midnight	3.28	1,810	6 p. m.	8.64	9,940
						12 midnight	6.47	6,100
2 a. m.	13.23	20,200						
			July 9					
4 a. m.	13.06	19,900				*July 26*		
6 a. m.	13.06	19,900						
8 a. m.	13.20	20,200	12 noon	3.10	1,590	4 a. m.	5.15	4,240
10 a. m.	13.20	20,200	12 midnight	2.93	1,430	12 noon	4.38	3,200
12 noon	12.60	18,700				12 midnight	3.64	2,220
2 p. m.	11.04	15,000						
			July 22					
4 p. m.	9.05	10,700				*July 27*		
6 p. m.	7.70	8,140						
8 p. m.	7.15	7,240	12 noon	1.86	474	6 a. m.	3.40	1,920
10 p. m.	6.82	6,580	6 p. m.	1.95	536	12 noon	3.26	1,760
12 midnight	6.52	6,100	12 midnight	2.87	1,330	12 midnight	2.97	1,430

Gage height, in feet, and discharge, in second-feet, at indicated time, 1935—Con.

Time	Feet	Second-feet
July 28		
12 noon	2.77	1,270
6 p.m.	2.73	1,270
12 midnight	3.61	2,160
July 29		
1 a.m.	3.66	2,220
6 a.m.	3.29	1,810
12 noon	3.12	1,590
12 midnight	2.80	1,280
July 30		
12 noon	2.58	1,070
12 midnight	2.43	937
July 31		
12 noon	2.33	847
12 midnight	2.24	768
Aug. 1		
6 a.m.	2.27	794
10 a.m.	4.49	3,330
12 noon	5.84	5,060
2 p.m.	6.21	5,640
6 p.m.	5.62	4,780
12 midnight	4.94	3,850
Aug. 2		
2 a.m.	5.04	3,980
6 a.m.	4.78	3,720
8 a.m.	4.90	3,850
12 noon	4.23	3,000
6 p.m.	3.49	2,040
12 midnight	3.23	1,760

Time	Feet	Second-feet
Aug. 3		
2 a.m.	3.22	1,700
10 a.m.	4.65	3,460
12 noon	4.85	3,720
3 p.m.	5.05	3,980
6 p.m.	5.04	3,980
12 midnight	7.91	8,540
Aug. 4		
4 a.m.	8.58	9,940
6 a.m.	8.64	9,940
12 noon	7.65	7,960
6 p.m.	5.75	5,060
12 midnight	4.95	3,980
Aug. 5		
6 a.m.	4.40	3,200
12 noon	4.01	2,680
6 p.m.	3.74	2,360
12 midnight	3.53	2,100
Aug. 6		
6 a.m.	3.42	1,920
11 a.m.	3.44	1,980
6 p.m.	3.20	1,700
12 midnight	3.09	1,590
Aug. 7		
2 a.m.	3.09	1,590
4 a.m.	4.55	3,400
6 a.m.	8.10	8,940
7 a.m.	9.75	12,400
10 a.m.	11.90	17,100
12 noon	13.00	19,700
8 p.m.	15.93	26,800
9 p.m.	15.97	27,100
12 midnight	15.80	26,600

Time	Feet	Second-feet
Aug. 8		
2 a.m.	15.60	26,100
6 a.m.	15.35	25,500
10 a.m.	14.90	24,300
12 noon	14.40	23,100
6 p.m.	12.68	19,000
12 midnight	11.51	16,100
Aug. 9		
6 a.m.	10.64	14,100
10 a.m.	10.06	13,000
12 noon	9.70	12,200
12 midnight	8.15	9,140
Aug. 10		
10 a.m.	7.03	6,900
4 p.m.	6.54	6,100
10 p.m.	6.74	6,420
12 midnight	6.68	6,420
Aug. 11		
12 noon	6.23	5,640
12 midnight	5.61	4,780
Aug. 12		
12 noon	5.07	4,110
12 midnight	4.67	3,590
Aug. 13		
10 a.m.	4.40	3,200
2 p.m.	4.46	3,260
12 midnight	4.11	2,810
Aug. 14		
12 noon	3.77	2,360
12 midnight	3.48	2,040
Aug. 15		
12 noon	3.27	1,760
12 midnight	3.08	1,590

CLEAR FORK AT NEWVILLE, OHIO

LOCATION.—Lat. 40°37′48″, long. 82°23′02″, in SE¼ sec. 3, T. 21 N., R. 17 W., at highway bridge at Newville, a quarter of a mile below mouth of Opossum Run. Zero of gage is 1,018.32 feet above mean sea level.

DRAINAGE AREA.—175 square miles.

GAGE-HEIGHT RECORD.—Chain gage read twice daily to hundredths. Gage heights used to half tenths between 2.3 and 3.3 feet; hundredths below and tenths above these limits.

STAGE-DISCHARGE RELATION.—Defined to 5,420 second-feet by current-meter measurements; extended to peak discharge from area-velocity study.

MAXIMA.—1935: Discharge observed, 11,700 second-feet July 4 (gage height, 12.90 feet).

Flood of March 1913 reached a stage of 15.7 feet.

Mean discharge, in second-feet, 1935

Day	July	Aug.	Day	July	Aug.	Day	July	Aug.	Day	July	Aug.
1	56	161	9	213	702	17	92	199	25	2,690	77
2	45	140	10	173	457	18	80	173	26	494	77
3	42	1,320	11	126	404	19	173	144	27	287	88
4	6,300	615	12	104	256	20	86	115	28	199	70
5	2,090	272	13	100	199	21	80	113	29	161	68
6	573	199	14	92	186	22	213	100	30	131	71
7	573	5,380	15	336	161	23	272	94	31	108	70
8	319	1,780	16	135	161	24	144	84			
Mean monthly discharge, in second-feet										532	450
Run-off, in inches										3.50	2.96

Gage height, in feet, and discharge, in second-feet, at indicated time, 1935

Time	Feet	Second-feet
July 3		
6 a. m.	1.70	37
6 p. m.	1.79	49
12 midnight	2.80	287
July 4		
6 a. m.	5.40	1,520
8 a. m.	6.26	2,170
10 a. m.	7.35	3,200
12 noon	8.80	4,950
6 p. m.	12.90	11,700
12 midnight	9.10	5,380
July 5		
2 a. m.	7.11	2,890
4 a. m.	6.48	2,330
12 noon	6.26	2,170
6 p. m.	6.20	2,090
12 midnight	5.58	1,640
July 6		
6 a. m.	4.10	793
12 noon	3.56	573
6 p. m.	3.25	439
Aug. 2		
8 a. m.	2.30	149
6 p. m.	2.21	128
12 midnight	2.58	227
Aug. 3		
6 a. m.	3.20	421
12 noon	4.79	1,150
6 p. m.	6.78	2,600
12 midnight	5.55	1,640
Aug. 4		
6 a. m.	4.34	890
6 p. m.	3.30	457

Time	Feet	Second-feet
Aug. 5		
6 a. m.	2.82	287
6 p. m.	2.68	256
Aug. 6		
12 noon	2.50	199
6 p. m.	2.47	186
12 midnight	5.30	1,450
Aug. 7		
7 a. m.	9.28	5,680
12 noon	8.84	4,950
6 p. m.	9.00	5,230
12 midnight	7.65	3,420
Aug. 8		
4 a. m.	6.69	2,510
8 a. m.	6.13	2,010
12 noon	5.82	1,780
6 p. m.	5.40	1,520
12 midnight	4.90	1,200
Aug. 9		
6 a. m.	4.40	940
4 p. m.	3.61	573
12 midnight	3.24	439
Aug. 10		
8 a. m.	3.04	369
6 p. m.	3.60	573
12 midnight	3.81	658
Aug. 11		
6 a. m.	3.34	457
6 p. m.	2.97	336

Time	Feet	Second-feet
Aug. 12		
6 a. m.	2.77	272
6 p. m.	2.64	242
Aug. 13		
6 a. m.	2.54	213
6 p. m.	2.50	199
Aug. 14		
6 a. m.	2.50	199
6 p. m.	2.40	173
Aug. 15		
6 a. m.	2.35	161
6 p. m.	2.32	149
Aug. 16		
6 a. m.	2.35	161
6 p. m.	2.32	149
Aug. 17		
6 a. m.	2.32	149
2 p. m.	2.50	199
8 p. m.	2.72	256
Aug. 18		
6 a. m.	2.50	199
6 p. m.	2.38	173
Aug. 19		
6 a. m.	2.30	149
6 p. m.	2.26	140
Aug. 20		
6 a. m.	2.18	122
6 p. m.	2.12	108

JEROME FORK AT JEROMEVILLE, OHIO

LOCATION.—Lat. 40°48′07″, long. 82°12′01″, in SW¼ sec. 5, T. 21 N., R. 15 W., at highway bridge at Jeromeville, 1 mile above mouth of Oldtown Run. Zero of gage is 949.14 feet above mean sea level.

DRAINAGE AREA.—120 square miles.

GAGE-HEIGHT RECORD.—Graph constructed from twice-daily chain-gage readings. Gage heights used to half tenths between 2.1 and 2.8 feet; hundredths below and tenths above these limits.

STAGE-DISCHARGE RELATION.—Defined to 2,600 second-feet by current-meter measurements; extended to peak discharge from area-velocity study.

MAXIMA.—1935: Discharge, 3,090 second-feet at midnight Aug. 7 (gage height, from graph, 11.16 feet).

1925–34: Discharge observed, 3,130 second-feet Feb. 26, 1929 (gage height, 11.3 feet).

Stage known, about 15.1 feet in March 1913.

REMARKS.—Records for August supersede those published in Water-Supply Paper 783.

Mean discharge, in second-feet, 1935

Day	July	Aug.	Day	July	Aug.	Day	July	Aug.	Day	July	Aug.
1	7.8	8.4	9	16	746	17	14	44	25	50	17
2	7.4	51	10	14	322	18	11	40	26	39	17
3	7.8	268	11	11	229	19	9.4	32	27	20	20
4	350	46	12	10	128	20	8.4	28	28	15	24
5	91	23	13	309	97	21	6.9	25	29	12	17
6	40	189	14	33	78	22	85	22	20	10	15
7	39	2,640	15	18	55	23	28	21	31	8.4	15
8	22	2,670	16	17	47	24	26	19			
Mean monthly discharge, in second-feet										43.1	257
Run-off, in inches										0.41	2.47

Gage height, in feet, and discharge, in second-feet, at indicated time, 1935

Time	Feet	Second-feet
July 4		
7 a. m.	2.06	168
7 p. m.	3.45	533
Aug. 2		
2 a. m.	0.99	8.9
6 a. m.	0.98	8.4
6 p. m.	1.85	120
12 midnight	2.80	363
Aug. 3		
6 a. m.	3.10	447
6 p. m.	1.81	111
Aug. 4		
6 a. m.	1.50	56
6 p. m.	1.36	39
Aug. 5		
6 a. m.	1.25	28
6 p. m.	1.16	20
Aug. 6		
6 a. m.	1.12	17
6 p. m.	1.06	13
8 p. m.	2.60	309
12 midnight	6.80	1,590

Time	Feet	Second-feet
Aug. 7		
6 a. m.	9.26	2,420
12 noon	10.23	2,730
6 p. m.	10.80	2,950
12 midnight	11.16	3,090
Aug. 8		
6 a. m.	10.82	2,950
12 noon	10.16	2,730
6 p. m.	9.29	2,420
12 midnight	7.62	1,840
Aug. 9		
6 a. m.	5.10	1,050
12 noon	3.58	591
6 a. m.	2.69	336
12 midnight	2.40	255
Aug. 10		
6 a. m.	2.24	216
5 p. m.	3.01	419
12 midnight	2.78	363
Aug. 11		
6 a. m.	2.51	282
6 p. m.	2.18	203
Aug. 12		
6 a. m.	1.99	153
6 p. m.	1.80	111

Time	Feet	Second-feet
Aug. 13		
6 a. m.	1.70	91
6 p. m.	1.75	101
Aug. 14		
6 a. m.	1.68	87
6 p. m.	1.58	70
Aug. 15		
6 a. m.	1.50	58
6 p. m.	1.46	52
Aug. 16		
6 a. m.	1.42	47
6 p. m.	1.40	44
Aug. 17		
6 a. m.	1.40	44
6 p. m.	1.40	44
Aug. 18		
6 a. m.	1.37	41
6 p. m.	1.34	38
Aug. 19		
6 a. m.	1.30	33
6 p. m.	1.28	31

LAKE FORK NEAR LOUDONVILLE, OHIO

LOCATION.—Lat. 40°37′11″, long. 82°11′10″, in NE¼ sec. 8, T. 19 N., R. 15 W., at highway bridge 2 miles above mouth and 3 miles southeast of Loudonville. Zero of gage is 902.53 feet above mean sea level.

DRAINAGE AREA.—342 square miles.

GAGE-HEIGHT RECORD.—Graph constructed from twice-daily gage readings. Gage heights used to half tenths between 1.1 and 2.2 feet; hundredths below and tenths above these limits.

STAGE-DISCHARGE RELATION.—Defined nearly to peak discharge by current-meter measurements, except that it is affected by backwater from high stages of the Mohican River for which the correction was estimated.

MAXIMA.—1935: Discharge, 6,030 second-feet 11 a. m. Aug. 7 (gage height, 14.0 feet, due to backwater).

1931–32: Discharge, 3,000 second-feet Jan. 18, 1932 (gage height, 8.80 feet). Flood of March 1913 reached a stage of 26 feet.

REMARKS.—Discharges Aug. 7–9 computed by using slope as a factor. Records for August supersede those published in Water-Supply Paper 783.

Mean discharge, in second-feet, 1935

Day	July	Aug.	Day	July	Aug.	Day	July	Aug.	Day	July	Aug.
1	46	134	9	78	4,810	17	60	189	25	744	78
2	43	134	10	64	2,760	18	50	174	26	223	74
3	41	1,600	11	56	1,520	19	41	147	27	154	94
4	278	810	12	47	810	20	36	128	28	128	116
5	278	364	13	223	555	21	38	116	29	134	78
6	122	223	14	154	364	22	74	104	30	94	74
7	160	4,300	15	110	259	23	74	94	31	74	69
8	104	5,130	16	78	206	24	64	88			
Mean monthly discharge, in second-feet										125	826
Run-off, in inches										0.42	2.79

Gage height, in feet, and discharge, in second-feet, at indicated time, 1935

Time	Feet	Second-feet
Aug. 1		
2 a. m.	2.02	147
8 a. m.	2.15	167
4 p. m.	1.90	134
8 p. m.	1.56	94
Aug. 2		
2 a. m.	1.30	69
8 a. m.	1.40	78
4 p. m.	1.87	128
8 p. m.	2.30	189
12 midnight	2.93	298
Aug. 3		
4 a. m.	3.89	555
8 a. m.	5.40	1,060
12 noon	7.38	1,880
6 p. m.	7.96	2,240
12 midnight	7.48	1,930
Aug. 4		
4 a. m.	6.30	1,400
8 a. m.	5.41	1,060
2 p. m.	4.65	777
6 p. m.	4.30	678
12 midnight	3.92	555
Aug. 5		
8 a. m.	3.52	441
8 p. m.	3.01	319
Aug. 6		
8 a. m.	2.68	259
8 p. m.	2.42	206
10 p. m.	2.59	241
12 midnight	3.90	555

Time	Feet	Second-feet
Aug. 7		
6 a. m.	11.40	3,480
8 a. m.	13.20	5,270
10 a. m.	13.90	6,010
11 a. m.	14.00	6,030
12 noon	13.95	5,980
2 p. m.	13.55	5,500
4 p. m.	13.16	5,280
6 p. m.	12.92	5,100
8 p. m.	12.75	4,870
12 midnight	12.50	4,490
Aug. 8		
6 a. m.	12.31	4,740
12 noon	12.36	5,210
6 p. m.	12.42	5,510
10 p. m.	12.46	5,650
Aug. 9		
6 a. m.	12.10	5,290
12 noon	11.60	4,770
6 p. m.	10.92	4,340
12 midnight	10.10	3,950
Aug. 10		
8 a. m.	8.99	3,200
4 p. m.	7.90	2,170
6 p. m.	7.63	1,990
12 midnight	7.40	1,880
Aug. 11		
4 a. m.	7.38	1,880
8 a. m.	7.23	1,780
12 noon	6.87	1,640
6 p. m.	5.99	1,280
12 midnight	5.39	1,060

Time	Feet	Second-feet
Aug. 12		
8 a. m.	5.01	912
2 p. m.	4.70	810
8 p. m.	4.44	711
12 midnight	4.30	678
Aug. 13		
6 a. m.	4.11	615
12 noon	3.94	555
6 p. m.	3.78	526
12 midnight	3.61	469
Aug. 14		
6 a. m.	3.45	414
12 noon	3.27	388
6 p. m.	3.10	341
12 midnight	2.94	298
Aug. 15		
6 a. m.	2.81	278
12 noon	2.72	259
6 p. m.	2.65	241
12 midnight	2.57	241
Aug. 16		
12 noon	2.43	206
12 midnight	2.36	206
Aug. 17		
12 noon	2.34	189
12 midnight	2.34	189
Aug. 18		
12 noon	2.28	180
12 midnight	2.11	169
Aug. 19		
12 noon	2.00	147

KOKOSING RIVER NEAR MILLWOOD, OHIO

LOCATION.—Lat. 40°22′40″, long. 82°14′30″, in sec. 3, T. 6 N., R. 10 W., at highway bridge 2½ miles southeast of Millwood. Zero of gage is 841.06 feet above mean sea level.

DRAINAGE AREA.—472 square miles.

GAGE-HEIGHT RECORD.—Water-stage recorder graph. Gage heights used to half tenths between 5.2 and 6.8 feet; hundredths below and tenths above these limits.

STAGE-DISCHARGE RELATION.—Defined to 11,800 second-feet by current-meter measurements; extended to peak discharge on basis of slope-area determination.

MAXIMA.—1935: Discharge, 27,100 second-feet 4 p. m. July 4 (gage height, 17.75 feet).

1921–34: Discharge observed, 16,500 second-feet Mar. 20, 1927 (gage height, 12.0 feet, on gage at former site a quarter of a mile downstream).

Stage known, 22.0 feet, present site and datum, in March 1913 (discharge, 40,000 second-feet (revised) by slope-area method).

REMARKS.—Records for July and August supersede those published in Water-Supply Paper 783; for complete revised records see Water-Supply Paper 803.

Mean discharge, in second-feet, 1935

Day	July	Aug.	Day	July	Aug.	Day	July	Aug.	Day	July	Aug.
1	134	2,920	9	713	2,200	17	292	900	25	2,150	384
2	117	2,020	10	563	1,500	18	288	1,220	26	1,470	365
3	139	1,960	11	470	1,580	19	567	885	27	769	336
4	11,000	2,580	12	394	975	20	310	762	28	792	389
5	7,440	1,260	13	355	900	21	258	671	29	978	305
6	2,060	811	14	314	671	22	319	570	30	509	271
7	1,740	10,400	15	361	533	23	636	458	31	384	258
8	995	7,440	16	480	900	24	811	431			
Mean monthly discharge, in second-feet										1,220	1,511
Run-off, in inches										2.97	3.69

Gage height, in feet, and discharge, in second-feet, at indicated time, 1935

Time	Feet	Second-feet
July 3		
12 noon	3.43	105
7 p. m.	3.46	112
10 p. m.	4.18	335
11 p. m.	4.08	298
July 4		
4 a. m.	5.55	1,180
6 a. m.	5.62	1,220
9 a. m.	7.74	3,110
12 noon	12.05	8,700
4 p. m.	17.95	27,100
10 p. m.	14.58	15,700
July 5		
1 a. m.	13.85	13,300
5 a. m.	14.44	15,100
10 a. m.	11.00	6,900
2 p. m.	8.53	3,890
10 p. m.	7.24	2,640
July 6		
2 a. m.	6.91	2,370
7 a. m.	7.00	2,460
12 noon	6.45	1,960
10 p. m.	5.98	1,560
July 7		
3 a. m.	6.69	2,190
12 noon	6.06	1,600
7 p. m.	6.00	1,560
12 midnight	5.71	1,300
July 8		
12 noon	5.29	975
12 midnight	5.06	797
July 31		
12 noon	4.40	384
12 midnight	4.34	355
Aug. 1		
5 a. m.	4.31	341
7 a. m.	5.48	1,140
12 noon	9.85	5,260
6 p. m.	8.37	3,790
12 midnight	7.52	2.920

Time	Feet	Second-feet
Aug. 2		
5 a. m.	7.17	2,640
7 a. m.	7.50	2,920
12 noon	6.35	1,880
12 midnight	5.53	1,180
Aug. 3		
2 a. m.	5.69	1,300
9 a. m.	6.77	2,240
12 noon	6.47	1,960
5 p. m.	5.99	1,560
11 p. m.	7.65	3,020
Aug. 4		
3 a. m.	7.41	2,820
6 a. m.	7.64	3,020
12 noon	7.11	2,550
12 midnight	6.23	1,780
Aug. 5		
12 noon	5.56	1,180
12 midnight	5.23	938
Aug. 6		
8 a. m.	5.13	848
12 noon	5.08	811
12 midnight	4.94	713
Aug. 7		
4 a. m.	4.92	699
8 a. m.	11.66	8,100
12 noon	15.11	17,200
1 p. m.	15.53	18,500
8 p. m.	13.87	13,600
12 midnight	13.49	12,500
Aug. 8		
4 a. m.	14.08	14,200
10 a. m.	11.06	7,060
4 p. m.	8.82	4,190
12 midnight	7.84	3,200
Aug. 9		
12 noon	6.58	2,100
12 midnight	5.93	1,520
Aug. 10		
10 a. m.	5.65	1,260
2 p. m.	5.57	1,180
10 p. m.	6.83	2,280

Time	Feet	Second-feet
Aug. 11		
2 a. m.	6.27	1,780
6 a. m.	6.28	1,830
4 p. m.	5.90	1,480
12 midnight	5.59	1,220
Aug. 12		
12 noon	5.31	975
12 midnight	5.09	818
Aug. 13		
12 noon	5.35	995
12 midnight	5.06	797
Aug. 14		
12 noon	4.86	657
12 midnight	4.73	570
Aug. 15		
12 noon	4.60	492
12 midnight	4.72	563
Aug. 16		
9 a. m.	4.70	550
12 noon	5.44	1,100
8 p. m.	5.56	1,180
12 midnight	5.43	1,100
Aug. 17		
12 noon	5.10	825
12 midnight	5.50	1,140
Aug. 18		
8 a. m.	5.70	1,300
5 p. m.	5.55	1,180
12 midnight	5.38	1,060
Aug. 19		
12 noon	5.17	878
12 midnight	5.07	804
Aug. 20		
12 noon	5.01	762
12 midnight	4.94	713

KILLBUCK CREEK AT KILLBUCK, OHIO

LOCATION.—Lat. 40°29′43″, long. 81°59′10″, in SW¼ sec. 6, T. 8 N., R. 7 W., at highway bridge at Killbuck, one-eighth of a mile below mouth of Black Creek. Zero of gage is 788.05 feet above mean sea level.

DRAINAGE AREA.—466 square miles.

GAGE-HEIGHT RECORD.—Graph constructed from twice-daily chain-gage readings to hundredths. Gage heights used to half tenths between 2.2 and 3.5 feet; hundredths below and tenths above these limits.

STAGE-DISCHARGE RELATION.—Defined to 6,300 second-feet from current-meter measurements; extended to peak discharge from area-velocity study.

MAXIMA.—1935: Discharge, about 21,900 second-feet 7 a. m. Aug. 7 (gage height, 21.77 feet, from flood mark).

1930–34: Discharge observed, 3,650 second-feet May 14, 1933 (gage height, 14.64 feet).

REMARKS.—Records for July and August supersede those published in Water-Supply Paper 783.

Mean discharge, in second-feet, 1935

Day	July	Aug.	Day	July	Aug.	Day	July	Aug.	Day	July	Aug.
1	84	362	9	194	5,500	17	126	476	25	1,470	164
2	76	496	10	156	4,450	18	84	396	26	952	164
3	71	2,360	11	118	4,150	19	72	320	27	495	164
4	860	3,790	12	104	3,200	20	66	272	28	780	217
5	1,260	2,680	13	194	2,120	21	68	250	29	1,140	164
6	639	1,430	14	148	1,400	22	111	217	30	495	154
7	495	16,700	15	104	928	23	201	195	31	291	144
8	246	9,500	16	231	620	24	192	184			
Mean monthly discharge, in second-feet										372	2,038
Run-off, in inches										0.92	5.04

Gage height, in feet, and discharge, in second-feet, at indicated time, 1935

Time	Feet	Second-feet
July 3		
8 a. m.	2.73	71
6 p. m.	2.76	74
12 midnight	3.54	186
July 4		
6 a. m.	4.96	399
12 noon	7.20	751
6 p. m.	11.00	1,410
10 p. m.	11.39	1,520
July 5		
2 a. m.	11.19	1,460
8 a. m.	10.57	1,330
4 p. m.	9.78	1,190
12 midnight	8.45	967
July 6		
6 a. m.	7.00	719
12 noon	6.00	559
6 p. m.	5.68	511
12 midnight	5.87	543
July 7		
8 a. m.	6.20	591
4 p. m.	5.36	463
12 midnight	4.60	336
July 8		
6 a. m.	4.20	276
6 p. m.	3.84	231

Time	Feet	Second-feet
July 24		
8 a. m.	3.38	164
6 p. m.	3.40	164
10 p. m.	4.30	306
July 25		
2 a. m.	7.84	865
6 a. m.	11.30	1,520
11 a. m.	12.15	1,820
6 p. m.	11.49	1,540
12 midnight	10.55	1,330
July 26		
6 a. m.	9.35	1,120
12 noon	8.03	899
6 p. m.	7.26	767
12 midnight	6.75	687
July 27		
12 noon	5.50	495
12 midnight	4.59	336
July 28		
8 a. m.	4.28	291
12 noon	5.90	559
6 p. m.	10.85	1,380
10 p. m.	11.43	1,540
July 29		
4 a. m.	10.90	1,410
12 noon	9.52	1,150
6 p. m.	8.45	967
12 midnight	7.30	783

Time	Feet	Second-feet
July 30		
6 a. m.	6.00	559
12 noon	5.28	447
6 p. m.	4.88	383
12 midnight	4.63	351
July 31		
12 noon	4.21	291
12 midnight	3.95	246
Aug. 1		
6 a. m.	3.95	246
12 noon	4.58	336
6 p. m.	5.67	511
12 midnight	5.13	431
Aug. 2		
8 a. m.	4.07	261
10 a. m.	4.04	261
12 noon	4.23	291
6 p. m.	6.54	655
12 midnight	10.45	1,310
Aug. 3		
4 a. m.	11.87	1,770
8 a. m.	12.50	2,120
4 p. m.	13.33	2,680
12 midnight	14.10	3,270
Aug. 4		
6 a. m.	14.62	3,700
1 p. m.	15.15	4,290
6 p. m.	14.89	3,990
12 midnight	14.46	3,610

Gage height, in feet, and discharge, in second-feet, at indicated time, 1935—Continued

Time	Feet	Second-feet	Time	Feet	Second-feet	Time	Feet	Second-feet
Aug. 5			*Aug. 9*			*Aug. 15*		
6 a. m.	14.00	3,190	6 a. m.	16.56	6,100	6 a. m.	10.09	1,050
12 noon	13.41	2,750	12 noon	16.36	5,700	6 p. m.	8.57	806
8 p. m.	12.32	1,990	6 p. m.	16.16	5,300	*Aug. 16*		
Aug. 6			*Aug. 10*			8 a. m.	7.61	650
6 a. m.	10.98	1,460	6 a. m.	15.86	4,750	6 p. m.	6.97	560
2 p. m.	9.60	1,190	6 p. m.	15.68	4,450	*Aug. 17*		
6 p. m.	9.10	1,100	*Aug. 11*			8 a. m.	6.51	490
10 p. m.	12.00	1,820	6 a. m.	15.55	4,300	6 p. m.	6.23	448
12 midnight	14.95	4,090	6 p. m.	15.50	4,150	*Aug. 18*		
Aug. 7			12 midnight	15.35	4,000	8 a. m.	5.88	409
4 a. m.	20.78	18,000	*Aug. 12*			6 p. m.	5.64	370
7 a. m.	21.77	21,900	12 noon	14.87	3,300	*Aug. 19*		
12 noon	21.29	19,800	12 midnight	14.25	2,600	8 a. m.	5.30	332
6 p. m.	20.25	15,900	*Aug. 13*			6 p. m.	5.13	308
12 midnight	19.56	13,900	12 noon	13.68	2,190	*Aug. 20*		
Aug. 8			12 midnight	13.00	1,700	8 a. m.	4.89	284
6 a. m.	18.94	11,700	*Aug. 14*			6 p. m.	4.80	272
12 noon	18.03	9,180	12 noon	12.14	1,390			
6 p. m.	17.00	6,900	4 p. m.	11.69	1,310			
12 midnight	16.74	6,300	6 p. m.	11.50	1,280			
			12 midnight	10.81	1,160			

WILLS CREEK AT BIRDS RUN, OHIO

Location.—Lat. 40°10′09″, long. 81°39′06″, in SW ¼ sec. 19, T. 4 N., R. 4 W., 200 feet below mouth of Birds Run at Birds Run. Zero of gage is 740.98 feet above mean sea level.

Drainage area.—730 square miles.

Gage-height record.—Water-stage recorder graph. Gage heights used to half tenths between 3.0 and 4.8 feet; hundredths below and tenths above these limits.

Stage-discharge relation.—Defined to 12,000 second-feet by current-meter measurements; extended to peak discharge from area-velocity study.

Maxima.—1935: Discharge, 13,500 second-feet noon Aug. 8 (gage height, 27.90 feet).

1928–34: Discharge, 8,450 second-feet Mar. 17, 1933 (gage height, 23.08 feet).

Stage known, 28.8 feet, present site and datum, March 1913 (discharge at Wills Creek dam site, 8 miles below gage, 22,300 second-feet, computed by Zanesville office of Corps of Engineers, U. S. Army).

Mean discharge, in second-feet, 1935

Day	July	Aug.	Day	July	Aug.	Day	July	Aug.	Day	July	Aug.
1	262	99	9	221	13,100	17	80	1,540	25	90	194
2	175	190	10	168	12,000	18	72	760	26	102	156
3	120	2,100	11	130	10,500	19	64	520	27	111	148
4	720	3,040	12	112	8,610	20	58	392	28	125	382
5	1,850	2,830	13	98	7,060	21	47	362	29	231	922
6	1,720	2,480	14	78	5,710	22	50	472	30	378	706
7	807	11,000	15	71	4,260	23	74	472	31	188	448
8	370	13,300	16	81	2,240	24	81	296			
Mean monthly discharge, in second-feet										282	3,429
Run-off, in inches										0.45	5.42

Gage height, in feet, and discharge, in second-feet, at indicated time, 1935

Time	Feet	Second-feet	Time	Feet	Second-feet	Time	Feet	Second-feet
Aug. 2			*Aug. 7*			*Aug. 14*		
2 a. m.	2.60	101	4 a. m.	24.74	8,500	12 noon	21.75	5,790
10 a. m.	2.60	101	6 a. m.	26.70	11,300	12 midnight	20.81	5,080
2 p. m.	3.16	162	10 a. m.	27.55	12,900	*Aug. 15*		
8 p. m.	4.38	344	5 p. m.	27.16	12,200	12 noon	19.55	4,360
12 midnight	5.10	456	12 midnight	27.46	12,700	12 midnight	17.02	3,190
Aug. 3			*Aug. 8*			*Aug. 16*		
4 a. m.	9.03	1,160	12 noon	27.90	13,500	12 noon	13.44	2,120
8 a. m.	11.66	1,710	12 midnight	27.89	13,500	6 p. m.	12.30	1,850
12 noon	14.34	2,340	*Aug. 9*			12 midnight	11.50	1,670
6 p. m.	16.08	2,860	12 noon	27.72	13,100	*Aug. 17*		
10 p. m.	16.30	2,940	12 midnight	27.48	12,700	12 noon	9.60	1,280
Aug. 4			*Aug. 10*			12 midnight	8.05	960
2 a. m.	16.52	3,000	12 noon	27.10	12,000	*Aug. 18*		
12 noon	16.68	3,080	12 midnight	26.80	11,500	12 noon	6.84	742
12 midnight	16.51	3,000	*Aug. 11*			12 midnight	6.06	616
Aug. 5			12 noon	26.26	10,600	*Aug. 19*		
12 noon	16.02	2,830	12 midnight	25.56	9,610	12 noon	5.50	520
11 p. m.	15.40	2,650	*Aug. 12*			12 midnight	5.02	440
Aug. 6			12 noon	24.81	8,610	*Aug. 20*		
4 a. m.	15.40	2,650	12 midnight	24.06	7,850	12 noon	4.71	392
12 noon	14.70	2,440	*Aug. 13*			12 midnight	4.39	344
8 p. m.	13.76	2,220	12 noon	23.33	7,060	*Aug. 21*		
10 p. m.	14.26	2,340	12 midnight	22.60	6,430	12 noon	4.17	304
12 midnight	16.95	3,190						

LICKING RIVER AT TOBOSO, OHIO

LOCATION.—Lat. 40°03′26″, long. 82°13′12″, at highway bridge at Toboso, Licking County, 3 miles below mouth of Rock Fork. Zero of gage is 744.84 feet above mean sea level.

DRAINAGE AREA.—672 square miles.

GAGE-HEIGHT RECORD.—Water-stage recorder graph except for period July 1, 5–9, when it was based on comparative hydrograph. Gage heights used to half tenths between 2.7 and 4.7 feet; hundredths below and tenths above these limits.

STAGE-DISCHARGE RELATION.—Defined to peak discharge by current-meter measurements.

MAXIMA.—1935: Discharge, 20,000 second-feet 3 a. m. Aug. 8 (gage height, 16.95 feet).

1921–34: Discharge observed, 23,600 second-feet (revised) Feb. 26, 1929 (gage height, 17.9 feet).

Discharge known, 35,000 second-feet March 1913 (gage height, 20.0 feet, from floodmarks), computed by Muskingum Watershed Conservancy District.

REMARKS.—Records for August supersede those published in Water-Supply Paper 783.

Mean discharge, in second-feet, 1935

Day	July	Aug.	Day	July	Aug.	Day	July	Aug.	Day	July	Aug.
1	95	364	9	330	4,520	17	165	3,400	25	492	368
2	93	415	10	256	2,360	18	129	2,420	26	306	394
3	93	1,060	11	211	3,870	19	120	1,130	27	204	355
4	2,300	2,820	12	182	1,540	20	129	756	28	475	509
5	3,900	1,100	13	158	1,320	21	158	554	29	916	464
6	700	473	14	139	1,200	22	145	466	30	412	415
7	490	8,370	15	136	830	23	145	420	31	256	377
8	400	15,400	16	226	1,440	24	179	390			
Mean monthly discharge, in second-feet										450	1,919
Run-off, in inches										0.77	3.30

Gage height, in feet, and discharge, in second-feet, at indicated time, 1935

Time	Feet	Second-feet
Aug. 1		
2 a. m.	1.71	215
6 a. m.	1.80	248
10 a. m.	1.74	226
2 p. m.	2.58	581
4 p. m.	2.58	581
10 p. m.	2.17	398
Aug. 2		
2 a. m.	2.36	482
12 noon	2.20	411
2 p. m.	2.23	424
12 midnight	2.08	360
Aug. 3		
4 a. m.	2.10	368
7 a. m.	2.88	732
8 a. m.	2.97	756
12 noon	4.33	1,530
3 p. m.	3.89	1,260
6 p. m.	3.99	1,320
10 p. m.	4.47	1,590
Aug. 4		
3 a. m.	6.47	3,200
6 a. m.	6.37	3,110
11 a. m.	6.52	3,200
8 p. m.	5.64	2,430
12 midnight	5.03	1,970
Aug. 5		
6 a. m.	4.10	1,380
12 noon	3.40	980
6 p. m.	2.99	780
12 midnight	2.70	637
Aug. 6		
12 noon	2.33	468
12 midnight	2.14	385

Time	Feet	Second-feet
Aug. 7		
4 a. m.	2.10	368
6 a. m.	2.18	402
8 a. m.	3.33	955
12 noon	12.76	10,300
2 p. m.	13.77	11,900
8 p. m.	15.90	16,500
12 midnight	16.79	19,300
Aug. 8		
3 a. m.	16.95	20,000
8 a. m.	16.62	18,600
12 noon	16.04	16,800
6 p. m.	14.20	12,600
12 midnight	10.57	7,580
Aug. 9		
10 a. m.	8.00	4,660
10 p. m.	6.12	2,840
Aug. 10		
6 a. m.	5.22	2,110
3 p. m.	4.73	1,760
8 p. m.	6.46	3,200
10 p. m.	6.37	3,110
Aug. 11		
2 a. m.	7.36	4,060
5 a. m.	7.24	3,860
12 noon	7.74	4,360
3 p. m.	7.60	4,260
6 p. m.	7.10	3,760
12 midnight	5.60	2,430
Aug. 12		
8 a. m.	4.57	1,660
4 p. m.	3.90	1,260
12 midnight	3.63	1,110

Time	Feet	Second-feet
Aug. 13		
7 a. m.	3.41	980
10 a. m.	4.00	1,320
2 p. m.	3.79	1,200
6 p. m.	4.59	1,690
12 midnight	4.46	1,590
Aug. 14		
12 noon	3.79	1,200
12 midnight	3.32	930
Aug. 15		
12 noon	3.09	830
12 midnight	2.92	732
Aug. 16		
9 a. m.	2.83	708
2 p. m.	4.76	1,830
6 p. m.	6.80	3,470
12 midnight	7.90	4,560
Aug. 17		
1 a. m.	7.93	4,560
6 a. m.	7.40	4,060
12 noon	6.59	3,290
8 p. m.	5.95	2,750
12 midnight	6.00	2,750
Aug. 18		
4 a. m.	6.39	3,110
12 noon	5.61	2,430
12 midnight	4.31	1,500
Aug. 19		
12 noon	3.62	1,080
12 midnight	3.28	930
Aug. 20		
12 noon	2.94	756
12 midnight	2.69	632

SALT CREEK NEAR CHANDLERSVILLE, OHIO

LOCATION.—Lat. 39°54′31″, long. 81°51′36″, above concrete control in SW¼ sec. 10, T. 13 N., R. 12 W., just above highway bridge 2 miles northwest of Chandlersville, Muskingum County.

DRAINAGE AREA.—75.6 square miles.

GAGE-HEIGHT RECORD.—Water-stage recorder graph.

STAGE-DISCHARGE RELATION.—Defined by current-meter measurements to 4,180 second-feet; affected by backwater from Muskingum River Aug. 8–13. Gage heights used to half tenths between 2.0 and 3.7 feet; hundredths below and tenths above these limits.

MAXIMUM.—1935: Discharge, 4,300 second-feet 11:30 a. m. Aug. 7 (gage height, 13.90 feet).

REMARKS.—Gage-height record and some discharge measurements furnished by U. S. Soil Conservation Service.

Mean discharge, in second-feet, 1935

Day	July	Aug.	Day	July	Aug.	Day	July	Aug.	Day	July	Aug.
1	12.0	214	9	26	270	17	7.6	55	25	36	13.3
2	9.0	100	10	16.0	470	18	4.4	53	26	27	11.6
3	7.5	145	11	10.9	600	19	3.4	40	17	26	107
4	67	127	12	7.8	265	20	3.5	31	28	581	296
5	59	49	13	6.1	150	21	3.7	26	29	58	48
6	24	31	14	5.0	89	22	12.0	27	30	17.5	29
7	23	2,370	15	5.2	66	23	6.8	19.9	31	10.6	21
8	38	540	16	8.5	56	24	6.7	15.4			
Mean monthly discharge, in second-feet										36.4	204
Run-off, in inches										0.55	3.12

Gage height, in feet, and discharge, in second-feet, at indicated time, 1935

Time	Feet	Second-feet
July 3		
12 noon	0.78	7.5
12 midnight	.83	9.0
July 4		
12 noon	1.13	24
3 p. m.	1.75	140
6 p. m.	2.05	189
10 p. m.	1.58	102
July 5		
2 a. m.	1.70	131
12 noon	1.30	42
July 6		
12 noon	1.11	22
8 p. m.	1.07	19.3
12 midnight	1.22	32
July 8		
12 noon	.95	13.3
3 p. m.	.95	13.3
7 p. m.	1.50	81
12 midnight	1.33	47
July 16		
1 a. m.	.78	7.5
12 noon	.68	5.2
4 p. m.	.70	5.6
6 p. m.	1.00	15.4
8 p. m.	1.00	15.4
12 midnight	.91	11.6
July 22		
9 a. m.	.61	3.9
11 a. m.	1.18	28
12 noon	1.18	28
6 p. m.	1.02	16.5
12 midnight	.88	10.6
July 24		
12 noon	.65	4.6
4 p. m.	.65	4.6
10 p. m.	.92	12.0
11 p. m.	1.15	26
12 midnight	1.21	31
July 25		
2 a. m.	1.16	26
4 a. m.	1.42	64
7 a. m.	1.30	42
12 noon	1.30	42
July 26		
12 noon	.91	11.6
5 p. m.	.88	10.6
8 p. m.	1.48	77
9 p. m.	1.48	77
10 p. m.	1.55	94
11 p. m.	1.68	126
12 midnight	1.53	89

Time	Feet	Second-feet
July 27		
12 noon	1.05	18.2
6 p. m.	1.00	15.4
12 midnight	.96	13.7
July 28		
12 noon	0.83	9.0
1 p. m.	.83	9.0
2 p. m.	1.75	140
3 p. m.	8.35	1,470
4 p. m.	8.80	1,600
5 p. m.	7.50	1,210
6 p. m.	6.10	918
8 p. m.	3.20	374
10 p. m.	1.83	155
12 midnight	1.62	112
Aug. 1		
2 a. m.	.84	9.3
5 a. m.	2.35	231
9 a. m.	1.68	126
11 a. m.	4.25	554
2 p. m.	2.20	210
3 p. m.	2.24	217
6 p. m.	2.83	312
Aug. 2		
3 a. m.	1.55	94
6 a. m.	1.65	119
2 p. m.	1.43	66
4 p. m.	1.90	166
12 midnight	1.43	66
Aug. 3		
1 a. m.	2.57	260
3a. m.	1.55	94
8 a. m.	1.37	55
10 a. m.	1.55	94
1 p. m.	1.53	89
4 p. m.	2.14	203
6 p. m.	1.95	174
9 p. m.	2.56	260
Aug. 4		
1 a. m.	2.02	182
4 a. m.	2.10	196
10 a. m.	1.68	126
4 p. m.	1.57	98
Aug. 5		
6 a. m.	1.38	56
6 p. m.	1.30	42
Aug. 6		
6 a. m.	1.23	34
6 p. m.	1.18	28

Time	Feet	Second-feet
Aug. 7		
1 a. m.	1.17	27
5 a. m.	2.10	196
8 a. m.	13.40	3,950
11 a. m.	13.84	4,230
12 noon	13.80	4,230
1 p. m.	13.40	3,950
6 p. m.	11.13	2,580
11 p. m.	10.43	2,240
Aug. 8		
3 a. m.	6.58	1,020
6 a. m.	5.07	600
8 a. m.	5.25	501
12 noon	6.11	420
12 midnight	8.06	320
Aug. 9		
12 noon	8.06	270
Aug. 10		
6 a. m.	5.89	220
1 p. m.	5.32	205
4 p. m.	6.77	500
6 p. m.	7.11	880
10 p. m.	7.60	1,000
Aug. 11		
1 a. m.	7.07	900
5 a. m.	6.60	800
9 a. m.	5.64	650
9 p. m.	3.90	380
Aug. 12		
11 a. m.	2.53	260
2 p. m.	2.48	252
Aug. 13		
5 a. m.	1.94	172
12 noon	1.62	112
6 p. m.	1.70	131
Aug. 14		
6 a. m.	1.56	97
6 p. m.	1.50	81
Aug. 15		
12 noon	1.42	64
12 midnight	1.41	62
Aug. 27		
12 noon	.89	10.9
8 p. m.	.90	11.2
10 p. m.	5.50	798
11 p. m.	6.25	938
12 midnight	6.06	918
Aug. 28		
3 a. m.	4.33	572
5 a. m.	4.45	590
8 a. m.	3.10	356
12 noon	1.95	174

SUPPLEMENTARY RECORDS OF FLOOD DISCHARGE

This section includes the record of stage and discharge of the Muskingum River at Coshocton, to which previous reference has been made. The value of this record is due chiefly to the strategic location of Coshocton. This record also serves, by subtraction of records of discharge at stations immediately upstream, to show the run-off in the local area above Coshocton over which the storm of August 6–7 centered.

The gage of the Weather Bureau upon which this record is based is on the Tuscarawas River 1,300 feet above its confluence with the Walhonding River to form the Muskingum River. During low-water periods the stage at the gage may not represent the stage of the Muskingum River at its head, but in flood, because of the effect of overflow and backwater, as shown on plate 8, *A*, the stage at the station is very closely related to that of the Muskingum. Consequently the stage record is indicative of the discharge of the Muskingum River only during high-water periods, and some adjustment of low-water discharge has therefore been made on the basis of comparison with river-measurement stations above and below Coshocton.

In this section also are records of discharge at sites of six flood-control dams under construction based on gage-height records furnished by the Corps of Engineers, United States Army, and measurements of discharge made by the Muskingum Watershed Conservancy District and the Geological Survey. These records were selected for inclusion in this report in order that they may serve to define the run-off and flood characteristics of the rivers in the extreme eastern parts of the basin, which were not otherwise separately observed. Moreover, current-meter measurements were available through a range adequate for the development of a stage-discharge relation, although generally the rating developed was but poorly defined, the higher parts being based on graphical extensions and the results of hydrographic comparisons. Only those portions of the record needed to define the rise and recession of the flood at these places are included.

The records included in this section are accompanied by station descriptions, which present information for the interpretation of the data.

MUSKINGUM RIVER AT COSHOCTON, OHIO

LOCATION.—Lat. 40°16′45″, long. 81°52′15″, in Coshocton, on Tuscarawas River 1,300 feet above confluence with Walhonding River to form the Muskingum River. Zero of gage is 733.52 feet above mean sea level.

DRAINAGE AREA.—4,847 square miles (below confluence of Walhonding and Tuscarawas Rivers).

GAGE-HEIGHT RECORDS.—Gage read one or more times daily.

STAGE-DISCHARGE RELATION.—Based on gage-height relation with Geological Survey river-measurement station established on Muskingum River near Coshocton in 1936.

MAXIMA.—1935: Discharge, 88,500 second-feet 5 a. m., Aug. 8 (gage height, 24.65 feet).

Discharge known, 202,000 second-feet March 1913, computed by Corps of Engineers, U. S. Army (gage height, 30.5 feet).

REMARKS.—Gage-height record furnished by U. S. Weather Bureau.

Gage height, in feet, at 8 a. m., and discharge in second-feet, August 1935

Day	Feet	Second-feet	Day	Feet	Second-feet	Day	Feet	Second-feet
1	3.0	2,560	12	15.0	38,300	23	3.5	3,400
2	3.2	2,860	13	12.1	28,200	24	3.4	3,200
3	6.0	9,170	14	8.3	16,000	25	3.2	2,860
4	9.9	20,900	15	7.2	12,800	26	3.2	2,860
5	9.5	19,600	16	5.4	7,500	27	3.1	2,700
6	10.1	21,400	17	5.4	7,500	28	3.1	2,700
7	21.8	68,600	18	5.5	7,700	29	3.2	2,860
8	24.6	88,500	19	5.5	7,700	30	3.1	2,700
9	22.0	69,600	20	4.4	5,300	31	3.0	2,560
10	21.1	64,400	21	3.8	4,000			
11	18.2	50,600	22	3.3	3,030			

Supplemental records of gage height, in feet, and discharge, in second-feet, Aug. 7–8, 1935

Day	Time	Feet	Second-feet	Day	Time	Feet	Second-feet
7	2 p. m.	23.43	79,500	8	4 p. m.	23.55	80,400
8	5 a. m.	24.65	88,500	8	5 p. m.	23.40	79,000
8	8 a. m.	24.59	88,500				

McGUIRE CREEK AT LEESVILLE DAM SITE, NEAR LEESVILLE, OHIO

LOCATION.—Lat. 40°28′10″, long. 81°11′45″, on McGuire Creek about 1 mile above mouth and about 1½ miles northeast of Leesville, Carroll County. Zero of gage C is 913.00 feet above mean sea level.

DRAINAGE AREA.—48 square miles.

GAGE-HEIGHT RECORD.—Twice daily gage readings; estimated for Aug. 4, 11, and 18.

STAGE-DISCHARGE RELATION.—Defined by current-meter measurements to 400 second-feet; based on measurements made after 1935.

MAXIMUM DISCHARGE.—1,370 second-feet at 5 a. m. Aug. 3 (gage height, 11.2 feet on gage C).

REMARKS.—Gage-height record furnished by Corps of Engineers, U. S. Army; discharge measurements made by Muskingum Watershed Conservancy District.

Mean discharge, in second-feet, August 1935

Day	Discharge	Day	Discharge	Day	Discharge	Day	Discharge
1	13.5	6	110	11	83	16	118
2	48	7	990	12	75	17	88
3	1,150	8	608	13	78	18	65
4	585	9	205	14	80	19	50
5	215	10	125	15	118	20	45

CONOTTON CREEK NEAR NEW CUMBERLAND, OHIO

LOCATION.—Lat. 40°31′, long. 81°19′, in sec. 33, T. 15 N., R. 7 W., about 2 miles south of New Cumberland. Zero of gage is 890.82 feet above mean sea level.

DRAINAGE AREA.—242 square miles.

GAGE-HEIGHT RECORD.—Staff gage read frequently during floods, irregularly at other times; not read on Aug. 6 and 13.

STAGE-DISCHARGE RELATION.—Defined by current-meter measurements to 4,000 second-feet.

MAXIMUM DISCHARGE.—5,650 second-feet at 11:30 p. m. Aug. 7 (gage height, 6.85 feet).

REMARKS.—Gage-height record furnished by Corps of Engineers, U. S. Army; discharge measurements made by Muskingum Watershed Conservancy District.

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Mean discharge, in second-feet, August 1935

Day	Discharge	Day	Discharge	Day	Discharge	Day	Discharge
3	1,900	6	1,750	9	1,960	12	600
4	3,420	7	3,750	10	1,180	13	500
5	2,520	8	4,050	11	830	14	450

INDIAN FORK AT ATWOOD DAM SITE, NEAR ATWOOD, OHIO

LOCATION.—Lat. 40°31′35″, long. 81°17′10″, about ⅝ mile above the mouth and 2½ miles southwest of Atwood, Tuscarawas County. Zero of B gage is 888.05 feet above mean sea level.

DRAINAGE AREA.—70 square miles.

GAGE-HEIGHT RECORD.—Frequent readings on gages during high water, twice-daily readings at other times.

STAGE-DISCHARGE RELATION.—Defined by current-meter measurements to 700 second-feet.

MAXIMUM DISCHARGE.—1,660 second-feet at 8 p. m. Aug. 7 (gage height, 901.12 feet on B gage).

REMARKS.—Gage-height record furnished by Corps of Engineers, U. S. Army; discharge measurements made by Muskingum Watershed Conservancy District.

Mean discharge, in second-feet, August 1935

Day	Discharge	Day	Discharge	Day	Discharge	Day	Discharge
1	20	5	790	9	600	12	130
2	35	6	210	10	310	13	110
3	770	7	1,160	11	215	14	81
4	1,185	8	1,275				

STILLWATER CREEK AT PIEDMONT DAM SITE, AT PIEDMONT, OHIO

LOCATION.—Lat. 40°11′20″, long. 80°15′50″, about half a mile west of Piedmont, Harrison County, and about half a mile above mouth of Boggs Fork. Zero of gage 2 is 874.00 feet above mean sea level.

DRAINAGE AREA.—122 square miles.

GAGE-HEIGHT RECORD.—Staff gage read two or more times daily.

STAGE-DISCHARGE RELATION.—Defined by current-meter measurements to 940 second-feet.

MAXIMUM DISCHARGE.—3,840 second-feet at 2 a. m. Aug. 8 (gage height, 13.01 feet on gage 2).

REMARKS.—Gage-height record furnished by Corps of Engineers, U. S. Army; discharge measurements made by Muskingum Watershed Conservancy District.

Mean discharge, in second-feet, August 1935

Day	Discharge	Day	Discharge	Day	Discharge	Day	Discharge
1	80	6	780	11	420	16	320
2	145	7	1,640	12	260	17	230
3	910	8	3,140	13	150	18	125
4	1,980	9	1,450	14	120	19	105
5	1,400	10	820	15	125	20	80

STILLWATER CREEK AT TIPPECANOE, OHIO

LOCATION.—Lat. 40°16′, long. 81°17′, in sec. 22, T. 12 N., R. 7 W., at Tippecanoe, Harrison County, just below mouth of Brushy Fork. Zero of gage is 849.00 feet above mean sea level.

DRAINAGE AREA.—286 square miles.

GAGE-HEIGHT RECORD.—Staff gage read frequently during floods, irregularly at other times.

STAGE-DISCHARGE RELATION.—Defined by current-meter measurements to 2,500 second-feet.

MAXIMUM DISCHARGE.—6,450 second-feet at 1 p. m. Aug. 8 (gage height, 18.73 feet).

REMARKS.—Gage-height record furnished by Corps of Engineers, U. S. Army; discharge measurements made by Muskingum Watershed Conservancy District.

Mean discharge, in second-feet, August 1935

Day	Discharge	Day	Discharge	Day	Discharge	Day	Discharge
1	250	6	2,370	11	1,830	16	480
2	320	7	3,300	12	1,150	17	480
3	380	8	6,180	13	630	18	350
4	1,940	9	4,160	14	370	19	280
5	2,750	10	2,650	15	270	20	240

BRUSHY FORK NEAR TIPPECANOE, OHIO

LOCATION.—Lat. 40°16′15″, long. 81°16′40″, about half a mile east of Tippecanoe, Harrison County, and about 1⅓ miles above the mouth. Zero of gage A is 858.00 feet above mean sea level.

DRAINAGE AREA.—70 square miles.

GAGE-HEIGHT RECORD.—Staff gage read two or more times daily.

STAGE-DISCHARGE RELATION.—Defined by current-meter measurements to 220 second-feet.

MAXIMUM DISCHARGE.—1,020 second-feet at noon Aug. 8 (gage height, 11.52 feet on gage A).

REMARKS.—Gage-height record furnished by Corps of Engineers, U. S. Army; discharge measurements made by Muskingum Watershed Conservancy District.

Mean discharge, in second-feet, August 1935

Day	Discharge	Day	Discharge	Day	Discharge	Day	Discharge
1	68	6	425	11	230	16	135
2	95	7	535	12	130	17	105
3	115	8	955	13	75	18	75
4	380	9	620	14	60	19	60
5	440	10	345	15	55	20	50

RECORDS OF STAGE AT LOCKS AND DAMS ON MUSKINGUM RIVER

The records of stage on the Muskingum River presented in table 7 were furnished by the Corps of Engineers, United States Army. They define the flood hydrograph at intervals along the river and so are useful in studies of channel storage, flood routing, and river regulation.

Plate 8, *B*, is a view of the Muskingum River at Zanesville showing passage of the flood over Dam 10.

The altitudes of the zeros of the gages given in this table are those determined by the Muskingum Watershed Conservancy District in February 1937. The altitudes of the zeros of lock gages as determined by the Corps of Engineers, United States Army, during the summer of 1934 are listed in table 8.

A summary of maximum stages on the Muskingum River is presented in the section on "Summary of flood discharge."

TABLE 7.—*Gage height, in feet, on Muskingum River at Locks 1-11 during August 1935*

Lock 1

[Zero of upper gage, 574.68 feet; lower gage, 566.41 feet]

Time	Upper gage	Lower gage	Time	Upper gage	Lower gage	Time	Upper gage	Lower gage
Aug. 6			*Aug. 10*			*Aug. 14*		
6 a. m.	13.5	21.2	6 a. m.	[1]	28.8	6 a. m.	15.8	16.2
8 a. m.	13.4	21.1	8 a. m.	[1]	28.6	8 a. m.	15.6	16.0
2 p. m.	13.2	20.6	2 p. m.	[1]	28.4	2 p. m.	15.3	14.8
6 p. m.	13.0	20.0	6 p. m.	[1]	28.1	6 p. m.	15.0	14.3
Aug. 7			*Aug. 11*			*Aug. 15*		
6 a. m.	14.3	20.6	6 a. m.	[1]	26.8	6 a. m.	14.0	13.7
8 a. m.	14.5	20.8	8 a. m.	[1]	26.6	8 a. m.	13.9	13.6
2 p. m.	15.8	24.9	2 p. m.	[1]	26.3	2 p. m.	13.4	12.8
6 p. m.	[1]	27.3	6 p. m.	[1]	25.8	6 p. m.	13.1	12.2
Aug. 8			*Aug. 12*					
6 a. m.	[1]	30.0	6 a. m.	16.0	24.2			
8 a. m.	[1]	30.0	8 a. m.	16.0	24.0			
2 p. m.	[1]	30.0	2 p. m.	16.0	22.6			
6 p. m.	[1]	29.8	6 p. m.	16.0	21.4			
Aug. 9			*Aug. 13*					
6 a. m.	[1]	29.3	6 a. m.	16.0	17.5			
8 a. m.	[1]	29.1	8 a. m.	16.0	17.4			
2 p. m.	[1]	29.0	2 p. m.	16.0	17.0			
6 p. m.	[1]	28.8	6 p. m.	16.0	16.7			

Lock 2

[Zero of upper gage, 586.56 feet; lower gage, 576.66 feet]

Aug. 6			*Aug. 10*			*Aug. 14*		
6 a. m.	11.4	14.6	6 a. m.	19.9	[1]	6 a. m.	13.9	19.3
8 a. m.	11.3	14.4	8 a. m.	19.8	[1]	8 a. m.	13.8	19.1
2 p. m.	11.2	14.2	2 p. m.	19.5	[1]	2 p. m.	13.5	18.6
6 p. m.	11.2	14.1	6 p. m.	19.2	[1]	6 p. m.	13.2	18.1
Aug. 7			*Aug. 11*			*Aug. 15*		
6 a. m.	11.7	14.7	6 a. m.	18.9	[1]	6 a. m.	12.3	16.2
8 a. m.	12.4	16.4	8 a. m.	18.8	[1]	8 a. m.	12.1	16.0
2 p. m.	14.9	21.3	2 p. m.	18.6	[1]	2 p. m.	11.7	15.5
6 p. m.	15.9	23.5	6 p. m.	18.4	[1]	6 p. m.	11.4	14.7
12 midnight	--------	25.5						
Aug. 8			*Aug. 12*					
6 a. m.	16.6	[1]	6 a. m.	17.6	26.0			
8 a. m.	16.5	[1]	8 a. m.	17.5	25.8			
2 p. m.	16.6	[1]	2 p. m.	17.0	25.2			
6 p. m.	16.9	[1]	6 p. m.	16.6	24.7			
Aug. 9			*Aug. 13*					
6 a. m.	18.4	[1]	6 a. m.	15.7	22.7			
8 a. m.	18.6	[1]	8 a. m.	15.5	22.4			
2 p. m.	19.2	[1]	2 p. m.	15.1	21.6			
6 p. m.	19.5	[1]	6 p. m.	14.8	21.0			

[1] Gage drowned out.

TABLE 7.—*Gage height, in feet, on Muskingum River at Locks 1–11 during August 1935*—Continued

Lock 3

[Zero of upper gage, 600.14 feet; lower gage, 587.13 feet]

Time	Upper gage	Lower gage
Aug. 6		
6 a. m.	10.9	14.6
8 a. m.	10.9	14.5
2 p. m.	10.9	14.4
6 p. m.	10.8	14.3
Aug. 7		
6 a. m.	11.4	16.6
8 a. m.	12.5	17.8
10 a. m.	14.2	20.4
12 noon	14.5	21.2
2 p. m.	13.9	22.3
4 p. m.	14.4	23.2
6 p. m.	14.7	24.2
8 p. m.	14.8	24.6
10 p. m.	14.9	24.8
12 midnight	14.9	24.9
Aug. 8		
2 a. m.	14.7	24.7
4 a. m.	14.7	24.7
6 a. m.	14.6	24.6
8 a. m.	14.6	24.4
10 a. m.	14.6	24.4
12 noon	14.7	24.5
2 p. m.	14.8	24.6
4 p. m.	15.0	25.0
6 p. m.	15.2	25.4
8 p. m.	15.4	25.8
10 p. m.	15.5	26.2
12 midnight	15.7	26.6
Aug. 9		
2 a. m.	16.0	27.1
4 a. m.	16.3	27.5
6 a. m.	16.5	27.9
8 a. m.	16.8	28.3
10 a. m.	17.1	28.7
12 noon	17.3	29.0
2 p. m.	17.5	29.3
4 p. m.	17.7	29.6
6 p. m.	17.9	29.8
8 p. m.	18.0	30.0
10 p. m.	18.1	30.2
12 midnight	18.1	30.2
Aug. 10		
2 a. m.	18.1	30.2
4 a. m.	18.1	30.3
6 a. m.	18.0	30.2
8 a. m.	17.9	30.0
10 a. m.	17.8	29.8
12 noon	17.8	29.6
2 p. m.	17.7	29.5
4 p. m.	17.5	29.3
6 p. m.	17.3	29.2
8 p. m.	17.2	29.1
10 p. m.	17.1	29.1
12 midnight	17.0	29.0
Aug. 11		
2 a. m.	17.0	29.0
4 a. m.	17.0	29.0
6 a. m.	17.0	29.0
8 a. m.	16.9	28.9
10 a. m.	16.9	28.9
12 noon	16.9	28.8
2 p. m.	16.8	28.6
4 p. m.	16.7	28.4
6 p. m.	16.6	28.2
8 p. m.	16.5	28.0
10 p. m.	16.3	27.8
12 midnight	16.2	27.7
Aug. 12		
2 a. m.	16.1	27.4
4 a. m.	16.0	27.2
6 a. m.	15.8	27.0
8 a. m.	15.6	26.7
10 a. m.	15.6	26.5
12 noon	15.4	26.2
2 p. m.	15.3	26.0
4 p. m.	15.2	25.7
6 p. m.	15.1	25.5
8 p. m.	15.0	25.2
10 p. m.	14.9	24.8
12 midnight	14.7	24.4
Aug. 13		
6 a. m.	14.2	23.5
8 a. m.	14.1	23.0
4 p. m.	13.8	22.2
6 p. m.	13.5	21.5
12 midnight	13.2	20.7
Aug. 14		
6 a. m.	13.0	19.9
8 a. m.	12.9	19.7
4 p. m.	12.7	19.0
6 p. m.	12.4	18.4
12 midnight	12.1	17.6
Aug. 15		
6 a. m.	11.7	16.4
8 a. m.	11.5	15.9
4 p. m.	11.1	15.0
6 p. m.	11.0	14.6
12 midnight	10.8	14.0
Aug. 16		
6 a. m.	10.7	13.4
8 a. m.	10.6	13.2
2 p. m.	10.6	12.9
6 p. m.	10.2	12.6
Aug. 17		
6 a. m.	10.1	12.0
8 a. m.	10.1	12.0
2 p. m.	10.0	11.9
6 p. m.	10.0	11.9

Lock 4

[Zero of upper gage, 610.66 feet; lower gage, 601.74 feet]

Time	Upper gage	Lower gage
Aug. 6		
6 a. m.	12.1	14.7
8 a. m.	12.0	14.5
2 p. m.	11.8	14.3
6 p. m.	11.6	14.0
Aug. 7		
6 a. m.	14.0	18.0
8 a. m.	14.6	20.0
2 p. m.	15.2	22.5
4 p. m.	16.5	23.6
6 p. m.	17.2	24.6
8 p. m.	17.9	25.2
10 p. m.	18.0	25.6
12 midnight	18.0	25.8
Aug. 8		
2 a. m.	17.9	25.7
4 a. m.	17.6	25.3
6 a. m.	17.3	25.0
8 a. m.	17.2	24.7
10 a. m.	17.4	24.8
12 noon	17.6	25.2
2 p. m.	17.8	25.6
4 p. m.	18.1	26.1
6 p. m.	18.5	26.6
8 p. m.	18.7	27.1
10 p. m.	18.8	27.4
12 midnight	19.0	28.1
Aug. 9		
2 a. m.	19.3	28.5
4 a. m.	19.6	28.8
6 a. m.	20.0	29.4
8 a. m.	20.4	29.8
10 a. m.	20.7	30.3
12 noon	21.0	30.5
2 p. m.	21.4	30.6
4 p. m.	21.8	30.8
6 p. m.	22.1	30.9
8 p. m.	22.1	30.9
10 p. m.	22.1	30.8
12 midnight	22.1	30.8

TABLE 7.—*Gage height, in feet, on Muskingum River at Locks 1–11 during August 1935*—Continued

Lock 4—Continued

Time	Upper gage	Lower gage
Aug. 10		
2 a. m.	21.6	30.7
4 a. m.	21.1	30.6
6 a. m.	20.8	30.5
8 a. m.	20.4	30.4
10 a. m.	20.2	30.3
12 noon	19.9	30.2
2 p. m.	19.8	30.0
4 p. m.	19.7	29.8
6 p. m.	19.7	29.7
8 p. m.	19.7	29.7
10 p. m.	19.7	29.6
12 midnight	19.7	29.6
Aug. 11		
2 a. m.	19.7	29.7
4 a. m.	19.8	29.9
6 a. m.	19.9	30.0
8 a. m.	19.8	29.7
10 a. m.	19.8	29.4
12 noon	19.7	29.1
2 p. m.	19.7	29.0
4 p. m.	19.6	28.9
6 p. m.	19.5	28.7
8 p. m.	19.4	28.4
10 p. m.	19.3	28.2
12 midnight	19.3	28.1

Time	Upper gage	Lower gage
Aug. 12		
2 a. m.	19.2	28.0
4 a. m.	19.1	27.8
6 a. m.	19.0	27.5
8 a. m.	19.0	27.3
10 a. m.	18.7	27.0
12 noon	18.4	26.6
2 p. m.	18.0	26.2
6 p. m.	17.8	25.4
12 midnight	17.4	25.0
Aug. 13		
6 a. m.	16.0	24.2
8 a. m.	15.6	23.7
12 noon	15.4	23.0
2 p. m.	15.2	22.4
6 p. m.	15.1	21.8
12 midnight	15.0	21.0
Aug. 14		
6 a. m.	13.9	20.0
8 a. m.	13.8	19.9
2 p. m.	13.6	19.0
6 p. m.	13.3	18.2
12 midnight	12.7	17.1

Time	Upper gage	Lower gage
Aug. 15		
6 a. m.	12.1	16.0
8 a. m.	12.0	15.8
2 p. m.	11.7	15.1
6 p. m.	11.4	14.4
12 midnight	11.2	13.7
Aug. 16		
6 a. m.	11.0	--------
8 a. m.	10.9	--------
2 p. m.	10.7	12.7
6 p. m.	10.6	12.4
12 midnight	10.4	12.0
Aug. 17		
6 a. m.	10.3	11.9
8 a. m.	10.3	11.9
2 p. m.	10.2	11.8
6 p. m.	10.1	11.7
Aug. 18		
6 a. m.	10.0	11.3
8 a. m.	9.9	11.2
2 p. m.	9.9	11.1
6 p. m.	9.8	10.9

Lock 5

[Zero of upper gage, 621.46 feet; lower gage, 611.08 feet]

Time	Upper gage	Lower gage
Aug. 6		
6 a. m.	11.8	16.0
8 a. m.	11.8	15.9
2 p. m.	11.7	15.8
6 p. m.	11.5	15.7
Aug. 7		
6 a. m.	11.7	18.0
8 a. m.	12.5	20.0
2 p. m.	14.4	24.0
6 p. m.	15.9	25.4
8 p. m.	16.2	25.6
10 p. m.	16.4	25.6
12 midnight	16.5	25.7
Aug. 8		
2 a. m.	16.6	25.8
4 a. m.	16.8	25.9
6 a. m.	16.9	26.0
8 a. m.	17.5	26.5
2 p. m.	18.8	[1]
6 p. m.	[1]	[1]
Aug. 11		
6 p. m.	20.0	[1]

Time	Upper gage	Lower gage
Aug. 12		
6 a. m.	19.2	[1]
8 a. m.	19.1	[1]
2 p. m.	18.3	[1]
6 p. m.	17.8	[1]
Aug. 13		
6 a. m.	15.7	24.8
8 a. m.	15.6	24.6
2 p. m.	15.0	23.7
6 p. m.	14.6	22.8
Aug. 14		
6 a. m.	13.7	21.0
8 a. m.	13.6	20.7
2 p. m.	13.3	20.2
6 p. m.	13.0	19.7
Aug. 15		
6 a. m.	11.7	17.1
8 a. m.	11.6	16.9
2 p. m.	11.5	16.0
6 p. m.	11.1	15.6

Time	Upper gage	Lower gage
Aug. 16		
6 a. m.	10.5	14.7
8 a. m.	10.5	--------
2 p. m.	10.3	14.0
6 p. m.	10.2	13.6
Aug. 17		
6 a. m.	10.0	13.2
8 a. m.	10.0	13.2
2 p. m.	9.9	13.0
6 p. m.	9.9	12.9
Aug. 18		
6 a. m.	9.6	12.3
8 a. m.	9.6	12.2
2 p. m.	9.5	12.1
6 p. m.	9.5	12.0
Aug. 19		
6 a. m.	9.2	11.2
8 a. m.	9.2	11.2
2 p. m.	9.1	11.1
6 p. m.	9.1	11.0

[1] Gage drowned out.

TABLE 7.—*Gage height, in feet, on Muskingum River at Locks 1–11 during August 1935*—Continued

Lock 6

[Zero of upper gage, 633.78 feet; lower gage, 622.26 feet]

Time	Upper gage	Lower gage
Aug. 6		
6 a. m.	11.5	13.5
10 a. m.	11.5	13.5
2 p. m.	11.5	13.5
6 p. m.	11.5	13.5
Aug. 7		
6 a. m.	11.7	13.9
10 a. m.	13.6	16.2
2 p. m.	14.7	18.5
6 p. m.	15.5	20.2
8 p. m.	15.8	20.7
10 p. m.	16.1	21.1
12 midnight	16.3	21.4
Aug. 8		
2 a. m.	16.5	21.7
4 a. m.	16.7	22.2
6 a. m.	16.9	22.6
8 a. m.	17.1	23.0
10 a. m.	17.4	23.5
12 noon	17.6	24.1
2 p. m.	17.9	24.8
4 p. m.	18.2	25.4
6 p. m.	18.5	26.2
8 p. m.	18.8	26.9
10 p. m.	19.1	27.7
12 midnight	19.3	28.4
Aug. 9		
2 a. m.	19.5	28.7
4 a. m.	19.7	29.1
6 a. m.	19.8	29.4
8 a. m.	19.9	29.6
10 a. m.	20.0	29.8
12 noon	20.1	29.9
2 p. m.	20.2	30.0
4 p. m.	20.1	30.0
6 p. m.	20.1	29.9
8 p. m.	20.0	29.8
10 p. m.	19.9	29.7
12 midnight	19.8	29.5

Time	Upper gage	Lower gage
Aug. 10		
2 a. m.	19.7	29.3
4 a. m.	19.6	29.1
6 a. m.	19.4	28.9
8 a. m.	19.3	28.8
10 a. m.	19.1	28.5
12 noon	18.9	28.3
2 p. m.	18.8	28.0
4 p. m.	18.8	27.9
6 p. m.	18.8	27.7
8 p. m.	18.8	27.6
10 p. m.	18.8	27.6
12 midnight	18.8	27.6
Aug. 11		
2 a. m.	18.7	27.4
4 a. m.	18.7	27.4
6 a. m.	18.6	27.3
8 a. m.	18.5	27.2
10 a. m.	18.5	27.1
12 noon	18.4	26.8
2 p. m.	18.3	26.6
4 p. m.	18.3	26.5
6 p. m.	18.2	26.2
8 p. m.	18.1	26.0
10 p. m.	18.0	25.8
12 midnight	17.8	25.5
Aug. 12		
2 a. m.	17.5	25.3
4 a. m.	17.4	25.0
6 a. m.	17.3	24.6
8 a. m.	17.3	24.4
10 a. m.	17.1	24.1
12 noon	17.0	23.8
2 p. m.	16.8	23.5
4 p. m.	16.6	23.3
6 p. m.	16.5	22.8
12 midnight	16.1	21.9
Aug. 13		
6 a. m.	15.7	20.8
10 a. m.	15.5	20.3
2 p. m.	15.2	19.8
6 p. m.	14.9	19.2
12 midnight	14.5	18.5

Time	Upper gage	Lower gage
Aug. 14		
6 a. m.	14.1	18.0
10 a. m.	13.9	17.5
2 p. m.	13.6	17.0
6 p. m.	13.3	16.5
12 midnight	12.7	15.2
Aug. 15		
6 a. m.	12.2	14.7
10 a. m.	11.8	14.3
2 p. m.	11.5	13.7
6 p. m.	11.3	13.5
12 midnight	11.0	13.0
Aug. 16		
6 a. m.	10.8	12.7
10 a. m.	10.6	12.5
2 p. m.	10.5	12.2
6 p. m.	10.4	12.0
Aug. 17		
6 a. m.	10.3	11.8
10 a. m.	10.3	11.8
2 p. m.	10.3	11.7
6 p. m.	10.1	11.5
Aug. 18		
6 a. m.	9.8	11.0
10 a. m.	9.8	11.0
2 p. m.	9.8	11.0
6 p. m.	9.7	10.9

TABLE 7.—*Gage height, in feet, on Muskingum River at Locks 1–11 during August 1935*—Continued

Lock 7

[Zero of upper gage, 643.93 feet; lower gage, 634.42 feet]

Time	Upper gage	Lower gage
Aug. 6		
6 a. m.	11.9	15.2
8 a. m.	11.9	15.1
2 p. m.	11.9	15.1
6 p. m.	11.9	15.1
Aug. 7		
6 a. m.	11.9	15.2
8 a. m.	12.3	15.7
2 p. m.	15.5	21.6
6 p. m.	16.4	23.2
8 p. m.	16.6	23.6
10 p. m.	16.8	24.0
12 midnight	17.0	24.4
Aug. 8		
2 a. m.	17.2	24.8
4 a. m.	17.6	25.4
6 a. m.	18.3	25.9
8 a. m.	18.8	26.5
10 a. m.	19.5	27.3
12 noon	20.0	28.4
2 p. m.	20.4	29.0
4 p. m.	21.0	29.7
6 p. m.	21.5	30.4
8 p. m.	21.9	30.9
10 p. m.	22.1	31.2
11 p. m.	22.5	31.5
Aug. 10		
10 a. m.	21.0	30.2
12 noon	21.0	29.9
2 p. m.	20.9	29.8
4 p. m.	20.9	29.8
6 p. m.	20.9	29.7
8 p. m.	20.8	29.6
10 p. m.	20.8	29.6
12 midnight	20.8	29.6

Time	Upper gage	Lower gage
Aug. 11		
2 a. m.	20.7	29.6
4 a. m.	20.7	29.5
6 a. m.	20.7	29.4
8 a. m.	20.7	29.4
10 a. m.	20.6	29.2
12 noon	20.6	28.8
2 p. m.	20.5	28.7
4 p. m.	20.2	28.5
6 p. m.	20.1	28.4
8 p. m.	19.7	28.1
10 p. m.	19.6	27.8
12 midnight	19.4	27.7
Aug. 12		
2 a. m.	19.2	27.5
4 a. m.	19.0	27.3
6 a. m.	18.9	26.8
8 a. m.	18.7	26.6
10 a. m.	18.5	26.4
12 noon	18.2	26.1
2 p. m.	18.0	25.7
4 p. m.	17.8	25.5
6 p. m.	17.5	25.1
12 midnight	16.9	24.3
Aug. 13		
6 a. m.	16.3	23.4
8 a. m.	16.2	23.2
2 p. m.	15.7	22.3
6 p. m.	15.4	21.8
12 midnight	14.9	21.1
Aug. 14		
6 a. m.	14.6	20.9
8 a. m.	14.5	20.2
2 p. m.	14.0	19.3
6 p. m.	13.6	18.7
12 midnight	13.1	17.8

Time	Upper gage	Lower gage
Aug. 15		
6 a. m.	12.4	16.3
8 a. m.	12.3	16.0
2 p. m.	11.8	15.1
6 p. m.	11.6	14.7
12 midnight	11.5	14.2
Aug. 16		
6 a. m.	11.1	13.7
8 a. m.	11.0	13.6
2 p. m.	10.8	13.2
6 p. m.	10.6	12.8
Aug. 17		
6 a. m.	10.6	12.6
8 a. m.	10.6	12.6
2 p. m.	10.5	12.5
6 p. m.	10.4	12.3
Aug. 18		
6 a. m.	10.0	11.8
8 a. m.	10.0	11.7
2 p. m.	10.0	11.6
6 p. m.	10.0	11.5

Lock 8

[Zero of upper gage, 652.95 feet; lower gage, 644.44 feet]

Time	Upper gage	Lower gage
Aug. 6		
6 a. m.	13.6	15.0
8 a. m.	13.6	14.9
2 p. m.	13.5	14.8
6 p. m.	13.4	14.7
Aug. 7		
6 a. m.	13.8	15.0
2 p. m.	15.1	17.7
6 p. m.	17.3	22.8
8 p. m.	17.6	23.3
10 p. m.	17.7	23.7
12 midnight	17.9	24.0
Aug. 8		
2 a. m.	18.2	24.4
4 a. m.	18.6	25.2
6 a. m.	19.0	26.0
8 a. m.	19.3	26.7
10 a. m.	19.5	27.0
12 noon	19.9	27.7
2 p. m.	20.3	28.4
4 p. m.	20.6	28.9
6 p. m.	20.9	29.4
8 p. m.	21.1	29.8
10 p. m.	21.3	30.2
12 midnight	21.4	30.5

Time	Upper gage	Lower gage
Aug. 9		
2 a. m.	21.5	30.7
4 a. m.	21.6	30.9
6 a. m.	21.6	30.9
8 a. m.	21.6	30.9
10 a. m.	21.6	30.9
12 noon	21.6	30.9
2 p. m.	21.4	30.6
4 p. m.	21.2	30.3
6 p. m.	20.9	30.1
8 p. m.	20.7	29.9
10 p. m.	20.5	29.7
12 midnight	20.3	29.5
Aug. 10		
2 a. m.	20.1	29.3
4 a. m.	19.9	29.1
6 a. m.	19.8	28.9
8 a. m.	19.7	28.8
10 a. m.	19.6	28.7
12 noon	19.5	28.6
2 p. m.	19.2	28.3
4 p. m.	19.1	28.2
6 p. m.	19.0	28.2
8 p. m.	18.9	28.1
10 p. m.	18.8	28.0
12 midnight	18.7	28.0

Time	Upper gage	Lower gage
Aug. 11		
2 a. m.	18.7	28.0
4 a. m.	18.6	27.9
6 a. m.	18.5	27.8
8 a. m.	18.4	27.7
10 a. m.	18.3	27.6
12 noon	18.1	27.5
2 p. m.	18.0	27.4
4 p. m.	17.9	27.3
6 p. m.	17.8	27.1
8 p. m.	17.7	26.9
10 p. m.	17.5	26.8
12 midnight	17.4	26.7
Aug. 12		
2 a. m.	17.4	26.7
4 a. m.	17.3	26.5
6 a. m.	17.3	26.4
8 a. m.	17.2	26.2
10 a. m.	17.2	26.0
12 noon	17.1	25.8
2 p. m.	17.1	25.4
4 p. m.	17.0	25.0
6 p. m.	17.0	24.5
12 midnight	16.8	23.6

TABLE 7.—*Gage height, in feet, on Muskingum River at Locks 1–11 during August 1935*—Continued

Lock 8—Continued

Time	Upper gage	Lower gage	Time	Upper gage	Lower gage	Time	Upper gage	Lower gage
Aug. 13			*Aug. 15*			*Aug. 17*		
6 a. m.	16.6	22.6	6 a. m.	13.2	15.4	6 a. m.	12.0	12.2
8 a. m.	16.5	22.3	8 a. m.	13.2	15.4	8 a. m.	12.0	12.2
2 p. m.	16.4	21.4	2 p. m.	13.3	15.7	2 p. m.	12.0	12.2
6 p. m.	16.2	21.0	6 p. m.	13.0	14.2	6 p. m.	11.9	11.9
Aug. 14			*Aug. 16*			*Aug. 18*		
6 a. m.	15.6	19.8	6 a. m.	12.2	13.0	6 a. m.	11.6	11.7
8 a. m.	15.5	19.5	8 a. m.	12.2	12.9	8 a. m.	11.6	11.7
2 p. m.	15.0	18.6	2 p. m.	12.1	12.6	2 p. m.	11.5	11.3
6 p. m.	14.7	17.9	6 p. m.	12.0	12.4	6 p. m.	11.5	11.3

Lock 9

[Zero of upper gage, 663.98 feet; lower gage, 655.46 feet]

Time	Upper gage	Lower gage	Time	Upper gage	Lower gage	Time	Upper gage	Lower gage
Aug. 6			*Aug. 10*			*Aug. 14*		
6 a. m.	12.5	16.1	2 a. m.	23.9	31.7	6 a. m.	14.6	21.3
8 a. m.	12.4	16.0	4 a. m.	23.7	31.5	8 a. m.	14.5	21.0
2 p. m.	12.4	16.1	6 a. m.	23.5	31.4	2 p. m.	13.8	19.9
6 p. m.	12.4	16.1	8 a. m.	23.3	31.2	6 p. m.	13.7	19.1
Aug. 7			10 a. m.	23.1	31.0	12 midnight	13.0	17.9
6 a. m.	12.5	16.4	12 noon	23.0	30.9	*Aug. 15*		
8 a. m.	13.2	18.6	2 p. m.	23.0	30.8	6 a. m.	12.6	16.6
10 a. m.	14.6	22.0	4 p. m.	23.0	30.8	8 a. m.	12.5	16.4
12 noon	16.3	24.5	6 p. m.	23.0	30.8	2 p. m.	12.2	15.6
2 p. m.	17.2	25.2	8 p. m.	23.0	30.8	6 p. m.	12.1	15.2
4 p. m.	17.8	25.7	10 p. m.	23.0	30.8	12 midnight	11.9	14.7
6 p. m.	18.0	26.1	12 midnight	22.9	30.7	*Aug. 16*		
8 p. m.	18.4	26.4	*Aug. 11*			6 a. m.	11.8	14.1
10 p. m.	18.8	27.0	2 a. m.	22.8	30.6	8 a. m.	11.7	13.9
12 midnight	19.6	27.6	4 a. m.	22.6	30.4	2 p. m.	11.5	13.4
Aug. 8			6 a. m.	22.5	30.3	6 p. m.	11.4	13.2
2 a. m.	20.0	28.4	8 a. m.	22.3	30.1	*Aug. 17*		
4 a. m.	20.6	29.2	10 a. m.	22.1	29.9	6 a. m.	11.4	13.2
6 a. m.	21.5	29.9	12 noon	21.9	29.7	8 a. m.	11.4	13.2
8 a. m.	22.1	30.6	2 p. m.	21.7	29.5	2 p. m.	11.3	12.9
10 a. m.	22.9	31.4	4 p. m.	21.5	29.3	6 p. m.	11.3	12.7
12 noon	23.5	32.0	6 p. m.	21.3	29.1	*Aug. 18*		
2 p. m.	24.0	32.6	8 p. m.	21.1	28.9	6 a. m.	11.1	12.2
4 p. m.	24.6	33.3	10 p. m.	20.9	28.7	8 a. m.	11.1	12.1
6 p. m.	25.1	33.8	12 midnight	20.7	28.5	2 p. m.	11.0	12.1
8 p. m.	25.5	34.2	*Aug. 12*			6 p. m.	11.0	12.0
10 p. m.	25.7	34.5	2 a. m.	20.3	28.2			
12 midnight	25.7	34.6	4 a. m.	20.1	28.0			
Aug. 9			6 a. m.	19.9	27.5			
2 a. m.	25.9	34.8	8 a. m.	19.8	27.2			
4 a. m.	26.0	34.9	10 a. m.	19.6	27.0			
6 a. m.	26.0	34.9	12 noon	19.2	26.8			
8 a. m.	26.0	34.9	2 p. m.	18.8	26.7			
10 a. m.	25.9	34.8	4 p. m.	18.6	26.5			
12 noon	25.7	34.6	6 p. m.	18.5	26.2			
2 p. m.	25.4	34.4	8 p. m.	17.9	26.1			
4 p. m.	25.2	34.2	10 p. m.	17.6	25.7			
6 p. m.	25.0	33.7	12 midnight	17.5	25.5			
8 p. m.	24.8	33.5	*Aug. 13*					
10 p. m.	24.6	33.2	6 a. m.	16.5	24.5			
12 midnight	24.2	32.0	8 a. m.	16.3	24.3			
			2 p. m.	15.5	23.4			
			6 p. m.	15.0	22.8			
			12 midnight	14.6	22.3			

TABLE 7.—*Gage height, in feet, on Muskingum River at Locks 1–11 during August 1935*—Continued

Lock 10

[Zero of upper gage, 681.37 feet; lower gage, 665.04 feet]

Time	Upper gage	Lower gage
Aug. 6		
6 a.m.	12.1	15.8
8 a.m.	12.1	15.8
10 a.m.	12.1	15.8
2 p.m.	12.2	15.8
6 p.m.	12.2	15.8
Aug. 7		
6 a.m.	12.6	16.7
8 a.m.	13.1	17.5
10 a.m.	13.2	20.1
12 noon	13.6	21.2
2 p.m.	13.8	22.2
4 p.m.	14.1	23.0
6 p.m.	14.6	23.8
8 p.m.	15.1	24.6
10 p.m.	15.7	25.4
12 midnight	16.3	26.4
Aug. 8		
2 a.m.	16.8	27.4
4 a.m.	17.4	28.3
6 a.m.	17.9	29.2
8 a.m.	18.4	30.0
10 a.m.	19.1	30.8
12 noon	19.7	31.6
2 p.m.	20.1	32.2
4 p.m.	20.6	32.7
6 p.m.	21.0	33.0
8 p.m.	21.1	33.3
10 p.m.	21.0	33.3
12 midnight	21.1	33.5
Aug. 9		
2 a.m.	21.4	33.6
4 a.m.	21.3	33.55
6 a.m.	21.3	33.5
8 a.m.	21.1	33.3
10 a.m.	21.0	33.1
12 noon	20.8	32.85
2 p.m.	20.6	32.5
4 p.m.	20.4	32.1
6 p.m.	20.1	31.9
8 p.m.	19.9	31.7
10 p.m.	19.7	31.4
12 midnight	19.6	31.1
Aug. 10		
2 a.m.	19.6	30.9
4 a.m.	19.5	30.7
6 a.m.	19.4	30.6
8 a.m.	19.4	30.5
10 a.m.	19.2	30.3
12 noon	19.1	30.2
2 p.m.	19.1	30.1
4 p.m.	19.1	30.2
6 p.m.	19.1	30.2
8 p.m.	19.0	30.1
10 p.m.	18.8	30.0
12 midnight	18.8	29.9
Aug. 11		
2 a.m.	18.7	29.7
4 a.m.	18.6	29.6
6 a.m.	18.5	29.4
8 a.m.	18.5	29.3
10 a.m.	18.3	29.1
12 noon	18.1	28.9
2 p.m.	18.0	28.7
4 p.m.	17.9	28.5
6 p.m.	17.8	28.2
8 p.m.	17.7	28.0
10 p.m.	17.5	27.8
12 midnight	17.4	27.4
Aug. 12		
2 a.m.	17.3	27.1
4 a.m.	17.2	26.8
6 a.m.	17.0	26.5
8 a.m.	16.9	26.2
10 a.m.	16.7	25.9
2 p.m.	16.5	25.3
6 p.m.	16.2	24.7
12 midnight	15.9	23.8
Aug. 13		
6 a.m.	15.5	23.0
8 a.m.	15.4	22.7
10 a.m.	15.3	22.4
2 p.m.	15.0	21.8
6 p.m.	14.8	21.5
Aug. 14		
6 a.m.	14.0	20.2
8 a.m.	13.9	19.9
10 a.m.	13.7	19.5
2 p.m.	13.5	18.9
6 p.m.	13.1	18.2
Aug. 15		
6 a.m.	12.1	16.1
8 a.m.	12.0	16.0
10 a.m.	11.9	15.8
2 p.m.	11.8	15.2
6 p.m.	11.7	15.0
Aug. 16		
6 a.m.	11.2	14.0
8 a.m.	11.1	13.8
10 a.m.	11.0	13.7
2 p.m.	10.9	13.4
6 p.m.	10.8	13.2
Aug. 17		
6 a.m.	10.3	13.3
8 a.m.	10.2	13.2
10 a.m.	10.2	13.1
2 p.m.	10.2	12.9
6 p.m.	10.2	12.8
Aug. 18		
6 a.m.	10.0	12.2
8 a.m.	10.0	12.4
10 a.m.	10.0	12.4
2 p.m.	10.0	12.3
6 p.m.	9.9	12.1

TABLE 7.—*Gage height, in feet, on Muskingum River at Locks 1–11 during August 1935*—Continued

Lock 11

[Zero of upper gage, 690.34 feet]

Time	Upper gage
Aug. 6	
6 a. m.	11.9
8 a. m.	11.9
12 noon	12.0
2 p. m.	12.0
6 p. m.	12.0
Aug. 7	
6 a. m.	12.3
8 a. m.	13.0
10 a. m.	13.5
12 noon	14.2
2 p. m.	14.7
4 p. m.	15.7
6 p. m.	16.5
8 p. m.	17.5
10 p. m.	18.7
12 midnight	19.6
Aug. 8	
2 a. m.	20.6
4 a. m.	21.4
6 a. m.	22.0
8 a. m.	22.7
10 a. m.	23.3
12 noon	23.7
2 p. m.	24.2
4 p. m.	24.5
6 p. m.	24.85
8 p. m.	24.95
10 p. m.	25.1
12 midnight	25.1
Aug. 9	
2 a. m.	25.15
4 a. m.	25.05
6 a. m.	25.05
8 a. m.	24.95
10 a. m.	24.8
12 noon	24.7
2 p. m.	24.6
4 p. m.	24.5
6 p. m.	24.4
8 p. m.	24.3
10 p. m.	24.2
12 midnight	24.1
Aug. 10	
2 a. m.	24.1
4 a. m.	24.0
6 a. m.	23.9
8 a. m.	23.9
10 a. m.	23.7
12 noon	23.6
2 p. m.	23.6
4 p. m.	23.5
6 p. m.	23.4
8 p. m.	23.4
10 p. m.	23.2
12 midnight	23.1
Aug. 11	
2 a. m.	22.9
4 a. m.	22.8
6 a. m.	22.6
8 a. m.	22.4
10 a. m.	22.2
12 noon	22.0
2 p. m.	21.9
4 p. m.	21.7
6 p. m.	21.5
8 p. m.	21.3
10 p. m.	21.1
12 midnight	20.9
Aug. 12	
2 a. m.	20.7
4 a. m.	20.5
6 a. m.	20.3
8 a. m.	20.0
12 noon	19.6
2 p. m.	19.4
6 p. m.	18.8
12 midnight	18.1
Aug. 13	
6 a. m.	17.3
8 a. m.	17.1
2 p. m.	16.3
6 p. m.	16.1
12 midnight	15.4
Aug. 14	
6 a. m.	14.6
8 a. m.	14.4
12 noon	13.9
2 p. m.	13.5
6 p. m.	12.9
Aug. 15	
6 a. m.	11.7
8 a. m.	11.6
12 noon	11.4
2 p. m.	11.2
6 p. m.	11.1
Aug. 16	
6 a. m.	10.5
8 a. m.	10.4
12 noon	10.2
2 p. m.	10.1
6 p. m.	9.9
Aug. 17	
8 a. m.	9.4
10 a. m.	9.3
2 p. m.	9.3
6 p. m.	9.3
Aug. 18	
6 a. m.	9.0
8 a. m.	9.0
12 noon	9.0
2 p. m.	9.0
6 p. m.	8.9

TABLE 8.—*Altitude of zero of lock gages and crests of dams on Muskingum River*

[From survey made in 1934 by Corps of Engineers, U. S. Army]

Lock and dam No.	Location	Distance between mouth and lock (miles)[1]	Zero of gage (feet above mean sea level)		Crest of dam (feet above mean sea level)
			Upper	Lower	
1	Marietta	0.2	575.11	566.84	582.69
2	Devol	5.8	587.45	577.13	593.45
3	Lowell	13.0	600.57	587.54	607.64
4	Beverly	24.3	610.96	602.03	616.96
5	Luke Chute	33.0	621.72	611.30	627.72
6	Stockport	39.1	634.05	622.52	640.05
7	McConnelsville	48.0	644.14	634.62	650.15
8	Eagleport	56.0	653.11	644.60	661.11
9	Philo	66.8	654.12	655.89	672.12
10	Zanesville	75.0	681.25	665.03	687.55
11	Ellis	83.9	690.34	680.88	[2] 699.30

[1] The Ohio River, compilation of charts, navigable depths, and distances, made by Chief of Engineers, U. S. Army, 1935.
[2] Movable top; altitude of fixed part, 695.40 feet.

SUMMARY OF FLOOD DISCHARGES

Table 9 presents determinations of the maximum flood flow at river-measurement stations and at other places in the Muskingum River Basin. These places are indicated in figure 8 by the number given in the first column of table 9. The period of record is generally

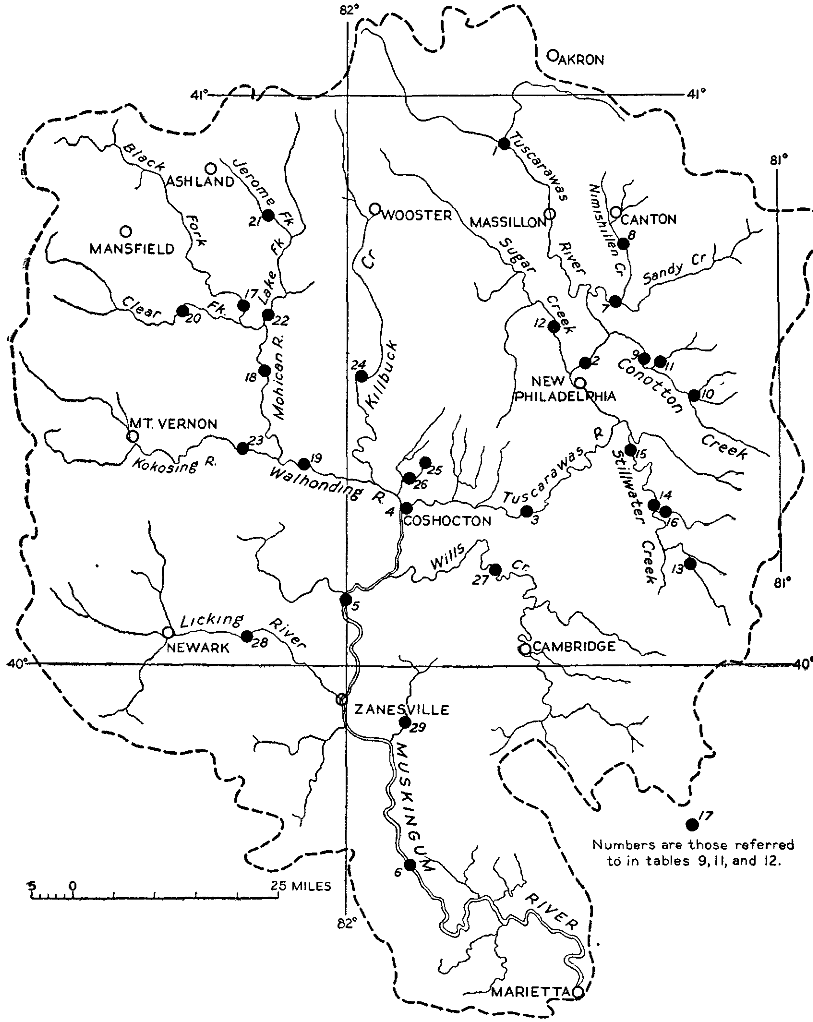


FIGURE 8.—Map showing location of flood-discharge determinations in the Muskingum River Basin, August 1935.

given only for the stations existing at the time of the flood of August 1935 and conforms to their period of operation. The maximum discharge during the flood of March 1913 is given for those river-measurement stations for which the discharge determined is the greatest known.

TABLE 9.—*Summary of flood discharges in Muskingum River Basin*

No. on map (fig. 8)	Stream	Place of measurement	Drainage area (square miles)	Period of record	Maximum discharge recorded prior to August 1935		Maximum discharge of flood of March 1913	Maximum discharge during flood of August 1935			
					Date	Second-feet		Time	Second-feet	Second-feet per square mile	Method of determination
1	Tuscarawas River	Clinton	165	1926–35	Mar. 15, 1933	2,660		Aug. 8, 3 p. m.	2,700	16.4	Stage-discharge relation.
2	do	Near Dover	1,398	1923–35	Mar. 16, 1933	20,600	62,000	Aug. 8, 4 to 6 a. m.	22,300	16.0	Do.
3	do	Newcomerstown	2,432	1921–35	Mar. 17, 1933	32,900	83,000	Aug. 9, 6 a. m.	41,700	17.1	Do.
4	Muskingum River	Coshocton	4,847				202,000	Aug. 8, 5 a. m.	[1] 88,500	18.3	Gage-height relation with station established in 1936.
5	do	Dresden	5,982	1921–35	Mar. 23, 1927	63,300	228,000	Aug. 9, 2 a. m.	100,000	16.7	Stage-discharge relation.
6	do	McConnelsville	7,411	1921–35	Mar. 19, 1933	75,100	270,000	Aug. 9, 10 a. m. to 1 p. m.	104,000	14.0	Do.
7	Sandy Creek	Sandyville	481	1923–35	Feb. 26, 1929	11,600		Aug. 7, 12 m.	12,600	26.2	Do.
8	Nimishillen Creek	North Industry	175	1921–35	do	9,000±		Aug. 7, 4 a. m.	8,240±	47.1	Do.
9	Conotton Creek	Near New Cumberland.	242					Aug. 7, 11:30 p. m.	5,650	23.3	Do.
10	McGuire Creek	Leesville dam site, near Leesville.	48					Aug. 7, 10 a. m.	[2] 1,230	25.6	Do.
11	Indian Fork	Atwood dam site, near Atwood.	70					Aug. 7, 8 p. m.	1,660	23.7	Do.
12	Sugar Creek	Strasburg	310	1931–33, 1934–35	Mar. 15, 1933	6,940		Aug. 7, 2 to 4 p. m.	19,700	63.5	Do.
13	Stillwater Creek	Piedmont dam site, at Piedmont.	122					Aug. 8, 2 a. m.	3,840	31.4	Do.
14	do	Tippecanoe	286					Aug. 8, 1 p. m.	6,450	22.6	Do.
15	do	Uhrichsville	367	1922–35	Dec. 16, 1927	4,960		Aug. 8, 8 p. m. to Aug. 9, 4 a. m.	7,650	20.8	Do.
16	Brushy Fork	Near Tippecanoe	70					Aug. 8, 12 m.	1,020	14.6	Do.
17	Black Fork	Loudonville	342	1931–35	Mar. 21, 1933	3,500	[3] 11,700	Aug. 7, 6:15 a. m.	5,860	17.1	Do.
18	Mohican River	Greer	942	1921–35	Mar. 21, 1927	15,400	55,000	Aug. 7, 1 p. m.	17,700	18.8	Do.
19	Walhonding River	Pomerene	1,488	1921–35	Feb. 26, 1929	27,800	80,000	Aug. 7, 9 p. m.	27,100	18.2	Do.
20	Clear Fork	Newville	175	1934–35	July 4, 1935	11,700		Aug. 7, 7 a. m.	5,680	32.5	Do.
21	Jerome Fork	Jeromeville	120	1925–35	Feb. 26, 1929	3,130		Aug. 7, 12 p. m.	3,090	25.8	Do.
22	Lake Fork	Near Loudonville	342	1931–32, 1934–35	Jan. 18, 1932	3,000		Aug. 7, 11 a. m.	6,030	17.6	Do.
23	Kokosing River	Near Millwood	472	1921–35	July 4, 1935	27,100	40,000	Aug. 7, 1 p. m.	18,500	39.2	Do.
24	Killbuck Creek	Killbuck	466	1930–35	May 14, 1933	3,650		Aug. 7, 7 a. m.	21,900	47.0	Do.
25	Little Mill Creek	Near Coshocton	1.70						[4] 5,420	3,190	Slope area (n=0.045).
26	do	do	7.10						[4] 9,020	1,270	Do.
27	Wills Creek	Birds Run	730	1928–35	Mar. 17, 1933	8,450	[5] 22,300	Aug. 8, 12 m.	13,500	18.5	Stage-discharge relation.
28	Licking River	Toboso	672	1921–35	Feb. 26, 1929	23,600	35,000	Aug. 8, 3 a. m.	20,000	29.8	Do.
29	Salt Creek	Near Chandlersville	75.6	1935				Aug. 7, 11:30 a. m.	4,300	56.8	Do.

[1] Computed by Muskingum Watershed Conservancy District.
[2] Maximum discharge during August 1935 was 1,370 second-feet at 5 a. m. August 3.
[3] Discharge at Charles Mill dam site, about 16 miles above gage.
[4] Furnished by U. S. Soil Conservation Service.
[5] Discharge at Wills Creek dam site, below gage.

The two miscellaneous determinations of discharge on Little Mill Creek included within the tabulation were made by the slope-area method. This method is adequately described by Johnson[13] and Dalrymple,[14] together with discussion of the significance of the coefficients employed. These two determinations (presumably for a momentary peak) represent the maximum intensity of run-off determined during the storm. The discharges of 5,420 second-feet for 1.7 square miles and 9,020 second-feet for 7.1 square miles are equivalent to 3,190 and 1,270 second-feet per square mile, respectively, and correspond to rates of run-off of 4.90 and 1.95 inches per hour from the drainage basins. Little Mill Creek Basin is near the center of the storm where the precipitation averaged 12 inches in as many hours, but the maximum intensity of rainfall is not known. Maximum rates of discharge in other small streams, notably Bucklew Run and White Eyes and Evans Creeks, in the center of the storm area, are not known. Rates of run-off in these streams would presumably also be comparable with that of Little Mill Creek. Unfortunately no high-water marks are available on these other streams.

The above two supplementary determinations on Little Mill Creek have been based on cross sections of the river channel and contiguous overflow channels made by the Soil Conservation Service in December 1935 and on high-water marks observed by the Corps of Engineers, United States Army, immediately after the flood. The computed rates of run-off are indicative of rates of precipitation much higher than can be substantiated by any of the available data.

The maximum rate of discharge per square mile at river-measurement stations listed in table 9 is that of Sugar Creek at Strasburg—63.5 second-feet per square mile, equivalent to about 0.10 inches per hour from its drainage area of 310 square miles. The precipitation over Sugar Creek Basin, the southern part of which is near the central part of the storm area, was about 6.3 inches in 12 hours.

The indicated discharge rates listed in table 9 for basins larger than 10 square miles seem low when compared with outstanding floods of record in other areas. They are, however, a measure of the concentration of flood waters in unusual storms in the Muskingum River Basin.

Table 10 shows the maximum stages on the Muskingum River for the flood of 1935 and compares them with the maximum stages attained in the flood of 1913.

[13] Johnson, Hollister, The New York State flood of July 1935: U. S. Geol. Survey Water-Supply Paper 773-E, pp. 251-254, 1936.

[14] Dalrymple, Tate, and others, Major Texas floods of 1936: U. S. Geol. Survey Water-Supply Paper 816, pp. 11-16, 1937.

TABLE 10.—*Summary of flood stages in Muskingum River*

Name of gage	Miles above mouth of Muskingum River	Zero of gage [1]	Maximum stage during flood of August 1935		Previous maximum stage	
			Gage height (feet)	Time	Gage height (feet)	Date
Lock No. 1 Lower	0.2	566.41	30.0	Aug. 8, 6 a. m. to 2 p. m.	59.9	Mar. 29, 1913.
Lock No. 1 Upper	.3	574.68		do		
Lock No. 2 Lower	5.8	576.66			[2] 629.8	March 1913.
Lock No. 2 Upper	5.9	586.56	19.9	Aug. 10, 6 a. m.		
Lock No. 3 Lower	13.6	587.13	30.3	Aug. 10, 3 a. m. to Aug. 10, 5 a. m.	[2] 636.0	March 1913.
Lock No. 3 Upper	14.1	600.14	18.1	Aug. 9, 10 p. m. to Aug. 10, 5 a. m.		
Lock No. 4 Lower	24.2	601.74	30.9	Aug. 9, 6–9 p. m.	45.9	Mar. 28, 1913.
Lock No. 4 Upper	24.7	610.66	22.1	Aug. 9, 6–12 p. m.	37.1	Do.
Lock No. 5 Lower	33.4	611.08			49.1	March 1913.
Lock No. 5 Upper	33.5	621.46	[3] 23.28	Aug. 9, 3 p. m.	38.7	Do.
Lock No. 6 Lower	39.2	622.26	30.0	Aug. 9, 1–4 p. m.	46.4	Do.
Lock No. 6 Upper	39.3	633.78	20.2	Aug. 9, 1–3 p. m.	35.0	Do.
Lock No. 7 Lower	48.3	634.42			49.1	
Lock No. 7 Upper	48.6	643.93			40.8	Mar. 27, 1913.
McConnelsville	48.6	650.31	17.02	Aug. 9, 10 a. m. to 1 p. m.	33.5	Do.
Lock No. 8 Lower	56.1	644.44	30.9	Aug. 9, 4 a. m. to noon	50.0	March 1913.
Lock No. 8 Upper	56.2	652.95	21.6	Aug. 9, 3 a. m. to noon	41.5	Do.
Lock No. 9 Lower	66.9	655.46	34.9	Aug. 9, 4–8 a. m.	50.7	Do.
Lock No. 9 Upper	67.0	663.98	26.0	do	42.3	Do.
Lock No. 10 Lower	75.1	665.04	33.6	Aug. 9, 2–3 a. m.	51.8	Mar. 27, 1913.
Lock No. 10 Upper	75.9	681.37	21.4	Aug. 9, 1–3 a. m.	37.8	Do.
Lock No. 11 Lower	84.2	680.88			50.3	March 1913.
Lock No. 11 Upper	84.3	690.34	25.15	Aug. 9, 2 a. m.	40.9	Do.
Dresden	91.0	693.15	31.60	do	46.0	Do.
Coshocton [4]	110.0	733.5	24.65	Aug. 8, 5 a. m.	[5] 30.5	Mar. 26, 1913.

[1] Elevation, in feet, above mean sea level, determined by the Muskingum Watershed Conservancy District.
[2] Altitude above mean sea level from floodmark.
[3] Based on floodmark.
[4] U. S. Weather Bureau gage.
[5] Observed at 4 a. m.; Corps of Engineers, U. S. Army, give 31.8 feet.

NOTE.—See table 14 (pp. 94–98) for maximum altitudes from floodmarks.

RAINFALL AND RUN-OFF STUDIES

GENERAL FEATURES

Comparisons of rainfall with the associated run-off are of great importance in an appraisal of the effect of the prevailing hydrologic conditions on the magnitude and concentration of flood run-off. Moreover, these comparisons serve as tests of the accuracy and adequacy of the base data. For these comparisons, the records of rainfall and run-off have been separated into three distinct periods—August 1–5, the period immediately antecedent to the flood, August 6–8, embracing the flood period itself, and August 9–11. Table 11 gives the average rainfall over the several basins listed and the computed run-off associated with each of the separate rainfall periods.

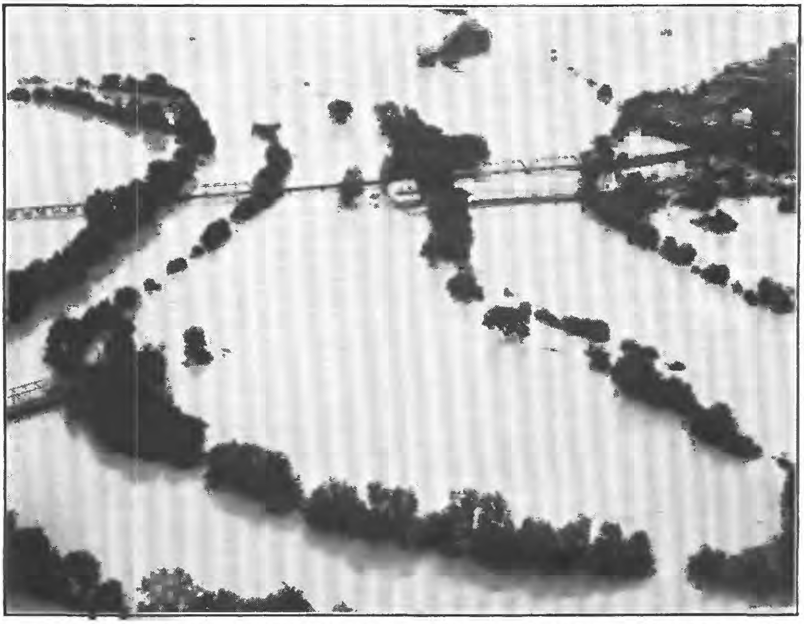
TABLE 11.—*Rainfall and associated direct run-off of flood of August 1935*

[Mean depth, in inches, over drainage areas]

No. on map (fig. 8)	Stream	Location	Drainage area (square miles)	Aug. 1-5 Rainfall[1]	Aug. 1-5 Run-off	Aug. 1-5 Difference	Aug. 6-8 Rainfall	Aug. 6-8 Run-off	Aug. 6-8 Difference	Aug. 9-11 Rainfall[1]	Aug. 9-11 Run-off	Aug. 9-11 Difference	Ratio of maximum 24-hour run-off to total run-off Aug. 6-8 (percent)
1	Tuscarawas River	Clinton	165	3.15	0.4	2.75	2.9	1.65	1.25	0.25	0.1	0.15	34
2	do	Near Dover	1,398	2.95	.7	2.25	3.5	1.75	1.75	.6	.15	.45	30
3	do	Newcomerstown	2,432	3.2	.75	2.45	4.0	1.85	2.15	.6	.2	.4	30
4	Muskingum River	Coshocton	4,847	2.65	.35	2.3	4.3	2.55	1.75	.6	.3	.3	24
5	do	Dresden	5,982	2.85	.35	2.5	4.5	2.75	1.75	.6	.3	.3	20
6	do	McConnelsville	7,411	2.7	.35	2.35	4.15	2.3	1.85	.7	.35	.35	21
7	Sandy Creek	Sandyville	481	2.8	.85	1.95	2.85	1.4	1.45	.40	.15	.25	50
8	Nimishillen Creek	North Industry	175	2.8	.7	2.1	3.15	1.5	1.65	.5	.1	.4	72
9	Conotton Creek	Near New Cumberland	242	2.95	1.25	1.7	2.8	(2)	(2)	.35	1.3	1.85	
10	McGuire Creek	Leesville dam site. Near Leesville.	48	2.45	1.3	1.15	2.5	(2)	(2)	.3	1.15	1.65	
11	Indian Fork	Atwood dam site. Near Atwood.	70	2.8	1.25	1.55	2.95	1.5	1.45	.3	.05	.25	
12	Sugar Creek	Strasburg	310	3.3	.8	2.5	6.3	2.5	3.8	.8	.2	.6	65
13	Stillwater Creek	Piedmont dam site, at Piedmont.	122	4.0	1.4	2.6	3.15	(2)	(2)	.4	1.85	1.7	
14	do	Tippecanoe	286	3.7	.95	2.75	3.4	(2)	(2)	.45	2.1	1.75	
15	do	Uhrichsville	367	3.55	1.05	2.5	3.6	(2)	(2)	.45	2.9	1.15	24
16	Brushy Fork	Near Tippecanoe	70	3.5	.65	3.0	2.65	(2)	(2)	.45	1.15	1.95	
17	Black Fork	Loudonville	342	1.4	.15	1.25	3.7	1.2	2.5	.4	.35	.05	40
18	Mohican River	Greer	942	2.05	.3	1.75	3.7	1.45	2.25	.55	.15	.4	39
19	Walhonding River	Pomerene	1,488	2.25	.4	1.85	3.4	1.35	2.05	.55	.1	.45	43
20	Clear Fork	Newville	175	3.05	.35	2.7	2.95	1.5	1.45	.5	.05	.5	76
21	Jerome Fork	Jeromeville	120	1.7	.1	1.6	3.5	1.85	1.65	.65	.1	.55	50
22	Lake Fork	Near Loudonville	342	2.0	.15	1.85	3.85	1.65	2.2	.65	.1	.55	32
23	Kokosing River	Near Millwood	472	2.8	.6	2.2	2.65	1.4	1.25	.55	.15	.4	64
24	Killbuck Creek	Killbuck	466	2.8	.65	2.15	5.4	2.8	2.6	.65	.3	.35	47
27	Wills Creek	Birds Run	730	3.65	.45	3.2	5.25	3.7	1.55	.65	.2	.45	17
28	Licking River	Toboso	652	1.5	.25	1.3	2.9	1.5	1.4	1.1	.25	.85	58
29	Salt Creek	Near Chandlersville	75.6	2.2	.25	1.9	2.85	1.6	1.25	1.0	.5	.5	87

[1] Computed by Muskingum Watershed Conservancy District.

[2] Included in next period.



A. CONFLUENCE OF TUSCARAWAS AND WALHONDING RIVERS DURING FLOOD.
Photograph furnished by Corps of Engineers, U. S. Army.

B. MUSKINGUM RIVER AT ZANESVILLE DURING FLOOD, SHOWING TURBULENCE PRODUCED BY DAM 10.
Photograph by Parkins Commercial Studio, Zanesville, Ohio, furnished by Muskingum Watershed Conservancy District.

Mean areal precipitation during the period August 1–5 and August 9–11 over the several basins has been computed by the Thiessen method,[15] drawing the lines by the method of perpendicular bisectors described by Horton.[16] This mean is based only on regularly read rain gages. The computed data were supplied by the Muskingum Watershed Conservancy District. Mean areal precipitation over the several basins during the major storm period, August 6–8, was based on the isohyetal map (pl. 2) plus proper correction for the precipitation on August 7 and 8 in the northern part of the basin. The preparation of this map has been explained in a previous section of this report. The storm of August 6–7 was followed, on the afternoon of August 7 and during August 8, by local showers, more particularly in the northeastern part of the basin, where nearly 0.8 inch of rainfall was recorded at Wooster on the afternoon of August 7 and 0.6 inch at Akron during August 8. At all other places it was materially less and in the central and southern basins virtually zero. This local precipitation over the upper headwaters, which followed the major storm after the tributary streams had begun to subside, had no effect on the flood crests, but it was nevertheless added to the storm precipitation as determined from plate 2 because its associated run-off was so closely identified with that of the major rise.

The records of daily mean discharge at the river-measurement stations published herein have been used as a basis for determining the direct run-off during the storm periods, using the following method. A discharge hydrograph for each discharge record to be analyzed was constructed covering the period July 31 to August 15. The hydrograph of Kokosing River near Millwood is presented in figure 9 to show the procedure adopted for the separation of the direct run-off into the three periods.

On July 31, as shown at point A on figure 9, stream flow had generally receded from previous rains so that the flow was largely from ground-water sources. Associated with the rains during the first period, August 1–5, there was a rise in stream flow to one or more peaks, B and B′ corresponding to the separate showers during the period, followed by a recession to C after cessation of rainfall. The rise associated with the major storm period of the night of August 6–7 began variously from late August 6 in the eastern basin to early August 7 in the western basin, culminated in a peak D, and then receded to E. In the northwestern part of the basin, several hydrographs disclose double peaks, as shown on figure 9 as D′, possibly indicative of rainfall on the afternoon or evening of August 7. The automatic recorder at Wooster registered 0.77 inch between 6 and 7

[15] Thiessen, A. H., Precipitation averages for large areas: U. S. Dept. Agr., Weather Bur., Monthly Weather Rev., vol. 39, No. 7, p. 1083, July 1911.

[16] Horton, R. E., Rational study of rainfall data, Eng. News-Record, pp. 211–213, Aug. 2, 1917.

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p. m. on August 7. There were no general rains over the basin until August 10, only light scattered showers. There was therefore, in general, ample time in the small basins at least for substantial recession of flow before interruption by subsequent rise from the rainfall associated with the third rainfall period, August 9–11, which produced a small rise in stream flow (point F) on or about August 10.

The volume represented by the hydrograph is the total run-off that reached the stream channels both as direct run-off (over the surface or in many places immediately beneath it) and as ground-water run-

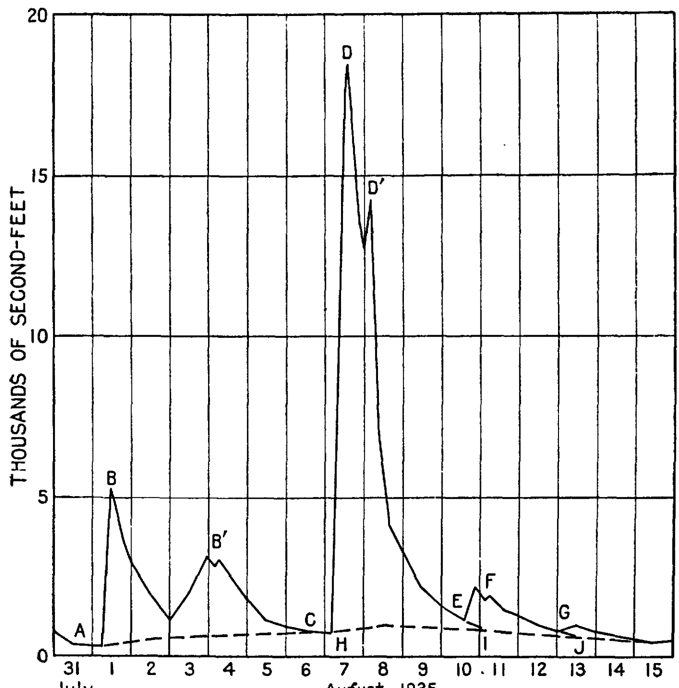


FIGURE 9.—Discharge hydrograph of Kokosing River near Millwood, July 31 to Aug. 15, showing method of analysis used in determining direct run-off associated with each storm period.

off resulting from the storm precipitation, plus the stream flow that would have been maintained if there had been no increment after July 31 (point A).

The increase in stream flow directly attributable to the rains of August 1–11 has been estimated by making an approximation of the positions of A, C, I, J on the graph of the total ground-water flow and assuming that the enclosed area above that line represents the increment in stream flow resulting from the direct run-off associated with the rains that fell after July 31. The latter area is believed to include essentially all the surface run-off resulting from the storm precipitation but may include some superficial subsurface flow, such as perchedwater effluent, that was discharged into the stream channel with a promptness approaching that of the surface run-off. The direct run-off has been further analyzed to show the approximate direct run-off associated with each of the three rainfall periods August 1–5, August 6–8, and August 9–11. This analysis has required an estimation of recession graphs C–H, E–I, and G–J, representing the recession in discharge after each rain period, had there been no subsequent rainfall.

Although in the example shown these recession graphs are short, in some of the larger basins the recession from the major peak D was not so complete as that shown in figure 9 before the run-off associated with the rains of the third period reached the gaging stations. For hydrographs of such basins, the estimated recession graph E–I represented a considerably longer period than shown in figure 9, and therefore its definition might be subject to greater error. For several basins listed, the position of the recession graph E–I was considered so uncertain that the separation of run-off associated with the periods August 6–8 and August 9–11 was not attempted.

The three separate areas A–B–B′–C, C–D–D′–E–I, and E–F–G–J–I were determined by arithmetical computation, and the results in mean depths in inches over the several basins are listed in table 11 together with the associated rainfall.

In three typical basins the analyses of rainfall and run-off during the major storm period have been extended to determine progressively the variations in volumes of water retained in the basin. (See figs. 10–12, included within the following section, which present detailed analyses of the rainfall and run-off of selected basins during August 6–8.) Determining the retention, or the amount of water that had not appeared in the stream channels as direct run-off at any time, is essentially determining the difference at corresponding times between the rainfall and the direct run-off into the stream-channel system. This difference is obtained by subtracting from the cumulative summation of the mean depth of precipitation in the basin at 2-hour intervals, as determined from daily records of rain gages appurtenant to each basin, distributed in 2-hour periods on the basis of the record of the time-distribution of rainfall at nearby automatic rainfall gages, the cumulative summation of the observed stream flow of the direct run-off at corresponding 2-hour intervals adjusted for the volume of storage in the surface channel system of the basin above the river-measurement station,[17] with due allowance for the effect of rising stages.

This retention, which represents the total retained water in the basin exclusive of the amount in stream channels, has been segregated to show the total abstractions, which include infiltration, vegetal

[17] Langbein, W. B., Some channel storage studies and their applications to the determination of infiltration: Am. Geophys. Union Trans., 1938, pp. 435–445.

interception, and rainfall required to wet ground surfaces and fill surface depressions and to show the temporary surface detention.

DISCUSSION OF RESULTS

AUGUST 1-5

Precipitation during the first period, August 1–5, as shown on figure 7, averaged 2.85 inches over the basin above Marietta. The rains during this period consisted of a series of scattered local showers, but the total was rather high; in the far eastern and southern parts of the basin the precipitation exceeded that of the major storm period of August 6–7. The maximum precipitation was 6.1 inches, at

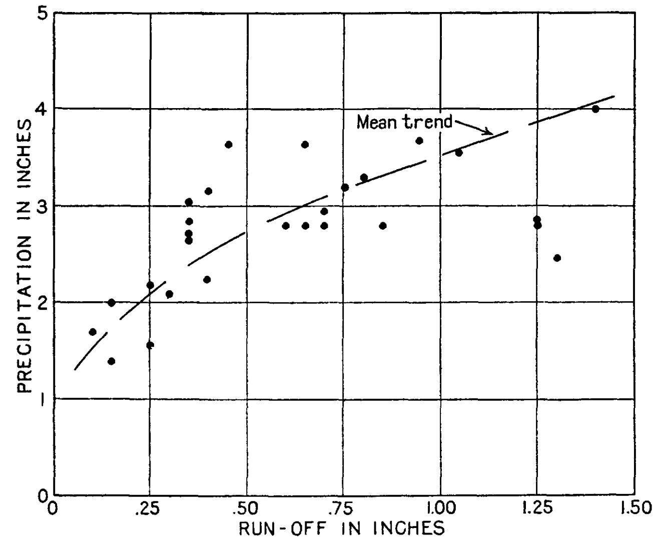


FIGURE 10.—Graphical comparison of rainfall and associated direct run-off, August 1-5, as given in table 11.

Marietta, at the mouth of the Muskingum River; the minimum, in the northwestern part of the basin, was 0.74 inch at Plymouth. The areal distribution in precipitation over the basin, as shown by figure 7, was very irregular. Plate 5 shows hourly rainfall at recording rain gages and also indicates the irregular and scattered nature of the summer rains of this period. At Akron, Zanesville, and Parkersburg, there were four separate and significant showers during this period; at Plymouth there were five; and at Columbus there was only one.

The direct run-off averaged 0.35 inch over the basin above McConnelsville. It ranged from 1.4 inches for Stillwater Creek above Piedmont, in the southeastern part of the basin, with 4 inches of rainfall, to 0.1 inch for Jerome Fork above Jeromeville, in the northwestern part of the basin, with 1.7 inches of rainfall.

Figure 10 is a graph showing rainfall during August 1–5 and corresponding run-off for the basins listed in table 11. A line has been drawn on the diagram to indicate the mean trend, although no definite relation of rainfall to run-off is indicated. There are, of course, other factors besides volume of precipitation that determine the volume of run-off; of these factors soil moisture and texture and rate of rainfall are most influential. Consequently to the extent that the base data and methods of analysis are adequate, wide departures from the mean trend would be indicative of corresponding variations in these factors. The diagram does not represent any one of the individual storms but rather, as pointed out previously, the total rainfall of a 5-day period of scattered showers. Moreover, the diagram does not take account of differences in soil types that may exist, although some basins are within the glaciated region and others are south of the moraine. Nevertheless, a general trend is shown, which may be of some significance. For example, it appears that about 1 inch of rainfall was essential to produce sensible run-off. Moreover, it is indicated that on the average an increase of rainfall from 3 inches to 4 inches doubled the volume of run-off.

The difference between rainfall and associated run-off averaged 2.35 inches over the basin above McConnelsville. Variations in the retention were principally related to variations in precipitation, indicating that the absorptive capacity of the soil had not been reached.

Except in the eastern part of the basin where rainfall exceeded 4 inches, the stream stages reached during this period were not outstanding. The peak discharge of McGuire Creek at Leesville on August 3 was slightly greater than that reached on August 7, and in adjoining basins the two flood peaks were also of comparable magnitudes. However, the major significance to be ascribed to the earlier storm period was its effect on the rainfall-run-off relations during the major storm period of August 6–7. The retention of 2.35 inches in the basin from the rains of August 1–5 (minus the losses due to evaporation and transpiration) reduced to some degree at least the capacity of the soil for absorbing the heavier rains of August 6–7.

Base flow, composed largely of effluent from ground-water storage, reflects to some degree the soil moisture conditions, although in those areas where the zone of aeration is deep, relations between the two might be very tenuous. Figure 11 shows a graph of daily mean discharge of Killbuck Creek at Killbuck for the period July 15 to August 31, on which the estimated base flow has been drawn. Attention should be directed toward the great increase in base flow that began on or about July 20 and culminated during the flood rise associated with the rains of August 6–7. A very considerable part of this rise took place during the period from July 31 to August 6.

AUGUST 6–8

The period August 6–8 included the outstanding storm of August 6–7, during which precipitation approached close to 12 inches in the central basin, as shown in plate 2. The average rainfall over the basin above Marietta was 4.1 inches, and the greatest mean precipitation over any basin whose run-off was measured was 6.3 inches—over Sugar Creek Basin above Strasburg. The rain during the storm of August 6–7, listed in table 11, practically all fell during 12 hours except in those areas in the northern part of the basin that received

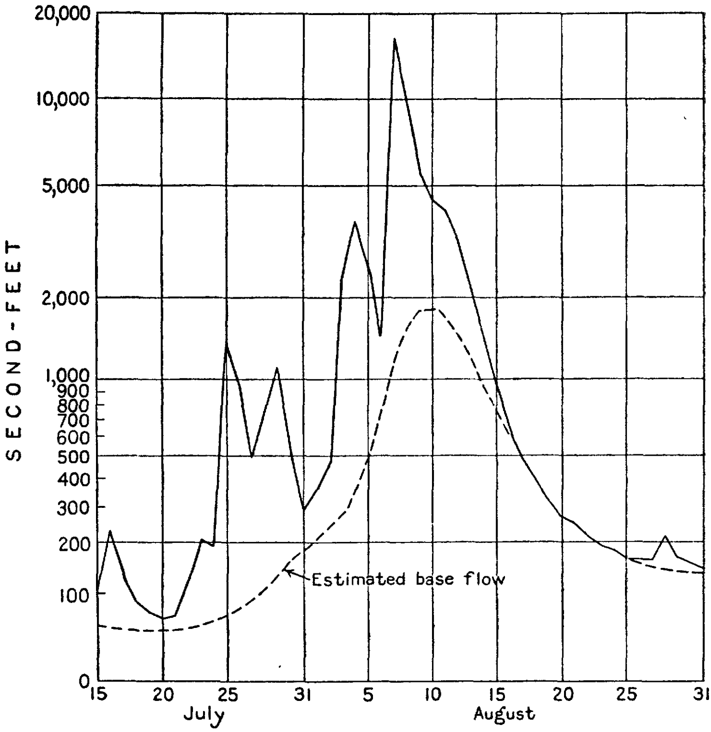


FIGURE 11.—Graph of daily mean discharge, Killbuck Creek at Killbuck, July 15 to August 31, showing estimated base flow.

average precipitation of about 0.1 to 0.5 inch during short showers on the afternoon of August 7 or August 8, which is included in the amounts listed in table 11. As indicated by table 3, the precipitation was not uniformly distributed during the 12-hour period. The precipitation during the hour of maximum rainfall ranged from 22 percent of the total, at Akron, to 57 percent, at Columbus, and the average shown by the recording stations within the basin was about 32 percent. The average hourly rate of precipitation may be taken as about 8 percent of the total precipitation as listed in table 11 and the maximum hourly rate as 32 percent of the total.

Run-off averaged 2.3 inches over the basin above McConnelsville and ranged from 1.2 inches over the basin of Black Fork above Loudonville to a maximum of 3.7 inches over the basin of Wills Creek above Birds Run. Figure 12 shows a graphical comparison of the run-off in relation to the corresponding rainfall for the basins listed in table 11. A line has been drawn on this diagram to indicate the mean trend of the rainfall-run-off relation. Generally during this storm the rates of rainfall were approximately proportional to

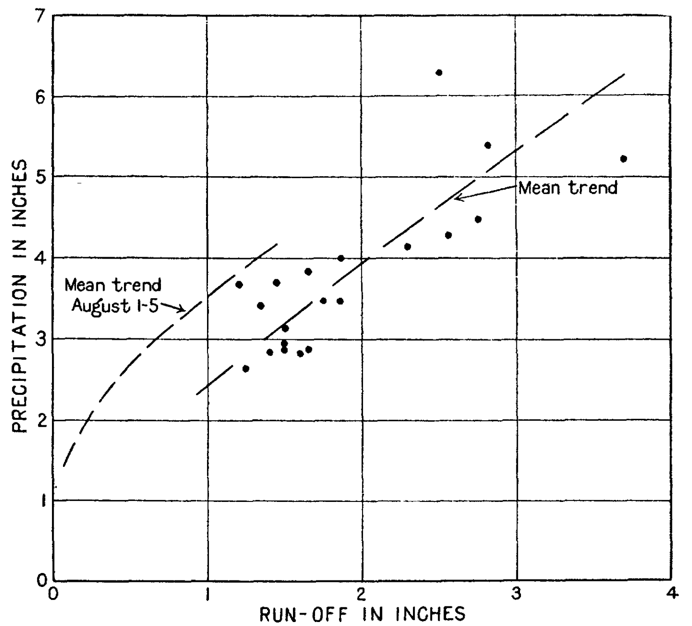


FIGURE 12.—Graphical comparison of rainfall and associated direct run-off, August 6–8, as given in table 11.

the amounts of rainfall, so that the variations in inherent basin and soil characteristics are the principal factors to which departure of the plotted points from the mean trend may be attributed. Some variations in rainfall and run-off relation may be due to the fact that antecedent rainfall was not the same over each basin. On figure 12 is also shown the mean rainfall-run-off trend during the period August 1–5, taken from figure 10.

Comparison of the trends of the two periods indicates that for 3 inches of rainfall, 0.7 inch more of run-off occurred during August 6–8 than during August 1–5. This difference may be ascribed to the influence of two factors: first, the effect of the 2-inch retention remaining in the basin after the rains of August 6–7, and second, the difference in distribution of the rains during the two periods. As already pointed out, the rains during the earlier period were a series of scattered showers that, although of considerable volume and intensity, provided

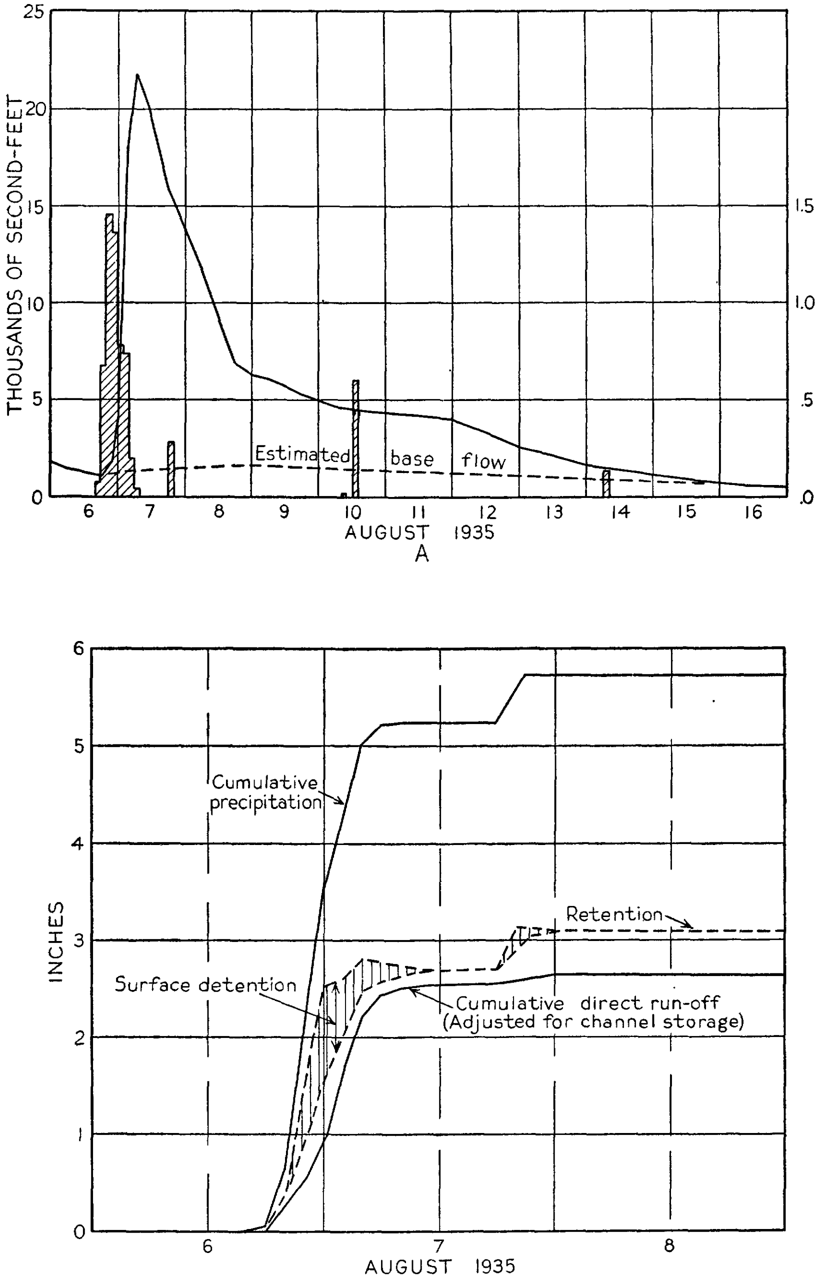


FIGURE 13.—Analysis of rainfall and run-off, Killbuck Creek Basin above Killbuck, August 6–8

opportunity for material abstraction through vegetal interception and intervening evaporation, whereas the precipitation during August 6–8 was almost entirely concentrated in one storm of about 12 hours' duration.

If the hydrologic conditions attending the storm of August 6–7 were such as to be represented by the trend line indicated in figure 10 for August 1–5 then the run-off for the period August 6–8 would be about 1.6 inches from the basin above McConnelsville instead of 2.3. Assuming similar distribution of run-off at McConnelsville the peak stage under the hypothetical conditions would be about 12 feet instead of 17.02 feet as actually recorded, a lowering of 5 feet.

On the basis of 12 hours of significant rainfall, the differences for this period listed in table 11 indicate average rates of absorption between 0.32 and 0.10 inch per hour with an average of 0.16 inch per hour (assuming no loss by evaporation, which may be material in midsummer).

Figures 13 to 15 furnish detailed analyses of rainfall and run-off of three selected areas in the upper Muskingum River Basin—namely Killbuck Creek above Killbuck, Nimishillen Creek above North Industry, and Sandy Creek above Sandyville.

Part *A* of each of these figures shows a discharge hydrograph for the period August 6–16 and rainfall in inches at 2-hour intervals August 6–10. Part *B* shows (1) the cumulative precipitation in inches, plotted at 2-hour intervals from the same data used to plot the graph in part *A*, (2) the cumulative direct run-off into the stream channels (direct run-off adjusted for changes in channel storage) also plotted at 2-hour intervals, (3) the retention, which is the difference between cumulative rainfall and cumulative run-off at corresponding time, and (4) the retention minus the depth of surface detention (the latter shown as a shaded area). The depth of surface detention was computed by the method described by Sherman.[18] The methods used to construct these diagrams have been outlined in the preceding section.

Attention is particularly directed to the shaded area designated "depth of surface detention."[19] The maximum depth of surface detention was 0.78 inch at Sandy Creek, 0.89 inch at Nimishillen Creek, and 0.96 inch at Killbuck Creek. In each basin the surface detention reached its maximum immediately after the period of most intensive rainfall and was nearly coincident with the maximum rate

[18] Sherman, L. K., Determination of infiltration-rates from surface run-off: Am. Geophys. Union Trans., 1938, pp. 430–435.

[19] Surface detention is defined as the equivalent depth of water remaining in the basin in temporary storage during a storm, which is effective in producing flow towards the stream channels but is at the same time being absorbed by the ground and receiving contributions from the continuing rainfall. The depth of surface detention may be said to determine the indefinite zone that exists during a storm between the direct run-off and the retention.

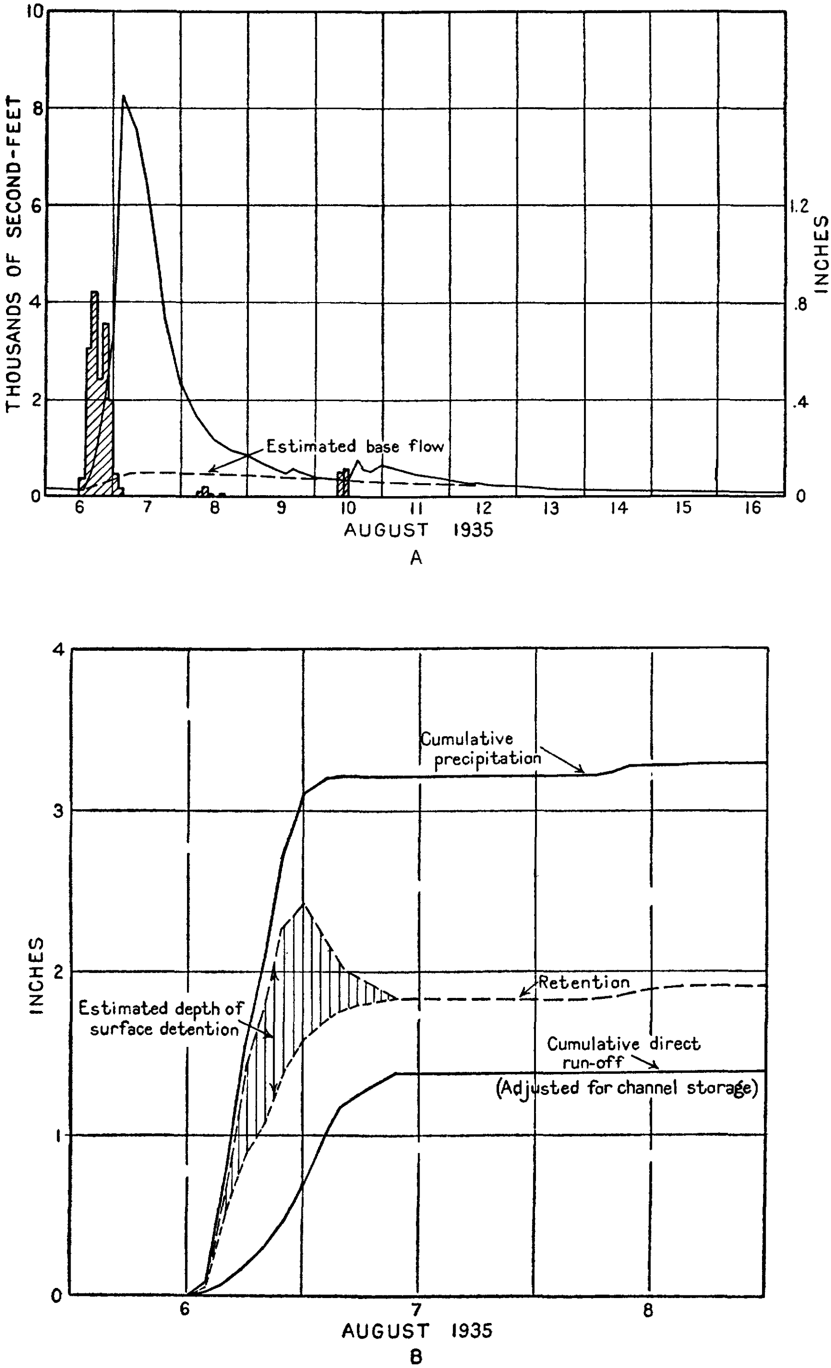
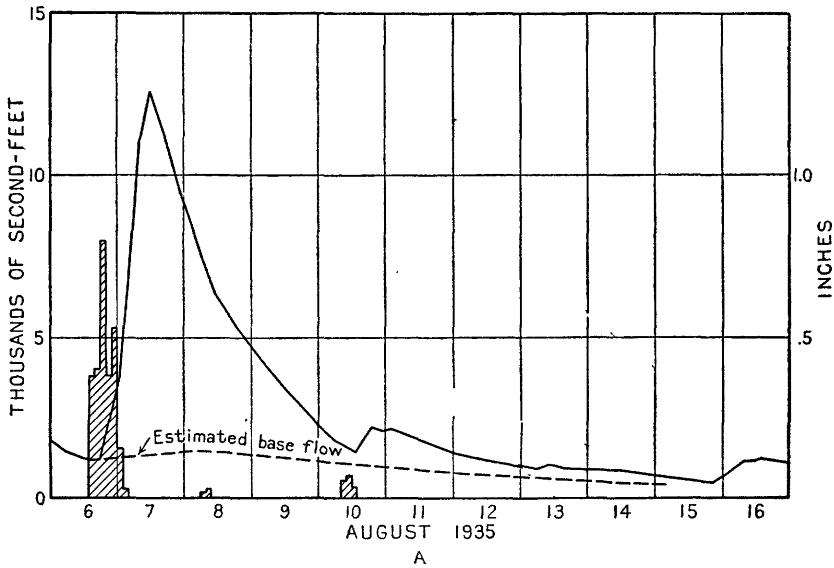


FIGURE 14.—Analysis of rainfall and run-off, Nimishillen Creek Basin above North Industry, August 6-8.



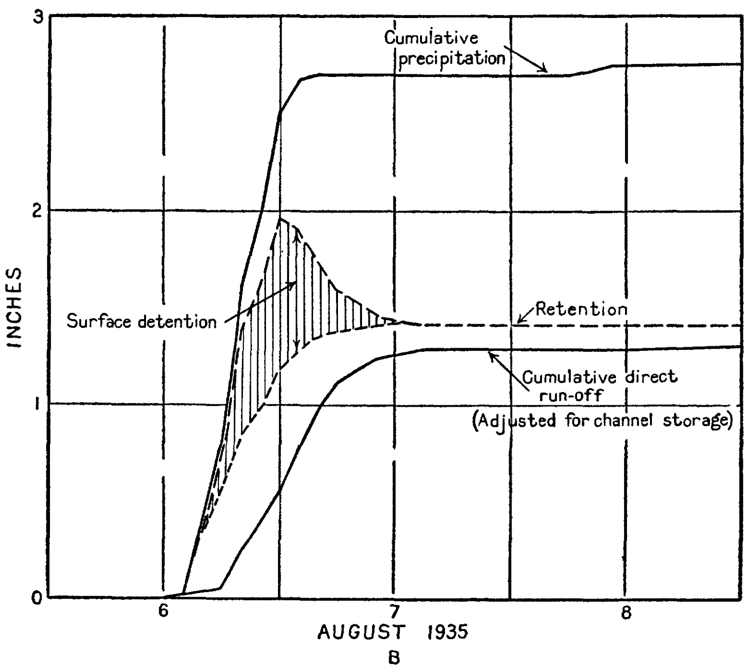


FIGURE 15.—Analysis of rainfall and run-off, Sandy Creek Basin above Sandyville, August 6–8.

of channel inflow. It was approximately proportional to the depth of rainfall and to the rate of channel inflow. These depths, approaching 1 inch, afford quantitative evidence of the large quantities of water accumulated in the basin and in transit to channels.

The abstractions from rainfall are principally due to interception by vegetation, water required to fill surface depressions prior to the commencement of surface run-off, absorption, and evaporation. The first two items may be classified under the heading of initial abstractions; they are largely ultimately disposed of by evaporation, although some of the depression storage infiltrates after cessation of rainfall. Estimates of the initial abstraction made from figures 13 to 15 indicate that a depth of rain of about 0.5 inch was required to produce run-off of 0.10 inch. Estimates of the initial abstraction made by this method are very susceptible to error from inaccurate relative timing of the rainfall and the run-off. Maximum rates of abstractions during the storm as determined from figures 13 to 15, which might be in part ascribed to infiltration, are listed below, together with maximum rates of areal precipitation and maximum rates of channel inflow.

Maximum rates of abstraction

Basin	Precipitation (inches per hour)	Channel inflow (inches per hour)	Infiltration (inches per hour)	Surface detention (depth in inches)
Killbuck Creek above Killbuck	0.72	0.35	0.31	0.96
Sandy Creek above Sandyville	.40	.12	.18	.78
Nimishillen Creek above North Industry	.42	.14	.23	.89

The above maxima were not necessarily coincident. Generally the maximum depth of surface detention preceded the maximum rate of channel inflow by 2 hours and the maximum rate of infiltration was generally associated with the period of maximum precipitation. The amounts of infiltration shown above are of value in an appraisal of the capacity of the soil to serve as an agency for the disposal of potential flood waters. During the winter storm of December 26, 1936, to January 25, 1937,[20] the infiltration capacity in the Muskingum River Basin did not exceed 0.09 inch per hour and generally averaged about 0.04 inch per hour, which is materially less than the results for the summer season as above presented.

The three selected basins whose rainfall and run-off were analyzed as described were not within the area of most intensive rainfall, and therefore they do not disclose behavior within that area. Unfortunately there are no continuous records of run-off or rainfall available for the area of most intensive rainfall that would permit detailed analysis.

[20] Floods of Ohio and Mississippi Rivers January-February 1937: U. S. Geol. Survey Water-Supply Paper 838, p. 540, 1938.

An important characteristic of flood run-off is the degree to which it is concentrated with respect to time. The concentration is usually evaluated in the form of a ratio between the flood discharge for a short interval of time and the flood discharge for a comparatively long interval of time. The last column of table 11 lists the ratio between the run-off during the maximum 24 hours and the total run-off associated with the rains of August 6–8. The factors of greatest influence on these concentration ratios are duration of storm, size of drainage area, channel characteristics, shape and slope of drainage basin, and direction of storm movement.

As the rains of August 6–8 largely occurred during the 12-hour storm of August 6–7, except in the areas in the northern part of the

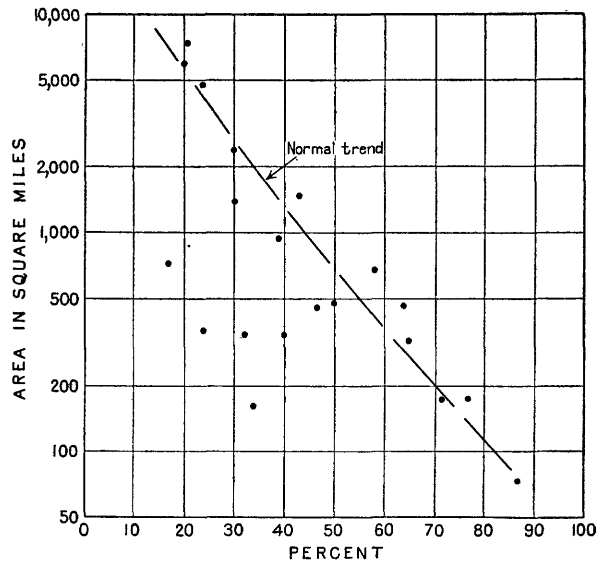


FIGURE 16.—Relation of ratio between maximum 24-hour run-off and total direct run-off associated with rains of August 6–8 to drainage area.

basin that were affected by scattered showers of August 7 and 8, the storm factors may be considered uniform, and variations in the concentration may be largely related to inherent basin characteristics outlined above.

Figure 16 shows a plot of the concentration ratio with drainage area, on which the mean trend has been indicated. Substantial variations from this trend can be attributed to variations in the factors as above outlined. Basin numbers 1, 15, 17, 21, 22, and 27 (see table 11), which plot to the left of the mean trend, are characteristically sluggish and contain comparatively large volumes of channel and valley storage and so have low concentration ratios. This characteristic will be treated at greater length in the succeeding section on channel-storage studies. Of the above basins, those numbered 1, 17, 21, and 22 are in the northern part of the Muskingum River Basin and may have been affected by the light rains of August 7–8, which would tend to decrease the concentration ratio as computed by the method described.

AUGUST 9–11

Precipitation during the period August 9–11 consisted largely of showers during the afternoon of August 10, as shown graphically on plate 5. There was an average rainfall of 0.7 inch over the basin above McConnelsville. This period is of very little importance with respect to the flood, except that in the lower basin the run-off pro-

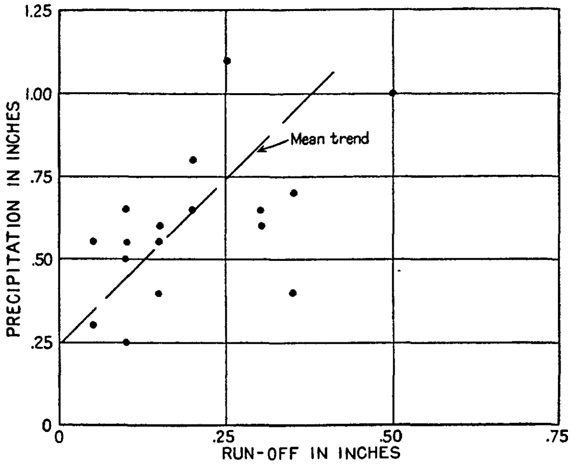


FIGURE 17.—Graphical comparison of rainfall and associated direct run-off, August 9–11, as given in table 11.

duced by the rainfall of August 10 tended to prolong the flood stages somewhat.

As shown by table 11, run-off associated with the rainfall of August 9–11 averaged 0.35 inch over the basin above McConnelsville and ranged between a maximum 0.50 inch over Salt Creek Basin above Chandlersville and a minimum of 0.05 inch over Indian Fork Basin above Atwood dam site. Figure 17 shows a comparison of the rainfall during this period with the associated run-off. The mean trend shown on this figure should be compared with that shown on figure 10 for the period August 1–5. Under the hydrologic conditions attending the rains of August 1–5 there would have been no run-off produced by the comparatively light rainfalls of August 9–11, so the run-off may be largely ascribed to the retention from the large antecedent rainfall during the period August 1–7.

CHANNEL STORAGE STUDIES

The study of the channel phase of flood run-off is one of the important uses to which continuous records of stream discharge may be put. The value and significance of the channel system and adjacent flood plains as a reservoir for the temporary storage and eventual discharge of flood water and the effect of such storage on flood-crest discharge has been discussed in an earlier report describing the floods of January 1937 in the Ohio River Basin.[21]

The quantitative evaluation of the channel storage provides a convenient method for detailed analyses of the concentration of flood water with respect to time, the combination of flow from several tributaries into the major streams, and the routing of such flood waters through the channel system to the mouth or point of outflow.

In flood-routing procedure involving computations of nonsteady flow through river channels, there is great need for the development of relations between the volume of storage in partial basin areas or in specific river reaches and the rate of discharge from such storage. Moreover channel storage tends to obscure the evidence of all but the most general relations between storm precipitation and the resulting run-off, and in studies of rainfall and run-off the adjustment of the observed flow for the effects of such storage is necessary to derive hydrographs of inflow into stream channels free of the modifying influences of storage. The volume of channel storage in terms of discharge may be derived through topographic surveys of the river channels together with observations of water height throughout the channel system, which in large areas would require considerable time and expense, or it may be conveniently derived through analyses of records of flood discharge.[22]

In partial recognition of their general use and for specific use as comparative measures of basin characteristics, several relations between channel storage[23] and the rates of discharge have been derived for several drainage areas in the Muskingum River Basin using methods described by Horton [24] and Langbein.[25] These methods consist essentially of analyses of the recession limbs of flood hydrographs on the assumption that the steeper portion of the recession limb represents drainage of surface water run-off that remains as storage in the channel system after the cessation of rainfall. Table 12 lists the volume

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[21] Floods of Ohio and Mississippi Rivers, January-February 1937: U. S. Geol. Survey Water-Supply Paper 838, pp. 594-605, 1938.

[22] McCarthy, G. T., The unit hydrograph and flood routing, unpublished manuscript presented at Conference of North Atlantic Division, Corps of Engineers, U. S. Army, June 24, 1938.

[23] The term " channel storage" in this report includes the volume of water in defined stream channels, however small, as well as that on the adjacent flood plains: it is synonymous in this sense with "valley storage."

[24] Horton, R. E., Natural stream channel storage: Am. Geophys. Union Trans., 1936, pp. 406-415.

[25] Langbein, W. B., Some channel storage studies and their application to the determination of infiltration: Am. Geophys. Union Trans., 1938, pp. 435-447.

of channel storage so computed at rates of flow of 1, 5, and 10 second-feet per square mile above selected gaging stations in the Muskingum River Basin. Figure 18 shows these volumes in relation to the

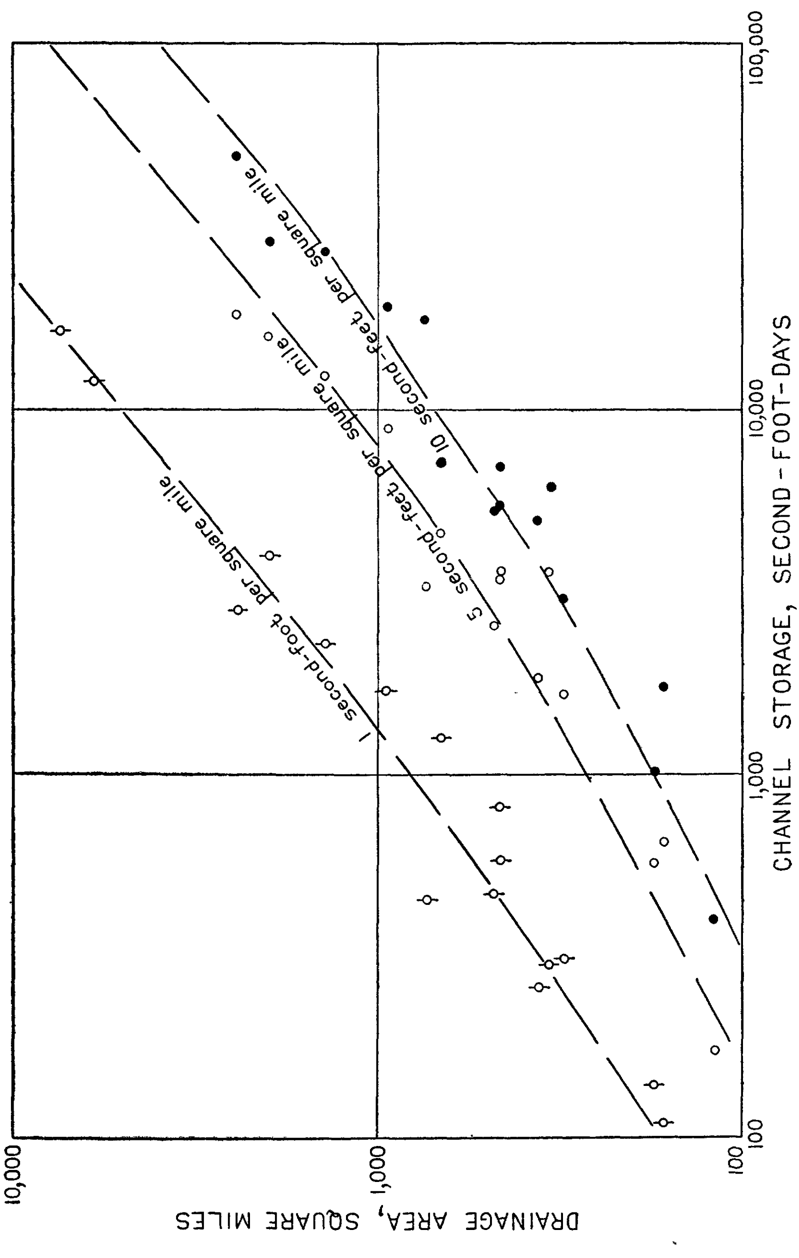

FIGURE 18.—Channel storage at indicated rates of discharge in relation to drainage area above gaging stations in the Muskingum River Basin.

drainage area. The lines of mean trend in figure 18 corresponding to rates of flow of 1, 5, and 10 second-feet per square mile are for comparative purposes only. It may be noted that the larger drainage areas contain a larger volume of storage per unit of area than the smaller areas. Of the basins studied it appears that on the basis of storage at 10 second-feet per square mile those numbered 1, 15, 17, and 27 had more than average storage volume. They are among the basins indicated in the section on "Rainfall and run-off studies" as being sluggish on the basis of comparison of the concentration ratio. Comparison of the mean trend with similar studies of the Wabash River Basin [26] indicates that within the limits and scope of these studies the storage volume tends to be proportional to the size of the drainage areas.

TABLE 12.—*Channel storage in selected drainage areas in Muskingum River Basin at indicated rates of flow*

No. on map (fig. 8)	Basin	Drainage area (square miles)	Channel storage, in second-foot-days, at indicated discharge rates per square mile		
			1 second-foot	5 second-feet	10 second-feet
1	Tuscarawas River at Clinton	165	110	650	1, 750
2	Tuscarawas River near Dover	1, 398	2, 300	12, 400	26, 800
3	Tuscarawas River at Newcomerstown	2, 432	2, 880	18, 500	49, 500
5	Muskingum River at Dresden	5, 982	12, 000	72, 000	175, 000
6	Muskingum River at McConnelsville	7, 411	16, 500	88, 000	205, 000
7	Sandy Creek at Sandyville	481	460	2, 580	5, 370
8	Nimishillen Creek at North Industry	175	140	570	1, 030
12	Sugar Creek at Strasburg	310	310	1, 550	3, 000
15	Stillwater Creek at Uhrichsville	367	260	1, 840	4, 950
17	Black Fork at Loudonville	342	350	3, 610	6, 180
18	Mohican River at Greer	942	1, 600	8, 450	17, 000
19	Walhonding River at Pomerene	1, 488	4, 000	16, 000	29, 000
21	Jerome Fork at Jeromeville	120	40	175	400
23	Kokosing River near Millwood	472	820	3, 400	5, 200
24	Killbuck Creek at Killbuck	466	580	3, 400	7, 000
27	Wills Creek at Birds Run	730	450	3, 300	17, 750
28	Licking River at Toboso	672	1, 270	4, 630	7, 150

Jarvis [27] presents data to show that maximum rates of flow of record in the Muskingum and Wabash River Basins in relation to drainage area as expressed in terms of the Myers scale do not appear to approach the peak rates of flow from outstanding floods in other regions. This may be due to lack of comparable rainfall or other climatic factors or the differences in basin characteristics. It is believed that in the comparison of peak rates of flow of different streams, differences in channel storage are important factors that warrant consideration. With equivalent volumes of run-off, the lower rates of discharge will be associated with those basins that possess the greater volumes of channel and flood-plain storage. Plate 3 shows two typical flood plains in the Muskingum River Basin during the flood.

As shown in figure 5, during August 8 the smaller streams in the Muskingum River Basin had begun to recede, and by midnight the

[26] Langbein, W. B., op. cit., pp. 435–447.

[27] Jarvis, C. S., in Low dams—a manual of design for small water storage projects, p. 32, Water Resources Comm. of Nat. Resources Comm., 1939.

greater part of the flood waters was in the larger streams. The crest at McConnelsville was not reached until noon of August 9. By methods described in Water-Supply Paper 838, it has been computed that the total volume of storage of direct run-off in the channels and on the flood plains above McConnelsville reached a maximum of about 31,500,000,000 cubic feet at about midnight of August 8. This volume is equivalent to about 1.83 inches over the basin above

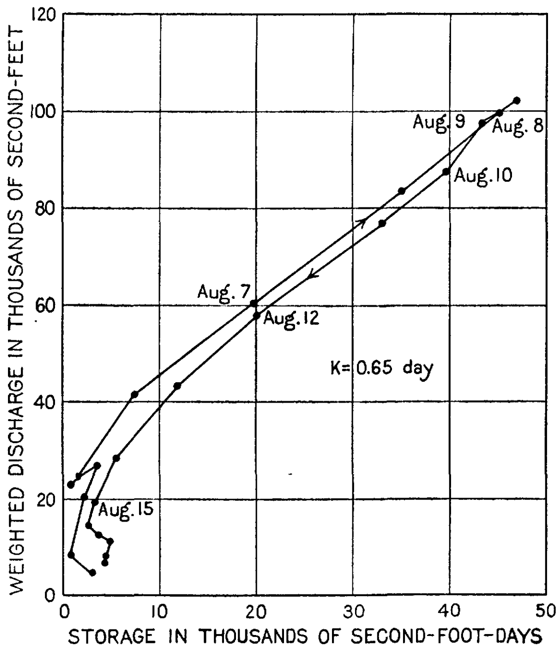

FIGURE 19.—Storage in Muskingum River between Dresden and McConnelsville in relation to discharge.

McConnelsville or about 80 percent of the total direct run-off from the flood.

The increase in valley storage during August 7 and 8 was equivalent to an average of 180,000 second-feet or 1.7 times the peak discharge at McConnelsville. These results afford some indication of the volume of valley storage available in the Muskingum River Basin and of its significance with respect to flood discharge.

In flood-routing problems, relations between the volume of storage in specific river reaches and the rate of discharge are useful. Figure 19 shows such a relation for the Muskingum River between Dresden and McConnelsville as developed from flood records at these two places by methods explained by McCarthy.[28] This method consists essentially of the preparation of tabulations of cumulative differences at selected intervals of time—generally daily, but twice daily during

[28] McCarthy, G. T., op. cit.

times of rapid changes in discharge—from August 1 to August 20 between the sums of the measured or estimated run-off into the reach and the measured outflow. The cumulative differences are equal to the water stored or released in the given reach from the beginning of the tabulation to the end of each selected interval. These amounts of storage were plotted as in figure 19 against the corresponding weighted mean discharge at the end of each selected interval. The weighted mean discharge was determined by assigning estimated weights of 75 percent to the discharge at the lower station and 25 percent to the discharge at the upper station. The upper part of this discharge-storage relation approaches a straight line whose slope (change in storage divided by corresponding change in discharge) is designated by the letter K. A similar relation was found for other selected reaches in the Muskingum River Basin. Values of K for such reaches in the Muskingum River Basin computed on the basis of flood records of August 1935 and January 1937 are listed in table 13 together with the volume of storage in the indicated reaches at a rate of flow of 10 second-feet per square mile of drainage area. The length of a reach, L, when divided by the value of K for the corresponding reach yields a quotient, $\frac{L}{K}$, which equals the ratio between an increase in discharge and the corresponding increase in channel cross-sectional area and is comparable with the velocity of flood movement in Seddon's formula.[29] The significance of wave velocity in river hydraulics is discussed in detail by Thomas,[30] who describes its usefulness in appraising the hydraulic properties of river channels, in evaluating the effects of changing stage on the stage-discharge relation, and in flood routing.[31] The values of K in days as derived above and listed in table 13 are equal to the ratios between storage and discharge under conditions prevailing during actual floods in the indicated river reaches. Insofar as these conditions approach those of uniformly progressive flow in which no modifications of flood-wave shape are produced by intervening tributaries or by other factors, such values of K are equivalent to the time of travel of a flood wave from the upper end to the lower end of the indicated reaches. These values of K should be compared with the actual times of crest discharge as discussed in the section "General features of the flood," where there is also described the relative effects of tributary inflow and normal wave motion on flood-crest timing during the flood of August 1935.

[29] Seddon, J. A., River hydraulics: Am. Soc. Civil Eng. Trans., vol. 43, p. 179, 1900.

[30] Thomas, H. A., The hydraulics of flood movements in rivers: Carnegie Inst. Technology, pp. 17-38, 1934 [reissued 1937].

[31] Jones, B. E., A method for correcting river discharge for a changing stage: U. S. Geol. Survey Water-Supply Paper 375, pp. 117-130, 1916.

TABLE 13.—*Summary of channel storage characteristics of selected river reaches in Muskingum River Basin*

River	Reach	Length (miles)	Storage at 10 second-feet per square mile (second-foot-days)	K (days)	L/K (miles per day)
Tuscarawas River	Dover to Newcomerstown	38.0	21,500	1.11	34
Do	Newcomerstown to Coshocton	[1] 21.2	20,000	.48	44
Muskingum River	Coshocton to Dresden	19.0	44,000	.81	22.5
Do	Dresden to McConnelsville	42.4	26,000	.64	66
Mohican River	Greer to Pomerene	[2] 15.2	3,300	.275	55

[1] Weighted average of distance from Newcomerstown to Coshocton along Tuscarawas River and from Pomerene to Coshocton along Walhonding River. Weights based on total flow through Tuscarawas and Walhonding Rivers during flood period.
[2] Weighted average of distance from Greer to Pomerene along Mohican River and from Millwood to Pomerene along Kokosing and Mohican Rivers. Weights equal to total flow through Mohican and Kokosing Rivers during flood period.

FLOOD CREST STAGES

During and immediately after the flood of August 1935 various agencies, principally the Corps of Engineers, United States Army, and the Muskingum Watershed Conservancy District, began to identify and mark crest stages reached by the rivers in the flood area. Field parties were dispatched to obtain comprehensive and systematic information with respect to these floodmarks and to refer them to mean sea level datum. Their relative positions were identified by distances from the mouths of the respective rivers.

Table 14 presents records of flood crest stages for the major river systems in the region covered by this report. These records are of special interest in planning future developments along the rivers. However, these crest stages were generally exceeded by those of the flood of March 1913.

TABLE 14.—*Flood crest stages, August 1935*

Stream and location	Miles above mouth	Date and time	Altitude (feet)
Tuscarawas River:			
U. S. Highway 224, 300 feet southeast of Pennsylvania and Baltimore & Ohio R. R. crossing.	111.6	Aug. 8	963.70
Barberton, Snyder Ave. bridge, downstream from right abutment.	108.8	do	961.17
Clinton, Geological Survey gaging station	102.0	Aug. 8, 3 p. m.	948.10
Canal Fulton, bridge on State Route 93, downstream from right abutment.	97.8	Aug. 8	945.25
Crystal Springs, highway bridge, telephone pole on upstream side.	92.4	do	940.50
Massillon, northeast corner of Cherry Rd. and 1st St., NW.	88.8	do	936.03
Massillon, 50 feet upstream from 3d St. Bridge, left bank.	88.2	do	935.56
Massillon, 50 feet downstream from 3d St. Bridge, left bank.	88.2	do	935.16
Navarre, above West Lebannon Bridge, right bank	82.5		932.31
Navarre, bridge on U. S. Highway 21, downstream side of left abutment.	81.7		919.88
Bolivar, 1.3 miles west of, 40 feet downstream from bridge abutment, left bank.	75.5		906.10
Zoar, ½ mile southeast of, on Ohio Power Co. power house	66.2	Aug. 8, 10 a. m.	890.56
Zoarville, near, on upstream left wing wall of bridge on State Highway 8.	63.0		884.68

See footnotes at end of table.

TABLE 14.—*Flood crest stages, August 1935*—Continued

Stream and location	Miles above mouth	Date and time	Altitude (feet)
Tuscarawas River—Continued.			
Dover, near, at Geological Survey gaging station, left bank	58.9	Aug. 8, 5 a. m	876.77
Dover, step at 124 Broadway	56.2		873.84
New Philadelphia, at waterworks	52.8	Aug. 8, 3 a. m	865.39
Biedler, Baltimore & Ohio R. R. trestle over Tuscarawas River.	48.0	Aug. 8	852.34
Tuscarawas, southeast corner of Cherry St. and East Ave.	42.4	do	840.47
Clay Township, at mouth of Frys Creek	37.6	do	832.68
Clay Township, near Pennsylvania R. R. opposite Belden Brick Co. plant	33.1	Aug. 8, 10 p. m	822.70
Newcomerstown, Geological Survey gaging station	22.6	Aug. 9, 6 a. m	801.28
West Lafayette, 1 mile north of, upper side of highway bridge.	10.7	Aug. 8	774.4
Coshocton, U. S. Weather Bureau gage	0	Aug. 8, 5 a. m	758.17
Muskingum River:			
Conesville Station, stake above Wheeling & Lake Erie Ry., right bank.	102.5	Aug. 8	740.78
Muskingum-Coshocton County line road, right bank	97.4	do	732.47
Trinway, about ½ mile above, at intersection of State Routes 77 and 16.	93.7	do	728.12
Dresden, near, at Geological Survey gaging station	91.5	Aug. 9, 2 a. m	724.75
Ellis, Lock 11, upper gage	84.3	do	715.5
Zanesville, lock 10, upper gage	75.9	do	702.6
Duncan Falls, ¾ mile above, at bridge across Miller Run, left bank.	68.1		691.25
Philo, Lock 9, upper gage	67.05	Aug. 9, 6 a. m	690.1
Gaysport, at Gaysport Bridge, 100 feet to right of State Route 77.	62.2		684.97
Rokeby, Lock 8, upper gage	56.2	Aug. 9, 9 a. m	675.55
Morgan Township, 200 feet north of Salt Run, left bank	50.7	Aug. 9	669.88
McConnelsville, at waterworks, left bank	49.3	do	668.27
McConnelsville, Geological Survey gaging station	48.6	Aug. 9, noon	667.33
Stockport, Lock 6, upper gage	39.3	Aug. 9, 2 p. m	654.2
Luke Chute, Lock 5, from high-water marks	33.5	Aug 9, 3 p. m	644.74
Beverly, Lock 4, upper gage	24.7	Aug. 9, 8 p. m	633.1
Adams Township, culvert over Coal Run, left bank	18.6		625.25
Lowell, Lock 3, upper gage	14.1	Aug. 10, 2 a. m	618.7
Muskingum Township, at mouth of March Run, left bank	9.6		613.19
Devol, Lock 2, upper gage	5.9	Aug. 10, 6 a. m	607.4
Marietta, Lock 1, upper gage	.4	Aug. 8, 10 a. m	596.1
Sandy Creek:			
East Rochester, about 50 feet upstream from bridge, right bank.	32.3	Aug. 7	1,085.97
Minerva, about 50 feet upstream from bridge, left bank	27.6	do	1,041.81
Malvern, 100 feet upstream from bridge on State Route 80, right bank.	21.6	do	992.20
Waynesburg, about 1 mile northeast of, 100 feet upstream from bridge on State Highways 43 and 80.	17.6	do	966.55
Magnolia, 300 feet upstream from bridge on State Route 80.	13.7	do	949.6
Sandyville, Geological Survey gaging station	7.3	Aug. 7, 11:30 a. m	927.09
Bolivar Dam, Corps of Engineers, U. S. Army, gage	.9	Aug. 7, 4 p. m	902.20
Nimishillen Creek:			
Canton, about 8 feet upstream from Middle Bridge	17.0	Aug. 7	1,045.28
Canton, under bridge on 4th St., SE	14.3	do	1,026.41
Canton, under west end of Mill Rd. Bridge	11.7	do	1,000.82
North Industry, bridge over Nimishillen Creek	9.3	do	988.0
North Industry, 0.65 mile south of, at Geological Survey gaging station.	8.3	Aug. 7, 4 a. m	980.28
Junction of Highway 8 and Magnolia Road	3.6	Aug. 7	953.27
East Sparta, 1.2 miles south of, at Ohio Power Co. substation.	1.7	do	937.45
Sandyville Station, 30 feet west of bridge over Nimishillen Creek.	.6	do	931.55
Sugar Creek:			
Orrville-Wooster road, 200 feet downstream from bridge	36.5		1,022.20
McQuaid, 1,000 feet east of, on bridge on U. S. Highway 30, on southeast wing wall.	30.8	Aug. 7	1,007.71
Dalton, 3 miles south of, Wheeling & Lake Erie Ry. bridge, on east end.	26.5	do	993.15
Brewster, Wheeling & Lake Erie Ry. yards, northwest end.	22.9	do	981.35
Junction of Baltimore & Ohio R. R. and Wheeling & Lake Erie Ry.	17.2	do	968.82
Beach City, 500 feet north of Baltimore & Ohio R. R. station.	14.2	do	963.29
Beach City Dam, Corps of Engineers, U. S. Army, gage	11.8	Aug. 7, 3:30 p. m	942.46
Strasburg, near, at Geological Survey gaging station	7.0	Aug. 7, 2–4 p. m	910.94
Dover, Baltimore & Ohio R. R. yards, on pump house	1.4	Aug. 7	877.04

See footnotes at end of table.

TABLE 14.—*Flood crest stages, August 1935*—Continued

Stream and location	Miles above mouth	Date and time	Altitude (feet)
Stillwater Creek:			
Kirkwood Township, highway bridge in the SW¼ sec. 11, T. 9, R. 6.	51.6		916.83
Flushing Township, highway bridge across Sixmile Run, sec. 13, T. 10, R. 6.	48.3		907.44
Moorefield Township, 500 feet above highway bridge in the NE¼ sec. 34, T. 10, R. 6, Corps of Engineers, U. S. Army gage.	40.9	Aug. 7	888.15
Freeport, in office on Philadelphia St.	35.0	do	881.21
Washington Township, Baltimore & Ohio R. R. bridge in sec. 15, T. 12, R. 7.	29.2	Aug. 8, 10 a. m.	874.77
Tippecanoe, ¼ mile northwest of Baltimore & Ohio R. R. bridge.	24.9	Aug. 8, 10:30 a. m.	867.5
Rush Township, Baltimore & Ohio R. R. bridge in the SW¼ sec. 25, T. 13, R. 7.	20.5	Aug. 8	861.69
Mill Township, near Baltimore & Ohio R. R. and State Route 8 in the SE¼ sec. 27, T. 13, R. 7.	16.4	do	858.9
Mill Township, Baltimore & Ohio R. R. bridge in the SE¼ sec. 1, T. 6, R. 1.	9.9	Aug. 9	955.31
Uhrichville, 1 mile south of, Geological Survey staff gage at Dennison Water Supply Co.	7.08	Aug. 8–9, 8 p. m. to 4 a. m.	853.57
Urichsville, on Pennsylvania R. R. bridge	4.81	Aug. 9	852.0
Mill Township, at Pennsylvania R. R. bridge	.7	Aug. 8	848.3
Black Fork:			
Franklin Township, at bridge in the NW¼ sec. 10, T. 22, R. 18.	36.6	Aug. 6	1,021.1
Weller Township, bridge in the NW¼ sec. 20, T. 24, R. 17, on left downstream abutment.	30.1	do	1,010.24
Mifflin Township, bridge in south-central part of sec. 3, T. 23, R. 17, on right downstream abutment.	24.2	do	1,003.90
Mifflin Township, below highway bridge in the SE¼ sec. 35, T. 23, R. 17, right bank.	17.9		987.64
Monroe Township, above Pennsylvania R. R. bridge in the SE¼ sec. 11, T. 22, R. 17, left bank.	14.4		986.40
Green Township, highway bridge in the SW¼ sec. 29, T. 20, R. 16, on downstream side, left bank.	8.2		961.27
Loudonville, Geological Survey gaging station	2.6	Aug. 7, 6 a. m.	940.75
Hanover Township, Pennsylvania R. R. bridge in the NE¼ sec. 11, T. 19, R. 16, lower side, right bank.	1.1		935.06
Mohican River:			
Hanover Township, just below Black Fork, left bank	27.7	Aug. 7	931.38
Knox Township, just above highway bridge in the SW¼ sec. 20, T. 19, R. 15.	22.5		908.18
Greer, Geological Survey gaging station	16.3	Aug. 7, 12:30 p. m.	886.54
Union Township, 100 feet below dam in the NW¼ sec. 21, T. 8 N., R. 10 W., right bank.	11.6	Aug. 7	869.21
Tiverton Township, 400 feet above highway bridge in third quarter.	6.6	do	853.91
Newcastle Township, right bank, 400 feet above bridge on U. S. Highway 36.	.5	do	835.48
Walhonding River:			
Walhonding, 1 mile west of, on tree	23.2	do	835.41
Walhonding, 1 mile east of, on post west of abutment of Pennsylvania R. R. bridge.	20.7		825.83
Pomerene, Geological Survey gaging station	19.4	Aug. 7, 9 p. m.	821.50
Nellie, highway bridge, on northwest wing wall	15.6	Aug. 7	810.58
Warsaw, highway bridge, near north abutment	11.3	do	793.38
Roscoe, 2.9 miles west of, on upstream wing wall of bridge, left bank.	4.6	Aug. 8	766.50
Roscoe, 200 feet upstream from highway bridge, right bank	.3	do	757.60
Clear Fork:			
Worthington Township, in the SW¼ sec. 17, T. 21, R. 17	15.1	Aug. 7	1,066.52
Worthington Township, highway bridge in the SW¼ sec. 16, T. 21, R. 17, upper side.	13.8	do	1,052.19
Newville, Geological Survey gaging station	10.6	Aug. 7, 7 a. m.	1,027.60
Monroe Township, near Alfred W. Darling buildings in the SE¼ sec. 36.	7.9	Aug. 7	1,001.51
Pleasant Hill Dam, Corps of Engineers, U. S. Army, upper gage.	5.5	Aug. 7, 8 a. m.	980.14
Pleasant Hill Dam, Corps of Engineers, U. S. Army gage	5.0	do	974.20
Hanover Township, southeast corner of sec. 8, T. 19, R. 16, right bank.	3.2	Aug. 7	962.21
Hanover Township, left bank, just above bridge on State Route 3 in the NE¼ sec. 15, T. 19, R. 16.	.4	do	934.57
Jerome Fork:			
Montgomery Township, in the NW¼ sec. 23, T. 22, R. 16	10.8	do	972.38
Montgomery Township, at small steel truss bridge on county road in the SE¼ sec. 25, T. 22, R. 16.	8.3	do	966.13
Jeromeville, Geological Survey gaging station, from high-water mark.	6.0	Aug. 7, about midnight.	960.5

See footnotes at end of table.

TABLE 14.—*Flood crest stages, August 1935*—Continued

Stream and location	Miles above mouth	Date and time	Altitude (feet)
Jerome Fork—Continued.			
Jeromeville, about 4 miles southeast of, near center of sec. 15, T. 21, R. 15.	2.9	Aug. 7	949.7
Mohican Township, at bridge near center of sec. 26, T. 21, R. 15.	.2	Aug. 8	946.3
Lake Fork:			
Mohican Township, at bridge in east-central part of sec. 34, T. 21, R. 15.	12.7	do	942.9
Mohicanville Dam, 1,500 feet upstream from, Corps of Engineers, U. S. Army, gage.	12.5	Aug. 8, 1:30 p. m	942.3
Mohicanville Dam, 1,500 feet downstream from, Corps of Engineers, U. S. Army, gage.	11.9	do	941.2
Washington Township, at Pennsylvania R. R. bridge	6.4	Aug. 7	925.96
Loudonville, near, Geological Survey gaging station, from high-water mark.	1.9	Aug. 7, 11 a. m	916.78
Kokosing River:			
Howard, near Pennsylvania R. R. station	11.8	Aug. 7	[1] 898.43
Union Township, 80 feet north of railroad on Wm. W. Whitney property.	8.3	do	[2] 875.57
Millwood, 2½ miles southeast of, at Geological Survey gaging station.	5.3	Aug. 7, 1 p. m	[3] 856.59
Butler Township, on H. C. Young property	3.2	Aug. 7	[4] 844.78
Newcastle Township, near corner of John and Minerva Walters residence.	2.0	do	[5] 838.41
Killbuck Creek:			
Wooster, west of, on north side of U. S. Highway 30, 300 feet east of Killbuck Creek in southeast corner of sec. 6, T. 15, R. 13.	48.6	do	857.5
Wooster Township, on Highway 3, in the SW¼ sec. 9, T. 15, R. 13.	47.0	do	856.1
Wooster, south of, west of road, near Blue Knob, near line between secs. 21 and 28, T. 15, R. 13.	45.2	do	846.3
Prairie Township, 200 feet north of road near northwest corner of sec. 28, T. 13, R. 14.	37.2	do	838.8
Holmesville, west of, 150 feet east of bridge near southeast corner of sec. 4, Prairie Township.	34.1	do	836.4
Millersburg, 1½ miles north of, west side of road near point at which railroad and highway are nearest.	29.9	do	825.0
Millersburg, south of, west of State Highway 76, near northeast corner of the NW¼ sec. 2, Mechanic Township.	25.9	do	815.1
Killbuck, northwest corner of railroad depot in	21.6	do	811.4
Killbuck, Geological Survey gaging station		Aug. 7, 7 a. m	809.82
Killbuck Township, road near center of sec. 16, right side, T. 8 N., R. 7 W.	19.4	Aug. 7	806.3
Clark Township, 300 feet south of bridge across Doughty Run, west side of road.	13.7	do	800.0
Clark Township, north side of road in the SW¼ sec. 18, T. 7 N., R. 7 W.	11.2	do	798.0
Bethlehem Township, between railroad crossing and creek, southeast of road.	4.3	do	790.2
Mill Creek:			
Mound, 4.9 miles upstream from, 150 feet north of bridge, west side of road.	15.0	do	920.29
Mound, 3.75 miles from, 100 feet north of creek	13.8	do	886.66
Mound, 2.5 miles north of	12.6	do	863.41
Mound, 1.5 miles north of	11.5	do	845.84
Mound, bridge in, northwest corner of	9.9	do	820.93
Little Mill Creek, 1.0 mile north of mouth of	8.8	do	811.49
Little Mill Creek, 0.4 mile upstream from mouth of	8.2	do	801.53
Mill Creek Rd., east of, 0.4 mile north of State Highway 76	7.2	do	796.96
Lake Park, 4.9 miles north of, 250 feet north of iron bridge on highway.	5.9	do	790.80
Lake Park, 3.8 miles north of, 400 feet south of road leading to iron bridge.	4.7	do	781.60
Lake Park, 2.2 miles north of	2.8	do	773.18
Lake Park, 0.9 mile north of	1.0	do	758.96
Lake Park, 0.2 mile north of	.3	do	761.08
Beards Run:			
Mill Creek Township House, 50 feet upstream from concrete bridge.	1.3	do	862.32
Little Mill Creek:			
Crawford Township, upstream from road southeast of center of sec. 15, T. 7 N., R. 5 W., left bank.	5.4	do	975.97
Crawford Township, below bridge in NW¼ sec. 16, T. 7 N., R. 5 W., left bank.	4.6	do	927.53
Mill Creek Township, below bridge in SE¼ sec. 20, T. 7 N., R. 6 W., right bank.	3.9	do	894.79
Mill Creek Township, below bridge west of center of sec. 21, T. 7 N., R. 6 W., left bank.	2.8	do	856.83

See footnotes at end of table.

TABLE 14.—*Flood crest stages, August 1935*—Continued

Stream and location	Miles above mouth	Date and time	Altitude (feet)
Little Mill Creek—Continued.			
Keene Township, northeast of bridge over Little Mill Creek in NE¼ sec. 2, T. 6 N., R. 6 W.	1.8	do	832.97
Keene Township, above bridge near southeast corner of sec. 3, in sec. 2, T. 6 N., R. 6 W., right bank.	1.3	do	823.15
Keene Township, above bridge near southeast corner of sec. 3, T. 6 N., R. 6 W.	.8	do	810.54
Turkey Run:			
Lake Park, 8.7 miles upstream from	3.1	do	897.74
Lake Park, 7.8 miles upstream from	2.0	do	855.01
Lake Park, 6.7 miles north of, east of State Highway 76	1.0	do	808.64
Spoon Creek:			
State Highway 76, 3.4 miles east of	2.7	do	814.28
State Highway 76, ½ mile east of, above iron bridge 200 feet east of large red barn.	.6	do	774.24
Wills Creek:			
On U. S. Highway 21, 400 feet from Baltimore & Ohio R. R.	78.9	Aug. 8	804.70
Byesville, ¼ mile south of, on State Highway 21	71.8	do	800.67
Chapman Run, at railway spur	65.6	do	794.31
Cambridge, upstream from 9th St. Bridge, right bank	61.6	Aug. 8, 10 p. m.	796.72
Cambridge, 2½ miles north of, at highway bridge	56.6	Aug. 8	791.24
Cambridge Township, Pennsylvania R. R. bridge near line between secs. 4 and 24, T. 2 N., R. 3 W.	52.6	do	786.10
Liberty Township, near covered bridge at mouth of Salt Fork.	48.7	do	783.61
Kimbolton, ½ mile east of, at east end of highway bridge	41.7	do	777.79
Kimbolton, Pennsylvania R. R. bridge, 4½ miles west of	34.6	do	771.32
Birds Run, Geological Survey gaging station	30.8	Aug. 8, noon	768.88
Birds Run, highway bridge, 2½ miles northwest of	26.9	Aug. 8	764.45
Bacon Run, at first bridge on, above mouth of	18.9	do	757.96
Plainfield, highway bridge on line between secs. 23 and 24, T. 4 N., R. 5 W.	13.4	do	750.16
Marquand Mill	9.9	do	748.17
Meeks Bridge, left abutment	2.7	do	739.08
Wakatomika Creek:			
Ashcraft Ford	15.5		768.42
Frazeysburg, highway bridge west of, downstream side	11.6	Aug. 10, 8 p. m.	750.0
Frazeysburg, first Pennsylvania R. R. bridge, downstream side.	6.7	Aug. 10, 10:30 a. m.	735.30
Dresden, west of, covered bridge on road across valley, downstream side.	5.4	Aug. 10, 10:50 a. m.	731.62
Dresden, highway bridge at west city limits of	1.0		726.30
Licking River:			
Newark, on east side of Webb St	27.8	Aug. 7	801.51
Clay Lick, on Baltimore & Ohio R. R. bridge	21.6	do	781.33
Toboso, Geological Survey gaging station	17.6	Aug. 8, 3 a. m.	761.79
Nashport, at bridge over Licking River	12.5	Aug. 8	743.64
Poverty Run, on Baltimore & Ohio R. R. bridge	7.9	do	725.99
Dillon Falls, about 150 feet north of bridge	3.4	do	707.36
Zanesville, on Wall St. between Lee and Jackson Sts	1.0	Aug. 9	699.9

[1] Crest of flood of July 4 was 899.76 feet.
[2] Crest of flood of July 4 was 877.07 feet.
[3] Crest of flood of July 4 was 859.01 feet.
[4] Crest of flood of July 4 was 846.46 feet.
[5] Crest of flood of July 4 was 839.21 feet.

These data are also of value for furnishing basic information as to valley or channel storage and the natural or artificial effects of channel improvements and channel construction. The table shows the observation points along the principal rivers of the basin by reference to local features and river distances. The date and time of crest, where known, and the altitude of crest are generally available at places of information sufficient in number for satisfactory definition of the profile of the flood crest along the river. Where observations were more numerous than needed for adequate definition of a flood profile, selection for publication has been limited to those observations that are essential for that purpose. Table 15 lists minor streams in which flood-crest data are available as indicated below but were not included in table 14. Because of the great number of flood-crest observations on the minor streams, necessitated by the irregularity of the flood profiles, publication of those flood crests does not seem practicable. The table, however, gives the distance above the mouth of the respective streams to which these flood data apply. All available information is accessible for examination in the district office of the Geological Survey at Columbus, Ohio, and in the office of the Muskingum Watershed Conservancy District at New Philadelphia, Ohio.

TABLE 15.—*Streams for which unpublished data on flood crest stages are available*

Stream	Miles above mouth
Tuscarawas River:	
Wolf Creek	3
Hudson Run	1
Mud Run	1
Wetmore Creek	3
West Sippo Creek	1
East Sippo Creek	3
Newman Creek	6
Chippewa Creek	16
Sandy Creek:	
Still Fork of Sandy Creek	7.2
Bear Run	2.8
Conotton Creek	35.2
McGuire Creek	6.3
North Fork of McGuire Creek	[1] 6.2
Indian Fork	10.0
Huff Run	3.8
Sugar Creek:	
South Fork of Sugar Creek	17.6
Brush Run	2.2
Indian Trail Creek	5.0
Walnut Creek	9.6
Middle Fork of Sugar Creek	3.8
Stone Creek (tributary to Tuscarawas River proper)	10.0
Oldtown Creek	9.0
Beaverdam Creek	6.0
Tuscarawas River—Continued.	
Stillwater Creek:	
Skull Fork	10.4
Brushy Fork	12.9
Laurel Fork	2.35
Little Stillwater Creek	20.0
Buckhorn Creek	2.2
Walhonding River:	
Mohican River:	
Muddy Fork	5.6
Kiser Ditch	4.2
Muskingum River:	
Wills Creek:	
Seneca Fork	21.8
Crooked Creek	2.5
Beaver Creek	4.7
Glady Run	.2
Buffalo Fork	8.1
Leatherwood Creek	11.6
Birds Run	3.6
White Eyes Creek	15.3
Licking River:	
North Fork	20.9
South Fork	9.7
Raccoon Creek	7.7
Rocky Fork	1.6

[1] Miles above mouth of McGuire Creek.

Figures 20 to 22 present the flood profiles referred to previously of the principal rivers of the Muskingum Basin showing the relative positions of the crests attained during the floods of August 1935 and March 1913; the low-water profile is also shown.

RECORDS OF OTHER FLOODS

Adequate knowledge of the floods of the past provides an effective basis upon which to formulate plans for protection against future floods and for control of the flood waters. Systematic observation of stage and discharge of rivers in the Muskingum River Basin covers short periods of time and may be said to be in its infancy. The records available diminish materially as they extend into the past. River stage observations at the locks of the Muskingum River were begun in 1888 and are nearly continuous to date. River stage observations at upstream points in the basin for flood warning purposes were

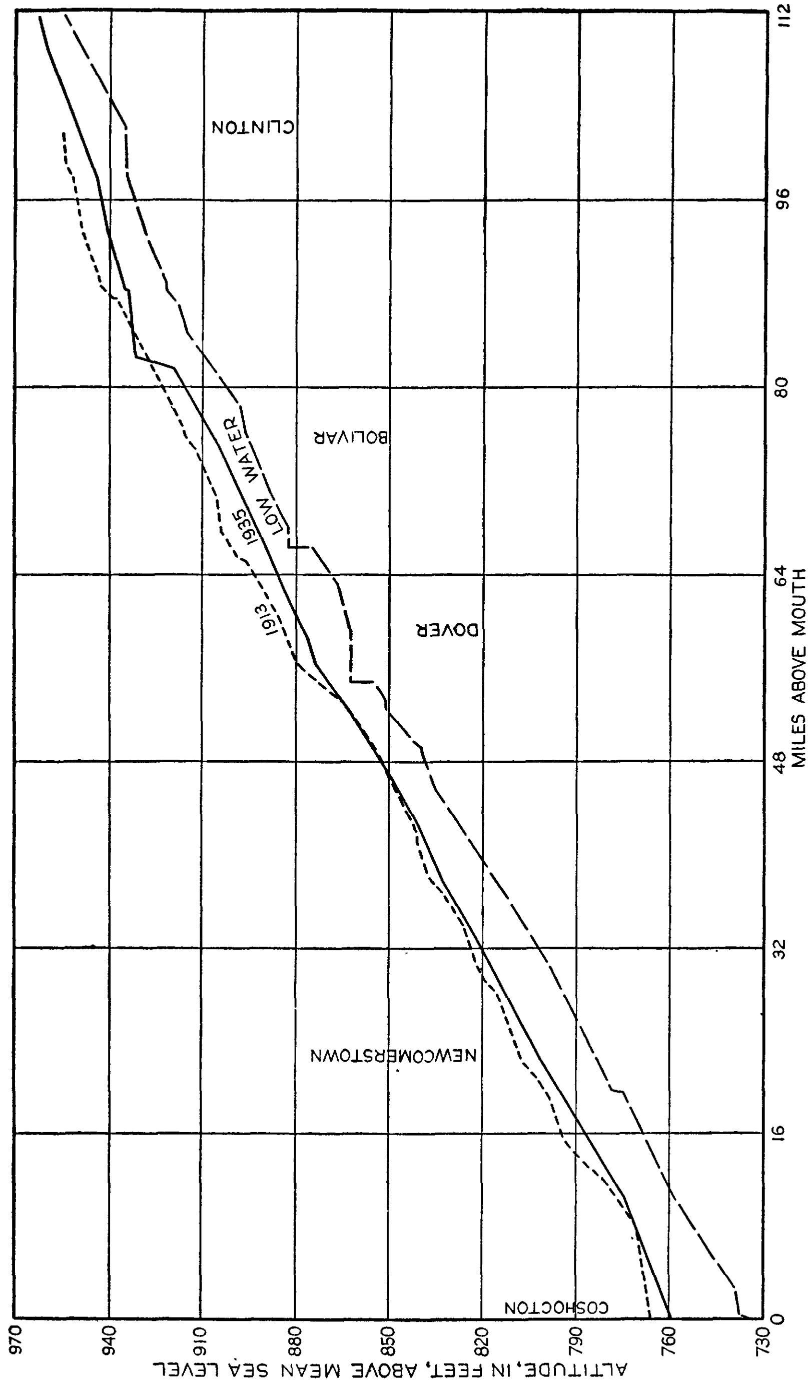

FIGURE 20.—Profile of maximum crest stages on Tuscarawas River during floods of August 1935 and March 1913.

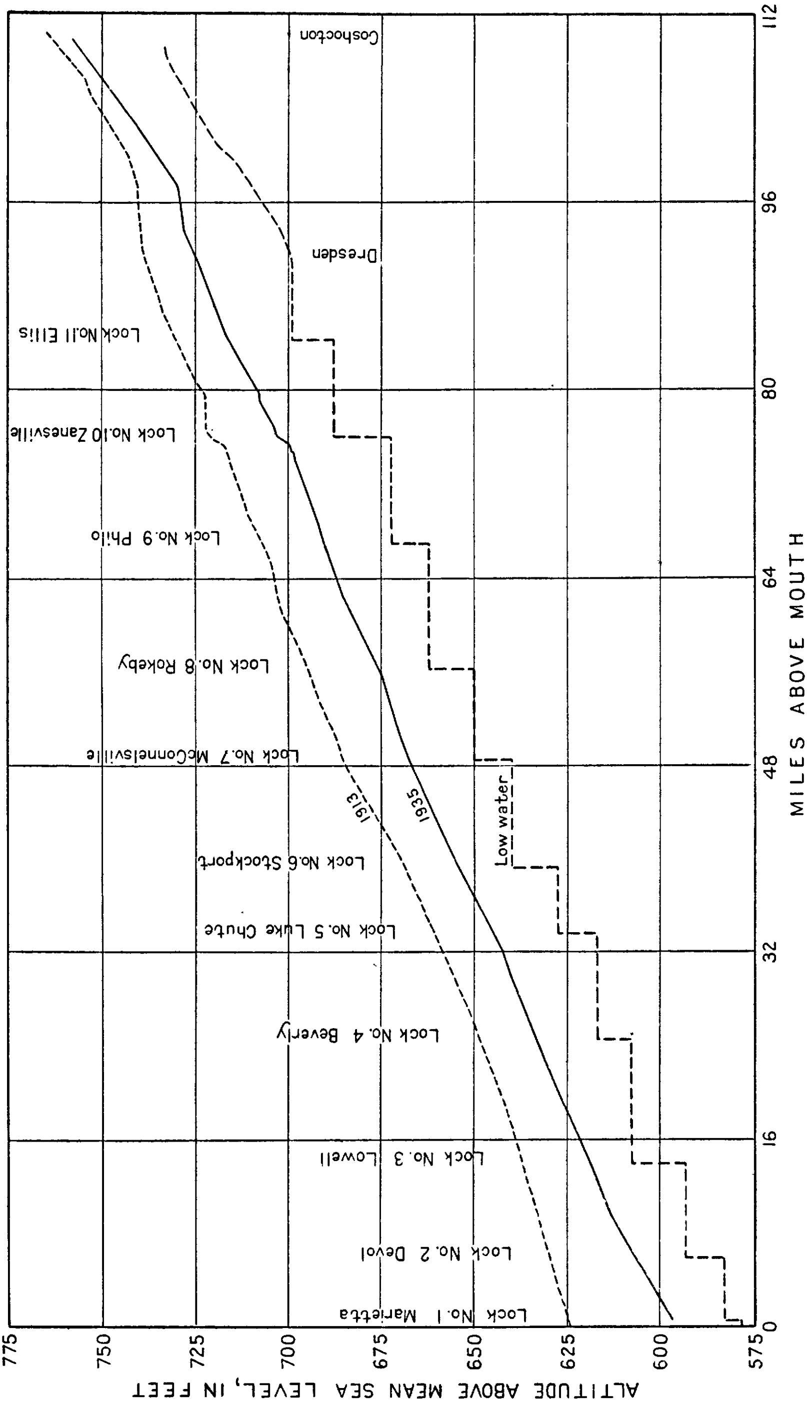

FIGURE 21.—Profile of maximum crest stages on Muskingum River during floods of August 1935 and March 1913.

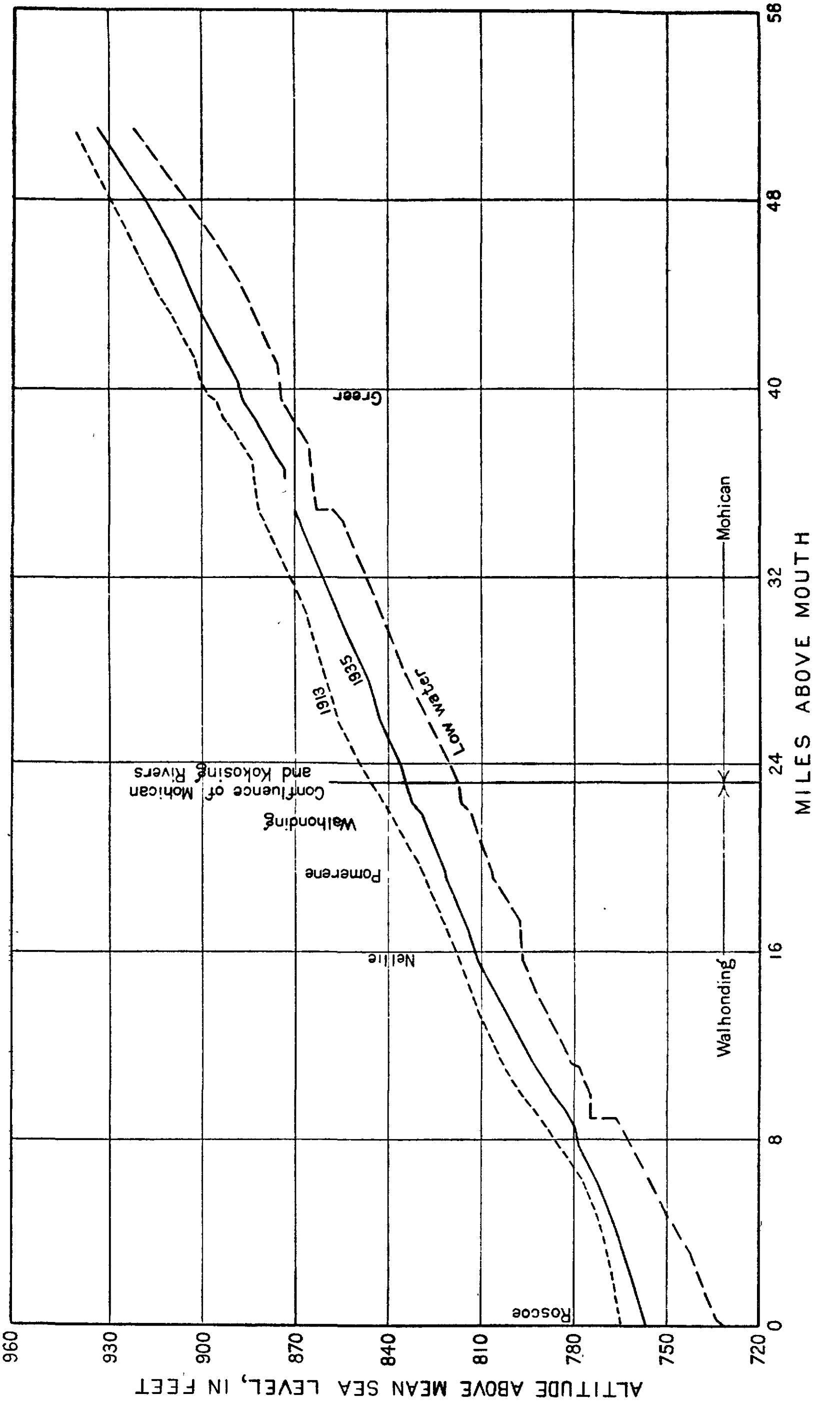

FIGURE 22.—Profile of maximum crest stages on Mohican and Walhonding Rivers during floods of August 1935 and March 1913.

undertaken by the United States Weather Bureau in 1905. A program of river measurement was begun by the Geological Survey in 1921.[31a]

Some information about outstanding floods of the period antedating the initiation of systematic river observations can be found in articles in newspapers and other journals of the past. Such information, however, is generally available only for the major rivers, and little definite information regarding floods on the smaller tiibutaries is obtainable.

OTHER SUMMER STORMS AND FLOODS[32]

In the period of about 150 years during which this region has been inhabited by white men there seems to be no indication of another summer storm and flood in the Muskingum River Basin of the magnitude and extent of that of August 1935. The rainfall of August 1935 caused the highest summer stages of record on many major streams, including the Tuscarawas River from Dover downstream, the lower reaches of the Walhonding River, Wills Creek below Cambridge, Killbuck Creek below Millersburg, and the main Muskingum River. In some streams, especially the smaller tributaries near the center of the storm, the stages resulting from this rain were the highest that old residents could recall. Inasmuch as the Muskingum River has been used for navigation, the records for the past 50 years for the main stream are complete. For the 50 years preceding that period the records of extraordinarily high stages seem to be fairly complete.

Of all storms to which the Muskingum River Basin has been subjected, the 5-day winter storm of March 1913 stands out in the resultant high stream stages generally prevalent on the major tributaries, on the Muskingum River proper, and on the Ohio River in the vicinity of the mouth of the Muskingum. The Ohio River record of March 1913 in this reach was exceptional in that it was not surpassed by the recent floods of March 1936 and January 1937. Of the other storms the 10-day storm of January 1937 stands second on the Muskingum proper. These were both winter storms of long duration embracing nearly the entire Ohio River Basin, causing generally less severe conditions on small tributaries than local summer storms of the cloudburst type and those general summer storms similar to that of August 1935. In 12- and 24-hour rainfall intensities few winter storms have approached the summer storms. However, during the

[31a] Records of stream flow for the Muskingum River Basin are published annually in Surface water supply of the United States, Part 3, Ohio River Basin, which is a part of the series of Geological Survey water-supply papers. A summary of stream-flow records prior to 1921 has been published in Sherman, C. E., Ohio stream flow, Part 1, Areas of lakes and drainage basins; run-off records prior to 1921, Ohio State Univ. Eng. Exper. Sta., Bull. 73, 164 pp., 1932.

[32] Based on material furnished the authors by Waldo E. Smith.

winter a greater portion of the rainfall appears as run-off than during the summer, even during intensive storms. Basic soil and vegetal conditions are more favorable for the retention of potential flood water in summer than in winter. Furthermore, the base or groundwater flow usually is less in summer than in winter.

Since this report has been in preparation another summer storm has occurred that possibly stands second to that of August 1935 in general magnitude. This is the storm of June 20–21, 1937. The overnight precipitation was as much as 7.51 inches at Bucyrus, where it centered near the watershed that divides the Muskingum, Sandusky, and Olentangy Rivers. This rainstorm commenced between 8 and 10 o'clock on the evening of June 20, breaking almost simultaneously over a broad belt extending from Bucyrus and Akron southeastward to Carrollton and Cambridge and beyond and progressing slowly southwestward. The Licking River Basin received very little rain before midnight of June 20, but the rain continued until well into the afternoon of June 21, accumulating a total of about 4 inches. Across the Muskingum River Basin from the Licking River Basin southeastward, heavy rain fell, causing the highest summer stages of record on a few of the western tributaries, of which the most notable is the Kokosing River. The storm resulted in record-breaking stages on the headwaters of the Sandusky and Olentangy Rivers. A maximum stage of 27.5 feet was reached at Zanesville, on the Muskingum River proper, 2.5 feet above flood stage but 6.0 feet below the crest stage of the flood of August 1935. The maximum stage was reduced somewhat by the automatic action of the flood-control reservoirs that were in an advanced stage of construction at the time.

In July 1913 another summer storm occurred, farther to the southwest than those of 1935 or 1937, so that the northeastern third of the Muskingum Basin received only relatively light rain. It extended, however, with a total rainfall of 2 inches or more over a broad belt to the northwestern corner of the State and into Indiana and Michigan,[33] and similarly to the southeast into West Virginia. The heaviest rainfall, as much as 7.4 inches at Toboso, occurred over the lower Licking River Valley above Zanesville. This likewise resulted in high stages, but it had been preceded by a protracted dry period which probably tended to reduce the run-off. The maximum stage recorded on the Muskingum River at Zanesville was 23.0 feet or 2 feet below flood stage. More detailed reports concerning this storm and resulting flood have been published by the United States Weather Bureau and the State of Ohio.[34]

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[33] Sherman, C. E., The Ohio water problem: Ohio State Univ., Coll. Eng., Bull. 15, p. 10, fig. 5, 1915.

[34] Climatological data for July 1913, District No. 3, Ohio Valley: U. S. Dept. Agr. ,Weather Bur., Monthly Weather Rev., vol. 41, pp. 996–997, July 1913. Alexander, W. H., A climatological history of Ohio: Ohio State Univ., Eng. Exper. Sta., Bull. 26, 741 pp., 1924.

A summer storm that merits consideration here, since it preceded the August storm by only a month, is the storm of July 3–4, 1935. During the night of July 3 the observer at Bangorville, in the northwestern part of the basin, cooperating with the Weather Bureau,

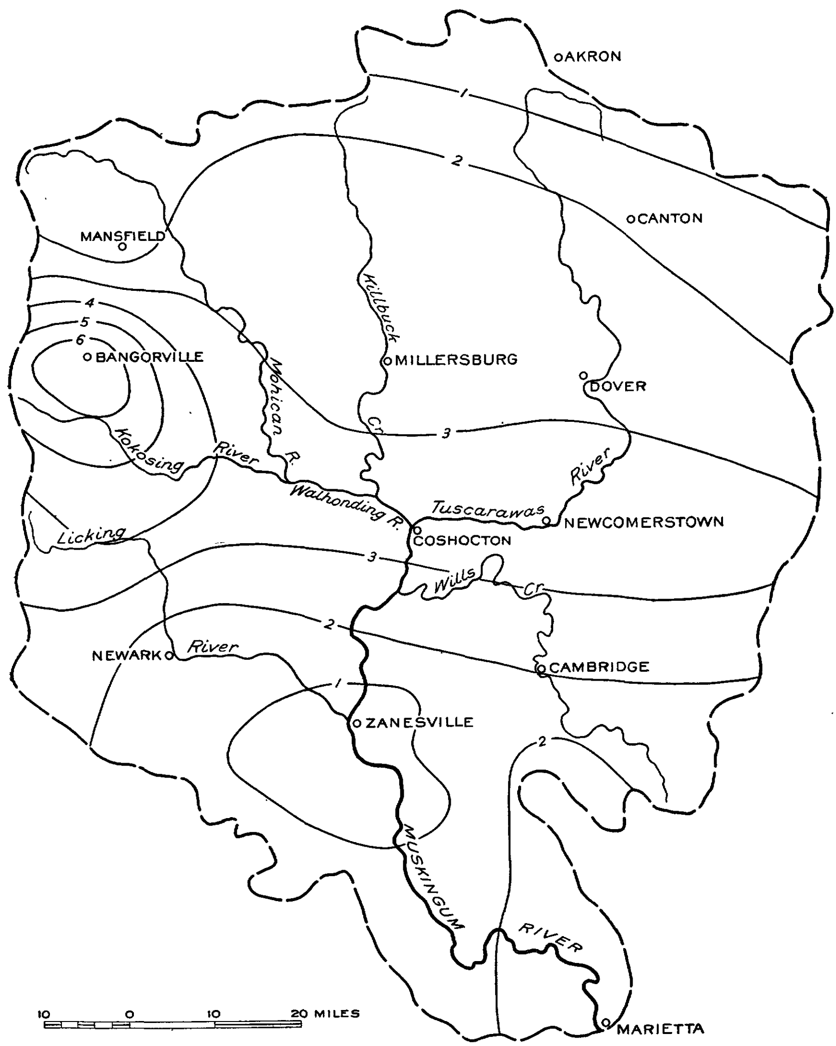

FIGURE 23.—Map of Muskingum River Basin showing lines of equal precipitation, July 3-5, 1935.

reported a rainfall of 5.91 inches, followed by 1.08 inches within the next 2 days. Nearby stations reported 3 to 4 inches, with an average over the Walhonding River Basin above Coshocton of about 2.6 inches. Figure 23 shows lines of equal precipitation for this period. Local floods of great intensity occurred on several tributaries of the Walhonding River, notably on the Kokosing River, over which the storm centered (see fig. 23). The crest stages at Millwood, on the Kokosing River, and at Newville, on Clear Fork, exceeded those of a month later as indicated in table 9. In other parts of the basin the flood was greatly surpassed by that of August 1935.

The stages of the Muskingum River in early September 1863 and May 1893 indicate that widespread summer storms occurred over the basin at those times, both of which may have equalled or exceeded the storms of June 1937 and July 1913 but did not approach that of August 1935 in producing maximum stages on the Muskingum.

The local cloudburst type of summer storm is of little importance in major flood considerations, since stages on the principal rivers may not be appreciably affected although on small drainage areas it may frequently result in record-breaking stages and local erosion and damage. In the consideration of local flood problems, the effects of such storms are significant. One such storm is worthy of mention. On July 16, 1914, 7.09 inches of rain fell in a period of 90 minutes near Cambridge, Ohio, in the Wills Creek Basin.[35] The rain gage of the cooperating observer at Cambridge was apparently very near the center of this storm, which was very local in its nature, probably not more than 25 square miles receiving more than 1 inch of rain.

Newspapers furnish many references to contemporary local summer storms and floods but usually give no definite information with respect to precipitation or river stages, except in general ways not susceptible of translation into quantitative terms. During the period 1832 to 1909 newspapers published accounts of at least 61 separate intensive summer storms and consequent floods in the Muskingum River Basin. The following quotations from newspaper sources were selected from a compilation made by the Soil Conservation Service and are furnished more as examples of the nature of these data than as evidence of the severity of the floods.

On Thursday evening last, rain commenced falling in this vicinity with unusual rapidity, continuing more or less during the night and the next day and night. The result was that Killbuck and all its tributaries got on a bender and played smash. In many places the bottoms were entirely overflowed doing considerable damage to the crops and fences. Our oldest citizens have not known Killbuck to be so high for a number of years, not since 1832.[36]

Crops, Fences, and Other Property Washed Away

The most copious rainfall that has ever been known in this county occurred on last Saturday and Sunday. There had been more or less rain for three weeks, and the ground was soaked with water and the streams all swollen. On Saturday there were several very heavy rains doing much damage but on Sunday afternoon the rain fell in torrents for hours filling all the streams of the county, principally Meigs Creek, Four Mile Creek, and Wolf Creek.[37]

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[35] Alexander, W. H., op. cit., p. 306.
[36] The Holmes County Farmer, June 17, 1858.
[37] The McConnelsville Herald, Aug. 6, 1875.

STORM AND FLOOD OF MARCH 1913

The great storm of March 1913, to which frequent reference has been made, was the result of a very unusual and unfavorable combination of weather conditions and when measured by its duration, extent of territory covered, and total rainfall it may be classed as one of the greatest storms on record in the eastern United States. The storm itself embraced nearly the entire Ohio River Basin and centered along an east-west axis just north of the central part of Ohio, where in 5 days the precipitation averaged about 10 inches over 6,000 square miles. The storm was described in detail in several reports.[38]

The daily and total rainfall over the principal subdivisions of the Muskingum River Basin as computed by the Muskingum Watershed Conservancy District are as follows:

Rainfall, in inches, in Muskingum River Basin, Mar. 23–27, 1913

Area	23	24	25	26	27	Total
Tuscarawas River above Coshocton	0.75	1.61	2.15	1.55	0.50	6.56
Walhonding River above Coshocton	.99	1.73	4.13	1.44	.90	9.19
Muskingum River above Coshocton	.86	1.66	3.07	1.49	.69	7.77
Muskingum River above Marietta	.63	1.34	2.56	1.77	.64	6.94

The floods that resulted from this storm throughout the State of Ohio and in the Ohio River above Point Pleasant, W. Va., as far as Woodland, W. Va., are the greatest known. In the Miami River Basin the consequences of these floods led to the construction of the famous system of retarding reservoirs. Throughout this region the flood stages attained are the highest of record on all major streams and have since served as a standard with which all subsequent floods are compared. However, practically no records of measured discharge are available for the floods of 1913 in Ohio, as an active river-measurement program was not initiated in that State until 1921. Estimates of maximum flood discharge at river-measurement stations within the Muskingum Basin have been made by the Corps of Engineers, United States Army, and others as indicated, based on interpretations of precipitation records, high-water marks, and channel conveyance. These estimates are given in table 16. Attention is also directed to the 1913 flood profile on the Tuscarawas, Muskingum, and Walhonding Rivers shown in figures 20 to 22.

[38] Horton, A. H., and Jackson, H. J., The Ohio Valley flood of March–April, 1913, including comparisons with some earlier floods: U. S. Geol. Survey Water-Supply Paper 334, 96 pp., 1913. Henry, A. J., The floods of 1913 in the rivers of the Ohio and lower Mississippi Valleys: U. S. Dept. Agr., Weather Bur. Bull. Z, pp. 1–103, 1913. Special report on the flood of March 1913: Ohio State Board of Health, Monthly Bull., May 1913 (also reprinted separately). Morgan, A. E., The Miami Valley and the 1913 flood: Miami Conservancy Dist., Tech. Repts. pt. 1, 125 pp., 1917.

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TABLE 16.—*Summary of maximum stages and discharges during flood of March 1913*

Stream	Place	Drainage area (square miles)	Altitude of zero of gage (feet above mean sea level)	Crest stage at gage (feet)	Maximum discharge	
					Second-feet	Second-feet per square mile
Tuscarawas River	Clinton	165	933.28	22.2		
Do	Near Dover	1,398	861.51	23.5	[1] 62,000	44.4
Do	Newcomerstown	2,432	780.03	26.5	[2] 83,000	34.1
Muskingum River	Coshocton	4,847	733.52	[3] 30.5	202,000	41.7
Do	Dresden	5,982	693.15	46.0	228,000	38.1
Do	McConnelsville	7,411	650.31	33.5	270,000	36.4
Sandy Creek	Sandyville	481	913.25	[4] 14.8	[5] 18,400	38.3
Sugar Creek	Strasburg	310			[6] 16,700	
Stillwater Creek	Uhrichsville	367	839.37	17.5	[7] 8,200	22.3
Black Fork	Loudonville	342	928.46	±20.5	[8] 11,700	[8] 54.2
Mohican River	Greer	942	872.91	27.0	[9] 55,000	58.4
Walhonding River	Pomerene	1,488	805.53	21.6	[10] 80,000	53.8
Clear Fork	Newville	175	1,018.32	15.7	[11] 18,900	[11] 95.0
Jerome Fork	Jeromeville	120	949.14	15.1		
Lake Fork	Near Loudonville	342	902.53	26.0	[12] 20,500	[12] 76.2
Kokosing River	Millwood	472	841.06	22.0	40,000	84.8
Wills Creek	Birds Run	730	740.98	28.8	[13] 22,300	[13] 26.4
Licking River	Toboso	672	744.84	20.0	[14] 35,000	52.1

[1] Muskingum Watershed Conservancy District estimates 50,500 second-feet.
[2] Muskingum Watershed Conservancy District estimates 80,000 second-feet.
[3] Observed at 4 a. m. Mar. 26 by U. S. Weather Bureau; Corps of Engineers give 31.8 feet as maximum stage, with respect to the same datum.
[4] Not comparable with present stages owing to change in channel.
[5] Corps of Engineers, U. S. Army, estimates 26,100 second-feet at Bolivar dam site, 502 square miles drainage area.
[6] At Beach City dam site, 300 square miles; the Muskingum Watershed Conservancy District estimates 19,000 second-feet at same location.
[7] Computed by the Muskingum Watershed Conservancy District.
[8] At Charles Mill dam site, 16 miles above gage, 216 square miles.
[9] Computed by the Geological Survey.
[10] Computed by the Geological Survey; Corps of Engineers, U. S. Army, estimates 102,000 second-feet.
[11] At Pleasant Hill dam site, 199 square miles.
[12] At Mohicanville dam site, 269 square miles.
[13] At Wills Creek dam site, below gage, 844 square miles.
[14] Computed by Muskingum Watershed Conservancy District.

The following is a compilation by the Muskingum Watershed Conservancy District of damages inflicted by the flood of March 1913 in the Muskingum River Basin.

Damages in Muskingum River Basin by flood of March 1913

County	County and municipal bridges and roads	Railroads and other public utilities [1]	Private property	Works to improve navigation [1]	Total
Washington	[1] $391,000	$235,000	[2] $1,463,000	$45,000	$2,134,000
Morgan	[3] 284,000	70,000	[2] 538,200	29,000	921,200
Muskingum	[3] 864,000	982,000	[2] 3,335,000	38,000	5,219,000
Coshocton	[1] 330,000	510,000	[2] 368,000		1,208,000
Licking	[1] 26,000	8,000	[1] 18,000		52,000
Guernsey	[1] 7,000	5,000	[1] 5,500		17,500
Tuscarawas	[3] 350,000	148,000	[2] 418,000		916,000
Stark	[1] 166,000	125,000	[2] 942,000		1,233,000
Holmes	[1] 54,000	50,000	[1] 43,000		147,000
Wayne	[1] 48,000	160,000	[1] 59,000		267,000
Knox	[1] 97,000	149,000	[1] 116,000		362,000
Ashland	[1] 116,000	51,000	[1] 41,000		208,000
Richland	[1] 107,000	215,000	[2] 550,000		872,000
Summit	[1] 16,000	10,000	[1] 18,000		44,000
Total	2,856,000	2,718,000	7,914,700	112,000	13,600,700

[1] From report of the Ohio Valley Flood Board of Sept. 12, 1916: House Document No. 1792, 64th Cong., 2d sess., Dec. 21, 1916.
[2] Obtained from local sources believed to be reliable.
[3] County and city records of bonds issued and expenditures or estimates of expenditures for bridges and road repairs.

FLOODS ON MUSKINGUM RIVER

The records of flood crest stages as obtained from the United States Weather Bureau gage at Coshocton are given in table 17.

TABLE 17.—*Annual maximum stages of Muskingum River and all crest stages above 13 feet observed at Weather Bureau gage at Coshocton*

Date	Gage height	Date	Gage height	Date	Gage height
1884, Feb.	25.4	1917, Apr. 7	11.6	1928, Feb. 16	10.4
1898, Mar.	26.4	1918, Feb. 15	16.2	1929, Jan. 20	14.0
1907	23.7	1919, Aug. 6	15.3	Feb. 27	20.0
1910	23.8	1920, Apr. 22	17.6	1930, Jan. 15	[2]16.2
1911, Dec. 16	13.2	1921, Mar. 10	13.5	1931, Dec. 14	10.7
1912, Feb. 27	13.5	Mar. 29	15.7	1932, Jan. 19	12.5
Mar. 30	15.4	1922, Apr. 15	14.4	1933, Mar. 17	17.2
Apr. 4	14.3	1923, May 13	14.6	May 15	15.7
1913, Jan. 13	15.5	1924, Jan. 12	14.0	1934, Mar. 6	8.9
Jan. 18	14.8	Mar. 30	15.3	1935, Aug. 8	24.65
Jan. 24	14.0	1925, Feb. 25	10.2	1936, Feb. 17	14.3
Mar. 26	[1]30.5	1926, Feb. 27	13.6	Feb. 28	20.8
1914, Mar. 29	12.2	1927, Jan. 23	19.2	Mar. 26	13.8
1915, Feb. 5	15.2	Mar. 22	20.1		
1916, Jan. 2	16.4	Dec. 2	17.7		
Mar. 28	14.7	Dec. 17	17.4		

[1] Observed at 4 a. m.; Corps of Engineers, U. S. Army, give 31.8 for maximum stage, when referred to a zero of 733.52 feet.
[2] Estimated by the Geological Survey.

NOTE.—Available continuous records begin in 1911. All maximum stages as given above refer to present altitude of zero, 733.52 feet above mean sea level. Prior to 1934 the gage was 3.0 feet higher.

The State of Ohio improved the Muskingum River for navigation by the construction of 11 locks and dams between Marietta and Dresden, which were completed in 1841. The operation and maintenance of the navigation works were turned over by the State to the Corps of Engineers, United States Army, in 1887, when the keeping of continuous records of river stages was initiated.

The compilations of known flood stages at Locks 10, 7, and 1, as prepared by Waldo E. Smith and W. T. Collins of the Muskingum Watershed Conservancy District, are assembled in tables 18, 19, and 20 for convenient reference. Check has been made against the original records kept at Lock 10 at Zanesville and other possible sources, appropriate reference being given to such sources. Except as noted, gage heights listed for years prior to 1888 were obtained from information in the files of the Corps of Engineers.

The compilation of crest stages at the lower gage at Lock 10 at Zanesville given in table 18 includes all crests above 25 feet and the highest of each year since 1888, as obtained from the original lock records. Crest stages for the years 1832, 1860, and 1884 were obtained from other unpublished data of the Corps of Engineers. The crest stages for the years since 1888 are based on records consisting of three or four readings made daily since 1888, with the exception of that for March 1913, which is based on a floodmark.

TABLE 18.—*Annual maximum stages and all crest stages above 25.0 feet of Muskingum River at Lock 10, lower gage, Zanesville*

Date	Gage height (feet)	Date	Gage height (feet)	Date	Gage height (feet)
1832, Feb	34.8	1904, Jan. 25	27.2	1919, May 10	21.7
1860, Apr	33.5	Mar. 5	25.9	1920, Apr. 22	26.8
1884, Feb	34.5	Apr. 3	27.9	1921, Mar. 29	23.2
1888, Nov. 11	18.1	1905, May 15	19.2	1922, Apr. 15	25.7
1889, Jan. 28	15.9	1906, Mar. 28	24.5	1923, Dec. 23	19.9
1890, Mar. 14	22.9	1907, Jan. 21	25.3	1924, Mar. 30	25.8
1891, Feb. 17	27.3	Mar. 14	31.9	1925, Feb. 12	17.2
1892, Feb. 9	17.1	1908, Mar. 4	26.3	1926, Feb. 27	19.8
1893, Feb. 11	26.2	1909, Feb. 25	26.0	1927, Jan. 23	26.0
May 21	30.1	1910, Jan. 19	29.0	Mar. 22	26.7
1894, Feb. 13	17.8	Mar. 3	32.5	1928, Mar. 31	18.2
1895, Dec. 27	17.4	1911, Jan. 30	23.5	1929, Feb. 27	26.4
1896, July 25	20.8	1912, Apr. 3	22.8	1930, Jan. 15	24.9
1897, Mar. 6	24.5	1913, Jan. 12	25.6	1931, Dec. 14	19.4
1898, Mar. 24	36.8	Mar. 27	[1] 51.8	1932, Jan. 18	20.4
1899, Jan. 15	20.1	1914, Mar. 30	20.4	1933, Mar. 19	26.5
1900, Mar. 7	19.4	1915, Feb. 6	24.6	1934, Mar. 6	15.8
1901, Apr. 27	24.5	1916, Mar. 28	25.1	1935, Aug. 9	33.6
1902, Apr. 12	17.1	1917, Mar. 14	20.3		
1903, Mar. 11	23.9	1918, Feb. 15	25.6		

[1] Based on floodmark.

NOTE.—The elevation of the zero of this gage as determined by different agencies at different times has varied, although the position of the gage has apparently never been changed. In February 1937 the Muskingum Watershed Conservancy District determined the zero to be 665.04 feet above mean sea level.

The records of observed crest stages at the upper and lower gages at Lock 7 at McConnelsville, listed in table 19, are generally based on two or more readings made daily since 1888. Crests prior to 1888 given in table 19 are based on the account furnished by Captain Irven Travis, lockmaster at Lock 7 from 1887 until 1928. Captain Travis' account appears later in this report.

TABLE 19.—*Annual maximum stages and all crest stages above 16 feet on upper gage and above 24 feet on lower gage of Muskingum River at Lock 7, McConnelsville*

Date	Upper gage	Lower gage	Date	Upper gage	Lower gage	Date	Upper gage	Lower gage
1810, Nov. 10 [1]			1902, July 4	14.5	18.7	1916, Mar. 28	17.5	24.4
1832, Feb. 16 [1]			1903, Mar. 1	17.1	23.6	1917, Jan. 6	14.6	19.6
1847, Feb.	[1] 20.6		1904, Jan. 25	[5] 19.0	26.2	1918, Feb. 15	17.8	24.8
1860, Apr. 13	[1] 23.3		Mar. 5	18.2	25.0	1919, May 11	15.6	21.8
1884, Feb. 9	[1] 24.6		Apr. 4	19.3	27.0	1920, Apr. 22	18.3	25.7
1888, Nov. 11	13.2	16.1	1905, Mar. 9	13.7	17.7	1921, Mar. 29	16.2	22.2
1889, Jan. 28	12.0	13.5	1906, Mar. 28	17.0	23.4	1922, Apr. 16	18.0	25.0
1890, Jan. 17	[2] 15.0	19.0	1907, Jan. 21	17.4	24.1	1923, Dec. 23	14.6	19.5
Mar. 14	[3] 16.2	20.8	Mar. 14-15	23.0	31.0	1924, Mar. 30	17.8	25.0
1891, Feb. 17	[3] 19.2	25.1	1908, Feb. 16	16.8	23.1	1925, Feb. 24	13.0	16.9
1892, Feb. 9	[3] 13.0	16.4	Mar. 4	18.0	25.0	1926, Feb. 4	16.2	23.6
1893, Feb. 11	18.9	25.7	1909, Feb. 25	17.7	24.7	1927, Jan. 23	18.0	25.4
May 3	21.4	26+	1910, Jan. 19	20.6	27.8	Mar. 22	18.5	25.9
1894, Feb. 13	13.3	17.3	Mar. 3	23.1	31.6	Dec. 16	17.3	24.5
1895, Mar. 2	12.1	19.0	1911, Jan. 30	16.2	22.2	1928, Mar. 31	13.1	17.2
1896, July 24	16.0	22.2	1912, Feb. 27	15.6	21.3	1929, Feb. 28	18.0	25.6
1897, Mar. 6	17.1	23.8	Apr. 3	15.6	21.6	1930, Jan. 15	17.3	24.3
1898, Jan. 24	15.9	21.9	1913, Jan. 12	17.4	24.4	1931, Dec. 14	14.1	19.0
Mar. 24-25	[4] 25+	27+	Mar. 27-28	[6] 29+	([6])	1932, Jan. 19	14.5	20.1
1899, Jan. 15-16	14.3	19.4	July 14	19.9	27.8	1933, Mar. 19	26.5	18.9
1900, Mar. 7	14.0	18.7	1914, Apr. 2	14.6	20.0	May 15	16.8	23.8
1901, Apr. 27	17.1	23.7	1915, Feb. 6	17.0	23.7	1934, Mar. 4	12.6	15.8
1902, Apr. 12-13	12.9	16.0	1916, Jan. 3	17.0	23.6	1935, Aug. 9	23.6	32.8

[1] From account furnished by Capt. Irven Travis.
[2] Highest during period 1884-90.
[3] Read all night.
[4] Gages submerged, water 66 inches on wall at guard gate, 21 inches higher than on Feb. 9, 1884; U. S. Weather Bureau gives 26.4 feet as crest stage on upper gage.
[5] Highest during period 1898-1904.
[6] Gages submerged; U. S. Weather Bureau gives 40.8 feet on upper gage and 49.1 feet on lower gage.

NOTE.—Upper gage: February 1890, altitude of zero given as 644.838 feet above mean sea level, changed by resetting gage to 644.628 feet at 2 p. m. on Dec. 12, 1891, when gage read 7.2 feet as against 7.2 feet previously. No change in installation made thereafter. Altitude of zero of gage as determined by the Muskingum Watershed Conservancy District in February 1937, 643.93 feet.

Lower gage: February 1890, zero altitude given as 636.829 feet, changed by resetting gage to 634.990 feet at 2 p. m. on Oct. 21, 1891, when gage read 4.4 feet as against 2.8 feet previously. No change in installation made thereafter. Altitude of zero of gage as determined by Muskingum Watershed Conservancy District in February 1937, 634.42 feet.

Table 20 gives for the lower gage at Lock 1, Marietta, all crests of 30.0 feet or more and the highest for each calendar year from 1888 to April 1938 inclusive, except January 1892 to June 1894 inclusive, when no definite records were kept. In general, the record at the lower gage at Lock 1 is more detailed and more complete than the record at the city gage on the Ohio River at Marietta. Readings have been made several times daily throughout the period of observation. In 1888, 1889, and 1894, routine readings were made at 8 a. m., 1 p. m., and 8 p. m.; in 1890 and 1891, 6 a. m., 10 a. m., 2 p. m., and 6 p. m.; from 1895 to 1913, 6 a. m., 2 p. m., and 6 p. m.; and from 1914 to May 1938, 6 a. m., 8 a. m., 2 p. m., and 6 p. m.

Table 20 also gives all the available crest stages for the city gage on the Ohio River from 1873 to 1935, when observation was discontinued by the United States Weather Bureau. The records from 1873 to April 1913 were taken from a Geological Survey water-supply paper,[39] and those from April 1913 to 1935 from the annual publications of the United States Weather Bureau.[40] From 1913 to 1935 all

[39] Horton, A. H., and Jackson, H. J., The Ohio Valley flood of March-April 1913: U. S. Geol. Survey Water-Supply Paper 334, pp. 14-17, 1913.

[40] Daily river stages at the river gage stations on the principal rivers of the United States: U. S. Dept. Agric., Weather Bur., vols. 12 to 33.

gage crests of 28.4 feet or higher and the highest for each calendar year are given.

TABLE 20.—*Observed crest stages at lower gage, Lock 1, and at city gage on Ohio River at Marietta*

Date	Lower gage at Lock 1 on Muskingum (feet)	City gage on Ohio River (feet)
1847, Feb.	-------	[1] 40.6
1873, Dec. 16	-------	38.5
1874, Jan. 9	-------	37.7
1875, Aug. 3	-------	35.3
1881, Feb. 14	-------	39.3
1882, Feb. 23	-------	35.0
1883, Feb. 9	-------	43.7
1884, Feb. 9	-------	52.8
1888, Jan. 10	26.8	-------
1889, Feb. 21	20.3	-------
1890, Mar. 24	33.1	[2] 33.5
1891, Feb. 20	43.3	43.8
1892	(3)	-------
1893, Feb. 11	-------	36.4
1894, Jan.	(3)	-------
June	-------	-------
Dec. 16	14.2	-------
1895, Jan. 11	36.2	-------
1896, Apr. 1	30.7	-------
1897, Feb. 25	32.8	36.0
1898, Mar. 26	48.3	47.5
1899, Mar. 7	25.1	-------
1900, Jan. 23	23.9	-------
1901, Apr. 23	(4)	41.4
1902, Mar. 3	33.5	38.4
Apr. 12	33.5	-------
1903, Mar. 3	39.0	38.6
1904, Jan. 25	-------	40.8
Mar. 6	38.5	37.8
1905, Mar. 12	31.6	-------
Mar. 23	40.5	40.4
1906, Apr. 2	31.4	-------
1907, Jan. 21	32.8	-------
1907, Mar. 16	51.8	48.7
1908, Feb. 18	40.7	39.1
Mar. 9	34.0	36.4
Mar. 21	38.0	36.4
1909, Feb. 26	36.8	35.0
May 3	34.5	-------
1910, Jan. 21	34.0	-------
Mar. 4	41.2	39.6
1911, Jan. 17	35.0	-------
Jan. 31	(5)	-------
Sept. 17	30.0	-------
1912, Mar. 25	37.5	-------
Apr. 4	32.9	-------
1913, Jan. 13	44.2	42.6
Mar. 29	59.9	[6] 58.3
Nov. 17	35.5	34.0
1914, Mar. 31	33.9	32.3
1915, Feb. 4	42.3	40.5
Dec. 20	31.5	29.7
1916, Jan. 4	[7] 33.7	32.0
Jan. 15	[7] 31.2	29.2
Mar. 24–25	30.1	28.4
Mar. 30	37.3	35.6
1917, Jan. 24	31.4	29.2
Mar. 15	38.1	36.7
1918, Feb. 15	32.4	30.5
Feb. 22	36.5	34.5
Mar. 17	35.7	34.0
1919, Jan. 4	32.5	30.7
Nov. 28	31.7	30.1
1920, Mar. 15	36.3	34.8
Apr. 23	30.4	28.4
1921, Nov. 30	35.5	34.0
1921, Dec. 27	30.8	29.6
1922, Apr. 17	34.0	32.4
1923, May 15	28.4	26.5
1924, Jan. 5	36.8	34.9
Apr. 1	40.4	39.1
May 15	37.4	35.8
1925, Feb. 13	31.2	29.5
1926, Nov. 19	28.1	26.5
1927, Jan. 24	45.7	44.0
Mar. 23	[7] 35.9	34.3
Dec. 3	32.7	30.5
Dec. 17	42.5	40.7
1928, Apr. 1	28.9	27.0
1929, Mar. 1	34.7	33.1
1930, Jan. 16	30.1	28.4
Feb. 28	32.7	30.9
1931, Apr. 5	31.0	29.5
1932, Apr. 3	28.2	26.3
1933, Mar. 17	42.7	41.0
Mar. 21–22	37.8	36.1
1934, Mar. 7–8	28.6	26.2
1935, Mar. 14	33.1	-------
Aug. 8	30.0	-------
1936, Feb. 29	35.0	-------
Mar. 20	48.1	-------
Mar. 28	40.4	-------
1937, Jan. 26–27	54.9	-------
Apr. 29	40.0	-------
Dec. 20	35.1	-------
1938, Mar. 17	29.6	-------
Apr. 4	31.1	-------

[1] Based on account furnished by Capt. Irven Travis.
[2] Date not known.
[3] No records.
[4] Above 24.3.
[5] Above 35.0.
[6] Published as 58.6 feet in "Daily River Stages at the River Gage Stations on the Principal Rivers of the United States," by the U. S. Weather Bureau.
[7] From the annual publication of the U. S. Weather Bureau "Daily River Stages at the River Gage Stations on the Principal Rivers of the United States" for the year indicated.

NOTE.—The lower gage at Lock 1 on the Muskingum River is about 0.2 mile above the right bank of the Ohio River. The city gage on the Ohio River is in the vicinity of the intersection of Ohio and Second Streets, Marietta, about 0.1 mile upstream from the left bank of the Muskingum River.
The altitude of the zero of each of the two gages has been expressed in varying figures since their establishment, although the position of the gages has apparently never been changed. In February 1937 the Muskingum Watershed Conservancy District determined the zero of the lower gage at Lock 1 to be 566.41 feet above mean sea level, and the city gage zero to be 568.02 feet above mean sea level. No attempt has been made to reconcile differences in water surface elevation at the crest as determined by the two gages for the same flood.

Because of its contribution to the flood history of the Muskingum River, an article entitled "Facts about Muskingum Valley floods" by Captain Irven Travis, which appeared in the McConnelsville Herald for February 14, 1935, is reprinted here. Captain Travis was lockmaster at Lock 7 at McConnelsville from 1887 to 1928. The article is included through the courtesy of the publisher of the McConnelsville Herald.

FACTS ABOUT MUSKINGUM VALLEY FLOODS

(As Observed by Captain Irven Travis)

In writing of floods of the Muskingum valley, it seems proper to enumerate them in the order of their occurrence. Nov. 10, 1810, is as far back as we feel justified in mentioning and is the first of which there is any record. In those days, no gauges were established; neither was there anyone to report the weather conditions and flood notes as was so ably done in 1913. To give an idea of this flood of 1810, we can do no more than give gauge readings at Cincinnati, which was 64.3. These figures will show at least, that high water occurred at this time in the Muskingum as this river and its tributaries drain practically 1-5 of the area of the State of Ohio. This reading at Cincinnati has been exceeded but four times to date; and each of the four times, the Muskingum has furnished a liberal share of the water.

1832

The next flood of importance was Feb. 16, 1832. The water gauge at Cincinnati read 63.7, which is 0.6 less than the flood of 1810. I find no record of damage by either of these floods and there could be none to the improvements of the river as the locks and dams were not built at that time; but they were finished before our next flood, which was in 1847. This was seven years after the completion of locks and dams, which were known as The Muskingum River Improvements.

Muskingum Improved

In March 1836, the improvement of the Muskingum was authorized by an act of the state legislature, and an appropriation of $400,000 was also made for that purpose. In August of the same year, proposals were called for to be opened at McConnelsville on the 20th of the following October. Three years was the alloted time in which to complete this work, but for various causes, such as changes of the location of dams, contention concerning the size of locks, high water, etc., five years elapsed before its completion. Since then, the improvements have been subject to damage by many floods.

The first to do damage probably should not be classed as a flood. It occurred in 1842 or 43 when the river cut around the dam at Luke Chute, now known as Dam No. 5. This was quite a loss as many acres of valuable land were destroyed on which stood several houses which made this place of such importance as to be called Rocktown. In the closing of this break, the nearby hills owned by John Buck were practically cleared of timber.

1847

In February 1847, another flood is recorded, and although the river had now been improved for about seven years, there seems to be less known of this than of previous high waters. There is no report even from Cincinnati, but Marietta reported 40.6. However, it was of enough importance to cause much damage to the river improvements. Navigation was suspended for a long period and at a time when it was most keenly felt, for a good business had been built up in the seven years of slackwater navigation. The greatest damage was at the head of the canal at Beverly, where the canal bank was carried away for six or seven hundred feet. The entire river now passed through this crevasse.

* * * * * * *

Now to get back to the subject and give gauge readings of this flood, I will say the water was 3 inches deep on the Goodlive & McClain bar room counter, whatever that indicates. This counter was located in the old American house which stood on the site of the present Van Fossen building. It is known, however, that the reading was a little less than the next flood, April 13, 1860.

1860

This many of us remember, therefore a more definite report can be given. This, again, exceeded any previous flood. The water stood 29 inches deep on the abutment at the head of the canal, which reduced to gauge readings as have since been established, would read 23.3. This would be about 3 feet deep on the famous bar room counter before mentioned.

This breaking of the record was then, as it has been in all later floods, very gratifying to some people. While this was a very destructive flood, the greatest damage was to the river improvements. The most severe loss was at Stockport, now known as Dam No. 6. Here the water cut around the east end of the dam, carrying in its path, a small farm or rather a small part of a large farm. This land was owned by Arthur Taggart whom the State of Ohio paid $2500 as damage and in a few years Mr. Taggart was raising a better corn crop on this territory than before.

The total cost of the repairs at this point was about $60,000.

* * * * * * *

Many marks showing the crest waterline were placed on what were thought to be permanent buildings, but I doubt if any can now be found. One of these marks was a board nailed on the joist of the second floor of the Shepard mill which stood immediately below the locks. Another mark of black paint was on the corner post of the floral hall in the fair ground, and the still famous bar room counter remained as a bench mark to measure from. None of these marks now remain. The river having been improved by the state, as has been mentioned, had up to this time been managed by a board of public works. On the 2nd day of June, 1861, the public works of Ohio were leased by an act of the legislature passed May 9 of the same year. The lessees were to pay a rental of $20,075 per year. This lease continued in force until December 1, 1877, at which time the lessees abandoned the public works and by appointment of the superior court of Montgomery county, they were placed in the hands of a receiver until May 15, 1878, at which time the state board again took possession.

The Great Gorge of 1867

While great damage was done during the high water of 1867, this probably should not be classed among the big floods, as it was not general and was caused by the gorging of the heavy ice. The first bridge spanning the river between McConnelsville and Malta was built of iron and was nearing completion. The three main spans were in place but the draw had not been erected. The piers were not nearly so high as at present, having been raised two and possibly three times since.

There was very heavy ice in the river and when the ice flow came in the spring, it gorged at many places, both above and below McConnelsville. When the gorge from above came down, it stopped against the bridge piers. There was no strong current as another gorge below had backed the water up over the dam. When this gorge below let go, the river fell suddenly and an immense pressure was created on the gorge now resting against the bridge, and as the water was rising above and falling below, the ice soon crowded the bridge off the piers. Two spans went off, but the one next to the draw remained. This was on Saturday, Feb. 2, and about 7 o'clock p. m., when the crash came. The friction of the iron struck fire, which was like a flash of lightning, and the roar was equal to thunder. One span dropped through the ice, a short distance below the piers. The other was carried on the top of the gorge and dropped below the dam, where much of the iron was recovered during the next summer. Quite a lot of this iron was carried on down the river and was found below the Stockport dam. This deposit of iron in the river below the dam was a picnic for us boys. For this was nuggets, compared with hunting bones and old rubber in the alleys. Most of this iron was cast and for such pieces as we could handle, we found ready sale to the Pittsburgh packet and could then buy ammunition and fishing tackle. Much damage was done to the McConnelsville dam by this run of ice, there being breaks at two points where the dam was gone down to bedrock.

First Bridge in 1867

While this does not pertain to floods, I will say that the remaining span of the bridge was taken down and a covered bridge of wood was erected, which was our first bridge in service and was opened for traffic on Sept. 5, 1867. The present bridge, therefore, is the fourth on the one set of piers. This, as you all will agree, is a fine structure, and in my estimation is more symmetrical and of finer appearance than any spanning the Muskingum.

1884

Our next flood in this valley was in 1884, which again was a record breaker. The crest was recorded on February 9, reaching a depth of 45 inches on the abutment at the head of the canal. This, compared with the present gauge, would read 24 ft., 8 in., which would be about 21 inches higher than that of April 13, 1860. Again much loss was sustained, but it is difficult, at this date, to give much information concerning individual losses. However, this is the first instance when floods came to be regarded as a calamity for which the people felt that it was incumbent upon them to make some provision for the relief of the sufferers. Consequently, a meeting was called at the Morris music hall at which a considerable sum of money was raised, augmented by a canvass of the two towns. Little of this money was used here but was sent on down the river to towns which had suffered more. For the same purpose, our state legislature made an appropriation of $20,000 and Gov. Hoadley appointed Atty. J. T. Crew, who was then a resident of McConnelsville, to inspect the homes of the unfortunate in the different districts and to aid those who had little of anything with which to repair their dwellings. Mr. Crew reported that he found many instances where the people hesitated to receive aid, feeling that it made them appear as objects of charity.

I think it can be truthfully said that had Mr. Crew been in the same position after the flood of 1913 he would have found few cases of that kind. In this flood, as usual, the Muskingum improvement suffered another great loss, the principal one being at Taylorsville. The river at this point is narrower than at any other on the river, the natural rock bluff on the one side and the lock wall on the other chokes the current, so it often happened that the water was practically level on the dam, one mile above. Steamboats could pass up over this dam—nothing to prevent if they were able to stem the current at this narrow point. It was the choking of the water here that caused the river to overflow the canal banks, crossing the canal and getting back to its channel below the lock. Through navigation was again suspended and freight was transferred from Mason's Landing below, to Duncan Falls above the dam. The bridge at Duncan Falls had been carried off the pier by this flood and this made it possible for boats to pass up over the dam at times when there was sufficient water, thus avoiding transfer. No serious losses were sustained at McConnelsville, but much was prevented by timely action of our citizens in raising the embankment at the head of the canal and on the west side of the river. Business men of all classes could have been seen at this work. The late C. L. Barker was one of the principal laborers. This work went on continuously by night and day, hot coffee and lunch being brought by the women folk.

A Record Run

When it became known that the river had cut across the canal at Taylorsville, it was apparent that through navigation would be interfered with. Capt. Ed Martin, who was interested in the steamboats Gen. H. F. Devol and Lizzie Cassell, which were at Zanesville, summoned his pilots who lived in McConnelsville to Zanesville. This trip was made overland, of course, and via Chandlersville. Upon their arrival at Zanesville, a council was held, when it was decided to run these two boats out while there was plenty of water, rather than have them bottled up to lay idle. So without delay longer than to raise steam, these two boats started. One of them landed at Malta in one hour and 35 minutes and the other made a landing a few minutes later. This, no doubt, is the fastest time on record for a Muskingum river boat.

1898

Having two more floods to mention, both of still greater proportions, I will pass to that of March 1898. The water reached the highest point at 9 p. m. on March 24th, and remained stationary until 5 p. m., the following day. Water gauges had now been established and the reading was 24 feet and 7 inches, which was about 22 inches higher than that of 1884.

Since 1887, the Muskingum Improvement has been controlled by the federal government and had been much improved. The lock and dam, having been previously rebuilt, were in much better condition to withstand flood waters, so no great damage was done. There was slight interruption in navigation on account of several of the lock chambers being partially filled with sand, logs, etc. Again, as in 1884, prompt action and continuous work for days was necessary and a repetition of the efforts of 1884 prevented heavy loss. In building the embankment across the head of the island near the Elk Eye Mill, 3500 grain sacks were used, each filled with earth and built in crib fashion and kept above the level of the rising water.

The Flood

We will now have something to say of THE flood. It seems unnecessary to attempt to go into detail concerning this flood of March, 1913, as many, both old and young, certainly have a vivid recollection of the worry and excitement of our citizens. How quickly the news spread when at 1 p. m. on Friday morning, Mar. 28, the water, after having reached a stage of 40 ft. and 8 inches began to fall, after leaving its mark 14 ft. and 4 inches above that of any previous high water. In the reports of losses and damages caused by this flood, there was not much said about the government loss as this did not concern anybody very much. I may say that the lower lock gates at both Locks Nos. 5 and 6, Luke Chute and Stockport, were floated out of their recesses and lodged a short distance below. These gates were wrecked and the irons recovered and new gates built.

At McConnelsville, the head of the canal was completely filled with sand and long before the water had fallen to normal, teams were driven across this fill. In one respect, this was fortunate, as the bridge had been dumped into the canal a short distance below the abutment where it lay upside down. The bridge was hauled out of the canal, turned over and finally replaced on its pivot and shows no signs of the accident. This is probably the only bridge that got back home and there were 15 that spanned the Muskingum carried away between Zanesville and Marietta. The only bridge remaining was the famous Y bridge at Zanesville and it was seriously damaged. It was my business at this exciting time to take care of government property, and I gave it my undivided attention, which was simply to stand and watch it go and report that it had gone.

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