FLOOD INSURANCE STUDY

VOLUME 1 of 2

DELAWARE COUNTY, PENNSYLVANIA (ALL JURISDICTIONS)

This Preliminary FIS report only includes revised Floodway Data and Flood Profiles. The unrevised Floodway Data and Flood Profiles will appear in the final FIS report.

COMMUNITY NAME	COMMUNITY NUMBER	COMMUNITY NAME	COMMUNITY NUMBER	COMMUNITY NAME	COMMUNITY NUMBER
ALDAN, BOROUGH OF	420401	GLENOLDEN, BOROUGH OF	420416	ROSE VALLEY, BOROUGH OF	420431
ASTON, TOWNSHIP OF	421602	HAVERFORD, TOWNSHIP OF	420417	RUTLEDGE, BOROUGH OF	420432
BETHEL, TOWNSHIP OF	421606	LANSDOWNE, BOROUGH OF	420418	SHARON HILL, BOROUGH OF	420433
BROOKHAVEN, BOROUGH OF	420403	LOWER CHICHESTER, TOWNSHIP OF	421604	SPRINGFIELD, TOWNSHIP OF	420434
CHADDS FORD, TOWNSHIP OF	420402	MARCUS HOOK, BOROUGH OF	420419	SWARTHMORE, BOROUGH OF	420435
CHESTER, CITY OF	420404	MARPLE, TOWNSHIP OF	420420	THORNBURY, TOWNSHIP OF	425390
CHESTER, TOWNSHIP OF	420405	MEDIA, BOROUGH OF	420421	TINICUM, TOWNSHIP OF	421605
CHESTER HEIGHTS, BOROUGH OF	420406	MIDDLETOWN, TOWNSHIP OF	420422	TRAINER, BOROUGH OF	420437
CLIFTON HEIGHTS, BOROUGH OF	420407	MILLBOURNE, BOROUGH OF	422408	UPLAND, BOROUGH OF	420438
COLLINGDALE, BOROUGH OF	420408	MORTON, BOROUGH OF	420423	UPPER CHICHESTER, TOWNSHIP OF	420439
COLWYN, BOROUGH OF	420409	NETHER PROVIDENCE, TOWNSHIP OF	420424	UPPER DARBY, TOWNSHIP OF	420440
CONCORD, TOWNSHIP OF	420410	NEWTOWN, TOWNSHIP OF	420991	UPPER PROVIDENCE, TOWNSHIP OF	420441
DARBY, BOROUGH OF	420411	NORWOOD, BOROUGH OF	420425	YEADON, BOROUGH OF	420442
DARBY, TOWNSHIP OF	421603	PARKSIDE, BOROUGH OF	420426		
*EAST LANSDOWNE, BOROUGH OF	420412	PROSPECT PARK, BOROUGH OF	420427		
EDDYSTONE, BOROUGH OF	420413	RADNOR, TOWNSHIP OF	420428		
EDGMONT, TOWNSHIP OF	420414	RIDLEY, TOWNSHIP OF	420429		
FOLCROFT, BOROUGH OF	420415	RIDLEY PARK, BOROUGH OF	420430		

* No Special Flood Hazard Areas Identified

REVISED: **PRELIMINARY MARCH 4, 2016**

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
42045CV001C

NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program have established repositories of flood hazard data for floodplain management and flood insurance purposes. This Flood Insurance Study (FIS) may not contain all data available within the repository. It is advisable to contact the community repository for any additional data.

Part or all of this FIS may be revised and republished at any time. In addition, part of this FIS may be revised by the Letter of Map Revision process, which does not involve republication or redistribution of the FIS. It is, therefore, the responsibility of the user to consult with community officials and to check the community repository to obtain the most current FIS components.

Initial Countywide FIS Effective Date:	September 30, 1993
Revised Countywide FIS Date:	May 2, 1995 – To add Base Flood Elevations, to change Special Flood Hazard Areas, and to change zone designations November 18, 2009 – To change Special Flood Hazard Areas, to delete Special Flood Hazard Areas, to reflect updated topographical information, and to incorporate previously issued Letters of Map Revision September 2, 2015 – to incorporate new detailed Coastal Flood Hazard Analyses and to incorporate Letters of Map Revision [TBD] – to change Base Flood Elevations, Special Flood Hazard Areas and zone designations; to reflect updated topographical information; to update roads and road names, and to reflect levee deaccreditation

This Preliminary FIS report only includes revised Floodway Data and Flood Profiles. The unrevised Floodway Data and Flood Profiles will appear in the final FIS report.

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* Flood Profile 34P is no longer published
** Flood Profile is not available
***Harvey Run Revised, panels 60P-62P no longer published

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Flood Insurance Rate Map

FLOOD INSURANCE STUDY
DELAWARE COUNTY, PENNSYLVANIA (ALL JURISDICTIONS)

1.0 INTRODUCTION

1.1 Purpose of Study

This countywide Flood Insurance Study (FIS) investigates the existence and severity of flood hazards in, or revises and updates previous FISs / Flood Insurance Rate Map (FIRM) in the geographic area of Delaware County, Pennsylvania, including: the City of Chester; the Townships of Aston, Bethel, Chadds Ford, Chester, Concord, Darby, Edgmont, Haverford, Lower Chichester, Marple, Middletown, Nether Providence, Newtown, Radnor, Ridley, Springfield, Thornbury, Tinicum, Upper Chichester, Upper Darby, and Upper Providence; and the Boroughs of Aldan, Brookhaven, Chester Heights, Clifton Heights, Collingdale, Colwyn, Darby, East Lansdowne , Eddystone, Folcroft, Glenolden, Lansdowne, Marcus Hook, Media, Millbourne, Morton, Norwood, Parkside, Prospect Park, Ridley Park, Rose Valley, Rutledge, Sharon Hill, Swarthmore, Trainer, Upland, and Yeadon (hereinafter referred to collectively as Delaware County).

Please note that on the effective date of this study, the Borough of East Lansdowne has no mapped Special Flood Hazard Areas (SFHAs). This does not preclude future determinations of SFHAs that could be necessitated by changed conditions affecting the community (i.e. annexation of new lands) or the availability of new scientific or technical data about flood hazards.

This FIS aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This FIS has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates. This information will also be used by Delaware County to update existing floodplain regulations as part of the Regular Phase of the National Flood Insurance Program (NFIP), and by local and regional planners to further promote sound land use and floodplain development. Minimum floodplain management requirements for participation in the NFIP are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some states or communities, floodplain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence, and the State (or other jurisdictional agency) shall be able to explain them.

1.2 Authority and Acknowledgments

The sources of authority for this FIS are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The original September 30, 1993, countywide FIS was prepared to include incorporated communities within Delaware County into a countywide FIS. A revised countywide FIS was prepared in May 2, 1995.

Information on the authority and acknowledgments for each jurisdiction shown on this countywide FIS, as compiled from their previously printed FIS report narratives, is shown on the following pages.

Aldan, Borough of:	The hydrologic and hydraulic analyses for the FIS effective March 17, 1980, were prepared by the U.S. Army Corps of Engineers (USACE), Philadelphia District, for the Federal Emergency Management Agency (FEMA), formerly the Federal Insurance Administration (FIA), under Inter-Agency Agreement No. IAA-H-7-76, Project Order No. 17. That work was completed in September 1977.
Aston, Township of:	The hydrologic and hydraulic analyses for the FIS effective January 16, 1981, were performed under Contract No. H-4758 by Pickering, Corts, and Summerson, Inc., for the FIA. That work was completed in November 1979. The hydrologic and hydraulic analyses for Chester Creek and West Branch Chester Creek were previously performed by the USACE, Philadelphia District.
Chester, City of:	The hydrologic and hydraulic analyses for the FIS effective August 6, 1976, were performed by the USACE, Philadelphia District, for the FIA under Inter-Agency Agreement No. IAA- H-2-73, Project Order No. 2. That work was completed in February 1974. For the revision dated February 1, 1979, the hydrologic and hydraulic analyses for Ridley Creek and Chester Creek were prepared by Dewberry, Nealon, & Davis for the FIA. That work was completed in August 1977.

Chester, Township of:	The hydrologic and hydraulic analyses for the FIS effective November 15, 1983, were obtained from the FIS for the Township of Aston, effective January 16, 1981.
Chester Heights, Borough of:	The hydrologic and hydraulic analyses for the FIS effective July 16, 1979, were prepared by the USACE, Philadelphia District, for the FIA, under Inter-Agency Agreement No. IAA-H-7-76, Project Order No. 25 and Inter-Agency Agreement No. IAA-H-10-77, Project Order No. 4. That work was completed in January 1978. Portions of the hydrologic and hydraulic analyses were prepared by Dewberry, Nealon, & Davis.
Clifton Heights, Borough of:	The hydrologic and hydraulic analyses for the FIS effective November 16, 1976, were prepared by the Delaware River Basin Commission for the FIA, under Contract No. H-3747.
Collingdale, Borough of:	The hydrologic and hydraulic analyses for the FIS effective November 16, 1976, were prepared by the Delaware River Basin Commission for the FIA, under Contract No. H-3747.
Colwyn, Borough of:	The hydrologic and hydraulic analyses for the FIS effective November 2, 1976, were prepared by the USACE, Philadelphia District, for the FIA, under Inter-Agency Agreement No. IAA-H-2-73, Project Order No. 13, and modified under Inter-Agency Agreement No. IAA-H-16-75, Project Order No. 22.
Concord, Township of:	The hydrologic and hydraulic analyses for the FIS effective July 5, 1977, were performed by the Soil Conservation Service (SCS) for the FIA under Inter-Agency Agreement No. IAA-4-83, Project Order No. 6 and Inter-Agency Agreement No. IAA-H-23-74, Project Order No. 11. That work was completed in September 1975.

Darby, Borough of:	The hydrologic and hydraulic analyses for the FIS effective January 18, 1977, were prepared by the USACE, Philadelphia District, for the FIA, under Inter-Agency Agreement No. IAA- H-2-73, Project Order No. 13, and modified under Inter-Agency Agreement No. IAA-H-16-75, Project Order No. 22.
Darby, Township of:	The hydrologic and hydraulic analyses for the FIS effective October 3, 1983 were prepared by the USACE for the FEMA as part of the analyses for the City of Philadelphia, and the Boroughs of Sharon Hill and Colwyn.
Edgmont, Township of:	The hydrologic and hydraulic analyses for the FIS effective September 1, 1977, were prepared by the Delaware River Basin Commission for the FIA, under Contract No. H-3747.
Eddystone, Borough of:	The hydrologic and hydraulic analyses for the FIS effective August 2, 1976, were prepared by the USACE, Philadelphia District, for the FIA, under Inter-Agency Agreement No. IAA-H-2-73, Project Order Nos. 13 and 14.
Folcroft, Borough of:	The hydrologic and hydraulic analyses for the FIS effective February 1, 1977, were prepared by the Delaware River Basin Commission for the FIA, under Contract No. H-3747.
Glenolden, Borough of:	The hydrologic and hydraulic analyses for the FIS effective May 18, 1981, were prepared by the Delaware River Basin Commission for the FIA, under Contract No. H-3747. That work was completed in February 1976.
Haverford, Township of:	The hydrologic and hydraulic analyses for the FIS effective January 5, 1977, were prepared by the Delaware River Basin Commission for the FIA, under Contract No. H-3747.
Lansdowne, Borough of:	The hydrologic and hydraulic analyses for the FIS effective August 3, 1981, were prepared by the USACE Philadelphia District, for FEMA, under Inter-Agency Agreement No. IAA-H-18-78, Project Order No. 22. That work was completed in November 1979.

Lower Chichester, Township of:	The hydrologic and hydraulic analyses for the FIS effective July 16, 1980, were prepared by the USACE, Philadelphia District, for FEMA, under Inter-Agency Agreement No. IAA-H-18-78, Project Order No. 22. That work was completed in December 1978. The hydrologic and hydraulic analyses for the revision effective September 30, 1992, were prepared by the USACE for FEMA, under Inter-Agency Agreement No. EMW-90-E-3286, Project Order No. 7, Task Letter No. 90-7. That work was completed in February 1991.
Marcus Hook, Borough of:	The hydrologic and hydraulic analyses for the FIS effective March 16, 1981, were prepared by the USACE, Philadelphia District, for the FIA, under Inter-Agency Agreement No. IAA- H-18-78, Project Order No. 22. That work was completed in January 1980.
Marple, Township of:	The hydrologic and hydraulic analyses for the FIS effective September 1, 1977, were prepared by the Delaware River Basin Commission for the FIA, under Contract No. H-3747.
Media, Borough of:	The hydrologic and hydraulic analyses for the FIS effective July 20, 1981, were prepared by the USACE, Philadelphia District, for FEMA, under Inter-Agency Agreement No. IAA-H-9-79, Project Order No. 33. That work was completed in July 1980.
Middletown, Township of:	The hydrologic and hydraulic analyses for the FIS effective August 15, 1978, were prepared by the Delaware River Basin Commission for the FIA, under Contract No. H-3747. That work was completed in November 1977. Portions of the hydrologic and hydraulic analyses were prepared by Betz Environmental Engineers, Inc., and Dewberry, Nealon, & Davis.

Millbourne, Borough of: The hydrologic and hydraulic analyses for the FIS effective June 15, 1981, were prepared by the USACE, Philadelphia District, for FEMA, under Inter-Agency Agreement No. IAA-H-18-78, Project Order No. 39. That work was completed in September 1979.

Morton, Borough of: The hydrologic and hydraulic analyses for the FIS effective July 16, 1979, were prepared by the USACE, Philadelphia District, for the FIA, under Inter-Agency Agreement No. IAA-H-10-77, Project Order No. 16. That work was completed in June 1978.

Nether Providence, Township of: The hydrologic and hydraulic analyses for the FIS effective December 1, 1978, were prepared by the Delaware River Basin Commission for the FIA, under Contract No. H-3747.

In the revision effective September 28, 1990, the hydrologic and hydraulic analyses were prepared by H. Gilroy Damon Associates, Inc., for FEMA. That work was completed in August 1989.

Newtown, Township of: The hydrologic and hydraulic analyses for the FIS effective March 17, 1980, were prepared by the USACE for the FIA, under Inter-Agency Agreement Nos. IAA-H-2-73, IAA-H-19-74, and IAA-H-16-75, and Project Order Nos. 13 (Amendment 1), 15, and 22. The hydraulic analyses for portions of Crum Creek were prepared by Betz, Converse, and Murdoch, Inc. That work was completed in February 1978.

Norwood. Borough of: The hydrologic and hydraulic analyses for the FIS effective November 3, 1981, were prepared by the Delaware River Basin Commission for FEMA, under Contract No. H-3747. That work was completed in October 1977.

Prospect Park, Borough of: The hydrologic and hydraulic analyses for the FIS effective September 18, 1979, were prepared by the USACE, Philadelphia District, for the FIA, under Inter-Agency Agreement No. IAA-H-10-77, Project Order No. 16. That work was completed in July 1978.

Radnor, Township of:	The hydrologic and hydraulic analyses for the FIS effective August 1, 1977, were prepared by the Delaware River Basin Commission for the FIA, under Contract No. H-3747.
Ridley, Township of:	The hydrologic and hydraulic analyses for the FIS effective July 6, 1982, were prepared by the USACE, Philadelphia District, for FEMA, under Inter-Agency Agreement No. IAA-H-2-73, Project Order No. 4. That work was completed in July 1978. The hydrologic and hydraulic analyses were previously prepared by Betz, Converse, and Murdoch, Inc.
Ridley Park, Borough of:	The hydrologic and hydraulic analyses for the FIS effective July 2, 1979, were prepared by the USACE, Philadelphia District, for the FIA, under Inter-Agency Agreement Nos. IAA-H-7-76 and IAA-H-10-77, Project Order No. 17, Amendment Nos. 2 and 3. That work was completed in May 1978.
Rose Valley, Borough of:	The hydrologic and hydraulic analyses for the FIS effective February 2, 1977, were prepared by the USACE, Philadelphia District, for the FIA, under Inter-Agency Agreement No. IAA- H-19-74, Project Order No. 17.
Rutledge, Borough of:	The hydrologic and hydraulic analyses for the FIS effective September 18, 1979, were prepared by the USACE, Philadelphia District, for the FIA, under Inter-Agency Agreement No. IAA-H-10-77, Project Order No. 16. That work was completed in August 1978.
Sharon Hill, Borough of:	The hydrologic and hydraulic analyses for the FIS effective February 15, 1979, were prepared by the USACE, Philadelphia District, for the FIA, under Inter-Agency Agreement No. IAA- H-10-77, Project Order No. 3. That work was completed in December 1977.
Springfield, Township of:	The hydrologic and hydraulic analyses for the FIS effective July 19, 1977, were prepared by the Delaware River Basin Commission for the FIA, under Contract No. H-3747.
Swarthmore, Borough of:	The hydrologic and hydraulic analyses for the

FIS effective November 16, 1976, were prepared by the Delaware River Basin Commission for the FIA, under Contract No. H-3747.

Tinicum, Township of: The hydrologic and hydraulic analyses for the FIS effective November 1, 1979, were prepared by the USACE, Philadelphia District, for FEMA, under Inter-Agency Agreement No. IAA-H-7-76, Project Order No. 17, Amendment No. 2 and IAA-H-10-77, Project Order No. 3. Portions of the hydrologic analysis were prepared by the USACE Hydrologic Engineering Center (HEC) at Davis, California. That work was completed in October 1977.

Trainer, Borough of: The hydrologic and hydraulic analyses for the FIS effective September 30, 1977, were prepared by the Delaware River Basin Commission for the FIA, under Contract No. H-3747. That work was completed in 1975.
In the revision effective September 4, 1986, the hydrologic and hydraulic analyses were prepared by Dewberry & Davis for FEMA, under Contract No. EMW-C-0968. That work was completed in July 1985.

Upland, Borough of: The hydrologic and hydraulic analyses for the FIS effective June 10, 1976, were prepared by the USACE, Philadelphia District, for the FIA, under Inter-Agency Agreement No. IAA-H-19-74, Project Order No. 17.

Upper Chichester, Township of: The hydrologic and hydraulic analyses for the FIS effective May 16, 1977, were prepared by the Delaware River Basin Commission for the FIA, under Contract No. H-3747.

For the revision effective July 15, 1992, the hydrologic and hydraulic analyses were prepared by the USACE, Philadelphia District for FEMA, under Inter-Agency Agreement No. EMW-90- E-3286, Project Order No. 7, Task Letter No. 90-7. That work was completed in February 1991.

Upper Darby, Township of:	The hydrologic and hydraulic analyses for the FIS effective September 1, 1977, were prepared by the Delaware River Basin Commission for the FIA, under Contract No. H-3747.
Upper Providence, Township of:	The hydrologic and hydraulic analyses for the FIS effective June 15, 1977, were prepared by the Delaware River Basin Commission for the FIA, under Contract No. H-3747.
Yeadon, Borough of:	The hydrologic and hydraulic analyses for the FIS effective May 1, 1979, were prepared by the USACE, Philadelphia District, for the FIA under Inter-Agency Agreement No. IAA-H-7- 76, Project Order No. 17. That work was completed in December 1977.

FIS report narratives have not been published for the following communities, therefore the authority and acknowledgments of their hydrologic and hydraulic analyses are not available: the Townships of Bethel and Thornbury; and the Boroughs of Brookhaven and Parkside.

No new hydrologic and hydraulic analyses were prepared for the countywide FIS effective September 30, 1993; however, flood hazard information for various communities within Delaware County was updated to reflect the most up-to-date analyses, where appropriate.

In the May 2, 1995, FIS revision to the Delaware County countywide FIS, hydrologic and hydraulic analyses for Spring Run and Bezor's Run in the Township of Upper Chichester were prepared by the USACE, Philadelphia District, for FEMA under Inter-Agency Agreement No. EMW-92-E-3839, Project Order No. 1, Task Letter No. 92-10. That work was completed in May 1993.

For the November 18, 2009, revision, no revised hydrologic and hydraulic analyses were prepared. All flood hazard mapping was updated to the ArcGIS 9.2 format based on FEMA guides and specifications. All detailed studies were redelineated and mapped based on more detailed and up-to-date topographic information provided by the Delaware Valley Regional Planning Commission. The topographic information consisted of 5 foot contour data derived from 2005 orthophotography covering the geographic area of Delaware County. In addition, the following Letters of Map Revision (LOMRs) were incorporated:

Case No.: 05-03-A446P, for the Borough of Collingdale
Case No.: 07-03-0012P, for the Township of Thornbury

The Digital Flood Insurance Rate Map (DFIRM) conversion for this study was performed by AMEC, Earth & Environmental, Inc. for FEMA, under Contract No. HSFE03-07-D-0030, Task Order HSFE03-07-J-0006.

For the September 2, 2015, FIS revision, an analysis was performed to establish the frequency peak elevation relationships for coastal flooding in Delaware County. The study replaces outdated coastal storm surge stillwater elevations in Delaware County, and serves as the basis for the updated FIRM. Study efforts were initiated in 2008 and concluded in 2013.

The storm surge study was conducted for FEMA by USACE and its project partners under Project HSFE03-06-X-0023, "NFIP Coastal Storm Surge Model for Region III" and Project HSFE03-09-X-1108, "Phase III Coastal Storm Surge Model for FEMA Region III". The work was performed by the Coastal Processes Branch (HF-C) of the Flood and Storm Protection Division (HF), U.S. Army Engineer Research and Development Center – Coastal & Hydraulics Laboratory (ERDC-CHL).

The coastal analysis and mapping for Delaware County was conducted for FEMA by RAMPP under Contract No. HSFEHQ-09-D-0369, Task Order HSFE03-09-0002.

In addition, the following LOMRs were incorporated:

Case No.: 08-03-1531P, for the Boroughs of Eddystone and Ridley Park and the Township of Ridley
Case No.: 11-03-0374P, for the Township of Ridley

Base map information shown on the November 11, 2009, FIRM was obtained in digital format from the Delaware Valley Regional Planning Commission and Delaware County. Road centerlines, streamlines, and township/borough boundaries were provided by Delaware County. The county boundary was downloaded from the 2006 TIGER/Line files. 2002 and 2005 digital orthophotos were provided by the Delaware Valley Regional Planning Commission. Adjustments were made to specific base map features to align them to 1"=200' scale orthophotos.

For the [TBD], countywide FIS, the hydrologic and hydraulic analyses were performed for approximately 7.45 miles of detailed studies on portions of Brandywine Creek, Harvey Run, and Harvey Run Branch. This work is a part of the larger Brandywine-Christina, Hydrologic Class Unit (HUC)-8 02040205 Watershed study. This work was completed in October 2015. Also included in this FIS is a restudy of Chester Creek to reflect the deaccreditation of the Chester Levee in the City of Chester.

Base map information show on the [TBD], FIRMs was obtained in digital format from the Delaware Valley Regional Planning Commission and Delaware County. Road centerlines, streamlines, and township/borough boundaries were provided by Delaware County. The county boundary was downloaded from 2006 TIGER/Line files.

The projection used in the preparation of this map was Universal Transverse Mercator (UTM) Zone 18. The horizontal datum was NAD 83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

1.3 Coordination

An initial CCO meeting is held typically with representatives of FEMA, the community, and the study contractor to explain the nature and purpose of a FIS and to identify the streams to be studied by detailed methods. A final CCO meeting is held typically with representatives of FEMA, the community, and the study contractor to review the results of the study.

The dates of the initial and final CCO meetings held for the incorporated communities within the boundaries of Delaware County are shown in the following tabulation:

TABLE 1 – INITIAL AND FINAL CCO MEETINGS

Community Name	Initial CCO Date	Final CCO Date
Aldan, Borough of	December 16, 1975	October 26, 1978
Aston, Township of	May 11, 1978	July 11, 1980
Bethel, Township of	*	*
Brookhaven, Borough of	*	*
Chester, City of	*	*
Chester, Township of	*	February 24, 1983
Chester Heights, Borough of	*	January 31, 1979
Clifton Heights, Borough of	*	March 16, 1976
Collingdale, Borough of	*	November 18, 1975
Colwyn, Borough of	*	February 11, 1976
Concord, Township of	*	December 17, 1975
Darby, Borough of	*	*
Darby, Township of	*	April 8, 1983
Eddystone, Borough of	*	*
Edgmont, Township of	*	February 10, 1976
Folcroft, Borough of	September 1974	March 15, 1976
Glenolden, Borough of	*	*

*Data Not Available

TABLE 1 – INITIAL AND FINAL CCO MEETINGS – continued

Community Name	Initial CCO Date	Final CCO Date
Haverford, Township of	*	*
Lansdowne, Borough of	December 13, 1977	February 5, 1981
Lower Chichester, Township of	December 5, 1977	February 5, 1981
Marcus Hook, Borough of	December 12, 1977	October 6, 1980
Marple, Township of	*	March 3, 1976
Media, Borough of	November 14, 1978	*
Middletown, Township of	*	March 16, 1976
Millbourne, Borough of	December 13, 1977	September 5, 1980
Morton, Borough of	September 28, 1976	January 31, 1979
Nether Providence, Township of	*	*
Newtown, Township of	*	September 11, 1979
Norwood, Borough of	September 1974	April 8, 1981
Parkside, Borough of	*	*
Prospect Park, Borough of	September 29, 1976	January 31, 1979
Radnor, Township of	*	April 12, 1976
Ridley, Township of	*	February 8, 1982
Ridley Park, Borough of	December 17, 1975	January 31, 1979
Rose Valley, Borough of	*	June 1974
Rutledge, Borough of	September 29, 1976	January 31, 1979
Sharon Hill, Borough of	December 4, 1975	September 6, 1978
Springfield, Township of	*	April 14, 1976
Swarthmore, Borough of	*	February 1976
Tinicum, Township of	December 4, 1975	March 22, 1979
Trainer, Borough of	*	February 9, 1976
Upland, Borough of	*	*
Upper Chichester, Township of	September 17, 1974	March 26, 1976
Upper Darby, Township of	*	April 14, 1976
Upper Providence, Township of	*	March 8, 1976
Yeadon, Borough of	December 11, 1975	October 26, 1978

* Data not available

The date of the final CCO meeting for the September 30, 1993, countywide FIS was December 11, 1992.

For the November 18, 2009, FIS revision, all jurisdictions were notified by telephone in July 2006 that the FIS would be updated.

For the September 2, 2015, FIS revision, a RiskMAP coordination meeting was held on February 9, 2012, with representatives from FEMA, the jurisdictions of Delaware County, and the USACE. A final CCO meeting was held on May 13, 2014, with representatives from FEMA, the jurisdictions of Delaware County, the USACE, and RAMPP (the mapping partner).

For the [TBD], FIS revision, a Discovery meeting was held on November 9, 2012, for the Brandywine Christina Watershed and was attended by FEMA, Delaware

County representatives and RAMPP. A Flood Risk Review meeting was held for the Chester Levee area on July 16, 2015.

2.0 AREA STUDIED

2.1 Scope of Study

This FIS covers the geographic area of Delaware County, Pennsylvania and includes part of the Brandywine-Christina Watershed, Hydrologic Unit Code 02040205.

The Brandywine-Christina watershed is located in southeastern Pennsylvania, northern Delaware, and northeastern Maryland. The majority of the watershed is located in Chester County, PA and New Castle County, DE and covers small areas of Delaware County, PA and Cecil County, MD. The Christina River is the principal tributary of Delaware River within the watershed. The Christina River has headwaters in southeastern Pennsylvania and flows southerly to enter New Castle County, DE where it changes direction and flows northeasterly where it discharges into the Delaware River estuary.

Brandywine Creek is the principal tributary of the Christina River, which contributes flows from northern half of the watershed. The headwaters for the Brandywine Creek originate in the Welsh Mountains near Honeybrook, in the western part of Chester County, PA. Brandywine Creek flows southeasterly and discharges flows into Christina River near Wilmington, DE.

All or portions of the flooding sources listed in Table 2 “Flooding Sources Studied by Detailed Methods” were studied by detailed methods. Limits of detailed study are indicated on the Flood Profiles (Exhibit 1) and on the FIRM (Exhibit 2).

TABLE 2 – FLOODING SOURCES STUDIED BY DETAILED METHODS

Bezor’s Run	Hermesprota Creek (MacDade Boulevard Reach)
Brandywine Creek	Hermesprota Creek (Upper Reach)
Cherry Farm Lane Tributary	Lewis Run
Chester Creek	Little Crum Creek
Chester Creek Tributary	Little Darby Creek
Chrome Run	Lobbs Run
Cobbs Creek	Marcus Hook Creek
Crum Creek (Lower Reach)	Muckinipattis Creek
Crum Creek (Upper Reach)	Naaman Creek
Darby Creek	Naylors Run
Delaware River	Old Barn Drive Tributary
Dilworthtown Road Tributary	Pony Tail Run
East Branch Chester Creek	Ridley Creek
East Branch Marcus Hook	Rocky Run
East Branch Chester Creek Tributary 2	South Fork West Branch Chester Creek
	Spring Run

TABLE 2 – FLOODING SOURCES STUDIED BY DETAILED METHODS – continued

Foxes Run	Stackhouse Mill Run
Green Creek	Stoney Creek
Gulph Creek	Stony Creek
Harvey Run	Sweet Water Road Tributary
Harvey Run Branch	Vernon Run
Hermesprota Creek (Lower Reach)	West Branch Chester Creek

The following tabulation lists streams that have names in this countywide study other than those used in the previously printed FISs for the communities in which they are located:

Community	Old Name	New Name
Aston, Township of	Marcus Hook Creek	East Branch Marcus Hook Creek
Springfield, Township of	Stoney Creek Tributary No. 1	East Branch Stony Creek
Thornbury, Township of	an unnamed tributary	Elaine Drive Tributary
	an unnamed tributary	Sweet Water Rd Tributary
	an unnamed tributary	East Branch Chester Creek Tributary 2
Trainer, Borough of	Tributary No. 2	Tributary 1 to Marcus Hook Creek
	Tributary No. 1	Tributary 2 to Marcus Hook Creek
Upper Chichester, Township of	Tributary 1	Tributary 3 to Marcus Hook Creek
	Tributary No. 2	Tributary 4 to Marcus Hook Creek
	Tributary No. 3	Tributary 5 to Marcus Hook Creek
	Tributary No. 4	Tributary 6 to Marcus Hook Creek
	Tributary No. 5	Tributary A to East Branch Naaman Creek
	Tributary No. 6	Tributary B to East Branch Naaman Creek
	Tributary No. 7	Tributary to Baldwin Run
	Tributary No. 8	Goodley's Run
Nether Providence, Township of	Tributary 1	Crum Creek Tributary No. 2

Community	Old Name	New Name
Marple, Township of	Tributary 1	Crum Creek Tributary No. 3
	Tributary 2	Crum Creek Tributary No. 4
Upper Providence, Township of	Unnamed Tributary	Broomalls Run
	Unnamed Tributary	Gayley Run

Pony Tail Run is also known as Little Pony Trail Creek in the planimetric base mapping files provided by Delaware County GIS Services.

The September 30, 1993, countywide FIS was carried out in order to include flood hazard information for incorporated communities within Delaware County into a countywide FIS; as part of the study, the analyses were included for the flooding sources shown in Table 3, "Scope of Study." The [TBD], FIS revision, may supersede the limits in this table, please see the description for the [TBD], FIS revision on the following pages.

TABLE 3 – SCOPE OF STUDY

Stream Name	Limits of Study
Brandywine Creek	From the downstream county boundary to a point approximately 1,150 feet upstream of U.S. Route 1
Chester Creek	From the confluence with the Delaware River to the confluence of East Branch Chester Creek
Chester Creek Tributary	From the confluence with Chester Creek to a point approximately 770 feet upstream of Andrien Road
East Branch Chester Creek	From the confluence with Chester Creek to a point approximately 1,200 feet upstream of Cheyney Road
East Branch Chester Creek Tributary 2	From the downstream county boundary to approximately 1,800 feet upstream of the downstream county boundary
West Branch Chester Creek	From the confluence with Chester Creek to a point approximately 1,900 feet upstream of confluence of Elaine Drive Tributary
South Fork West Branch Chester Creek	From the confluence with West Branch Chester Creek to Smith Bridge Road
Chrome Run	From the confluence with Chester Creek to a point approximately 160 feet upstream of St. Andrews Drive

TABLE 3 – SCOPE OF STUDY – continued

Stream Name	Limits of Study
Cobbs Creek	From the confluence with the Delaware River to a point approximately 1,000 feet upstream of College Avenue
Crum Creek (Lower Reach)	From the confluence with the Delaware River to the dam at Springton Reservoir
Little Crum Creek	From the confluence with Crum Creek to a point approximately 600 feet upstream of Michigan Avenue and from Yale Avenue to Amherst Avenue
Darby Creek	From the confluence with the Delaware River to St. Davids Road
Little Darby Creek	From the confluence with Darby Creek to a point approximately .96 mile upstream and from a point approximately 53 feet downstream of Maplewood Avenue to Sugartown Road
Delaware River	For its entire length within the county
Foxes Run	From Malin Road to a point approximately 1,050 feet upstream of the swim club exit
Green Creek	From a point approximately 1000 feet upstream of the confluence with Chester Creek to Bethel Road
Gulph Creek	From County Line Road to Chamounix Road
Harvey Run	From the confluence with Brandywine Creek to confluence of Harvey Run Branch
Harvey Run Branch	From confluence with Harvey Run to 1,600 feet upstream of Painters Crossing Road
Hermesprota Creek (Lower Reach)	From the downstream corporate limits of the Borough of Sharon Hill to approximately 1,210 feet upstream of CONRAIL
Hermesprota Creek (Upper Reach)	From Chester Pike to CSX Transportation
Lewis Run	From the confluence with Crum Creek to Battles Lane
Lobbs Run	From the confluence with Darby Creek to approximately 1,350 feet upstream of Maryland Avenue

TABLE 3 – SCOPE OF STUDY – continued

Stream Name	Limits of Study
Marcus Hook Creek	From the confluence with Delaware River to the confluence of Bezor's Run
East Branch Marcus Hook Creek	From the confluence with Bezor's Run to Conchester Road
Muckinipattis Creek	From the downstream corporate limits of the Borough of Glenolden to a point approximately 0.7 mile upstream
Naaman Creek	From a point approximately 6.65 miles upstream of the confluence with the Delaware River to a point approximately 800 feet upstream of Larkin Road
Naylors Run	From the confluence with Cobbs Creek to Garrett Road; from approximately 0.5 mile downstream of Lansdowne Avenue (U.S. Route 13) to a point approximately 0.7 mile upstream of Bond Avenue; and from West Chester Pike to Manoa Road
Pony Tail Run	From the confluence with Ridley Creek to Stackhouse Mill Road
Ridley Creek	From the confluence with the Delaware River to a point approximately 1.8 mile upstream of Sackesville Road; from Media Station Road to a point approximately 1.2 mile upstream of the confluence of Spring Run; and from a point approximately 0.4 mile downstream of Delchester Road to a point approximately 200 feet upstream of the confluence of Stackhouse Mill Run
Rocky Run	From a point approximately 1.89 miles upstream of the confluence with Chester Creek to a point approximately 0.18 mile upstream of Brooke Lane
Stackhouse Mill Run	From the confluence with Ridley Creek to Valley Road
Stoney Creek	From approximately 0.78 mile upstream of confluence with the Delaware River to a point approximately 475 feet upstream
Stony Creek	From the confluence with Darby Creek to a point approximately 240 feet upstream of Church Road

TABLE 3 – SCOPE OF STUDY – continued

Stream Name	Limits of Study
Sweet Water Road Tributary	From the confluence with East Branch Chester Creek to a point approximately 0.6 mile upstream
Vernon Run	From CONRAIL to a point approximately 260 feet upstream of Walker Lane

The September 30, 1993, countywide FIS incorporated the determination of a LOMR, dated January 11, 1989, issued by FEMA, for the Township of Springfield. The project in the vicinity of the Golf View Estates Subdivision consisted of a revision of two unnamed tributaries to Whiskey Run Creek.

The September 30, 1993, countywide FIS incorporated the determination of a Letter of Map Amendment issued by FEMA for the Westinghouse Electric Corporation premises "A", Lot 1, south of Highland Avenue, east of Front Street on the west side of the Delaware River.

In the May 2, 1995, countywide FIS revision, both Bezor's Run, from the confluence with Marcus Hook Creek to a point approximately 1.3 miles upstream; and Spring Run, from the confluence with Naaman Creek to the upstream corporate limits of the Township of Upper Chichester, were studied by detailed methods.

For the November 18, 2009, FIS revision, no new flood hazard areas were identified.

For the September 2, 2015, FIS revision, new flood hazard areas were studied for the Delaware River and associated backwater flooding for Chester Creek, Crum Creek (Lower Reach), Darby Creek, Marcus Hook Creek, and Ridley Creek. In addition, this FIS revision incorporates 2 LOMRs issued by FEMA, dated December 18, 2009 and January 7, 2011. The December 18, 2009, LOMR is for Boeing – Crum Creek Flood Control Improvements in the Boroughs of Eddystone and Ridley Park, and the Township of Ridley. The January 7, 2011, LOMR is for the Township of Ridley.

For the [TBD], FIS revision, the following tabulation describes the flood hazard areas that were studied.

Stream Name	Limits of Study
Brandywine Creek	From the downstream county boundary to a point approximately 1,150 feet upstream of U.S. Route 1
Harvey Run	From the confluence with Brandywine Creek to confluence of Harvey Run Branch
Harvey Run Branch	From confluence with Harvey Run to 1,600 feet upstream of Painters Crossing Road
Chester Creek	From confluence with Delaware River to I-95

For the [TBD], FIS revision, no LOMRs have been issued for the revision area, therefore none were incorporated.

The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development and proposed construction.

All or portions of numerous flooding sources in the county were studied by approximate methods. Approximate analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to, and agreed upon by, FEMA and the various affected communities.

2.2 Community Description

Delaware County is located in southeastern Pennsylvania. The county is bordered by the City of Philadelphia to the east; the Delaware River and Gloucester County, New Jersey to the southeast; New Castle County, Delaware to the southwest; Chester County, Pennsylvania to the west, north, and northwest; and Montgomery County, Pennsylvania to the north.

The area experiences a continental climate somewhat tempered by the proximity of the Atlantic Ocean. Temperatures are mild, seldom exceeding 100 degrees Fahrenheit (°F) or dropping below 0°F. Precipitation is well- distributed throughout the year, averaging 43 inches annually. The county experiences an even distribution of precipitation and a uniform climate.

Topography in the county is hilly, with elevations ranging from approximately 40 feet to nearly 300 feet above mean sea level. Level land occurs mainly on hilltops or in floodplains of the streams.

2.3 Principal Flood Problems

Historically, the worst flooding problems in the county have been caused by regional storms such as hurricanes rather than localized storms (Delaware Valley Regional Planning Commission [DVRPC], 1972).

Many historic sources mention a severe flood known as the Lammas Flood. Reportedly, on August 3, 1843, intense rain raised the creek levels from 19 to 23 feet in a matter of minutes. Raging waters swept away bridges, took lives, and caused extensive property damage (DVRPC, 1974).

Other damage-causing floods occurred in 1955 and June 1972 (Tropical Storm Agnes) as a result of hurricanes. Minor flood damage to roadways is caused occasionally by short-duration, high-intensity summer thunderstorms which generate large amounts of storm water runoff.

Tropical Storm Agnes produced a flood crest elevation of 167.0 feet on Brandywine Creek at Chadds Ford, Pennsylvania. The previous flood of record at that location was a flood crest elevation of 165.5 feet on March 5, 1920. More recently, Hurricane Floyd produce produced torrential rainfall and a peak streamflow of 26,900 cfs with a gage height of 17.15 feet on September 17, 1999.

In August 1955, torrential rains from Hurricane Diane, caused flooding disasters along the entire coast of the United States.

The county suffered extensive damage along the eastern seaboard during September 1960 as a result of the intensive force from Hurricane Donna. Overbank flooding occurred along Darby Creek, resulting in part from debris piled against bridges, which caused a temporary damming effect.

Floodwaters in some overbank areas were three to five feet deep. Along the creek, numerous private residences, industrial establishments, and commercial properties experienced flooding of cellars and first floors.

The worst flooding problems readily recalled by a local official were experienced in September 1971 (DVRPC, 1972). This storm resulted from a stationary frontal system that produced a succession of intense thunderstorms beginning the morning of September 11 and ending in the afternoon of September 13. Small amounts of rain fell September 14 and 15 throughout the area (U.S. Geological Survey [USGS], 1973). Considerable expense was incurred by the communities in the county for cleanup operations (DVRPC, 1972). Flood damage during the September 1971 storm resulted from the streams within the county overtopping its banks. Four fatalities were attributed to this storm and 450 persons were left homeless (USACE, 1974). Flooding on Crum Creek was reported to be less severe than elsewhere in the county. Maximum stream flow during this flood exceeded the previously recorded maximum peak flow (June 1950) by 6,600 cfs at the USGS gaging station on Chester Creek, Chester, Pennsylvania. The Chester Creek Basin area was declared a flood disaster area by the Federal and State governments (USGS, 1973).

For the Township of Concord, the record flood also occurred in September 1971. A USGS gaging station recorded a flood crest of 8.38 feet above the previous highest recorded flood stage. According to the USGS report, entitled “Flood of September 1971 in Southeastern Pennsylvania”, (USGS, 1973) damage to homes,

businesses, and public property amounted to millions of dollars within the Chester Creek Basin.

Within the Township of Edgmont, flooding problems exist along Crum Creek, Stackhouse Mill Run, and Pony Tail Run near Hunters Road and Pony Tail Drive (Edgmont, undated). Because the township is situated near the headwaters of Crum Creek and Ridley Creek, flooding in the township can be caused by both localized high-intensity storms and regional storms such as hurricanes.

During the August 1974 storm, the Township of Haverford experienced flooding problems along Cobbs Creek. Cobbs Creek flows through a 20-foot by 6-foot box culvert under Wynnefield Drive. This culvert floods to a depth of four feet during intense rain storms. Due to the restricted channel flow east of Wynnefield Drive and heavy runoff from the township's parklands located two hundred feet north of the culvert, water backs up and causes flooding (Pennoni Associates, 1975).

Flooding along Naylors Run in the township is caused by short-duration, high-intensity storms. Naylors Run has the potential to rise to a depth of 15 feet above the top of its channel walls causing flooding for home owners.

In the Township of Radnor, Darby Creek drains into an area of approximately 15 square miles. Consequently, Darby Creek and Little Darby Creek are subject to flooding from localized short-duration, high intensity storms rather than regional storms. Similar localized storms affect Gulph Creek within the township. Flooding along Little Darby Creek and Darby Creek in the township results largely from inadequate culvert size at several locations. Flood waters of Little Darby Creek back up behind Maplewood Avenue at the Mill Dam Club due to inadequate culvert capacity. Flooding at this location in the Township of Radnor is said to occur about once a year (Radnor, 1975). Lack of capacity of six culverts along Ithan Creek and a tributary to Darby Creek, which drains the central portion of the township causes flooding problems. All six of the inadequate culverts along Ithan Creek occur in the vicinity of Iven Avenue and Creek Drive, near the Township Building (Radnor, 1974). Of the 17 culverts along Gulph Creek within the township, five lack sufficient capacity to “accommodate the flow produced by a storm having a recurrence frequency of 25-years” (Radnor, 1975). The five culverts are located at the following places: Forest Road, Beech Tree Lane, Walnut Avenue, Chamounix Road, and Gulph Creek Road.

In the Township of Tinicum, Interstate Route 95 is built on fill and effectively forms a dike, which prevents the floodwaters of Darby Creek from flooding south of the highway. The low-lying nature of the township, however, makes several areas susceptible to localized flooding from the ponding of storm runoff.

2.4 Flood Protection Measures

Subsequent to the June 1972 flooding, the USACE, in conjunction with the Pennsylvania Department of Environmental Resources, undertook a stream channel improvement program on Marcus Hook Creek in the vicinity of Market Street in the Township of Upper Chichester (DVRPC, 1972). Stream channel improvements included channeling and installing riprap.

Floodplain ordinances were adopted by the majority of communities within the county. These ordinances regulate development of floodplain areas.

Many dikes have been constructed within the Township of Tinicum along the Delaware River, Darby Creek, Long Hook Creek, and along many roads. Since the Delaware River and Darby Creek are tidal, tide gates are located at each end of Long Hook Creek, which empties into them. These tidal control measures can reduce property damage, but several of the dikes will be topped by a 1-percent annual chance flood. The tide gate at the mouth of Long Hook Creek on Darby Creek will be topped by the 2-percent annual chance flood. Although the tide gate at the mouth of Long Hook Creek on the Delaware River will not be topped by the 100-year flood, the adjacent dike has some low points that will allow water to wash into Long Hook Creek. The dikes along Darby Creek and the Delaware River have been taken into account in the flood delineation for the FIS for the Township of Tinicum.

In the Township of Upper Darby, there is a flood control dam in Naylors Run Park and detention basin on Naylors Run between Garrett Road and Sherbrook Boulevard. The gabion dam in Naylors Run Park was completed in 1975. The dam has been fitted with an uncontrolled outlet facility capable of passing 1,000 cfs. Flood flow storage commences when upstream flow exceeds 1,000 cfs (USACE, undated). The ponding area on Naylors Run upstream of Sherbrook Boulevard has an approximate storage capacity of 20 million gallons. This impounding area has been effective in reducing peak flood flows under certain storm patterns, but its capacity is not sufficient to prevent many flooding occurrences (USACE, undated). Because no severe storm has passed over Naylors Run basin since completion of the Naylors Run Park Dam, effectiveness of the dam and impounding area for controlling peak flood flows has not been adequately tested.

There are five existing dams located in the Darby Creek watershed (four in the Township of Upper Darby and one in the Borough of Clifton Heights); these dams have very limited storage capacity and do not affect flood flows in the communities within Delaware County.

At certain times during the year, primarily midsummer or early-fall, the poo1s of Springton Reservoir in the Townships of Marple and Upper Providence and Geist Reservoir in the Township of Nether Providence are drawn down below the spillway elevation due to increases in water demand. When the pools are below spillway elevation, significant storage is available in the reservoirs for flood flows.

The Borough of Clifton Heights initiated a program, which removed debris from the stream channel and floodway of Darby Creek (MacCombie, 1976). Effectiveness of these measures was evident during the August 1974 flood, which produced a peak stream flow 1,550 cfs greater than the September 1971 flood. Minimal flood damage was experienced during the August 1974 flood because debris did not accumulate appreciably at the three dams or Baltimore Pike Bridge.

There is one small dam located on Crum Creek upstream of the Baldwin Company Footbridge in the Borough of Eddystone that would have no significant effect on flood flows. Portions of the channel along Crum Creek are lined with concrete or mortared stone, offering some protection from flood control measures that would alter the flood flows on any of the streams within the study area.

In the Borough of Folcroft, a high, natural bank along the tidal marsh of Darby Creek protects the southern portion of the borough from flood waters.

In the Borough of Trainer, a dike exists around the British Petroleum Tank Farm on the banks of the Delaware River to protect all outlining areas in case of ruptures in any of the tanks. This dike does afford protection against the 1-percent annual chance flood.

In the Borough of Upland, the General State Authority installed a storm drainage system. This project was completed in early 1976. Although the storm drainage system will not significantly affect the flood flows on Chester Creek, the flood hazard designations for the tributaries studied by approximate methods will be affected.

Flood warnings and predictions of flood peaks are issued by the National Oceanic and Atmospheric Administration Flood Forecasting Centers located at Harrisburg, Pennsylvania, and Trenton, New Jersey.

In the City of Chester, a non-accredited, earthen levee exists along Chester Creek. This structure does not provide protection against the 1 percent annual chance flood. As part of this FIS, this structure was studied using the Levee Analysis and Mapping Procedures (LAMP) approach.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the county, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude which are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10-, 2-, 1-, and 0.2-percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (1 percent chance of annual exceedance) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge- frequency relationships for each flooding source studied in detail affecting the county.

Information on the methods used to determine peak discharge-frequency relationships for the streams is described.

Natural flood-flow frequency data for the following streams were derived from local regionalized frequency curves based on statistical analysis of stream flow records from 15 gages located in the area and operated by the USGS: Crum Creek, Little Crum Creek, Chrome Run, Lewis Run, Marcus Hook Creek, East Branch Marcus Hook Creek, Pony Tail Run, Rocky Run, Stackhouse Mill Run, Stony Creek, Vernon Run, and the portion of Ridley Creek within the Township of Edgmont (USGS, 1974). The analysis of each gage followed the standard log-Pearson Type III statistical technique outlined in USGS Bulletin 15 (Water Resources Council [WRC], 1967). Results were regionalized through linear regression analysis of the log-log relationship for peak flow versus drainage area for all gages at each return interval.

Because Springton Reservoir has an effect on downstream flooding on Crum Creek, flows below the reservoir were adjusted by a reservoir routing technique. Peak outflow rates over the spillway at Springton Reservoir were calculated for each return period (10-, 2-, 1-, and 0.2- percent annual chance). Differences between peak natural inflows to the reservoir and outflows over the spillway representing the reduction in peak downstream flows caused by the calculated peak downstream flow reductions caused by reservoir were subtracted from all natural (unregulated) downstream flows to obtain regulated downstream flows.

For the Darby Creek and Cobbs Creek Basin, the hydrologic analysis included historical storms analysis and development of a rainfall runoff model of each individual drainage basin using the USACE's Hydrologic Engineering Center (HEC) HEC-l Flood Hydrograph Computer Program (October 1970 version) (USACE, 1970).

The HEC-l program was used in conjunction with recorded precipitation data to model historical events (National Weather Service [NWS], 1970). Hypothetical rainfall distributions were developed for the 10-, 2.5-, and 1-percent annual chance events using the NWS Technical Paper No. 40 (USACE, 1977). The rainfall runoff models were then used to determine the peak flow and hydrograph for each frequency event at various index locations.

Then the log-Pearson Type III method was used to develop discharge- frequency curves from the historical flood records at four stream gaging stations (three on Cobbs Creek and one on Darby Creek). The USACE Regional Frequency Study was also used to develop peak flow frequency curves at each gage from adopted regional parameters (USACE, 1974). A standard project storm was developed using criteria developed by the USACE (USACE, 1965).

Final discharge-frequency curves were computed from composite analyses of stream flow gage records, the rainfall runoff model, regionalized discharge-frequency data, and the USACE's Standard Project Flood. Minor adjustments were then made to calibrate the resultant frequency curves to reflect gaged records.

Peak flood flows for Darby Creek, Cobbs Creek, Little Darby Creek, Foxes Run, Gulph Creek, Hermesprota Creek, and Naylors Run were determined from local regionalized frequency curves derived from the frequency-discharge and drainage area relationships cited above.

For Chester Creek and the portion of West Branch Chester Creek downstream of the Township of Concord, flood flow frequency data was based on a statistical analyses of stage-discharge records covering a 44-year period at USGS gaging station No. 01477000 (at Dutton Mill Bridge, three miles northwest of Chester). The above analysis followed the standard log-Pearson Type III method as outlined by the WRC (WRC, 1976). From this, a hydrologic data model was developed for Chester Creek Basin using the USACE, HEC-l model (October 1970 version). The hydrology for Chester Creek was based on the previously developed data from the USACE (USACE, 1961).

For the portion of West Branch Chester Creek within the Township of Concord and for South Fork West Branch Chester Creek and Green Creek, the drainage basin above stream gaging station No. 01477000 located on Chester Creek at New Dutton Mill Road was divided into subareas. The gage was established in August 1931 and had 42-years of continuous records at the time of analysis. Soils for each subarea were classified and subarea hydrologic parameters were determined. NWS Bulletin No. 40, “Rainfall Frequency Atlas of the United States,” (TP-40) (U.S.

Department of Commerce [USDOC], 1963) was used to develop the rainfall depth-duration-frequency relationships. This data was then adjusted to represent the annual rainfall.

Synthetic flood hydrographs were developed and flood routed to the stream gage using the Natural Resources Conservation Service (NRCS) TR-20 Automatic Data Processing Program (U.S. Department of Agriculture [USDA], 1969). The synthetic peak discharges compared favorably with the discharges developed from a frequency analysis developed from a log-Pearson Type III distribution analysis of annual peak flow data (WRC, 1967). Discharges for the 0.2-percent annual chance floods were determined by straight-line extrapolation of a single-log graph of flood discharges computed for frequencies up to 1-percent annual chance.

A gaging station on Ridley Creek located at the Fox Bank Bridge, on Manchester Road in the Township of Nether Providence, was the principal source of data for defining discharge-frequency relationships for Ridley Creek. The gage was in operation for the period 1932 to 1955. Ridley Creek statistics for this period were adjusted by correlation with nearby Chester Creek statistics (USDA, 1969). The stream gage on Chester Creek near Chester, has been in operation from 1932 to the present. Discharge-frequency curves for Ridley Creek were computed using the log-Pearson Type III analysis with an expected probability adjustment and a regional skew value of 0.4 as indicated in the Regional Frequency Study, Upper Delaware and Hudson River Basins (USACE, 1974).

Flood flow frequency data for Naaman Creek were developed using TR- 55. TR-55 is a procedure for calculating storm runoff and peak discharges for small watersheds tending towards urbanization.

Naaman Creek is an ungaged basin with no historic data available for calibration. Therefore, peak discharges calculated using the TR-55 were compared to discharges calculated using USGS-IND and PSU-IV (Pennsylvania State University [PSU], 1981 & 1990). The TR-55 discharges were also calculated compared to a log-Pearson Type III statistical analysis of gages from similar watersheds in the area. The TR-55 discharges compare favorably to discharge calculated using other methods.

Due to its small drainage area, the discharges for Lobbs Run were calculated by the rational method. The discharges for the 0.2-percent annual chance flood were determined by straight-line extrapolation of flood discharges computed for frequencies up to 100-years.

For Muckinipattis Creek, the peak discharges were taken from the USACE Special Flood Hazard Report (USACE, 1977). For Stony Creek, the peak discharges were based on discharge-drainage area relationships for Darby and Muckinipattis Creeks.

The PSU-IV Rational Method was used to develop flood frequency discharges for Bezor's Run and Spring Run (PSU, 1981).

No new hydrologic analysis was developed for the November 18, 2009, and September 2, 2015, countywide revisions.

For the [TBD], FIS revision, detailed hydrologic analysis was performed on portions of Brandywine Creek, Harvey Run, and Harvey Run Branch as part of Brandywine-Christina Watershed Study. An updated hydrologic analysis of Chester Creek was performed for the Chester Levee LAMP analysis

The hydrologic analyses for Harvey Run and Harvey Run Branch involved determination of peak discharges for the 10-, 2-, 1-, and 0.2-percent-annual-chance storm events using Pennsylvania Regression Equations. The peak discharges for Pennsylvania Regression Equations were computed using methodology presented in the publication "Regression Equations for Estimating Flood Flows at Selected Recurrence Intervals for Ungaged Streams in Pennsylvania" (SIR 2008-5102).

The hydrologic analyses for Brandywine Creek involved determination of peak flood discharges for the 10-, 2-, 1-, and 0.2-percent-annual-chance storm events using gage weighted regression methodology presented in SIR 2008-5102. Log-Pearson Type III analysis for USGS 01481000 was performed by following the methodology presented in USGS Bulletin 17B using PeakFQ software program. The results of gage analysis were transferred to ungaged locations where drainage areas were between 50 and 150 percent of the gaging station drainage area. The peak discharges computed using gage analysis were weighted with regression equation peak discharges to obtain final peak flows using the methodology presented in SIR 2008-5102.

Drainage basin area delineations for this hydrologic study were performed using hydro corrected 10 feet Digital Elevation Model (DEM) created by mosaicking 3-meter DEM from Pennsylvania Digital Base Mapping Program (PAMAP) and USGS 10-meter Digital Elevation Models (DEMs). The DEMs were mosaicked using ESRI's ArcGIS 10.0 and basin area delineations were performed using ArcHydro Version 2.0.

Carbonate bedrock and urban area percentages necessary for Pennsylvania regression equations were computed using GIS based shapefile for carbonate bedrock layer and using 2006 National Land Cover Database.

This hydrologic analysis for Chester Creek is based on 83 years of annual peak flow records available at USGS gage station 01477000, as well as the Pennsylvania USGS regression equations. The USGS PeakFQ program was used to develop peak flow discharges at the gage location. The USGS Streamstats program was used to compute peak flow estimates using regression equations. Weighting and transfer equations were then used to compute the final discharges at the mouth of Chester Creek.

Approximate hydrologic analysis determined peak discharges for the 10-, 2-, 1-, and 0.2-percent-annual-chance storm events using Pennsylvania Regression Equations using SIR 2008-5102 methodology.

A summary of the drainage area-peak discharge relationships for the streams studied by detailed methods is shown in Table 4, "Summary of Discharges."

TABLE 4 – SUMMARY OF DISCHARGES

Flooding Source and Location	Drainage Area (sq. miles)	Peak Discharges (cfs) 10-percent annual chance	2-percent annual chance	1-percent annual chance	0.2-percent annual chance
BEZOR'S RUN					
At confluence with Marcus Hook Creek	0.6	210	320	390	580
BRANDYWINE CREEK					
At Delaware-Pennsylvania State boundary	299.8	17,137	27,593	32,711	46,325
At a point 100 feet upstream of confluence with Cossart Run	295.2	16,872	27,166	32,205	45,609
At a point 90 feet upstream of the confluence with Craig Run	292.4	16,710	26,904	31,895	45,169
At a point 90 feet upstream of its confluence with Harvey Run	288	16,459	26,501	31,417	44,492
At USGS gaging station No. 01481000	288	16,440	26,470	31,380	44,440
At a point 90 feet 100 feet upstream of its confluence with Ring Run	285.3	16,306	26,254	31,123	44,077
CHERRY FARM LANE TRIBUTARY					
At confluence with West Branch Chester Creek	0.1	150	180	220	510
CHESTER CREEK					
Upstream of USGS gaging Station No. 4470, located downstream of Dutton Mill Bridge	66.6	7,927	14,209	17,651	22,860
Upstream of confluence of West Branch Chester Creek	35.9	4,760	9,350	11,900	21,600

TABLE 4 – SUMMARY OF DISCHARGES – continued

Flooding Source and Location	Drainage Area (sq. miles)	Peak Discharges (cfs) 10-percent annual chance	2-percent annual chance	1-percent annual chance	0.2-percent annual chance
CHROME RUN					
At confluence with Chester Creek	1.5	560	1,100	1,400	2,250
COBBS CREEK					
At USGS gaging Station No. 0147550	22.0	5,000	8,800	11,200	19,000
Downstream of Naylors Run	16.9	3,700	6,700	8,400	15,500
Downstream of Indian Creek	10.3	3,200	5,400	6,600	10,500
CRUM CREEK (LOWER REACH)					
Approximately 800 feet upstream of Bullens Lane	35.1	3,000	5,500	6,800	9,300
CRUM CREEK (UPPER REACH)					
At West Chester Pike Bridge	15.8	2,500	4,150	5,000	7,000
DARBY CREEK					
At confluence with Delaware River	77.2	13,000	24,000	33,500	54,600
At confluence of Muckinipattis Creek	71.0	11,500	21,500	29,000	49,600
Downstream of confluence of Cobbs Creek	62.3	10,800	20,000	26,000	45,900
At Cobbs Creek	39.7	7,200	13,000	17,000	31,300
Approximately 1,640 feet downstream of Providence Road	37.6	6,900	12,800	16,500	30,800
Approximately 3,420 feet upstream of State Road	30.6	6,100	11,200	14,900	26,400
Approximately 0.46 mile upstream of Radnor and Chester Roads (State Route 320)	15.0	3,350	6,100	8,100	15,000
Approximately 0.34 mile upstream of confluence of Little Darby Creek	6.5	1,800	3,200	4,100	7,100
At St. David's Road	5.8	1,700	3,000	3,800	6,800

TABLE 4 – SUMMARY OF DISCHARGES – continued

Flooding Source and Location	Drainage Area (sq. miles)	Peak Discharges (cfs) 10-percent annual chance	2-percent annual chance	1-percent annual chance	0.2-percent annual chance
DILWORTH ROAD TRIBUTARY					
At confluence with West Branch Chester Creek	0.3	260	350	470	1,440
EAST BRANCH MARCUS HOOK CREEK					
At confluence with Bezor's Run	1.6	700	1,150	1,390	1,880
FOXES RUN					
At Marlin Avenue	1.3	460	780	1,000	1,675
GREEN CREEK					
At confluence with Chester Creek	4.1	1,100	1,900	2,300	3,500
Approximately 1.9 miles upstream of confluence with Chester Creek	2.1	800	1,400	1,700	2,600
GULPH CREEK					
At stream mile 2.85	2.8	860	1,500	1,925	3,300
At stream mile 4.72	2.2	700	1,325	1,690	2,725
HARVEY RUN					
At confluence with Brandywine Creek	3.9	1,210	2,108	2,569	3,878
At a point 100 ft. downstream of Ring Road	2.8	992	1,735	2,118	3,205
At a point 980 ft. downstream of Hayburn Road	2.1	823	1,442	1,762	2,671
HARVEY RUN BRANCH					
At confluence with Harvey Run	0.2	214	374	456	687
Approximately 90 ft downstream of Painters Crossing Road	0.2	187	323	393	587
HERMESPROTA CREEK (LOWER REACH)					
Downstream corporate limits of the Borough of Sharon Hill	1.0	290	500	640	1,190

TABLE 4 – SUMMARY OF DISCHARGES – continued

Flooding Source and Location	Drainage Area (sq. miles)	Peak Discharges (cfs) 10-percent annual chance	2-percent annual chance	1-percent annual chance	0.2-percent annual chance
HERMESPROTA CREEK (MACDADE BOULEVARD REACH)					
At MacDade Boulevard	0.4	*	*	857	*
HERMESPROTA CREEK (UPPER REACH)					
At Chester Pike	32.8	275	460	590	960
LEWIS RUN					
At confluence with Crum Creek	1.4	740	1,170	1,370	1,890
LITTLE CRUM CREEK					
At confluence with Crum Creek	3.2	1,080	1,700	2,050	2,800
At Yale Avenue	1.3	630	1,050	1,250	1,650
LITTLE DARBY CREEK					
At confluence with Darby Creek	3.6	1,100	1,900	2,450	4,200
LOBBS RUN					
At confluence with Darby Creek	0.6	796	1,021	1,154	1,400
MARCUS HOOK CREEK					
At confluence with the Delaware River	5.4	1,350	2,300	2,700	3,700
MUCKINIPATTIS CREEK					
At Academy Avenue[1]	1.7	720	1,250	1,550	2,600
NAAMAN CREEK					
Upstream of confluence of West Branch Naaman Creek	4.9	1,350	2,350	3,060	4,750
Upstream of confluence of East Branch Naaman Creek	2.3	660	1,220	1,600	2,500
Upstream of confluence of Spring Run	1.1	340	570	810	1,550

* Data Not Available

TABLE 4 – SUMMARY OF DISCHARGES – continued

Flooding Source and Location	Drainage Area (sq. miles)	Peak Discharges (cfs) 10-percent annual chance	2-percent annual chance	1-percent annual chance	0.2-percent annual chance
NAYLORS RUN					
At confluence with Cobbs Creek	4.5	1,300	2,300	3,000	5,000
At Garrett Road	3.4	1,200	2,100	2,700	4,600
Approximately 290 feet downstream of U.S. Route 13 bypass	2.8	880	1,550	2,000	3,400
Approximately 370 feet, upstream of Bond Avenue	2.6	880	1,550	2,000	3,400
At West Chester Pike	1.1	410	720	920	1,520
OLD BARN DRIVE TRIBUTARY					
At confluence with West Branch Chester Creek	0.3	20	150	300	1,550
PONY TAIL RUN					
At confluence with Ridley Creek	0.4	270	360	390	450
RIDLEY CREEK					
At confluence with the Delaware River	38.2	3,700	7,200	9,500	17,400
Approximately 1,000 feet upstream of Chester Park Drive	35.6	3,600	7,100	9,400	17,200
At USGS gaging station No. 4765 at Fox Bank Bridge at Moylan, Pennsylvania	31.9	3,400	6,700	8,800	16,100
Approximately 0.4 mile downstream of Delchester Road	18.5	2,820	4,800	5,800	8,600
ROCKY RUN					
At confluence with Chester Creek	1.5	560	1,100	1,400	2,250
SOUTH FORK WEST BRANCH CHESTER CREEK					
Approximately 950 feet upstream of confluence with West Branch Chester Creek	4.8	1,150	2,000	2,500	3,700

TABLE 4 – SUMMARY OF DISCHARGES – continued

Flooding Source and Location	Drainage Area (sq. miles)	Peak Discharges (cfs) 10-percent annual chance	2-percent annual chance	1-percent annual chance	0.2-percent annual chance
SOUTH FORK WEST BRANCH CHESTER CREEK (continued)					
Approximately 0.7 mile downstream of Smith Bridge Road	2.1	530	950	1,200	1,800
SPRING RUN					
At confluence with Naaman Creek	1.0	430	717	877	1,300
STACKHOUSE MILL RUN					
At confluence with Ridley Creek	2.4	860	1,450	1,725	2,400
STONEY CREEK					
At CONRAIL crossing	0.7	570	720	820	920
At confluence with Darby Creek	2.9	750	1,300	1,650	3,100
At 13th Avenue Bridge	2.3	630	1,100	1,350	2,600
At Morton Avenue	1.0	300	500	650	1,200
VERNON RUN					
At CONRAIL crossing	0.2	220	295	315	365
WEST BRANCH CHESTER CREEK					
At confluence with Chester Creek	19.1	4,120	7,600	9,670	16,800
At confluence of Green Creek	17.3	3,980	7,100	9,260	15,900
Approximately 0.2 mile downstream of Smith Bridge Road	13.1	2,500	4,400	5,400	8,200
Approximately 225 feet downstream of Baltimore Pike (U.S. Route 1)	4.8	1,500	2,650	3,250	4,900
Approximately 100 feet downstream of confluence of West Branch Chester Creek Tributary No. 3	2.6	980	1,750	2,150	3,250
At confluence with Elaine Drive Tributary	2.1	610	945	1,660	6,545

Drainage area-peak discharge relationships are not available for Chester Creek Tributary, East Branch Chester Creek, East Branch Chester Creek Tributary 2, and Sweet Water Road Tributary. For Chester Creek Tributary, East Branch Chester Creek, East Branch Chester Creek Tributary 2, Sweet Water Road Tributary, and the portion of West Branch Chester Creek within the Township of Thornbury, the hydrologic characteristics of the streams' drainage basins were determined by standard NRCS methods. This information was taken from the FIRM for the Township of Thornbury (FEMA, 1975).

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals. Users should be aware that flood elevations shown on the FIRM represent rounded whole-foot elevations and may not exactly reflect the elevations shown on the Flood Profiles or in the Floodway Data table in the FIS report. Flood elevations shown on the FIRM are primarily intended for flood insurance rating purposes. For construction and/or floodplain management purposes, users are cautioned to use the flood elevation data presented in this FIS report in conjunction with the data shown on the FIRM.

In the September 30, 1993, countywide FIS, cross sections for the backwater analyses for the following flooding sources were field surveyed: Chester Creek; West Branch Chester Creek, within the Township of Concord; South Fork West Branch Chester Creek; Cobbs Creek; Darby Creek; Foxes Run; Green Creek; Hermesprota Creek (Lower Reach); Hermesprota Creek (Upper Reach); Lewis Run; Lobbs Run; Marcus Hook Creek; Stoney Creek; and Stony Creek. Cross sections for the backwater analyses for the following flooding sources were field surveyed by the NRCS: East Branch Chester Creek and West Branch Chester Creek, upstream of the corporate limits with the Township of Concord. Cross sections for the backwater analyses for the following flooding sources were field surveyed by Betz Environmental Engineers, Inc.: Chrome Run; Little Crum Creek; Little Darby Creek; Gulph Creek; Hermesprota Creek (Upper Reach); Naylors Run; Pony Tail Run; Ridley Creek; Rocky Run; Stackhouse Mill Run; and Vernon Run. Cross sections for the backwater analyses for the following flooding sources were field surveyed by the USACE, Philadelphia District: Crum Creek; Little Crum Creek; East Branch Marcus Hook Creek; Muckinipattis Creek; and Naaman Creek.

Cross-sectional data for West Branch Chester Creek, downstream of the corporate limits with the Township of Concord were field surveyed and delineated from aerial photographs flown in February 1973 (A.O. Quinn Associates, 1973). Cross-sectional data for Naylors Run culvert were derived from studies and plans supplied by the Township of Upper Darby (Upper Darby 1959, 1962[a], 1962[b], 1967, and 1971). Channel bottom elevations for Ridley Creek were verified by Dewberry, Nealon, & Davis, and bridges were surveyed by the USACE.

Cross sections were located at close intervals above bridges and culverts in order

to compute the backwater effects of those structures.

Water-surface elevations for the majority of flooding sources were determined using the USACE HEC-2 step-backwater computer program (USACE, 1988). Water-surface elevations for the following sources were determined using the NRCS Automatic Data Processing (ADP) Methods: East Branch Chester Creek; East Branch Chester Creek Tributary; East Branch Chester Creek Tributary 2, Elaine Drive Tributary; and Sweet Water Road Tributary (USDA, 1970). Water-surface elevations for Green Creek were determined by the WSPIN method (USDA, 1970).

Starting water-surface elevations for streams studied in detail in the September 30, 1993, countywide FIS, and not superseded by the [TBD], FIS revision are summarized in Table 5, "Starting Water-Surface Elevations."

TABLE 5 – STARTING WATER-SURFACE ELEVATIONS

Stream	Starting Water-Surface Elevations Based on the Following Methods:
Chester Creek	USACE stage-frequency curve of the Delaware River
Chester Creek Tributary	Computed water-surface elevations for East Branch Chester Creek
East Branch Chester Creek	Computed water-surface elevations for Chester Creek
East Branch Chester Creek Tributary 2	Computed water-surface elevations for East Branch Chester Creek
West Branch Chester Creek	
Downstream of the corporate limits with the Township of Concord	From backwater profile for Chester Creek
Within the Township of Concord	From rate curve developed from a surveyed cross section several thousand feet below the Township of Concord corporate limit; for the original countywide study*
Upstream of the corporate limits with the Township of Concord	Based on profile for West Branch Creek in the Township of Concord

* These starting water-surface elevations have been adjusted to agree with the downstream profile with the Township of Concord

TABLE 5 – STARTING WATER-SURFACE ELEVATIONS – continued

Stream	Starting Water-Surface Elevations Based on the Following Methods:
South Fork West Branch Chester Creek	From rating curve developed from a surveyed cross section located several thousand feet below the study area using the Manning equation
Chrome Run	From computed water-surface elevations for Chester Creek
Cobbs Creek	From computed water-surface elevations for Darby Creek
Crum Creek	Based on coincident conditions of tidal flooding on the Delaware River
Little Crum Creek	From computed water-surface elevations for Crum Creek
Darby Creek	From previously published report for Darby Creek (USACE, 1977)
Little Darby Creek	From computed water-surface elevations for Darby Creek
Foxes Run	From computed water-surface elevations for Darby Creek
Green Creek	Determined from a rating curve developed from a surveyed cross section using the Manning equation
Gulph Creek	Based on rating curve controlled by County Line Road
Hermesprota Creek (Lower Reach)	By critical depth method downstream of the Borough of Sharon Hill corporate limits
Hermesprota Creek (Upper Reach)	Based upon high tide elevations on Darby Creek adjacent to the Borough of Folcroft
Lewis Run	From computed water-surface elevations for Crum Creek
Lobbs Run	From computed water-surface elevations for Darby Creek

TABLE 5 – STARTING WATER-SURFACE ELEVATIONS – continued

Stream	Starting Water-Surface Elevations Based on the Following Methods:
Marcus Hook Creek	One-year tide of 6.1 from the Delaware River, based on backwater tides for 10-, 2-, 1-, and 0.2-percent frequency for the Delaware River, then superimposed on Lower Reach of Marcus Hook Creek
East Branch Marcus Hook Creek	From computed water-surface elevations for Marcus Hook Creek
Muckinipattis Creek	From computed water-surface elevations for Darby Run
Naylors Run (in the vicinity of Patterson Avenue)	From computed water-surface elevations for Cobbs Creek
Naylors Run (in the vicinity of Chester Pike [State Route 3])	Determined under assumption that West Chester Pike (State Route 3) acts as a control structure
Naaman Creek	One-year tide of the Delaware River, based on backwater tides for 10-,2-,1-, and 0.2-percent frequency for the Delaware River, then superimposed on Lower Reach of Naaman Creek
Pony Tail Run	Based on a rating curve derived from energy/slope considerations at stream mile 14.32 on Ridley Creek
Ridley Creek	From USACE stage-frequency curve for the Delaware River
Rocky Run	From computed water-surface elevations for Chester Creek
Stackhouse Mill Run	Based on rating curve derived from energy/slope considerations at stream mile 14.32 on Ridley Creek
Stoney Creek	Based on high tide elevation for selected recurrence interval on the Delaware River
Stony Creek	From computed water-surface elevations for Darby Creek

TABLE 5 – STARTING WATER-SURFACE ELEVATIONS – continued

Stream	Starting Water-Surface Elevations Based on the Following Methods:
Sweet Water Road Tributary	From computed water-surface elevations for East Branch Chester Creek
Vernon Run	From computed water-surface elevations for Ridley Creek taken from the FIS for the Borough of Rose Valley

For the September 30, 1993, countywide FIS, channel and overbank roughness factors (Manning's "n") were assigned on the basis of field inspection, USACE work, and engineering judgment (Chow, 1959, USDOC, 1961, USACE, 1982, Hoggan, 1989).

In the May 2, 1995, FIS revision, starting water-surface elevations for Bezor's Run and Spring Run were based on the Slope-area method.

In the [TBD], FIS revision, hydraulic analyses were performed as a part of Brandywine-Christina Watershed Study. The hydraulic analysis included detailed analyses for approximately 7.45 miles for portions of Brandywine Creek, Harvey Run, and Harvey Run Branch, as well as approximately 1.6 miles of Chester Creek. The analyses consisted of determining the water-surface elevations for the 10-, 2-, 1-, and 0.2-percent-annual-chance flood events and floodway analysis was also performed.

The hydraulic models were developed using HEC-RAS Version 4.1 and the HEC-GeoRAS ArcGIS extension (version 10.0). Cross sections were generated using HEC-GeoRAS and LiDAR data collected by PAMAP in 2006 to 2008. The average point spacing for the LiDAR data was 3.8 feet. The streamlines were generated using 2-foot contour data and were corrected using aerial photography. Manning's "n" value polygons for the studied streams were created using the aerial imagery and different land use values were determined using Manning's N values published by Ven Te Chow in 1959 and field reconnaissance.

The normal depth method downstream boundary condition was used for Brandywine Creek, Harvey Run, and Harvey Run Branch models were computed using the ground profile slopes from available topography. Chester Creek drains into the Delaware River a tidally influenced reach. Mean-High-High-Water (MHHW) was calculated as 3.17 ft using data from NOAA's Center for Operation Oceanographic Products and Services website. This elevation was higher than starting WSELs for all profiles in the model using normal depth. Therefore, MHHW was used as the boundary condition for all profiles.

For Brandywine Creek, the hydraulic model was calibrated within 0.5 feet of observed USGS gage rating curve at gage 01481000 located near Chadds Ford. Manning's "n" values were used as one of the primary hydraulic parameters for model calibration.

Approximate hydraulic study was not performed as part of this revision.

The following tabulation in Table 6, “Manning’s “n” Values”, shows the channel and overbank “n” values for the streams studied by detailed methods in this countywide FIS.

For this countywide FIS, locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 4.2), selected cross section locations are also shown on the FIRM (Exhibit 2). Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals.

TABLE 6 – MANNING'S "n" VALUES

Stream	Channel “n”	Overbank “n”
Bezor’s Run	0.040	0.080
Brandywine Creek	0.028-0.032	0.030-0.12
Cherry Farm Lane Tributary	*	*
Chester Creek	0.030-0.060	0.050-0.010
Chester Creek Tributary	*	*
Chrome Run	0.040-0.060	0.028-0.100
Cobbs Creek	0.028-0.070	0.070
Crum Creek	0.024-0.040	0.032-0.080
Darby Creek	0.018-0.060	0.030-0.145
Dilworthtown Road Tributary	*	*
East Branch Chester Creek	*	*
East Branch Chester Creek Tributary 2	*	*
East Branch Marcus Hook Creek	0.070	0.050
Foxes Run	0.035	0.050-0.075
Green Creek	0.045	0.033-0.125
Gulph Creek	0.040	0.070
Harvey Run	0.037-0.042	0.030-0.12
Harvey Run Branch	0.020-0.045	0.030-0.12
Hermesprota Creek (Lower Reach)	0.028-0.035	0.030-0.050
Hermesprota Creek (MacDade Reach)	*	*
Hermesprota Creek (Upper Reach)	0.040	0.070
Lewis Run	0.035	0.050
Little Crum Creek	0.024-0.040	0.032-0.080
Little Darby Creek	0.040	0.070
Lobbs Run	0.030-0.035	0.040-0.090
Marcus Hook Creek	0.025-0.050	0.040-0.070
Muckinpattis Creek	0.028-0.035	0.030-0.050
Naaman Creek	0.040-0.045	0.085-0.100
Naylors Run	0.018-0.050	0.070
Old Barn Drive Tributary	*	*
Pony Tail Run	*	*
Ridley Creek	0.024-0.070	0.030-0.070

* Data not available

TABLE 6 – MANNING'S "n" VALUES – continued

Stream	Channel "n"	Overbank "n"
Rocky Run	0.040-0.060	0.070
South Fork West Branch Chester Creek	0.045	0.050-0.125
Spring Run	0.040	0.070
Stockhouse Mill Run	*	*
Stoney Creek	0.050	0.070
Stony Creek	0.024-0.040	0.032-0.080
Sweet Water Road Tributary	*	*
Vernon Road	0.040	0.070
West Branch Chester Creek	0.040-0.045	0.060-0.110

* Data not available

The hydraulic analyses for this study are based on the effects of unobstructed flow. The flood elevations shown on the profiles are valid only if hydraulic structures remain unobstructed, and dams and other flood control structures operate properly and do not fail.

All qualifying benchmarks within a given jurisdiction that are catalogued by the National Geodetic Survey (NGS) and entered into the National Spatial Reference System (NSRS) as First or Second Order Vertical and have a vertical stability classification of A, B or C are shown and labeled on the FIRM with their 6-character NSRS Permanent Identifier.

Benchmarks catalogued by the NGS and entered into the NSRS vary widely in vertical stability classification. NSRS vertical stability classifications are as follows:

- Stability A: Monuments of the most reliable nature, expected to hold position/elevation (e.g., mounted in bedrock)

- Stability B: Monuments which generally hold their position/elevation (e.g., concrete bridge abutment)

- Stability C: Monuments which may be affected by surface ground movements (e.g., concrete monument below frost line)

- Stability D: Mark of questionable or unknown vertical stability (e.g., concrete monument above frost line, or steel witness post)

In addition to NSRS benchmarks, the FIRM may also show vertical control monuments established by a local jurisdiction; these monuments will be shown on the FIRM with the appropriate designations. Local monuments will only be placed on the FIRM if the community has requested that they be included, and if the monuments meet the aforementioned NSRS inclusion criteria.

To obtain current elevation, description, and/or location information for benchmarks shown on the FIRM for this jurisdiction, please contact the Information Services Branch of the NGS at (301) 713-3242, or visit their Web site at www.ngs.noaa.gov.

It is important to note that temporary vertical monuments are often established during the preparation of a flood hazard analysis for the purpose of establishing local vertical control. Although these monuments are not shown on the FIRM, they may be found in the Technical Support Data Notebook (TSDN) associated with the FIS report and FIRM for these communities. Interested individuals may contact FEMA to access these data.

3.3 Coastal Analyses

Coastal analyses, considering storm characteristics and the shoreline and bathymetric characteristics of the flooding sources studied, were carried out to provide estimates of the elevations of floods of the selected recurrence intervals along the shoreline. Users of the FIRM should be aware that coastal flood elevations are provided in Table 7, "Summary of Stillwater Elevations" in this report. If the elevation on the FIRM is higher than the elevation shown in this table, a wave height, wave runup, and/or wave setup component likely exists, in which case, the higher elevation should be used for construction and/or floodplain management purposes.

Development is extensive along the entire Delaware River shoreline within the Delaware County. The entire coastline is comprised of manufacturing and storage facilities, as well as commercial docks and historic sites. Elevations vary from sea level to approximately 19.5 feet North American Vertical Datum of 1988 (NAVD88). Behind the shoreline, development continues with extensive high density residential areas and manufacturing sites.

An analysis was performed to establish the frequency peak elevation relationships for coastal flooding in Delaware County. The FEMA Region III office, initiated a study in 2008 to update the coastal storm surge elevations within the state of Virginia, Maryland, Delaware, and the District of Columbia including the Atlantic Ocean, Chesapeake Bay, its tributaries, Delaware Bay and tidal portions of the Delaware River. The study replaces outdated coastal storm surge stillwater elevations for all FISs in the study area, including Delaware County, Pennsylvania (All Jurisdictions), and serves as the basis for updated FIRMs. Study efforts were initiated in 2008 and concluded in 2013.

The end-to-end storm surge modeling system includes the Advanced Circulation Model for Oceanic, Coastal and Estuarine Waters (ADCIRC) for simulation of 2-dimensional hydrodynamics (Luettich, et. al., 2008). ADCIRC was dynamically coupled to the unstructured numerical wave model Simulating WAves Nearshore (unSWAN) to calculate the contribution of waves to total storm surge (USACE, 2012). The resulting model system is typically referred to as SWAN+ADCIRC

(USACE, 2012). A seamless modeling grid was developed to support the storm surge modeling efforts. The modeling system validation consisted of a comprehensive tidal calibration followed by a validation using carefully reconstructed wind and pressure fields from three major flood events for the Region III domain: Hurricane Isabel, Hurricane Ernesto, and Extratropical Storm Ida. Model skill was accessed by quantitative comparison of model output to wind, wave, water level and high water mark observations.

The tidal surge for those areas affected by Delaware Bay affect the entire shoreline within Delaware County. The entire southwestern coastline, from Naaman Creek to north of Darby Creek, is more prone to damaging wave action during high wind events due to the significant fetch over which winds can operate.

The storm-surge elevations for the 10-, 2-, 1-, and 0.2-percent-annual-chance floods were determined for the Delaware River and are shown in Table 7, "Summary of Stillwater Elevations." The analyses reported herein reflect the stillwater elevations due to tidal and wind setup effects.

TABLE 7 – SUMMARY OF STILLWATER ELEVATIONS

	Elevation (feet, NAVD88)			
Flooding Source and Location	10-percent annual chance	2-percent annual chance	1-percent annual chance	0.2-percent annual chance
DELAWARE RIVER				
At Marcus Hook	6.9	7.6	8.3	10.9
At confluence of Ridley Creek	7.1	7.8	8.4	11.0
At confluence of Darby Creek	7.1	7.9	8.5	11.2
At Fort Mifflin	7.4	8.3	8.9	11.4

The methodology for analyzing the effects of wave heights associated with coastal storm surge flooding is described in a report prepared by the National Academy of Sciences (NAS, 1977). This method is based on three major concepts. First, depth-limited waves in shallow water reach maximum breaking height that is equal to 0.78 times the stillwater depth. The wave crest is 70 percent of the total wave height above the stillwater level. The second major concept is that wave height may be diminished by dissipation of energy due to the presence of obstructions, such as sand dunes, dikes and seawalls, buildings and vegetation. The amount of energy dissipation is a function of the physical characteristics of the obstruction and is determined by procedures prescribed in the NAS report. The third major concept is that wave height can be regenerated in open fetch areas due to the transfer of wind energy to the water. This added energy is related to fetch length and depth.

Figure 1, "Transect Schematic", is a profile for a typical transect illustrating the effects of energy dissipation and regeneration on a wave as it moves inland. This

figure shows the wave crest elevations being decreased by obstructions, such as buildings, vegetation, and rising ground elevations, and being increased by open, unobstructed wind fetches. Actual wave conditions in the county may not include all the situations illustrated in Figure 1.

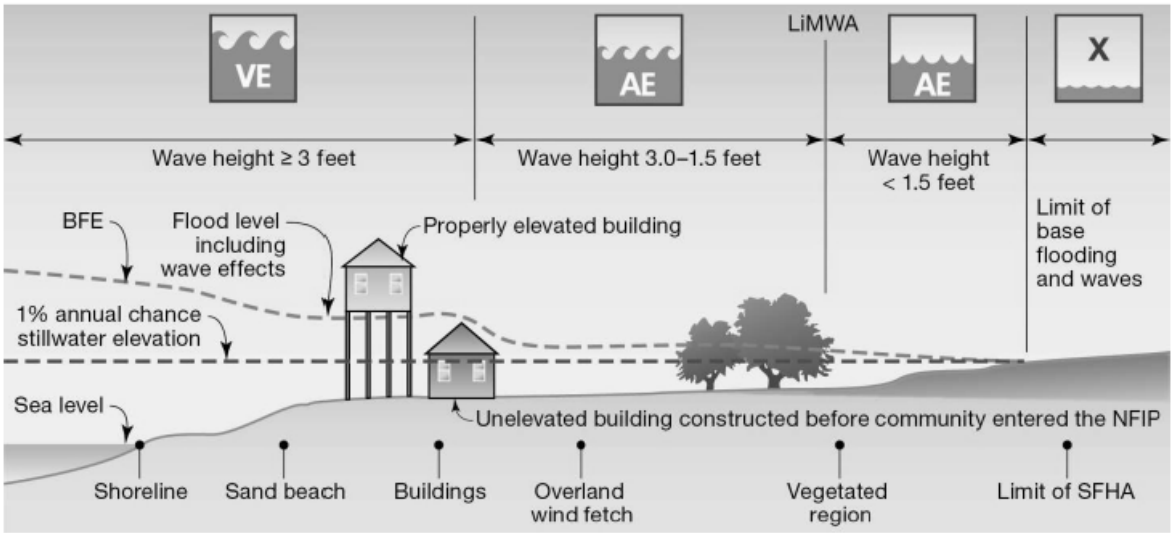

FIGURE 1 – TRANSECT SCHEMATIC

The coastal analysis and mapping for Delaware County was conducted for FEMA by RAMPP under Contract No. HSFEHQ-09-D-0369, Task Order HSFE03-09-0002. The coastal analysis involved transect layout, field reconnaissance, erosion analysis, and overland wave modeling including wave setup, wave height analysis and wave runup.

Wave heights were computed across transects that were located along riverfront areas of Delaware County, as illustrated on the FIRM. The transects were located with consideration given to existing transect locations and to the physical and cultural characteristics of the land so that they would closely represent conditions in the locality, as illustrated in Figure 2, “Transect Location Map.”

FIGURE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

DELAWARE COUNTY, PENNSYLVANIA
(ALL JURISDICTIONS)

0 0.5 1 2 3 4 Miles

TRANSECT LOCATION MAP

Each transect was taken perpendicular to the shoreline and extended inland to a point where coastal flooding ceased. Along each transect, wave heights and elevations were computed considering the combined effects of changes in ground elevation, vegetation, and physical features. The stillwater elevations for a 1-percent-annual-chance event were used as the starting elevations for these computations. Wave heights were calculated to the nearest 0.1 foot, and wave elevations were determined at whole-foot increments along the transect. The location of the 3-foot breaking wave for determining the terminus of the Zone VE (area with velocity wave action) was computed at each transect.

Wave height calculations used in this study follow the methodologies described in the FEMA guidance for coastal mapping (FEMA, 2007a). Wave setup results in an increased water level at the shoreline due to the breaking of waves and transfer of momentum to the water column during hurricanes and severe storms. For the Delaware County study, wave setup was determined directly from the coupled wave and storm surge model The total stillwater elevation (SWEL) with wave setup was then used for simulations of inland wave propagation conducted using FEMA's Wave Height Analysis for Flood Insurance Studies (WHAFIS) model Version 4.0 (FEMA, 2007b). WHAFIS is a one-dimensional model that was applied to each transect in the study area. The model uses the specified SWEL, the computed wave setup, and the starting wave conditions as input. Simulations of wave transformations were then conducted with WHAFIS taking into account the storm-induced erosion and overland features of each transect. Output from the model includes the combined SWEL and wave height along each cross-shore transect allowing for the establishment of Base Flood Elevations (BFEs) and flood zones from the shoreline to points inland within the study area.

Wave runup is defined as the maximum vertical extent of wave uprush on a beach or structure. FEMA's 2007 Guidelines and Specifications require the 2-percent wave runup level be computed for the coastal feature being evaluated (cliff, coastal bluff, dune, or structure) (FEMA, 2007a). The 2-percent runup level is the highest 2 percent of wave runup affecting the shoreline during the 1-percent annual chance flood event. Each transect defined within the Region III study area was evaluated for the applicability of wave runup, and if necessary, the appropriate runup methodology was selected and applied to each transect. Runup elevations were then compared to WHAFIS results to determine the dominant process affecting BFEs and associated flood hazard levels. Based on wave runup rates, wave overtopping was computed following the FEMA 2007 Guidelines and Specifications.

Computed controlling wave heights at the shoreline range from 2.6 feet to 4.1 feet. The corresponding wave elevation at the shoreline varies from 9.0 feet NAVD88 to 11.8 feet NAVD88. Vertical reinforced coastlines serve to reduce wave height z.

Between transects, elevations were interpolated using topographic maps, land-use and land cover data, and engineering judgment to determine the aerial extent of

flooding. The results of the calculations are accurate until local topography, vegetation, or cultural development within the community undergo major changes. Table 8, "Transect Data", provides the Delaware River 10-, 2-, 1- and 0.2-percent annual chance stillwater elevations and the starting wave conditions for each transect.

TABLE 8 – TRANSECT DATA

		Starting Wave Conditions for the 1% Annual Chance			Starting Stillwater Elevations (ft NAVD88) Range of Stillwater Elevations (ft NAVD88)			
Flood Source	Transect	Coordinates	Significant Wave Height H_s (ft)	Peak Wave Period T_p (sec)	10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Delaware River	1	N 39.810894 W -75.413482	2.8	3.2	6.9	7.7	8.3	11.0
Delaware River	2	N 39.814025 W -75.4.6883	2.8	3.1	6.9	7.7	8.3	11.0
Delaware River	3	N 39.818314 W -75.398667	2.7	3.0	7.0	7.7	8.4	11.0
Delaware River	4	N 39.822845 W -75.396440	2.5	3.0	7.0	7.7	8.4	11.1
Delaware River	5	N 39.823101 W -75.390341	2.7	3.1	7.0	7.7	8.4	11.0
Delaware River	6	N 39.828189 W -75.382932	2.7	3.1	7.0	7.7	8.4	11.0
Delaware River	7	N 39.832349 W -75.376628	2.7	3.0	7.0	7.7	8.4	11.0
Delaware River	8	N 39.837263 W -75.368986	2.8	3.1	7.0	7.8	8.4	11.0
Delaware River	9	N 39.841353 W -75.360258	2.9	3.2	7.0	7.7	8.4	11.0
Delaware River	10	N 39.844400 W -75.353645	2.9	3.2	7.0	7.7	8.4	11.0
Delaware River	11	N 39.848663 W -75.345949	2.9	3.3	7.1	7.8	8.4	11.0

TABLE 8 – TRANSECT DATA – continued

Flood Source	Transect	Starting Wave Conditions for the 1% Annual Chance			Starting Stillwater Elevations (ft NAVD88) Range of Stillwater Elevations (ft NAVD88)			
		Coordinates	Significant Wave Height H_s (ft)	Peak Wave Period T_p (sec)	10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Delaware River	12	N 39.850486 W -75.340144	3.0	3.4	7.1	7.8	8.4	11.1
Delaware River	13	N 39.853760 W -75.332630	3.0	3.4	7.1	7.8	8.5	11.1
Delaware River	14	N 39.856320 W -75.324720	3.2	3.6	7.1	7.9	8.5	11.1
Delaware River	15	N 39.859398 W -75.316730	3.0	3.4	7.1	7.9	8.5	11.2
Delaware River	16	N 39.862102 W -75.309616	3.0	3.4	7.1	7.9	8.6	11.2
Delaware River	17	N 39.860950 W -75.305649	3.2	3.5	7.1	7.9	8.6	11.2
Delaware River	18	N 39.860322 W -75.293249	2.8	3.1	7.2	8.0	8.6	11.2
Delaware River	19	N 39.860071 W -75.280662	2.7	3.1	7.2	8.0	8.6	11.2
Delaware River	20	N 39.858486 W -75.264709	2.4	2.9	7.3	8.1	8.6	11.2
Delaware River	21	N 39.858663 W -75.246564	2.2	2.9	7.2	8.1	8.7	11.2
Delaware River	22	N 39.866149 W -75.227340	2.4	2.8	7.4	8.2	8.8	11.3

3.4 Vertical Datum

All FIS reports and FIRMs are referenced to a specific vertical datum. The vertical datum provides a starting point against which flood, ground, and structure elevations can be referenced and compared. Until recently, the standard vertical datum used for newly created or revised FIS reports and FIRMs was the National Geodetic Vertical Datum of 1929 (NGVD 29). With the completion of the NAVD 88, many FIS reports and FIRMs are now prepared using NAVD 88 as the referenced vertical datum.

All flood elevations shown in this FIS report and on the FIRM are now referenced to NAVD 88. In order to perform this conversion, effective NGVD 29 elevation values were adjusted downward by 1.06 feet. Structure and ground elevations in the community must, therefore, be referenced to NAVD 88. It is important to note that adjacent communities may be referenced to NGVD 29. This may result in differences in base flood elevations across the corporate limits between the communities.

For more information on NAVD 88, see Converting the National Flood Insurance Program to the North American Vertical Datum of 1988, FEMA Publication FIA-20/June 1992, or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242
http://www.ngs.noaa.gov/

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound floodplain management programs. To assist in this endeavor, each FIS report provides 1-percent annual chance floodplain data, which may include a combination of the following: 10-, 2-, 1-, and 0.2 percent annual chance flood elevations; delineations of the 1-percent and 0.2-percent annual chance floodplains; and a 1-percent annual chance floodway. This information is presented on the FIRM and in many components of the FIS report, including Flood Profiles, and Floodway Data tables. Users should reference the data presented in the FIS report as well as additional information that may be available at the local community map repository before making flood elevation and/or floodplain boundary determinations.

4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1-percent annual chance flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent annual chance flood is employed to indicate additional areas of flood risk in the county. For the streams studied in detail, the 1-percent annual chance and 0.2-percent annual chance boundaries have been determined at each cross section. The delineations are based on the best available topographic information.

For the [TBD], FIS revision, terrain feature dataset developed from LiDAR data was used for the floodplain mapping. LiDAR flown by Woolpert from 2006 to 2008 in support of PAMAP was used for the topographic data development for the Pennsylvania portion of the Brandywine-Christina Watershed. The LiDAR was downloaded from the Pennsylvania Spatial Data Access (PASDA) website (http://www.pasda.psu.edu/) in LASer (LAS) format in NAD83 State Plane Pennsylvania South Federal Information Processing Standards (FIPS) 3702 Feet projection. Vertical units were in NAVD88, with elevations in feet.

For the November 18, 2009, FIS revision, all streams for which water-surface elevations had been previously calculated were redelineated using 5-foot contours provided by the DVRPC.

The 1-percent and 0.2-percent annual chance floodplain boundaries are shown on the FIRM. On this map, the 1-percent annual chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A, AE, and AO), and the 0.2-percent annual chance floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 1-percent and 0.2-percent-annual chance floodplain boundaries are close together, only the 1-percent annual chance floodplain boundary has been shown. Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

For the streams studied by approximate methods, only the 1-percent-annual-chance floodplain boundary is shown on the FIRM. Approximate floodplain boundaries have been revised using a baseline HEC-RAS hydraulic model and automated mapping procedures. The new approximate floodplains were delineated based on 5-foot contours provided by the DVRPC. For flooding sources previously studied by approximate methods which could not be revised, the floodplain boundaries were determined by adjusting the effective approximate floodplain boundaries as designated on the previous FIRM.

4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the NFIP, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 1-percent annual chance floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the 1-percent-annual-chance flood can be carried without substantial increases in flood heights. Minimum federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this FIS are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

The floodways presented in this study were computed on the basis of equal conveyance reduction from each side of the floodplains. The results of these computations are tabulated at selected cross sections for each stream segment for which a floodway is computed (Table 10).

As shown on the FIRM (Exhibit 2), the floodway widths were determined at cross sections; between cross sections, the boundaries were interpolated. In cases where the boundaries of the floodway and the 1-percent annual chance flood are either close together or collinear, only the floodway boundary has been shown. Portions of the floodways for Brandywine Creek, Cobbs Creek, Crum Creek (Upper Reach) and Ridley Creek extend beyond the county boundary.

No floodways were computed for the following streams: a portion of the downstream reach of Chester Creek affected by the tidal influence of the Delaware River; East Branch Chester Creek; Chester Creek Tributary; East Branch Chester Creek Tributary 2; the portion of the West Branch Chester Creek that flows through the Township of Thornbury; Darby Creek, downstream of a point located approximately 1,380 feet downstream of the confluence of Cobbs Creek, the Delaware River, Hermesprota Creek (Upper Reach); a portion of the downstream reach of Ridley Creek; Stoney Creek; Sweet Water Road Tributary.

For the downstream portion of Naylors Run, between its mouth and Garrett Road, equal conveyance reduction methods of floodway delineation were attempted, but were largely supplemented by interpretation of the floodway concept in view of engineering principles, which were based on the controlling effect of weir flow at streets and culverts, the necessity to maintain access to the culvert path, and to allow for drain-off of impounded flood waters. The floodway for Naylors Run was determined on the basis of equal conveyance reduction from approximately 0.5 mile downstream of Lansdowne Avenue (U.S. Route 13).

For streams that were redelineated for the September 2, 2015, FIS revision, regulatory floodways were retained from the previous effective FIRMs. All floodway widths, section areas, flows and elevations were taken directly from the effective floodway tables, with a datum adjustment of -1.06 applied to the elevations. Table 9, "Topographic Mapping," lists the topographic maps used to delineate the floodplain boundaries for each community's precountywide printed FIS as well as the revised floodplain delineations for the original countywide FIS (Quinn, 1973, Aerial Photographs, 1973, USGS, varies, Topographical Maps, undated, Quinn, undated a, Glenolden, 1959, Quinn, 1975, Haverford, 1972, Consultants, Inc., 1978, Damon 1971, FEMA, 2009, Quinn, undated b, undated c, 1973, and 1975).

TABLE 9 – TOPOGRAPHIC MAPPING

Community/Topographic Mapping Source	Scale	Contour Interval
BOROUGH OF ALDAN		
7.5-Minute Series Topographic Maps, USGS	1:24,000	10 feet
TOWNSHIP OF ASTON		
Topographic Maps, A. O. Quinn Associates of Horsham	1:2,400	5 feet
CITY OF CHESTER		
7.5-Minute Series Topographic Maps, USGS	1:24,000	10 feet
TOWNSHIP OF CHESTER		
Topographic Maps, A.O. Quinn Associates of Horsham	1:2,400	5 feet
7.5-Minute Series Topographic Maps, USGS	1:24,000	10 feet
Flood Hazard Boundary Map FEMA, formerly FIA	1:24,000	10 feet
BOROUGH OF CHESTER HEIGHTS		
7.5-Minute Series Topographic Maps, USGS	1:24,000	10 feet
BOROUGH OF CLIFTON HEIGHTS		
Topographic Maps, A.O. Quinn Associates of Horsham	1:4,800	5 feet
BOROUGH OF COLLINGDALE		
7.5-Minute Series Topographic Maps, USGS	1:24,000	10 feet
BOROUGH OF COLWYN		
7.5-Minute Series Topographic Maps, USGS	1:24,000	10 feet
TOWNSHIP OF CONCORD		
7.5-Minute Series Topographic Maps, USGS	1:24,000	10 feet

TABLE 9 – TOPOGRAPHIC MAPPING – continued

Community/Topographic Mapping Source	Scale	Contour Interval
BOROUGH OF DARBY		
7.5-Minute Series Topographic Maps, USGS	1:24,000	10 feet
TOWNSHIP OF DARBY		
7.5-Minute Series Topographic Maps, USGS	1:24,000	10 feet
BOROUGH OF EDDYSTONE		
7.5-Minute Series Topographic Maps, USGS	1:24,000	10 feet
TOWNSHIP OF EDGMONT		
Ridley Creek Watershed. Topographic Maps, A.O. Quinn Associates of Horsham	1:4,800	5 feet
BOROUGH OF FOLCROFT		
Work Maps, A.O. Quinn Associates of Horsham	1:4,800	5 feet
BOROUGH OF GLENOLDEN		
Zoning Map, Borough of Glenolden, Delaware County	N/A	N/A
TOWNSHIP OF HAVERFORD		
Zoning Map Township of Haverford, Delaware County	1:4,800	5 feet
BOROUGH OF LANSDOWNE		
7.5-Minute Series Topographic Maps, USGS	1:24,000	10 feet
TOWNSHIP OF LOWER CHICHESTER		
7.5-Minute Series Topographic Maps, USGS	1:24,000	10 feet
BOROUGH OF MARCUS HOOK		
Aerial Photography Consultants, Inc.	1:4,800	4 feet
TOWNSHIP OF MARPLE		
Flood Plan Township of Marple, Delaware County	1:4,800	5 feet
BOROUGH OF MEDIA		
Flood Hazard Boundary Map FEMA, formerly FIA	1:24,000	10 feet
TOWNSHIP OF MIDDLETOWN		
Ridley Creek Watershed. Topographic Maps, A.O. Quinn Associates of Horsham	1:4,800	5 feet
BOROUGH OF MILLBOURNE		
7.5-Minute Series Topographic Maps, USGS	1:24,000	10 feet
BOROUGH OF MORTON		
7.5-Minute Series Topographic Maps, USGS	1:24,000	10 feet

TABLE 9 – TOPOGRAPHIC MAPPING – continued

Community/Topographic Mapping Source	Scale	Contour Interval
TOWNSHIP OF NETHER PROVIDENCE		
Ridley Creek Watershed. Topographic Maps, A.O. Quinn Associates, of Horsham	1:4,800	5 feet
TOWNSHIP OF NEWTOWN		
7.5-Minute Series Topographic Maps, USGS	1:24,000	10 feet
BOROUGH OF NORWOOD		
Topographic Maps A.O. Quinn Associates of Horsham	1:4,800	5 feet
BOROUGH OF PROSPECT PARK		
7.5-Minute Series Topographic Maps, USGS	1:24,000	10 feet
TOWNSHIP OF RADNOR		
Work Maps. Township of Radnor, A.O. Quinn Associates of Horsham	1:2,400	5 feet
TOWNSHIP OF RIDLEY		
7.5-Minute Series Topographic Maps, USGS	1:24,000	10 feet
BOROUGH OF RIDLEY PARK		
7.5-Minute Series Topographic Maps, USGS	1:24,000	10 feet
TOWNSHIP OF RIDLEY PARK		
7.5-Minute Series Topographic Maps, USGS	1:24,000	10 feet
BOROUGH OF RUTLEDGE		
7.5-Minute Series Topographic Maps, USGS	1:24,000	10 feet
TOWNSHIP OF RUTLEDGE		
7.5-Minute Series Topographic Maps, USGS	1:24,000	10 feet
BOROUGH OF SHARON HILL		
7.5-Minute Series Topographic Maps, USGS	1:24,000	10 feet
TOWNSHIP OF SPRINGFIELD		
Work Maps. Darby Creek Watershed and Crum Creek Watershed, A.O. Quinn Associates of Horsham	1:2,400	5 feet
BOROUGH OF SWARTHMORE		
Work Maps, A.O. Quinn Associates of Horsham	1:4,800	5 feet
TOWNSHIP OF TINICUM		
7.5-Minute Series Topographic Maps, USGS	1:24,000	10 feet
BOROUGH OF TRAINER		
Topographic Maps, A.O. Quinn Associates of Horsham	1:4,800	5 feet

TABLE 9 – TOPOGRAPHIC MAPPING – continued

Community/Topographic Mapping Source	Scale	Contour Interval
TOWNSHIP OF TRAINER		
Topographic Maps, A.O. Quinn Associates of Horsham	1:4,800	5 feet
BOROUGH OF UPLAND		
7.5-Minute Series Topographic Maps, USGS	1:24,000	10 feet
TOWNSHIP OF UPPER CHICHESTER		
7.5-Minute Series Topographic Maps, USGS	1:24,000	10 feet
TOWNSHIP OF UPPER DARBY		
7.5-Minute Series Topographic Maps, USGS	1:24,000	10 feet
BOROUGH OF YEADON		
7.5-Minute Series Topographic Maps, USGS	1:24,000	10 feet

In the May 2, 1995 revision, along Bezor's Run, for areas immediately upstream of Bethel Road, field surveys were required to accurately delineate the floodplain due to discrepancies found in the existing USGS topographic map in this vicinity.

Encroachment into areas subject to inundation by floodwaters having hazardous velocities aggravates the risk of flood damage, and heightens potential flood hazards by further increasing velocities. A listing of stream velocities at selected cross sections is provided in Table 10, "Floodway Data." In order to reduce the risk of property damage in areas where the stream velocities are high, the community may wish to restrict development in areas outside the floodway. For the portion of Vernon Run studied in detail, a floodway has been shown but no floodway data is available for Table 10.

The area between the floodway and 1-percent annual chance floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation of the 1-percent annual chance flood by more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 3, "Floodway Schematic".

Near the mouths of streams studied in detail, floodway computations are made without regard to flood elevations on the receiving water body. Therefore, "Without Floodway" elevations presented in Table 10 for certain downstream cross sections of Cobbs Creek, Crum Creek (Lower Reach), Little Crum Creek, Little Darby Creek, Harvey Run, and Marcus Hook Creek are lower than the regulatory flood elevations in that area, which must take into account the 1-percent annual chance flooding due to backwater from other sources.

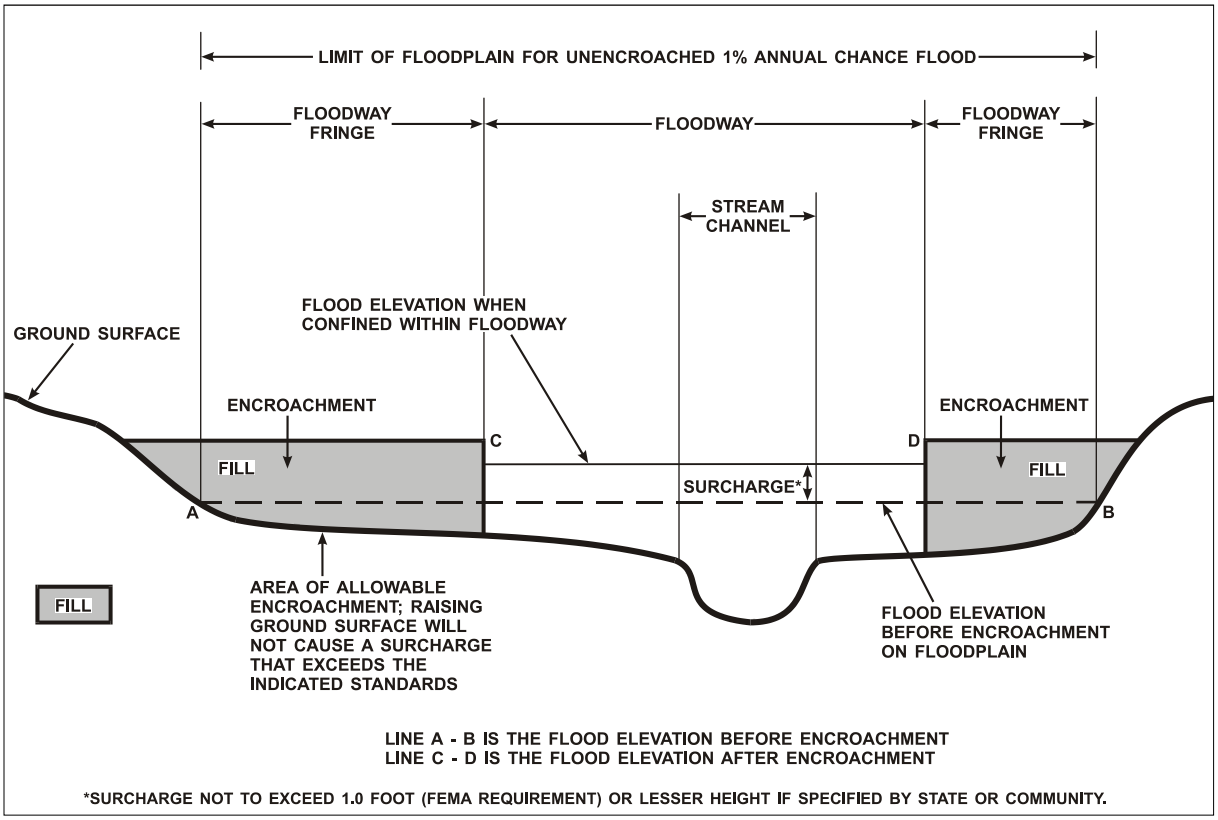

FIGURE 3 – FLOODWAY SCHEMATIC

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Bezor's Run								
A	700[1]	45	57	6.9	87.0	87.0	87.1	0.1
B	1,150[1]	45	85	4.6	91.5	91.5	91.8	0.3
C	1,620[1]	29	49	7.9	99.6	99.6	99.6	0.0
D	2,950[1]	45	79	4.9	116.2	116.2	116.5	0.3
E	4,820[1]	45	88	4.5	129.1	129.1	129.7	0.6
F	6,850[1]	45	74	5.3	162.8	162.8	162.8	0.0
Brandywine Creek								
A	4,670[2]	293/170[3]	4,226	5.3	153.4	153.4	154.3	0.9
B	10,750[2]	532/152[3]	6,815	3.3	158.2	158.2	159.1	0.9
C	17,270[2]	879/550[3]	8,329	2.7	163.0	163.0	163.7	0.7
D	20,340[2]	721/551[3]	7,921	2.8	164.8	164.8	165.5	0.7
Chester Creek								
A	1,089[4]	274	2,483	7.1	11.3	11.3	12.3	1.0
B	1,519[4]	311	3,132	5.6	15.2	15.2	15.5	0.3
C	2,321[4]	278	3,130	5.6	16.2	16.2	17.2	1.0
D	3,106[4]	165	2,944	6.0	18.8	18.8	19.8	1.0
E	3,504[4]	480	5,037	3.5	19.9	19.9	20.7	0.8
F	4,234[4]	205	3,772	4.7	20.5	20.5	21.1	0.6
G	4,526[4]	240	3,504	5.0	20.7	20.7	21.4	0.7

[1] Feet above Marcus Hook Creek
[2] Feet above county boundary
[3] Width/width within county boundary
[4] Feet above confluence with Delaware River

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

DELAWARE COUNTY, PA
(ALL JURISDICTIONS)

FLOODWAY DATA

BEZOR'S RUN – BRANDYWINE CREEK – CHESTER CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Chester Creek (continued)								
H	4,748	350	4,804	3.7	21.5	21.5	22.5	1.0
I	6,099	1,380	16,167	1.1	22.0	22.0	22.9	0.9
J	7,495	860	10,796	1.6	22.0	22.0	22.9	0.9
K	8,985	405	6,621	2.7	22.3	22.3	23.2	0.9
L	9,145	388	7,850	2.6	24.8	24.8	25.2	0.4
M	9,885	247	5,330	3.8	24.9	24.9	25.3	0.4
N	10,910	529	7,723	2.6	25.5	25.5	25.8	0.3
O	13,110	448	8,349	2.4	26.2	26.2	26.7	0.5
P	14,710	370	4,984	4.1	26.4	26.4	27.0	0.6
Q	14,800	467	8,258	2.5	26.8	26.8	27.3	0.5
R	15,390	449	7,910	2.6	26.9	26.9	27.4	0.5
S	17,600	352	4,441	4.6	27.8	27.8	28.4	0.6
T	19,200	355	4,055	5.0	29.7	29.7	30.4	0.7
U	21,300	194	3,035	6.7	32.7	32.7	33.6	0.9
V	22,850	252	2,925	6.9	36.3	36.3	37.2	0.9
W	24,330	336	4,465	4.6	40.7	40.7	41.1	0.4
X	25,280	355	4,480	4.5	42.3	42.3	42.7	0.4
Y	26,480	263	3,887	5.2	44.4	44.4	44.8	0.4
Z	29,700	166	2,511	8.1	50.3	50.3	50.8	0.5
AA	30,520	164	2,660	7.6	53.6	53.6	54.0	0.4
AB	32,440	337	5,582	3.6	61.3	61.3	61.5	0.2

[1] Feet above confluence with Delaware River

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

DELAWARE COUNTY, PA
(ALL JURISDICTIONS)

FLOODWAY DATA

CHESTER CREEK

5.0 INSURANCE APPLICATIONS

For flood insurance rating purposes, flood insurance zone designations are assigned to a community based on the results of the engineering analyses. The zones are as follows:

Zone A

Zone A is the flood insurance rate zone that corresponds to the 1-percent annual chance floodplains that are determined in the FIS by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no BFEs or depths are shown within this zone.

Zone AE

Zone AE is the flood insurance rate zone that corresponds to the 1-percent annual chance floodplains that are determined in the FIS by detailed methods. In most instances, whole-foot BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone AO

Zone AO is the flood insurance rate zone that corresponds to areas of 1-percent annual chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. Average whole-foot depths derived from the detailed hydraulic analyses are shown within this zone.

Zone X

Zone X is the flood insurance rate zone that corresponds to areas outside the 0.2-percent annual chance floodplain, areas within the 0.2-percent annual chance floodplain, and to areas of 1-percent annual chance flooding where average depths are less than 1 foot, areas of 1-percent annual chance flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 1-percent annual chance flood by levees. No BFEs or depths are shown within this zone.

6.0 FLOOD INSURANCE RATE MAP

The FIRM is designed for flood insurance and floodplain management applications.

For flood insurance applications, the map designates flood insurance rate zones as described in Section 5.0. In the 1-percent-annual-chance floodplains that were studied by detailed methods, shows selected whole-foot base flood elevations or average depths. Insurance agents use the zones and base flood elevations in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

For floodplain management applications, the map shows by tints, screens, and symbols, the 1-percent and 0.2-percent-annual chance floodplains. Floodways and the locations of selected cross sections used in the hydraulic analyses and floodway computations are shown where applicable

The current FIRM presents flooding information for the entire geographic area of Delaware County. Historical data relating to the precountywide maps prepared for each community up to September 30, 1993, countywide FIS, are presented in Table 11, "Community Map History."

7.0 OTHER STUDIES

This is a multi-volume FIS. Each volume may be revised separately, in which case it supersedes the previously printed volume. Users should refer to the Table of Contents in Volume 1 for the current effective date of each volume; volumes bearing these dates contain the most up-to-date flood hazard data.

Because it is based on more up-to-date analyses, this FIS supersedes the previously printed FIS for Delaware County, Pennsylvania (All Jurisdictions) (FEMA, 2015).

This study is authoritative for purposes of the NFIP and the data presented here either supersede or are compatible with previous determinations.

The [TBD], countywide FIS, is a part of the larger Brandywine-Christina watershed study. Additional materials related to the entire Brandywine-Christina watershed study may be obtained by accessing the TSDN.

8.0 LOCATION OF DATA

Information concerning the pertinent data used in preparation of this study can be obtained by contacting Federal Insurance and Mitigation Division, Federal Emergency Management Agency, One Independence Mall, Sixth Floor, 615 Chestnut Street, Philadelphia, Pennsylvania 19106-4404.

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE	FIRM EFFECTIVE DATE	FIRM REVISIONS DATE
Aldan, Borough of	December 21, 2973	June 11, 1976	September 17, 1980	March 12, 1982
Aston, Township of	October 25, 1974	June 18, 1976	July 16, 1981	
Bethel, Township of	January 24, 1975	None	August 10, 1979	
Brookhaven, Borough of	February 9, 1973	None	February 14, 1976	December 4, 1981
Chadds Ford, Township of	July 19, 1974	June 11, 1976	September 5, 1979	
Chester, City of	March 2, 1973	August 6, 1976	August 1, 1979	
Chester, Township of	December 21, 1973	August 6, 1976	May 15, 1984	
Chester Heights, Borough of	March 30, 1973	August 6, 1976	January 16, 1980	
Clifton Heights, Borough of	October 12, 1973	October 1, 1976	May 16, 1977	
Collingdale, Borough of	February 2, 1977	None	February 2, 1977	
Colwyn, Borough of	November 16, 1973	April 16, 1976	May 2, 1977	
Concord, Township of	August 30, 1974	None	January 5, 1978	
Darby, Borough of	November 23, 1974	April 16, 1976	July 18, 1977	
Darby, Township of	August 30, 1974	October 17, 1975	April 3, 1984	

TABLE 11

FEDERAL EMERGENCY MANAGEMENT AGENCY

DELAWARE COUNTY, PA (ALL JURISDICTIONS)

COMMUNITY MAP HISTORY

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE	FIRM EFFECTIVE DATE	FIRM REVISIONS DATE
East Landowne, Borough of*	October 1, 1976	None	November 6, 1981	
Eddystone, Borough of	April 6, 1973	February 8, 1974 June 25, 1976	February 2, 1977	
Edgmont, Township of	February 8, 1974	None	September 1, 1977	
Folcroft, Borough of	August 1, 1977	None	August 1, 1977	
Glenolden, Borough of	February 11, 1977	None	November 18, 1981	
Haverford, Township of	December 21, 1973	None	July 5, 1977	
Lansdowne, Borough of	May 31, 1974	May14, 1976	February 3, 1982	
Lower Chichester, Township of	May 31, 1974	May 7, 1976	September 22, 1978	January 16, 1981 September 30, 1982
Marcus Hook, Borough of	December 21, 1973	May 7, 1976	September 16, 1981	
Marple, Township of	February 1, 1974	None	September 1, 1977	
Media, Borough of	February 21, 1975	None	September 28, 1979	January 20, 1982
Middletown, Township of	April 12, 1974	May 28, 1976	February 15, 1979	
Millbourne, Borough of	January 24, 1975	None	September 22, 1978	December 15, 1981

*No Special Flood Hazard Areas Identified

TABLE 11

FEDERAL EMERGENCY MANAGEMENT AGENCY

DELAWARE COUNTY, PA (ALL JURISDICTIONS)

COMMUNITY MAP HISTORY

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE	FIRM EFFECTIVE DATE	FIRM REVISIONS DATE
Morton, Borough of	February 14, 1975	September 26, 1975	January 16, 1980	
Nether Providence, Township of	February 20, 1973	None	December 1, 1978	September 28, 1990
Newtown, Township of	January 23, 1974	June 11, 1976	September 17, 1980	
Norwood, Borough of	July 30, 1976	None	May 3,1982	
Parkside, Borough of	March 30, 1973	None	July 5, 1977	
Prospect Park, Borough of	July 26, 1974	May 7, 1976	March 18, 1980	
Radnor, Township of	January 25, 1974	None	August 1, 1977	
Ridley, Township of	April 27, 1973	August 6, 1976	January 6, 1983	
Ridley Park, Borough of	July 19, 1974	June 4, 1976	January 2, 1980	
Rose Valley, Borough of	May 25, 1973	November 21, 1975 February 13, 1976	February 2, 1977	
Rutledge, Borough of	July 19, 1974	May 28, 1976	March 18, 1980	
Sharon Hill, Borough of	December 21, 1973	June 18, 1976	August 15, 1979	
Springfield, Township of	January 4, 1974	None	January 19, 1978	

TABLE 11

FEDERAL EMERGENCY MANAGEMENT AGENCY

DELAWARE COUNTY, PA (ALL JURISDICTIONS)

COMMUNITY MAP HISTORY

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE	FIRM EFFECTIVE DATE	FIRM REVISIONS DATE
Swarthmore, Borough of	January 9, 1974	None	May 16, 1977	
Thornbury, Township of	April 27, 1973	None	April 27, 1973	July 1, 1974 October 17, 1975
Tinicum, Township of	December 6, 1974	None	May 1, 1980	
Trainer, Borough of	November 30, 1973	None	September 30, 1977	September 4, 1986
Upland, Borough of	February 8, 1973	None	December 10, 1976	
Upper Chichester, Township of	January 23, 1974	None	May 16, 1977	July 15, 1992
Upper Darby, Township of	January 4, 1974	June 18, 1978	March 1, 1978	June 5, 1981
Upper Providence, Township of	February 16, 1973	None	June 15, 1977	
Yeadon, Borough of	June 28, 1974	August 27, 1976	November 1, 1979	

TABLE 11

FEDERAL EMERGENCY MANAGEMENT AGENCY

DELAWARE COUNTY, PA
(ALL JURISDICTIONS)

COMMUNITY MAP HISTORY

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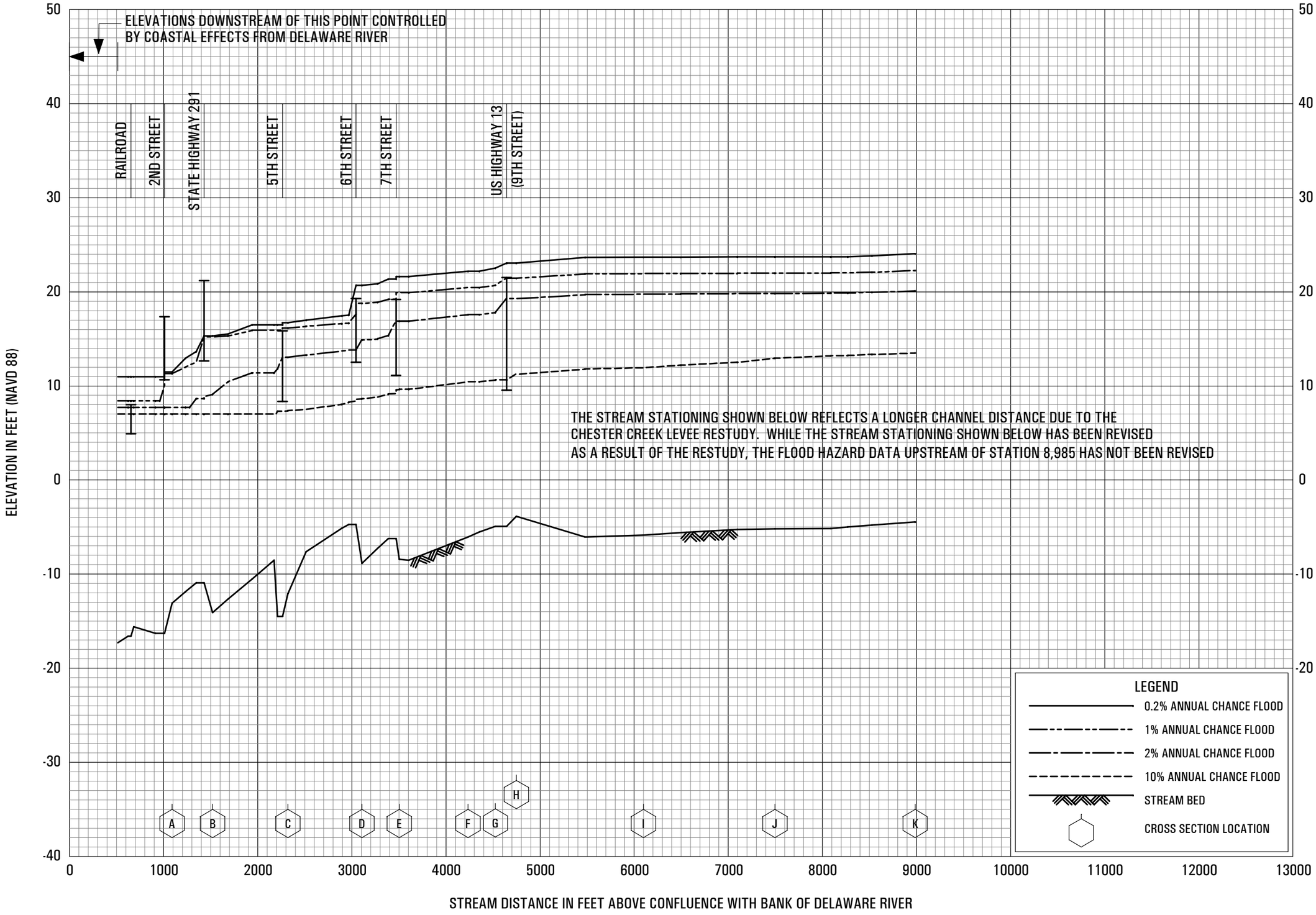

FLOOD PROFILES

CHESTER CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

DELAWARE COUNTY, PA

(ALL JURISDICTIONS)

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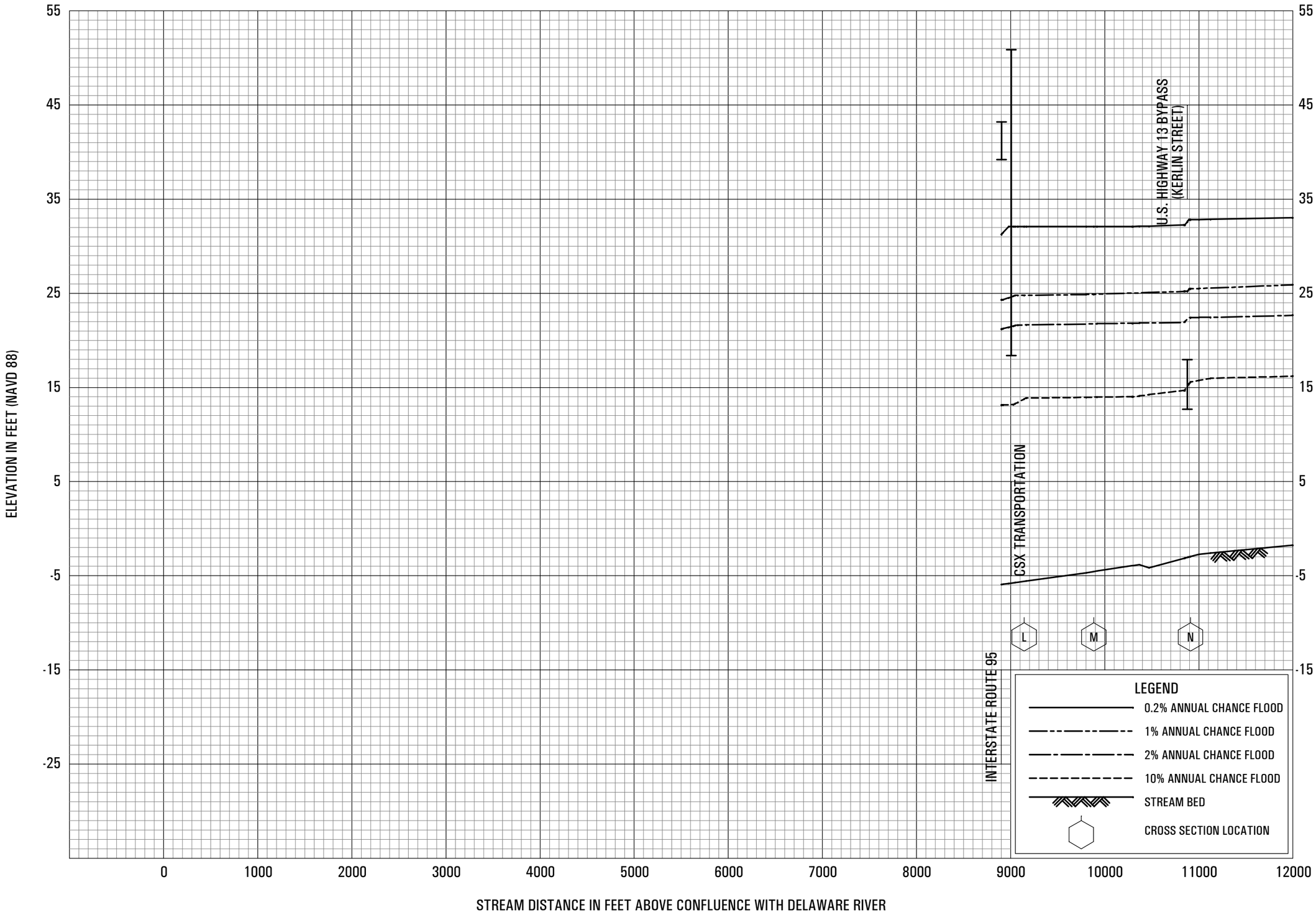

FLOOD PROFILES

CHESTER CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

DELAWARE COUNTY, PA

(ALL JURISDICTIONS)

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