Form 9-014

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WASHINGTON 25, D. C.

FLOODS OF JULY 4-8, 1969 IN NORTH-CENTRAL OHIO

By

Ronald I. Mayo, Hydraulic Engineer

Earl E. Webber and Davis W. Ellis, Hydrologists

Prepared in cooperation with
the Ohio Department of Natural
Resources, Division of Water

OPEN-FILE REPORT

Columbus, Ohio
November 1971

U. S. GOVERNMENT PRINTING OFFICE 16—68863-2

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ABSTRACT

The storm of July 4-5, 1969, in north-central Ohio was an unprecedented event; never before has such intense and widespread precipitation been recorded for a summer storm in Ohio (U.S. Dept. of Commerce, 1969). More than 14 inches of rainfall in less than 24 hours were observed at several places. In areal extent more than 4 inches of rainfall occurred on about 6,000 square miles.

Record-breaking floods were observed at many places in north-central Ohio. Of the 50 sites for which the peak discharge was determined 40 are located on unregulated streams. The peak discharge at five of the 40 sites was four times as large as the discharge of the 50-year flood and the peak discharge for 17 sites was more than twice as large as that of the 50-year flood.

Severe losses in terms of lives and property damage were experienced; 41 deaths and more than $66 million in property damage were attributed to the rainstorm, accompanying wind, and resulting floods.

This report summarizes peak stages and (or) discharges at 55 sites including five reservoirs, in upper Muskingum River basin, in lower Sandusky River basin, and in the Huron River, Vermilion River, and Black River basins.

INTRODUCTION

The disastrous floods of July 4-8, 1969, in north-central Ohio were caused by the most intense and widespread summer storm recorded in Ohio. A line of thunderstorms, accompanied by wind gusts up to 100 miles per hour, moved into Ohio from Lake Erie in the evening of July 4 while thousands of people were gathered along the lake shore to observe fireworks displays. Although there were several hundred small boats on the lake, only three people were drowned as a consequence of capsized boats which had been upset by the wind squalls. Altogether 41 deaths were attributed to the storm and resulting floods. The largest loss of life was due to rapidly rising streams following torrential rains during the night of July 4-5.

The rains subsided on the 5th of July and amounts up to 14.8 inches were reported to have fallen in less than 24 hours, with the larger part falling during the 12 hours from 7 p.m. on the 4th to 7 a.m. on the 5th of July. Although rainfalls of 14 inches in 24 hours are unusual in Ohio, a more outstanding feature of the storm was the wide extent of heavy rainfall. An area of about 6,000 square miles in north-central Ohio received in excess of 4 inches of rainfall, and some small areas received as much as 14 inches of rainfall.

Severe flooding occurred on the unregulated tributaries of the Muskingum River upstream from Coshocton and on streams in the Lake Erie basin between Sandusky River and Rocky River. The 1969 flood exceeded other notable floods in north-central Ohio, particularly those that occurred in 1913, 1935, and 1959. The 1969 peak discharges at the gaging stations on Huron River at Milan, Vermilion River near Vermilion, and Black River at Elyria were about double the magnitudes of the January 1959 flood peaks, which were the maximums previously known in those areas. The peak discharges at five miscellaneous (ungaged) sites in the Muskingum River basin were on the order of four times the magnitude of their respective 50-year floods.

To define maximum rates of runoff, indirect measurements of peak discharges were obtained at 19 miscellaneous sites on streams in the areas of greatest rainfall. Results of these measurements supplement records for gaging stations in the area in describing the severity of the floods. Indirect measurements of peak discharge were obtained at 14 gaging stations to provide better definition of the stage-discharge relationships.

Purpose and Scope

The purpose of this report is to present a compilation of hydrologic data that document the magnitudes of the outstanding floods that resulted from the storm of July 4-5, 1969. The increasing public interest in flood protection and flood-plain management attests to the advisability of preserving significant information on the flood in one report. This report documents pertinent information on the July 1969 flood in a form useful to those designers, planners, and others who are concerned with flood-protection or other water-related projects.

The report discusses the precipitation, flood damages, measurement of flood discharges, and relates the magnitude of the 1969 floods to those of maximum floods previously known and to the 50-year flood. The flood data herein are limited to instantaneous maximum stages and discharges. Information on volumes of flood runoff and duration of flooding may be obtained from the annual report of the U.S. Geological Survey (1969) entitled, "Water Resources Data for Ohio, Part 1, Surface Water Records."

Acknowledgments

The documentation of basic streamflow records in Ohio is part of a continuing cooperative program with the Ohio Department of Highways, the Ohio Department of Natural Resources, the Miami Conservancy District, the city of Columbus, and the Corps of Engineers, Department of the Army.

The field and office work of collecting and tabulating basic records of streamflow as well as the analyses of the flood investigations were primarily the responsibility of the Columbus district office under the supervision of J. J. Molloy, district chief.

R. H. Tice, flood specialist, Mid-Continent Region, assisted in making reconnaissance surveys, outlined field work for indirect discharge measurements, and recommended methods of computing some of the complex measurements.

Many Federal, State, municipal and private agencies supplied information pertinent to the investigation. The isohyetal map and other meteorological data and the information on flood damage were furnished by the Division of Water, Ohio Department of Natural Resources, and the National Weather Service. Acknowledgement of other data furnished is made where the data appear in the text.

METEOROLOGY OF THE STORM

Showers and thunderstorms began in northwest Ohio during the morning of July 4, 1969, in connection with a warm front which was moving northeastward. By 5 p.m. the front had moved through Ohio, except for the extreme northeast, and general clearing followed. At 7 p.m. the Cleveland radar showed a nearly solid east-west line of thunderstorms just off Lake Erie shore which presented a definite threat to northern Ohio.

The thunderstorms, accompanied by vivid lightning, heavy rains, and wind gusts of up to 100 miles per hour, moved onto shore toward the east-southeast at a speed of about 50 miles per hour. Following the first storms, an area of great atmospheric instability remained almost stationary for nearly 8 hours. Between 8 p.m. on the 4th of July and 1 a.m. on the 5th of July numerous storms with torrential rains moved southeastward through the area of instability which was located approximately 30 miles either side of a line from Toledo to Dennison in Tuscarawas County. The cumulative precipitation for two representative sites that depicts the intensity of the storm is shown in figure 1.

Marvin Miller, State climatologist, stated that, "Never before has Ohio reported widespread heavy rains of the magnitude which fell between 7:00 p.m. on the 4th and 7:00 a.m. on the 5th." The isohyetal map in figure 2 shows the areal distribution of the rainfall for the storm of July 4-5. The map is based on data given in table 1 which includes rainfall records of the National Weather Service (NWS) and results of a "bucket" survey made by the Ohio Division of Water. The probable accuracy of results from a bucket survey is somewhat less than the accuracy of records from standard NWS rain gages, but the additional information, together with data from standard gages, define a reasonably accurate isohyetal map.

The precipitation-area relation for the storm of July 4-5 is given in table 2. The relation was compiled by planimetering the isohyets in figure 2.

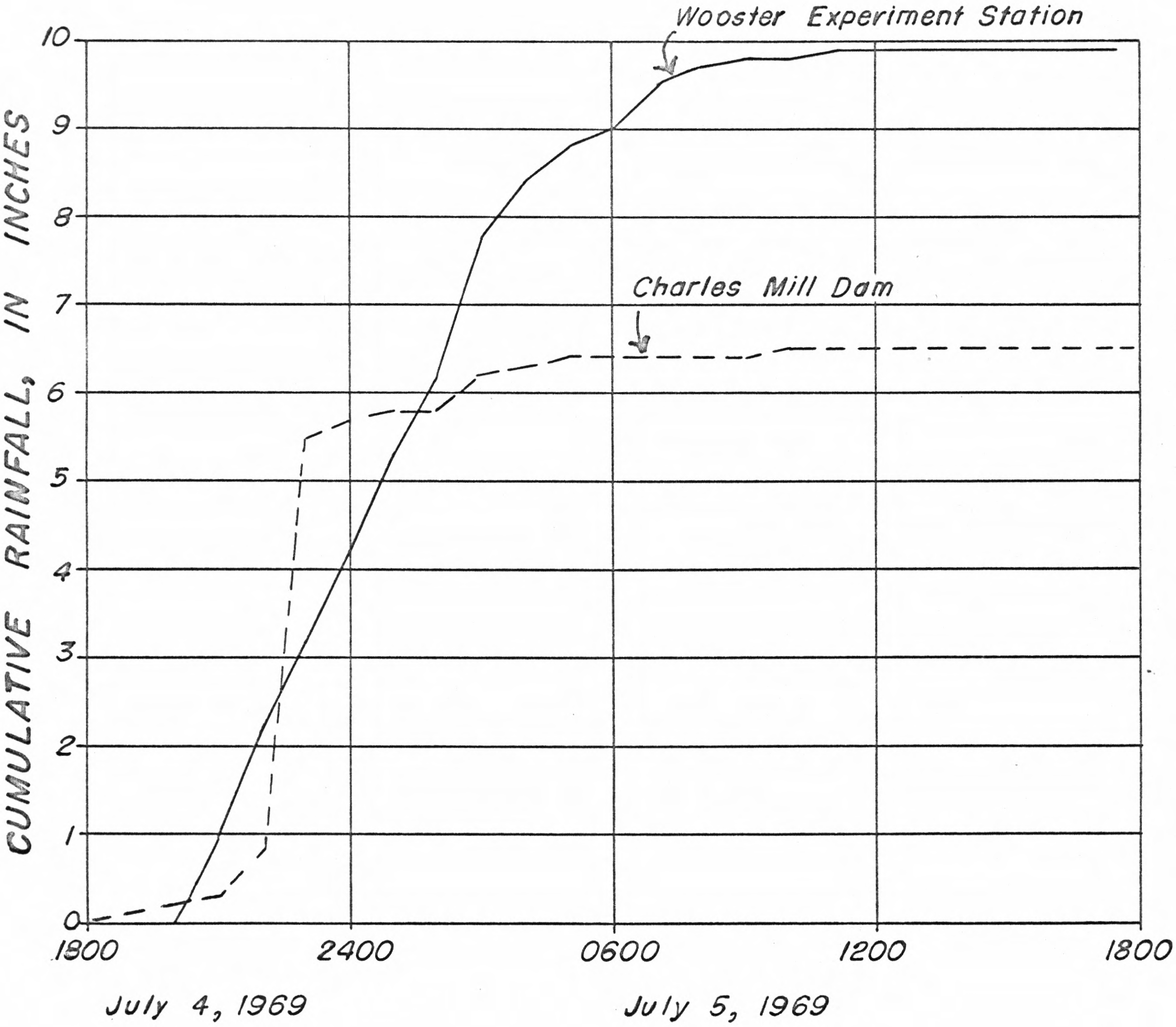

Figure 1.--Cumulative rainfall at selected recording precipitation stations in north-central Ohio.

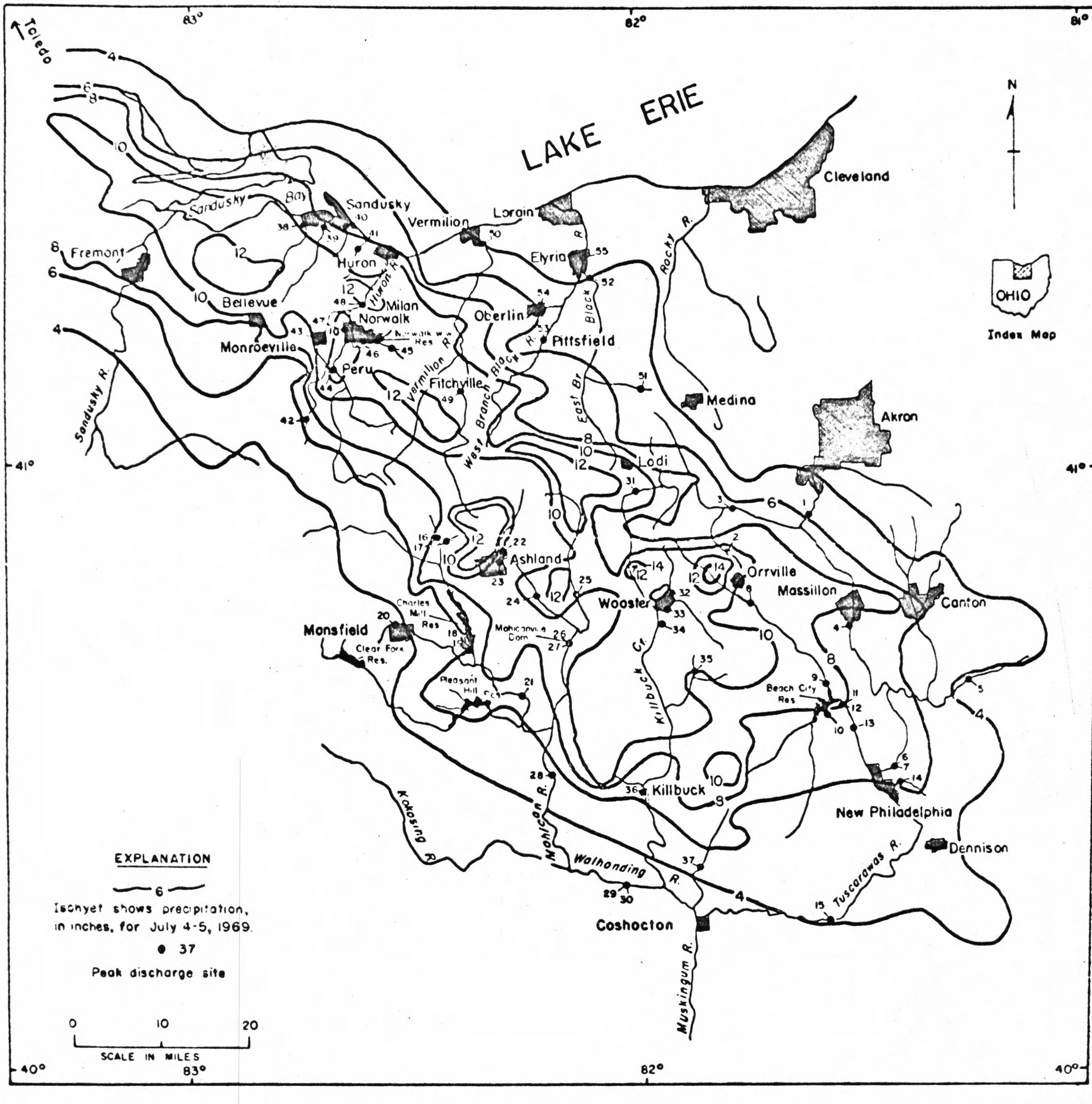

Figure 2.--Location of flood-determination points and isohyets for storm of July 4-5, 1969, in north-central Ohio.

Table 1.--Records of precipitation, July 4-5, 1969, in north-central Ohio.

Reported by [a]	Rain in inches [b]	Latitude			Longitude		
		deg	min	sec	deg	min	sec
Bowling Green Swg. Pl.	4.03	41	23		83	38	
Fostoria W End Substa	0.43	41	09		83	26	
Fremont	9.55	41	20		83	07	
Tiffin	2.23	41	07		83	10	
Upper Sandusky	0.24	40	50		83	17	
Bucyrus	0.48	40	49		82	59	
Plymouth	5.02	41	00		82	40	
Norwalk Swg. Pl.	9.72	41	16		82	37	
Sandusky	5.90	41	27		82	43	
Put in Bay Perry Mon.	2.36	41	39		82	48	
Toledo Sewage	3.73	41	41		83	29	
Toledo Blade	5.10	41	39		83	32	
Oberlin	4.17	41	18		82	13	
Elyria 3 E	3.45	41	23		82	04	
Cleveland WB Airport	2.87	41	24		81	51	
Akron Sewage Works	2.06	41	09		81	34	
Chippewa Lake	5.28	41	05		81	54	
Akron Canton WB AP	3.61	40	55		81	26	
Louisville	3.57	40	50		81	15	
Marshallville 1 SSW	9.44	40	54		81	44	
Wooster Exp. Sta.	10.36	40	47		81	56	
Ashland	8.99	40	52		82	18	
Mansfield WB AP	5.06	40	49		82	31	
Mansfield 6 W	1.18	40	45		82	38	
Charles Mill Dam	6.62	40	44		82	22	
Mohicanville Dam	9.67	40	44		82	09	
Pleasant Hill Dam	5.86	40	37		82	20	
Millersburg 1 W	7.80	40	33		81	56	
Greer	5.69	40	31		82	12	
Fredericktown	1.24	40	29		82	32	
Danville 2 W	2.08	40	26		82	18	
Gambier	2.25	40	23		82	23	
Mohawk Dam	1.77	40	21		82	05	
Centerburg	2.26	40	18		82	42	
Utica	2.21	40	15		82	27	
Alexandria 4 WSW	0.48	40	05		82	41	
Newark Wtr. Wks.	0.47	40	05		82	25	
Buckeye Lake	0.84	39	56		82	29	
Zanesville FAA AP	1.68	39	57		81	54	
Norwich 1 E	0.76	39	59		81	47	
Wills Creek Dam	1.88	40	09		81	51	
Cooperdale	2.51	40	13		82	04	
Coshocton Swg. Pl.	2.22	40	15		81	52	
Newcomerstown 1 NNE	4.66	40	17		81	36	
Coshocton Agr. Rsch. Sta.	5.15	40	22		81	48	
New Philadelphia	5.13	40	30		81	27	
Dover Dam	6.50	40	34		81	25	
Beach City Dam	8.74	40	38		81	34	
Bolivar Dam	6.15	40	39		81	26	
Carrollton 2 NW	2.52	40	36		81	06	
Atwood Dam	5.08	40	32		81	17	
Leesville Dam	3.64	40	28		81	11	
Tappan Dam	2.95	40	21		81	14	
Clendening Dam	4.55	40	16		81	17	
Piedmont Dam	3.50	40	11		81	13	
Middlebourne	1.47	40	03		81	20	
Cambridge Swg. Pl.	1.83	40	02		81	36	
Senecaville Dam	1.48	39	55		81	26	
Barnesville Water Wks.	2.59	39	58		81	10	
Ed Johlin	4.4	41	39	30	83	26	20
Martin Ruedy	8+	41	37	20	83	25	00
Carl Vogtsberger	6+	41	38	20	83	20	50
Merle Kuhn	5+	41	37	50	83	15	20
Mary Bockbrader	5.5+	41	25	00	83	26	40
Emmanuel Miller	6	41	27	20	83	27	40
Charles Goodman	6	41	29	30	83	27	10
Earl Schulte	4.2	41	32	00	83	26	00
Paul Schinin	7	41	34	20	83	27	10
Norman Bockbrader	4.6	41	33	50	83	29	50
Lawrence Gruetter	7.2+	41	35	30	83	22	40
Lyle Hellwig	8+	41	33	20	83	20	20
Carl Rothert	6	41	30	20	83	19	20
Fred Bringe	8.5	41	34	00	83	19	20
Ronald Pfeiffer	11	41	35	00	83	16	10
Wilbur Pfeiffer	8+	41	36	20	83	15	30
W. Hasselkus, Jr.	5.4+	41	28	50	83	14	00
Emerson Fillmore	8+	41	29	50	83	10	10
State Highway Garage	12	41	31	10	83	09	00
Gaylord Croll	10	41	32	40	83	08	40
Harry Winter	9.8	41	34	00	83	08	00
Howard Moore	8+	41	35	30	83	08	40
William Gyde	8.4+	41	36	10	83	08	00
Walter C. Miller	5.5+	41	32	40	83	05	10
Dick Kaspar	10	41	29	30	83	01	00
Harold Johannsen	7.8+	41	29	40	82	55	50
Mark Ford	3.5+	41	34	20	82	51	20

Table 1.--Records of precipitation, July 4-5, 1969, in north-central Ohio.--continued

Reported by [a]	Rain in inches [b]	Latitude deg	Latitude min	Latitude sec	Longitude deg	Longitude min	Longitude sec
Jack Gaydos	6+	41	32	10	82	42	50
William Allwardt	10+	41	25	20	83	23	10
August Gross	8.1	41	23	50	83	23	50
Merlin Schlea	7.5+	41	24	10	83	22	40
Alfred Schroeder	11+	41	24	10	83	20	10
Dale Sherrard	6+	41	21	20	83	19	50
Carl Bauer	7	41	21	50	83	16	30
Harold Draeger	9.5	41	26	40	83	13	10
Tom Wagner	7+	41	23	40	83	11	50
Edgar Bolen	8.5	41	21	30	83	13	40
William Roth	4.3	41	17	50	83	11	30
Forest Longanbach	5.1	41	16	20	83	11	30
Paul Murray	5.0	41	15	30	83	08	50
Unknown	5.5	41	16	10	83	05	10
Daniel Michaels	6.2+	41	18	10	83	06	20
Byron Kiser	9+	41	18	20	83	04	10
H. W. Rathbun	5+	41	17	20	83	03	30
Melvin Shaffer	8.5	41	21	10	83	04	10
Davis Sunderland	8.5	41	21	20	83	06	40
Richard Saionz	8.8	41	23	10	83	09	00
Unknown	6	41	23	10	83	04	00
Unknown	11	41	24	50	83	00	40
Wahl	12.5	41	21	00	82	57	30
Kuns	8.2	41	15	30	82	58	20
M. Love	10.75	41	16	10	82	54	20
Ohio Exp. and Development Ctr.	11.60	41	26	00	82	52	20
Unknown	11+	41	26	30	82	47	50
Unknown	11.7	41	22	10	82	49	20
Barden Graves	11.3	41	22	00	82	49	00
Robert Moser	13.2	41	20	50	82	49	50
Wayne Bunting	13.7	41	20	50	82	47	30
Kenneth Edwards	12.5	41	21	10	82	47	00
John Schaeffer	10.1	41	17	30	82	46	30
Mrs. Glenn Sargeant	7.3	41	17	50	82	43	00
Leroy Stotz	7.5+	41	19	30	82	41	30
Clarence Hermes	9.5	41	22	50	82	44	30
Eugene Windau	10	41	23	40	82	44	00
NASA (Sandusky)	10.07	41	23	10	82	41	10
NASA (Sandusky)	9.2	41	23	10	82	40	00
BGSU (Firelands Campus)	7.80	41	23	50	82	35	30
Charles Nickels	8.8	41	21	30	82	36	30
E.H.O.V.E. School	12	41	20	00	82	37	50
Mabel Stoll	11.5	41	17	10	82	36	50
Merlyn Miller	13.10	41	17	50	82	34	00
Harold Schuster	10.5	41	19	50	82	34	00
C. C. Nottke Jr.	10.5	41	18	40	82	32	40
Wayne Schlessman	10.3	41	19	30	82	34	50
George Coultrip	10+	41	18	10	82	32	50
George Danilla	11.9	41	18	10	82	30	40
Bill Heckleman	12	41	18	20	82	29	40
Max Krueger	6	41	19	30	82	28	50
William Schneider	5+	41	22	30	82	28	20
Trinter	5.5	41	22	50	82	21	50
Mrs. Paul Knott	5.8	41	21	00	82	21	40
Dennis Green	9.4	41	17	00	82	23	10
Unknown	3.5	41	23	10	82	18	10
Harry Stick	5	41	22	00	82	16	50
SCS Secretary	3.6	41	22	20	82	10	40
Unknown	5.5+	41	19	30	82	14	30
Moles	5.4	41	15	40	82	00	40
Dutte	4.5	41	15	50	82	08	20
Charles Luikart	7+	41	16	30	82	15	20
Schlecter	8	41	17	50	82	18	50
D. P. Davidson	6.5	41	14	50	82	15	20
SCS	4.60	41	14	10	82	15	10
Leon Hastings	7	41	11	00	82	08	30
Herbert Miller	6.6	41	09	10	82	09	20
Wellington Water Works	8.3+	41	09	10	82	14	40
Findley State Park	6	41	07	20	82	13	00
William Murray	8+	41	05	30	82	16	40
Thompson	7.3	41	07	00	82	07	50
Ray Stroup	7.4	41	05	00	82	07	20
L. R. Barnhart	5.5	41	04	20	82	01	30
John E. Keim	10.3	41	02	00	82	01	00
Clark Brooks	7	41	01	40	81	56	10
Lucas	5.0	41	05	10	81	56	20
Paul Krugle	5.8	41	08	40	82	01	20
Schnabel	5	41	11	30	82	01	20
Morlock	3.0	41	10	50	81	55	40
Stienges	2.5	41	14	30	81	55	30
Charles Miller	3.1	41	14	20	81	44	10
R. Schaffer	2.5	41	14	00	81	42	10
Kreuger	2.6	41	12	00	81	46	10
Medina Water Works	2.8	41	09	10	81	49	20
Farm Pakt Pickles	2.8	41	07	50	81	49	20
Seville Elevator	8	41	00	30	81	51	50

Table 1.--Records of precipitation, July 4-5, 1969, in north-central Ohio.--continued

Reported by [a]	Rain in inches [b]	Latitude deg	Latitude min	Latitude sec	Longitude deg	Longitude min	Longitude sec
George Rohrer	4	41	02	20	81	48	40
Wadsworth Sewage Plant	3.45	41	00	30	81	45	00
D. E. Hardies	4.85	41	00	10	81	43	30
Barberton (CAK-15)	2.25	41	04		81	36	
Bill Smith	5.5	41	05	50	82	57	30
Gary Weller	6.5	41	10	40	82	58	10
Walter Hansen	5	41	15	10	82	55	10
R. C. Walters	7+	41	13	30	82	54	50
Harlow Boyer	6.3	41	15	00	62	52	50
Arthur Hansen	8.6	41	13	20	82	50	40
Raymond Longsheid	4.9	41	13	30	82	50	20
C. W. Korndorfer	10+	41	14	20	82	48	20
George Reamer	8.7	41	13	10	82	48	50
George Sherman	9.0	41	14	50	82	45	50
W. Horn	10	41	14	40	82	45	50
J. Neil	9.5	41	16	00	82	45	10
Philip Martin	9.6	41	15	00	82	44	10
Warren Jump	11.5	41	15	40	82	42	40
Martin Bros.	9.5+	41	15	10	82	43	20
J. Bauer	12	41	15	10	82	40	00
R. Schied	7.5	41	12	40	82	45	00
Walter Miller	5.5	41	12	30	82	49	20
Cletus Alt	6+	41	11	10	82	49	50
Joseph Didion	5.6	41	11	20	82	48	30
S. Ruffing	5.0	41	10	40	82	47	10
Harvey Schide	5.5	41	11	00	82	44	00
Russell Bumb	4.0	41	09	10	82	47	20
Wise	3.1	41	08	30	82	47	50
Jerald Daniel	4	41	06	00	82	47	00
A. J. Teagarden	5.8+	41	05	20	82	47	00
R. O. Wurtz	4.5	41	05	00	82	49	50
Richard Shook	3.5	41	02	40	82	49	50
E. P. Hoyles	4.0	41	02	40	82	49	10
Mrs. Keesy	4.4	41	02	10	82	46	50
Louis Cramer	3.5	41	00	20	82	48	50
Virgil Cramer	3.0	40	59	50	82	48	10
Agricultural Exp. Sta.	4.65	41	00	40	82	43	50
Pagerski	4.7	41	01	10	82	41	20
Dennis Miller	6	41	01	50	82	38	40
Morris	7.5	41	01	50	82	36	20
Keefer	8+	41	03	50	82	35	10
Albert Smith	5.8	41	03	30	82	41	00
Willard Stein	8	41	04	50	82	41	00
Wilbur Baker	8.0	41	06	00	82	41	00
Ralph L. Walcher	9.5	41	06	10	82	33	20
Stoneham	9	41	07	10	82	35	20
M. H. Weissenberger	8.6	41	11	40	82	32	20
Unknown	12.8	41	10	40	82	34	30
Hintz	10+	41	10	20	82	35	20
Clarence Brown	11.5	41	10	40	82	38	50
H. W. Kmann	12	41	08	50	82	41	20
Melvin Keefer	10.9	41	09	50	82	41	10
Mike Sabo	12.5	41	10	20	82	41	00
Fred Hipp	13.5	41	11	00	82	40	50
Ron Stieber	12	41	16	30	82	38	50
Harold Schnee	11.6	41	17	00	82	38	30
Unknown	11+	41	16	40	82	36	50
Linder	11.5	41	14	00	82	33	10
Henry Horning	9+	41	16	40	82	32	00
Forrest Richmond	11.5	41	16	10	82	29	30
Unknown	9.5	41	15	30	82	28	40
Jack Liles	10+	41	16	20	82	28	00
Unknown	9	41	17	00	82	24	00
C. G. Todd	11+	41	15	30	82	23	50
Martin Todd	8+	41	13	50	82	21	40
Bowman	10.5	41	10	20	82	21	00
L. Gibson	11	41	11	00	82	25	50
Wayne Patchen	11	41	11	50	82	29	30
W. Pickworth	8.8+	41	09	40	82	29	20
Carl Gerstenberger	13.5	41	09	20	82	29	40
Moore	12	41	08	40	82	27	10
Unknown	4.8	41	08	50	82	21	00
Robert Timmons	11.3	41	07	20	82	24	30
Melvin Deppen	12+	41	07	20	82	27	40
Loyal Dunlap	11	41	05	30	82	20	50
Reidy	11+	41	05	00	82	22	40
Sewage Plant (N. London)	12.5	41	05	30	82	24	20
Johnson Porter	12.5	41	05	40	82	27	40
Howard	11	41	05	10	82	29	20
Saunders	8.5	41	02	50	82	29	20
Johnston	7.5	41	00	50	82	32	30
Zimmerman	8	41	01	00	82	29	10
Frank Dosson	7+	40	59	20	82	27	20
Shiloh Sewage Plant	4.6	40	58	20	82	36	10
Raymond Wells	6.75	40	57	00	82	32	10
Leo Fair	8	40	56	00	82	25	30
Willis Esbenshade	8	40	54	20	82	26	20

Table 1.--Records of precipitation, July 4-5, 1969, in north-central Ohio.--continued

Reported by [a]	Rain in inches [b]	Latitude deg	Latitude min	Latitude sec	Longitude deg	Longitude min	Longitude sec
Ross Hovey	8	40	54	30	82	27	20
Reynolds	4.5	40	54	30	82	33	50
Lowell Strauch	2.5	40	54	30	82	43	10
Will	4.0	40	50	30	82	39	10
Unknown	4	40	51	30	82	34	20
Lee Oswalt	6	40	51	40	82	29	30
Richard Gramley	8	40	49	50	82	28	10
Robert Wilson	5.5	40	49	50	82	27	50
Mrs. Groff	6.3	40	49	20	82	26	10
Don Green	5.25	40	44	40	82	25	20
Richard Lehnhart	5	40	42	50	82	25	50
Kisling	3.15	40	41	40	82	32	00
Joseph Wagenhals	6.56	40	39	10	82	28	40
Derald Darling	7.25	40	38	00	82	21	20
Clark Garber	4.90	40	35	20	82	25	30
Paramore	11.3+	41	03	00	82	25	40
George Willard	10	41	03	30	82	18	10
Rob Roy Crumrine	12+	41	03	30	82	16	50
William Cowhick	12	41	03	30	82	14	10
Vanbuskirk	12+	41	02	20	82	12	10
Swope	8.3+	41	01	40	82	14	20
Szabo	11.5+	41	02	30	82	18	00
Unknown	8.5+	41	01	40	82	18	30
Coffman	8+	41	00	50	82	17	40
Llouser	8.5	41	00	40	82	20	50
Unknown	8+	41	01	50	82	21	20
Unknown	9.5	41	01	40	82	23	20
Unknown	9+	41	01	00	82	22	10
M. Baer	9.8	41	00	40	82	23	00
Unknown	12+	40	56	30	82	24	30
Unknown	8.5+	40	57	20	82	23	50
Unknown	7.3+	40	58	10	82	20	40
Unknown	12+	40	58	10	82	19	20
Unknown	8.8+	41	59	30	82	14	30
Unknown	8.5+	40	59	10	82	14	00
Unknown	10	41	00	40	82	12	10
Unknown	7.8	40	55	20	82	14	00
Kettering	7.7+	40	54	10	82	13	30
Unknown	8.2+	40	55	20	82	16	00
Unknown	12+	40	55	20	82	16	50
Unknown	12+	40	55	40	82	19	00
Unknown	8.5+	40	54	00	82	23	20
Vines	12	40	51	30	82	24	10
Unknown	8.2	40	48	10	82	21	20
Gortner	8+	40	53	20	82	09	30
Unknown	12+	40	51	30	82	09	20
Cripe	10.5+	40	50	30	82	12	00
Funk	10.5	40	50	00	82	09	20
Ross	12+	40	48	30	82	11	50
Tugend	8.6	40	46	40	82	14	20
Long	9.5	40	44	10	82	19	00
Unknown	9	40	43	00	82	17	00
Spreng	6.5	40	39	10	82	16	40
Hefflfinger	6.8	40	38	40	82	13	40
Neiderhiser	7.2	40	41	20	82	14	30
Unknown	9	40	41	30	82	11	20
Unknown	11.2	40	42	30	82	07	50
Mrs. M. L. Zickefoose	13.5	40	59	10	82	05	20
Clair T. Jones	12.3	40	55	10	82	07	10
Lloyd C. Shew	10.5	40	53	30	82	05	40
Duane Kline	9	40	57	10	82	05	20
Mrs. Orland A. Shaum	10.3	40	57	00	82	02	50
Harold Tettmeier	8.20	40	56	10	82	01	50
Robert Schulz	7.5	40	56	40	82	00	50
Arther Irvin	7.7	40	54	50	81	59	00
Robert Cockrell	11.5	40	58	40	81	58	10
E. O. Moore	8.15+	40	57	10	81	57	30
Fredrick Hookway	8.5	40	55	50	81	55	30
Harold Bowman	7.7	40	55	40	81	54	20
Herb Werstler	7+	40	58	10	81	54	40
Doylestown (CAK-21)	6.05	40	58		81	42	
Chester Kieffaber	9.2	40	54	10	81	44	30
Don Weygandt	9.64	40	52	30	81	43	00
Marion Mast	10.1	40	52	20	81	44	50
Winston C. King	10.71	40	51	00	81	47	20
William D. Wagner	10.5	40	50	40	81	47	50
Carl J. Conrad	14	40	52	00	81	49	20
Roy Ramseyer	7.5	40	54	50	81	49	20
Fred Stein	11.6	40	52	20	81	52	00
Donald L. Moomaw	12	40	52	00	81	52	00
Paul Schmidt	11.0	40	51	50	81	54	40
Ralph Basom	11.5	40	52	20	81	55	20
Ralph Metz	11.7	40	52	20	81	56	30
Richard D. Kinney	11.3	40	49	40	81	54	40
Mrs. Alan Collins	9.8	40	49	20	81	55	50

Table 1.--Records of precipitation, July 4-5, 1969, in north-central Ohio.--continued

Reported by [a]	Rain in inches [b]	Latitude deg	Latitude min	Latitude sec	Longitude deg	Longitude min	Longitude sec
John Wilson	12.7	40	49	40	81	56	30
George Still	11.53	40	50	00	81	57	00
Joe Ritter	11.6	40	50	40	81	58	20
E. A. Bosler	11.5	40	51	00	81	59	50
Russell J. McConahay	11.6	40	52	10	82	00	20
F. C. Wright	14.8	40	52	00	82	00	40
Robert M. Martin	9+	40	51	50	82	02	50
Walter Ogden	10.6	40	51	50	82	05	10
Vernon F. Fair	11.1	40	51	30	82	06	00
Mrs. R. G. Donaldson	10.2	40	50	00	82	05	00
Kenneth Reichert	11.2	40	50	30	82	02	40
John Slater	10.6	40	49	20	82	00	20
Larry Landman	11.5+	40	46	20	82	01	20
Wayne Firebaugh	9.6	40	45	30	82	04	40
Charles F. Esselburn	11.1	40	42	30	82	06	30
Shreve (CAK-68)	6.75+	40	42		80	02	
Luther Gilmor	9.8+	40	43	00	81	58	30
Kenneth Wirt	12.0	40	43	50	81	56	40
Malva Shetler	10.5	40	41	00	81	49	10
George R. Maurer	11.0	40	42	30	81	49	00
Unknown	11	40	43	10	81	49	20
Ronald Gochnauer	11.3	40	44	40	81	50	00
Mrs. Ella Manson	10.2	40	45	50	81	49	20
Harold W. Snyder	9.87	40	46	40	81	50	40
Irvin E. Snyder	10.2+	40	49	00	81	50	20
Orie Conrad	13.0	40	50	00	81	50	30
Dwayne Burns	13.8+	40	49	30	81	49	30
Apple Creek (CAK-52)	10.20	40	48		81	48	
Mrs. Elmer Wenger	7	40	49	00	81	42	30
Ronald Hahn	8.97+	40	45	10	81	44	50
Emerson M. Hostetler	12.0	40	44	30	81	43	10
Wilford Neuenschwander	9.2	40	45	00	81	42	00
Mrs. Roy Young	9	40	50	20	81	37	10
William B. Weible	6.95	40	51	30	81	33	50
N. Canton (CAK-28)	4.65	40	52		81	25	
Harry V. Sebald	3.6	40	51	50	81	24	00
Lyman Brett	2.7	40	57	00	81	22	50
Hartville (CAK-26)	3.01	40	57		81	20	
Harrisburg (CAK-25)	2.70	40	52		81	13	
Wilbur Elliott	5.1	40	46	10	81	13	20
Eleanor Coleman	3.2	40	49	40	81	15	50
Louisville (CAK-27)	2.90	40	50		81	16	
Canton NE (CAK-22)	5.1	40	50		81	20	
Canton NW (CAK-23)	5.1	40	50		81	23	
Canton WPC (CAK-24)	5.25	40	47		81	22	
Miss Sandra Schmader	8.0	40	47	20	81	25	10
Massillon (CAK-14)	6.7	40	46		81	32	
Mrs. L. J. Peterman	7.8	40	43	10	81	31	10
Magnolia (CAK-U)	3.95	40	39		81	18	
Chesterville (CAK-46)	1.30	40	29		82	44	
Chester-Sparta (CAK-47)	1.70	40	26		82	40	
Waterford (CAK-51)	1.46	40	33		82	36	
Mt. Liberty (CAK-50)	2.40	40	21		82	38	
Green Valley (CAK-49)	1.76	40	25		82	31	
Mt. Vernon (CAK-44)	2.39	40	22		82	29	
Homer (CAK-41)	1.70	40	15		82	32	
Johnstown (CAK-42)	0.24	40	09		82	42	
Fredonia (CAK-40)	0.34	40	08		82	30	
Wayne E. Power	11.6	40	35	10	82	07	30
Mr. Lang	8+	40	36	20	82	03	20
Vernon D. Kline	8+	40	37	50	81	59	50
Gerald Nowels	11.2	40	35	50	81	58	20
Clifford Woodruff	10.1+	40	33	30	82	01	20
Paul Leanard	8.0	40	32	20	82	00	50
John L. Bower	11.5	40	30	40	82	06	10
Robert L. Watts	4.60	40	28	20	82	07	00
Harvey Beller	5.4	40	28	00	82	01	20
Merton Guthrie	7.8+	40	27	30	81	54	30
Caroline Straits	7.85	40	29	00	81	56	00
Mr. Steele	7	40	31	00	81	56	00
Mrs. Geraldine Snyder	7.8	40	32	50	81	56	50
Tom Bernard	9	40	31	50	81	54	00
Holmesville (CAK-60)	11.05	40	38		81	54	
K. P. Sterling	9	40	40	00	81	51	40
Eli D. Schlabach	11	40	39	20	81	48	40
Irvin Weaver	9.2+	40	38	50	81	49	00
Noah A. Mast	8.5+	40	38	00	81	42	40
Ezra Y. Miller	8.0	40	36	30	81	47	10
Blake Boyd	9.7	40	34	00	81	49	00
William H. Miller	8.5	40	33	50	81	47	10
Vernon Raber	9	40	34	00	81	46	50
Yoder Hybrid Corn Co.	8.9	40	33	30	81	47	50
Lynn Newnham	9.8	40	33	40	81	48	00
Levi Schlabach	11.1	40	30	50	81	48	00

Table 1.--Records of precipitation, July 4-5, 1969, in north-central Ohio.--continued

Reported by [a]	Rain in inches [b]	Latitude deg	Latitude min	Latitude sec	Longitude deg	Longitude min	Longitude sec
Andy Hershberger	9.1	40	30	10	81	47	00
Roman Miller	6.5+	40	30	50	81	44	30
Levi Troyer	6.2	40	30	00	81	40	10
Coshocton Agr. Rsch. Sta. (MC-6)	5.74	40	26	00	81	48	40
Coshocton Agr. Rsch. Sta. (91)	6.68	40	24	30	81	47	30
Coshocton Agr. Rsch. Sta. (27)	5.45	40	23	20	81	48	20
Coshocton Agr. Rsch. Sta. (MC-4)	6.61	40	23	50	81	50	30
Coshocton Agr. Rsch. Sta. (39)	5.19	40	23	00	81	49	20
Coshocton Agr. Rsch. Sta. (56)	4.46	40	22	00	81	50	20
Coshocton Agr. Rsch. Sta. (54)	4.87	40	22	10	81	49	30
Robert Strock	4.67	40	26		81	42	
Sugar Creek (CAK-29)	7.45	40	38		81	33	
Cecil A. Yockey	6.36	40	34	20	81	34	20
Harry Graef, Jr.	6.6	40	32	10	81	27	10
Corps of Engineers	6.30	40	30	30	81	27	00
W. I. Kaderly	6.8	40	29	20	81	23	30
Ray Stansbury	4.6	40	28	40	81	22	40
Dennison Water (CAK-30)	4.26	40	22		81	20	
Mrs. Matthews	3.47	40	13	40	81	26	20

[a] Stations with CAK designation in parentheses are part of the Akron-Canton Weather Bureau Flash Flood network.

[b] += container overflowed.

Table 2.--Precipitation-area relation for the storm of July 4-5, 1969

Precipitation, in inches (equaled or exceeded)	Area, in square miles
12[1/]	192
10	1,163
8	2,234
6	3,494
4	5,793

1/ Maximum reported, 14.8 inches.

GENERAL DESCRIPTION OF THE FLOODS

Floods resulting from the heavy rains of July 4-5, 1969, occurred on most of the streams draining into Lake Erie between the Portage River on the west and the Rocky River on the east, and on the tributaries of the Muskingum River upstream from Coshocton, Ohio.

The tributaries at the headwaters of the Portage and Sandusky Rivers overflowed their banks damaging many acres of farm crops. However, the flood volumes in these river basins were neither large nor concentrated enough to cause more than nominal flooding of their main stems. The same conditions prevailed at the eastern boundary of the flood area in the Rocky River and Cuyahoga River basins. Floods on the Huron River, Vermilion River, and Black River and on their principal tributaries were about twice the magnitude of their estimated 50-year floods. In the Muskingum River basin, Jerome Fork, Muddy Fork, Killbuck Creek, and Chippewa Creek had extreme floods on both their main stems and their principal tributaries.

The south half of the city of Sandusky was turned into a large lake for the second time in three years by flooding from four small tributaries of Lake Erie. A few miles south of Sandusky, the city of Bellevue was inundated for the first time since June 1939. There are no surface streams of any consequence flowing through Bellevue, but the city is built on a network of underground streams and caverns that serve as its sewerage system. Ten inches of rain falling in 16 hours, plus runoff from rural areas to the south forced water and sewage back into the sink holes. Parts of the city were under 8 feet of water for several days. Due to the lack of an adequate natural drainage system in Bellevue, 5,600 feet of pipe were laid to pump the flood water into a drainage ditch emptying into Sandusky Bay (U.S. Corps of Engineers, 1970c).

The outstanding flood features for each major river basin in the flood area are summarized in the following paragraphs.

Muskingum River

The July 1969 floods were greatest on the tributaries of the Muskingum River upstream from Coshocton. There was flood damage in many of the cities and towns in this area. Almost every road into Wooster was closed for a period following the flood peak. Operation of the city's water treatment plant was not resumed until July 11. Orrville was without electric power until July 7. Water 3-4 feet deep in Killbuck flooded 95 percent of the homes in this village causing extensive damage. Many roads and bridges throughout the 10-county area were washed out.

Flood control reservoirs operated by the Corps of Engineers were effective in reducing flood stages in the Walhonding River basin and on the lower Tuscarawas River and Muskingum River. Beach City Reservoir, on Sugar Creek, a tributary of Tuscarawas River, and Mohicanville Reservoir on Lake Fork of Mohican River, being near the centers of heaviest rainfall, were operated nearly to capacity. The rainfall rate above these reservoirs was so intense that both had to be programmed to release flood water during the late evening of July 5. In spite of these releases, Beach City Reservoir peaked within 3 inches of the level of the emergency spillway, at 97.8 percent of its capacity. Mohicanville Reservoir came to within 8 inches of the spillway, using 94.4 percent of its capacity (U.S. Corps of Engineers, 1970d).

The severest flooding, in terms of hydrologic significance, occurred on streams in the headwater area of the Muskingum River. The five sites, shown in figure 3, where the peak discharges were about four times the magnitude of the corresponding 50-year floods are located in the Muskingum River basin.

There were two peaks of about the same stage on the Tuscarawas River at Newcomerstown. The first peak about 8-10 a.m. July 6, was the result of direct flood runoff, and the second about 48 hours later appears largely to have resulted from reservoir releases. The Muskingum River at Coshocton, which is just downstream from the confluence of the Tuscarawas River and Walhonding River had a single peak occurring about 1 a.m. on July 7. The Huntington District, Corps of Engineers, reported that four upstream reservoirs reduced the potential flood stage of the Tuscarawas River at New Philadelphia by 6.4 feet, and the 12 reservoirs upstream from Coshocton reduced the stage of the Muskingum River at Coshocton by 8.4 feet.

Huron River

The July 1969 flood on the Huron River resulted from an estimated 7.3 inches of rainfall on the watershed within a 24-hour period (U.S. Corps of Engineers, 1970a). The flood peak at the Milan gaging station was 1.8 times the magnitude of the estimated 50-year flood. The stage was 7 feet higher than that of the next highest recorded flood, that of January 1959. Records at this station are continuous since March 1950.

The peak discharge on the West Branch Huron River at Monroeville (drainage area, 218 sq mi) was 1.9 times the magnitude of the estimated 50-year flood. On the East Branch Huron River at Peru (drainage area, 29.2 sq mi) the peak discharge was 2.8 times that of its estimated 50-year flood.

Many streets in Monroeville were under 4 feet of water for 3 days following the flood. At Milan, 2 miles below the confluence of the East and West branches, the lower residential areas and the camp grounds and trailer parks along the river were inundated.

The flooding of Norwalk Creek in the city of Norwalk was aggravated by the failure of the dam at one of the city's three water-supply reservoirs. The earth embankment of the lower reservoir was breached at 9:30 a.m. Saturday (July 5). This reservoir also serves as a cooling pond for the municipal electric plant. The city was without water and electricity for several days after the flood. At the height of the flood the only major highway open into Norwalk was U.S. 20. Cole Creek, a small tributary of the East Branch Huron River, overflowed and inundated 50 trailers and 16 cars in a small park in Norwalk.

The city of Huron, at the mouth of the Huron River, suffered extensive damage, both from the river and from high winds and waves on Lake Erie. Flood waters from the river forced several hundred residents from their homes. The resort areas at Franklin Flats, Boyer's Trailer Park, and Willow Bend Camp site were the hardest hit.

Vermilion River

The July 1969 flood on the Vermilion River was the highest known. It was reported that the flood crested at 3 p.m. Saturday (July 5) in the city of Vermilion, receded about 18 inches by 6 p.m. and rose again to its highest stage, 13 feet above flood stage, about 4 a.m. Sunday. This is 2 feet higher than the stage of the highest flood previously known, that of March 1913, and 5 feet higher than the flood of January 1959 (U.S. Corps of Engineers, 1970b).

At the gaging station, 3.5 miles upstream from Vermilion, the 1959 flood was the highest previously recorded since the record began in March 1950. The peak stage for the 1969 flood at the gaging station was 3.3 feet higher than that of January 1959. The 1969 peak discharge at the gage was about twice the magnitude of the estimated 50-year flood, and upstream at Fitchville (drainage area, 107 sq mi) the peak discharge was determined to be about three times the magnitude of the estimated 50-year flood.

Flooding in the Vermilion River watershed resulted from an estimated 6.7 inches of rain falling within a 24-hour period.

Black River

The greatest flood of record on the Black River was that of July 6, 1969. At the Elyria gaging station, 0.8 mile downstream from the confluence of the East and West branches, the stage was 26.4 feet, 3.5 feet higher than the next highest flood, which occurred in January 1959. The discharge at the gage was 2.5 times the magnitude of the estimated 50-year flood. Records have been kept at this station since October 1944. The greatest historical flood (highest known flood prior to the period of record) was that of March 1913 and evidence indicates that it was lower than both the 1959 and 1969 floods (U.S. Corps of Engineers, 1970).

The peak discharge of the 1969 flood on the West Branch Black River at Pittsfield (drainage area, 79.4 sq mi) was 3.1 times the magnitude of the estimated 50-year flood at this site. Plum Creek, a small tributary of West Branch Black River (drainage area, 4.83 sq mi) peaked at Oberlin with a discharge 1.5 times that of the estimated 50-year flood.

On the East Branch Black River at Elyria (former gaging station, drainage area, 217 sq mi), the peak discharge was 1.5 times the magnitude of the estimated 50-year flood. At a point upstream on East Branch near the village of River Corners the stream overtopped the southern embankment of Spencer Lake and washed out the northern embankment. This lake, owned by the Ohio Department of Natural Resources, Division of Wildlife, is located about 9 miles northwest of Lodi, Medina County.

It was estimated that the floods in the Black River watershed resulted from 4.2 inches of rainfall within a 24-hour period.

FLOOD DAMAGES

The storm of July 4-5, 1969, caused severe losses in terms of lives and property damages in a 21-county area of north-central Ohio; 41 deaths and more than $66 million in property damage were attributed to the storm and resulting flood.

The initial line of thunderstorms moved onto Lake Erie shore at a time when people were gathering at shoreline parks for special Fourth of July programs and fireworks displays. For this occasion, small-boat owners anchored their crafts just offshore to observe the fireworks. There were only three lives lost on the lake even though hundreds of boaters were caught by the storm. Thousands of trees were uprooted as the initial wind gusts, of up to 100 miles per hour, moved onshore. In Toledo alone city officials estimated that at least 250 of the 5,000 downed trees either fell onto houses or blocked streets.

The timing of the storm, as well as its intensity and total rainfall, was a significant factor in contributing to the inordinate number of deaths that occurred. Streams throughout the area rose so rapidly during the night of July 4-5 that many people were trapped by overbank flooding, inundated highways and washed out bridges (see fig. 3). Of the total number of deaths, 25 persons were drowned, 8 were killed by falling trees, 6 were electrocuted by fallen wires, 1 was killed by lightning, and 1 died from other storm-related injuries (U.S. Dept. of Commerce, 1969).

Estimates of damages resulting from the storm of July 4-5, 1969, including wind and flood damages, are summarized as follows on the basis of data from the American Red Cross, U.S. Department of Agriculture, Corps of Engineers, GPO : 1955 O—334275

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

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Figure 3.--Representative stage hydrographs.

Civil Defense, and newspaper clippings:

Type of damage	Losses
Private property --------------------	$5,407,000
Crops and livestock -----------------	20,520,000
Boats -------------------------------	1,248,750
Cars --------------------------------	4,000,000
Public property and utilities -------	35,000,000
Total ----------------------------	$66,175,750

Flood damages in the Muskingum River basin were reduced considerably by the system of 15 flood-control reservoirs in the basin. The Corps of Engineers reported (1970d) that, "In all, the system of reservoirs reduced downstream damages from an estimated 49.6 million dollars to 4.6 million dollars...." The rainfall distribution was such that the Mohicanville and Beach City reservoirs were in the area of maximum runoff. Consequently their storage capacities were almost fully utilized; about 94 percent of available storage in Mohicanville Reservoir was used and about 98 percent of available storage in Beach City Reservoir was used.

It was reported that 292 bridge structures were damaged or destroyed and that roads were closed at more than 900 places in the flooded area. Traffic on Interstate Highways 71, 77, and 80 (Ohio Turnpike) was temporarily affected by high waters. Interstate Highway 71, which runs in a northeast-southwest direction through the center of the flooded area was closed at two places.

It was closed 3 miles southeast of Ashland for about 9 hours on July 5 by overflow from Jerome Fork, and 1 mile northeast of Burbank for about 25 hours on July 5-6 due to backwater from Killbuck Creek. Backwater from the Tuscarawas River covered one south-bound lane of Interstate Highway 77 at New Philadelphia for about 24 hours but through traffic was maintained continuously. Passenger-car traffic was routed off the Ohio Turnpike (I-80) for about 6 hours on July 5 but the depth of water on the road was not great enough to halt truck traffic.

Several towns were without water supply, electricity, and telephone service for varying periods of time. Dam failures occurred at water-supply reservoirs for Ashland, Norwalk, and Greenwich. Dams also failed at several recreational lakes and at many farm ponds.

SUSPENDED SEDIMENT LOADS

The amount of suspended sediment carried by a stream is indicative of land erosion in the basin. The loss of soil by erosion during a flood is a loss for which monetary damage figures are not ordinarily assigned. Sediment records are available at only one site in the flood area and they are indicative of the severity of the soil loss during the flood of July 1969.

Records of total suspended-sediment loads have been obtained for Killbuck Creek at Killbuck (station no. 03-1390) since October 1962. The sediment yield at this station during the flood of July 1969 is compared, in the following table, with the maximum yield previously observed.

Item	Date	Suspended-sediment load	
		Tons	Tons per square mile
Maximum daily load:			
Previous flood -----	March 10, 1964	7,790	16.9
Flood of July 1969 -	July 5, 1969	121,000	262
Maximum monthly load:			
Previous flood -----	March 1964	30,620	66.3
Flood of July 1969 -	July 1969	279,280	605

The maximum daily load of 121,000 tons on July 5 exceeded the total annual load for each of the preceding six water-years of record. The suspended sediment load during the 3-day period of July 5-7, 1969, amounted to 247,700 tons which is 75 percent of the total suspended load for the entire water year.

The above figures do not include the bed load which generally is not more than 10 percent of the total load for streams in Ohio.

FLOOD STAGES AND DISCHARGES

Determination of Flood Discharge

Discharges at a gaging station usually are determined by applying the record of stage to a stage-discharge relation developed from current-meter measurements obtained at various stages. The record of stage is generally obtained from a water-stage recorder which provides a continuous graphic or punch-tape record of stage. The reliability of the stage-discharge relation depends upon the stability of the stream channel or control structure and upon how adequately the discharge measurements define the experienced range in stage. Most Ohio stream channels are subject to scour and fill, especially during floods, so frequent current-meter measurements are made to define changes in the stage-discharge relation.

The magnitude, intensity, and duration of the July 1969 flood were such that it was not possible to obtain current-meter measurements at or near the peak discharge at several gaging stations. Many access roads and bridges were flooded or washed out; the duration of the flood peaks on some smaller streams was too short to permit measurement; and the number of sites requiring measurements was more than could be covered by the available personnel in the short period that the streams were in flood. Consequently, the peak discharge was obtained by slope-area, contracted-opening, culvert, or other types of indirect discharge measurements to define the high-water rating at 14 gaging stations.

Indirect discharge measurements were obtained also at 19 miscellaneous (ungaged) sites to further document the severity and hydrologic significance of this outstanding flood event. These measurements are indirect only in the sense that the data for determining the peak discharges were obtained subsequent to the flood. They are based on field surveys of high-water profiles, channel geometry, and structural geometry of dams, bridges, and roadways; and are computed in accordance with established hydraulic principles. Procedures for making indirect measurements are described in publications of the U.S. Geological Survey.

Summary of Flood Stages and Discharges

Maximum stages and discharges are summarized in table 3 at 55 sites in or near the flood area. The table includes data for gaging stations, reservoir stations, and for miscellaneous sites. The values of maximum discharge, in cubic feet per second, are of flow as it passed the measuring sites and no adjustments have been made for effects of storage or regulation. The maximum stage and contents, in acre-feet, are given for the five reservoir stations.

The map numbers in the table apply to the location map (fig. 2). The gaging stations and measurement sites are numbered in downstream order, beginning with streams in the Ohio River basin and continuing to streams tributary to Lake Erie. The U.S. Geological Survey (USGS) numbers are permanently assigned to the gaging stations in a downstream-order system and are used in publications of the U.S. Geological Survey. The State numbers are assigned to gaging stations and measurement sites in a downstream order system beginning with streams tributary to Lake Erie and continuing to streams in the Ohio River basin. These numbers are used in publications of the Ohio Division of Water. The USGS and State numbers are both included for the convenience of those wishing to compare the flood data with that given in other reports of the U.S. Geological Survey or in publications of the State of Ohio.

The "Period of record" includes the years for which the annual maximum stage and (or) discharge are known. Information on floods outside the periods of gaging-station operation are shown for those stations where it is available Thus, the period of record does not necessarily correspond to that in which a gaging station was operated.

Relative Magnitude of the Flood

One way of describing the enormity of a particular flood is to compare its peak discharge with peak discharges for other floods recorded at the same site. This comparison is given in table 3, which includes the maximum floods known previous to the July 1969 flood. The 1969 flood was largest at 20 of the 25 sites where flood discharges are not significantly affected by regulation and where records of prior floods are available. Although this comparison shows that the 1969 flood was an outstanding event it does not indicate how often a flood of that magnitude may be expected to recur, nor how the 1969 flood compares hydrologically with other outstanding floods that occurred in different areas. Recurrence intervals are used to evaluate the probable frequency of future flooding.

The recurrence interval is the average interval, in years, during which a flood of a given magnitude will be exceeded once. The 50-year flood, for example, has a 50-year recurrence interval and it can be expected to occur, on the average, once in 50 years. Stated in terms of probability the 50-year flood has a 2-percent chance of occurring in any year.

Cross and Mayo (1969) present methods to determine recurrence intervals up to 50 years for floods on unregulated streams in Ohio. These methods together with the gaging-station records were used to determine the probable frequency of the 1969 flood at the unregulated sites listed in table 3. The recurrence interval at most of the sites exceeded 50 years. The frequency of the flood at those sites is expressed in the last column of table 3 as the ratio of its peak discharge to the discharge of the 50-year flood.

The severity and infrequency of the 1969 flood are illustrated graphically in figure 4 in which peak discharges at the 40 unregulated sites are compared with the corresponding 50-year flood discharges. The 50-year flood discharge was exceeded at 35 of the sites. At 10 sites the peak discharge was more than three times as large as the 50-year flood discharge and at five sites it was more than four times as large. It is evident that the flood of July 1969 was an extremely rare event.

Table 3.--Summary of flood stages and discharges in north-central Ohio.

Number			Stream and place of determination	Drainage area (sq mi)	Period of record	Maximum flood previously known			Maximum during present flood			
Map	USGS	State				Date	Gage height (ft)	Discharge (cfs)	Date	Gage height (ft)	Discharge (cfs)	Ratio to 50-year flood
			MUSKINGUM RIVER BASIN									
1	3-1160	142	Tuscarawas River at Clinton ------	174	1913, 1927-69	3- -13 8- 8-35	22.2 14.82	 2,700	7-6&7-69	17.00	[a]1,500	3[b]
2	3-1161	143	Little Chippewa Creek near Smithville ---------------------	16.4	1947-69	1-21-59	14.30	1,800	7- 5-69	17.17	3,930	2.1
3	3-1162	143.1	Chippewa Creek at Easton ---------	146	1959-69	1-21-59	14.17	10,100	7- 5-69	16.02	[a]12,500	1.2
4	3-1170	145	Tuscarawas River at Massillon ----	518	1938-69	1-22-59	13.46	7,220	7- 5-69	16.43	[a]10,700	1.4
5	3-1175	146	Sandy Creek at Waynesburg --------	253	1939-69	1-22-59	10.05	15,000	7- 6-69	5.30	[a]2,180	1[b]
6	3-1220	157	Dover Reservoir near Dover -------	1,404	1939-69	6-11-47	902.68	[c]92,890	7-12-69	905.00[a,c]	109,000	---
7	3-1225	158	Tuscarawas River below Dover Dam near Dover --------------------	1,405	1913, 1924-69	3- -13 1-26-37	23.5 15.51	62,000 26,400	7-15-69	8.10	[a]7,130	---
8	------	158.5	Sugar Creek near Dalton ----------	52.5	1969	-------	-----	------	7- 5-69	-----	12,300	3.4
9	3-1230	159	Sugar Creek above Beach City Dam near Beach City ----------------	160	1945-69	1-22-59	[d]20.04	[e]7,960	7- 5-69	[f]23.76	[a]10,000	1.2
10	3-1234	159.6	Dundee Creek at Dundee -----------	.71	1966-69	5- -67	21.03	72	7- 5-69	30.18	340	1.4

See footnotes at end of table.

Table 3.--Summary of flood stages and discharges in north-central Ohio--continued.

Number			Stream and place of determination	Drainage area (sq mi)	Period of record	Maximum flood previously known			Maximum during present flood			
Map	USGS	State				Date	Gage height (ft)	Discharge (cfs)	Date	Gage height (ft)	Discharge (cfs)	Ratio to 50-year flood
11	3-1235	160	Beach City Reservoir near Beach City	300	1939-69	1-23-59	973.24	[c]53,520	7- 6-69	976.25	[a,c]70,120	---
12	3-1240	161	Sugar Creek below Beach City Dam near Beach City	300	1939-69	3-13-39	9.53	7,500	7- 6-69	11.26	[a]7,520	---
13	3-1245	162	Sugar Creek at Strasburg	311	1932-33 1935-39 1962-69	8- 7-35	12.70	19,700	7- 7-69	9.40	[a]7,700	---
14	3-1250	163	Home Creek near New Philadelphia	1.64	1937-69	9- 4-61	4.45	299	7- 7-69	5.77	[a]378	1.2
15	3-1290	172	Tuscarawas River at Newcomerstown	2,443	1913, 1922-69	3- -13 1-26-37	21.5 20.65	83,000 46,800	7- 8-69	9.43	[a]12,100	---
16	------	175.9	Whetstone Creek at Olivesburg	11.8	1969	-------	-----	------	7- 5-69	-----	9,610	4.0
17	3-1293	176	Whetstone Creek Tributary near Olivesburg	0.236	1950-69	7-26-56	5.71	155	7- 5-69	8.25	310	2.2
18	3-1295	177	Charles Mill Reservoir near Mifflin	215	1939-69	1-25-59	1,013.53	[c]53,780	7-10-69	1,010.86	[a,c]42,450	---

See footnotes at end of table.

Table 3.--Summary of flood stages and discharges in north-central Ohio--continued.

Number			Stream and place of determination	Drainage area (sq mi)	Period of record	Maximum flood previously known			Maximum during present flood			
Map	USGS	State				Date	Gage height (ft)	Discharge (cfs)	Date	Gage height (ft)	Discharge (cfs)	Ratio to 50-year flood
19	3-1300	178	Black Fork below Charles Mill Dam near Mifflin -------------	217	1913, 1939-69	3- -13 3-13-63	------- [g]8.45	11,700 2,800	7- 5-69	6.39	[a]1,810	---
20	3-1305	179	Touby Run at Mansfield ----------	5.44	1947-69	6- 6-47	4.17	965	7- 5-69	2.73	[a]527	4[b]
21	3-1315	181	Black Fork at Loudonville -------	349	1932-69	1-22-59	13.65	7,780	7- 5-69	14.11	[a]8,460	---
22	------	185.7	Jerome Fork at Ashland ----------	38.3	1969	-------	--------	------	7- 5-69	--------	23,700	4.2
23	------	185.8	Town Run at Ashland -------------	6.86	1969	-------	--------	------	7- 5-69	--------	3,400	1.8
24	3-1340	186	Jerome Fork at Jeromesville -----	120	1913, 1926-49, 1959 1962-64, 1966, 1969	3- -13 1-22-59	15.1 13.9	------ 13,000	7- 5-69	17.5	[h]27,000	3.2
25	------	186.5	Muddy Fork near West Salem ------	30.3	1969	-------	--------	------	7- 5-69	--------	17,500	4.1
26	3-1345	187	Mohicanville Reservoir near Mohicanville -----------------	271	1939-69	6-15-47	957.60	[c]59,820	7- 7-69	962.35	[a,c]96,340	---

See footnotes at end of table.

Table 3.--Summary of flood stages and discharges in north-central Ohio--continued.

Number			Stream and place of determination	Drainage area (sq mi)	Period of record	Maximum flood previously known			Maximum during present flood			
Map	USGS	State				Date	Gage height (ft)	Discharge (cfs)	Date	Gage height (ft)	Discharge (cfs)	Ratio to 50-year flood
27	3-1350	188	Lake Fork below Mohicanville Dam near Mohicanville -------------	271	1939-69	3-13-39	9.34	3,920	7- 5-69	14.32	[a]5,490	---
28	3-1360	190	Mohican River at Greer ----------	948	1913, 1922-69	3- -13 8- 7-35	27.0 13.63	[h]55,000 17,700	7- 5-69	14.59	[a]20,500	---
29	3-1380	193	Mohawk Reservoir near Nellie ----	1,504	1939-69	1-25-59	873.94	[c]176,100	7-14-69	868.50	[a,c]146,000	---
30	3-1385	194	Walhonding River below Mohawk Dam, at Nellie ----------------	1,505	1913, 1922-69	3- -13 1-25-37	26.9 18.8	102,000 24,000	8- 1-69	11.80	[a]8,000	---
31	------	194.1	Killbuck Creek at Burbank -------	42.4	1969	-------	-------	-------	7- 5-69	--------	6,810	1.2
32	------	194.17	Little Apple Creek at Wooster ---	10.9	1969	-------	-------	-------	7- 5-69	--------	6,260	2.6
33	------	194.18	Apple Creek at Wooster ----------	48.3	1969	-------	-------	-------	7- 5-69	--------	26,300	4.2
34	3-1389	194.2	Jennings ditch tributary near Wooster ----------------------	.90	1946, 1966-69	6-16-46	29.0	1,880	7- 5-69	27.67	670	1.8
35	------	194.4	North Branch Salt Creek at Fredericksburg ----------------	10.9	1946, 1969	6-16-46	--------	4,000	7- 5-69	--------	4,910	4.0

See footnotes at end of table.

Table 3.--Summary of flood stages and discharges in north-central Ohio--continued.

Number			Stream and place of determination	Drainage area (sq mi)	Period of record	Maximum flood previously known			Maximum during present flood			
Map	USGS	State				Date	Gage height (ft)	Discharge (cfs)	Date	Gage height (ft)	Discharge (cfs)	Ratio to 50-year flood
36	3-1390	195	Killbuck Creek at Killbuck -------	462	1931-69	8- 7-35	21.77	28,800	7- 5-69	26.40	47,500	2.0
37	3-1400	205	Mill Creek near Coshocton --------	27.2	1937-69	6-28-57	12.73	7,650	7- 5-69	13.92	[a]8,720	1.1
			LAKE ERIE TRIBUTARIES									
38	------	47.431	Mills Creek at State Highway 387, Sandusky ----------------------	40.5	1966, 1969	7-12-66	-------	3,650	7- 5-69	--------	4,940	48[b]
39	------	47.437	Pipe Creek at State Highway 2, Sandusky ----------------------	20.3	1966, 1969	7-12-66	-------	2,360	7- 5-69	--------	[b]4,500	1.4
40	-------	47.447	Plum Brook at U.S. Highway 250, Bogart -----------------------	3.46	1966, 1969	7-12-66	-------	727	7- 5-69	--------	1,100	1.3
41	-------	47.448	Sawmill Creek near Huron ---------	13.5	1969	-------	-------	-------	7- 5-69	--------	4,610	2.0
42	-------	47.485	West Branch Huron River tributary at Holiday Lake near Willard ---	13.8	1969	-------	-------	-------	7- 5-69	--------	2,630	1.1

See footnotes at end of table.

Table 3.--Summary of flood stages and discharges in north-central Ohio--continued.

Number			Stream and place of determination	Drainage area (sq mi)	Period of record	Maximum flood previously known			Maximum during present flood			
Map	USGS	State				Date	Gage height (ft)	Discharge (cfs)	Date	Gage height (ft)	Discharge (cfs)	Ratio to 50-year flood
43	------	49.49	West Branch Huron River at Monroeville --------------------	218	1969	-------	-------	--------	7- 5-69	-------	30,800	1.9
44	------	47.6	East Branch Huron River at Peru --	29.2	1969	-------	-------	--------	7- 5-69	-------	11,400	2.8
45	4-1981	48	Norwalk Creek near Norwalk -------	4.92	1947-69	5-12-56	14.37	1,060	7- 5-69	17.19	1,880	1.6
46	------	48.5	Norwalk Creek at Norwalk ---------	10.1	1969	-------	-------	--------	7- 5-69	-------	[h,i]5,100	---
47	4-1985	49	East Branch Huron River near Norwalk -----------------------	85.5	1924-35	2-26-29	9.5	4,700				
					1959, 1969	1-21-59	12.3	--------	7- 5-69	16.45	[h]22,000	3.6
48	4-1990	50	Huron River at Milan -------------	371	1951-69	1-22-59	24.08	25,800	7- 5-69	31.1	[a]49,600	1.8
49	------	50.2	Vermilion River at Fitchville ----	107	1969	-------	-------	--------	7- 5-69	-------	23,400	3.0
50	4-1995	51	Vermilion River near Vermilion ---	262	1951-69	1-21-59	13.80	20,500	7- 6-69	17.14	[a]40,800	2.1
51	4-1998	51.3	Neff Run near Litchfield ---------	.76	1966-69	4- -69	20.52	152	7- 5-69	18.27	34	1[b]
52	4-2000	52	East Branch Black River at Elyria ------------------------	217	1923-35	3-14-33	10.10	11,400				
					1959, 1969	1-21-59	14.7	--------	7- 5-69	17.5	23,100	1.5

See footnotes at end of table.

Table 3.--Summary of flood stages and discharges in north-central Ohio--continued.

Number			Stream and place of determination	Drainage area (sq mi)	Period of record	Maximum flood previously known			Maximum during present flood			
Map	USGS	State				Date	Gage height (ft)	Discharge (cfs)	Date	Gage height (ft)	Discharge (cfs)	Ratio to 50-year flood
53	------	52.4	West Branch Black River at Pittsfield --------------------	79.4	1969	------	-------	---------	7- 5-69	--------	23,600	3.1
54	4-2001	53	Plum Creek at Oberlin -----------	4.83	1947-69	1-21, 22-59	16.13	990	7- 5-69	17.70	1,560	1.5
55	4-2005	54	Black River at Elyria -----------	396	1945-69	1-22-59	22.9	24,000	7- 6-69	26.4	[a]51,700	2.5

[a] Flood hydrograph available.
[b] Recurrence interval, in years.
[c] Maximum contents in acre-feet.
[d] Maximum gage height, Jan. 23, 1959 (backwater from Beach City Reservoir).
[e] Mean daily discharge.
[f] Maximum gage height, July 6, 1969 (backwater from Beach City Reservoir).
[g] Maximum gage height March 14, 1939.
[h] Estimate.
[i] Dam failure.

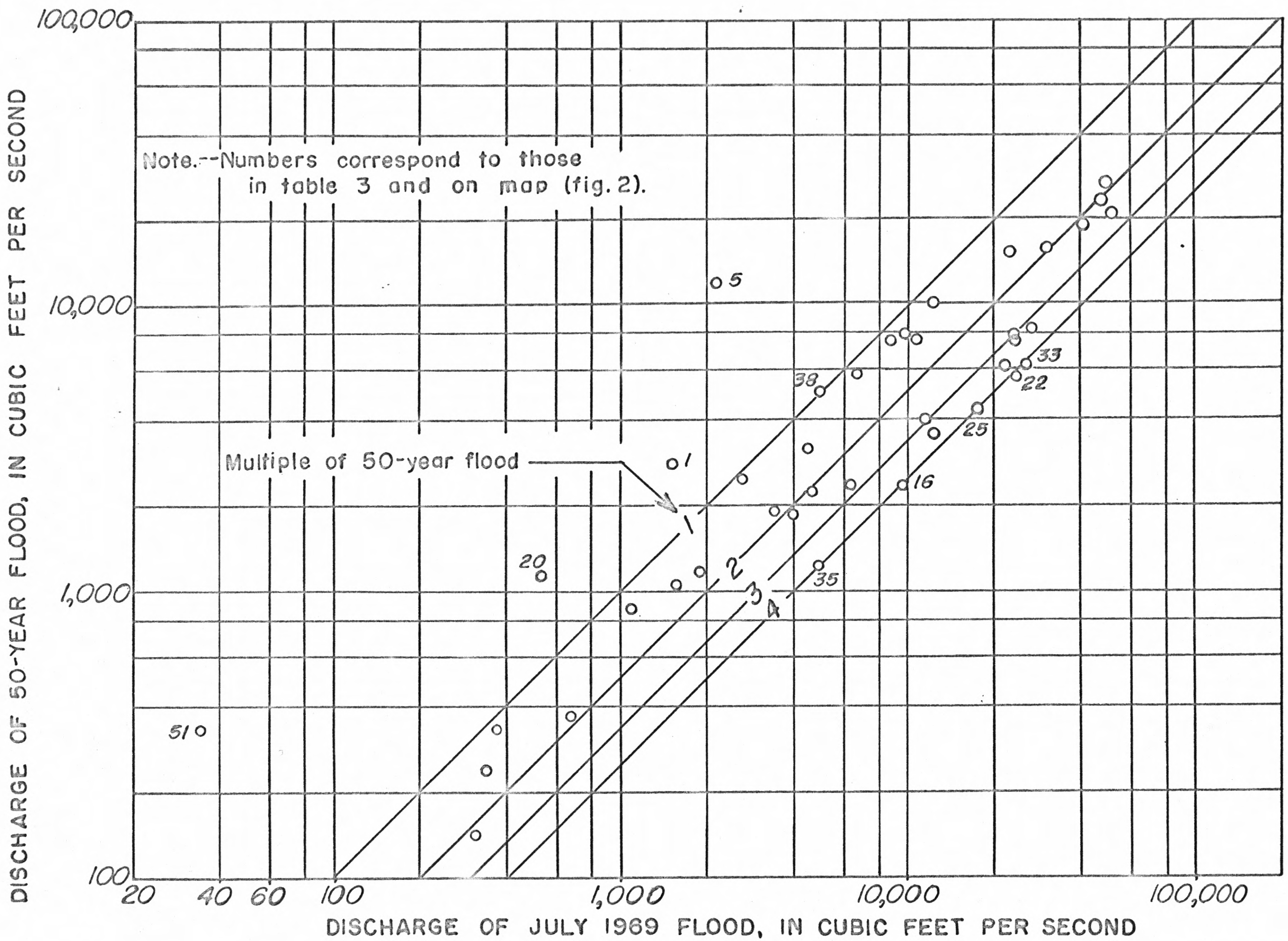

Figure 4.--Comparison of peak discharge for July 1969 floods with corresponding 50-year flood discharge.

ADDITIONAL DATA

In addition to the information presented in this report, other data that will be invaluable in flood-plain management studies and in planning and design of flood-control works, highway and railroad bridges and other structures that occupy flood plains were obtained.

Immediately following the flood, personnel from the Buffalo and Huntington Districts, Corps of Engineers, U.S. Army; the U.S. Soil Conservation Service, the Ohio Division of Water, the Ohio Department of Highways, and the U.S. Geological Survey made extensive surveys in the flood area.

Flood profiles were surveyed along the Huron, Vermilion and Black Rivers, and along Norwalk, Bonney and Skellenger Creeks by the Buffalo District, Corps of Engineers. These profile data and corresponding flood-area maps are presented in reports on the three river basins (U.S. Corps of Engineers, 1970). Additional data were obtained on the East Branch Black River in Grafton, Lagrange, Spencer, Chatham and Harrisville Townships by the Ohio Division of Water, U.S. Soil Conservation Service, and the Ohio Department of Highways.

In the Muskingum River basin, flood profiles were surveyed along the Mohican River, Black Fork, Jerome Fork, and Muddy Fork by the Department of Highways and the data are published by the Ohio Division of Water. Profiles of Killbuck Creek above Wooster, Little Apple Creek and Apple Creek at Wooster, Salt Creek, and Daughty Creek were surveyed by the Department of Highways. Unpublished profile data for these streams are available from the Ohio Division of Water.

The Huntington District, Corps of Engineers surveyed Killbuck Creek from Wooster to the mouth, a portion of Jerome Fork and Muddy Fork above Mohicanville dam, and Sugar Creek above Beach City dam to Brewster. These data are available from the Huntington District office.

Sugar Creek above Brewster and below Beach City dam, Chippewa Creek from the mouth to Chippewa Lake, and the Tuscarawas River from Barberton to Navarre, and from Dover dam to Newcomerstown were surveyed by the Department of Highways. Unpublished flood-profile data for these streams are available from the Muskingum Watershed Conservancy District (MWCD) office in New Philadelphia. Highwater marks were set along the Tuscarawas River from Newcomerstown to Coshocton by the MWCD, but were not surveyed.

Engineers of the U.S. Geological Survey obtained flood-profile elevations along Killbuck Creek, Apple Creek and Little Apple Creek in the vicinity of Wooster. These data are available in an open-file report, (Webber and Mayo, 1970). The Geological Survey also surveyed highwater profiles along short reaches of the streams in the vicinity of the 33 indirect measurements obtained in the flood area. Well defined reference marks were established during these surveys so that the data could be recovered in the event there is need to relate the highwater elevations to mean sea level. Descriptions of the reference marks and highwater marks are included in the survey notes which are on file with the indirect measurements in the Columbus district office.

Flood hydrographs are available in the District office of the U.S. Geological Survey for regular stream gaging and reservoir stations. (See table 3.)

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