DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
DELAWARE RIVER BASIN COMMISSION

HYDROLOGIC INVESTIGATIONS
ATLAS HA-246

Base from U.S. Geological Survey topographic quadrangles: Easton 1956, and Riegelsville 1956.

SCALE 1:24 000

CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

MAP LOCATION

EXPLANATION

Boundary of 1942 flood	1942	Flood of August 19, 1955	
Boundary of 1955 flood	1955	Cross section location	
Flood of May 24, 1942		River miles measured along stream channel	178

Photograph by Easton Express

AERIAL VIEW OF FLOODED AREAS IN EASTON, PA. (ON LEFT) AND PHILLIPSBURG N.J. (ON RIGHT). AUGUST 19, 1955. PRIOR TO PEAK STAGE. VIEW LOOKING NORTHWARD

FLOODS ON DELAWARE AND LEHIGH RIVERS AT EASTON, PENNSYLVANIA–PHILLIPSBURG, NEW JERSEY

This report presents hydrologic data on the extent, depth, and frequency of flooding on the Delaware and Lehigh Rivers in the vicinity of Easton, Pa.-Phillipsburg, N.J. It has been prepared to aid individuals, organizations, and governmental agencies, so that they may have a technical basis of making decisions on use of flood-prone areas.

Areas inundated by the floods of August 19, 1955, and May 24, 1942, are shown on the map. The areal extent of flooding was delineated on the basis of floodmarks identified in the field and flood profiles were developed from these data. Depths of inundation and limits of overflow of floods of various sizes can be estimated by using the relations presented.

The maximum known flood since colonial times in the vicinity of Easton, Pa.-Phillipsburg, N.J., occurred on August 19, 1955. This flood exceeded the second highest known flood—that of October 10, 1903—by 5½ feet at the Northampton Street Bridge in Easton, Pa. Other notable floods occurred on January 8, 1841, June 5, 1862, December 16, 1901, March 2, 1902, March 12, 1936, March 19, 1936, and May 24, 1942. The erratic distribution of flood events is shown by figure 1.

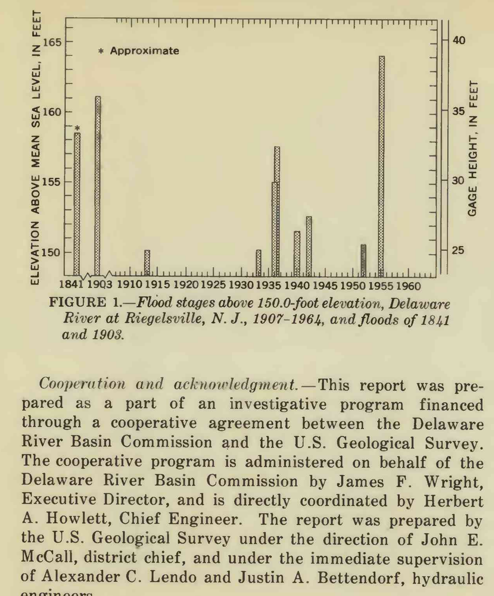

FIGURE 1.—*Flood stages above 150.0-foot elevation, Delaware River at Riegelsville, N. J., 1907-1964, and floods of 1841 and 1903.*

Cooperation and acknowledgment.—This report was prepared as a part of an investigative program financed through a cooperative agreement between the Delaware River Basin Commission and the U.S. Geological Survey. The cooperative program is administered on behalf of the Delaware River Basin Commission by James F. Wright, Executive Director, and is directly coordinated by Herbert A. Howlett, Chief Engineer. The report was prepared by the U.S. Geological Survey under the direction of John E. McCall, district chief, and under the immediate supervision of Alexander C. Lendo and Justin A. Bettendorf, hydraulic engineers.

Acknowledgment is made to the following agencies for some of the data used in this report: New Jersey Department of Conservation and Economic Development; Pennsylvania Department of Forests and Waters; Corps of Engineers, U.S. Army; Delaware River Joint Toll Bridge Commission; U.S. Weather Bureau; City Engineer, city of Easton, Pennsylvania; Town Engineer, town of Phillipsburg, New Jersey; and the Pennsylvania Railroad Company. Additional data were obtained from utility companies, industrial firms, and residents in the area, and from field investigations.

Flood height.—The height of a flood at a gaging station usually is stated in terms of gage height or stage, which is the height of the water surface above a selected datum plane. Gage heights for gaging stations can be converted to elevations above mean sea level, datum of 1929, by adding the gage height to the appropriate datum of the gage.

Elevation, gage height, and year of occurrence of each flood above 150-foot elevation on the Delaware River at Riegelsville, N.J., during the period of 1907-1964, are shown in figure 1. Historical floods of 1841 and 1903 are also shown in figure 1 for comparison.

Flood discharge.—The rate of discharge of stream is the volume of flow that passes a particular location in a given time. Usually discharge rates are expressed in units of cubic feet per second (cfs). Peak discharge is the maximum discharge attained by a flood. The peak discharge during a flood generally occurs at the time of maximum height of the flood, but if a stream is affected by variable backwater, the peak discharge may not coincide with maximum stage.

Data on major floods recorded at gaging stations on the Delaware River at Easton, Pa., and at Riegelsville, N. J., are given below.

Major floods recorded at gaging stations on the Delaware River

Date of flood	At Northampton Street Bridge Easton, Pa.		At Riegelsville, N. J.		
	Stage (feet)	Elevation above mean sea level (feet)	Stage (feet)	Elevation above mean sea level (feet)	Discharge (cubic feet per second)
Jan. 8, 1841	-	-	-	-	[a]250,000
Oct. 10, 1903	[b]93.3	[b]193.5	35.9	161.02	275,000
Mar. 28, 1913	-	-	25.0	150.12	144,000
Aug. 25, 1933	-	-	25.0	150.12	141,000
Mar. 12, 1936	85.46	185.67	29.8	154.92	185,000
Mar. 19, 1936	87.95	188.16	32.45	157.57	237,000
Apr. 1, 1940	81.23	181.44	26.47	151.59	154,000
May 24, 1942	83.00	183.21	27.50	152.62	164,000
Dec. 12, 1952	80.60	180.81	25.40	150.52	140,000
Aug. 19, 1955	[b]98.90	[b]199.11	38.85	163.97	340,000

[a] Estimated for Center Bridge, 22.5 miles downstream.
[b] From floodmark.

Flood frequency.—Frequency of floods at the U.S. Geological Survey gaging station on the Delaware River at Riegelsville, N.J., (figs. 2 and 3) and at the Delaware River Joint Toll Bridge Commission gaging station on the Delaware River at Easton, Pa., (fig. 4) is based on a regionalized flood-frequency study (Tice, 1958). The general relation between frequency and discharge is shown in figure 2, and general relation between frequency and stage is shown in figures 3 and 4. The relation between frequency and stage is dependent on the relation of stage to discharge. Any changes in the stage-discharge relation, caused by stream dredging, straightening stream channel, filling, and building of floodwalls in the immediate vicinity of the gages could alter stage-discharge relations and hence frequency-stage relations. Changes upstream such as building reservoirs or floodwalls and filling or dredging the stream channel will alter the frequency-discharge relations. Extrapolation of the curves beyond the limits shown is not recommended because of the possibility of large errors.

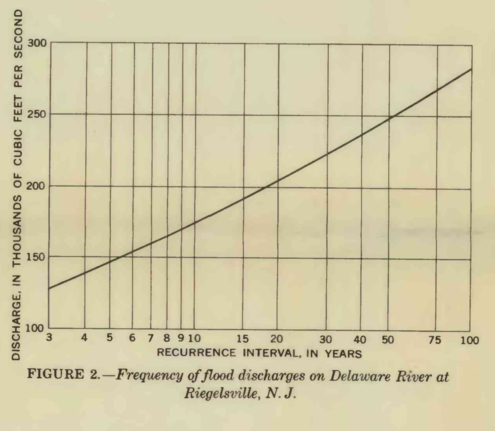

FIGURE 2.—*Frequency of flood discharges on Delaware River at Riegelsville, N.J.*

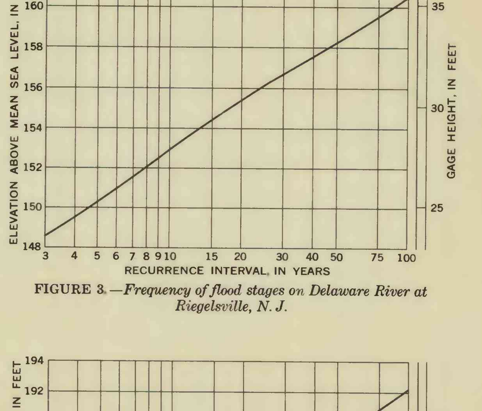

FIGURE 3.—*Frequency of flood stages on Delaware River at Riegelsville, N.J.*

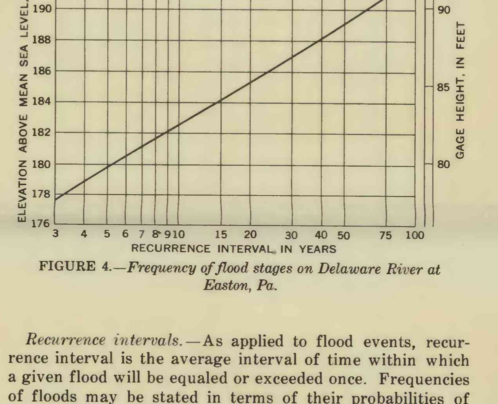

FIGURE 4.—*Frequency of flood stages on Delaware River at Easton, Pa.*

Recurrence intervals.—As applied to flood events, recurrence interval is the average interval of time within which a given flood will be equaled or exceeded once. Frequencies of floods may be stated in terms of their probabilities of occurrence (virtually reciprocals of their recurrence intervals for floods with recurrence intervals greater than 10 years). For example, a flood with a 25-year recurrence interval would have a 4-percent chance of being equaled or exceeded in any given year, or a flood with a 50-year recurrence interval would have a 2-percent chance of being equaled or exceeded in any given year.

The general relation between recurrence interval and flood height is tabulated in the following table for Delaware River at Riegelsville, N.J., and at Easton, Pa.

Recurrence interval (years)	Elevation above mean sea level (feet)	
	Delaware River at Northampton Street Bridge, Easton, Pa. (for flow downstream from mouth of Lehigh River)	Delaware River at Riegelsville, N. J.
100	192.1	160.4
75	190.9	159.6
50	189.2	158.3
35	187.7	157.2
25	186.3	156.2
10	182.6	152.8
3	177.7	148.5

The flood of August 19, 1955, delineated on the map, has an estimated recurrence interval of more than 150 years. The smaller flood of May 24, 1942, also delineated, has an estimated recurrence interval of 11 years.

It is emphasized that recurrence intervals are average figures—the average number of years that will elapse between occurrences of floods that equal or exceed a given magnitude. The fact that a major flood is experienced in one year does not reduce the probability of that flood being exceeded in the next year or even in the next week.

Flood profiles.—The profiles of the water surface along the Delaware River, constructed from marks left by the floods of August 19, 1955, October 10, 1903, March 19, 1936, and May 24, 1942, are shown in figure 5. Included also in figure 5 are the following profiles: (1) August 1955 flood modified by planned and existing (1966) flood-control works; (2) approximate elevation of top of bank (a line connecting the lowest points on either right or left or both banks at which inundation will begin); (3) low-water surface of September 3, 1964; and (4) profile of thalweg (a line connecting the lowest points in the stream channel).

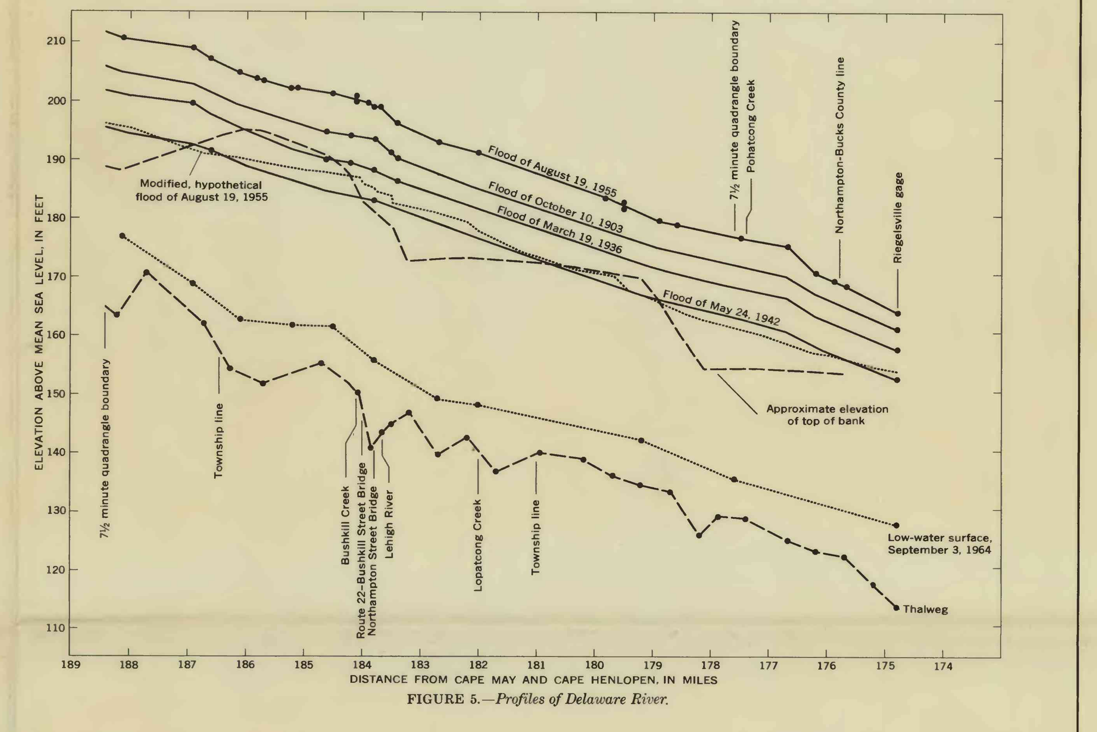

FIGURE 5.—*Profiles of Delaware River.*

The profiles of the water surface along the Lehigh River constructed from marks left by the floods of August 19, 1955, and May 23-24, 1942, are shown in figure 6. The low-water profile also is shown.

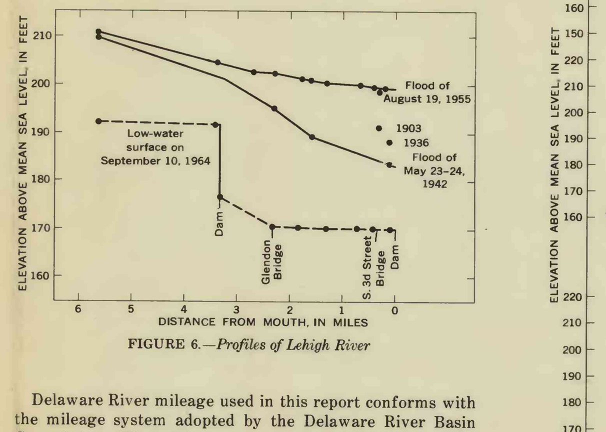

FIGURE 6.—*Profiles of Lehigh River*

Delaware River mileage used in this report conforms with the mileage system adopted by the Delaware River Basin Commission. The origin or zero mile is at the mouth of the Delaware Bay. River miles used for the profiles of figure 5 correspond to those marked along the Delaware River on the flood map.

Flood depths.—Depth of flooding at any point can be estimated by subtracting the ground elevation from the water-surface elevations indicated by the profiles of 5 and 6. The ground elevation can be estimated from the contours on the map. More accurate elevations can be obtained by leveling to nearby bench marks.

Thirteen cross sections are shown in figures 7 and 8 to illustrate the depth of flooding at these sites for several floods.

Tributaries.—With the exception of the Lehigh River, flooding on the tributaries to the Delaware River shown on the flood map is due to backwater from the Delaware River. Floods generated by local storms on the tributaries would have different frequencies and profiles. Inundation on the Lehigh River as shown on the flood map is due primarily to floods on the Lehigh River, backwater from the Delaware River, or a combination of the two conditions. The effect varies at different locations along the Lehigh River for different floods according to the relative size of the floods on the Lehigh and Delaware Rivers and the timing of the flood peaks.

River miles used for several tributaries to the Delaware River on the flood map have their origin or zero point at the mouth of the tributary.

Future conditions.—Changes in the river-channel conditions that would affect the water-carrying capacities may alter the inundation pattern of future floods. Changes that could affect the water-carrying capacities of the river are dikes, highway fills, or channel dredging and straightening. Increase of flood-control capacity also may have a sizable effect on future floods. Existing and planned flood-control works, as they become operative, would modify future floods. For example, figure 5 shows the modification of the August 1955 flood, computed by the Corps of Engineers, based on projects completed since August 1955, and the latest designs for additional projects in the comprehensive plan for the Delaware River basin.

Additional data.—Information in this report is presented in greater detail in an open-file report by Farlekas (1965), listed below. Additional information pertaining to floods in Easton, Pa.-Phillipsburg, N.J., vicinity may be obtained at the office of the U.S. Geological Survey, Trenton, N.J., and from the following reports:

Bogart, D. B., 1960, Floods of August-October 1955 New England to North Carolina: U.S. Geol. Survey Water-Supply Paper 1420, 854 p.
Farlekas, G. M., 1965, Extent and frequency of floods in the vicinity of Easton, Pa.-Phillipsburg, N.J.: U.S. Geol. Survey open-file report, 61 p.
Thomas, D. M., 1964, Floods in New Jersey, magnitude and frequency: New Jersey Dept. of Conserv. and Econ. Devel., Div. Water Policy and Supply, Water Resources Circ. 13, 145 p.
Tice, R. H., 1958, Delaware River basin flood frequency: U.S. Geol. Survey open-file report, 10 p.
U.S. Geological Survey, 1937, The floods of March 1936, Part 2, Hudson River to Susquehanna River region: U.S. Geol. Survey Water-Supply Paper 799, 380 p.

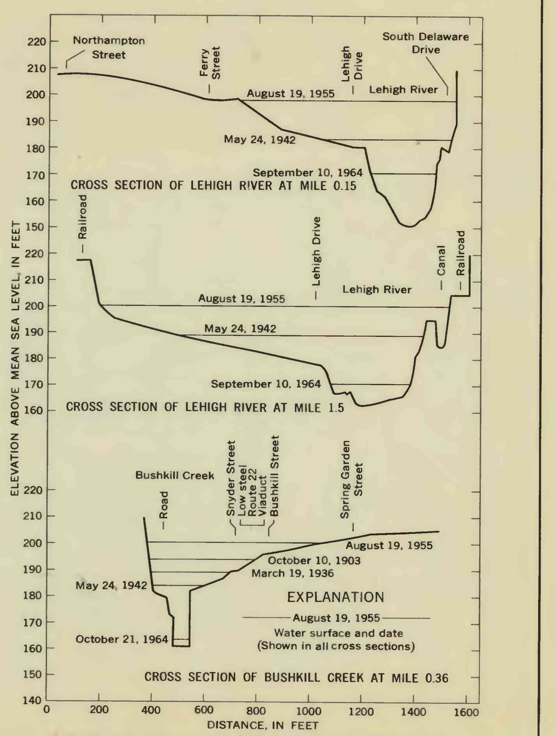

FIGURE 8.—*Cross sections of Lehigh River and Bushkill Creek*

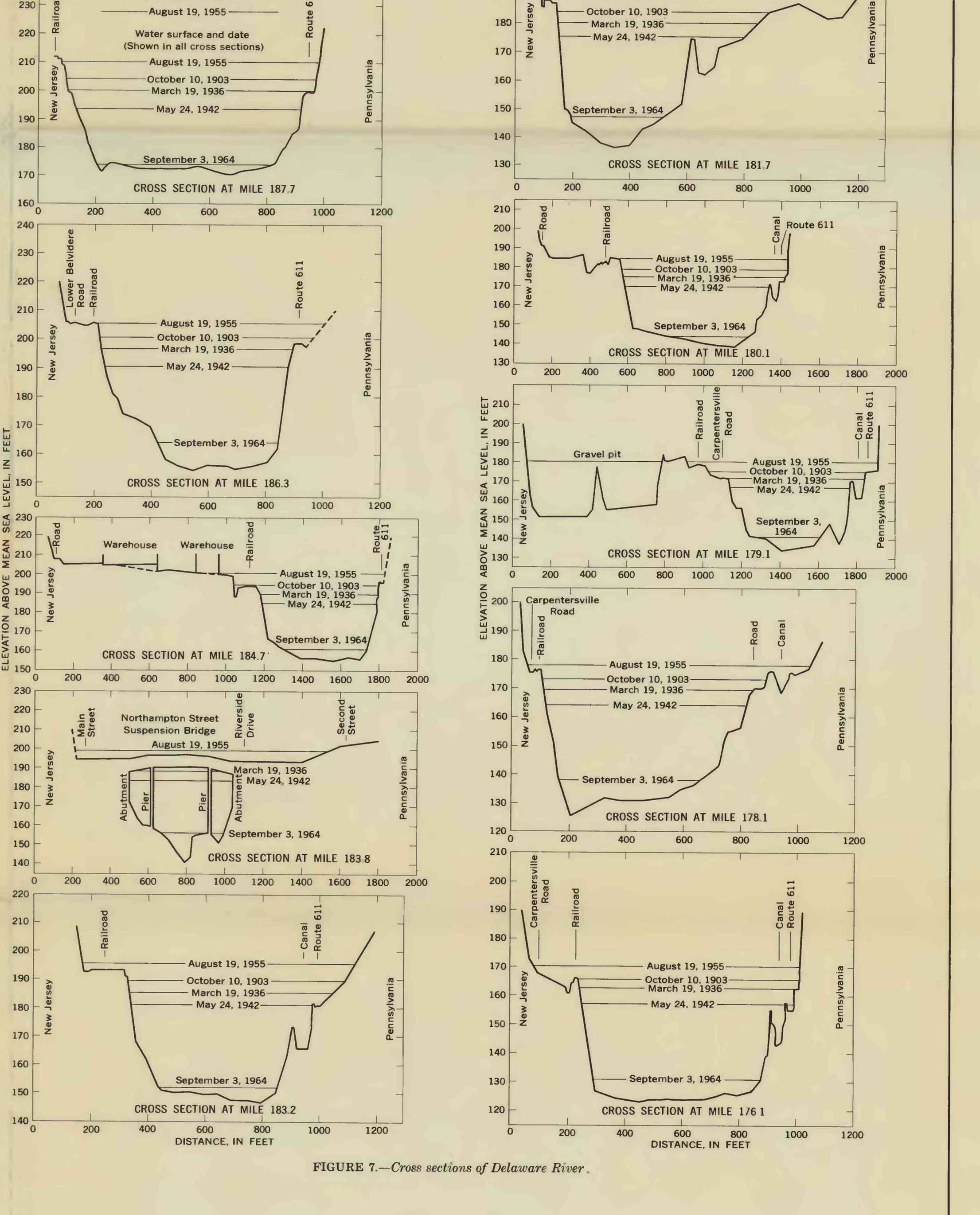

FIGURE 7.—*Cross sections of Delaware River.*

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FLOODS AT EASTON, PENNSYLVANIA—PHILLIPSBURG, NEW JERSEY

By
George M. Farlekas

1967

For sale by U.S. Geological Survey, price $1.00