FLOODS IN UPPER MILLSTONE RIVER BASIN IN VICINITY OF HIGHTSTOWN, NEW JERSEY

This atlas provides hydrologic data for evaluating the extent, depth, and frequency of flooding in Upper Millstone River basin in the vicinity of Hightstown, New Jersey. The report area is a total of 30 miles of the reach of the Millstone River, Rocky Brook, Cranbury Brook, Big Bear Brook, and Big Bear Brook tributary in Mercer and Middlesex Counties.

The approximate boundaries of inundation of the floods of September 21–22, 1938, and August 27–28, 1967, are delineated on the map below and illustrate the difference between a flood of a large magnitude and a comparatively small flood. The areal extent of flooding was delineated on the basis of floodmarks obtained by interviews with local residents, indentification in the field, or from various publications and agency records.

The atlas provides technical guidance for individuals, organizations, and governmental agencies in planning the economic uses of flood-prone areas. Evaluation of the flood hazard is necessary for the optimum development of the flood plain consistent with the flood risk.

Cooperation and acknowledgment.—The preparation of this report is part of the investigative program financed through a cooperative agreement between the New Jersey Department of Conservation and Economic Development, Division of Water Policy and Supply, and the U.S. Geological Survey. The cooperative program is administered on behalf of the Department of Conservation and Economic Development by Robert A. Roe, Commissioner, and is directly coordinated by George R. Shanklin, Director and Chief Engineer of the Division of Water Policy and Supply. The report was prepared by the Geological Survey under the direction of J. E. McCall, district chief, and under the immediate supervision of A. C. Lendo, supervising hydraulic engineer.

Acknowledgment is made to the following agencies for some of the data used in this report: New Jersey Department of Conservation and Economic Development; U.S. Department of Agriculture, Soil Conservation Service; New Jersey Topographic Engineer; Mercer County Engineer; Stony Brook-Millstone River Watershed Association; township engineers for East Windsor, West Windsor, and Plainsboro Townships; Hightstown Borough Engineer; and many local industrial firms and residents of the area.

Physical features.—The Upper Millstone River basin is almost entirely in the Atlantic Coastal Plain physiographic province. The watershed area is part of a gentle undulated plain that slopes to the northwest. The basin is underlain by unconsolidated or poorly consolidated layers of gravel, sand, and clay of Late Cretaceous age. Overlying these deposits is the Pensauken Formation of Pleistocene age which consists mainly of unconsolidated sand and gravel occurring as a discontinuous veneer.

The stage hydrographs of a flood event at Millstone River at Plainsboro gage show a gradual rise and a gradual recession. The slow response of streamflow to precipitation is due to the high surface permeability of the basin and effects of swamp and woodland areas of the flood plain.

Flood history.—Information on floods in the basin prior to the establishment of the gaging station on Millstone River at Plainsboro in May 1964 is scarce and of a general nature. Examination of local newspapers and interviews with local residents indicate that the greatest flood in the last 40 years on Rocky Brook and on Millstone River downstream from Rocky Brook, was that of September 17, 1934. Dam failures at Perrineville and Etra Lakes on Rocky Brook augmented peak stages. The flood of September 21–22, 1938, was the second greatest in 40 years. Dam failures at the same locations on Rocky Brook increased the downstream peaks. The flood of September 1938 was the greatest in the last 40 years on Cranbury Brook and Millstone River upstream from Rocky Brook.

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 a gaging station can be converted to elevations above mean sea level by adding the gage height to the sea level elevation of the zero of the gage. Flood heights shown in this report are elevations above mean sea level, datum of 1929, which is equivalent to the New Jersey Geodetic Control Survey datum.

Flood discharge.—The rate of discharge of a stream is the volume of flow that passes a specific cross section in a unit of time. Usually discharge rates are expressed in 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.

Flood frequency.—Flood-frequency relations in this report are based on a regionalized flood-frequency study by Thomas (1964) and are given in figures 1 and 2. The flood-frequency curves were prepared for the following sites: U.S. Geological Survey gaging station on Millstone River at Plainsboro; Millstone River at U.S. Highway 130; Rocky Brook at Peddie Lake Dam, Hightstown; Cranbury Brook at Plainsboro Pond Dam at Plainsboro; and Big Bear Brook at Grovers Mills Pond Dam at Grovers Mills.

The relation between frequency and stage for each of the above sites is given in figure 2. The two curves given for Millstone River at Plainsboro illustrate the extreme conditions that were recorded at the gaging station for the period of May 1964 to September 1967. The difference between the two curves is due to the variable stage-discharge relation.

The stage-discharge relation at each site is not necessarily permanent and is affected by changes in the physical conditions at the site. Stream dredging, straightening of channel, filling and changing the dam structure could alter the stage-discharge relation and hence, the frequency-elevation (stage) relation.

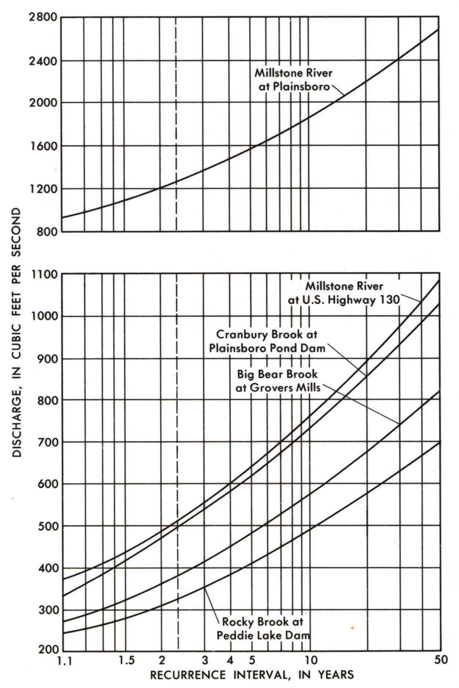


FIGURE 1.—*Frequency of flood discharges on Millstone River, Rocky Brook, Cranbury Brook, and Big Bear Brook.*

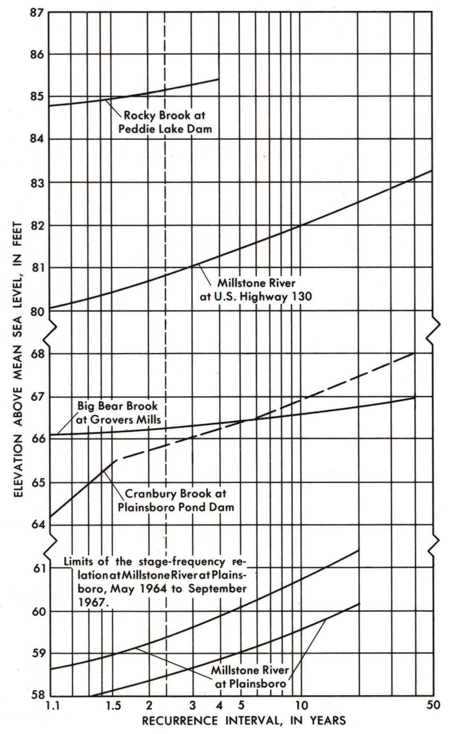


FIGURE 2.—*Frequency of flood stages on Millstone River, Rocky Brook, Cranbury Brook, and Big Bear Brook.*

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 can 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 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 relation between recurrence interval and flood height or discharge at the five sites (figs. 1 and 2) is tabulated below:

Recurrence interval (years)	Millstone River at Plainsboro	Millstone River at U.S. Highway 130		Rocky Brook at Peddie Lake Dam Hightstown		Cranbury Brook at Plainsboro Pond Dam		Big Bear Brook at Grovers Mills	
	Discharge (cubic feet per second)	Elevation above mean sea level (feet)	Discharge (cubic feet per second)	Elevation above mean sea level (feet)	Discharge (cubic feet per second)	Elevation above mean sea level (feet)	Discharge (cubic feet per second)	Elevation above mean sea level (feet)	Discharge (cubic feet per second)
50	2,690	83.2	1,075	–	700	–	1,030	–	815
40	2,550	83.0	1,030	–	665	68.0	980	67.0	775
30	2,410	82.8	970	–	630	67.8	925	66.9	730
20	2,210	82.5	890	–	575	67.5	845	66.8	670
10	1,850	82.0	760	–	490	66.9	725	66.6	575
5	1,550	81.4	635	–	410	66.4	615	66.5	480
1.5	1,110	80.4	435	85.0	285	65.4	415	66.2	325

The recurrence intervals of the floods of September 22–23, 1938, August 13, 1955, August 27–28, 1967, and September 21–22, 1966, are tabulated in the table below for the five sites in the basin.

Site	Recurrence interval, in years			
	Sept. 1938	Aug. 1955	Sept. 1966	Aug. 1967
Millstone River at Plainsboro (U.S.G.S. gaging station) . . .	50	8.5	1.04	1.7
Millstone River at U.S. Highway 130	35	7.0	1.04	1.09
Rocky Brook at Peddie Lake Dam, Hightstown	> 50	>8.5	1.9	1.9
Cranbury Brook at Plainsboro Pond Dam, Plainsboro	42	6.0	1.12	1.5
Big Bear Brook at Grovers Mills Pond Dam, Grovers Mills . .	–	–	1.01	3.8

Flood profiles.—Profiles of the water surface of the floods of September 21–22, 1938, August 13, 1955, and August 27–28, 1967, for Millstone River, Rocky Brook, and Cranbury Brook are shown in figures 3–5. The profile of the flood of August 27–28, 1967, is given in figure 6 for Big Bear Brook and Big Bear Brook tributary. Figure 6 also shows the profile of the flood of September 21–22, 1938, for a part of Big Bear Brook. Included in figures 3–6 are profiles of low-water surface of October 4 or 5, 1967, and profile of the thalweg (a line connecting the lowest points in the streambed).

The change in the profiles at some bridges and dams indicated the difference in water surface at the upstream and downstream sides of bridges and dams. Changes in channel capacity through bridge openings, flow over the dam, or accumulation of debris may alter the water-surface profiles and change the overflow pattern of floods.

Distances along the channel of the Millstone River used in the profiles were first established by the Works Progress Administration, New Jersey Riparian and Stream Survey in 1935–39, and are continuous with those used by Thomas and Tice (1964) and Bettendorf (1967). The zero point of the channel distances for Rocky Brook, Cranbury Brook, Big Bear Brook, and Big Bear Brook tributary are located at the mouth of the respective streams.

Flood depths.—Depth of flooding at any point can be estimated by subtracting the ground elevation from the water-surface elevation at the same point using the profiles in figures 3–6. Elevation of the ground surface can be determined accurately by levels to nearby bench marks and reference points that are listed in the open-file report by Farlekas (1968). Rough approximation of ground elevations can be estimated from the contours on the map. Fourteen cross sections (figs. 7–10) illustrate the depth of flooding at these sites for several specific floods, for which the dates are given. The low-water surface of October 4 or 5, 1967, is also given to illustrate the differences in elevation.

Extent of flooding.—The boundaries of inundation for the flood of September 1938 are shown on the flood map. The recurrence interval of this flood for five sites is given in the above table. The boundaries of the flood of August 1967 are also shown on the map to illustrate the difference in areal extent of flooding of a large and a small flood. The flood boundaries shown on the map reflect hydraulic conditions as they existed when the floods occurred.

Future conditions.—Hydrologic conditions are not constant. Changes in the basin hydrologic regimen may alter the inundation pattern of future floods. Changes such as urban-suburban development will tend to increase surface runoff and peak discharges, especially for the small, more frequent floods. Changes in the stream regimen such as stream dredging, straightening, filling and building on the flood plain, altering the highway embankment and bridges crossing the stream may change the flood-inundation patterns. Alteration of existing dams or building new dams will probably affect floodflows. In addition, the frequency-discharge relations may be altered by upstream changes such as construction of reservoirs and flood walls.

Additional data.—Additional data pertaining to floods in the Upper Millstone River basin can be obtained at the office of the U.S. Geological Survey, Trenton, N.J., and from the following reports:

Bettendorf, J. A., 1966, Extent and frequency of inundation of flood plain in vicinity of Princeton, New Jersey: U.S. Geol. Survey open-file report, 31 p.
________1967, Floods on Millstone River and Stony Brook in vicinity of Princeton, New Jersey: U.S. Geol. Survey Hydrol. Inv. Atlas HA–245.
Farlekas, G. M., 1968, Extent and frequency of floods on Upper Millstone River basin in vicinity of Hightstown, N.J.: U.S. Geol. Survey open-file report, 50 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.
Thomas, D. M., and Tice, R. H., 1964, Floods on Raritan and Millstone Rivers in Somerset County, New Jersey: U.S. Geol. Survey Hydrol. Inv. Atlas HA–104.

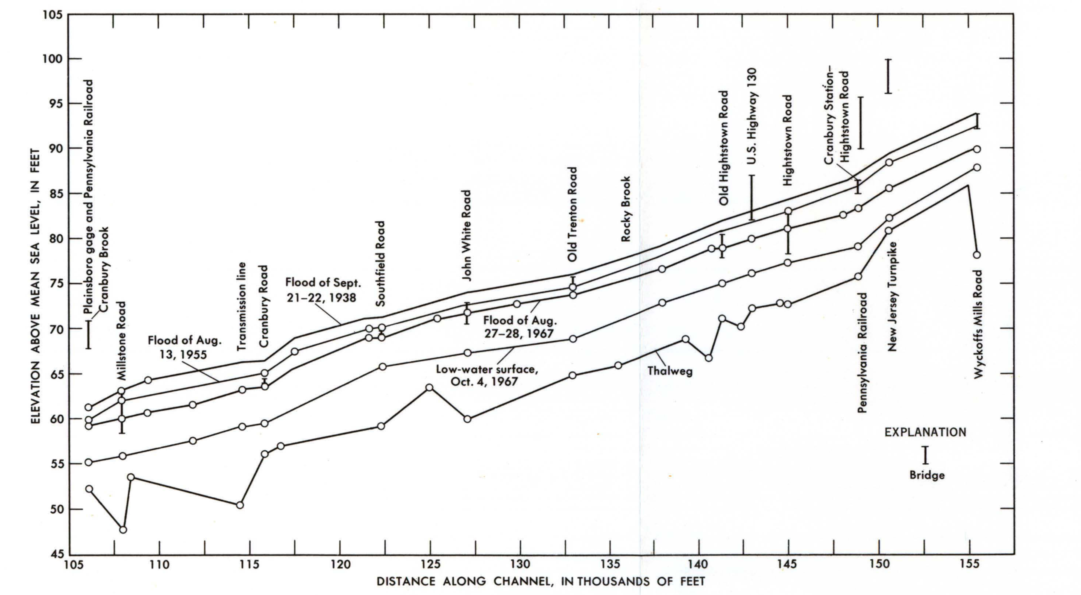


FIGURE 3.—*Profiles of Millstone River.*

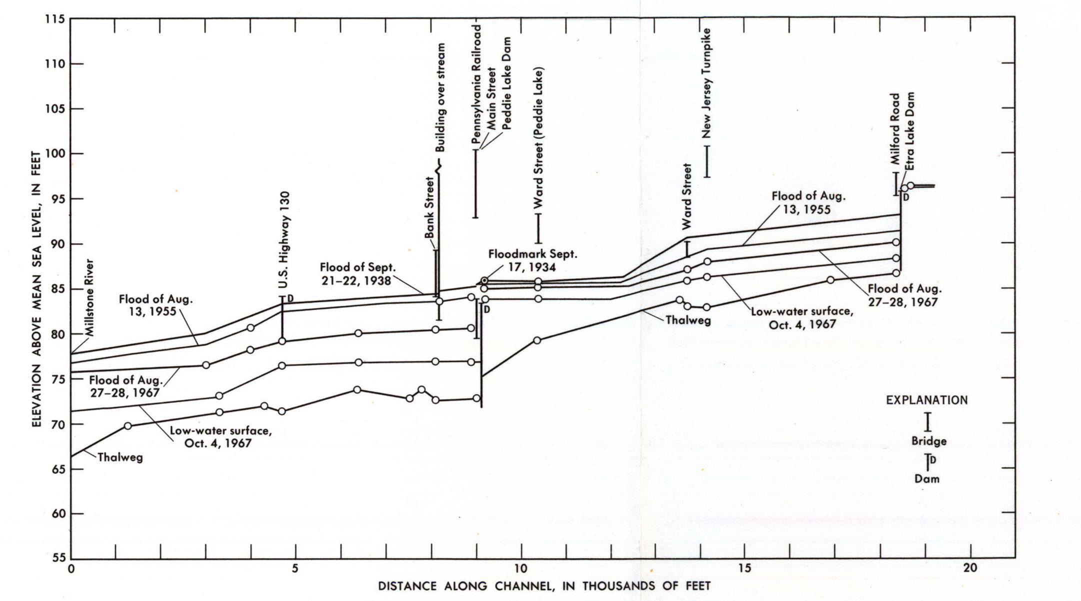


FIGURE 4.—*Profiles of Rocky Brook.*

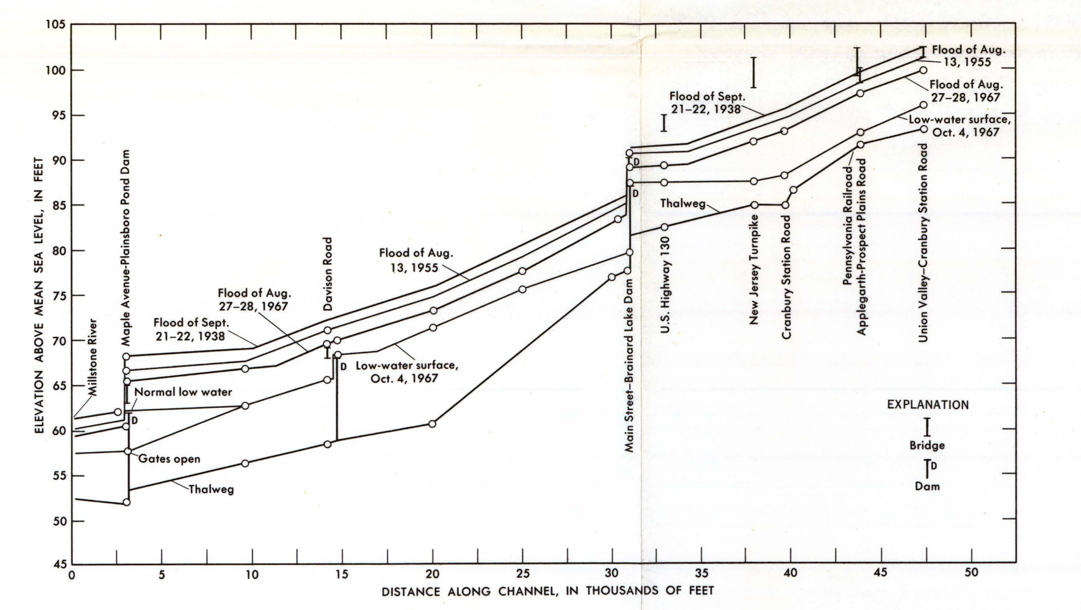


FIGURE 5.—*Profiles of Cranbury Brook.*

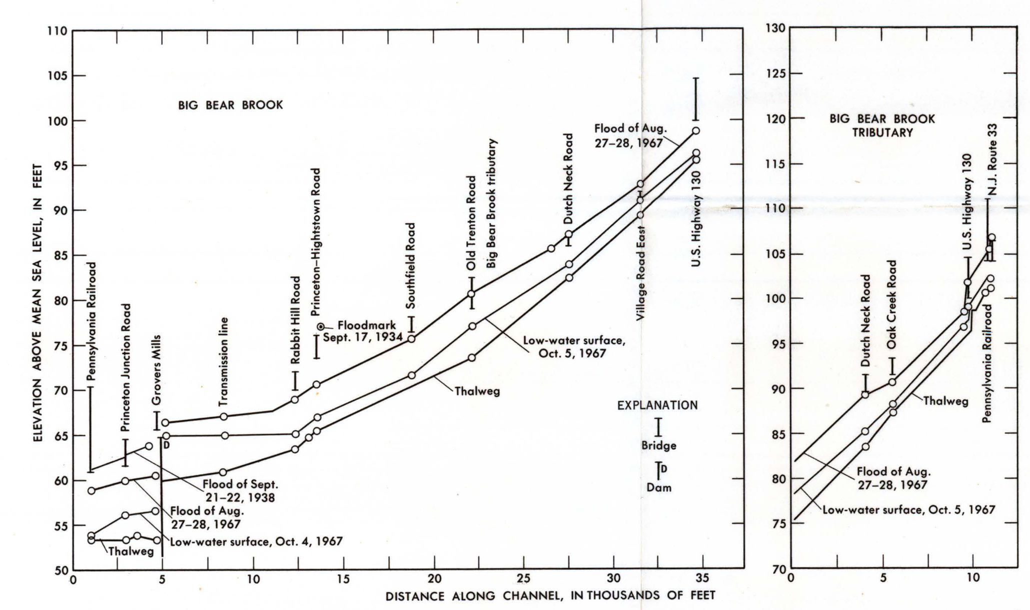


FIGURE 6.—*Profiles of Big Bear Brook and tributary.*

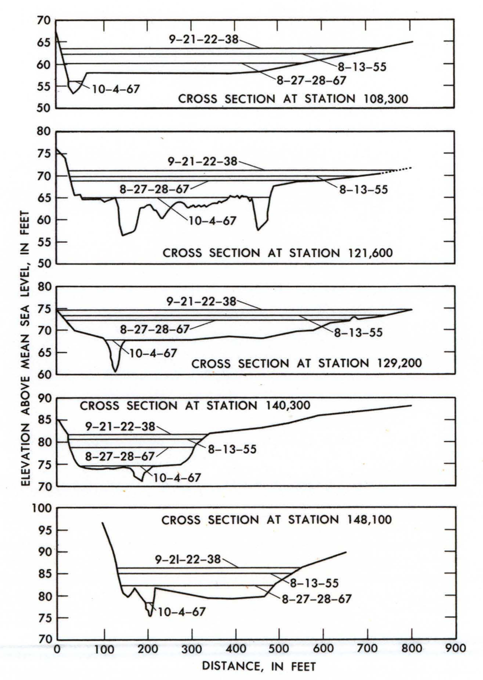


FIGURE 7.—*Cross sections of Millstone River, looking downstream.*

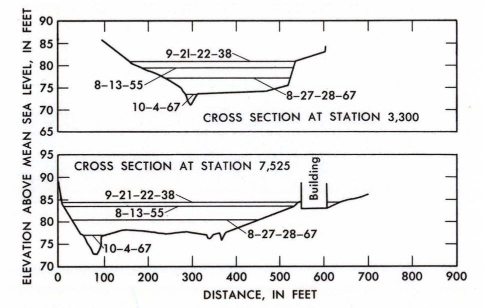


FIGURE 8.—*Cross sections of Rocky Brook, looking downstream.*

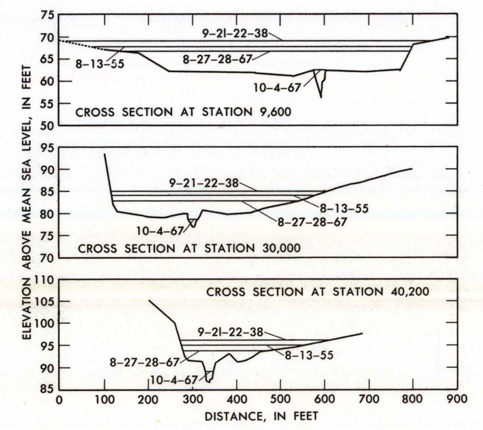


FIGURE 9.—*Cross sections of Cranbury Brook, looking downstream.*

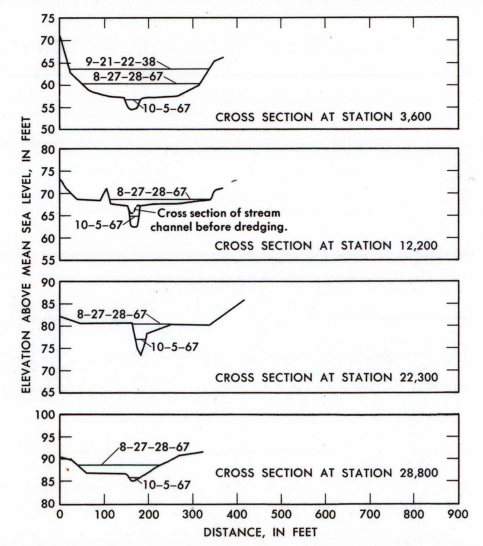
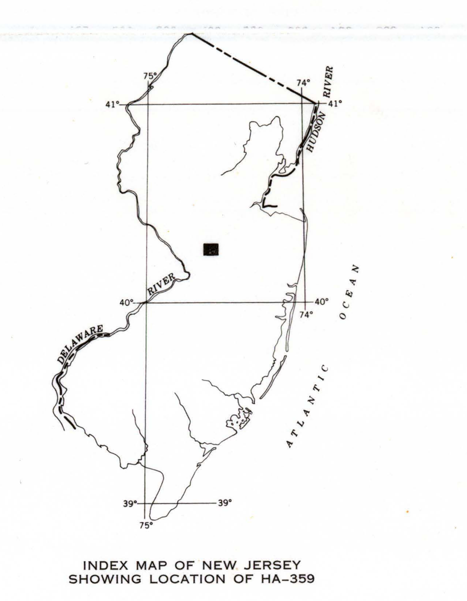
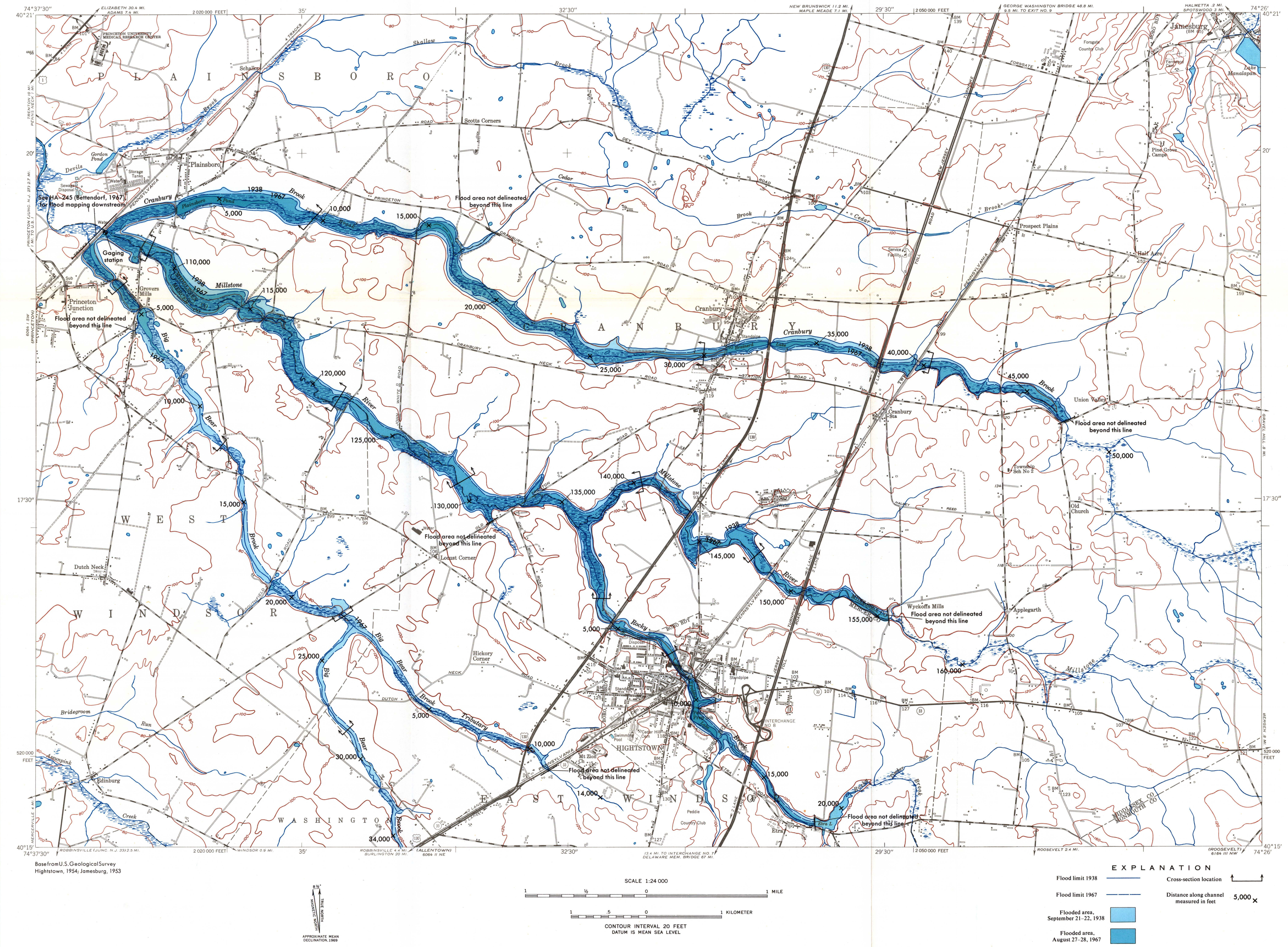


FIGURE 10.—*Cross sections of Big Bear Brook, looking downstream.*



INDEX MAP OF NEW JERSEY SHOWING LOCATION OF HA-359



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