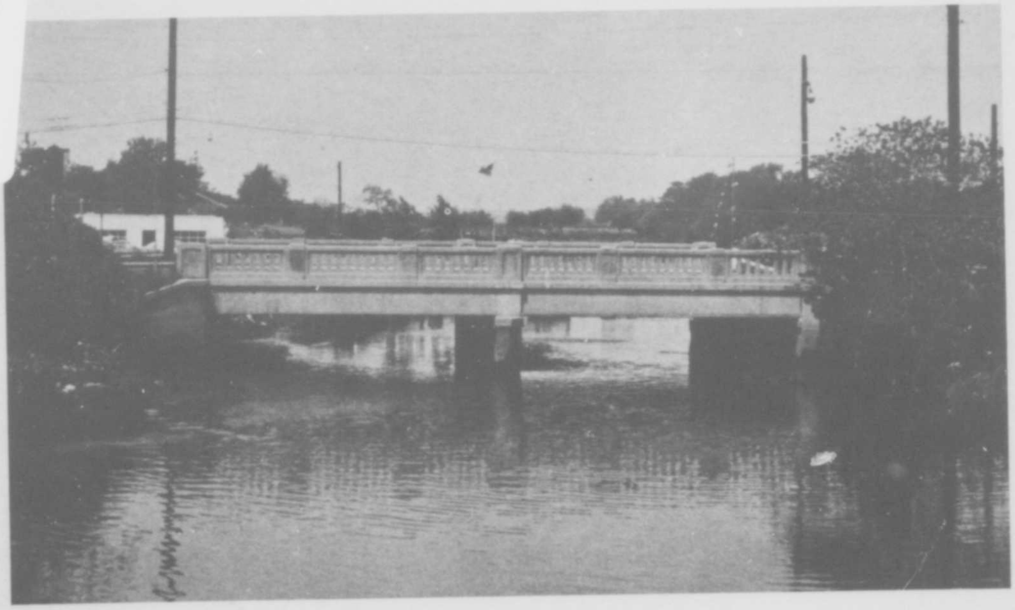
FLOOD PLAIN INFORMATION
LITTLE TIMBER CREEK

CAMDEN COUNTY
NEW JERSEY



PREPARED FOR
CAMDEN COUNTY PLANNING BOARD
AND
NEW JERSEY DEPARTMENT OF CONSERVATION
AND ECONOMIC DEVELOPMENT
BY
CORPS OF ENGINEERS, U.S. ARMY
PHILADELPHIA DISTRICT
MARCH, 1969

FLOOD PLAIN INFORMATION – Little Timber Creek, Camden County, New Jersey

TO THE REQUESTOR:

This Flood Plain Information (FPI) Report was prepared by the Philadelphia District office of the U.S. Army Corps of Engineers, under the continuing authority of the 1960 Flood Control Act, as amended. The report contains valuable background information, discussion of flood characteristics and historical flood data for the study area. The report also presents through tables, profiles, maps and text, the results of engineering studies to determine the possible magnitude and extent of future floods, because knowledge of flood potential and flood hazards is important in land use planning and for management decisions concerning floodplain utilization. These projections of possible flood events and their frequency of occurrence were based on conditions in the study area at the time the report was prepared.

Since the publication of this FPI Report, other engineering studies or reports may have been published for the area. Among these are Flood Insurance Studies prepared by the Federal Insurance Administration of the Federal Emergency Management Agency, Flood Insurance Studies generally provide different types of flood hazard data (including information pertinent to setting flood insurance rates) and different types of floodplain mapping for regulatory purposes and in some cases provide updated technical data based on recent flood events or changes in the study area that may have occurred since the publication of this report.

It is strongly suggested that, where available, Flood Insurance Studies and other sources of flood hazard data be sought out for the additional, and, in some cases, updated flood plain information which they might provide. Should you have any questions concerning the preparation of, or data contained in this FPI Report, please contact:

U.S. Army Corps of Engineers
Philadelphia District
Custom House, 2nd and Chestnut Streets
Philadelphia, PA 19106

ATTN: Flood Plain Mgt. Services Branch, NAPEN-M

Telephone number: (215) 597-4807

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REPORT DOCUMENTATION PAGE

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14

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- Flood plains

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report covered the flood situation along Little Timber Creek from its confluence with the main stem upstream to Route 295. Based upon information relating to rainfall, runoff, historical and current flood heights and other technical data, the study brought together records of the largest known floods of the past, describing various situations concerning magnitude and occurrence data and flood forecasting.

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

Under authority of Section 206 of the 1960 Flood Control Act as amended the flood plain information was prepared by the U.S. Army Corps of Engineers Philadelphia District at the request of the Camden County Planning Board. The information should be considered for its historical nature. Since the publication of this FPI report other Flood Insurance studies have been undertaken and should also be consulted for more current information.

CORPS OF ENGINEERS, U.S. ARMY
PHILADELPHIA DISTRICT

FLOOD PLAIN INFORMATION ON LITTLE TIMBER CREEK

IN CAMDEN COUNTY, NEW JERSEY

PHILADELPHIA, PENNSYLVANIA
MARCH, 1969

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INTRODUCTION

At the request of the Camden County Planning Board and the Gloucester County Planning Board, through the New Jersey Department of Conservation and Economic Development, a flood plain information study was undertaken for the Big Timber Watershed. The study includes three reports pertaining to three areas within the watershed, namely the Little Timber Creek, the Main Stem and South Branch Big Timber Creek and the North Branch Big Timber Creek. The results of that portion of the study which is incorporated in this report are for the use of state and local officials as guidance in further development and regulation of the flood plain.

This report covers the flood situation along the Little Timber Creek from its confluence with the main stem upstream to Route 295. The report covers several significant phases of the Little Timber Creek flood problem. It brings together records of the largest known floods of the past, describing various situations concerning magnitude and occurrence data, as well as the treatment of possible future floods, their frequency and hazards.

The report is based upon information on rainfall, runoff, historical and current flood heights and other technical data bearing upon occurrence and size of floods in the Little Timber Creek area.

The report contains maps, profiles and cross sections which indicate the extent of flooding that has been experienced in the past and that which might occur in the future. County and municipal agencies should find this data helpful in planning the best use of the flood plains.

With the information obtained from this study, floor levels of buildings may be planned at a reasonable elevation to avoid damage. If this is not desirable or practical, they would then proceed with full recognition of the hazards of flooding which may be incurred by encroachment within the flood plain areas.

Since this study is intended to provide the basis for further study and planning on the part of communities along the Little Timber Creek to minimize vulnerability to flood damages, the report does not include plans for the solution of flood problems. Development of flood plain areas should be controlled by local planning programs through zoning and subdivision regulations, the construction of flood protection works or a combination of the two approaches.

The Philadelphia District of the Corps of Engineers will upon request provide technical assistance to Federal, State and Local agencies in the interpretation and use of the information contained herein and will provide other available flood data related thereto.

SUMMARY OF FLOOD SITUATION

The Little Timber Creek flows in a westerly direction from its head waters west of Tavistock to its confluence with the Big Timber Creek near the Delaware River. This report covers the Little Timber Creek from its confluence with the Big Timber Creek upstream to U.S. Route 295 in Haddon Heights Borough. The total distance of this reach is 3.5 miles.

There are residential developments along the Little Timber Creek as it flows through the municipalities of Haddon Heights Borough, Mt. Ephraim Borough, Bellmawr Borough, Gloucester City and Brooklawn Borough within the limits of the report. Portions of this land have been inundated by floods of the past and a substantially greater area is within reach of the potentially greater floods of the future.

There are no stream flow records of the Little Timber Creek. Residents along the stream have been interviewed and newspaper files and historical documents searched for information concerning past floods. From these investigations and from studies of possible future floods on the Little Timber Creek, the local flood situation, both past and future, has been developed.

Flood conditions on Little Timber Creek may be caused by tidal stages in Delaware River or runoff in the creek, or a combination of the two. The following discussion of major floods deals with these three types.

* * *

THE GREATEST FLOOD known to have occurred on the Little Timber Creek took place in September 1940 and resulted from a highly localized storm with its center at Ewan, Gloucester

County, New Jersey. Newspapers point out the disastrous proportions of the flood and leave no doubt that it was far greater than any known to the oldest residents at that time. This storm was the flood of record for the upper reaches of the study area.

* * *

ANOTHER GREAT FLOOD in August 1933 was the highest flood in the tidal reaches of the Little Timber Creek and was primarily the result of tide conditions on the Delaware River augmented by heavy rain.

* * *

OTHER LARGE FLOODS on the Little Timber Creek occurred on August 13, 1955 and in November 1950. These floods were within one foot of the August 1933 flood.

* * *

NEW JERSEY FLOODWAY AND FLOOD HAZARD AREA DESIGN FLOODS have been used extensively by the State of New Jersey for planning purposes. They are determined from analysis of floods on this stream and other streams in the same general area, as described in the New Jersey Flood Hazard Report No. 1, *Delineation of Flood Hazard Areas*, augmented by the consieration of coincidental tidal effects. The analysis indicates that the Floodway Design Flood would be about 0.75 feet higher than the November 1950 flood and the Flood Hazard Area Design Flood would be about 1.5 feet higher than the November 1950 flood. The derivation of these two floods is discussed on Pages 31 through 36 of this report.

* * *

STANDARD PROJECT FLOOD - determinations indicate that floods about six feet higher than the November 1950 flood could occur on the Little Timber Creek. These floods would be about 4 to 5 feet higher than the Floodway Design and Flood Hazard Areas Design Floods. The derivation of the Standard Project Flood is discussed on page 36 of this report.

* * *

FLOOD DAMAGES that would result from recurrences of major known floods would be substantial. Even more extensive damages would be caused by the Standard Project Flood because of its wider extent, greater depth and higher velocities.

* * *

THE MAIN FLOOD SEASON for the Little Timber Creek is in the summer and fall. Many of the higher floods have resulted from tidal conditions, some of which are associated with hurricane activity. However, floods due to intense local thunderstorms occur in the summer and large floods may occur at any time.

* * *

VELOCITIES OF WATER during major floods range up to six feet per second (about 4 miles per hour) in the channel of the Little Timber Creek. Velocities on the flood plain would vary widely, depending upon location, but generally would be less than 2 feet per second. Velocities greater than 3 feet per second combined with depths of 3 feet or greater are generally considered hazardous.

* * *

DURATION OF FLOODS is difficult to determine for the Little Timber Creek because of the tidal influence: tidal flood stages follow the tide cycles and thus can rise from normal levels to extreme flood peaks in a very short time and may continue for several days. Fluvial floods are generally of short duration (24 hours or less).

* * *

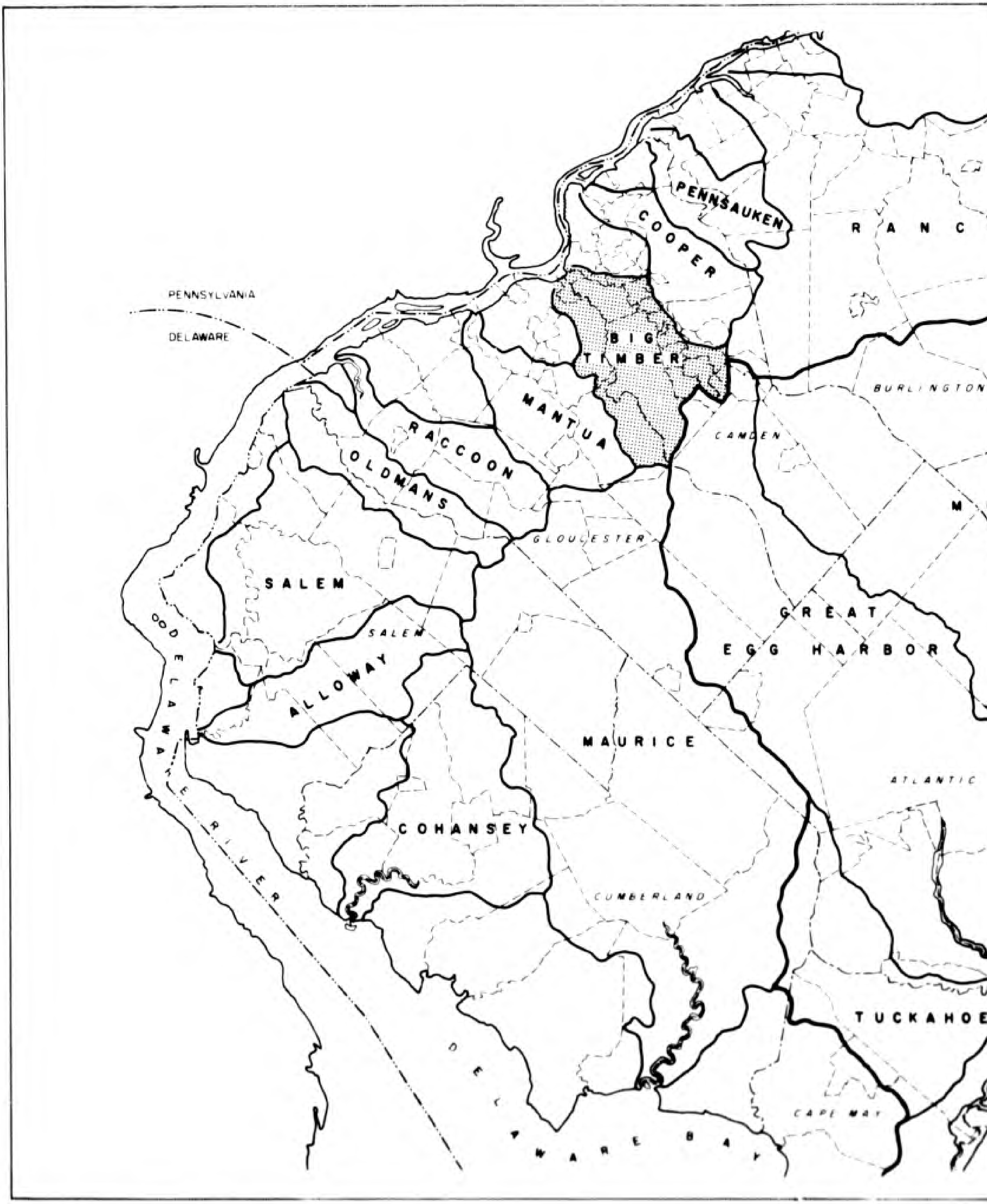
HAZARDOUS CONDITIONS would occur during large floods as a result of the rapidly rising streams, high velocities and deep flows.

* * *

FLOOD DAMAGE PREVENTION MEASURES - there are no existing, authorized or proposed local flood control or related measures in the study area or upstream in the watershed; nor are there any specific flood plain regulations in the municipalities through which the Little Timber Creek flows. However, the State of New Jersey has enacted certain encroachment laws which are discussed on Page 9 of this report.

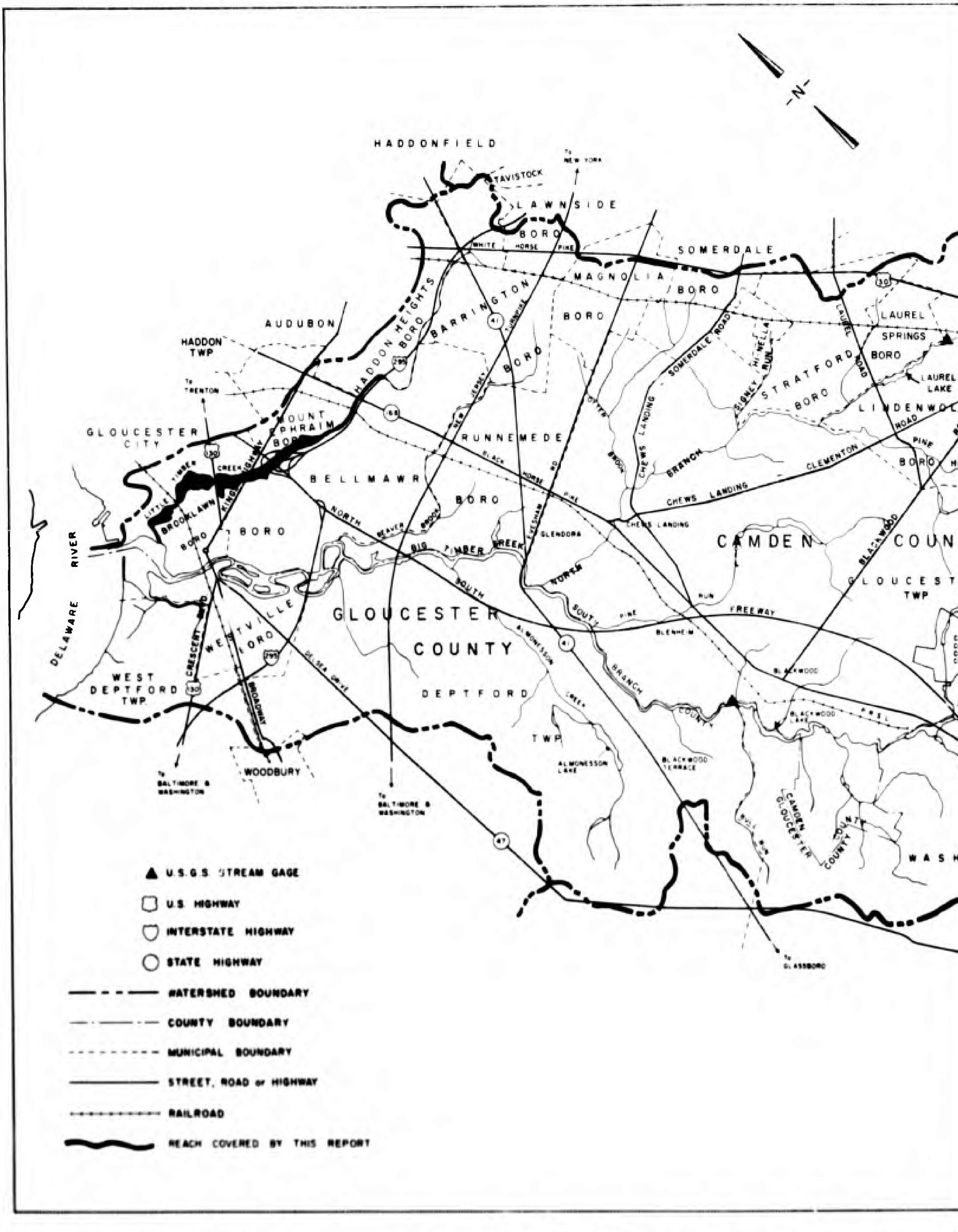
* * *

FUTURE FLOOD HEIGHTS that would be reached if the Floodway Design, Flood Hazard Area Design and Standard Project Floods occurred at selected locations within the study area are shown in Table 1. The table gives a comparison of these flood crests and also shows the comparison with available flood heights for the September 1940 flood. High water data for this flood is limited due to a lack

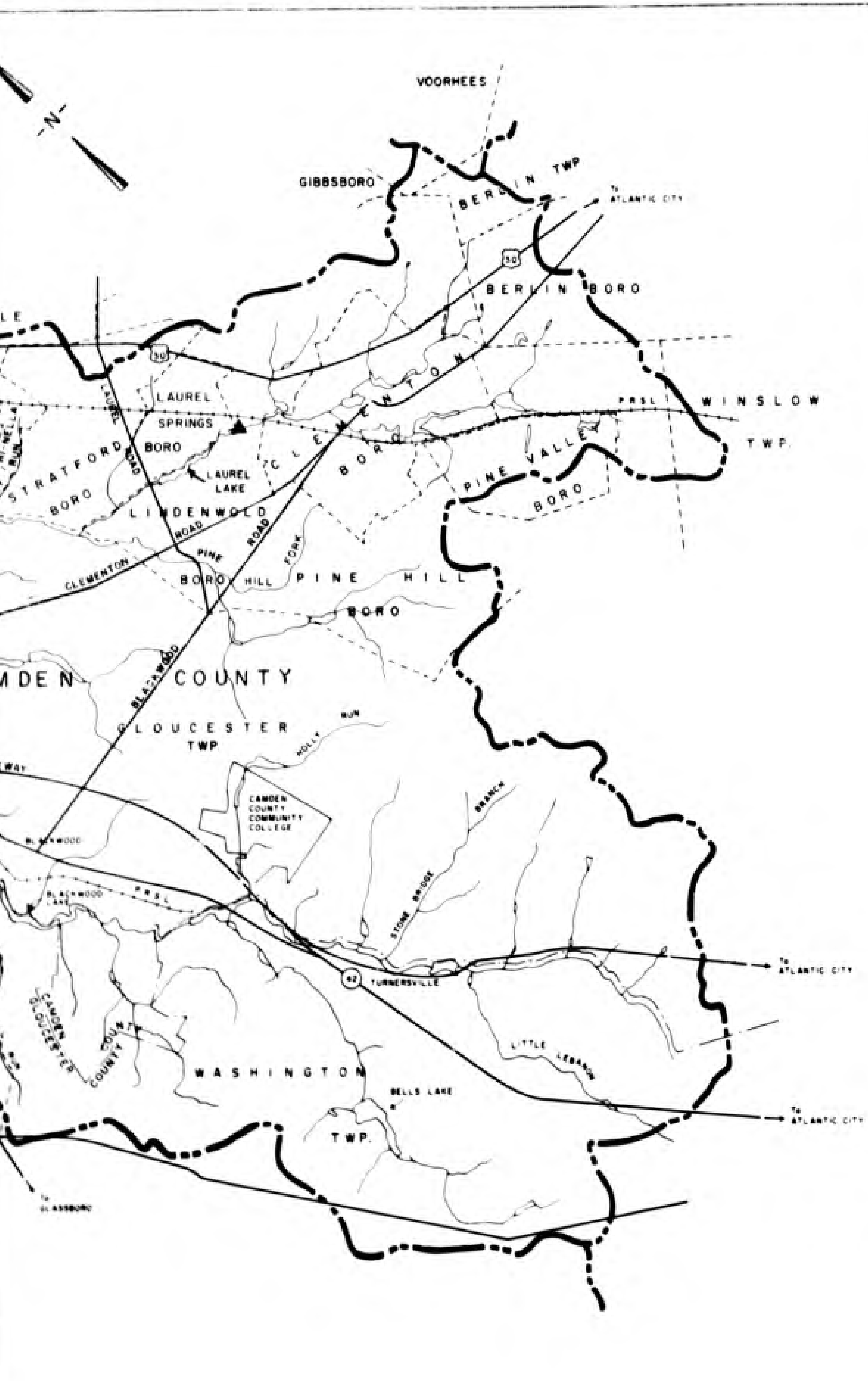

PENNSYLVANIA
DELAWARE
PENNSAUKEN
COOPER
RANC
BIG TIMBER
MANTUA
RACCOON
OLDMANS
BURLINGTON
CAMDEN
GLOUCESTER
M
SALEM
SALEM
ALLOWAY
GREAT EGG HARBOR
MAURICE
ATLANTIC
COHANSEY
CUMBERLAND
TUCKAHOE
CAPE MAY
DELAWARE RIVER
DELAWARE BAY

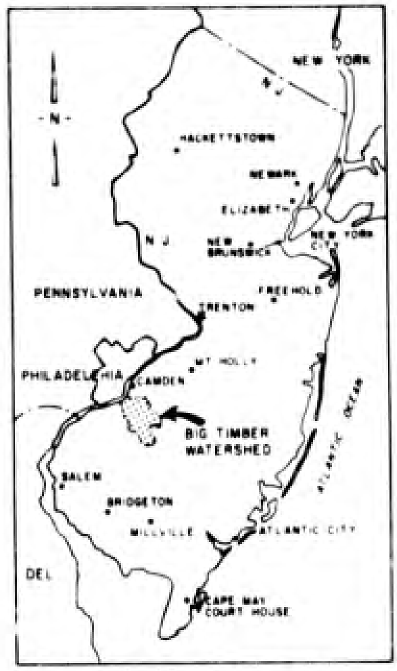

N
RANCOCAS
CEDAR
BURLINGTON
MULLICA
GREAT
HARBOR
ATLANTIC
ABSECON
TUCKAHOE
CAPE MAY
ATLANTIC OCEAN
CORPS OF ENGINEERS, U S ARMY
PHILADELPHIA DISTRICT
MAJOR WATERSHEDS
SOUTHERN NEW JERSEY
SCALE 5 0 5 MILES
MARCH 1969

PLATE I



-N-
HADDONFIELD
TAVISTOCK
LAWNSIDE BORO
To NEW YORK
SOMERDALE
MAGNOLIA BORO
BARRINGTON BORO
AUDUBON
HADDON TWP
HADDON HEIGHTS BORO
To TRENTON
GLOUCESTER CITY
MOUNT EPHRAIM BORO
RUNNEMEDE
BELLMAWR BORO
BROOKLAWN BORO
DELAWARE RIVER
WESTVILLE BORO
GLOUCESTER COUNTY
DEPTFORD TWP
WEST DEPTFORD TWP
WOODBURY
To BALTIMORE & WASHINGTON
CAMDEN COUNTY
GLOUCESTER TWP
STRATFORD BORO
LAUREL SPRINGS BORO
LAUREL LAKE
LINDENWOLD
CHEWS LANDING
BLENHEIM
BLACKWOOD
BLACKWOOD LAKE
BLACKWOOD TERRACE
ALMONESSON LAKE
GLENDORA
BIG TIMBER CREEK
NORTH BRANCH
SOUTH BRANCH
LITTLE TIMBER CREEK
KINGS HIGHWAY
CRESCENT BLVD
BROADWAY
DEL SEA DRIVE
FREEWAY
CAMDEN GLOUCESTER COUNTY
To GLASSBORO
WASH
U.S.G.S. STREAM GAGE
U.S. HIGHWAY
INTERSTATE HIGHWAY
STATE HIGHWAY
WATERSHED BOUNDARY
COUNTY BOUNDARY
MUNICIPAL BOUNDARY
STREET, ROAD or HIGHWAY
RAILROAD
REACH COVERED BY THIS REPORT





LOCATION MAP

SCALE IN MILES

0 10 20 30

CORPS OF ENGINEERS, U.S. ARMY

PHILADELPHIA DISTRICT

BIG TIMBER WATERSHED

SCALE 1 0 1 MILES

MARCH 1969

PLATE 2

of gaging stations and the sparse development of the area in 1940. For these reasons no discharge estimates have been made nor has a water surface profile been prepared for this flood. The comparisons with the 1940 flood have been made utilizing available high water information obtained after the flood. Since the high water marks may have been affected by surges due to debris accumulations, whereas the procedures used in computing the Floodway Design, Flood Hazard Area Design and Standard Project Floods assumed that no obstructions due to the accumulation of debris would occur, the comparison with the September 1940 flood may be somewhat questionable.

* * *

TABLE 1

RELATIVE FLOOD HEIGHTS

LITTLE TIMBER CREEK

Flood	Location	Mile Above Mouth	Flood Height	Est. Peak Discharge	Above (Below) Sept. 1940 Flood
			feet	cfs	feet
Sept. 1940	Confluence with Main Stem	-0-	-	-	-
Floodway Design			9.6	950	-
Flood Hazard Area Design			10.4	1,190	-
Standard Project			14.7	1,500	-
Sept. 1940	Bell Road	2.80	10.0	-	-
Floodway Design			9.6	500	(0.4)
Flood Hazard Area Design			10.4	600	0.4
Standard Project			14.7	850	4.7

GENERAL CONDITIONS

Big Timber Creek with its main tributaries of Little Timber Creek and the North and South Branches, flows into Delaware River at Gloucester City and drains portions of both Camden and Gloucester Counties, New Jersey. The Big Timber Creek and South Branch form a long boundary between these two counties.

That portion of Big Timber Creek covered by this report consists of the tributary of Little Timber Creek from its confluence with the Main Stem, upstream to Route 295, a distance of about 3.5 stream miles. It flows generally in a northwesterly direction and drains an area of approximately 3.83 square miles in Camden County. The stream is tidal for a considerable portion of this reach and the adjacent areas are, therefore, subject to flooding from both tidal fluctuations in Delaware River and fresh water runoff in the stream. There are broad marsh areas at the mouth of the creek which are subject to tidal flooding.

Within the study area the stream flows through Gloucester City and the Boroughs of Haddon Heights, Mt. Ephraim, Bellmawr and Brooklawn.

Although the soils of the two Counties have been subjected to a variety of influences over the years, the climate recently has been temperate with an annual rainfall of about 44 inches, which is well absorbed by fairly level, high lying soils. Monthly precipitation is generally well distributed throughout the year. Temperatures in the Counties average a little above freezing in the winter and above 73° F in the summer. The region has ample water for farm, urban and industrial uses, varying in depth from 3 to 350 feet below the surface.

Gloucester and Camden Counties are a direct and vital link between the economies of New Jersey and Pennsylvania. Along with Mercer and Burlington Counties they constitute the New Jersey members of the Delaware Valley Regional Planning Commission. This area, along with Philadelphia and its adjacent areas, is the center of one of the world's largest commercial and industrial complexes.

The two county area exchanges more workers, in both directions, with Philadelphia than with any of the neighboring New Jersey Counties. These extensive movements are reinforced by a developing regional transportation system which includes public transit. The region is within a one day drive of one third of the nation's population. The Philadelphia International Airport is approximately one hour airtime from all major cities along the northeast coast. The rail shipping time to the same general area is approximately three days.

Contemplated improvements in Delaware River Port facilities will have a great impact on the diversity and extent of major industries locating in the bi-county area, and with the generation of new jobs will come new business and housing developments. Therefore, a knowledge of the flood plain areas and their vulnerability to serious flooding will be of great benefit in planning for the future.

Settlement

Since the days of the Lenni-Lenape Indians, Gloucester County has successively accommodated settlements of

Swedes and Finns in the early seventeenth century and English Quakers in the later colonial times. Dutch and Swedish explorers of the estuary of the Delaware River in the early seventeenth century led to later settlement of the area known as Camden County. In 1681, William Cooper traveled down Delaware River from Burlington to settle on the point of land which was later named after him and which served as a station for the ferry to Philadelphia and as a gateway to southern New Jersey. This point of land was later subdivided and renamed Camden after an English judge sympathetic to the colonies.

Since the Camden port is on an inside, erosion bend and in a leeward position on Delaware River, it had a natural disadvantage which inhibited development in comparison to the thriving premiere colonial city of Philadelphia. Modern technology has improved Camden's competitive position as a port facility.

Camden County was formed from territories of Gloucester County in 1844, and this section of eastern shore of the Delaware prospered. Historic development of the bi-county area extended from its origin in Camden City eastward from Delaware River. Even today nearly 60 percent of the total regional industry is within a four to five mile radius of downtown Camden. However, the trend today is for the location of industry in the suburban areas. An abundance of groundwater, transportation and labor are basic justifications for predicting continued growth in the Camden-Gloucester County area.

Flood Damage - Prevention Measures

There are no existing, authorized or proposed flood control or related measures in the study area or upstream in the watershed, nor are there any local flood plain zoning regulations in the County. However, the State of New Jersey enacted an encroachment law in 1929 which is essentially a preventative flood loss measure. The law is known as the "1929 Encroachment Law (R.S. 58:1-26)" and is administrated by the Division of Water Policy and Supply of the Department of Conservation and Economic Development. The law reads in part as follows:

> "No structure within the natural and ordinary high water mark of any stream shall be made by any public authority or private person or corporation without notice to the [Division] and in no case without complying with such conditions as the [Division] may prescribe for preserving the channel and providing for the flow of water therein to safeguard the public against danger from the waters impounded or affected by such a structure and this prohibition shall apply to any renewal of existing structures." 1/

Under provision of this law, the Division issues permits for the construction of bridges, culverts, fills, walls, channel improvements, pipe crossings and other encroachments located within the natural and ordinary high water mark of the streams. Another New Jersey encroachment law (Chapter 229, Laws of 1938, amending a previous law known as R.S. 40:46-1), permits municipalities of the State to construct improvements, remove obstructions, define the location, establish widths, grades and elevations of any

1/ Flood Damage Alleviation in New Jersey - Water Resources Circular 3 - 1961 by State of New Jersey-Department of Conservation and Economic Development.

stream and to prevent encroachments thereon, subject to approval by the State of the flood carrying capacity to be provided. Under this law counties in New Jersey are permitted to assist municipalities in local flood damage alleviation programs. The New Jersey flood plain designation and marking law, enacted in 1962 [R.S. 58:16A (50-54)], empowers the Division of Water Policy and Supply to delineate and mark flood hazard areas, and coordinate effectively the development, dissemination, and use of information on floods and flood damage that may be available.

Currently, the Division of Water Policy and Supply is conducting an extensive study to delineate all major streams within the Raritan River Basin. The Division plans to delineate all major New Jersey streams eventually. Further information in this regard can be obtained from the Department of Conservation and Economic Development, Division of Water Policy and Supply, John Fitch Way Plaza, 11th Floor, P.O. Box 1390, Trenton, New Jersey 08625.

The development of adequate flood plain information as furnished in this report, will enable State and local authorities to further implement existing statutes and regulations.

Flood Warning and Forecasting Services

This watershed does not receive specific flood warning or forecasting services from the U.S. Weather Bureau at the present time. General weather forecasts of intense rainfall with accompanying flash flood warnings are issued by the Weather Bureau Office at the Philadelphia International Airport.

The Stream and Its Valley

Little Timber Creek flows generally in a northwesterly direction from its headwaters west of Tavistock to its confluence with Big Timber Creek near Delaware River. The stream drainage system for the Big Timber Creek Watershed is shown on Plate 2. In the headwater areas the flood plains are relatively narrow. They gradually increase in width to approximately 800 feet at the confluence with the Main Stem of Big Timber Creek. Elevations in the basin range from a maximum of 60 feet sld at the headwaters near Tavistock to less than 10 feet sld at the mouth. The creek parallels Route 295 for approximately 1.8 miles above the North-South Freeway.

The drainage area of Little Timber Creek is highly developed with most of the land use devoted to single family dwellings. Even though the area is highly urbanized, there is presently little development within the flood plain areas, which now consist primarily of wooded tracts and marshland. Earth fill operations along various sections of the stream are being carried on which encroach upon the flood plain. There are some structures located within the potential flooded areas, however these are few. Any further major development along the creek will result in encroachment on the flood plain areas. Pertinent drainage areas of Little Timber Creek are given in Table 2.

TABLE 2

DRAINAGE AREAS

BIG TIMBER CREEK WATERSHED

	Location	Distance Above Mouth 1000 feet	Drainage Area sq. mi.
Main Stem and South Branch	Confl. with Delaware River	-0-	62.8
	Little Timber Creek	2.5	59.0
	Almonesson Creek	22.1	49.4
	North Branch	29.0	44.5
	Above North Branch	33.4	25.4
	Bull Run	47.6	20.4
	Blackwood Lake	49.0	18.7
North Branch	Confl. with Main Stem	-0-	19.1
	Otter Brook	8.9	18.1
	Signey Run	16.0	14.0
	Pine Hill Run	20.9	12.3
	Laurel Springs	24.9	6.4
Little Timber	Confl. with Main Stem	-0-	3.8
	Bell Road	14.8	2.0

Developments in the Flood Plain

Plate 7 is an index of the two sheets that show the flooded areas of the Little Timber Creek within the study area. The study area lies in the highly urbanized part of Camden County. Most of the flood plain area is, however, presently in woodland and marshland. There is some encroachment onto the flood plain by filling operations and scattered single family dwellings.

The population trends of the nine county Delaware Valley Regional Planning Commission indicate that the growth rate for the region has been very close to that of the nation for the past eighty years. Since 1910, the approximate increase in population for the region has been one half million persons per decade, with the exception of the depression years.

The long term growth of the region has its base in diversified manufacturing activities such as oil refining, steel machinery, transportation equipment, and instruments production. In recent years the population growth rate has been more rapid than at any other time in the past. With the advent of mass transportation, such as the High Speed Rail Line to Lindenwold and the proposed high speed rail line to Woodbury, together with the new highway systems, population and density increases within the study area will be accelerated in the next few decades. The estimated 1965 population of Camden and Gloucester Counties is approximately 600,000 people. The Research and Statistics section of the Division of Economic Development, New Jersey Department of Conservation and Economic Development, estimates a two county population of 869,000 in 1985, and a population of over one million by the year 2010.

Population estimates indicate that a most rapid and dramatic growth will take place in those municipalities within the Big Timber Creek Watershed. Some of these municipalities are approaching saturation, while others such as Gloucester and Washington Townships have room for expansion. The advent of high rise buildings in this region also lends credence to a predicted large population expansion.

Plates 3 and 4 indicate municipal population densities for 1965 and 1980 respectively in the five communities in the study area. These communities are now the most densely populated in Camden County. Gloucester City, and the boroughs of Haddon Heights and Mt. Ephraim are already in the 6,000 persons per square mile and over category, while Bellmawr and Brooklawn Boroughs are in the 3,000 to 6,000 persons per square mile category. The projected average density by the year 1980 is over 6,000 persons per square mile for all communities along Little Timber Creek.

Downstream below Broadway the flood plain widens to encompass the Gloucester City Sewage Treatment Plant and the surrounding industrial section of Gloucester City. According to a recent survey for the U.S. Army Corps of Engineers, the August 13, 1955 and August 1962 floods caused an estimated $123,000 in damage along Little Timber Creek.

Undeveloped land within the study area is scarce. In order to control future development within the flood plain areas and minimize future flood losses, adequate regulatory measures are essential.

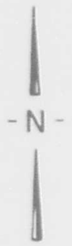
Bridges Across the Stream

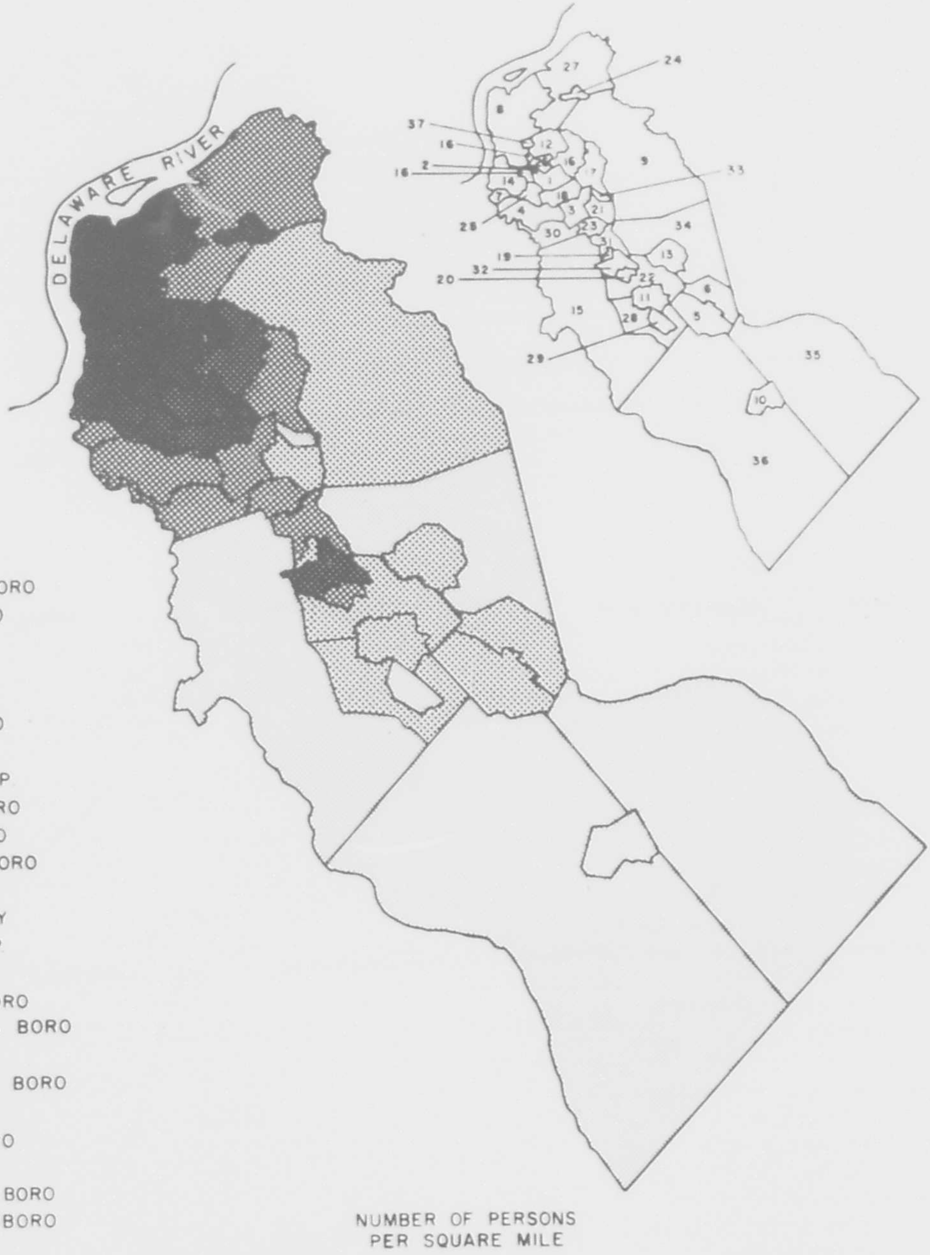
Six highways, three highway approach ramps and two railroad bridges, cross Little Timber Creek within the study limits. Table 3 gives pertinent elevations for these bridges and shows their relation to the New Jersey Floodway Design, New Jersey Flood Hazard Area Design and the Standard Project Floods.

The highways crossing the Creek are: Broadway, Crescent Boulevard, Kings Highway, the North-South Freeway, Bell Road and the Black Horse Pike. The roadway surface of the highway crossings, with the exception of Broadway, Crescent Boulevard and Kings Highway are above the Standard Project Flood level. The North-South Freeway and its Route 295 interchange complex, 11,200 feet above the mouth, is situated within the Little Timber Creek flood plain.

The Pennsylvania-Reading Seashore Lines railroad crosses the Creek at two locations: parallel and adjacent to Broadway and parallel and adjacent to the Black Horse Pike. The railroad bridge near Broadway is subject to flooding by both the New Jersey Flood Hazard Area and the Standard Project Floods, while the bridge near Black Horse Pike is well above the Standard Project Flood level.

The Broadway bridge, located 5,100 feet above the mouth of Little Timber Creek, is a concrete structure with two 30 foot spans. Both the New Jersey Floodway and the New Jersey Flood Hazard Area Design Floods would be above the floor of the bridge, while the Standard Project Flood would completely cover the bridge. The head loss under all circumstances would be negligible.





1. AUDUBON BORO
2. AUDUBON PARK BORO
3. BARRINGTON BORO
4. BELLMAWR BORO
5. BERLIN BORO
6. BERLIN TWP
7. BROOKLAWN BORO
8. CAMDEN CITY
9. CHERRY HILL TWP
10. CHESILHURST BORO
11. CLEMENTON BORO
12. COLLINGSWOOD BORO
13. GIBBSBORO BORO
14. GLOUCESTER CITY
15. GLOUCESTER TWP
16. HADDON TWP
17. HADDONFIELD BORO
18. HADDON HEIGHTS BORO
19. HI-NELLA BORO
20. LAUREL SPRINGS BORO
21. LAWNSIDE BORO
22. LINDENWOLD BORO
23. MAGNOLIA BORO
24. MERCHANTVILLE BORO
25. MOUNT EPHRAIM BORO
26. OAKLYN BORO
27. PENNSAUKEN TWP
28. PINE HILL BORO
29. PINE VALLEY BORO
30. RUNNEMEDE BORO
31. SOMERDALE BORO
32. STRATFORD BORO
33. TAVISTOCK BORO
34. VOORHEES TWP
35. WATERFORD TWP
36. WINSLOW TWP
37. WOODLYNNE BORO

NUMBER OF PERSONS PER SQUARE MILE

0 - 1000

1000 - 3000

3000 - 6000

6000 & OVER

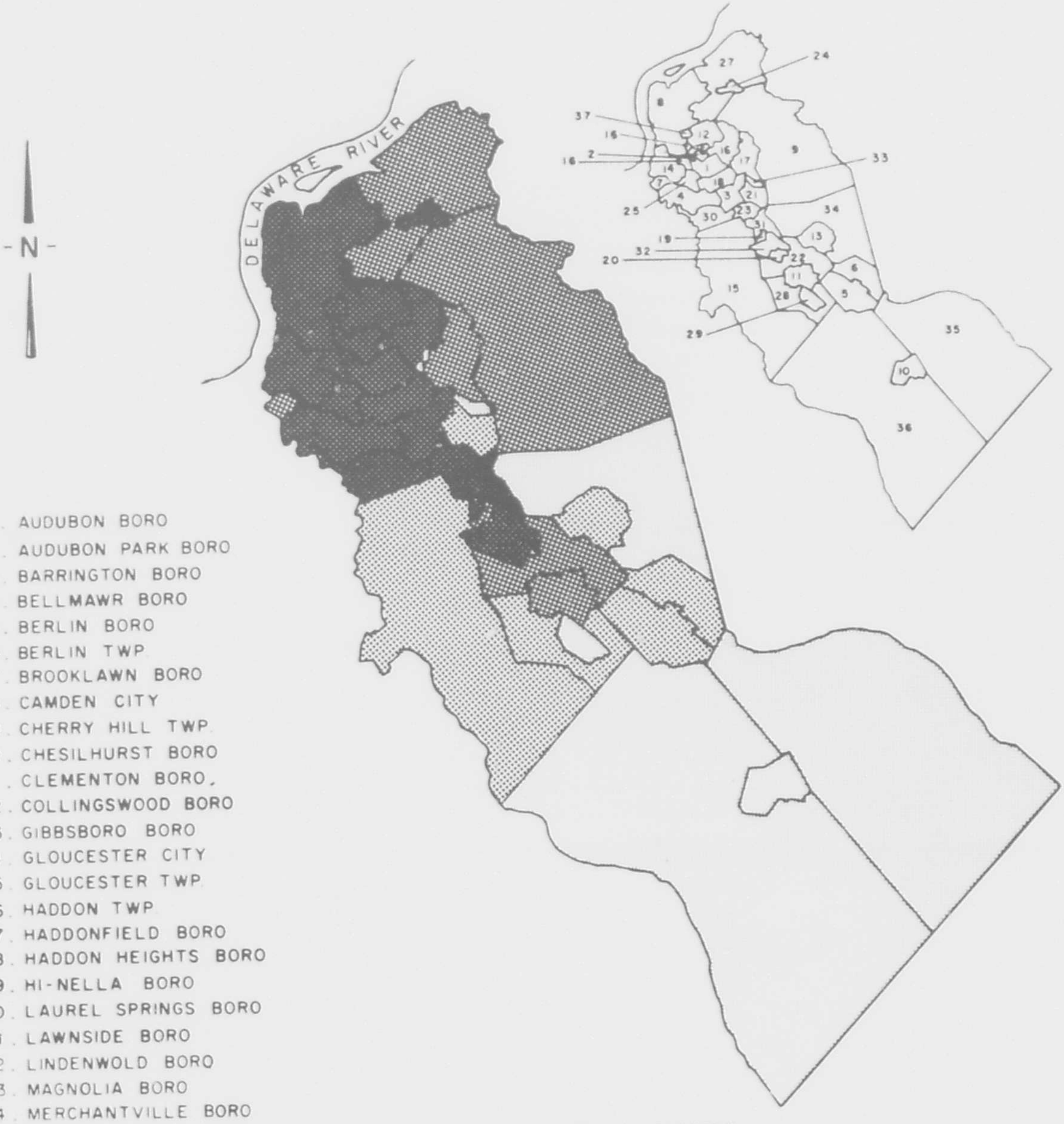
CORPS OF ENGINEERS, U.S. ARMY
PHILADELPHIA DISTRICT

1965 MUNICIPAL POPULATION DENSITIES CAMDEN COUNTY

4 3 2 1 0 4
SCALE MILES

MARCH 1969

PLATE 3



1. AUDUBON BORO
2. AUDUBON PARK BORO
3. BARRINGTON BORO
4. BELLMAWR BORO
5. BERLIN BORO
6. BERLIN TWP.
7. BROOKLAWN BORO
8. CAMDEN CITY
9. CHERRY HILL TWP.
10. CHESILHURST BORO
11. CLEMENTON BORO.
12. COLLINGSWOOD BORO
13. GIBBSBORO BORO
14. GLOUCESTER CITY
15. GLOUCESTER TWP.
16. HADDON TWP.
17. HADDONFIELD BORO
18. HADDON HEIGHTS BORO
19. HI-NELLA BORO
20. LAUREL SPRINGS BORO
21. LAWNSIDE BORO
22. LINDENWOLD BORO
23. MAGNOLIA BORO
24. MERCHANTVILLE BORO
25. MOUNT EPHRAIM BORO
26. OAKLYN BORO
27. PENNSAUKEN TWP.
28. PINE HILL BORO
29. PINE VALLEY BORO
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31. SOMERDALE BORO
32. STRATFORD BORO
33. TAVISTOCK BORO
34. VOORHEES TWP.
35. WATERFORD TWP.
36. WINSLOW TWP.
37. WOODLYNNE BORO

NUMBER OF PERSONS PER SQUARE MILE

0 - 1000

1000 - 3000

3000 - 6000

6000 & OVER

CORPS OF ENGINEERS, U.S. ARMY
PHILADELPHIA DISTRICT

1980 MUNICIPAL POPULATION DENSITIES

CAMDEN COUNTY

4 3 2 1 0 4
SCALE MILES

MARCH 1969

TABLE 3

BRIDGES ACROSS LITTLE TIMBER CREEK

1000 FEET ABOVE MOUTH	IDENTIFICATION	STREAM BED ELEV. FEET	FLOOR ELEV. FEET	FLOODWAY DESIGN FLOOD CREST (1) FEET	FLOOD HAZARD AREA DESIGN FLOOD CREST (1) FEET	STANDARD PROJECT FLOOD CREST (1) FEET	UNDERCLEARANCE ELEV. FEET	UNDERCLEARANCE FLOODWAY DESIGN FLOOD ABOVE FEET	UNDERCLEARANCE FLOODWAY DESIGN FLOOD BELOW FEET
5.1	BROADWAY	-8.0	8.8	9.6	10.4	14.7	5.4		4.2
5.4	PENNSYLVANIA-READING SEASHORE LINES	-7.0	10.2	9.6	10.4	14.7	8.0		1.6
8.0	CRESCENT BOULEVARD	-6.6	13.3	9.6	10.4	14.7	10.0	0.4	
9.5	KINGS HIGHWAY	-1.5	9.2	9.6	10.4	14.7	6.7		2.9
11.0	APPROACH TO NORTH-SOUTH FREEWAY	-1.5	18.0	9.6	10.4	14.7	6.2		3.4
11.2	NORTH-SOUTH FREEWAY	-1.6	(2)	9.6	10.4	14.7	6.7		2.9
11.4	APPROACH TO NORTH-SOUTH FREEWAY	-0.3	19.0	9.6	10.4	14.7	6.9		2.7
14.8	BELL ROAD	2.2	(2)	9.6	10.4	14.7	9.6		
16.6	PENNSYLVANIA-READING SEASHORE LINES	7.3	18.6	11.5	12.0	14.7	17.6	6.1	
17.2	BLACK HORSE PIKE	6.6	(2)	12.6	13.2	14.7	13.6	1.0	
17.4	APPROACH TO BLACK HORSE PIKE	6.8	(2)	13.1	14.7	15.1	15.3	2.2	

(1) ELEVATION OF CREST LOCATED IMMEDIATELY DOWNSTREAM FROM BRIDGE.

(2) ROADWAY LOCATED ON TOP OF HIGH EARTH FILL. ELEVATION NOT DETERMINED

NOTE: ALL ELEVATIONS ARE REFERENCED TO MEAN SEA LEVEL - 1929 ADJUSTMENT (SLD).

The railroad bridge, only 300 feet upstream from Broadway, is a timber structure that would be inundated by either the New Jersey Flood Hazard Area Design or the Standard Project Floods. In either case the head loss would be negligible. A flood on the order of the New Jersey Floodway Design Flood would rise about 1.55 feet above the bridge underclearance, and, although the head loss would be negligible, the nature of the bridge construction is such that excessive clogging from debris and consequent obstruction could be expected.

Crescent Boulevard crosses the Creek about 8,000 feet above its mouth on a 42 foot single span concrete bridge. Only a flood on the order of the Standard Project Flood would rise above the roadway and head losses would be negligible under all conditions.

Kings Highway, crossing 1,500 feet further upstream, would, like Broadway, be flooded by both the New Jersey Floodway Design and New Jersey Flood Hazard Area Design Flood, and would be completely covered by the Standard Project Flood. The head losses under any of these conditions would be negligible.

The Broadway, Crescent Boulevard and Kings Highway bridges are shown in Figure 1. These three are the most significant bridges within the study limits since they are the only highway bridges that would be under water in the event of major flooding.

The North-South Freeway, crossing Little Timber Creek 11,200 feet above its mouth, along with the two approach ramps, one upstream and one downstream from the Freeway, are actually concrete box culverts with earth fill elevating the roadway above the Standard Project Flood level. The head losses are, once again, negligible.

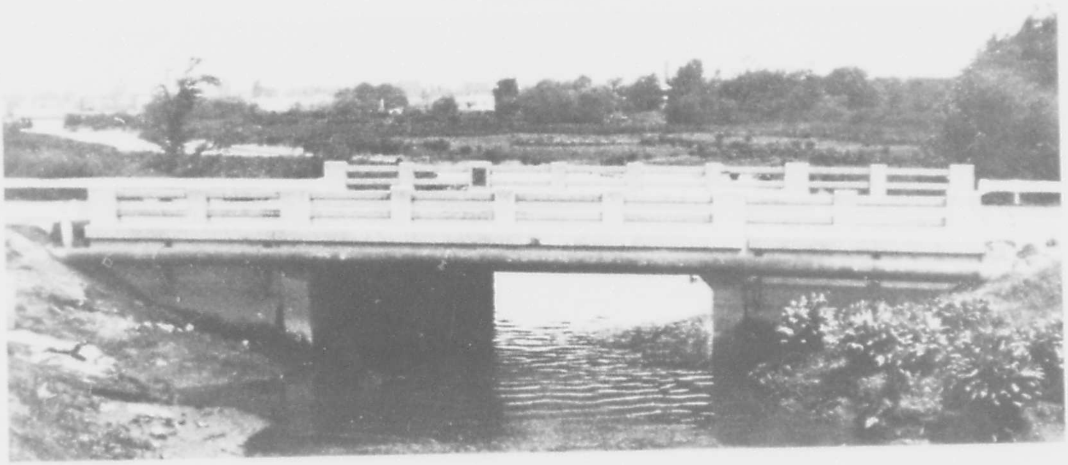


Figure 1.--LITTLE TIMBER CREEK BRIDGES

Upper view is upstream side of Broadway bridge. Middle view is upstream side of Crescent Boulevard bridge. Lower view is upstream side of Kings Highway bridge.

Bell Road, 14,800 feet above the mouth, is also elevated above the flood levels by earth fill over a concrete box culvert. There would be some head loss encountered during a flood of the magnitude of the New Jersey Flood Hazard Area Design flood but the loss would be slight. Under other conditions the head losses are negligible.

The second Pennsylvania-Reading Seashore Lines crossing of Little Timber Creek is 16,600 feet above the mouth. The structure is a corrugated metal pipe arch which elevates the road bed above the Standard Project Flood. Head losses are negligible.

Black Horse Pike crosses the Creek 17,200 feet above its mouth. The roadway is elevated by earth fill over a concrete box culvert. Head losses are encountered at this structure, but they are not large, reaching a maximum of about 1.5 feet for a flood of the magnitude of the New Jersey Flood Hazard Area Design Flood.

Two hundred feet further upstream is an approach ramp from Route 295 to the Black Horse Pike. It is another concrete box culvert and head losses are negligible.

Obstructions to Flood Flow

With the exception of the minor restrictions at the bridges previously described, there are no other permanent obstructions to flood flow. However, the low head losses encountered at the bridge restrictions are based upon the assumption that there would be no accumulation of debris to clog these openings. Such clogging, especially likely in the case of the culvert crossings, could create considerably more extensive flooding upstream than would otherwise be anticipated.

The U.S. Army Corps of Engineers made a flood damage survey of this area of Little Timber Creek in 1964. The survey revealed that at that time, the stream bed in the upper areas of Little Timber Creek was badly choked with natural and man-made debris. With this condition, intense rainfall such as occurred in September 1940, would create an extremely serious condition by blocking bridges and culverts resulting in the abnormal flooding of surrounding areas. These areas should be cleared of their accumulated debris in order to facilitate future flood flows and reduce damages.

FLOOD SITUATION

Flood Records

With the exception of the low-flow and crest-stage partial record stations at Laurel Springs on the North Branch and at Blackwood Lake on the South Branch, no stream gaging information is available for the Big Timber Creek watershed. The low-flow gages were established in 1959 and 1964 respectively, and the crest-stage gages in 1964.

Information on past floods was obtained from interviews with local residents and from a search of newspaper files and historical records. Field investigations and office computations were made to supplement the historical data obtained. Flood profiles and cross sections have been plotted and are presented in this report.

The floods of major importance in recent times are the August 1933, September 1940, November 1950 and the August 1955 floods.

Flood Stages and Discharges

The relative flood heights and discharges for the Standard Project, New Jersey Flood Hazard Area Design and N' ' Jersey Floodway Design Floods and historical flood elevations, are shown at selected points within the watershed in Table 4. The discharge assumed to represent runoff at the time of the maximum anticipated tide stage, which is the controlling condition throughout virtually the entire area of study, was considerably less than those shown.

The following tide stages were observed in the Delaware River near the mouth of Big Timber Creek during the period of record:

TIDAL FLOODS

Date	Elevation (sld) Feet
August, 1933	8.6
November, 1950	8.5
August 13, 1955	8.0
August 19-20, 1955	7.2

For Little Timber Creek, Table 4 indicates a flow elevation in 1940 of 10.0 feet at Bell Road, and an elevation in 1955 of 8.8 feet at the confluence with the Main Stem. At the confluence with the Main Stem, the Standard Project Flood elevation would be 14.7 feet with a discharge of 1500 cfs.

Velocities

Peak velocities for the Standard Project, the New Jersey Flood Hazard Area Design and the New Jersey Floodway

TABLE 4

RELATIVE FLOOD HEIGHTS AND PEAK DISCHARGES

BIG TIMBER WATERSHED

TRIBUTARY	LOCATION	FLOODWAY DESIGN FLOOD HEIGHT FEET	FLOODWAY DESIGN FLOOD DISCHARGE CFS	FLOOD HAZARD AREA DESIGN FLOOD HEIGHT FEET	FLOOD HAZARD AREA DESIGN FLOOD DISCHARGE CFS	STANDARD PROJECT FLOOD HEIGHT FEET	STANDARD PROJECT FLOOD DISCHARGE CFS	1940 FLOOD HEIGHT FEET	1955 FLOOD HEIGHT FEET
MAIN STEM - SOUTH BRANCH	CONFL. WITH DELAWARE RIVER	9 6	4 300	10 4	5 350	14 7(1)	13 300		8 0
	CONFL WITH BEAVER BROOK	9 6	3 750	10 4	4 750	14 7(1)	12 350	10 0	
	CONFL WITH NORTH BRANCH	9 6	3 350	10 4	4,200	14 7(1)	11 800	14 0	
	BLACKWOOD LAKE	12 5	1 175	13 0	1 470	18.2	5 450	27 2	
NORTH BRANCH	CHEWS LANDING -SOMERDALE ROAD	10 5	1 600	12 2	2 000	21 6	4 000	21 0	
	DAM BELOW LAUREL ROAD	21 3	700	22 2	900	23 8	1 700	27 2	
LITTLE TIMBER	CONFL WITH MAIN STEM	9 6	950	10 4	1 190	14 7	1 500		8 8
	BELL ROAD	9 6	500	10 4	600	14 7	850	10 0	

(1) STAGE FOR TIDAL FLOOD (THE DISCHARGE IN THESE CASES IS FOR RUNOFF HAVING THE SAME FREQUENCY)

NOTE ALL ELEVATIONS ARE REFERENCED TO MEAN SEA LEVEL 1929 ADJUSTMENT (SLD)

Design Floods are shown in Table 5. The discharges and velocities do not reflect the effect of tidal flooding or backwater from bridges. Since the discharges at the time of anticipated maximum tide stage would be considerabl_ less than those shown in Table 4, their respective velocities are not critical and were, therefore, not shown.

Flooded Areas, Flood Profiles, and Cross Sections

Plates 8 and 9 show the approximate flooded areas along the Little Timber Creek for the Standard Project, the New Jersey Flood Hazard Area Design and the New Jersey Floodway Design Floods.

The actual limits of these overflow areas on the ground may vary somewhat from those shown on the map because the ten foot contour interval and scale of the topographic maps do not permit precise plotting of the flooded area boundaries. Also, during the process of reproduction of both the topographic maps and the aerial photographs, some distortions occur. However, the assumptions made are conservative and reasonable and a good generalized picture of the flood situation is presented.

Plate 10 shows the high water profile for the Standard Project Flood, the New Jersey Flood Hazard Area Design Flood and the New Jersey Floodway Design Flood. Also shown on the same plate are the available high water marks for the September 1940 and August 1955 floods.

Plate 11 shows three of the cross sections at various points along the study reach of the Little Timber Creek.

TABLE 5

PEAK VELOCITIES

BIG TIMBER WATERSHED

TRIBUTARY	LOCATION	FLOODWAY DESIGN FLOOD CHANNEL (FEET PER SECOND)	FLOODWAY DESIGN FLOOD OVERBANK (FEET PER SECOND)	FLOOD HAZARD FLOOD DESIGN FLOOD CHANNEL (FEET PER SECOND)	FLOOD HAZARD FLOOD DESIGN FLOOD OVERBANK (FEET PER SECOND)	STANDARD PROJECT FLOOD CHANNEL (FEET PER SECOND)	STANDARD PROJECT FLOOD OVERBANK (FEET PER SECOND)
MAIN STEM	CONFL. WITH DELAWARE RIVER	1.1	–	1.4	–	3.4	–
SOUTH BRANCH	BLACKWOOD LAKE	5.0	1.7	5.5	2.0	9.2	3.6
NORTH BRANCH	CONFL. WITH MAIN STEM	0.4	0.2	0.5	0.2	1.6	0.7
NORTH BRANCH	CONFL. WITH SIGNEY RUN	0.7	0.3	0.8	0.3	1.4	0.6
LITTLE TIMBER	BLACK HORSE PIKE	4.8	1.1	5.3	1.3	6.0	1.5

NOTE: THE ABOVE TABLE DOES NOT REFLECT THE EFFECT OF TIDAL FLOODING.

The locations of all four sections are shown on Plates 8 and 9. The elevation and extent of overflow for the Standard Project Flood, the New Jersey Flood Hazard Area Design Flood, and the New Jersey Floodway Design Flood are shown as part of the cross section information.

FLOOD DESCRIPTIONS

The following are descriptions of known large floods that have occurred in the vicinity of the Little Timber Creek. They are based upon newspaper accounts, historical records and field investigations.

September 1940 Flood

The historical non-tidal flood of record occurred in September 1940 and resulted from a highly localized storm with its center at Ewan, Gloucester County, New Jersey. The following table lists amounts of precipitation recorded during the 1940 storm in the general area:

Station or Location	Precipitation (inches)	Duration (hours)
Ewan, N.J.	24*	8
Cohansey, N.J.	10.93	12
Goldsboro, N.J.	6.20	12
N. Merchantville, N.J.	5.19	12
Trenton, N.J.	3.84	12
Philadelphia, Pa.	Trace	

* Unofficial reading

The following account was given in the Evening Bulletin, Philadelphia, Pennsylvania, Monday, September 2, 1940:

The storm was of a freakish nature, arising from a combination of weather factors.

First, weather observers pointed out a cool high pressure area settled over New England late Saturday. Then as the result of a tropical born hurricane 100 miles out to sea, there were waves of moist warm air. In addition there were thundershowers over Central Pennsylvania and a low pressure area moving from the Great Lakes.

Apparently these conditions merged over the five County area causing a rainfall of unusual intensity, accompanied at times by high winds.

The area lashed by rain and high winds covered Camden, Burlington, Gloucester, Cumberland and Salem Counties. The disturbance extended roughly from the Mt. Holly area in Burlington County to Bridgeton on the south.

The excessive amount of runoff resulting from the storm caused numerous dam failures in the watershed which, in turn, had a domino effect on other downstream dams and bridges. Information of which dams failed and the downstream effect of the failures is, at best, limited. High water data are also limited due to the sparse development in this area in 1940, and no discharge estimates have been made. The available high water marks were affected by surges from upstream dam failures and any attempts to estimate discharges by standard methods would require study beyond the scope of this investigation. For these reasons, no water-surface profile was prepared for the September 1940 flood. However, available high water marks obtained as part of a flood damage survey made in 1964 are shown on the profile drawing in this report.

The flood damage survey indicated that the stream bed in the upper areas of the Little Timber Creek is badly choked with natural and man-made debris, and serious rainfall such as in September 1940 would create a very bad condition by blocking bridges and culverts and subsequently flooding the surrounding area.

The following are excerpts from newspapers concerning the 1940 flood in the Big Timber Watershed:

The Evening Bulletin
Philadelphia, Penna.
Monday, September 2, 1940

Flood Loss Set at Millions
In Camden County

Heaviest of the damage in the lower part of the county occurred in the vicinity of Blackwood Lake, Chews Landing and Glendora, with more than 200 homes flooded.

Sections of Black Horse Pike pavement were washed out and the bridge over Timber Creek, near Chews Landing was closed.

GLOUCESTER DAMS BREAK
Cloudburst Causes Nearly All Lakes
in County to Give Way

Benjamin F. Dubois, Gloucester county road supervisor, said this morning that the dams of almost all lakes in the county had given way under the cloudburst, and that there are 15 major road washouts.

The Philadelphia Inquirier
Philadelphia, Pennsylvania
Monday, September 2, 1940

WESTVILLE: Three feet of water engulfed 50 homes in the Timber Park Section. Residents, used to flood behavior of Big Timber Creek, refused to panic, declaring they would not worry until the water rose two more feet. They used rowboats to visit neighbors.

The Philadelphia Inquirer
Philadelphia, Pennsylvania
Tuesday, September 3, 1940

FLOODED DISTRICTS IN SOUTH JERSEY FIGHT TOWARD NORMALCY

With amazing vitality, a five County area of Southern New Jersey fought its way yesterday through flood destruction estimated to have caused between $5,000,000 and $7,500,000, to achieve an approximation of normalcy by nightfall.

The flood-ravaged area extended roughly from Mt. Holly, in Burlington county, on the north, in a wide arc southward through Millville to Bridgeton in Cumberland county.

<u>November 1950 Flood</u>

This flood resulted from tide conditions in the Delaware River. A tide stage of 8.5 feet sld was observed in the Delaware River near the mouth of the Big Timber Creek during this flood.

The following are excerpts from newspapers concerning the 1950 flood on the Big Timber Watershed.

Courier-Post
Camden, New Jersey
Saturday, November 25, 1950

Thousands of acres of South Jersey were under water this afternoon as the Cooper River and the Big Timber and Newton creeks overflowed.

Worst hit section of the area was Westville, where 40 homes along Timber Avenue, on the banks of Big Timber creek, were flooded.

Water was three feet deep in the first floors of these houses, with the families taking refuge on the second floors.

Courier-Post
Camden, New Jersey
Monday, November 27, 1950

100 Left Homeless By Creek Flooding in Gloucester County

In Westville, where Big Timber creek overflowed its banks and submerged 40 homes along Timber Avenue, officials ordered an evacuation at 9 p.m. Saturday.

Rescuers were forced to use rowboats to reach the homes, where many of the inhabitants had fled to second floors when the onrushing waters submerged first floors.

Asked if the local defense system had received any instructions from the state during the emergency, (Westville Major Joseph C.) *Tarpine replied in the negative.*

FUTURE FLOODS

This section of the report discusses the Standard Project Flood, the New Jersey Floodway Design Flood and the New Jersey Flood Hazard Area Design Flood on the Little Timber Creek, Camden County, New Jersey.

The Standard Project Flood is used by the Corps of Engineers for design purposes and reflects the runoff from a large storm that is considered reasonably likely to occur. Floods of the magnitude of the Standard Project Flood represent reasonable upper limits of expected flooding. The New Jersey Floodway Design Flood and the New Jersey Flood Hazard Area Design Flood represent flood limits that may reasonably be expected to occur more frequently, although they are not of the magnitude of the Standard Project Flood.

In addition to the Standard Project Flood the Corps of Engineers usually computes a flood of lesser magnitude which would occur more frequently than the Standard Project Flood. This flood is known as the Intermediate Regional Flood. However, since it would be of the same general magnitude as the Floodway Design Flood used herein, it has not been included in this report.

The delineation of large floods on the Little Timber Creek in great measure depends upon recorded experiences in the flood region. Comparative stream flow data for neighboring streams and regions of comparable size can be used to indicate probable large floods on the Little Timber Creek. Therefore, it is useful to consider storms and floods that have occurred in the region where the watersheds have similar characteristics such as topography, soil conditions, land use, rainfall, etc. Maximum known flood discharges on streams in the same geographical region as the Little Timber Creek are shown in Table 6.

DETERMINATION OF THE NEW JERSEY FLOODWAY DESIGN AND FLOOD HAZARD AREA DESIGN FLOODS

Definitions of the Floodway and Flood Hazard Area are as follows:

"Floodway" - the channel and portions of the adjacent flood plain necessary to preserve the natural regimen of a stream for the reasonable passage of the Floodway Design Flood.

"Flood Hazard Area" - the Floodway and any additional portions of the flood plain inundated by the Flood Hazard Area Design Flood.

The New Jersey Floodway Design and the New Jersey Flood Hazard Area Design Floods have been used extensively by the State of New Jersey for planning purposes. The definitions of and the method used in the

TABLE 6

MAXIMUM KNOWN FLOOD DISCHARGES ON STREAMS IN THE REGION OF LITTLE TIMBER CREEK

STREAM	LOCATION	DRAINAGE AREA SQ. MI.	DATE	PEAK DISCHARGE AMOUNT CFS	PEAK DISCHARGE PER SQ. MI. CFS
MAURICE RIVER	AT NORMA, NEW JERSEY	113	SEPTEMBER 1, 1940	7,360	65
N. BR. RANCOCAS CR.	AT PEMBERTON, NEW JERSEY	111	AUGUST 21, 1939	1,730	15.5
CHESTER CREEK	NEAR CHESTER, PENNSYLVANIA	61.1	NOVEMBER 25, 1950	14,400	236
RIDLEY CREEK	AT MOYLAND, PENNSYLVANIA	31.9	NOVEMBER 25, 1950	5,720	180
ALLOWAY CREEK	AT ALLOWAY, NEW JERSEY	21.9	SEPTEMBER 12, 1960	1,860	85
OLDMANS CREEK	NEAR WOODSTOWN, NEW JERSEY	19	SEPTEMBER 1, 1940	8,100	427
SALEM RIVER	AT WOODSTOWN, NEW JERSEY	14.6	SEPTEMBER 1, 1940	22,000	1,500
MANTUA CREEK	AT PITMAN, NEW JERSEY	6.8	SEPTEMBER 1, 1940	4,200	618
STILL RUN	NEAR MICKLETOWN, NEW JERSEY	4.0	SEPTEMBER 12, 1960	275	69

determination of these floods is described in the New Jersey Flood Hazard Report No. 1 *Delineation of Flood Hazard Areas.*

In determining the magnitude of the Floodway Design and Flood Hazard Area Design Floods, discharge-frequency relationships were developed according to the procedures described in the New Jersey Water Resources Circular No. 13, *Floods in New Jersey:Magnitude and Frequency,* prepared in 1964 by the U.S. Geological Survey in cooperation with the State of New Jersey. Since the study area does not lie wholly within a single flood-frequency region or hydrologic area as defined in Circular No. 13, modifications were recommended by the Department of Conservation and Economic Development of the State of New Jersey. These modifications are as follows:

a. The Big Timber Watershed was assumed to have flood-frequency and hydrologic characteristics equivalent to the average characteristics of the flood-frequency regions and hydrologic areas (as delineated in Circular No. 13) in which it lies.

b. The Floodway Design and Flood Hazard Area Design Floods are determined by applying "multiples" to the mean annual flood as shown in the New Jersey Flood Hazard Report No. 1.

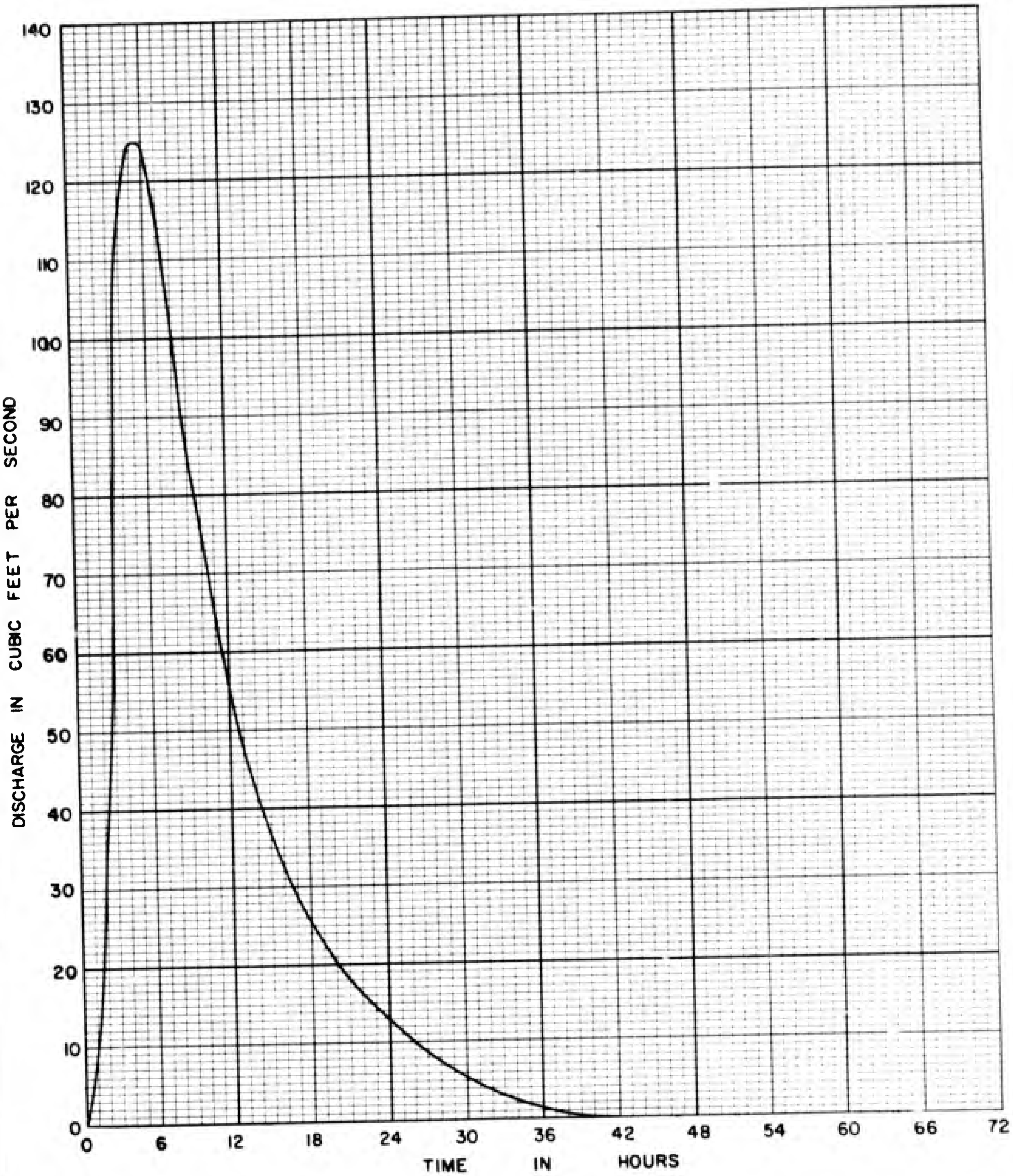
This modified procedure was then used to develop frequency-discharge relationships for the Little Timber Creek at its confluence with the Big Timber Creek. The values obtained do not reflect tidal effects. Furthermore, it was assumed that no obstruction due to accumulations of debris and no failure of upstream dams would occur. In the resulting frequency analysis the present state of urbanization was considered, so that resulting flood lines shown in this report represent the affected area with conditions similar to those existing at the time this report was prepared.

The unit hydrograph shown on Plate 5, was prepared for the Little Timber Creek approximately 700 feet downstream from Bell Road, using the procedures described in paragraph 106, Appendix M of the Delaware River Basin Report, House Document #522, 87th Congress, Second Session. A second method of developing synthetic unit hydrographs, Snyder's Method, was used to verify this hydrograph. Because of the lack of data such as area-capacity curves, regulation schedules, outlet rating curves, travel times, routing constants, and the failure potential of each dam, it was felt that a detailed routing procedure might lead to erroneous results. The synthetic hydrographs, on the other hand, are believed to be reasonably accurate and representative of conditions which are likely to occur for the more severe storm events.

Table 7 indicates the flood heights and peak discharges for the Floodway Design Flood on the Little Timber Creek.

TABLE 7
FLOODWAY DESIGN FLOOD
FLOOD HEIGHTS AND PEAK DISCHARGES

	Distance Above Mouth 1000 feet	Drainage Area sq. mi.	Height feet msl	Discharge cfs
Confl. with Big Timber	-0-	3.8	9.55	950
Bell Road	14.6	2.0	9.55	500



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PHILADELPHIA DISTRICT

THREE HOUR UNIT HYDROGRAPH

HEAD OF TIDE

LITTLE TIMBER CREEK

MARCH 1969

PLATE 5

Table 8 indicates the flood heights and peak discharges that would occur on the Little Timber Creek during the New Jersey Flood Hazard Area Design Flood.

TABLE 8
FLOOD HAZARD AREA DESIGN FLOOD
FLOOD HEIGHTS AND PEAK DISCHARGES

	Distance Above Mouth 1000 feet	Drainage Area sq. mi.	Height feet msl	Discharge cfs
Confl. with Big Timber	-0-	3.8	10.4	1,190
Bell Road	14.6	2.0	10.6	600

An inspection of the high water profiles and high water marks on Plate 10 indicates that historical floods were higher than both the Floodway Design and Flood Hazard Area Design Floods in some areas, but lower in others.

The Flood Hazard Area Design Flood profile was determined by considering two independent events, each of which have approximately the same frequency of occurrence. The resulting water surface profile represents the worst of the two conditions at any particular station. Specifically, a tide level of 10.4 feet sld at the mouth of the Main Stem, coincidentally with the peak runoff of a one year flood was used for the first condition. The second condition assumed an annual high tide of 6 feet sld, to occur coincidentally with the peak Flood Hazard Area Design Flood discharge. It should be pointed out that a one year flood is one which, over a long period of record, can be expected to be equalled or exceeded on the average of once per year. It will not necessarily occur once in every calendar year.

Water surface profile computations based on these conditions were then corrected to reflect the effect of bridge conditions.

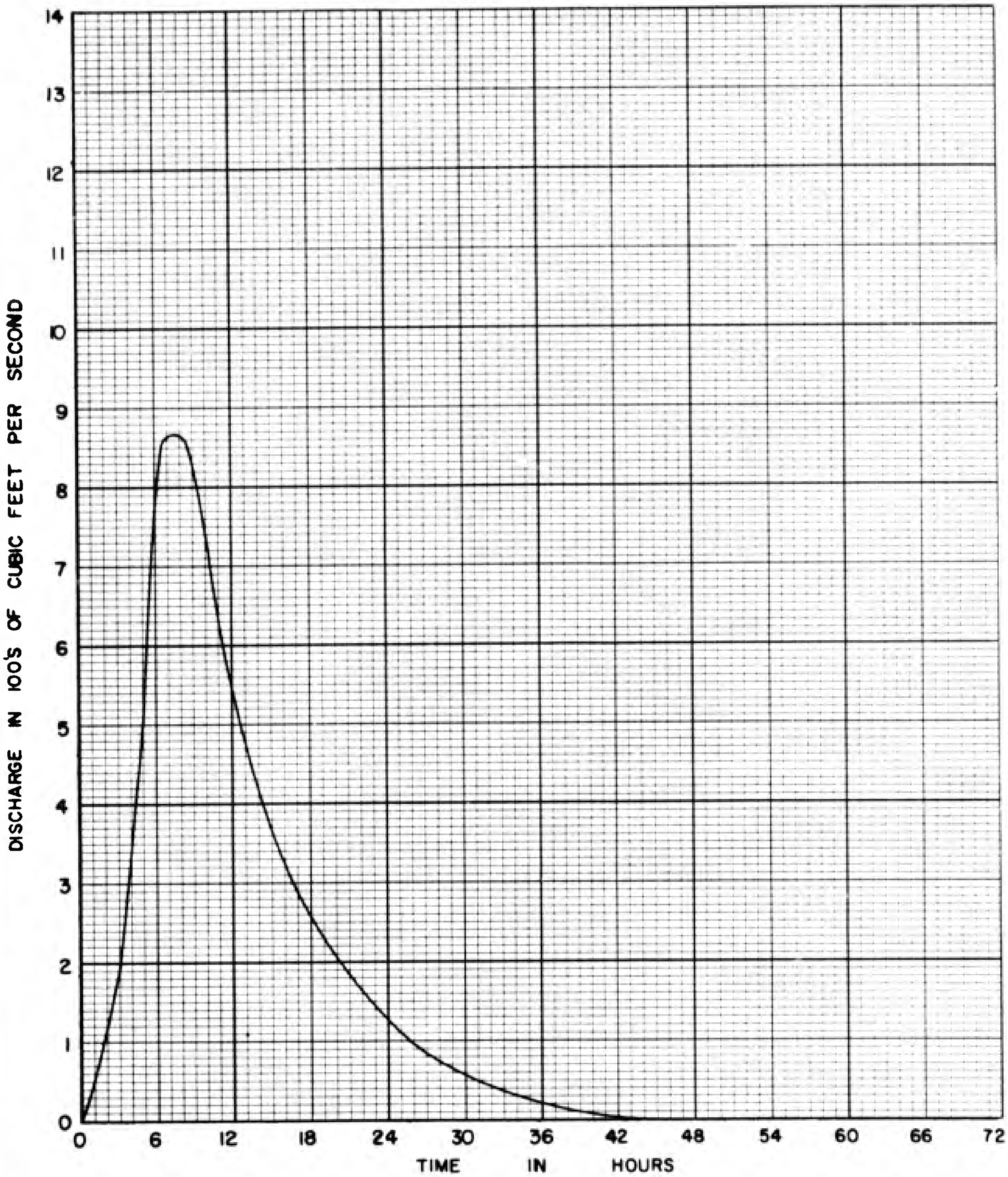
The Floodway Design Flood profile was determined in a similar manner using a tide level of 9.6 feet sld.

DETERMINATION OF THE STANDARD PROJECT FLOOD

It is rare that a specific stream has experienced the largest flood that is likely to occur. Although flooding may have been severe in the past, it is a commonly accepted fact that in practically all cases, sooner or later, a flood of a larger magnitude will probably occur. The Corps of Engineers, in cooperation with the U.S. Weather Bureau, has made broad and comprehensive studies and investigations based on the vast records of experienced storms and floods and has evolved generalized procedures for estimating the flood potential of streams. These procedures have been used in determining the Standard Project Flood, defined as the largest flood that can be expected from the most severe combination of meteorological and hydrological conditions that are considered reasonably charactertistic of the geographical region involved. Larger floods are possible and are discussed on Page 38.

The methods used in determining the Standard Project Flood are applied to those locations for which unit hydrographs were developed. It should be pointed out that the resulting Standard Project Flood hydrograph, which is shown on Plate 6, indicates relatively high discharges.

Standard Project Flood profiles were developed by the same method used for the Flood Hazard Area Design Flood as discussed on Page 35 of this report. A tide level of



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PHILADELPHIA DISTRICT

SPF HYDROGRAPH

HEAD OF TIDE

LITTLE TIMBER CREEK

MARCH 1969

14.7 feet sld at the mouth of the Main Stem was used in these determinations. This tide level was obtained from the hurricane study, *"Delaware River and Bay-Pennsylvania, New Jersey and Delaware,"* House Document No. 348, 88th Congress, 2nd Session, and was considered to result from surges due to a Standard Project Hurricane at the mouth of Delaware Bay.

Table 9 indicates the Standard Project Flood heights and peak discharges. On the Little Timber Creek at Bell Road the Standard Project Flood height would exceed the 1940 flood height by 4.7 feet. At the confluence with the Big Timber Creek, the August 13, 1955 flood height was 8.8 feet, or 5.9 feet below the Standard Project Flood height of 14.7 feet.

TABLE 9
STANDARD PROJECT FLOOD
FLOOD HEIGHTS AND PEAK DISCHARGES

	Distance Above Mouth 1000 feet	Drainage Area sq. mi.	Height feet msl	Discharge cfs
Confl. with Big Timber	-0-	3.8	14.7	1,500
Bell Road	14.6	2.0	14.7	850

Frequency

It is not practical to assign a frequency to the Standard Project Flood. The occurrence of such a flood would be a rare event; however, it could occur in any one year.

Possible Larger Floods

Floods larger than the Standard Project Flood are possible. However, the combination of factors that would be necessary to produce such floods would seldom occur. The consideration of floods of this magnitude is of greater importance in some instances than in others, but should not be overlooked in a comprehensive study of any flood plain problem.

HAZARDS OF GREAT FLOODS

Hazardous conditions occur during floods as a result of the rapid rise of water, wind and water velocities and, in some instances, the pounding action of waves. The hydrology of the study area involves two typical flooding conditions which generate flood hazards: tidal flooding and fluvial flooding. The latter has two ways of damaging whatever lies in its path or comes under its influence. The first is by inundation and is caused when the stream overflows its banks and floods large areas. The second is damage by high water velocity, as discussed under Velocities of Water, when the stream sweeps down its channel and flood plain. Inundation causes extensive damage from water and silt and is often a serious menace to health.

Hazards may also be produced by buildings, piers, and spits of man-made land deflecting the normal currents against a formerly safe and unprotected opposite bank. Although such structures may be protected in themselves, they may cause serious damage to the opposite bank and detrimental changes in the stream channel for some distance downstream. Other flood hazards not evident in an individual reach may be produced by causes outside the reach itself, such as the sudden release of water from upstream ice and debris jams, or by the failure of an upstream impounding structure. Rising water can also cause short circuits in electrical systems resulting in fires destroying properties that might otherwise have been subject to only minor damage. In addition, the operation of emergency vehicles such as fire engines and rescue vehicles can be seriously hampered by flood waters.

Tidal flooding presents the same general hazards of fluvial flooding although these may at times be compounded to some degree by wave action. The high velocities of flood waters can damage and destroy bridges, embankments and paving; undermine and collapse buildings; and pile up debris and transport sediment to slack water areas where damaging deposits are formed.

Areas Flooded and Heights of Flooding

The areas along the Little Timber Creek which would be flooded by the New Jersey Floodway Design, New Jersey Flood Hazard Area Design and Standard Project Floods are shown on Plates 8 and 9. It should be noted that, as explained on Page 24, the flooded areas shown are only a generalized representation.

Depths of flow under various flooding conditions may be estimated from the high water profiles on Plate 10. These profiles were computed in accordance with stream characteristics determined from topographic maps, a field survey in 1967 to determine stream cross-section geometry and available historical flood data. Water surface profiles were then corrected to reflect the effect of bridge restrictions, and their accuracy is consistent with the purpose of this study and the accuracy of the basic data.

The profiles have, however, been prepared under the assumption that all bridge structures would stand and no clogging would occur, because it is impossible to forecast the degree of either occurrence. Since these profiles depend in part upon the extent of such destruction or clogging, they cannot be interpreted as infallible representations of the maximum heights which flooding might reach.

Figures 2 and 3 show the heights that would be reached by the New Jersey Floodway Design, New Jersey Flood Hazard Area Design and Standard Project Floods on buildings presently existing within the flood plain along the Little Timber Creek.

Velocities, Rates of Rise and Duration

The velocity of flood flow is dependent upon the size and shape of the stream cross section, the condition of the stream and the slope of the stream bed, all of which vary from one stream to another and at different locations on the same stream. Table 10 gives the maximum velocities that would occur in the main channel and overbank area of the Little Timber Creek at Black Horse Pike during the New Jersey Floodway Design, New Jersey Flood Hazard Area Design and Standard Project Floods.

TABLE 10
MAXIMUM VELOCITIES
LITTLE TIMBER CREEK AT BLACK HORSE PIKE

Flood	Maximum Velocities Channel (ft. per second)	Maximum Velocities Overbank (ft. per second)
New Jersey Floodway Design Flood	4.8	1.1
New Jersey Flood Hazard Area Design Flood	5.3	1.3
Standard Project Flood	6.0	1.5

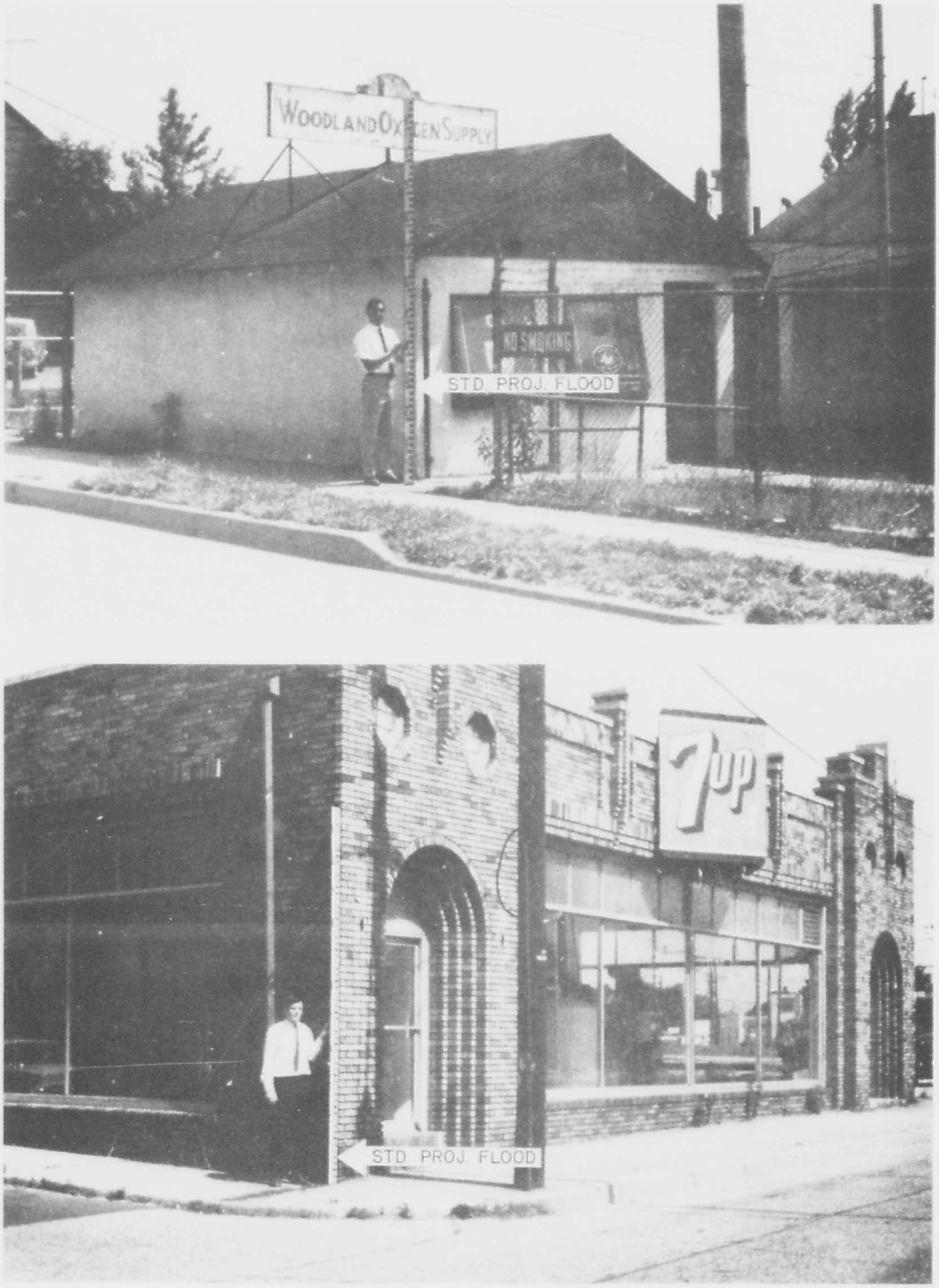

Figure 2.--FLOOD HEIGHTS ON LITTLE TIMBER CREEK

The upper view is Woodland Oxygen Supply on Broadway in Gloucester City. The lower view is the 7-Up Bottling Plant, also on Broadway in Gloucester City.

Figure 3.--FLOOD HEIGHTS ON LITTLE TIMBER CREEK

The upper view is the Brooklawn Fire House on Chestnut Street. The lower view is the Gloucester City Sewage Treatment Plant, located west of Broadway.

Floods on the Little Timber Creek are severely affected by tidal action, so that realistic determinations of the rate of rise and duration of flooding are not feasible. However, it can readily be seen that dangerous conditions can exist in the flood plain, since it is generally accepted that flood depths in excess of 3 feet in conjunction with velocities in excess of 3 feet per second represent a hazard in developed areas.

GLOSSARY OF TERMS

Flood. An overflow of lands not normally covered by water and that are used or are usable by man. Floods have two essential characteristics: the inundation of land is temporary; and the land is adjacent to and inundated by overflow from a river or stream, or an ocean, lake or other body of standing water.

Normally a "flood" is considered as any temporary rise in stream flow or stage, but not the ponding of surface water that results in significant adverse effects in the vicinity. Adverse effects may include damages from overflow of land area, temporary backwater effects in sewers and local drainage channels, creation of unsanitary conditions or other unfavorable situations by deposition of materials in stream channels during flood recessions, rise of ground water coincident with increased stream flow, and other problems.

Flood Crest. The maximum stage or elevation reached by the waters of a flood at a given location.

Floodway Design Flood. A flood that inundates the channel and portions of the adjacent flood plain necessary for the reasonable passage of flood waters. This area is known as the Floodway and represents the minimum area of the flood plain required for passage of flood waters without aggravating flood conditions upstream or downstream. This flood is used extensively by the State of New Jersey for planning purposes. See also - Flood Hazard Area Design Flood.

Flood Hazard Area Design Flood. A flood greater than the Floodway Design flood, that inundates the Floodway and additional portions of the flood plain. This area is known as the Flood Hazard Area. The Floodway (see Floodway Design Flood) is an integral part of the Flood Hazard Area. This flood is also used extensively by the State of New Jersey for planning purposes.

Flood Peak. The maximum instantaneous discharge of a flood at a given location. It usually occurs at or near the time of the flood crest.

Flood Plain. The relatively flat area or low lands adjoining the channel of a river, stream or watercourse, or ocean, lake, or other body of standing water which has been or may be covered by flood water.

Flood Profile. A graph showing the relationship of water surface elevation to location, the latter generally expressed as the distance above the mouth for a stream of water flowing in an open channel. It is generally drawn to show surface elevation for the crest of a specific flood, but may be prepared for conditions at a given time or stage.

Flood Stage. The stage or elevation at which overflow of the natural banks of a stream or body of water begins in the reach or area in which the elevation is measured.

Head Loss. The loss of energy experienced by water flowing through a constriction such as a culvert, bridge or narrow channel, resulting in a drop in water surface elevation on the downstream side of the constriction.

Left Bank. The bank on the left side of a river, stream or watercourse, looking downstream.

Low Steel (or Underclearance). See "Underclearance".

Right Bank. The bank on the right side of a river, stream, or watercourse, looking downstream.

Standard Project Flood. The flood that may be expected from the most severe combination of meteorological and hydrological conditions that is considered reasonably characteristic of the geographical area in which the drainage basin is located, excluding extremely rare combinations. Peak discharges for these floods are generally about 40 percent to 60 percent of the Probable Maximum Floods for the same basins. Such floods, as used by the Corps of Engineers, are intended as practicable expressions of the degree of protection that should be sought in the design of flood control works, the failure of which might be disastrous.

Underclearance. The lowest point of a bridge or other structure over or across a river, stream, or watercourse, that limits the opening through which water flows. This is referred to as "low steel" in some regions.

AUTHORITIES, ACKNOWLEDGEMENTS AND INTERPRETATION OF DATA

This report has been prepared in accordance with the authority granted by Section 206 of the Flood Control Act of 1960 (PL 86-645), as amended.

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Assistance and cooperation of the U.S. Weather Bureau, U.S. Geological Survey, U.S. Coast and Geodetic Survey, New Jersey Department of Conservation and Economic Development, Camden County Planning Board, Gloucester County Planning Board, and private citizens in supplying useful data is appreciated.

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This report presents the local flood situation for the Little Timber Creek in Camden County, New Jersey.

The Philadelphia District of the Corps of Engineers will, upon request, provide interpretation and limited technical assistance in the application of data presented herein.

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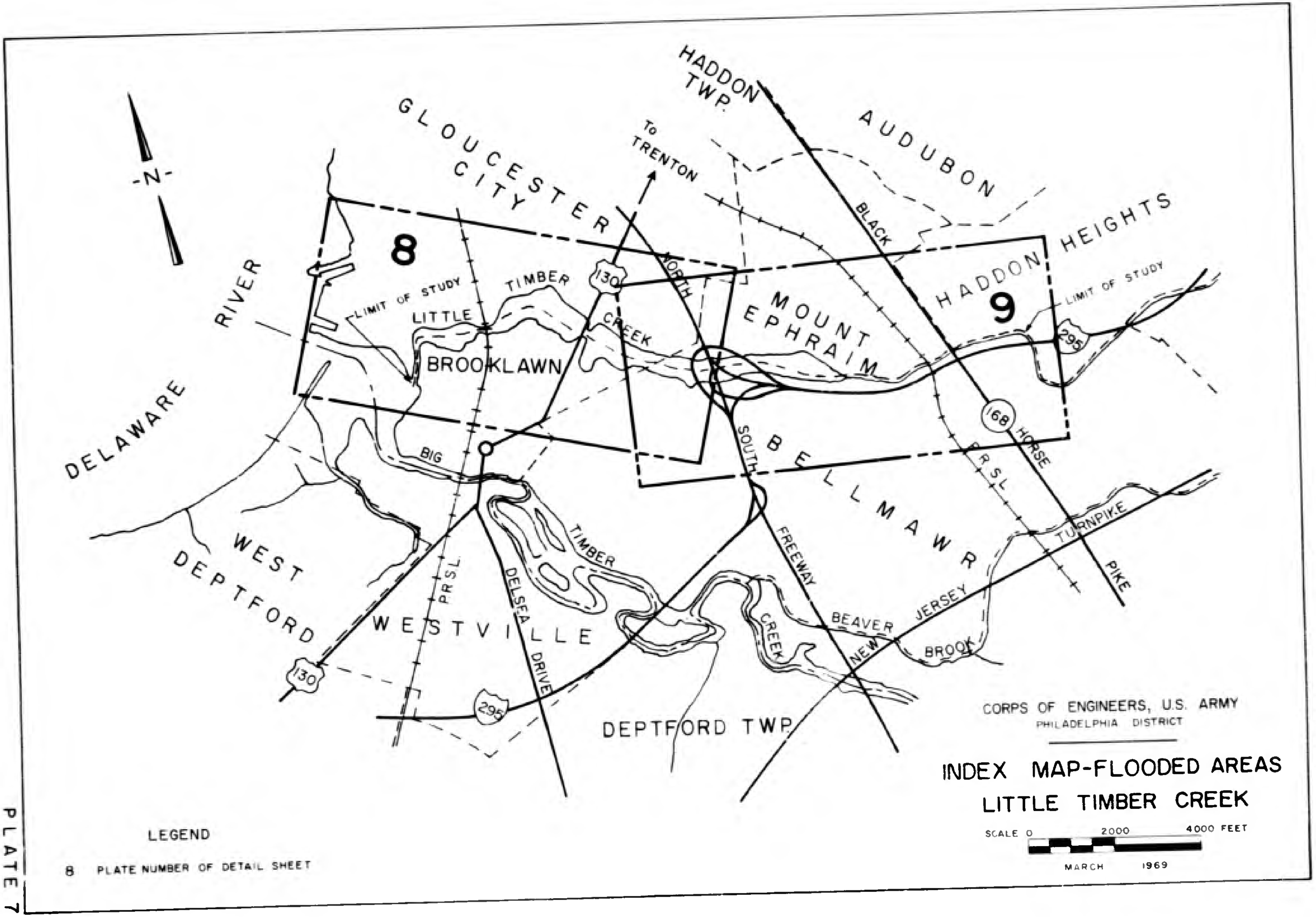
Prepared for the Corps of Engineers by John G. Reutter Associates, Consulting Engineers, Camden, New Jersey.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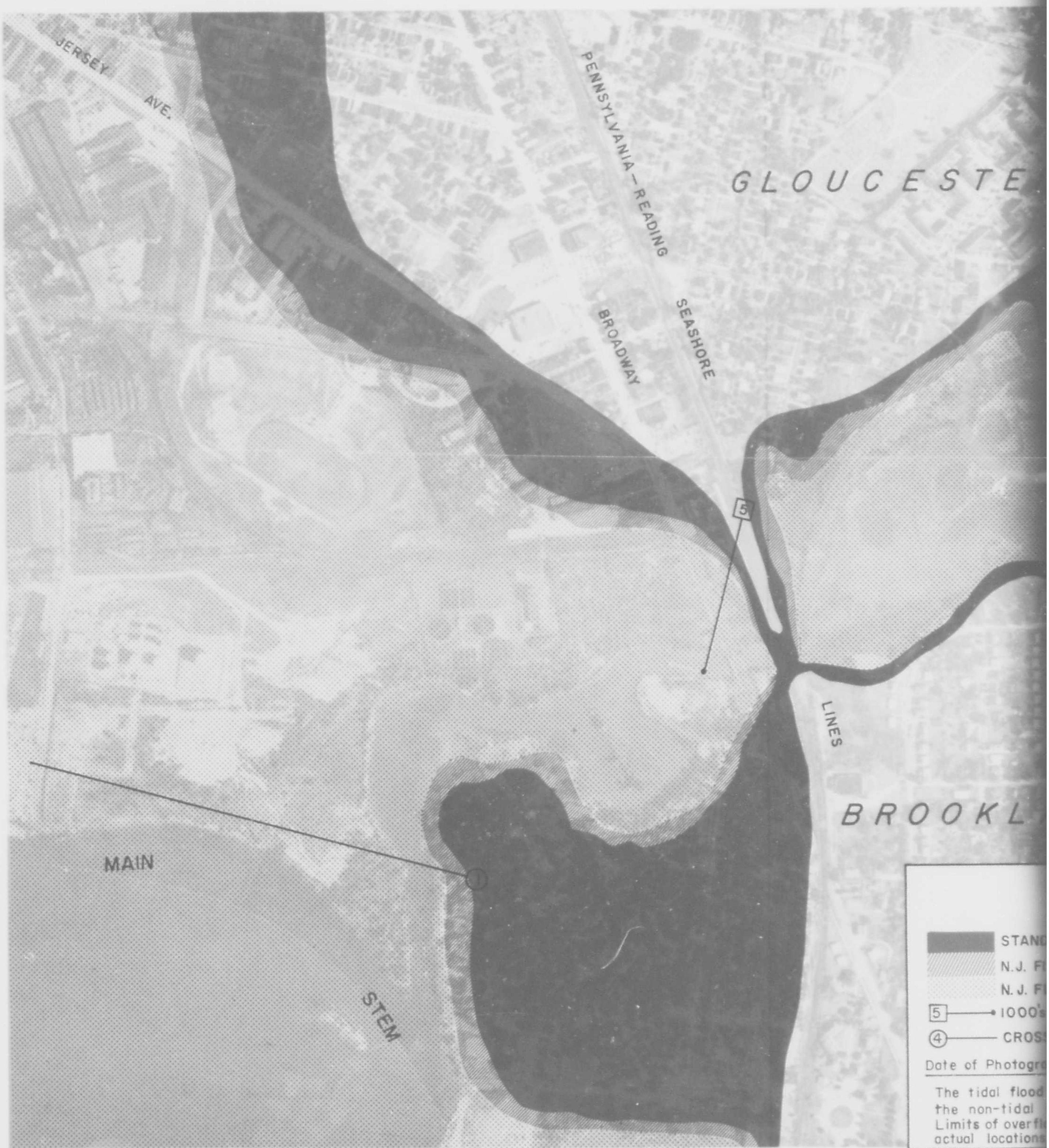
GLOUCESTER CITY
HADDON TWP.
AUDUBON
HADDON HEIGHTS
To TRENTON
DELAWARE RIVER
8
9
LIMIT OF STUDY
LITTLE TIMBER CREEK
BROOKLAWN
MOUNT EPHRAIM
BLACK HORSE PIKE
168
130
295
NORTH SOUTH FREEWAY
BELLMAWR
P R S L
BIG TIMBER CREEK
DELSEA DRIVE
WESTVILLE
WEST DEPTFORD
DEPTFORD TWP.
NEW JERSEY TURNPIKE
BEAVER BROOK
LEGEND
8 PLATE NUMBER OF DETAIL SHEET
CORPS OF ENGINEERS, U.S. ARMY
PHILADELPHIA DISTRICT
INDEX MAP-FLOODED AREAS
LITTLE TIMBER CREEK
SCALE 0 2000 4000 FEET
MARCH 1969

PLATE 7



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PENNSYLVANIA - READING
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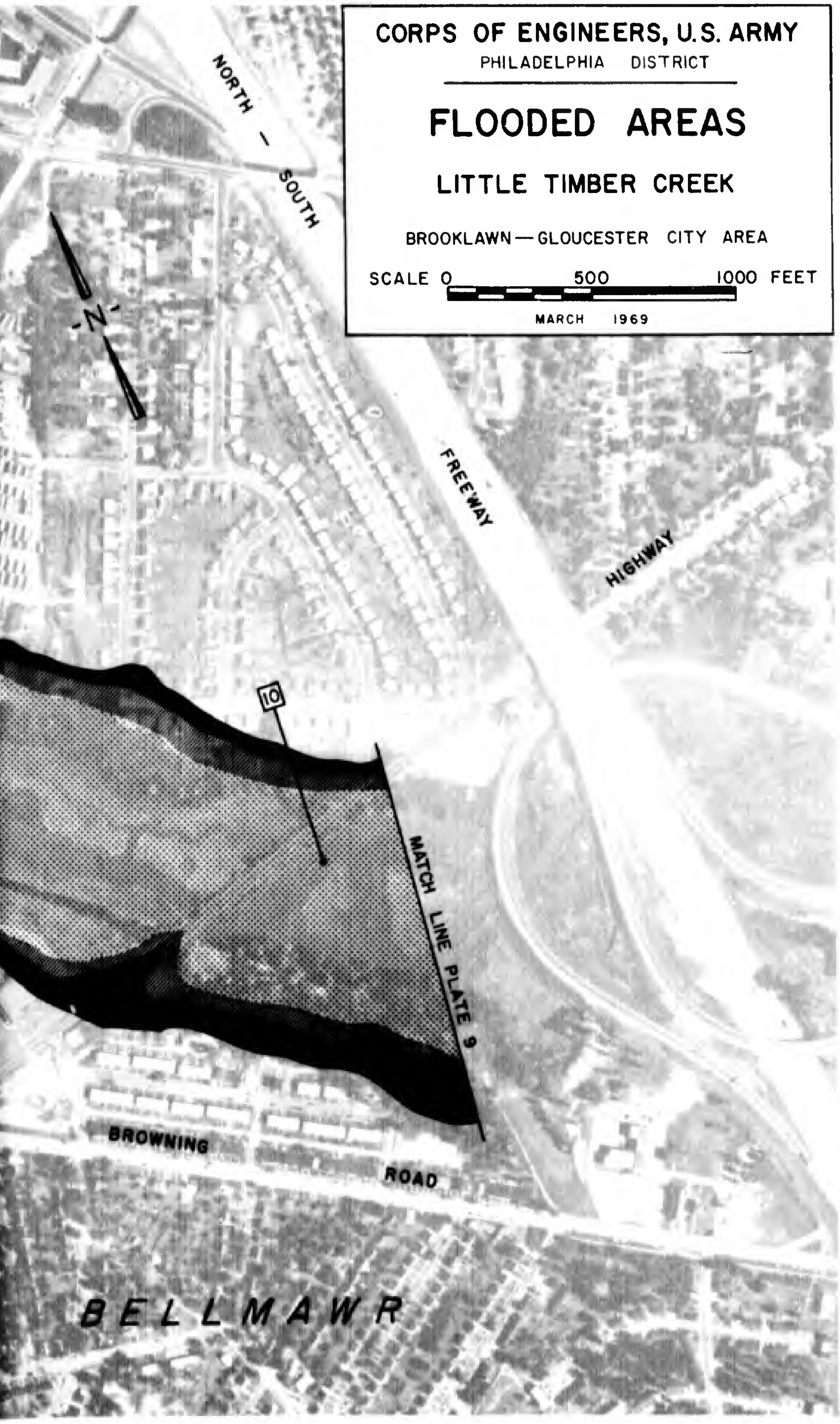
OVERFLOW LIMITS
STANDARD PROJECT FLOOD
N.J. FLOOD HAZARD AREA DESIGN FLOOD
N.J. FLOODWAY DESIGN FLOOD
5 1000's OF FEET ABOVE MOUTH
4 CROSS SECTION
Date of Photography September 1963
The tidal flood of record was in August 1933, the non-tidal flood of record in September 1940. Limits of overflow indicated may vary somewhat from actual locations on ground, as explained in the report


CORPS OF ENGINEERS, U.S. ARMY
PHILADELPHIA DISTRICT
FLOODED AREAS
LITTLE TIMBER CREEK
BROOKLAWN — GLOUCESTER CITY AREA
SCALE 0 500 1000 FEET
MARCH 1969
NORTH — SOUTH
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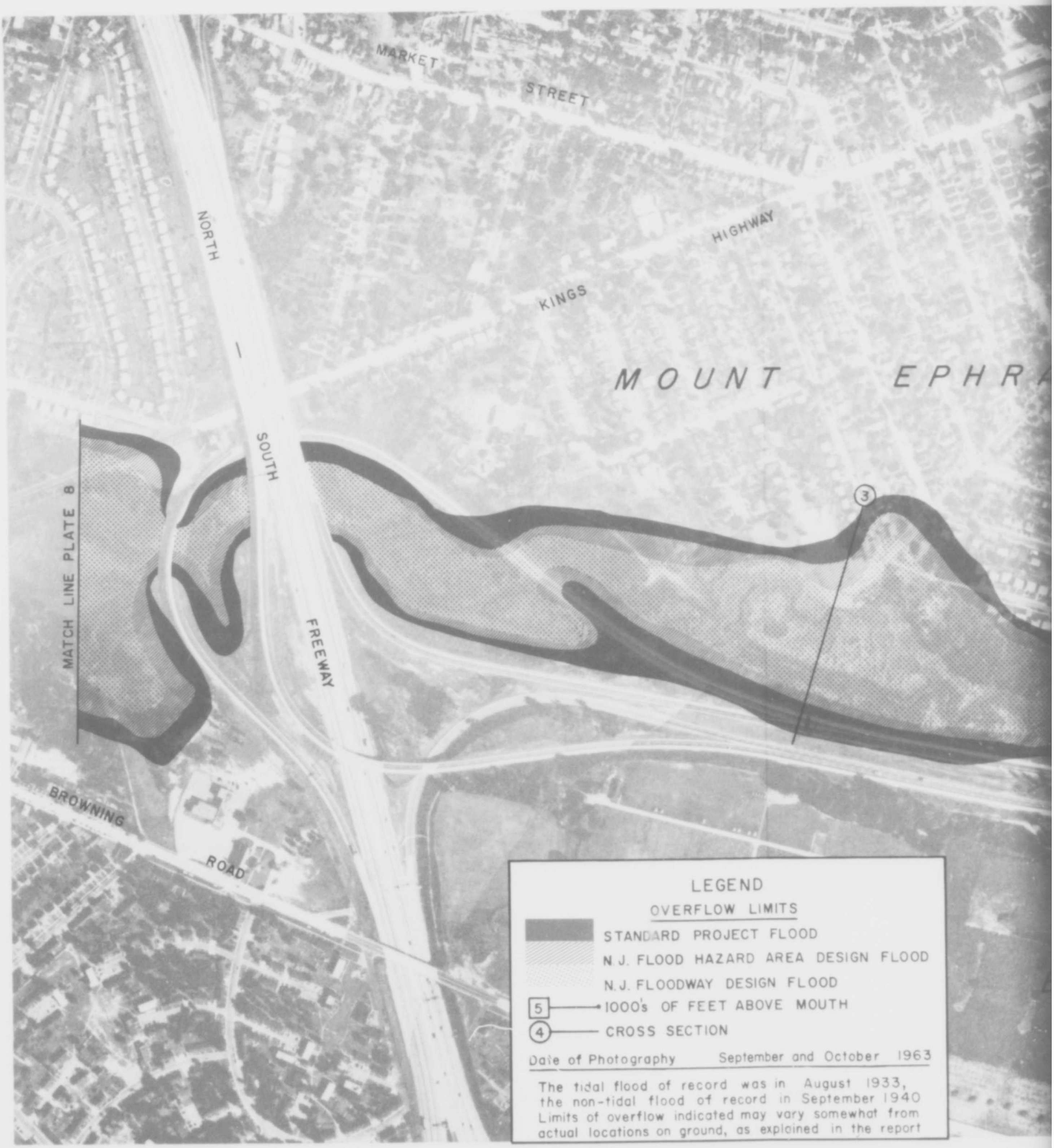
FREEWAY
HIGHWAY
10
MATCH LINE PLATE 9
BROWNING ROAD
BELLMAWR



MARKET
STREET
NORTH
SOUTH
FREEWAY
KINGS
HIGHWAY
MOUNT EPHR
MATCH LINE PLATE 8
3
BROWNING
ROAD
LEGEND
OVERFLOW LIMITS
STANDARD PROJECT FLOOD
N.J. FLOOD HAZARD AREA DESIGN FLOOD
N.J. FLOODWAY DESIGN FLOOD
5 1000's OF FEET ABOVE MOUTH
4 CROSS SECTION
Date of Photography September and October 1963
The tidal flood of record was in August 1933, the non-tidal flood of record in September 1940. Limits of overflow indicated may vary somewhat from actual locations on ground, as explained in the report


HADDON
HEIGHTS
EPHRAIM
PENNSYLVANIA-READING
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LINES
BLACK
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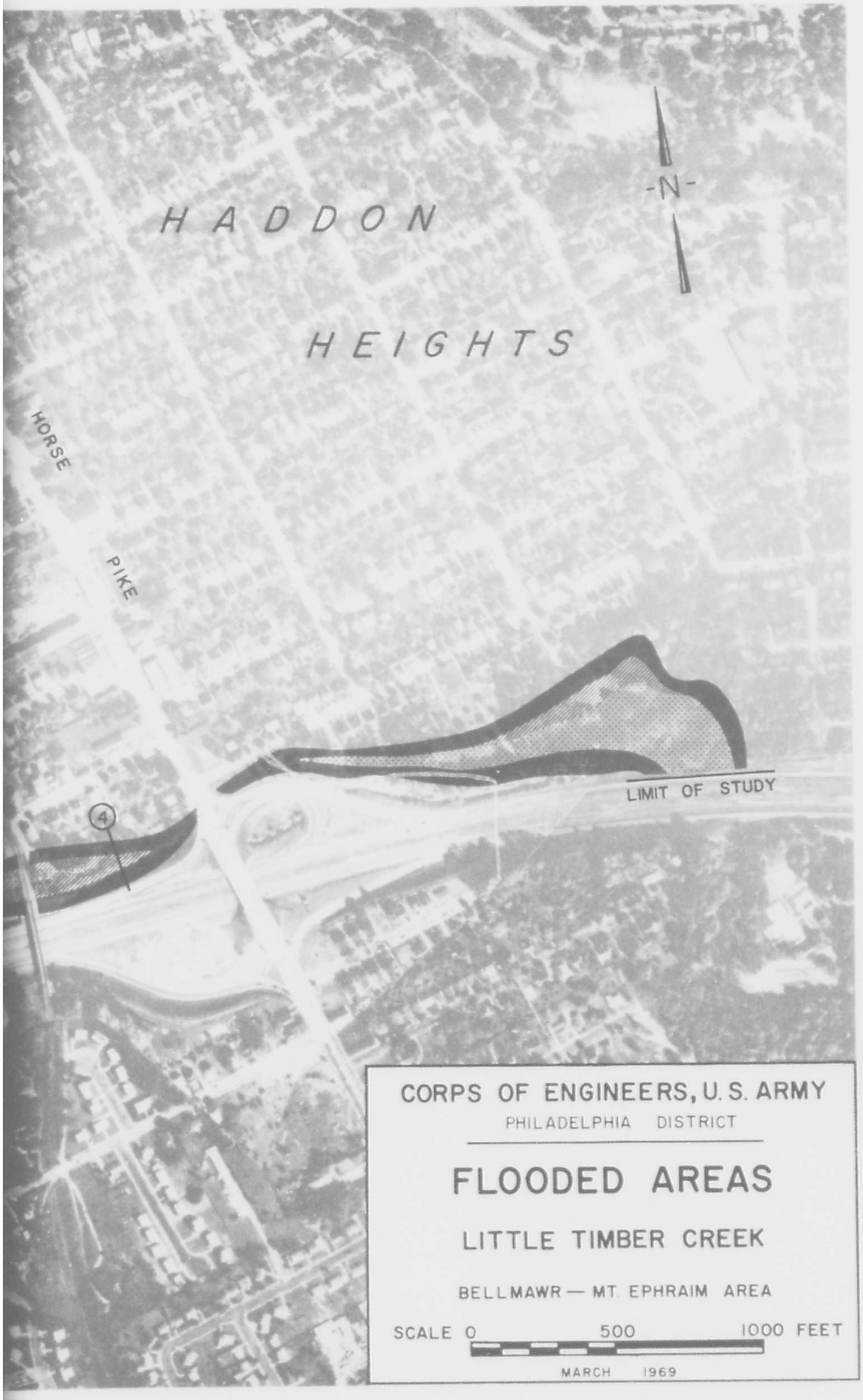
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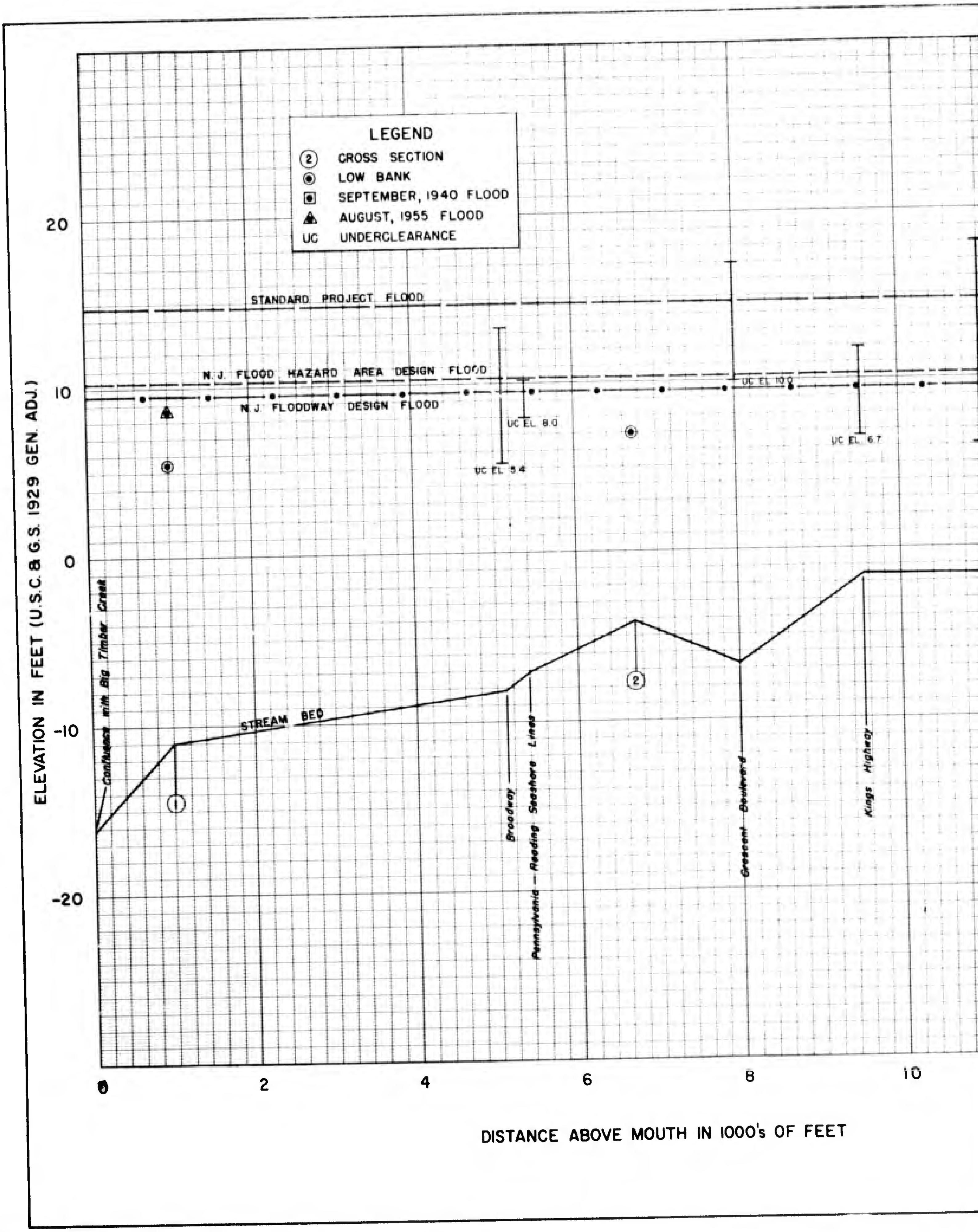
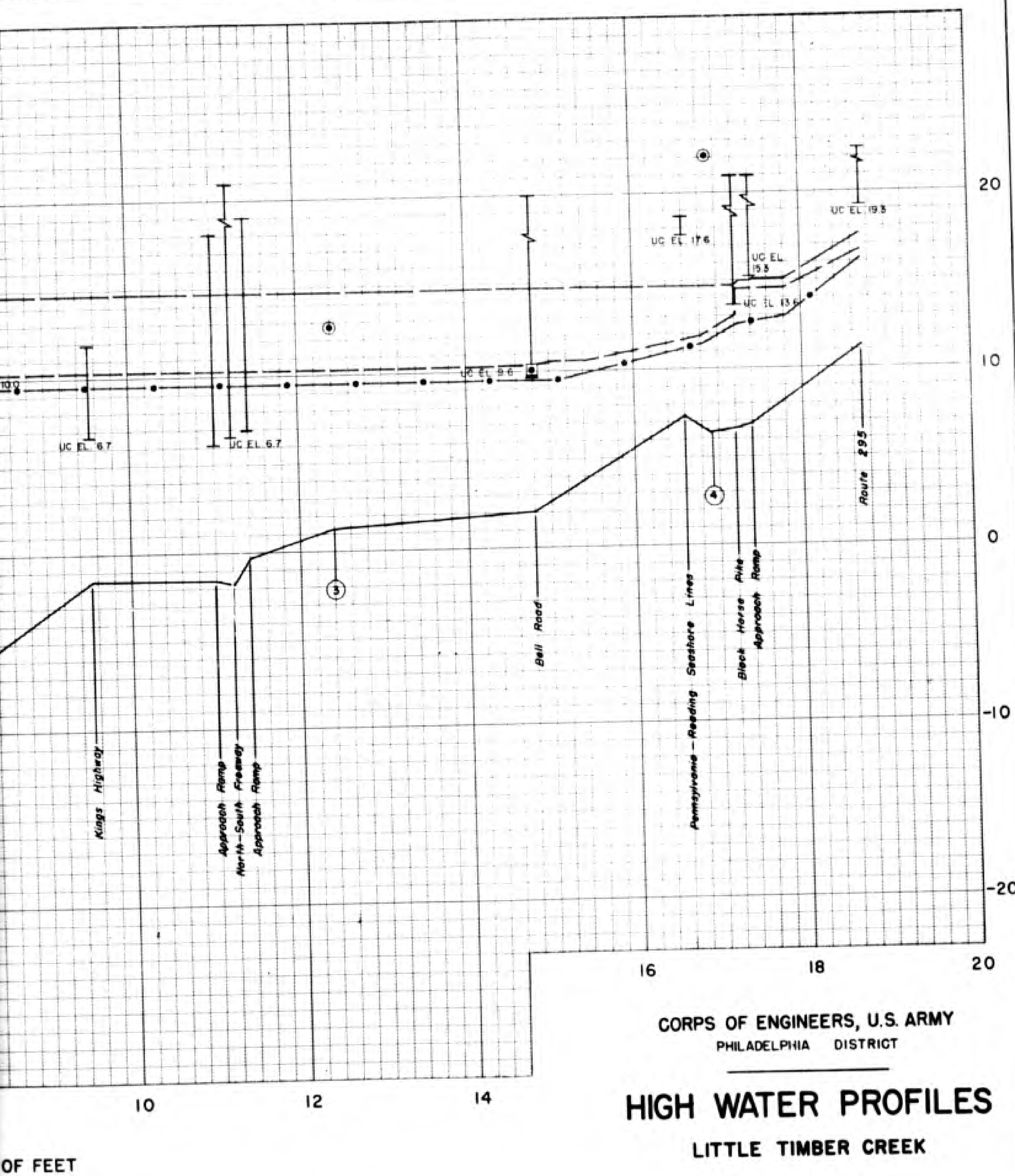
LIMIT OF STUDY
4
CORPS OF ENGINEERS, U. S. ARMY
PHILADELPHIA DISTRICT
FLOODED AREAS
LITTLE TIMBER CREEK
BELLMAWR — MT. EPHRAIM AREA
SCALE 0 500 1000 FEET
MARCH 1969

PLATE 9

3



LEGEND
CROSS SECTION
LOW BANK
SEPTEMBER, 1940 FLOOD
AUGUST, 1955 FLOOD
UC UNDERCLEARANCE
STANDARD PROJECT FLOOD
N.J. FLOOD HAZARD AREA DESIGN FLOOD
N.J. FLOODWAY DESIGN FLOOD
UC EL 10.0
UC EL 8.0
UC EL 5.4
UC EL 6.7
STREAM BED
Confluence with Big Timber Creek
Broadway
Pennsylvania — Reading Seashore Lines
Crescent Boulevard
Kings Highway
ELEVATION IN FEET (U.S.C. & G.S. 1929 GEN. ADJ.)
20
10
0
-10
-20
0
2
4
6
8
10
DISTANCE ABOVE MOUTH IN 1000's OF FEET

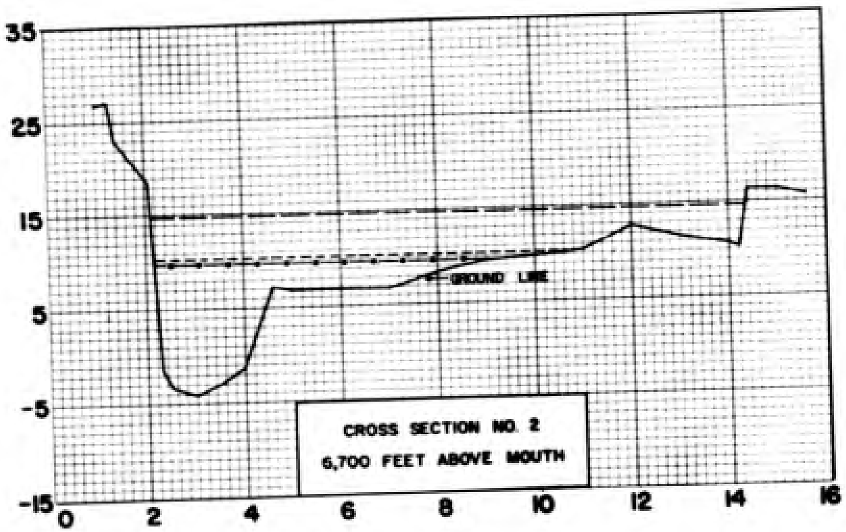


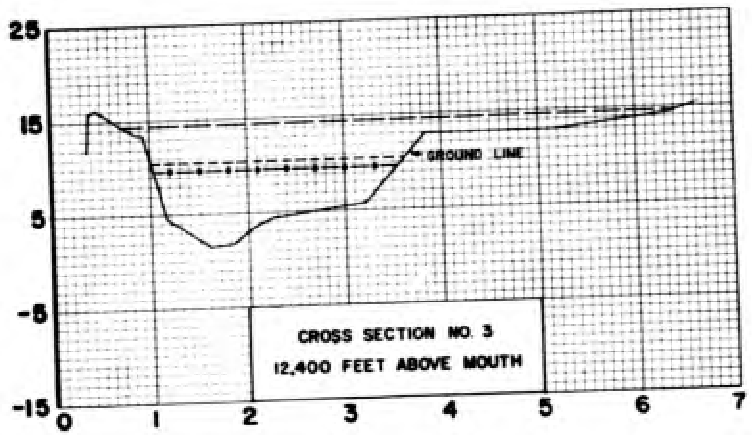
CORPS OF ENGINEERS, U.S. ARMY
PHILADELPHIA DISTRICT

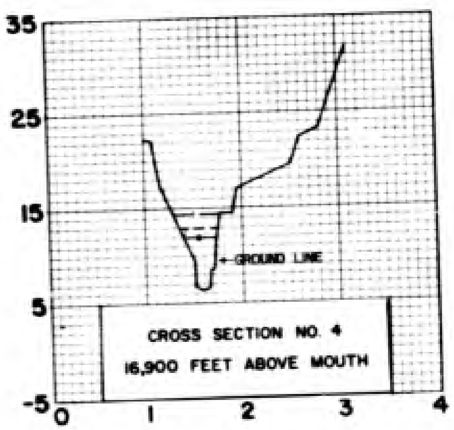
HIGH WATER PROFILES

LITTLE TIMBER CREEK

MARCH 1969







ELEVATION IN FEET (U.S.C. & G.S. 1929 GEN. ADJ.)

HORIZONTAL DISTANCE IN HUNDRED FEET

LEGEND:
- ——— Standard Project Flood
- ------ N.J. Flood Hazard Area Design Flood
- —•—•— N.J. Floodway Design Flood

Sections taken looking downstream
Cross section #1 not shown

CORPS OF ENGINEERS, U.S. ARMY
PHILADELPHIA DISTRICT

CROSS SECTIONS

LITTLE TIMBER CREEK

MARCH 1969

PLATE II