Appendix H
Preliminary FEMA/FIRM Maps (February 2015)

FLOOD INSURANCE STUDY

FEDERAL EMERGENCY MANAGEMENT AGENCY

VOLUME 1 OF 2

UNION COUNTY, NEW JERSEY

(ALL JURISDICTIONS)

COMMUNITY NAME	NUMBER	COMMUNITY NAME	NUMBER
BOROUGH OF FANWOOD	340463	CITY OF SUMMIT	340476
BOROUGH OF GARWOOD	340464	TOWN OF WESTFIELD	340478
BOROUGH OF KENILWORTH	340466	TOWNSHIP OF BERKELEY HEIGHTS	340459
BOROUGH OF MOUNTAINSIDE	340468	TOWNSHIP OF CLARK	345290
BOROUGH OF NEW PROVIDENCE	345306	TOWNSHIP OF CRANFORD	345291
BOROUGH OF ROSELLE	340472	TOWNSHIP OF HILLSIDE	340465
BOROUGH OF ROSELLE PARK	340473	TOWNSHIP OF SCOTCH PLAINS	340474
CITY OF ELIZABETH	345523	TOWNSHIP OF SPRINGFIELD	345321
CITY OF LINDEN	340467	TOWNSHIP OF UNION	340477
CITY OF PLAINFIELD	345312	TOWNSHIP OF WINFIELD[1]	340479
CITY OF RAHWAY	345314		

[1] No Special Flood Hazard Areas Identified

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

REVISED: **PRELIMINARY FEBRUARY 3, 2015**

FLOOD INSURANCE STUDY NUMBER
34039CV001B
Version Number 2.2.2.2

NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program (NFIP) 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 20, 2006

Revised Countywide FIS Date: [TBD] – to change Base Flood Elevations, Special Flood Hazard Areas and zone designations; to update the effects of wave actions, roads and road names; and to reflect revised shoreline and updated topographic information.

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

ATTENTION: On FIRM panels 34039C0024G and 34039C035G the Elizabeth River levee and on FIRM panels 34039C0043G and 34039C0044G the Rahway River levee have not been demonstrated by the community or levee owner(s) to meet the requirements of Section 65.10 of the NFIP regulations in 44 CFR as it relates to the levee's capacity to provide 1-percent annual chance flood protection. The subject areas are identified on FIRM panels (with notes and bounding lines) and in the FIS report as potential areas of flood hazard data changes based on further review.

FEMA has updated the levee analysis and mapping procedures for non-accredited levees. Until such time as FEMA is able to initiate a new flood risk project to apply the new procedures, the flood hazard information on the aforementioned FIRM panel(s) that are affected by the Elizabeth River and Rahway River levees are being added as a snapshot of the prior previously effective information presented on the FIRMs and FIS reports dated September 20, 2006. As indicated above, it is expected that affected flood hazard data within the subject area could be significantly revised. This may result in floodplain boundary changes, 1-percent annual chance flood elevation changes, and/or changes to flood hazard zone designations.

The effective FIRM panels (and the FIS report) will again be revised at a later date to update the flood hazard information associated with the Elizabeth River and Rahway River levees when FEMA is able to initiate and complete a new flood risk project to apply the new levee analysis and mapping procedures.

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Exhibit 1 – Flood Profiles (continued)

FLOOD INSURANCE STUDY
UNION COUNTY, NEW JERSEY (ALL JURISDICTIONS)

1.0 INTRODUCTION

1.1 Purpose of Study

This countywide Flood Insurance Study (FIS) revises and updates previous FISs/Flood Insurance Rate Maps (FIRMs) for the geographic area of Union County, including: the Boroughs of Fanwood, Garwood, Kenilworth, Mountainside, New Providence, Roselle, and Roselle Park; the Cities of Elizabeth, Linden, Plainfield, Rahway, and Summit; the Town of Westfield; and the Townships of Berkeley Heights, Clark, Cranford, Hillside, Scotch Plains, Springfield, Union, and Winfield (hereinafter referred to collectively as Union County).

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 county that will be used to establish actuarial flood insurance rates. This information will also be used by Union County to update existing floodplain regulations as part of the Regular Phase of the National Flood Insurance Program (NFIP), and will also be used 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 (CFR) at 44 CFR, 60. 3.

Please note that on the effective date of this FIS, the Township of Winfield has no Special Flood Hazard Areas (SFHAs) identified. This does not precluded future determinations of SFHAs that could be necessitated by changes conditions affecting the community (i.e. annexation of new lands) or the availability of new scientific or technical data about flood hazards.

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) will be able to explain them.

Please also note that FEMA has identified one or more levees in this jurisdiction that have not been demonstrated by the community or levee owner(s) to meet the requirements of 44 CFR Part 65.10 of the NFIP regulations (44CFR65.10) as it relates to the levee's capacity to provide 1-percent annual chance flood protection. As such, temporary actions being taken until such time as FEMA is able to initiate a new flood risk project to apply new levee analysis and mapping procedures. Please refer to the Notice to Flood Insurance Study Users page at the front of this FIS report for more information.

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 September 20, 2006, the countywide FIS was prepared to include all the incorporated communities within Union County into a single countywide FIS.

Information on the authority and acknowledgments for each jurisdiction included in this countywide FIS, as compiled from their previously printed precountywide FIS reports, is shown below.

Berkeley Heights, Township of: the hydrologic and hydraulic analyses for the original October 1977 FIS report and March 1, 1978, FIRM were prepared by Pfisterer, Tor, and Associates for the Federal Emergency Management Agency (FEMA), under Contract No. H-3737. That work was completed in November 1975.

In the February 19, 1992, FIS revision, a portion of Snyder Avenue Brook was revised to reflect updated hydraulic analyses performed by Dewberry and Davis for FEMA and to reflect updated topographic information. That work was completed in June 1990. In addition, new hydrologic and hydraulic analyses for a portion of Blue Brook were taken from the January 19, 2001, FIS for the Township of Scotch Plains.

In the January 6, 1999, FIS revision, the hydrologic and hydraulic analyses for Blue Brook and Green Brook were prepared by Leonard Jackson and Associates for FEMA, under Contract No. EMW-90-R-3127. That work was completed in March 1993.

In the November 21, 2001, FIS revision, the hydrologic and hydraulic analyses for the Passaic River were prepared by Leonard Jackson and Associates for FEMA, under

Contract No. EMN 96-C0-0026. That work was completed in November 1998.

Clark, Township of:	the hydrologic and hydraulic analyses for the FIS report dated March 2, 1982, represented a revision of the original analyses by the U. S. Army Corps of Engineers (USACE), New York District, for FEMA. The updated version was prepared by the State of New Jersey, Department of Environmental Protection (NJDEP), Division of Water Resources under agreement with FEMA. That study, which was completed in January 1979, covered all significant flooding sources in the Township of Clark. The hydrologic and hydraulic analyses in the updated study were computed by Richard Browne Associates.
Cranford, Township of:	the hydrologic and hydraulic analyses for the FIS report dated August 16, 1982, represented a revision of the original analyses by the USACE, New York District, for FEMA, under an Inter-Agency Agreement. The updated version was prepared by the NJDEP, Division of Water Resources, under agreement with FEMA. That study, which was completed in May 1979, covered all significant flooding sources in the Township of Cranford. The hydrologic and hydraulic analyses in the updated study were computed by Richard Browne Associates.
Elizabeth, City of:	the hydrologic and hydraulic analyses for the FIS report dated November 1, 1985, represented a revision of the original analyses. The updated version was prepared by the RBA Group for FEMA, under Contract No. EMW-C-1195. That work was completed in November 1984.
Garwood, Borough of:	the hydrologic and hydraulic analyses for the FIS report dated May 17, 1988, represented a revision of the original analyses prepared by Pfisterer, Tor and

Associates for FEMA, under Contract No. H-3737. In the revised study, the hydraulic analysis for Garwood Brook was performed by Dewberry and Davis based on data prepared by Keller and Kirkpatrick, Inc., for the Borough of Garwood. That work was completed in April 1987.

Hillside, Township of:	the hydrologic and hydraulic analyses for the FIS report dated March 1979 were performed by the NJDEP, Division of Water Resources, for FEMA, formerly the Federal Insurance Administration (FIA), under Contract No. H-3855. That work, which covered all significant flooding sources affecting the Township of Hillside, was completed in November 1977.
Kenilworth, Borough of:	the hydrologic and hydraulic analyses for the FIS report dated September 2, 1982, were prepared by the NJDEP, Division of Water Resources, for FEMA, under Contract No. S-90024. The hydrologic and hydraulic analyses were conducted by URS Corporation, Inc., under subcontract to the NJDEP. That work was completed in November 1980.
Linden, City of:	for the original May 24, 1976, FIS report and November 24, 1976, FIRM, the hydrologic and hydraulic analyses for Morses Creek, Peach Orchard Brook, West Brook, Kings Creek, and the Arthur Kill-Rahway River tidal floodplain were prepared by the USACE, New York District, for FEMA, under Inter-Agency Agreement No. IAA-H- 19-74, Project Order Nos. 17, 18, and 23. In the March 2, 1994, FIS revision, the hydrologic and hydraulic analyses for Peach Orchard Brook and West Brook were prepared by Leonard Jackson and Associates for FEMA, under Contract No. EMW- 90-3127. That work was completed in December 1991. Tidal flooding along

	Arthur Kill (including backwater effects on the Rahway River, Kings Creek, Piles Creek, Marshes Creek, and Morses Creek) was taken from the information used July 5, 1994, FIS for the City of New York City, New York.
Mountainside, Borough of:	the hydrologic and hydraulic analyses for the FIS report dated August 1976 were performed by Pfisterer, Tor and Associates for FEMA, formerly the FIA, under Contract No. H-3737.
New Providence, Borough of:	for the November 23, 1973, FIRM, the hydrologic and hydraulic analyses were prepared by the Soil Conservation Service (SCS) for FEMA, under Inter-Agency Agreement No. IAA-H-16-72, Project Order No. 10. That work was completed in November 1971.
	For the May 16, 1994, FIS revision, the hydrologic and hydraulic analyses for the Passaic River, Salt Brook, and West Branch of Salt Brook were prepared by the NJDEP. That work was completed in September 1982.
	For the December 20, 2001, FIS revision, the hydrologic and hydraulic analyses for the Passaic River was prepared by Leonard Jackson and Associates for FEMA, under Contract No. EMN-96-C0-0026. That work was completed in November 1998.
Plainfield, City of:	the hydrologic and hydraulic analyses for the FIS report dated January 18, 1983, represented a revision of the original analyses by the U.S. Geological Survey (USGS), for FEMA, under Inter-Agency Agreement No. IAA-H- 19-71. The updated version was prepared by the NJDEP, Division of Water Resources, under Contract No. H-4623. The hydrologic and hydraulic analyses in the updated study were prepared by URS Corporation, Inc.,

subcontractors to the State of New Jersey under Contract No. S-90024, Project "Y". That work was completed in November 1980, and covered all significant flooding sources in the City of Plainfield.

Rahway, City of: the hydrologic and hydraulic analyses in the February 2, 1982, FIS and August 2, 1982, FIRM represented a revision of the original analyses by the USACE, New York District, for FEMA. The updated version was prepared by the NJDEP, Division of Water Resources, under agreement with FEMA. That study was completed in January 1979. The hydrologic and hydraulic analyses in updated study were computed by Richard Browne Associates.

For the December 20, 2002, FIS revision, the hydrologic and hydraulic analyses were derived from the City of Linden, Union County, New Jersey, FIS, dated March 2, 1994.

Roselle, Borough of: the hydrologic and hydraulic analyses for the FIS report dated January 1978, were performed by Pfisterer, Tor and Associates for FEMA, formerly the FIA, under Contract No. H-3737. That work was completed in February 1975, and covered all significant flooding sources affecting the Borough of Roselle.

Scotch Plains, Township of: in the original September 30, 1977, FIS report, the hydrologic and hydraulic analyses were prepared by Anderson-Nichols and Co. Inc., for FEMA, formerly the FIA, under Contract No. H-3715. That work was completed in April 1976.

For the January 19, 2001, FIS revision, the hydrologic and hydraulic analyses for Green and Blue Brooks were prepared by Leonard Jackson and Associates for FEMA, under Contract No. EMW- 90-R-3127. That work was completed in March 1993. Further revisions were made to the hydraulic analyses for Green and Blue Brooks by Leonard Jackson and Associates, that work was completed in March 2000.

Springfield, Township of: the hydrologic and hydraulic analyses for the FIS report dated February 2, 1982, represented a revision of the original analyses by the USACE, New York District, for FEMA. The updated revision was prepared by the NJDEP, Division of Water Resources, under agreement with FEMA. That study, which was completed in May 1979, covered all significant flooding sources in the Township of Springfield. The hydrologic and hydraulic analyses in the updated study were computed by Richard Browne Associates.

Summit, City of: for the original August 1976 FIS report and February 2, 1977, FIRM, the hydrologic and hydraulic analyses were prepared by the USGS, Water Resources Division, Trenton, New Jersey, for FEMA, formerly the FIA, under Inter-Agency Agreement No. IAA-H-20- 74, Project Order No. 16. That work was completed on July 7, 1975.

For the May 2, 2002, FIS revision, the hydrologic and hydraulic analyses for the Passaic River was prepared by Leonard Jackson and Associates for FEMA, under Contract No. EMN-96-C0-0026. That work was completed in November 1998.

Union, Township of: the hydrologic and hydraulic analyses for the FIS report dated February 1978, were performed by Pfister, Tor and Associates for FEMA, formerly the FIA, under Contract No. H-3737. That work was completed in November 1975, and covered all significant flooding sources affecting the community.

Westfield, Town of: the hydrologic and hydraulic analyses for the FIS report dated June 1979, were performed by the NJDEP, for FEMA, formerly the FIA, under Contract No. H-385.5. That work was completed in November 1977, and covered all significant flooding sources affecting the community.

The authority and acknowledgments for the Borough of Fanwood and the Township of Winfield are not available because no community-based FIS reports were ever published for these communities.

For September 20, 2006, FIS, revised hydrologic and hydraulic analyses for the Rahway River were conducted by Dewberry and Davis, LLC under Contract No. EMW-2000-C0-0003. That work was completed in March 2006. In addition, updated hydraulic information for the Elizabeth River in the Township of Hillside, developed by the USACE, New York District, was incorporated into that study.

For the September 20, 2006, FIS, the digital base map files used in the revision were obtained from the Union County Bureau of Geographic Information Systems (GIS), and were produced at a scale of 1"=100' from photography dated 1999 or later.

For the [TBD], FIS revision, coastal storm surge elevations were updated and revised within the states of New York and New Jersey for the Atlantic Ocean, including Newark Bay and Arthur Kill. The study replaces outdated coastal analysis, for approximately 7.5 miles of coastline in Union County, as well as previously published storm surge stillwater elevations for all FIS Reports in the study area, including Union County, New Jersey, and serves as the basis for updated FIRMs. The coastal study for the New Jersey Atlantic Ocean coast and New York City coast was conducted for FEMA by the Risk Assessment, Mapping, and Planning Partners (RAMPP) under contract HSFEHQ-09-D-0369 task order HSFE02-09-J-0001. This work was completed in December 2012.

In addition for the [TBD], FIS revision, RAMPP performed approximately 3.9 miles of detailed hydraulic analyses along the Elizabeth River in the City of Elizabeth. Also, Flood Profiles for the streams falling on revised panels, 34039C0014G, 34039C0015G, 34039C0023G, 34039C0024G, 34039C0025G, 34039C0026G, 34039C0033G, 34039C0034G, 34039C0035G, 34039C0036G, 34039C0043G, 34039C0044G, 34039C0045G, 34039C0046G, 34039C0047G, and 34039C0048G, were updated to the North American Vertical Datum of 1988 (NAVD88). The new detailed analyses along the Elizabeth River and the Flood Profile update were conducted for FEMA under contract HSFEHQ-09-D-0369 task order HSFE02-09-J-0001. This work was completed in December 2014.

For the [TBD], FIS revision, the basemap files were provided in digital format by the State of New Jersey Office of Information Technology. This information was derived from digital orthophotos produced at a scale of 1:24,000 with a 1-foot pixel resolution from photography dated 2012.

The digital FIRM was produced in New Jersey State Plane projection, FIPZONE 2900. The horizontal datum used was North American Datum of 1983 (NAD 83), GRS80 spheroid. Corner coordinates shown on the FIRM are in latitude and longitude referenced to the New Jersey State Plane projection, NAD 83. Differences in the datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent counties may result in slight positional differences in map features at the county boundaries. These differences do not affect the accuracy of information shown on the FIRM.

1.3 Coordination

Consultation Coordination Officer's (CCO) meetings may be held for each jurisdiction in this countywide FIS. 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 prior to the September 20, 2006, FIS for all jurisdictions within Union County are shown in Table 1, "Initial and Final Precountywide CCO Meetings."

Table 1 – Initial and Final Precountywide CCO Meetings

Community Name	Initial CCO Date	Final CCO Date
Berkeley Heights, Township of	*	June 16, 2000
Clark, Township of	November 16, 1976	November 2, 1981
Cranford, Township of	November 16, 1976	October 27, 1981
Elizabeth, City of	April 12, 1983	April 24, 1985
Garwood, Borough of	*	April 1, 1975
Hillside, Township of	*	September 5, 1978
Kenilworth, Borough of	*	April 13, 1982
Linden, City of	*	November 30, 1992
Mountainside, Borough of	November 19, 1974	August 19, 1975
New Providence, Borough of	*	May 30, 2000
Plainfield, City of	*	July 22, 1982
Rahway, City of	*	November 28, 2001
Roselle, Borough of	*	June 30, 1975
Roselle Park, Borough of	*	*
Scotch Plains, Township of	*	*

*Data not available

Table 1 – Initial and Final Precontywide CCO Meetings – continued

Community Name	Initial CCO Date	Final CCO Date
Springfield, Township of	November 9, 1979	August 10, 1981
Summit, City of	*	June 6, 2000
Union, Township of	May 9, 1975	February 3, 1976
Westfield, Town of	May 5, 1975	November 18, 1978

*Data not available

There are no precountywide initial and final CCO meeting dates for the Borough of Fanwood and the Township of Winfield because no community-based FIS reports were ever published for these communities.

For the September 20, 2006, FIS, final CCO meetings were held April 21, 2004, and April 23, 2004. These meetings were attended by representatives from the Boroughs of Fanwood, Kenilworth, New Providence; Cities of Elizabeth, Linden, Plainfield, Rahway, and Summit; Town of Westfield; Townships of Berkeley Heights, Clark, Cranford, Hillside, Springfield; Union County, the State of New Jersey, FEMA, and the study contractor.

The results of the [TBD] FIS revision, were reviewed at the final CCO meeting held on [TBD date], and attended by representatives of [insert attendee list]. All of the concerns and/or issues raised at that meeting have been addressed.

2.0 AREA STUDIED

2.1 Scope of Study

This FIS covers the entire geographic area of Union County, New Jersey.

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

Arthur Kill	Morses Creek
Black Brook	Newark Bay
Blue Brook	Nomahegan Brook
Branch 1, Nomahegan Brook	Nomahegan Brook – Echo Lake
Branch 3, Nomahegan Brook	Orchard Creek
Branch 7, Nomahegan Brook	Passaic River
Branch 10-24	Peach Orchard Brook
Branch 10-30-1	Piles Creek
Branch 10-34	Pumpkin Patch Brook
Branch 22	Rahway River
Branch 22-11	Robinsons Branch

Table 2 – Flooding Sources Studied by Detailed Methods – continued

Branch Blue Brook	Robinsons Branch 15
Branch Green Brook	Robinsons Branch 15-1
Branch West Brook	Robinsons Branch 15-2
Bryant Brook	Salt Brook
Bryant Brook Branch	Snyder Avenue Brook
Cedar Brook	South Branch Rahway River
College Branch	Southwest Branch
Drainage Ditch	Stream 10-30
East Branch Rahway River	Sub-Branch, Branch 2, Nomahegan Brook
East Branch Green Brook	Tributary A
Elizabeth River	Tributary B
Gallows Hill Road Branch	Tributary C
Garwood Brook	Trotter Lane Branch
Green Brook	Van Winkles Branch
Irvington Branch	Vauxhall Branch
Jouet Brook	Vauxhall Subbranch
Kings Creek	West Branch
Lehigh Valley Branch	West Branch of Salt Brook
Lightning Brook	West Branch West Brook
Maplewood Branch	West Brook
Macro Creek Tributary 9-1-7-1	Winans Creek
Marshes Creek	Winding Brook

For the September 20, 2006, FIS, the Rahway River was restudied by detailed methods.

For the [TBD], FIS revision, Table 3, "[TBD], Scope of Revision" describes the limits of the updated analysis for the Elizabeth River. Flood Profiles (Exhibit 1) for the streams on the revised FIRM panels, 34039C0014G, 34039C0015G, 34039C0023G, 34039C0024G, 34039C0025G, 34039C0026G, 34039C0033G, 34039C0034G, 34039C0035G, 34039C0036G, 34039C0043G, 34039C0044G, 34039C0045G, 34039C0046G, 34039C0047G, and 34039C0048G were updated to NAVD88. All other profiles will be converted to NAVD88 in an upcoming issuance of the FIS.

Table 3 – [TBD], Scope of Revision

Stream Name	Limits of Revised or New Detailed Study
Elizabeth River	From the confluence with Arthur Kill to approximately 340 feet upstream of Trotter Lane

Riverine flooding sources throughout Union County have been studied by detailed methods at different times and prior to the September 20, 2006, FIS, often on a community-by-community basis. Table 4, "Model Dates for Riverine

Flooding Sources" represents the hydraulic modeling dates for the detailed study flooding sources in the county.

Table 4 – Model Dates for Riverine Flooding Sources

Stream Name	Community	Most Recent Model Date
Black Brook	Borough of Kenilworth	November 1982
	Township of Union	November 1975
Blue Brook	Township of Berkeley Heights	March 2000
	Borough of Mountainside	August 1976
	Township of Scotch Pines	March 2000
Branch 10-24	Township of Union	November 1975
Branch 10-30-1	Borough of Kenilworth	November 1980
Branch 10-34	Township of Union	November 1975
Branch 22	Township of Scotch Pines	March 1993
Branch 22-11	Township of Scotch Pines	March 1993
Branch Blue Brook	Township of Scotch Pines	March 1993
Branch Green Brook	Township of Berkeley Heights	March 2000
Branch 1, Nomahegan Brook	Borough of Mountainside	August 1976
Branch 2, Nomahegan Brook	Borough of Mountainside	August 1976
Branch 3, Nomahegan Brook	Borough of Mountainside	August 1976
Branch 7, Nomahegan Brook	Borough of Mountainside	August 1976
Branch West Brook	Borough of Roselle	February 1975
Bryant Brook	Township of Springfield	May 1979
Bryant Brook Branch	Township of Springfield	May 1979
Cedar Brook	City of Plainfield	November 1980
	Township of Berkeley Heights	March 2000
College Branch	Township of Cranford	May 1979
Drainage Ditch	Borough of Kenilworth	November 1980
	Township of Cranford	November 1980
	Township of Springfield	November 1980
	Township of Union	November 1980
East Branch Rahway River	Township of Union	December 1991
East Branch Green Brook	Township of Scotch Pines	March 1993
Elizabeth River	City of Elizabeth	December 2014
	Township of Hillside	November 1977
Gallow Hill Road Branch	Township of Cranford	November 1980
Garwood Brook	Township of Cranford	November 1980
	Borough of Garwood	April 1987
Green Brook	Township of Berkeley Heights	March 2000
	Township of Scotch Plains	March 1993
	City of Plainfied	November 1980
Irvington Branch	Township of Union	November 1980
Jouet Brook	Borough of Roselle	February 1975
Kings Creek	City of Linden	July 1994

Table 4 – Model Dates for Riverine Flooding Sources – continued

Stream Name	Community	Most Recent Model Date
Lehigh Valley Branch	Township of Union	November 1980
Lightning Brook	Township of Union	November 1980
Maplewood Branch	Township of Union	November 1980
Nomahegan Brook	Borough of Mountainside	August 1976
Nomahegan Brook – Echo Lake	Borough of Mountainside	August 1976
Orchard Creek	City of Rahway	December 1991
Passaic River	Township of Berkeley Heights	November 1998
	Borough of New Providence	November 1998
	City of Summit	November 1998
Peach Orchard Brook	City of Linden	December 1991
	Borough of Roselle	February 1975
Pumpkin Patch Brook	Township of Clark	January 1979
Rahway River	Its Entirety in Union County	September 2006
Robinsons Branch	Township of Clark	January 1979
	City of Rahway	
	Township of Scotch Plains	April 1976
Robinsons Branch 15	Town of Westfield	November 1977
Robinsons Branch 15-1	Town of Westfield	November 1977
Robinsons Branch 15-2	Town of Westfield	November 1977
Salt Brook	Borough of New Providence	September 1982
Snyder Avenue Brook	Township of Berkeley Heights	November 1998
South Branch Rahway River	City of Rahway	December 1991
Southwest Branch	Township of Union	November 1980
Stream 10-30	Borough of Kenilworth	November 1980
Sub-Branch, Branch 2, Nomahegan Brook	Borough of Mountainside	August 1976
Tributary A	Township of Scotch Plains	April 1976
Tributary B	Township of Scotch Plains	April 1976
Tributary C	Township of Scotch Plains	April 1976
Trotters Lane Branch	Township of Union	November 1980
Van Winkles Branch	Township of Springfield	May 1979
Vauxhaull Branch	Township of Union	November 1980
Vauxhaull Subbranch	Township of Union	November 1980
West Branch	Township of Union	November 1980
West Branch of Salt Brook	Borough of New Providence	September 1982
West Branch West Brook	Borough of Roselle	February 1975
West Brook	Township of Cranford	May 1979
	Borough of Kenilworth	November 1980
	City of Linden	December 1991
	Borough of Roselle	February 1975
Winding Brook	Township of Scotch Plains	April 1976

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

Community	Old Name	New Name
Cranford, Township of	Orchard Street Branch	Garwood Brook
Westfield, Township	Tributary to Rahway River	Gallows Hill Road Branch
Union, Township of	East Branch	East Branch Rahway River
Rahway, City of	South Branch	South Branch Rahway River

The September 20, 2006, countywide FIS incorporated the determinations of letters issued by FEMA resulting in map changes (Letter of Map Revision [LOMR], Letter of Map Revision – based on Fill [LOMR-F], and Letter of Map Amendement [LOMA]) as shown in the tabulation below.

Community	Flooding Source(s)/Project Identifier	Effective Date	Type
Berkeley Heights, Township of	Passaic River Tributaries	April 23,2003	LOMR
	Snyder Avenue Brook/ Berkeley Heights Convalescent Center	May 12, 2003	LOMR
Garwood, Borough of	Garwood Brook	May 12, 2003	LOMR
Kenilworth, Borough of	To correct road configuration	June 17, 1994	LOMR
	West Brook/Channelization & Detention Basin	April 3, 1996	LOMR
Linden, City of	Jouet Brook/Jouet Brook Flood Control Project	August 10, 1999	LOMR
	West Brook/West Brook Phase 3 Channel Improvements	August 10, 1999	LOMR
Roselle, Borough of	West Brook/Channelization & Detention Basin	April 2, 1996	LOMR
	Jouet Brook/Jouet Brook Flood Control Project	August 10, 1999	LOMR
	West Brook/West Brook Phase 3 Channel Improvements	August 10, 1999	LOMR
	Branch West Brook and West Branch West Brook	February 20, 2004	LOMR
Scotch Plains, Township of	Green Brook/The Reserve at Scotch Plains	December 12, 2003	LOMR
Union, Township of	Irvington Branch/Channel Improvements	August 10, 2000	LOMR

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.

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 Union County.

2.2 Community Description

Union County is located in northeastern New Jersey, centered approximately 20 miles southwest of New York City and is a part of the New York metropolitan area. There are 21 communities in Union County. The Boroughs of Mountainside and New Providence, the City of Summit, and the Townships of Berkeley Heights and Springfield are located in the northwest portion of the county. The Borough of Fanwood, the City of Plainfield, the Town of Westfield, and the Township of Scotch Plains are located in the southwestern section of the county. The Boroughs of Garwood, Kenilworth, Roselle, and Roselle Park, and the Townships of Cranford and Winfield comprise the central portion of the county. The northeastern part of the county consists of the Cities of Elizabeth and the Townships of Hillside and Union. The Cities of Linden and Rahway, and the Township of Clark make up the southeastern portion of Union County.

Union County is bordered to the east and northeast by the City of Bayonne, in Hudson County, New Jersey. To the north, the county is bordered by the following communities of Essex County: the City of Newark, the Town of Irvington, and the Townships of Maplewood and Millburn. To the northwest, the county is bordered by the following communities of Morris County: the Borough of Chatham, the City of Passaic, and the Township of Chatham. It is bordered to the southwest by communities of Somerset County: the Borough of Watchung, the City of North Plainfield, and the Townships of Green Brook and Warren. The following communities of Middlesex County border Union County to the south: the Boroughs of Carteret, Dunellen, Metuchen, and South Plainfield, and the Townships of Piscataway and Woodbridge. It is bordered to the east by Staten Island, in the City of New York, New York.

According to the United States (U.S.) Census Bureau, at the 2000 U.S. Census, the population was 522,541 in Union County (U.S. Census Bureau, 2010). At the 2010 U.S. Census the population was 536,499, an increase of 13,958 (2.7-percent) from the 2000 Census (U.S. Census Bureau, 2010). According to the 2010 U.S. Census, Union County had a population density of 4,955 people per square mile (water excluded) making it the 15^{th}-most densely populated county in the U.S., and the third-densest in New Jersey, behind Hudson County and Essex County.

The topography of the county is generally flat to gently rolling, with elevations increasing gradually from east to west, marked by low parallel ridges generally running in a northeast direction. The Watchung Mountains, in the extreme western portion of the county, comprise the largest of these ridges. Elevations in Union County range from less than 10 feet in the marshes of the east, along Arthur Kill, to greater than 500 feet in the Watchung Mountains.

A very high percentage of the land in Union County has been developed. The county consists primarily of established residential communities with small, interspersed commercial and industrial zones. More intense commercial development exists in the eastern part of the county. The land along the eastern shoreline of the county is characterized by industrial development and port activity.

The climate of the county is mostly continental, due to the predominance of winds from the interior. The temperatures for the area average approximately 31 degrees Fahrenheit (°F) during the winter months and approximately 75°F in the summer months. The average rainfall is approximately 42 to 50 inches per year.

2.3 Principal Flood Problems

Flooding in Union County can occur during any season of the year, since New Jersey lies within the major storm tracks of North America. The worst storms, however, have occurred in late summer or early fall when tropical disturbances such as hurricanes are most prevalent.

For the [date] countywide FIS revision, special consideration was given to storms which caused damages to the area in recent years, including Hurricane Sandy in 2012 and Hurricane Irene in 2011 (FEMA, 2013).

Hurricane Sandy ("Superstorm Sandy") came ashore as an immense tropical storm in Brigantine, New Jersey, on October 29, 2012. On October 30, 2012, President Obama approved a Major Disaster Declaration (FEMA-4086-DR-NJ) for the State of New Jersey. Rainfall amounts associated with Hurricane Sandy in New Jersey were between 2 to 4 inches, while the storm produced almost a foot of rain in states to the south. A full moon made the high tides 20 percent higher than normal and amplified the storm surge. The New Jersey shore suffered the most damage, battered by 14-foot waves at the shoreline, while 32-foot waves were recorded at National Oceanic and Atmospheric Administration (NOAA) Buoy 44065, and wind gusts up to 88 miles per hour. Governor Chris Christy declared a state of emergency on October 31, 2013. The New Jersey shore suffered the most damage. Some barrier island communities suffered severe "wash over" including the creation of two temporary inlets. Seaside communities were damaged and destroyed along the coastline. Approximately 2.7 million households had lost power. In Union County, residents coped with downed power lines, trees and flooding as Hurricane Sandy hit the area (Union County, 2012). In the Town of Westfield, dozens of homes were left uninhabitable in the wake of Hurricane Sandy (Mustac, 2012). In the Township of Cranford, local authorities reported major damage from wind and widespread power outages, however no flooding was reported within the entire Township (Rybolt, 2012). This is in sharp contrast to the Township of Cranford's experience during Hurricane Irene in August 2011 when there was significant flooding experienced.

Having earlier been downgraded to a tropical storm, Hurricane Irene came ashore at Little Egg Inlet in southern New Jersey; on August 28, 2011. In anticipation of the storm, Governor Chris Christy declared a state of emergency on August 25, 2011. Mandatory evacuations were ordered throughout the State of New Jersey. Wind Speeds were recorded at 75 mph and rain totals reached over 10 inches in many parts of the state. 1.46 million customers lost power during the storm. Overall damage estimates, for the State of New Jersey, came to over $1 billion dollars (in 2011 dollars); with over 200,000 homes and buildings being damaged.

In Union County, flooding impacts from Hurricane Irene amounted to $15 million in residential (392 homes) and businesses (30) losses; $560,000 spent in emergency response actions during the storm, followed by an additional $775,000 in restoration work (Mayors Council Rahway River Watershed Flood Control, Date Unknown). The Mayors Council Rahway River Watershed Flood Control reported it was estimated that there were $31.8 million worth of private insurance claims by homeowners in Union County due to Hurricane Irene. In the Township of Cranford over $4 million in damages to Brookside Avenue School and Cranford Highschool; the 1st floor of the Cranford Municipal Building was damaged and deemed unusable; 1600 homes were impacted with 300 first floors damaged with FEMA estimating homeowners losses at approximately $16.5 million. Over 70,000 tons of damaged household debris was removed from the Township of Cranford and there were significant safety and public works expenses to manage the storm and its aftermath.

In the City of Rahway, Hurricane Irene cost almost $700,000 of municipal public safety and public works expense to response to the storm and left homes severely damaged, including several with serious foundation problems, heavily damaged commercial properties and the church on West Grande damaged (Mayors Council Rahway River Watershed Flood Control, Date Unknown).

In the Township of Springfield over 80 homes had severe flooding with damages estimated at $8 million; 70 homes and 40 businesses has basement flooding with damages estimated at $2.3 million; and the township spent over $400,000 in public safety and public works costs (Mayors Council Rahway River Watershed Flood Control, Date Unknown).

The main stem of the Rahway River conveys storm water runoff from an area of

25 square miles as it cross U. S. Route 22 in the Township of Springfield and has a total drainage area of 41 square miles before it discharges into Arthur Kill in the Carteret. Increased storm water runoff due to construction of impervious areas has strained the limited capacity of stream channels and man-made restrictions, including bridges, resulting in floodwaters leaving the channels of the river and its branches and inundating signification developed areas of Millburn, Union, Springfield, Kenilworth, Cranford and Rahway and to a lesser degree in other municipalities (Mayors Council Rahway River Watershed Flood Control, Date Unknown).

Prior to the September 20, 2006, FIS the most serious and widespread flooding in the county occurred in August 1971, as a result of tropical storm Doria. Other major floods of record occurred in September 1960, September 1966, May 1968, August 1973, July 1975, and September 1999.

Township of Berkeley Heights

In the Township of Berkeley Heights, the Passaic River flows along the northern corporate limits in a relatively flat valley. Although the channel is well defined for low and normal flows, the stream floods the adjacent plain during high stages, and flooding becomes especially widespread at the junction points with the four tributaries in the township area. The Passaic River tributaries run in narrow channels, and overbank flooding is common at medium- to low-frequency flood flows because backwater from the Passaic River tends to build up sediment in the downstream portions of the tributaries. The upper reaches of these tributaries are appreciably sloped because they are located on the steeper portions of the Second Watchung Mountain ground slope. These steep slopes reduce the time of concentration of storm waters during severe storms and increase the discharge volumes expected during storms.

The Green Brook segment south of Horseshoe Road to Plainfield Avenue has flooded in the past and has caused property damage. Another area subject to flooding extends from Oak Way to Valley Road.

Blue Brook itself is well channelized up to where it crosses Valley Road, at which point it enters a broader-bottomed valley. Branch Blue Brook is very steeply sloped and causes flooding at its confluence with the main channel. Part of the flooding is caused by an inadequate culvert (Elson T. Killam Associates, 1971).

Township of Clark

Areas in the Township of Clark periodically inundated, as a result of heavy rainfall, lie primarily along Robinsons Branch upstream of the Middlesex Reservoir and along Pumpkin Patch Brook. Robinsons Branch and the Rahway River affect a large number of communities in Union County. Stream flows on both the Rahway River and Robinsons Branch are gaged. The Rahway River has a gage upstream of St. Georges Avenue in the City of Rahway (USGS gage No. 01395000) at which a systematic record has been kept since 1922. There is also a gage located at U.S. Route 22 in Springfield, New Jersey, (USGS gage No. 01394500) that has been operating since 1938. The gage on Robinsons Branch is located at Milton Lake in Rahway (USGS gage No. 01396000) and has been in operation since 1940.

The September 1999 storm was the most severe on record at the time along the Rahway River with the peak discharge reaching 5,590 cubic feet per second (cfs), the equivalent to a 60-year recurrence interval flood. On Robinsons Branch, the September 1999 storm was more severe than the 1975 storm. The peak discharge was 4,800 cfs.

Township of Cranford

In the Township of Cranford, the Rahway River, Garwood Branch and Gallows Hill Road Branch have caused flooding. The Riverside Drive and Balmiere Parkway areas are the most seriously flooded areas in the Township of Cranford. The Union County Park Commission dike along Riverside Drive has been overtopped many times in recent memory, with flood waters nearly 7 feet deep recorded along Riverside Drive.

Cranford Engineering Department records show that during the August 1973 flood, 350 acres of the township were flooded and approximately 450 homes were damaged by floodwaters.

The City of Elizabeth

The City of Elizabeth has experienced flooding from riverine flows in the Elizabeth River and from tidal flooding along Newark Bay and Arthur Kill. The most severe floods to affect the area were tidal floods associated with hurricanes. During Hurricane Donna on September 12, 1960, the water level at East Newark (applicable to Newark Bay) reached 8.4 feet at high tide, a level of 5.5 feet above the normal high tide.

Areas along the Elizabeth River which show approximate 1-percent annual chance flooding on the landward side of the levee between the New Jersey Turnpike and Bridge Street are not caused by overtopping of the levee. It is interior drainage areas which flood as a result of the levee system interior drainage system.

Township of Hillside

The Township of Hillside has experienced flooding problems along the East Branch Rahway River. Flooding along the East Branch Rahway River is caused by an inadequate culvert and the inability of the main stream to carry the floodwaters. The stream's hydraulic inadequacy creates a backwater which inundates the 6-foot by 16-foot culvert along Central Avenue. During the August 1971 storm, heavy damage occurred along Central, Long, Silver, Boston, Baltimore, and St. Louis Avenues and along Baker, State, South State, and Acme Streets.

Borough of Kenilworth

The residential and industrial areas in the Borough of Kenilworth that border the Rahway River and its tributaries are all low-lying with respect to the channel bottoms of the streams. As a result, during severe storms such as those experienced in 1971 and 1973, yards, roads, basements, and other residential and industrial structures sustained flooding. The floodplain was extremely wide, encompassing whole blocks in certain instances. Although the depth of the floodwater was minimal, it advanced due to the extremely flat terrain.

Past flooding caused by backwater from the Rahway River has been severe. On August 18, 1971, a high-water mark of 71.5 was recorded. As a result of the August 1973 storm, floodwaters from the Rahway River extended as far as Willshire Drive in the southwestern section of Kenilworth.

The flooding problem is aggravated by various factors. The stream channels are confined and undersized due to excessive floodplain development in the past. Also, most hydraulic structures are undersize and incapable of handling flows generated by large storms.

City of Linden

The City of Linden is subject to both tidal and fluvial flooding, although tidal wave velocities are dampened by the meanders of the stream channels. This tidal influence is less severe than the fluvial flooding along these waterways. The city is subject to fluvial flooding along Peach Orchard Brook, West Brook, and Kings Creek.

The fluvial floods are usually the result of coastal storms. The intense antecedent rainfall with the passage of tropical storm Doria caused widespread flooding in the central and northeastern communities of New Jersey. Flooding caused severe damage to dwellings and commercial establishments along Peach Orchard Brook and West Brook.

Borough of Mountainside

Flooding of considerable magnitude occurred in the Borough of Mountainside during tropical storm Doria in August 1971 and from a rainstorm on August 2 and 3, 1973. The latter caused considerable damage within Echo Lake Park when an abutment of the dam was breached, causing the collapse of two bridges on the main channel of Nomahegan Brook and the collapse of a bridge on Branch 2. The water level of Echo Lake has remained low since that time as a result of this failure. There was extensive flooding outside the park area along Nomahegan Brook at New Providence Road and at Mountain Avenue. Other areas which were inundated were the culvert crossings of Branch 2 and 3 at U. S. Route 22 and areas along Charles Street where Branch 1 crosses into Springfield. There were several other locations that experienced local flooding due to inadequate storm sewer capacity and inadequate inlet capacity. In addition, some of the culverts crossing Nomahegan Brook and its branches were identified as being inadequate (Elson T. Killam Associates, Inc., 1971).

Although the volume of flow in Blue Brook was very high during the August 1973 rainstorm, very little damage occurred within the borough limits due to the undeveloped character of the Watchung Reservoir.

<u>Borough of New Providence</u>

In the Borough of New Providence, the Passaic River floods the low-lying areas along its banks. Salt Brook causes most of the borough's damage as water runs off quickly from the steep areas and inundates the low-lying flatter areas.

<u>City of Plainfield</u>

Within the City of Plainfield, most of the flooding problems which occur are a result of water which flows out of Green Brook in Scotch Plains and in the area of Leland Avenue in Plainfield and flows through the streets across the basin divide into Cedar Brook. This diversion leads to a condition where flood depths are deeper at a distance from the stream than they are in the immediate area. This occurs because after water tops the basin divide (roughly defined by East Front Street) it backs up behind the CONRAIL embankment which has only two openings (Richmond and Berkman Streets) leading to Cedar Brook. This results in a large floodplain throughout the northern portion of the city even though the majority of Green Brook flows are contained within and adjacent to its banks.

<u>City of Rahway</u>

Areas in the City of Rahway periodically inundated as a result of heavy rainfall lie along the Rahway River downstream of St. Georges Avenue, along Robinsons Branch downstream of Maple Avenue, and along the entire length of the South Branch Rahway River and Orchard Creek. Flooding along the Rahway River downstream of Monroe Street and along South Branch Rahway River downstream of East Inman Avenue is caused by both riverine and tidal flooding.

<u>Borough of Roselle</u>

The Borough of Roselle experienced considerable flooding during tropical storm

Doria in August 1971. Flooded areas included portions along West Brook, from St. Georges Avenue to Raritan Road; along Branch West Brook, north of the Staten Island Rapid Transit embankment; along Jouet Brook, from St. Georges Avenue to Grand Street; along Peach Orchard Brook, from St. Georges Avenue to Park Drive in Warinanco Park. There was also local flooding in the area of Branch West Brook, which is enclosed in pipe from Sixth Avenue to First Avenue. The widest point of this inundation centered at Third Avenue and Vine Street. Damage caused by tropical storm Doria included basement flooding; flooding of low-lying first floors of dwellings adjacent to West Brook, Jouet Brook, and Peach Orchard Brook; and damages to a light footbridge over the Branch West Brook.

Borough of Roselle Park

In the Borough of Roselle Park, the only major flood problems occur along Morses Creek during severe storms. A detention basin, box culverts, and riprap has been constructed for Morses Creek. Major floods have occurred on Morses Creek in 1968, 1971, 1973, and 1975. Frequencies are unavailable because no gages are located on this stream.

Township of Scotch Plains

The floodplains of the streams that run through the Township of Scotch Plains support much residential and commercial development, and structures on the floodplains have been damaged by floods in the past.

Flooding along Robinsons Branch-Rahway River is aggravated by low-lying stream banks and wide floodplains. The backwater effect of high water stages on Robinsons Branch-Rahway River causes much of the flooding along the lower reaches of Winding Brook and Branch 22.

On the north side of Scotch Plains, widespread flooding occurs along Green Brook, East Branch Green Brook, and Cedar Brook. During the 100-year flood, waters from Green Brook inundate Front Street in the vicinity of Terrill Road and Farley Avenue, and along Mountain Avenue at Park Street. These waters then overflow into the Cedar Brook watershed, flooding several streets. This overflow is in the form of water flowing down the streets to Cedar Brook, with an estimated depth of 6 inches during the base flood. During the 500-year flood, a similar overflow occurs along East Branch Green Brook on Mountain Avenue in the vicinity of Westfield Avenue and Mountainview Avenue.

Flood elevations along the lower portion of East Branch Green Brook are affected by the backwater from the main branch of Green Brook. Further upstream on East Branch Green Brook, much of the flooding that inundates U. S. Route 22 near Mountainview Avenue results from an inadequate 36-inch diameter pipe upstream of Mountainview Avenue.

On Cedar Brook, flooding in the Terrill Road area is aggravated by twin 72-inch diameter pipes which are inadequate to carry the flood flow.

Township of Springfield

Flooding in the Township of Springfield occurs along the Rahway River, the lower sections of Van Winkles Brook, and between Bryant Brook and Bryant Brook Branch.

City of Summit

In the City of Summit, the Passaic River is the major source of flooding. Major floods have occurred along the Passaic River in 1903, 1905, 1907, 1936, 1971, and 1973. The flood of August 1973 was the worst flood recorded at that time at the gaging station on the Passaic River in Chatham in 45 years; this flood had a peak discharge of 3,380 cfs. The banks of the Passaic River are relatively steep and cause the water-surface elevation to rise significantly during the periods of intense rainfall. Salt Brook and several other small tributaries to the Passaic River in the corporate area experience minor flooding.

Township of Union

One of the important features of the Township of Union that lessens damages during high and medium frequency flooding events is the fact that the overbank of the Rahway River is located in Union County parklands. As a consequence, very little flooding problems have been noted on the Township of Union side of the Rahway River downstream of Morris Avenue (New Jersey Route 82), although the Springfield bank has had extensive levees built to protect adjoining residential areas. The Morris Avenue bridge has been described as inadequate to pass medium-to-low frequency stream discharges, because it causes high stream stages upstream (Union County, New Jersey, Date Unknown).

Along the upstream reaches of the East Branch Rahway River, flooding has been frequently reported at the intersection of Valley Street and Springfield Avenue, and along parts of Franklin Street downstream of Vauxhall Road.

Flooding along the Vauxhall Branch has been reported in the open area between Carol Drive and Audrey Terrace. This high-water condition is caused by the backwater effects of Rahway River above Morris Avenue.

Further upstream on the Vauxhall Branch, frequent flooding has been caused mainly by inadequate channel and culvert capacities in the open stream section between Burnet Avenue and Vauxhall Road. The subbranch of the Vauxhall Branch north and upstream of I-78 has also contributed to the flooding problems experienced at the Springfield Avenue intersection with Valley Street, where the capacity of the relocated channel of this subbranch has proven to be inadequate during severe rainstorms. This is caused mainly by the inadequate culvert capacity under the main roadway of I-78 and the adjoining access ramp.

Flooding along Branch 10-34 west of Springfield Road is caused by backwater effects of high stream stages in the main channel.

Flooding along the main channel of the Elizabeth River is also lessened by the fact that the Township of Union overbank is situated in Union County parklands. Areas frequently inundated in the past include the Trotters Lane bridge at the Township Line, and at the North Avenue bridge, which cuts through the Ursino Lake Detention Basin. Further upstream along the main channel, flooding during severe storms has affected residences along Roberts Street, and has caused local damage to residences downstream of Union Avenue.

Along Trotters Lane Branch, severe flooding has been reported on many occasions at Morris Avenue due to the inadequate capacity of the Trotters Lane storm sewer. Flooding in the upstream reaches of this stream has been lessened by the construction of a detention basin in the area west of Woodland Avenue; however, low-lying parts of the Keane College grounds were inundated during the flood of 1973 when the detention basin was not yet in operation.

The Lehigh Valley Branch has reported flooding due to backwater effects at its confluence with the main channel and at Morris and Huguenot Avenues upstream, due to inadequate culvert capacity.

The West Branch of the Elizabeth River has had reports of flooding in the vicinity of its confluence with the main stem up to Vauxhall Road. The upstream portions have had only isolated and local flooding reports during severe storm events.

Lightning Brook has been a source of severe local flooding. The main stem of the brook has had flooding reported at Stuyvesant Avenue. The Maplewood and Southwest Branches have flooded Morrison, Stecher, Bahmoral Avenues, and Tyler Street, due to inadequate culvert and channel capacity. The Irvington Branch has flooded Stuyvesant Avenue and properties along Myrtle Street upstream of I-78, which has inadequate culvert capacity. Ostwood Terrace has been severely inundated at the channel crossing, due to inadequate culvert capacity.

2.4 Flood Protection Measures

Within the this jurisdiction, there are one or more levees that have not been demonstrated by the communities or levee owner(s) to meet the requirements of 44 CFR Part 65.10 of the NFIP regulations as they relates to the levee’s capacity to provide 1-percent-annual-chance flood protection. Please refer to the Notice to Flood Insurance Study Users page at the front of this FIS report for more information.

Communities enlist a variety of strategies to protect their residents from flood hazards, from structural measures to mitigation strategies and ordinances. FIS Report users are encouraged to visit the community's local website for the most recent information on flood protection measures.

Additionally there are groups and organizations active in Union County. For example, the Mayor's Council Rahway River Watershed Flood Control has published a Flood Risk Management Needs Statement outline flood protection measures needed in the Rahway River Watershed.

Prior to the September 20, 2006, FIS the flood protection measures identified are summarized below.

<u>Township of Berkeley Heights</u>

Within the Township of Berkeley Heights, the flooding problems along the main stream of the Passaic River have long been recognized and studied. Various proposals have been put forward to alleviate flooding during high stages in the stream reach adjacent to the Township of Berkeley Heights.

The Union County Park Commission has a program of land acquisition along the Passaic River which has had a beneficial impact on floodplain encroachment and flood drainage for adjacent improved properties.

The upper reaches of the four Passaic River tributaries are steeply sloped; recommendations have been made to place these fast-flowing reaches in piped sewers. Some of these recommendations have been carried out.

There are several bridges and culverts within the Township of Berkeley Heights that have been identified as being marginal or inadequate (NJDEP, 1974).

<u>Township of Cranford</u>

The Township of Cranford has put great effort into trying to alleviate flooding within the township. Funds were expended for engineering survey and feasibility studies for all streams in the Township of Cranford. As a result of these reports, the Rahway River was dredged to increase its flow capacity, the old Public Service Dam upstream of South Avenue was removed, and various dikes were extended and raised. Union County built a stormwater retention basin on the Rahway River in Lenape Park, located at the Cranford-Springfield corporate limits. This retention basin has increased the natural detention of the park through the use of a control structure located approximately 100 feet upstream of Kenilworth Boulevard, and the construction of dikes around the perimeter of the park. Two tributaries located in the Borough of Kenilworth which had previously discharged into the Rahway River now discharge into the Drainage Ditch, located outside the dikes on the northeastern corporate limits. The Drainage Ditch flows into the Rahway River just below the retention basin.

Other flood protection measures include early warning telemetry equipment tied in to the USGS gage in Springfield. The equipment was placed in operation in December 1973 to enable township officials to monitor flows on a continuous basis during a major storm. Two pumps were acquired to drain the area behind the Riverside Drive Dike. Channel improvements have been made along the lower 5,400 feet of Gallows Hill Road Branch, and two stormwater retention basins have been constructed further upstream. One basin is located in the Fairview Cemetery in Westfield, and the other is located upstream of Brookside Place Road in Cranford. The stormwater retention basins and stream improvements provide protection for 100-year flooding along Gallows Hill Road Branch.

While there is no question that all of these improvements have had a beneficial effect on reducing flooding, wide-spread flooding during a 100-year storm can be expected because the Riverside Drive dikes will be overtopped and floodwaters will back up behind bridges. The Riverside Drive dikes would be overtopped by a flood with a 20-year recurrence interval.

City of Elizabeth

Within the City of Elizabeth, the USACE has completed a flood control project along the Elizabeth River which consists of levees, channelization, and the reconstruction of bridges. FEMA specifies that all levees must have a minimum of three feet freeboard against 1-percent annual chance flood to be considered a safe flood protection structure. The levee system on the Elizabeth River does meet the FEMA freeboard requirement.

Residents and businesses within the city depend on warnings issued through radio, television, and local newspapers for information concerning possible flood conditions. Flood warnings and predicted flood peaks are issued by the Flood Forecasting Center of NOAA, located at Trenton, New Jersey.

Borough of Garwood

In the Borough of Garwood, channel modifications have taken place along Garwood Brook in order to limit the potential for flood damage.

Township of Hillside

In the Township of Hillside, flood control measures along the Elizabeth River have consisted of levee construction and channel improvements. An earthen levee with interior flood control facilities has been constructed along the left bank of the river from just downstream of the U.S. Route 22 bridge to the vicinity of Harvard Avenue. This levee has been certified by the USACE and provides protection from the 1-percent annual chance flood. The North Avenue bridge was widened and raised further controlling flooding from the Elizabeth River in the township.

City of Linden

Within the City of Linden, flood control measures in the study area have consisted of channel improvements and removal of restrictions. Two partially state-funded flood control projects were granted to Union County to improve the channel of West Brook from Eleventh Street to St. Georges Avenue (State Route 27). The county also has improved the West Brook channel from Clinton to Winans Avenues. Concrete flumes, trapezoidal channels, and new bridges were constructed at these locations, thus lowering fluvial flood elevations in this area and reducing upstream backwater effects. In addition, an extensive piped storm relief system was constructed in the areas to the east of West Brook, providing good interior drainage in the project area, and reducing the frequency of flooding along West Brook.

Borough of Mountainside

Within the Borough of Mountainside, although the impoundment of Nomahegan Brook and Blue Brook is mainly for recreation purposes, it affords some minor protection from floods.

Following a 1962 report on storm drainage facilities for Mountainside, the borough has carried out a program of improving storm water drainage in line with the recommendations of that report (Elson T. Killam Associates, 1962). The report identified a number of problem areas along Branches 2, 3, and 7 of Nomahegan Brook. The storm drainage improvements have substantially decreased the flooding which occurs in those areas where the pipes have been installed. Storms of medium to high frequency can be handled by these new pipes.

Borough of New Providence

Extensive channel work on Salt Brook and its tributaries has been done within the Borough of New Providence. Some of the smaller upland streams were piped as development took place. Many of the downstream channels have been modified to carry larger flows.

City of Rahway

The USACE has completed two flood control projects within the City of Rahway, one on the Rahway River and one on South Branch Rahway River. Earthen dikes were constructed along the western bank of the Rahway River between Monroe Street and its confluence with South Branch Rahway River, and along both banks of South Branch Rahway River for a distance of approximately 0.5 mile upstream from the mouth. The Rahway River project includes moveable flood gates across East Milton and East Hazelwood Avenues. The South Branch Rahway River project includes a moveable flood gate across Main Street near East Hazelwood Avenue and a pumping station on Main Street for interior drainage.

The USACE has also planned projects along Robinsons Branch, and along the South Branch Rahway River upstream of the existing project, both of which include channel improvements and flood impoundments. However, the South Branch Rahway River project was abandoned because of the cost while the Robinsons Branch project is awaiting funding; therefore, its effects were not considered in the December 2, 2002, FIS for the City of Rahway.

The City of Rahway has completed channel improvements along Orchard Creek between Orchard Street and Bramhall Road. These improvements were intended to reduce erosion of the channel banks and have only a minimal effect on reducing flooding from a 100-year storm. The storm water retention basin on the Rahway River in Lenape Park was designed to reduce the peak flow for the 100-year storm by 20 percent in Rahway, which would result in approximately a 1.0-foot drop in the 1-percent annual chance flood level. Peak flood elevations downstream of Monroe Street are controlled by tidal flooding from the Arthur Kill, so the reduction in flow has a negligible effect on the flood levels.

<u>Borough of Roselle Park</u>

Within the Borough of Roselle Park, because of a general drainage study conducted by the consulting engineering firm of Luster and Guariello Associates, Inc., a number of flood protection improvements have been implemented along Morses Creek Tributary 9-1-7-1 (Luster and Guariello Associates, 1974). The most notable of these improvements are as follows:

- Replacement of a box culvert in the Central Railroad right-of-way. The existing structure was inadequate for the drainage area served and was replaced with a 54-inch diameter reinforced concrete pipe;
- Construction of a detention basin at the Hawthorne Street playground area. The basin was designed to impound surface runoff for controlled discharge downstream thereby reducing drainage structure requirements downstream and alleviating flooding problems.
- A number of other improvements, generally in terms of pipe and culverts, were recommended in the aforementioned report.
- The Carpenter Place Detention basin has been constructed to limit flood damage in the Borough of Roselle Park. The channel for Morses Creek has been modified also, including installation of circular and box concrete culverts and a trapezoidal channel with riprap.

Township of Scotch Plains

Within the Township of Scotch Plains, a stream improvement project was completed on the lower portion of East Branch Green Brook, consisting of a diversion chamber and a 78-inch diameter relief pipe, located on the north side of

U.S. Route 22 and extending downstream from the 36-inch diameter pipe near Montainview Avenue, emptying into an improved channel. The reinforced concrete-lined, improved channel begins near Scotland Street and continues downstream to the confluence with Green Brook.

Winding Brook's channel also has a section of improved channel that extends upstream from the confluence with Robinson's Branch-Rahway River for approximately 0.5 mile.

Inundation on the south side of the Township of Scotch Plains generally occurs along Robinson's Branch-Rahway River and the lower portion of Winding Brook and Branch 22. A large portion of these areas consists of undeveloped swamps and lowlands. By providing flood retention areas, these swamps and lowlands reduce some flooding. NOAA in cooperation with the New Jersey Division of Water Resources, has installed a flood stage sensing device on Green Brook.

The Civil Defense Department, assisted by the Scotch Plains Police Department and the City Manager's Office, is responsible for local flood warnings and evacuations.

Township of Springfield

Within the Township of Springfield, a dike is located near Marion Avenue and Interstate Route 78. Although the dike is built high enough to retain the 100-year storm, there is a low-lying section on the ramp from Springfield Avenue to Interstate Route 78 over which the water can flow. The 500-year storm overtops all the dikes in Springfield.

The Township of Springfield has also constructed a dike along the Rahway River between Morris Avenue and Springfield Avenue. This dike does not meet the FEMA freeboard requirement.

In 1976, the Township of Springfield channelized and realigned Van Winkles Brook from Mountain Avenue downstream to CONRAIL. In addition, a dike was constructed along Garden Oval. About 350 feet of Van Winkles Brook downstream of Morris Avenue has been improved with a concrete lining.

Both Bryant Brook and Bryant Brook Branch were realigned between Mountain Avenue and Interstate Route 78. In addition to replacing the major bridges and culverts, Bryant Brook was improved with a concrete channel lining and Bryant

Brook Branch was improved with a combination concrete and earthen channel.

Township of Union

Within the Township of Union, the headwaters of Trotters Lane Branch have been developed as a detention basin by the Township of Union and help the flooding problem downstream at Keane College.

Parts of the Lehigh Valley Branch between Minute Arms and Huguenot Avenue have been channelized, and the Huguenot Avenue culvert has been rebuilt; however, the area still experiences flooding problems during severe storms.

Along Lightning Brook, the Union Avenue bridge was reconstructed and the channel was flumed between Oakland and Stuyvesant Avenues and at the point where the Irvington and Maplewood Branches join. None of these improvements has prevented flooding of Stuyvesant Avenue during heavy rainfalls. The Southwest Branch channel was walled and paved between Tyler Street and Morrison Avenue, but still experiences flooding during heavy storms. The Irvington Branch was flumed upstream of Stanley Terrace and the Stanley Terrace bridge was rebuilt to allow greater channel conveyance.

The upper part of the Vauxhall Branch between Liberty and Burnet Avenues is in culvert and pipe, but this improvement was not designed to fully alleviate flooding problems related to low-frequency flooding events. The Vauxhall Subbranch was relocated extensively at the point where it crosses Interstate-78 (I-78) and upstream of I-78, where it was relocated on the north side of the roadway. The relocation and the culverts under I-78 did not solve the flooding problems during medium- and low-frequency storms, which have noticeably affected this area.

Township of Westfield

The Town of Westfield has experienced very few problems with flooding, and only a small number of flood protection measures have been undertaken. A retention basin along Gallows Hill Road Branch was constructed at the Fairview Cemetery to alleviate flooding problems in this area. The basin was originally designed for a storm frequency of 50 years and a storage capacity of 2.92 acre-feet. Discharge is controlled by an outlet structure at the upstream end of two 48-inch pipes at Gallows Hill Road. Calculations indicate that the basin will be adequate to deter floods of the 50-year frequency.

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 FIS. 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 annual 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 exceedence) 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 county at the time of completion of this FIS. Maps and flood elevations will be amended periodically to reflect future changes.

Note: Within this jurisdiction there are one or more levees that have not been demonstrated by the community or levee owner to meet the requirements of 44CFR 65.10 as it relates to the levee's capacity to provide 1-percent annual chance flood protection. Please refer to the Notice to Flood Insurance Study Users page at the front of this FIS report for more information.

3.1 Hydrologic Analyses

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

Information on the methods used to determine peak discharge-frequency relationships for the streams studied by detailed methods is shown below.

For each community within Union County that has a previously printed FIS report, the hydrologic analyses described in those reports have been compiled and are summarized below.

For the February 19, 1992, Township of Berkeley Heights FIS, the hydrologic analyses for Blue Brook was taken from the Township of Scotch Plains (FEMA, 1977). For Snyder Avenue Brook, peak discharges were determined using the USACE Hydrologic Engineering Center's (HEC) HEC-1 Flood Hydrograph Computer Package (USACE, 1985).

For the Drainage Ditch, flows obtained from Stream 10-30 and Branch 10-30-1 using Technical Paper 40 were transferred by using a drainage area proportion and an approved coefficient.

The interpolated values for Garwood Brook at the Rahway River were obtained from a log-log plot of discharge versus drainage area for the 10-, 2-, 1-, and 0.2-percent chance recurrence intervals. Discharges for subareas above the mouth of

Garwood Brook were computed assuming that the ratio of discharge to that at the mouth is equal to the ratio of the respective areas with an exponent of 0.75.

For the Borough of New Providence, hydrologic analyses were carried out to establish the peak discharge-frequency relationships for Passaic River, Salt Brook, and West Branch Salt Brook studied in detail affecting the community. With the exception of Central Branch of Salt Brook and South Fork, the regional regression formulas for this area were used to compute the 1-percent annual chance discharges for all other streams included in this study.

The SCS Technical Release No. 20 computer program was used to determine routed peak discharges on Salt Brook and West Branch Salt Brook for the 10-, 2-, 1-percent annual chance flood events (U.S. Department of Agriculture, 1983).

The hydrologic analyses employed in the City of Plainfield are based on work presented in the USACE Feasibility Report on Flood Control for the Green Brook Subbasin (URS Corporation, Inc., 1980). The analysis is complicated by the fact that, for certain storms, water diverts out of the Green Brook basin and flows into Cedar Brook. Discharge-frequency relationships were developed at both the upstream (Union Avenue in Scotch Plains) and the downstream (Norwood Avenue in Plainfield) limits of the diversion.

The initial step in the analysis was to derive an “actual” unit hydrograph at the USGS gage (No. 01403500) in the City of Plainfield. Based in this hydrograph, synthetic hydrographs were developed upstream and downstream of the gage along Green Brook. Next, peak discharge-frequency relationships at the gage were determined which could then be transposed using drainage area relationships.

The discharge-frequency relationship for the City of Plainfield gaging station is based on the natural, annual flood series for the gage because the series is non-homogeneous. It includes some events which are not true flood peaks but are residuals of larger, partially diverted floods. Rather, the discharge-frequency relationship is based on an adjusted series in which estimates of what would have happened if no diversion flow has occurred, replace the natural residual flows.

The overflow area was divided into eight portions, and the diversion for each was evaluated using a trial and error methodology based on balancing an assumed stage with the resulting stage developed from a subsequent backwater analysis. The amount of diversion at each point was estimated by treating the Green Brook-Cedar Brook divide as a broaded-crested weir. A check was made by running backwater computations to match historic flood marks using flows incremented (as the flow line progressed upstream) to reflect the diversion. This accounts for the reduction in peak discharges upstream of the USGS gage.

A final verification of the synthetic relations was done by generating flood hydrographs using rainfall data from Technical Paper No. 40 (U.S. Department of Commerce, 1963). These discharges were then augmented with flows diverting from the Green Brook basin, resulting in final peak discharges for the portion of Cedar Brook studied in detail.

Peak flows for the South Branch Rahway River were determined using relationships developed through a statistical regression analysis of data collected at over 100 gages across the State of New Jersey (U.S. Department of the Interior, 1974). This analysis accounts for urban development, natural retention created by lakes and swamps, stream slope, and drainage area.

The Morses Creek Drainage Basin, encompassing the entire Borough of Roselle, is ungaged. Basic hydrologic data consists of isohyetal mappings of rainfall data during storms such as tropical storm Doria in 1971 and the flood of August 2 and 3, 1973 (New Jersey Department of Environmental Protection, 1971; U.S. Department of the Interior, 1974).

Within the Borough of Roselle, the flood discharge-frequency relationships for West Brook and its branch (drainage area 3.55 square miles), Peach Orchard Brook (drainage area 0.76 square mile), and Jouet Brook (drainage area 1.14 square miles) were patterned on relationships developed by the USACE, New York District, for downstream reaches of West Brook and Peach Orchard Brook in the City of Linden. All drainage areas referred to are measured at the southern boundary of the Borough of Roselle.

Flood discharge values for reaches upstream from the southern boundary of Roselle were determined by applying ratios of drainage areas, with an exponent of 0.75, to the discharge values at the boundary.

Preliminary routing of the flood resulting from tropical storm Doria in 1971 indicated that stream controls in the upstream reach of West Brook were instrumental in regulating discharges to lower values. The ratio of actual to unregulated flows for tropical storm Doria, estimated by the USACE to have a 70- year frequency, was assumed to apply to floods of greater and lower frequency.

For Robinson's Branch, peak discharges for the 10-, 2-, 1-, and 0.2-percent annual chance floods were based on data previously developed by the USACE.

The flow distribution between Bryant Brook and Bryant Brook Branch was obtained by balancing the energy grade lines of the separate hydraulic computer models. Discharge-frequency estimates for Lightning Brook at the confluence with Elizabeth River (drainage area 3.13 square miles) were determined by adjusting estimates for Elizabeth River (drainage area 18.0 square miles), assuming that the discharge varies with (A) 0.75. Discharge-frequency estimates for the upstream reaches of Lightning Brook, Irvington Branch, Maplewood

Branch, and Southwest Branch were computed assuming a relationship (A) 0.75 as related to the discharge of Lightning Brook at its confluence.

For the Town of Westfield, the discharge-frequency relationships for the Gallows Hill Road Branch were calculated by multiplying values obtained from the FIS for Garwood, New Jersey (FEMA, 1976), by the ratio of drainage areas, with an exponent of 0.75. This method was also used to establish discharges for the Fairview Cemetery retention basin and basin overflow calculations.

For Cedar Brook, peak discharges for the 10-, 2-, 1-, and 0.2-percent chance recurrence intervals were developed using Special Report 38 (State of New Jersey, Department of Environmental Protection, 1974). These discharges were then augmented with flows for diverting from the Green Brook Basin, resulting in final peak discharges for the portion of Cedar Brook studied in detail.

The 1-percent annual chance discharge at the mouth of Blue Brook, where it flows into Green Brook, was obtained from flood-discharge frequency relationships developed by the USACE. The USACE determined the values for Blue Brook by applying the ratio of peak flows for synthetic unit hydrographs to the flood discharge frequency values for Green Brook at U.S. Route 22. For Blue Brook, at the borough corporate limits, the 1-percent annual chance discharge value was obtained by applying the ratio of drainage areas with an exponent of 0.75 to the value at the mouth.

Peak discharges for the four tributaries of the Passaic River and for Branch Blue and Branch Green Brooks were determined by the rational method for 10-year and 1-percent annual chance recurrence intervals, with rainfall-duration relationships estimated by the USACE for Plainfield (Water Resources Council, 1967). The 2-percent annual chance peak discharge was determined by interpolation. Peak discharges for the 0.2-percent annual chance recurrence interval were estimated at twice 1-percent annual chance values, based on relationships for West Brook and Peach Orchard Brook in Roselle, New Jersey.

Peak discharges for Gallows Hill Road Branch were taken from the FIS for the Town of Westfield (FEMA, 1979). These flows were determined taking into account the Fairview Cemetery retention basin in Westfield and the Brookside Retention Basin in Cranford. The methodology used involved calculating the peak discharges to the point in question by the rational formula, disregarding the drainage area tributary to the Fairview Cemetery. The peak flows resulting from routing through the retention basins were then added to local channel drainage to obtain the final flows.

For College Branch, peak discharges were determined using the rational formula, since the drainage area is less than 1.0 square mile. Runoff coefficients were estimated by field observation based on published values for different land uses (Ven Te Chow, 1959). The 0.2-percent annual chance discharge values were based on synthetic unit hydrographs and the standard project rainfall for the region. The 1-percent annual chance discharge values were estimated by the rational formula, with rainfall intensity obtained by dividing the 1-percent annual chance depth for Rahway, New Jersey, by the unit hydro graph lag time. Discharges for 2-, and 10-percent annual chance return intervals were determined by extending a plot of the log-Pearson Type III distribution based on logarithmic mean and standard deviation of discharge values for Saddle River at Lodi, New Jersey.

Two methods for determining peak frequency-discharge relationships were used in the Borough of Roselle Park FIS. For the section of the streams where the drainage basin is approximately 1.0 square mile or larger, USGS Special Report 38, was used to determine peak discharges (U.S. Department of the Interior, 1974). For the sections of streams where the drainage basins are less than 1.0 square mile, the Rational Method was used to determine peak discharges. The Rational Method is based on a determination of the intensity of rainfall (I), the runoff coefficient (C), and the drainage area (A). This is equated to discharge by the use of the formula $Q = CIA$.

Because of the criteria set forth above, the Morses Creek Tributary 9-1-7-1 peak discharges were determined by the Rational Method. Consideration was also given to storage along stream 9-1-7-1 through a routing analysis as described in Section 3.2 "Hydraulic Analyses." The Morses Creek peak discharges were determined by USGS Special Report 38 (U.S. Department of the Interior, 1974).

Discharges for Morses Creek were determined using the methodology described above, except that the analyses were modified at the newly installed detention basin in the Borough of Roselle Park FIS. Routing at the detention basin was performed using the USACE HEC-1 computer program (USACE, 1985).

Discharge-frequency estimates for Vauxhall Branch (drainage area 1.51 square miles) and Vauxhall Subbranch (drainage area 0.56 square mile) were obtained by using the rational method.

Discharge-frequency estimates for Branch 10-34 at its confluence with the Rahway River (drainage area 0.32 square mile) were obtained by the rational method.

Discharge-frequency estimates for Lehigh Valley Branch above the confluence with Elizabeth River (drainage area 0.84 square mile) were obtained by the rational method.

Discharge-frequency estimates for Trotters Lane Branch at its confluence with Elizabeth River (drainage area 0.95 square mile) were obtained by the rational method.

Peak discharges for Robinsons Branch 15 were determined using USGS Special Report 38 (U.S. Department of the Interior, 1974). Peak discharges for Robinsons Branch 15-1 and Robinsons Branch 15-2 were determined by the Rational Method. Consideration was also given to storage along the Tributary to Rahway River through a routing analysis.

Discharges for Stream 10-30, Branch 10-30-1, and Branch 10-24 were developed through the application of hypothetical rainfall patterns based on Technical Paper No. 40 and distributed on the basis of the Standard Project Flood. These runoff distributions were then applied to synthetic unit hydrographs to develop the flood discharges. For the Drainage Ditch discharges, flows obtained from Stream 10-30 and Branch 10-30-1 using Technical Paper 40 were transferred by employing a drainage area proportion and an approved coefficient. Due to the natural detention area upstream of the restrictive Springfield Road bridge, flows for Black Brook obtained by the Technical Paper No. 40 method were then routed using the Modified Puls method. For West Brook, discharges were obtained using the Rational Method.

Peak discharges for Orchard Creek were determined using the rational formula since the drainage area was less than 1.0 square mile. Runoff coefficients were estimated by field observation based on published values for different land uses.

For Branch West Brook and West Branch West Brook, peak discharges were determined using New Jersey Special Report 38 (U.S. Department of the Interior, 1974).

Peak flows for Pumpkin Patch Brook were determined using the relationships contained in a report developed by the USGS in cooperation with the State of New Jersey Department of Environmental Protection (U.S. Department of the Interior, 1974). A statistical regression analysis was performed using data collected at over 100 gages across the State of New Jersey. This analysis accounts for urban development, natural retention created by lakes and swamps, stream slope, and drainage area.

The hydrologic analyses for West Brook were prepared by M. Disko Associates of Union, New Jersey, using the procedure described in the state publication, <u>Magnitude and Frequency of Floods in New Jersey with Effects of Urbanization</u> (U.S. Department of the Interior, 1974).

The hydrologic analyses for Peach Orchard Brook were prepared utilizing the SCS unit hydrograph. The peak discharge of each hydrograph was determined by the procedure used in Special Report No. 38 (U.S. Department of the Interior, 1974). The hydrograph calculations, routing, lagging, and summations were prepared using the USACE HEC-1 program (USACE, 1985). The construction of the Jouet Brook detention basin and channel improvements were incorporated in the analyses of the Peach Orchard Brook and Jouet Brook flood peak discharges.

For Winding Brook, Tributary A, Branch 22, Branch 22-11, Tributary B, East Branch Green Brook, Tributary C, and Cedar Brook, hydrologic analyses were based upon the method for estimating flood-peak magnitudes developed under a cooperative program between the State of New Jersey Division of Water Resources and the USGS in Special Report 38 (U.S. Department of the Interior, 1974). Through a series of mathematical and graphical relations, various hydrologic parameters were used to estimate the peak discharges for the 10-, 2-, 1-, and 0.2-percent annual chance floods. The parameters included stream drainage area, main channel slope, surface storage area, and an index of manmade impervious cover based upon basin population and development. The 0.2-percent annual chance discharge value was extrapolated from the lower frequency floods.

Frequency-discharge drainage area curves were prepared from these data for Robinson's Branch-Rahway River, Winding Brook, Tributary A, Branch 22, Branch 22-11, Tributary B, East Branch Green Brook, Tributary C, and Cedar Brook.

Peak flows for Van Winkles Brook and Bryant Brook were determined using the relationships contained in Special Report 38, developed by the USGS in cooperation with the State of New Jersey, Department of Environmental Protection (U.S. Department of the Interior, 1974). These relationships were developed through a statistical regression analysis of data collected at over 100 gages across the State of New Jersey. This analysis accounts for urban development, natural retention created by lakes and swamps, stream slope and drainage area.

Discharge-frequency estimates for West Branch (drainage area 3.08 square miles) above confluence with Elizabeth River, were based on the method outlined in New Jersey Department of Environmental Protection, Report No. 38 (U.S. Department of the Interior, 1974).

Within the Township of Berkeley Heights, the hydrology for the Passaic River was determined using a log-Pearson Type III analysis based on USGS gage data in the Township of Chatham at station No. 1379500.

The peak discharges for Green Brook and Blue Brook were based on the results of a technical coordination meeting with Anderson-Nichols Co., Inc., which reflect changes in the drainage area for both streams. Peak discharges were determined by use of the frequency-discharge relationships described in Special Report No.38 to reflect the significant hydrologic events of August 1973 (U.S. Department of the Interior, 1975; U.S. Department of the Interior, 1974). The results of this methodology were compared to the USACE's log-Pearson Type III studies made for Green Brook above the Plainfield gage which was not considered in the original USACE computations. The frequency-discharge relationships as derived by both methods were considered comparable, and the use of the newly developed hydrology by the USGS was accepted for use in this study (U.S. Department of the Interior, 1975). Flows for partial drainage area of Green Brook and Blue Brook were estimated by applying a ratio of drainage areas to the 0.75 power to discharges at locations derived by the methods described above.

The discharge-frequency relationships for the Elizabeth River were determined for the FIS for the Township of Union, New Jersey (FEMA, 1975). These peak discharges were obtained by log-Pearson Type III analyses (Water Resources Council, 1977) of data from the USACE gaging station on the Elizabeth River, at Elizabeth, New Jersey. At the time of the pre-countywide analyses, this gaging station had 38 years of record. The gaging station was originally located 85 feet upstream from the Westfield Avenue bridge, in the City of Elizabeth. On December 27, 1972, a new gaging station was established at Ursino Lake, Township of Hillside, 75 feet upstream from the Trotters Lane bridge. Peak discharge records for 1973-1974 at the new gaging station at Ursino Lake were adjusted by the USACE to correlate with the records from the old gaging station site. The discharges associated with the Township of Hillside were then computed by assuming that flows would vary according to drainage areas as

$$(A_1/A_2)^{0.75}$$

Where: A = Drainage Areas.

Peak discharges for Robinsons Branch were based on stream flow records at USGS gage No. 01396000 at Milton Lake. Values for the 10-, 2-, 1-, and 0.2-percent annual chance peak discharges were calculated using a log-Pearson Type III statistical distribution of the annual peak flows from 1940 through 1977, using a weighted gage skew coefficient (U.S. Department of the Interior, 1963-1976; Water Resources Council, 1977). These flows calculated at the gage were transposed to other specific sites along Robinsons Branch using the drainage area-discharge formula:

$$\frac{Q_1}{Q_2} = \frac{A_1^{\,T}}{A_2}$$

where: A_1 and A_2 are the drainage areas at the specific site and the gage, T is the transfer coefficient, Q_2 is the peak discharge at the gage for a particular flood, and Q_1 is the resulting peak discharge at the site. A transfer coefficient of 0.85 was used because the resulting peak discharges agreed well with those used in the Township of Scotch Plains FIS (FEMA, 1977).

Hydrologic analyses for Kings Creek were prepared by the USACE using the log-Pearson Type III analysis on the physically similar, gaged Saddle River at Lodi, New Jersey, and transferring this information to the study area, via areal comparisons (Water Resources Council, 1967).

The hydrology for the Passaic River was determined using a proportional adjustment based on log-Pearson Type III analyses using USGS gage data at Pine Brook.

Peak discharge-frequency relationships for the gage were developed in accordance with the methods of frequency analysis contained in "Guidelines for Determining Flood Flow Frequency" (Water Resources Council, 1977). The log-Pearson Type III distribution of flood data was used as the basic distribution for defining the annual flood series. This method assumes that the logarithms of the annual peak discharges are normally distributed and that statistical procedures apply.

For the Township of Scotch Plains, peak discharges for Green Brook and Blue Brook were based on the results of a technical coordination meeting with Anderson-Nichols & Co., Inc. Peak discharges were determined by use of the frequency-discharge relationships described in Special Report 38, adjusted to reflect the significant hydrologic events of August 1973 (U.S. Department of the Interior, 1974; U.S. Department of the Interior, 1975). The results of this methodology were compared to the USACE log-Pearson Type III studies made for Green Brook above the Plainfield gage which was not considered in the original USACE computations. The frequency-discharge relationships as derived by both methods were considered comparable, and the use of the newly developed hydrology by the USGS was accepted for use in this FIS (U.S. Department of the Interior, 1975). Flows for partial drainage areas of Green Brook and Blue Brook were estimated by applying a ratio of drainage areas to the 0.75 power to discharges at locations derived by the methods described above.

For the City of Summit, the hydrology for the Passaic River was determined using a proportional adjustment based on log-Pearson Type III analysis using USGS gage data at Pine Brook and a log-Pearson Type III analysis using USGS gage data at Chatham.

Discharge-frequency estimates for the East Branch Rahway River were obtained by log-Pearson Type III analyses (Water Resources Council, 1967) at the old confluence with West Branch of Rahway River (drainage area 9.1 square miles) using statistical parameters derived from the gaging station at Springfield, New Jersey (drainage area 25.5 square miles) on the basis of physical similarity between the two basins. The discharge-frequency relationships for the new confluence point of the East Branch (drainage area 7.6 square miles) and upstream reaches were obtained by assuming discharges vary with (A) 0.75.

For Nomahegan Brook at its mouth, flood flow-frequency data were based on statistical analysis of stage-discharge records for two gaging stations on the Rahway River, operated by the USGS. One gaging station is located at Springfield, New Jersey. Its drainage basin area is 25.5 square miles and the length of record used was from 1938 to 1973. The other gaging station is located at Rahway, New Jersey, with a drainage basin area of 40.9 square miles. The length of record used was from 1908 to 1915 and from 1921 to 1973. This analysis followed the standard log-Pearson Type III method as outlined by the Water Resources Council (Water Resources Council, 1977), and was performed by the USACE, New York District.

For locations on Nomahegan Brook between the mouth and Echo Lake Dam, discharges were determined by multiplying the values at the mouth by the ratio of drainage areas, with an exponent of 0.75. This was done in accordance with a practice used by the USACE.

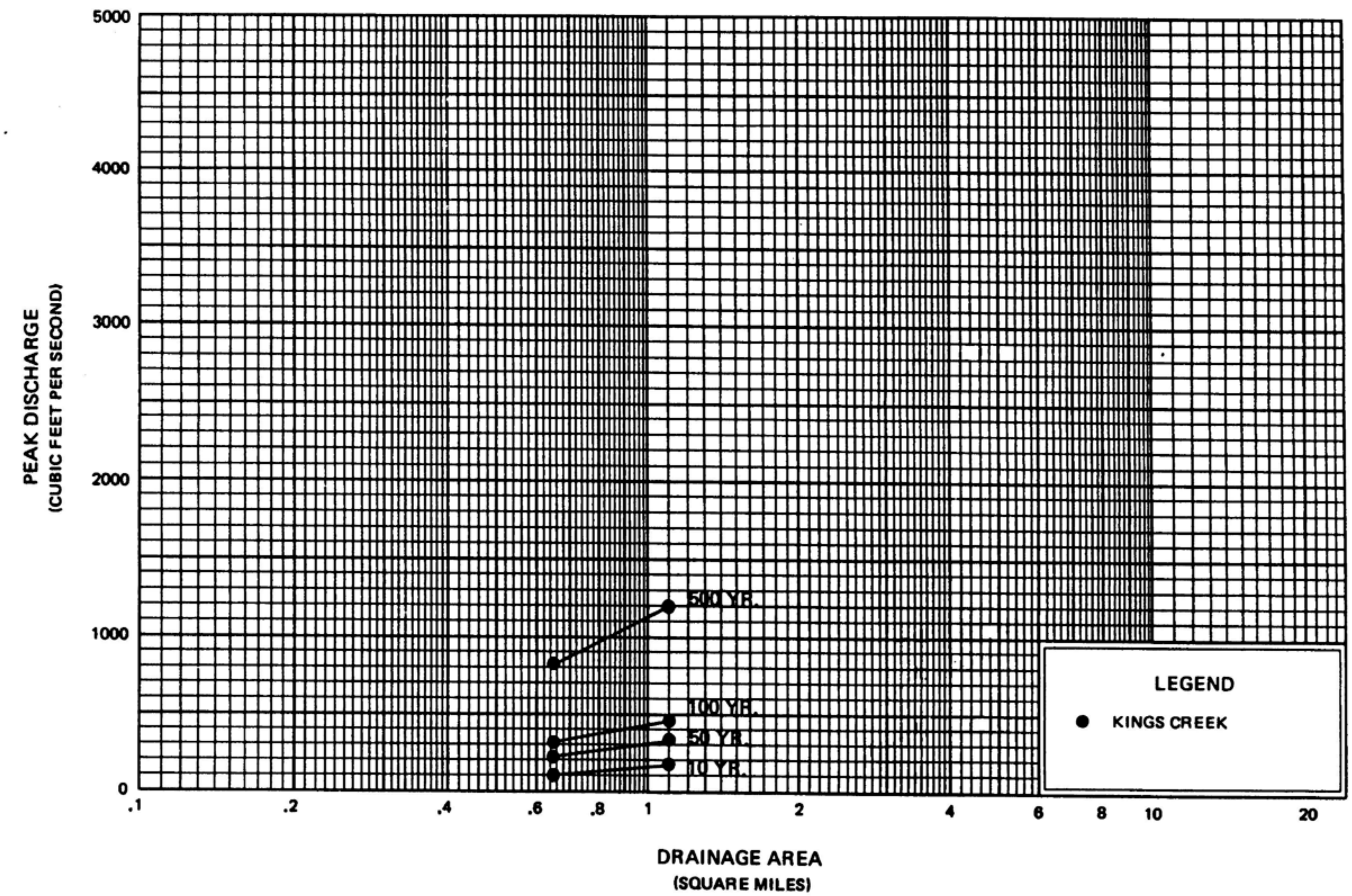
For locations on Nomahegan Brook upstream of Echo Lake, and for its branches, flood discharges up to the 1-percent annual chance value were computed using Special Report No. 38 (U.S. Department of the Interior, 1974). This method is in close agreement with the study techniques used at the mouth of Nomahegan Brook. For discharges for return periods between 1- and 0.2-percent annual chance, the flood-frequency curves were extended by comparing them with curves for stations downstream of Echo Lake.

For the September 20, 2006, FIS, an archived USACE HEC-1 flood hydrograph package computer model was used to verify and calibrate the September 16, 1999, Tropical Storm Floyd flood event in the Rahway River basin with the published hydrographs at the Springfield, New Jersey (01394500) and Rahway, New Jersey (01395000) USGS stream gages. For calibration, stage-storage relationships at Lenape Park were updated based on information provided by the Union County Department of Engineering. Also, stage-storage relationships at Nomahegan Park were calculated from topographic data provided by the Township of Cranford. For the analysis of the 10-, 2-, 1-, and 0.2-percent annual chance rainfall estimates were taken from NOAA Atlas 14, Volume 2, Version 2, for Springfield, New Jersey.

For [TBD], FIS revision hydrologic analyses were prepared for the Elizabeth River using gage data and New Jersey Regression Equations. The regional regression equations are used to improve the estimates of flood magnitude and frequency at gaged sites by weighting together the log-Pearson Type III data and the estimated data from the regression equations, according to their equivalent years of record.

The peak discharge computation procedure for using New Jersey Regression equations is presented in the publication "*Methodology for Estimation of Flood Magnitude and Frequency for New Jersey Streams*" (USGS, 2009). Based on physiography, soils, and precipitation, New Jersey is divided into five hydrologic regions. Union County falls within the Glaciated Portion of Piedmont Floodplain Region. The regression analysis indicated that flood discharge is related to the drainage area, main channel slope, percentage of lake and wetland areas in the basin, population density, and the flood-frequency region.

A summary of the drainage area-peak discharge relationships for all of the streams studied by detailed methods is shown in Table 5, “Summary of Discharges.” Drainage area-peak discharge relationships not presented in Table 5 are presented in Figure 1, “Frequency-Discharge, Drainage Area Curves.”



FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ
(ALL JURISDICTIONS)

FREQUENCY DISCHARGE, DRAINAGE AREA CURVES

KINGS CREEK

FIGURE 1

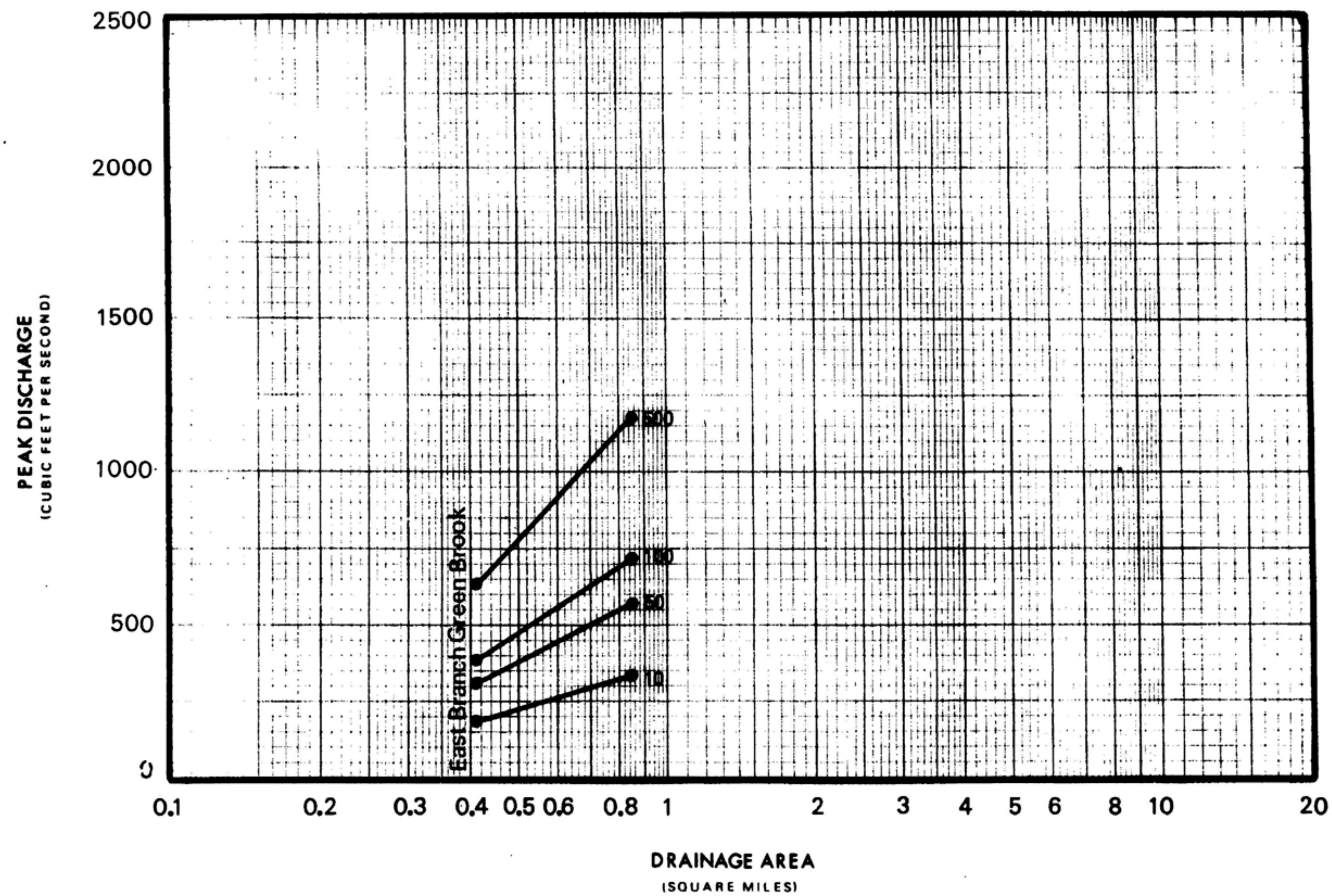


FIGURE 1

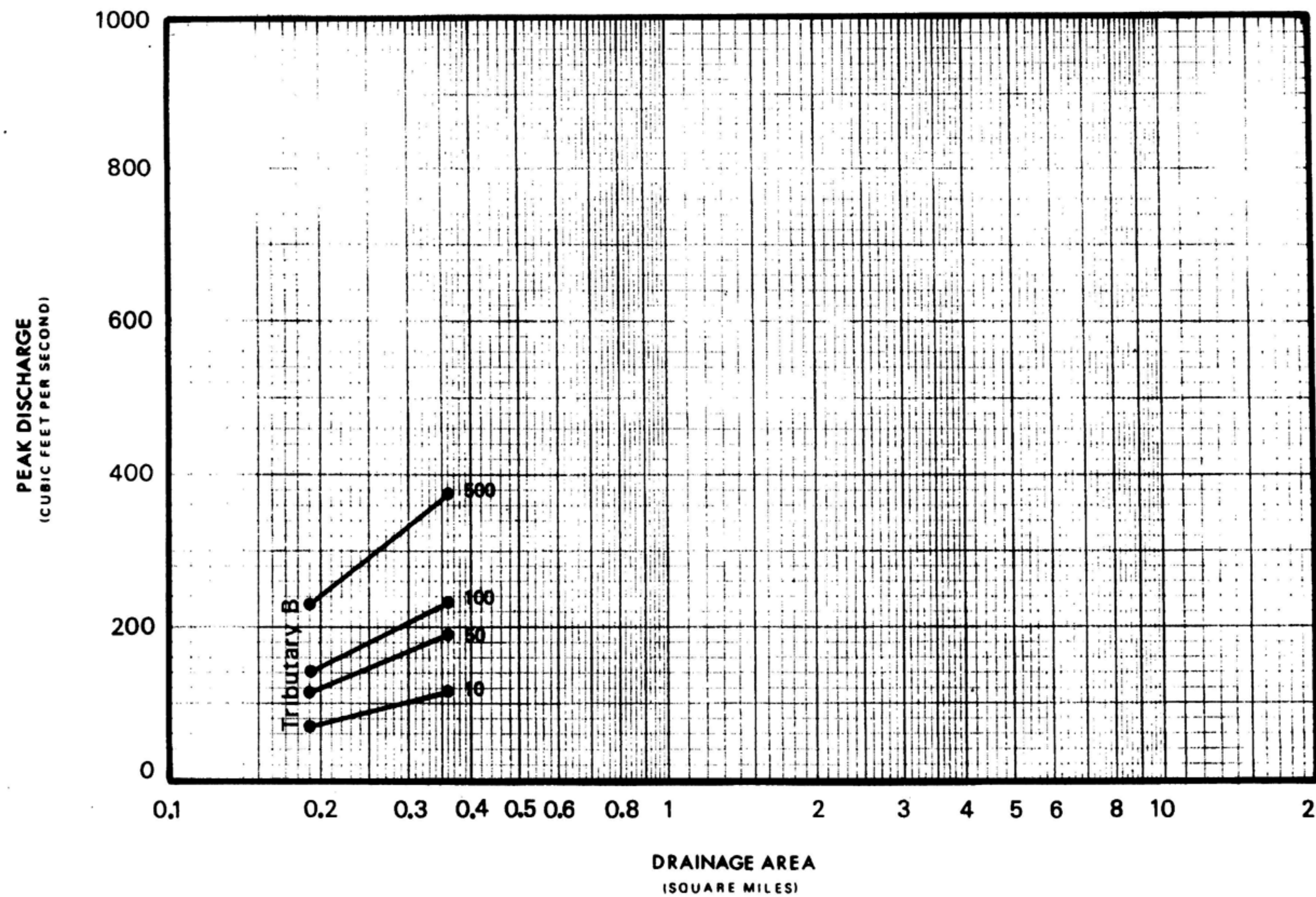
FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)

FREQUENCY-DISCHARGE, DRAINAGE AREA CURVES

EAST BRANCH GREEN BROOK



FEDERAL EMERGENCY MANAGEMENT AGENCY

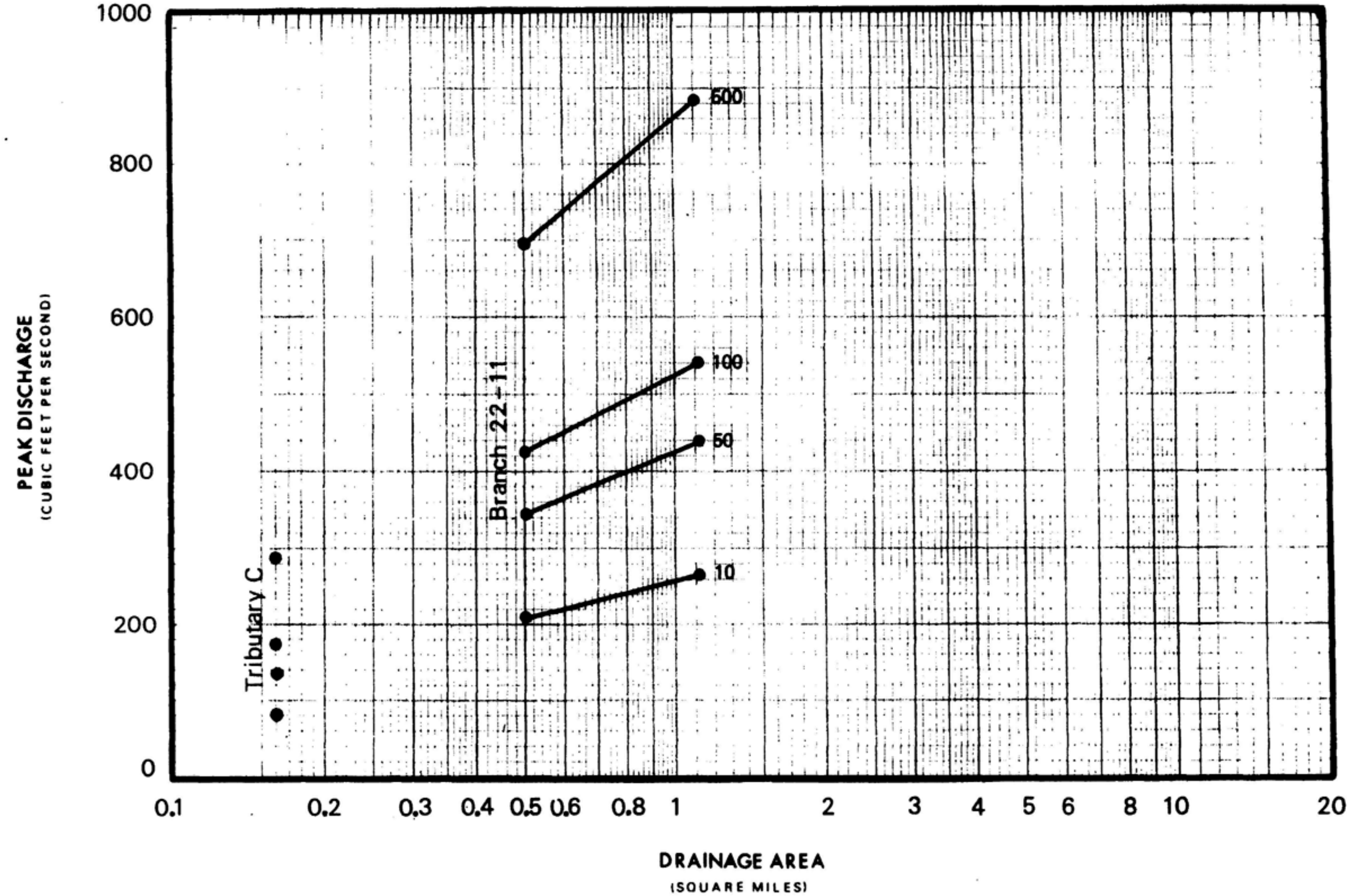
UNION COUNTY, NJ

(ALL JURISDICTIONS)

FREQUENCY-DISCHARGE, DRAINAGE AREA CURVES

TRIBUTARY B

FIGURE 1



FEDERAL EMERGENCY MANAGEMENT AGENCY

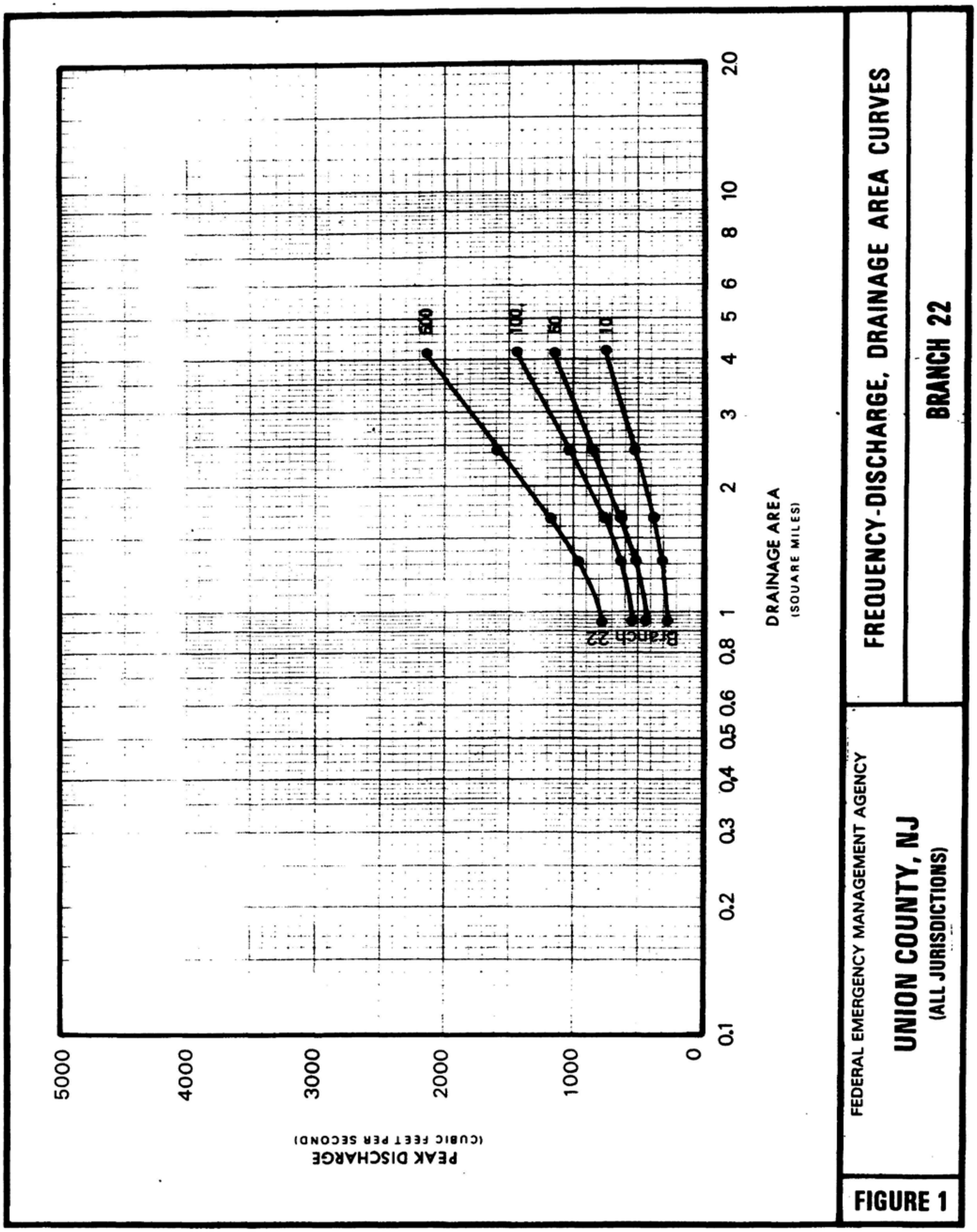
UNION COUNTY, NJ

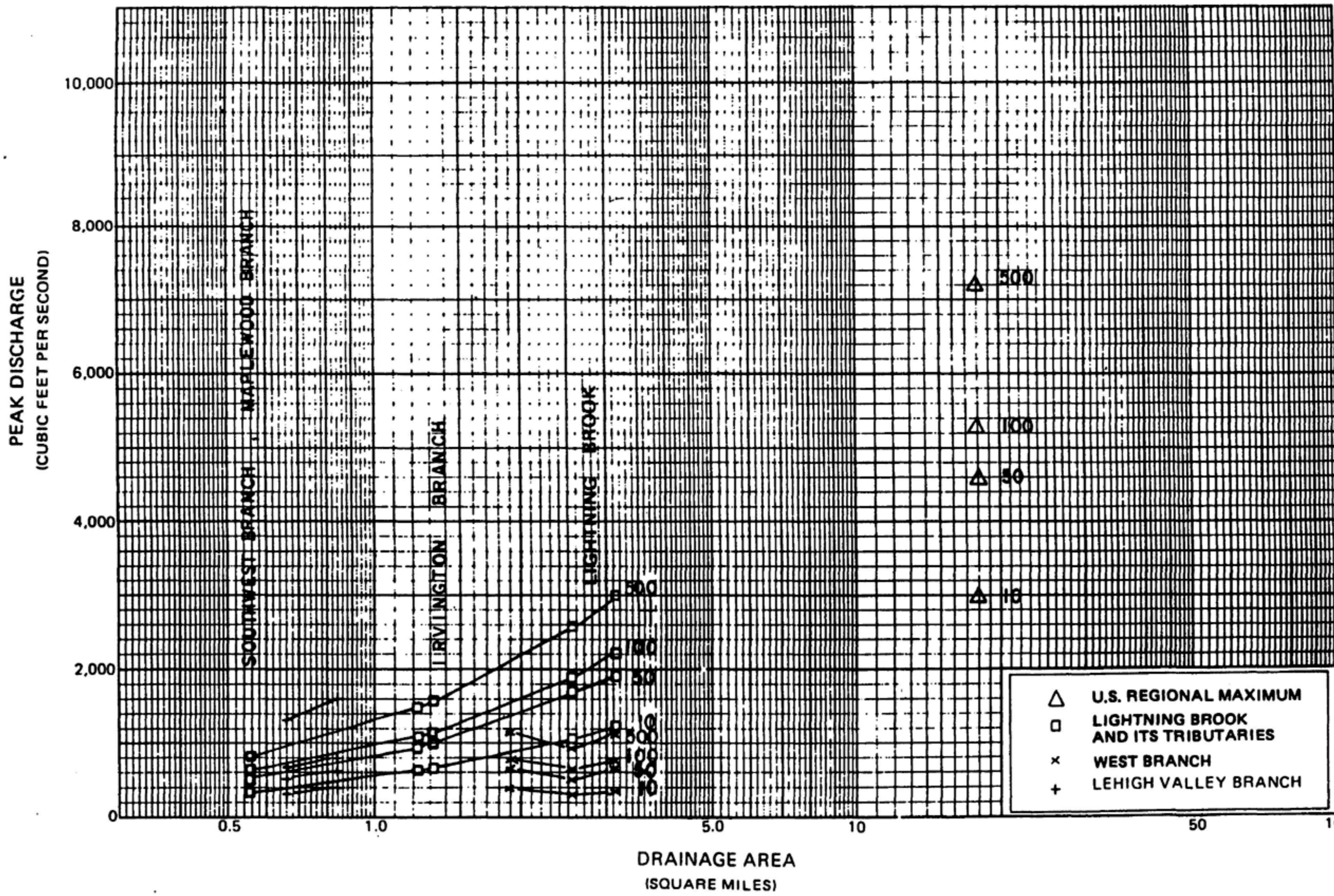
(ALL JURISDICTIONS)

FREQUENCY-DISCHARGE, DRAINAGE AREA CURVES

TRIBUTARY C, BRANCH 22–11

FIGURE 1


PEAK DISCHARGE
(CUBIC FEET PER SECOND)
5000
4000
3000
2000
1000
0
DRAINAGE AREA
(SQUARE MILES)
0.1
0.2
0.3
0.4
0.5
0.6
0.8
1
2
3
4
5
6
8
10
20
500
100
50
10
Branch 22
FEDERAL EMERGENCY MANAGEMENT AGENCY
UNION COUNTY, NJ
(ALL JURISDICTIONS)
FREQUENCY-DISCHARGE, DRAINAGE AREA CURVES
BRANCH 22
FIGURE 1



FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ
(ALL JURISDICTIONS)

FREQUENCY-DISCHARGE, DRAINAGE AREA CURVES

LEHIGH VALLEY BRANCH-WEST BRANCH-LIGHTNING BROOK-IRVINGTON BRANCH-MAPLEWOOD BRANCH-SOUTHWEST BRANCH

FIGURE 1

Table 5 – Summary of Discharges

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
BLACK BROOK					
At the confluence with the Rahway River	0.32	175	190	195	240
BLUE BROOK					
At confluence with Green Brook	6.30	1,380	2,480	3,240	5,200
Upstream of confluence with Green Brook	3.61	655	1,200	1,590	2,550
At Sky Top Drive	3.28	565	1,040	1,400	2,250
Approximately 3,140 feet upstream of Sky Top Drive	2.76	455	830	1,090	1,790
Approximately 1,040 feet downstream of Berkeley Heights-Summit corporate limits	2.55	382	710	949	1,582
BRANCH 10-24					
At the Cranford-Kenilworth corporate limits	0.19	200	250	275	400
At Bloomingdale Avenue	0.14	160	200	220	320
BRANCH 10-30-1					
At the confluence with Dranage Ditch	0.13	150	190	210	300
BRANCH WEST BROOK					
At confluence with West Brook	1.19	199	294	346	446
At Sixth Avenue	1.12	190	280	329	424
At Third Avenue	0.54	103	159	191	248
At Second Avenue	0.43	85	132	158	207
BRYANT BROOK					
At mouth	3.0	800	1,260	1,530	2,270
Upstream of the confluence of Bryant Brook Branch	2.1	550	880	1,070	1,590

Table 5 – Summary of Discharges – continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs)			
		10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
BRYANT BROOK BRANCH					
At confluence with Bryant Branch	0.5	190	290	360	530
CEDAR BROOK					
At county boundary	4.90	900	1,670	2,120	3,070
COLLEGE BRANCH					
At mouth	0.5	430	550	610	730
DRAINAGE DITCH					
At its confluence with the Rahway River	0.61	470	595	645	945
Upstream of Stream 10-30	0.19	200	250	280	400
ELIZABETH RIVER					
At its confluence with Arthur Kill, Downstream of South Front Street	23.1	3,513	4,434	4,811*	5,689
At Trotters Lane, Downstream of Ursino Lake	18.1	2,967	3,752	4,071	4,825
At the Elizabeth-Union-Hillside corporate limits	16.95	2,751	4,532	5,242	6,941
Just downstream of Liberty Avenue – below the confluence with Elizabeth River, West Branch	14.5	2,569	3,936	4,528	6,160
Just upstream of U.S. Route 22	9.9	1,918	2,939	3,381	4,600
Just upstream of Union Avenue	6.7	1,443	2,211	2,543	3,460
GALLOWS HILL ROAD BRANCH					
At mouth	1.1	275	339	365	402
At Brookside Place Road	0.9	105	133	140	203

*Peak discharge calculated for New Jersey Flood Hazard Area Design Flood (NJFHADF) is equal to the 1-percent annual chance flow plus an additional 25-percent in flow, and not to exceed the 0.2-percent annual chance flow – at this location the NJFHADF is equal to the 0.2-percent annual chance flood.

Table 5 – Summary of Discharges – continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
GARWOOD BROOK					
At mouth	1.4	450	700	940	1,460
GREEN BROOK					
Downstream of confluence of Stony Brook	18.20	3,650	6,100	7,900	15,200
Upstream of confluence of Stony Brook	10.30	2,040	2,500	2,850	4,150
At the Plainfield gage	9.75	1,815	1,950	2,100	2,635
At Norwood Avenue	9.00	1,750	1,780	1,850	2,135
From Leland Avenue to Netherwood Avenue	8.50	1,795	2,000	2,100	2,350
At Plainfield-Scotch Plains corporate limits	1*	1,730	2,550	2,630	3,060
Just downstream of U.S. Route 22	1*	1,620	2,480	2,700	3,100
Just downstream of Union Avenue	1*	1,450	2,600	3,370	5,410
At Terrill Road	4.90	900	1,670	2,120	3,070
Downstream of first crossing of New Providence Road	2.55	643	1,180	1,570	2,550
Approximately 400 feet downstream of first crossing of Bonnie Burn Road	1.60	475	870	1,160	1,890
Approximately 1,500 feet downstream of first crossing of Plainfield Avenue	0.77	256	465	620	1,010
Approximately 400 feet downstream of Plainfield Avenue	0.53	194	352	469	764
JOUET BROOK					
At St. Georges Avenue	1.03	141	215	251	328
At Rivington Street	0.98	128	194	227	296
At Frank Street	0.95	121	182	213	276
At Morris Street	0.92	113	170	190	257
At Warren Street	0.90	108	162	188	244
At Spruce Street	0.87	100	149	173	224
At Columbus Avenue	0.85	95	141	163	211

* Flow diversion between Green Brook and Cedar Brook watersheds – discharge-drainage area relationship inapplicable

Table 5 – Summary of Discharges – continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
JOUET BROOK (continued)					
At Spruce Street	0.76	85	104	119	152
At Warren Street	0.75	70	100	114	146
At Detention Pond	0.74	67	96	109	139
At Eighth Street	0.66	168	271	327	435
At Seventh Street	0.60	153	246	294	391
At Sixth Street	0.53	135	218	260	345
At Fifth Street	0.50	127	205	245	326
MORSES CREEK TRIBUTARY 9-1-7-1					
At Roselle-Roselle Park corporate limits, retained flow	0.38	43	61	68	87
At Roselle-Roselle Park corporate limits, unretained flow	0.38	175	250	285	390
NOMAHEGAN BROOK					
At Cranford-Westfield corporate limits	3.87	580	1,050	1,300	2,020
At Downstream end of Echo Lake	2.79	450	800	1,000	1,580
ORCHARD CREEK					
At mouth	1.4	661	865	930	1,100
At upstream corporate limits of Rahway	0.4	472	600	665	800
PASSAIC RIVER					
At confluence with Rockaway River	141.00	2,780	4,010	4,637	6,080
At Chatham gaga (No. 01379500)	100.00	2,182	3,030	3,414	4,190
PEACH ORCHARD BROOK					
Above confluence with West Brook	3.81	425	927	1,309	2,615
At CONRAIL	2.68	381	812	1,137	2,232
Above confluence of Jouet Brook	0.96	161	360	510	1,028

Table 5 – Summary of Discharges – continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
PUMPKIN PATCH BROOK					
At mouth	2.7	610	970	1,190	1,770
At county boundary	1.8	440	710	870	1,300
RAHWAY RIVER					
Downstream of confluence of South Branch Rahway River	77.4	4,874	8,175	9,932	14,984
Downstream of confluence of Robinsons Branch	64.8	3,498	6,127	7,404	11,904
At Rahway Gage (No. 01395000)	40.8	2,013	3,942	5,360	9,407
At Rahway Valley Railroad	36.3	1,962	3,877	5,207	9,195
At Kenilworth Boulevard (confluence of Nomahegan Brook)	30.9	1,765	3,586	4,808	8,412
Downstream of Lenape Park	30.8	1,810	4,775	6,825	11,796
At Springfield Gage (No. 01394500)	25.3	2,316	5,118	6,589	10,549
Downstream of the confluence of Van Winkles Brook	23.1	2,187	4,947	6,283	9,773
At Interstate 78	15.8	1,940	3,700	4,790	8,600
ROBINSONS BRANCH					
At mouth	22.9	1,980	3,280	4,000	6,125
At Rahway Gage No. 01396000	21.6	1,885	3,125	3,800	5,830
At Middlesex Reservoir Dam	20.5	1,800	2,990	3,640	5,575
Downstream of Winding Brook	15.8	1,400	2,150	2,500	3,580
Upstream of Winding Brook (mile 5.1)	12.6	1,170	1,850	2,120	3,020
At county boundary	5.8	1,000	1,600	1,820	2,600
ROBINSONS BRANCH 15					
At Scotch Plains-Westfield corporate limits	2.16	560	885	1,075	1,650

Table 5 – Summary of Discharges – continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
ROBINSONS BRANCH 15 (continued)					
Above confluence with Robinsons Branch 15-1	1.59	435	695	840	1,300
Above confluence with Robinsons Branch 15-2	1.02	303	492	600	920
ROBINSONS BRANCH 15-1					
At confluence with Robinsons Branch 15	0.46	318	442	486	620
ROBINSONS BRANCH 15-2					
At confluence with Robinsons Branch 15 (Lower)	0.39	240	314	344	450
At end of upper open channel portion near Tice Place	0.28	185	245	270	350
SALT BROOK					
At confluence with Passaic River	5.2	1,200	1,870	2,260	*
Upstream of confluence of West Branch of Salt Brook	4.1	1,000	1,570	1,900	*
SOUTH BRANCH RAHWAY RIVER					
At mouth	12.1	1,630	2,510	3,010	4,400
At county boundary	10.2	1,450	2,250	2,700	3,970
STREAM 10-30					
At the confluence with Drainage Ditch	0.40	350	440	480	700
TRIBUTARY TO RAHWAY RIVER					
At Cranford-Westfield corporate limits	0.53	160	195	210	270
Near Cranford Avenue	0.38	64	71	75	92

*Data Not Available

Table 5 – Summary of Discharges – continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
VAN WINKLES BROOK					
At mouth	5.4	1,180	1,840	2,230	3,260
Upstream of the confluence of Bryant Brook	2.1	610	980	1,190	1,770
At county boundary	1.2	410	670	860	1,230
WEST BRANCH OF SALT BROOK					
At confluence with Salt Brook	1.0	400	640	785	*
Upstream of Central Avenue	0.7	335	545	670	*
WEST BRANCH WEST BROOK					
At confluence with Branch West Brook	0.51	77	111	127	246
At Third Avenue	0.48	72	103	118	234
At Second Avenue	0.43	64	91	103	215
At First Avenue	0.42	62	88	100	210
WEST BROOK					
At the dam	9.71	1,036	1,799	2,440	4,650
Above confluence of Peach Orchard Brook	5.90	962	1,491	1,786	2,492
At Clinton Street	5.37	890	1,398	1,675	2,340
At U.S. Routes 1 and 9	4.99	845	1,315	1,577	2,206
At Munsell Avenue	4.39	752	1,175	1,411	1,975
At Linden Avenue	4.28	731	1,144	1,374	1,926
At Elizabeth Avenue	4.01	688	1,078	1,296	1,820
At Knopf Street	3.91	670	1,052	1,265	1,776
At Henry Street	3.83	651	1,023	1,230	1,729
At Wood Avenue	3.70	628	989	1,189	1,627
At St. Georges Avenue	3.54	637	1,004	1,209	1,527
At Brooklawn Avenue	3.39	600	947	1,141	1,481
At Raritan Road	2.97	533	846	1,020	1,344
At Roselle-Roselle Park corporate limits	0.97	141	174	181	271
At upstream corporate limit of Roselle Park	0.71	335	450	480	650

*Data Not Available

Table 5 – Summary of Discharges – continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
WEST BROOK (continued)					
At the Kenilworth-Roselle Park corporate limits	0.48	280	350	405	585
At Michigan Avenue	0.43	258	322	373	539
At Market Street	0.38	235	294	340	491
At Sumner Avenue	0.34	216	270	313	453

For streams studied by approximate methods, depth-discharge-frequency relationships for non-coastal plain sites in New Jersey, based on the mean annual flood, were used to establish flows and boundaries.

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the source 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 tables in the FIS report. For construction and/or floodplain management purposes, users are encouraged to use the flood elevation data presented in this FIS in conjunction with the data shown on the FIRM. Users of the FIRM should also be aware that coastal flood elevations are provided in the Summary of Stillwater Elevations table 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.

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 the computed water-surface elevations for floods of the selected recurrence intervals.

The hydraulic analyses for this FIS were based on unobstructed flow. The flood elevations shown on the profiles (Exhibit 1) are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

For each community within Union County that has a previously printed FIS report, the hydraulic analyses described in those reports have been compiled and are summarized below.

For all flooding sources studied by detailed methods, water-surface elevations of floods of the selected recurrence intervals were computed through use of the USACE HEC-2 step-backwater computer program (USACE, 1991).

Starting elevations for the Vauxhall Branch above Burnet Avenue were based on computing a rating curve for the culvert inlet at that point, calibrated against a floodmark.

Starting elevations for the Lehigh Valley Branch, West Branch, and Lightning Brook tributaries were obtained from flood profile elevations computed for the Elizabeth River main channel at their respective confluence points. Starting elevations for the Trotters Lane Branch were obtained by means of a rating curve developed for the Trotters Lane storm drain at Morris Avenue.

Within the Township of Berkeley Heights, cross sections for Green Brook and Blue Brook were obtained from previous studies prepared by the NJDEP and were supplemented with field surveys. Cross sections for the Passaic River were obtained from existing topographic information used in the previous January 6, 1999, FIS (FEMA, 1999). For Branch Blue Brook, Branch Green Brook, and Snyder Avenue Brook, cross sections for the backwater analyses were field surveyed and were located at close intervals above and below bridges and culverts to compute the significant backwater effects of these structures in urbanized areas. Existing topographic maps were used to augment surveyed cross-section data in the overbank areas.

Within the Township of Clark, cross-section data and bridge and culvert geometry for Pumpkin Patch Brook were field-surveyed by the USACE for their studies in the basin (USACE, 1973a). The USACE cross sections were used on Robinsons Branch downstream of Featherbed Lane, while the data developed for the Township of Scotch Plains FIS were used upstream (FEMA, 1977).

The acceptability of all assumed hydraulic factors, cross sections, and hydraulic structure data was checked by computations that duplicated historic floodwater profiles.

Within the Township of Cranford, cross-section data and bridge and culvert geometry for Garwood Brook, Gallows Hill Road Branch and College Branch were based on plans prepared for the Cranford Engineering Department and supplemented where required by new field surveys.

Within the City of Plainfield, cross-section information for Green Brook was obtained from Flood Hazard Report No. 3, Green Brook (State of New Jersey, 1972). This report is based on topographic maps prepared from aerial photographs dated March 1968 (Quinn and Associates, Inc., 1968). The maps were updated by field reconnaissance to include development in the floodplain areas. All bridges and culverts that were modified since these reports were surveyed to obtain elevation data and structural geometry.

For Cedar Brook, channel cross sections and partial overbank cross sections were obtained through field surveys. All bridges and culverts were surveyed to obtain elevation data and structural geometry. The overbanks were extended using topographic maps prepared from an aerial survey dated March 1979 (Topographic Data Consultants, Inc., 1979a). Cross sections for the backwater analyses of the streams studied by detailed methods were selected at close intervals above and below bridges and culverts in order to compute the significant backwater effects of those structures.

Within the Borough of Roselle, cross sections for the backwater analysis of West Brook and Branch West Brook, Jouet Brook, and Peach Orchard Brook were field surveyed and were located at close intervals above and below bridges and culverts in order to compute the significant backwater effects of these structures in urbanized areas. An existing topographic map (Hudson, Franklin, Consulting Engineer, 1962) was used to augment surveyed cross-section data in the overbank areas.

Within the Township of Scotch Plains, cross sections for the backwater analyses of the streams studied by detailed methods were field-surveyed and were located at close intervals above and below bridges and culverts in order to compute the significant backwater effects of these structures in the developed areas. In long segment lengths between structures, approximate valley cross sections were also surveyed.

Cross sections for Blue Brook and Green Brook were taken from previous studies performed by the NJDEP and were supplemented by field inspections. All bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry.

Starting water-surface elevations for Green Brook were taken from the City of Plainfield FIS (FEMA, 1983). The elevations were in agreement with a feasibility report prepared by the USACE (URS Corporation, Inc., 1980). Starting water surfaces for Blue Brook were taken from its confluence with Green Brook where their peaks were coincident at a point of combined flow.

Within the Township of Springfield, cross-section data and bridge and culvert geometry for Van Winkles Brook were obtained from field surveys by the USACE for their study of the Rahway River basin (USACE, 1973b).

Cross-section data and structural geometry for Bryant Brook and Bryant Brook Branch were obtained from channel improvement plans developed for the township, and construction plans for Interstate Route 78 developed for the New

Jersey Department of Transportation (Richard J. Jeske, Inc., 1972; State of New Jersey, 1978).

Within the Township of Union, cross sections for the backwater analysis of West Branch, Lehigh Valley Branch, Lightning Brook, Maplewood Branch, Irvington Branch, Southwest Branch, East Branch Rahway River, Branch 10-34, and Vauxhall Branch were field surveyed and were located at close intervals above and below bridges, culverts, and weirs in order to compute significant backwater effects of these structures in urbanized areas. Use was made of the cross-sectional channel survey on the main channel of the Rahway River previously surveyed by the USACE and of cross sections surveyed along the channel of parts of Lightning Brook surveyed by the township engineer. Existing sewer plates with street elevations, where available, were used to augment surveyed cross-section data in the overbank areas.

Within the Town of Westfield, channel cross sections and partial overbank cross sections were obtained through field surveys. The overbanks were extended using topographic maps derived from aerial photos (Westfield Aerial Survey, 1971). In areas where the maps did not indicate recent development, full cross sections of the streams were taken.

Starting water-surface elevations for the Passaic River were determined from the Township of Fairfield, New Jersey, FIS at the corporate limits for the Township of Fairfield and the Borough of West Caldwell (station 243,680). Starting water-surface elevations for the four tributaries of the Passaic River were determined from flood profile elevations of the Passaic River at their respective confluences.

For the Township of Berkeley Heights, the hydraulic analyses represent the conditions of culverts at the time of the original study and are based generally on unobstructed flow. Exceptions to this rule were made on Green Brook at Plainfield Avenue at Runnel's Hospital for the 0.2-percent annual chance flood which is expected to obstruct the bridge opening in the same manner as the August 1973 flood, both being of comparable discharge magnitude. The same premise applies to the Green Brook bridge crossing at Valley Road.

Normal depth from slope/area calculations was used as the starting water-surface elevation for Pumpkin Patch Brook.

Starting water-surface elevations for the Drainage Ditch, Garwood Brook, Gallows Hill Road Branch and College Branch were determined from normal depths taken from slope/area calculations.

Within the Borough of Garwood, the starting water-surface elevation for Garwood Brook at its confluence with the Rahway River was obtained from a study of the Rahway River. Water-surface profiles were developed by using USGS gage data at Springfield and Rahway, which are located upstream and downstream, respectively, from the Rahway River confluence point. Additional detailed profile information as obtained from records kept by the Union County Park Commission from 1938 through 1973. Numerous flood marks for both the flood of August 3, 1973, and Tropical Storm Doria of August 28 and 29, 1971, were obtained from borough officials and local citizens. Many of these are documented with photographs, showing the actual flooding conditions. The HEC-2 backwater computer runs were calibrated by modeling the discharges of the flood of August 2, 1972, so that the computed stream profile for natural stream conditions matched six known flood mark points. The stream has been remodeled in this revised study to incorporate channel modifications.

Within the City of Linden, starting water-surface elevations for all streams except Arthur Kill were obtained from a known water-surface elevation from Arthur Kill were obtained from a known water-surface elevation from Arthur Kill. Starting water-surface elevations for Arthur Kill were obtained from the City of New York City, New York, FIS (FEMA, 1994).

Channel cross sections and partial overbank cross sections for Drainage Ditch, Branch 10-30, West Brook, Branch 10-24, Branch 10-30-1, and Black Brook were obtained through field surveys. The overbanks were extended using topographic maps compiled from aerial photographs (Topographic Data Consultants, 1979b).

Starting water-surface elevations for Branch 10-24, Black Brook, and the Drainage Ditch were determined using the slope/area method. For Stream 10-30 and Branch 10-30-1, starting water-surface elevations were established by considering their peak discharge on the peak discharge of the Drainage Ditch and selecting the corresponding stage elevation of the Drainage Ditch.

For Salt Brook and West Branch of Salt Brook, starting water-surface elevations were calculated using a known water-surface elevation.

Within the City of Rahway, starting water-surface elevations for South Branch Rahway River were obtained from a known water-surface elevation from Arthur Kill. Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals. Hydraulic calculations on South Branch Rahway River were begun at a 10-percent annual chance recurrence interval tidal level. Calculations on Robinsons Branch were begun at coincident Rahway River flood elevations determined using the hydrograph analysis contained in the USACE report on flood control for Robinsons Branch (USACE, 1973a). For Orchard Creek, hydraulic calculations were begun at the upstream end of the railroad culvert using elevations resulting from a hydrologic routing through the culvert based on a tail water elevation equal to that of a 10-percent annual chance flood on the South Branch Rahway River.

The HEC-2 model used for the South Branch Rahway River was coded originally in 1975 as part of a report, Special Flood Hazard Information Report, the South Branch of the Rahway River, prepared for the New York District USACE (USACE, 1975). This model was updated, where required, to reflect current conditions in the watershed and adjusted to allow the development of a valid floodway.

The Robinsons Branch model was calibrated to measured high water marks from the August 1971 storm.

The starting elevations for the water-surface profiles for West Brook and Peach Orchard Brook were obtained from the the City of Linden FIS and reconfirmed by flood mark data available along St. Georges Avenue. The starting elevations for Jouet Brook were obtained by computing a staged discharge curve based on flood mark elevation data for tropical storm Doria. Starting elevations for Branch West Brook were determined from computed stream profile elevations of West Brook and its confluence with the branch.

Within the Borough of Roselle Park, cross sections for the flooding sources studied by detailed methods were obtained from field surveys. The overbanks were extended using topographic maps supplied by the Borough of Roselle Park from an aerial survey (Borough of Roselle Park, 1970). In areas where the aerial photographs did not indicate recent development, full cross sections of the streams were taken. All bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry to compute the significant backwater effects of these structures.

Starting water-surface elevations for Morses Creek were taken from the FIS for the Borough of Roselle (FEMA, 1978). For Morses Creek Tributary 9-1-7-1, starting water-surface elevations were based on stage-discharge relationships for the retention basin at the Hawthorne Street playground area. Starting elevations for Morses Creek Tributary 9-1-7 were determined using the slope/area method. Starting water-surface elevations for Peach Orchard Creek were derived from headwater depths at the downstream box culvert with inlet controls.

Morses Creek Tributary 9-1-7-1 was analyzed for a detention basin. A standard inflow-outflow routing procedure based on an empirical hydrograph was used in the analysis. A separate analysis was performed by the borough engineer and results were comparable. Based upon these calculations, the retention basin design indicates that flooding will not occur along Morses Creek Tributary 9-1-7-1. Also, detailed analysis for the upstream and downstream drainage piping along Morses Creek Tributary 9-1-7-1 indicates that they are adequate to eliminate flooding in this area. Since all floods are contained in the basin and culverts, no profiles or floodway data have been developed.

Similarly, profiles and floodway data tables were not developed for Peach Orchard Brook and Morses Creek Tributary 9-1-7 since they are shallow flooding areas within the Borough of Roselle Park. First, the streams were analyzed without external effects to establish flood elevations. The analyses indicated that Peach Orchard Brook should be designated as a shallow flooding area. Then the flood outlines based upon these elevations were evaluated. The resultant flood outlines are a combination of stream backwater and overland flow from Morses Creek Tributary 9-1-7.

The acceptability of all assumed hydraulic factors, cross sections and hydraulic structure data was checked by computations that duplicated historic flood-water profiles.

For Van Winkles and Bryant Brook, normal depth, developed from slope/area calculations, was used for starting water-surface elevations.

Bryant Brook and Bryant Brook Branch were modeled as a single stream system. The discharge entering the system was distributed into each channel by a trial and error procedures varying the flow split until the energy grade lines at the upstream end of each stream balanced.

No profile was shown for the Old Channel Rahway River as this information was taken from the FIS for the Township of Springfield, which contained no profile information (FEMA, 1982).

Starting elevations for Branch 10-34, Vauxhall Branch, East Branch Rahway River, and South Branch Rahway River were obtained from flood profile elevations computed for the main, or receiving, stream at their respective confluence points. Starting elevations for the Vauxhall Branch above Burnet Avenue were based on computing a rating curve for the culvert inlet at that point, calibrated against a flood mark.

Starting water surface elevations for the Lehigh Valley Branch, West Branch, and Lightning Brook tributaries were obtained from flood profile elevations computed for the Elizabeth River main channel at their respective confluence points. Starting water surface elevations for the Trotters Lane Branch were obtained by means of a rating curve developed for the Trotters Lane storm drain at Morris Avenue.

Gallows Hill Road Branch was analyzed for the retention basin along the stream. A standard inflow-outflow routing procedure based on an empirical hydrograph, was used in the analysis. These calculations indicate that the retention basin will be adequate to prevent flooding in the area.

Starting water-surface elevations were determined for Robinsons Branch 15 using the slope-energy method downstream of the corporate limits through bridge structures; for Robinsons Branch 15-1 and Robinsons Branch 15-2 at the points of confluence with Robinsons Branch 15; for Nomahegan Brook-Echo Lake via the

FIS for Mountainside, New Jersey (FEMA, 1976); and for Tributary to Rahway River using the slope/area method.

Within the Borough of Mountainside, cross sections for the backwater analysis of Nomahegan Brook and its four tributaries were field surveyed and were located at close intervals above and below bridges and culverts to compute the significant backwater effects of these structures in urbanized areas. Existing topographic maps were used to augment surveyed cross-section data in the overbank areas.

Channel and roughness factors (Manning's "n") for these computations were assigned on the basis of field reconnaissance of floodplain areas. The computer program was calibrated by routing floodflows of the August 1973 storm through floodmarks obtained from published sources and by interviewing local residents. Flood mark information obtained by interview was integrated with known elevations which were obtained during the survey phase.

The 1-percent annual chance flood for Blue Brook, from a point approximately 1.4 miles upstream of Seeley's Pond Dam to the upstream corporate limits, was approximated by the use of flood mark information obtained for the storm of August 2 and 3, 1973, adjusted to a 1-percent annual chance frequency.

Within the Township of Hillside, for the streams studied by approximate methods, depth-discharge-frequency relationships for non-coastal plain sites in New Jersey (based on the mean annual flood) were used, along with information supplied by the Township Engineer and field investigation; to establish flows and boundaries (State of New Jersey, 1964).

Historical flood limits combined with engineering judgment were used to define the extent of flooding in the area studied by approximate methods. These limits were then compared to approximate limits of flooding determined using curves established for non-coastal plain sites in New Jersey by the NJDEP. The curves use the mean annual flood discharge for a specific area to predict the depth of flow for a specific frequency.

Elevations, depths, and boundaries for AO and AH zones along Arlington Avenue, Randolph Road, and South Avenue were determined by historical information and engineering judgment.

In the Borough of Roselle, for the flooding sources studied by approximate methods, the extent of flooding was determined using information from the Borough of Roselle Park engineer and through field observation.

For the September 20, 2006, FIS, cross-section data for the Rahway River were obtained from photogrammetric surveys, field surveys, and existing HEC-2 models developed as part of previous FISs. All bridges, dams, and culverts were field surveyed or modeled using as-built plans to obtain elevation data and structural geometry. Starting water-surface elevations for the Rahway River were determined by obtaining mean-higher high water on Arthur Kill. Water-surface elevations of floods of the selected recurrence intervals were computed using the USACE HEC-RAS computer program, version 3.1.2 (USACE, 2004). Water-surface profiles for the Elizabeth River within the Township of Hillside and Union were compiled based on HEC-2 input and output files obtained from and developed by the USACE, New York District, for flood control projects along the Elizabeth River. Starting water-surface elevations were taken from the FIS for the City of Elizabeth (FEMA, 1985).

For the [TBD], FIS, detailed hydraulic analyses were carried out using HEC-RAS, version 4.1 (USACE, 2010). Cross-sections were cut from the available topographic data using RAMPP's GEORAMPP toolset within an Environmental Systems Research Institute (ESRI) ArcMap Geographic Information Systems platform. Study methods studies utilized GeoRAS version 4.2 in conjunction with GeoRAMPP toolset. Light Detection and Ranging (LiDAR) data was obtained from the LiDAR acquisition iniittative led by the USGS in 2006 for the metropolitan New Jersey area. That LiDAR data was used to create the terrain model used. Field survey information was collected along natural channel cross-sections for the channels of detailed studied streams. The channel survey data were used as the terrain source for the channels and the topographic data were used as the terrain source for the overbanks for the detailed study streams. For cross-sections that were not surveyed, channel geometry was interpolated between surveyed cross-sections and extrapolated beyond channel cross-sections.

In some instances, the terrain model did not pick up the full depth or shape of the channel or the true height of the channel banks as noted in the field reconnaissance or field survey. For example, the terrain model may not pick up data within steep slopes or steep banks. For cases where there was a difference between the terrain model and the contour data, engineering judgment was used to determine the floodplain boundary based on the field survey and/or field reconnaissance and contour data.

For the Elizabeth River, Overbank Manning's "n" polygons were based on Chow's publication of Open Channel Hydraulics and the "Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Flood Plains" were used as a reference for "n" value selection (Chow, 1959).

Calibration for the Elizabeth River hydraulic model was carried out using stream gage data recorded at the USGS gage location at Ursino Lake in Elizabeth, NJ (01393450). The USGS gage data reported peak discharges and corresponding gage heights which were used for model calibration.

Starting water surface elevations for the Elizabeth River were obtained from the Arthur Kill, updated for this FIS revision as a part of the coastal analyses.

Roughness factors (Manning's “n”) used in the hydraulic computations for all detailed streams were chosen by engineering judgment and were based on field observations of the streams and floodplain areas. Roughness factors for all streams studied by detailed methods are shown in Table 6, “Manning's “n” Values.”

Table 6 – Manning’s “n” Values

Stream	Channel "n"	Overbank "n"
Blue Brook	0.040	0.070
Branch 10-24	0.020-0.035	0.050-0.120
Branch 10-30-1	0.025-0.035	0.080-0.100
Bryant Brook	0.020	0.030-0.060
Bryant Brook Branch	0.040	0.030-0.060
Cedar Brook	0.025-0.035	0.060-0.080
College Branch	0.025-0.040	0.060
Drainage Ditch	0.030-0.035	0.060-0.100
East Branch Rahway River	*	*
Elizabeth River	0.020-0.030	0.035-0.140
Gallows Hill Road Branch	0.018	*
Garwood Brook	0.025-0.040	0.060
Green Brook	0.035-0.055	0.050-0.160
Morses Creek	0.012-0.035	0.050-0.150
Morses Creek Tributary 9-1-7-1	0.012-0.035	0.05-0.150
Nomahegan Brook	0.015-0.035	0.080-0.120
Nomahegan Brook-Echo Lake	0.015-0.035	0.080-0.120
Orchard Creek	0.040	0.020-0.060
Passaic River	0.025-0.055	0.025-0.080
Peach Orchard Brook	0.012-0.035	0.05-0.150
Pumpkin Patch Brook	0.040	0.050-0.080
Rahway River	0.018-0.050	0.015-0.080
Robinsons Branch	0.030-0.100	0.060-0.150
Robinsons Branch 15	0.015-0.035	0.080-0.120
Robinsons Branch 15-1	0.015-0.035	0.080-0.120
Robinsons Branch 15-2	0.015-0.035	0.080-0.120
Salt Brook	0.017-0.040	0.050-0.080
South Branch Rahway River	0.030-0.040	0.060-0.100
Tributary to Rahway River	0.015-0.035	0.080-0.120
Van Winkles Brook	0.040	0.060
West Branch of Salt Brook	0.017-0.048	0.060-0.080
West Brook	0.015-0.035	0.060-0.120

* Data Not Available

The channel and overbank "n" values are not available for the following streams studied by detailed methods:

Branch 10-34
Branch 22
Branch 22-11
Branch Blue Brook
Branch Green Brook
Branch West Brook
Branches 1, 2, 3, and 7 of Nomahegan Brook
East Branch Green Brook
Irvington Branch
Jouet Brook
Kings Creek
Lehigh Valley Branch
Lightning Brook
Maplewood Branch
Snyder Avenue Brook
Southwest Branch
Stream 10-30
Subbranch, Branch 2 Nomahegan Brook
Tributary A
Tributary B
Tributary C
Trotters Lane Branch
Vauxhall Branch
Vauxhall Sub-Branch
West Branch
West Branch West Brook
Winding Brook

All elevations for the updated coastal analyses and the Elizabeth River and corresponding FIRM panels (34039C0014G, 34039C0015G, 34039C0023G, 34039C0024G, 34039C0025G, 34039C0026G, 34039C0033G, 34039C0034G, 34039C0035G, 34039C0036G, 34039C0043G, 34039C0044G, 34039C0045G, 34039C0046G, 34039C0047G, and 34039C0048G) are referenced to NAVD88. All other FIRMs panels are referenced to the National Geodetic Vertical Datum of 1929 (NGVD29) and will be updated in a future update.

Qualifying bench marks within a given jurisdiction that are cataloged 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.

Bench marks cataloged 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 well (e.g., mounted in bedrock)

- Stability B: Monuments which generally hold their position/elevation well (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 bench marks, 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 bench marks 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 associated with this FIS and FIRM. Interested individuals may contact FEMA to access this data.

3.3 Coastal Analyses

Coastal storm surge analyses were performed for the Newark Bay and Arthur Kill and all the bays and inlets within these areas.

The extent of coastal flooding due to hurricanes and northeasters is determined by three factors: 1) the nature of the storm with respect to intensity, duration, and path; 2) astronomical tide conditions at the time the storm-surge wave reaches the shore; and 3) the physical geometry and bathymetry of a particular area, which affects the time and passage of the surge wave.

The FEMA, Region II office, initiated a study in 2009 to update the coastal storm surge elevations within the states of New York and New Jersey including the Atlantic Ocean, the Barnegat Bay, the Raritan Bay, the Jamaica Bay, the Long Island Sound and their tributaries. The study replaces outdated coastal analysis as well as previously published storm surge stillwater elevations for all FIS Reports in the study area, including Union County, New Jersey, and serves as the basis for updated FIRMs. The coastal study for the New Jersey Atlantic Ocean coast and New York City coast was conducted for FEMA by RAMPP under contract HSFEHQ-09-D-0369 task order HSFE02-09-J-0001.

The region wide, 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. ADCIRC was dynamically coupled to the unstructured numerical wave model Simulating Waves Nearshore (unSWAN) to calculate the contribution of waves to total storm surge (FEMA, 2013). The resulting model system is typically referred to as SWAN+ADCIRC (FEMA, 2013). 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 five major flood events for the Region II domain: the 1938 hurricane, Hurricane Ethel, Hurricane Gloria, and two extra-tropical storms, from 1991 and 1992. Two of the more recent storm events, Hurricane Irene and Hurricane Sandy were not used in this study for validation. Both Hurricane Irene and Hurricane Sandy occurred during the study or after this storm surge was completed. Hurricane Irene was a major rainfall event and did not produce major coastal tidal flooding. The climatology of Hurricane Sandy, at this time, is not well studied.

Model skill was assessed by quantitative comparison of model output to wind, wave, and water level and high water mark observations. The model was then used to simulate 30 historical extra-tropical storms and 157 synthetic hurricanes to create a synthetic water elevation record from which the 10-, 2-, 1-, and 0.2-percent annual chance of exceedence elevations were determined.

Wave set up is the increase in mean water level above the still water level due to momentum transfer to the water column by waves that are breaking or otherwise dissipating their energy (Dean, 2010). For the New York and New Jersey surge 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 the wave modeling.

The stillwater elevations for the 10-, 2-, 1-, and 0.2- percent annual chance floods determined for the primary sources of flooding in Union County: Arthur Kill and Newark Bay are shown in Table 7, "Transect Data". The analysis reported herein reflect the stillwater elevations due to tidal and wind setup effects. 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.

The Newark Bay and Arthur Kill are the primary flooding sources in Union County. Coastal flooding along Newark Bay and Arthur Kill along the eastern boundary of the county affects the municipalities along this shoreline including the City of Elizabeth and the Newark Airport. In Union the shoreline is primarily industrial and is protected by bulkheads.

The tidal surge in the Newark Bay and Arthur Kill affects approximately 7.5 miles (mi.) of Union County coastline, and all of the coastline was modeled for overland wave propagation. The fetch length across the Newark Bay varies from approximately 0.8 to 1.6 mi., and across the Arthur Kill varies from approximately 0.1 to 0.6 mi.

The coastal hydraulic analysis for this countywide FIS revision involved transect layout, field reconnaissance, and overland wave modeling including wave setup, wave height and wave run-up analysis.

Transects represent the locations where the overland wave height analysis was modeled and are placed with consideration given to topography, land use, shoreline features and orientation, and the available fetch distance. Each transect was placed to capture the dominant wave direction, typically perpendicular to the shoreline and extended inland to a point where coastal flooding ceased. Along each transect, wave heights were computed considering the combined effects of changes in ground elevation, obstructions, and wind contributions. Transects were placed along the shoreline along all sources of primary flooding in Essex County, as illustrated on the FIRMs and Figure 2, "Transect Location Map". Transects also represent locations visited during field reconnaissance to assist in parameterizing obstructions and observing shore protection features.

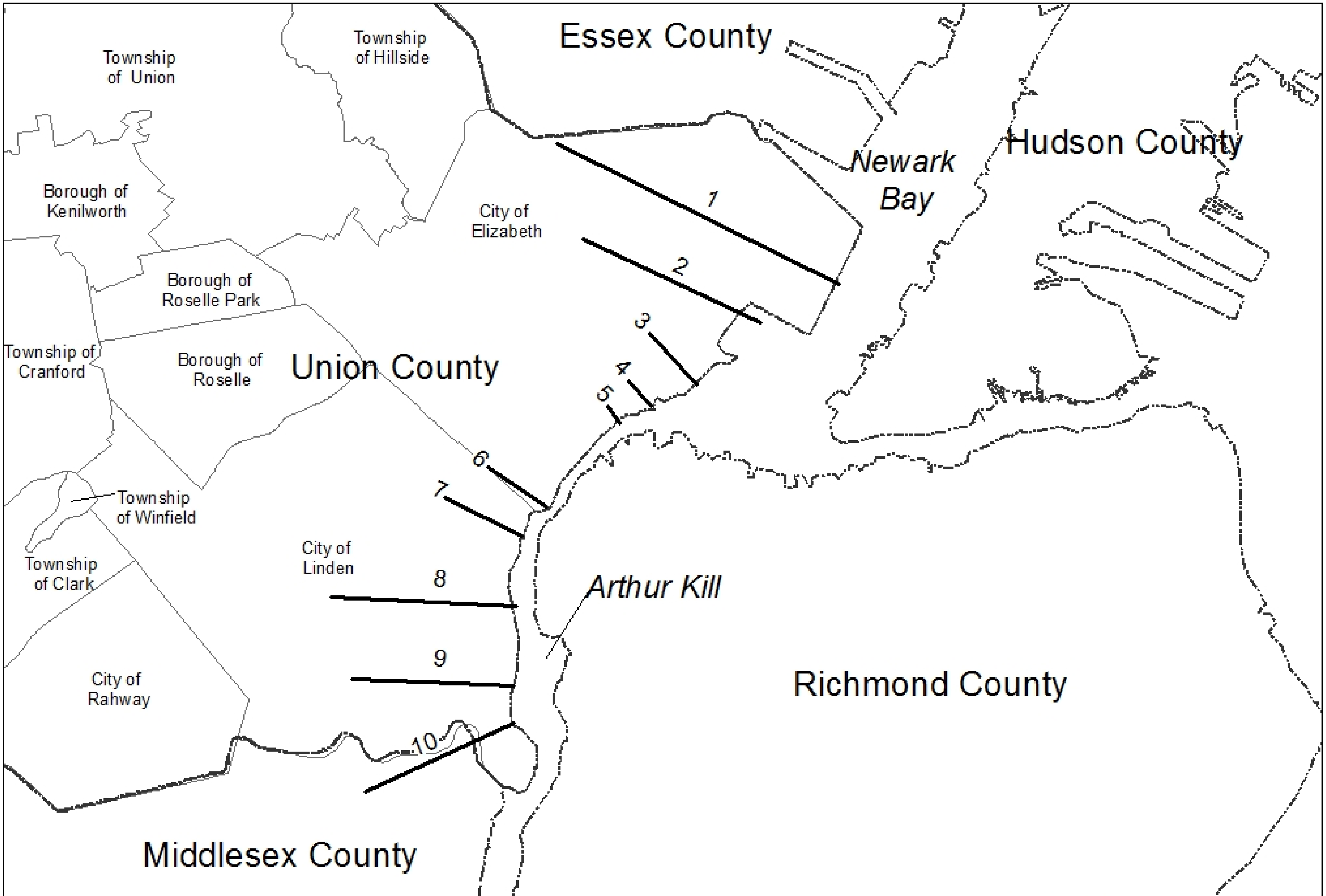


Figure 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NEW JERSEY (ALL JURISDICTIONS)

TRANSECT LOCATION MAP

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) (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 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.

Simulations of inland wave propagation were 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 total stillwater and starting wave information extracted from the coupled wave and storm surge model. In Table 7, "Transect Data," the 10-, 2-, 1-, and 0.2-percent annual chance stillwater elevations for each transect are provided along with the starting wave height and period. Simulations of wave transformations were then conducted with WHAFIS taking into account the storm-induced erosion and overland features of each transect. The model outputs the combined flood elevation from the total 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 heights were calculated to the nearest 0.1 foot, and BFEs were determined at whole-foot increments along the transects.

<u>Table 7 – Transect Data</u>

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
Newark Bay	1	N 40.665911 W 74.144472	3.23	3.43	7.0 7.0 – 7.1	9.7 9.1 – 9.8	10.8 10.5 - 12.7	13.8 13.6 – 15.3
Newark Bay	2	N 40.660539 W 74.159336	2.97	2.92	7.0 6.8 – 7.1	9.7 9.1 – 9.8	10.9 10.6 – 10.9	13.9 13.7 – 14.6
Newark Bay	3	N 40.651747 W 74.171237	2.49	3.18	7.1 6.6 – 7.1	9.8 9.4 – 9.8	11.0 10.9 – 11.2	13.9 13.9 – 14.0

Table 7 – 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
Newark Bay	4	N 40.648891 W 74.180046	2.12	2.91	7.2 7.1 – 7.2	9.9	11.1 11.0 – 11.1	14.0
Arthur Kill	5	N 40.646484 W 74.185803	1.82	2.59	7.2	9.9 9.9 – 10.0	11.1 11.1 – 11.7	14.1 13.9 – 14.1
Arthur Kill	6	N 40.634647 W 74.19972	1.69	2.32	7.3	10.2 9.6 – 10.2	11.5 11.2 - 11.5	14.6 14.6 – 14.9
Arthur Kill	7	N 40.630539 W 74.204308	1.29	2.17	7.5 4.7 – 7.6	10.3 9.8 – 10.3	11.6 11.4 – 11.6	14.8 14.7 - 15.0
Arthur Kill	8	N 40.620725 W 74.205306	1.58	2.32	7.4 2.7 – 7.6	10.4 9.5 - 10.4	11.6 11.2 - 12.8	14.9 14.8 – 15.4
Arthur Kill	9	N 40.609615 W 74.205865	1.16	2.02	7.5 7.5 – 8.4	10.4 9.9 - 10.8	11.7 11.5 - 12.8	14.9 14.8 – 15.5
Arthur Kill	10	N 40.604288 W 74.205772	1.28	2.01	7.5 7.5 - 7.6	10.4 10.4 - 10.5	11.7 11.6 - 11.8	14.9 14.9 - 15.2

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 II 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.

The results of the overland wave height and runup calculations are accurate until local topography, vegetation, or cultural development within the community undergoes major changes. Consequently between transects, elevations were interpolated using topographic maps, land-use and land-cover data, and engineering judgment to determine the extent of coastal flood zones.

Areas of coastline subject to significant wave attack are referred to as coastal high hazard area. The USACE has established the 3-foot breaking wave as the criterion for identifying the limit of coastal high hazard area. The 3-foot wave has been determined to be the minimum size wave capable of causing major damage to conventional wood frame of brick veneer structures. The one exception to the 3-foot wave criteria is where a primary frontal dune exists. The limit of the coastal high hazard area then becomes the landward toe of the primary frontal dune or where a 3-foot or greater breaking wave exists, whichever is most landward. The coastal high hazard zone is depicted on the FIRMs as Zone VE, where the delineated flood hazard includes wave heights equal to or greater than three feet. Zone AE is depicted on the FIRMs where the delineated flood hazard includes wave heights less than three feet. A depiction of how the Zones VE and AE are mapped is shown in Figure 3, "Transect Schematic".

Post-storm field visits and laboratory tests have confirmed that wave heights as small as 1.5 feet can cause significant damage to structures when constructed without consideration to the coastal hazards. Additional flood hazards associated with coastal waves include floating debris, high velocity flow, erosion, and scour which can cause damage to Zone AE-type construction in these coastal areas. To help community officials and property owners recognize this increased potential for damage due to wave action in the AE zone, FEMA issued guidance in December 2008 on identifying and mapping the 1.5-foot wave height line, referred to as the Limit of Moderate Wave Action (LiMWA). While FEMA does not impose floodplain management requirements based on the LiMWA, the LiMWA is provided to help communicate the higher risk that exists in that area (FEMA, 2008). Consequently, it is important to be aware of the area between this inland limit and the Zone VE boundary as it still poses a high risk, though not as high of a risk as Zone VE, see Figure 3, "Transect Schematic".

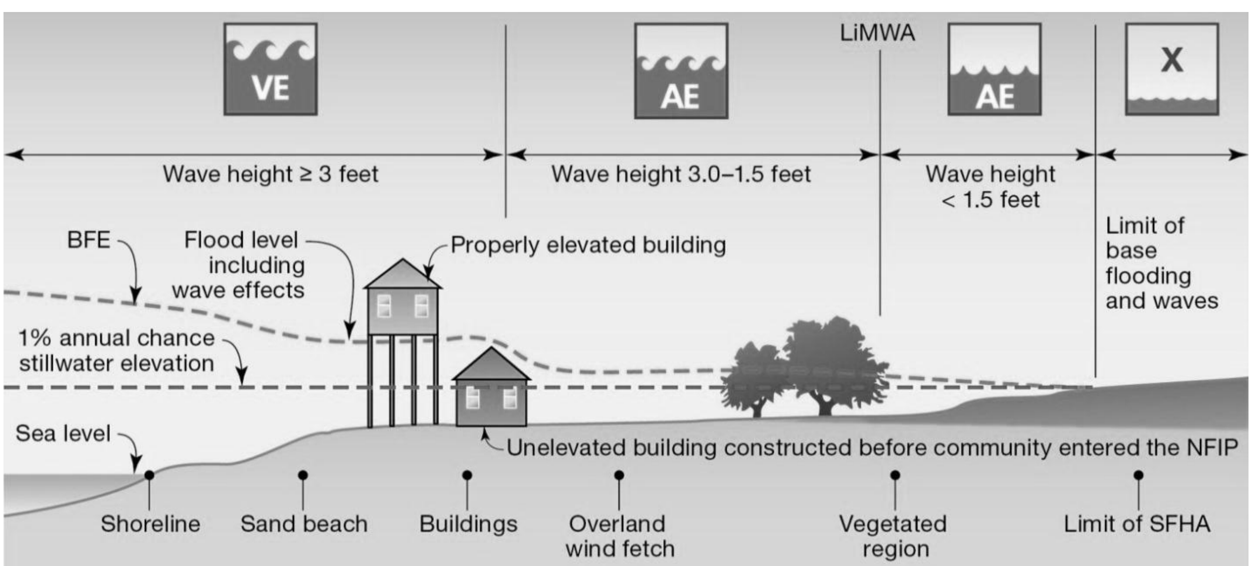


Figure 3 – Transect Schematic

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 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.

Not all of the flood elevations shown in this FIS report and on the FIRM are referenced to NAVD 88. For FIRM panels and Flood Profiles not associated with this revision, flood elevations are referenced to NGVD 29 and will be updated in the near future. 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.

As noted above, the elevations shown in this FIS report and on the FIRM for the revised panels (34039C0014G, 34039C0015G, 34039C0023G, 34039C0024G, 34039C0025G, 34039C0026G, 34039C0033G, 34039C0034G, 34039C0035G, 34039C0036G, 34039C0043G, 34039C0044G, 34039C0045G, 34039C0046G, 34039C0047G, and 34039C0048G) in Union County are referenced to NAVD 88. Ground, structure, and flood elevations may be compared and/or referenced to NGVD 29 by applying a standard conversion factor. The conversion factor to NGVD 29 is +1.03 foot. The conversion between datum may be expressed as an equation:

NAVD 88 = NGVD 29 – 1.03 foot

The BFEs shown on the FIRM represent whole-foot rounded values. For example, a BFE of 102.4 will appear as 102 on the FIRM and 102.6 will appear as 103. Therefore, users that wish to convert the elevations in this FIS to NGVD 29 should apply the stated conversion factor to elevations shown on the Flood Profiles and supporting data tables in the FIS report, which are shown at a minimum to the nearest 0.1 foot.

For information regarding conversion between the NGVD 29 and NAVD 88, visit the National Geodetic Survey (NGS) website at www.ngs.noaa.gov, or contact the NGS at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282
Fax: (301) 713-4172, or
Telephone: (301) 713-3242

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- 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, Floodway Data tables, and Summary of Stillwater Elevation 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 (500-year) flood is employed to indicate additional areas of flood risk in the community. For each stream studied by detailed methods, the 1- and 0.2-percent-annual-chance floodplain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic and orthophoto topographic maps.

For the September 20, 2006, FIS, for each stream studied by detailed methods, the 1- and 0.2-percent annual chance floodplain boundaries were combined into a single countywide FIS. A description of how those floodplains were determined from the community based studies is described below.

For the Township of Berkeley Heights, in the 1978 FIS, the boundaries between cross sections were interpolated using topographic maps at a scale of 1:1,200 with a contour interval of 2 feet (Aero Science Corporation, 1960). In the 1992 revision, the boundaries between cross sections were interpolated using topographic maps at a scale of 1"=100' with a contour interval of 2 feet (Aero Science Corporation, 1960; Robinson Aerial Surveys, Inc., March 1974). For the

1999 revision, the boundaries between cross sections were interpolated using topographic maps at a scale of 1"=200' with a contour interval of 1 foot and USGS topographic maps at a scale of 1:24,000 with a contour interval of 20 feet (NJDEP, 1987; U.S. Department of Interior, 1981). In the 2001 revision, the boundaries between cross sections were interpolated using topographic maps at a scale of l "=200' with a contour interval of 2 feet (Aerial Reduction Associates, 1978).

For the Township of Clark, in the 1982 FIS, the boundaries between cross sections were interpolated using topographic maps at a scale of 1:2,400 with a contour interval of 5 feet (USACE, 1973c).

For the Township of Cranford, in the 1982 FIS, the boundaries between cross sections were interpolated using topographic maps at a scale of 1:2,400 with a contour interval of 2 feet (Aerial Reduction Associates, 1973).

For the Borough of Garwood, in the 1988 FIS, the boundaries between cross sections were interpolated using topographic maps at a scale of 1:200 with a contour interval of 2 feet and at a scale of 1:1,200 with a contour interval of 2 feet (Aerial Reduction Associates, 1973; Robinson Aerial Surveys, 1976).

For the Township of Hillside, in the 1979 FIS, the boundaries between cross sections were interpolated using topographic maps at a scale of 1:2,400, with a contour interval of 5 feet (Geod-Aerial Mapping, Inc., March 1976).

For the Borough of Kenilworth, in the 1982 FIS, the boundaries between cross sections were interpolated using topographic maps at a scale of 1"=200' with a contour interval of 5 feet (Topographic Data Consultants, Inc., March 1979b).

For the Borough of Mountainside, the boundaries between cross sections were interpolated using topographic maps at a scale of 1:1,200 with a contour interval of 2 feet (Aero Sciences Corporation, April 1967).

For the Borough of New Providence, in the 1994 FIS, the boundaries between cross sections were interpolated using topographic maps at a scale of 1:24,000 with a contour interval of 20 feet (U.S. Department of the Interior, 1955; photorevised 1981). In the 2001 revision, the boundaries between cross sections were interpolated using topographic maps at a scale of l "=200', with a contour interval of 2 feet (Aerial Data Reduction Associates, April 1978).

For the City of Plainfield, in the 1983 FIS, the boundaries between cross sections were interpolated using topographic maps at a scale of 1:2,400 with a contour interval of 5 feet for Green Brook and topographic maps at a scale of 1:2,400 with a contour interval of 2 feet for Cedar Brook (Topographic Data Consultants, Inc., March 1979a; Quinn and Associates, Inc., March 1968).

For the Borough of Roselle, in the 1978 FIS, the boundaries between cross sections were interpolated using topographic maps at a scale of 1:6,000, with a contour interval of 2 feet (Hudson, Franklin, December 1962).

For the Borough of Roselle Park, in the 1980 FIS, the boundaries between cross sections were interpolated using topographic maps at a scale of 1:1,200 with a contour interval of 2 feet (Borough of Roselle Park, 1970). In the 1997 revision, the boundaries between cross sections were interpolated using topographic maps at a scale of l "=100' with a contour interval of 2 feet (M. Disko Associates, Unpublished).

For the Township of Scotch Plains, in the 2001 FIS, the boundaries between cross sections were interpolated using topographic maps at scales of 1:4,800 and 1:6,000 with a contour interval of 2 feet (Township of Scotch Plains, 1967), using NJDEP Floodway and Flood Hazard Area Delineation maps at a scale of 1"=200' with a contour interval of 1 foot, and topographic maps at a scale of 1:24,000 with a contour interval of 20 feet (NJDEP, 1987; U.S. Department of Interior, 1955; photorevised 1981).

For the Township of Springfield, in the 1982 FIS, the boundaries between cross sections were interpolated using topographic maps at a scale of 1:2,400 with a contour interval of 2 feet (Township of Springfield Topographic Maps, Unpublished).

For the City of Summit, in the 1977 FIS, the boundaries between cross sections were interpolated using topographic maps at a scale of 1:24,000 with a contour interval of 20 feet (U.S. Department of the Interior, 7.5-Minute Series Topographic Maps). In the 2002 revision, the boundaries between cross sections were interpolated using USGS 15-Minute Series Topographic Maps at a scale of 1:24,000 with a contour interval of 10 feet (U.S. Department of the Interior, 1981).

For the Town of Westfield, in the 1979 FIS, the boundaries between cross sections were interpolated using topographic maps at a scale of 1:1,200, with a contour interval of 2 feet, prepared by photogrammetric methods from aerial photographs (Westfield Aerial Survey, 1971).

In the Borough of Fanwood, boundaries were delineated using topographic maps at a scale of l"=100', with a contour interval of 2 feet (Borough of Fanwood, 1992).

For the Rahway River floodplain, the boundaries between cross sections were interpolated using topographic maps at a scale of 1:1,200, with a contour interval of 2 feet and at a scale of 1:2,400, with a contour interval of 5 feet (Topographic Data Consultants, 1979a). This delineation was supplemented by detailed survey information submitted by the Township of Cranford.

In cases where the 1- and 0.2-percent annual chance flood boundaries are close together, only the 1-percent annual chance flood boundary has been shown.

Within this jurisdiction there are one or more levees that have not been demonstrated by the community or levee owner(s) to meet the requirements of 44CFR Part 65.10 of the NFIP regulations as it relates to the levee's capacity to provide 1-percent annual chance flood protection. As such, the floodplain boundaries in this area were taken directly from the previously effective FIRM and are subject to change. Please refer to the Notice to Flood Insurance Study Users page at the front of this FIS report for more information on how this may affect the floodplain boundaries shown on the FIRM.

For [TBD], FIS revision, the 1- and 0.2-percent annual chance floodplain boundaries for the Elizabeth River, from the confluence of Arthur Kill to approximately 340 feet upstream of Trotter Lane, were delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using Geographic Information Software and LiDAR obtained from the LiDAR acquisition initiative led by the USGS in 2006 for the metropolitan New Jersey Area.

For the areas studied by approximate methods, the boundary of the 1-percent annual chance flood was delineated using maps from the USACE Elizabeth River Flood Control Project (USACE, July 1981). The approximate flood boundary was delineated around detention ponds at an elevation equivalent to the 1-percent annual chance flood on the Elizabeth River, information supplied by Borough of Garwood officials and from backwater effects from Garwood Brook, the boundary of the 1-percent annual chance flood was based on depth-discharge-frequency relationships for non-coastal plain sites in New Jersey for the mean annual flood and field investigations (State of New Jersey, 1964), using the Flood Hazard Boundary Map for the Borough of Kenilworth (FEMA, 1973), were delineated on the community street map at a scale of l "=600' (Plainfield, 1976), using information supplied by the borough engineer through field investigations, and delineated using topographic maps at a scale of 1:1,200 with a contour interval of 2 feet (Borough of Roselle Park, April 1970). For the section of East Branch Green Brook that was studied by approximate methods, the 100-year floodplain was estimated from field inspection of the floodplains and information supplied by Township of Scotch Plains officials.

The 1- and 0.2-percent-annual-chance floodplain boundaries are shown on the FIRM (Exhibit 1). On this map, the 1-percent-annual-chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A, AE, AO, and VE), and the 0.2-percent-annual-chance floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 1- 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.

New Jersey Flood Hazard Area Design Flood (NJFHADF)

The State of New Jersey, Department of Environmental Protection (the Department) is mandated to delineate and regulate flood hazard areas pursuant to N.J.S.A. 58:16A-50 et seq., the Flood Hazard Area Control Act. This Act authorizes the Department to adopt land use regulations for development within the flood hazard areas, to control stream encroachments and to integrate the flood control activities of the municipal, county, State and Federal Governments.

The State's Flood Hazard Area delineations are defined by the New Jersey Flood Hazard Area Design Flood. In 1974, the Water Policy and Supply Council passed a resolution stating that the New Jersey Flood Hazard Area Design Flood shall be equal to a design flood discharge 25-percent greater in flow than the 100 year or 1- percent annual chance flood. In addition, the floodway shall be based on encroachments that produce no more than a 0.2 foot water surface rise above the 100 year or 1-percent annual chance flood. These flood hazard area delineations must be adopted by NJDEP.

For the Elizabeth River, from the confluence with Arthur Kill to approximately 340 feet upstream of Trotter Lane, the NJFHADF floodplain boundary was delineated in addition to the 1- and 0.2-percent-annual-chance boundaries. The NJFHADF is equal to the 0.2-percent annual chance flood.

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 base flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1 foot and the State of New Jersey standards limit the increase to 0.2 feet, provided that hazardous velocities are not produced. The floodways in this study 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 for certain stream segments on the basis of equal-conveyance reduction from each side of the floodplain. Floodway widths were computed at cross sections. Between cross sections, the floodway boundaries were interpolated. The results of the floodway computations are tabulated for selected cross sections (See Table 8, “Floodway Data”). In cases where the floodway and 1-percent-annual-chance floodplain boundaries are either close together or collinear, only the floodway boundary is shown.

Please note that portions of the floodways for East Branch Rahway River, Green Brook, Rahway River, Passaic River, and Van Winkles Brook extend beyond the county boundary.

The areas of the Lenape Park Stormwater Retention Basin and Nomahegan Lake have been delineated as floodways to prevent encroachment in these valuable storage areas. For some portions of Gallows Hill Road Branch and for the entire length of the Drainage Ditch within Cranford, the floodway is coincident with the channel banks. The floodway for the Drainage Ditch was taken from the FIS for the Borough of Kenilworth.

Within the City of Elizabeth, since the 1-percent annual chance flood is always contained either within the Elizabeth River levee or within the channelization, the floodway presented in this study is shown on the land side toe of the levee when along the levee, and along the channel bank where the 1-percent chance annual flood is contained within the channel. This is to insure that no development will occur on the levee, on the river side of the levee, or within the channel. Since the floodway along the Elizabeth River was defined by regulatory constraints and not by encroachment, there are no surcharges, and no cross sections are shown on the FIRM or on the Flood Profiles.

For the Elizabeth River within the Townships of Hillside and Union, the floodway is not based on hydraulic modeling and is to be considered an administrative floodway. The floodway was taken from the previously effective FIRMs for the Townships of Hillside and Union, except in areas where the effective floodway boundaries were outside the revised 1-percent annual chance floodplain. In these areas, the floodway was made coincident with the 1-percent annual chance floodplain.

Within the City of Linden, no floodway was computed for Kings Creek. No floodway was computed for Arthur Kill, Rahway River, Morses Creek, Piles Creek, and Marshes Creek because they are tidal.

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 8, "Floodway Data." 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.

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 8 for certain downstream cross sections of Black Brook, Branch 10-30-1, Branch 10-34, Bryant Brook, Bryant Brook Branch, College Branch, Drainage Ditch, Gallows Hill Road Branch, Garwood Brook, Lehigh Valley Branch, Lightning Brook, Pumpkin Patch Brook, Rahway River, Robinsons Branch, South Branch, Stream 10-30, Tributary A, Van Winkles Brook, Vauxhall Branch, and Vauxhall Subbranch 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.

The following streams do not have any Floodway Data table information: Branch West Brook, Kings Creek, Nomahegan Brook-Echo Lake, Robinsons Branch 15-1, Robinsons 15-2, and West Branch West Brook.

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 WSEL of the base flood more than 0.2 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 4, "Floodway Schematic."

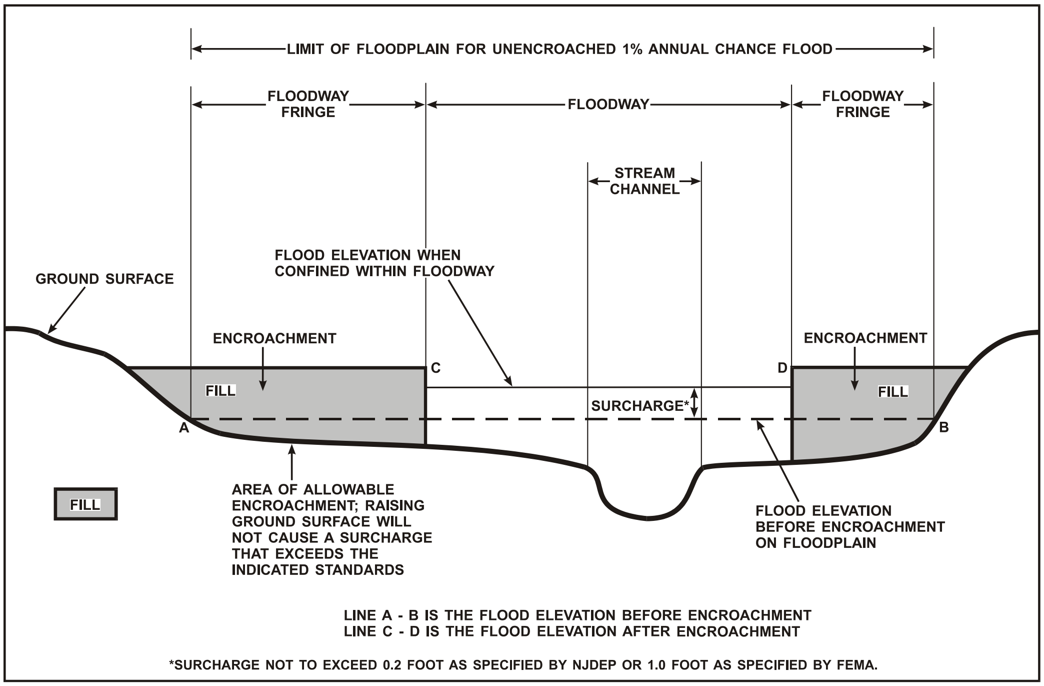


Figure 4 – Floodway Schematic

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
Elizabeth River								
A	20,738	161	*	*	22.1	22.1	*	*
B	21,685	304	*	*	23.9	23.9	*	*
C	23,125	192	*	*	28.6	28.6	*	*
D	24,525	100	*	*	32.8	32.8	*	*
E	25,343	86	*	*	34.4	34.4	*	*
F	26,931	190	*	*	37.0	37.0	*	*
G	28,363	100	*	*	39.0	39.0	*	*
H	29,069	200	*	*	40.1	40.1	*	*
I	31,349	125	*	*	43.4	43.4	*	*
J	32,549	300	*	*	46.1	46.1	*	*
K	33,894	60	*	*	48.1	48.1	*	*
L	35,481	200	*	*	52.8	52.8	*	*
M	36,763	141	*	*	56.3	56.3	*	*
N	37,961	130	*	*	61.3	61.3	*	*
O	39,377	52	*	*	70.4	70.4	*	*

[1]Feet above confluence with Arthur Kill

*Data not available, administrative floodway, see Section 4.2 for detailed explanation

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY
UNION COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

ELIZABETH RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
Irvington Branch								
A	280[1]	244	914	1.3	78.8	78.8	78.9	0.1
B	820[1]	25	101	11.5	80.3	80.3	80.3	0.0
C	995[1]	26	156	7.4	83.1	83.1	83.1	0.0
D	1,280[1]	300	862	1.3	89.4	89.4	89.4	0.0
E	1,525[1]	*	*	*	89.5	89.5	*	*
F	2,147[1]	*	*	*	96.6	96.6	*	*
G	2,338[1]	*	*	*	100.5	100.5	*	*
H	2,784[1]	*	*	*	106.6	106.6	*	*
I	3,069[1]	*	*	*	111.9	111.9	*	*
Jouet Brook								
A	2,025[2]	13	29	8.6	27.7	27.7	27.7	0.0
B	2,320[2]	13	37	6.7	27.7	27.7	27.7	0.0
C	2,690[2]	13	35	6.2	28.6	28.6	28.6	0.0
D	3,090[2]	13	45	4.2	30.3	30.3	30.3	0.0
E	3,380[2]	13	37	5.1	30.5	30.5	30.5	0.0
F	3,600[2]	12	32	5.4	31.2	31.2	31.2	0.0
G	4,360[2]	26	61	2.7	33.4	33.4	33.4	0.0
H	5,320[2]	22	43	2.8	34.9	34.9	34.9	0.0
I	5,580[2]	7	13	8.2	35.2	35.2	35.2	0.0
J	6,510[2]	7	19	5.8	38.4	38.4	38.4	0.0

[1]Feet above confluence with Lightning Brook

[2]Feet above confluence with Peach Orchard Brook

*Floodway contained in channel

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY
UNION COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

IRVINGTON BRANCH
JOUET BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
Jouet Brook (Cont'd)								
K	6,944[1]	24	80	4.1	40.8	40.8	40.8	0.0
L	7,465[1]	20	63	4.6	43.2	43.2	43.3	0.1
M	8,159[1]	18	59	4.4	49.0	49.0	49.0	0.0
N	8,526[1]	48	195	1.3	53.5	53.5	54.3	0.8
O	8,814[1]	31	102	2.4	54.1	54.1	54.8	0.7
Lehigh Valley Branch								
A	50[2]	698	5,137	0.2	38.5	38.5[3]	38.7	0.2
B	551[2]	513	2,218	0.4	38.5	38.5[3]	38.7	0.2
C	1,513[2]	24	78	10.4	39.6	39.6	39.6	0.0
D	1,935[2]	124	178	3.8	45.7	45.7	45.7	0.0
E	2,440[2]	63	114	6.0	48.2	48.2	48.2	0.0
F	3,081[2]	229	253	2.7	52.0	52.0	52.1	0.1
G	4,016[2]	10	52	13.1	58.1	58.1	58.1	0.0

[1]Feet above confluence with Peach Orchard Brook
[2]Feet above confluence with Elizabeth River
[3]Elevation computed without consideration of backwater effects from Elizabeth River

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY
UNION COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

JOUET BROOK
LEHIGH VALLEY BRANCH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
Lightning Brook								
A	100[1]	812	5,159	0.4	54.2	54.2[4]	54.2	0.0
B	1,412[1]	52	301	7.3	55.0	55.0	55.2	0.2
C	2,460[1]	43	255	8.7	60.9	60.9	60.9	0.0
D	2,900[1]	51	290	7.6	62.4	62.4	62.5	0.1
E	3,966[1]	60	582	3.8	74.5	74.5	74.7	0.2
F	4,556[1]	58	522	4.2	75.1	75.1	75.3	0.2
G	4,942[1]	221	578	3.6	78.1	78.1	78.3	0.2
Maplewood Branch								
A	515[2]	77	367	3.0	78.4	78.4	78.4	0.0
B	1,880[2]	70	933	0.7	81.5	81.5	81.5	0.0
Orchard Creek								
A	980[3]	65	352	2.4	16.6	16.6	16.6	0.0
B	2,068[3]	90	438	2.0	17.5	17.5	17.5	0.0
C	2,440[3]	131	324	2.6	17.8	17.8	18.0	0.2
D	2,752[3]	120	339	2.5	18.7	18.7	18.8	0.1
E	3,736[3]	137	163	5.3	20.9	20.9	20.9	0.0
F	4,196[3]	143	368	2.3	21.9	21.9	22.0	0.1
G	4,660[3]	120	199	4.3	24.3	24.3	24.4	0.1
H	5,254[3]	69	136	6.3	29.8	29.8	29.8	0.0

[1]Feet above confluence with Elizabeth River
[2]Feet above confluence with Lightning Brook
[3]Feet above confluence with South Branch Rahway River
[4]Elevation computed without consideration of backwater effects from Elizabeth River

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY
UNION COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

LIGHTNING BROOK - MAPLEWOOD BRANCH
ORCHARD CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
Peach Orchard Brook								
A	90	230	1,324	1.0	*	*	*	*
B	1,110	315	2,435	0.5	*	*	*	*
C	2,190	195	1,310	1.0	*	*	*	*
D	2,810	325	2,147	0.6	*	*	*	*
E	3,390	185	589	2.2	10.7	10.7	10.9	0.2
F	4,020	208	1,209	1.1	11.5	11.5	11.6	0.1
G	4,370	115	693	1.9	11.7	11.7	11.8	0.1
H	4,940	36	235	5.6	12.4	12.4	12.5	0.1
I	5,330	57	236	5.5	13.2	13.2	13.3	0.1
J	5,690	25	187	4.5	15.1	15.1	15.3	0.2
K	6,140	82	246	3.4	17.3	17.3	17.5	0.2
L	6,770	350	1,449	0.8	21.4	21.4	21.4	0.0
M	7,140	308	806	1.4	21.7	21.7	21.7	0.0
N	7,640	230	935	1.2	23.8	23.8	23.8	0.0
O	8,040	267	883	1.3	23.9	23.9	23.9	0.0
P	8,400	360	1,945	0.6	24.0	24.0	24.1	0.1
Q	8,820	185	851	1.3	24.0	24.0	24.1	0.1
R	9,080	31	157	3.2	25.1	25.1	25.2	0.1
S	9,530	34	134	3.8	26.4	26.4	26.4	0.0
T	9,710	208	372	1.2	27.5	27.5	27.7	0.2
U	10,830	531	2,506	0.2	31.9	31.9	32.1	0.2
V	11,330	330	1,816	0.3	31.9	31.9	32.1	0.2

[1]Feet above confluence with West Brook

*Coastal analyses supersedes riverine, floodway shown for administrative purposes

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY
UNION COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

PEACH ORCHARD BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
Rahway River								
A	4,268	205[2]	4,541	2.1	*	*	*	*
B	7,680	390[2]	4,735	2.0	*	*	*	*
C	9,632	218[2]	4,108	2.3	*	*	*	*
D	12,622	182[2]	2,567	3.6	*	*	*	*
E	15,524	300[2]	3,743	2.5	*	*	*	*
F	17,386	185[2]	3,317	2.8	*	*	*	*
G	20,292	350	2,481	3.8	*	*	*	*
H	22,337	279	2,064	4.5	*	*	*	*
I	22,939	194	1,824	5.1	*	*	*	*
J	25,144	214	1,893	4.4	*	*	*	*
K	26,541	132	1,030	8.1	*	*	*	*
L	28,089	355	1,885	3.3	13.3	13.3	13.3	0.0
M	29,899	538	4,274	1.4	14.9	14.9	15.0	0.1
N	32,259	131	880	7.0	17.7	17.7	17.8	0.1
O	34,300	344	2,461	2.5	21.9	21.9	22.1	0.2
P	36,463	249	1,435	4.3	22.8	22.8	23.0	0.2
Q	38,376	252	2,154	2.9	26.5	26.5	26.6	0.1
R	42,096	404	1,628	3.8	29.8	29.8	29.9	0.1
S	44,906	285	1,914	3.2	33.3	33.3	33.3	0.0
T	50,390	271	2,480	2.5	49.8	49.8	50.0	0.2
U	54,395	267	1,797	3.4	51.6	51.6	51.8	0.2

[1]Feet above confluence with Arthur Kill
[2]Width within Union County
*Coastal analyses supersedes riverine, floodway shown for administrative purposes

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY
UNION COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

RAHWAY RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
Rahway River (Cont'd)								
V	55,841	131	1,039	5.9	52.0	52.0	52.2	0.2
W	60,138	285	2,070	3.0	60.9	60.9	61.1	0.2
X	62,142	227	1,384	4.5	63.2	63.2	63.3	0.1
Y	63,633	205	1,991	3.1	67.1	67.1	67.2	0.1
Z	66,160	262	1,679	3.7	68.8	68.8	69.0	0.2
AA	68,324	260	1,957	3.2	70.2	70.2	70.4	0.2
AB	70,227	255	2,509	2.5	70.7	70.7	70.9	0.2
AC	72,530	861	7,863	0.8	71.2	71.2	71.4	0.2
AD	74,930	461	3,821	1.7	71.8	71.8	72.0	0.2
AE	78,959	711	4,393	1.5	73.6	73.6	73.7	0.1
AF	81,879	203	2,103	3.1	79.6	79.6	79.8	0.2
AG	84,674	453	3,684	1.7	82.5	82.5	82.5	0.0
AH	88,894	386	4,223	1.1	85.2	85.2	85.4	0.2
AI	94,428	458	2,631	1.8	85.9	85.9	86.1	0.2
AJ	95,114	196	2,048	2.3	89.9	89.9	90.1	0.2
AK	95,721	112	1,476	3.2	90.2	90.2	90.4	0.2

[1]Feet above confluence with Arthur Kill

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY
UNION COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

RAHWAY RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
Robinsons Brnach								
A	0.036	280	1,470	2.5	13.3	10.3[2]	10.5	0.2
B	0.119	59	554	6.8	13.3	11.0[2]	11.2	0.2
C	0.170	61	775	4.8	13.3	13.1[2]	13.2	0.1
D	0.277	186	1,238	3.0	15.0	15.0	15.1	0.1
E	0.374	234	1,882	2.0	15.5	15.5	15.6	0.1
F	0.488	60	656	5.7	15.8	15.8	16.0	0.2
G	0.623	470	3,812	1.0	16.9	16.9	17.0	0.1
H	0.807	167	642	5.8	17.3	17.3	17.3	0.0
I	0.854	350	1,728	2.2	18.0	18.0	18.2	0.2
J	0.955	404	1,572	2.4	18.8	18.8	19.0	0.2
K	1.184	480	1,424	2.6	20.6	20.6	20.7	0.1
L	1.384	342	1,997	1.8	22.5	22.5	22.6	0.1
M	1.521	450	2,200	1.6	22.9	22.9	23.0	0.1
N	1.733	297	1,406	2.5	25.2	25.2	25.2	0.0
O	1.902	297	1,406	2.5	25.9	25.9	25.9	0.0
P	2.241	41	287	12.3	29.6	29.6	29.6	0.0
Q	2.252	42	352	10.0	31.6	31.6	31.6	0.0
R	2.339	166	2,171	1.6	46.7	46.7	46.7	0.0
S	2.428	500	5,612	0.6	46.7	46.7	46.7	0.0
T	2.920	409	3,468	1.0	46.7	46.7	46.7	0.0
U	3.104	610	5,329	0.7	47.0	47.0	47.0	0.0

[1]Miles above confluence with Rahway River

[2]Elevation computed without consideration of backwater effects from Rahway River

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY
UNION COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

ROBINSONS BRANCH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
Robinsons Branch (Cont'd)								
V	3.636	99	780	4.5	47.0	47.0	47.0	0.0
W	3.684	259	2,136	1.7	47.3	47.3	47.4	0.1
X	3.849	127	1,218	2.9	47.4	47.4	47.5	0.1
Y	4.083	190	1,042	2.4	48.5	48.5	48.7	0.2
Z	4.248	265	1,668	1.5	49.1	49.1	49.3	0.2
AA	4.437	435	2,466	1.0	49.5	49.5	49.7	0.2
AB	4.681	195	1,041	2.4	50.1	50.1	50.3	0.2
AC	4.933	115	788	3.1	51.4	51.4	51.5	0.1
AD	5.075	110	530	4.0	52.4	52.4	52.6	0.2
AE	5.202	209	656	3.2	54.6	54.6	54.7	0.1
AF	5.262	200	722	2.9	55.5	55.5	55.6	0.1
AG	5.364	200	1,719	1.2	56.0	56.0	56.2	0.2
AH	5.448	290	2,323	0.9	56.2	56.2	56.4	0.2
AI	5.565	885	6,668	0.3	56.3	56.3	56.5	0.2
AJ	5.728	995	8,222	0.3	56.3	56.3	56.5	0.2
AK	5.901	1,190	11,486	0.2	57.0	57.0	57.2	0.2
AL	6.082	1,430	13,952	0.1	57.0	57.0	57.2	0.2
AM	6.256	1,425	12,925	0.2	57.0	57.0	57.2	0.2
AN	6.764	150	6,361	0.3	57.0	57.0	57.2	0.2

[1]Miles above confluence with Rahway River

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY
UNION COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

ROBINSONS BRANCH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
South Branch Rahway River								
A	0.042[1]	122	711	3.9	*	*	*	*
B	0.100[1]	160	578	4.8	*	*	*	*
C	0.129[1]	170	702	3.9	*	*	*	*
D	0.263[1]	145	871	3.2	*	*	*	*
E	0.367[1]	180	885	3.1	*	*	*	*
F	0.487[1]	165	1,094	2.5	*	*	*	*
G	0.600[1]	125	528	5.2	*	*	*	*
H	0.693[1]	100	558	4.9	*	*	*	*
I	0.830[1]	46	450	6.1	*	*	*	*
J	0.850[1]	100	481	5.7	*	*	*	*
K	0.945[1]	200	1,795	1.5	12.4	12.4	12.5	0.1
L	1.091[1]	175	970	2.8	12.6	12.6	12.8	0.2
M	1.195[1]	325	2,165	1.3	13.3	13.3	13.5	0.2
Southwest Branch								
A	120[2]	143	416	1.5	78.8	78.8	79.0	0.2
B	537[2]	379	653	1.0	79.1	79.1	79.3	0.2
C	1,076[2]	131	176	3.5	80.9	80.9	80.9	0.0
D	1,473[2]	280	332	1.9	82.5	82.5	82.7	0.2
E	2,300[2]	150	317	2.0	86.3	86.3	86.3	0.0

[1]Miles above confluence with Rahway River
[2]Feet above confluence with Maplewood Branch
*Coastal analyses supersedes riverine, floodway shown for administrative purposes

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY
UNION COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

SOUTH BRANCH RAHWAY RIVER
SOUTHWEST BRANCH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
Trotters Lane Branch								
A	1,120[1]	245	1,078	0.7	26.2	26.2	26.4	0.2
B	2,035[1]	31	80	9.1	27.0	27.0	27.0	0.0
C	3,145[1]	14	39	9.6	37.0	37.0	37.0	0.0
D	3,799[1]	114	259	1.3	42.7	42.7	42.9	0.2
E	4,561[1]	240	565	0.7	47.8	47.8	48.0	0.2
F	5,104[1]	19	32	7.3	48.5	48.5	48.5	0.0
G	5,225[1]	10	27	8.7	49.3	49.3	49.4	0.1
Vauxhall Branch								
A	430[2]	181	2,414	0.5	89.7	88.5[3]	88.7	0.2
B	1,500[2]	846	7,502	0.1	89.7	88.7[3]	88.7	0.0
C	2,520[2]	755	3,158	0.1	89.7	88.7[3]	88.7	0.0
D	5,430[2]	240	1,354	0.3	102.7	102.7	102.7	0.0
E	6,010[2]	10	37	11.1	109.7	109.7	109.7	0.0
F	6,390[2]	86	160	2.6	114.8	114.8	114.8	0.0
G	7,640[2]	46	72	5.7	128.3	128.3	128.3	0.0

[1]Feet above mouth
[2]Feet above confluence with Rahway River
[3]Elevation computed without consideration of backwater effects from the Rahway River

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY
UNION COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

TROTTERS LANE BRANCH
VAUXHALL BRANCH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
West Branch Elizabeth River								
A	900	344	1,550	0.5	41.7	41.7	41.9	0.2
B	1,573	151	210	3.6	43.3	43.3	43.3	0.0
C	2,900	42	90	8.4	49.3	49.3	49.3	0.0
D	3,764	29	119	6.4	53.0	53.0	53.0	0.0
E	4,650	154	565	1.4	54.3	54.3	54.3	0.0
F	5,170	42	202	3.8	54.4	54.4	54.5	0.1
G	5,970	11	61	10.5	54.2	54.2	54.4	0.2
H	7,100	719	7,059	0.1	57.5	57.5	57.5	0.0
I	7,950	800	8,393	0.1	57.5	57.5	57.5	0.0
J	8,650	645	2,295	0.3	57.5	57.5	57.5	0.0
K	9,046	47	239	2.7	57.5	57.5	57.5	0.0
L	9,668	67	286	2.8	58.4	58.4	58.4	0.0
M	10,290	46	282	2.8	58.9	58.9	59.0	0.1
N	11,500	247	1,308	0.6	58.9	58.9	59.0	0.1

[1]Feet above confluence with Elizabeth River

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY
UNION COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

WEST BRANCH ELIZABETH RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
West Brook								
A	440	550	5,558	0.4	*	*	*	*
B	1,600	442	3,961	0.5	*	*	*	*
C	2,800	563	4,606	0.4	*	*	*	*
D	3,510	330	1,462	1.2	*	*	*	*
E	4,540	80	638	2.8	*	*	*	*
F	5,050	68	547	3.1	*	*	*	*
G	5,500	82	669	2.5	*	*	*	*
H	5,970	90	516	3.2	*	*	*	*
I	6,370	95	712	2.4	*	*	*	*
J	6,725	50	382	4.4	*	*	*	*
K	7,210	46	295	5.3	*	*	*	*
L	7,910	54	297	5.3	*	*	*	*
M	8,515	53	278	5.7	12.7	12.7	12.8	0.1
N	9,000	55	271	5.8	13.8	13.8	13.9	0.1
O	9,440	60	189	7.5	14.6	14.6	14.7	0.1
P	10,050	30	180	7.8	15.7	15.7	15.7	0.0
Q	10,680	24	192	7.2	18.9	18.9	18.9	0.0
R	10,970	24	194	6.7	19.6	19.6	19.6	0.0
S	11,500	24	166	7.8	19.9	19.9	19.9	0.0
T	12,060	24	135	9.6	20.2	20.2	20.2	0.0
U	12,880	24	115	11.0	22.1	22.1	22.1	0.0

[1]Feet above confluence with Morses Creek

*Coastal analyses supersedes riverine, floodway shown for administrative purposes

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY
UNION COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

WEST BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
West Brook (Cont'd)								
V	13,710	23	143	8.6	25.3	25.3	25.3	0.0
W	14,270	23	102	12.0	26.5	26.5	26.5	0.0
X	15,130	22	112	10.6	29.9	29.9	29.9	0.0
Y	15,700	22	98	12.1	31.3	31.3	31.4	0.1
Z	16,120	50	113	10.7	33.3	33.3	33.3	0.0
AA	16,320	22	109	11.1	33.7	33.7	33.7	0.0
AB	18,140	22	111	10.3	38.8	38.8	38.8	0.0
AC	18,650	28	162	7.0	41.2	41.2	41.2	0.0
AD	19,390	25	136	7.5	43.2	43.2	43.2	0.0
AE	19,900	51	256	3.8	47.3	47.3	47.3	0.0
AF	20,960	90	701	1.3	49.0	49.0	49.1	0.1
AG	21,630	150	546	1.7	49.6	49.6	49.7	0.1
AH	22,730	49	171	3.0	53.3	53.3	53.4	0.1
AI	23,480	33	134	3.9	55.6	55.6	55.7	0.1
AJ	24,050	145	234	2.2	57.7	57.7	57.7	0.0
AK	24,910	55	106	4.9	59.3	59.3	59.3	0.0
AL	25,570	57	231	2.3	61.5	61.5	61.6	0.1
AM	25,890	49	239	1.7	62.1	62.1	62.2	0.1
AN	26,110	90	681	3.2	63.9	63.9	64.1	0.2
AO	26,380	150	243	1.7	64.6	64.6	64.8	0.2
AP	27,700	33	99	3.1	65.0	65.0	65.2	0.2

[1]Feet above mouth confluence with Morses Creek

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY
UNION COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

WEST BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
West Brook (Cont'd)								
AQ	30,860	335	1,735	0.3	72.4	72.4	72.6	0.2
AR	32,423	65	104	3.9	73.5	73.5	73.6	0.1
AS	32,681	31	110	3.7	74.2	74.2	74.3	0.1
AT	33,689	60	116	3.5	76.5	76.5	76.5	0.0
AU	34,520	24	85	4.4	79.9	79.9	80.0	0.1
AV	34,980	33	81	4.6	80.6	80.6	80.7	0.1
AW	36,640	33	181	1.7	86.7	86.7	86.9	0.2
AX	37,130	18	108	2.9	86.8	86.8	86.9	0.1

[1]Feet above confluence with Morses Creek

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY
UNION COUNTY, NJ
(ALL JURISDICTIONS)

FLOODWAY DATA

WEST BROOK

5.0 INSURANCE APPLICATION

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

Zone A

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

Zone AH

Zone AH is the flood insurance rate zone that corresponds to the areas of one percent annual chance shallow flooding (usually areas of ponding) where average depths are between 1 and 3 feet. Whole-foot BFEs derived from the detailed hydraulic analysis is shown at selected intervals within this zone.

Zone AO

Zone AO is the flood insurance rate zone that corresponds to the areas of one 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 analysis is shown within this zone.

Zone AR

Area of special flood hazard formerly protected from the one annual chance flood event by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the one percent annual chance or greater flood event.

Zone A99

Zone A99 is the flood insurance rate zone that corresponds to areas of the one percent annual chance floodplain that will be protected by a Federal flood protection system where construction has reached specified statutory milestones. No BFEs or depths are shown within this zone.

Zone V

Zone V is the flood insurance rate zone that corresponds to the one percent annual chance coastal floodplains that have additional hazards associated with storm waves. Because approximate hydraulic analysis is performed for such areas, no BFEs are shown within this zone.

Zone VE

Zone VE is the flood insurance rate zone that corresponds to the one percent annual chance coastal floodplains that have additional hazards associated with storm waves. Whole-foot BFEs derived from the detailed hydraulic analysis is shown at selected intervals 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 areas of one percent annual chance flooding where average depths are less than 1 foot, areas of one percent annual chance flooding where the contributing drainage area is less than 1 square mile, and areas protected from the one percent annual chance flood by levees. No BFEs or depths are shown within this zone.

Zone D

Zone D is the flood insurance rate zone that corresponds to unstudied areas where flood hazards are undetermined, but possible.

6.0 FLOOD INSURANCE RATE MAP

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

Within this jurisdiction there are one or more levees that have not been demonstrated by the community or levee owner(s) to meet the requirements of 44CFR Part 65.10 of the NFIP regulations as it relates to the levee's capacity to provide 1-percent annual chance flood protection. Please refer to the Notice to Flood Insurance Study Users page at the front of this FIS report for more information on how this may affect the FIRM.

For flood insurance applications, the map designates flood insurance rate zones as described in Section 5.0 and, in the 1-percent-annual-chance floodplains that were studied by detailed methods, shows selected whole-foot BFEs or average depths. Insurance agents use zones and BFEs 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- and 0.2-percent-annual-chance floodplains, floodways, and the locations of selected cross sections used in the hydraulic analysis and floodway computations.

The countywide FIRM presents flooding information for the entire geographic area of Union County. Historical data relating to the FIRMs prepared for each community, prior to the September 20, 2006, initial countywide FIS, are presented in Table 9, "Community Map History."

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE	FIRM EFFECTIVE DATE	FIRM REVISIONS DATE
Berkeley Heights, Township of	May 24, 1974	None	March 1, 1987	February 19, 1992 January 6, 1999 November 21, 2001
Clark, Township of	December 23, 1971	None	December 23, 1971	July 1, 1974 May 14, 1976 September 2, 1982
Cranford, Township of	September 2, 1970	None	June 25, 1971	July 1, 1974 January 30, 1976 February 16, 1983
Elizabeth, City of	May 22, 1970	None	May 8, 1971	July 1, 1974 December 26, 1975 August 27, 1976 December 1, 1978 November 1, 1985
Fanwood, Borough of[1]	N/A	N/A	N/A	
Garwood, Borough of	February 1, 1977	None	February 1, 1977	May 17, 1988
Hillside, Township of	January 9, 1974	None	September 14, 1979	
Kenilworth, Borough of	October 26, 1973	June 18, 1976	March 2, 1983	

[1] This community does not have map history prior to the first countywide mapping

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ (ALL JURISDICTIONS)

COMMUNITY MAP HISTORY

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE	FIRM EFFECTIVE DATE	FIRM REVISIONS DATE
Linden, City of	June 7, 1974	July 16, 1976	November 24, 1976	March 2, 1994
Mountainside, Borough of	February 16, 1977	None	February 16, 1977	
New Providence, Borough of	November 23, 1973	None	November 23, 1973	July 1, 1974 February 6, 1976 September 3, 1976 May 16, 1994 December 20, 2001
Plainfield, City of	June 26, 1971	None	June 26, 1971	July 1, 1974 June 13, 1975 July 18, 1983 July 16, 1997
Rahway, City of	December 23, 1971	None	December 23, 1971	July 1, 1974 September 5, 1976 August 2, 1982 December 20, 2002
Roselle, Borough of	July 17, 1978	None	July 17, 1978	
Roselle Park, Borough of	April 22, 1977	None	June 4, 1980	November 5, 1997

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ (ALL JURISDICTIONS)

COMMUNITY MAP HISTORY

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE	FIRM EFFECTIVE DATE	FIRM REVISIONS DATE
Scotch Plains, Township of	January 9. 1974	None	September 30, 1977	July 18, 1980 January 19, 2001
Springfield, Township of	October 13, 1971	None	October 13, 1971	July 1, 1974 January 9, 1976 August 2, 1982
Summit, City of	March 16, 1973	None	February 2, 1977	May 2, 2002
Union, Township of	May 11, 1973	None	August 1, 1978	
Westfield, Town of	December 18, 1979	None	December 18, 1979	
Winfield, Township of [1,2]	N/A	N/A	N/A	

[1] No Special Flood Hazard Areas Identified
[2] This community does not have map history prior to the first countywide mapping

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ
(ALL JURISDICTIONS)

COMMUNITY MAP HISTORY

7.0 OTHER STUDIES

Information pertaining to revised and unrevised flood hazards for each jurisdicition within Union County has been compiled into this FIS. Therefore, this FIS either supersedes or is compatible with all previous studies published on streams studied in this report and should be considered authoritative for the purposes of the NFIP.

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.

8.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting FEMA, Federal Insurance and Mitigation Division, FEMA Region II, 26 Federal Plaza, Room 1351, New York, New York, 10278.

9.0 BIBLIOGRAPHY AND REFERENCES

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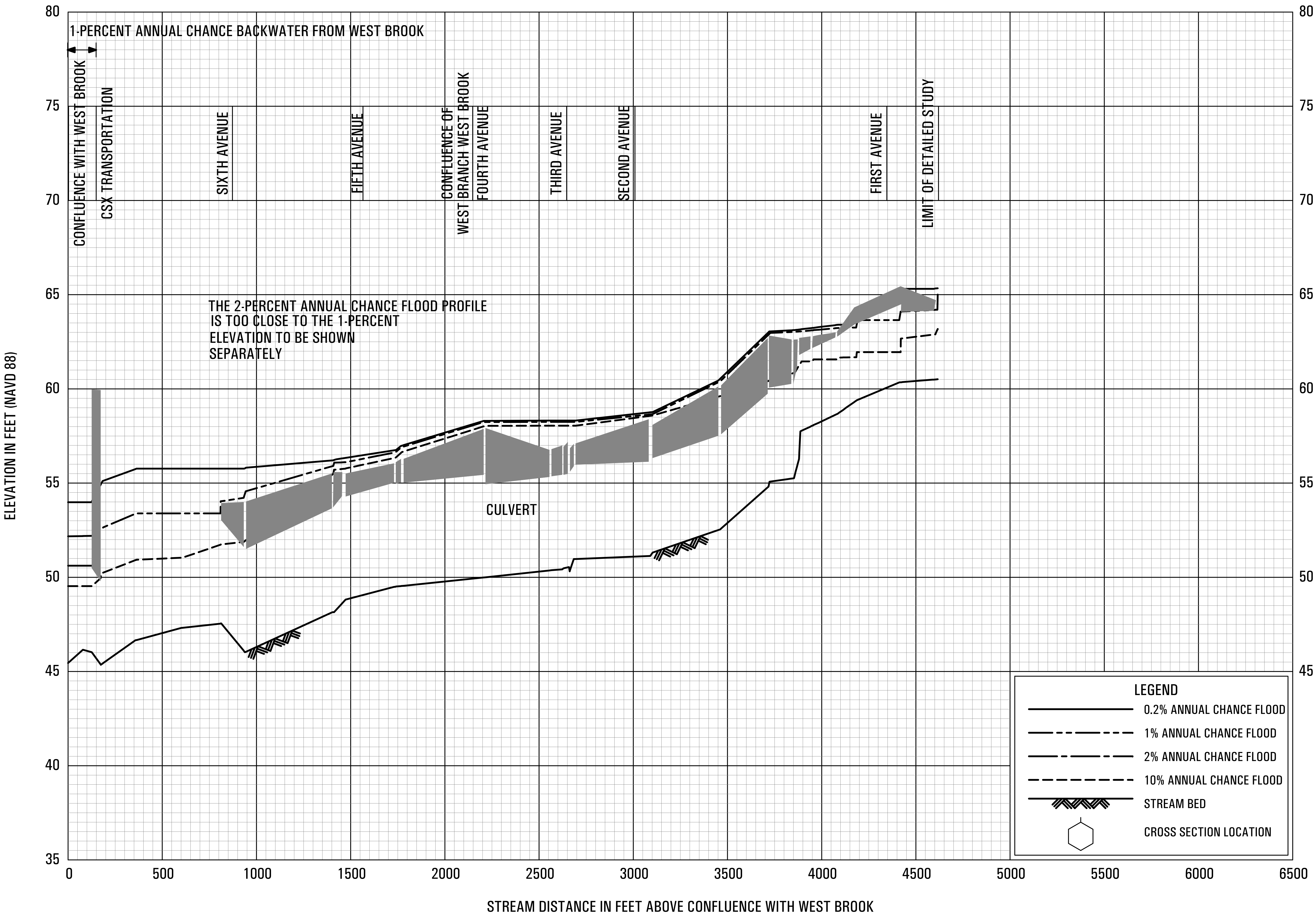


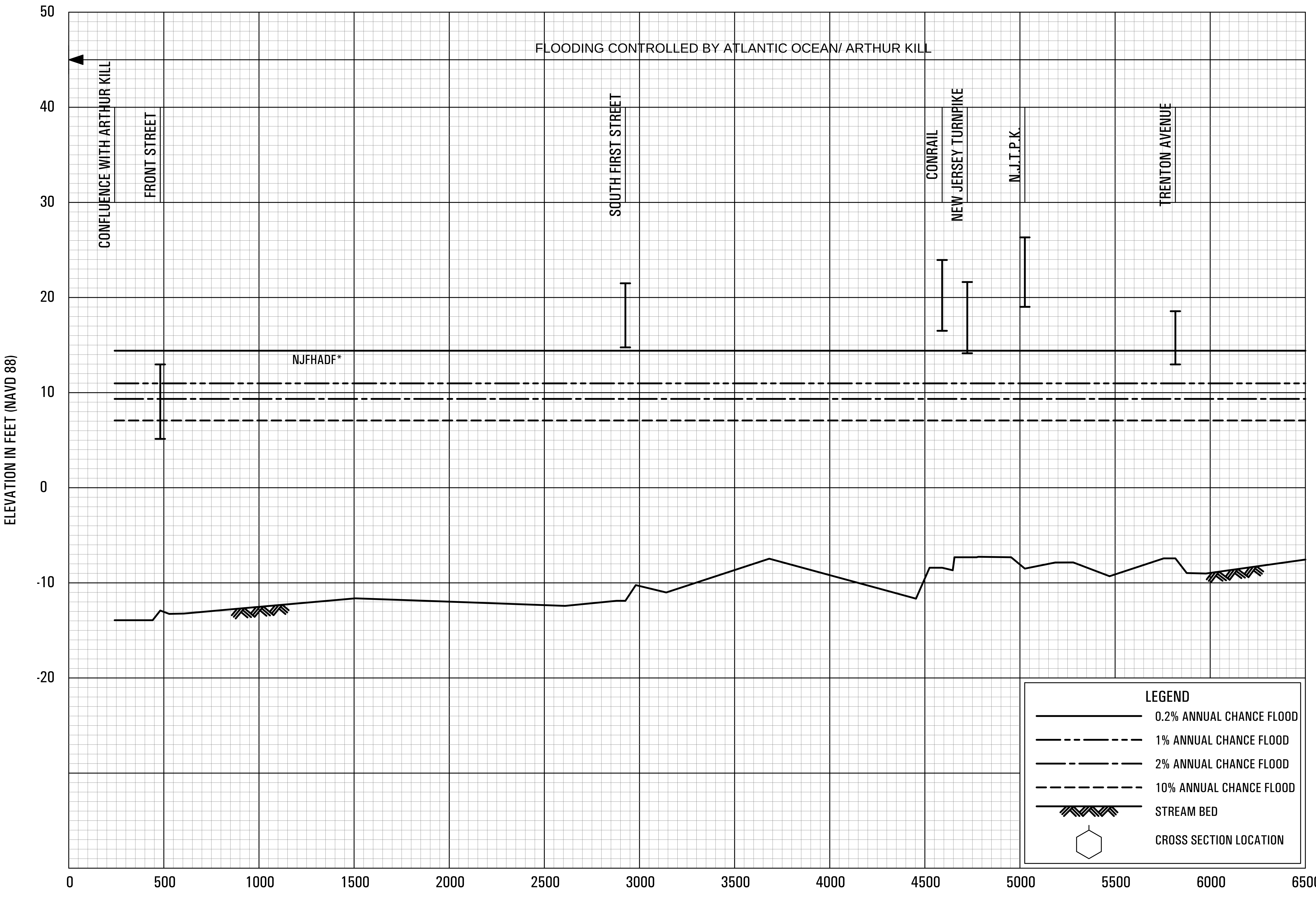
FLOOD PROFILES

BRANCH WEST BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

AND INCORPORATED AREAS



* NEW JERSEY FLOOD HAZARD AREA DESIGN FLOOD (NJFHADF) IS EQUAL TO THE 0.2-PERCENT-ANNUAL CHANCE FLOOD.

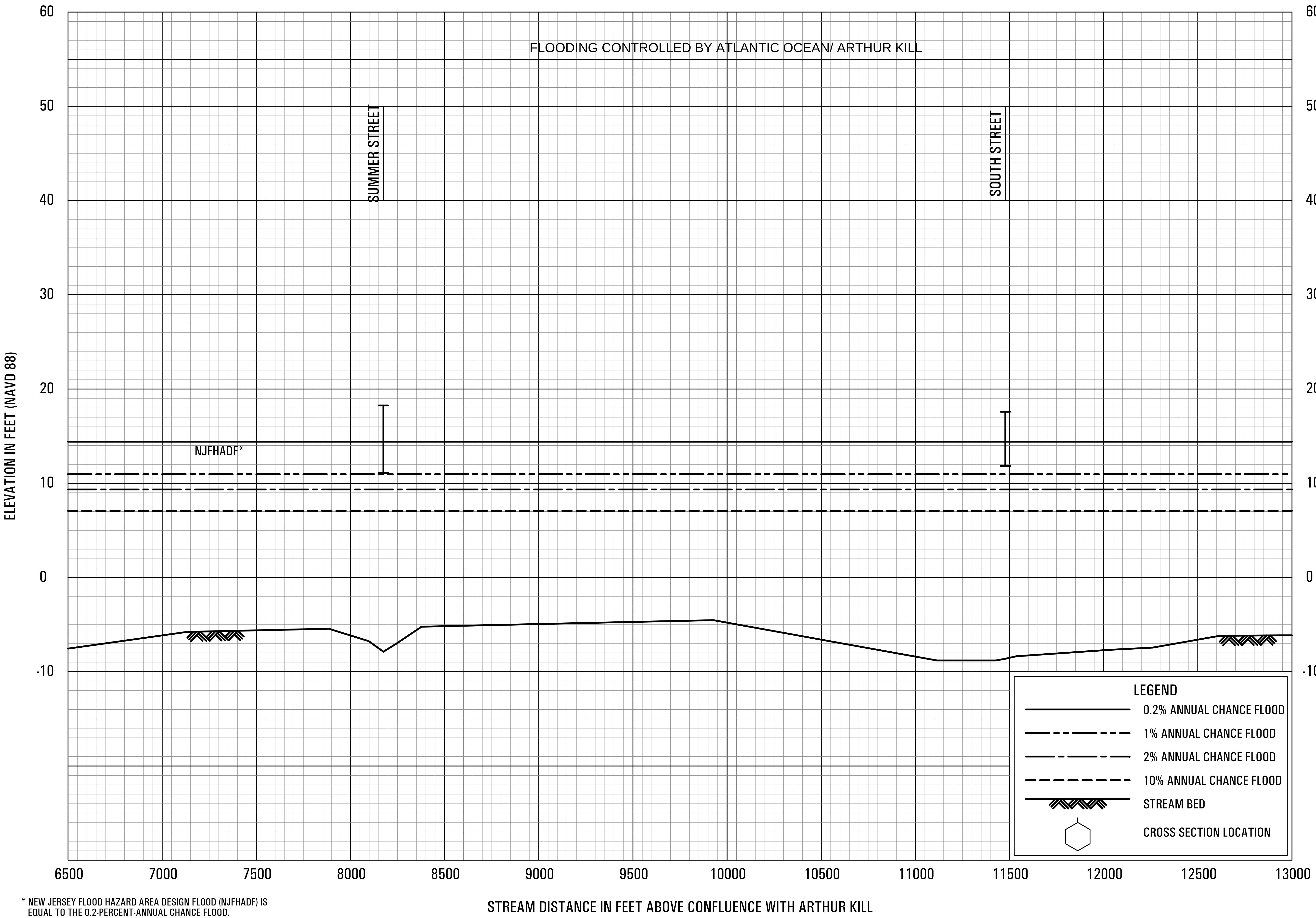
FLOOD PROFILES

ELIZABETH RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)



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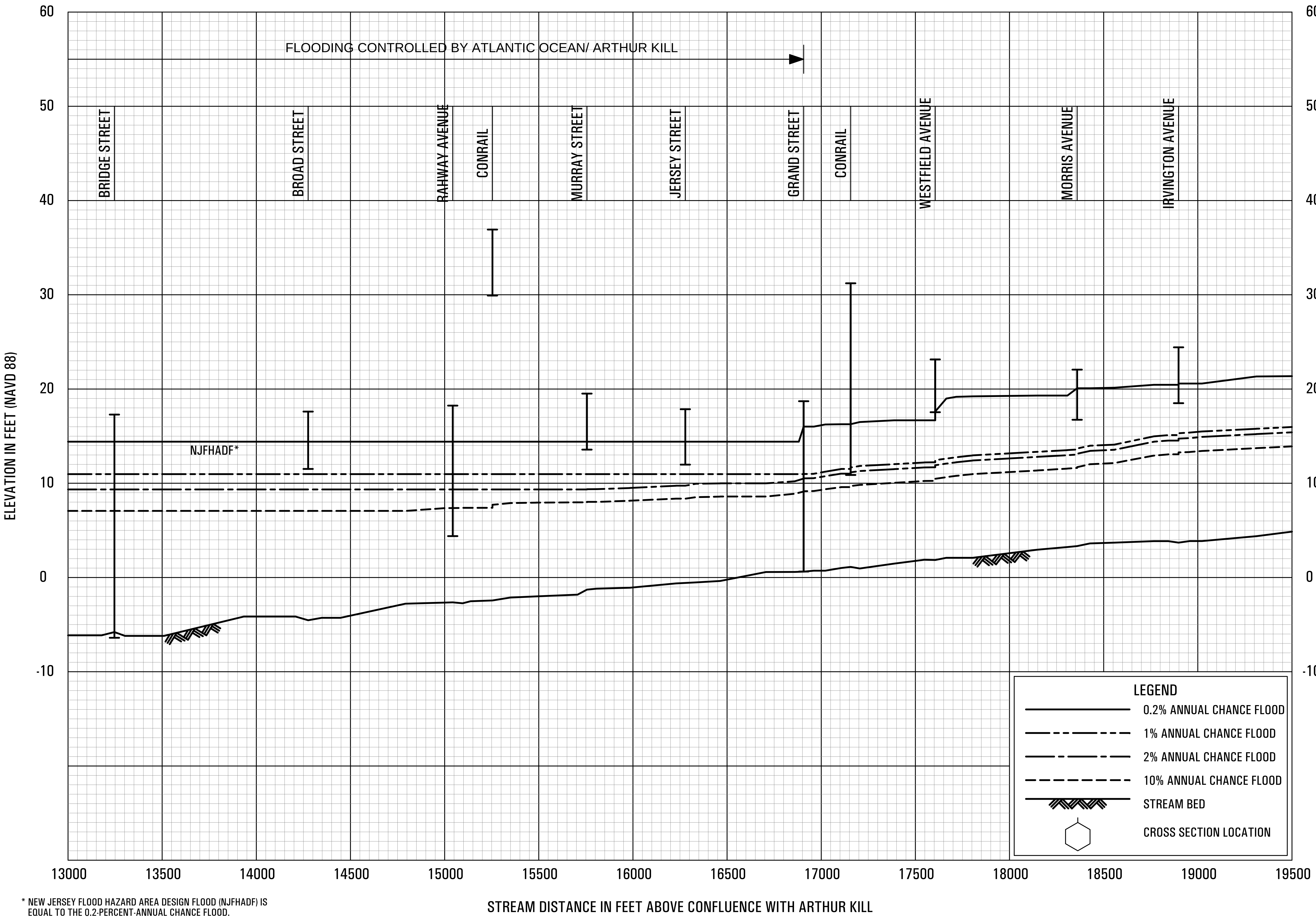
FLOOD PROFILES

ELIZABETH RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)



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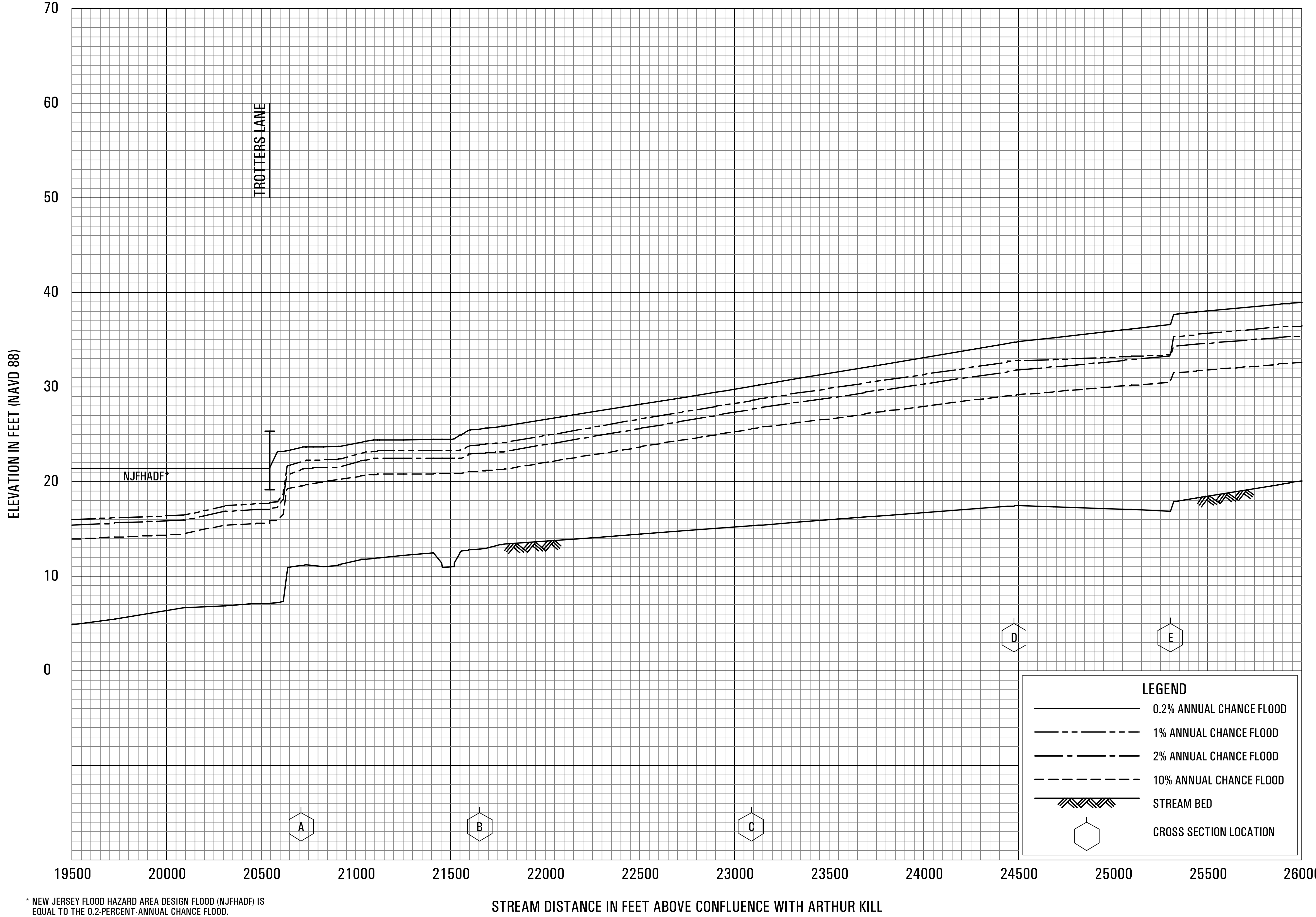
FLOOD PROFILES

ELIZABETH RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)



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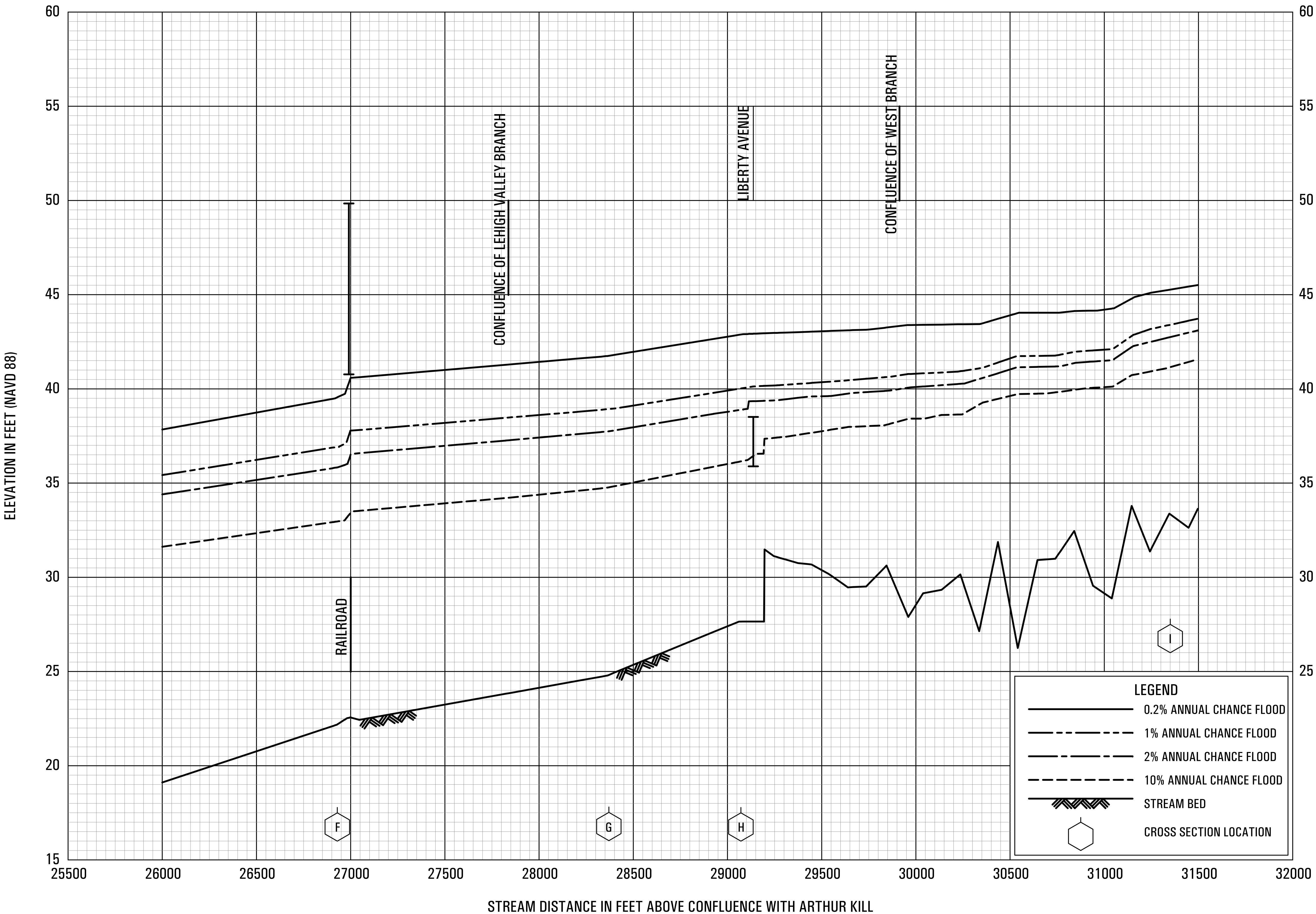
FLOOD PROFILES

ELIZABETH RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)



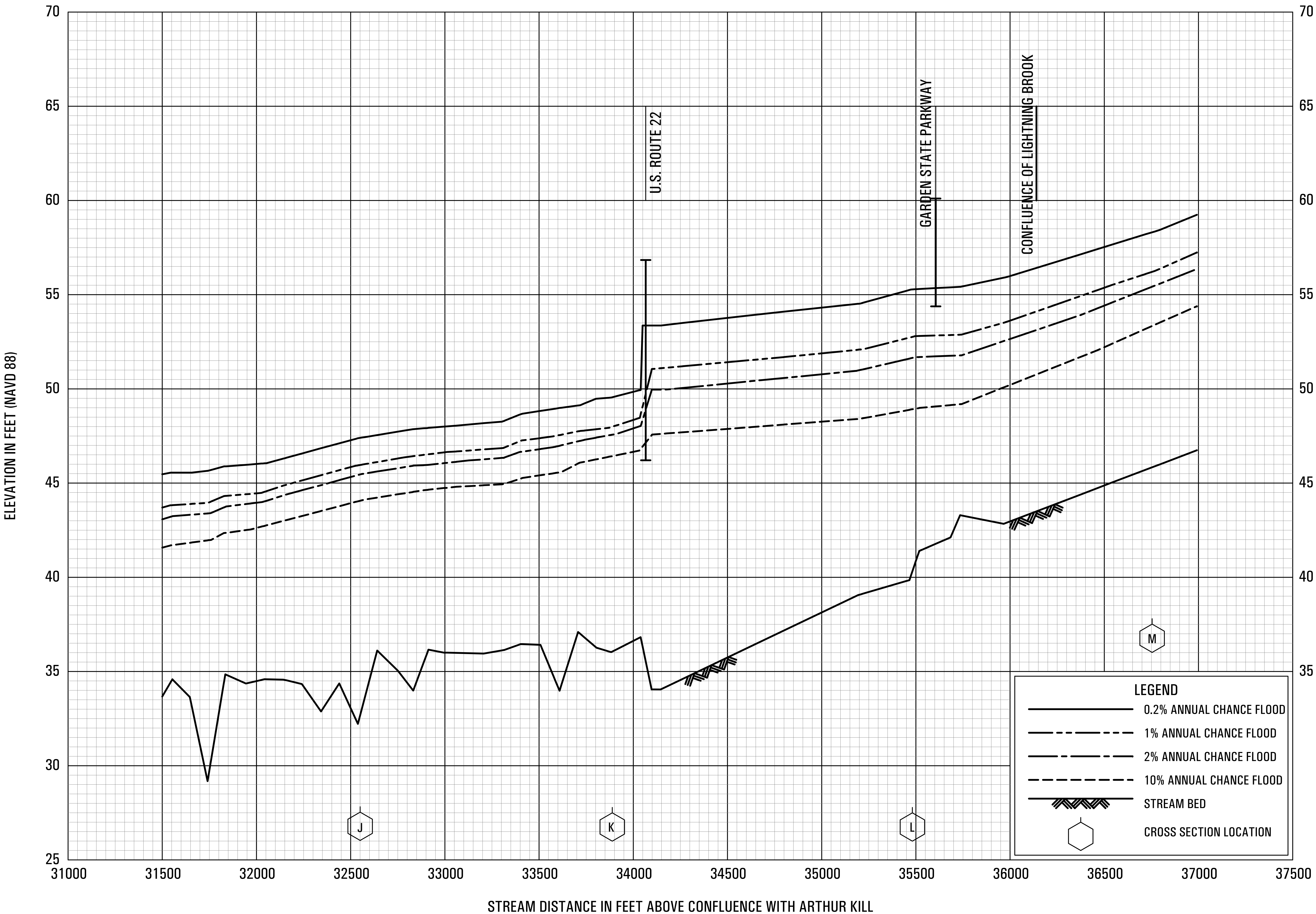
FLOOD PROFILES

ELIZABETH RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)



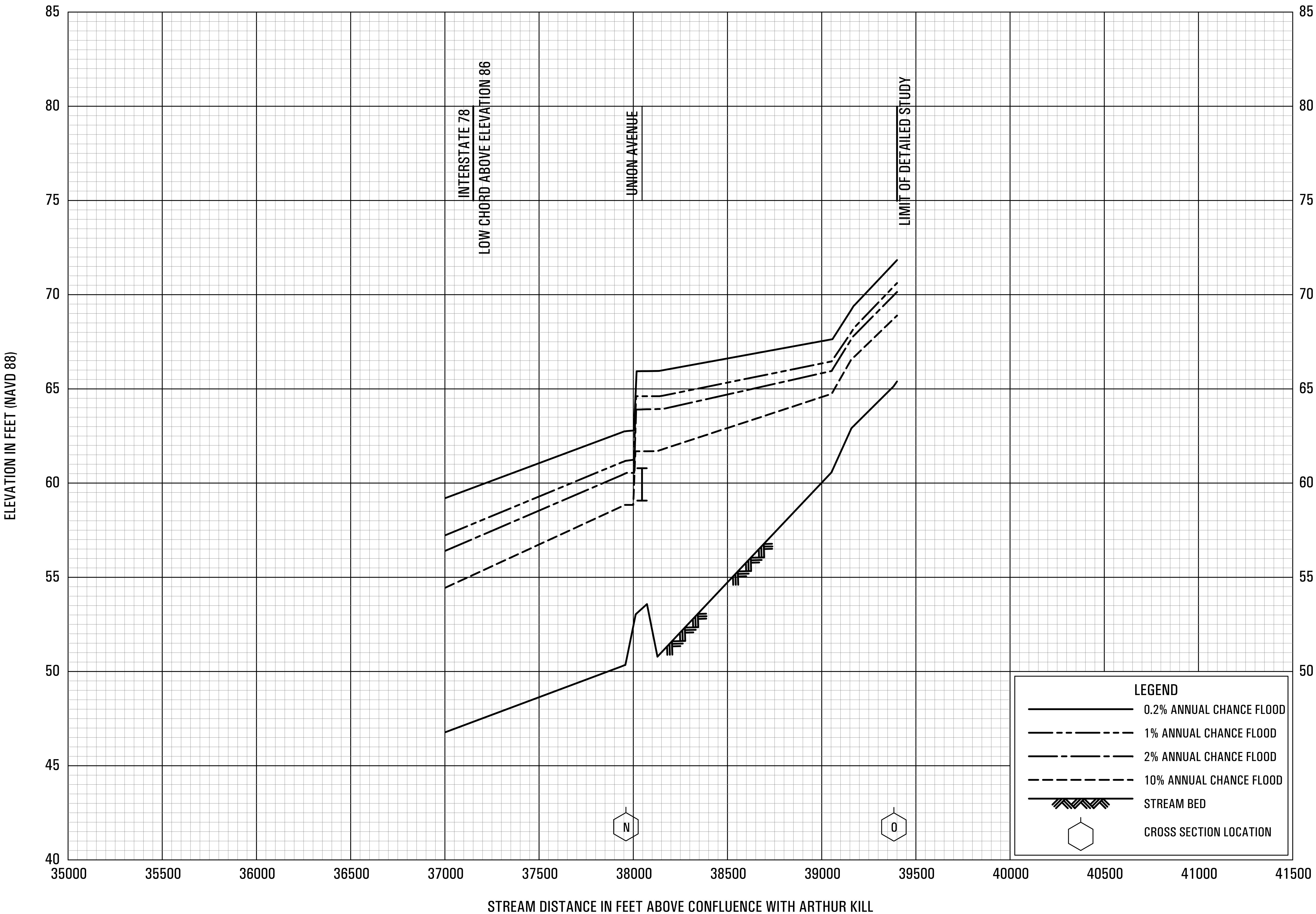
FLOOD PROFILES

ELIZABETH RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)



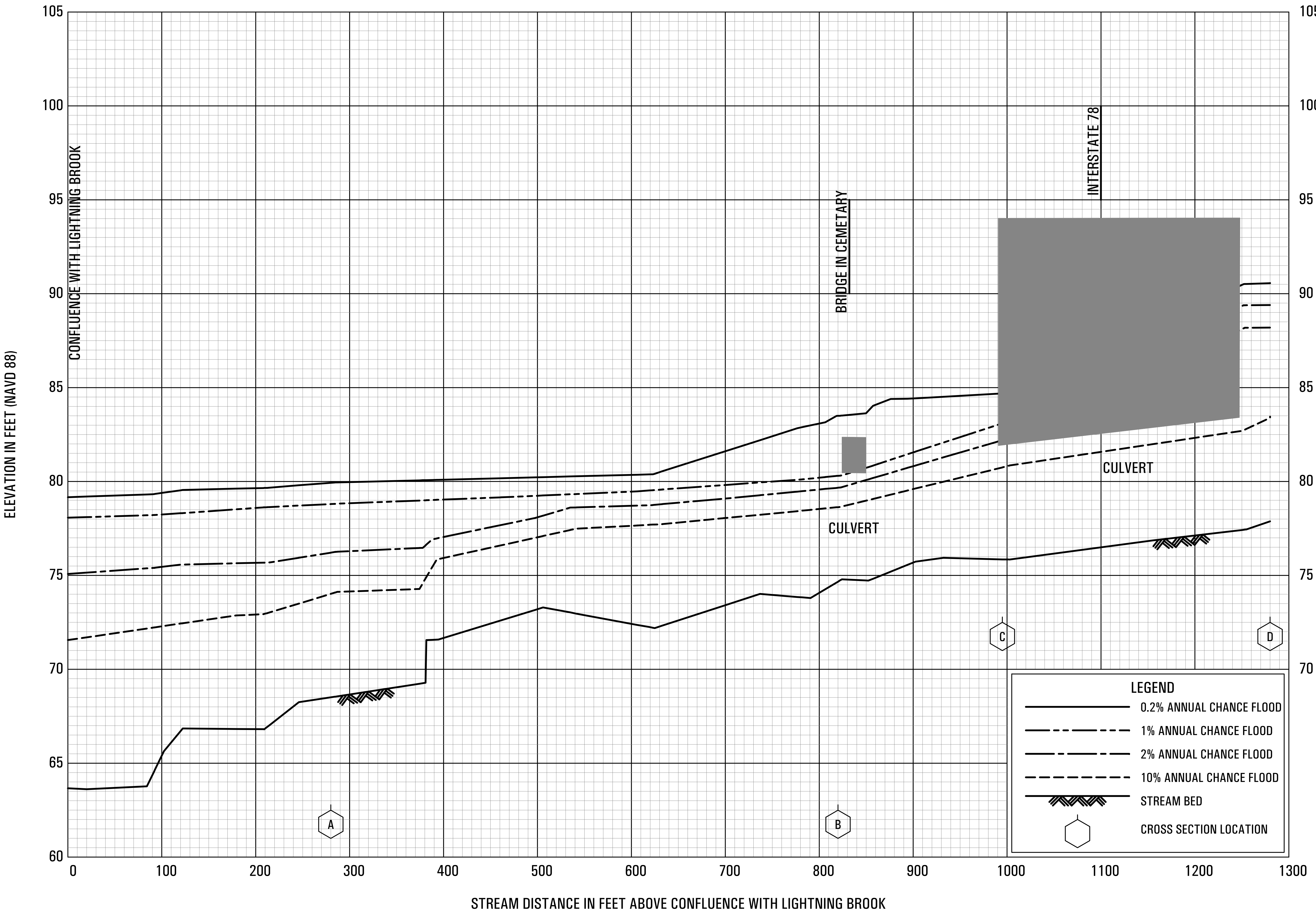
FLOOD PROFILES

ELIZABETH RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)



FLOOD PROFILES

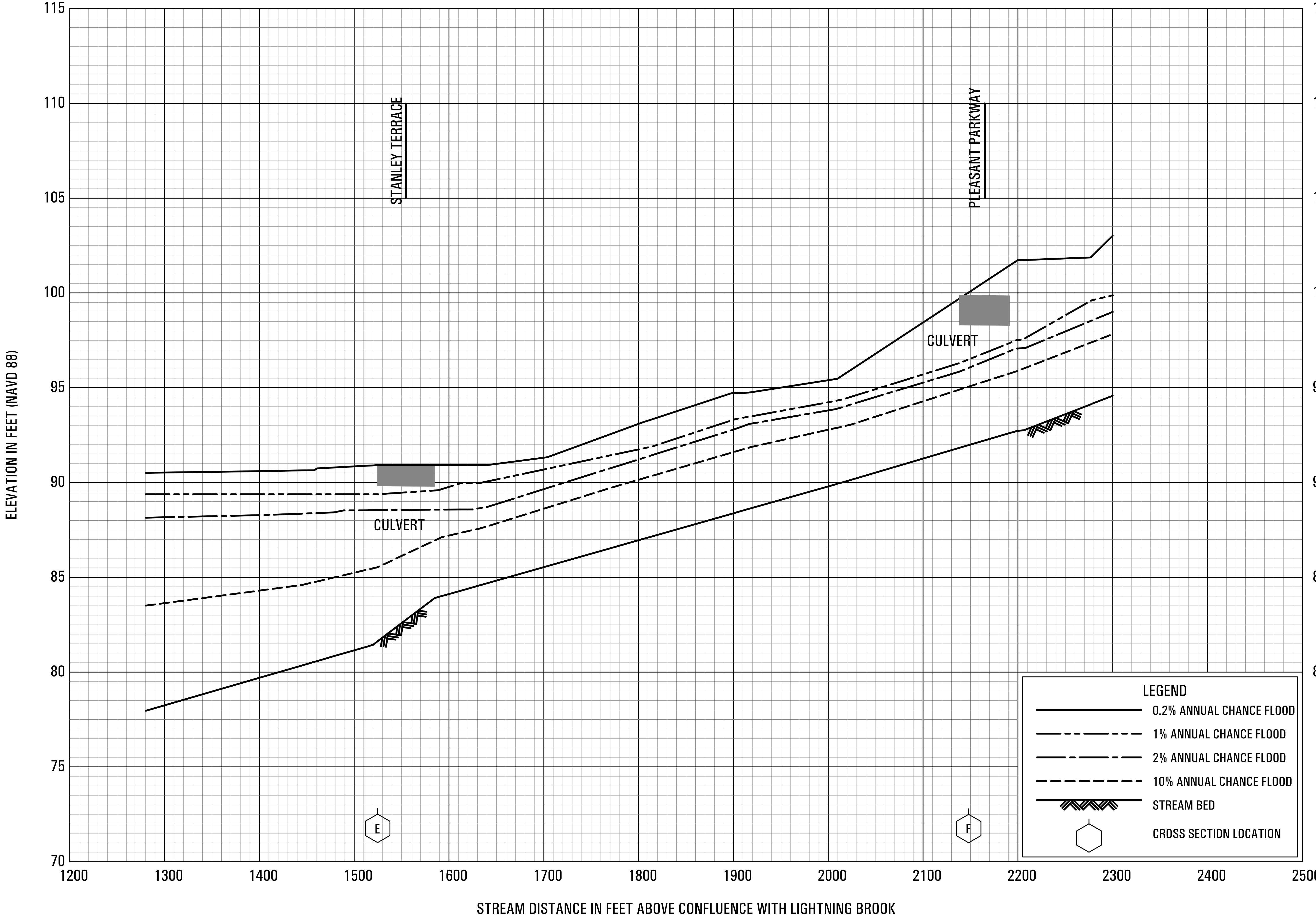
IRVINGTON BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)

69P



FLOOD PROFILES

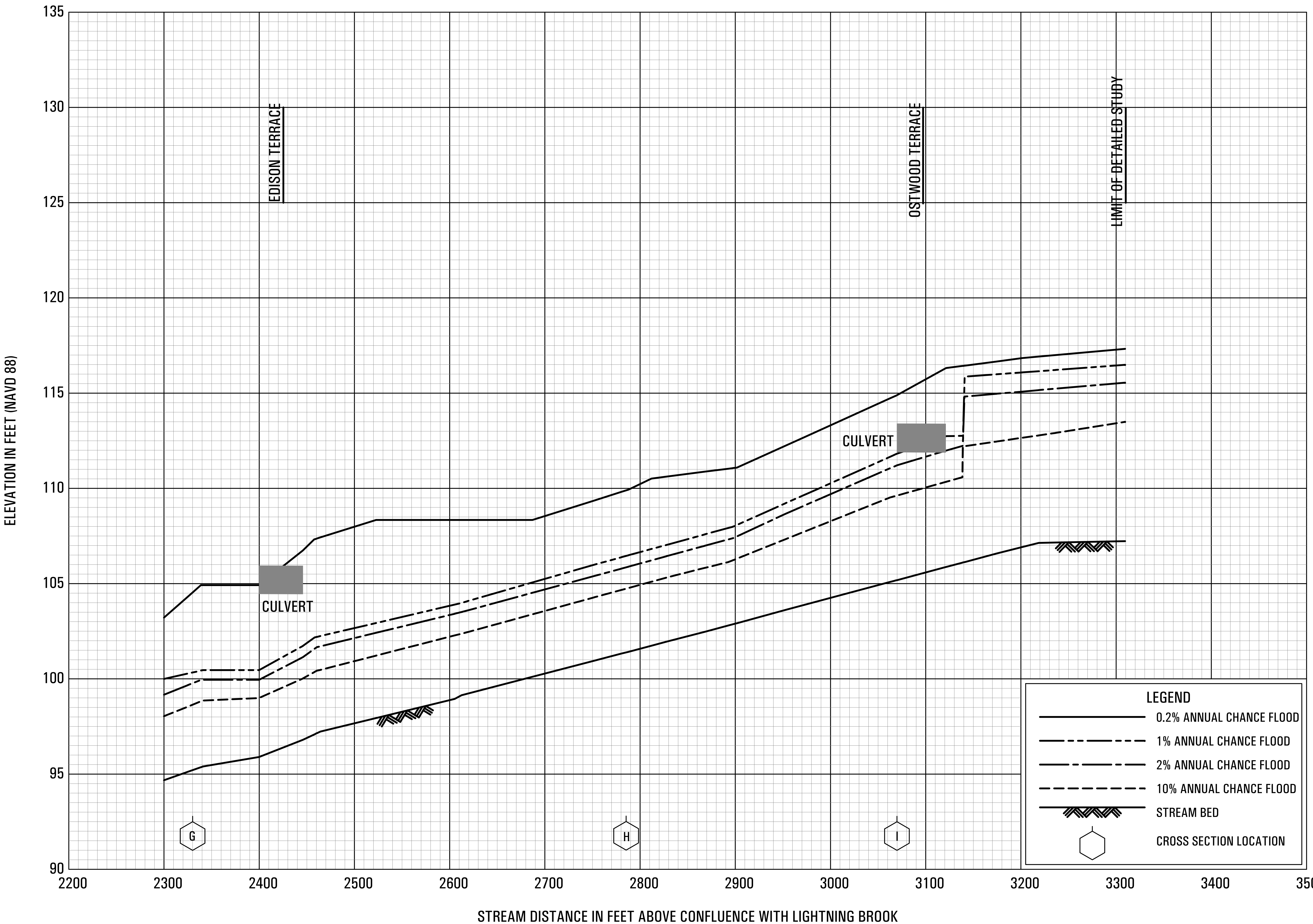
IRVINGTON BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)

70P



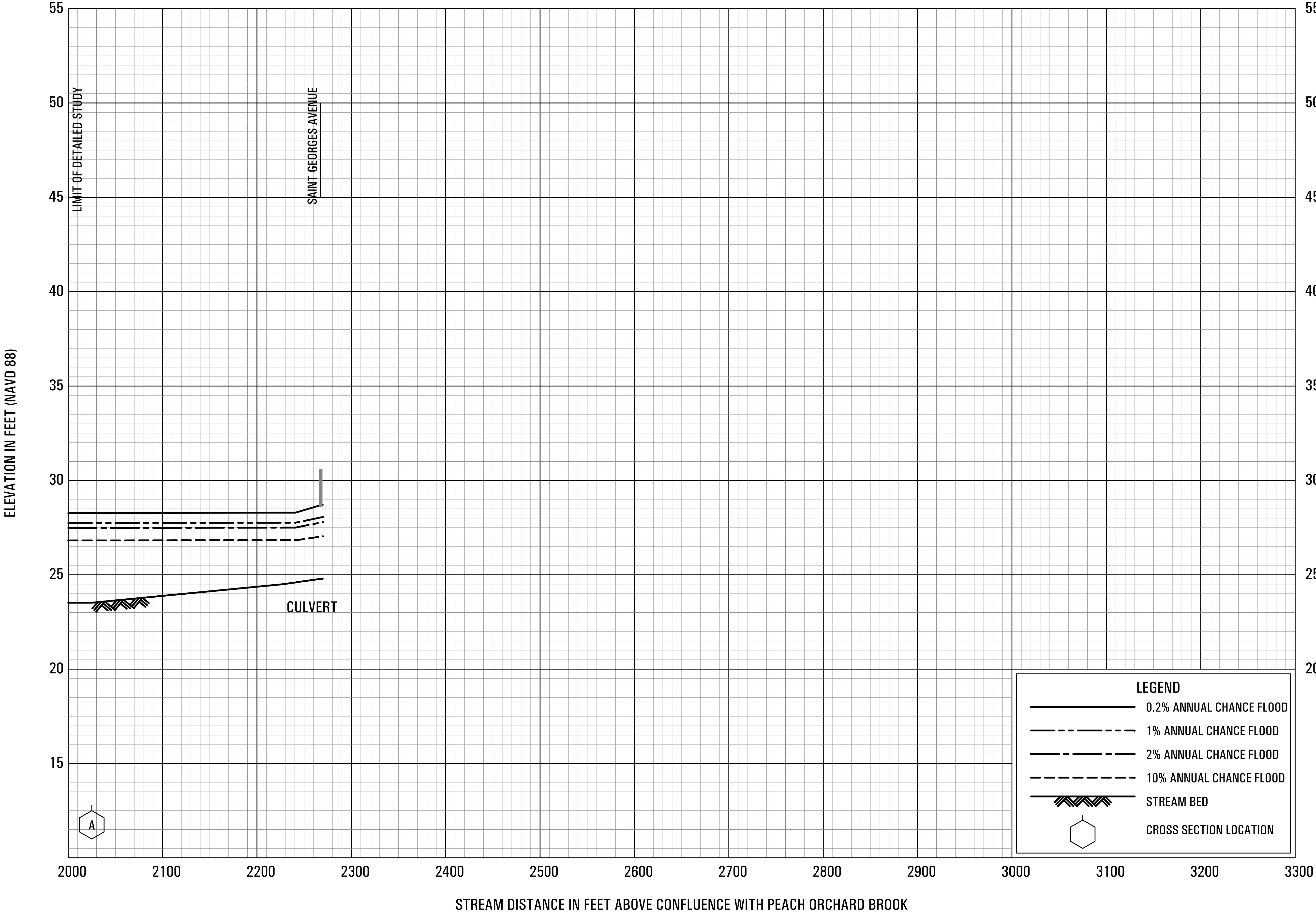
FLOOD PROFILES

IRVINGTON BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)



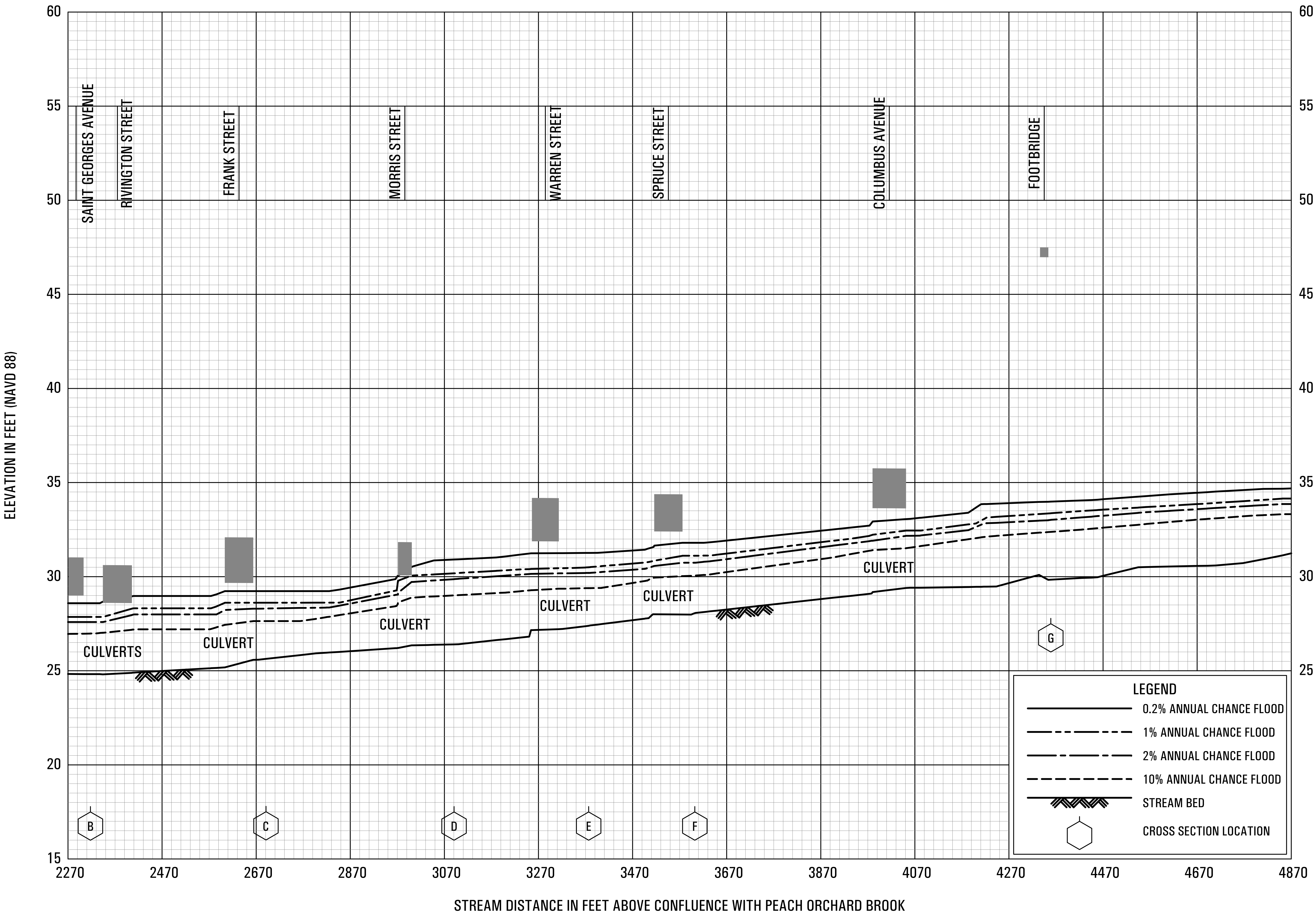
FLOOD PROFILES

JOUET BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)



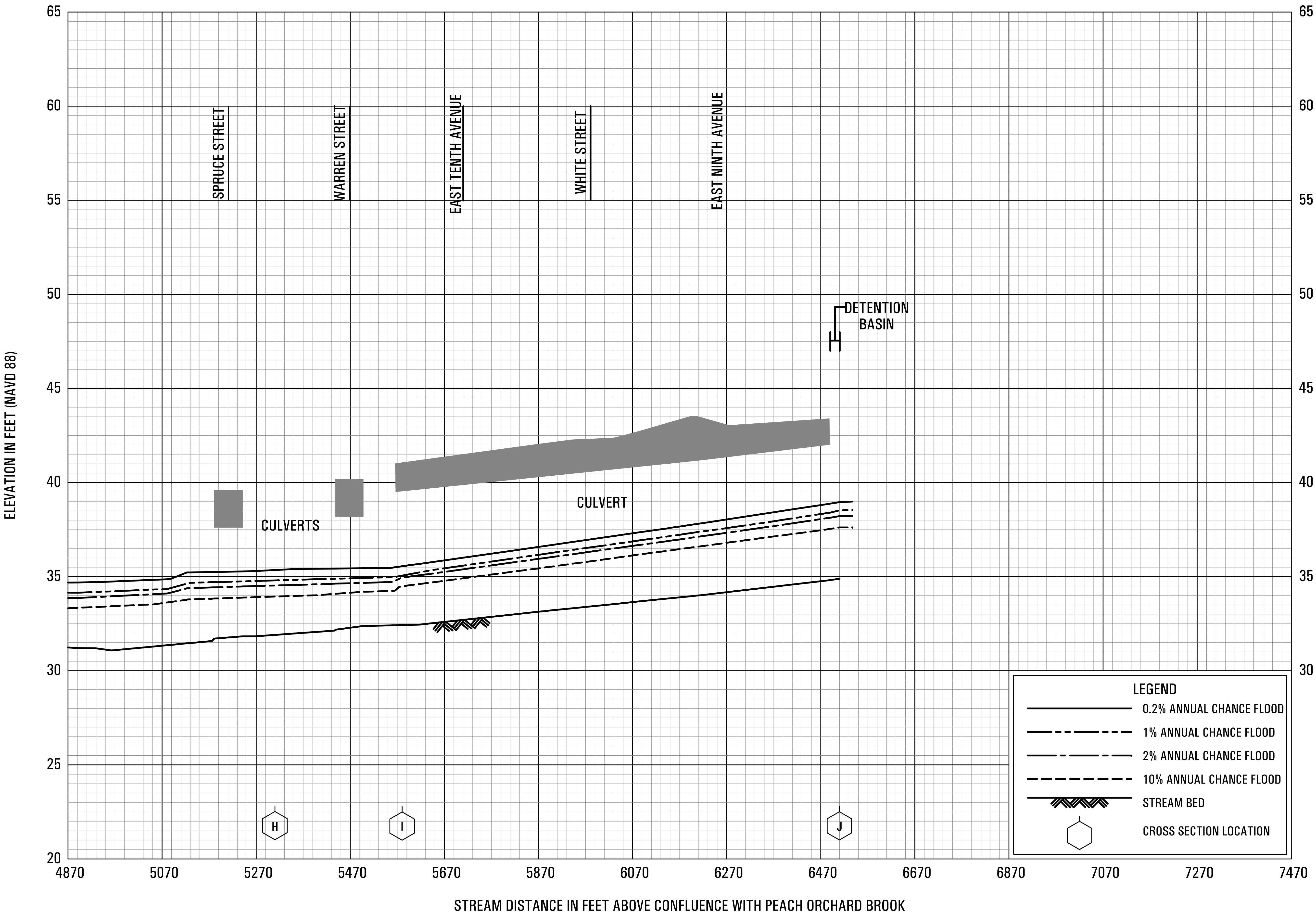
FLOOD PROFILES

JOUET BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)



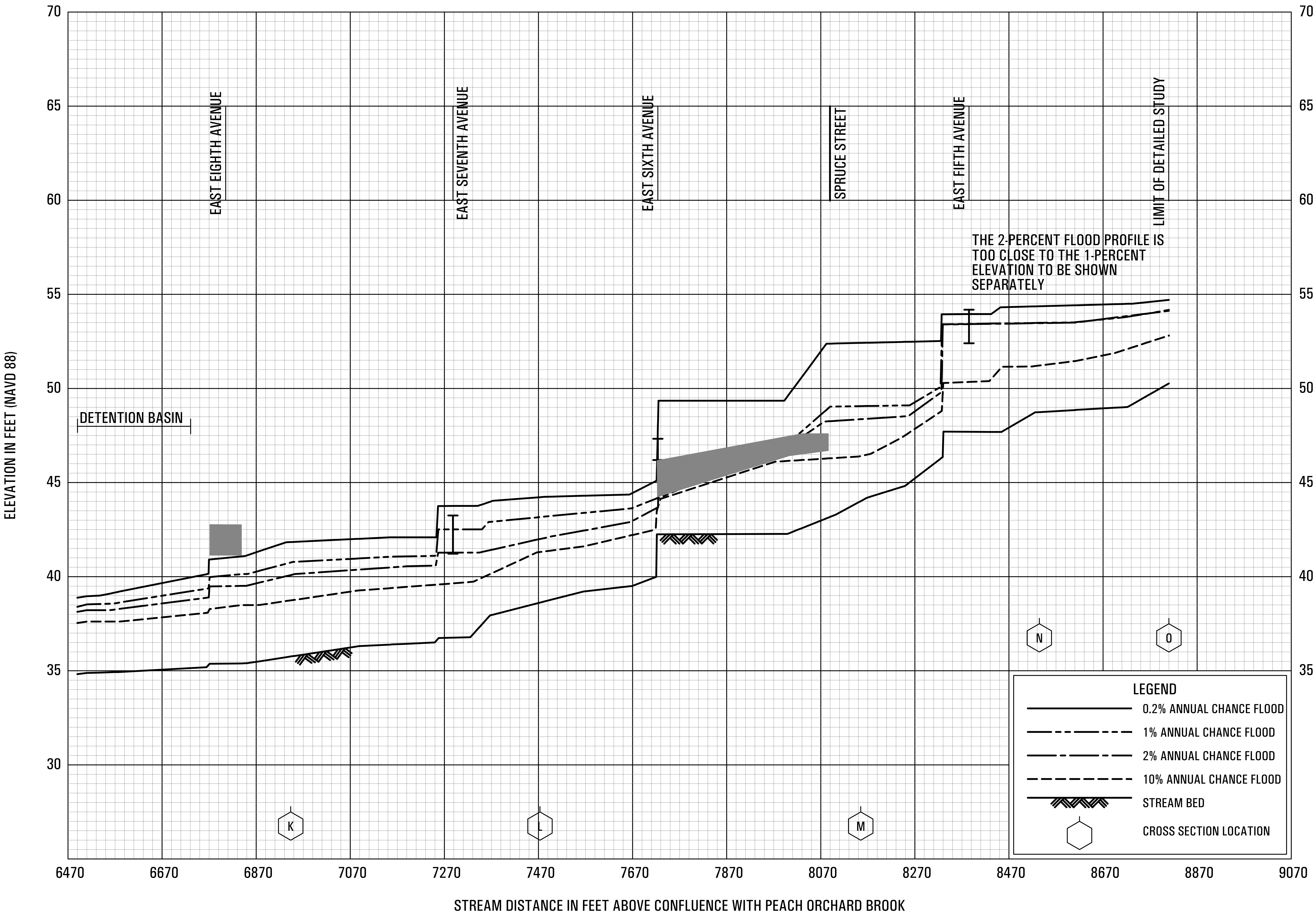
FLOOD PROFILES

JOUET BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)



FLOOD PROFILES

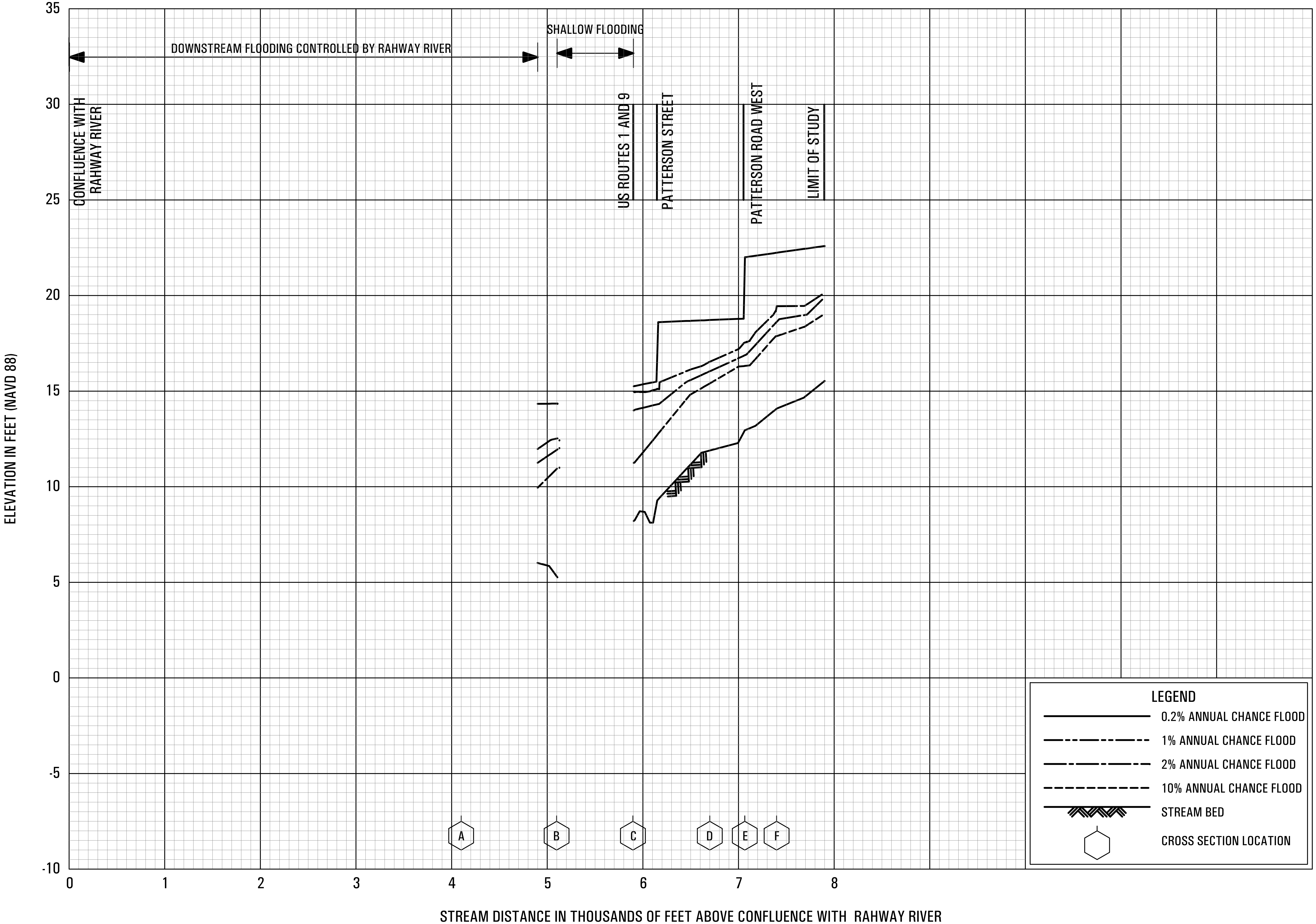
JOUET BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)

75P



FLOOD PROFILES

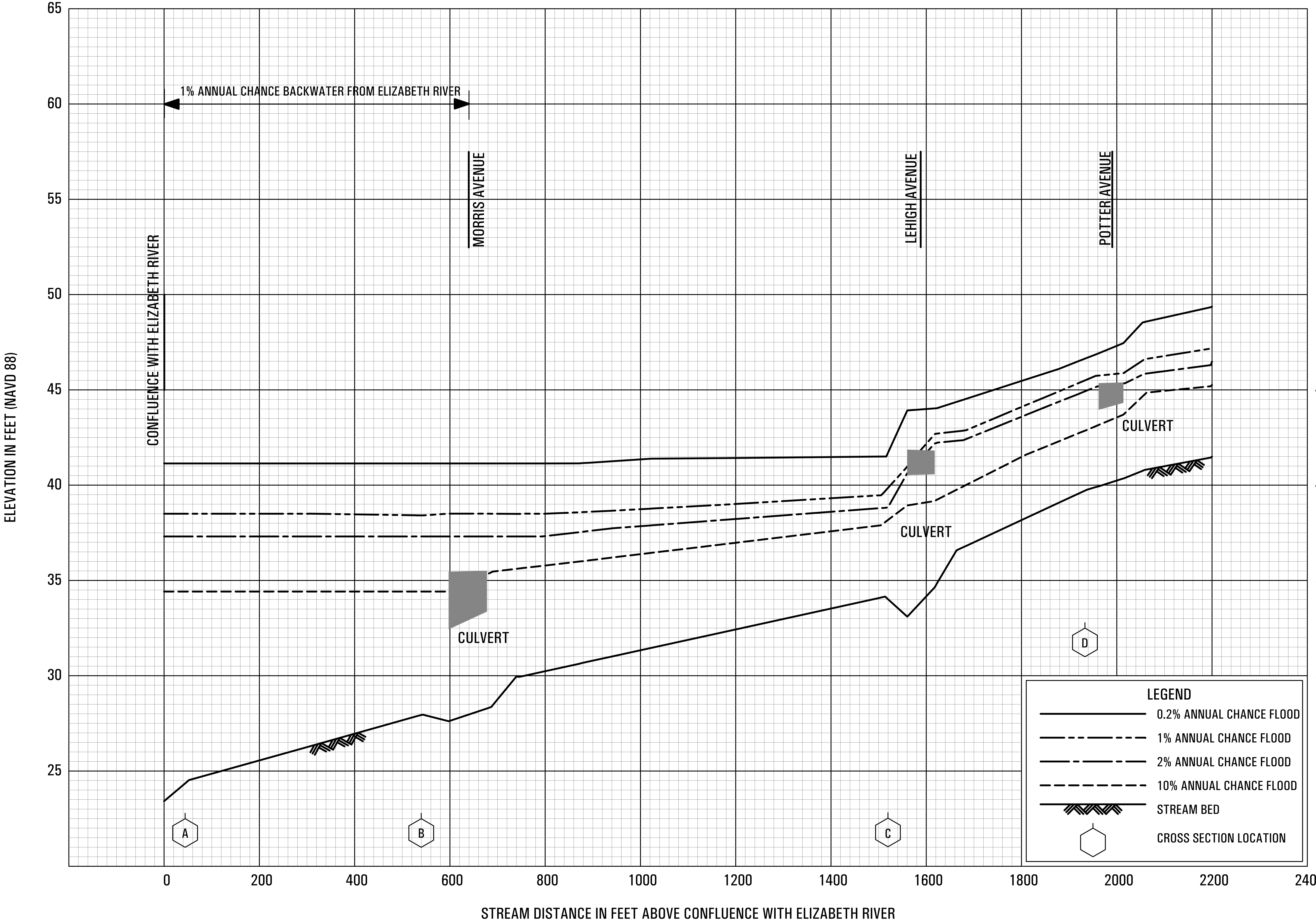
KINGS CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)

76P



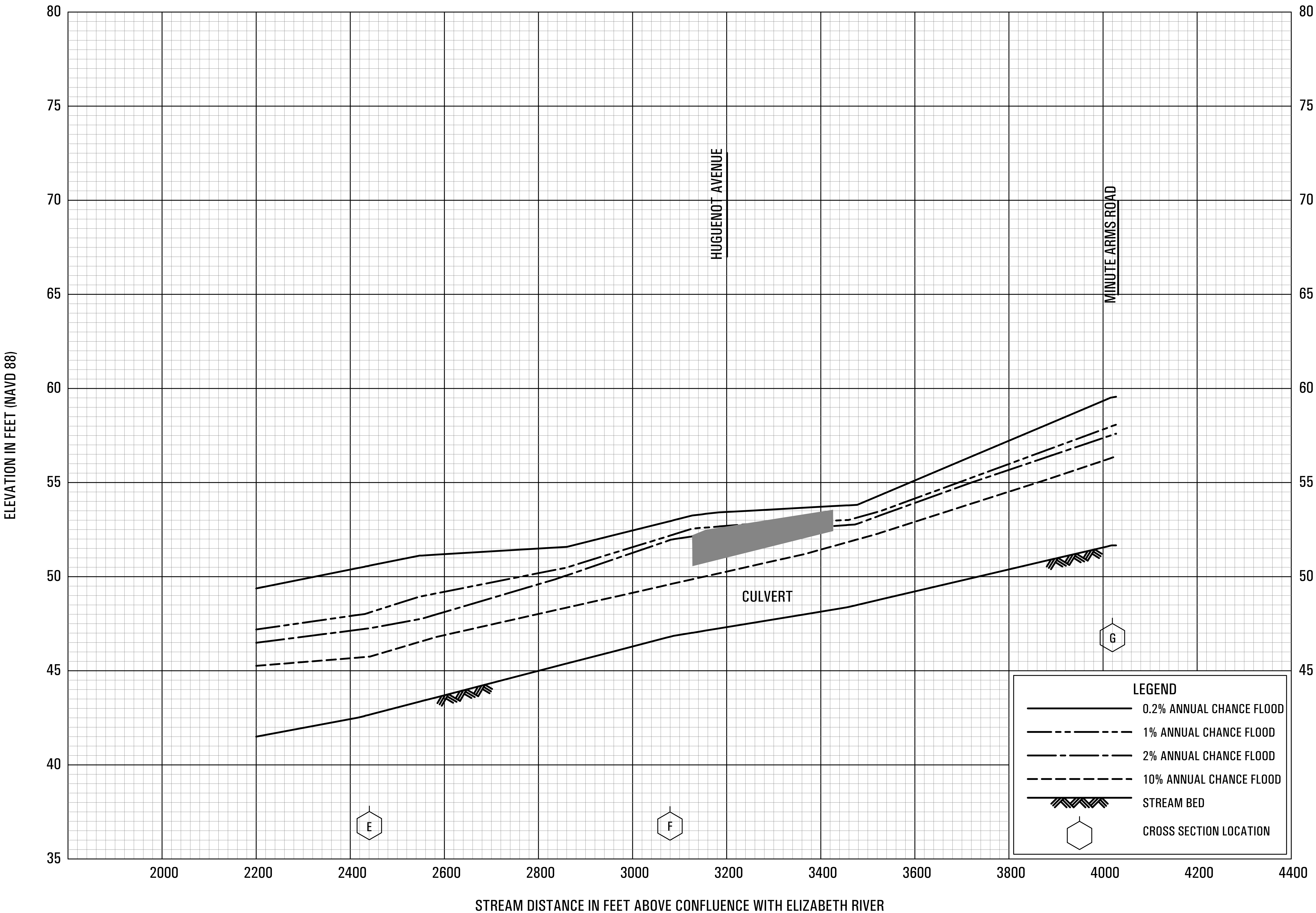
FLOOD PROFILES

LEHIGH VALLEY BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)



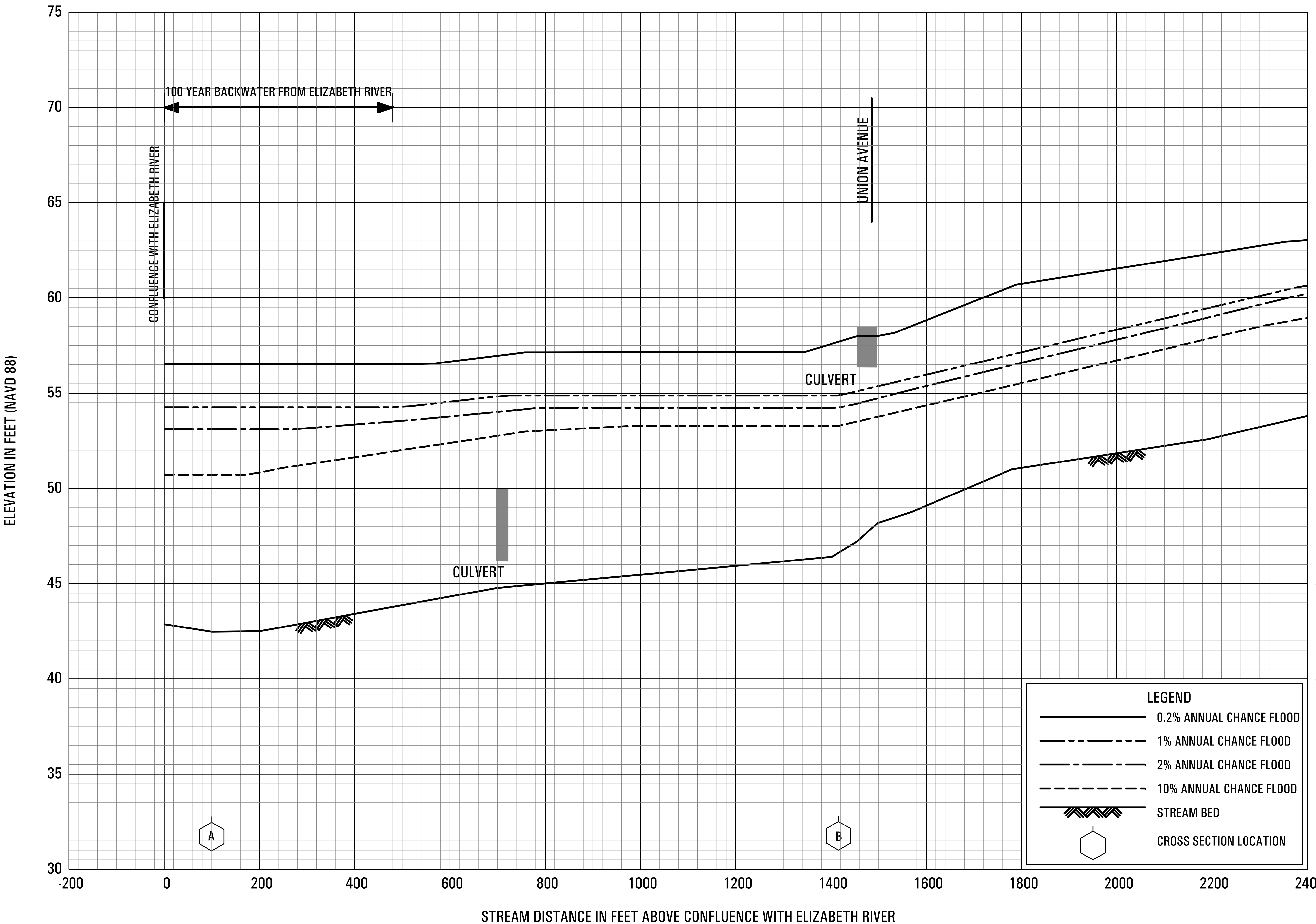
FLOOD PROFILES

LEHIGH VALLEY BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)



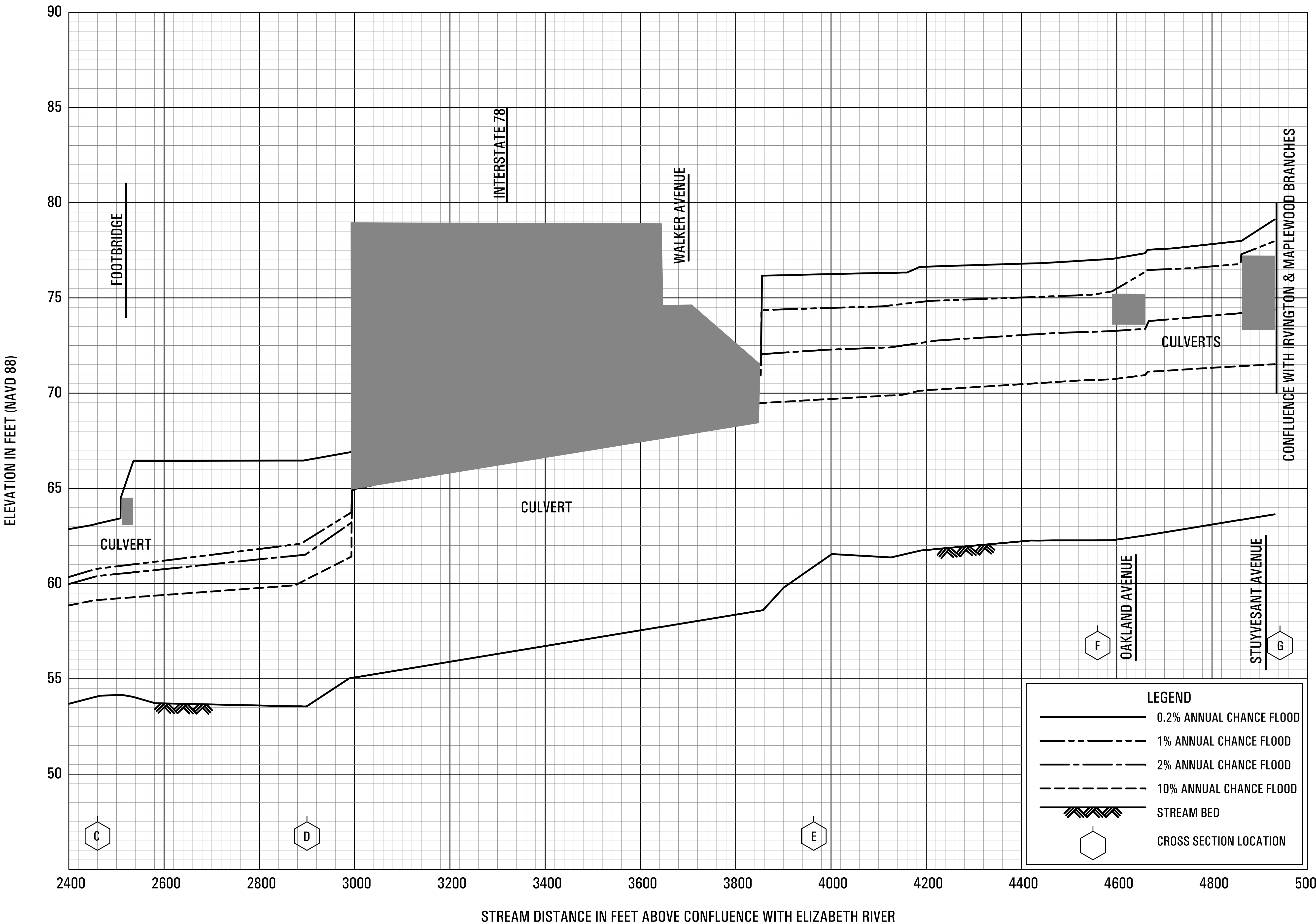
FLOOD PROFILES

LIGHTNING BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)



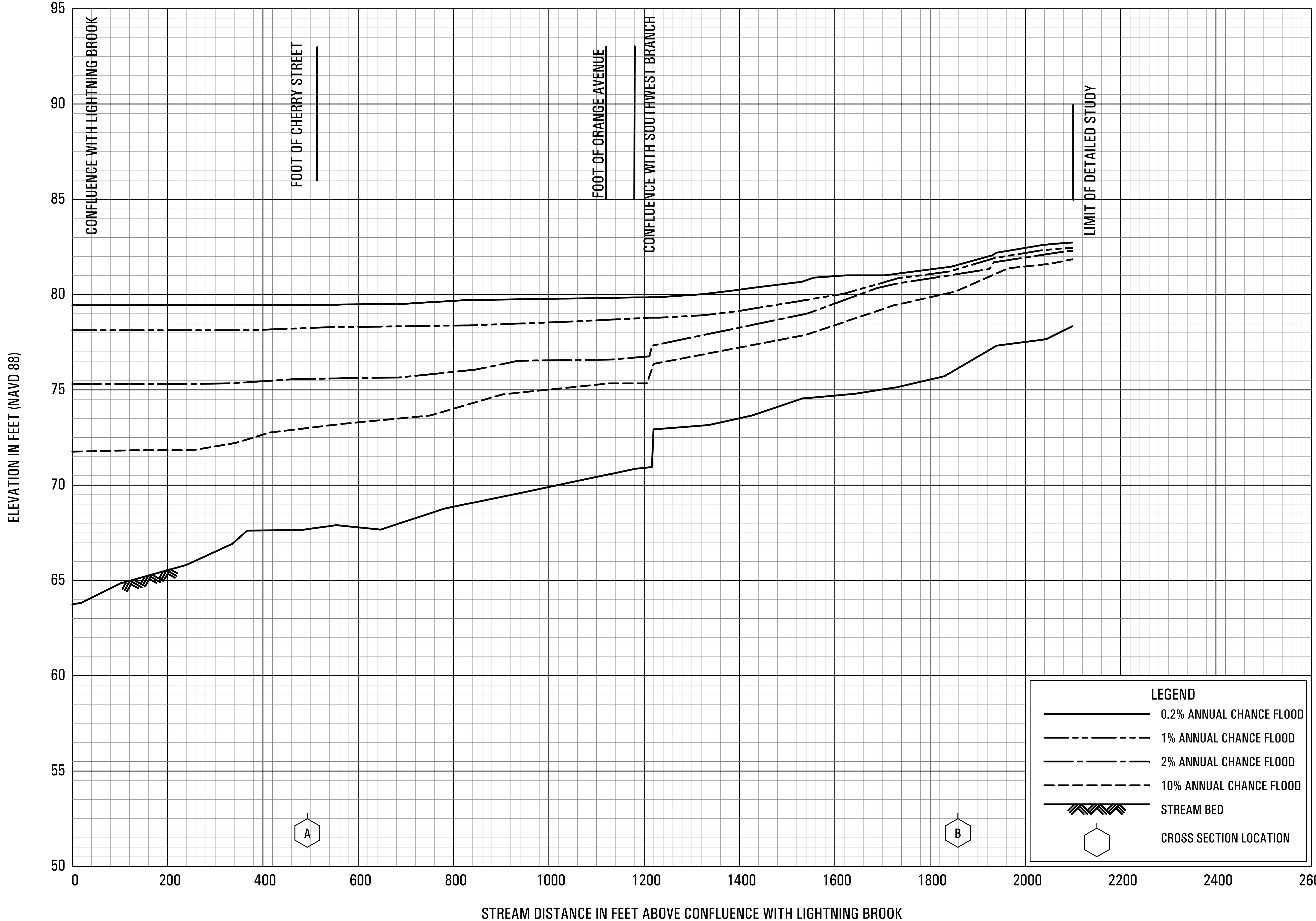
FLOOD PROFILES

LIGHTNING BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)



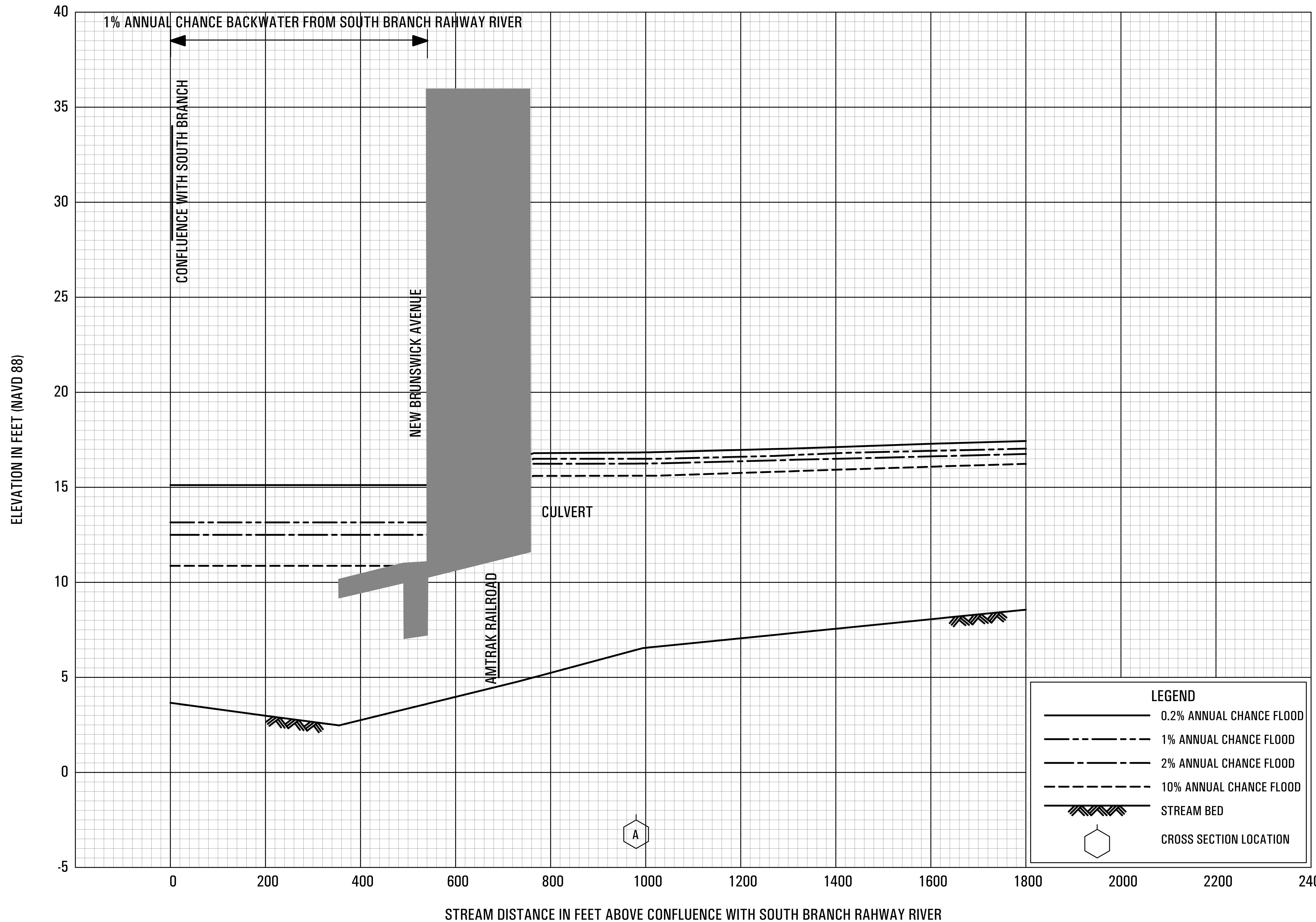
FLOOD PROFILES

MAPLEWOOD BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)



FLOOD PROFILES

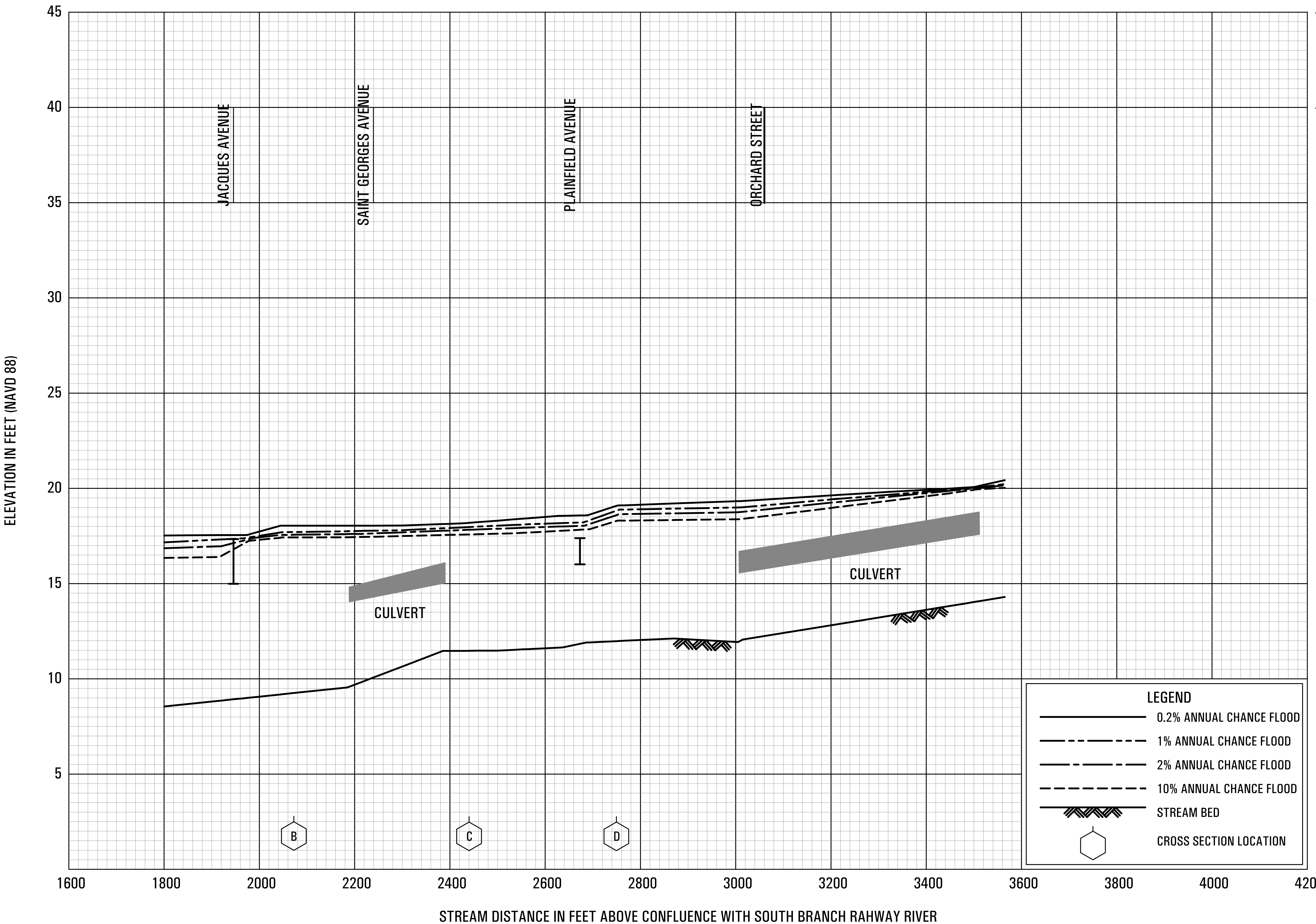
ORCHARD CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)

91P



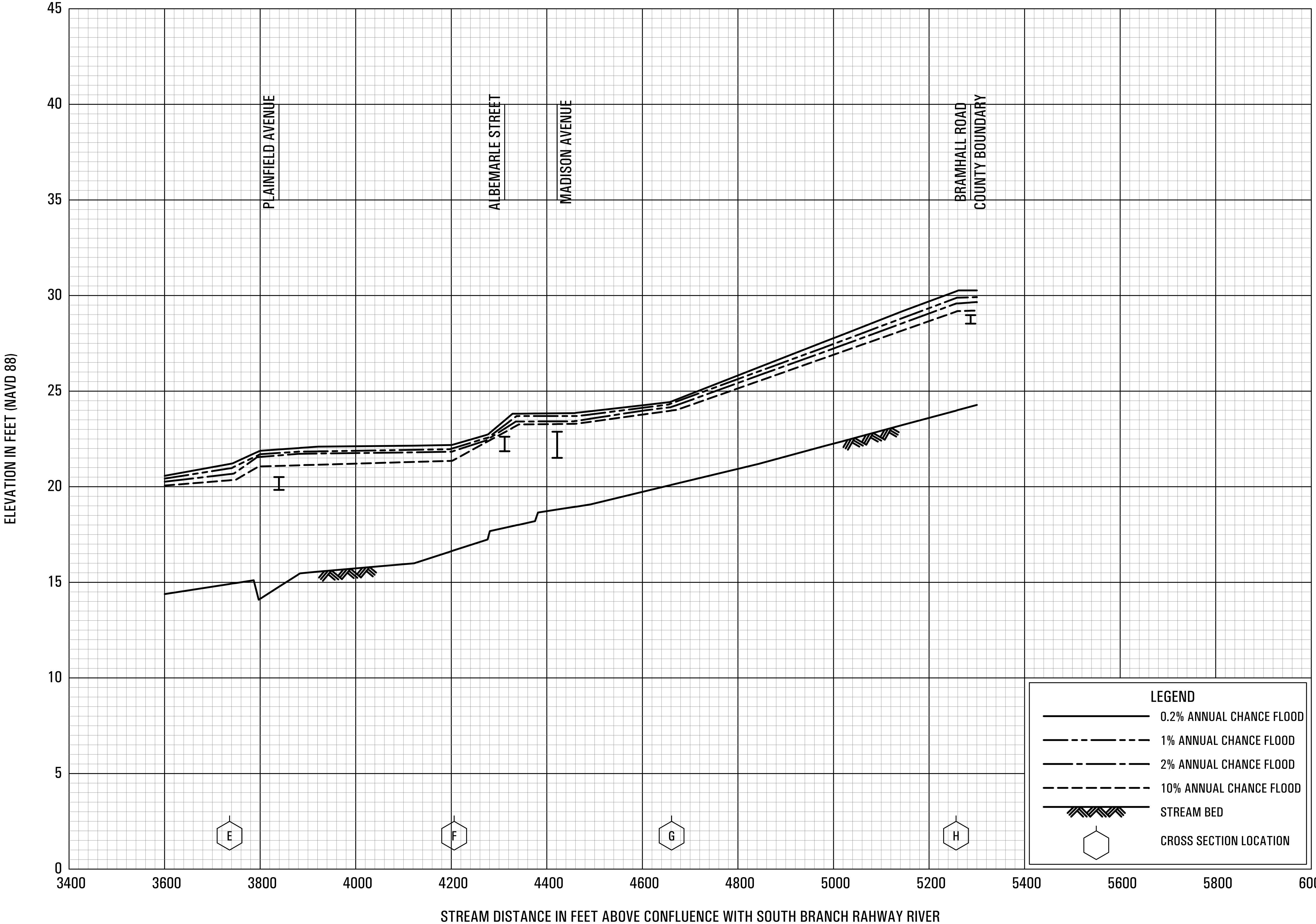
FLOOD PROFILES

ORCHARD CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)



FLOOD PROFILES

ORCHARD CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)

FLOOD INSURANCE STUDY

FEDERAL EMERGENCY MANAGEMENT AGENCY

VOLUME 2 OF 2

UNION COUNTY, NEW JERSEY

(ALL JURISDICTIONS)

COMMUNITY NAME	NUMBER	COMMUNITY NAME	NUMBER
BOROUGH OF FANWOOD	340463	CITY OF SUMMIT	340476
BOROUGH OF GARWOOD	340464	TOWN OF WESTFIELD	340478
BOROUGH OF KENILWORTH	340466	TOWNSHIP OF BERKELEY HEIGHTS	340459
BOROUGH OF MOUNTAINSIDE	340468	TOWNSHIP OF CLARK	345290
BOROUGH OF NEW PROVIDENCE	345306	TOWNSHIP OF CRANFORD	345291
BOROUGH OF ROSELLE	340472	TOWNSHIP OF HILLSIDE	340465
BOROUGH OF ROSELLE PARK	340473	TOWNSHIP OF SCOTCH PLAINS	340474
CITY OF ELIZABETH	345523	TOWNSHIP OF SPRINGFIELD	345321
CITY OF LINDEN	340467	TOWNSHIP OF UNION	340477
CITY OF PLAINFIELD	345312	TOWNSHIP OF WINFIELD[1]	340479
CITY OF RAHWAY	345314		

[1] No Special Flood Hazard Areas Identified

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

REVISED: **PRELIMINARY FEBRUARY 3, 2015**

FEMA

FLOOD INSURANCE STUDY NUMBER
34039CV002B
Version Number 2.2.2.2

NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program (NFIP) 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 20, 2006

Revised Countywide FIS Date: [TBD] – to change Base Flood Elevations, Special Flood Hazard Areas and zone designations; to update the effects of wave actions, roads and road names; and to reflect revised shoreline and updated topographic information.

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

ATTENTION: On FIRM panels 34039C0024G and 34039C035G the Elizabeth River levee and on FIRM panels 34039C0043G and 34039C0044G the Rahway River levee have not been demonstrated by the community or levee owner(s) to meet the requirements of Section 65.10 of the NFIP regulations in 44 CFR as it relates to the levee's capacity to provide 1-percent annual chance flood protection. The subject areas are identified on FIRM panels (with notes and bounding lines) and in the FIS report as potential areas of flood hazard data changes based on further review.

FEMA has updated the levee analysis and mapping procedures for non-accredited levees. Until such time as FEMA is able to initiate a new flood risk project to apply the new procedures, the flood hazard information on the aforementioned FIRM panel(s) that are affected by the Elizabeth River and Rahway River levees are being added as a snapshot of the prior previously effective information presented on the FIRMs and FIS reports dated September 20, 2006. As indicated above, it is expected that affected flood hazard data within the subject area could be significantly revised. This may result in floodplain boundary changes, 1-percent annual chance flood elevation changes, and/or changes to flood hazard zone designations.

The effective FIRM panels (and the FIS report) will again be revised at a later date to update the flood hazard information associated with the Elizabeth River and Rahway River levees when FEMA is able to initiate and complete a new flood risk project to apply the new levee analysis and mapping procedures.

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FIGURES

TABLES

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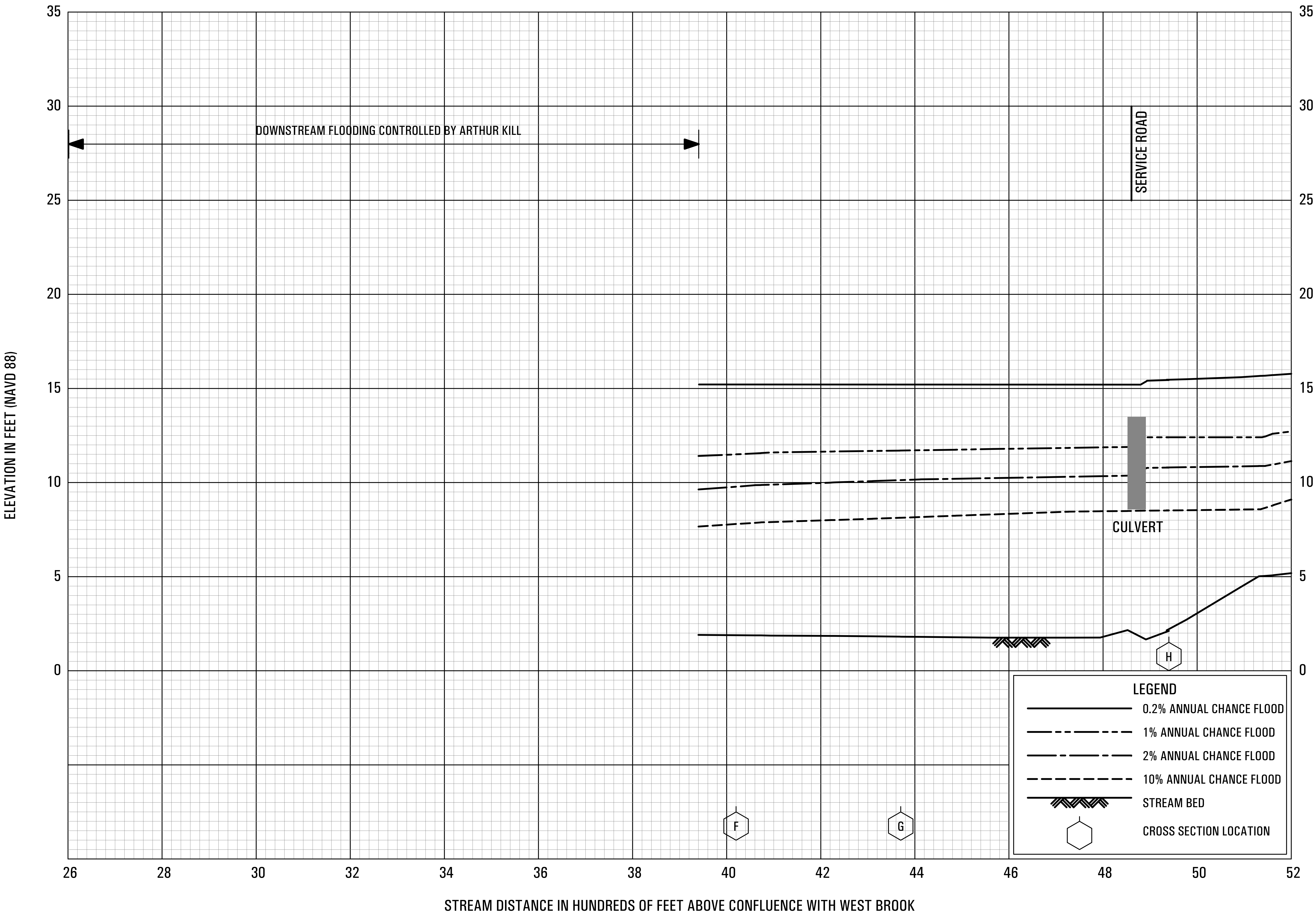
EXHIBITS – continued

Exhibit 1 – Flood Profiles (continued)



FLOOD PROFILES

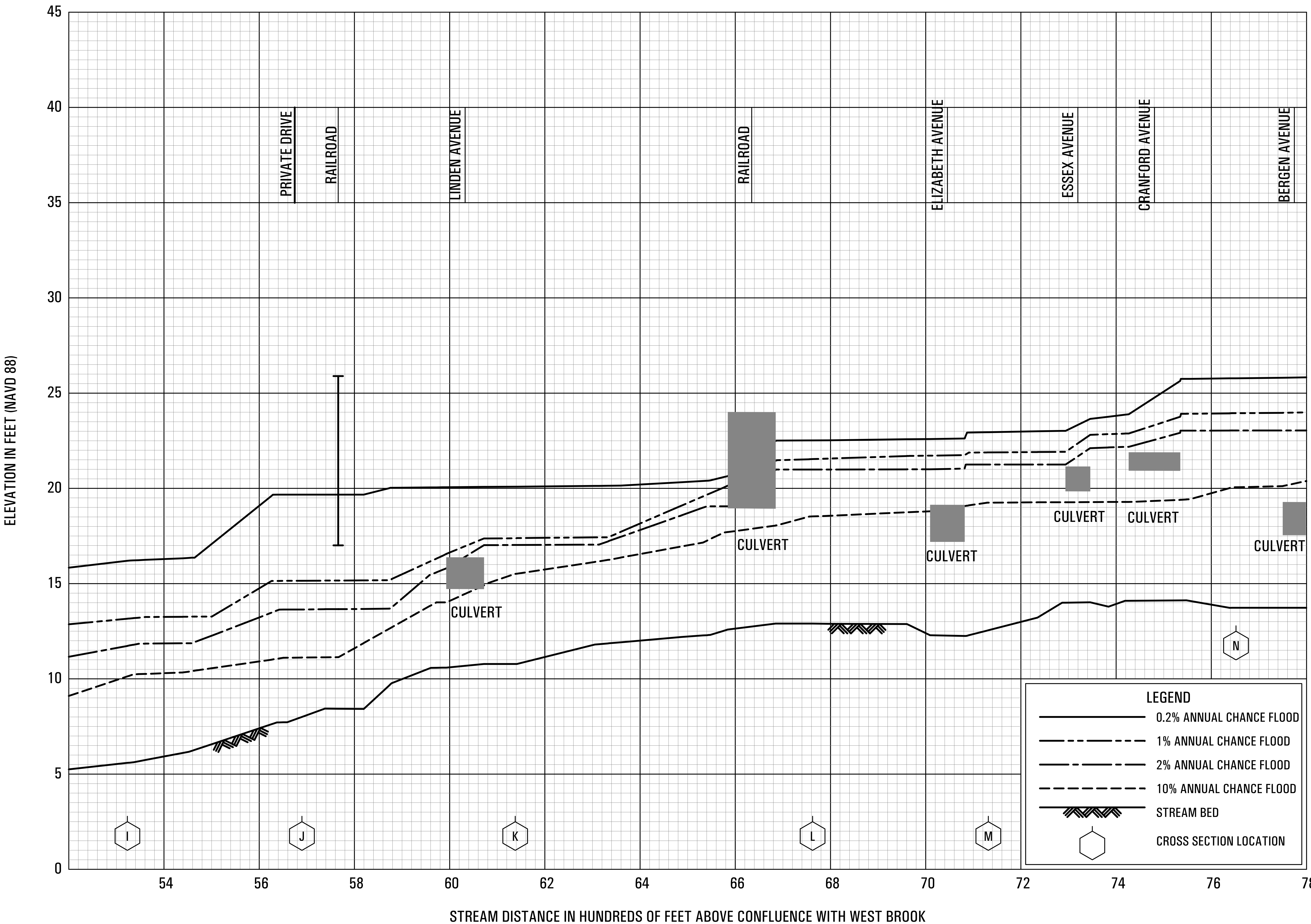
PEACH ORCHARD BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)

104P



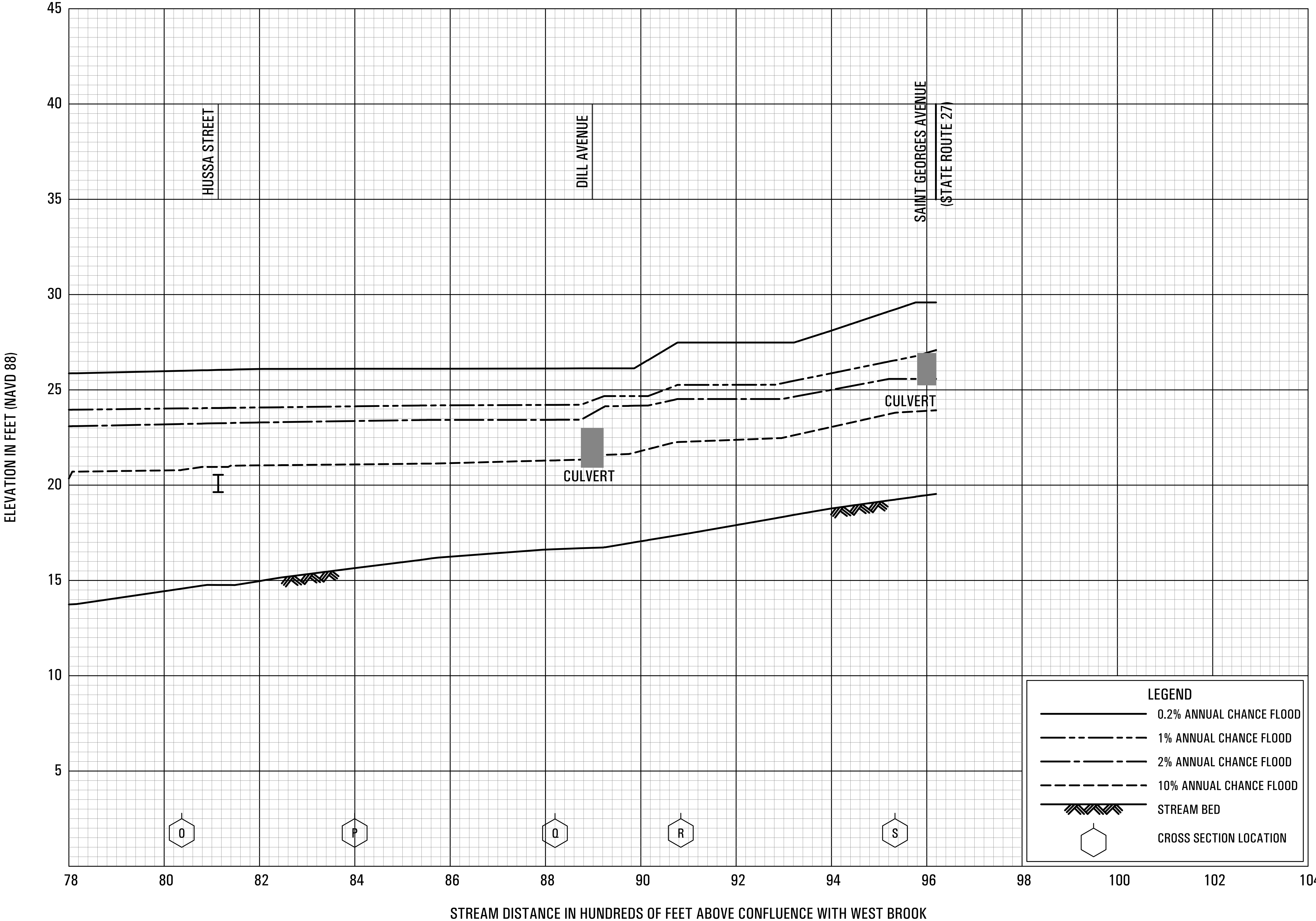
FLOOD PROFILES

PEACH ORCHARD BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)



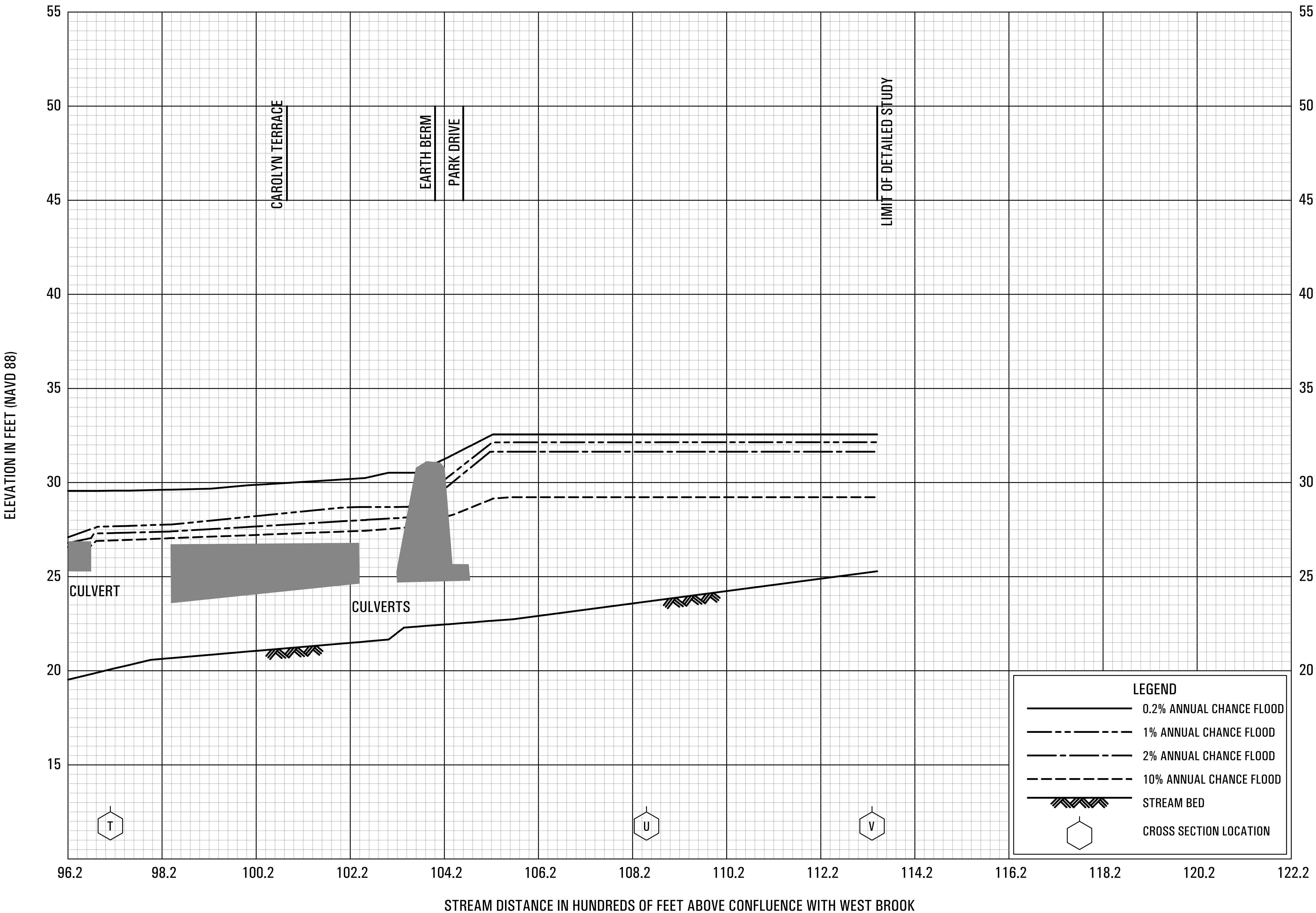
FLOOD PROFILES

PEACH ORCHARD BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)



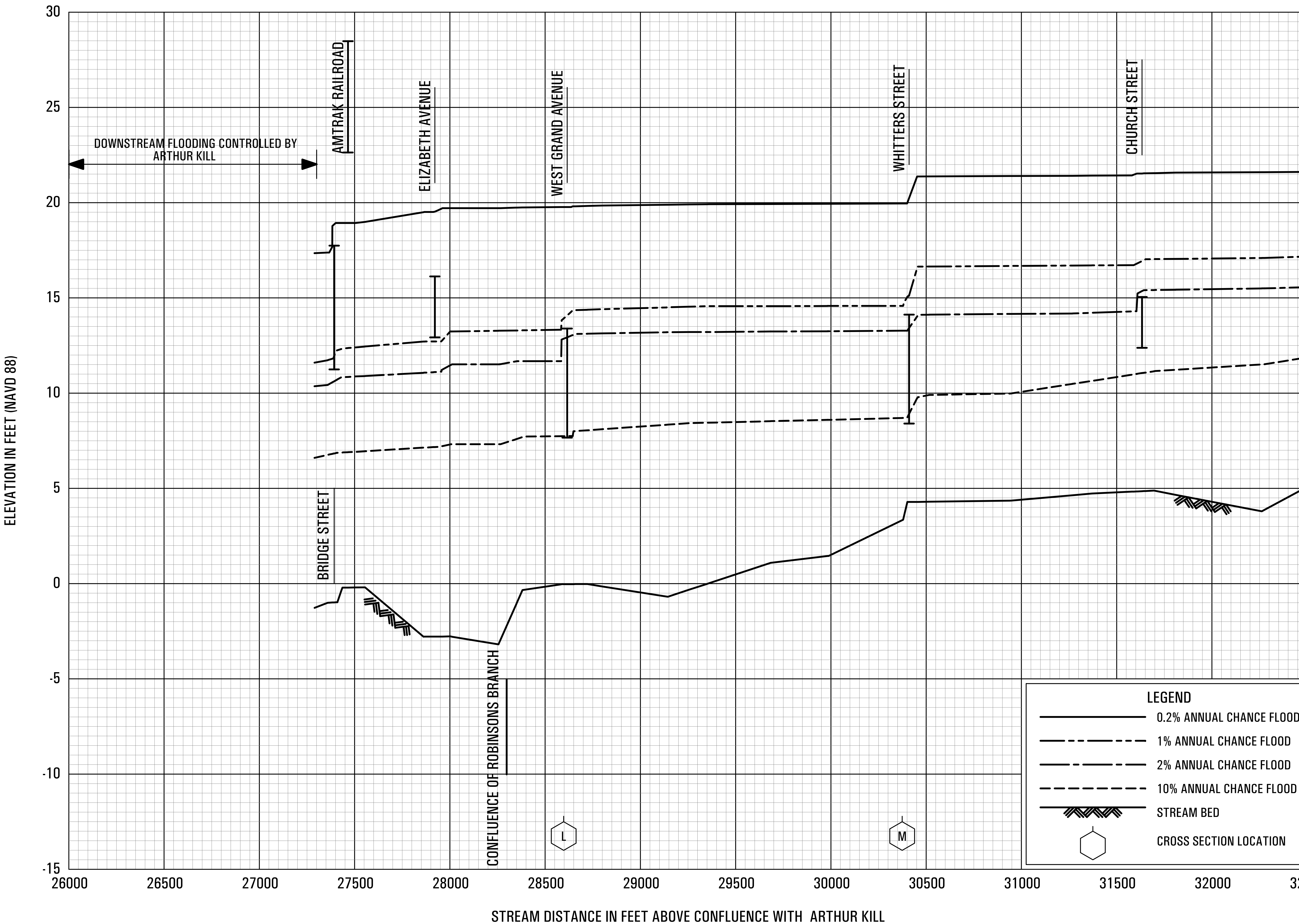
FLOOD PROFILES

PEACH ORCHARD BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)

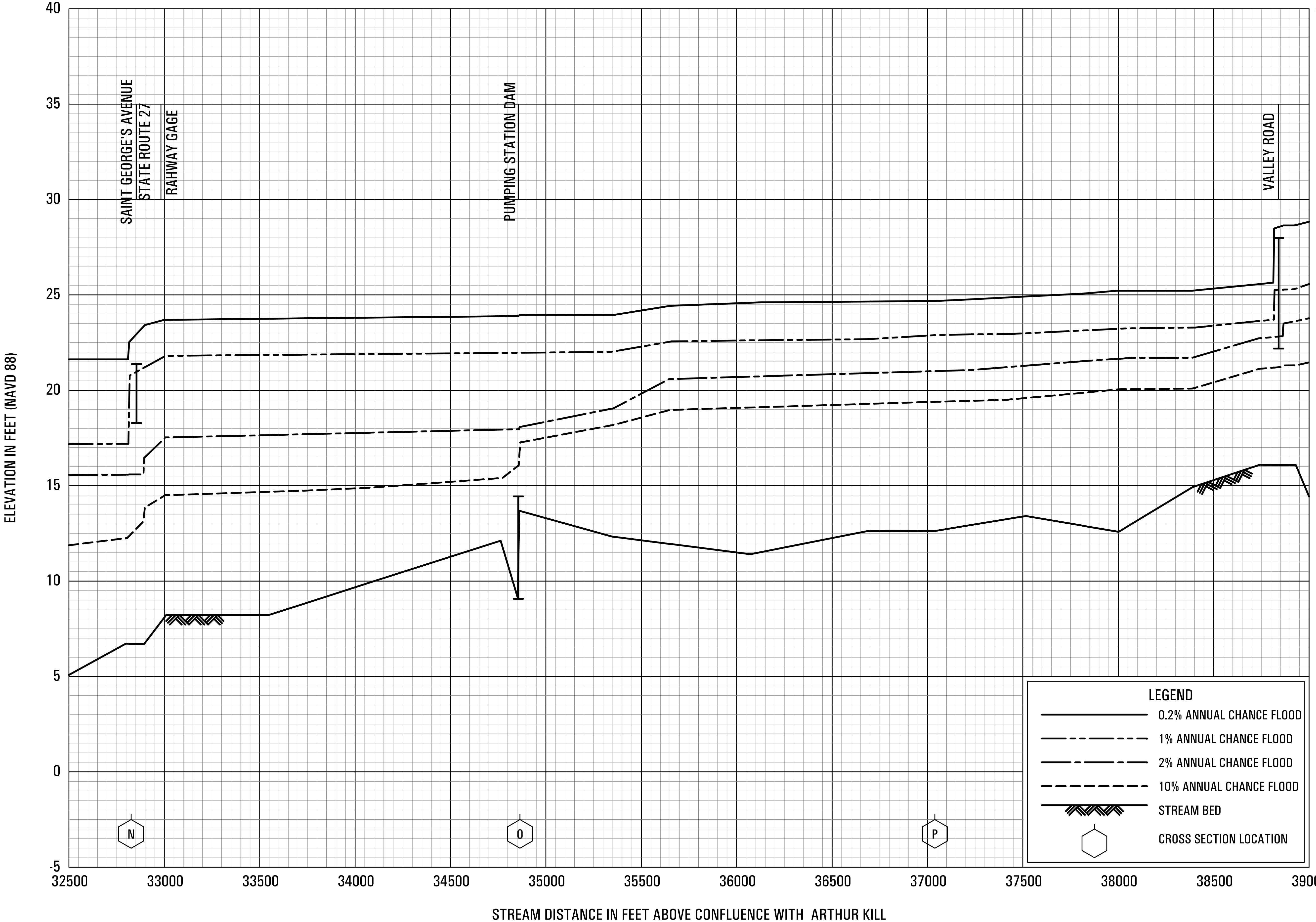


FLOOD PROFILES

RAHWAY RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ
(ALL JURISDICTIONS)



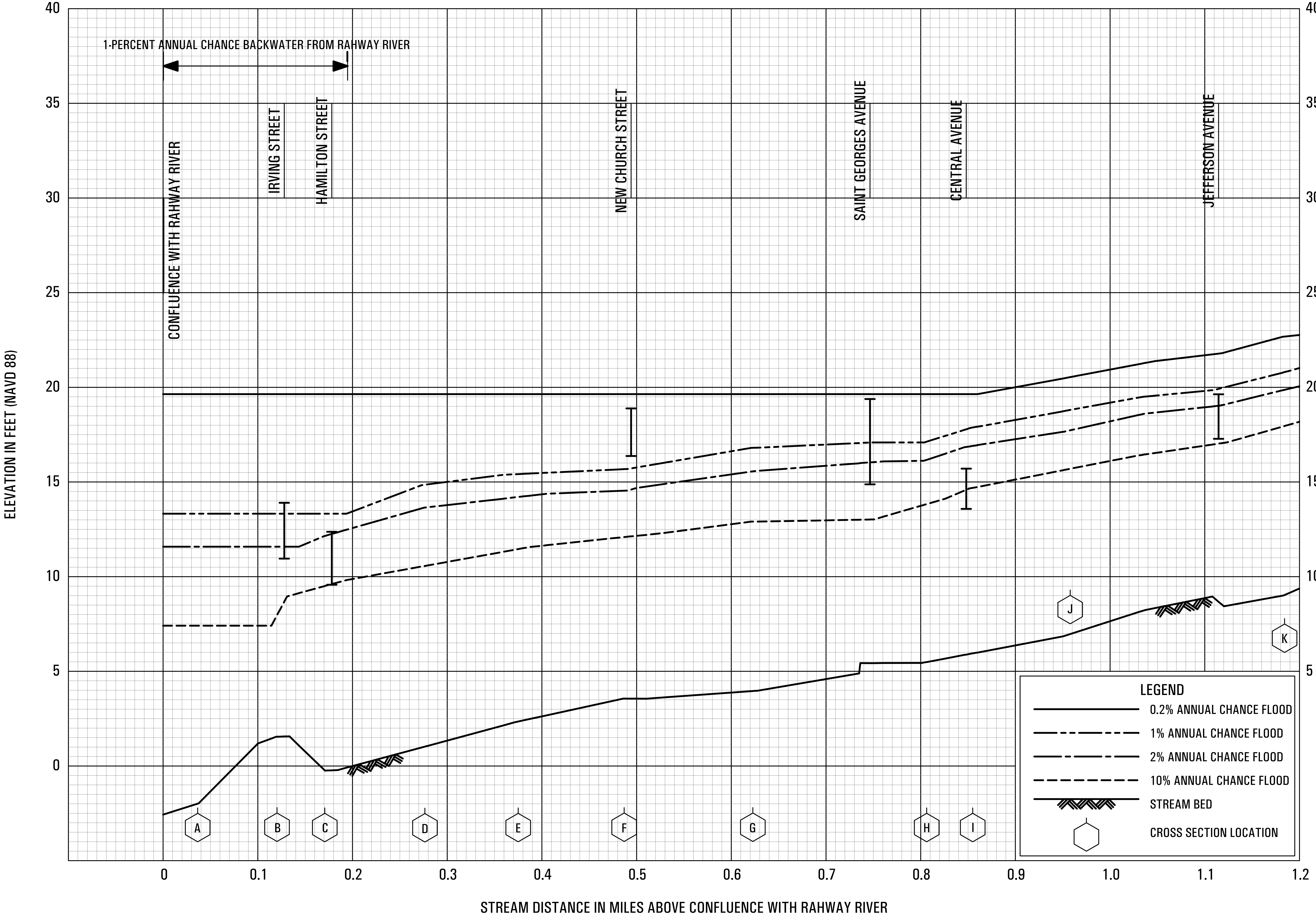
FLOOD PROFILES

RAHWAY RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)



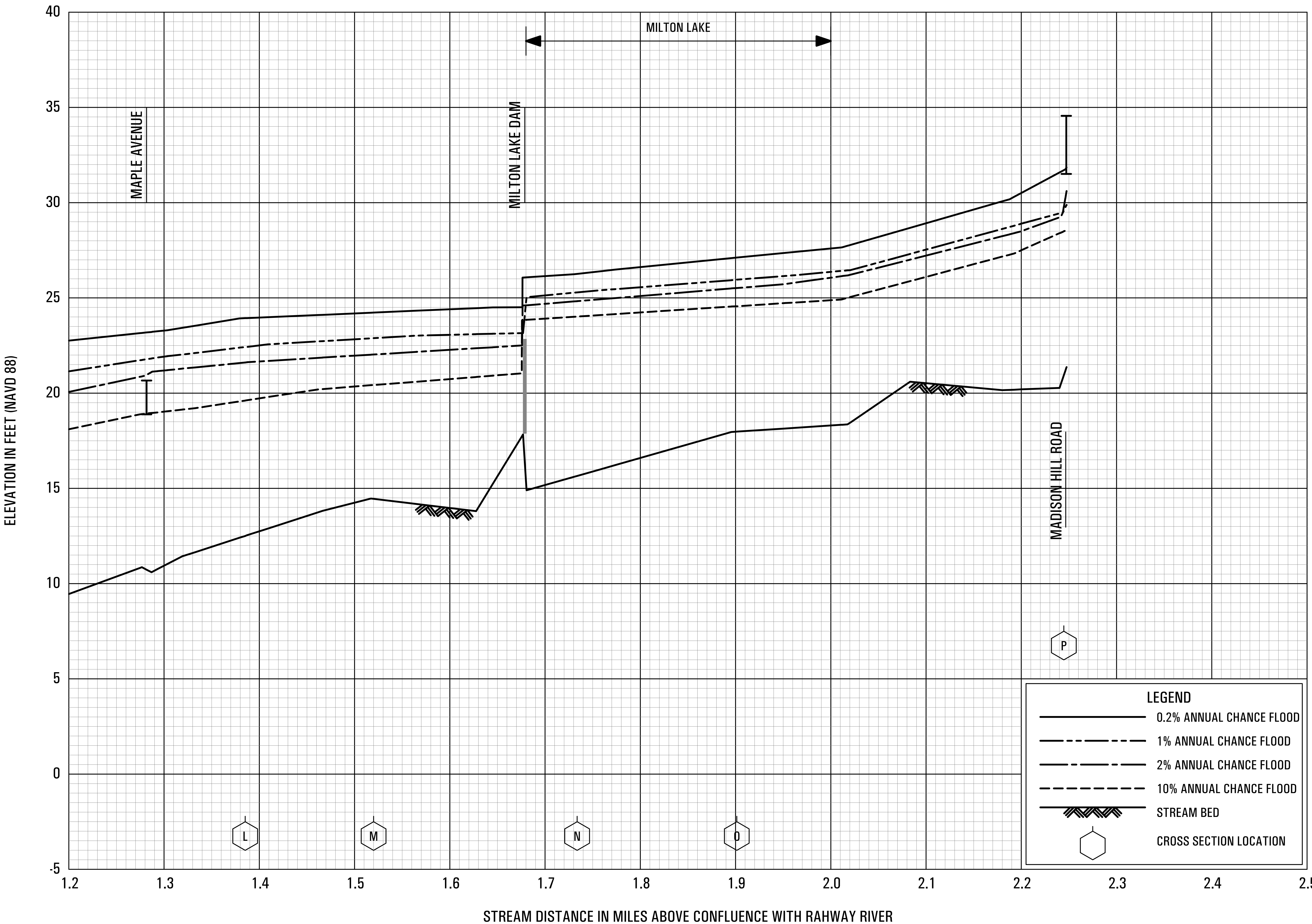
FLOOD PROFILES

ROBINSONS BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)



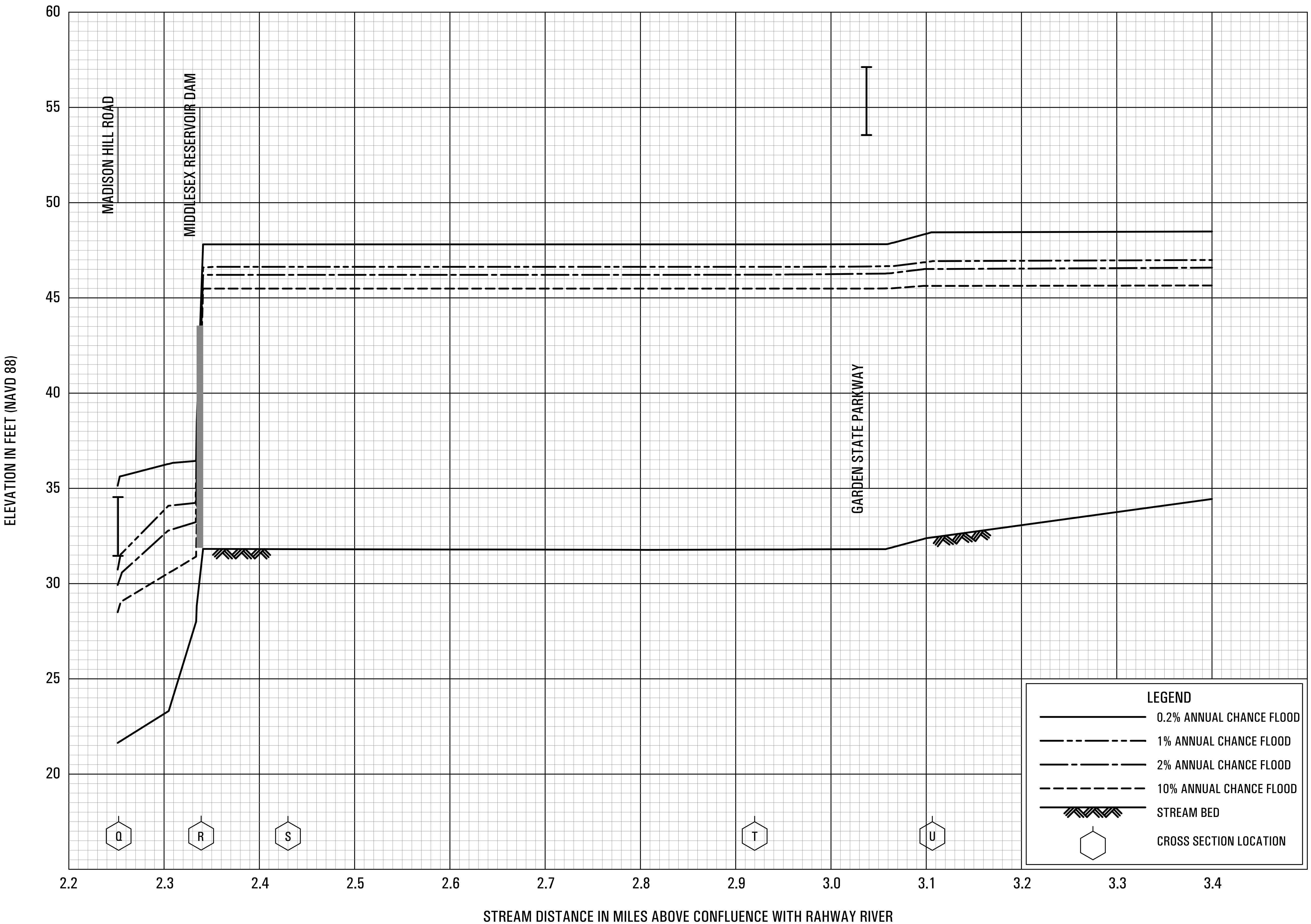
FLOOD PROFILES

ROBINSONS BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)



FLOOD PROFILES

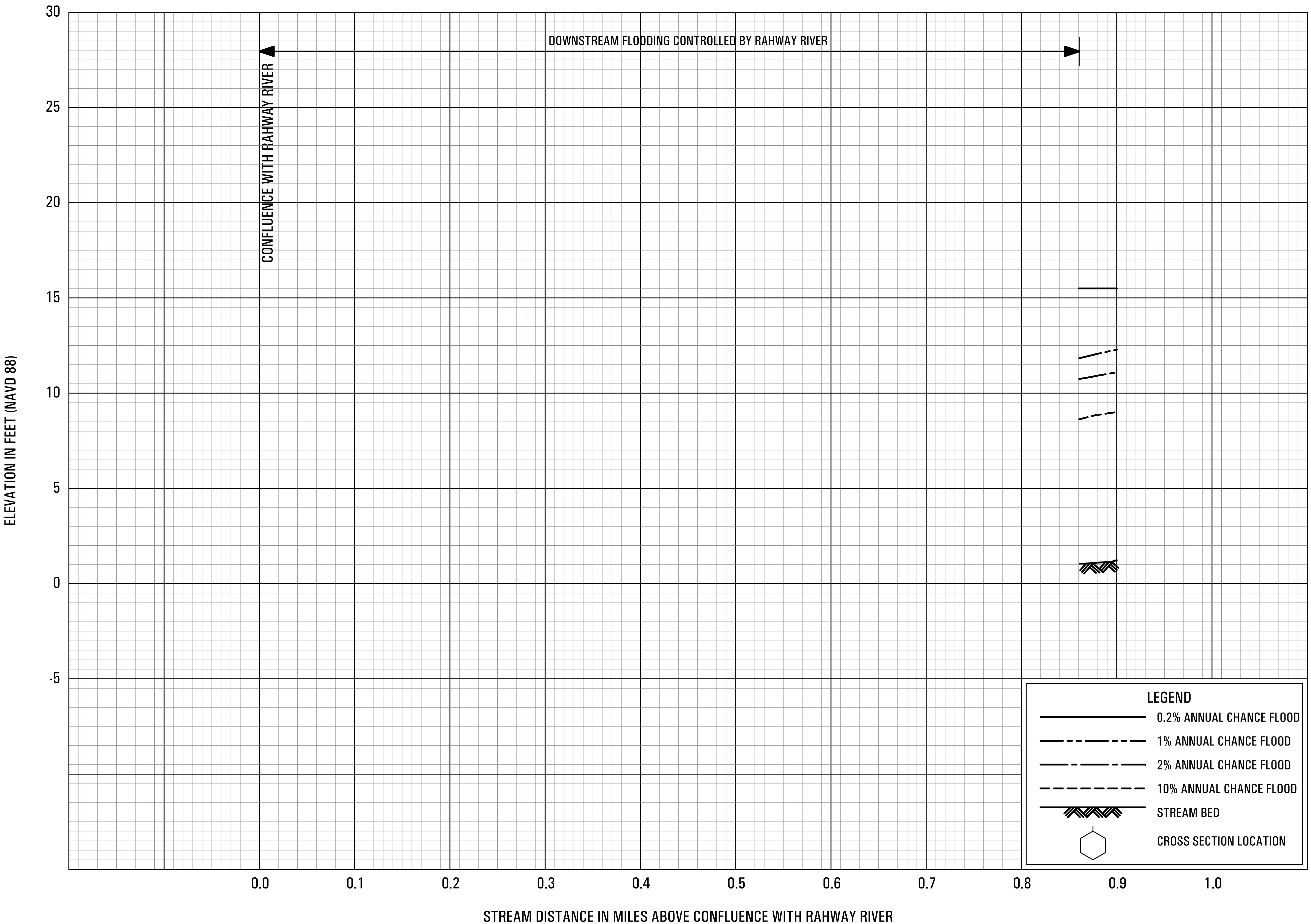
ROBINSONS BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)

127P



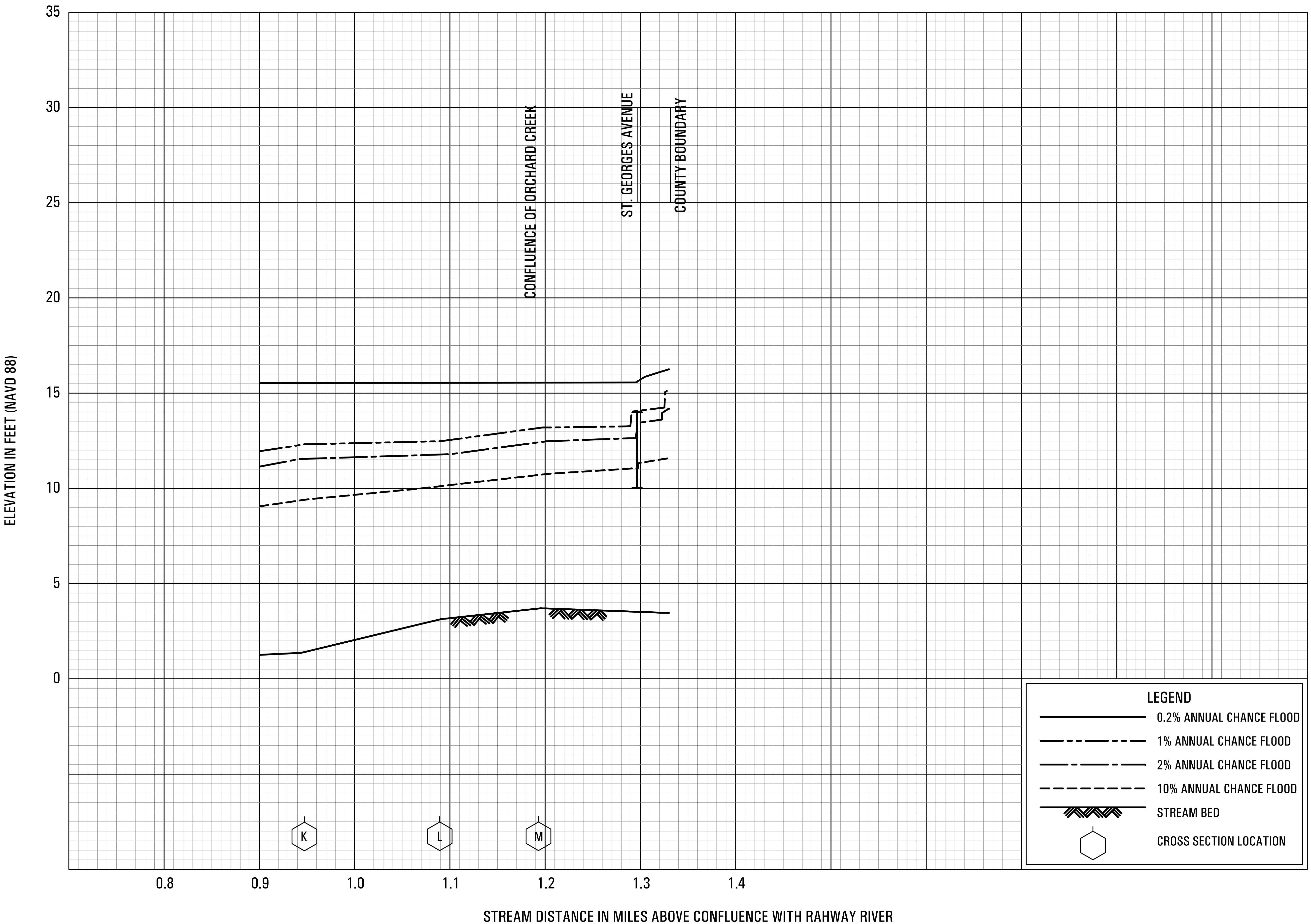
FLOOD PROFILES

SOUTH BRANCH RAHWAY RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS



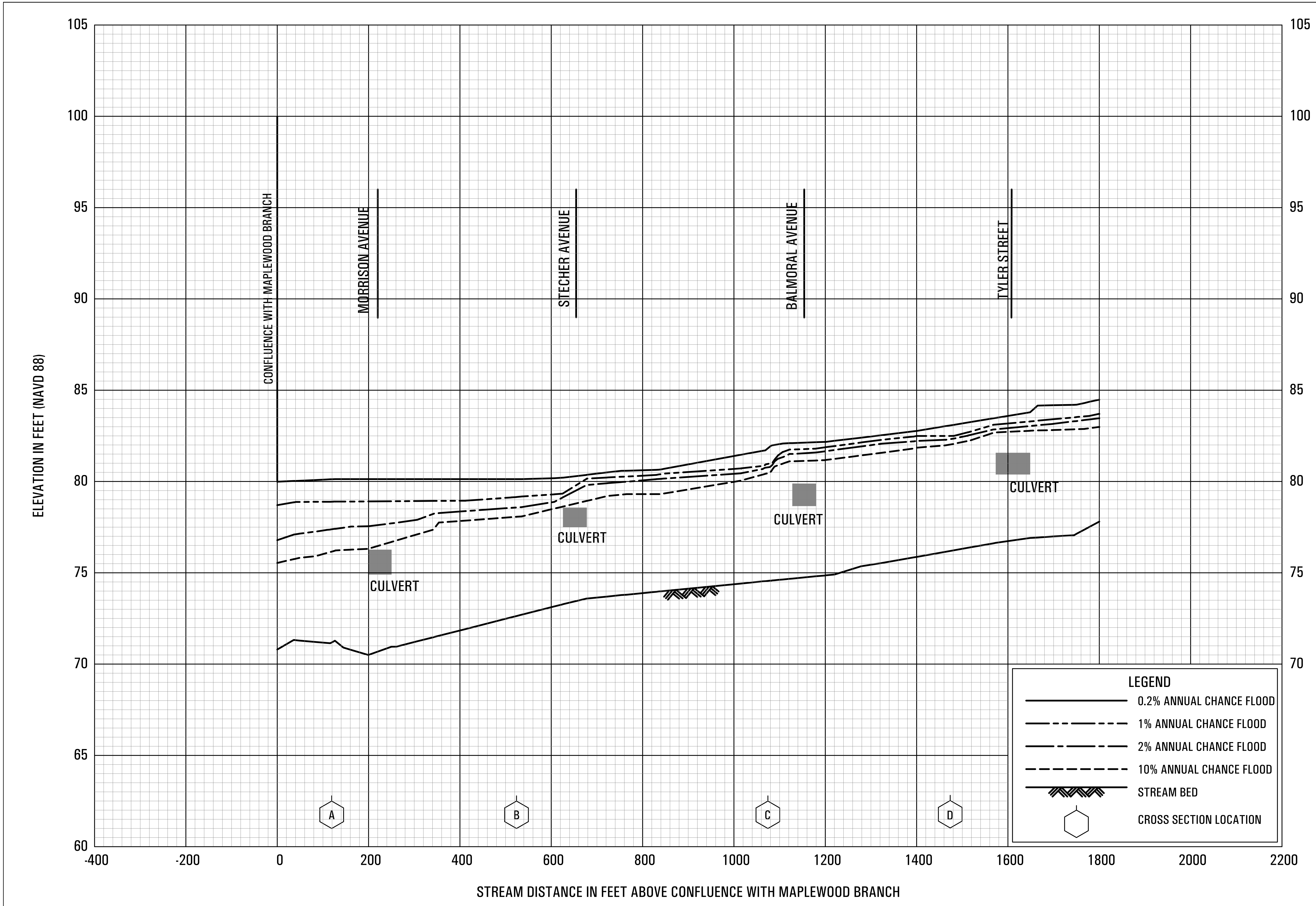
FLOOD PROFILES

SOUTH BRANCH RAHWAY RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)



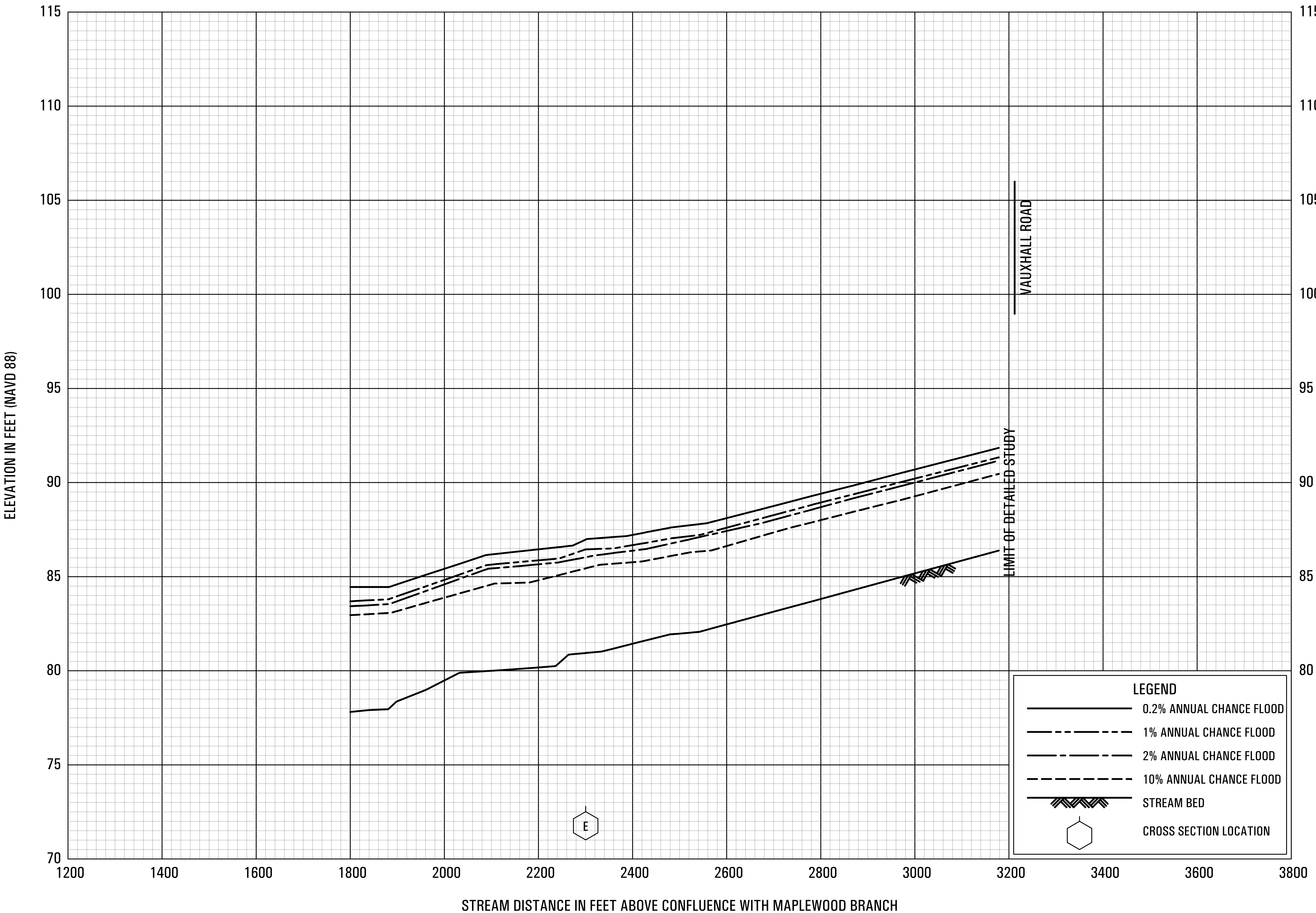
FLOOD PROFILES

SOUTHWEST BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)



FLOOD PROFILES

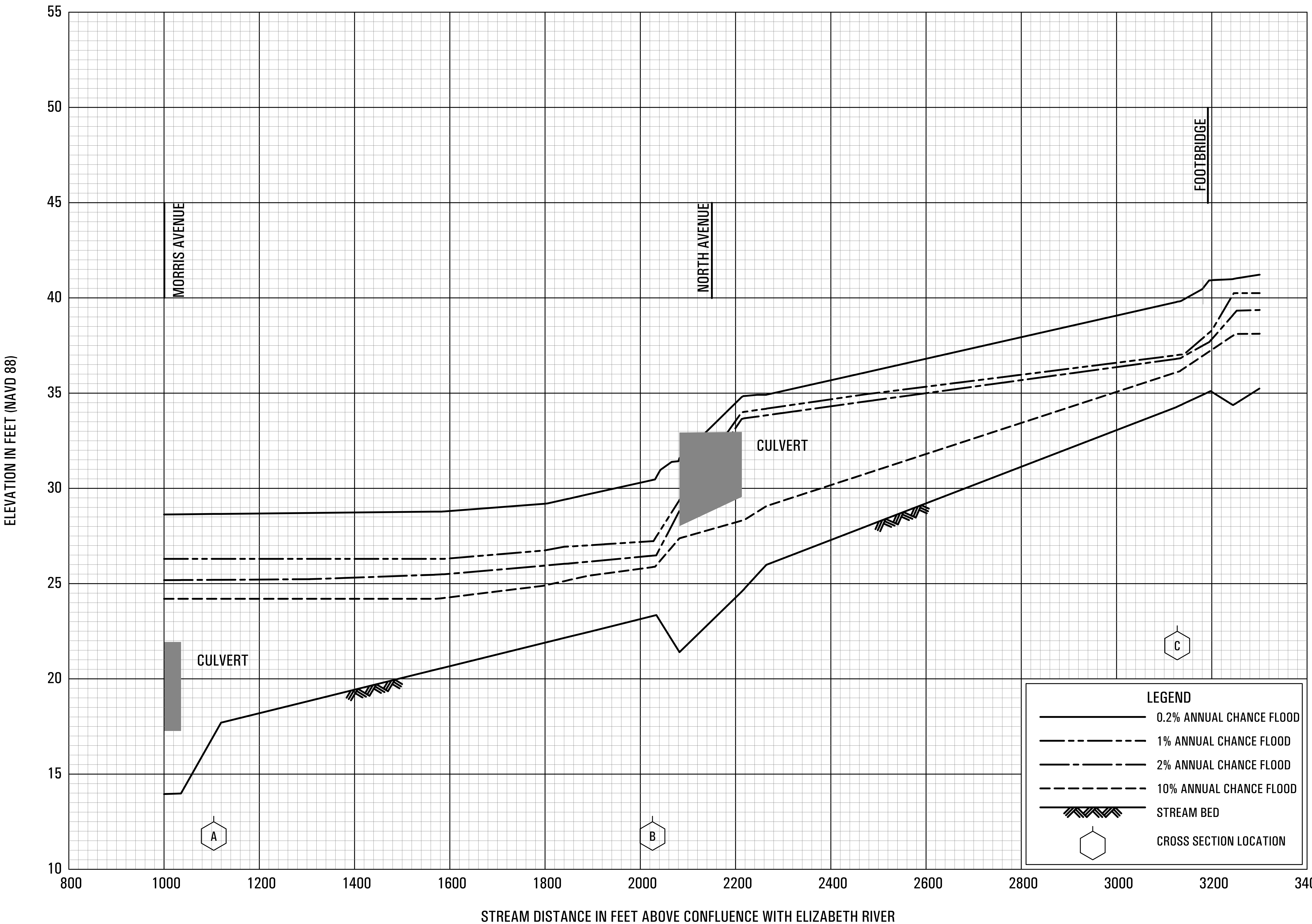
SOUTHWEST BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)

150P



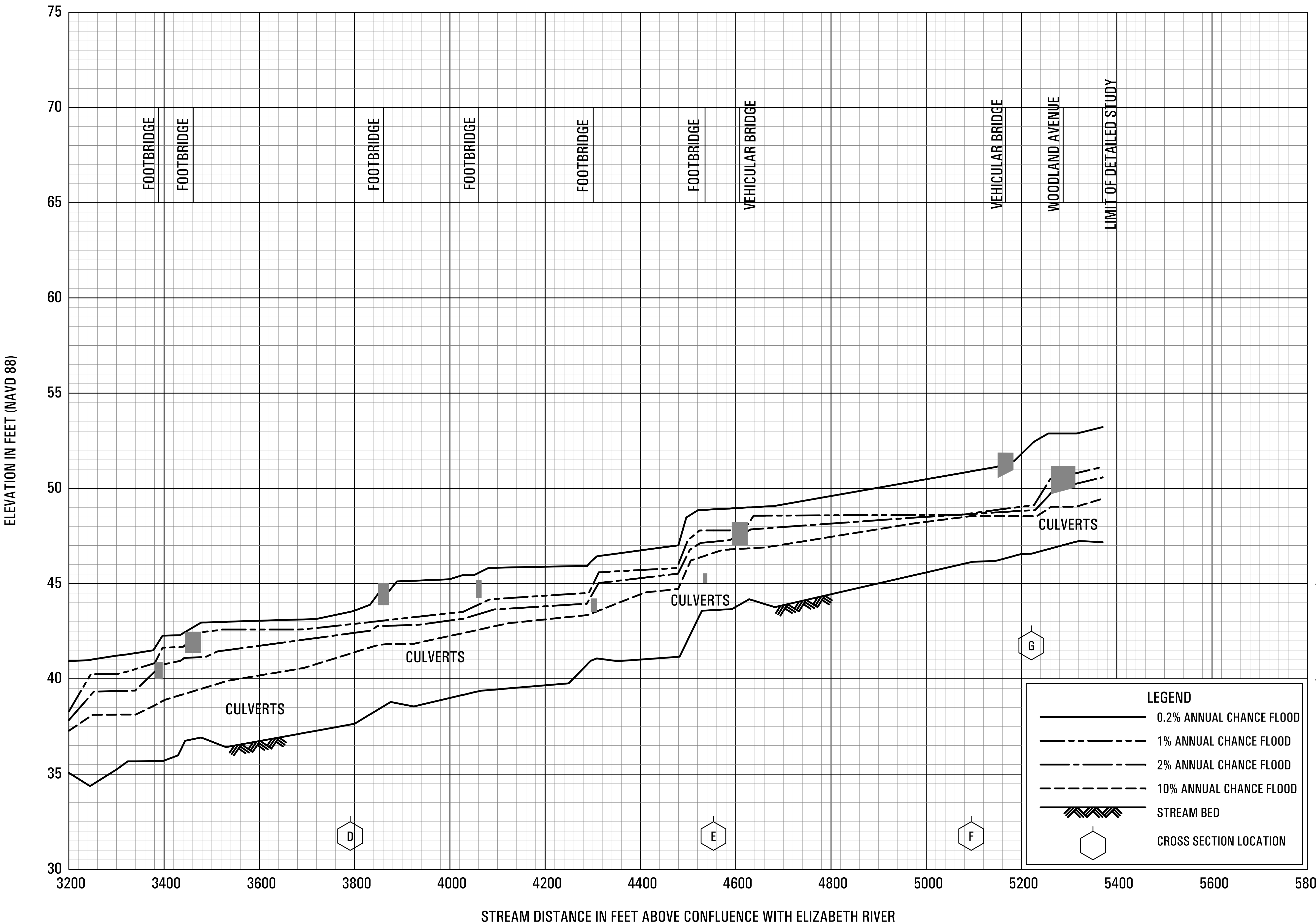
FLOOD PROFILES

TROTTERS LANE BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)

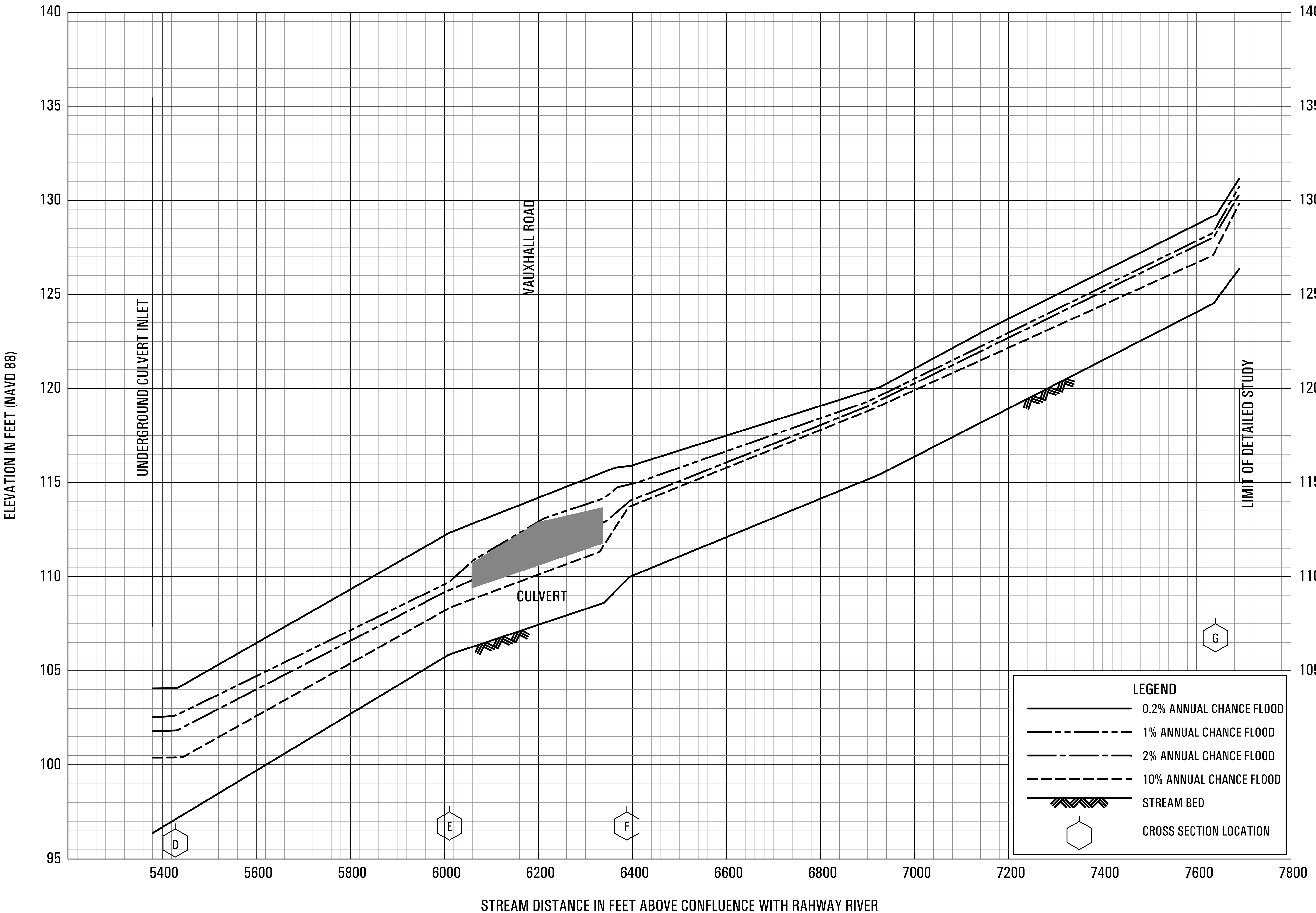


FLOOD PROFILES

TROTTERS LANE BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ
(ALL JURISDICTIONS)



FLOOD PROFILES

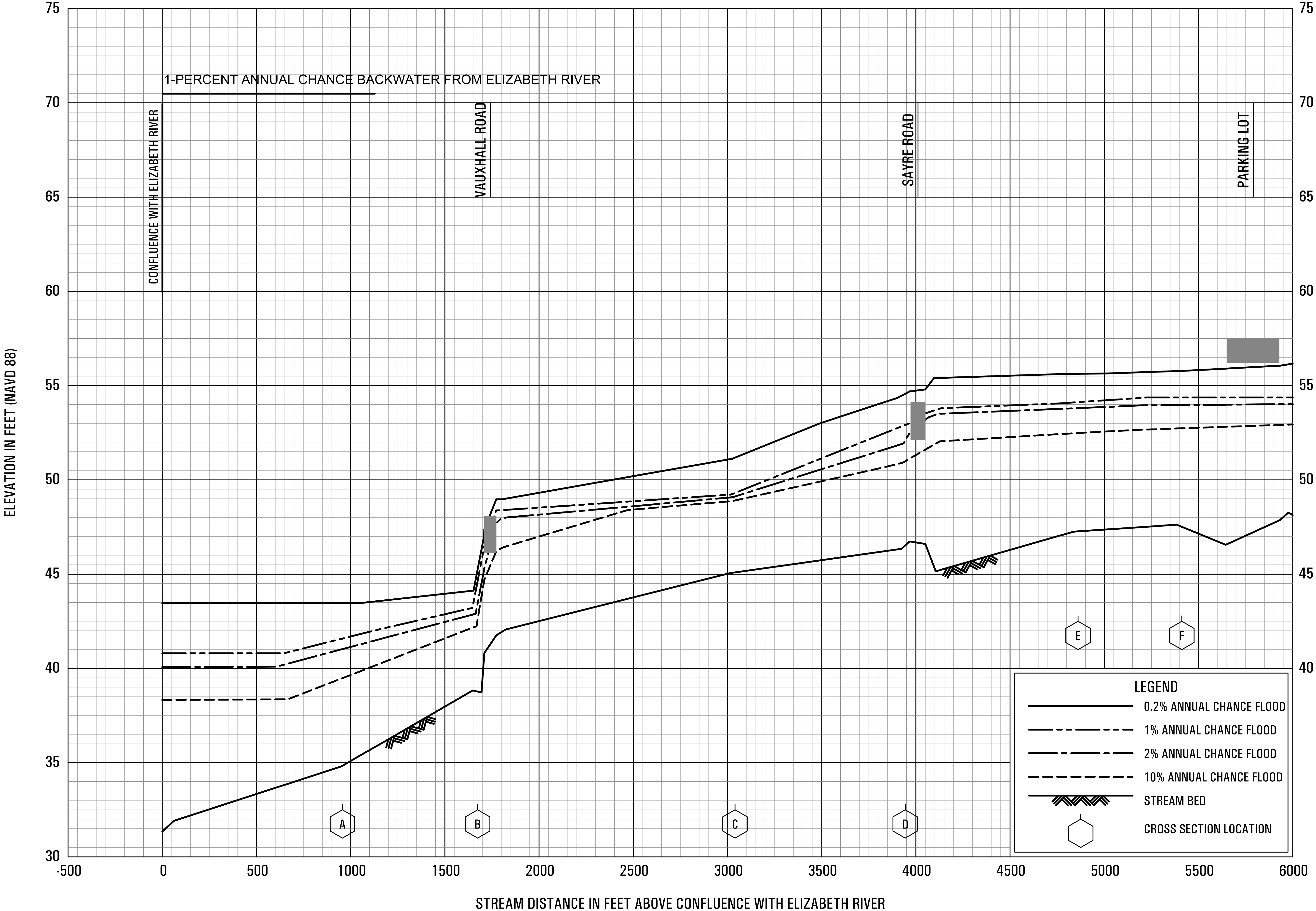
VAUXHALL BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)

165P



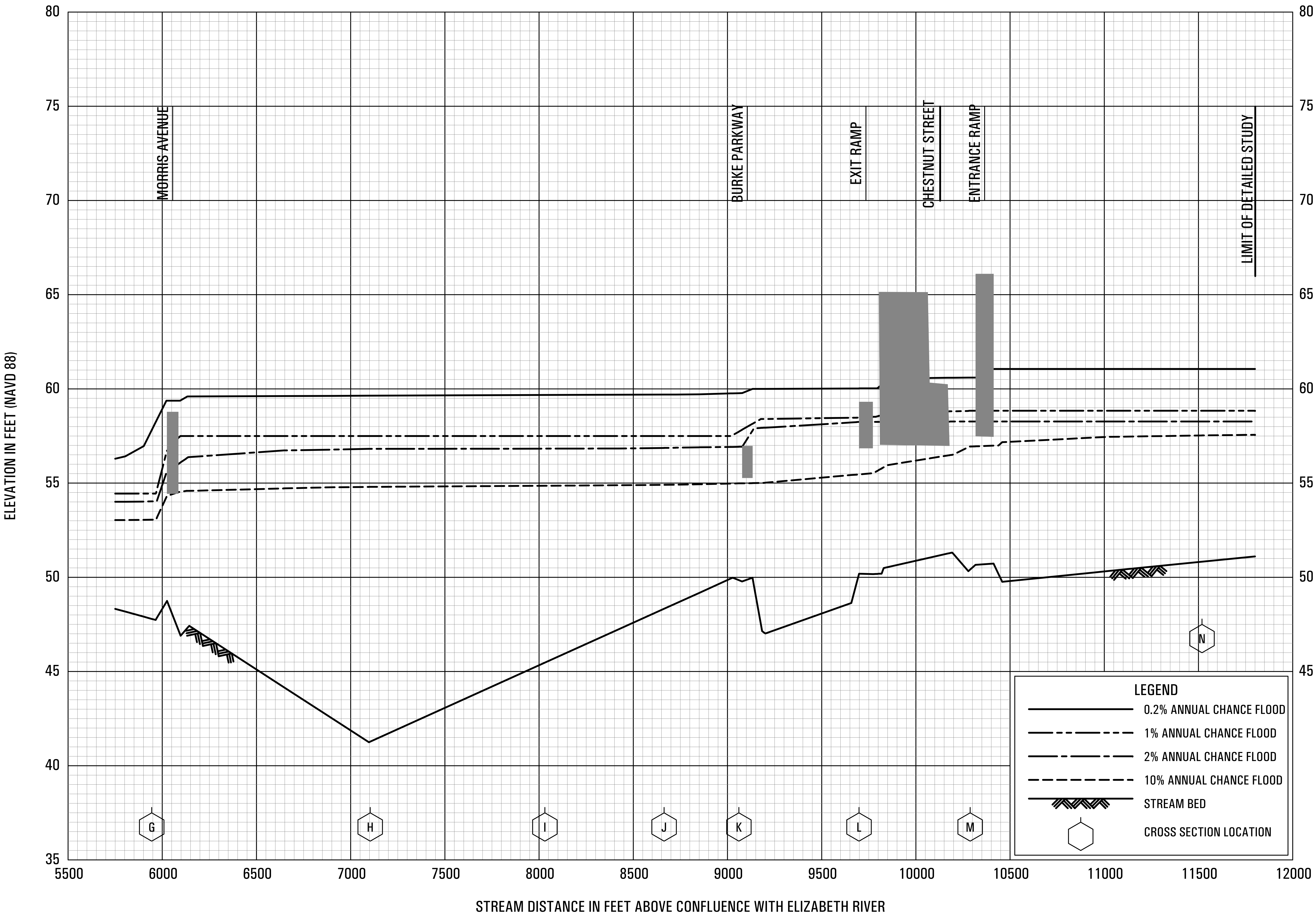
FLOOD PROFILES

WEST BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)



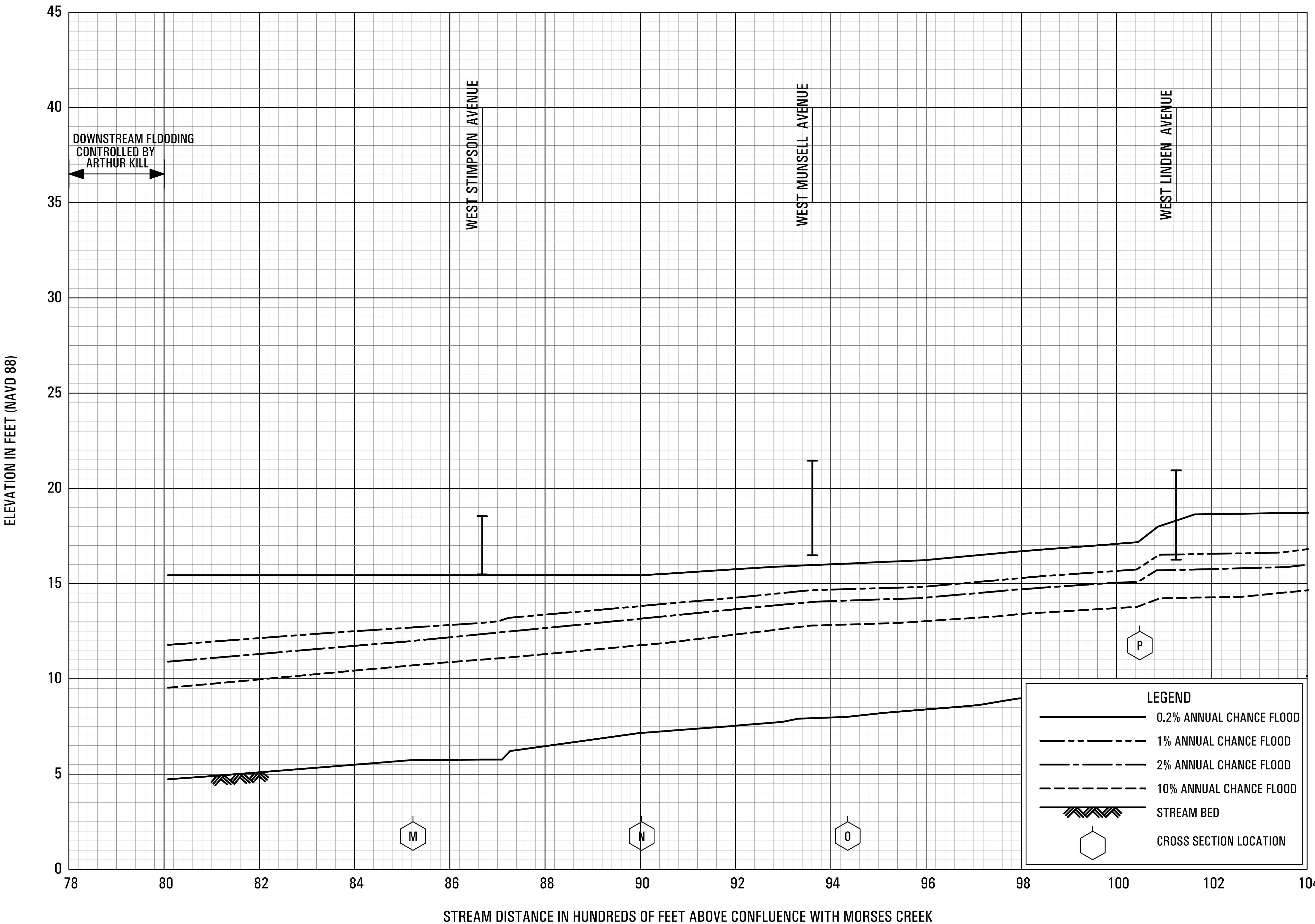
FLOOD PROFILES

WEST BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)



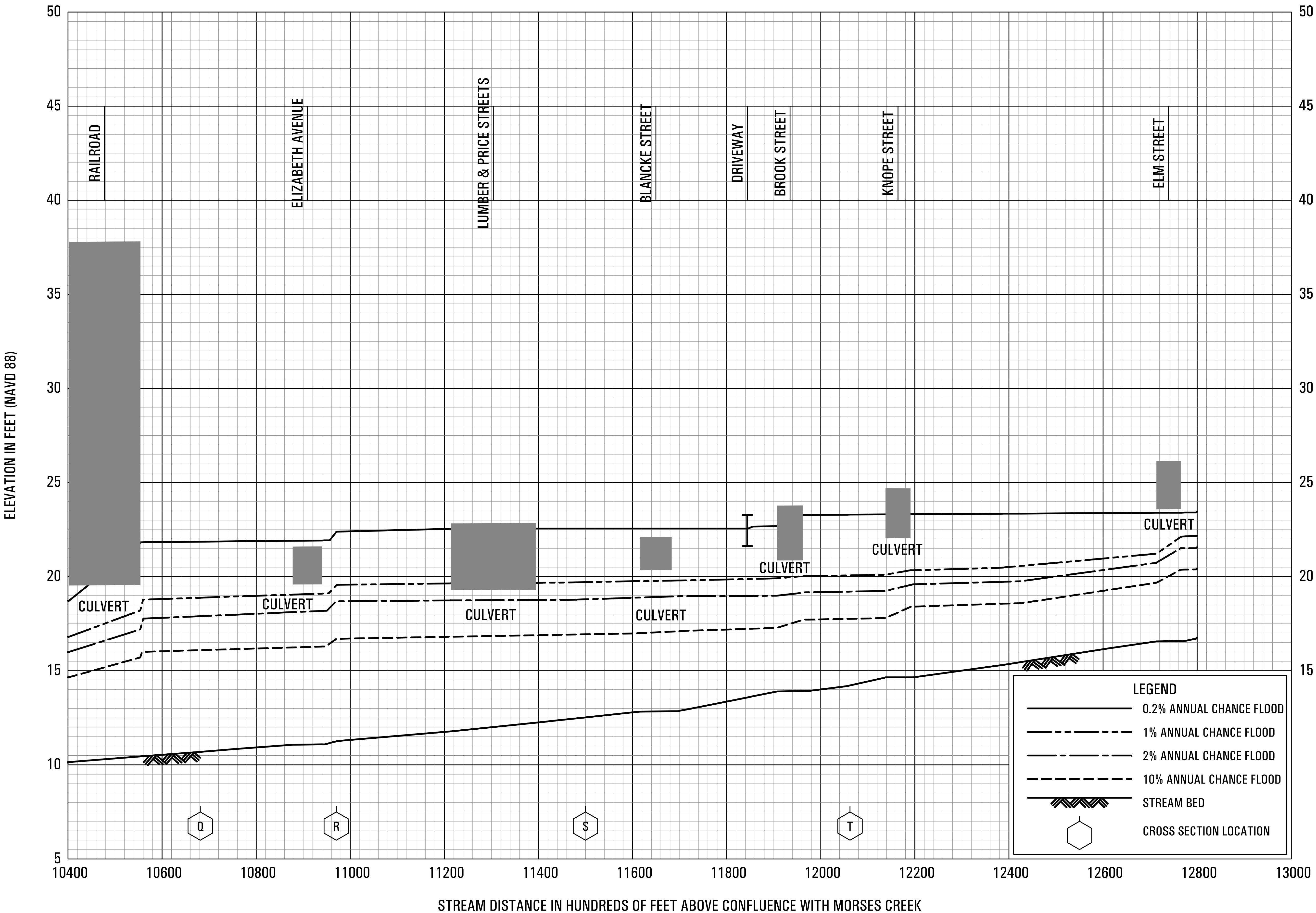
FLOOD PROFILES

WEST BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)



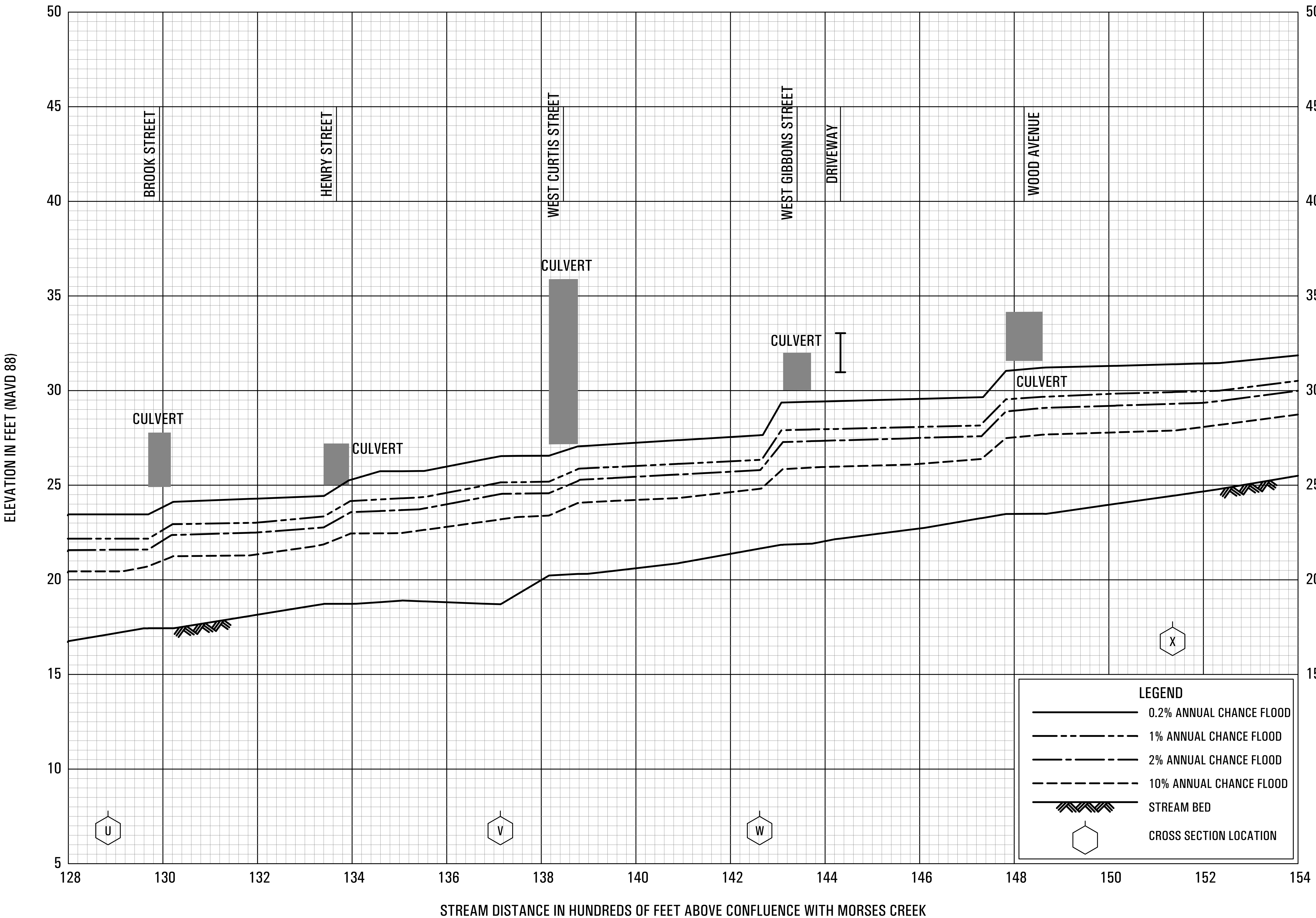
FLOOD PROFILES

WEST BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)



FLOOD PROFILES

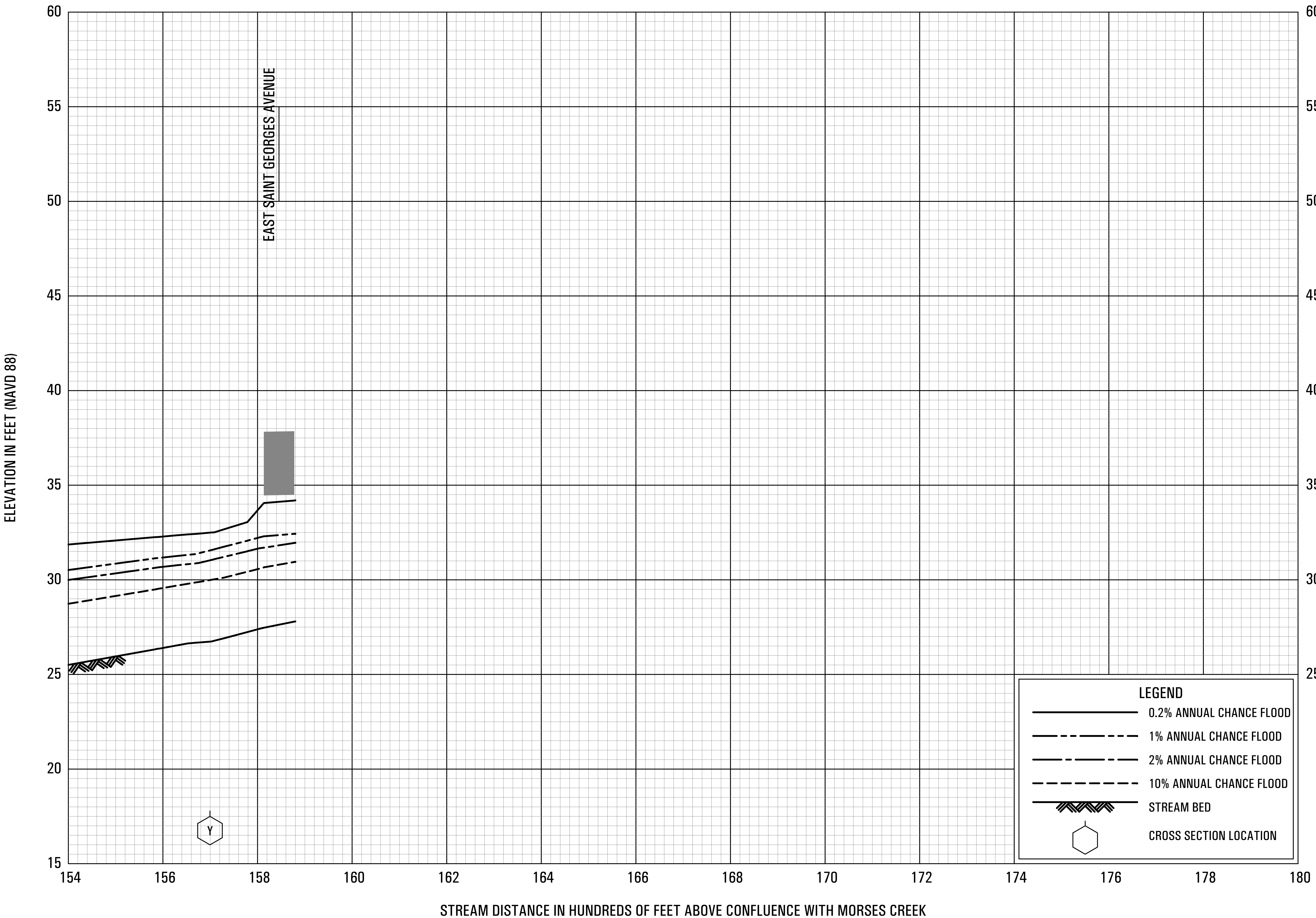
WEST BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)

178P



FLOOD PROFILES

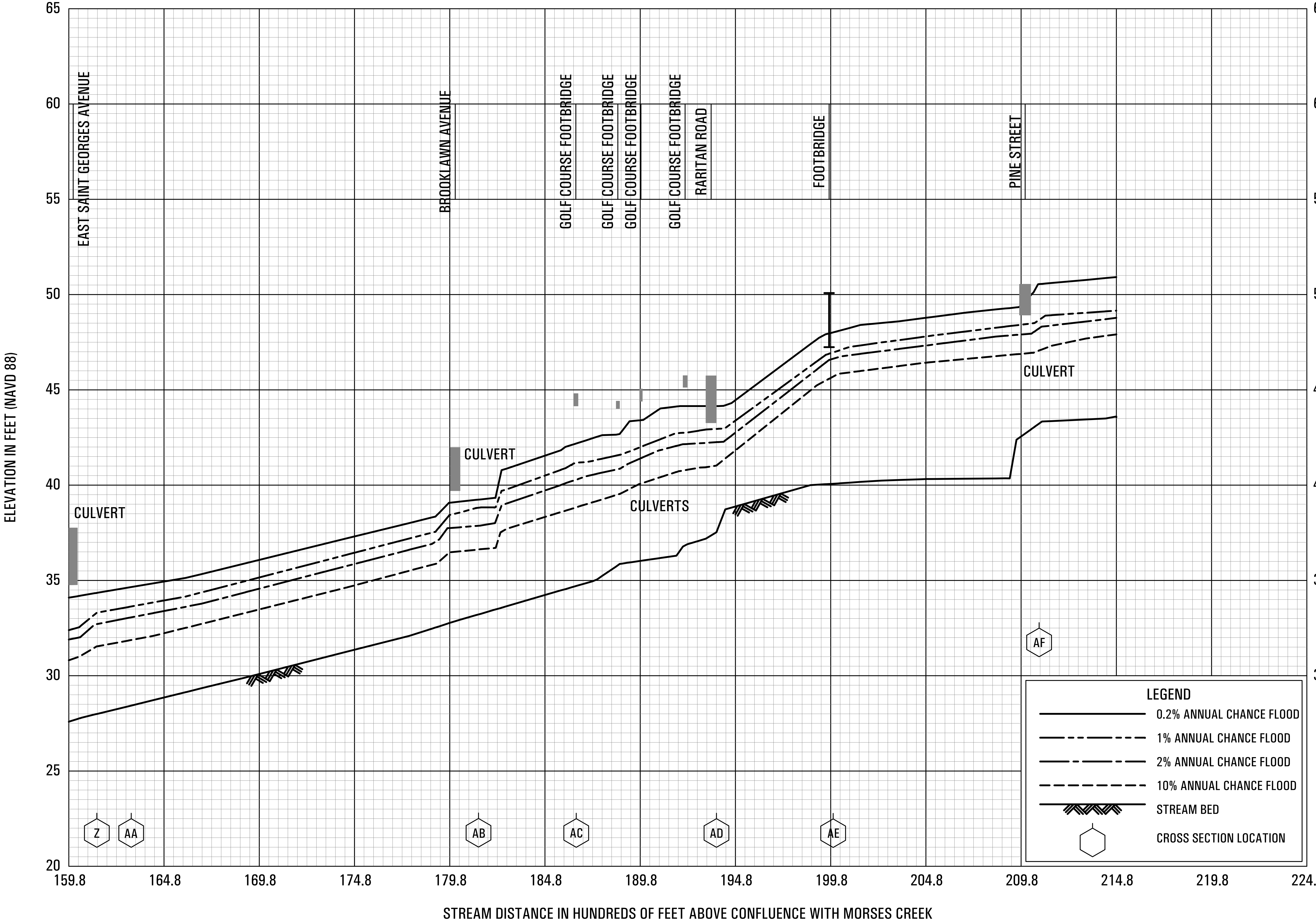
WEST BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)

179P



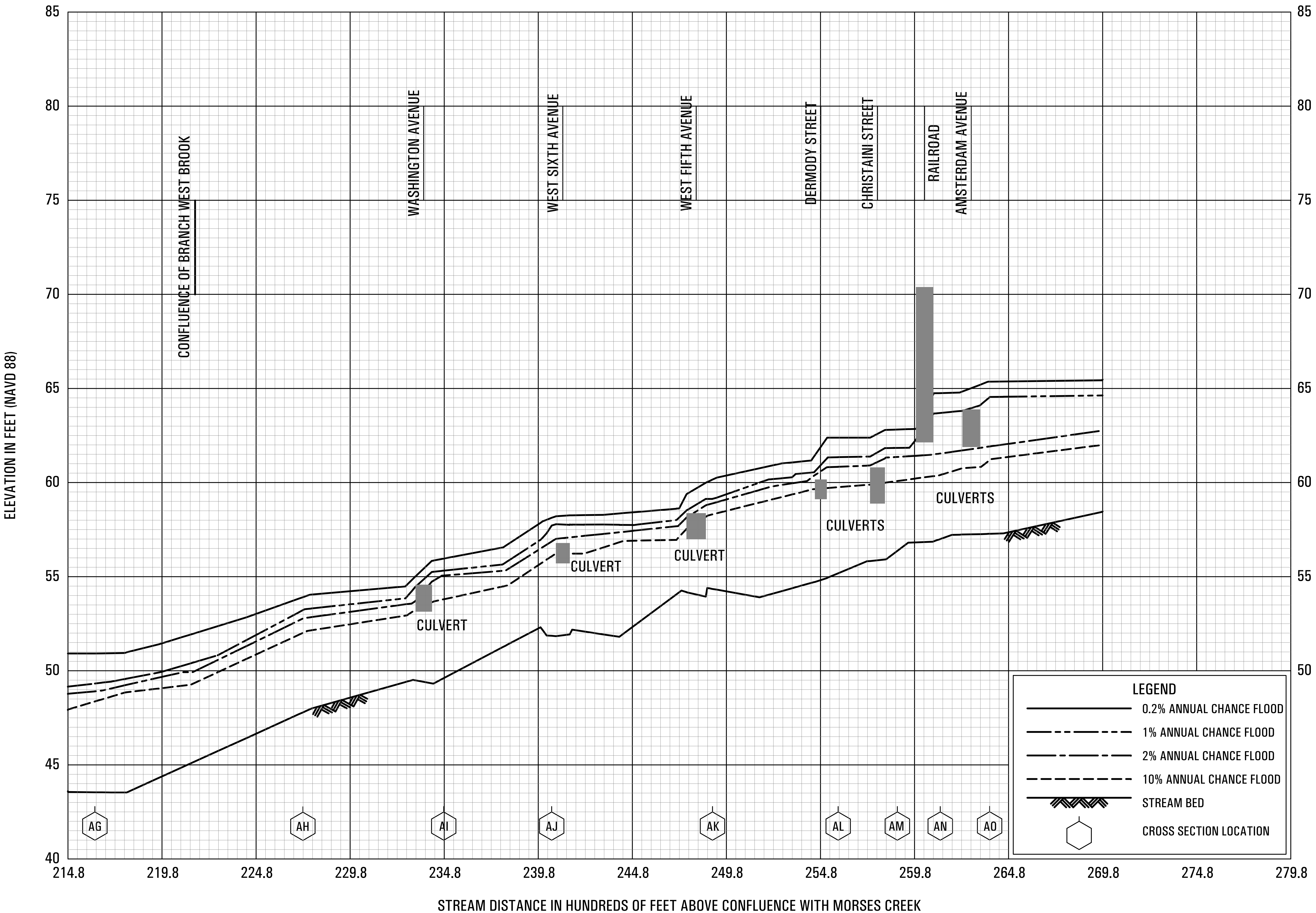
FLOOD PROFILES

WEST BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)



FLOOD PROFILES

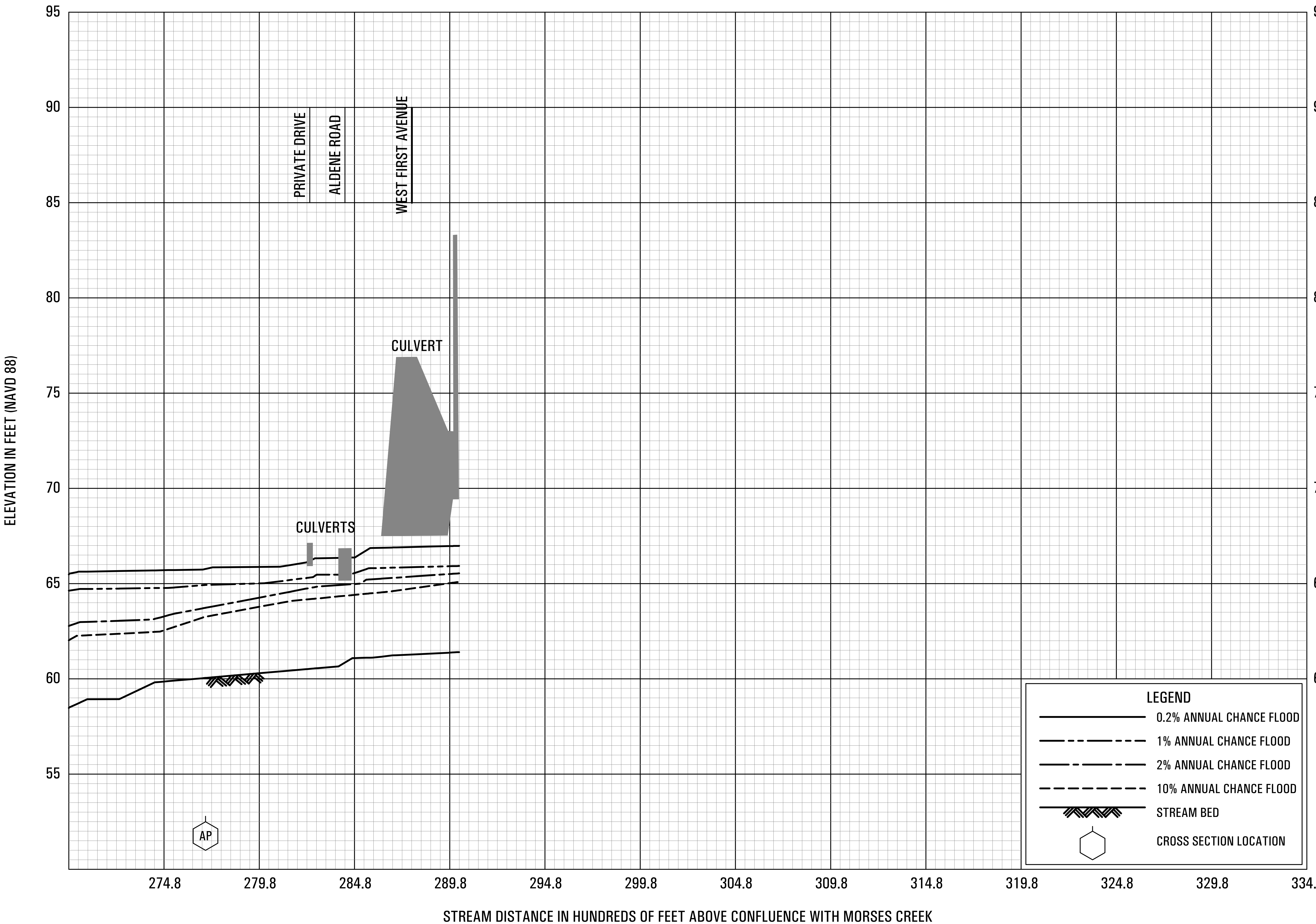
WEST BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)

181P



FLOOD PROFILES

WEST BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

UNION COUNTY, NJ

(ALL JURISDICTIONS)

182P