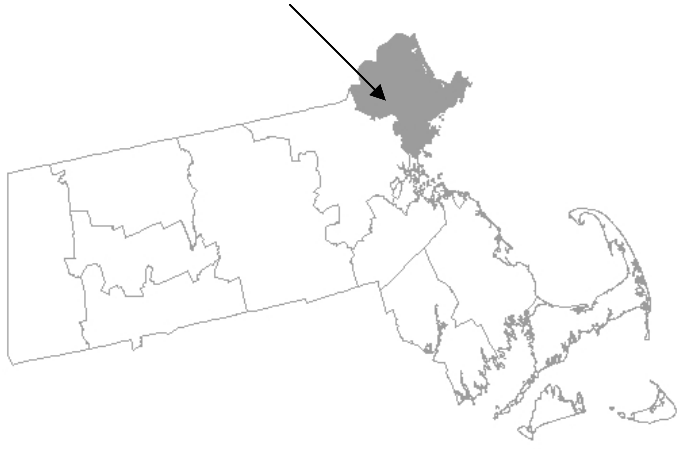
FLOOD INSURANCE STUDY

ESSEX COUNTY, MASSACHUSETTS
(ALL JURISDICTIONS)



COMMUNITY NAME	COMMUNITY NUMBER
AMESBURY, TOWN OF	250075
ANDOVER, TOWN OF	250076
BEVERLY, CITY OF	250077
BOXFORD, TOWN OF	250078
DANVERS, TOWN OF	250079
ESSEX, TOWN OF	250080
GEORGETOWN, TOWN OF	250081
GLOUCESTER, CITY OF	250082
GROVELAND, TOWN OF	250083
HAMILTON, TOWN OF	250084
HAVERHILL, CITY OF	250085
IPSWICH, TOWN OF	250086
LAWERENCE, CITY OF	250087
LYNN, CITY OF	250088
LYNNFIELD, TOWN OF	250089
MANCHESETER, TOWN OF	250090
MARBLEHEAD, TOWN OF	250091
MERRIMAC, TOWN OF	250092
METHUEN, CITY OF	250093
MIDDLETON, TOWN OF	250094
NAHANT, TOWN OF	250095
NEWBURY, TOWN OF	250096
NEWBURYPORT, CITY OF	250097
NORTH ANDOVER, TOWN OF	250098
PEABODY, CITY OF	250099
ROCKPORT, TOWN OF	250100
ROWLEY, TOWN OF	250101
SALEM, CITY OF	250102
SALISBURY, TOWN OF	250103
SAUGUS, TOWN OF	250104
SWAMPSCOTT, TOWN OF	250105
TOPSFIELD, TOWN OF	250106
WENHAM, TOWN OF	250107
WEST NEWBURY, TOWN OF	250108

PRELIMINARY
May 28, 2009

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
25009CV000A

NOTICE TO
FLOOD INSURANCE STUDY USERS

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

Selected Flood Insurance Rate Map panels for the community contain information that was previously shown separately on the corresponding Flood Boundary and Floodway Map panels (e.g., floodways, cross sections). In addition, former flood hazard zone designations have been changed as follows:

Old Zone	New Zone
A1 through A30	AE
V1 through V30	VE
B	X
C	X

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

Initial Countywide FIS Effective Date:

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Flood Insurance Rate Map

FLOOD INSURANCE STUDY
ESSEX COUNTY, MASSACHUSETTS [ALL JURISDICTIONS]

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study (FIS) revises and updates information on the existence and severity of flood hazards in the geographic area of Essex County, including the Towns of Amesbury, Andover, Boxford, Danvers, Essex, Georgetown, Groveland, Hamilton, Ipswich, Lynnfield, Manchester, Marblehead, Merrimac, Middleton, Nahant, Newbury, North Andover, Rockport, Rowley, Salisbury, Saugus, Swampscott, Topsfield, Wenham and West Newbury; the Cities of Beverly, Gloucester, Haverhill, Lawrence, Lynn, Methuen, Newburyport, Peabody and Salem (referred to collectively herein as Essex County), and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood-risk data for various areas of the community that will be used to establish actuarial flood insurance rates and to assist the community in its efforts to promote sound floodplain management. Minimum floodplain management requirements for participation in the National Flood Insurance Program (NFIP) are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some states or communities, floodplain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. These criteria take precedence over the minimum federal criteria for purposes of regulating development in the floodplain, as set forth in the Code of Federal Regulations at 44 CFR, 60.3. In such cases, the more restrictive criteria take precedence and the state (or other jurisdictional agency) will be able to explain them.

1.2 Authority and Acknowledgments

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

This FIS was prepared to incorporate all the communities within Essex County in a countywide format. Information on the authority and acknowledgements for each jurisdiction included in this countywide FIS, as compiled from their previously printed FIS reports, is shown below:

Amesbury, Town of	For the original December 1979 study, the hydrologic and hydraulic analyses were prepared by the U.S. Army Corps of Engineers (USACE) for the Federal Emergency Management Agency (FEMA), under Inter-Agency Agreement No. IAA-H-7-76,

Amesbury, Town of - cont'd	Project Order No. 25, and Inter-Agency Agreement No. IAA-H-10-77, Project Order No. 1. This work was completed in August 1978. In the October 29, 1982, revision, the hydrologic and hydraulic analyses for Lake Attitash were taken from the FIS for the Town of Merrimac, Essex County, Massachusetts, and were prepared by Cullinan Engineering Co, Inc., for FEMA under Contract No. H-4797 (Reference 1). This work was completed in July 1980. The hydrologic and hydraulic analyses for this revision were taken from the FIS for the Town of South Hampton, Rockingham County, New Hampshire, and were prepared by the U.S Geological Survey (USGS) for FEMA, under Inter-Agency Agreement No. EM-89-E-2997, Project Order No. 5 (Reference 2). This work was completed in September 1990.
Andover, Town of	The hydrologic and hydraulic analyses for the June 5, 1989 study represent a revision of the original analyses prepared by the USACE for FEMA, under Inter-Agency Agreement No. IAA-H-2-73, Project Order No. 4. This work was completed in February 1975. The hydraulic analyses for the Merrimack River and the Shawsheen River; and the addition of detailed study analyses for Fish Brook, Hussey Brook, and Hussey Brook Tributary represent a revision to the original FIS for the Town of Andover. This updated study was performed by the USACE, New England Division, for FEMA, under Inter-Agency Agreement No. EMW-E-0941. This work was completed in July 1986.
Beverly, City of	The hydrologic and hydraulic analyses for the March 18, 1986 study were prepared by Stone & Webster Engineering Corporation for FEMA, under Contract No. H-4772. This work was completed in July 1983.
Boxford, Town of	The hydrologic and hydraulic analyses for the June 3, 1991 study were prepared by Camp, Dresser, and McKee Inc. (CDM) for FEMA, under Contract No. EM-86-C-2250. This work was completed in May 1989.

Danvers, Town of	The hydrologic and hydraulic analyses for the January 1990 study were prepared by Anderson-Nichols and Company, Inc., for the Federal Insurance Administration (FIA), under Contract No. H-4524. This work, which was completed in November 1978, covered all significant flooding sources in the Town of Danvers.
Essex, Town of	The hydrologic and hydraulic analyses for the July 17, 1986 study were prepared by Stone & Webster Engineering Corporation for the Federal Emergency Management Agency (FEMA), under Contract No. H-4772. This work was completed in April 1984.
Georgetown, Town of	The hydrologic and hydraulic analyses for the December 1979 study were performed by Sverdrup & Parcel and Associates, Inc., for the FIA, under Contract No. H-4037. This work, which was completed in March 1978, covered all significant flooding sources affecting the Town of Georgetown.
Gloucester, City of	The hydrologic and hydraulic analyses for the January 17, 1986 study were prepared by Stone & Webster Engineering Corporation for FEMA, under Contract No. H-4772. This work was completed in September 1983.
Groveland, Town of	The hydrologic and hydraulic analyses for the April 1980 study were performed by Sverdrup & Parcel and Associates, for the FIA, under Contract No. H-4037. This work, which was completed in April 1978, covered all significant flooding sources affecting the Town of Groveland.
Hamilton, Town of	The hydrologic and hydraulic analyses for the June 4, 1990 study were prepared by CDM for FEMA, under Contract No. EMW-86-R-2250. This work was completed in November 1987.
Haverhill, City of	The hydrologic and hydraulic analyses for the August 16, 1982 study were prepared by Cullinan Engineering Co., Inc., for FEMA, under Contract No. H-4797. The hydrologic and hydraulic analyses for a portion of the Merrimack River were performed by CDM. This work was completed in January 1981.

Ipswich, Town of	The hydrologic and hydraulic analyses for the February 5, 1986 study were prepared by Stone & Webster Engineering Corporation for FEMA, under Contract No. H-4772. This work was completed in October 1983.
Lawrence, City of	The hydrologic and hydraulic analyses for the February 2, 1982 study were prepared by Cullinan Engineering Co., Inc., for FEMA, under Contract No. H-4797. This work was completed in January 1981.
Lynn, City of	The hydrologic and hydraulic analyses for the August 1, 1984 study were prepared by Stone & Webster Engineering Corporation for FEMA, under Contract No.H-4 772. This work was completed in May 1983.
Lynnfield, Town of	The hydrologic and hydraulic analyses for the February 1, 1980 study were performed by CDM, for the FIA, under Contract No. H-3861. This work, which was completed in January 1978, covered all significant flooding sources affecting the Town of Lynnfield.
Manchester, Town of	The hydrologic and hydraulic analyses for the September 4, 1986 study were prepared by Stone & Webster Engineering Corporation for FEMA, under Contract No. H-4772. This work was completed in August 1983.
Marblehead, Town of	The hydrologic and hydraulic analyses for the July 3, 1985 study were prepared by Stone & Webster Engineering Corporation for FEMA, under Contract No. H-4772. This work was completed in June 1983.
Merrimac, Town of	The hydrologic and hydraulic analyses for the January 5, 1982 study were prepared by Cullinan Engineering Co., Inc., for FEMA, under Contract No. H-4797. This work was completed in July 1980.

Methuen, City of	The hydrologic and hydraulic analyses for the June 18, 1987 study for the determination and delineation of floodplains in Methuen were originally performed by the USACE, for FEMA, under Inter-Agency Agreement No. IAA-H-10-77, Project Order No. 5. This work was completed in June 1978 (Reference 3). The hydrologic and hydraulic analyses for Bartlett Brook, Peat Meadow Brook, Bare Meadow Brook (from Hawkes Brook to Hills Pond) and Hawkes Brook (from a point 3,750 feet upstream of Bare Meadow Brook to North Street) and the hydraulic analysis of the Merrimack River along the Methuen-Andover corporate limits were performed by Schoenfeld Associates, Inc. for the FEMA, under Contract No. EMW-C-0280. In addition, the flood plains and floodways for all streams studied in detail in Methuen were delineated on new topographic maps developed specifically for this FIS (Reference 4). This work, which was completed in October 1983, covered all flooding sources affecting the City of Methuen.
Middleton, Town of	The hydrologic and hydraulic analyses for the May 1980 study were prepared by Anderson-Nichols and Company, Inc. for the FIA, under Contract No. H-4524. This work was completed in October 1978.
Nahant, Town of	The hydrologic and hydraulic analyses in the March 28, 1984 study represent a revision of the original analyses performed by New England Division of the U.S. Army Corps of Engineers for FEMA. The updated version was prepared by Stone & Webster Engineering Corporation for FEMA, under Contract No. H-4 772. This work was completed in April 1983.
Newbury, Town of	The hydrologic and hydraulic analyses in the July 17, 1986 study represent a revision of the original analyses performed by New England Division of the USACE for FEMA. The updated 1986 version was prepared by Stone & Webster Engineering Corporation for FEMA, under Contract No. H-4 772. This work was completed in April 1983.

Newburyport, City of	The hydrologic and hydraulic analyses in the November 1, 1985 study represent a revision of the original analyses performed by the USACE for FEMA. The updated 1985 version was prepared by Stone & Webster Engineering Corporation for FEMA, under Contract No. H-4772. The updated work was completed in December 1983.
North Andover, Town of	For the original December 15, 1982 study, the hydrologic and hydraulic analyses were prepared by Cullinan Engineering Co., Inc. for FEMA, under Contract No. H-4797. This work was completed in November 1980. For the June 2, 1993 revision, the hydrologic and hydraulic analyses were prepared by CDM. For FEMA, under Contract No. EMW-88-R-2627. This work was completed in October 1990.
Peabody, City of	The hydrologic and hydraulic analyses for the November 1979 study were prepared by Anderson-Nichols and Company, Inc., for the FIA, under Contract No. H-4524. This work, which was completed in November 1978, covered all significant flooding sources in the City of Peabody.
Rockport, Town of	The hydrologic and hydraulic analyses for the December 19, 1984 study were prepared by Stone & Webster Engineering Corporation for FEMA, under Contract NO. H-4772. This work was completed in September 1983.
Rowley, Town of	The hydrologic and hydraulic analyses for the August 5, 1986 study were prepared by Stone & Webster Engineering Corporation for FEMA, under Contract No. H-4772. This work was completed in September 1980. The wave height and wave runup analyses were added by Dewberry & Davis using information supplied by Stone & Webster in the Flood Insurance Studies for the Towns of Ipswich and Newbury. The coastal analyses were completed in December 1983.
Salem, City of	The hydrologic and hydraulic analyses in the February 5, 1985 study represents a revision of the original analyses by Anderson & Nichols, Inc., for FEMA, under Contract No. H-3715. The updated version was prepared by Stone & Webster

Salem, City of - cont'd	Engineering, Corporation for FEMA, under Contract No. H-4772. This work was completed in July 1983. The hydrologic and hydraulic analyses in the updated study were completed by Stone & Webster.
Salisbury Town of	The hydrologic and hydraulic analyses in the September 4, 1986 study represents a revision of the original analyses by the USACE, New England Division, for the Federal Emergency Management Agency (FEMA), under Inter-Agency Agreement No. IAA-H-2-73, Project Order No. 13 and 14 and Amendment No. 1 thereto. The updated version was prepared by Stone & Webster Engineering Corporation for FEMA, under Contract No. H-4772. This study was completed in January 1984. The hydrologic and hydraulic analyses in the updated study were computed by Stone & Webster Engineering Corporation.
Saugus, Town of	The hydrologic and hydraulic analyses for the July 19, 1982 study were prepared by Stone and Webster Engineering Corporation for FEMA, under Contract No. H-4772. This work was completed in November 1980.
Swampscott, Town of	The hydrologic and hydraulic analyses for the January 3, 1985 study were performed by Stone & Webster Engineering Corporation for FEMA, under Contract No. H-4772. This work was completed in May 1983.
Topsfield, Town of	The hydrologic and hydraulic analyses in the original December 1979 study were prepared by Harris-Taupes Associates for FEMA under Contract No. H-4024. The work for the original study was completed in April 1978. The hydrologic and hydraulic analyses in the revision dated June 17, 1991 were prepared by CDM, for FEMA, under Contract No. EMW-86-C-2250. That work was completed in March 1989. In the June 2, 1994 revision, the hydrologic and hydraulic analyses were prepared by Roald Haestad, Inc., for FEMA, under Contract No. EMW-90-C-3126. This work was completed in January 1992.

Wenham, Town of	The hydrologic and hydraulic analyses in the August 19, 1991 study represent a revision of the original 1989 analyses prepared by CDM, for FEMA, under Contract NO. EMW-86-C-2250. The work for the original study was completed in December 1987. The hydrologic and hydraulic analyses for the Ipswich River in the 1991 revision were taken from the June 2, 1994 FIS for the Town of Topsfield.
West Newbury, Town of	The hydrologic and hydraulic analyses for the December 1978 study were performed by CDM. for the FIA, under Contract No. H-3861. This work, which was completed in January 1977, covered all significant flooding sources affecting the Town of West Newbury.

Base map information shown on this FIRM was derived from digital orthophotography. Base map files were provided in digital form by Massachusetts Geographic Information System (MassGIS). Ortho imagery was produced at a scale of 1:5,000. Aerial photography is dated April 2005. The projection used in the preparation of this map was Massachusetts State Plane mainland zone (FIPSZONE2001). The horizontal datum was NAD83, GRS1980 spheroid.

1.3 Coordination

The purpose of an initial Consultation Coordination Officer's (CCO) meeting is to discuss the scope of the FIS. A final meeting is held to review the results of the study.

The dates of the initial, intermediate and final CCO meetings held for the incorporated communities within Essex County are shown in Table 1, "CCO Meeting Dates for Precountywide FIS."

TABLE 1 - CCO MEETING DATES FOR PRECOUNTYWIDE FIS

Community Name	Initial CCO Date	Intermediate CCO Date	Final CCO Date
Amesbury, Town of	January, 1976	*	March 19, 1979
Andover, Town of	August 8, 1983	*	May 10, 1988
Beverly, City of	April 5, 1978	September 7, 1983	November 7, 1984
Boxford, Town of	January 1986	*	February 23, 1990

* Data Not Available

TABLE 1 - CCO MEETING DATES FOR PRECOUNTYWIDE FIS – cont'd

Community Name	Initial CCO Date	Intermediate CCO Date	Final CCO Date
Danvers, Town of	November 29, 1978	*	June 21, 1979
Essex, Town of	April 4, 1978	September 22, 1980	January 28, 1985
Georgetown, Town of	June 1976	November 21, 1977	November 20, 1978
Gloucester, City of	April 5, 1978	February 1980/ October 12, 1983	August 16, 1984
Groveland, Town of	May 1976	September 12, 1977/ January 16, 1978	September 29, 1978
Hamilton, Town of	January 1986	*	April 8, 1989
Haverhill, Town of	May 1978	October 16, 1980	September 24, 1981
Ipswich, Town of	April 4, 1978	December 19, 1983	September, 18, 1984
Lawrence, City of	May 4, 1978	November 11, 1980	August 26, 1981
Lynn, City of	March 28, 1978	*	February 28, 1984
Lynnfield, Town of	August 28, 1975	*	September 27, 1978
Manchester, Town of	April 5, 1979	January 1980/ September 7, 1984	April 9, 1984
Marblehead, Town of	April 25, 1978	December 12, 1979/ July 5, 1983	February 2, 1984
Merrimac, Town of	May 1978	May 1980	April, 15, 1981
Methuen, City of	August 23, 1979	*	May 2, 1985
Middleton, Town of	November 1, 1977	November 30, 1978	June 27, 1979
Nahant, Town of	*	*	November 17, 1983
Newbury, Town of	April 12, 1978	February 1980	October 9, 1984

* Data Not Available

TABLE 1 - CCO MEETING DATES FOR PRECOUNTYWIDE FIS – cont'd

Community Name	Initial CCO Date	Intermediate CCO Date	Final CCO Date
Newburyport, City of	April 12, 1978	February 1980	November 27, 1984
New Andover, Town of	March 1987	*	September 26, 1991
Peabody, City of	May 13, 1977	November 30, 1978	June 21, 1979
Rockport, Town of	April 5, 1978	February 1980/ October 12, 1983	June 5, 1984
Rowley, Town of	April 4, 1978	September 29, 1980	April 8, 1985
Salem, City of	April 20, 1978	September 7, 1983	September 11, 1984
Salisbury, Town of	April 12, 1978	January 1980/ January 30, 1984	November 19, 1984
Saugus, Town of	March 28, 1978	January 26, 1981	February 3, 1982
Swampscott, Town of	April 20, 1978	December 12, 1979	March 5, 1984
Topsfield, Town of	January 23, 1990	*	February 23, 1990
Wenham, Town of	January 1986	January 13, 1988	August 17, 1988
West Newbury, Town of	August 20, 1975	*	August 20, 1975

*Data not available

For this countywide revision, the initial Consultation Coordination Officer (CCO) meeting was held on September 27th and 28th, 2005, and was attended by representatives of Essex County communities, Massachusetts Office of Coastal Zone Management, FEMA's Regional Management Center for Region I, Ocean Coastal Consultants, Inc. (OCC), and CDM.

The results of the countywide study were reviewed at the final CCO meeting held on ________________________________, and attended by representatives of ____. All problems raised at that meeting have been addressed in this study.

2.0 AREA STUDIED

2.1 Scope of Study

This FIS report covers the geographic area of Essex County, Massachusetts, including the incorporated communities listed in Section 1.1. The areas studied by detailed methods were selected with priority given to all known flood hazards and areas of projected development or proposed construction.

All or portions of the flooding sources listed in Table 2, "Flooding Sources Studied by Detailed Methods," were studied by detailed methods in the pre-countywide FIS's. Limits of detailed study are indicated on the Flood Profiles (Exhibit 1) and on the DFIRM.

TABLE 2 –FLOODING SOURCES STUDIED BY DETAILED METHODS

Flooding Source Name	Description of Study Reaches
Argilla Brook	In the Town of Groveland, from its confluence with Johnson Creek to the Center Street Bridge
Atlantic Ocean	Along the entire eastern coastline of Essex County
Bare Meadow Brook	In the City of Methuen, from its confluence with the Merrimack River to the Hills Pond Dam
Bartlett Brook	In the City of Methuen, from its confluence with the Merrimack River to the pipeline crossing to the north of North Lowell Street
Bates Brook	In the Town of Lynnfield, from its confluence with Pillings Pond to Midland road
Beaver Brook (Town of Danvers)	In the Town of Danvers, from the Sylvan Street Dam to Nichols Street

TABLE 2 –FLOODING SOURCES STUDIED BY DETAILED METHODS – cont'd

Flooding Source Name	Description of Study Reaches
Beaver Brook (Town of West Newbury)	In the Town of West Newbury, from Middle Street to approximately 4,400 feet upstream from Tewksbury Street
Beaverdam Brook	In the Town of Lynnfield, from its confluence with the Saugus River to the Main Street culvert
Bennett's Pond Brook	In the Town of Saugus, from its confluence with the Saugus River to Lewis O. Gray Drive
Beverly Harbor	At the Danvers River Estuary, from State Highway 1A to the Atlantic Ocean
Boston Brook	In the town of Middleton, from its confluence with the Ipswich River in to approximately 4,000 feet upstream from Hawkins Lane in the Town of North Andover
Branch of Ipswich & Cleveland Brook	In the Town of Topsfield, from its confluence with the Ipswich River to approximately 300 feet upstream from Washington Street
Bulford Brook	In the Town of Georgetown, from its confluence with Penn Brook to approximately 2,400 feet upstream from State Highway 133 (East Main Street)
Centerville Creek	In the City of Beverly, from its confluence with Beverly Cove to approximately 100 feet upstream from Common Lane

TABLE 2 –FLOODING SOURCES STUDIED BY DETAILED METHODS – cont'd

Flooding Source Name	Description of Study Reaches
Chubbs Brook	From confluence with Chubb Creek to approximately 65 feet upstream from State Highway 127 (Hale Street) in Beverly
Chubb Creek	On the border of the City of Beverly and the Town of Manchester, from its confluence with Manchester Bay to State Highway 127 (Hale Street)
Coastal Flooding	Affecting the entire eastern coastline of Essex County, resulting from the Atlantic Ocean
Cochichewick Brook	In the Town of North Andover, from its confluence with the Merrimack River to Stevens Pond
Crane River & Crane Brook	In the Town of Danvers, from its confluence with Porter River to approximately 650 feet past the Border-to-Boston Bike Trail
Creek Brook	From its confluence with the Merrimack River to Crystal Lake
Egg Rock	Off the coast of the Town of Nanhant, island located in Nahant Bay
Emerson Brook	From its confluence with the Ipswich River to approximately 20 feet upstream from Liberty Street in Middleton
Fish Brook	From its confluence with the Ipswich River to confluence with Mosquito Brook
Fish Brook (Town of Andover)	From confluence with Merrimack River to Greenwood Road

TABLE 2 –FLOODING SOURCES STUDIED BY DETAILED METHODS – cont'd

Flooding Source Name	Description of Study Reaches
Fiske Brook	In the Town of Saugus, from its confluence with Shute Brook to approximately 820 feet upstream from its confluence with Shute Brook
Goldwaite Brook	In the City of Peabody, from its confluence with Proctor Brook to approximately 100 feet upstream from First Avenue
Harris Brook	In the City of Methuen, from its confluence with the Spicket River to approximately 75 feet upstream from Hampshire Road
Haverhill-Riverside Airport Brook	In the City of Haverhill, from its confluence with the Merrimack River to upstream to approximately 100 feet upstream from Kenoza Street
Hawkes Brook	In the City of Methuen, from its confluence with Bare Meadow Brook to approximately 100 feet upstream from North Street
Howlett Brook & Pye Brook	In the Town of Topsfield, from its confluence with the Ipswich River to approximately 600 upstream from State Highway 97 (Haverhill Road)
Hussey Brook	In the Town of Andover, from its confluence with the Shawsheen River to approximately 3700 feet upstream from Beacon Street
Hussey Brook Tributary	In the Town of Andover, from its confluence with Hussey Brook to approximately 200 feet upstream from Beacon Street

TABLE 2 –FLOODING SOURCES STUDIED BY DETAILED METHODS – cont'd

Flooding Source Name	Description of Study Reaches
Ipswich River	In the Town of Ipswich, from State Route 133 to the Essex County (Town of Lynnfield)/Middlesex County (Town of North Reading) Corporate Limits
Jackman Brook	From the Town of Newbury/Town of Georgetown Corporate Limits to Jewett Street in the Town of Georgetown
Johnson Creek	In the Town of Groveland, from its confluence with the Merrimack River to Washington Street
Lake Attitash	On the Town of Amesbury/Town of Merrimac Corporate Limits
Little River	In the City of Haverhill, from its confluence with the Merrimack River to the Massachusetts Essex County (City of Haverhill)/ New Hampshire Rockingham County (Town of Plaistow) Corporate Limits
Massachusetts Bay	Along the eastern coastline of Essex County from its southern border to Cape Anne
Merrimack River	In the City of Amesbury, from the Newburyport Lighthouse to the Essex County (Town of Andover)/Middlesex County (Town of Dracut) Corporate Limits
Mile Brook	In the Town of Topsfield, from its confluence with the Ipswich River to its divergence from Howlett Brook and Pye Brook

TABLE 2 –FLOODING SOURCES STUDIED BY DETAILED METHODS – cont'd

Flooding Source Name	Description of Study Reaches
Miles River	From its confluence with the Ipswich River to Dodge Row in the Town of Wenham
Mill River (Town of Gloucester)	From Dr. Osman Babson Road to approximately 400 feet upstream of Access Road
Mill River (Town of Rowley)	From just downstream of U.S. Route 1 to approximately 3700 feet upstream of Mill Dam
Millvale Reservoir Brook	From its confluence with the Merrimack River to Millvale Reservoir
Mosquito Brook	From Brookview Road in Boxford to approximately 50 feet upstream of Chestnut Street in the Town of North Andover
North Beverly Drainage Ditch	From its confluence with Bass River to approximately 1300 feet upstream of Russell Street in Beverly
North River & Proctor Brook	From Grove Street in Salem to approximately 120 feet upstream from Peabody Road in the City of Peabody
North Tributary Brook	From its confluence with Artichoke River – Reservoir to approximately 6000 feet upstream of Garden Street in West Newbury
Parker River (Town of Boxford)	From the Groveland/Boxford Corporate Limits to approximately 50 feet upstream of State Route 133
Parker River (Town of Georgetown)	From the Groveland/ Georgetown Corporate Limits to approximately 2400 feet upstream of Bailey Lane

TABLE 2 –FLOODING SOURCES STUDIED BY DETAILED METHODS – cont'd

Flooding Source Name	Description of Study Reaches
Parker River (Town of Newbury)	In the Town of Newbury, from 500 feet downstream of the Central Street Dam to the Town of Newbury/Town of Georgetown Corporate Limits
Peat Meadow Brook	In the City of Methuen, from its confluence with the Spicket River to approximately 30 feet upstream of Forest Street
Penn Brook	In the Town of Georgetown, from its confluence with Parker River (Town of Georgetown) to the Town of Georgetown/Town of Newbury Corporate Limits
Pillings Pond	In the Town of Lynnfield, from its confluence with Bates Brook to approximately 5000 feet downstream from its confluence with Bates Brook
Powwow River	In the Town of Amesbury, from its confluence with the Merrimack River to its confluence with Lake Gardner
Porter River & Frost Fish Brook	In the Town of Danvers, from approximately 1,500 feet upstream from Kernwood Avenue to Coolidge Road
Saugus River	In the Town of Saugus, from the Hamilton Street Bridge (Upstream Face) to the Essex County (Town of Lynnfield)/Middlesex County (Town of Wakefield) Corporate Limits

TABLE 2 –FLOODING SOURCES STUDIED BY DETAILED METHODS – cont'd

Flooding Source Name	Description of Study Reaches
School Brook	In the Town of Topsfield, from its confluence with Branch of Ipswich and Cleveland Brook to approximately 150 feet upstream of State Highway 97 (High Street)
Shawsheen River	In the Town of North Andover, from its confluence with the Merrimack River to the Essex County (Town of Andover)/Middlesex County (Town of Tewksbury) Corporate Limits
Shute River	In the Town of Saugus, from approximately 2500 feet downstream from Central Street Culvert (Upstream Face) to approximately 250 feet upstream of Pennybrook Road
Spicket River	In the City of Lawrence, from its confluence with the Merrimack River to the Massachusetts Essex County (City of Methuen)/New Hampshire Rockingham County (Town of Salem)
Strongwater Brook	In the City of Peabody, from its confluence with North River and Proctor Brook to Pierpont Street
Tidal Flooding	Flooding from the Atlantic Ocean affecting all Essex County coastline, bays, estuaries, tidal rivers, tidal flats and tidal streams and surrounding areas
Tapley Brook	In the City of Peabody, from its confluence with Goldthwaite Brook to approximately 1600 feet upstream of Sidneys Pond Dam

TABLE 2 –FLOODING SOURCES STUDIED BY DETAILED METHODS – cont'd

Flooding Source Name	Description of Study Reaches
Tributary to the Ipswich River	In the Town of Middleton, from its confluence with the Ipswich River to approximately 1050 feet upstream of Pleasant Street
Tributary to Neal Pond	In the Town of Merrimac, from Birch Meadow Road to Birch Meadow Loop
Upper Artichoke Reservoir	On the Town of West Newbury/City of Newburyport Corporate Limits from its confluence with Arichoke River – Reservoir to approximately 80 feet downstream of Rogers Street
Unnamed Tributary to Fish Brook	In the Town of Topsfield, from its confluence with Fish Brook to the Town of Topsfield/Town of Boxford Corporate Limits
Volume-Elevation Study	Sluice Pond, Flax Pond, and Cedar Pond in the Town of Lynn
Waters River	In the Town of Danvers, from its confluence with Danvers River to approximately 4600 feet upstream of State Highway 35 (Water Street)

For this countywide revision, revised coastal analyses were performed for the open water flooding sources in the communities of Salisbury and Newburyport. In addition, redelineation of coastal flood hazard data was performed for open water flooding sources in the communities of Beverly, Danvers, Essex, Gloucester, Ipswich, Lynn, Manchester, Marblehead, Nahant, Newbury, Peabody, Rockport, Rowley, Salem, Saugus and Swampscott.

Detail-studied flooding sources that were not restudied as part of this revision may include a profile baseline on the FIRM. The profile baselines for these flooding sources were based on the best available data at the time of their study and are depicted as they were on the previous FIRMs. In some cases the transferred profile baseline may deviate significantly from the channel or may be outside of the floodplain.

Approximate analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to, and agreed upon, by FEMA and the individual communities within Essex County. For this countywide revision, no new approximate studies were executed.

All or portions of the flooding sources listed in Table 3, "Flooding Sources Studied by Approximate Methods," were studied by approximate methods in the precountywide FISs.

TABLE 3 - FLOODING SOURCES STUDIED BY APPROXIMATE METHODS

Flooding Source Name	Community (s)
Alewife Brook	Essex
Argilla Brook	Groveland
Bachelder Brook	Rowley
Back River	Amesbury, Merrimac
Bagness School	Groveland
Baldpate Pond	Boxford
Bare Meadow Brook Tributary	Methuen
Bare Meadow Brook	Methuen
Bass River	Beverly
Beaver Brook Tributary	West Newbury
Beaver Brook	Danvers, Groveland
Beaver Pond	Beverly
Beavor Brook	West Newbury
Bennetts Pond	Saugus
Birch Pond	Lynn, Saugus
Boston Brook	Middleton, North Andover
Breeds Pond	Lynn
Browns Pond	Peabody
Bull Brook Reservoir	Ipswich
Cat Brook	Manchester
Cedar Pond	Boxford, Wenham
Centerville Creek	Beverly
Chadwick Pond	Boxford, Haverhill
Chebacco Lake	Essex
Chubb Creek	Beverly
Chubbs Brook	Beverly
Cobbler Brook	Merrimac
Coy Pond	Wenham
Crane Brook	Danvers
Crystal Lake	Haverhill
Dow Brook Reservoir	Ipswich
East Meadow	Haverhill

TABLE 3 - FLOODING SOURCES STUDIED BY APPROXIMATE METHODS – cont'd

Flooding Source Name	Community (s)
Egypt Pond	Ipswich
Emerson Brook	Middleton
Fish Brook	Andover, Boxford
Fiske Brook	Saugus
Flood Prone Areas	Groveland
Forest River	Salem
Fourmile Pond	Boxford
Fowler Brook	Danvers
Frost Fish Brook	Danvers
Goldwaite Brook	Peabody
Gravelly Brook	Ipswich
Grindle Brook	Groveland, Haverhill
Hawkes Brook	Methuen
Hawkes Pond	Saugus
Hood Pond	Ipswich
Hoveys Pond	Boxford
Howlett Brook	Topsfield
Hussey Brook	Andover
Jackman Brook	Georgtown
Johnson Pond	Boxford, Groveland
Kimballs Pond	Boxford
Lake Cochichewick	North Andover
Lake Pentucket	Haverhill
Lake Saltonstall	Haverhill
Low development potential	Gloucester, Lynnfield
Lowe Pond	Boxford
Lower Millpond	Rowley
Low-Lying Area	Newburyport
Lufkin Creek	Essex, Methuen, Middleton, Topsfield
Mile Brook	Topsfield
Mill River	Rowley
Minimal Flood Harzards	Gloucester, Lynnfield
Mosquito Brook	North Andover
Muddy Pond	Wenham
Muddy Run	Ipswich
Mystic Pond	Methuen
Neal Pond	Merrimac
Nichols Brook	Danvers, Middleton, Topsfield
Norris Brook	Danvers, Peabody
North Beverly Drainage Ditch	Beverly
North River	Salem
Norwood Pond	Beverly
Ox Pasture Brook	Rowley

TABLE 3 - FLOODING SOURCES STUDIED BY APPROXIMATE METHODS – cont'd

Flooding Source Name	Community (s)
Parker River	Georgtown, Groveland
Peat Meadow Brook	Methuen
Pennys Brook	Saugus
Ponding Areas	Hamilton, Lawrence
Proctor Brook	Peabody
Putnamville Reservior	Danvers, Topsfield
Pye Brook	Boxford, Topsfield
Rantoul Pond	Ipswich
Rogers Brook	Andover
Salen Pond	North Andover
Saw Mill Brook	Manchester
Sharpners Pond	North Andover
Shoe Pond	Beverly
Skug River	Andover
Smaller Watercourses	Georgtown
Snows Brook	Haverhill
Soginese Creek	Essex
Sperrys Pond	Boxford
Spofford Pond	Boxford
Stearns Pond	North Andover
Stevend Pond	Boxford
Stevens Pond	North Andover
Stiles Pond	Boxford
Strawberry Brook	Lynn
Stream Tributary	Groveland
Streams feeding water bodies	Haverhill
Strongwater Brook	Peabody
Sudden Pond	North Andover
Swamp Brook	Rowley
Tapley Brook	Peabody
Thompson's Meadow	Salem
Towne Pond	Boxford
Tributary A	Middleton
Unnamed Areas	Beverly, Saugus
Unnamed Bogs	Essex
Unnamed Drainage Areas	Merrimac
Unnamed Ponding Area	Wenham
Unnamed Streams	Amesbury, Danvers, Essex,
Unnamed Swamps	Danvers, Ipswich, Peabody
Unnamed Tributaries	Andover, Groveland, Manchester,
Unnnamed Ponds	Boxford, North Andover
Unnnamed Streams	North Andover, Peabody
Upper Artichoke Reservoir	West Newbury
Upper Millpond	Rowley
Walden Pond	Lynn, Saugus
Waters River	Danvers
Wenham Lake	Beverly, Wenham

TABLE 3 - FLOODING SOURCES STUDIED BY APPROXIMATE METHODS – cont'd

Flooding Source Name	Community (s)
West Meadow River	Haverhill
Wetlands	Groveland, Haverhill, Haverhill
Wheeler Brook	Georgtown
Wilson Pond	Rowley

This FIS also incorporates 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 Amendment [LOMA]), as shown in Table 4, "Letters of Map Change."

TABLE 4 – LETTERS OF MAP CHANGE

Community	Case Number	Flooding Source	Letter Date
Andover, Town of	04-01-007P	Skug River	03/16/2004
Beverly, City of	08-01-0002P	Massachusetts Bay	08/01/2008
Methuen, City of	199102431FIA	Hawkes Brook	06/14/1988
Wenham, Town of	06-01-B791P	Pond1 and Pond 2	02/15/2007

2.2 Community Description

Essex County is located in northeastern Massachusetts. In Essex County, there are twenty-six (26) towns and eight (8) cities. The Towns of Amesbury, Rockport, Groveland, Middleton, Newbury, Georgetown, Merrimac, Manchester, Salisbury, West Newbury and the Cities of Gloucester, Salem, Newburyport, Methuen, and Haverhill are located in northern Essex County. The Towns of Hamilton and Topsfield are in the central portion of the county. The Cities of Beverly, Lynn, Peabody, Salem and Towns of Danvers, Lynnfield, Marblehead, Swampscott are located in the southern portion of the county. The Town of Andover is located in the northeastern portion of the county. The Towns of Boxford, North Andover and the City of Lawrence are located in the western portion of the county. The Towns of Essex, Rowley, Nahant, Ipswich and Wenham are located in the eastern portion of the county.

Essex County is bordered on the north by the State of New Hampshire and on the east by Atlantic Ocean. It is bordered on the west by Middlesex and Essex Counties in Massachusetts, and to the south by Suffolk County.

According to census records, the population of Essex County was 723,419 in 2000 (Reference 5). The total area in Essex County consists of 1,444 mi^2, including 328 mi^2 of water area. All communities in Essex County, along with their population and total area, are listed in Table 5, "Population and Total Area by Community."

TABLE 5 – POPULATION AND TOTAL AREA BY COMMUNITY

Community	Total Area (sq. mi)[1]	Population[1]
Amesbury, Town of	13.7	16,429
Andover, Town of	32.1	31,247
Beverly, City of	22.7	39,198
Boxford, Town of	24.6	7,921
Danvers, Town of	14.1	25,212
Essex, Town of	15.9	3,267
Georgetown, Town of	13.2	7,377
Gloucester, City of	41.5	30,308
Groveland, Town of	9.4	6,038
Hamilton, Town of	14.9	8,315
Haverhill, Town of	42.1	59,902
Ipswich, Town of	32.0	12,987
Lawrence, City of	7.4	70,066
Lynn, City of	13.5	87,122
Lynnfield, Town of	10.5	11,542
Manchester, Town of	18.3	5,228
Marblehead, Town of	19.6	20,377
Merrimac, Town of	8.8	6,138
Methuen, City of	23.1	43,979
Middleton, Town of	14.4	7,744
Nahant, Town of	15.5	3,632
Newbury, Town of	26.5	6,717
Newburyport, City of	10.6	17,144
N. Andover, Town of	27.8	27,202
Peabody, City of	16.9	51,441
Rockport, Town of	17.6	7,767
Rowley, Town of	20.6	5,500
Salem, City of	18.1	40,922
Salisbury, Town of	17.9	7,827
Saugus, Town of	11.8	26,078
Swampscott, Town of	6.7	14,412
Topsfield, Town of	12.8	6,141
Wenham, Town of	8.1	4,440
W. Newbury, Town of	14.6	4,450

[1]Data obtained from U.S Census Bureau (Reference 5)

2.3 Principle Flood Problems

Past flooding on the streams within Essex County indicates that flooding can occur during any season of the year. Most major floods have occurred during February, March, and April and are usually the result of spring rains and/or snowmelt. Floods occurring during the midsummer and late summer are often associated with tropical storms moving up the Atlantic coastline. Severe flooding in Essex County generally occurs as a result of hurricanes or melting snows and spring rains, with more localized flooding caused by summer thunder-storms.

Trees, brush, and other vegetation growing along stream banks impede flood flows during high waters, thus creating backwater and increasing flood heights. Furthermore, trees, ice, and other debris may be washed away and carried downstream to collect on bridges and other obstructions. As the flood flow and debris surges downstream until another obstruction is encountered. Debris may collect against a bridge or culvert until the load exceeds the structural capacity, causing its destruction. It is difficult to predict the degree to which, or the location where, debris may accumulate. Therefore, in the development of the flood profiles it has been necessary to assume no accumulation of debris or obstruction of flow.

The flood problems for the communities within Essex County have been compiled and are described below:

Historical records indicate that since December 1740, numerous storms and floods have occurred in the Merrimack River Basin. The two latest and the most significant occurred in March 1936 and September 1938. The most severe, the 1936 flood resulted from a combination of heavy rains and extensive snow melts. The other, in 1938, was from torrential rains associated with a hurricane passing over the Merrimack River basin at a time when the ground was saturated from an earlier storm. While studies determining the recurrence frequency are not available, it is estimated that floods of the 1936 magnitude and the 1938 magnitude recur approximately every 200 years and every 50 years, respectively. Flooding from the mouth of the Merrimack River in Salisbury and Newburyport, Massachusetts, to the Deer Island Bridge between Amesbury and Newburyport is primarily affected by high tides. Upstream of this bridge, flooding has been caused by either high tides or high-river flows, separately or in coincidence.

Outstanding floods caused by heavy rainfall alone or by a combination of heavy rain and melting snow, have occurred along both the Shawsheen and Merrimack Rivers in Andover. Records of river stages and discharges on the Merrimack River at Lawrence, Massachusetts, have been maintained by the Essex Company at the Essex Company Dam (2 miles downstream of the Andover town line) since 1848. No records of stream stages or discharges are available for the lower portion of the Shawsheen River in Andover. However, flood information has been obtained from records of the Massachusetts Geodetic Survey and the USACE, as well as from local authorities and residents. The Essex Company Dam is the hydraulic control for the entire Merrimack River in Andover. Discharges and stages of the greatest known floods of record measured at the Essex Company Dam since 1852 are shown in the following tabulation:

Date	Stage[1] (Feet NAVD)	Estimated Peak Discharge (cfs)
March 20-21, 1936	52.3	174,000
September 23, 1938	49.2	121,000
April 23, 1852	48.48	108,000
March 3, 1896	48.10	105,000
April 16, 1895	47.21	89,900
April 6, 1960	46.53[2]	79,000[2]
November 6, 1927	46.51	78,900
April 20, 1933	46.36	76,200
March 4, 1902	46.14	73,100

[1] Does not reflect the peak discharge or stages that would have occurred had they been modified by the five upstream flood control reservoirs that were constructed subsequent to the tabulated events

[2]Modified by Franklin Falls, Blackwater, and MacDowell Dams

The Shawsheen River is characterized by a shallow, meandering channel with predominantly low banks. Floodplains are generally wide and flat and covered with grasses and trees. Investigations indicate that the flood of record on the Shawsheen River also occurred as often on the Shawsheen River as on the Merrimack River.

The most significant recorded floods were those occurring in March 1936 and in September 1938. The 1936 flood was the result of a combination of heavy rains and extensive snow melt, while the 1938 flood was caused by heavy precipitation over the Merrimack River basin at a time when the ground was saturated from an earlier storm. The USACE has estimated the 1936 flood to have an occurrence interval in excess of 1-percent-annual-chance, while the 1938 flood has a recurrence interval of approximately 2-percent-annual-chance (References 6 and 7).

Low-lying areas of Beverly, Essex, Gloucester, Ipswich, Lynn, Manchester, Marblehead, Nahant, Newbury, Newburyport, Rockport, Rowley, Salem, Salisbury, Saugus, and Swampscott are subject to the periodic flooding and wave attack that accompany coastal storms, such as northeasters and hurricanes. The

Town of Essex is protected from the heaviest wave attack by the barrier islands at Crane and Coffin Beaches. The majority of these storms cause damage only to low coastal roads, boats, beaches, and seawalls. Occasionally, a major storm accompanied by strong onshore winds and high tides results in surge and wave activity that causes extensive property damage and erosion. Some of the more significant storms in the area include those of December 1909 and 1959, November 1945, 1963, and 1968, and February 1972 and 1978. These storms damaged harbors and marinas and residential and commercial developments in the coastal areas.

Chebacco Lake occasionally floods in the spring but is not believed to threaten property in Essex.

Coastal flooding in Beverly has been particularly evident in the low-lying areas on the north end of Dane Street Beach. Riverine flooding has not generally been a serious problem in the city. The only significant problem reported is the frequent flooding of a portion of Cabot Street by North Beverly Drainage Ditch. This flooding is due primarily to an undersized culvert at Cabot Street and heavy siltation of the Boston and Maine rail road culverts just downstream of Cabot Street.

Few detailed records of flooding are available for the Town of Boxford or for the Town of Hamilton. Major storms in the region occurred in 1936, 1938, 1949, 1955, 1968, 1976, 1979 and 1987. Little information is available for any of these storms. In Boxford, the April 1987 storm caused overtopping of several roads located around local streams. During the April 1987 storm, the town suffered approximately $37,000 worth of flood damages, of which the town recovered approximately $14,000 of eligible damages from Federal Emergency Relief. Numerous residential and commercial basements were pumped by the Fire Department. At least 5 roads were overtopped by floodwaters. Most of these were caused by high backwater from downstream ponds, although in one case the culvert system serving as the Stiles Pond outlet was overtopped and required replacement. In Hamilton, the April 1987 storm caused overtopping of the approaches to the Winthrop Street Bridge by the Ipswich River. The bridge could not be crossed for several days until the floodwaters receded. The Winthrop Street crossing is located downstream of the Town of Hamilton, but was covered in detail in the Flood Insurance Study for the Town of Ipswich (Reference 8). During the April 1987 storm, flow from the Ipswich River was contained by Wenham Swamp and its large storage capacity. The area is not monitored for flood elevations, and therefore no high-water marks are available. The area contiguous to the Miles River has not experienced any major flooding problems. There were incidents of flooded basements and ponded yards during the April 1987 storm, but these occurrences can be attributed to the high local groundwater table and the inability of the soil to percolate rainfall.

Major storms in the North Andover region occurred in 1936, 1938, 1949, 1955, 1968, 1976, 1979, and 1987. The Shawsheen and Merrimack Rivers are significantly larger than Boston and Mosquito Brooks and have historical records of flooding predating the 1936 flood. Each of these rivers experienced their most severe flooding during the 1936 storm (Reference 9). However, no flooding information for these early period storms is available for either Boston or Mosquito Brook, probably because each brook flows through lightly populated or underdeveloped areas where flooding impacts impose little economic damage. The history of the Merrimack River contains information on flood dating back to 1846. The most significant recorded floods occurred in March 1936 and September 1938. The 1936 flood resulted from a combination of heavy rains and extensive snowmelt. The 1938 flood was caused by torrential rains associated with a hurricane passing over the Merrimack River basin at a time when the ground was saturated from an earlier storm. The USACE estimated the 1936 flood had a recurrence interval in excess of the 1-percent-annual-chance flood and estimated the 1938 flood had a recurrence interval of about 2-percent-annual-chance (Reference 10). The flood of 1936 is also the flood of record on the Shawsheen River. Flooding along the lower portion of the Shawsheen River is influenced by the rise in water-surface elevation of the Merrimack River. During severe floods, backwater from the Merrimack River has extended up the Shawsheen River through North Andover and Lawrence as far south as Andover, a distance of 5 miles. Following the 1936 flood, the Massachusetts Geodetic Survey gathered high-water mark data for the Merrimack River and the Shawsheen River in North Andover (Reference 11). High-water marks for the Merrimack River included elevations of 39.1 feet at the North Andover-Haverhill corporate limits, 43.4 feet at the Boston and Maine Railroad signal located 475 feet northeast of North Main Street, 43.2 feet at the building at 45 Riverview Street, and 43.2 feet at the building at 16 Sutton Street. High-water marks for the Shawsheen River included elevations of 43.4 feet at Marblehead Street near Sutton Street Bridge, 43.8 feet at Massachusetts Avenue approximately 1,200 feet east of the bridge over the Shawsheen, 43.5 feet at Loring Street Bridge at the North Andover-Lawrence corporate limits, and 43.4 feet at Green Street Bridge at the North Andover-Lawrence corporate limits.

Both riverine and tidal waters cause flood problems in Danvers. The history of tidal flooding in the study area can be traced by referring to the records of storm tides measured at Boston since 1851. Riverine flooding on the Ipswich River has been documented by gage records and high-water marks. Records at the Middleton gage on the Ipswich River give an indication of the magnitude of flood discharges in Danvers, located just downstream. The Middleton gage began operation in 1938. The flood of record occurred on January 26, 1979, and had a measured peak discharge of 835 cubic feet per second (cfs).

Georgetown has not experienced any severe storm damage in the past. Minor flooding has occurred throughout the town. Two of these areas are Baldpate Road, which floods due to runoff from Littles Hill, and Andover Street, North

Street, and Bailey Lane at Parker River. Rock pond and Pentucket Pond have not had flood problems in the past.

Groveland has experienced extensive flooding in the past. The most notable storm was in 1936, a storm classified as being greater than a 1-percent-annual-chance storm. Major flooding inundated the banks of the Merrimack River. The hardest hit area was along Main Street, near Gardener Street. Bates Bridge over the Merrimack River was nearly overtopped. Also hit hard were areas along Johnson Creek from its confluence with Merrimack River to a point upstream of Main Street. Minor flooding is caused by blocked and inadequate culverts throughout the town.

History of flooding on the Merrimack River in Hamilton, Lawrence, and Merrimac contains information dating back to 1846. The most significant recorded floods were those occurring in March 1936 and September 1938. The 1936 flood was the result of a combination of heavy rains and excessive snowmelt. The 1938 flood was caused by torrential rains associated with a tropical storm passing over the Merrimack River basin at a time when the ground was saturated from an earlier storm. The USACE estimated that the 1936 flood has a recurrence interval in excess of 1-percent-annual-chance and the 1938 flood has a recurrence interval of approximately 2-percent-annual-chance (8). Flooding along the Little River is influenced by the rise in water-surface elevations from the Merrimack River, During severe flooding, the backwater from the Merrimack River extends up the Little River above the entrance to the arch culvert running under the city. During these periods of high backwater, pumps have been utilized to convey floodwaters from the Little River to the Merrimack River. The Massachusetts Geodetic Survey gathered Merrimack, Shawsheen and Spicket River high-water mark data in the City of Lawrence resulting from the 1936 flood (Reference 12).

Riverine flooding in Ipswich caused by inland precipitation runoff has led to little damage from the Ipswich and Miles Rivers due to limited construction in vulnerable areas. In March 1936 and March 1968, floods with recurrence intervals of approximately 50 years were recorded on the Ipswich River at the gage located at the Willowdale Dam. There is no gage on the Miles River, but it can be assumed that this river had floods of similar severity in 1936 and 1968. Neither flood had significant effects on developed land. Kimball Brook, another tributary of the Ipswich River, has flooded Peabody Street, Safford Street, and Cherry Street. Due to the nature of the flooding and limited scope of the stream, it was not studied in detail.

Principal flood problems in the Lawrence are localized in nature because of undersized culverts. In October 1962 and March 1968, major flooding was experienced on the Saugus River and the Ipswich River. Damage was confined to flooded basements because of standing water.

During the February 6-7, 1978 in Manchester, blizzard, the coastal areas particularly prone to flooding and damage were Ocean Street and Raymond Street. In the Ocean Street area, considerable debris washed over the revetment structure and onto residential property. Residences off Raymond Street, on the beach at Kettle Cove, experienced flooding and wave attacks. There was less severe flooding occurred around Lobster Cove and Boardman Avenue near the entrance to Manchester Harbor. Further, there was extensive damage to the riprap which protects the back side of Singing Beach.

Marblehead Harbor in Marblehead is exposed to winds from the northeast. During the February 6-7, 1978, a blizzard there was overtopping of the seawall at the south end of the harbor, and waters flooded the causeway that links Marblehead and Marblehead Neck. Although the seawall was not breached, it did sustain structural damage. In addition, there was some damage to structures on Front Street, where foundations rested on rocks at the water's edge. This damage, however, was not extensive.

Causes of significant flooding in Methuen are generally similar to those of the lower Merrimack River basin. Of the 76 largest floods experienced since 1846 at Lowell, upstream on the Merrimack River, 59 occurred in the months of March, April, or May and resulted from snowmelt augmented by rainfall, as happened during the record March 1936 flood. Floods resulting from heavy rainfall alone, however, may also be expected during the other seasons of the year, as in the cases of the floods of November 1927 and September 1938 (Reference 1 in Methuen). The flood history of the Merrimack River contains information of floods as far back as 1785. There is little documentation available for the early floods. However, dates and peak discharges of the five largest floods at the U.S. Geological Survey (USGS) gaging station in Lowell, Massachusetts (No. 01100000) 1,100 feet downstream of the confluence of the Merrimack and Concord Rivers and 4.2 miles upstream of the Andover-Dracut-Methuen corporate limits are listed below. The total drainage area is 4,635 square miles (Reference 3).

Although overbank flooding occurs nearly every year along some reaches of the Ipswich River in Middleton, floods of a catastrophic nature are rare due to the large storage capacity of the many marshes through which the Ipswich flows (Reference 13). The flood of record at the South Middleton gage (No. 01101500) on the Ipswich River occurred on January 26, 1979, with a recorded peak discharge of 835 cubic feet per second (cfs). Prior to 1979, the worst flooding occurred in March 1968, which was the most severe since February 1886, although it is uncertain exactly how the two floods compare since the latter is known only through reports of local residents (Reference 13). In March 1936, a flood similar in magnitude to the 1968 flood occurred on the Ipswich River.

During the February 1978 blizzard in Nahant, seawall or tidal reinforcement damage was sustained on Wilson Road, Castle Road, Nahant Road, Wendell

Road, Willow Road to Wharf Street, on the coast near the intersection of Cliff Road and Nahant Road and near the intersection of Marginal Road and Winter Street, and at the beach between Little Nahant and Nahant. Major areas prone to flooding within Nahant include the causeway leading into the main part of the town, the interior region between Pond Beach and Black Back Beach, and the area between Wharf Street and Furbush Road. Housing in the flood-prone areas of the town consists principally of year-round residences. The majority of the homes throughout the flood prone areas are single-family, wood-frame structures with basements.

In addition to flooding in Newbury, serious shorefront erosion has occurred at Plum Island since the early 1880s, when the mouth of the Merrimack River was located approximately 0.5 mile south of its present position. Jetties, which were constructed at the turn of the century, had stabilized the entrance of the river at its present location and tended to create a buildup of the oceanfront shores on the northern end of the island. However, since 1938, continuous recession of the shoreline has occurred, resulting primarily from severe storm surges and coincident wave action.

One of the most severe storms in Newbury occurred on February 19, 1972, destroying a wide fronting beach and back lying dunes and damaging or destroying several cottages. This storm rendered the island susceptible to further damage. Riverine flooding has not generally been as serious of a problem as coastal flooding in the Newbury area. Extreme water levels on the Parker River upstream of Central Street and on the Little River upstream of Boston Street are primarily caused by runoff from heavy rainfall and snowmelt.

The problem of flooding and erosion on Plum Island in Newburyport dates back to the early 1800s when the Merrimack River was approximately 0.5 mile south of its present position. Jetties which were built at the turn of the century stabilized the entrance to the Merrimack River to its present location and created a buildup of oceanfront shores at the north end of the island. Since 1928, continuous recession of the shoreline has occurred, primarily as a result of severe storm surge and wave attack. In 1970, a revetment was placed along the south shore of the mouth of the river to protect the U.S. Coast Guard Station, which has since moved upstream to a more protected area. One of the most severe storms recorded in this area occurred on February 19, 1972, and destroyed a wide fronting beach and the back-lying sand dunes. This storm rendered the island even more susceptible to severe damage in the future. Flooding on the Merrimack River upstream of the Newburyport Bridge has been caused by high tides or high river flows, separately or in coincidence. The high river flows have resulted from heavy rainfall or from a combination of rainfall and snowmelt. Since 1923, the USGS has continuously recorded Merrimack River flows at the gage 28 miles upstream of Newburyport in Lowell, Massachusetts. This station measures runoff from a 4,635 square mile drainage area, or 93 percent of the drainage area that contributes flow to the Merrimack River at Newburyport.

The major floods in Peabody have resulted from rainfall alone or in combination with snowmelt. Flooding on the Ipswich River has been documented by gage records, high-water marks, and personal accounts. Records at the Middleton and Ipswich gages on the Ipswich River give an indication of the magnitude of flood discharges in Peabody, which is located between the two gages. The Middleton gage began operation in 1938. The highest flood of record occurred in January 1979 and had a measured peak flow of 835 cubic feet per second (cfs). Other major floods, in order of decreasing peak discharge, are as follows: March 1968, October: 1962, March 1969, January 1958, March 1948, July 1938, December 1969, and March 1954. The gage at Ipswich began recording flows in 1931. Its highest flood of record also occurred in 1968, but a flood that occurred in March 1936, showed a peak discharge of nearly the same magnitude (References 14 and 15). Based upon accounts of Ipswich residents, a flood that occurred in February 1886 reached a higher elevation than that for the 1936 flood, however, no measurements of this 1886 flood are available (Reference 13). The 1936 flood had a flood height of 51.2 feet on the Ipswich River at Boston Street. The Ipswich River had 1968 flood heights of 52.8 and 51.3 feet at Boston Street and the USGS gaging station at South Middleton, respectively (References 11 and 16). Gage records and published high-water narks are not available to document floods on the North River, Proctor Brook, Goldthwaite Brook, Strongwater Brook, and Tapley Brook. The hydrologic conditions that cause major flooding on the Ipswich River can result in flooding on these smaller streams.

During the February 6-7, 1978 blizzard in Rockport, damage occurred to coastal areas around Penzance Road, Old Harbor, and Pigeon Cove.

The area of the City of Salem that has been consistently the most heavily damaged is Salem Willows. Also subject to damage are areas within Salem Harbor, such as Derby Wharf, Palmerus Cove, and Forest River Park.

Continuing erosion in Salisbury associated with severe storms also acts to reduce beach and dune width to below protective and recreational use requirements (Reference 17).

River flooding in Saugus has not been a serious problem in the tidal area. The non-tidal flooding problems are primarily due to flooding' along the Saugus River and its tributaries.

During the February 6-7, 1978, blizzard in Swampscott, damage occurred to the Ocean Avenue Extension and its seawall and in the area adjacent to the beach club at Phillips Beach. These sites have greater exposure to northeast winds than other locations on the Swampscott coastline.

Investigations have revealed instances of severe flooding in Topsfield during the floods of March 1936, March 1968, and April 1987. Existing records from gaging stations in the Ipswich River basin show that the 1987 flood had the greatest peak discharge of the three events and was rated larger than the 1-percent-annual-chance recurrence interval flood. The March 1936 flood resulted from inadequate culverts and debris blockage at culvert entrances. Flooded areas included Salem Road at River Road; State Route 97 at the Ipswich River; Topsfield Fairgrounds; Grove Street; Prospect Street near the branch of Ipswich River (locally known as Cleveland Brook); Haverhill Road; and Pond Street. Wenham Swamp caused residential flooding. Damage was minimal, however, due to marginal development of the areas. Based on the Ipswich River gage No. 01102000 at Ipswich, Massachusetts, the peak discharges of the 1936, 1968, and 1987 events were 2,610; 2,680; and 3,550 cubic feet per second (cfs), respectively. The 1936 and 1968 events were estimated as having an approximate 2-percent-annual-chance frequency and, as mentioned in the previous paragraph, the 1987 event was estimated to have an average frequency greater than 1-percent-annual-chance. Precipitation measurements for the 1987 event were indicative of a rainfall that occurs much more frequently than 1-percent-annual-chance; the resulting high flow rate was due to antecedent conditions.

Major storms in Wenham occurred in 1936, 1938, 1949, 1955, 1968, 1976, 1979, and 1987. Little information is available for any of these early period storms. The April 1987 storm caused overtopping of an access road located just downstream of the outlet to Longham Reservoir. Flooding along the Miles River is minimal. Some low-lying houses adjacent to the river experienced flooded basements and ponded yards during the 1987 storm, but these occurrences can be attributed to the high local groundwater table, and the inability of the soil to percolate rainfall.

The only major flooding the Town of West Newbury has experienced was along the Merrimack and the Artichoke Rivers in 1936 and 1938. As a result of these floods, any building which occurred subsequent to 1936 along the Merrimack has been carried out with foundations set above the 1938 flood levels. No factors have aggravated the flood problems. The frequencies of the 1936 and 1938 floods cannot be estimated.

2.4 Flood Protection Measures

Flood protection measures for Essex County have been compiled and are summarized below:

There are four completed reservoirs located upstream in New Hampshire. These projects are operated in conjunction with each other to reduce flooding on the upstream tributaries and main stem of the Merrimack River. As a result of these projects, flood discharges along the Merrimack River in Essex County have been significantly reduced. In addition to the upstream reservoirs, the USACE has also completed five local protection projects, but they are not designed to affect flooding in Essex County. These structures are the Franklin Falls Dam on the Pemigewasset River, the Edward McDowell Dam on Nubanusit Brook, the Blackwater Dam on the Blackwater River; and two dams that control Hopkinton Lake, the Everett Dam on the Piscataquog River and the Hopkinton Dam on the Contoocook River. The USACE studies indicate that the five completed projects would have reduced the peak discharge of the 1936 flood on the Merrimack River at Andover by approximately 35 percent. No flood control reservoirs have been built in the Massachusetts portion of the Merrimack River basin, and none are contemplated. In part, this is because of the relatively flat topography, which does not permit storage of large volumes of floodwaters behind a single large dam without flooding adjacent developed areas. There are also 14 non-federal reservoir or lake systems existing in the Merrimack River Basin with usable storage in excess of 4,000 acre-feet. These reservoirs have no storage specifically allocated for flood control; however, they are drawn down during the winter months and are capable of storing significant amounts of runoff during the spring snowmelt period. Dams located at Tuxbury Pond, Lake Gardner, and immediately downstream of Pond Street on the Powwow River do not provide flood protection measures.

The State of Massachusetts provides concrete seawalls and stone revetments to protect coastal highways in Essex County. Other protective structures were generally constructed and are maintained by the communities and private property owners to satisfy their individual requirements and financial capabilities. These structures include such backshore protection as timber and steel sheet piles, bulkheads, stone revetments, concrete seawalls, and pre-cast concrete units (Reference 17).

The principal protection along the Essex County coastline consists of a system of concrete and stone seawalls, approximately half of which are maintained by the communities and the remaining half by private owners.

At Kettle Cove in Manchester, each house has its own seawall, some of which were rebuilt after the February 1978 storm.

There is a partially submerged breakwater approximately 2 miles offshore of Rockport which affords some protection to the general area of Sandy Bay. At Rockport Harbor, there is a shore attached breakwater.

Regulation of the outlet structures of the major ponds in the Town of Boxford provide a limited means of controlling flood levels both upstream and downstream of the ponds. No other structural control measures exist on the study streams in the town. The Town of Boxford has adopted zoning laws which define Conservancy Districts that coincide with the extent of wetlands along river channels in the town. The zoning bylaws and the zoning map for the Town of Boxford defines the extent of the Conservancy Districts (Reference 18). The zoning map indicates the locations and elevations of the Conservancy Districts, and the bylaws extend the coverage to adjacent wetland areas as defined by Massachusetts wetland statutes. Furthermore, the zoning bylaws specify that residential lots include at least one acre of land not subject to the 1-percent-annual-chance flood as defined by the FIS or as determined by engineering methods specified by Massachusetts wetland regulations.

There are no flood control structures in Danvers. The swampy nature of the Ipswich River Basin and of some of the smaller streams of Danvers is a natural form of flood protection, since swamps store water and reduce peak flood discharges. The Town of Danvers has flood plain zoning regulations as a protection against flood hazards. The regulations are intended to restrict construction within the flood plain districts there by minimizing flood damage. In an effort to minimize flooding problems, several stream improvement programs have been carried out in Danvers. Channelization and culvert design projects have been completed on Crane River, Crane Brook, and Beaver Brook (References 19, 20, 21, 22, and 23).

No structural flood protection measures exist within the Town of Hamilton to alleviate flooding within the community. The town has zoned a Conservancy District that is intended, among other purposes, to "protect the public health and safety, persons and property against hazards of flood water inundation; for the protection of the community against the costs which may be incurred when unsuitable development occurs in swamps, marshes, along watercourses, or in areas subject to floods;" (Reference 24). Parts of both the Ipswich and Miles Rivers are located within the Conservancy District.

There are several federal and non-federal water resource developments which significantly affect flood flows in the Merrimack River. These projects consist of reservoirs, dams, lakes, channel improvements, and other flood-retarding structures and are described in greater detail below. As a result of these projects, flood discharges along the river have been significantly reduced.

The Soil Conservation Service (SCS) constructed a number of small flood-retarding structures on three tributaries to the Merrimack River. These are located in the Baker, Souhegan, Sudbury, Assabet and Concord watersheds and designed primarily for flood protection to specific downstream damage areas. None of these projects affect flooding conditions in the Essex County communities.

Five USACE flood control dams are located in the Merrimack River Basin. The Blackwater Dam, completed in 1941 at Webster, New Hampshire, has a drainage area of 28 square miles and flood control storage of 46,000 acre-feet. The Edward MacDowell Dam, completed in 1950 at Peterborough, New Hampshire has a drainage area of 44 square miles and flood control storage of 12,800 acre-feet. The Franklin Falls Dam, completed in 1943 at Franklin, New Hampshire, has a drainage area of 1,000 square miles and flood control storage of 150,600 acre-feet. Hopkinton Lake Dam, completed in 1962 at Hopkinton, New Hampshire, has a drainage area of 382 square miles and a flood control storage of 70,1000 acre-feet. Everett Lake Dam, completed in 1961 at Weare, New Hampshire, has a drainage area of 64 square miles and flood control storage of 85,500 acre-feet. Hopkinton Lake and Everett Lake Dam projects are considered to operate as a single unit since they are connected by a canal. By the operation of these five projects, peak flows at the Lowell gage would be reduced from 173,000 cubic feet per second (cfs) to 112,000 cfs during a recurrence of the record 1936 flood. Tidal flood barriers have not been constructed and are not planned for this area; however, the USACE has constructed and maintains two jetties, 4,118 and 2,445 feet long respectively, at the confluence of the Merrimack River to maintain a good navigational opening and to reduce the erosion of Plum Island and Salisbury Beach.

In addition, several reservoirs exist in Haverhill that do not significantly contribute to flood control, including Crystal Lake Reservoir and Millvale Reservoir. Prior to the flood of September 1938, the Emergency Relief Administration completed construction of concrete floodwalls and a concrete pressure conduit along the north bank of the Merrimack River and the Little River in the vicinity of the center of the City of Haverhill. The concrete floodwalls are equipped with two foot flashboards with a crest elevation of 25.2 feet. There are no new or planned flood control measures which would significantly affect flood conditions in the City of Haverhill.

The Essex Company Dam, also known as Great Stone Dam, is located on the Merrimack River in Lawrence (Reference 25), It was built to utilize the water power of Bodwells Falls. There are canals on both the north and south sides of the river, Under normal conditions, the canals would never be allowed to exceed an elevation of 41.77 feet due to control gates operated by the Essex Company. The dam does not provide flood protection other than to control water levels in the canals. The Malden Mills Dam is located at the outlet of Stevens Pond on the Spicket River. This dam provides flood control during periods of large flows in the Spicket River.

No tidal or riverine flood control structures have been built that would significantly affect flood conditions in Ipswich. The Willowdale dam is located approximately 4.6 miles upstream of State Route 133 on the Ipswich River. Also, there are several other small dams on the Ipswich and Miles Rivers within the town. These dams are used for water power, and none affect flood flows.

The Town of Lynnfield has a zoning ordinance which establishes a Flood Plain District. The purpose of this bylaw is to ensure that lands in the town subjected to seasonal or periodic flooding shall not be used for residences or other purposes which would endanger the health, safety, or welfare of its citizens. Currently, there are no flood protection structures in Lynnfield.

The City of Methuen has dredged Searles Pond and reconstructed a breached spillway at its lower end. The City also has replaced culverts at East Street in this area. All of this work is designed to reduce the effects of flooding along Bloody Brook, which flows from Searles Pond south to the Methuen-Lawrence corporate limits. The dams in Methuen are used for industrial purposes and have no effect on flood control.

There are several dams located on the Parker River within Newbury. These dams were not built for flood control, and they have no affect on flows from the river. Present and future demands associated with the seasonal tourist industry will further intensify the pressure for development of flood-prone coastal lands. However, the adoption of local and state development regulations concerning flood plain management will help alleviate storm-related losses (Reference 26).

No new or planned flood control measures have been reported which would significantly affect flood conditions in the Town of North Andover. There are five dams along the Shawsheen River located outside of the town which have little effect on flood flows in North Andover (Reference 10). Sutton Pond Dam, Osgood Pond Dam, and two spillways are located on Cochichewick Brook within the Town of North Andover. These structures have no effect on flood control. There are no structural flood control measures for either Boston Brook or Mosquito Brook. North Andover has zoned a floodplain district which includes all special flood hazard areas designated as Zone A or Zone AE. The Watershed Protection District is intended to protect Lake Cochichewick, the town's sole drinking water supply, and has no impact on this flood study. Both the Floodplain District and the Watershed Protection District are overlay districts.

There are no flood-control structures in Peabody. The Spring Pond reservoirs on the upstream end of Tapley Brook are operated for water supply, and not flood-control purposes. The swampy nature of the Ipswich River Basin and some of the smaller streams of Peabody is a natural form of flood protection, since swamps store water and reduce peak flood discharges. The City of Peabody has flood plain zoning laws as a protection against flood hazards. Flood plain districts are designated in the watersheds of the following streams: the Ipswich River, the Norris Brook, the North River, the Proctor Brook, the Goldthwaite Brook, the Tapley Brook, and the Strongwater Brook. The boundaries of the districts are described by elevation or by horizontal distance from the waterway. The construction of new structures, the dumping of trash, the alteration of topography that may increase flood hazards, and the storage of toxic or floatable materials is prohibited in these flood plain districts (Reference 27).

No structural flood protection measures exist within the town of Topsfield. However, as a result of the severe flooding in 1936, most of the culverts were modified or enlarged to handle increased discharge. As a result, flooding decreased significantly during the 1968 and 1987 flood in comparison with the 1936 flood. The Town of Topsfield has zoning measures to control development in wetland areas. These measures regulate development that would cause excessive increases in storm runoff, and impose strict control on public buildings and proposed private development (Reference 28).

There are no structural flood control measures currently located within the town of Wenham. However, as discussed in Section 2.2, the area along the Miles River is zoned as a Flood Plain District by the Town of Wenham. Zoning regulations in this Flood Plain District, with the exception of the area upstream of Longham Reservoir Dam, contain provisions that are more restrictive concerning floodplain development than those required by the NFIP. Longham Reservoir Dam does not provide any flood control for the community; it is utilized as a water supply source only.

There are no flood protection works that have been constructed or that are planned which would significantly affect flood conditions in the Town of Georgetown, Middleton, Saugus, Rowley and Groveland.

3.0 ENGINEERING METHODS

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

3.1 Hydrologic Analyses

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

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

Precountywide Analyses

The l0-, 2-, l-, and 0.2-percent-annual-chance peak discharges for the Porter River Frost Fish Brook, the Crane River, Crane Brook, and Beaver Brook were generated by applying regional equations developed by the USGS (Reference 29). These regional equations relate flows of various return periods to drainage area and main channel slope. The equations were derived by applying multiple regression techniques to the flow data and basin characteristics of 113 gaging stations located in Massachusetts; and in Vermont, New Hampshire, and Rhode Island near the Massachusetts border. The l0-, 2-, l-, and 0.2-percent-annual-chance peak flows at several stations on these 3 streams were calculated from the regional equations. The regional equation discharges were adjusted to account for impervious land surface area resulting from urbanization. This urbanization adjustment was based on runoff characteristics developed by the Soil Conservation Service (Reference 30).

The natural peak discharge frequencies used for the Merrimack River in Amesbury, Andover, Newburyport, Salisbury and West Newbury are from a report entitled Water Resources investigation, Merrimack River Basin, completed by the New England Division USACE in August 1972 (Reference 31,). This report presented a discharge-frequency relationship for the Merrimack River at Lowell, Massachusetts, that was developed using the log-Pearson Type III method in a statistical analysis of the annual peak discharge data recorded at the Lowell USGS gage (Reference32). The period of record for this gage extends from 1923 to the present. The probable river flows computed for Lowell was adjusted to conditions in the region by the addition of runoff from the intervening drainage area. These flows were then adjusted to reflect reductions caused by the operation of the upstream flood control reservoirs. These flows were adjusted by computing the storage of the reservoirs and routing the inflow hydrograph by the Straddle-Stagger method to the Lowell gage (Reference 33). The frequency of the routed discharge was developed by the log-Pearson Type III method (Reference 32).

There are no discharge records for the Powwow River. Originally, peak discharge frequencies for this river were derived using procedures presented in the report entitled, Estimating the Magnitude and Frequency of Floods on Natural Flow Streams in Massachusetts (Reference 29). The resulting flow values were also compared with the statistically analyzed gaged stream records, mentioned above, in the region and were found to be in general agreement.

The hydrologic analyses for the Powwow River for the revised August 3, 1992 Town of Amesbury FIS were taken from the FIS for the Town of South Hampton, New Hampshire (Reference 2). The drainage areas for the Powwow River were taken from a USGS report on hydrologic characteristics of streams in the Merrimack River Basin (Reference 33). The 1-percent-annual-chance discharges for the Powwow River were computed using regression equations published in a 1983 report entitled Estimating Peak Discharges of Small, Rural Streams in Massachusetts (Reference 34). These equations supersede those previously published in the 1977 Amesbury report.

Several steps were taken to compute the discharges for the 10-, 2-, 1-, and 0.2-percent-annual-chance floods for the Shawsheen River in Andover. First, statistical analysis, using a log-Pearson Type III distribution was performed at the USGS gaging station located on the Shawsheen River near Wilmington (gage No. 01100600). Since the Wilmington gage has a limited period of record of only 19 years, comparative analysis was also performed on longer term records in the region. The Ipswich River at South Middleton (gage No. 01101500), having a period of record of 45 years, was selected as being hydrologically similar to the Shawsheen River. A two station statistical comparison was then made between the Wilmington gage and the Ipswich River gage. The developed discharges compared quite closely with those used in the precountywide Andover FIS and, therefore, the existing analysis of the Ipswich River gage was used (Reference 6).

Peak discharges for the Shawsheen River were calculated by multiplying values adopted for the Town of Andover by the ratio of the drainage areas to the 0.75 exponential power (Reference 35).

The Fish Brook discharges were developed by statistical analysis and by empirical regression equations developed for the State of Massachusetts by the USGS (Reference 29). As there are no stream flows gaging stations on Fish Brook, four representative gaging stations throughout the region were used: Boulder Brook at East Bolton; Nashoba Brook at Acton; the Aberjona River at Winchester; and Stony Brook at Temple, New Hampshire. Statistical analyses were performed using a log-Pearson Type III distribution. Discharge frequencies were then transferred from each gage to Fish Brook by ratio of respective drainage areas to the 0.7 exponential power. Additionally, discharge frequencies were derived from the reference USGS empirical regression equations. These equations were applied using physical characteristics of the Fish Brook watershed. It was determined that the discharge frequencies developed by the two methods were comparable and the regression equation results were adopted. Hussey Brook discharge frequency information was developed using the same methodology as Fish Brook. It was determined that discharge frequencies developed by the two methods were comparable and the regression equation results were adopted. Discharge frequency for Hussey Brook Tributary was considered proportional to the adopted discharge frequencies for Hussey Brook by ratio of respective drainage areas.

Since the streams in Beverly are ungaged, the 10-, 2-, and 1-percent-annual-chance discharges were computed based on the Massachusetts flood magnitude and frequency formulas developed by the USGS for Centerville Creek, Chubbs Brook, and North Beverly Drainage Ditch (Reference 29). The study contractor performed a separate evaluation of these formulas and found them to be applicable to non-urban areas in the vicinity of Beverly. The USGS formulas predict discharges based on the parameters of watershed drainage area and main channel slope. The 0.2-percent-annual-chance discharge was determined by extrapolation. To account for the impact of urbanization on the North Beverly drainage area, adjustments were required in computing discharges. Existing methodology was modified to be compatible with Beverly's meterologic and hydrologic parameters (Reference 36).

The streams and rivers in Gloucester are ungaged; therefore, the l0-, 2-, l-, and 0.2-percent-annual-chance discharges for the Mill River were computed based on the Massachusetts flood magnitude and frequency formulas developed by the USGS (Reference 29). Stone & Webster performed a separate evaluation of these formulas and found them to be applicable to the Gloucester region. The USGS formulas predict discharges based on the parameters of watershed drainage area and main channel slope.

Since the Miles River in Ipswich is ungaged, the l0-, 2-, l-, and 0.2-percent-annual-chance discharges were computed based on the Massachusetts flood magnitude and frequency formulas developed by the USGS (Reference 29). The study contractor performed a separate evaluation of these formulas and found them to be applicable to the Ipswich region. The USGS formulas predict discharges based on the parameters of watershed drainage area and main channel slope.

Since the streams in Rowley are ungaged, the l0-, 2-, l-, and 0.2-percent-annual-chance discharges for the Mill River were computed based on the Massachusetts flood magnitude and frequency formulas developed by the USGS (Reference 29). The formulas predict discharges based on the parameters of watershed drainage area and main channel slope. The study contractor performed a separate evaluation of these formulas and found them to be applicable to the Rowley region.

A multiple regression analysis, developed by Johnson and Tasker (Reference 37), was employed to find runoff discharges in Georgetown. Standard USGS topographic quadrangle maps (Reference 38) were used to determine watershed areas and local topography. An annual precipitation value, representative for the region, of 3.67 feet per year was obtained from the U.S. Weather Bureau and used throughout southeastern Massachusetts (Reference 39) by determining values for slope and area and using them in conjunction with the precipitation value in the Johnson-Tasker formulas, values for runoff from 10-, 2-, l-, and 0.2 percent-annual-chance predicted. Exponents for the 0.2-percent-annual-chance storm frequency equation, though not given in the Johnson-Tasker Report, were determined by extrapolating the given values for the l0-, 2-, and 1-percent-annual-chance. Wherever possible, stream gage records were compared to these figures contributing flows from neighboring towns were obtained from other studies when available, or by isolating the associated watershed and applying the Johnson-Tasker regression analysis where no other study has been conducted. After comparison of predicted discharges with past floods, it was found that the Johnson-Tasker method breaks down in regions of flat slope or high storage. To correct these discrepancies, areas of swamp, bog, open water, and urban development were computed and assigned weighting values to account for storage and rapid urban runoff. The adjusted discharge figures more closely reflect the true nature of the basins involved. This method was used for the Town of Groveland as well.

For the Ipswich River in Gloucester, peak discharges for floods of the selected recurrence intervals were determined using a standard log-Pearson Type III analysis (Reference 40). Flow records (1931 through 1984) on the Ipswich River from the USGS gage, Ipswich River near Ipswich, Massachusetts (No. 01102000) were analyzed, and a discharge-frequency curve was developed. These discharges were then transposed using drainage area ratios and regional exponents for eastern Massachusetts. Peak discharges on the Miles River for floods of the selected recurrence intervals were estimated using Massachusetts regional equations developed by the USGS for small, rural watersheds (References 17 and 29).

Peak discharge-frequency relationships for the Ipswich River in Lynnfield and North Andover were taken from the precountywide North Reading FIS (Middlesex County, Massachusetts) (Reference 41). Frequency data were based on statistical analyses of stage-discharge records. Because no hydrologically similar gaged streams are in the area, flood flows for all other streams studied by detailed methods in Lynnfield, including Saugus River, Beaverdam and Bates Brooks, and Pillings Pond, were developed using the U.S. Soil Conservation Service method for estimating volume and rate of runoff in small watersheds (References 42, 43, and 44 in Lynnfield).

In Boxford, Middleton, Topsfield and Wenham, data from two gaging stations on the Ipswich River (USGS gages No. 01101500 at South Middleton, Massachusetts and No. 01102000 near Ipswich Massachusetts) were used to define frequency-discharge relationships on the Ipswich River. The discharges were determined by drainage weighted correlations.

Flow frequencies for the Ipswich River in Ipswich were developed by the USGS from data at the gage located at the Willowdale Dam. These frequencies were based on a statistical analysis of the systematic discharge record of 46 years and a historic record of 92 years. The standard log-Pearson Type III method outlined by Water Resources Council Bulletin No. 17 was followed in the analysis (Reference 32). Once the 10-, 2-, l-, and 0.2-percent-annual-chance discharges were obtained at the gage, the flows downstream of the gage were adjusted by using a formula that relates the flows between two basins as a function of the drainage areas (Reference 45). Since the Miles River in Ipswich is ungaged, the l0-, 2-, l-, and 0.2-percent-annaul-chance discharges were computed based on the Massachusetts flood magnitude and frequency formulas developed by the USGS (Reference 29). The study contractor performed a separate evaluation of these formulas and found them to be applicable to the Ipswich region. The USGS formulas predict discharges based on the parameters of watershed drainage area and main channel slope.

Peak discharge-frequency relationships for the Little River and Haverhill-Riverside Airport Brook were derived using procedures described by the USGS in Estimating the Magnitude and Frequency of Floods for Natural-Flow Streams (Reference 29). The technique was developed using multiple regression analyses to estimate flood peaks on ungaged, natural-flow streams in Massachusetts by relating peak discharges to basin and climatic parameters. The resulting peak discharges were verified using statistically analyzed data from nearby stream gages with similar watershed characteristics using a multiplication factor equal to the ratio of the drainage areas to the 0.75 exponential power. They were found to be in general agreement. The derivation of peak discharge-frequency relationships for Creek Brook and Millvale Reservoir Brook used the previously referenced USGS method in conjunction with a numerical integration reservoir routing of triangular inflow hydrographs (References 46 and 47). The routing process was incorporated to take into account the effects of storage in Crystal Lake and Millvale Reservoir upstream of Creek Brook and Millvale Reservoir Brook, respectively.

For the Spicket River, flows of selected recurrence intervals were developed utilizing a drainage area-peak discharge relationship in conjunction with corresponding peak discharges from the precountywide FIS for the Town of Methuen (Reference 48). The discharges were further refined by applying an adjustment for impervious land area in consideration of extensive urbanization over the lower reaches of the stream (Reference 49).

The Saugus River watershed is a complex hydrologic system. It contains three major storage areas: Lake Quannapowitt, a large swampy area in Reading; the swamp by the Wakefield Industrial Park; and two major tributary streams (the Reading Drainage Canal and Beaverdam Brook).

Because the culvert at Chestnut Street in Lynnfield acts as a control structure on Beaverdam Brook during periods of high flow, flood flows are reduced by routing through the swampy area upstream of Chestnut Street (Reference 50).

Runoff and flows tributary to Lake Quannapowitt were calculated by methods developed by the U.S. Soil Conservation Service and then routed through the lake (Reference 50). Because of the lake's storage capacity, flood flows could be significantly reduced. The out-flow hydrograph for Lake Quannapowitt developed for the l0-, 2-, 1-and 0.2-percent-annaual-chance recurrence intervals were hydrologically combined with flood flows developed for the Reading Drainage Canal. These flows were routed and again hydrologically combined with flows developed for Beaverdam Brook and the Pillings Pond outflow. Flows through the swamp by the Wakefield Industrial Park were then reduced (Reference 50) to take into account the effect of storage provided by the swamp and to obtain outflows over the Saugus River Dam (City of Lynn Diversion Works). Flows over the dam were then combined with flows developed from the incremental drainage areas below the dam to obtain flood flows on the Saugus River between the Town of Lynnfield's corporate limits and the Saugus River Dam.

The Pillings Pond basin complex is able to significantly reduce flood flows leaving the pond. Flood flows were calculated for Bates Brook from methods developed by the U.S. Soil Conservation Service (References 42, 43, and 44). The box culvert under the Boston and Maine Railroad embankment, which Bates Brook crosses, acts as a control structure during flood flows with the railroad embankment acting as a dike. This causes the swampy area on the upstream side of the railroad embankment to pond and store excess incoming flows not able to immediately pass through the box culvert. Flows were routed (Reference 50) through this storage area with the reduced flows allowed to enter Pillings Pond. These flows were then routed through the pond in combination with runoff tributary to Pillings Pond, to arrive at expected flood elevations for the pond.

There are no discharge records available for Tributary to Neal Pond. Peak discharge-frequency relationships were derived using procedures described in the USGS publication, Estimating the Magnitude and Frequency of Floods on Natural Flow Streams in Massachusetts (Reference 29). The technique was developed using multiple-regression analyses to estimate flood peaks on ungaged, natural-flow streams in Massachusetts by relating the peak discharge to basin and climatic parameters. The resulting peak discharges were verified with statistically analyzed data from nearby stream gages with similar watershed characteristics.

There are no discharge records for Bare Meadow Brook, Bartlett Brook, Harris Brook, Hawkes Brook, or Peat Meadow Brook. Peak discharge-frequencies for Bare Meadow Brook, Bartlett Brook, Harris Brook, and Peat Meadow Brook were derived by using procedures developed by the USGS (Reference 29). Resulting flows were also compared with statistically-analyzed stream records from the USGS gage at Lowell on the Merrimack River with 55 years of record (Reference 51). They were found to be in general agreement. Discharge-frequencies for Hawkes Brook, a tributary of Bare Meadow Brook, were developed by multiplying the adopted discharges for Bare Meadow Brook by a factor equal to the ratio of the drainage areas raised exponentially to the 0.7 power.

For Emerson Brook and Boston Brook, peak discharges were obtained using the regional equation for Massachusetts developed by the USGS (Reference 29). The regional equation relates stream flow to the parameters of drainage area and main channel slope. Peak discharges for Tributary A to the Ipswich River were calculated by routing peak flows through Middleton Pond using the reservoir routing and hydrograph methods developed by the Soil Conservation Service (SCS) (Reference 30). The storage effects of Middleton Pond are thus accounted for in the flow values of Tributary A.

Flow frequency for the Parker River in Newbury was based on a statistical analysis of USGS gage data. These data were analyzed in accordance with criteria outlined by the Water Resources Council (Reference 32). Frequency discharge data were based on a USGS computer model. The model was run on November 20, 1978, using a systematic record of 32 years and a generalized skew coefficient. The study contractor reviewed the input and assumption of the analysis and used it for this study. The discharges are based on Water Resources Council adjusted values. For the ungaged portion of the Parker River, short distances upstream and downstream of the gage were adjusted by means of proportional drainage basins as outlined by Chow (Reference 45).

Peak discharges for Parker River in Boxford were estimated using Massachusetts regional equations developed by the USGS for small rural watersheds (References 32 and 34).

Discharges for the Mill River were obtained from the precountywide FIS for the Town of Rowley (Reference 52).

Peak discharge-frequency relationships for Cochichewick Brook were determined using a method developed by the USGS (Reference 29). The method was developed using multiple-regression analyses to estimate flood peaks on ungaged natural-flow streams in Massachusetts by relating peak discharges to basin and climatic parameters. The resulting peak discharges were verified with statistically analyzed data from nearby stream gages having similar watershed characteristics by using a multiplication factor. The reservoir routing of a triangular inflow hydrograph was used to evaluate the effects of storage in Lake Cochichewick (References 46 and 47). The results of the analysis indicated no outflow due to regulation and available storage. The peak discharges for Boston and Mosquito Brooks for the l0-, 2-, l-, and 0.2-percent-annual-chance floods were estimated using Massachusetts regional equations developed by the USGS for small rural watersheds (References 34 and 53).

The l0-, 2-, l-, and 0.2-percent-annual-chance peak flows for Proctor Brook, the North River, Goldthwaite Brook and Strongwater Brook were generated by applying regional equations developed by the USGS (Reference 29). These regional equations relate flows of various turn periods to drainage area and main channel slope. The equations were derived by applying multiple regression techniques to the flow data and basin characteristics of 113 gaging stations located both in Massachusetts and in Vermont, New Hampshire and Rhode Island near the Massachusetts border. The l0-, 2-, l-, and 0.2-percent-annual-chance peak flows at several stations on these three streams were calculated from the regional equations. The regional equation flows were adjusted to account for impervious land surface area resulting from urbanization.

In determining peak discharges on Tapley Brook, hydrologic reservoir routings were performed on Browns Pond and on the upper and lower parts of Spring Pond (Reference 47). Browns Pond drains into Tapley Brook downstream of Spring Pond. The routing of Browns Pond revealed that peak flows were in significant to flooding on Tapley Brook. The l0-, 2-, l-, and 0.2-percent-annual-chance peak discharges used for Tapley Brook were determined by adding the peak discharges that resulted from the Spring Pond routing to peak discharges determined by applying the regional equation to the area draining directly in to Tapley Brook downstream of Spring Pond (Reference 29). It was determined that these two independent sets of discharges would reach the mouth of Tapley Brook at approximately the same time.

To account for the impact of urbanization on the drainage basins of the area, adjustments were required in computing discharges in Saugus for the Saugus River, Shute Brook, Bennett's Pond Brook, and Fiske Brook. Existing methodology in USGS Water Resources Investigation 23-74 was modified to be compatible with meteorologic and hydrologic parameters for Saugus (Reference 36). This methodology was implemented for the flooding sources in Saugus. Above the most downstream point, of the area along which the Saugus River forms the border between Saugus and Wakefield, the flows used in this study were taken from the FIS for the Town of Wakefield (Reference 54). In the Wakefield study, determination of flows on the Saugus River was performed using a different method than that employed for this study. When an attempt was made to match flows determined at the Saugus town boundary using both methods, it was found that the methods produced flows which were not in agreement at this common point. Return period flows above the Hamilton Street Bridge in Saugus were determined using the Massachusetts flood magnitude and frequency formulas (Reference 29). The flows above the town boundary were obtained from the Wakefield study (Reference 54). Between the Hamilton Street bridge and the Saugus town boundary, return period flows were determined at the U.S. Route 1 culvert. These flows were computed using a direct proportion, based on drainage basin size, of the flows between Hamilton Street and the Saugus town boundary. The drainage basin, area above U.S. Route 1 is slightly less than halfway between the area at the Saugus town boundary and Hamilton Street. Thus, each return period flow at the U.S. Route 1 culvert is slightly less than halfway between the flow at the to boundary and the flow at Hamilton Street. This method of interpolation provided a reasonable means of tying together flows computed using the two different methods.

In the original 1979 study for Topsfield, the peak discharge-frequency relationships for Howlett Brook and Mile Brook depended on the hydraulics of the immediate and downstream areas. For this reason, the peak discharge frequency relationship was determined using the USACE HEC-2 step-backwater computer program (References 55 and 56). The computer program uses the geometries and relative elevations of significant features of the waterway to predict the water-surface elevation (as well as other properties). The total flow for the Howlett-Pye-Mile Basin, as determined by the regression equations at each flood frequency, was divided between Howlett Brook and Mill Brook at various ratios and used in the computer program to predict the water-surface elevations at the origin of the two streams. The ratio of the flow split at which the elevations matched was then considered to be the appropriate flow assignment for the two brooks at that flood frequency (Reference 45).

In the precountywide June 1994 Topsfield revision, the peak discharge-frequency relationships for Howlett, Pye, and Mile Brooks were calculated using the Massachusetts regional regression equations, assuming no diversion from Howlett Brook to Mile Brook (Reference 53). The quantity of flow diverted from Howlett Brook to Mile Brook is controlled by the North Street culvert at Mile Brook. The capacity of the North Street culvert is affected by tailwater created by a dam located approximately 1,000 feet east of North Street. The diversion of flow from Howlett Brook to Mile Brook was assumed to occur with the pond at peak stage. The pond's peak stages for the various frequency floods were computed using the procedures outlined by the USACE (Reference 57). The flow rates diverted to Mile Brook for the various frequency floods were determined by trial and error.

In the June 17, 1991 Topsfield revision, peak discharge-frequency relationships for the 10-, 2-, and 1-percent-annual-chance floods for Pye Brook, Cleveland Brook, School Brook, and Fish Brook were developed using Massachusetts regional regression equations developed by the USGS for small rural streams. In this revision, for Cleveland Brook, School Brook, Fish Brook, and Unnamed Tributary to Fish Brook, peak discharge-frequency relationships of the selected recurrence intervals, excluding the 0.2-percent-annual-chance flood, were developed using Massachusetts regional regression equations developed by the USGS for small rural streams (References 32 and 53). These relationships were then modified, where appropriate, to reflect urbanization within the basin. This adjustment was performed using regional regression equations developed by the Soil Conservation Commission (Reference 34). The 0.2-percent-annual-chance discharges were determined by a straight-line extrapolation of the l0-, 2-, and 1-percent-annual-chance discharges.

Peak discharges of the selected recurrence intervals for the Miles River including Longham Reservoir were estimated using Massachusetts regional equations developed by the USGS for small rural watersheds (References 34 and 53).

Because no hydrologically similar gaged streams are in the area, flood flows for North Tributary Brook and Beaver Brook were developed using the Soil Conservation Service (SCS) method for estimating volume and rate of runoff in small watersheds. This method was developed using both land use and ground slope. Peak discharges for the approximate study streams were established using the above-mentioned SCS method (References 43, 58, and 59). Flood flows were routed (graphical method) through the upper Artichoke Reservoir to determine the peak discharges and maximum water-surface elevation to be expected (Reference 60).

Countywide Analyses

For this countywide revision, no new riverine Hydrologic Analyses were conducted.

Peak discharges for the 10-, 2-, 1-, and 0.2-percent-annual-chance floods of each flooding source studied in detail in Essex County are shown in Table 6.

TABLE 6 – SUMMARY OF DISCHARGES

PEAK DISCHARGES (CUBIC FEET SECOND)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQUARE MILES)	10-PERCENT ANNUAL CHANCE	2-PERCENT ANNUAL CHANCE	1-PERCENT ANNUAL CHANCE	0.2-PERCENT ANNUAL CHANCE
ARGILLA BROOK					
At Main Street in Groveland	1.7	212	290	342	616
At Cross Section B in Groveland	1.4	193	262	300	565
At Center Street in Groveland	0.9	174	233	277	51
BATES BROOK					
Upstream of Private Driveway in Lynnfield	0.7	125	230	275	345
Upstream of Confluence with Pillings Pond in Lynnfield	1.1	50	112	120	132
BEAVERDAM BROOK					
At Chesterbrook Street	1.2	80	100	105	112
At Main Street	1.5	80	100	105	112
BEAVER BROOK					
Middle Street in West Newbury	1.58	65	125	150	170
Confluence with Beaver Brook Tributary	0.72	25	55	70	80
At mouth in Danvers	2.2	170	270	320	470
At Maple Street in Danvers	1.7	150	240	290	430
At Cross Section K in Danvers	1.3	140	220	260	390
BARLETT BROOK					
Adjacent to cemetery in Methuen	6.3	310	520	630	970

TABLE 6 – SUMMARY OF DISCHARGES – cont'd

PEAK DISCHARGES (CUBIC FEET SECOND)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQUARE MILES)	10-PERCENT ANNUAL CHANCE	2-PERCENT ANNUAL CHANCE	1-PERCENT ANNUAL CHANCE	0.2-PERCENT ANNUAL CHANCE
BARE MEADOW BROOK					
At confluence with Merrimack River In Methuen	7.7	350	580	710	1,090
At confluence with Hawkes Brook In Methuen	2.7	180	320	400	620
450 ft. downstream of Oak Street In Methuen	1.1	110	190	230	370
Hill Pond In Methuen	0.2	34	61	80	123
BENNETTS POND BROOK					
At the confluence with the Saugus River	3.32	374	539	618	828
BOSTON BROOK					
At confluence with Ipswich River in Middleton	10.4	450	740	910	1,390
At Liberty River in Middleton	8.5	360	600	730	1,120
Downstream of Creighton Pond Tributary in Middleton	7.3	330	560	680	1,040
At downstream North Andover limits	5.7	230	365	435	580
At confluence of unnamed Tributary downstream of Footpath in North Andover	4.9	205	330	395	530
At confluence of unnamed Tributary upstream of Hawkins Lane in North Andover	4.2	185	300	355	490

TABLE 6 – SUMMARY OF DISCHARGES – cont'd

PEAK DISCHARGES (CUBIC FEET SECOND)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQUARE MILES)	10-PERCENT ANNUAL CHANCE	2-PERCENT ANNUAL CHANCE	1-PERCENT ANNUAL CHANCE	0.2-PERCENT ANNUAL CHANCE
BULFORD BROOK					
West Main Street in Georgetown	0.49	5	7	9	14
Cross Section B in Georgetown	0.35	4	6	8	13
Cross Section C in Georgetown	0.23	4	6	8	12
CRANE BROOK					
At Cross Section I in Danvers	2.9	190	300	350	500
Boston and Maine Railroad near Pine Street in Danvers	2.6	170	260	310	450
At Collins Street in Danvers	2.1	140	220	260	390
At Cross Section N in Danvers	1.6	110	180	210	310
At Andover Street in Danvers	1.3	90	140	170	250
Boston and Maine Railroad near Andover Street in Danvers	1.1	80	130	150	230
CRANE RIVER					
At mouth in Danvers	5.7	360	530	620	880
CREEK BROOK					
At confluence with Merrimack River in Haverhill	4.0	250	430	530	820
At Broadway Street in Haverhill	1.4	120	220	260	410

TABLE 6 – SUMMARY OF DISCHARGES – cont'd

PEAK DISCHARGES (CUBIC FEET SECOND)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQUARE MILES)	10-PERCENT ANNUAL CHANCE	2-PERCENT ANNUAL CHANCE	1-PERCENT ANNUAL CHANCE	0.2-PERCENT ANNUAL CHANCE
CHUBBS BROOK					
At its confluence with Chubb Creek in Beverly	1.36	80	135	166	259
CENTERVILLE CREEK					
At its confluence with Massachusetts Bay in Beverly	1.74	96	163	199	310
COCHICHEWICK BROOK					
At the confluence with the Merrimack River	2.2	150	250	310	480
CLEVELAND BROOK					
At its confluence with School Brook in Topsfield	0.4	70	110	130	170
EMERSON BROOK					
At confluence with Ipswich River in Middleton	5.8	230	390	470	720
FISH BROOK					
At confluence with Merrimack River	5.9	265	450	545	840
At confluence with the Ipswich River	17.8	480	760	900	1,190
Approximately 160 feet downstream of I-95 crossing in Boxford	15.8	450	700	830	1,065
At Towne Road crossing in Boxford	9.6	300	510	600	790
At its confluence with the Ipswich River	17.8	480	760	900	1,190

TABLE 6 – SUMMARY OF DISCHARGES – cont'd

PEAK DISCHARGES (CUBIC FEET SECOND)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQUARE MILES)	10-PERCENT ANNUAL CHANCE	2-PERCENT ANNUAL CHANCE	1-PERCENT ANNUAL CHANCE	0.2-PERCENT ANNUAL CHANCE
FISKE BROOK					
At the confluence with Shute Brook in Saugus	1.12	157	237	278	391
FROST FISH BROOK					
At Conant Street in Danvers	3.0	200	310	380	560
At Coolidge Road in Danvers	2.5	170	270	330	490
At Middleton-Topsfield Boxford corporate limits	76.1	1,077	1,584	1,829	2,478
Downstream of Boston Brook	71.9	1,023	1,506	1,741	2,366
Downstream of Tributary A to Ipswich River	53.8	790	1,173	1,362	1,872
At Middleton-North Reading corporate limits	42.5	630	930	1,130	1,620
GOLDWAITE BROOK					
At confluence with Proctor Brook in Peabody	4.93	350	530	630	910
Downstream of Allens Lane in Peabody	4.53	310	490	580	840
Downstream of Boston and Maine Railroad crossing in Peabody	3.90	260	410	480	710
1,750 feet downstream of Summit Street in Peabody	2.56	190	300	350	520
180 feet upstream of Summit Street in Peabody	2.17	150	230	270	400
Upstream of granite slab Bridge in Peabody	1.93	130	200	240	350
Upstream of pond above Corvin Street in Peabody	1.69	110	170	210	310
Downstream of First Avenue in Peabody	1.34	73	110	140	200

TABLE 6 – SUMMARY OF DISCHARGES – cont'd

PEAK DISCHARGES (CUBIC FEET SECOND)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQUARE MILES)	10-PERCENT ANNUAL CHANCE	2-PERCENT ANNUAL CHANCE	1-PERCENT ANNUAL CHANCE	0.2-PERCENT ANNUAL CHANCE
HARRIS BROOK					
At its confluence with Spicket River in Methuen	4.8	200	330	400	600
At Pelham Street in Methuen	2.9	140	230	280	420
HAWKER BROOK					
At confluence with Bare Meadow Brook in Methuen	4.2	210	360	440	690
3,750 feet upstream of Confluence with Bare Meadow Brook in Methuen	3.9	160	280	340	520
At Washington Street in Methuen	3.3	150	250	300	280
400 feet upstream of Maple Street in Methuen	1.3	90	150	180	280
HAVERHILL-RIVERSIDE AIRPORT BROOK					
At confluence with Merrimack River in Haverhill	0.7	50	90	120	180
HOWETT BROOK					
At the confluence Of the Ipswich River in Topsfield	8.70	275	450	535	730
At the confluence with Unnamed Tributary Upstream of East Street in Topsfield	7.04	235	380	465	630

TABLE 6 – SUMMARY OF DISCHARGES – cont'd

PEAK DISCHARGES (CUBIC FEET SECOND)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQUARE MILES)	10-PERCENT ANNUAL CHANCE	2-PERCENT ANNUAL CHANCE	1-PERCENT ANNUAL CHANCE	0.2-PERCENT ANNUAL CHANCE
HUSSEY BROOK					
At confluence with Shawsheen River	2.1	130	225	280	435
HUSSEY BROOK TRIBUTARY					
At confluence with Hussey Brook	0.8	50	90	110	170
IPSWITCH RIVER					
At corporate limits in Boxford	76.1	1,077	1,584	1,829	2,478
Middleton-Danvers corporate limits south of State Route 114 in Danvers	50.9	750	1,120	1,300	1,790
Downstream of Norris Brook in Danvers	48.2	720	1,070	1,240	1,710
At Peabody-Danvers Middleton corporate limits	44.6	630	930	1,130	1,620
At corporate limits in Topsfield	120.9	1,880	2,700	3,070	3,980
At confluence of Branch of Ipswich	92.6	1,360	2,080	2,440	3,430
At confluence with Mile Brook	109.3	1,755	2,520	2,860	3,725
At Central Street in Ipswich	148	2,023	3,016	3,251	4,196
At Middleton-Topsfield Boxford corporate limits in Middleton	76.1	1,077	1,584	1,829	2,478
Downstream of Boston Brook in Middleton	71.9	1,023	1,506	1,741	2,366
Downstream of Tributary A to Ipswich River	53.8	790	1,173	1,362	1,872
At Middleton-North Reading Corporate limits	42.5	630	930	1,130	1,620

TABLE 6 – SUMMARY OF DISCHARGES – cont'd

PEAK DISCHARGES (CUBIC FEET SECOND)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQUARE MILES)	10-PERCENT ANNUAL CHANCE	2-PERCENT ANNUAL CHANCE	1-PERCENT ANNUAL CHANCE	0.2-PERCENT ANNUAL CHANCE
JACKMAN BROOK					
Georgetown-Newbury Corporate Limits (Parish Road) In Georgetown	1.38	24	39	47	72
Jackman Street In Georgetown	0.66	12	19	22	34
Cross Section C In Georgetown	0.45	8	13	15	24
Jewett Street In Georgetown	0.24	4	7	8	13
JOHNSON CREEK					
At Cross Section A In Groveland	6.0	511	731	877	1623
At Main Street In Groveland	4.3	225	350	410	720
At Gravel Road Over Dam In Groveland	3.0	200	320	385	650
At Center Street In Groveland	2.9	190	308	362	603
At Cross Section E In Groveland	2.2	164	270	315	525
At Salem Street In Groveland	2.1	148	233	270	442
At Uptrack Road In Groveland	1.7	110	170	200	310
At Washington Street In Groveland	1.5	98	145	164	252
LITTLE RIVER					
At Winter Street in the Town of Haverhill	37.0	1,160	1,920	2,330	3,520
Upstream of I-95 in the Town of Haverhill	27.7	980	1,640	1,990	3,030
Downstream of Haverhill/ Plaistow corporate limits	20.8	660	1,065	1,275	1,865

TABLE 6 – SUMMARY OF DISCHARGES – cont'd

PEAK DISCHARGES (CUBIC FEET SECOND)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQUARE MILES)	10-PERCENT ANNUAL CHANCE	2-PERCENT ANNUAL CHANCE	1-PERCENT ANNUAL CHANCE	0.2-PERCENT ANNUAL CHANCE
NORTH BEVERLY DRAINAGE DITCH					
Upstream of Boston and Maine Railroad embankment in Beverly	1.16	174	253	290	393
NORTH RIVER					
At Salem corporate Limits in Peabody	9.96	640	990	1,140	1,620
Upstream of Strongwater Brook in Peabody	8.86	580	880	1,030	1,470
NORTH TRIBUTARY BROOK					
At Pikes Bridge Road in West Newbury	1.35	70	125	150	170
MERRIMACK RIVER					
At Amesbury	5,010	61,000	92,100	115,100	172,100
At Andover-Lawrence corporate limits	4,670	58,000	90,000	111,000	156,000
At Andover-Tewksbury corporate limits	4.644	58,000	90,000	111,000	156,000
At Bates Bridge in Groveland	*	*	*	*	*
At Downstream corporate limits in Haverhill	4,980	61,100	92,100	115,100	172,100
At downstream corporate limits in Lawrence	4,980	61,100	92,100	115,100	172,000
At USGS gage No. 1005 in Lawrence	4,672	58,000	90,000	111,000	156,000
At Haverhill/Methuen/ North Andover corporate limits	4,980	61,100	92,100	115,100	172,100
At Andover/Lawrence/ Methuen corporate limits	4,672	58,000	90,000	111,000	156,000

* Data not computed

TABLE 6 – SUMMARY OF DISCHARGES – cont'd

PEAK DISCHARGES (CUBIC FEET SECOND)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQUARE MILES)	10-PERCENT ANNUAL CHANCE	2-PERCENT ANNUAL CHANCE	1-PERCENT ANNUAL CHANCE	0.2-PERCENT ANNUAL CHANCE
MERRIMACK RIVER – cont'd					
At the Downstream Corporate limits of Merrimac	4,980	61,000	92,100	115,100	172,100
At the mouth in Newburyport	4,980	61,100	92,100	115,100	172,000
At the downstream North Andover limits	4,980	61,100	92,100	115,100	172,100
At Salisbury-Amesbury-Newburyport corporate limits	5,010	61,000	92,000	115,000	172,100
At the Mouth in West Newbury	4,980	61,100	92,100	115,100	172,100
MILL RIVER					
At tide gate under Washington Street In Gloucester	2.27	139	238	292	455
Adjacent to inter-Section of Poplar Street and York Road In Gloucester	1.59	107	182	224	351
At U.S Route 1 In Newbury	13.6	415	685	831	1,261
At U.S Route 1 In Rowley	13.6	415	685	831	1,261
MILE BROOK					
At U.S Route 1 in Topsfield	0.24	52	70	81	108
At dam approximately 1,000 feet downstream of North Street in Topsfield	0.16	42	60	71	88

TABLE 6 – SUMMARY OF DISCHARGES – cont'd

PEAK DISCHARGES (CUBIC FEET SECOND)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQUARE MILES)	10-PERCENT ANNUAL CHANCE	2-PERCENT ANNUAL CHANCE	1-PERCENT ANNUAL CHANCE	0.2-PERCENT ANNUAL CHANCE
MILES RIVER					
At downstream corporate limits in Hamilton	12.7	385	610	725	1,150
At its confluence with the Ipswich River	16	359	584	706	1,061
At downstream corporate limits in Wenham	8.6	298	472	563	900
At confluence of Unnamed Tributary above Wenham Lake	7.5	272	434	518	820
At Longham Reservoir Dam in Wenham	6.8	255	407	486	769
MILLVALE RESERVOIR BROOK					
At confluence with Merrimack River in Haverhill	8.6	240	400	490	790
At Millvale Road in Haverhill	6.7	160	270	350	620
MOSQUITO BROOK					
At downstream limits in North Andover	9.4	295	500	590	780
At confluence of Unnamed Tributary Downstream of Boxford Stream in North Andover	7.5	275	435	520	700
At confluence of unnamed Tributary upstream of Boxford Street in North Andover	5.1	210	340	405	540
At confluence of tributary from Stiles Pond in North Andover	3.1	155	245	295	400
Just upstream of cross section G in North Andover	2.6	135	220	265	350

TABLE 6 – SUMMARY OF DISCHARGES – cont'd

PEAK DISCHARGES (CUBIC FEET SECOND)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQUARE MILES)	10-PERCENT ANNUAL CHANCE	2-PERCENT ANNUAL CHANCE	1-PERCENT ANNUAL CHANCE	0.2-PERCENT ANNUAL CHANCE
MOSQUITO BROOK – cont'd					
At confluence of unnamed Tributary downstream of Salem Street in North Andover	1.4	95	150	180	245
At confluence of unnamed Tributary downstream of Abandoned dam in North Andover	0.8	60	100	120	165
NORTH BEVERLY DRAINAGE DITCH					
Upstream of Boston and Maine Railroad Embankment	1.16	174	253	290	393
PARKERS RIVER					
At downstream corporate limits in Boxford	3.6	170	270	325	460
Upstream of Willow Road crossing in Boxford	2.7	140	225	271	460
Approximately 640 feet Downstream of Main Street Crossing in Boxford	2.1	125	190	230	305
Georgetown-Groveland corporate Limits	11.24	198	317	382	585
Thurlow Street in Georgetown	10.80	190	305	368	562
Railroad Track Bed in Georgetown	9.94	175	280	338	517
Cross Section D in Georgetown	9.92	170	270	310	485

TABLE 6 – SUMMARY OF DISCHARGES – cont'd

PEAK DISCHARGES (CUBIC FEET SECOND)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQUARE MILES)	10-PERCENT ANNUAL CHANCE	2-PERCENT ANNUAL CHANCE	1-PERCENT ANNUAL CHANCE	0.2-PERCENT ANNUAL CHANCE
PARKERS RIVER – cont'd					
Mill Street in Georgetown	9.83	155	245	285	450
Railroad Track Bed in Georgetown	6.73	120	200	255	395
Pond Street in Georgetown	6.59	116	186	224	343
Cross Section H in Georgetown	6.04	110	175	215	330
Railroad Track Bed in Georgetown	5.90	105	170	208	310
West Main Street in Georgetown	5.81	102	164	198	302
Bailey Lane in Georgetown	5.12	95	150	180	285
Cross Section L in Georgetown	4.90	90	150	180	285
Cross Section M in Georgetown	4.71	83	133	160	245
At central Street in Newbury	24.2	393	605	714	1,019
Approximately 1,150 feet downstream of Larkin Street in Newbury	21.6	359	552	652	930
PEAT MEADOW BROOK					
At confluence with Spicket River in Methuen	2.0	100	160	200	310
At Interstate Route 93 in Methuen	1.5	80	140	170	270
At Forest Street in Methuen	0.2	20	30	40	70

TABLE 6 – SUMMARY OF DISCHARGES – cont'd

PEAK DISCHARGES (CUBIC FEET SECOND)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQUARE MILES)	10-PERCENT ANNUAL CHANCE	2-PERCENT ANNUAL CHANCE	1-PERCENT ANNUAL CHANCE	0.2-PERCENT ANNUAL CHANCE
PENN BROOK					
North Street in Georgetown	3.10	55	87	105	161
Summer Street in Georgetown	2.96	52	83	101	154
Road to High School in Georgetown	2.84	50	80	97	148
Penn Brook Avenue in Georgetown	2.74	47	76	92	141
East Main Street in Georgetown	2.20	43	70	85	130
Cross Section F in Georgetown	2.04	41	66	80	122
Cross Section G in Georgetown	1.87	37	57	71	109
East Street in Georgetown	1.64	33	50	62	95
State Highway 97 in Georgetown	1.31	28	43	53	81
Railroad Track Bed in Georgetown	1.28	23	36	44	67
PORTER RIVER					
At mouth in Danvers	12.5	720	1,070	1,240	1,750
Upstream of Waters River in Danvers	10.3	600	900	1,050	1,490
Upstream of Crane River in Danvers	4.4	260	410	490	720
At U.S Route 128 in Danvers	3.5	220	350	420	620
At confluence with Mile Brook	109.3	1,755	2,520	2,860	3,725
At Central Street	148	2,023	3,016	3,251	4,196

TABLE 6 – SUMMARY OF DISCHARGES – cont'd

PEAK DISCHARGES (CUBIC FEET SECOND)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQUARE MILES)	10-PERCENT ANNUAL CHANCE	2-PERCENT ANNUAL CHANCE	1-PERCENT ANNUAL CHANCE	0.2-PERCENT ANNUAL CHANCE
POWWOW RIVER					
At Lake Gardner Dam in Amesbury	49.1	*	*	1,720	*
At Tuxbury Pond Dam in Amesbury	45.9	*	*	1,640	*
PROCTOR BROOK					
Upstream of Goldwaite Brook in Peabody	3.52	240	360	420	610
Upstream of State Route 128 in Peabody	2.52	170	260	310	450
Upstream of Downing Road in Peabody	2.10	150	240	280	420
150 feet upstream of downing Road in Peabody	1.48	140	220	260	380
Downstream of Albert Road in Peabody	1.22	130	200	230	340
PYE BROOK					
At divergence into Howlett and Mile Brooks in Topsfield	6.14	240	380	455	615
SAUGUS RIVER					
Above Confluence With Reading Drainage Canal in Lynnfield	1.8	35	50	57	65
At State Route 128 Upstream Crossing (Main Street, Lynnfield)	5.4	190	310	330	395

*Data not computed

TABLE 6 – SUMMARY OF DISCHARGES – cont'd

PEAK DISCHARGES (CUBIC FEET SECOND)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQUARE MILES)	10-PERCENT ANNUAL CHANCE	2-PERCENT ANNUAL CHANCE	1-PERCENT ANNUAL CHANCE	0.2-PERCENT ANNUAL CHANCE
SAUGUS RIVER – cont'd					
Above Confluence with Unnamed Stream from Montrose Avenue (Wakefield)	11.3	115	185	215	340
At Hamilton Street Bridge in Saugus	22.6	564	923	1,118	1,683
At the U.S Route 1 Culvert in Saugus	18.6	432	715	846	1,187
At a point approximately 1,250 feet downstream of the Water Street culvert	15.7	340	570	655	840
At the Water Street culvert in Saugus	12.1	230	380	435	595
At the Montrose Avenue culvert in Saugus	11.3	115	185	215	340
SCHOOL BROOK					
At its confluence with Cleveland Brook	0.4	70	110	130	170
SHAWSHEEN RIVER					
At Andover-Lawrence corporate limits	70.5	1,450	2,170	2,525	3,550
At Andover-Tewksbury corporate limits	58.5	1,325	1,980	2,300	3,240
At confluence with Merrimack River in Lawrence	73.7	1,550	2,300	2,700	3,700
Downstream of Salem Turnpike in Lawrence	71.0	1,500	2,250	2,600	3,600
At the confluence with the Merrimack River	73.7	1,500	2,300	2,700	3,700
At upstream North Andover limits	70.7	1,500	2,250	2,600	3,600

TABLE 6 – SUMMARY OF DISCHARGES – cont'd

PEAK DISCHARGES (CUBIC FEET SECOND)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQUARE MILES)	10-PERCENT ANNUAL CHANCE	2-PERCENT ANNUAL CHANCE	1-PERCENT ANNUAL CHANCE	0.2-PERCENT ANNUAL CHANCE
SHUTE BROOK					
At the confluence with the Saugus River	3.22	470	664	757	1,000
STRONGWATER BROOK					
At confluence with Proctor Brook	1.08	77	120	140	210
SPICKET RIVER					
At confluence with Merrimack River in Lawrence	74.5	1,200	1,950	2,400	3,550
At Spruce Street in Lawrence	72.0	1,100	1,800	2,200	3,300
At Methuen Dam in Methuen	73.8	1,100	1,800	2,200	3,300
Below Harris Brook in Methuen	67.6	1,000	1,700	2,000	2,900
At the Massachusetts New Hampshire state line in Methuen	61.6	900	1,600	1,900	2,900
TAPLEY BROOK					
At confluence with Goldwaite Brook	1.34	81	1.35	165	250
TRIBUTARY TO NEAL POND					
At Birch Meadow Road No.2 in Merrimac	0.8	80	140	170	250
TRIBUTARY A TO IPSWICH RIVER					
At confluence with Ipswich River	2.0	76	143	175	236
At downstream end of Middleton Pond	1.6	41	85	111	170

TABLE 6 – SUMMARY OF DISCHARGES – cont'd

PEAK DISCHARGES (CUBIC FEET SECOND)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQUARE MILES)	10-PERCENT ANNUAL CHANCE	2-PERCENT ANNUAL CHANCE	1-PERCENT ANNUAL CHANCE	0.2-PERCENT ANNUAL CHANCE
UNNAMED TRIBUTARY TO FISH BROOK					
At confluence with Fish Brook	0.33	*	*	70	*
At Boxfield Road in Topsfield	0.25	*	*	29	*
At corporate limits in Topsfield	0.16	*	*	59	*
North Tributary Brook At Pikes Bridge Road	1.35	70	125	150	170
UPPER ARTICHOKE RESERVOIR					
At upper Artichoke Reservoir Dam in West Newbury	5.6	80	180	240	290

*Data not computed

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals. Users should be aware that flood elevations shown on the FIRM [Flood Insurance Rate Map (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. Flood elevations shown on the FIRM are primarily intended for flood insurance rating purposes. For construction and/or floodplain management purposes, users are cautioned to use the flood elevation data presented in this FIS in conjunction with the data shown on the FIRM.

All bridges, dams and culverts were field surveyed to obtain elevation data and structural geometry. Cross section data for the below-water sections were obtained from field surveys and topographic maps compiled by photogrammetric methods. Cross sections were located at close intervals above and below bridges, culverts, and dams in order to compute the significant backwater effects of these structures. In addition, cross sections were taken between hydraulic controls whenever warranted by topographic changes.

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.

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

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

Precountywide Analyses

In Merrimac, USACE bridge plans and intermediate valley cross sections were used to supplement field survey data. Base mapping, at a scale of 1" = 400' with a contour interval of 5 feet was used to develop overbank cross section data and additional valley cross sections as necessary (Reference 61). Below-water sections were also field surveyed at representative locations along Tributary to Neal Pond. Topographic maps at a scale of 1:4,800 with a contour interval of 5 feet were used to develop overbank cross section data and additional valley sections as necessary to satisfy hydraulic computation requirements (Reference 62).

In those areas where the analysis indicated super critical flow conditions, critical depth was assumed for the flood elevations because of the inherent instability of supercritical flow.

Water-surface elevations of floods of the selected recurrence intervals for the communities in Essex County were computed using the USACE HEC-2 step-backwater computer program (Reference 55). Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals.

The Powwow River starting water-surface elevation for the 10-percent-annual-chance flood elevation was taken from the annual tidal stage-elevation; the 2-percent-annual-chance was taken from the 5-year tidal stage-elevation; the 1-percent-annual-chance flood elevation was taken from the 10- tidal stage-elevation; and the 0.2-percent-annual-chance flood elevation was taken from the 25-year tidal stage elevation (Reference 33). For the precountywide revised portion of the Powwow River, the starting water-surface elevation for the 1-percent-annual-chance flood was taken from the FIS for the Town of South Hampton, New Hampshire (Reference 2).

Starting water-surface elevations for Unnamed Tributary to Fish Brook was determined using the discharge characteristics of the dam downstream of Lockwood Lane.

Starting water-surface elevations for Ipswich River, Bartlett Brook, Boston Brook, Emerson Brook, Howlett Brook, Pye Brook, Mile Brook, Branch of Ipswich, Bennett's Pond Brook, Cleveland Brook, School Brook, Shute Brook, Fish Brook, Parker River, North Beverly Drainage Ditch, Miles River, Tributary A to the Ipswich River, Fiske Brook, and Fish Brook were computed using the slope/area method.

Starting water-surface elevations for the Ipswich River in Ipswich and for Parker River in Newbury were determined using critical depth.

Starting water-surface elevations for the Little River, Creek Brook, Millvale Reservoir Brook, Shawsheen River, Spicket River, Cochichewick Brook, Bare Meadow Brook, and Haverhill-Riverside Airport Brook were determined to be the normal water-surface elevation of the Merrimack River at their respective confluences.

Starting water-surface elevations for Fish Brook were based on a stage discharge rating curve developed at the dam located at its mouth. Starting water-surface elevations on Hussey Brook were found to be coincident with developed flood profiles on the Shawsheen River. Starting water-surface elevations for Hussey Brook Tributary were found to be coincident with developed flood profiles on Hussey Brook.

Starting water-surface elevations for Chubbs Brook, Mill River, Saugus River, and Centerville Creek were based on the average spring high tide level.

Mean high tide in Beverly Harbor was used as the starting water-surface elevation for the 10-, 2-, 1-, and 0.2-percent-annual-chance floods on the Porter River and Frost Fish Brook, and on the Crane River and Crane Brook. Hydraulic analysis of the Ipswich River was performed in conjunction with the Middleton, Massachusetts, FIS, which involved a continuous backwater run from North Reading to Topsfield (Reference 63). Starting water-surface elevations on Beaver Brook were set equal to the flood elevations at Mill Pond, as determined in the Crane River and Crane Brook hydraulic analysis. The Waters River was analyzed using the tidal effects from Beverly Harbor (Reference 64).

Starting water-surface elevations for Parker River in Georgetown were taken from its confluence with the Merrimack River. The starting water-surface elevations for Penn Brook were taken at its confluence with Parker River. Bulford Brook starting elevations were taken at its confluence with Penn Brook. Starting elevations for Jackman Brook were obtained from field notes taken at the Georgetown corporate limits.

For Hawkes Brook, the starting water surface elevations were derived from its confluence elevations with Bare Meadow Brook. (Reference 65). Starting water surface elevations for Harris Brook were derived from its confluence elevations with the Spicket River. For Peat Meadow Brook the starting water-surface elevations were determined by the slope-area method.

Starting water-surface elevations for Unnamed Tributary to Fish Brook was determined using the discharge characteristics of the dam downstream of Lockwood Lane.

Maximum elevations of the Upper Artichoke Reservoir were used in starting water-surface elevations for North Tributary Brook. Starting water-surface elevations for all flood flows on Beaver Brook were started at the normal water elevations.

Starting water-surface elevations for the Merrimack River in Merrimack were taken from the 10-year tide elevation in Newburyport.

In Gloucester, for Mill River, water-surface elevations of floods of the selected recurrence intervals were computed using the One Dimensional Storm Surge Model for Coastal Rivers for the tidal reaches and the USACE HEC-2 step-backwater computer program for the inland reaches (References 55 and 66).

In some locations, water levels shown on the maps were computed by correlating synthetically produced water levels with elevations obtained during historic floods (Reference 67).

The areas analyzed by approximate methods were delineated after consideration of the 1-percent-annual-chance flood elevations from the backwater analysis on the detailed study areas and the communities respective precountywide Flood Hazard Boundary Maps.

Countywide Analyses

For this countywide revision, no new riverine Hydraulic Analyses were conducted.

Roughness factors (Manning's "n" values) used in the hydraulic computations were determined from field observations, guided by U.S. Geological Water Supply Publications. Table 7, "Mannning's "n" values" shows the channel and overbank "n" values for the streams studied by detailed methods:

TABLE 7 – MANNING’S “n” VALUES

Flooding Source	Channel "n"	Overbanks
Bare Meadow Brook	0.030-0.040	0.060-0.080
Bartlett Brook	0.030-0.040	0.030-0.080
Bates Brook (Lynnfield)	0.020-0.110	0.11
Beaver Brook (Danvers)	0.020-0.040	0.035-0.090
Beaverdam Brook (Lynnfield)	0.020-0.110	0.11
Bennett’s Pond Brook	0.013-0.050	0.07
Boston Brook (Middleton)	0.013-0.045	0.05-0.10
Boston Brook (North Andover)	0.020-0.060	0.020-0.080
Branch of Ipswich (Topsfield)	0.010-0.060	0.11
Centerville Creek	0.020-0.050	0.040-0.070
Channel Bottoms/Overbanks (West Newbury)	0.013-0.060	0.01
Chubbs Brook	0.030-0.050	0.030-0.090
Cleveland Brook (Topsfield)	0.010-0.060	0.11
Cochichewick	0.030-0.042	0.035-0.100
Crane Brook (Danvers)	0.020-0.040	0.035-0.090
Crane River (Danvers)	0.020-0.040	0.035-0.090
Creek Brook	0.015-0.065	0.017-0.125
Drainage Ditch (North Beverly)	0.014-0.050	0.05
Emerson Brook	0.015-0.06	0.07-0.08
Fish Brook	0.030-0.050	0.050-0.085
Fish Brook (Topsfield)	0.010-0.060	0.11
Fiske Brook	0.05	0.06
Frost Fish Brook (Danvers)	0.020-0.040	0.035-0.090
Georgetown Flood Plains	0.030-0.060	0.050-0.100
Goldthwaite Brook (Peabody)	0.023-0.045	0.030-0.15
Groveland Flood Plains	0.03-0.06	0.05-0.10
Hamilton Streams	0.020-0.050	0.020-0.070
Harris Brook	0.035	0.06
Haverhill-Riverside Airport Brook	0.035-0.040	0.100-0.060
Hawkes Brook	0.035-0.040	0.030-0.100
Howlett Brook (Topsfield)	0.010-0.100	0.050-0.100
Hussey Brook	0.030-0.055	0.080-0.100
Hussey Brook Tributary	0.030-0.055	0.080-0.100
Ipswich River (Danvers)	0.020-0.040	0.035-0.090
Ipswich River (Ipswich)	0.020-0.040	0.030-0.100

TABLE 7 – MANNING’S “n” VALUES – cont’d

Flooding Source	Channel "n"	Overbanks
Ipswich River (Lynnfield)	0.020-0.110	0.11
Ipswich River (Middleton)	0.03-0.045	0.033-0.15
Ipswich River (Topsfield)	0.010-0.060	0.11
Ipswich River (Wenham)	0.010-0.060	0.11
Little River	0.029-0.065	0.030-0.125
Merrimack River (Andover)	0.035-0.020	0.065-0.075
Merrimack River (Haverhill)	0.025-0.035	0.065
Merrimack River (Lawrence)	0.028	0.07
Merrimack River (Merrimac)	0.030-0.040	0.060-0.100
Merrimack River (Methuen)	0.023	0.08
Merrimack River (Newburyport)	0.04	0.075
Merrimack River (North Andover)	0.022-0.032	0.060-0.080
Merrimack River (North Andover)	0.022-0.032	0.060-0.080
Merrimack Tributary to Neal Pond	0.030-0.040	0.060-0.100
Mile Brook (Topsfield)	0.010-0.100	0.050-0.100
Miles River (Ipswich)	0.020-0.050	0.035-0.100
Miles River (Wenham)	0.020-0.050	0.020-0.070
Mill River (Gloucester)	0.013-0.040	0.1
Mill River (Newbury)	0.015-0.050	0.015-0.050
Mill River (Rowley)	0.015-0.060	0.015-0.090
Millvale Reservoir Brook	0.035-0.042	0.112-0.125
Mosquito Brook	0.020-0.070	0.020-0.070
North River (Peabody)	0.023-0.045	0.030-0.15
Parker River	0.020-0.040	0.1
Peat Meadow Brook	0.025-0.050	0.090-0.100
Porter River (Danvers)	0.020-0.040	0.035-0.090
Powwow River	0.035	0.06
Proctor Brook (Peabody)	0.023-0.045	0.030-0.15
Pye Brook (Topsfield)	0.010-0.100	0.050-0.100
Riverside Airport Brook	0.035-0.040	0.100-0.060
Saugus River	0.020-0.040	0.050-0.100
Saugus River (Lynnfield)	0.020-0.110	0.11
School Brook (Topsfield)	0.010-0.060	0.11
Shawsheen River (Andover)	0.030-0.045	0.050-0.085

TABLE 7 – MANNING'S "n" VALUES – cont'd

Flooding Source	Channel "n"	Overbanks
Shawsheen River (Lawrence)	0.023	0.06
Shawsheen River (North Andover)	0.03	0.07
Shute River	0.012-0.050	0.035-0.100
Spicket River (Methuen)	0.035-0.050	0.060-0.080
Spickett River (Lawrence)	0.03	0.07
Strongwater Brook (Peabody)	0.023-0.045	0.030-0.15
Tapley Brook (Peabody)	0.023-0.045	0.030-0.15
Topsfield Streams	0.010-0.100	0.050-0.100
Tributary A to the Ipswich River	0.015-0.04	0.04-0.09
Unnamed Tributary to Fish Brook	0.010-0.100	0.050-0.100
Waters River (Peabody)	0.023-0.045	0.030-0.15
West Newbury Channels and overbanks	0.030-0.040	0.060-0.085

3.3 Coastal Analysis

In New England, the flooding of low-lying areas is caused primarily by storm surges generated by extratropical coastal storms called northeasters. Hurricanes also occasionally produce significant storm surges in New England, but they do not occur nearly as frequently as northeasters. Due to its geographic location, Essex County is susceptible to flooding from both hurricanes and northeasters.

A northeaster is typically a large counterclockwise wind circulation around a low pressure. The storm is often as much as 1,000 miles wide, and the storm speed is approximately 25 mph as it travels up the eastern coast of the United States. Sustained wind speeds of 10-40 mph are common, with short-term wind speeds of up to 70 mph. Such information is available on synoptic weather charts published by the National Weather Service.

Areas of coastline subject to significant wave attack are referred to as coastal high hazard zones. The USACE has established the 3-foot breaking wave as the criterion for identifying the limit of coastal high hazard zones. The 3-foot wave has been determined as the minimum size wave capable of causing major damage to conventional wood frame or brick veneer structures. Wave height analyses were performed in the coastal communities of Essex County to determine wave heights and corresponding wave crest elevations for the areas inundated by the tidal flooding, wave runup analyses were performed to determine the height and extent of runup beyond the limit of tidal inundation. The results of these analyses were combined into wave envelopes, which were constructed by extending the maximum wave runup elevation seaward to its intersection with the wave crest profile.

The methodology for analyzing wave heights and corresponding wave crest elevations was developed by NAS (References 68, 69, 70, and 71). The wave runup was determined using the methodology developed by Stone and Webster Engineering Corporation for FEMA (Reference 70). The NAS methodology is based on three major concepts.

First, a storm surge on the open coast is accompanied by waves. The maximum height of these waves is related to the depth of water by the following equation:

$$H_b = 0.78d$$

where H_b is the crest to trough height of the maximum or breaking wave and d is the stillwater depth. The elevation of the crest of an unimpeded wave is determined using the equation:

$$Z_w = S_* + 0.7H_* = S_* + 0.55d$$

where Z_w is the wave crest elevation, S_* is the stillwater elevation at the site, and H_* is the wave height at the site. The 0.7 coefficient is the portion of the wave height which reaches above the stillwater elevation. H_b is the upper limit for H_*.

The second major concept is that the breaking wave height may be diminished by dissipation of energy by natural or man-made obstructions. The wave height transmitted past a given obstruction is determined by the following equation:

$$H_t = BH_i$$

where H_t is the transmitted wave height, H_i is the incident wave height, and B is a transmission coefficient ranging from 0.0 to 1.0. The coefficient is a function of the physical characteristics of the obstruction. Equations have been developed by NAS to determine B for vegetation, buildings, natural barriers such as dunes, and man-made barriers such as breakwaters and seawalls (Reference 68).

The third concept deals with unimpeded reaches between obstructions. New wave generation can result from wind action. This added energy is related to distance and mean depth over the unimpeded reach.

As part of this countywide update, revised coastal analyses were performed for the open water flooding sources in the communities of Salisbury and Newburyport. In addition, redelineation of coastal flood hazard data was performed for open water flooding sources in the communities of Beverly, Danvers, Essex, Gloucester, Ipswich, Lynn, Manchester, Marblehead, Nahant, Newbury, Peabody, Rockport, Rowley, Salem, Saugus and Swampscott. A description of the revised analyses is presented in the Countywide section below.

For each coastal community within Essex County that has been studied prior to this countywide update, the coastal analyses described in the previous FIS reports have been compiled and are summarized below.

Precountywide Analyses

The extent and frequency of recurrence of coastal flooding were determined by conducting a frequency analysis of annual maximum tidal heights along the coastlines of Essex County. Some historic storm-tide heights, consisting of an astronomical tide and a storm surge contribution, were determined by the mathematical simulation of historic northeasters and hurricanes as described above; others, for which associated storm data were not available, were obtained by a correlation analysis using tide data from Boston or Portsmouth, The data base at the Boston gage extended from 1978 discontinuously back to 1848; the shorter record at Portsmouth was lengthened by a statistical correlation with data at Boston and Portland. The annual maxima of these reproduced historic water elevations were fitted with a Pearson Type III distribution. The goodness of fit was tested with the chi-square test and accepted at the 95 percent confidence level. The variations in location and bathymetry require the reporting of separate storm-tide elevations for Lynn Harbor and Nahant Bay. A detailed description of the methodology employed in this analysis can be found in the report entitled Determination of Coastal Storm Tide Levels (Reference 72). Tidal flood elevations for the Saugus River were obtained from an unpublished USACE study. The USACE study is a detailed analysis of flooding on the Saugus and Pines Rivers and is appropriate for use in this study. For Cedar Pond, Sluice Pond, and Flax Pond, a volume-elevation analysis was performed for the 10- and 1-percent-annual-chance rainfalls. The water-surface elevation for each pond was developed by determining the respective drainage areas, time of concentration, and rainfall duration and amount.

Stillwater elevations for the Parker River were determined using a one dimensional storm surge model for coastal rivers (Reference 66). The one-dimensional model is based on the hydrodynamic equations of motion and conservation of mass. The model was used where applicable for estuaries within Rowley.

Areas of shallow flooding have been determined for the lee side of the dunes along Massachusetts Bay. In these areas, the wave runup elevation exceeded the dune crest elevation. The difference between the runup elevation and the dune crest was used to determine the depth of shallow flooding behind the dune (Reference 73). Areas of ponding have been determined along Massachusetts Bay and Beverly Harbor. In these areas, the wave runup elevation exceeded the bluff elevation. The amount of overtopping and flooding behind the bluff were determined based on the bluff elevation and surrounding topography (References 73 and 74).

In Marblehead, in some locations, water levels shown on the maps were computed by correlating synthetically produced water levels with elevations obtained during historic floods (Reference 15 in Marblehead). Historic flood damage information was also used to ensure reasonable delineation of flood-prone areas along the Marblehead shoreline (Reference 67).

The precountywide stillwater elevations for the 10-, 2-, 1-, and 0.2-percent-annual-chance floods have been determined and are shown in Table 8. The analyses reported in this study reflect the stillwater elevations, shown in Table 8, due to tidal and wind setup effects and include the contributions from wave action effects.

TABLE 8 - PRECOUNTYWIDE SUMMARY OF STILLWATER ELEVATIONS

	ELEVATION (feet NAVD 88)			
FLOODING SOURCE AND LOCATION	10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
ATLANTIC OCEAN				
Affecting Essex Bay for Its entire length within The corporate limits Of Essex	7.8	8.5	8.8	9.5
North Coast In Gloucester	7.8	8.6	8.9	9.6
South Coast In Gloucester	7.1	7.9	8.2	9
Entire shoreline within Ipswich	7.7	8.4	8.7	9.4
At Nahant Bay In Lynn	7.6	8.4	8.8	9.6
At Lynn Harbor In Lynn	8	8.8	9.2	9.9

TABLE 8 - PRECOUNTYWIDE SUMMARY OF STILLWATER ELEVATIONS – cont'd

	ELEVATION (feet NAVD 88)			
ATLANTIC OCEAN – cont'd				
Entire coastline of Manchester	7.3	8.1	8.4	9.2
Entire coastline of Marblehead	7.6	8.4	8.8	9.5
Entire coastline within Nanhant	7.7	8.5	8.9	9.7
Entire shoreline within Newburyport	7.4	8.1	8.4	9
Entire coastline of Rockport	7.5	8.3	8.6	9.2
Shoreline of Massachusetts Bay, Salem Harbor, and Beverly Harbor In Salem	7.7	8.5	8.8	9.6
Entire shoreline within Community of Salisbury	7.4	8.1	8.3	9
Saugus tidal area	8	8.8	9.2	10
Entire coastline of Swampscott	7.6	8.4	8.7	9.5
At the Rowley/Newbury Corporate limits	7.7	8.2	8.5	9.2
At the Ipswich/Rowley Corporate limits	7.7	8.4	8.7	9.4
BEVERLY HARBOR				
Waters River, Porter River, and Crane River In Danvers	8.4	9.5	10	11.6
Waters River Within Peabody Limits	8.4	9.5	10	11.6
At the Danvers River In Beverly	7.5	8.3	8.7	9.4

TABLE 8 – PRECOUNTYWIDE SUMMARY OF STILLWATER ELEVATIONS – cont'd

	ELEVATION (feet NAVD 88)			
BEVERLY HARBOR – cont'd				
At Mackerel Cove In Beverly	7.5	8.3	8.7	9.4
CEDAR POND				
In Lynn	98.2	*	109.7	*
FLAX POND				
In Lynn	54.2	*	54.8	*
LAKE ATTITASH				
Entire shoreline within The corporate limits	96.9	97.2	97.3	98
MASSACHUSETTS BAY				
At West Bay In Beverly	7.5	8.3	8.6	9.4
MERRIMACK RIVER				
In Amesbury	7.9	8.8	9.4	10.7
PARKERS RIVER				
Upstream of Boston & Maine Railroad of Mill River downstream of U.S Route 1 bridge In Rowley	6.6	7.2	7.4	8
PILLINGS POND				
At Lynnfield	97.4	98.1	98.3	98.8

TABLE 8 - PRECOUNTYWIDE SUMMARY OF STILLWATER ELEVATIONS – cont'd

	ELEVATION (feet NAVD 88)			
SAUGUS RIVER				
Between General Edwards Bridge and Salem Turnpike in Lynn	7.2	7.8	8.2	9
From Salem Turnpike to Boston Street in Lynn	6.7	7.3	7.6	8.4
SLUICE POND				
In Lynn	63.8	*	64.2	*
UPPER ARTICHOKE RESERVOIR				
Upstream of the Dam in Newburyport	12.6	12.9	13	13.1

Countywide Analyses

As part of this countywide update, revised coastal analyses were performed for the open water flooding sources in the communities of Salisbury and Newburyport. In addition, redelineation of coastal flood hazard data was performed for open water flooding sources in the communities of Beverly, Danvers, Essex, Gloucester, Ipswich, Lynn, Manchester, Marblehead, Nahant, Newbury, Peabody, Rockport, Rowley, Salem, Saugus and Swampscott. Redelineation of coastal flood hazards is defined as applying the results of previous coastal analyses to new or more detailed topographic data. Provided below is a summary of the analyses performed. All revised coastal analyses and redelineation of coastal flood hazards were performed in accordance with Appendix D "Guidance for Coastal Flooding Analyses and Mapping," (Reference 75) of the Guidelines and Specifications, as well as, the "Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update", (Reference 76).

For the communities with revised coastal analyses, published values in the Tidal Flood Survey (Reference 77) were used to estimate the stillwater elevations for the 10-, 2-, and 1-percent-annual-chance floods for open water flooding sources. The 0.2-percent-annual-chance stillwater elevations were extrapolated from the more the frequent stillwater elevations in the Tidal Flood Survey. For communities with redelineation of coastal flood hazard data, the 10-, 2-, 1- and 0.2-percent-annual-chance stillwater elevations are the same as published in the previous Flood Insurance Studies. Stillwater elevations for the revised and redelineated flooding sources are presented in Table 9.

TABLE 9 – SUMMARY OF REVISED STILLWATER ELEVATIONS

FLOODING SOURCE AND LOCATION	ELEVATION (feet NAVD 88)			
	10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
-				-
Beverly				
Massachusetts Bay				
At West Beach	7.5	8.3	8.6	9.4
Beverly Harbor				
At the Daniels River	7.5	8.3	8.7	9.4
At Mackerel Cove	7.5	8.3	8.7	9.4
Danvers				
Beverly Harbor	8.4	9.5	10.0	11.6
Essex				
Atlantic Ocean				
Essex Bay	7.8	8.5	8.8	9.5
Gloucester				
Atlantic Ocean				
North Coast	7.8	8.6	8.9	9.6
South Coast	7.1	8.1	8.1	9.2
Ipswich				
Atlantic Ocean	7.7	8.4	8.3	9.4
Lynn				
Atlantic Ocean				
At Nahant Bay	7.6	8.4	8.8	9.6
At Lynn Harbor	8.0	7.8	9.2	9.9

TABLE 9 – SUMMARY OF REVISED STILLWATER ELEVATIONS – cont'd

FLOODING SOURCE AND LOCATION	ELEVATION (feet NAVD 88)			
	10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
Lynn – con't				
Atlantic Ocean – cont'd				
Saugus River				
General Edwards Bridge to Salem Turnpike	7.2	7.8	8.2	9.0
Salem Turnpike to Boston Street	6.7	7.3	7.6	8.4
Manchester				
Atlantic Ocean	7.3	8	8.4	9.2
Marblehead				
Atlantic Ocean	7.6	8.4	8.8	9.5
Nahant				
Atlantic Ocean	7.7	8.5	8.9	9.7
Newbury				
Atlantic Ocean	7.4	8.1	8.4	9.0
Parker River				
Upstream of mouth to B&M Railroad bridge	7.4	8.1	8.4	9.0
B&M Railroad bridge	6.6	7.2	7.4	8.0
Newburyport				
Atlantic Ocean	7.8	8.6	8.9	9.7
Peabody				
Beverly Harbor-Waters River	8.4	9.5	10.0	11.6

TABLE 9 – SUMMARY OF REVISED STILLWATER ELEVATIONS – cont'd

FLOODING SOURCE AND LOCATION	ELEVATION (feet NAVD 88)			
	10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
Rockport				
Atlantic Ocean	7.5	8.3	8.6	9.2
Rowley				
Atlantic Ocean				
At Rowley/Newbury corporate limits	7.5	8.2	8.5	7.2
At Ipswich/Rowley corporate limits	7.7	8.4	8.7	9.4
Parker River				
Upstream of Boston & Maine railroad	6.6	7.2	7.4	8.0
Salem				
Atlantic Ocean	7.7	8.5	8.8	9.6
Salisbury				
Atlantic Ocean	7.8	8.6	8.9	9.7
Saugus				
Saugus tidal area	8.0	8.8	9.2	10.0
Swampscott				
Atlantic Ocean	7.6	8.4	8.7	9.5

For the communities with revised coastal analyses, the elevations presented in the Tidal Flood Survey are referenced to the National Tidal Datum Epoch (NTDE) of 1960-1978. The current tidal datum is based on the NTDE of 1983-2001. The NTDE is a specific 19 year period that includes the longest periodic tidal variations caused by the astronomic tide-producing forces. The value averages out long term seasonal meteorological, hydrologic, and oceanographic fluctuations and provides a nationally consistent tidal datum network (bench marks) by accounting for seasonal and apparent environmental trends in sea level rise that affect the accuracy of tidal datums. For use in this coastal analysis revision, the stillwater elevations presented in the Tidal Flood Survey were converted to the current tidal datum. A datum conversion factor of +0.05 feet was applied to the data in the Tidal Flood Survey for the communities of Salisbury and Newburyport.

For the communities with redelineation of coastal flood hazard data, the elevations presented in the previous Flood Insurance Studies are referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29). These elevations were converted to the North American Vertical Datum of 1988 (NAVD 88). The vertical datum shift between NGVD29 and NAVD88 was determined in accordance with Appendix B "Guidance for Converting to the North American Vertical Datum of 1988," (Reference 78) of the Guidelines and Specifications, as well as, the “Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update”, (Reference 76).

For the communities with revised coastal analyses, wave setup along the open coast was calculated using the procedures detailed in the “Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update”, (Reference 76). Specifically, the Direct Integration Method (DIM) was applied. Because much of the Essex County coastline has experienced historical flooding and damage above predicted surge and runup elevations, setup was assumed to be an important component of the analyses and was applied to the entire open coast shoreline in the revised community, except for areas inundated by wave runup.

For the communities with revised coastal analyses, offshore wave characteristics representing a 1-percent-annual-chance storm were determined using hindcast wave data from the US Army Corps of Engineers Wave Information Studies (WIS) stations. A Peaks-Over-Threshold statistical analysis (Reference 79) was applied on 20 years (1980-1999) of wave characteristic data from WIS Station 45, located offshore of the Town of Salisbury. For areas sheltered from direct ocean waves, such as the Merrimac River and west facing shorelines, wave characteristics representing a 1-percent-annual-chance storm were determined using a restricted fetch analysis and the US Army Corps of Engineers Automated Coastal Engineering System (ACES) software package. Mean wave characteristics were determined as specified in the FEMA guidance for V Zone mapping.

Wave heights and wave runup in the communities with revised coastal analyses were computed along transects that were located perpendicular to the average shoreline. The transects were located with consideration given to the physical and cultural characteristics of the land so that they would closely represent local conditions. Transects were spaced close together in areas of complex topography and dense development. In areas having more uniform characteristics, the transects were spaced at larger intervals. It was also necessary to locate transects in areas where unique flooding existed and in areas where computed wave heights varied significantly between adjacent transects.

Transect data for the communities with redelineation of coastal hazard data are referenced to each community's previous FIS.

Transect descriptions for the restudied coastal analyses and for the communities with redelineation of coastal hazard data are shown in Table 10 below and have been re-numbered to conform to countywide standards.

TABLE 10 - COUNTYWIDE TRANSECT DESCRIPTIONS

TRANSECT	LOCATION	1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
1	From 30 feet north of Beacon Street extending east approximately 315 east of the Town of Salisbury corporate limit lines	8.3	18.0
2	From Twelfth Street extending northeast to approximately 258 feet east of the Town of Salisbury corporate limit lines.	8.3	19.0
3	From 542 feet north of Liberty Stree extending east 176 feet east of the Town of Salisbury corporate limit lines.	8.3	20.0
4	From 12 feet north of Seventeenth Street extending east to approximately 369 feet east of the Town of Salisbury corporate limit lines.	8.3	19.0

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.

TABLE 10 - COUNTYWIDE TRANSECT DESCRIPTIONS – CONT'D

TRANSECT	LOCATION	1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
5	From 79 feet north of Old Town Way extending east 242 feet east of the Town of Salisbury corporate limit lines.	8.3	19.0
6	From 57 feet north of Beach Road extending east approximately 280 feet east of the Town of Salisbury corporate limit lines.	8.3	19.0
7	From 11 feet north of Fowler Street extending northeast to approximately 356 feet east of the Town of Salisbury corporate limit lines.	8.3	19.0
8	From 377 feet east of State Beach Road extending northeast to 247 feet east of the Town of Salisbury corporate limit lines.	8.3	20.0
9	From 271 feet east of Sweet Apple Street Lane extending southeast to approximately 43 feet beyond the Town of Salisbury corporate limit lines.	8.3	13.0

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.

TABLE 10 - COUNTYWIDE TRANSECT DESCRIPTIONS – CONT'D

TRANSECT	LOCATION	1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
10	From 284 feet east of Second Street extending southeast to 107 feet beyond the Town of Salisbury corporate limit lines.	8.3	13.0
11	From Water Street extending northeast to Merrimack River approximately 232 feet south of the City of Newburyport corporate limit lines.	8.4	16.0
12	From 10 feet east of Pine Street extending east-northeast into Joppa Flatt approximately 129 feet east of the City of Newburyport corporate limit lines.	8.4	15.0
13	From 62 feet south of Northern Boulevard extending southwest 106 feet west of the the City of Newburyport corporate limit lines.	8.4	17.0
14	From Northern Boulveard extending northeast into the Merrimack River approximately 491 feet south of the City of Newburyport corporate limit lines.	8.4	22.0
15	From 98 feet south of Sixty First Street extending east into the Atlantic Ocean approximately 320 feet north of the City of Newburyport corporate limit lines.	8.4	23.0

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.

TABLE 10 - COUNTYWIDE TRANSECT DESCRIPTIONS – CONT'D

TRANSECT	LOCATION	1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
16	From 1,626 feet south of the Town of Newburyport corporate limit lines extending east to 2,691 feet east of the Town of Newburyport corporate limit lines.	8.4	16.2
17	From 2,613 feet south of the Plum Island Turnpike extending east to .62 miles east of the Town of Newburyport corporate limit lines.	8.4	18.7
18	From .48 miles south of the Town of Rowley corporate limit lines extending northeaset into the Atlantic Ocean approximately .77 miles beyond the Town of Rowley corporate limit lines.	8.5	13.2
19	From 180 feet east of Plum Island Road extending east to 1.5 miles east of the Town of Ipswich corporate limit lines.	8.7	13.9
20	From 1,464 feet south of Plum Island Road to 1.01 miles north of the Town of Ispwich corporate limit lines.	8.7	13.9
21	From 76 feet south of Little Neck Road to .88 miles north of the Town of Ipswich corporate limit lines.	8.7	21.1

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.

TABLE 10 - COUNTYWIDE TRANSECT DESCRIPTIONS – CONT'D

TRANSECT	LOCATION	1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
22	From 75 feet south of Hilltop Road extending souteast to 670 feet south of the Town of Ipswich corporate limit lines.	8.7	15.0
23	From 628 feet west of Argilla Road extending northeast to 1,123 feet east of the Town of Ipswich corporate limit lines.	8.7	21.5
24	From 1,175 feet west of the Town of Essex corporate limit lines extending northeast to .72 miles past the Town of Ipswich corporate limit lines.	8.7	13.7
25	From 1,094 feet east of the Town of Essex corporate limit line extending west to approximately 415 feet south of Hog Island Channel.	8.8	14.2
26	From the Town of Essex corporate limit line extending south to 374 feet east of Conomo Point.	8.8	10.4
27	Gloucester Corporate Limit to Cross Island	8.8	13.2
28	From 395 feet north of Wingaersheek Road extending north .74 miles north of the City of Gloucester corporate limit lines.	8.9	14.2

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.

TABLE 10 - COUNTYWIDE TRANSECT DESCRIPTIONS – CONT'D

TRANSECT	LOCATION	1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
29	From 400 feet south of Wingaersheek Road extending north .58 miles north of the City of Gloucester corporate limit lines.	8.9	14.2
30	From 576 feet north of Nashua Avenue extending northwest approximately .58 miles past the City of Gloucester corporate limit lines.	8.9	19.3
31	Approximately 1,577 feet north of the Washington Street and Linwood Place intersection extending northwest .64 miles past the City of Gloucester corporate limit lines.	8.9	20.0
32	From 1,111 feet west of Folly Point Road extending west-northwest to approximately .70 miles west of the City of Gloucester corporate limit lines.	8.9	12.5
33	From 220 feet north of Linwood Avenue extending northeast 2,779 feet beyond the Town of Rockport corporate limit lines.	8.6	22.4
34	From 30 feet north of Pearson Way extending northeast into Sandy Bay approximately 2,702 feet beyond the Town of Rockport corporate limit lines.	8.6	15.2

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.

TABLE 10 - COUNTYWIDE TRANSECT DESCRIPTIONS – CONT'D

TRANSECT	LOCATION	1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
35	From 73 feet east of Jewett Road extending northeast into Sandy Bay approximately 1,053 feet beyond the Town of Rockport corporate limit lines.	8.6	22.2
36	From 96 feet east of Babcock Road extending northwest into Sandy Bay approximately .60 miles beyond the Town of Rockport corporate limit lines.	8.6	31.2
37	From 444 feet south of Pioneer Circle extending northeast approximately 242 feet beyond the Town of Rockport corporate limits.	8.6	16.2
38	From 294 feet south of Meadow Road extending southeast into the Atlantic Ocean approximately 2,280 feet beyond the Town of Rockport corporate limit lines.	8.6	22.5
39	From 970 feet north of State Highway 127A extending northeast into the Atlantic Ocean approximately 1,013 feet beyond the Town of Rockport corporate limit lines.	8.6	14.9

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.

TABLE 10 - COUNTYWIDE TRANSECT DESCRIPTIONS – CONT'D

TRANSECT	LOCATION	1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
40	From 197 feet west of State Highway 127A extending southeast into the Atlantic Ocean approximately 2,721 feet beyond the Town of Rockport corporate limit lines.	8.6	22.2
41	From 381 feet east of Frank Street extending southeast into the Atlantic Ocean approximately 2,175 feet beyond the Town of Rockport corporate limit lines.	8.6	14.2
42	From 107 feet south of Old Country Road extending southeast into the Atlantic Ocean approximately 2,160 feet past the Town of Rockport corporate limit lines.	8.6	15.7
43	From 171 feet east of Staknaught Road extending southeast to 1,437 feet north of Salt Island Road.	8.2	13.8
44	From 287 feet east of Nautilus Road extending east 132 feet east past the second crossing of the City of Gloucester corporate limit lines.	8.2	14.2
45	From 216 feet north of Grapevine Road extending east-northest to 1,568 feet east of the City of Gloucester corporate limit lines.	8.2	16.2

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.

TABLE 10 - COUNTYWIDE TRANSECT DESCRIPTIONS – CONT'D

TRANSECT	LOCATION	1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
46	From 341 feet south of Bemo Aveue extending southeast to 1,992 feet southeast of the City of Gloucester corporate limit lines.	8.2	13.0
47	From 336 feet south of Rouse Road extending south to .89 miles south of the Town of Gloucester corporate limit lines.	8.2	24.7
48	From 1,040 feet south of Western Avenue extending southeast to 2,646 feet past the City of Gloucester corporate limit lines.	8.2	25.0
49	Approximately 75 feet south of Norman Avenue extending southeast .62 miles south of the City of Gloucester corporate limit lines.	8.2	15.9
50	From Flume Road extending southwest to approximately 363 feet southwest of the City of Gloucester corporate limit lines.	8.2	18.6
51	From 53 feet west of Raymond Street extending south to 1,702 feet west of Shore Road.	8.4	13.9
52	From 233 feet north of Summer Street extending southwest to 673 feet east of Ocean Street.	8.4	13.5

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.

TABLE 10 - COUNTYWIDE TRANSECT DESCRIPTIONS – CONT'D

TRANSECT	LOCATION	1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
53	From 552 feet south of Beach Street extending southeast to 554 feet west of the Town of Manchester-By-The Sea corporate limit lines.	8.4	17.0
54	From 723 feet north of Gales Point Road extending southeast to 1,077 feet beyond the Town of Manchester-By-The-Sea corporate limit lines.	8.4	21.2
55	From 33 feet south of Gloucester Branch extending southeast to 503 feet south of the Town of Manchester-By-The Sea corporate limit lines.	8.4	13.6
56	From State Highway 127 extending southeast to approximately 430 feet into the City of Salem.	8.6	17.7
57	From Hale Street south to approximately 2,713 feet south of the City of Beverly corporate limit line.	8.6	14.2
58	From 735 feet west of Thissell Street extending southeast to .62 miles south of the City of Beverly corporate limit lines.	8.6	18.3
59	From 732 feet north of Hale Street extending southeast to .74 miles south of the City of Beverly corporate limit lines.	8.6	24.7

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.

TABLE 10 - COUNTYWIDE TRANSECT DESCRIPTIONS – CONT'D

TRANSECT	LOCATION	1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
60	From 68 feet north of Neptune Street extending south to 576 feet south of the City of Beverly corporate limit lines.	8.6	29.7
61	From 379 feet north of Water Street extending southeast to 587 feet south of the City of Beverly corporate limit lines.	8.3	15.2
62	From 278 feet east of Andrew Street extending northeast into Collins Cove approximately 786 feet east of Conners Road.	8.8	12.0
63	From 59 feet south of Columbus Avenue extending northeast into Beverly Harbor approximately 155 feet east of the City of Salem corporate limit lines.	8.8	13.9
64	From .39 miles south of Bay View Avenue extending northeast into Salem Sound approximately 645 feet east of the City of Salem corporate limit lines.	8.8	19.4
65	From 26 feet north of Riverbank Road extending northeast into Salem Harbor approximately 325 feet west of the City of Salem corporate limit lines.	8.8	13.2

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.

TABLE 10 - COUNTYWIDE TRANSECT DESCRIPTIONS – CONT'D

TRANSECT	LOCATION	1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
66	From the intersection of Rosedale Avenue and Riverway Road extending northeast to 107 feet west of the Town of Marblehead corporate limit lines.	8.8	12.9
67	From 466 feet east of Edgemere Road extending northeast to 261 feet east of Passenger Ferry Road.	8.8	14.2
68	From 19 feet north of Davis Road extending east to 66 feet beyond the Town of Marblehead corporate limit lines.	8.8	25.5
69	From 55 feet south of Front Street extending east to 460 feet north of the Town of Marblehead corporate limit lines.	8.8	29.2
70	From 401 feet north of Ocean Avenue extending northeast to 382 feet east of Cliff Street.	8.8	13.0
71	From 65 feet north of Harbor Avenue extending east-northeast to 487 feet west of Passenger Ferry.	8.8	32.3
72	From 305 feet west of Risley Road extending southeast to 103 feet north of the Town of Marblehead corporate limit lines.	8.8	25.9

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.

TABLE 10 - COUNTYWIDE TRANSECT DESCRIPTIONS – CONT'D

TRANSECT	LOCATION	1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
73	From 688 feet south of Cliff Street extending south to 385 feet beyond the Town of Marblehead corporate limit lines.	8.8	16.0
74	From 443 feet north of Clifton Heights extending east to 22 feet east of the Town of Marblehead corporate limit lines.	8.8	22.5
75	From 618 feet south of Swampscott Spirit Trail extending southeast 1,055 feet beyond the Town of Marblehead corporate limit lines.	8.8	12.9
76	From 26 feet south of Bellevue Road extending southeast to 280 feet beyond the Town of Swampscott corporate limit lines.	8.7	17.2
77	From 403 feet north of Phillips Beach Avenue extending east-southeast to 443 feet beyond the Town of Swampscott corporate limit lines.	8.7	14.2
78	From 45 feet south of Galloupes Point Road extending southeast to 1,551 feet beyond the Town of Swampscott corporate limit lines.	8.7	26.6

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.

TABLE 10 - COUNTYWIDE TRANSECT DESCRIPTIONS – CONT'D

TRANSECT	LOCATION	1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
79	From 290 feet east of Galloupes Point extending southwest to 1,244 feet beyond the Town of Swampscott corporate limit lines.	8.7	12.6
80	From 524 feet east of Sculpin Way extending southwest into Nahant Bay approximately 1,624 feet beyond the Town Swampscott corporate limit lines.	8.7	14.2
81	From 24 feet north of Ocean Terrace extending southeast into Nahant Bay approximately 712 feet beyond the Town of Swampscott corporate limit lines.	8.7	13.9
82	From 60 feet north of Basset street extending southeast to 230 feet west of the City of Lynn corporate limits.	8.8	16.0
83	From 228 feet west of Breen Street extending southeast to 64 feet south of the City of Lynn corporate limit lines.	8.8	18.2
84	From 214 feet west of Nahant Street extending southeast to 20 feet south of the City of Lynn corporate limit lines.	8.8	14.0

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.

TABLE 10 - COUNTYWIDE TRANSECT DESCRIPTIONS – CONT'D

TRANSECT	LOCATION	1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
85	From 72 feet east of Nahant Road extending east to 243 feet east of the Town of Nahant corporate limit lines.	8.9	17.2
86	From 166 feet south of Lenox Road extending northwest to 474 feet north of the Town of Nahant corporate limit lines.	8.9	16.4
87	From 98 feet south of Lenox Road extending east-southeast into Nahant Bay approximately 314 feet north of the Town of Nahant corporate limit lines.	8.9	24.7
88	From 73 feet east of Nahant Road extending northeast into Nahant Bay approximately 107 feet west of the Town of Nahant corporate limit lines.	8.9	14.2
89	From 55 feet north of Prospect Street extending northeast into Nahant Bay approximately 299 feet south of the Town of Nahant corporate limit lines.	8.9	23.1
90	From 75 feet north of Nahant Road extending northeast into Nahant Bay approximately 224 feet south of the Town of Nahant corporate limit lines.	8.9	24.2

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.

TABLE 10 - COUNTYWIDE TRANSECT DESCRIPTIONS – CONT'D

TRANSECT	LOCATION	1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
91	From 26 feet south of Nahant Road extending east-northeast into Nahant Bay approximately 411 feet west of the Town of Nahant corporate limit lines.	8.9	25.5
92	From 456 feet south of the Nahant Road and Cliff Street intersection extending east-southeast into Nahant Bay approximately 1,439 feet west of the Town of Nahant corporate limit lines.	8.9	24.5
93	From 53 feet south of Vernon Street extending southeast into the Atlantic Ocean approximately 1,036 feet north of the Town of Nahant corporate limit lines.	8.9	29.2
94	From 762 feet south of the intersection of Furbush Road and Walton Lane extending southeast to 189 feet south of the Town of Nahant corporate limit lines.	8.9	14.9
95	From 93 feet west of Willow Road extending southwest to 212 feet south of the Town of Nahant corporate limit lines.	8.9	16.6

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.

TABLE 10 - COUNTYWIDE TRANSECT DESCRIPTIONS – CONT'D

TRANSECT	LOCATION	1-PERCENT-ANNUAL-CHANCE STILLWATER	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
96	From 261 feet south of Pond street extending south towards Nahant Harbor approximately 348 feet north of the Town of Nahant corporate limits.	8.9	14.2
97	From 53 feet east of Spinney Path extending southwest to 178 feet beyond the Town of Nahant corporate limit lines.	8.9	15.2
98	From 27 feet south of Flash Road extending west to 224 feet east of the Town of Nahant corporate limit lines.	8.9	12.9
99	From 134 feet south of West Baltimore Street extending southwest to 240 feet north of the City of Lynn corporate limit lines.	9.2	14.2
100	From 528 feet west of Riley way extending southeast to 20 feet north o fthe City of Lynn corporate limti lines.	9.2	14.6

[1]Because of map scale limitations, the maximum wave elevation may not be shown on the FIRM.

For the communities with revised coastal analyses, the coastal transect data was developed from several sources. A NOAA Light Detection and Ranging LiDAR flight from 2000 provides coverage of the Atlantic coastline in Salisbury and Newburyport. The Massachusetts Office of Coastal Zone Management (MCZM) processed the NOAA LiDAR to produce bare earth points. For the Atlantic coast, the transects were extracted from the processed LiDAR data. For the transects located along the Merrimac River shoreline, transects were extracted from 2-foot contour topographic data supplied by the community for Newburyport and from 3 meter contour data supplied by the Massachusetts Office of Geographic and Environmental Information (MassGIS) for Salisbury. Additionally, portions of nine (9) coastal transects were field surveyed in February 2007 to supplement the contour data for the study area. As appropriate, coastal protection structure details and 0.0 ft NAVD elevation were included and noted in the transect field surveys. Bathymetric data from NOAA Nautical Charts were used to extend the transects offshore for wave runup calculations. Coastal processes that may affect the transect profile, such as dune erosion and seawall scour and failure, were estimated in accordance with Appendix D "Guidance for Coastal Flooding Analyses and Mapping," (Reference 75) of the Guidelines and Specifications, as well as, the "Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update", (Reference 76). Along each transect, wave envelopes were computed considering the combined effects of changes in ground elevation, vegetation, and physical features. Between transects, elevations were interpolated using topographic maps, land-use and land-cover data, and engineering judgment to determine the aerial extent of flooding. The results of the calculations are accurate until local topography, vegetation, or land development within the community undergo major changes.

Wave height and runup calculations used in the revised coastal analysis follow the methodologies described in the FEMA guidance for V Zone mapping specifically the "Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update", (Reference 76). WHAFIS 3.0 was used to predict wave heights.

The "Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update" (Reference 76) allows for the following methods to be used to determine wave runup: RUNUP 2.0 modeling software; "Technical Advisory Committee for Water Retaining Structures" (TAW) methodology; Automated Coastal Engineering System (ACES) software; and the Shore Protection Manual guidance (Reference 80). Each of the aforementioned methods has an appropriate set of nearshore conditions for which it should be applied. For example, the methods described in the Shore Protection Manual are to be used to determine runup on vertical structures.

The wave height and wave runup methodologies were used to compute wave envelope elevations associated with the 1-percent-annual-chance storm surge for the communities with revised coastal analyses in Essex County. Accurate topographic, land-use, and land cover data are required for the coastal analyses. The LiDAR, community supplied contours and MassGIS contours constitute the best available topographic data at the time of this study. Depths below mean low water were determined from National Ocean Survey Coastal Charts (Reference 81). The land-use and land cover data were obtained by field surveys and aerial photographs (Reference 82).

Areas of shallow flooding, designated AO zones, are shown along portions of the shoreline. These areas are the result of wave runup and overtopping behind seawalls and berms with average depths of 1 to 3 feet.

Three (3) primary topographic data sources were used in communities with redelineation of coastal flood hazards: the processed NOAA LiDAR data; community supplied contour information; and 3 meter contour data supplied by MassGIS. The results of the previous effective coastal analyses were then applied to this topographic data to develop the DFIRMs.

In accordance with Appendix D "Guidance for Coastal Flooding Analyses and Mapping," (Reference 75) of the Guidelines and Specifications, as well as, the "Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update", (Reference 76) the effect of the Primary Frontal Dune (PFD) on coastal flood hazard mapping was evaluated for all communities. In areas that had appropriate topographic data (LiDAR), the extent of the PFD was calculated in accordance with the Massachusetts Office of Coastal Zone Management methodology (Reference 83), then field verified. For other areas, the extent of the PFD was determined from field survey.

Table 11 "Transect Data," lists the flood hazard zone and base flood elevations for each transect, along with the 1-percent-annual-chance stillwater elevation for both communities with revised and redelineated coastal flood hazards.

TABLE 11 – COUNTYWIDE TRANSECT DATA

FLOODING SOURCE	STILLWATER ELEVATIONS (feet NAVD[1]) 10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance	ZONE	BASE FLOOD ELEVATION (feet NAVD)[1,2]
Beverly						
Massachusetts Bay						
TRANSECT 56	7.5	8.3	8.6	9.4	VE	30-11
					AE	11-8
					AO	DEPTH 2' AND 1'
TRANSECT 57	7.5	8.3	8.6	9.4	VE	30-11
					AE	11-8
					AO	DEPTH 2' AND 1'
TRANSECT 58	7.5	8.3	8.6	9.4	VE	30-11
					AE	11-8
					AO	DEPTH 2' AND 1'
TRANSECT 59	7.5	8.3	8.6	9.4	VE	30-11
					AE	11-8
					AH	9
					AO	DEPTH 2' AND 1'
TRANSECT 60	7.5	8.3	8.6	9.4	VE	30-11
					AE	11-8
					AH	9
					AO	DEPTH 2' AND 1'
TRANSECT 61	7.5	8.3	8.6	9.4	VE	14-11
					AE	11-9
					AH	10
					AO	DEPTH 2' AND 1'
Danvers						
Beverly Harbor	8.4	9.5	10.0	11.6	AE	10

[1]North American Vertical Datum of 1988

[2]Due to map scale limitations, base flood elevations shown on the FIRM represent average elevations for the zones depicted

TABLE 11 – COUNTYWIDE TRANSECT DATA – cont'd

FLOODING SOURCE	STILLWATER ELEVATIONS (feet NAVD[1]) 10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance	ZONE	BASE FLOOD ELEVATION (feet NAVD)[1,2]
Essex						
Atlantic Ocean						
TRANSECT 25	7.8	8.5	8.8	9.5	VE	13-10
					AE	11-9
TRANSECT 26	7.8	8.5	8.8	9.5	VE	13-10
					AE	11-9
TRANSECT 27	7.8	8.5	8.8	9.5	VE	13-10
					AE	11-9
Gloucester						
Atlantic Ocean						
TRANSECT 28	7.8	8.6	8.9	9.6	VE	29-11
					AE	11-9
					AO	DEPTH 2' AND 1'
					AH	10-9
TRANSECT 29	7.8	8.6	8.9	9.6	VE	29-11
					AE	11-9
					AO	DEPTH 2' AND 1'
					AH	10-9
TRANSECT 30	7.8	8.6	8.9	9.6	VE	29-11
					AE	11-9
					AO	DEPTH 2' AND 1'
					AH	10-9
TRANSECT 31	7.8	8.6	8.9	9.6	VE	29-11
					AE	11-9
					AO	DEPTH 2' AND 1'
					AH	10-9

[1]North American Vertical Datum of 1988

[2]Due to map scale limitations, base flood elevations shown on the FIRM represent average elevations for the zones depicted

TABLE 11 – COUNTYWIDE TRANSECT DATA – cont'd

FLOODING SOURCE	STILLWATER ELEVATIONS (feet NAVD[1]) 10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance	ZONE	BASE FLOOD ELEVATION (feet NAVD)[1,2]
Gloucester – cont'd						
Atlantic Ocean – cont'd						
TRANSECT 32	7.8	8.6	8.9	9.6	VE	29-11
					AE	11-9
					AO	DEPTH 2' AND 1'
					AH	10-9
TRANSECT 43	7.1	7.9	8.2	9	VE	29-10
					AE	10-8
					AO	DEPTH 2' AND 1'
					AH	10-9
TRANSECT 44	7.1	7.9	8.2	9	VE	29-10
					AE	10-8
					AO	DEPTH 2' AND 1'
					AH	10-9
TRANSECT 45	7.1	7.9	8.2	9	VE	29-10
					AE	10-8
					AO	DEPTH 2' AND 1'
					AH	10-9
TRANSECT 46	7.1	7.9	8.2	9	VE	29-10
					AE	10-8
					AO	DEPTH 2' AND 1'
					AH	10-9
TRANSECT 47	7.1	7.9	8.2	9	VE	29-10
					AE	10-8
					AO	DEPTH 2' AND 1'
					AH	10-9
TRANSECT 48	7.1	7.9	8.2	9	VE	29-10
					AE	10-8
					AO	DEPTH 2' AND 1'
					AH	10-9

[1]North American Vertical Datum of 1988

[2]Due to map scale limitations, base flood elevations shown on the FIRM represent average elevations for the zones depicted

TABLE 11 – COUNTYWIDE TRANSECT DATA – cont'd

FLOODING SOURCE	STILLWATER ELEVATIONS (feet NAVD[1]) 10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance	ZONE	BASE FLOOD ELEVATION (feet NAVD)[1,2]
Gloucester – cont'd						
Atlantic Ocean – cont'd						
TRANSECT 49	7.1	7.9	8.2	9	VE	29-10
					AE	10-8
					AO	DEPTH 2' AND 1'
					AH	10-9
TRANSECT 50	7.1	7.9	8.2	9	VE	29-10
					AE	10-8
					AO	DEPTH 2' AND 1'
					AH	10-9
Ipswich						
Atlantic Ocean						
TRANSECT 19	7.7	8.4	8.7	9.4	VE	21-11
					AE	11-9
					AO	DEPTH 1'
TRANSECT 20	7.7	8.4	8.7	9.4	VE	21-11
					AE	11-9
					AO	DEPTH 1'
TRANSECT 21	7.7	8.4	8.7	9.4	VE	21-11
					AE	11-9
					AO	DEPTH 1'
TRANSECT 22	7.7	8.4	8.7	9.4	VE	21-11
					AE	11-9
					AO	DEPTH 1'
TRANSECT 23	7.7	8.4	8.7	9.4	VE	21-11
					AE	11-9
					AO	DEPTH 1'
TRANSECT 24	7.7	8.4	8.7	9.4	VE	21-11
					AE	11-9
					AO	DEPTH 1'

[1]North American Vertical Datum of 1988

[2]Due to map scale limitations, base flood elevations shown on the FIRM represent average elevations for the zones depicted

TABLE 11 – COUNTYWIDE TRANSECT DATA – cont'd

FLOODING SOURCE	STILLWATER ELEVATIONS (feet NAVD[1]) 10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance	ZONE	BASE FLOOD ELEVATION (feet NAVD)[1,2]
Lynn						
Saugus River						
TRANSECT 99	8	8.8	9.2	9.9	VE	18-11
					AE	11-9
					AO	DEPTH 2' AND 1'
TRANSECT 100	8	8.8	9.2	9.9	VE	18-11
					AE	11-9
					AO	DEPTH 2' AND 1'
Atlantic Ocean						
TRANSECT 82	7.6	8.4	8.8	9.6	VE	14-11
					AE	11-9
					AO	DEPTH 2' AND 1'
TRANSECT 83	7.6	8.4	8.8	9.6	VE	14-11
					AE	11-9
					AO	DEPTH 2' AND 1'
TRANSECT 84	7.6	8.4	8.8	9.6	VE	14-11
					AE	11-9
					AO	DEPTH 2' AND 1'
Manchester						
Atlantic Ocean						
TRANSECT 51	7.3	8.1	8.4	9.2	VE	29-10
					AE	10-8
					AO	DEPTH 1'
					AH	9-8
TRANSECT 52	7.3	8.1	8.4	9.2	VE	29-10
					AE	10-8
					AO	DEPTH 1'
					AH	9-8

[1]North American Vertical Datum of 1988

[2]Due to map scale limitations, base flood elevations shown on the FIRM represent average elevations for the zones depicted

TABLE 11 – COUNTYWIDE TRANSECT DATA – cont'd

FLOODING SOURCE	STILLWATER ELEVATIONS (feet NAVD[1]) 10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance	ZONE	BASE FLOOD ELEVATION (feet NAVD)[1,2]
Manchester – con't						
Atlantic Ocean – cont'd						
TRANSECT 53	7.3	8.1	8.4	9.2	VE	29-10
					AE	10-8
					AO	DEPTH 1'
					AH	9-8
TRANSECT 54	7.3	8.1	8.4	9.2	VE	29-10
					AE	10-8
					AO	DEPTH 1'
					AH	9-8
TRANSECT 55	7.3	8.1	8.4	9.2	VE	29-10
					AE	10-8
					AO	DEPTH 1'
					AH	9-8
Marblehead						
Atlantic Ocean						
TRANSECT 66	7.6	8.4	8.8	9.5	VE	33-11
					AE	29-9
					AO	DEPTH 2' AND 1'
TRANSECT 67	7.6	8.4	8.8	9.5	VE	33-11
					AE	29-9
					AO	DEPTH 2' AND 1'
TRANSECT 68	7.6	8.4	8.8	9.5	VE	33-11
					AE	29-9
					AO	DEPTH 2' AND 1'
TRANSECT 69	7.6	8.4	8.8	9.5	VE	33-11
					AE	29-9
					AO	DEPTH 2' AND 1'

[1]North American Vertical Datum of 1988

[2]Due to map scale limitations, base flood elevations shown on the FIRM represent average elevations for the zones depicted

TABLE 11 – COUNTYWIDE TRANSECT DATA – cont'd

FLOODING SOURCE	STILLWATER ELEVATIONS (feet NAVD[1]) 10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance	ZONE	BASE FLOOD ELEVATION (feet NAVD)[1,2]
Marblehead – cont'd						
Atlantic Ocean – cont'd						
TRANSECT 70	7.6	8.4	8.8	9.5	VE	33-11
					AE	29-9
					AO	DEPTH 2' AND 1'
TRANSECT 71	7.6	8.4	8.8	9.5	VE	33-11
					AE	29-9
					AO	DEPTH 2' AND 1'
TRANSECT 72	7.6	8.4	8.8	9.5	VE	33-11
					AE	29-9
					AO	DEPTH 2' AND 1'
TRANSECT 73	7.6	8.4	8.8	9.5	VE	33-11
					AE	29-9
					AO	DEPTH 2' AND 1'
TRANSECT 74	7.6	8.4	8.8	9.5	VE	33-11
					AE	29-9
					AO	DEPTH 2' AND 1'
TRANSECT 75	7.6	8.4	8.8	9.5	VE	33-11
					AE	29-9
					AO	DEPTH 2' AND 1'
Nahant						
Atlantic Ocean						
TRANSECT 85	7.7	8.5	8.9	9.7	VE	29-11
					AE	19-9
					AO	DEPTH 2' AND 1'
TRANSECT 86	7.7	8.5	8.9	9.7	VE	29-11
					AE	19-9
					AO	DEPTH 2' AND 1'

[1]North American Vertical Datum of 1988

[2]Due to map scale limitations, base flood elevations shown on the FIRM represent average elevations for the zones depicted

TABLE 11 – COUNTYWIDE TRANSECT DATA – cont'd

FLOODING SOURCE	STILLWATER ELEVATIONS (feet NAVD[1]) 10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance	ZONE	BASE FLOOD ELEVATION (feet NAVD)[1,2]
Nahant – cont'd						
Atlantic Ocean – cont'd						
TRANSECT 87	7.7	8.5	8.9	9.7	VE	29-11
					AE	19-9
					AO	DEPTH 2' AND 1'
TRANSECT 88	7.7	8.5	8.9	9.7	VE	29-11
					AE	19-9
					AO	DEPTH 2' AND 1'
TRANSECT 89	7.7	8.5	8.9	9.7	VE	29-11
					AE	19-9
					AO	DEPTH 2' AND 1'
TRANSECT 90	7.7	8.5	8.9	9.7	VE	29-11
					AE	19-9
					AO	DEPTH 2' AND 1'
TRANSECT 91	7.7	8.5	8.9	9.7	VE	29-11
					AE	19-9
					AO	DEPTH 2' AND 1'
TRANSECT 92	7.7	8.5	8.9	9.7	VE	29-11
					AE	19-9
					AO	DEPTH 2' AND 1'
TRANSECT 93	7.7	8.5	8.9	9.7	VE	29-11
					AE	19-9
					AO	DEPTH 2' AND 1'
TRANSECT 94	7.7	8.5	8.9	9.7	VE	29-11
					AE	19-9
					AO	DEPTH 2' AND 1'
TRANSECT 95	7.7	8.5	8.9	9.7	VE	29-11
					AE	19-9
					AO	DEPTH 2' AND 1'

[1]North American Vertical Datum of 1988

[2]Due to map scale limitations, base flood elevations shown on the FIRM represent average elevations for the zones depicted

TABLE 11 – COUNTYWIDE TRANSECT DATA – cont'd

FLOODING SOURCE	STILLWATER ELEVATIONS (feet NAVD[1]) 10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance	ZONE	BASE FLOOD ELEVATION (feet NAVD)[1,2]
TRANSECT 96	7.7	8.5	8.9	9.7	VE	29-11
					AE	19-9
					AO	DEPTH 2' AND 1'
TRANSECT 97	7.7	8.5	8.9	9.7	VE	29-11
					AE	19-9
					AO	DEPTH 2' AND 1'
TRANSECT 98	7.7	8.5	8.9	9.7	VE	29-11
					AE	19-9
					AO	DEPTH 2' AND 1'
Newbury						
Atlantic Ocean/Parker River						
TRANSECT 16	7.4	8.1	8.4	9	VE	19-13
					AE	16-8
					AO	DEPTH 1'
TRANSECT 17	7.4	8.1	8.4	9	VE	19-13
					AE	16-8
					AO	DEPTH 1'
Newburyport						
Atlantic Ocean						
TRANSECT 11	7.8	8.6	8.9	9.7	VE	16-13
					AE	13-11
TRANSECT 12	7.8	8.6	8.9	9.7	VE	15-12
					AE	15, 12-10

[1]North American Vertical Datum of 1988

[2]Due to map scale limitations, base flood elevations shown on the FIRM represent average elevations for the zones depicted

TABLE 11 – COUNTYWIDE TRANSECT DATA – cont'd

FLOODING SOURCE	STILLWATER ELEVATIONS (feet NAVD[1]) 10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance	ZONE	BASE FLOOD ELEVATION (feet NAVD)[1,2]
TRANSECT 13	7.8	8.6	8.9	9.7	VE	17, 15-12
					AE	12-10
					AO	DEPTH 2'
TRANSECT 14	7.8	8.6	8.9	9.7	VE	22, 17-15
					AE	15-13
TRANSECT 15	7.8	8.6	8.9	9.7	VE	23, 16-15
					AE	15-9
Peabody						
Waters River	8.4	9.5	10.0	11.6	AE	10
Rockport						
Atlantic Ocean						
TRANSECT 33	7.5	8.3	8.6	9.2	VE	31-12
					AE	17-8
					AO	DEPTH 3' TO 1'
TRANSECT 34	7.5	8.3	8.6	9.2	VE	31-12
					AE	17-8
					AO	DEPTH 3' TO 1'
TRANSECT 35	7.5	8.3	8.6	9.2	VE	31-12
					AE	17-8
					AO	DEPTH 3' TO 1'
TRANSECT 36	7.5	8.3	8.6	9.2	VE	31-12
					AE	17-8
					AO	DEPTH 3' TO 1'
TRANSECT 37	7.5	8.3	8.6	9.2	VE	31-12
					AE	17-8
					AO	DEPTH 3' TO 1'

[1]North American Vertical Datum of 1988

[2]Due to map scale limitations, base flood elevations shown on the FIRM represent average elevations for the zones depicted

TABLE 11 – COUNTYWIDE TRANSECT DATA – cont'd

FLOODING SOURCE	STILLWATER ELEVATIONS (feet NAVD[1]) 10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance	ZONE	BASE FLOOD ELEVATION (feet NAVD)[1,2]
Rockport – cont'd						
Atlantic Ocean – cont'd						
TRANSECT 38	7.5	8.3	8.6	9.2	VE	31-12
					AE	17-8
					AO	DEPTH 3' TO 1'
TRANSECT 39	7.5	8.3	8.6	9.2	VE	31-12
					AE	17-8
					AO	DEPTH 3' TO 1'
TRANSECT 40	7.5	8.3	8.6	9.2	VE	31-12
					AE	17-8
					AO	DEPTH 3' TO 1'
TRANSECT 41	7.5	8.3	8.6	9.2	VE	31-12
					AE	17-8
					AO	DEPTH 3' TO 1'
TRANSECT 42	7.5	8.3	8.6	9.2	VE	31-12
					AE	17-8
					AO	DEPTH 3' TO 1'
Rowley						
Atlantic Ocean						
TRANSECT 18	7.5	8.2	8.5	9.2	VE	13
					AE	9-8
Salem						
Atlantic Ocean						
TRANSECT 62	7.8	8.6	8.9	9.7	VE	29-11
					AE	14-9
					AO	DEPTH 2' AND 1'

[1]North American Vertical Datum of 1988

[2]Due to map scale limitations, base flood elevations shown on the FIRM represent average elevations for the zones depicted

TABLE 11 – COUNTYWIDE TRANSECT DATA – cont'd

FLOODING SOURCE	STILLWATER ELEVATIONS (feet NAVD[1]) 10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance	ZONE	BASE FLOOD ELEVATION (feet NAVD)[1,2]
Salem – cont'd						
Atlantic Ocean – cont'd						
TRANSECT 63	7.8	8.6	8.9	9.7	VE	29-11
					AE	14-9
					AO	DEPTH 2' AND 1'
TRANSECT 64	7.8	8.6	8.9	9.7	VE	29-11
					AE	14-9
					AO	DEPTH 2' AND 1'
TRANSECT 65	7.8	8.6	8.9	9.7	VE	29-11
					AE	14-9
					AO	DEPTH 2' AND 1'
Salisbury						
Atlantic Ocean						
TRANSECT 1	7.4	8.1	8.3	9	VE	18-14
					AE	14-9
TRANSECT 2	7.4	8.1	8.3	9	VE	19-15
					AE	14-9
					AO	DEPTH 2'
TRANSECT 3	7.4	8.1	8.3	9	VE	20, 17-15
					AE	15-9
TRANSECT 4	7.4	8.1	8.3	9	VE	19, 17-15
					AE	14-9
TRANSECT 5	7.4	8.1	8.3	9	VE	19-15
					AE	14-9

[1]North American Vertical Datum of 1988

[2]Due to map scale limitations, base flood elevations shown on the FIRM represent average elevations for the zones depicted

TABLE 11 – COUNTYWIDE TRANSECT DATA – cont'd

FLOODING SOURCE	STILLWATER ELEVATIONS (feet NAVD[1]) 10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance	ZONE	BASE FLOOD ELEVATION (feet NAVD)[1,2]
Salisbury – cont'd						
Atlantic Ocean – cont'd						
TRANSECT 6	7.4	8.1	8.3	9	VE	19-15
					AE	14-9
TRANSECT 7	7.4	8.1	8.3	9	VE	19, 17-15
					AE	14-9
					AO	DEPTH 2'
TRANSECT 8	7.4	8.1	8.3	9	VE	20, 17-15
					AE	15-9
TRANSECT 9	7.4	8.1	8.3	9	VE	13-11
					AE	11-9
TRANSECT 10	7.4	8.1	8.3	9	VE	13-11
					AE	11-9
Saugus						
Saugus Tidal Area	8	8.8	9.2	10	AE	9
Swampscott						
Atlantic Ocean						
TRANSECT 76	7.6	8.4	8.7	9.5	VE	27-11
					AE	11-9
					AO	DEPTH 2' AND 1'
TRANSECT 77	7.6	8.4	8.7	9.5	VE	27-11
					AE	11-9
					AO	DEPTH 2' AND 1'

[1]North American Vertical Datum of 1988

[2]Due to map scale limitations, base flood elevations shown on the FIRM represent average elevations for the zones depicted

TABLE 11 – COUNTYWIDE TRANSECT DATA – cont'd

FLOODING SOURCE	STILLWATER ELEVATIONS (feet NAVD[1]) 10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance	ZONE	BASE FLOOD ELEVATION (feet NAVD)[1,2]
TRANSECT 78	7.6	8.4	8.7	9.5	VE	27-11
					AE	11-9
					AO	DEPTH 2' AND 1'
TRANSECT 79	7.6	8.4	8.7	9.5	VE	27-11
					AE	11-9
					AO	DEPTH 2' AND 1'
TRANSECT 80	7.6	8.4	8.7	9.5	VE	27-11
					AE	11-9
					AO	DEPTH 2' AND 1'
TRANSECT 81	7.6	8.4	8.7	9.5	VE	27-11
					AE	11-9
					AO	DEPTH 2' AND 1'

[1]North American Vertical Datum of 1988

[2]Due to map scale limitations, base flood elevations shown on the FIRM represent average elevations for the zones depicted

Figure 1, “Transect Schematic” represents s sample transect that illustrates the relationship between stillwater elevation, the wave crest elevation, the ground elevation profile and the location of the V/A zone boundary.

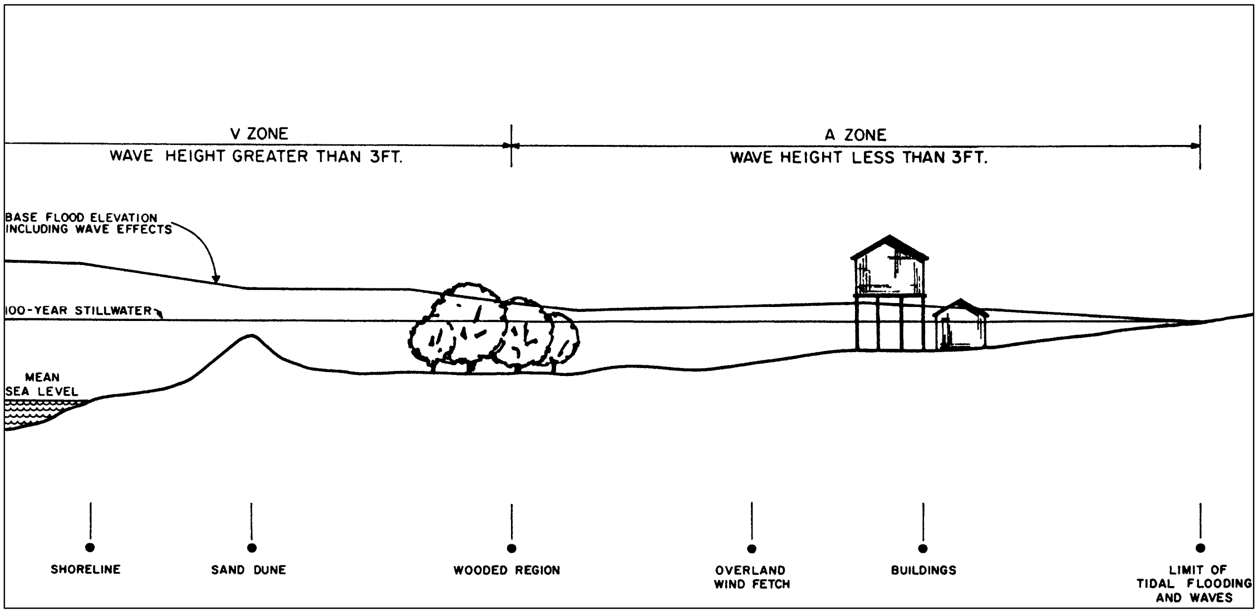


Figure 1. Transect Schematic

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 the National Geodetic Vertical Datum of 1929 (NGVD). With the completion of the North American Vertical Datum of 1988 (NAVD), many FIS reports and FIRMs are now prepared using NAVD 88 as the referenced vertical datum.

All flood elevations shown in this FIS report and on the FIRM are referenced to the NAVD 88. These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. Ground, structure, and flood elevations may be compared and/or referenced to NGVD 29 by applying a standard conversion factor. **The conversion factor from NGVD 29 to NAVD 88 is -0.8, and from NAVD 88 to NGVD 29 is +0.8.**

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

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

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 the FIS report and FIRM for this county. Interested individuals may contact FEMA to access these data.

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.

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

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound floodplain management programs. To assist in this endeavor, each FIS report provides 1-percent-annual-chance floodplain data, which may include a combination of the following: 10-, 2-, 1-, and 0.2-percent-annual-chance flood elevations; delineations of the 1- 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

In order to provide a national standard without regional discrimination, the 1-percent-annual-chance flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent-annual-chance flood is employed to indicate additional areas of flood risk in the community.

The 1- and 0.2-percent-annual-chance floodplain boundaries are shown on the FIRM (Exhibit 2). 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, V, 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.

Redelineation of coastal flood hazard data was performed for open water flooding sources in the communities of Beverly, Danvers, Essex, Gloucester, Ipswich, Lynn, Manchester, Marblehead, Nahant, Newbury, Peabody, Rockport, Rowley, Salem, Saugus and Swampscott by applying the results of previous coastal analyses to new or updated topographic data.

For unrevised flooding sources in Essex County, data was taken from previously printed FISs for each individual community and are compiled below.

For the streams studied in detail, the 1- and 0.2-percent-annual-chance floodplain boundaries have been delineated using the flood elevations determined at each cross section. The boundaries were interpolated between cross sections using topographic maps at at a scale of 1:4,800 with a contour interval of 5 feet in Andover (Reference 84); using photogrammetric maps in Beverly (Reference 85); at a scale of 1:4,800 with a contour interval of 4 feet in Boxford (Reference 86); at a scale of 1:2400 and 1: 4800 with contours intervals of 5 feet in Danvers, Lawrence, and Haverhill, Manchester, Merrimac, Methuen, Middleton, Salem, and Saugus (Reference 87 and 88); at a scale of 1:24000 with a contour interval of 10 feet in Amesbury, Groveland, Hamilton, Topsfield, Wenham, West Newbury, and Georgetown (Reference 38); using topographic maps in Ipswich, Lynn, Gloucester, and Essex, Newbury, Newburyport, Rowley, Salisbury and Swampscott (Reference 89); at scales of 1:24000 and 1:2400 with contour intervals of 10 and 5 feet in Lynnfield (References 90 and 91); at a scale of 1:2400 with a contour interval of 5 feet in Nahant (Reference 92); at a scale of 1:4800 feet with a contour interval of 10 feet in North Andover (Reference 93)

For the areas studied by approximate methods, the boundary of the 1-percent-annual-chance year flood was delineated using the Flood Hazard Boundary Map and topographic maps for the respective communities.

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, 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.

Floodway widths were computed at cross sections. 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 12, “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.

Since the communities of Newburyport and West Newbury are located directly across the river from Amesbury, the floodway for the Merrimack River in the Town of Amesbury was taken from the completed Flood Insurance Studies for these two communities (References 94 and 95). It is noted that the floodway limits on the Merrimack River are generally at the edge of the river bank with little resulting rise in water-surface.

Portions of the floodway widths for the Merrimack River, and the Shawsheen River extend beyond the corporate limits. The floodway boundaries for Hussey Brook Tributary are coincident with the channel banks.

Wherever applicable, the Powwow River floodway was computed by Method 6 of the HEC-2 computer program. Method 6 reduces conveyance equally on both sides until a one-foot rise in energy gradient is obtained. On portions of the Powwow River, the floodway concept is generally not applicable for bodies of water with significant impoundment effects. Because Lake Gardner and the large swampy area between West Whitehall Road and Tuxbury Pond in northwest Amesbury do provide storage, no floodway was computed along those portions of the Powwow River.

A floodway was not computed for North Beverly Drainage Ditch since the concept of a floodway does not apply to this drainage area. The flooding in this area is the result of ponding behind an insufficiently-sized culvert under the Boston and Maine Railroad tracks. The ponding upstream of the culvert reaches a 1-percent-annual-chance recurrence elevation of 19 feet regardless of any floodway that may or may not be present. Since water exits only through the culvert and not over the railroad tracks, it is inappropriate to incorporate a floodway there.

Portions of the floodway widths of the Ipswich River and Miles River extend beyond the corporate limits.

Portions of the floodway widths along the Merrimack River, Little River, Creek Brook, Millvale Reservoir Brook and Haverhill-Riverside Airport Brook are contained within the channel banks.

Floodway widths for portions of the Merrimack and Shawsheen Rivers extend beyond the corporate limits. Portions of the floodways on the Merrimack, Shawsheen and Spicket Rivers are contained within channel banks.

No floodway has been computed for Pillings Pond, because it is not appropriate to delineate a floodway for an impoundment area.

Because of the general hydrological makeup of Beaverdam Brook in the vicinity of the Chestnut Street crossing and Bates Brook in the vicinity of the Boston and Maine Railroad embankment crossing, encroachments could theoretically be allowed up to the existing channel banks without increasing the 1-percent-annual-chance elevation more than 1.0 foot. However, caution should be used in adopting this concept, because the loss of extensive overbank storage could possibly result in hazardous velocity conditions along portions of these brooks.

Floodways were computed on the Saugus River on Beaverdam Brook from its confluence with the Saugus River to the limit of detailed study, and on Bates Brook from Bourque Road to the limit of detailed study. Extreme caution should be exercised in allowing encroachments on the Saugus River above the Saugus River Dam, and on Beaverdam Brook for the following reasons. Loss of natural valley storage will mean a loss of attenuation.

Depending on the amount of encroachment permitted, there exists a possibility of a significant increase in flood discharges, due to this loss of attenuation, over those values used in computations in this report. Also, it should be noted that the City of Lynn uses the portion of the Saugus River above the dam as a part of their water supply system. Taking water from the Saugus River for this purpose was authorized by Chapter 256, Acts of 1883, and by Chapter 400, Acts of 1893, enacted by the legislature of the Commonwealth of Massachusetts. Because no survey information was available, that portion of the floodway on Beaverdam Brook between its confluence with the Saugus River and Main Street was based on the floodway computed for this brook above Chestnut Street.

Establishment of floodways on the Spicket River, Harris Brook, Bare Meadow Brook to its confluence with Hawkes Brook and to a point 3,750 feet above its confluence with Bare Meadow Brook was accomplished using Types 2, 5, and 6 of the HEC-2 program (Reference 55). Type 5 reduces conveyance equally on both sides of a stream until a 1.0-foot rise in water-surface is indicated, and Type 6 encroaches by equal conveyance until a 1.0-foot rise in the energy grade line is indicated. Although Types 5 and 6 were used for guidance, because of the small size and tortuous flow paths of many of the streams, Type 2 was utilized in an attempt to arrive at practical floodways with reasonably uniform widths. For Type 2, the left and right encroachment stations are made equidistant from one center line of the channel.

Establishment of floodways on the Merrimack River, Bare Meadow Brook from its confluence with Hawkes Brook to Hills Pond, Hawkes Brook from a point 3,750 feet above the confluence with Bare Meadow Brook to North Street, Bartlett Brook and Peat Meadow Brook was accomplished using Types 1 and 6 of the HEC-2 program. Type 6 was first used for guidance. Type 1 provides for the setting of floodway widths at each cross section and thus is made to delineate a smooth floodway.

Sections of Bare Meadow, Harris, Peat Meadow, Hawkes and Bartlett Brooks are affected by backwater.

In the downtown area of Peabody, flooding problems on North River, Proctor Brook and Goldthwaite Brook are compounded by culverts with insufficient capacity. Floodways for this area were not computed due to heavy urban development in the flood plain. It would he technically inaccurate to model a floodway in this area using conventional backwater analyses, where the natural stream channel frequently is nonexistent. However, in the event of redevelopment, detailed analysis of the area should be made to prevent an increase in the base flood elevation greater than 1.0 foot.

No floodway has been computed for the Merrimack River in the Town of Salisbury.

Portions of the floodway widths of the Saugus River extend beyond the corporate limits.

Portions of the floodway widths for the Ipswich River and Fish Brook extend beyond the corporate limits. No floodway is shown for Unnamed Tributary to Fish Brook.

No floodway was run on the Artichoke River, from its confluence with the Merrimack River to Curzon Mill Dam, because this reach is a tidal estuary. Between the Curzon Mill Dam and the Lower Artichoke Reservoir Dam on the

Artichoke River, no floodway was run because this reach of the river is a water impoundment area. From the Lower Artichoke Reservoir Dam to Pikes Bridge Road, which includes the lower reach of North Tributary Brook, no f1oodway was run because this reach of the Artichoke River is a water supply reservoir. The wide floodway between cross sections C and D of North Tributary Brook is due to the influence of the meandering stream.

Protection against the filling of flood storage areas is possible under the Massachusetts Wetlands Protection Act (General Laws Chapter 131, Section 40). This act controls, but does not ban development on wetlands. Wetlands are defined here, for the purpose of brevity, as inland wetlands-- marshes, swamps bordering on rivers, streams, and ponds--most any land which is periodically wet. The law requires that any person or governmental agency intending to remove, fill, dredge, or alter a wetland must ensure, by following various procedural and technical steps, that the activity will have no adverse effect on water supplies, storm and flood prevention, pollution prevention, or fisheries. In effect, the owner must develop his wetlands in accordance with the public's interest and safety.

The area between the floodway and 1-percent-annual-chance floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation (WSEL) of the base flood more than 1 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 2, “Floodway Schematic”.

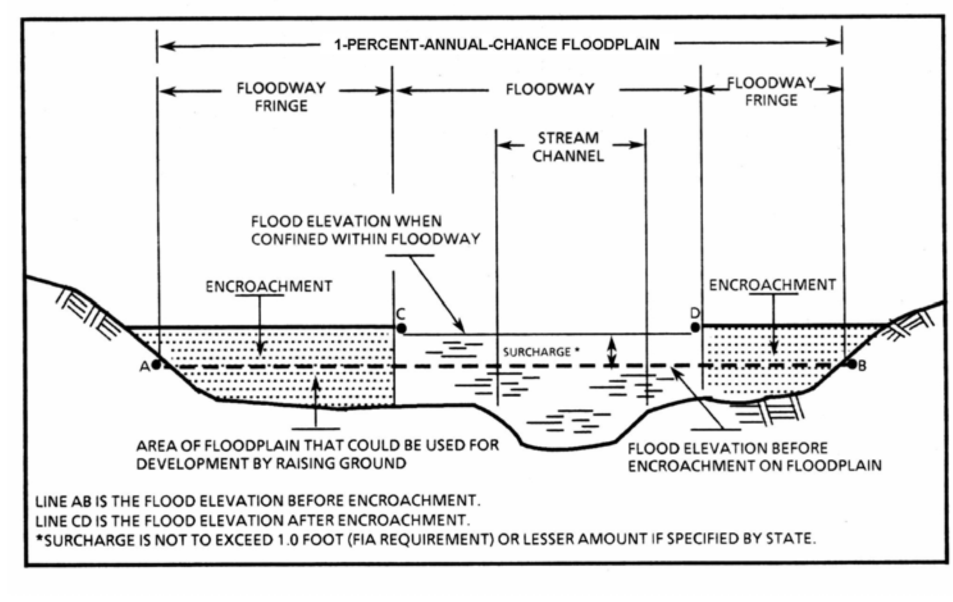


Figure 2. Floodway Schematic

Near the mouths of streams studied in detail, floodway computations are made without regard to flood elevations on the receiving water body. Therefore, 'Without Floodway" elevations presented in Table 12, Floodway Data, for certain downstream cross sections of the Powwow River, Mill River, Branch of Ipswich, Little River, Creek Brook, Millvale Reservoir Brook, Haverhill-Riverside Airport Brook, Porter River, Crane Rivers, and Hussey Brook Tributary are lower than the regulatory flood elevations in that area, which must take into account the 1-percent-annual-chance year flooding due to backwater from other sources.

One aspect of floodway and flood plain encroachment is sometimes overlooked and more often neglected: the cumulative effect of encroachment on flood discharge magnitude. Generally, as encroachment occurs, temporary storage areas are lost, velocities increase, and the magnitude of the discharge increases. As floodwaters move downstream, that increase can become more significant. The combined effect of a narrower flood plain and greater discharge can, due to hydraulic effects alone, produce a flood stage that exceeds the anticipated 1-percent-annual-chance flood.

FEMA does not encourage the filling in of the floodway fringe area. Local officials should be aware that even a 1-foot rise in the watersurface elevation can cause flooding in areas which would have received little or no flooding if such filling had not taken place. Careful consideration of the economic and human dislocation which will be caused by a rise in flood heights should be made before filling is allowed. Large quantities of fill in the fringe area could also disrupt the flood plain ecosystem, causing a major impact on local environmental resources.

Communities are encouraged by FEMA to adopt wider, more restrictive floodways and to minimize the amount of fill allowed in the fringe areas. Such actions also meet the intent of the Massachusetts Wetlands Protection Act (Massachusetts General Law, Chapter 13 1, Section 40). Under the provisions of the act, the local conservation commission and the Massachusetts Department of Environmental Quality Engineering have the authority to impose "orders of condition" regulating flood plain areas subject to flooding and wetland alterations. The orders normally require compensatory storage to replace any loss resulting from proposed flood plain alterations. "Compensatory storage" is the volume of flood plain storage which must be created for floodwater retention equaling the storage removed by alteration. Such requirements in flood plain areas are designed to minimize adverse effects on flood plain hydrology.

In order to achieve a unified flood plain and wetlands management program, numerous Massachusetts communities have adopted local zoning by-laws, ordinances, subdivision regulations, and local Board of Health regulations augmenting the minimum requirements of the NFIP and the Wetlands Protection Act. FEMA encourages the use of this FIS as the technical basis for adoption of a broader, more encompassing local flood plain management program than is required to meet the minimum standards of the NFIP.

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	1,400	76	571	0.6	21.4 [2]	18.3	19.2	0.9
B	3,500	13	36	9.5	30.4	30.4	31.1	0.7
C	6,650	162	619	0.6	49.8	49.8	50.7	0.9

[1] FEET ABOVE CONFLUENCE WITH JOHNSON CREEK

[2] ELEVATIONS COMPUTED CONSIDERING THE BACKWATER EFFECTS FROM JOHNSON CREEK

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

FLOODWAY DATA

ARGILLA BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	1,495	50	93	7.5	27.5 [2]	13.4	13.7	0.3
B	1,725	50	207	3.3	27.5 [2]	17.8	17.8	0.0
C	2,495	50	187	3.7	27.5 [2]	18.3	18.7	0.4
D	2,710	50	411	1.7	27.5 [2]	25.4	25.4	0.0
E	6,150	50	304	2.3	27.5 [2]	25.5	26.0	0.5
F	7,655	45	143	2.8	28.8	28.8	29.8	1.0
G	8,410	12	44	9.2	33.0	33.0	33.0	0.0
H	8,965	80	605	0.7	35.4	35.4	36.0	0.6
I	10,005	20	52	7.7	39.4	39.4	39.7	0.3
J	10,720	17	46	8.8	50.1	50.1	50.4	0.3
K	11,765	20	77	5.2	60.2	60.2	61.0	0.8
L	12,010	25	106	2.2	64.6	64.6	64.8	0.2
M	12,390	20	100	2.3	67.1	67.1	67.1	0.0
N	13,320	50	287	0.8	67.2	67.2	67.4	0.2
O	14,695	50	99	0.8	67.2	67.2	67.7	0.5
P	15,345	245	1,286	0.1	77.1	77.1	77.1	0.0

[1] FEET ABOVE CONFLUENCE WITH MERRIMACK RIVER

[2] ELEVATIONS COMPUTED CONSIDERING THE BACKWATER EFFECTS FROM MERRIMACK RIVER

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

FLOODWAY DATA

BARE MEADOW BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	320	55	185	3.4	51.7	40.5 [2]	40.6 [2]	0.1
B	630	150	966	0.7	51.7	44.6 [2]	44.6 [2]	0.0
C	1,200	230	1,485	0.4	51.7	44.7 [2]	44.7 [2]	0.0
D	1,910	30	109	5.8	51.7	44.7 [2]	44.7 [2]	0.0
E	2,215	11	51	12.3	51.7	47.7 [2]	47.7 [2]	0.0
F	3,290	30	78	8.1	53.2	53.2	53.5	0.3
G	4,130	45	181	3.5	58.5	58.5	59.2	0.7
H	5,890	155	525	1.2	60.3	60.3	61.3	1.0
I	7,840	230	774	0.8	61.1	61.1	62.1	1.0
J	8,310	55	114	5.5	61.9	61.9	62.3	0.4

[1] FEET ABOVE CONFLUENCE WITH MERRIMACK RIVER

[2] ELEVATIONS COMPUTED WITHOUT CONSIDERING BACKWATER EFFECTS FROM MERRIMACK RIVER

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

FLOODWAY DATA

BARTLETT BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A [2]	700	9	15	7.7	98.2	98.2	98.2	0.0
B [2]	750	9	46	2.6	101.8	101.8	101.8	0.0
C	880	20	118	1.0	101.9	101.9	101.9	0.0
D	980	4	19	6.2	101.9	101.9	102.0	0.1
E [2]	1,435	12	111	1.1	104.3	104.3	104.6	0.3
F [2]	1,845	12	93	2.3	104.3	104.3	105.1	0.8
G [2]	2,165	115	820	0.3	104.3	104.3	105.2	0.9
H	2,455	20	40	6.9	106.4	106.4	106.4	0.0
I [2]	2,705	8	40	6.9	109.3	109.3	109.3	0.0
J	2,720	8	41	6.7	109.4	109.4	109.4	0.0
K	2,960	9	29	10.3	110.4	110.4	110.4	0.0
L [2]	3,200	31	31	9.6	112.9	112.9	112.9	0.0
M	3,360	64	280	1.1	113.5	113.5	114.3	0.8
N	3,525	98	572	0.5	113.5	113.5	114.4	0.9
O [2]	3,980	6	33	9.1	113.5	113.5	114.4	0.9
P [2]	4,075	12	45	6.7	114.9	114.9	115.7	0.8
Q	4,345	94	293	1.0	116.3	116.3	117.3	1.0
R	4,605	12	32	9.4	120.2	120.2	121.0	0.8

[1] FEET ABOVE CONFLUENCE WITH PILLINGS POND

[2] INTERPOLATED CROSS SECTION

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

FLOODWAY DATA

BATES BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	1,368	45	480	0.7	30.8	30.8	30.8	0.0
B	1,954	85	835	0.4	31.7	31.7	31.8	0.1
C	2,350	180	1,685	0.2	31.7	31.7	31.8	0.1
D	3,263	15	130	2.5	31.7	31.7	32.2	0.5
E	4,208	20	145	2.2	31.8	31.8	32.6	0.8
F	5,671	20	130	2.5	35.3	35.3	35.3	0.0
G	7,017	30	80	4.0	44.3	44.3	45.1	0.8
H	7,857	50	245	1.2	51.5	51.5	52.5	1.0
I	8,976	40	175	1.6	52.0	52.0	53.0	1.0
J	9,678	50	180	1.6	53.6	53.6	54.3	0.7
K	10,761	65	365	0.8	55.6	55.6	55.9	0.3

[1] FEET ABOVE SYLVAN STREET DAM

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

FLOODWAY DATA

BEAVER BROOK (TOWN OF DANVERS)

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	0	9	38	3.9	69.2	69.2	69.2	0.0
B	935	187	507	0.2	69.8	69.8	69.8	0.0
C	2,715	4	8	8.7	77.0	77.0	77.0	0.0
D	2,975	18	68	1.0	78.8	78.8	79.4	0.6
E	3,135	4	18	3.9	78.8	78.8	79.4	0.6
F	4,195	141	311	0.2	79.5	79.5	79.9	0.4
G	6,285	10	11	6.1	85.6	85.6	86.2	0.6
H	7,435	16	31	2.2	93.4	93.4	94.0	0.6

[1] FEET ABOVE MIDDLE STREET

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA
(ALL JURISDICTIONS)

FLOODWAY DATA

BEAVER BROOK (TOWN OF WEST NEWBURY)

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	5,500	8	18	5.8	73.5	73.5	73.5	0.0
B[2]	5,560	8	20	5.2	74.1	74.1	74.1	0.0
C	5,900	11	40	2.6	74.9	74.9	75.5	0.6
D	6,200	3	10	10.5	75.7	75.7	75.7	0.0
E[2]	6,246	3	19	5.5	78.3	78.3	78.3	0.0
F	7,356	48	237	0.4	79.0	79.0	79.1	0.1
G	9,126	10	27	0.4	79.2	79.2	79.3	0.1
H	10,186	28	70	1.5	84.7	84.7	85.4	0.7
I	11,766	37	86	1.2	88.1	88.1	89.0	0.9
J	13,616	3	10	10.5	102.6	102.6	102.6	0.0

[1] FEET ABOVE CONFLUENCE WITH SAUGUS RIVER
[2] INTERPOLATED CROSS SECTION

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA
(ALL JURISDICTIONS)

FLOODWAY DATA

BEAVERDAM BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	-50	20	126	4.9	37.7	37.7	38.0	0.3
B	192	16	124	5.0	38.9	38.9	39.5	0.6
C	1,232	46	234	2.6	41.1	41.1	42.1	1.0
D	1,382	61	268	2.3	42.9	42.9	43.3	0.4
E	1,922	65	297	2.1	43.4	43.4	43.9	0.5
F	2,065	103	552	1.1	44.8	44.8	45.0	0.2
G	2,945	57	282	2.2	45.3	45.3	45.7	0.4
H	3,097	94	407	1.5	47.2	47.2	48.2	1.0
I	3,201	94	505	1.2	47.3	47.3	48.3	1.0
J	3,271	95	453	1.4	47.3	47.3	48.3	1.0
K	3,428	98	448	1.4	47.5	47.5	48.4	0.9
L	3,678	52	255	2.4	47.6	47.6	48.5	0.9
M	3,844	65	345	1.8	49.2	49.2	49.4	0.2
N	4,044	25	151	4.1	49.3	49.3	49.6	0.3
O	4,202	26	170	3.6	50.1	50.1	50.2	0.1
P	4,977	37	171	3.6	51.3	51.3	52.0	0.7
Q	5,077	87	371	1.7	52.7	52.7	53.0	0.3
R	6,557	73	298	2.1	53.6	53.6	54.4	0.8
S	6,733	50	660	0.9	56.9	56.9	57.5	0.6
T	7,013	55	283	2.2	57.7	57.7	57.9	0.2
U	7,513	17	60	10.3	58.7	58.7	58.9	0.2
V	7,699	37	140	4.4	62.8	62.8	62.8	0.0
W	7,929	30	149	4.1	63.4	63.4	64.1	0.7
X	8,226	67	431	1.4	64.2	64.2	64.7	0.5
Y	8,332	170	1,093	0.6	64.3	64.3	64.8	0.5
Z	9,232	223	776	0.8	64.3	64.3	64.8	0.5

[1] FEET ABOVE U.S. ROUTE 1 (DOWNSTREAM FACE)

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA
(ALL JURISDICTIONS)

FLOODWAY DATA

BENNETT'S POND BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	998	50	200	4.5	43.1 [2]	40.9	41.5	0.6
B	2,730	35	195	4.6	43.1 [2]	42.8	43.6	0.8
C	3,854	55	460	2.0	52.8	52.8	53.6	0.8
D	5,122	80	545	1.7	52.9	52.9	53.8	0.9
E	6,648	195	990	0.8	53.0	53.0	54.0	1.0
F	7,740	200	1,045	0.8	56.0	56.0	56.0	0.0
G	8,506	120	585	1.4	56.0	56.0	56.0	0.0
H	9,414	20	70	10.2	63.8	63.8	63.8	0.0
I	12,456	35	150	4.8	72.3	72.3	73.1	0.8
J	13,981	30	210	3.5	77.4	77.4	78.3	0.9
K	14,974	550	2,185	0.3	77.8	77.8	78.7	0.9
L	16,262	100	490	1.4	77.9	77.9	78.8	0.9
M	18,190	95	385	1.8	78.7	78.7	79.4	0.7
N	19,557	95	260	2.2	79.4	79.4	80.3	0.9
O	22,311	16	76	5.7	83.9	83.9	84.7	0.8
P	24,066	30	71	6.2	87.3	87.3	87.7	0.4
Q	24,711	26	117	3.7	91.3	91.3	91.4	0.1
R	25,586	30	159	2.7	94.4	94.4	94.5	0.1
S	26,951	20	116	3.7	94.8	94.8	95.4	0.6
T	28,361	50	401	1.1	100.9	100.9	101.6	0.7
U	29,158	150	1,702	0.2	101.0	101.0	101.7	0.7
V	30,151	50	243	1.6	101.1	101.1	101.8	0.7
W	32,348	90	301	1.3	102.0	102.0	102.7	0.7
X	32,881	30	177	2.2	104.4	104.4	104.8	0.4
Y	34,576	90	358	1.0	104.7	104.7	105.7	1.0
Z	36,566	80	224	1.6	105.7	105.7	106.7	1.0

[1] FEET ABOVE CONFLUENCE WITH IPSWICH RIVER
[2] ELEVATIONS COMPUTED CONSIDERING THE BACKWATER EFFECTS FROM IPSWICH RIVER

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA
(ALL JURISDICTIONS)

FLOODWAY DATA

BOSTON BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
BRANCH OF IPSWICH								
A	240	200	1,134	0.1	39.4	39.4	40.4	1.0
B	740	150	837	0.2	39.4	39.4	40.4	1.0
C	2,022	95	448	0.3	40.3	40.3	40.7	0.4
D	2,302	20	90	1.6	40.8	40.8	41.0	0.2
CLEVELAND BROOK								
E	2,522	16	104	1.2	43.2	43.2	43.3	0.1
F	3,222	40	203	0.6	43.2	43.2	43.3	0.1
G	4,120	76	673	0.2	46.8	46.8	46.8	0.0
H	4,390	35	140	0.9	46.8	46.8	47.1	0.3
I	4,752	10	19	6.7	47.4	47.4	47.7	0.3
J	5,775	40	127	1.0	54.6	54.6	54.6	0.0
K	6,575	40	118	1.1	54.7	54.7	54.8	0.1
L	6,950	30	64	0.6	55.7	55.7	55.9	0.2
M	7,290	19	27	1.3	57.8	57.8	58.8	1.0
N	7,800	16	18	2.0	72.6	72.6	72.6	0.0

[1] FEET ABOVE CONFLUENCE WITH IPSWICH RIVER

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

FLOODWAY DATA

BRANCH OF IPSWICH AND CLEVELAND BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	250	3	14	0.6	79.8 [2]	79.0	80.0	1.0
B	1,500	132	282	0.0	79.8 [2]	79.0	80.0	1.0
C	2,600	8	14	0.6	79.8 [2]	79.0	80.0	1.0

[1] FEET ABOVE CONFLUENCE WITH PENN BROOK

[2] ELEVATIONS COMPUTED CONSIDERING THE BACKWATER EFFECTS FROM PENN BROOK

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

FLOODWAY DATA

BULFORD BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	1,670	9	36	5.5	8.9	8.9	9.5	0.6
B	1,872	20	134	1.5	12.9	12.9	13.1	0.2
C	2,052	20	115	1.7	12.9	12.9	13.1	0.2
D	2,267	20	68	2.9	12.9	12.9	13.2	0.3
E	2,402	18	28	7.1	21.2	21.2	21.2	0.0
F	2,562	20	50	4.0	22.3	22.3	22.3	0.0
G	2,862	20	40	5.0	24.2	24.2	24.3	0.1
H	3,187	17	37	5.4	32.1	32.1	32.2	0.1
I	3,787	20	67	3.0	35.3	35.3	35.7	0.4
J	4,587	20	49	4.9	39.2	39.2	39.3	0.1
K	4,777	17	40	5.0	41.6	41.6	41.6	0.0
L	4,952	16	68	2.9	43.5	43.5	43.5	0.0
M	5,462	16	49	4.1	44.8	44.8	45.1	0.3
N	5,912	16	53	3.7	47.3	47.3	47.4	0.1
O	6,282	16	52	3.8	48.8	48.8	49.0	0.2
P	6,439	16	57	3.5	49.6	49.6	49.8	0.2
Q	6,739	57	113	1.8	49.9	49.9	50.2	0.3
R	7,339	16	71	2.8	50.2	50.2	51.2	1.0
S	7,468	22	119	1.7	53.9	53.9	53.9	0.0

[1] FEET ABOVE CONFLUENCE WITH MASSACHUSETTS BAY

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA
(ALL JURISDICTIONS)

FLOODWAY DATA

CENTERVILLE CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	4,860	280	82	2.0	9.3	9.3	9.3	0.0
B	5,450	130	249	0.7	9.8	9.8	10.2	0.4
C	5,635	15	72	2.3	13.3	13.3	13.3	0.0
D	5,785	25	100	1.7	13.3	13.3	13.5	0.2
E	5,923	25	141	1.2	16.7	16.7	16.7	0.0
F	6,313	28	105	1.6	16.7	16.7	16.8	0.1
G	6,803	20	26	6.5	18.2	18.2	18.2	0.0
H	6,959	28	168	1.0	24.6	24.6	24.8	0.2

[1] FEET ABOVE CONFLUENCE WITH CHUBB CREEK

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

FLOODWAY DATA

CHUBBS BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	310	7	47	6.6	32.6 [2]	23.3	24.0	0.7
B	360	22	114	2.7	32.6 [2]	24.1	24.8	0.7
C	580	12	73	4.3	32.6 [2]	24.4	25.1	0.7
D	890	34	55	5.6	32.6 [2]	32.5	32.5	0.0
E	1,110	18	39	7.9	47.9	47.9	47.9	0.0
F	2,200	80	462	0.7	49.1	49.1	49.1	0.0
G	2,560	16	36	8.5	52.5	52.5	52.5	0.0
H	2,630	22	115	2.7	53.9	53.9	53.9	0.0
I	2,650	22	40	7.7	73.2	73.2	73.2	0.0
J	3,100	80	291	1.1	74.4	74.4	74.4	0.0
K	3,350	38	105	3.0	74.4	74.4	74.4	0.0
L	4,170	45	167	1.9	75.9	75.9	75.9	0.0
M	4,200	140	591	0.5	88.9	88.9	88.9	0.0
N	4,900	43	67	4.6	88.9	88.9	88.9	0.0
O	5,370	50	107	2.9	90.3	90.3	90.3	0.0
P	6,070	14	54	5.8	93.3	93.3	93.4	0.1
Q	6,675	155	531	0.6	94.1	94.1	94.2	0.1
R	7,150	98	269	1.2	94.1	94.1	94.2	0.1
S	7,720	18	60	5.1	94.4	94.4	95.3	0.9
T	8,000	14	69	4.5	95.2	95.2	95.9	0.7
U	8,370	12	115	2.7	101.9	101.9	101.9	0.0
V	8,395	32	217	1.4	101.9	101.9	101.9	0.0
W	8,440	120	131	2.4	111.8	111.8	111.9	0.1
X	8,610	120	120	2.6	111.9	111.9	111.9	0.0

[1] FEET ABOVE CONFLUENCE WITH MERRIMACK RIVER

[2] ELEVATIONS COMPUTED CONSIDERING THE BACKWATER EFFECTS FROM MERRIMACK RIVER

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

FLOODWAY DATA

COCHICHEWICK BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
CRANE RIVER								
A	1,663	330	3,185	0.2	10.0 [2]	3.6	4.6	1.0
B	2,804	275	3,180	0.2	10.0 [2]	3.6	4.6	1.0
C	3,384	265	2,195	0.3	10.0 [2]	3.7	4.7	1.0
D	4,514	230	1,380	0.4	10.0 [2]	3.7	4.7	1.0
E	5,961	25	95	6.6	10.0 [2]	4.6	5.0	0.4
F	8,337	40	175	3.6	10.0 [2]	8.5	9.5	1.0
G	8,733	30	195	3.2	12.9	12.9	12.9	0.0
H	10,058	20	105	5.9	16.7	16.7	16.7	0.0
CRANE BROOK								
I	10,333	585	5,090	0.1	24.0	24.0	24.0	0.0
J	11,521	20	155	2.2	24.7	24.7	24.8	0.1
K	12,081	15	85	4.0	24.9	24.9	25.2	0.3
L	13,232	20	100	3.0	26.6	26.6	27.5	0.9
M	14,161	20	115	2.3	27.4	27.4	28.3	0.9
N	15,286	25	75	2.8	29.1	29.1	30.0	0.9
O	16,701	10	40	4.5	29.5	29.5	30.3	0.8
P	17,366	10	120	1.4	36.6	36.6	36.6	0.0
Q	18,242	10	55	3.1	36.7	36.7	37.1	0.4
R	18,892	20	145	1.0	39.9	39.9	40.5	0.6

[1] FEET ABOVE CONFLUENCE WITH PORTER RIVER
[2] ELEVATIONS COMPUTED CONSIDERING THE BACKWATER EFFECTS FROM BEVERLY HARBOR

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA
(ALL JURISDICTIONS)

FLOODWAY DATA

CRANE RIVER AND CRANE BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	345	*	50	10.5	25.8 [2]	14.2	14.2	0.0
B	445	19	78	6.8	25.8 [2]	16.4	16.4	0.0
C	880	*	69	7.7	25.8 [2]	20.0	20.3	0.3
D	950	25	152	3.5	25.8 [2]	21.3	21.3	0.0
E	3,620	60	148	3.6	35.2	35.2	35.4	0.2
F	5,035	*	66	3.9	37.4	37.4	38.4	1.0
G	5,160	*	70	3.7	37.7	37.7	38.7	1.0
H	5,250	*	244	1.1	40.5	40.5	40.5	0.0
I	7,095	40	51	5.1	42.1	42.1	42.1	0.0
J	10,360	100	77	3.4	128.2	128.2	128.2	0.0
K	10,925	98	616	0.4	136.7	136.7	136.7	0.0
L	11,010	99	87	3.0	142.4	142.4	142.4	0.0
M	11,740	35	69	0.3	147.2	147.2	147.9	0.7
N	11,800	*	5	3.8	152.0	152.0	152.0	0.0

[1] FEET ABOVE CONFLUENCE WITH MERRIMACK RIVER

[2] ELEVATIONS COMPUTED WITHOUT CONSIDERING BACKWATER EFFECTS FROM MERRIMACK RIVER

* FLOODWAY COINCIDENT WITH CHANNEL BANKS

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

FLOODWAY DATA

CREEK BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	1,093	50	140	3.4	43.1	41.8 [2]	42.3	0.5
B	2,635	120	660	0.7	58.0	58.0	58.0	0.0

[1] FEET ABOVE CONFLUENCE WITH IPSWICH RIVER

[2] ELEVATIONS COMPUTED WITHOUT CONSIDERING BACKWATER EFFECTS FROM IPSWICH RIVER

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

FLOODWAY DATA

EMERSON BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	300	600	2,302	0.5	40.6	40.6	41.6	1.0
B	1,160	600	2,012	0.6	40.8	40.8	41.8	1.0
C	2,443	110	769	1.5	43.9	43.9	44.2	0.3
D	4,482	200	938	1.0	45.1	45.1	45.4	0.3
E	6,395	300	1,299	0.7	45.4	45.4	47.0	1.6
F	7,095	300	875	1.0	45.5	45.5	46.2	0.7
G	7,802	80	603	1.4	46.2	46.2	47.0	0.8
H	9,995	80	240	3.4	48.1	48.1	48.4	0.3
I	13,005	90	161	4.7	54.1	54.1	54.1	0.0
J	13,304	30	136	5.5	56.3	56.3	56.3	0.0
K	13,545	70	530	1.4	61.3	61.3	61.3	0.0
L	16,895	40	230	3.2	61.5	61.5	61.5	0.0
M	18,981	80	698	1.1	69.4	69.4	69.4	0.0
N	19,225	160	674	1.1	80.0	80.0	80.1	0.1
O	19,495	370	3,110	0.2	80.0	80.0	80.1	0.1
P	21,095	40	223	3.4	80.0	80.0	80.0	0.0
Q	21,832	60	252	3.0	83.1	83.1	83.1	0.0
R	22,045	100	190	3.9	83.2	83.2	83.2	0.0
S	27,725	100	399	1.5	93.1	93.1	93.1	0.0
T	28,080	70	191	3.1	93.2	93.2	93.4	0.2
U	29,487	20	63	9.5	97.0	97.0	97.0	0.0
V	30,935	30	115	5.2	105.0	105.0	105.3	0.3
W	31,925	50	309	1.9	109.6	109.6	109.6	0.0
X	33,995	40	227	2.6	112.8	112.8	112.8	0.0
Y	35,520	30	239	2.5	112.9	112.9	113.6	0.7

[1] FEET ABOVE CONFLUENCE WITH IPSWICH RIVER

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

FLOODWAY DATA

FISH BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	260	50	688	0.8	54.3	54.3	55.3	1.0
B	1,000	36	93	5.9	63.4	63.4	64.0	0.6
C	4,440	380	1,127	0.5	83.5	83.5	83.6	0.1
D	9,900	568	169	3.2	105.9	105.9	106.6	0.7
E	14,400	140	402	0.3	115.9	115.9	116.3	0.4
F	15,465	80	372	0.3	121.3	121.3	121.6	0.3
G	18,480	60	358	0.4	121.9	121.9	122.1	0.2
H	20,470	44	174	0.7	121.9	121.9	122.1	0.2

[1] FEET ABOVE CONFLUENCE WITH MERRIMACK RIVER

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

FLOODWAY DATA

FISH BROOK (TOWN OF ANDOVER)

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	460	49	338	1.1	24.8	24.8	25.8	1.0
B	780	64	414	0.9	24.9	24.9	25.9	1.0

[1] FEET ABOVE CONFLUENCE WITH SHUTE BROOK

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA
(ALL JURISDICTIONS)

FLOODWAY DATA

FISKE BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	734	150	847	0.7	26.7	24.5 [2]	25.3	0.8
B	1,827	12	108	5.8	26.7	26.1 [2]	26.3	0.2
C	2,350	110	423	1.5	27.2	27.2	27.7	0.5
D	3,939	30	188	3.4	34.1	34.1	34.2	0.1
E	4,572	30	206	3.1	34.5	34.5	35.0	0.5
F	5,148	200	680	0.9	38.3	38.3	38.4	0.1
G	6,579	120	718	0.8	38.3	38.3	38.4	0.1
H	7,408	70	397	1.2	44.6	44.6	44.6	0.0
I	8,268	70	462	0.8	44.6	44.6	44.7	0.1
J	9,182	50	535	0.7	51.5	51.5	51.9	0.4
K	10,185	30	284	1.0	61.2	61.2	61.2	0.0
L	11,384	16	66	4.1	65.7	65.7	65.9	0.2
M	11,843	25	89	3.0	71.7	71.7	71.7	0.0
N	12,408	345	2,500	0.1	81.3	81.3	81.9	0.6
O	14,800	40	127	1.7	86.8	86.8	86.8	0.0
P	16,716	20	147	1.0	97.5	97.5	97.5	0.0

[1] FEET ABOVE CONFLUENCE WITH PROCTOR BROOK

[2] ELEVATIONS COMPUTED WITHOUT CONSIDERATING BACKWATER EFFECTS FROM PROCTOR BROOK

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

FLOODWAY DATA

GOLDTHWAITE BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	320	80	353	1.1	110.5 [2]	104.8	105.0	0.2
B	2,530	80	231	1.7	110.5 [2]	105.2	105.7	0.5
C	2,690	80	300	1.3	110.5 [2]	108.2	108.2	0.0
D	5,000	80	229	1.7	110.5 [2]	108.8	109.4	0.6
E	7,830	80	172	2.3	111.5	111.5	112.0	0.5
F	8,590	80	236	1.7	112.2	112.2	112.8	0.6
G	8,715	80	395	1.0	115.7	115.7	115.9	0.2
H	10,450	39	58	6.9	139.0	139.0	139.0	0.0
I	10,710	60	127	2.2	142.4	142.4	142.4	0.0
J	13,270	80	294	1.0	142.7	142.7	143.4	0.7
K	14,550	80	267	1.0	142.8	142.8	143.7	0.9
L	14,700	80	333	0.8	143.6	143.6	144.4	0.8

[1] FEET ABOVE CONFLUENCE WITH SPICKET RIVER
[2] ELEVATIONS COMPUTED CONSIDERING THE BACKWATER EFFECTS FROM SPICKET RIVER

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

FLOODWAY DATA

HARRIS BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	220	40	138	3.3	27.7 [2]	24.5	25.5	1.0
B	1,120	40	108	4.2	27.7 [2]	26.9	27.2	0.3
C	3,750	32	66	5.1	72.9	72.9	72.9	0.0
D	4,945	20	48	7.1	97.9	97.9	98.0	0.1
E	6,800	130	374	0.9	116.1	116.1	117.0	0.9
F	7,720	80	294	1.0	118.0	118.0	118.3	0.3
G	7,780	100	361	0.8	118.0	118.0	118.4	0.4
H	9,070	30	48	6.2	119.5	119.5	119.6	0.1
I	10,730	40	189	1.6	123.2	123.2	124.2	1.0
J	11,455	25	44	6.8	124.6	124.6	125.0	0.4
K	12,038	100	708	0.4	130.4	130.4	131.1	0.7
L	14,118	40	127	2.4	130.5	130.5	131.2	0.7
M	14,838	9	29	10.3	131.4	131.4	131.4	0.0
N	15,035	36	148	2.0	134.3	134.3	134.6	0.3
O	15,930	40	165	1.1	134.4	134.4	135.2	0.8
P	17,092	50	158	1.1	134.5	134.5	135.5	1.0
Q	17,810	25	75	2.4	135.3	135.3	136.1	0.8
R	18,890	45	155	1.2	144.5	144.5	145.5	1.0

[1] FEET ABOVE CONFLUENCE WITH BARE MEADOW BROOK

[2] ELEVATIONS COMPUTED CONSIDERING THE BACKWATER EFFECTS FROM MERRIMACK RIVER

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

FLOODWAY DATA

HAWKES BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
HOWLETT BROOK								
A	1,045	180	690	0.8	34.6	34.6	35.6	1.0
B	1,156	67	291	1.8	38.3	38.3	38.3	0.0
C	1,272	90	471	1.1	42.4	42.4	42.4	0.0
D	1,447	86	450	1.2	44.1	44.1	44.1	0.0
E	1,885	150	796	0.7	44.2	44.2	44.2	0.0
F	4,372	150	496	1.1	45.0	45.0	45.5	0.5
G	4,488	150	751	0.7	46.9	46.9	47.2	0.3
H	8,195	150	618	0.8	48.5	48.5	49.3	0.8
I	8,358	150	817	0.6	50.5	50.5	50.7	0.2
J	8,680	150	822	0.6	50.5	50.5	50.8	0.3
K	8,950	150	753	0.6	50.6	50.6	50.9	0.3
L	10,792	150	701	0.7	50.7	50.7	51.3	0.6
M	11,030	150	1,008	0.5	52.8	52.8	53.3	0.5
N	12,133	150	414	1.1	52.8	52.8	53.6	0.8
PYE BROOK								
O	13,200	150	650	0.7	53.5	53.5	54.2	0.7
P	14,652	150	443	1.0	54.4	54.4	55.0	0.6
Q	16,442	60	220	2.1	59.4	59.4	59.8	0.4
R	16,579	150	563	0.8	63.7	63.7	63.9	0.2
S	17,176	150	1,045	0.4	63.7	63.7	64.0	0.3

[1] FEET ABOVE CONFLUENCE WITH IPSWICH RIVER

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

FLOODWAY DATA

HOWLETT BROOK AND PYE BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	940	254	1,331	0.2	50.1	50.1	51.1	1.0
B	1,226	58	68	4.1	53.8	53.8	53.8	0.0
C	1,280	60	79	3.5	53.9	53.9	53.9	0.0
D	2,540	12	66	4.2	54.7	54.7	54.8	0.1
E	2,650	100	559	0.5	57.4	57.4	57.4	0.0
F	3,932	14	32	8.6	58.5	58.5	58.5	0.0
G	3,968	14	47	5.9	59.6	59.6	59.6	0.0
H	5,600	122	65	4.3	77.5	77.5	77.5	0.0
I	6,830	57	73	3.8	110.1	110.1	110.1	0.0
J	7,185	18	39	7.3	114.5	114.5	114.5	0.0
K	7,310	18	167	1.7	122.4	122.4	122.4	0.0
L	8,280	150	206	1.4	130.8	130.8	130.8	0.0
M	10,750	168	303	0.9	136.2	136.2	136.2	0.0

[1] FEET ABOVE CONFLUENCE WITH SHAWSHEEN RIVER

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA
(ALL JURISDICTIONS)

FLOODWAY DATA

HUSSEY BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	1,100	*	30	3.7	63.2	60.7 [2]	61.3	0.6
B	1,980	*	41	2.7	65.2	65.2	66.0	0.8
C	3,160	*	27	4.2	87.9	87.9	88.6	0.7
D	3,300	*	35	3.1	89.5	89.5	90.1	0.6
E	3,420	*	19	5.8	93.3	93.3	93.3	0.0

[1] FEET ABOVE CONFLUENCE WITH HUSSEY BROOK
* FLOODWAY COINCIDENT WITH CHANNEL BANKS
[2] ELEVATIONS COMPUTED WITHOUT CONSIDERING BACKWATER EFFECTS FROM HUSSEY BROOK

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA
(ALL JURISDICTIONS)

FLOODWAY DATA

HUSSEY BROOK TRIBUTARY

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	710	130	349	9.3	11.6	11.6	11.6	0.0
B	780	183	1,572	2.1	13.3	13.3	13.3	0.0
C	8,030	105	688	4.3	14.1	14.1	14.3	0.2
D	8,157	166	958	3.1	14.3	14.3	14.5	0.2
E	13,907	142	835	3.6	18.6	18.6	19.3	0.7
F	14,036	130	690	4.3	18.9	18.9	19.5	0.6
G	17,486	135	942	3.1	21.7	21.7	22.0	0.3
H	20,036	250	1,072	2.8	23.2	23.2	23.7	0.5
I	22,336	172	1,038	2.9	24.5	24.5	25.4	0.9
J	22,451	107	789	3.8	25.0	25.0	25.8	0.8
K	24,551	147	1,036	2.9	26.1	26.1	27.0	0.9
L	24,681	257	1,666	1.8	26.8	26.8	27.8	1.0
M	25,606	83	594	4.8	26.8	26.8	27.8	1.0
N	25,706	219	1,756	1.6	31.4	31.4	31.7	0.3
O	28,006	93	617	4.6	31.4	31.4	31.7	0.3
P	28,120	97	713	4.0	31.6	31.6	31.9	0.3
Q	28,490	136	749	4.1	31.6	31.6	32.6	1.0
R	31,494	150	1,132	2.7	33.4	33.4	34.2	0.8
S	33,294	250	1,782	1.7	34.4	34.4	35.1	0.7
T	34,989	335	2,335	1.3	34.5	34.5	35.3	0.8
U	36,473	195	2,326	1.3	35.1	35.1	35.9	0.8
V	41,727	600	2,697	1.1	35.3	35.3	36.3	1.0
W	45,159	800	3,847	0.8	35.8	35.8	36.7	0.9
X	47,513	429	2,290	1.2	36.0	36.0	36.9	0.9
Y	54,541	3,150	18,544	0.2	36.2	36.2	37.1	0.9
Z	60,249	2,825	7,484	0.4	36.2	36.2	37.1	0.9
AA	61,463	3,000	8,394	0.3	36.5	36.5	37.2	0.7

[1] FEET ABOVE STATE ROUTE 133

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA
(ALL JURISDICTIONS)

FLOODWAY DATA

IPSWICH RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
AB	64,404	100	1,288	2.2	38.1	38.1	38.3	0.2
AC	64,716	75	950	3.0	39.2	39.2	39.4	0.2
AD	66,722	250	2,353	1.2	39.4	39.4	39.8	0.4
AE	68,670	250	2,281	1.1	39.4	39.4	39.8	0.4
AF	69,806	275	1,687	1.4	39.5	39.5	39.9	0.4
AG	70,434	200	1,018	2.4	39.6	39.6	40.3	0.7
AH	71,833	750	3,893	0.6	39.7	39.7	40.6	0.9
AI	73,185	500	2,952	0.8	39.8	39.8	40.6	0.8
AJ	74,283	414	2,189	1.1	39.9	39.9	40.7	0.8
AK	75,286	450	2,534	1.0	40.0	40.0	40.8	0.8
AL	77,414	488	2,596	0.9	40.2	40.2	41.0	0.8
AM	79,093	700	3,480	0.7	40.4	40.4	41.1	0.7
AN	82,673	700	3,601	0.7	40.5	40.6	41.4	0.8
AO	83,673	60	590	3.1	40.6	39.9	40.9	1.0
AP	85,125	105	715	2.6	40.6	40.6	41.6	1.0
AQ	86,635	140	2,240	0.8	40.6	40.6	41.6	1.0
AR	87,422	145	1,015	1.8	41.2	41.2	42.2	1.0
AS	88,636	205	1,235	1.5	41.4	41.4	42.4	1.0
AT	89,724	160	1,065	1.6	41.5	41.5	42.5	1.0
AU	91,324	115	810	2.2	42.9	42.9	43.6	0.7
AV	93,504	270	1,830	0.7	43.1	43.1	43.9	0.8
AW	96,884	110	905	1.5	43.5	43.5	44.3	0.8
AX	100,173	180	1,060	1.3	44.1	44.1	45.0	0.9
AY	101,741	130	1,705	0.8	44.2	44.2	45.1	0.9
AZ	102,449	200	1,450	0.9	45.0	45.0	45.8	0.8
BA	103,985	180	1,250	1.1	45.1	45.1	45.9	0.8
BB	106,293	105	850	1.6	45.3	45.3	46.2	0.9

[1] FEET ABOVE STATE ROUTE 133

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA
(ALL JURISDICTIONS)

FLOODWAY DATA

IPSWICH RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
BC	106,926	200	1,220	1.1	45.4	45.4	46.3	0.9
BD	109,080	180	1,270	1.0	45.7	45.7	46.6	0.9
BE	110,400	420	2,410	0.5	45.8	45.8	46.7	0.9
BF	111,921	260	1,485	0.9	45.8	45.8	46.7	0.9
BG	113,442	145	900	1.4	46.0	46.0	47.0	1.0
BH	115,437	335	1,980	0.7	47.7	47.7	48.1	0.4
BI	118,621	1,340	7,135	0.2	47.8	47.8	48.2	0.4
BJ	121,578	585	2,565	0.5	47.8	47.8	48.2	0.4
BK	125,200	225	920	1.2	48.5	48.5	49.3	0.8
BL	128,405	70	485	2.3	50.6	50.6	51.6	1.0
BM	131,774	65	495	2.3	51.8	51.8	52.7	0.9
BN	132,693	45	370	3.0	52.7	52.7	53.4	0.7
BO	134,193	375	1,925	0.5	59.6	59.6	59.6	0.0
BP	134,793	70	345	3.0	59.6	59.6	59.6	0.0
BQ	136,093	60	380	2.7	60.2	60.2	60.6	0.4
BR	138,138	75	510	2.0	60.9	60.9	61.5	0.6
BS	138,248	55	370	2.8	61.1	61.1	61.6	0.5
BT	139,108	80	590	1.8	61.4	61.4	62.0	0.6
BU	139,168	50	410	2.5	61.6	61.6	62.1	0.5
BV	141,118	45	420	2.5	61.9	61.9	62.8	0.9
BW	143,158	100	675	2.4	62.2	62.2	62.2	0.0

[1] FEET ABOVE STATE ROUTE 133

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA
(ALL JURISDICTIONS)

FLOODWAY DATA

IPSWICH RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	0	9	21	2.2	18.2 [2]	16.7	17.7	1.0
B	2,560	3	7	6.9	27.1	27.1	27.2	0.1
C	3,775	10	5	4.2	28.9	28.9	28.9	0.0
D	5,905	1	1	6.0	55.9	55.9	55.9	0.0

[1] FEET ABOVE PARISH ROAD

[2] ELEVATIONS COMPUTED CONSIDERING THE BACKWATER EFFECTS FROM PARKER RIVER

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

FLOODWAY DATA

JACKMAN BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	1,700	64	335	2.6	20.6 [2]	11.1	12.1	1.0
B	2,900	158	435	1.2	20.6 [2]	12.1	12.9	0.8
C	4,400	200	280	1.8	34.6	34.6	34.6	0.0
D	6,150	115	571	0.6	39.1	39.1	39.5	0.4
E	6,800	10	30	9.8	40.5	40.5	41.4	0.9
F	8,400	139	1,168	0.2	75.3	75.3	75.3	0.0
G	10,500	206	1,125	0.2	75.3	75.3	75.3	0.0
H	11,200	316	2,004	0.1	76.6	76.6	76.6	0.0

[1] FEET ABOVE CONFLUENCE WITH MERRIMACK RIVER

[2] ELEVATIONS COMPUTED CONSIDERING THE BACKWATER EFFECTS FROM MERRIMACK RIVER

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

FLOODWAY DATA

JOHNSON CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	1775	*	248	9.4	22.4	15.7 [2]	16.2	0.5
B	1840	51	407	5.7	22.4	16.9 [2]	17.4	0.5
C	2310	*	259	9.0	22.4	17.0 [2]	17.4	0.4
D	2,380	*	226	10.3	22.4	17.0 [2]	17.5	0.5
E	4,025	*	1,121	2.1	24.2	24.2	24.3	0.1
F	5,995	95	785	3.0	26.3	26.3	26.4	0.1
G	6,065	160	1,590	1.5	26.6	26.6	26.7	0.1
H	7,215	197	1,544	1.5	26.9	26.9	27.1	0.2
I	7,995	*	721	3.2	27.1	27.1	27.3	0.2
J	10,820	*	520	4.5	27.6	27.6	28.0	0.4
K	11,240	*	318	7.3	28.2	28.2	28.9	0.7
L	11,310	62	383	6.1	28.2	28.2	29.1	0.9
M	12,940	695	2,997	0.7	30.2	30.2	30.6	0.4
N	15,140	240	2,535	0.8	34.8	34.8	34.9	0.1
O	20,160	45	733	1.7	38.0	38.0	38.2	0.2

[1] FEET ABOVE CONFLUENCE WITH MERRIMACK RIVER
[2] ELEVATIONS COMPUTED WITHOUT CONSIDERING BACKWATER EFFECTS FROM MERRIMACK RIVER
* FLOODWAY COINCIDENT WITH CHANNEL BANKS

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA
(ALL JURISDICTIONS)

FLOODWAY DATA

LITTLE RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	28,354	1,041	26,922	4.3	9.8	9.8	9.8	0.0
B	32,208	1,101	27,860	4.1	10.5	10.5	10.5	0.0
C	38,386	1,120	25,350	4.5	11.7	11.7	11.7	0.0
D	41,501	1,830	38,000	3.0	12.2	12.2	12.2	0.0
E	44,194	1,920	37,600	3.1	12.4	12.4	12.4	0.0
F	51,216	880	22,800	5.0	12.9	12.9	12.9	0.0
G	55,176	695	15,700	7.3	13.4	13.4	13.4	0.0
H	60,984	780	16,300	7.1	14.9	14.8	14.9	0.1
I	64,839	1,215	27,600	4.2	16.2	16.2	16.4	0.2
J	70,939	1,015	24,100	4.8	16.8	16.8	17.0	0.2
K	73,999	1,260	26,449	4.4	17.3	17.3	18.3	1.0
L	82,269	772	18,854	6.1	19.1	19.1	20.0	0.9
M	86,389	1,140	27,106	4.2	20.7	20.7	21.6	0.9
N	89,889	*	27,196	4.2	21.1	21.1	22.1	1.0
O	92,229	*	30,465	3.8	21.4	21.4	22.3	0.9
P	93,909	*	16,116	7.1	21.4	21.4	22.3	0.9
Q	97,289	616	16,645	6.9	22.0	22.0	23.0	1.0
R	100,049	*	17,981	6.4	22.7	22.7	23.7	1.0
S	100,294	*	19,426	5.9	22.9	22.9	23.9	1.0
T	100,594	*	15,437	7.5	22.9	22.9	23.9	1.0
U	102,619	*	13,575	8.5	23.1	23.1	24.0	0.9
V	105,599	*	24,161	4.8	24.3	24.3	25.3	1.0
W	108,299	*	16,070	7.2	24.4	24.4	25.3	0.9
X	111,924	*	17,163	6.7	25.1	25.1	26.0	0.9
Y	113,934	570	15,300	7.5	25.2	25.2	26.1	0.9
Z	114,899	570	15,150	7.6	25.8	25.8	26.4	0.6
AA	118,074	*	14,071	8.2	26.5	26.5	27.4	0.9

[1] FEET ABOVE NEWBURYPORT LIGHTHOUSE

* FLOODWAY COINCIDENT WITH CHANNEL BANKS

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA
(ALL JURISDICTIONS)

FLOODWAY DATA

MERRIMACK RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
AB	119,394	*	14,717	7.8	27.0	27.0	27.9	0.9
AC	122,894	*	19,584	5.9	28.3	28.3	29.3	1.0
AD	124,649	*	16,034	7.2	28.5	28.5	29.5	1.0
AE	129,337	613	17,504	6.6	30.5	30.5	31.5	1.0
AF	135,039	508	16,609	6.9	31.8	31.8	32.8	1.0
AG	137,151	533	16,008	7.2	32.2	32.2	33.2	1.0
AH	141,428	480	14,479	7.9	32.6	32.6	33.6	1.0
AI	143,148	740	20,550	5.6	33.6	33.6	34.6	1.0
AJ	147,008	*	15,052	7.4	34.2	34.2	35.2	1.0
AK	147,228	490	14,238	7.8	34.2	34.2	35.2	1.0
AL	149,148	549	16,819	6.6	35.0	35.0	36.0	1.0
AM	150,548	540	16,005	6.9	35.2	35.2	36.2	1.0
AN	150,668	*	16,919	6.6	35.5	35.5	36.5	1.0
AO	150,868	*	23,685	4.7	35.9	35.9	36.9	1.0
AP	150,888	*	6,979	15.9	46.1	46.1	46.3	0.2
AQ	155,348	*	16,891	6.6	49.6	49.6	50.2	0.6
AR	158,008	*	13,183	8.4	49.9	49.9	50.5	0.6
AS	158,908	746	18,329	6.1	50.0	50.0	51.0	1.0
AT	162,658	819	19,842	5.6	51.1	51.1	51.9	0.8
AU	166,038	967	23,632	4.7	52.5	52.5	53.2	0.7
AV	169,628	865	21,093	5.3	53.4	53.4	54.1	0.7
AW	171,528	1,144	19,672	5.6	54.0	54.0	54.6	0.6
AX	175,798	787	20,143	5.5	55.1	55.1	55.6	0.5
AY	180,498	630	17,016	6.5	55.9	55.9	56.3	0.4
AZ	182,248	626	15,841	7.0	56.5	56.5	56.9	0.4
BA	185,458	802	14,757	7.5	57.7	57.7	58.1	0.4

[1] FEET ABOVE NEWBURYPORT LIGHTHOUSE

* FLOODWAY COINCIDENT WITH CHANNEL BANKS

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

FLOODWAY DATA

MERRIMACK RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	11,060	16	30	2.7	42.4	42.4	42.7	0.3
B	11,180	16	42	1.9	43.3	43.3	43.4	0.1
C	11,335	47	200	0.4	47.3	47.3	47.3	0.0
D	11,540	64	317	0.3	47.3	47.3	47.3	0.0
E	11,800	106	597	0.1	52.2	52.2	52.2	0.0
F	12,340	70	291	0.2	52.2	52.2	52.2	0.0
G	12,630	264	1,195	0.1	52.2	52.2	52.2	0.0
H	12,905	70	230	0.2	53.2	53.2	53.2	0.0
I	14,035	20	164	0.2	53.2	53.2	53.2	0.0

[1] FEET ABOVE CONFLUENCE WITH IPSWICH RIVER

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA
(ALL JURISDICTIONS)

FLOODWAY DATA

MILE BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	390	32	155	4.6	14.0 [2]	12.0	12.0	0.0
B	1,380	57	283	2.5	14.0	14.0	14.9	0.9
C	1,496	57	192	3.7	14.8	14.8	15.4	0.6
D	2,931	52	155	4.6	19.3	19.3	19.3	0.0
E	3,123	25	144	4.9	19.5	19.5	19.5	0.0
F	5,603	62	421	1.7	20.0	20.0	20.9	0.9
G	5,723	62	417	1.7	20.1	20.1	21.0	0.9
H	6,323	126	703	1.0	20.2	20.2	21.1	0.9
I	6,475	50	303	2.3	21.4	21.4	22.0	0.6
J	8,405	219	1,053	0.7	21.4	21.4	22.2	0.8
K	8,520	30	230	3.1	23.1	23.1	23.1	0.0
L	9,750	30	228	3.1	23.1	23.1	23.8	0.7
M	9,871	123	1,084	0.7	23.4	23.4	24.1	0.7
N	11,471	30	241	2.9	23.4	23.4	24.1	0.7
O	11,584	30	230	3.1	24.3	24.3	24.4	0.1
P	13,004	31	253	2.8	24.3	24.3	25.2	0.9
Q	13,114	31	242	2.9	24.4	24.4	25.4	1.0
R	17,104	300	2,435	0.3	24.4	24.4	25.1	0.7
S	18,269	300	2,435	0.3	24.4	24.4	25.1	0.7
T	19,749	100	630	1.1	26.3	26.3	26.7	0.4
U	20,974	200	969	0.7	26.5	26.5	26.9	0.4
V	23,124	300	1,880	0.4	26.6	26.6	27.1	0.5
W	24,404	300	2,085	0.3	26.6	26.6	27.1	0.5
X	26,144	140	538	1.3	26.6	26.6	27.2	0.6
Y	27,524	300	2,032	0.4	26.7	26.7	27.3	0.6
Z	29,319	245	754	1.0	26.7	26.7	27.4	0.7
AA	30,064	100	959	0.8	30.2	30.2	30.5	0.3

[1] FEET ABOVE CONFLUENCE WITH IPSWICH RIVER

[2] ELEVATIONS COMPUTED CONSIDERING THE BACKWATER EFFECTS FROM IPSWICH RIVER

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

FLOODWAY DATA

MILES RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
AB	31,514	200	1,690	0.4	30.2	30.2	30.5	0.3
AC	33,724	200	1,416	0.5	30.2	30.2	30.5	0.3
AD	36,924	285	1,360	0.4	30.9	30.9	31.8	0.9
AE	37,458	100	510	1.1	31.8	31.8	32.4	0.6
AF	41,124	195	701	0.8	32.4	32.4	33.3	0.9
AG	41,620	100	801	0.7	37.9	37.9	38.9	1.0
AH	42,970	150	1,474	0.4	37.9	37.9	38.9	1.0
AI	53,484	22	122	4.2	41.9	41.9	42.3	0.4

[1] FEET ABOVE CONFLUENCE WITH IPSWICH RIVER

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

FLOODWAY DATA

MILES RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	120	230	1,097	0.3	8.9	6.1	6.1	0.0
B	1,520	90	100	2.9	8.9	7.1	7.1	0.0
C	1,870	90	350	0.6	11.3	11.3	11.3	0.0
D	2,220	20	40	5.6	12.4	12.4	12.8	0.4
E	2,392	10	39	5.8	15.3	15.3	15.3	0.0
F	2,590	15	40	5.7	17.1	17.1	17.8	0.7
G	2,704	30	140	1.6	20.4	20.4	20.4	0.0
H	3,104	25	82	2.7	20.5	20.5	20.9	0.4

[1] FEET ABOVE DR. OSMAN BABSON ROAD (DOWNSTREAM FACE)

[2] ELEVATIONS COMPUTED WITHOUT CONSIDERING BACKWATER EFFECTS FROM ATLANTIC OCEAN

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

FLOODWAY DATA

MILL RIVER (TOWN OF GLOUCESTER)

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	-27	28	102	8.2	7.4 [2]	4.2	4.2	0.0
B	51	90	547	1.5	8.0	8.0	8.0	0.0
C	828	42	224	3.7	8.2	8.2	8.3	0.1
D	1,518	30	138	6.0	9.9	9.9	10.5	0.6
E	1,595	18	106	7.9	11.5	11.5	11.5	0.0
F	1,885	16	77	10.8	14.8	14.8	15.6	0.8
G	1,909	15	98	8.5	17.5	17.5	17.5	0.0
H	2,059	60	282	2.9	18.2	18.2	18.5	0.3
I	2,080	72	116	7.2	21.3	21.3	21.3	0.0

[1] FEET ABOVE U.S. ROUTE 1

[2] ELEVATIONS COMPUTED CONSIDERING THE BACKWATER EFFECTS FROM PARKER RIVER

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

FLOODWAY DATA

MILL RIVER (TOWN OF ROWLEY)

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	70	78	155	3.2	17.8 [2]	2.2	2.2	0.0
B	960	*	84	5.8	17.8 [2]	10.8	11.0	0.2
C	1,115	*	178	2.8	17.8 [2]	17.4	17.4	0.0
D	2,615	*	104	4.7	19.2	19.2	19.8	0.6
E	3,710	*	58	6.0	26.7	26.7	27.2	0.5
F	3,840	*	161	2.2	30.2	30.2	31.0	0.8
G	4,350	*	71	5.0	31.0	31.0	31.3	0.3
H	4,420	*	70	5.0	44.6	44.6	44.6	0.0

[1] FEET ABOVE CONFLUENCE WITH MERRIMACK RIVER
[2] ELEVATIONS COMPUTED CONSIDERING THE BACKWATER EFFECTS FROM MERRIMACK RIVER
* FLOODWAY COINCIDENT WITH CHANNEL BANKS

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA
(ALL JURISDICTIONS)

FLOODWAY DATA

MILLVALE RESERVOIR BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	5,762	350	1,728	0.3	113.0	113.0	114.0	1.0
B	6,420	400	1,923	0.3	113.2	113.2	114.1	0.9
C	9,074	110	300	1.3	113.2	113.2	114.2	1.0
D	10,300	80	254	1.6	114.5	114.5	114.9	0.4
E	12,272	100	609	0.5	123.0	123.0	123.4	0.4
F	14,840	100	363	0.8	123.7	123.7	124.2	0.5
G	17,182	40	246	1.2	128.0	128.0	128.2	0.2
H	20,220	100	160	1.7	129.8	129.8	130.3	0.5
I	21,650	51	240	1.1	139.8	139.8	139.8	0.0
J	23,170	20	81	2.2	147.6	147.6	148.5	0.9
K	26,415	11	23	5.3	169.0	169.0	169.5	0.5
L	28,799	12	19	6.3	220.7	220.7	220.8	0.1
M	30,162	10	105	1.2	237.4	237.4	238.4	1.0

[1] FEET ABOVE BROOKVIEW ROAD

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA
(ALL JURISDICTIONS)

FLOODWAY DATA

MOSQUITO BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
NORTH RIVER								
A	2,212	80	325	3.5	10.0	10.0	11.0	1.0
B	2,841	70	345	3.3	12.4	12.4	12.5	0.1
C	3,326	60	270	3.8	13.6	13.6	14.0	0.4
PROCTOR BROOK								
D	8,152	150	440	1.0	39.6	39.6	39.7	0.1
E	8,939	60	245	1.7	40.8	40.8	40.8	0.0
F	9,604	100	255	1.6	42.0	42.0	42.0	0.0
G	10,344	100	265	1.6	42.5	42.5	42.8	0.3
H	11,436	100	515	0.8	46.9	46.9	46.9	0.0
I	12,862	60	260	1.6	47.1	47.1	47.3	0.2
J	13,306	45	300	1.0	51.4	51.4	52.1	0.7
K	13,712	60	570	0.5	51.5	51.5	52.2	0.7
L	14,404	60	360	0.9	54.9	54.9	55.4	0.5
M	14,837	50	235	1.3	55.1	55.1	55.5	0.4
N	15,808	90	325	0.9	55.2	55.2	55.6	0.4
O	17,778	90	215	1.3	57.1	57.1	57.8	0.7
P	19,626	100	255	1.1	61.4	61.4	61.4	0.0
Q	20,724	100	155	1.7	61.8	61.8	62.0	0.2
R	21,614	65	210	1.1	64.5	64.5	64.5	0.0
S	22,709	50	145	1.6	65.3	65.3	65.3	0.0

[1] FEET ABOVE GROVE STREET

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

FLOODWAY DATA

NORTH RIVER AND PROCTOR BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	970	17	23	6.6	22.5	22.5	22.5	0.0
B	1,120	5	24	6.3	33.1	33.1	33.1	0.0
C	1,250	8	3 1	4.9	35.6	35.6	35.6	0.0
D	4,360	18	64	2.5	49.3	49.3	50.1	0.8
E	7,000	162	447	0.5	49.7	49.7	50.6	0.9

[1] FEET ABOVE CONFLUENCE WITH ARTICHOKE RIVER - RESERVOIR

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

FLOODWAY DATA

NORTH TRIBUTARY BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	55,533	40	148	2.2	86.5	86.5	87.3	0.8
B	55,933	40	114	2.8	86.8	86.8	87.7	0.9
C	56,633	60	183	1.8	87.8	87.8	88.7	0.9
D	57,533	60	199	1.6	88.5	88.5	89.3	0.8
E	58,783	60	175	1.9	89.2	89.2	89.9	0.7
F	59,333	60	202	1.6	89.6	89.6	90.2	0.6
G	60,097	80	245	1.1	93.4	93.4	93.4	0.0
H	60,303	60	193	1.4	93.4	93.4	93.4	0.0
I	61,033	80	245	1.1	93.7	93.7	93.9	0.2
J	62,033	80	258	1.1	93.8	93.8	94.2	0.4
K	63,183	50	104	2.6	94.2	94.2	95.0	0.8
L	63,533	60	159	1.7	96.1	96.1	96.2	0.1
M	64,653	60	117	1.9	98.0	98.0	98.8	0.8
N	64,983	40	56	4.1	101.2	101.2	101.2	0.0
O	65,333	60	180	1.3	107.2	107.2	107.2	0.0
P	65,437	60	231	1.0	107.8	107.8	107.8	0.0
Q	65,883	50	49	4.6	110.3	110.3	110.3	0.0
R	66,233	55	81	2.8	114.8	114.8	114.9	0.1
S	66,833	60	552	0.4	129.5	129.5	129.5	0.0

[1] FEET ABOVE CENTRAL STREET DAM

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA
(ALL JURISDICTIONS)

FLOODWAY DATA

PARKER RIVER (TOWN OF BOXFORD)

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	26,000	36	87	4.4	61.7	61.7	62.7	1.0
B	27,464	20	96	4.0	64.0	64.0	64.7	0.7
C	35,144	16	74	4.6	69.3	69.3	70.3	1.0
D	35,464	28	121	2.8	70.7	70.7	71.5	0.8
E	36,344	175	69	4.9	73.2	73.2	73.2	0.0
F	37,280	10	35	6.4	74.5	74.5	75.5	1.0
G	37,720	19	66	3.4	76.6	76.6	77.3	0.7
H	42,050	59	345	0.6	81.9	81.9	82.6	0.7
I	42,750	12	81	2.8	81.9	81.9	82.7	0.8
J	43,445	43	150	1.5	84.4	84.4	85.2	0.8
K	45,150	82	387	0.5	84.4	84.4	85.4	1.0
L	46,270	30	177	1.1	84.4	84.4	85.4	1.0
M	47,550	76	304	0.5	84.4	84.4	85.4	1.0

[1] FEET ABOVE CENTRAL STREET DAM

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA
(ALL JURISDICTIONS)

FLOODWAY DATA

PARKER RIVER (TOWN OF GEORGETOWN)

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	0	45	89	8.0	16.7	16.7	16.7	0.0
B	6,635	51	230	2.8	18.4	18.4	18.7	0.3
C	6,745	47	252	2.6	19.2	19.2	19.5	0.3
D	7,695	38	279	2.3	25.7	25.7	25.7	0.0
E	9,037	171	1,381	0.5	25.8	25.8	25.8	0.0
F	9,177	17	61	10.8	26.3	26.3	26.3	0.0
G	10,287	33	227	2.9	29.6	29.6	30.5	0.9
H	10,767	60	92	7.1	33.7	33.7	33.7	0.0
I	10,872	26	166	3.9	40.9	40.9	40.9	0.0
J	10,922	140	864	0.8	41.3	41.3	41.3	0.0
K	11,482	42	201	3.3	41.3	41.3	41.3	0.0
L	11,612	30	159	4.1	41.9	41.9	41.9	0.0
M	11,872	77	100	6.5	47.5	47.5	47.5	0.0
N	13,157	14	57	11.5	58.3	58.3	58.3	0.0
O	13,287	30	174	3.7	61.0	61.0	61.0	0.0
P	13,387	39	326	2.0	61.9	61.9	61.9	0.0

[1] FEET ABOVE CENTRAL STREET DAM

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA
(ALL JURISDICTIONS)

FLOODWAY DATA

PARKER RIVER (TOWN OF NEWBURY)

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	200	85	120	1.7	109.0	104.0 [2]	104.4	0.4
B	960	50	74	2.7	109.0	106.1 [2]	106.8	0.7
C	2,020	35	105	1.9	110.7	110.7	111.2	0.5
D	2,500	120	411	0.5	110.9	110.9	111.5	0.6
E	3,365	490	3,908	0.1	111.0	111.0	111.6	0.6
F	4,150	60	304	0.6	111.0	111.0	111.6	0.6
G	4,670	36	72	2.4	111.3	111.3	112.0	0.7
H	5,510	20	68	2.5	112.7	112.7	113.3	0.6
I	5,950	90	245	0.7	114.5	114.5	114.6	0.1
J	6,790	100	401	0.4	114.5	114.5	114.6	0.1
K	8,650	100	312	0.4	114.5	114.5	114.6	0.1
L	9,370	60	96	1.4	114.5	114.5	114.9	0.4
M	11,920	90	75	1.8	122.5	122.5	122.5	0.0
N	14,070	9	17	4.0	127.6	127.6	128.2	0.6

[1] FEET ABOVE CONFLUENCE WITH SPICKET RIVER

[2] ELEVATIONS COMPUTED WITHOUT CONSIDERING BACKWATER EFFECTS FROM SPICKET RIVER

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

FLOODWAY DATA

PEAT MEADOW BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	300	10	36	3.0	74.5	74.5	75.5	1.0
B	1,260	8	27	3.9	77.6	77.6	77.9	0.3
C	2,700	8	31	3.4	79.3	79.3	79.4	0.1
D	3,516	4	16	6.1	80.5	80.5	80.9	0.4
E	4,476	6	25	3.9	81.8	81.8	82.1	0.3
F	6,025	51	206	0.4	82.2	82.2	82.6	0.4
G	8,953	16	15	5.5	83.5	83.5	83.5	0.0
H	10,697	3	11	7.4	89.1	89.1	89.9	0.8
I	12,300	53	204	0.4	92.6	92.6	93.4	0.8
J	14,100	123	533	0.1	93.5	93.5	94.3	0.8

[1] FEET ABOVE CONFLUENCE WITH PARKER RIVER

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA
(ALL JURISDICTIONS)

FLOODWAY DATA

PENN BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
PORTER RIVER								
A	9,335	380	3,685	0.1	10.0 [2]	3.6	4.6	1.0
B	10,090	385	4,660	0.1	10.0 [2]	4.0	5.0	1.0
C	10,497	460	2,305	0.2	10.0 [2]	4.0	5.0	1.0
D	11,442	55	375	1.1	10.0 [2]	4.0	5.0	1.0
E	12,350	65	350	1.2	10.0 [2]	4.1	5.1	1.0
F	13,533	85	430	1.0	10.0 [2]	4.2	5.2	1.0
FROST FISH BROOK								
G	14,721	20	100	3.9	10.0 [2]	8.0	8.1	0.1
H	15,418	50	100	3.8	10.0 [2]	9.8	10.5	0.7
I	16,320	10	35	10.5	12.7	12.7	12.9	0.2
J	16,838	20	110	3.4	15.1	15.1	16.1	1.0

[1] FEET ABOVE KERNWOOD AVENUE

[2] ELEVATIONS COMPUTED CONSIDERING THE BACKWATER EFFECTS FROM BEVERLY HARBOR

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

FLOODWAY DATA

PORTER RIVER AND FROST FISH BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	250	123	1,818	0.9	10.8 [2]	7.9	8.9	1.0
B	380	145	1,808	0.9	10.8 [2]	7.9	8.9	1.0
C	1,960	236	2,161	0.8	10.8 [2]	7.9	8.9	1.0
D	2,250	39	577	2.9	10.8 [2]	7.9	8.9	1.0
E	2,400	39	423	4.0	10.8 [2]	7.9	8.9	1.0
F	2,680	48	658	2.6	10.8 [2]	8.3	9.3	1.0
G	2,814	38	545	3.1	10.8 [2]	8.3	9.3	1.0
H	5,350	222	2,483	0.7	10.8 [2]	8.5	9.5	1.0
I	6,500	629	4,823	0.4	10.8 [2]	8.5	9.5	1.0
J	7,800	106	1,029	1.5	10.8 [2]	8.5	9.5	1.0
K	8,360	46	182	8.2	10.8 [2]	8.5	9.5	1.0
L	8,750	13	97	15.5	32.2	32.2	32.2	0.0
M	9,000	32	130	11.5	51.6	51.6	51.6	0.0
N	9,250	29	125	12.0	66.5	66.5	66.5	0.0
O	9,470	49	359	4.2	74.6	74.6	74.6	0.0
P	9,600	57	353	4.2	74.8	74.8	74.8	0.0
Q	10,350	86	703	2.1	75.2	75.2	75.2	0.0
R	10,470	94	833	1.8	76.7	76.7	76.7	0.0
S	10,940	77	715	2.1	76.7	76.7	76.8	0.1
T	11,060	73	755	2.0	77.1	77.1	77.2	0.1
U	11,330	115	894	1.7	77.1	77.1	77.2	0.1
V	11,405	74	250	6.0	89.0	89.0	89.0	0.0

[1] FEET ABOVE CONFLUENCE WITH MERRIMACK RIVER

[2] ELEVATIONS COMPUTED CONSIDERING THE BACKWATER EFFECTS FROM MERRIMACK RIVER

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

FLOODWAY DATA

POWWOW RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	565	*	19	6.4	18.9 [2]	12.7	12.9	0.2
B	1,185	15	111	1.1	22.7	22.7	23.3	0.6
C	2,430	*	25	4.7	30.4	30.4	30.9	0.5
D	2,485	50	334	0.4	30.4	30.4	31.4	1.0
E	3,315	120	485	0.2	30.5	30.5	31.5	1.0
F	4,625	50	74	1.6	36.3	36.3	36.4	0.1
G	5,770	100	265	0.5	50.7	50.7	51.6	0.9
H	5,840	98	355	0.3	50.8	50.8	51.6	0.8

[1] FEET ABOVE CONFLUENCE WITH MERRIMACK RIVER
[2] ELEVATIONS COMPUTED CONSIDERING THE BACKWATER EFFECTS FROM MERIMACK RIVER
* FLOODWAY COINCIDENT WITH CHANNEL BANKS

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA
(ALL JURISDICTIONS)

FLOODWAY DATA

RIVERSIDE AIRPORT BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	0	22	97	11.5	9.2	4.8 [2]	4.9	0.1
B	1,200	55	233	4.8	9.2	7.7 [2]	7.7	0.0
C	2,100	55	219	5.1	9.2	8.2 [2]	9.1	0.9
D	2,241	38	164	6.8	11.8	11.8	11.8	0.0
E	2,341	42	202	5.5	12.1	12.1	12.4	0.3
F	2,681	34	111	10.1	13.8	13.8	13.8	0.0
G	3,231	30	183	6.1	21.2	21.2	21.8	0.6
H	3,420	30	271	4.1	25.3	25.3	25.3	0.0
I	3,800	20	159	7.0	25.3	25.3	25.4	0.1
J	4,013	35	231	4.8	25.6	25.6	26.4	0.8
K	4,303	24	102	10.9	28.8	28.8	29.0	0.2
L	5,803	198	752	1.5	32.4	32.4	33.0	0.6
M	7,113	85	444	2.5	35.2	35.2	35.9	0.7
N	8,543	149	725	1.5	36.1	36.1	36.8	0.7
O	9,823	53	247	3.4	37.0	37.0	37.7	0.7
P	10,081	129	386	2.2	38.3	38.3	39.0	0.7
Q	11,381	24	150	5.6	40.5	40.5	40.9	0.4
R	13,181	163	921	0.9	41.5	41.5	42.1	0.6
S	15,556	30	172	4.9	42.2	42.2	42.7	0.5
T	16,095	61	147	5.7	45.0	45.0	45.0	0.0
U	17,464	48	191	4.4	45.6	45.6	46.1	0.5
V	18,204	186	862	1.0	45.8	45.8	46.7	0.9
W	18,854	27	119	7.1	46.1	46.1	46.7	0.6
X	19,894	92	314	2.7	49.6	49.6	50.5	0.9
Y	20,574	191	578	1.5	50.6	50.6	51.4	0.8
Z	21,194	85	299	2.8	51.0	51.0	51.9	0.9
AA	21,744	192	461	1.8	51.8	51.8	52.7	0.9

[1] FEET ABOVE HAMILTON STREET (UPSTREAM FACE)

[2] ELEVATIONS COMPUTED WITHOUT CONSIDERING BACKWATER EFFECTS FROM ATLANTIC OCEAN

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

FLOODWAY DATA

SAUGUS RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
AB	22,964	104	468	0.9	54.5	54.5	55.5	1.0
AC	23,704	74	337	1.3	54.9	54.9	55.9	1.0
AD	24,924	85	325	0.7	55.6	55.6	56.6	1.0
AE	25,984	45	181	1.2	56.6	56.6	57.1	0.5
AF	26,984	24	76	2.8	57.6	57.6	58.6	1.0
AG	27,834	52	142	1.5	59.4	59.4	60.1	0.7
AH	29,474	24	69	3.1	62.0	62.0	62.3	0.3
AI	29,734	23	70	3.1	62.7	62.7	63.1	0.4
AJ	29,814	15	55	3.9	63.0	63.0	63.5	0.5
AK[3]	29,864	15	67	3.2	63.5	63.5	63.9	0.4
AL	29,889	13	38	5.6	63.7	63.7	63.9	0.2
AM	30,099	19	66	3.2	64.9	64.9	65.7	0.8
AN	30,199	24	74	2.9	65.4	65.4	66.0	0.6
AO[3]	30,369	24	74	2.9	65.4	65.4	66.0	0.6
AP	30,530	14	41	5.2	65.6	65.6	66.0	0.4
AQ	30,579	19	57	3.8	66.9	66.9	67.3	0.4
AR	30,784	300	343	0.6	72.7	72.7	72.7	0.0
AS	30,864	300	175	1.2	72.7	72.7	72.7	0.0
AT	31,094	540	1,836	0.1	72.8	72.8	72.8	0.0
AU	31,304	400	2,127	0.1	72.8	72.8	72.8	0.0
AV	31,784	23	109	3.2	72.8	72.8	72.8	0.0
AW	32,734	246	1,278	0.4	72.9	72.9	72.9	0.0
AX	36,664	206	1,228	1.0	73.0	73.0	73.1	0.1
AY	41,584	210	930	1.0	73.7	73.7	74.1	0.4
AZ	41,619	294	177	5.0	74.5	74.5	74.5	0.0
BA	41,679	303	1,164	0.8	75.0	75.0	75.0	0.0
BB	42,729	35	121	2.7	75.5	75.5	75.6	0.1

[1] FEET ABOVE HAMILTON STREET (UPSTREAM FACE)

[3] INTERPOLATED CROSS SECTION

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

FLOODWAY DATA

SAUGUS RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
BC	42,789	23	74	4.5	75.5	75.5	75.6	0.1
BD	42,969	38	119	2.8	76.0	76.0	76.1	0.1
BE	43,659	50	232	1.4	76.8	76.8	77.0	0.2
BF	43,694	20	120	2.8	76.8	76.8	77.0	0.2
BG	43,819	50	239	1.4	77.0	77.0	77.2	0.2
BH	44,079	31	144	2.3	77.5	77.5	77.8	0.3
BI	44,104	20	93	3.5	77.5	77.5	77.8	0.3
BJ	44,260	21	109	3.0	77.9	77.9	78.2	0.3

[1] FEET ABOVE HAMILTON STREET (UPSTREAM FACE)

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA
(ALL JURISDICTIONS)

FLOODWAY DATA

SAUGUS RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	390	53	191	0.7	44.3	44.3	44.5	0.2
B	670	15	20	6.2	44.1	44.1	44.1	0.0
C	970	30	134	0.9	44.7	44.7	45.4	0.7
D	1,350	30	101	1.3	45.1	45.1	45.7	0.6
E	1,850	17	29	4.4	45.3	45.3	45.9	0.6
F	2,380	20	85	1.5	53.0	53.0	53.0	0.0
G	3,050	15	24	5.2	53.2	53.2	53.3	0.1
H	3,500	18	34	3.7	58.2	58.2	58.2	0.0
I	3,725	30	120	1.1	61.9	61.9	62.8	0.9
J	4,082	20	89	1.4	63.6	63.6	63.6	0.0

[1] FEET ABOVE CONFLUENCE WITH BRANCH OF IPSWICH

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA
(ALL JURISDICTIONS)

FLOODWAY DATA

SCHOOL BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	1,109	72	786	4.7	33.4 [2]	23.0	23.4	0.4
B	1,657	94	767	4.8	33.4 [2]	25.2	25.5	0.3
C	15,337	89	1,069	3.5	33.4 [2]	30.1	30.6	0.5
D	15,474	66	931	4.0	33.4 [2]	31.3	31.5	0.2
E	18,922	115	1,053	3.4	33.4 [2]	32.4	32.8	0.4
F	19,143	98	1,144	3.1	35.7	35.7	35.7	0.0
G	27,092	171	1,182	2.8	39.8	39.8	40.3	0.5
H	27,227	139	1,096	3.1	40.7	40.7	41.1	0.4
I	28,060	98	1,319	2.5	41.3	41.3	41.8	0.5
J	28,122	127	938	3.6	44.7	44.7	44.8	0.1
K	30,566	61	466	7.2	48.3	48.3	48.4	0.1
L	30,614	47	441	7.6	49.7	49.7	49.8	0.1
M	30,714	61	652	5.1	50.8	50.8	50.9	0.1
N	31,469	145	607	5.5	52.0	52.0	52.1	0.1
O	33,909	76	574	5.8	57.6	57.6	57.7	0.1
P	33,989	65	568	5.9	61.3	61.3	61.3	0.0
Q	34,444	84	912	3.5	62.2	62.2	62.3	0.1
R	34,576	84	946	3.4	63.8	63.8	64.1	0.3
S	44,619	80	638	5.0	63.8	63.8	64.3	0.5
T	45,270	87	742	4.3	64.8	64.8	65.2	0.4
U	45,340	91	1,397	2.3	71.2	71.2	71.6	0.4
V	49,199	128	1,176	2.8	72.0	72.0	72.4	0.4
W	49,280	670	4,283	0.8	74.6	74.6	74.8	0.2

[1] FEET ABOVE CONFLUENCE WITH MERRIMACK RIVER

[2] ELEVATIONS COMPUTED CONSIDERING THE BACKWATER EFFECTS FROM MERRIMACK RIVER

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

FLOODWAY DATA

SHAWSHEEN RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	-2,540	38	218	3.5	9.2	6.2 [2]	6.8	0.6
B	-240	31	179	4.2	9.7	9.7	10.4	0.7
C	0	12	72	10.5	13.1	13.1	13.1	0.0
D	50	26	201	3.8	15.4	15.4	15.4	0.0
E	730	27	188	4.0	15.5	15.5	16.1	0.6
F	830	27	209	3.6	15.6	15.5	16.3	0.8
G	985	32	196	3.9	15.6	15.6	16.4	0.8
H	2,445	26	130	4.6	18.0	18.0	18.8	0.8
I	2,540	12	85	7.1	21.2	21.2	21.3	0.1
J	2,642	12	130	4.5	24.3	24.3	24.3	0.0
K	3,467	30	280	2.1	24.5	24.5	24.6	0.1
L	3,558	15	152	3.9	24.6	24.6	24.9	0.3
M	3,698	31	307	1.9	24.6	24.6	25.2	0.6
N	3,836	57	449	1.3	24.8	24.8	25.7	0.9
O	4,008	34	321	1.8	24.8	24.8	25.7	0.9
P	4,348	28	248	1.1	24.8	24.8	25.8	1.0
Q	4,423	22	203	1.4	24.9	24.9	25.9	1.0

[1] FEET ABOVE CENTRAL STREET CULVERT (UPSTREAM)

[2] ELEVATIONS COMPUTED WITHOUT CONSIDERING BACKWATER EFFECTS FROM ATLANTIC OCEAN

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

FLOODWAY DATA

SHUTE BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	655	*	232	10.3	33.6 [2]	17.6	17.8	0.2
B	735	78	710	3.4	33.6 [2]	19.7	19.8	0.1
C	1,112	52	330	7.3	33.6 [2]	22.5	22.5	0.0
D	1,172	46	291	8.3	33.6 [2]	22.5	22.5	0.0
E	1,805	67	314	7.6	33.6 [2]	25.4	25.4	0.0
F	2,295	68	375	6.4	33.6 [2]	26.5	26.5	0.0
G	2,925	*	303	7.9	33.6 [2]	33.3	33.3	0.0
H	3,760	57	252	9.5	37.8	37.8	37.9	0.1
I	4,805	82	436	5.5	40.7	40.7	40.8	0.1
J	4,855	89	641	3.7	41.1	41.1	41.2	0.1
K	5,496	55	609	3.9	48.1	48.1	48.7	0.6
L	6,260	60	726	3.3	48.4	48.4	48.9	0.5
M	6,367	*	731	3.3	48.9	48.9	49.6	0.7
N	7,260	*	529	4.5	49.5	49.5	50.3	0.8
O	8,100	*	713	3.4	50.0	50.0	50.6	0.6
P	8,150	*	783	3.1	50.2	50.2	50.6	0.4
Q	8,950	*	774	3.1	50.2	50.2	50.7	0.5
R	9,052	*	546	4.4	50.2	50.2	50.7	0.5
S	9,750	*	738	3.3	50.6	50.6	51.0	0.4
T	10,966	*	545	4.0	51.4	51.4	52.2	0.8
U	11,016	*	475	4.6	51.4	51.4	52.2	0.8
V	11,055	*	489	4.5	51.9	51.9	52.6	0.7
W	11,484	*	1,142	1.9	52.5	52.5	53.5	1.0
X	11,498	*	232	9.5	56.8	56.8	56.9	0.1
Y	12,598	*	524	4.2	58.7	58.7	58.7	0.0
Z	14,500	80	783	2.8	59.4	59.4	60.3	0.9
AA	14,650	80	658	3.3	59.5	59.5	60.4	0.9

[1] FEET ABOVE CONFLUENCE WITH MERRIMACK RIVER
[2] ELEVATIONS COMPUTED CONSIDERING THE BACKWATER EFFECTS FROM MERRIMACK RIVER
* FLOODWAY COINCIDENT WITH CHANNEL BANKS

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA
(ALL JURISDICTIONS)

FLOODWAY DATA

SPICKET RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
AB	15,550	80	754	2.9	60.1	60.1	60.9	0.8
AC	15,710	80	677	3.3	60.8	60.8	61.4	0.6
AD	17,240	71	571	3.9	61.1	61.1	61.8	0.7
AE	17,450	70	550	4.0	61.3	61.3	61.9	0.6
AF	18,665	40	264	8.3	70.4	70.4	70.4	0.0
AG	18,880	38	178	12.4	71.6	71.6	71.6	0.0
AH	19,200	50	515	3.9	106.2	106.2	106.2	0.0
AI	19,400	76	532	3.8	107.1	107.1	107.5	0.4
AJ	20,620	80	510	3.9	107.1	107.1	107.8	0.7
AK	20,780	80	548	3.7	108.0	108.0	108.6	0.6
AL	22,785	80	738	8.7	109.1	109.1	109.5	0.4
AM	23,000	80	677	3.0	109.4	109.4	109.7	0.3
AN	23,950	80	742	2.7	109.7	109.7	110.0	0.3
AO	27,060	80	674	3.0	110.5	110.5	111.1	0.6
AP	28,700	80	739	2.7	110.7	110.7	111.6	0.9

[1] FEET ABOVE CONFLUENCE WITH MERRIMACK RIVER

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA
(ALL JURISDICTIONS)

FLOODWAY DATA

SPICKET RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	1,267	10	27	5.3	18.2	18.2	18.2	0.0

[1] FEET ABOVE CONFLUENCE WITH NORTH RIVER

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA
(ALL JURISDICTIONS)

FLOODWAY DATA

STRONGWATER BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	422	80	137	1.2	44.6	39.5 [2]	40.2	0.7
B	539	40	90	1.8	44.6	40.2 [2]	40.3	0.1
C	792	90	154	1.1	44.6	40.3 [2]	41.1	0.8
D	1,030	10	21	7.8	44.6	42.1 [2]	42.1	0.0
E	1,214	10	34	4.9	44.6	44.6	44.6	0.0
F	1,985	220	1,195	0.1	47.0	47.0	47.0	0.0
G	2,318	40	164	1.0	47.0	47.0	47.0	0.0
H	2,640	270	1,156	0.1	47.0	47.0	47.0	0.0
I	3,168	130	425	0.4	47.0	47.0	47.0	0.0
J	3,453	20	44	3.8	47.0	47.0	47.0	0.0

[1] FEET ABOVE CONFLUENCE WITH GOLDTHWAITE BROOK

[2] ELEVATIONS COMPUTED WITHOUT CONSIDERING BACKWATER EFFECTS FROM GOLDTHWAITE BROOK

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

FLOODWAY DATA

TAPLEY BROOK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	2,952	15	25	6.6	53.1	53.1	53.6	0.5
B	4,536	20	45	2.6	65.2	65.2	66.0	0.8
C	5,401	5	20	6.1	72.1	72.1	72.1	0.0
D	6,072	15	20	5.7	79.5	79.5	80.1	0.6
E	6,563	60	185	0.6	88.5	88.5	88.5	0.0
F	7,492	60	395	0.3	89.4	89.4	89.4	0.0

[1] DISTANCE IN FEET ABOVE CONFLUENCE WITH IPSWICH RIVER

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

FLOODWAY DATA

TRIBUTARY A TO IPSWICH RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	30	30	122	1.4	101.8	101.8	102.2	0.4
B	80	50	260	0.7	101.9	101.9	102.3	0.4
C	700	50	134	1.3	101.9	101.9	102.3	0.4
D	776	50	194	0.9	103.1	103.1	103.9	0.8
E	1,660	150	706	0.2	103.1	103.1	103.9	0.8
F	2,987	50	166	1.0	106.1	106.1	107.0	0.9

[1] FEET ABOVE BIRCH MEADOW ROAD

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

FLOODWAY DATA

TRIBUTARY TO NEAL POND

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 analyses. These zones are as follows:

Zone A

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

Zone AE

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

Zone AH

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

Zone AO

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

Zone V

Zone V is the flood insurance rate zone that corresponds to the 1-percent-annual-chance coastal floodplains that have additional hazards associated with storm waves. Because approximate hydraulic analyses are 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 1-percent-annual-chance coastal floodplains that have additional hazards associated with storm waves. Whole-foot BFEs derived from the detailed hydraulic analyses are 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, areas of 1-percent-annual-chance flooding where average depths are less than 1 foot, areas of 1-percent-annual-chance flooding where the contributing drainage area is less than 1 square mile (sq. mi.), and areas protected from the base flood by levees. No BFEs or depths are shown within this zone.

6.0 FLOOD INSURANCE RATE MAP

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

For flood insurance applications, the map designates flood insurance rate zones as described in Section 5.0 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 analyses and floodway computations.

The countywide FIRM presents flooding information for the entire geographic area of Essex County. Previously, FIRMs were prepared for each incorporated community and the unincorporated areas of the County identified as flood-prone. This countywide FIRM also includes flood-hazard information that was presented separately on Flood Boundary and Floodway Maps (FBFMs), where applicable. Historical data relating to the maps prepared for each community are presented in Table 13, "Community Map History."

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISION DATE(S)	FLOOD INSURANCE RATE MAP EFFECTIVE DATE	FLOOD INSURANCE RATE MAP REVISION DATE(S)
Amesbury, Town of	June 14, 1974	February 11, 1977	June 18, 1980	August 3, 1992
Andover, Town of	July 26, 1974	None	August 1, 1978	June 5, 1989
Beverly, City of	August 16, 1974	December 10, 1976	March 18, 1986	June 2, 1992
Boxford, Town of	August 30, 1974	October 15, 1976 July 26, 1977	June 3, 1991	None
Danvers, Town of	July 26, 1974	January 7, 1977	July 2, 1980	None
Essex, Town of	July 26, 1974	July 23, 1976	July 17, 1986	July 2, 1992 July 20, 1998
Georgetown, Town of	July 26, 1974	December 3, 1976	June 4, 1980	None
Gloucester, City of	July 26, 1974	February 18, 1977 October 1, 1983	January 17, 1986	July 2, 1992 July 20, 1998
Groveland, Town of	June 28, 1974	January 22, 1977 November 11, 1977	October 1, 1980	None
Hamilton, Town of	November 26, 1976	None	June 4, 1990	None
Haverhill, City of	July 19, 1974	February 13, 1976	February 16, 1983	None
Ipswich, Town of	October 18, 1974	September 17, 1976 October 1, 1983	August 5, 1985	July 2, 1992

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA (ALL JURISDICTIONS)

COMMUNITY MAP HISTORY

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISION DATE(S)	FLOOD INSURANCE RATE MAP EFFECTIVE DATE	FLOOD INSURANCE RATE MAP REVISION DATE(S)
Lawrence, City of	February 8, 1974	August 6, 1976	August 2, 1982	None
Lynn, City of	June 28, 1974	September 17, 1976	February 1, 1985	None
Lynnfield, Town of	September 6, 1974	September 3, 1976	February 1, 1980	July 16, 1990
Manchester by the Sea, Town of	April 5, 1974	October 29, 1976	September 4, 1986	July 2, 1992
Marblehead, Town of	June 28, 1974	June 18, 1976	July 3, 1985	None
Merrimac, Town of	October 18, 1974	September 3, 1976	July 5, 1982	None
Methuen, City of	August 30, 1974	April 8, 1977	July 2, 1980	July 18, 1987
Middleton, Town of	December 6, 1974	November 12, 1976	November 5, 1980	None
Nahant, Town of	June 7, 1974	None	July 19, 1976	September 28, 1984
Newbury, Town of	March 15, 1977	None	March 15, 1977	July 17, 1986 July 2, 1992
Newburyport, City of	July 26, 1974 October 22, 1976	None	February 15, 1978	November 1, 1985
North Andover, Town of	June 28, 1974	May 10, 1977	June 15, 1983	June 2, 1993
Peabody, City of	August 2, 1974	August 20, 1976	May 15, 1980	None

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA (ALL JURISDICTIONS)

COMMUNITY MAP HISTORY

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISION DATE(S)	FLOOD INSURANCE RATE MAP EFFECTIVE DATE	FLOOD INSURANCE RATE MAP REVISION DATE(S)
Rockport, Town of	August 9, 1974	October 8, 1976	June 19, 1985	July 2, 1992
Rowley, Town of	July 26, 1974	November 12, 1976	August 5, 1986	June 30, 1999
Salem, City of	July 26, 1974	None	March 15, 1977	August 5, 1985
Salisbury, Town of	September 13, 1974	None	May 2, 1977	June 24, 1977 September 4, 1986 July 2, 1992
Saugus, Town of	September 13, 1974	December 10, 1976	January 19, 1983	None
Swampscott, Town of	May 24, 1974	None	September 3, 1976	July 3, 1985 July 2, 1992
Topsfield, Town of	September 13, 1974	June 23, 1976	June 4, 1980	June 17, 1991 June 2, 1994
Wenham, Town of	July 26, 1974	July 23, 1976	June 19, 1989	August 19, 1991
West Newbury, Town of	August 16, 1974	None	June 15, 1979	None

TABLE 13

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA (ALL JURISDICTIONS)

COMMUNITY MAP HISTORY

7.0 OTHER STUDIES

Information pertaining to revised and unrevised flood hazards for each jurisdiction within Essex County has been compiled in this FIS. Therefore, this FIS supersedes all previously printed FIS reports, FIRMs, and/or FHBMs for all of the incorporated jurisdictions within Essex County.

Essex County is bordered by Suffolk County, MA to the south, Middlesex County, MA to the west, and Rockingham County, New Hampshire to the north. At the time of this revision, both of the Massachusetts counties were undergoing countywide revisions. They will all be in agreement with this countywide FIS.

This FIS report either supersedes or is compatible with all previous studies published on flooding sources studied in this report and should be considered authoritative for the purposes of the NFIP.

8.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting FEMA Region I, 99 High Street, 6th Floor, Boston, MA 02110.

9.0 BIBLIOGRAPHY AND REFERENCES

1. Federal Emergency Management Agency. Flood Insurance Study, Town of Merrimac, Essex County, Massachusetts, Washington, D. C., July 5, 1982.
2. Federal Emergency Management Agency, Flood Insurance Study, Town of South Hampton, Rockingham County, New Hampshire, Washington, D. C. July 15, 1992.
3. Federal Emergency Management Agency, Flood Insurance Study, Town of Methuen, Essex County, Massachusetts, Washington, D.C., January 1980.
4. Aerial Photography, Avis Airmap, Inc., Braintree, Massachusetts, Scale: 1:4,800, Contour Intervals feet, December 1980.
5. Census 2000 Summary File 1 Massachusetts/prepared by the U.S. Census Bureau, 2001.
6. U. S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, Town of Andover, Essex County, Massachusetts, Washington, D. C., August 1, 1978.
7. Federal Emergency Management Agency, Flood Insurance Study, City of Lawrence, Essex County, Massachusetts, Washington, D. C., August2, 1982.
8. Federal Emergency Management Agency, Flood Insurance Study, Town of Ipswich, Essex County, Massachusetts, Washington, D. C., August 5, 1985.

9 North Andover League of Women Voters, North Andover Know Your Town, North Andover, Massachusetts, 1988.

10 U. S. Army Corps of Engineers, New England Division, Flood Plain Information, Merrimack-Shawsheen-Spicket Rivers, Waltham, Massachusetts, 1972.

11 Commonwealth of Massachusetts, Geodetic Survey, High-Water Data, Flood of March 1936 in Massachusetts, Boston, Massachusetts, November 1963.

12 Massachusetts Geodetic Survey, High Water Data, Flood of March 1936 in Massachusetts, Boston, Massachusetts, November 1936.

13 U. S. Department of the Interior, Geological Survey, Water-Supply Paper 1826, Water Resources of the Ipswich River Basin, Massachusetts by E. A. Samuel, J. A. Baker, and R. A. Brackley, Washington, D. C., 1966.

14 U. S. Department of the Interior, Geological Survey, Water-Supply Paper 1671, Magnitude and Frequency of Floods in the United States, Part I-A, North Atlantic Slope Basin, Maine to Connecticut by Rice A. Green, Washington, D. C., 1964.

15 U. S. Department of the Interior, Geological Survey, Water Resources Data for Massachusetts, Boston, Massachusetts, Published Annually 1961-76.

16 U. S. Department of the Interior, Geological Survey, Hydrologic Investigations Atlas HA-482, Flood of March 1968, The Ipswich River, Massachusetts by L. A. Swallow and D. J. Fogarty, Washington, D. C., 1973.

17 U. S. Army Corps of Engineers, North Atlantic Division, National Shoreline Study, Regional Inventory Report, North Atlantic Region, Volume I, New York, 1971.

18 Town of Boxford, Zoning Bylaw of the Town of Boxford, Boxford, Massachusetts, August 1985

19 Town of Danvers, Zoning Map, Section XI A, Inland Flood Plain Watershed Protection Districts, Scale 1"=600', Danvers, Massachusetts, 1974.

20 Duffill Associates, Inc., Department of Public Works of Massachusetts, Division of Waterways, Proposed Drainage Improvements, Beaver Brook, Danvers, Massachusetts, Boston, Massachusetts, April 1957.

21 Duffill Associates, Inc., Department of Public Works of Massachusetts, Division of Waterways, Proposed Stream Improvements, Crane Brook, Mill Pond to Vicinity of Collins Street, Danvers, Boston, Massachusetts, August 1957.

22 Duffill Associates, Inc., Department of Public Works of Massachusetts, Division of Waterways, Proposed Stream Improvements, Crane Brook and Tributaries, Danvers, Boston, Massachusetts, April 1958.

23 Alan M. Voorhees & Associates, Inc., Hydraulic Report, Purchase Street, Crane River (Unpublished).

24 Town of Hamilton, Town of Hamilton Zoning By-Law, Hamilton,

Massachusetts, July 1986.

25 U. S. Army Corps of Engineers, New England Division, Flood Plain Information, Merrimack-Shawsheen-Spicket Rivers, Waltham, Massachusetts, 1972.

26 U. S. Army Corps of Engineers, New England Division, National Shoreline Study, Regional Inventory Report, North Atlantic Region, Volume 1, Waltham, Massachusetts, 1971.

27 City of Peabody, Revised Zoning Ordinance of the City of Peabody, Peabody, Massachusetts, December 16, 1975.

28 Town of Topsfield, Town of Topsfield Zoning By-Law, Topsfield, Massachusetts, July 1986.

29 U.S. Department of the Interior, Geological Survey, Estimating the Magnitude and Frequency of Floods on Natural Flow Streams in Massachusetts, Water Resources Investigation 77-39, Boston, Massachusetts, 1977.

30 U. S. Department of Agriculture, Soil Conservation Service, SCS National Engineering Handbook, Hydrology, Section i, Washington, D. C., August 1972.

31 U.S. Army Corps of Engineers; New England Division; Water Resources Investigation; Merrimack River Basin. August 1972.

32 water Resources Council, "Guidelines for Determining Flood Flow Frequency", Bulletin 17, Washington, D. C., March 1976.

32 Water Resources Council, "Guidelines for Determining Flood Flow Frequency", Bulletin 17, Washington, D. C., March 1976.

33 U. S. Department of the Interior; Geological Survey, Water-Resources Investigations Report 84-4284, Gazetteer of Hydrologic Characteristics of Streams in Massachusetts-Merrimack River Basin, Boston, Massachusetts, 1984.

34 U. S. Department of the Interior, Geological Survey, Water-Supply Paper 2214, Estimating Peak Discharges of Small; Rural Streams in Massachusetts, Washington, D. C., 1983.

35 U. S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, Town of Andover, Essex County, Massachusetts, Washington, D.C., June 5, 1989.

36 U. S. Department of the Interior, Geological Survey, Water Resources Investigations 23-74, An Approach to Estimating Flood Frequency for Urban Areas in Oklahoma by V. B. Sauer, Washington, D. C., July 1974.

37 Carl G. Johnson and Gary D. Tasker, Hydrologic Study: Small Watersheds, Progress Report on Flood Magnitude and Frequency of Massachusetts Streams, March 1974.

38 U.S. Department of the Interior, Geological Survey, 7.5-Minute Series Topographic Maps: Scale 1:24,000, Contour Interval 10 feet: Haverhill, Massachusetts (1972), Newburyport West, Massachusetts (1968), South Groveland, Massachusetts (1966), Georgetown, Massachusetts (1966)

39 U.S. Weather Bureau, Blue Hills Observatory, Milton, Massachusetts

40 U. S. Department of Commerce, National Oceanic and Atmospheric Administration, United States Coast Pilot 1, Atlantic Coast, Eastport to CapeCod, Asheville, North Carolina, National Climatic Center, November 1976.

41 U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, Town of North Reading, Massachusetts, June 1977

42 U.S. Department of Agriculture, Soil Conservation Service, Technical Paper No. 149, A Method for Estimating Volume and Rate of Runoff in Small Watersheds, April 1973

43 Technical Release No. 55, Urban Hydrology for Small Watersheds, January 1975

44 U.S. Department of Commerce, Weather Bureau, Technical Paper No. 40, Rainfall-Frequency Atlas of the United States, January 1963

45 Ven Te Chow, ed., Handbook of Applied Hydrology, New York, McGraw-Hill, 1964.

46 U. S. Department of the Interior, Bureau of Reclamation, Design of Small Dams, Washington, D. C., 1977.

47 W. Viessman, Jr., et al., Introduction to Hydrology, New York, New York, 1972.

48 Federal Emergency Management Agency, Federal Insurance Administration, Flood Insurance Study, Town of Tewksbury, Middlesex County, Massachusetts, Washington, D.C, July 2, 1981.

49 Federal Emergency Management Agency, Federal Insurance Administration, Flood Insurance Study, Town of Methuen, Essex County, Massachusetts, Washington, D. July 2, 1980.

50 G. M. Fair, and J. C. Geyer, Water-Supply and Wastewater Disposal, New York: John Wiley & Sons Inc., 1954

51 U.S. Department of the Interior, Geological Survey, Water Resources Data for Massachusetts, New Hampshire, Rhode Island, and Vermont, 1960, 1977.

52 Federal Emergency Management Agency, Flood Insurance Study, Town of Rowley, Essex County, Massachusetts (Unpublished).

53 U. S. Department of the Interior, Geological Survey, Water-Supply Paper 2207, Flood Characteristics of Urban Watersheds in the United States, by V.B. Sauer, W.O. Thomas, Jr., V.A. Stricher, and K.V. Wilson, Washington, D. C., 1983.

54 U. S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, Town of Wakefield, Middlesex County, Massachusetts, Washington, D. C., April 17, 1978.

55 U. S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-2 Water Surface Profiles. Generalized Computer Program, Davis, California, May 1991.

56 U. S. Army Corps of Engineers, Hydrologic Engineering Center, Application of the HEC-2 Bridge Routines. Training Document No.6, Davis, California, June 1974.

57 U. S. Department of the Interior, Geological Survey, 7.5-Minute Series Topographic Maps, Scale 1:24,000, Contour Intervals 10 Feet and 3 Meters: Georgetown, Massachusetts; Salem, Massachusetts.

58 U. S. Department of Agriculture, Soil Conservation Service, Technical Paper No. 149, A Method for Estimating Volume of Rate of Runoff In Small Watersheds, April 1973.

59 U. S. Department of Commerce, Weather Bureau, Technical Paper No. 40, Rainfall Frequency Atlas of the United States, January 1963.

60 Fair, G. M., and J. C. Geyer, Water Supply and Wastewater Disposal. New York: John Wiley & Sons, Inc., 1954.

61 Federal Emergency Management Agency, Federal Insurance Administration, Flood Insurance Study, Town of West Newbury, Essex County, Massachusetts, Washington, D. C., December 1978.

62 Teledyne Geotronics of Long Beach, California, Topographic Maps, Scale 1:4,800, Contour Interval 5 Feet: Merrimac, Massachusetts, April 1979.

63 U. S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, Town of Middleton, Massachusetts May 1980.

64 U. S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, City of Salem, Massachusetts (Unpublished).

65 Federal Emergency Management Agency, Flood Insurance Study, City of Lawrence, Essex County, Massachusetts, Washington, D.C., August 1982.

66 New England Coastal Engineering, One Dimensional Storm Surge Model for Coastal Rivers Including Application to the Damariscotta and Sheepscot Rivers, Maine, and Chatham Harbor, Massachusetts, Bangor, Maine, July 1977.

66 New England Coastal Engineers, Inc., A 1-D Numerical Storm Surge Model for Coastal Rivers Including Application ~ the Damariscotta and Sheepscot Rivers, Massachusetts, and Chatham Harbor, Massachusetts, July 1977.

67 U. S. Department of the Interior, Geological Survey, Water Resources Investigations 79-61, Coastal Flood of February 2, 1978, in Maine, Massachusetts, and New Hampshire, Boston, Massachusetts, 1979.

68 National Academy of Sciences, Methodology for Calculating Wave Action Effects Associated with Storm Surges, Washington, DC, 1977

69 U.S. Amy Corps of Engineers, Coastal Engineering Research Center, Coastal Engineering Technical Note No. 6, Revised Method for Wave Forecasting in Shallow Water, Fort Belvoir, Virginia, March 1981.

70 Stone and Webster Engineering Corporation, Manual for Wave Runup Analysis, Coastal Flood Insurance Studies, Boston, Massachusetts, November 1981.

71 U.S. Department of the Interior, Geological Survey, No. 79-61, Coastal Flood of February 7, 1978, in Maine, Massachusetts, and New England, Augusta, Maine, 1979.

72 Stone & Webster Engineering Corporation, Determination of Coastal Storm Tide Levels, Boston, Massachusetts, October 1978.

73 Jonathon French, Camp, Dresser & McKee, Memorandum on "Special Computation
Procedure Developed for Wave Runup Analysis for Casco Bay, FIS-Maine, 9700-153," December 29, 1982.

74 P. Williams, PRC Harris, Interoffice Correspondence on "Wave Runup Methodology, Massachusetts and Rhode Island Flood Insurance Study," April 7, 1983.

75 Federal Emergency Management Agency. (April 2003). Guidelines and Specifications for Flood Hazard Mapping Partners. Appendix D: Guidance for Coastal Flooding Analyses and Mapping. Washington, D.C.

76 Federal Emergency Management Agency, Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update, February 2007

77 U.S. Army Corp of Engineers, Hydraulics and Water Quality Section. Tidal Flood Profiles New England Coastline. September 1988.

78 Federal Emergency Management Agency. (April 2003). Guidelines and Specifications for Flood Hazard Mapping Partners. Appendix B: "Guidance for Converting to the North American Vertical Datum of 1988." Washington, D.C.

79 Goda, Y. (2000). Random Seas and Design of Maritime Structures. World Scientific, Singapore.

80 U.S. Army Corps of Engineers, Coastal Engineering Research Center. (1984). Shore Protection Manual. (Volumes I and II, 4th Edition). Washington, D.C.

81 U.S. Department of Commerce, Coast and Geodetic Survey, Gulf of Maine Coastal Chart, #13009, 34th Edition, March 1, 2009.

82 Geod Surveying and Aerial Mapping Corporation, of Oak Ridge, New Jersey, Aerial Photographs.

83 The Massachusetts Office of Coastal Zone Management (2006). Technical Report: "Primary Frontal Dune Delineation: A Geologically Based Quantitative Methodology for Sandy Beaches in Northeastern Massachusetts".

84 U. S. Army Corps of Engineers, New England Division, Topographic Maps, Scale 1:4,800, Contour Interval 5 Feet: Andover, Massachusetts.

85 James W. Sewall, Co., of Old Town, Maine, photogrammetric Maps, Scale 1"=400', Contour Interval 5 Feet: Beverly, Massachusetts, 1979.

86 Dewbury and Davis of Arlington, Virginia, Work Maps for Parker River and Fish Brook in Boxford, Massachusetts, 1:4800, Contour Interval 4 Feet, 1987.

87 Massachusetts Department of Public Works, Topographic Maps, Beverly Danvers, Peabody, Scale 1"=200', Contour Interval 5 feet, Boston, Massachusetts, December 1971.

88 Moore Survey and Mapping Corporation, Topographic Maps, Scale 1"-400', Contour Interval 5 Feet: Danvers, Massachusetts, December 1977.

89 James W. Sewall, Co., of Old Town, Maine, Topographic Maps, Scale 1:2,400, Contour Interval 5 Feet: Ipswich, Massachusetts, 1979.

90 U.S.. Department of the Interior, Geological Survey, Topographic M~, Scale 1:24,000, Contour Interval 10 feet: Reading, Massachusetts, (1966); Salem, Massachusetts (1970)

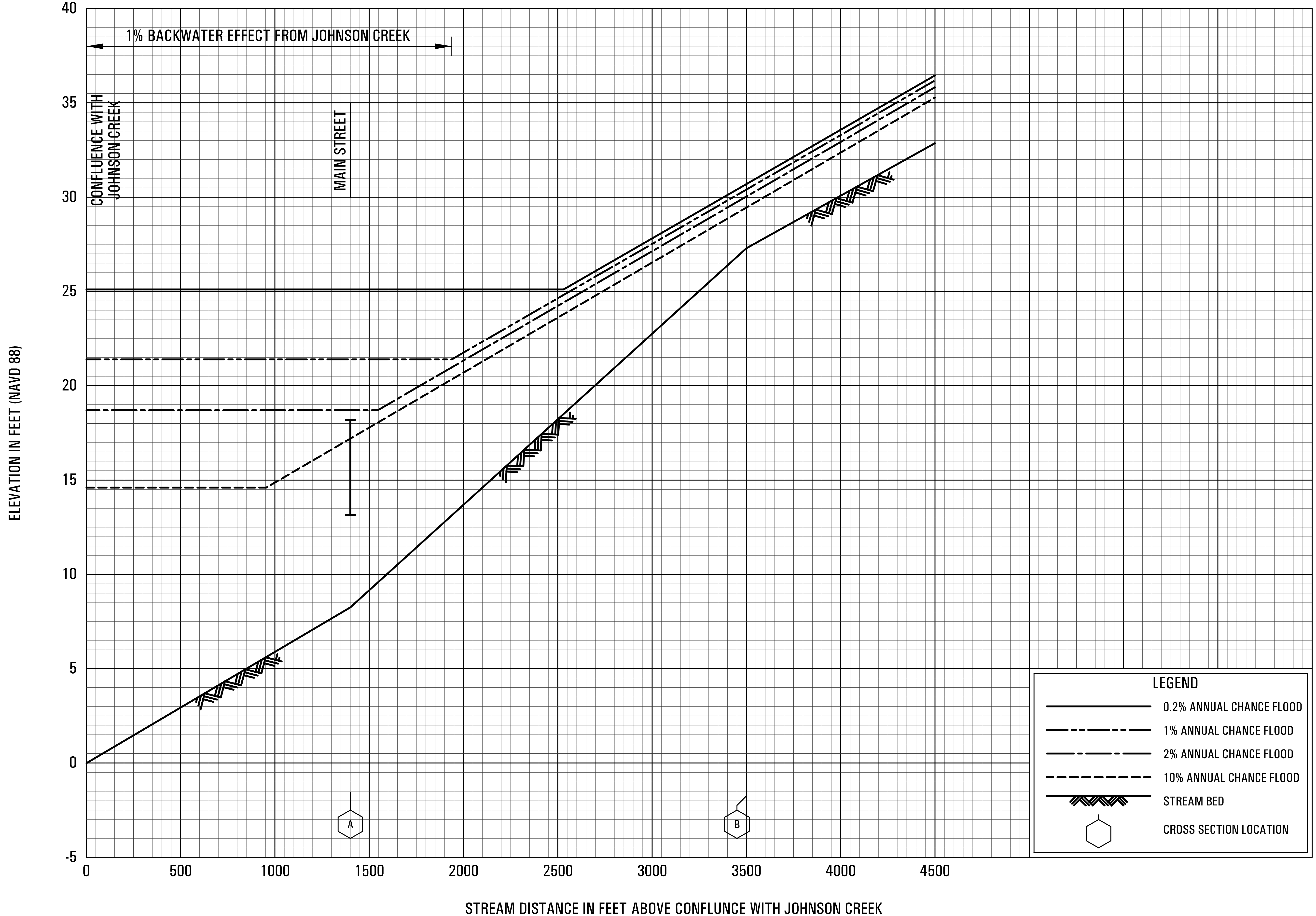
91 Commonwealth of Massachusetts, Department of Public Works, Topographic Maps, Route 128, Scale 1:24,000, Contour Interval 5 feet: Stoneham, Reading, Wakefield, and Lynnfield, Massachusetts, April 1973

92 James W. Sewall, Co., of Old Town, Maine, Topographic Maps, Scale 1:2,400, Contour Interval 5 Feet: Nahant, Massachusetts, December 1978.

93 U. S. Department of the Interior, Geological Survey, 7.5-Minute Series Topographic Maps, Scale 1:25,000, Contour Interval 10 Feet: South Groveland, 1979; Georgetown, 1979.

94 Federal Emergency Management Agency; Flood Insurance Study, City of Newburyport, Essex County; Massachusetts, Washington, D. C., November 1, 1985.

95 Federal Emergency Management Agency, Federal Insurance Administration, Flood Insurance Study, Town of West Newbury, Essex County, Massachusetts, Washington, D. C::-June ~1979.



FLOOD PROFILES

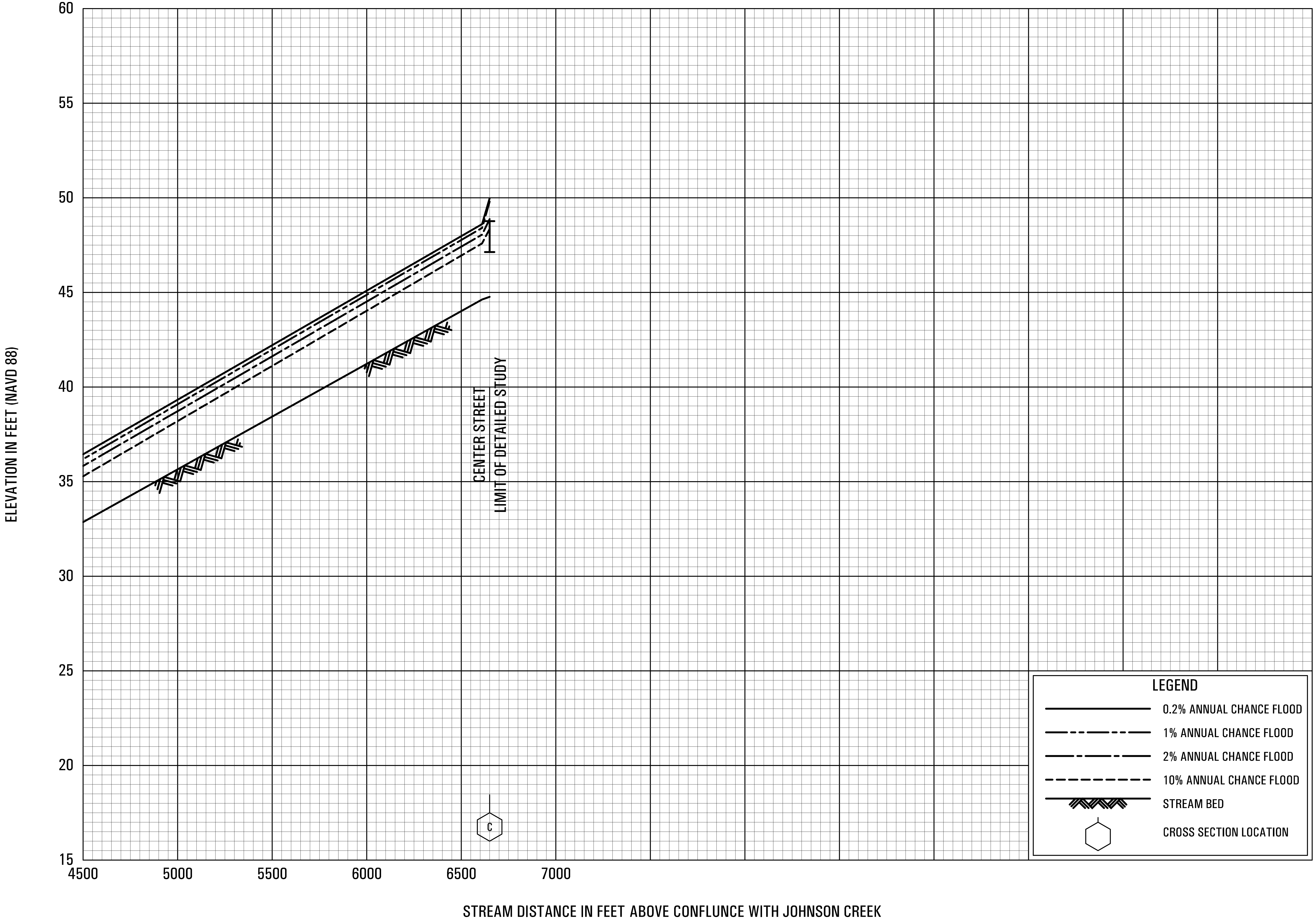
ARGILLA BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

01P



FLOOD PROFILES

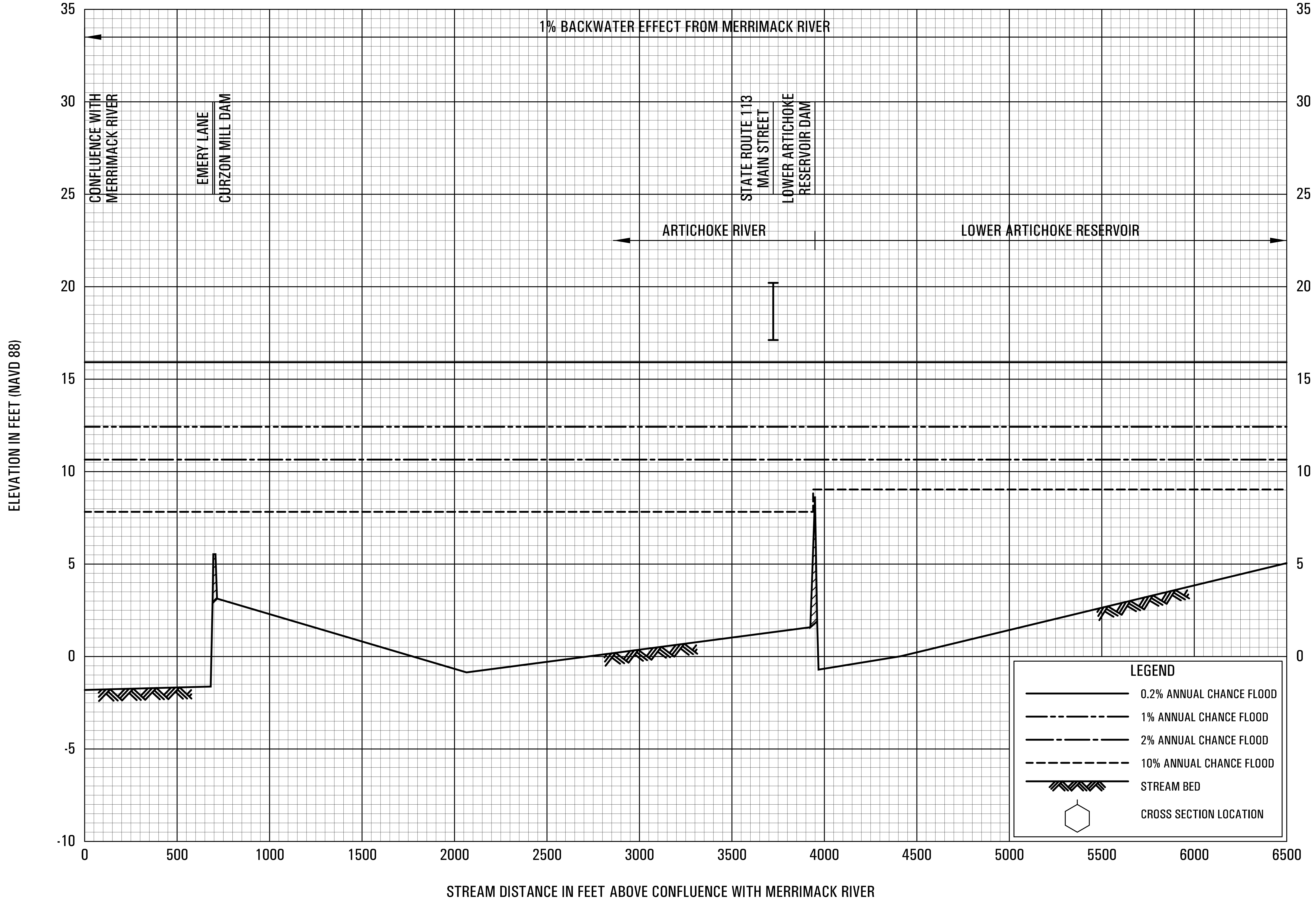
ARGILLA BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

02P



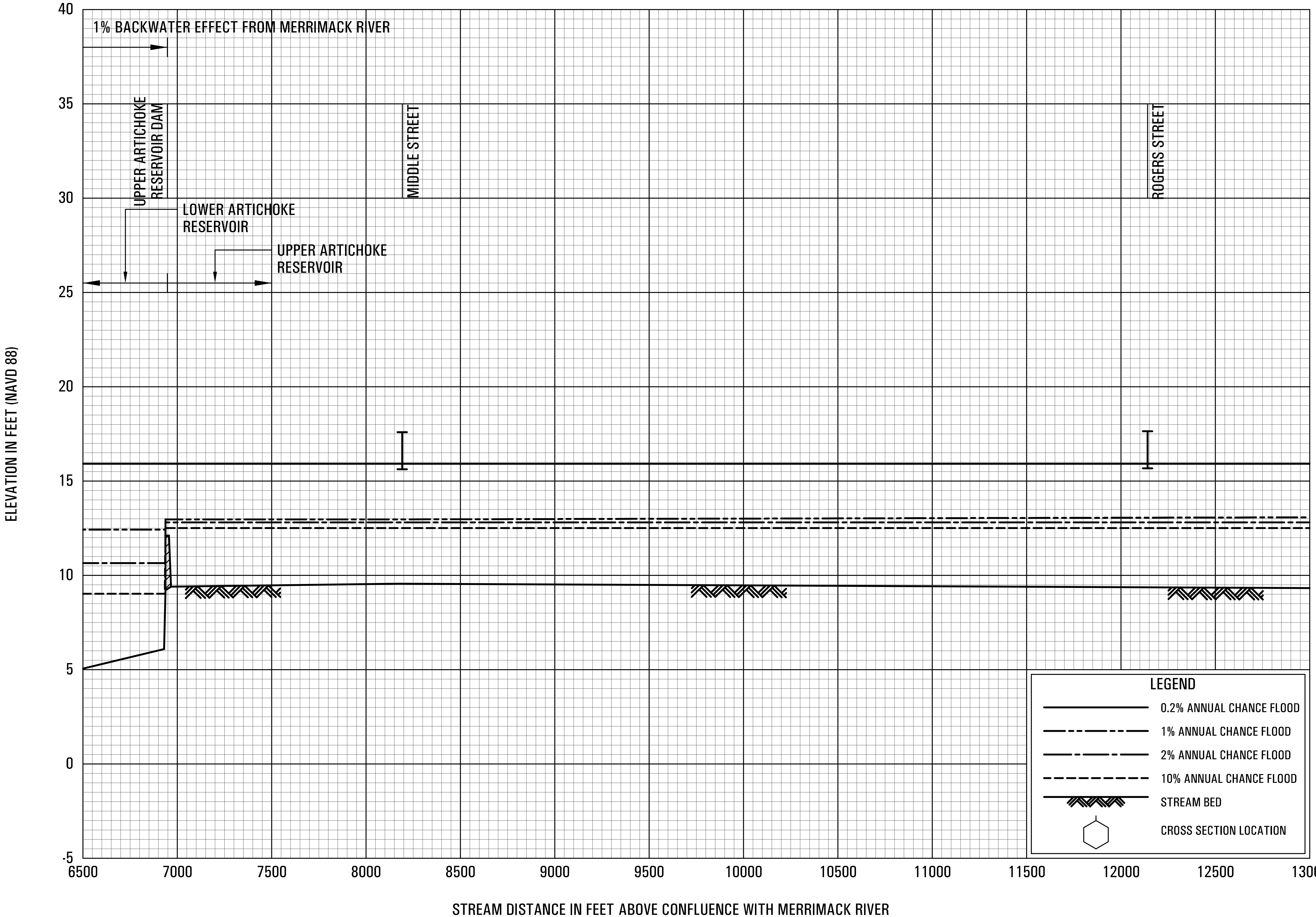
FLOOD PROFILES

ARTICHOKE RIVER - RESERVOIR

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



FLOOD PROFILES

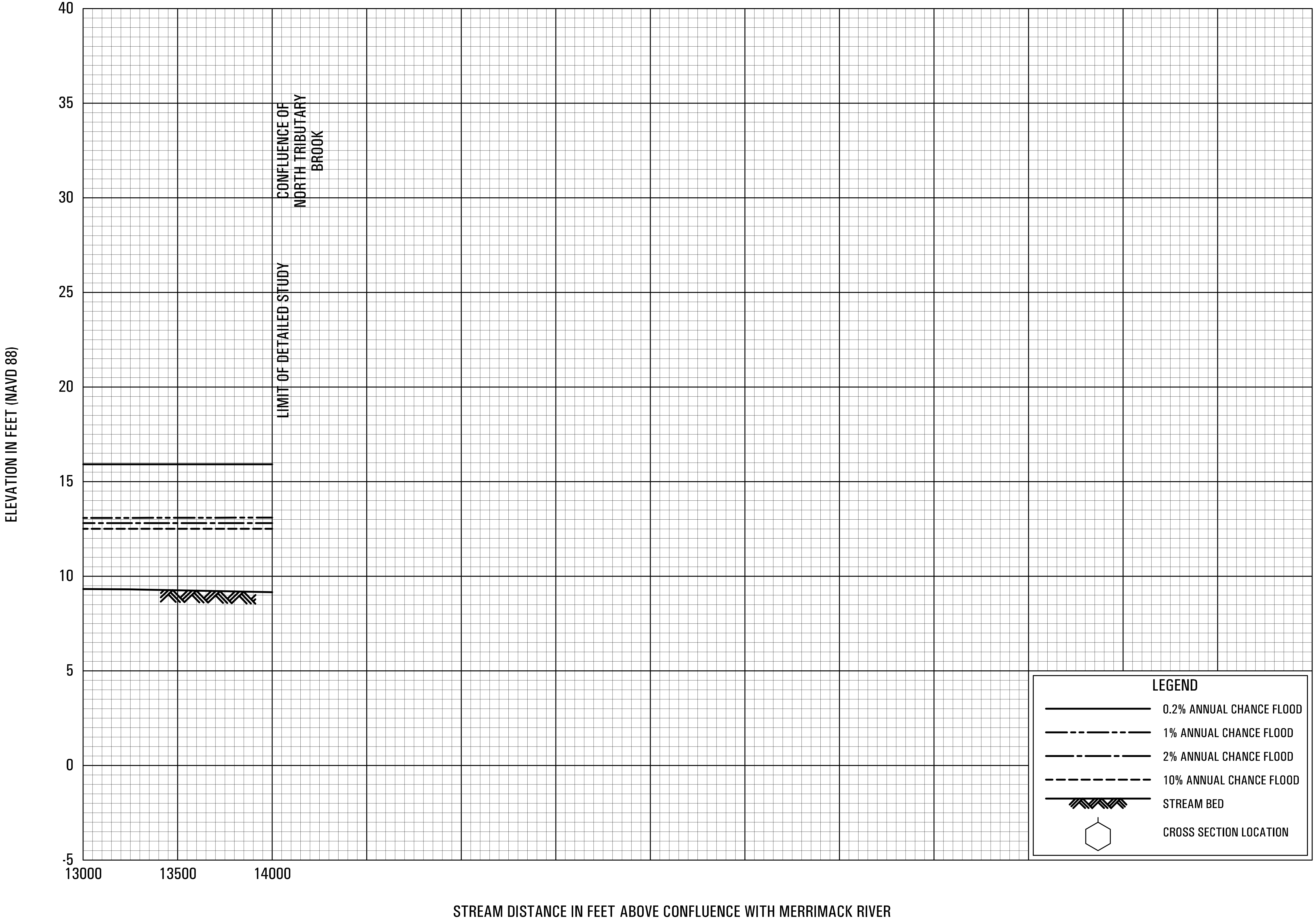
ARTICHOKE RIVER - RESERVOIR

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

04P



FLOOD PROFILES

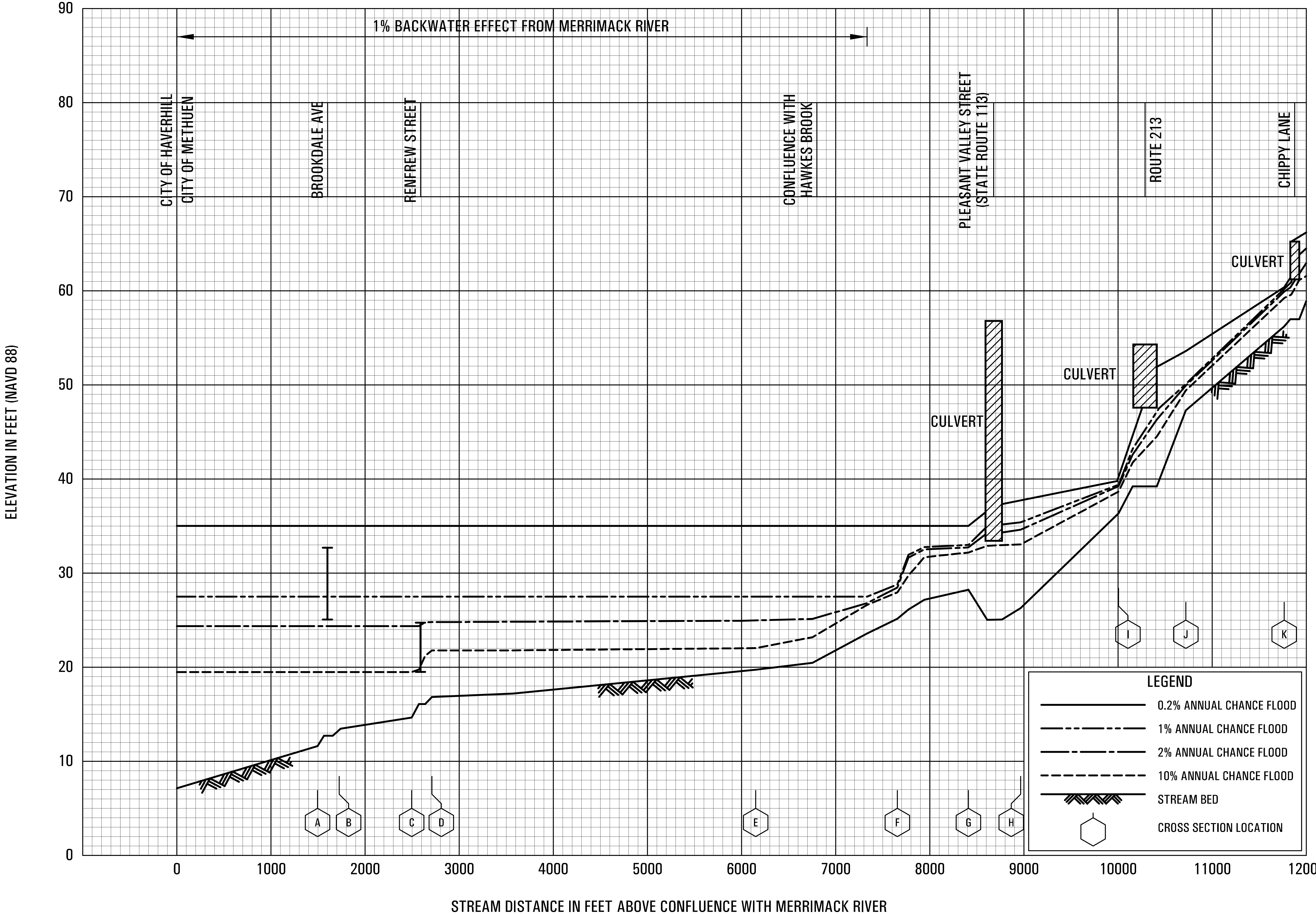
ARTICHOKE RIVER - RESERVOIR

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

05P



FLOOD PROFILES

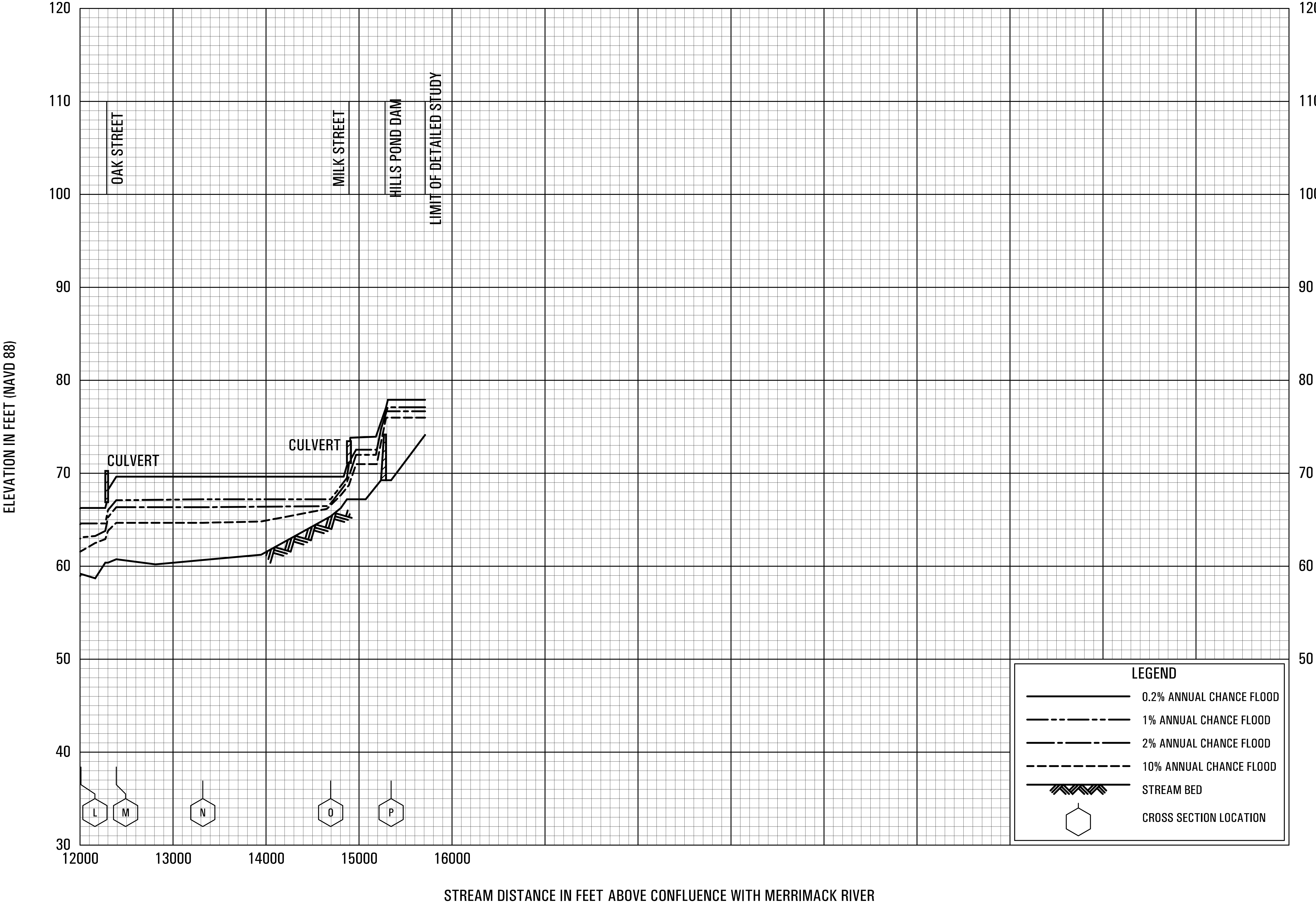
BARE MEADOW BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

06P



FLOOD PROFILES

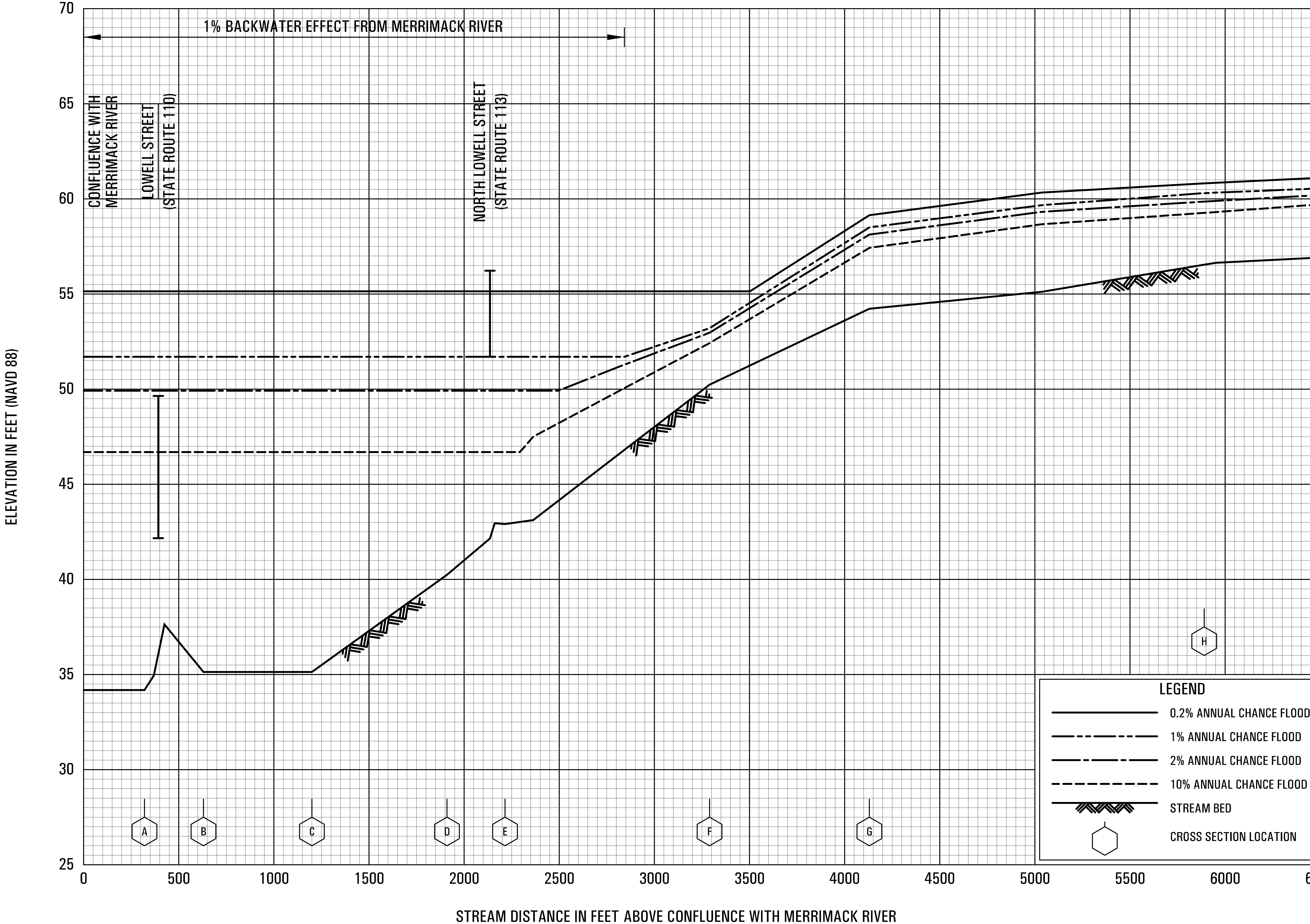
BARE MEADOW BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

07P



FLOOD PROFILES

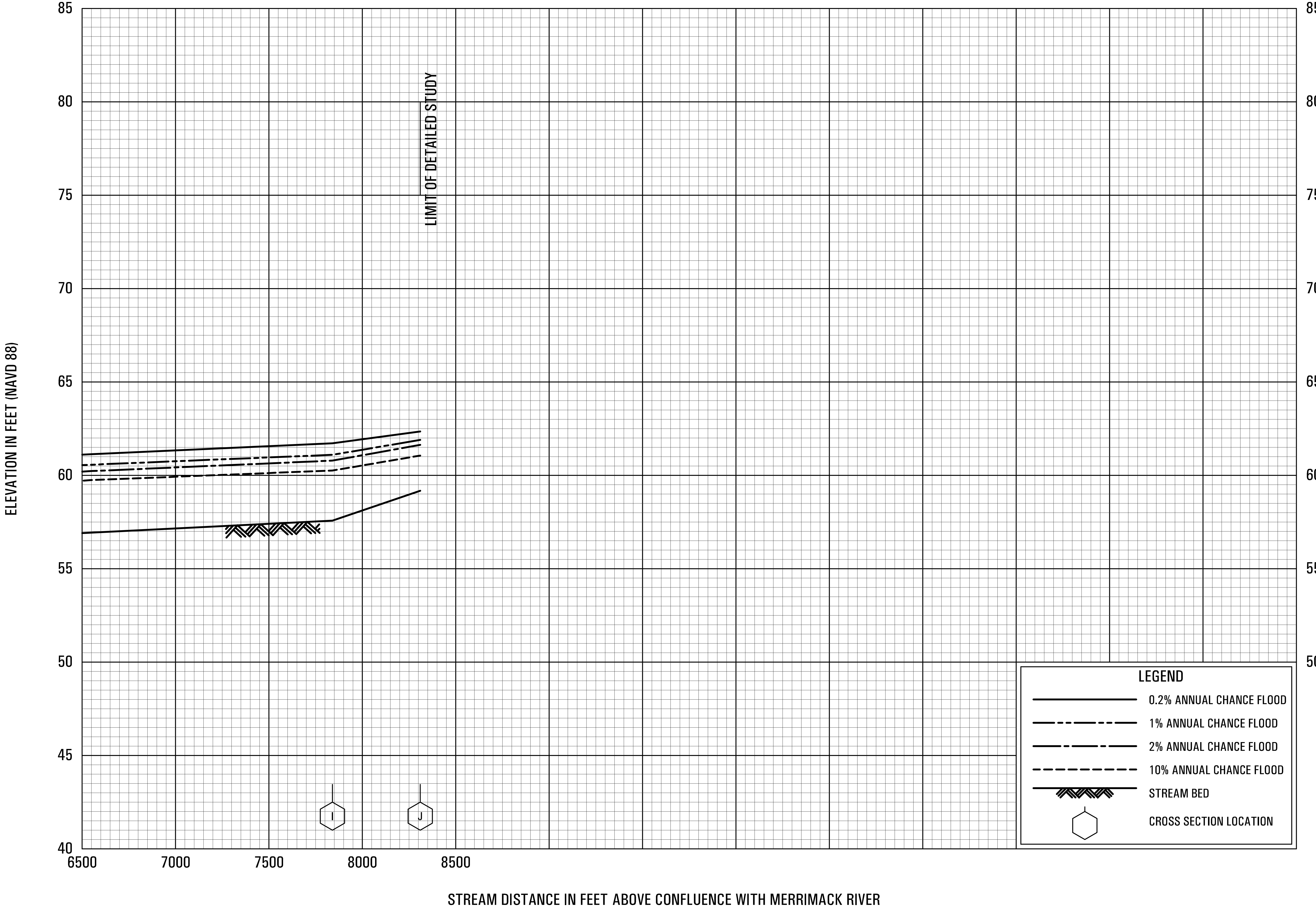
BARTLETT BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

08P



FLOOD PROFILES

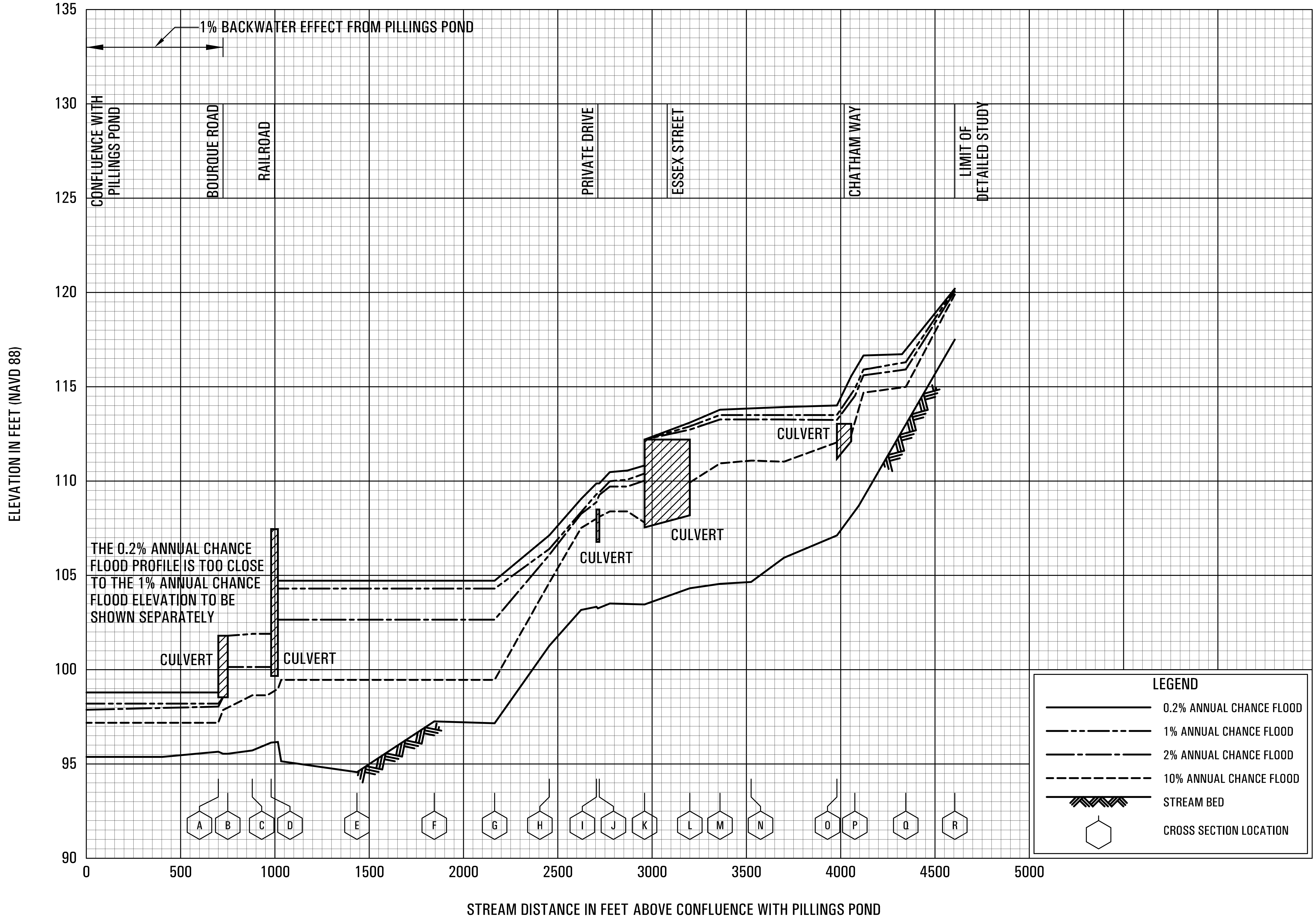
BARTLETT BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

09P



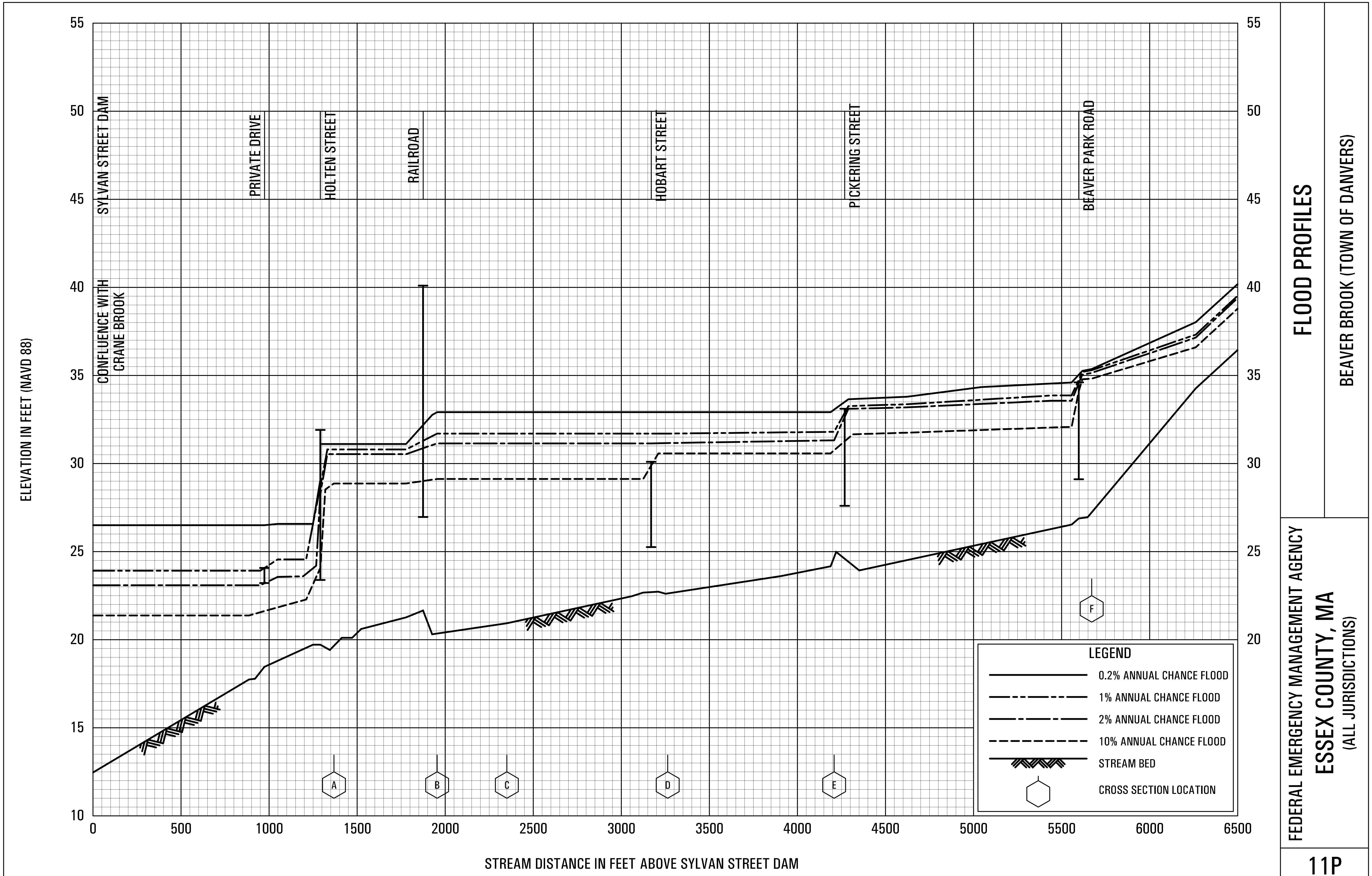
FLOOD PROFILES

BATES BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



FLOOD PROFILES
BEAVER BROOK (TOWN OF DANVERS)
FEDERAL EMERGENCY MANAGEMENT AGENCY
ESSEX COUNTY, MA
(ALL JURISDICTIONS)
11P
ELEVATION IN FEET (NAVD 88)
STREAM DISTANCE IN FEET ABOVE SYLVAN STREET DAM
SYLVAN STREET DAM
CONFLUENCE WITH CRANE BROOK
PRIVATE DRIVE
HOLTEN STREET
RAILROAD
HOBART STREET
PICKERING STREET
BEAVER PARK ROAD
LEGEND
0.2% ANNUAL CHANCE FLOOD
1% ANNUAL CHANCE FLOOD
2% ANNUAL CHANCE FLOOD
10% ANNUAL CHANCE FLOOD
STREAM BED
CROSS SECTION LOCATION
A
B
C
D
E
F
10
15
20
25
30
35
40
45
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55
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500
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1500
2000
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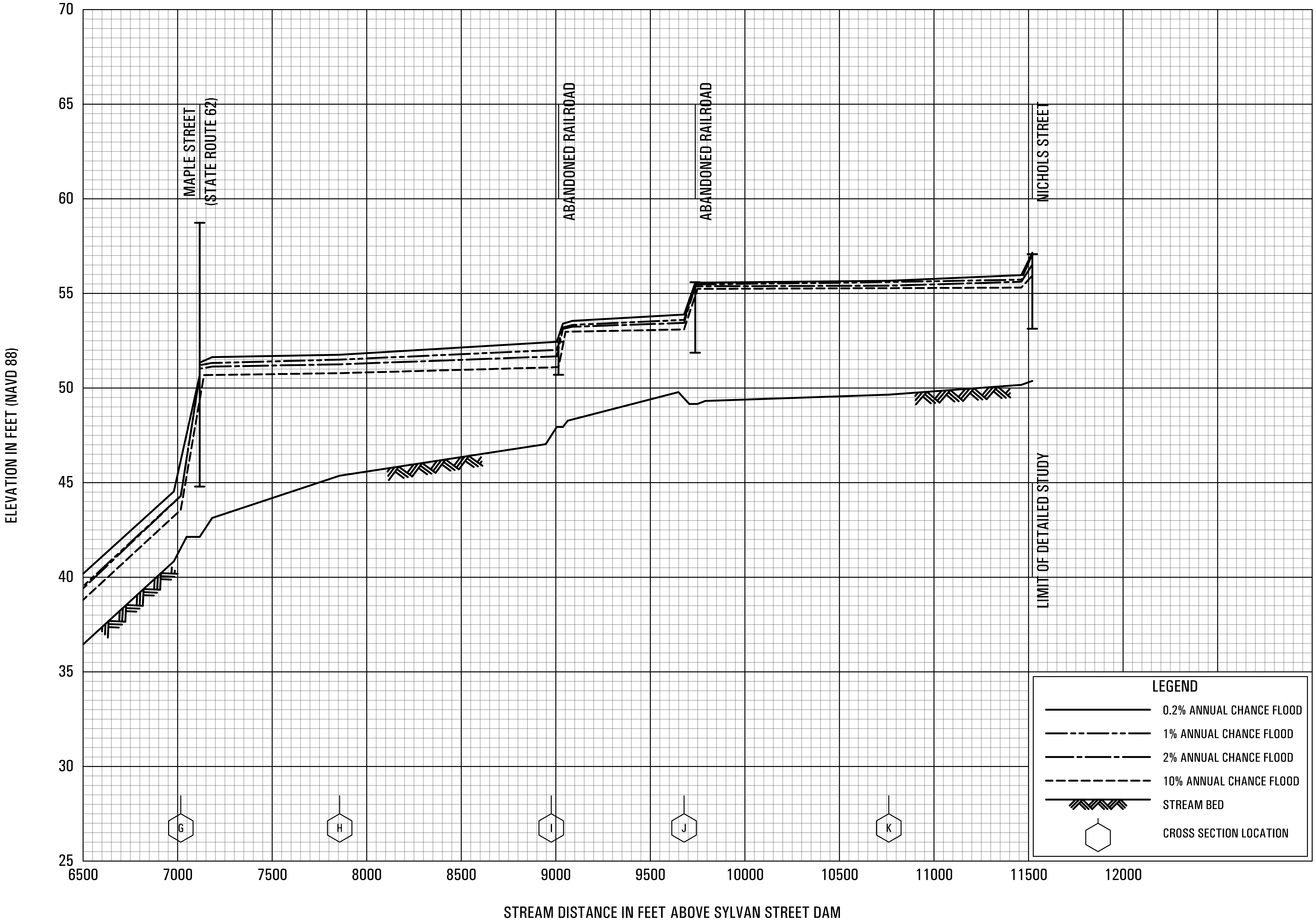
6000
6500



FLOOD PROFILES

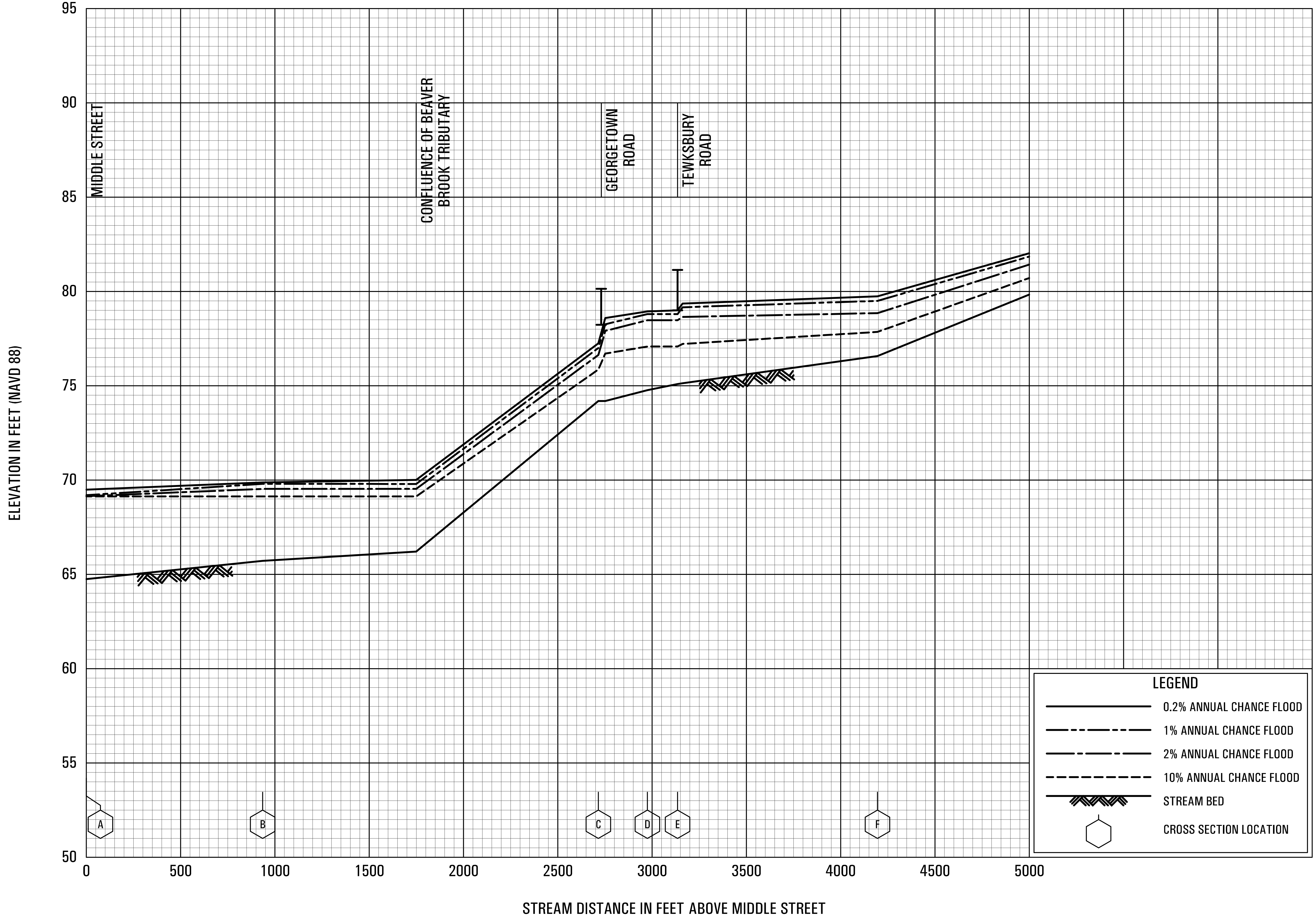
BEAVER BROOK (TOWN OF DANVERS)

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

12P



FLOOD PROFILES

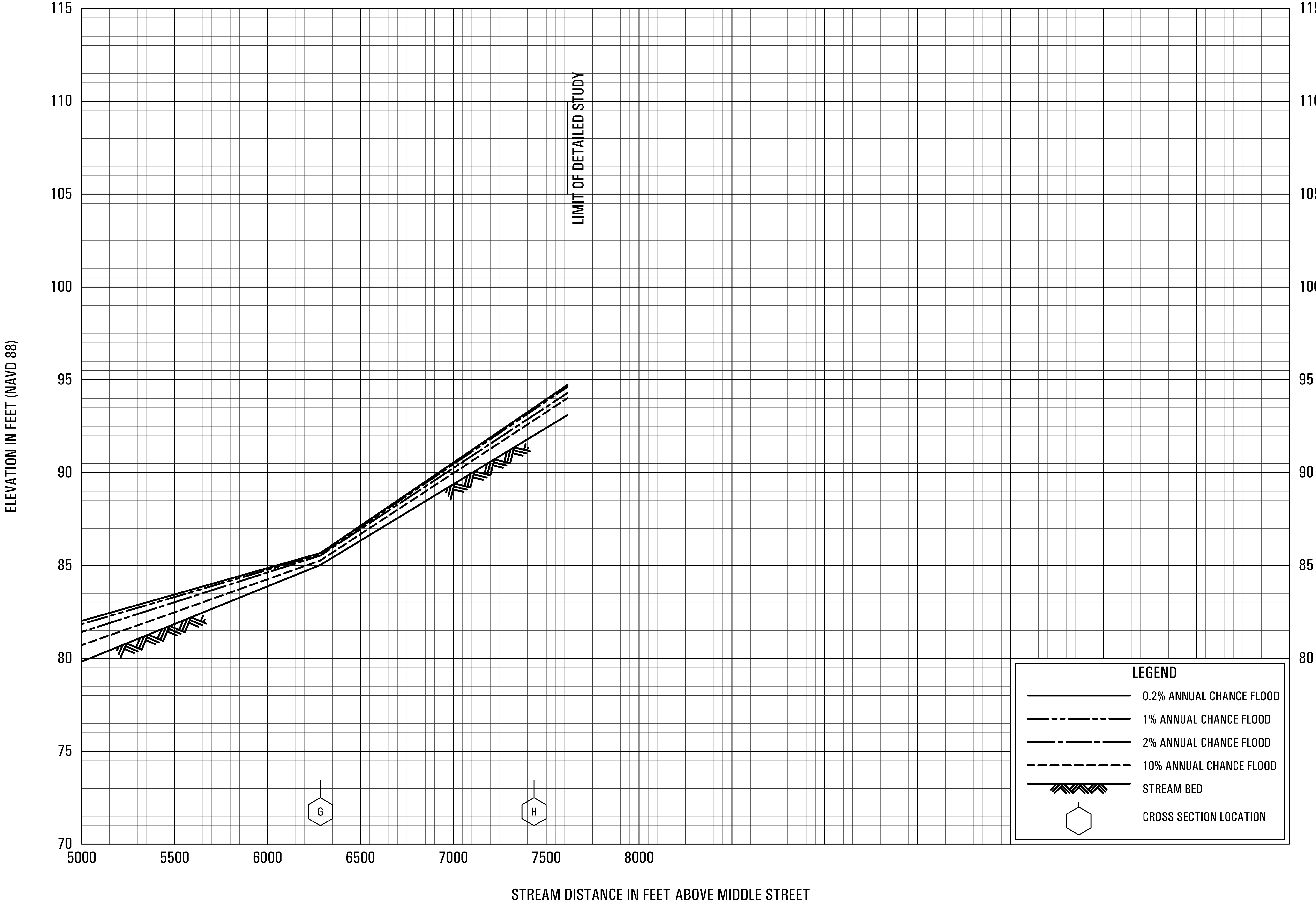
BEAVER BROOK (TOWN OF WEST NEWBURY)

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

13P



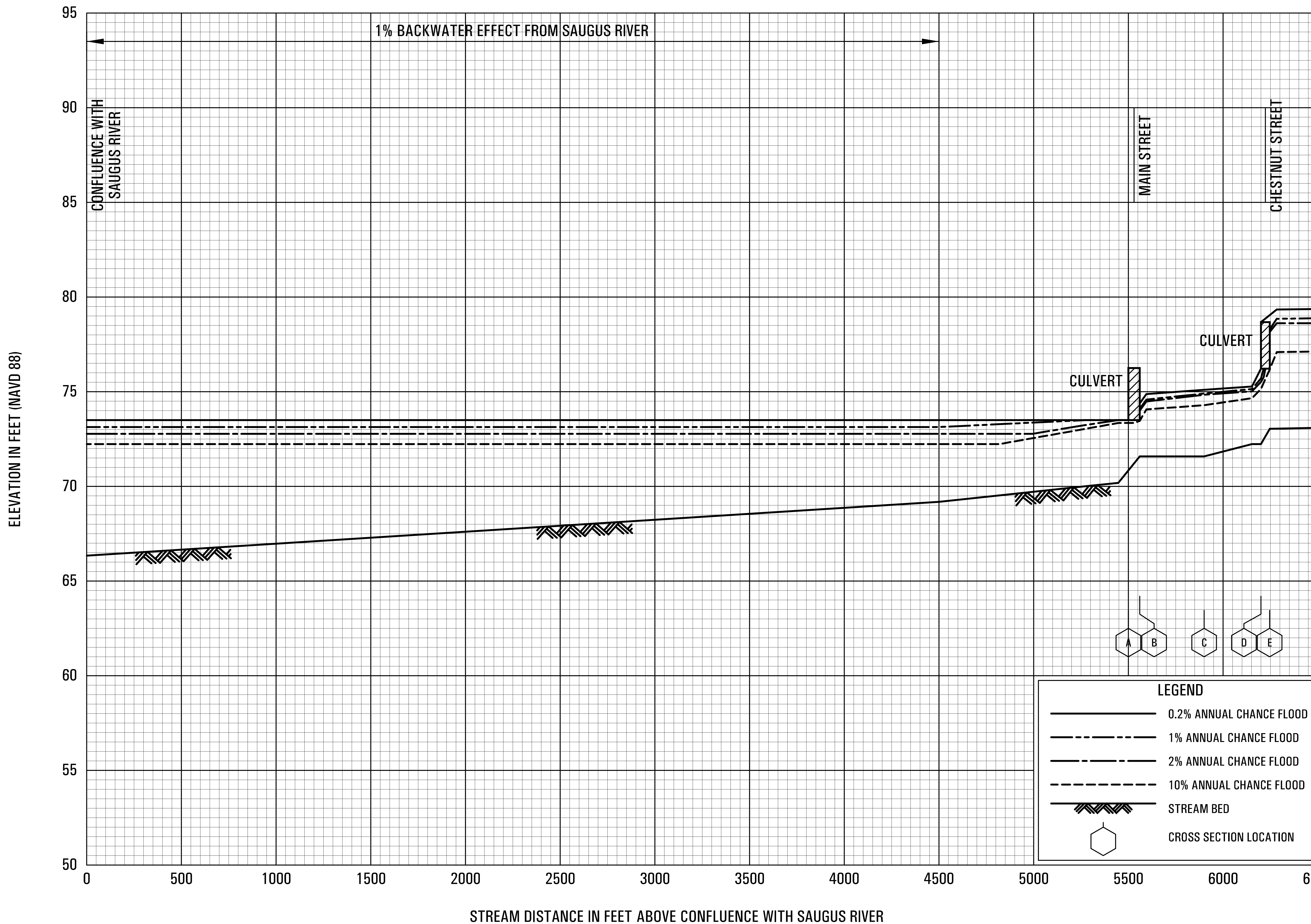
FLOOD PROFILES

BEAVER BROOK (TOWN OF WEST NEWBURY)

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



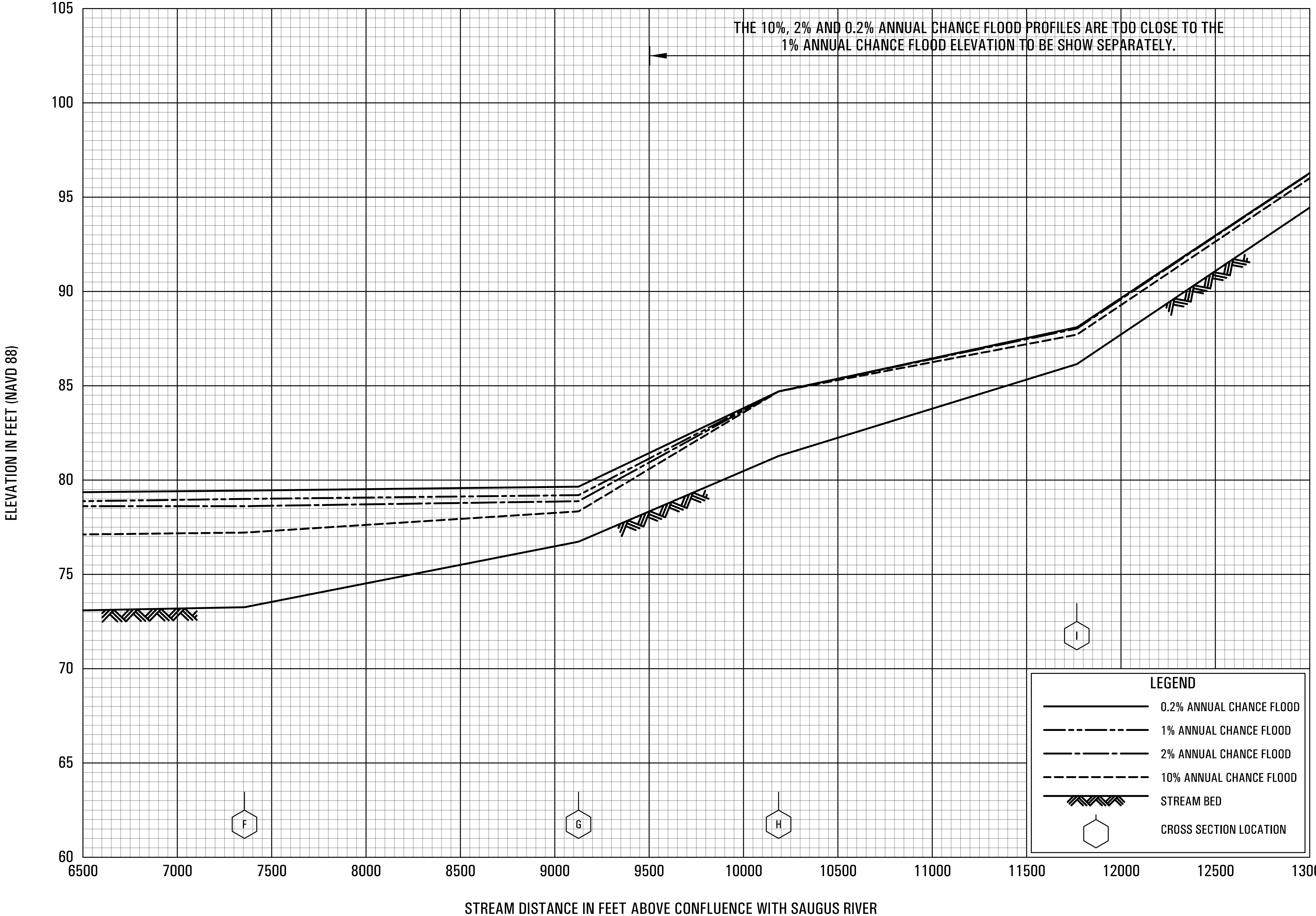
FLOOD PROFILES

BEAVERDAM BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



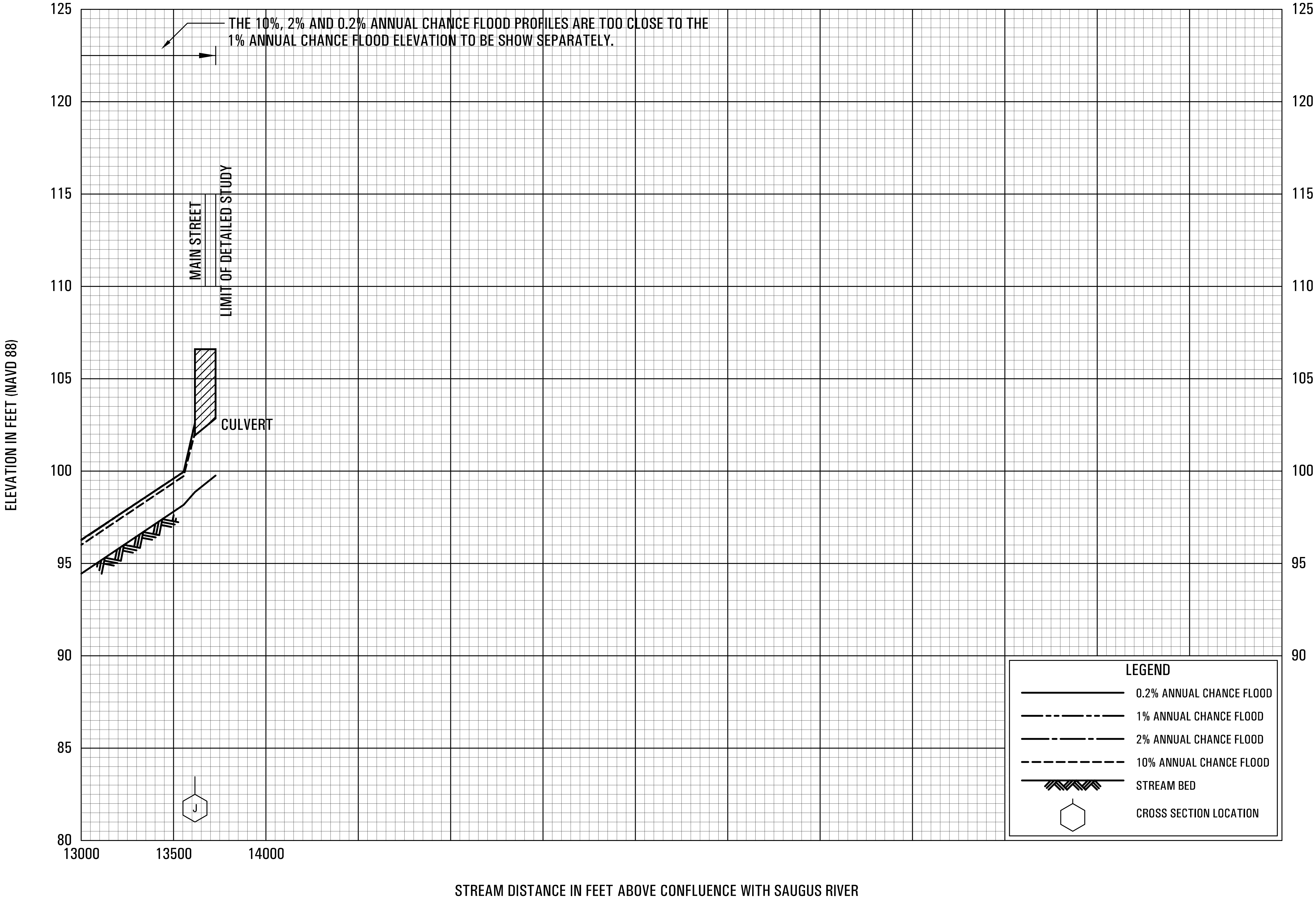
FLOOD PROFILES

BEAVERDAM BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



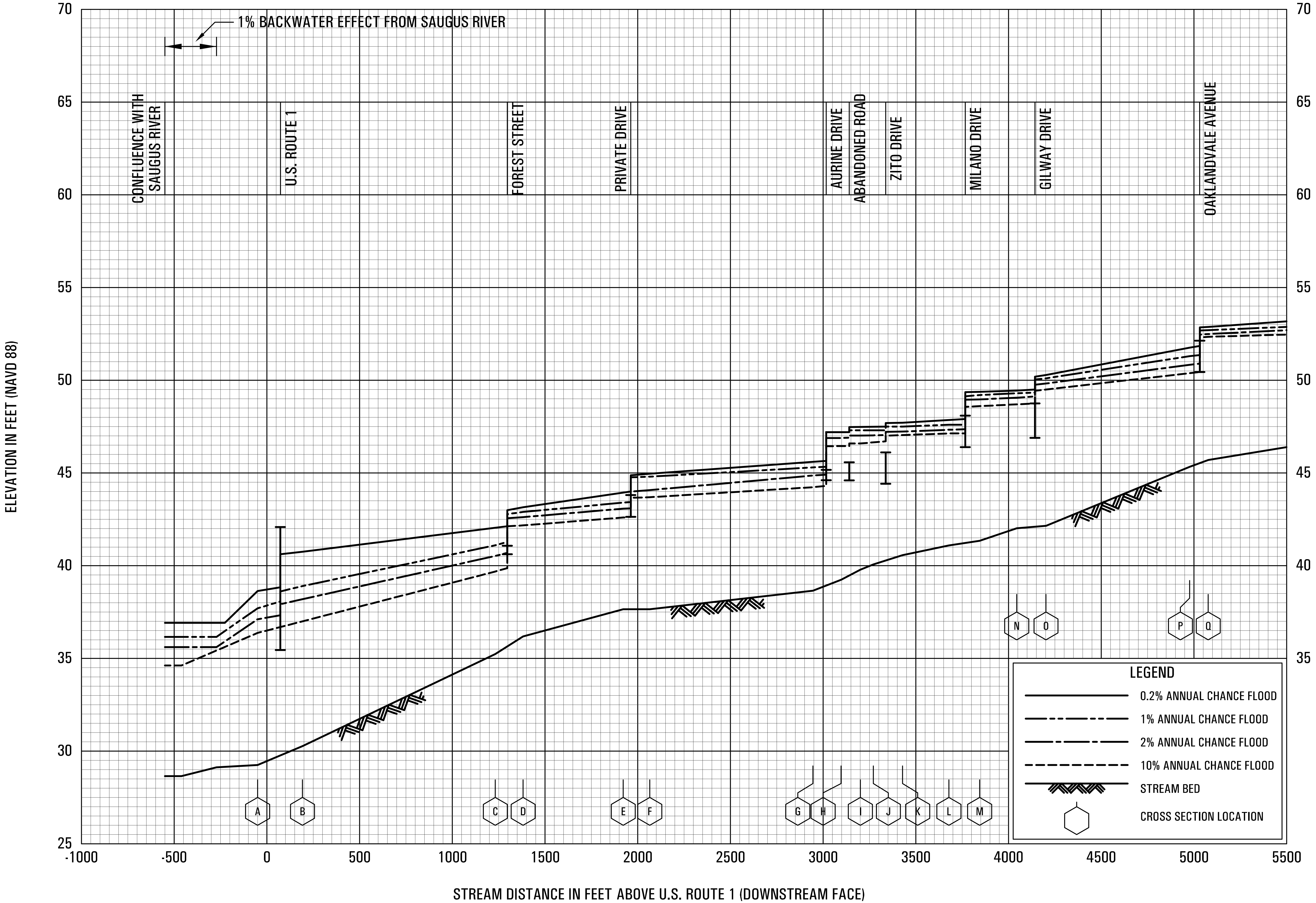
FLOOD PROFILES

BEAVERDAM BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



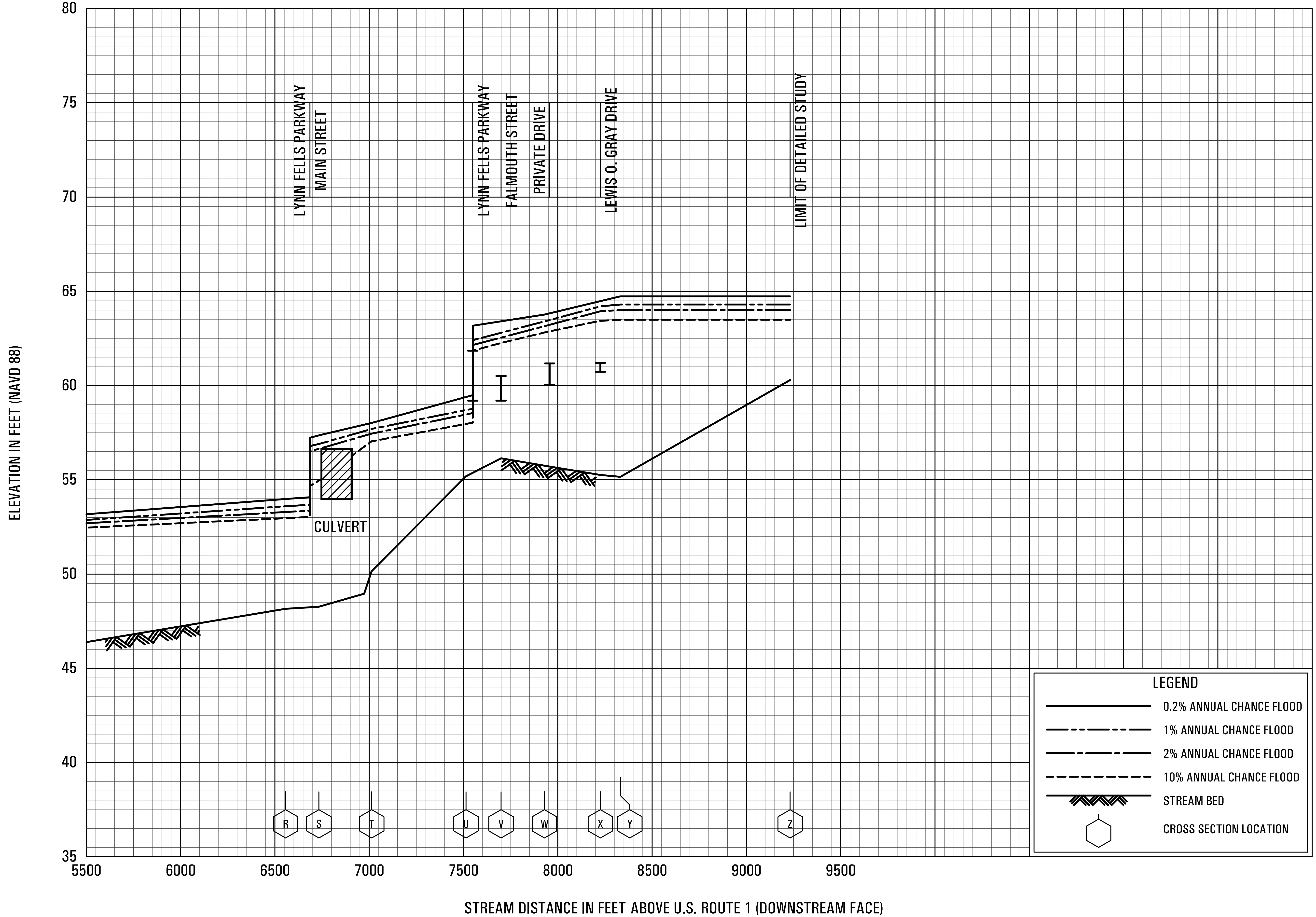
FLOOD PROFILES

BENNETT'S POND BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



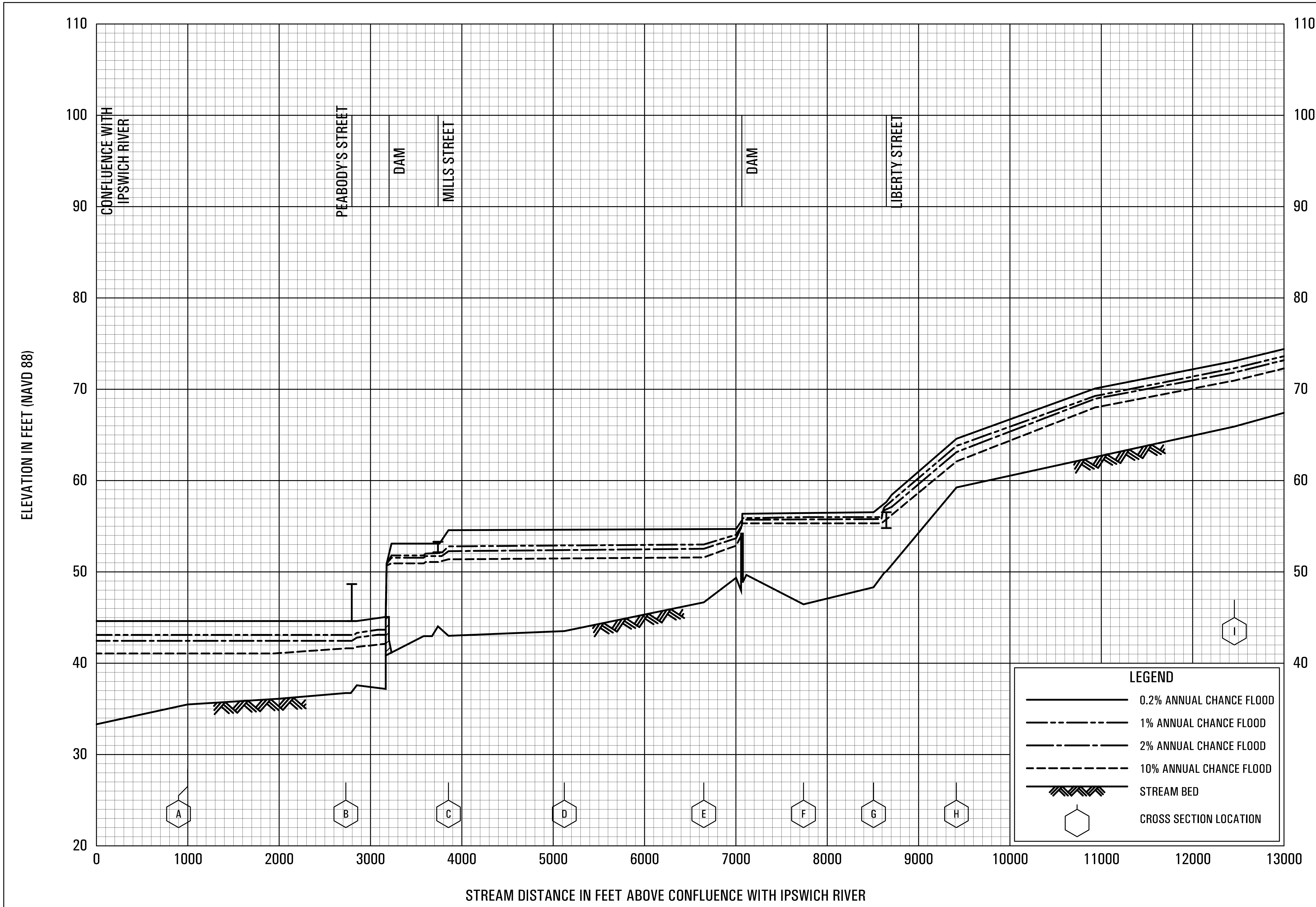
FLOOD PROFILES

BENNETT'S POND BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



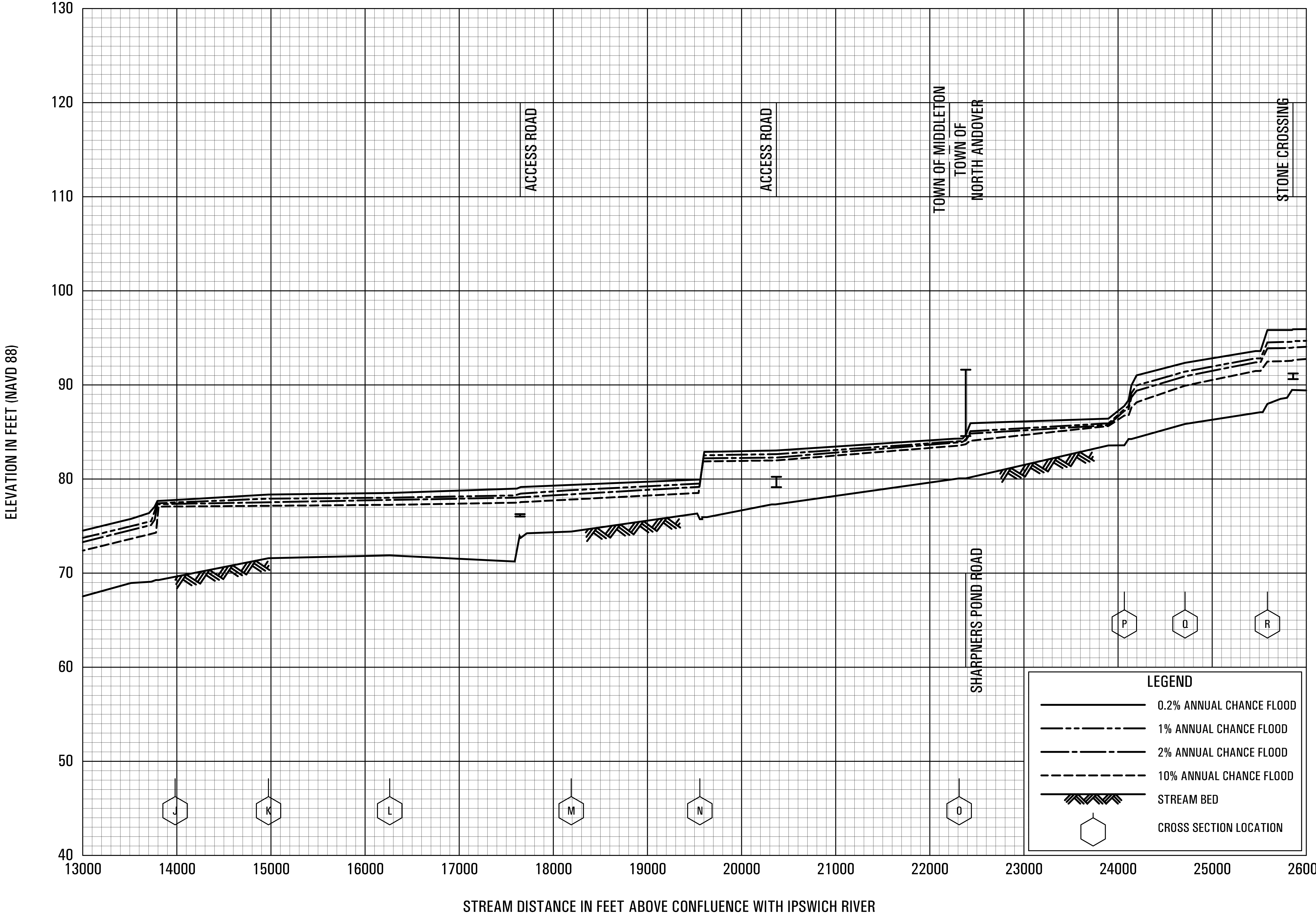
FLOOD PROFILES

BOSTON BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



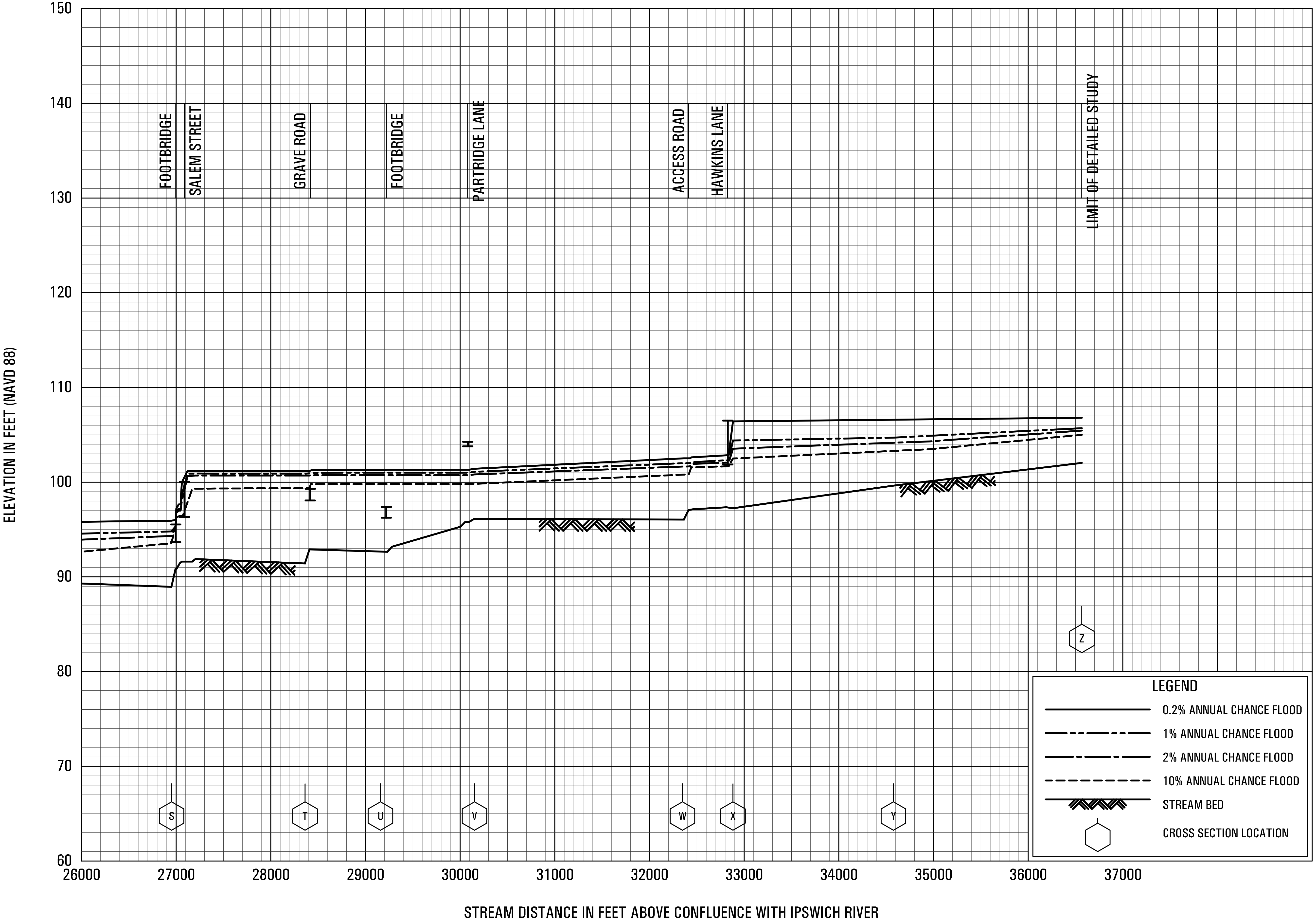
FLOOD PROFILES

BOSTON BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



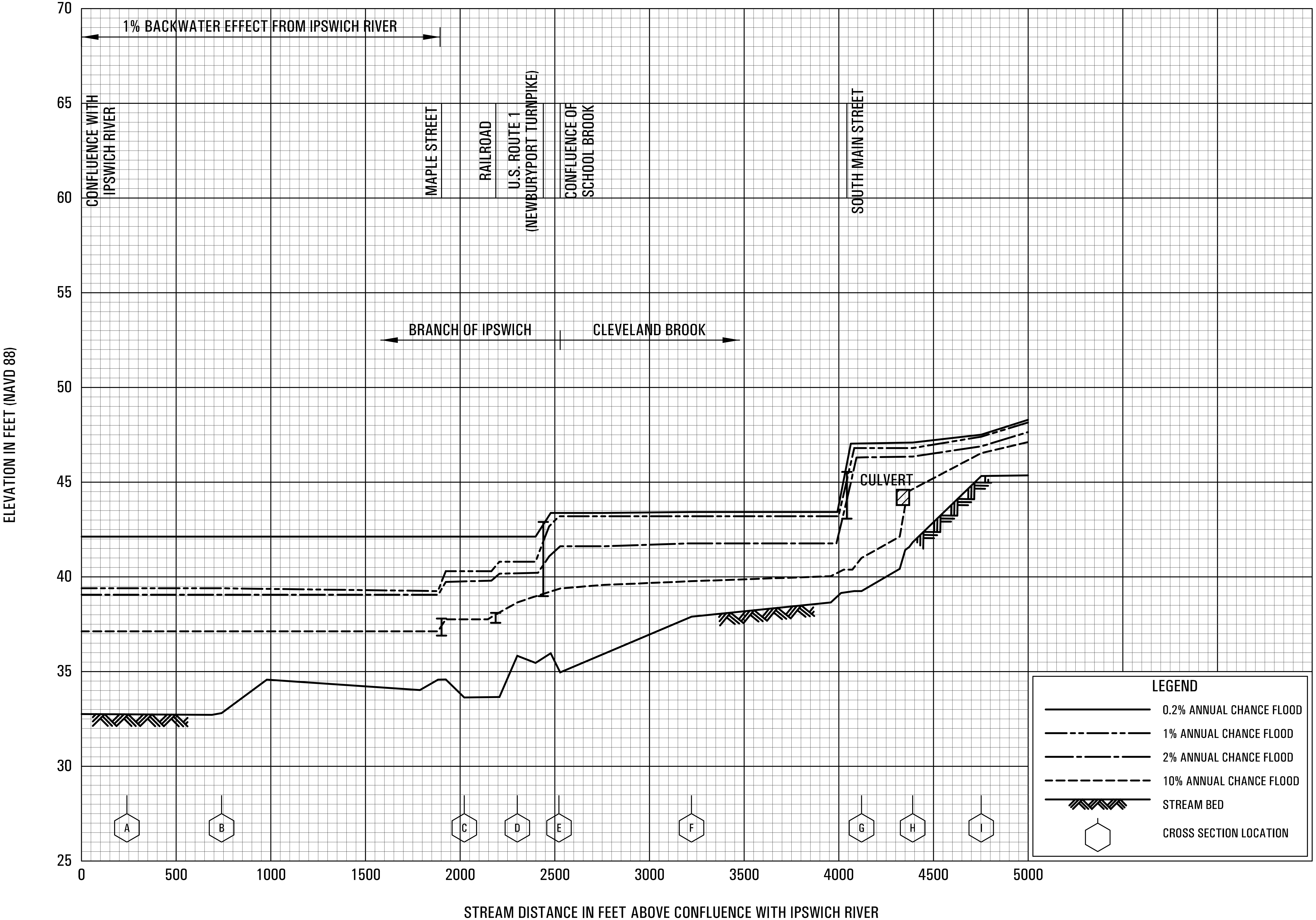
FLOOD PROFILES

BOSTON BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



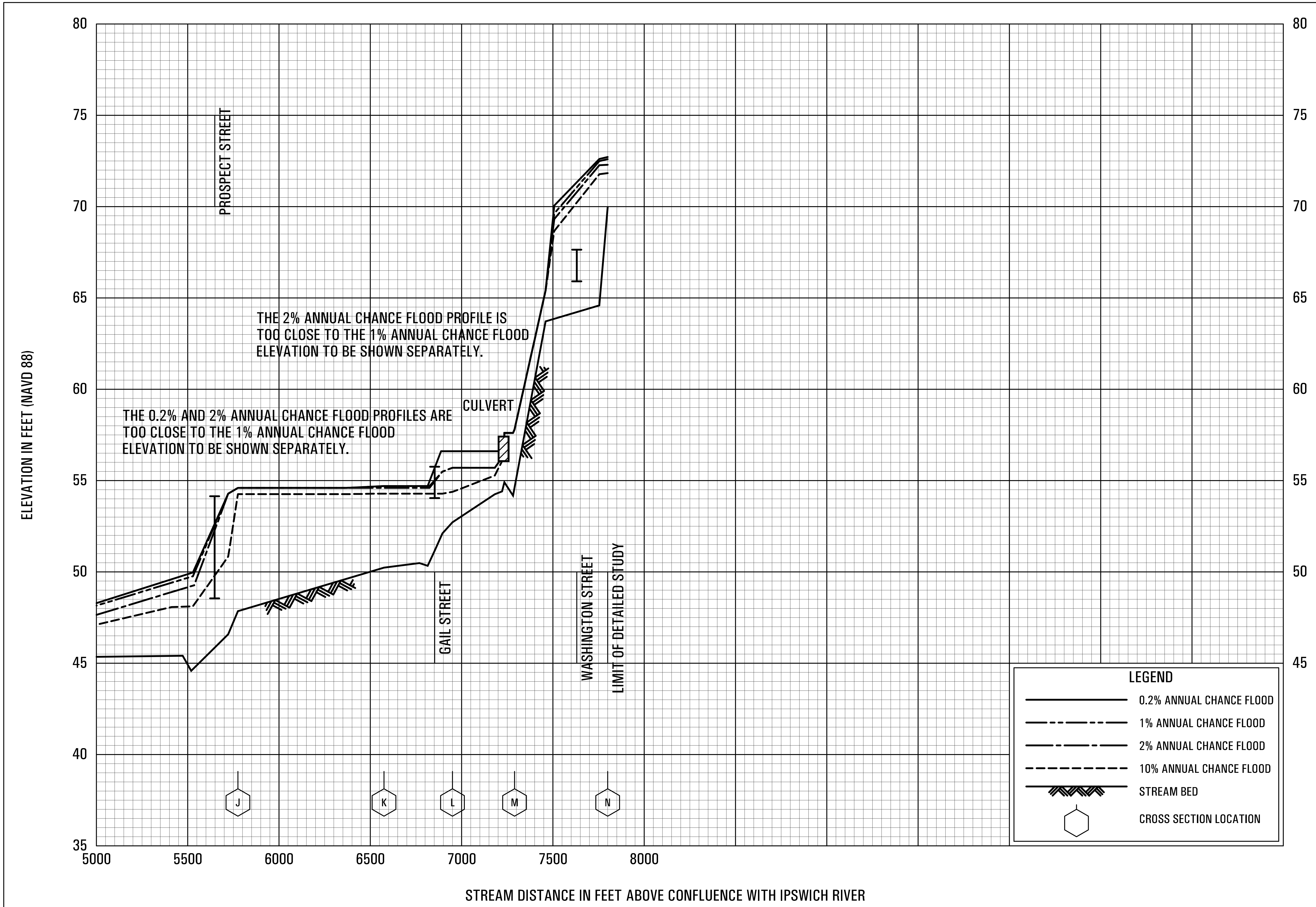
FLOOD PROFILES

BRANCH OF IPSWICH AND CLEVELAND BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA
(ALL JURISDICTIONS)

23P



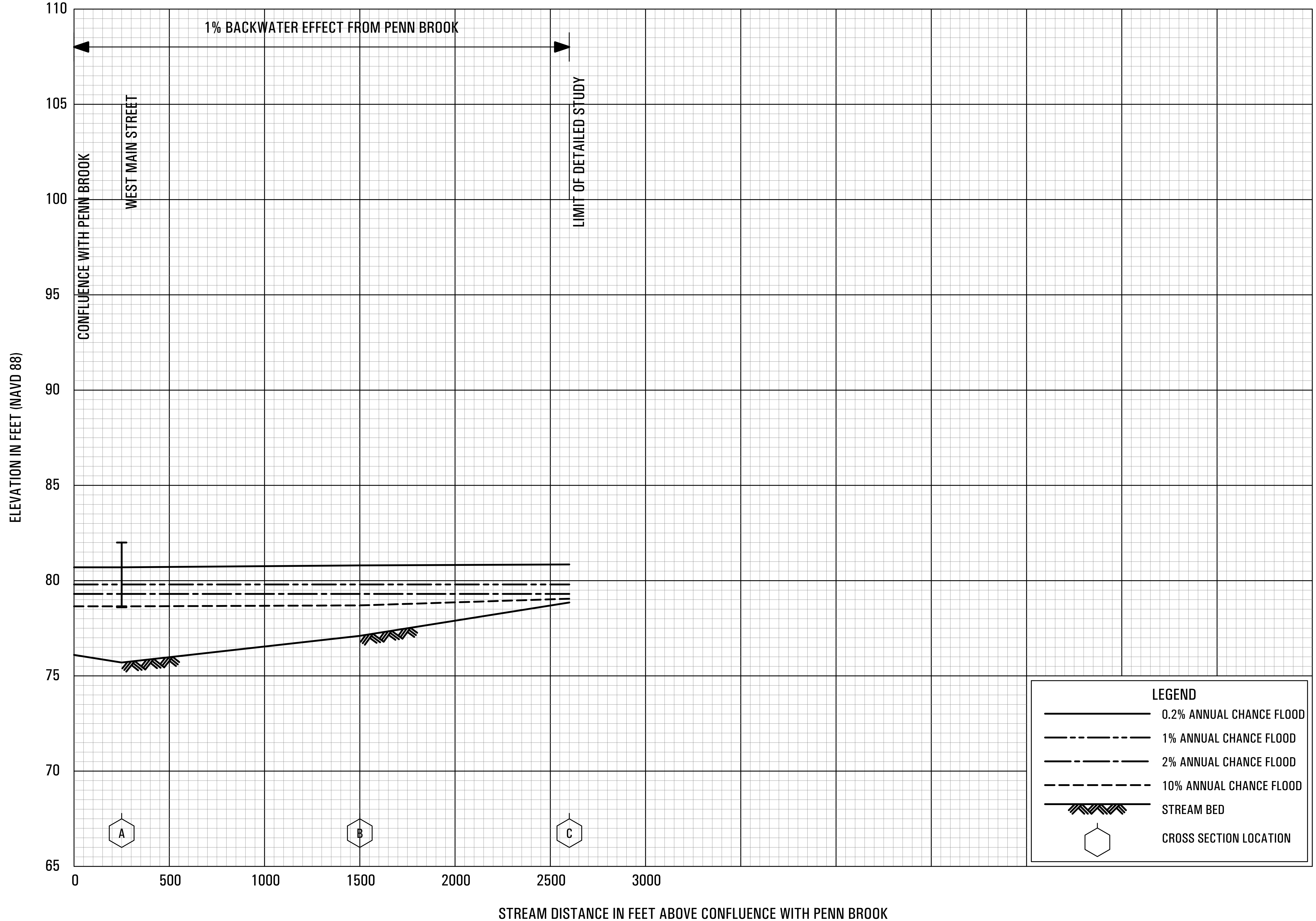
FLOOD PROFILES

CLEVELAND BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



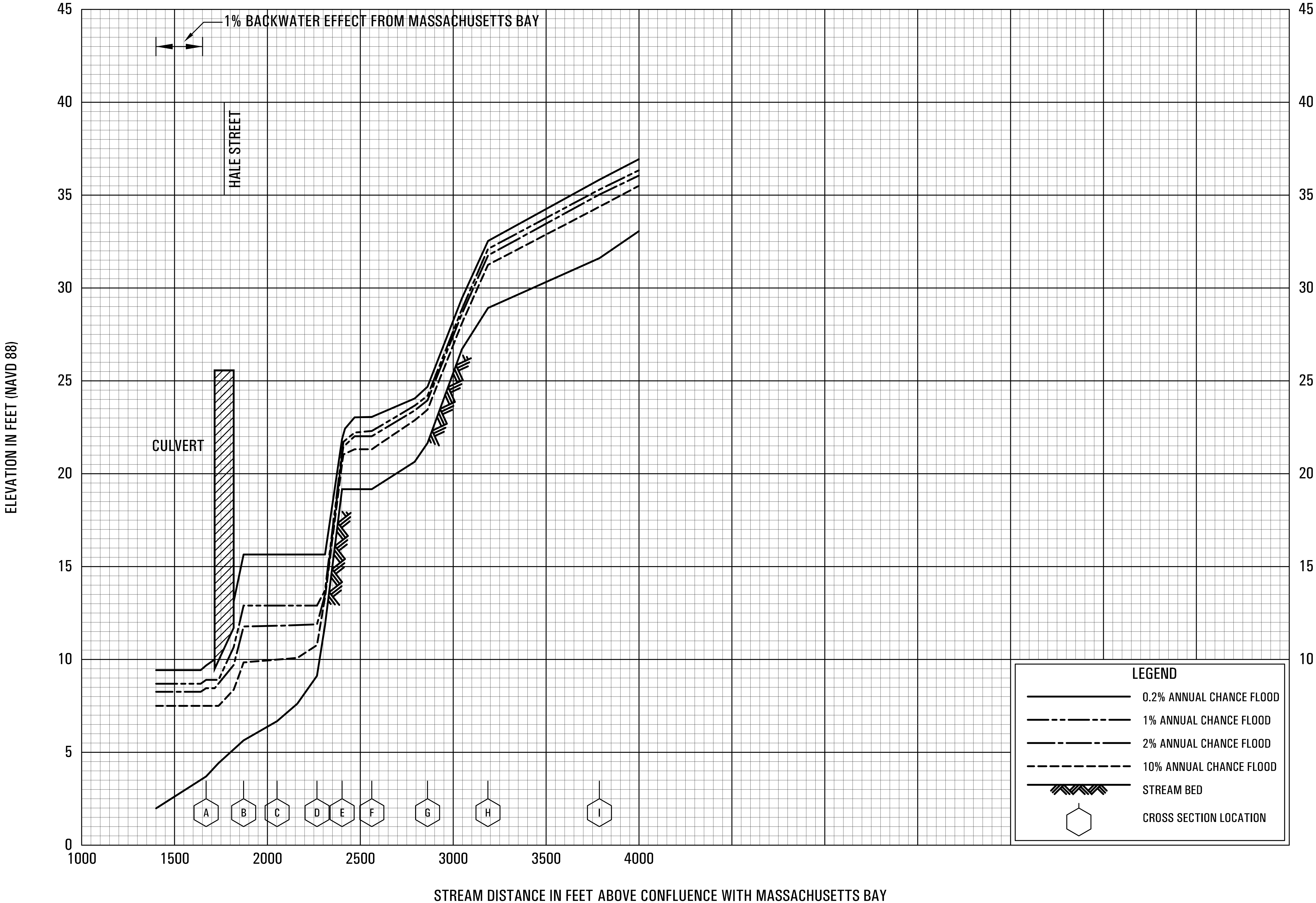
FLOOD PROFILES

BULFORD BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



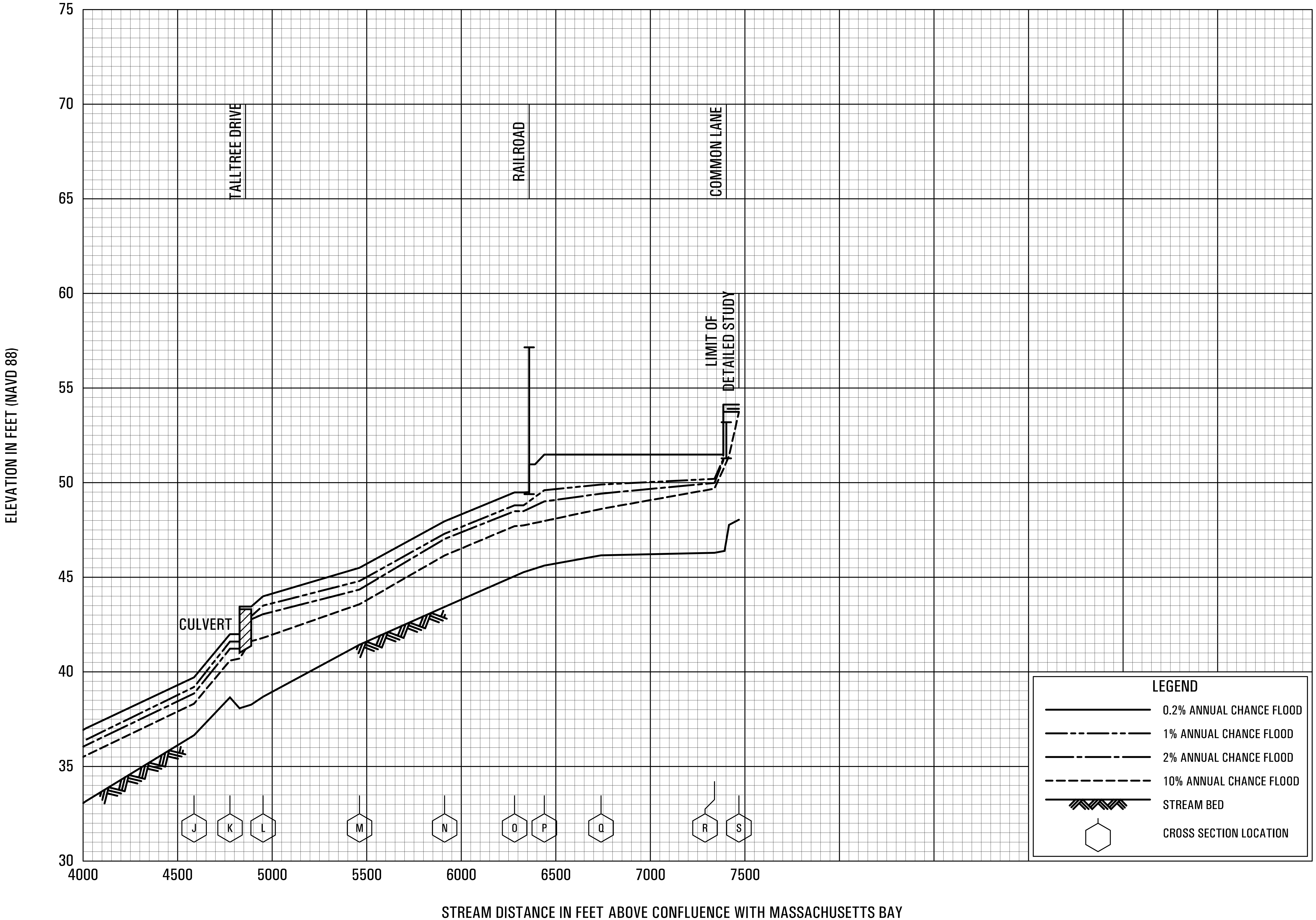
FLOOD PROFILES

CENTERVILLE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



FLOOD PROFILES

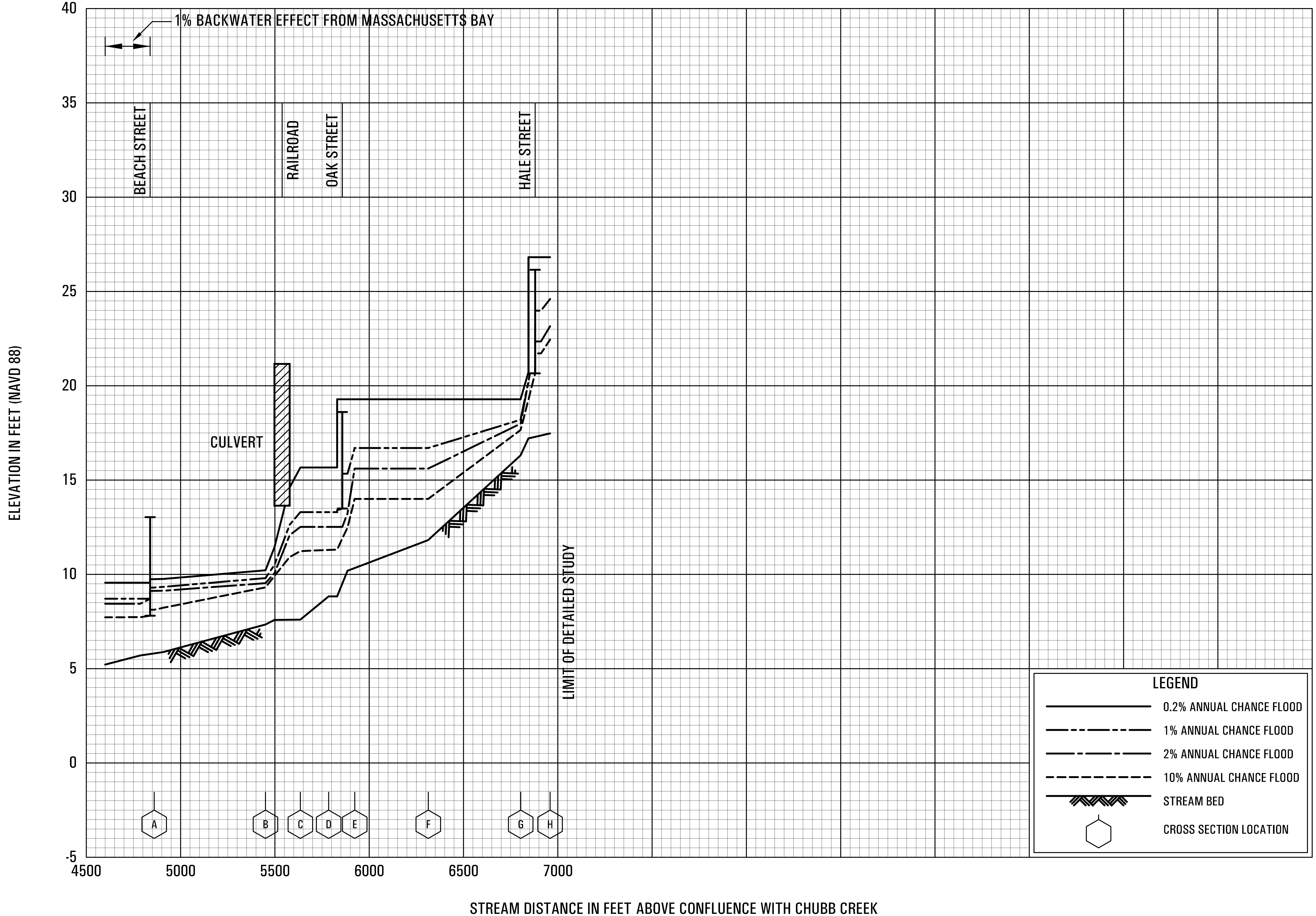
CENTERVILLE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

27P



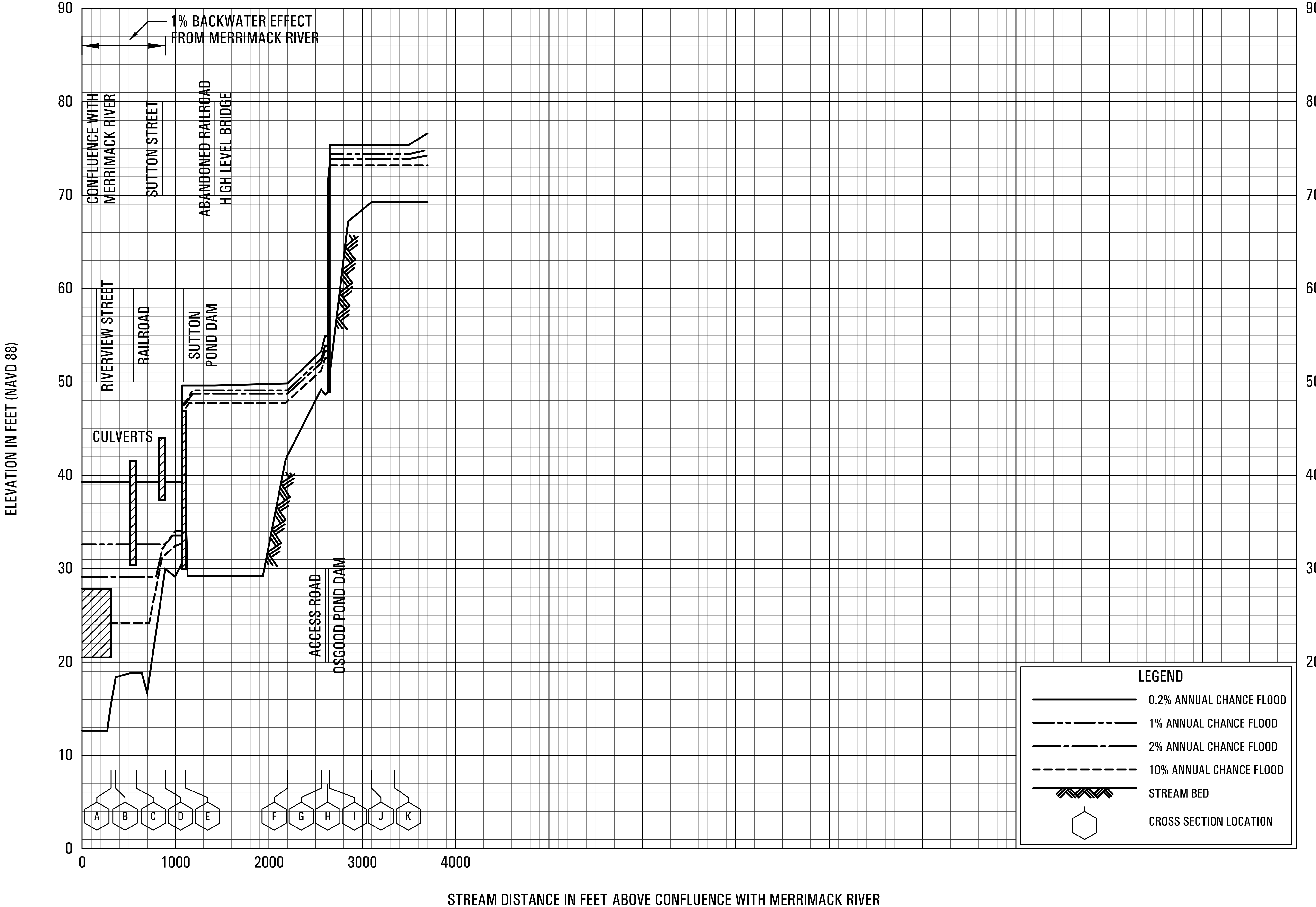
FLOOD PROFILES

CHUBBS BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

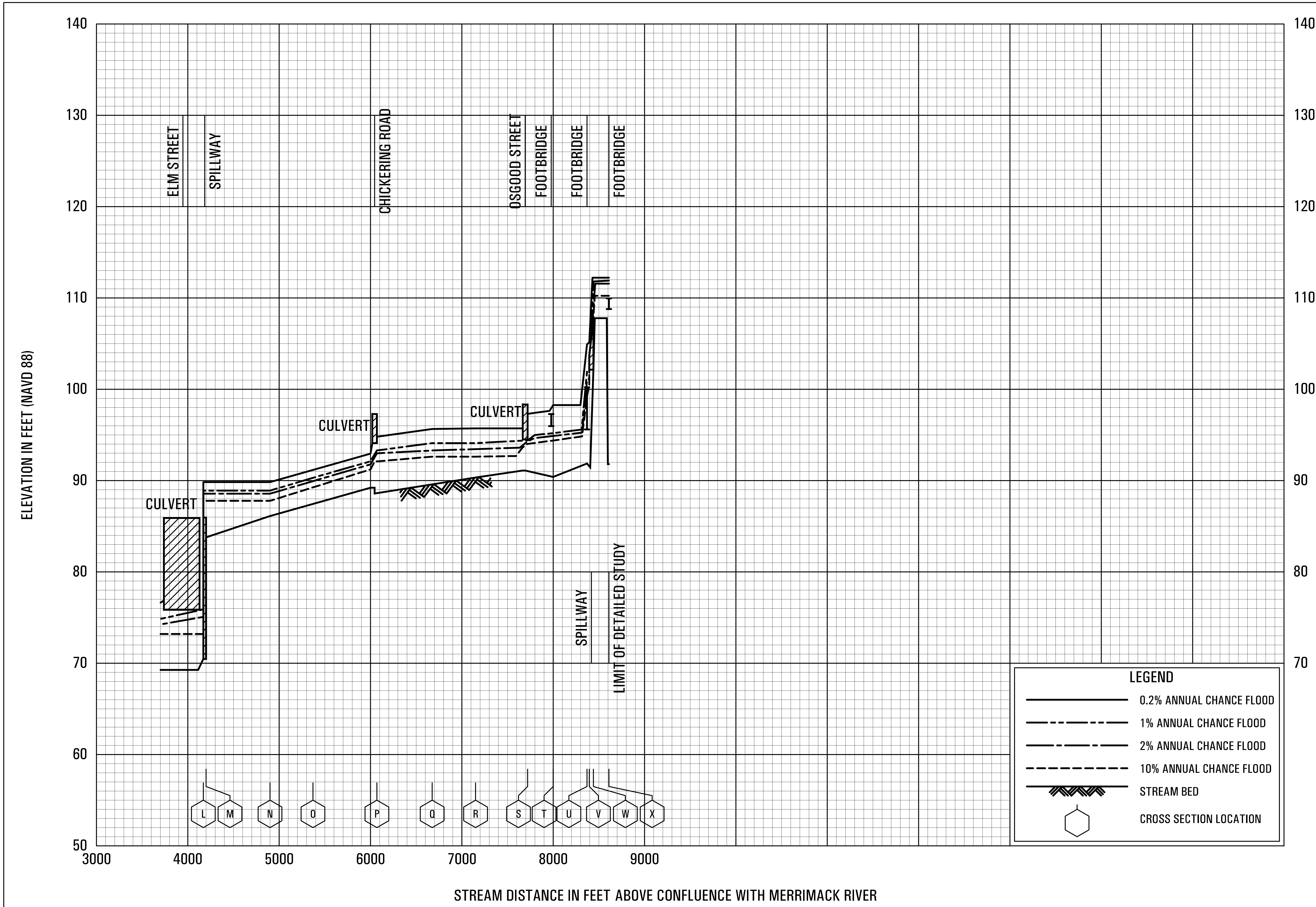


FLOOD PROFILES

COCHICHEWICK BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA
(ALL JURISDICTIONS)



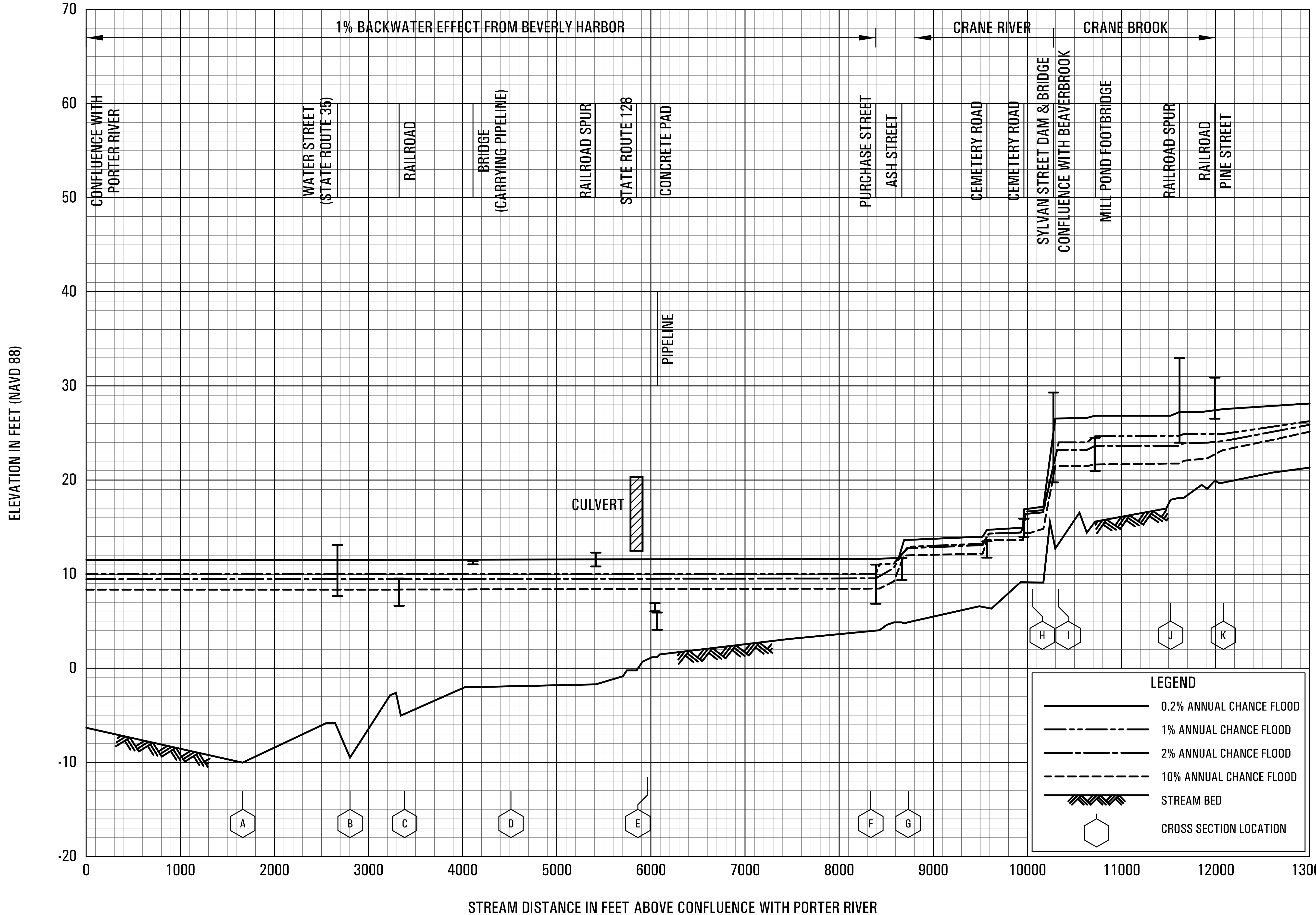
FLOOD PROFILES

COCHICHEWICK BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



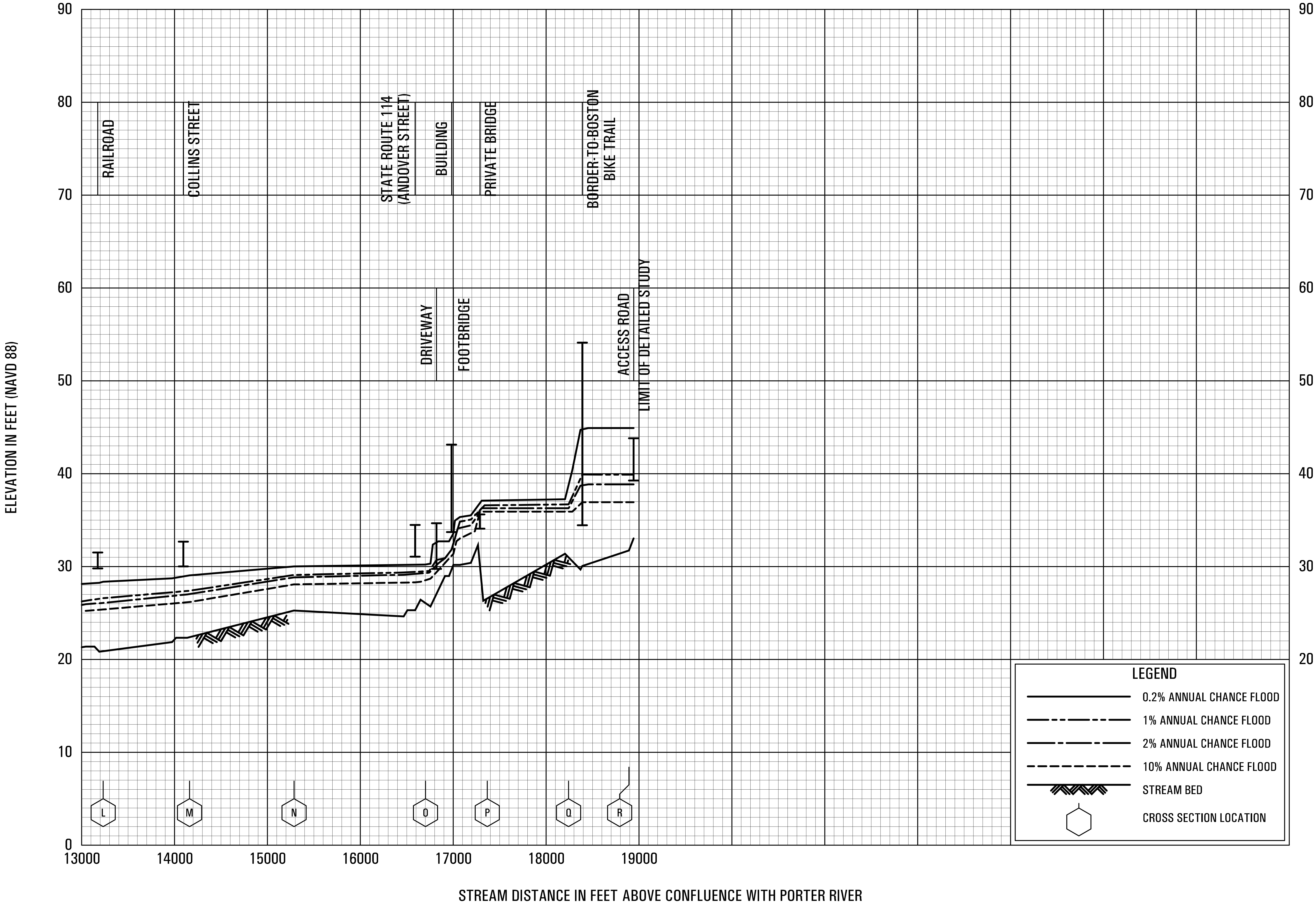
FLOOD PROFILES

CRANE RIVER AND CRANE BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



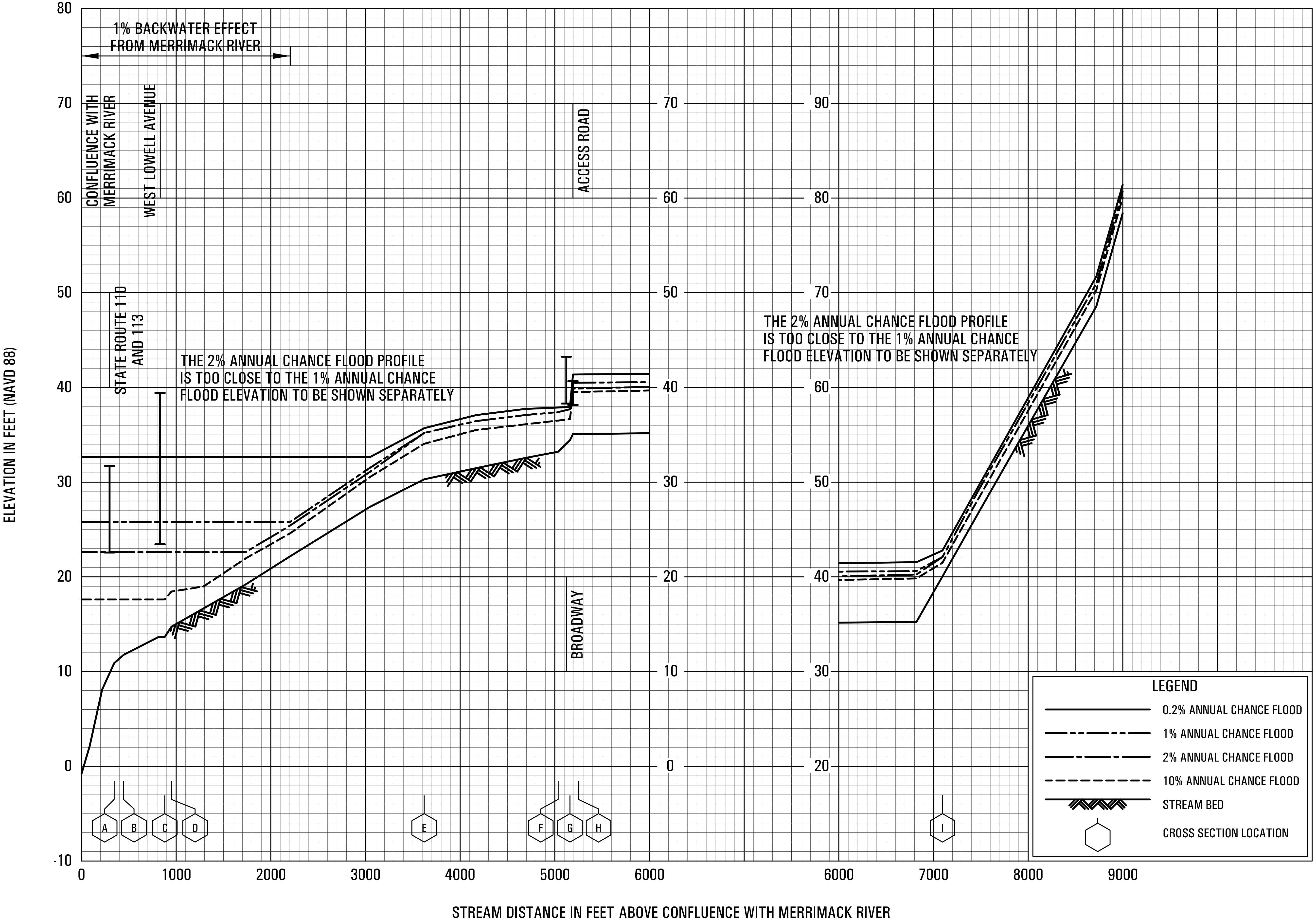
FLOOD PROFILES

CRANE BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



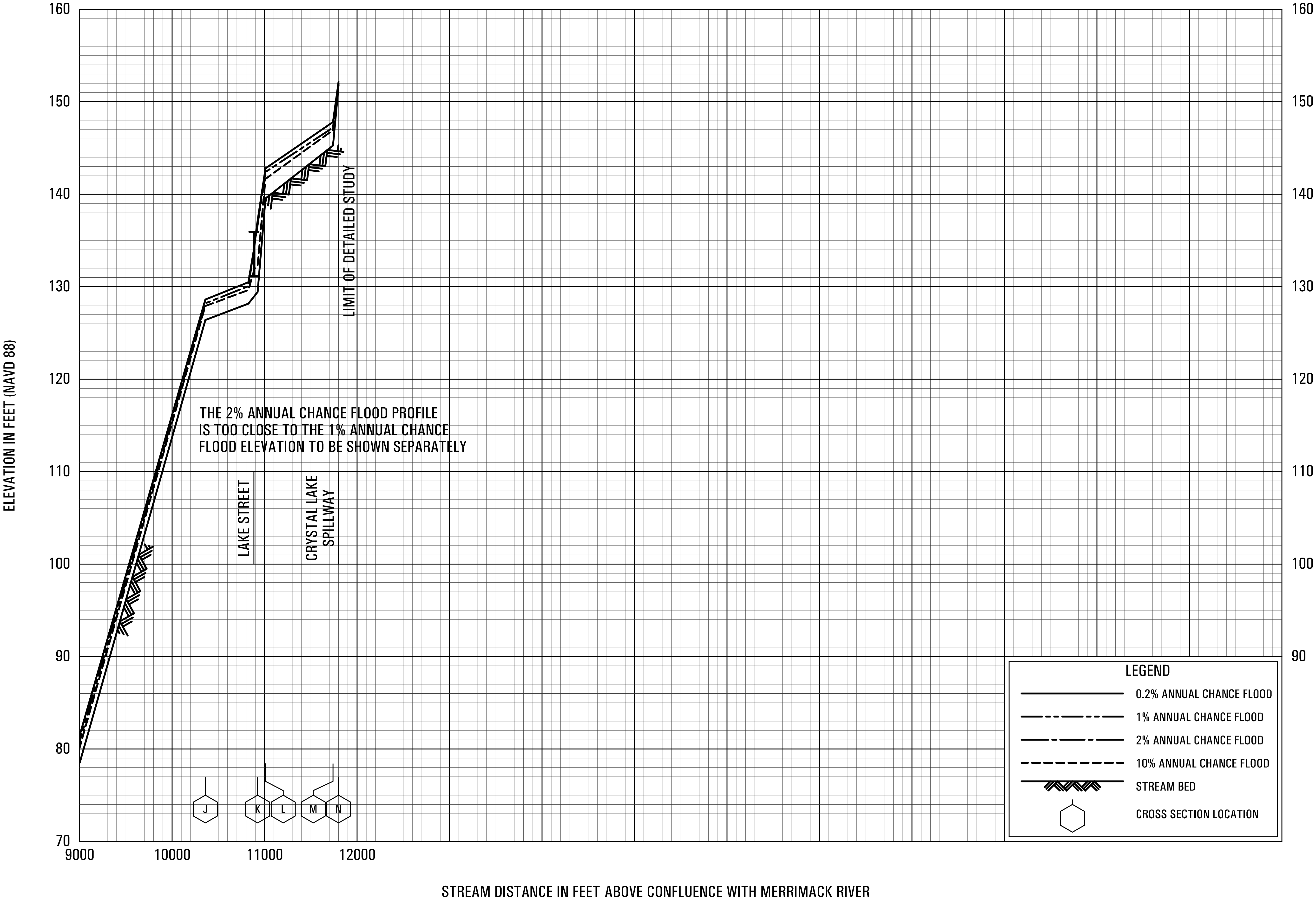
FLOOD PROFILES

CREEK BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



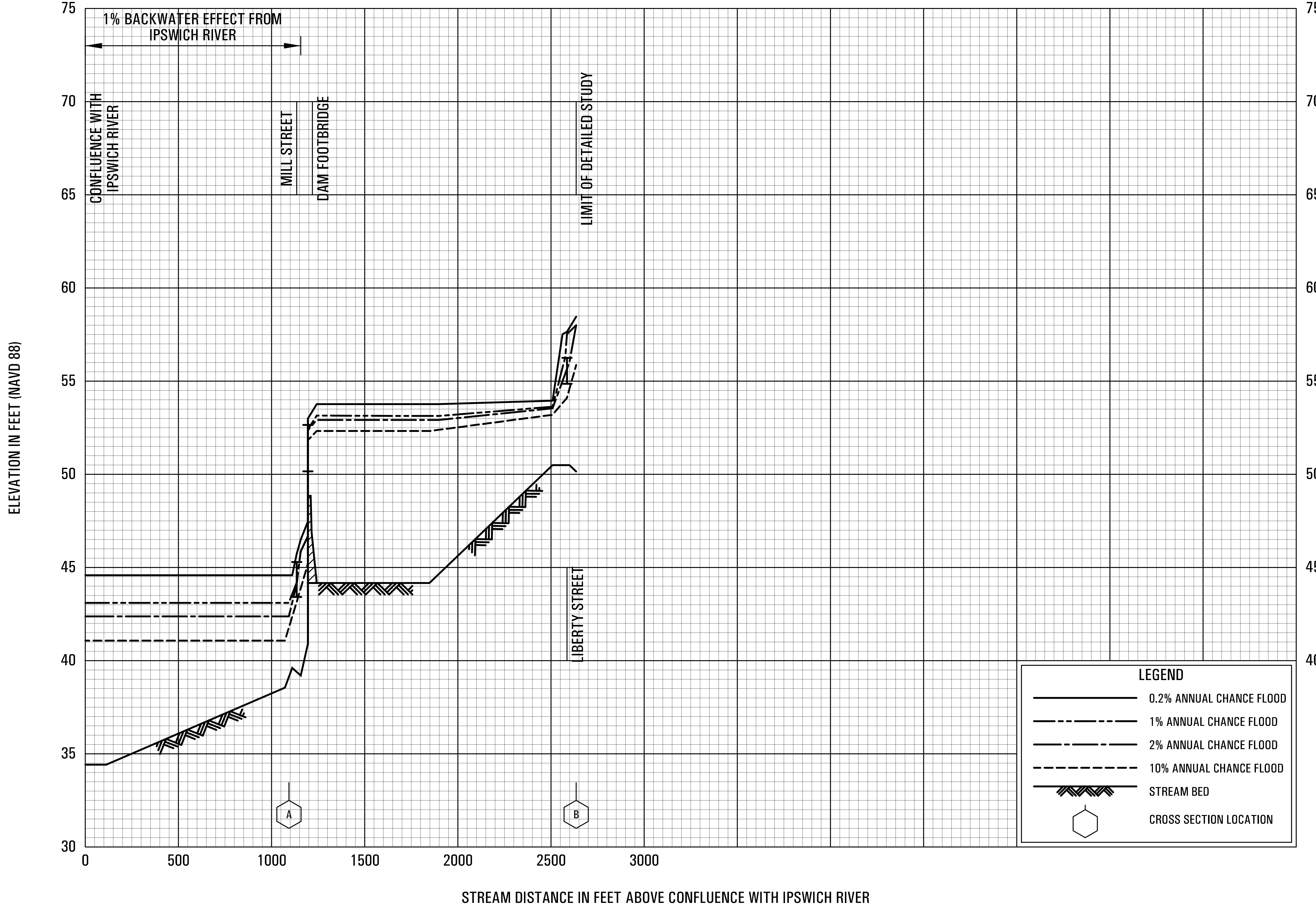
FLOOD PROFILES

CREEK BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



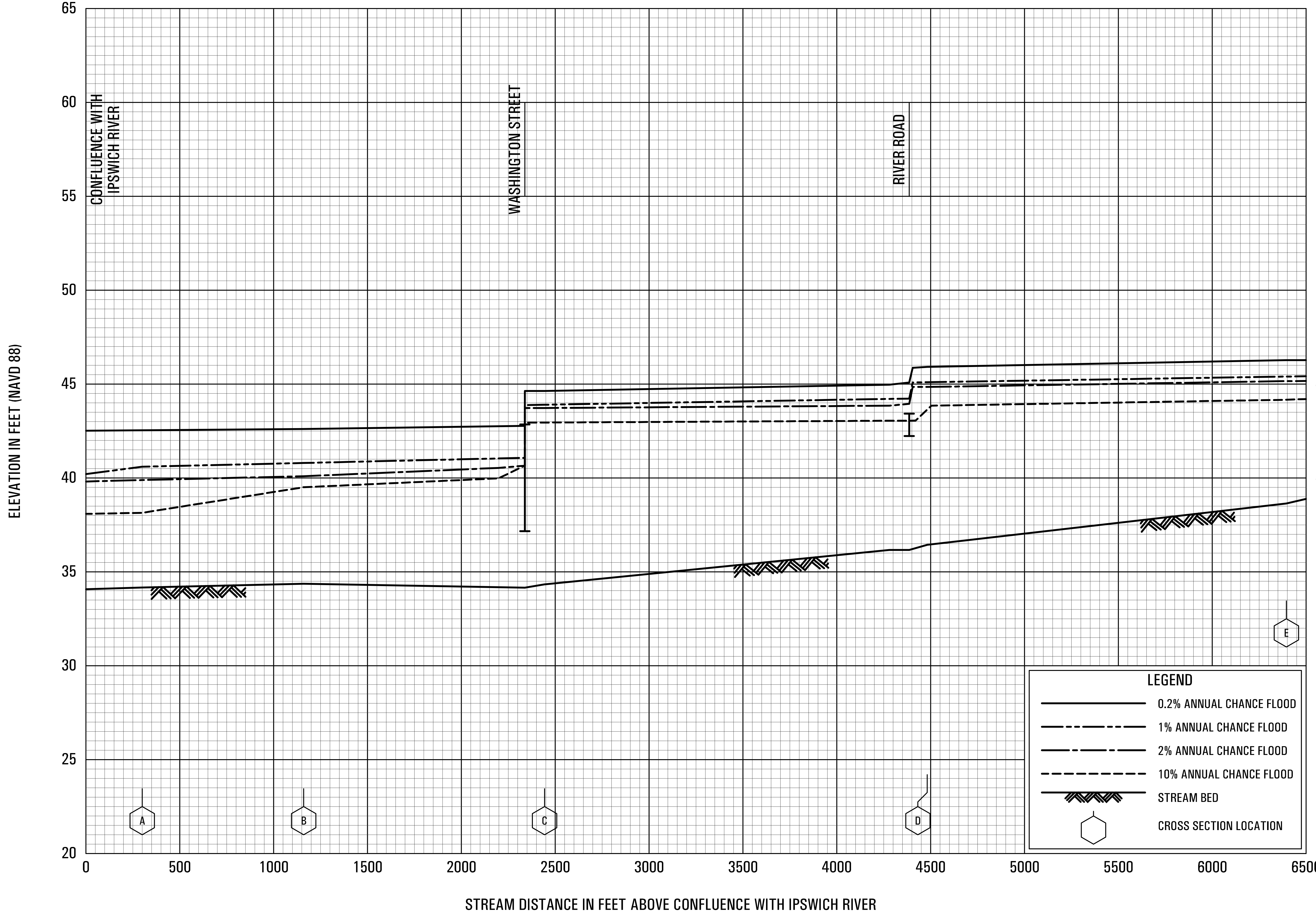
FLOOD PROFILES

EMERSON BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



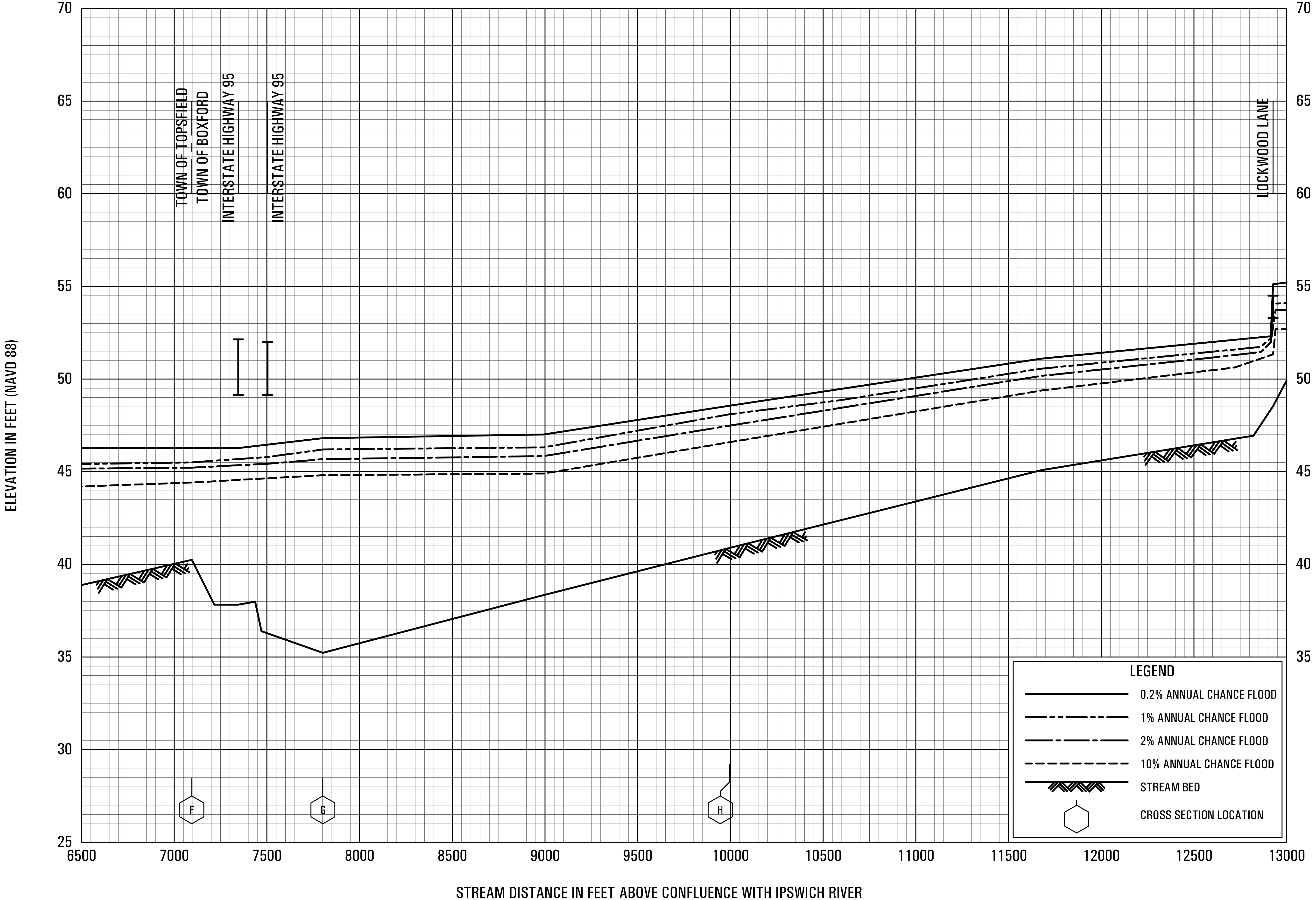
FLOOD PROFILES

FISH BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



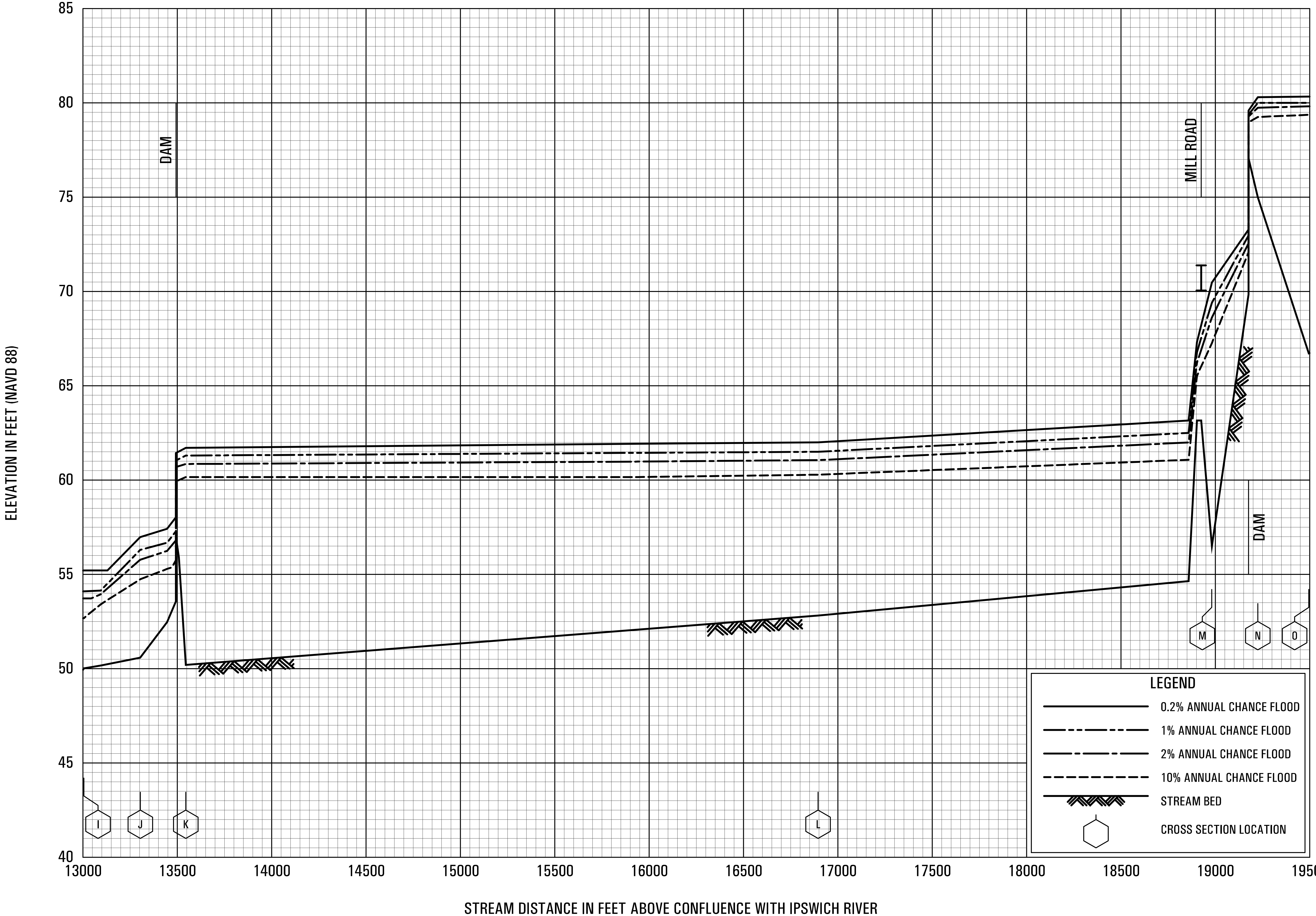
FLOOD PROFILES

FISH BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

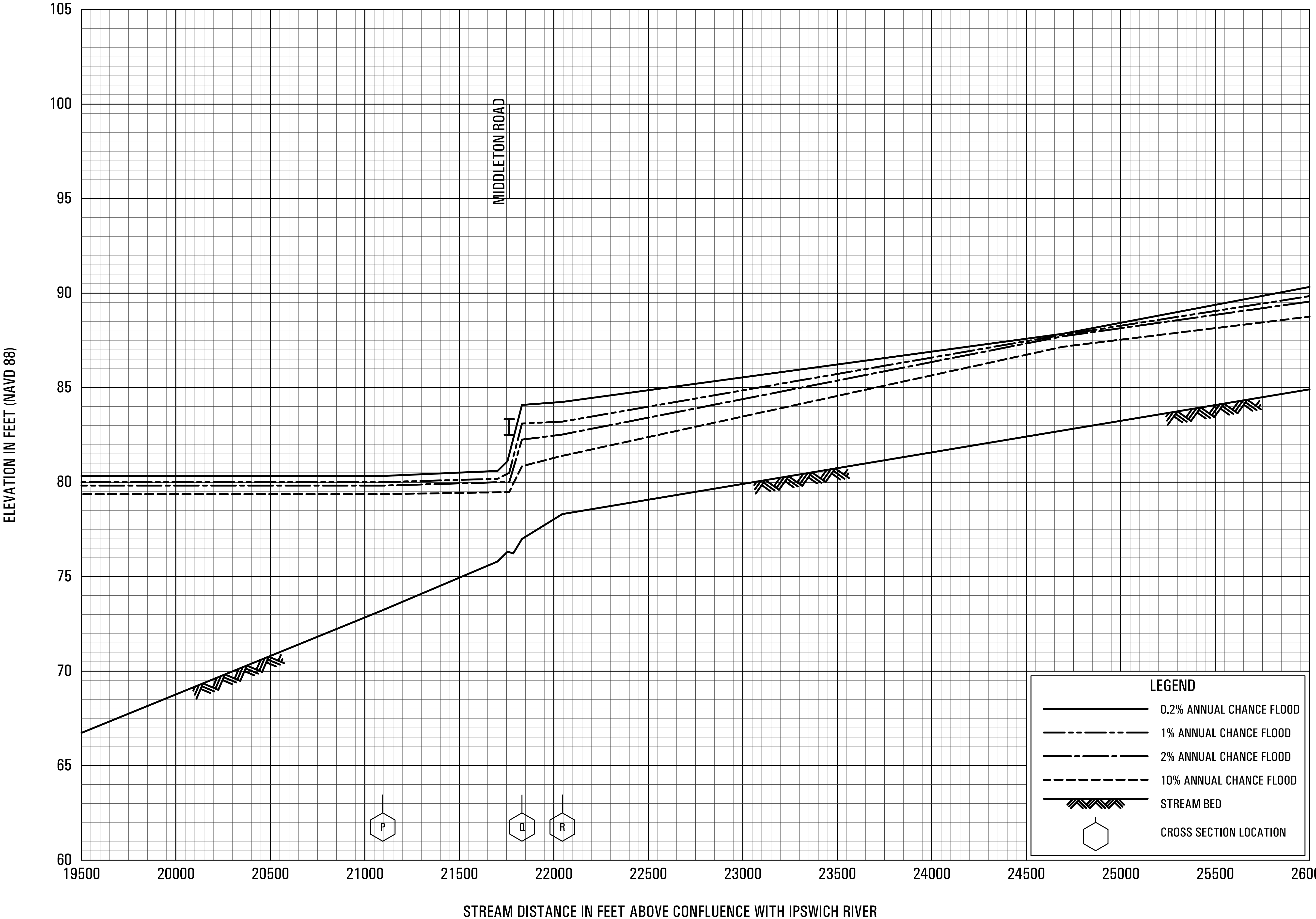


FLOOD PROFILES

FISH BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA
(ALL JURISDICTIONS)



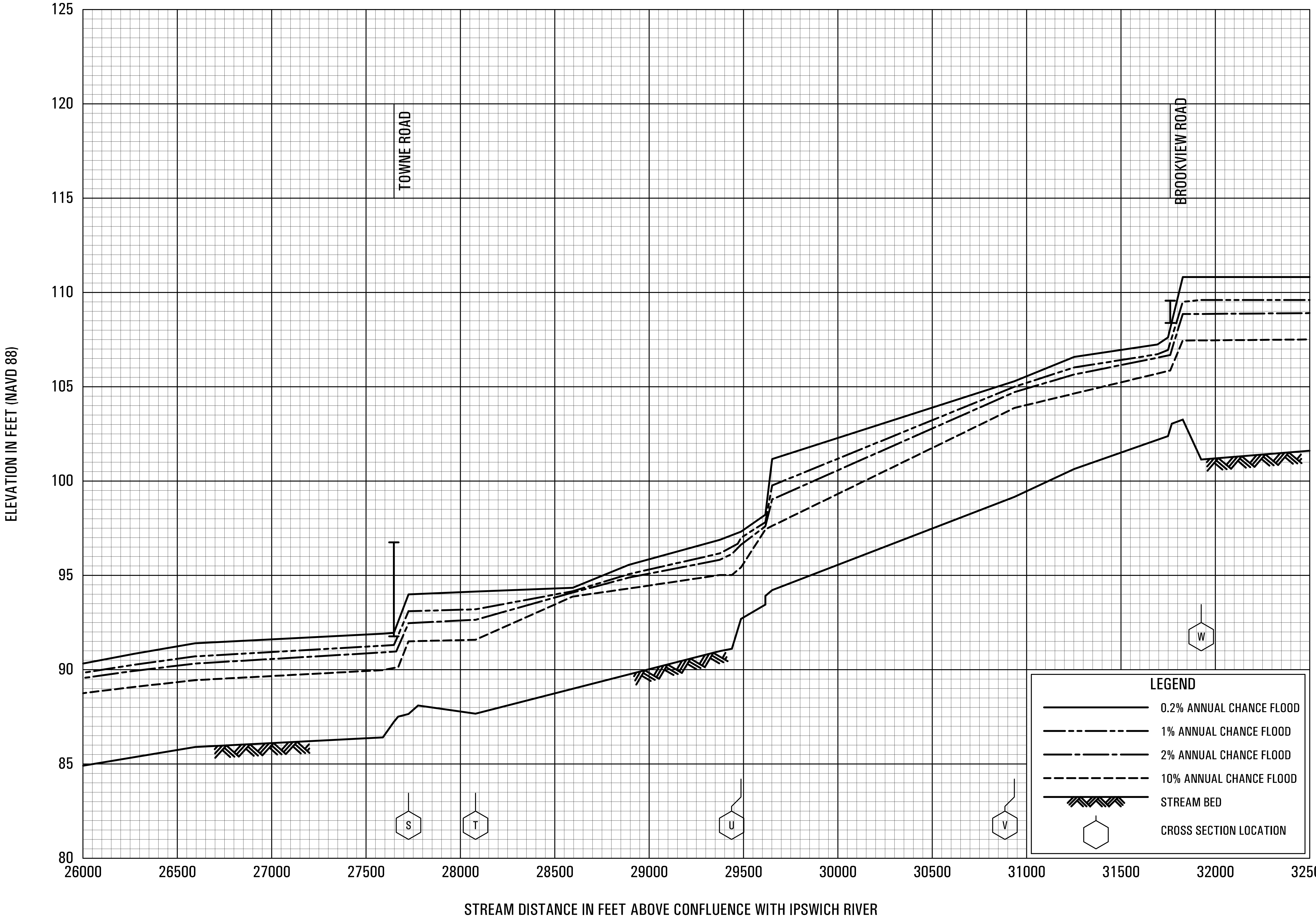
FLOOD PROFILES

FISH BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



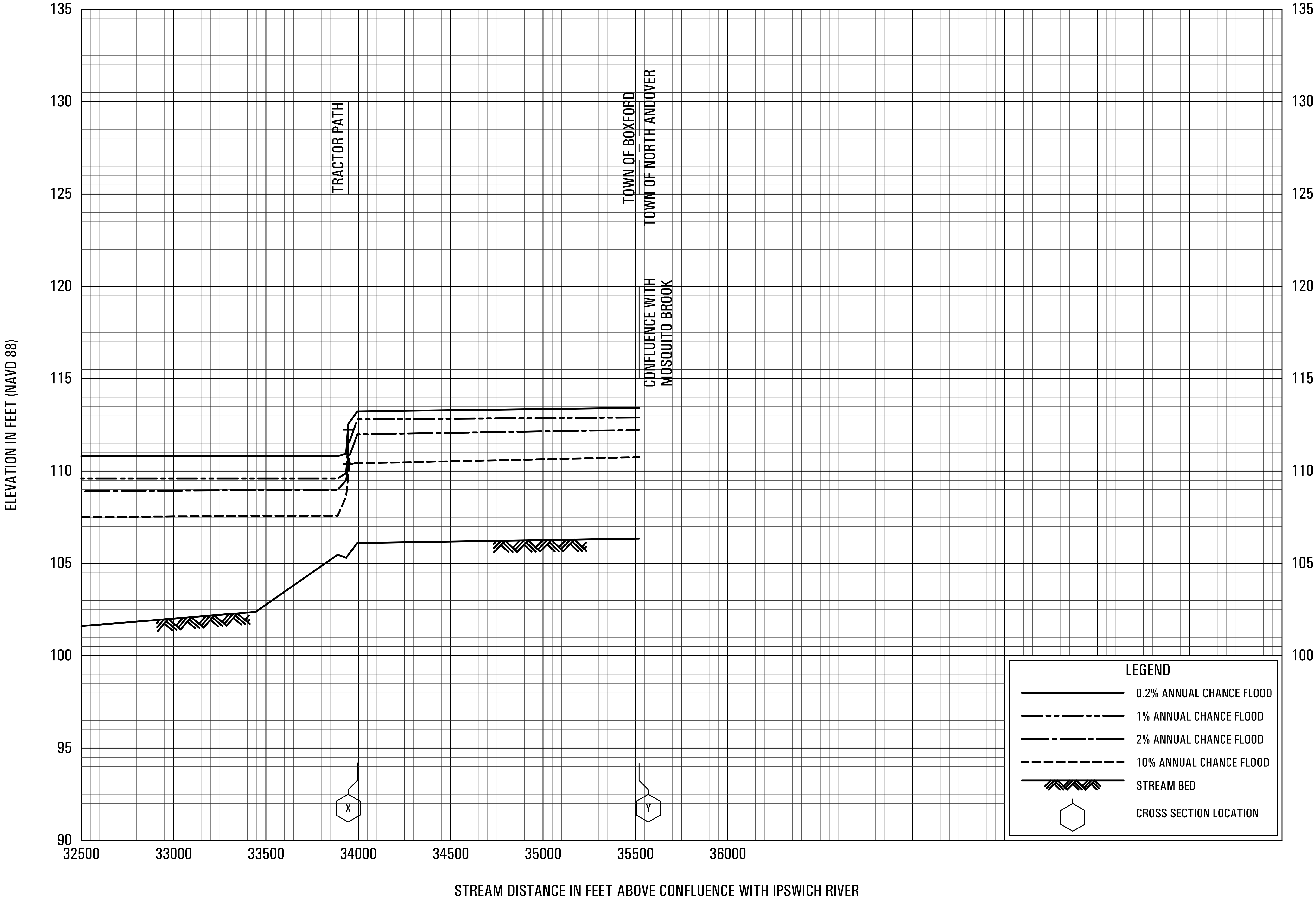
FLOOD PROFILES

FISH BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



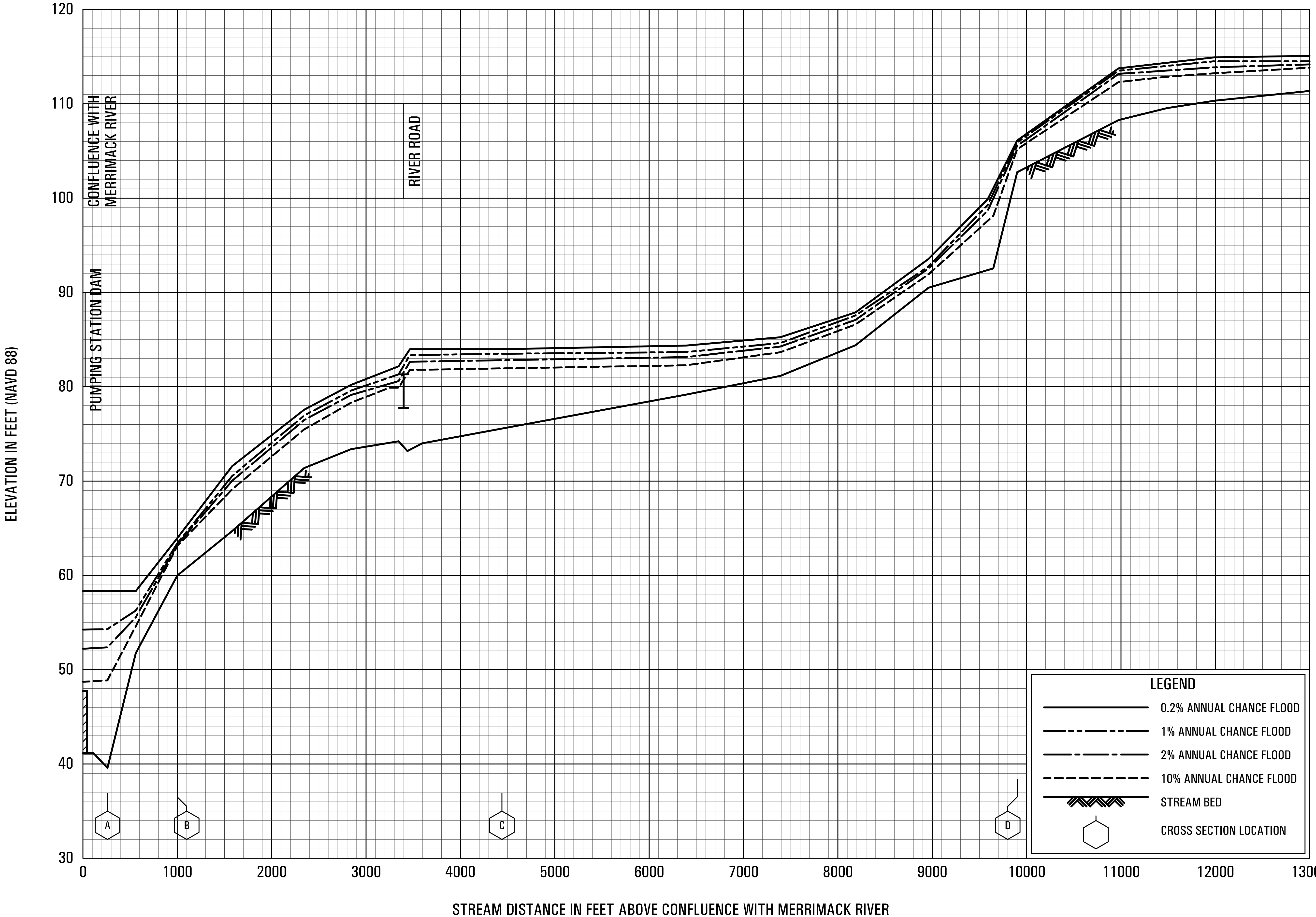
FLOOD PROFILES

FISH BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



FEDERAL EMERGENCY MANAGEMENT AGENCY

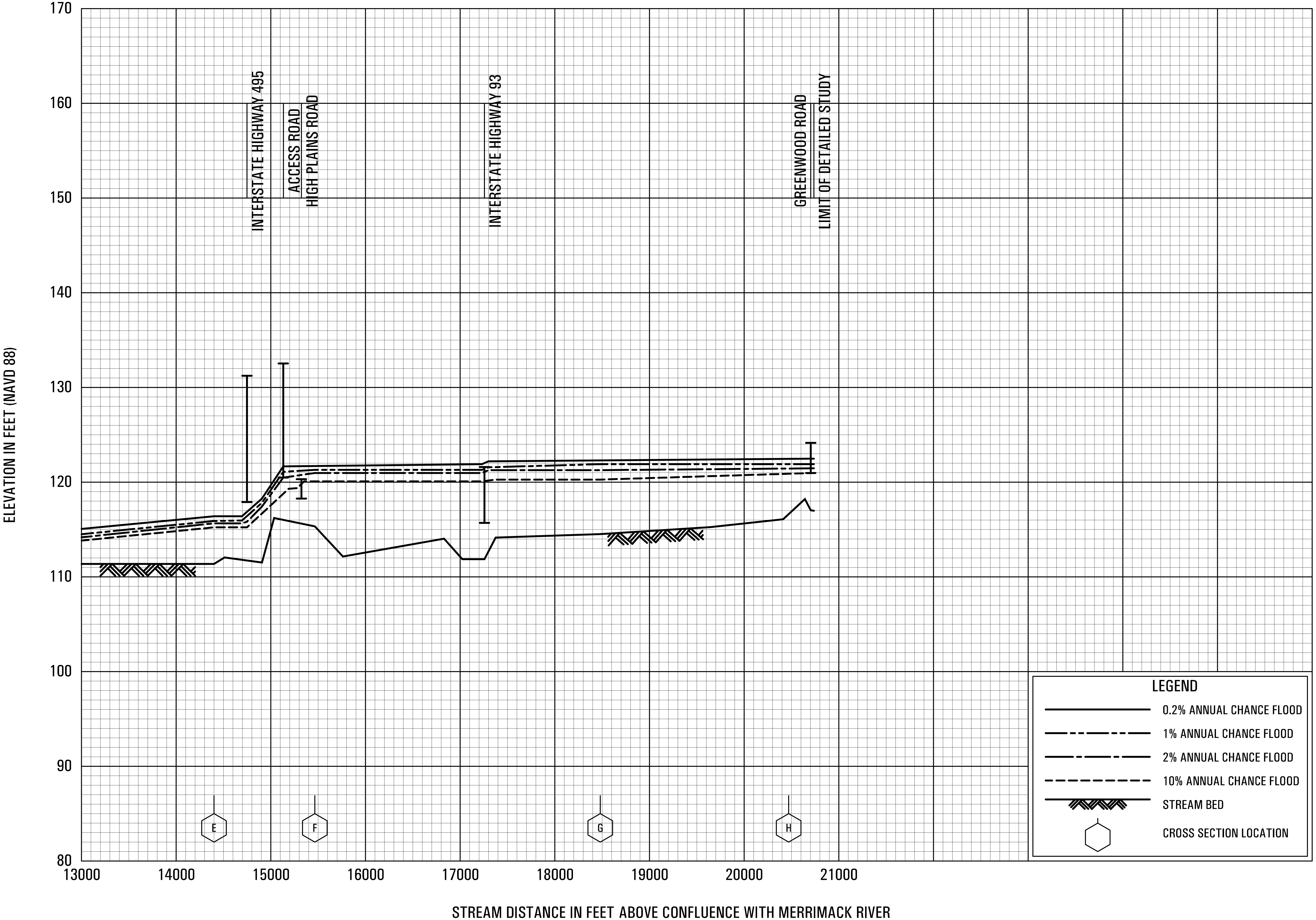
ESSEX COUNTY, MA

(ALL JURISDICTIONS)

FLOOD PROFILES

FISH BROOK (TOWN OF ANDOVER)

42P



FLOOD PROFILES

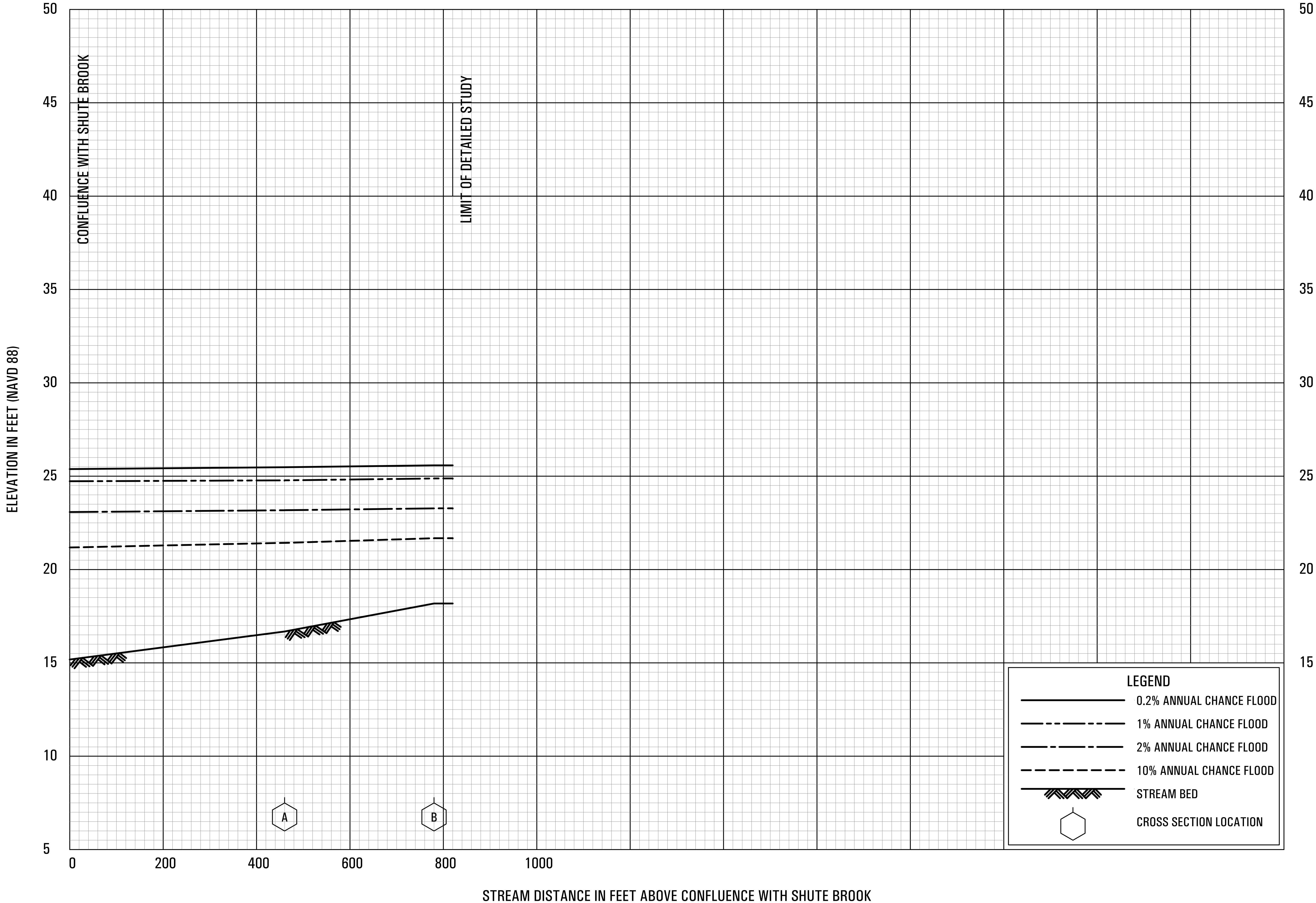
FISH BROOK (TOWN OF ANDOVER)

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

43P



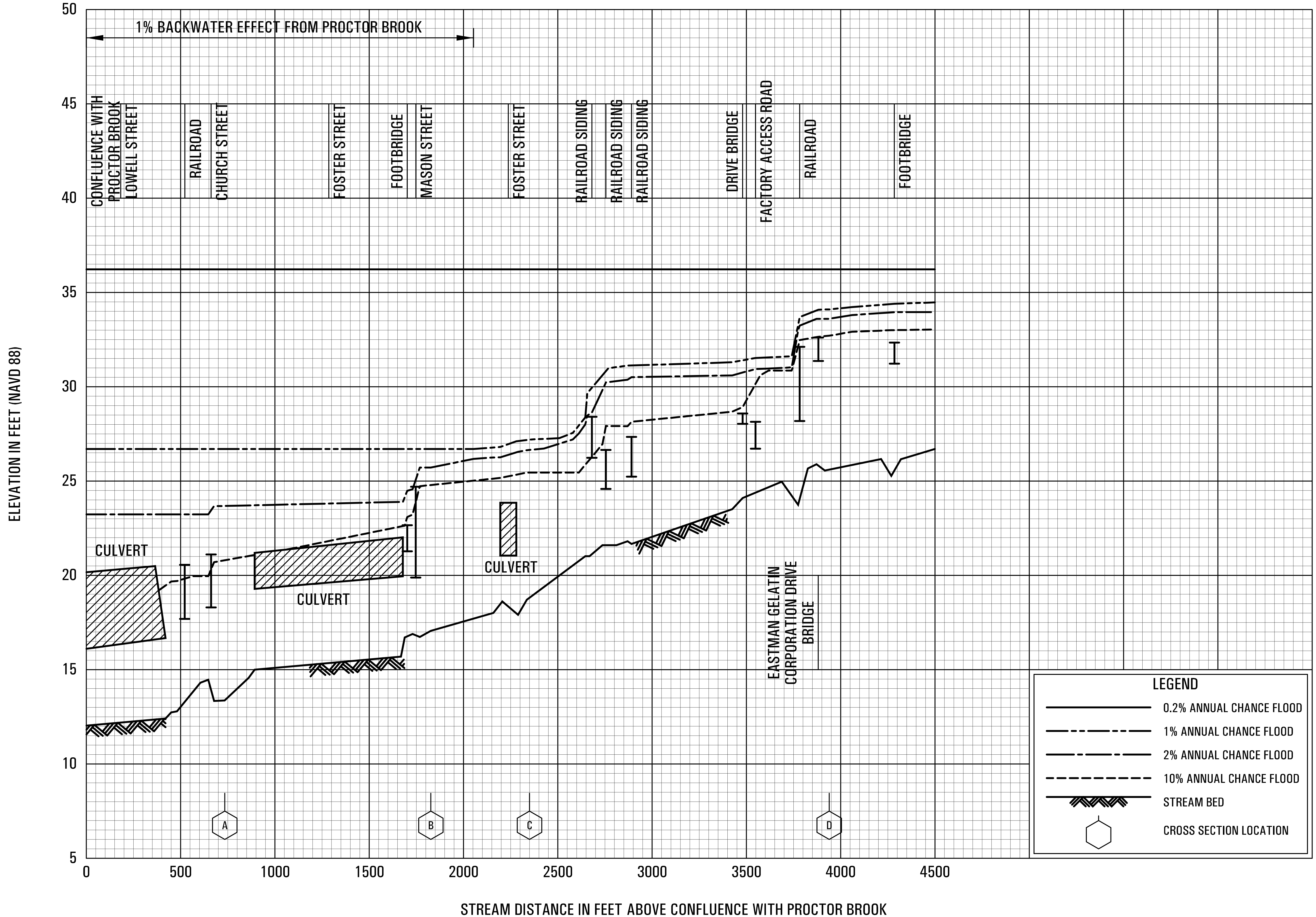
FLOOD PROFILES

FISKE BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



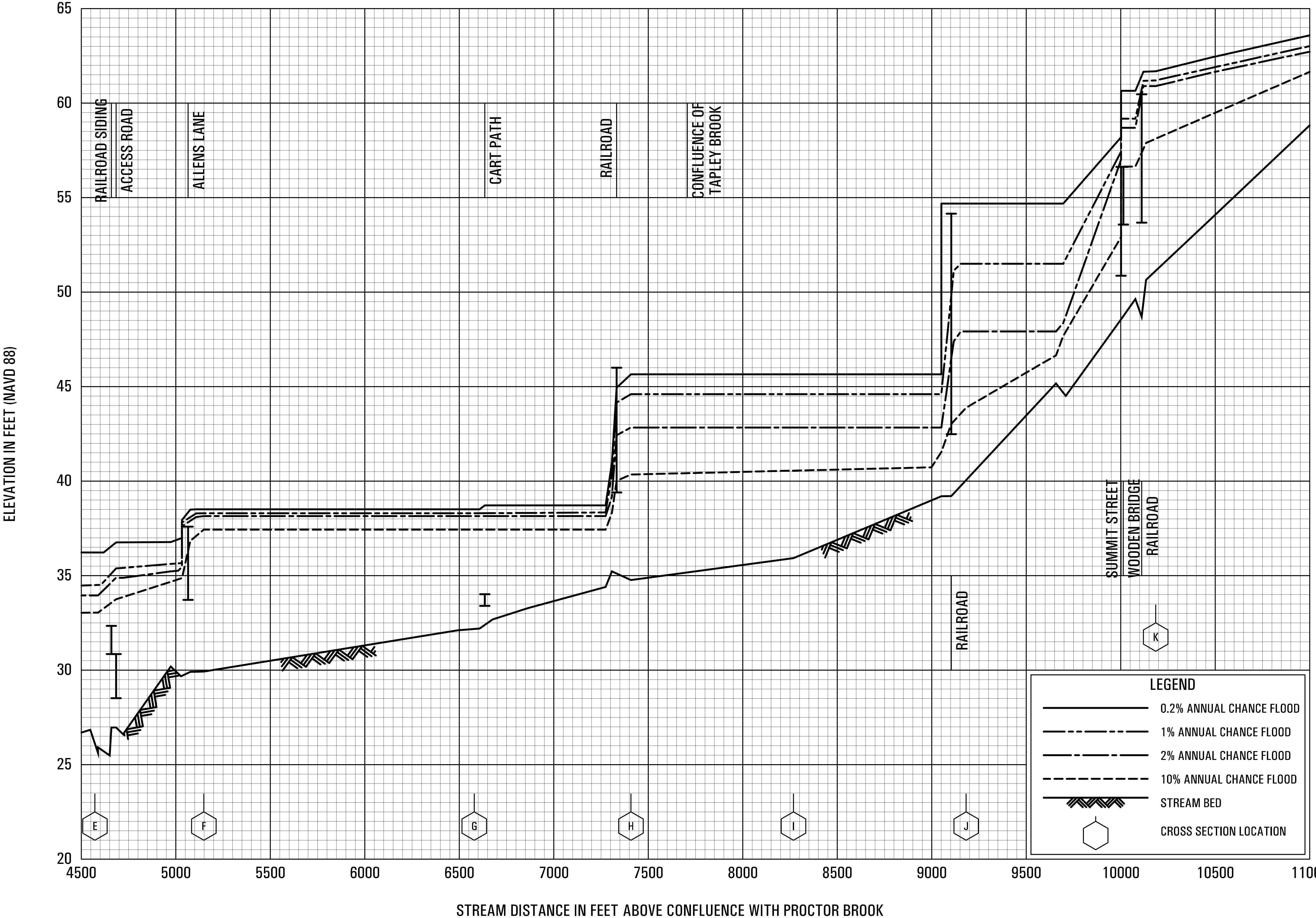
FLOOD PROFILES

GOLDTHWAITE BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



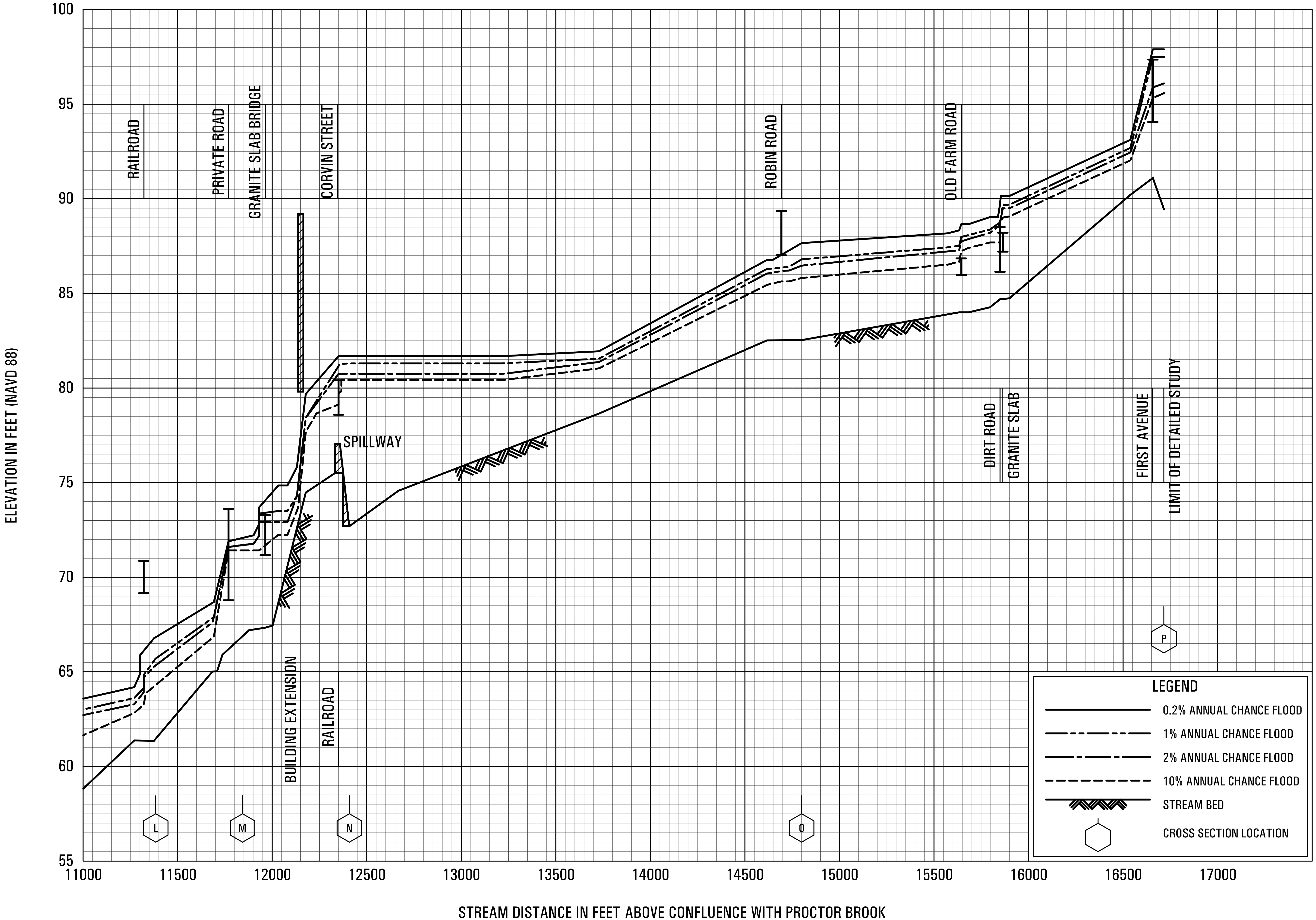
FLOOD PROFILES

GOLDTHWAITE BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



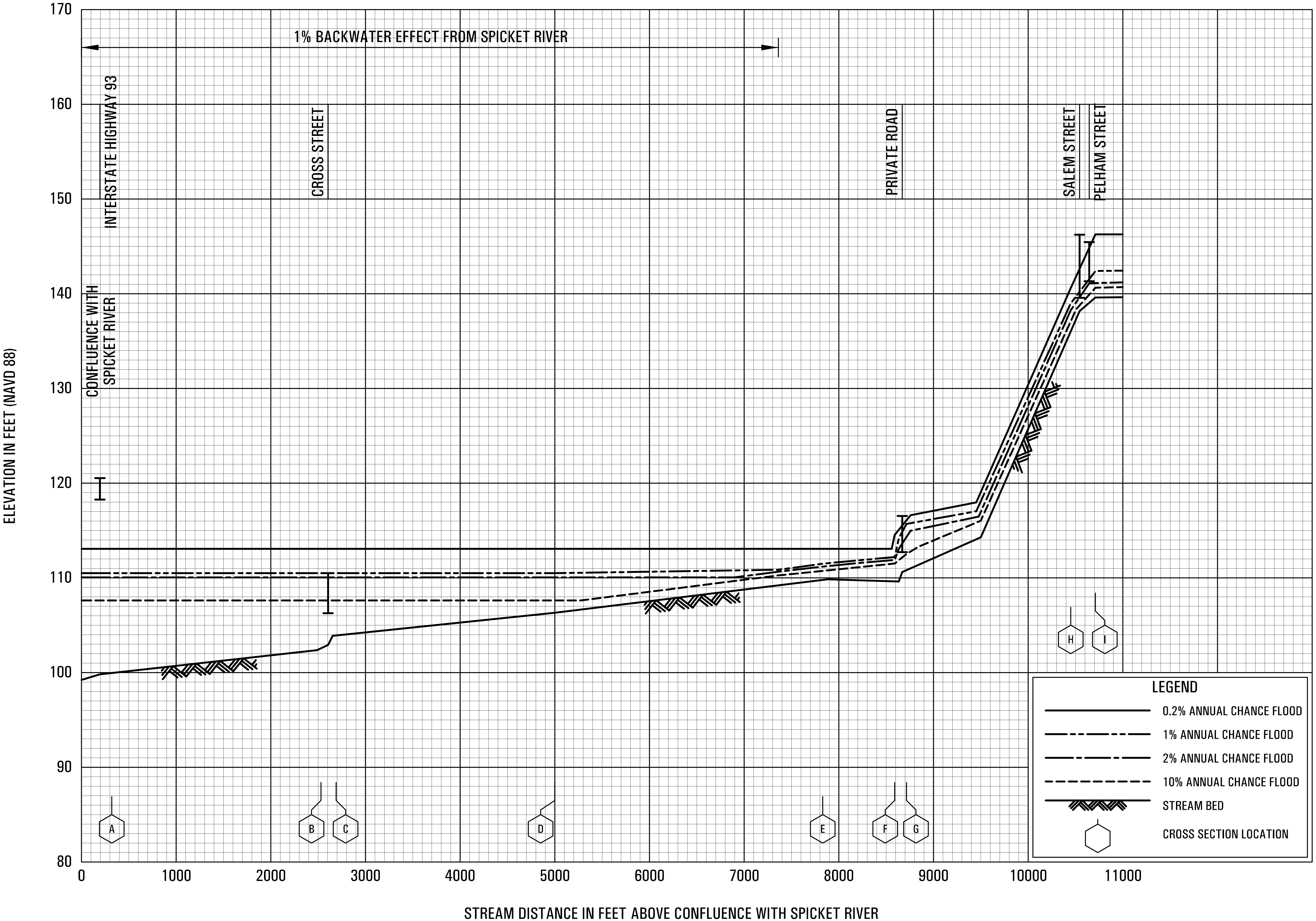
FLOOD PROFILES

GOLDTHWAITE BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

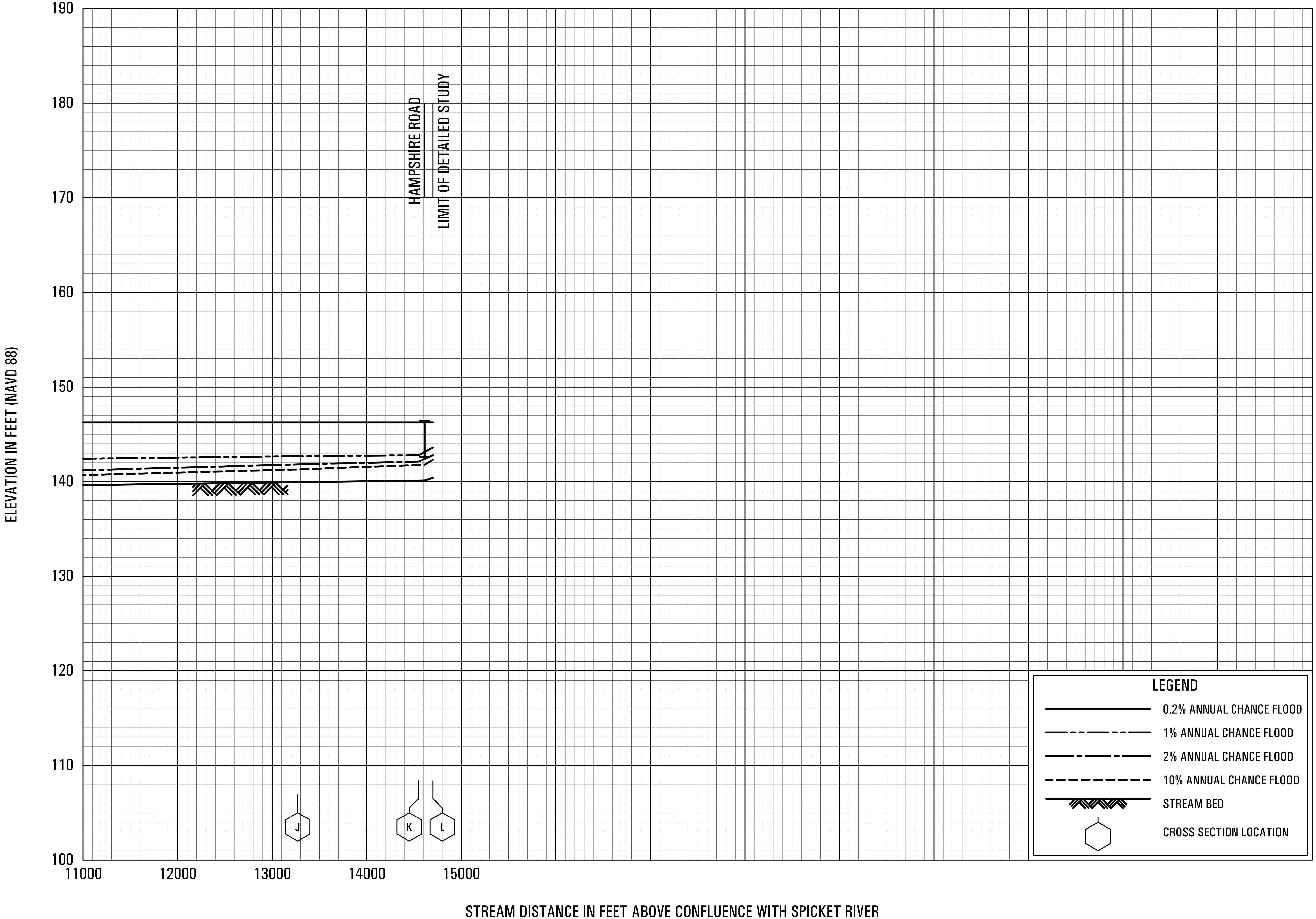


FLOOD PROFILES

HARRIS BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA
(ALL JURISDICTIONS)



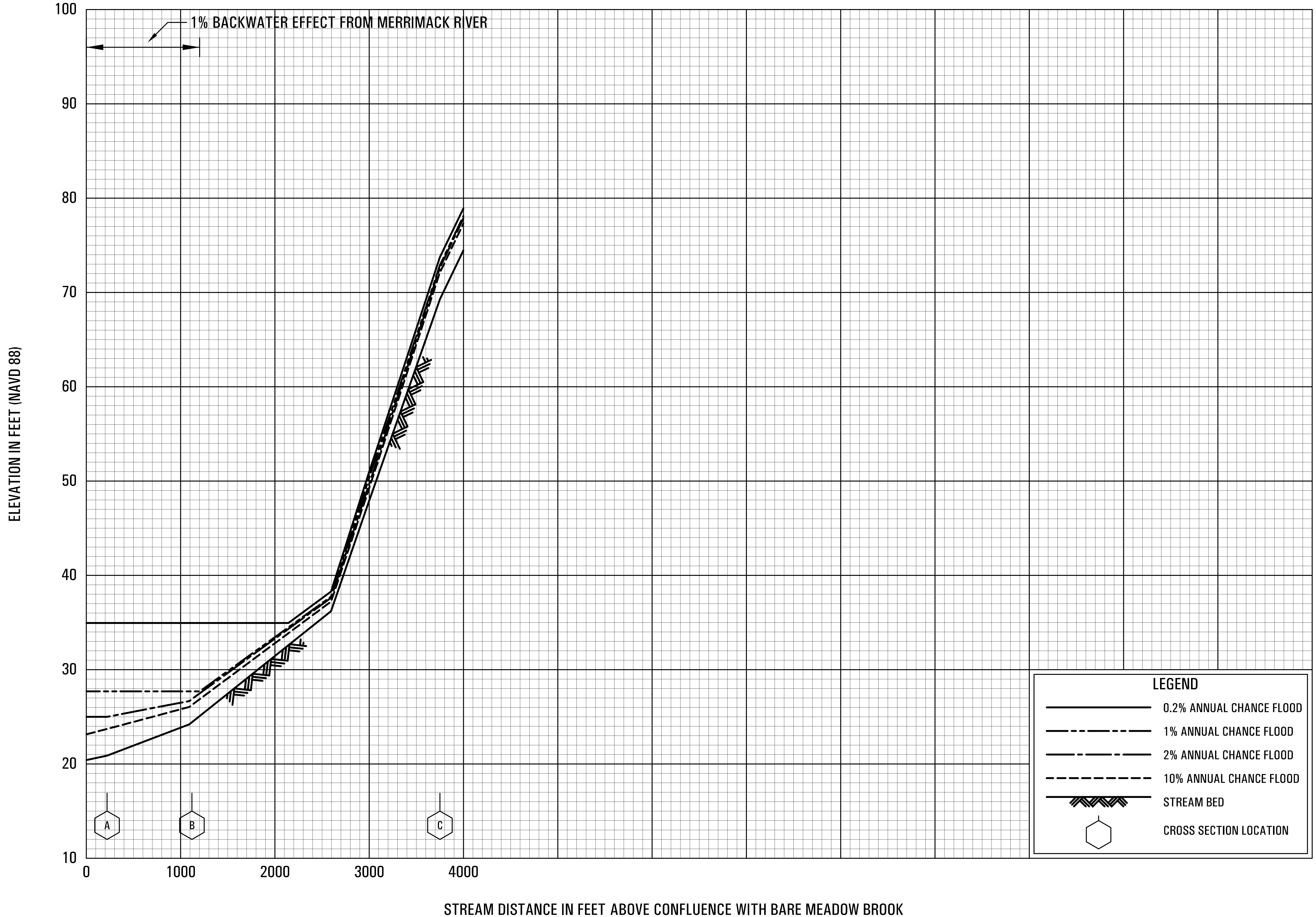
FLOOD PROFILES

HARRIS BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



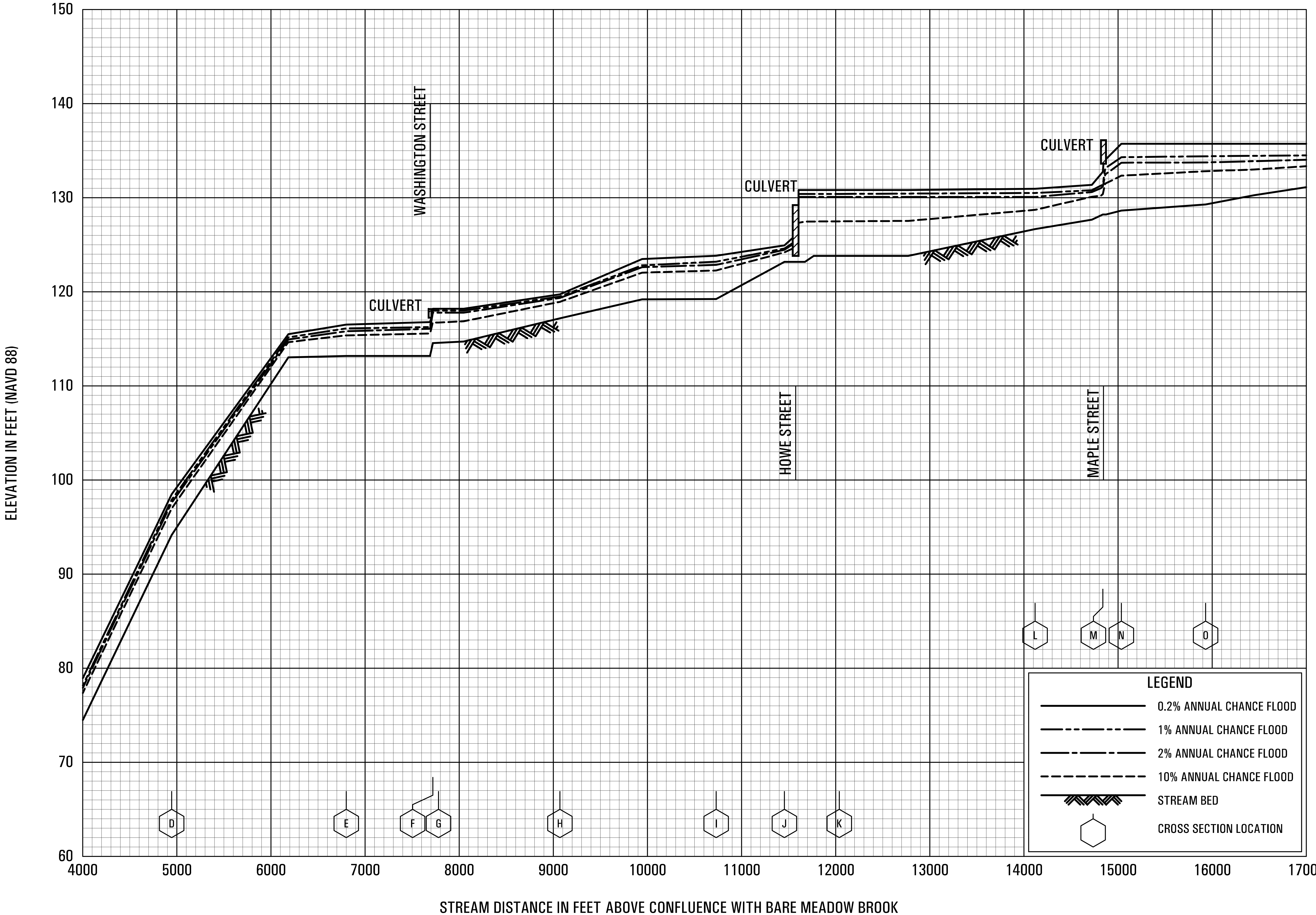
FLOOD PROFILES

HAWKES BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



FLOOD PROFILES

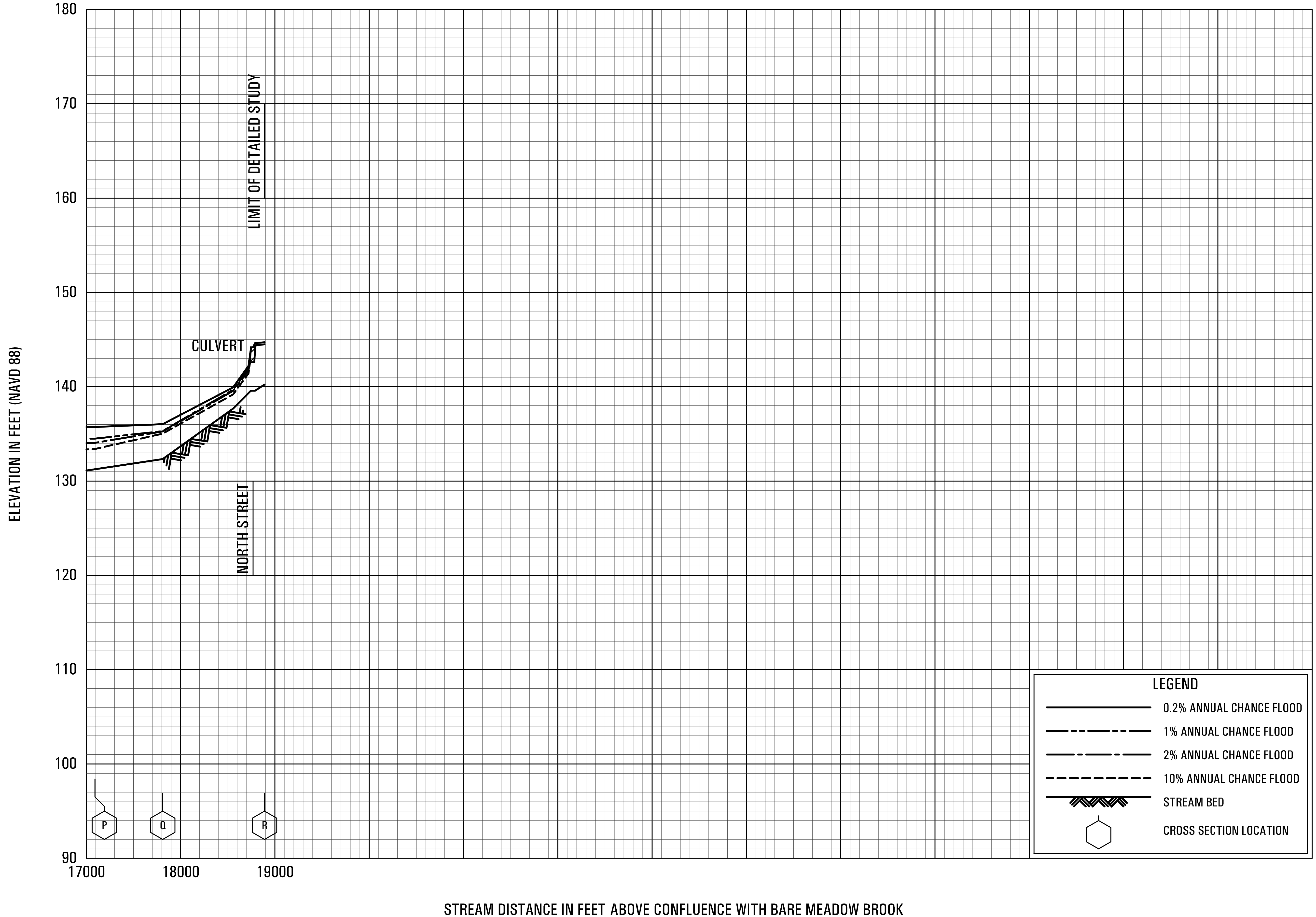
HAWKES BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

51P



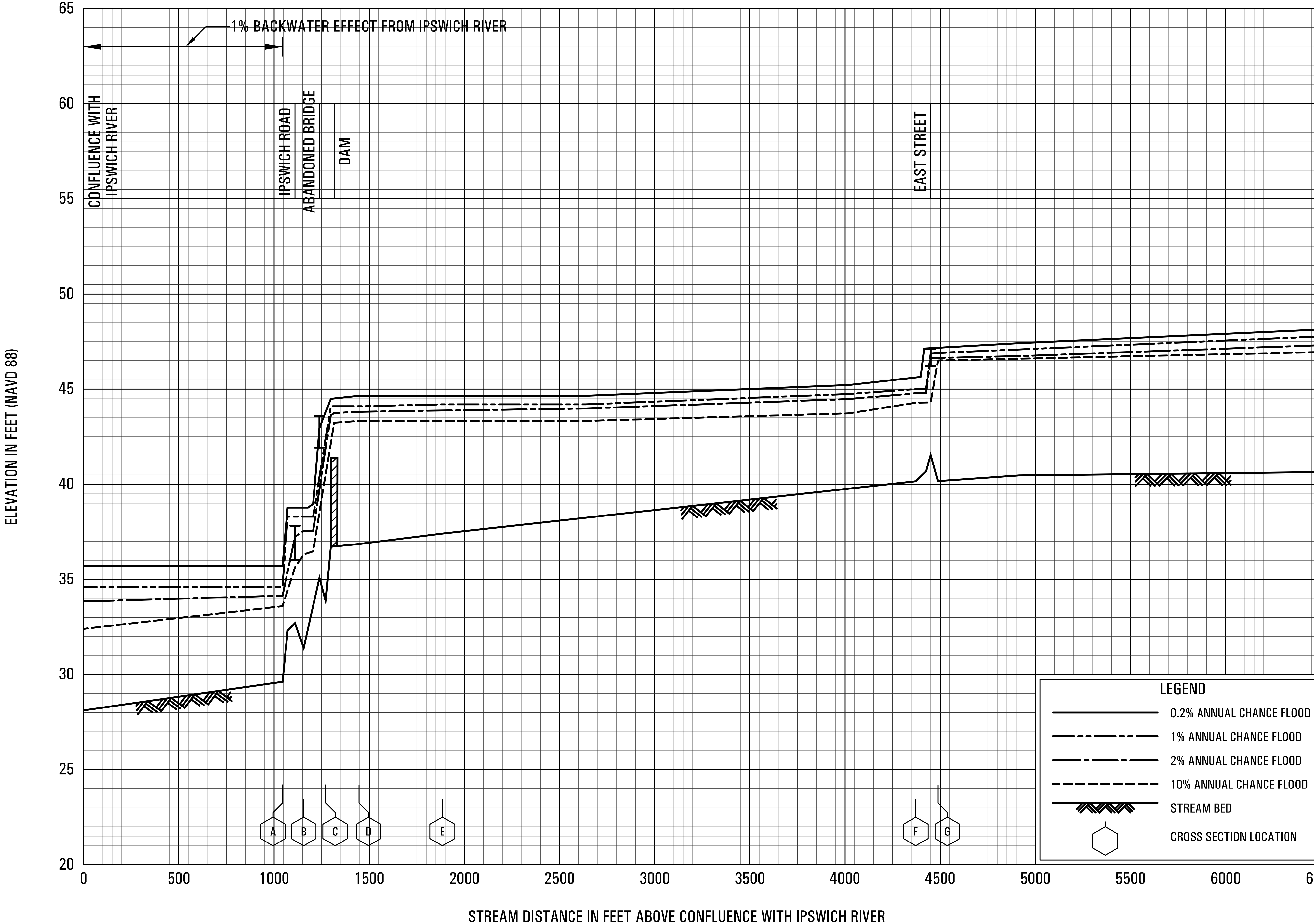
FLOOD PROFILES

HAWKES BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



FLOOD PROFILES

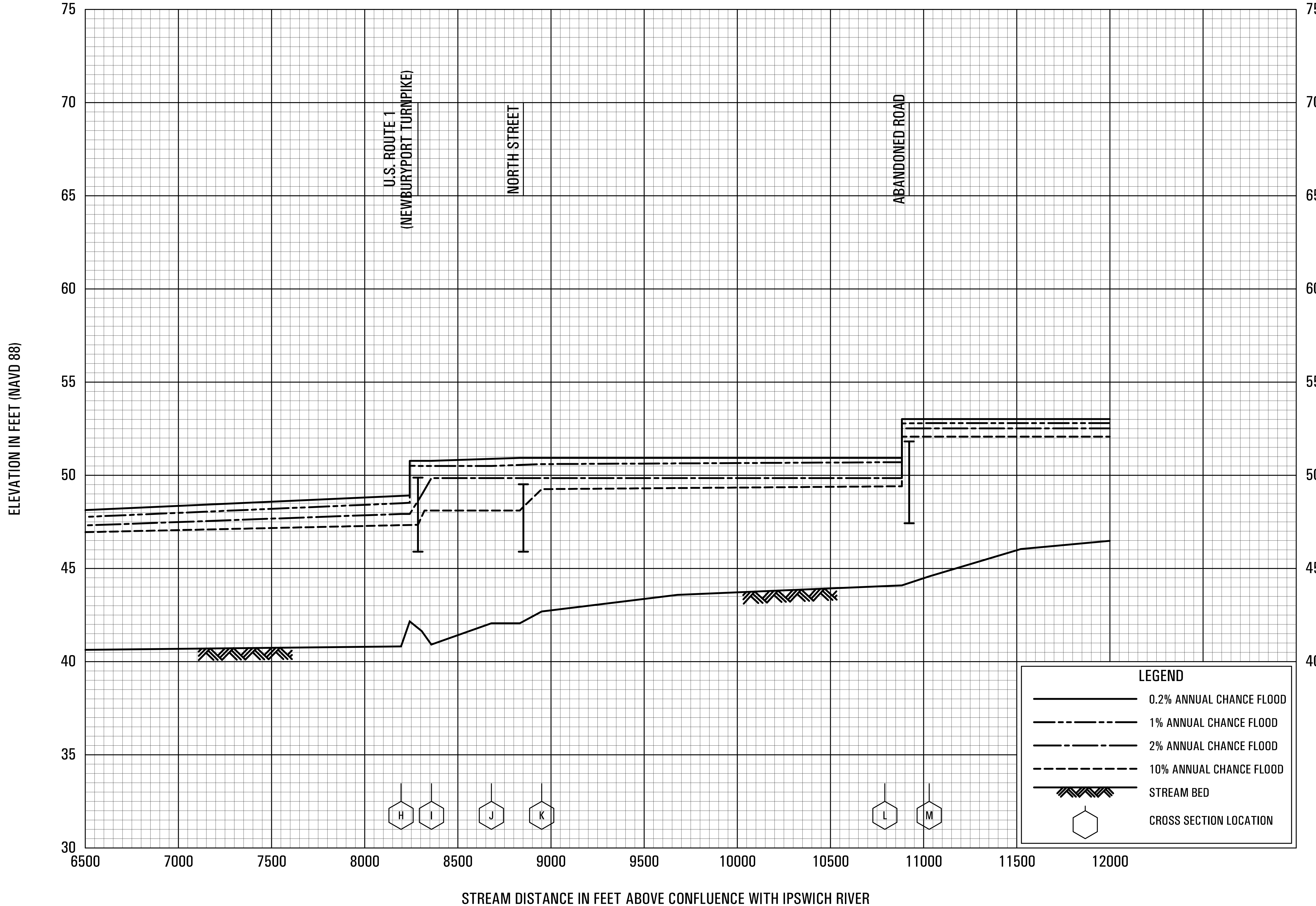
HOWLETT BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

53P



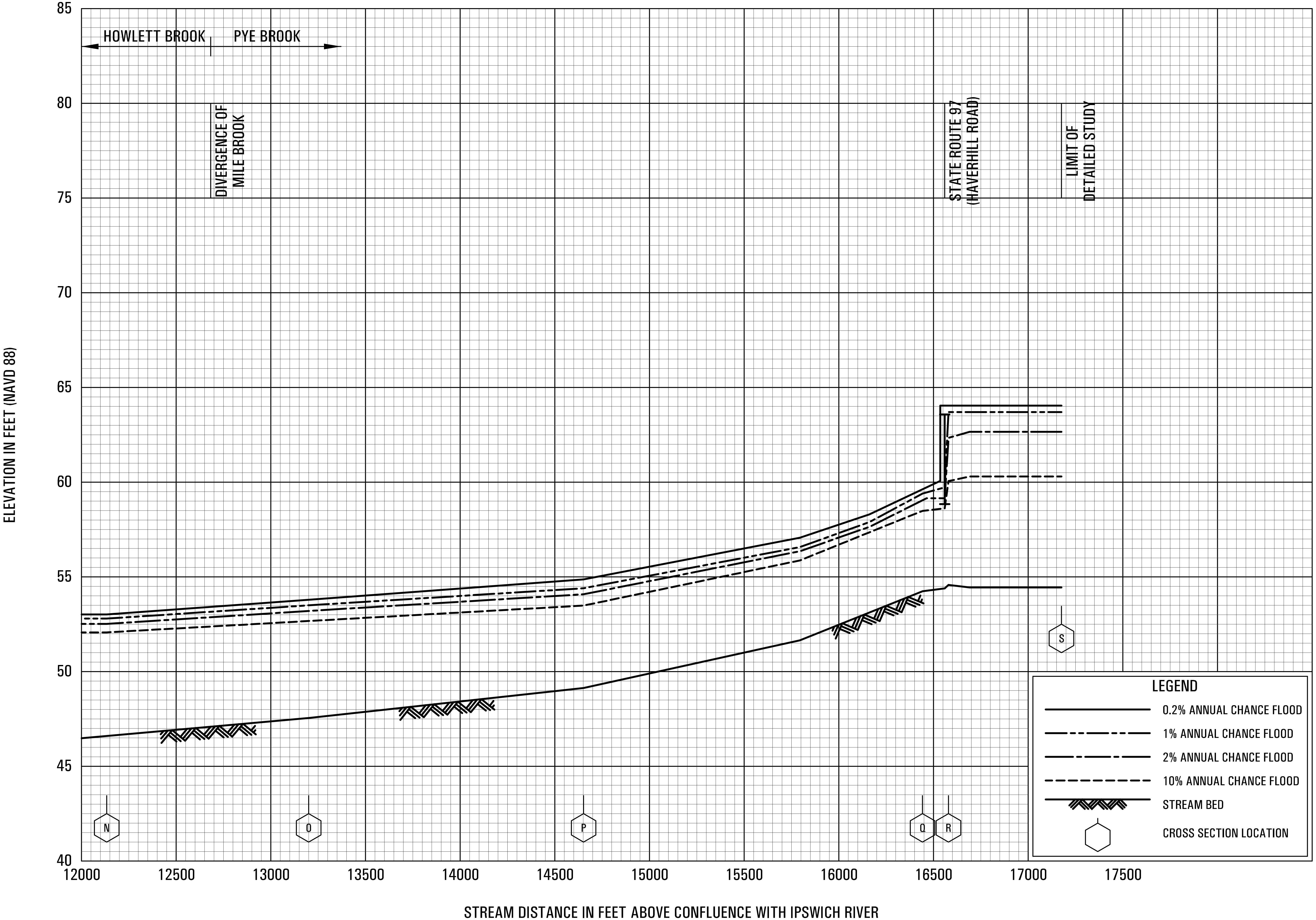
FLOOD PROFILES

HOWLETT BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

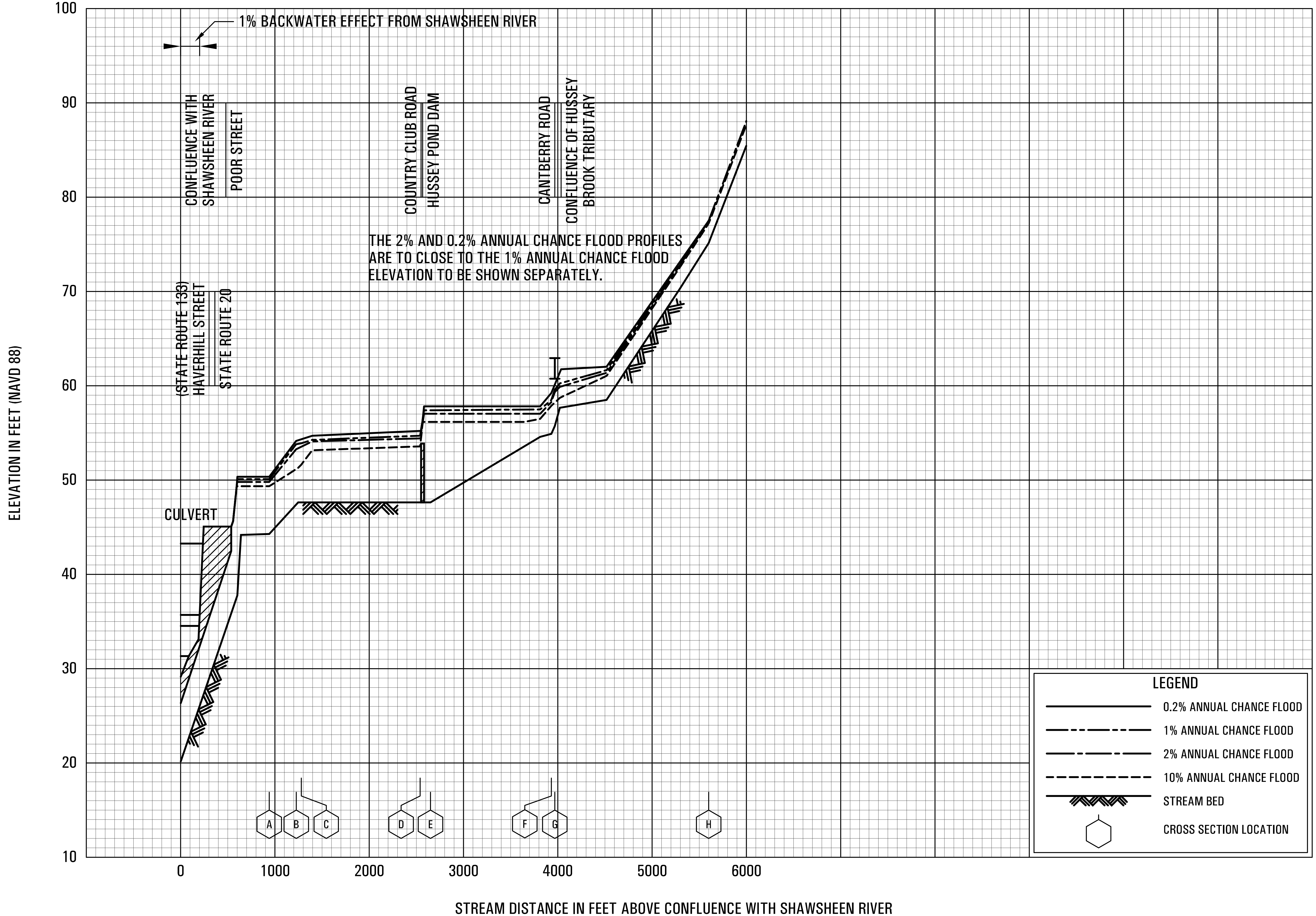


FLOOD PROFILES

HOWLETT BROOK AND PYE BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA
(ALL JURISDICTIONS)



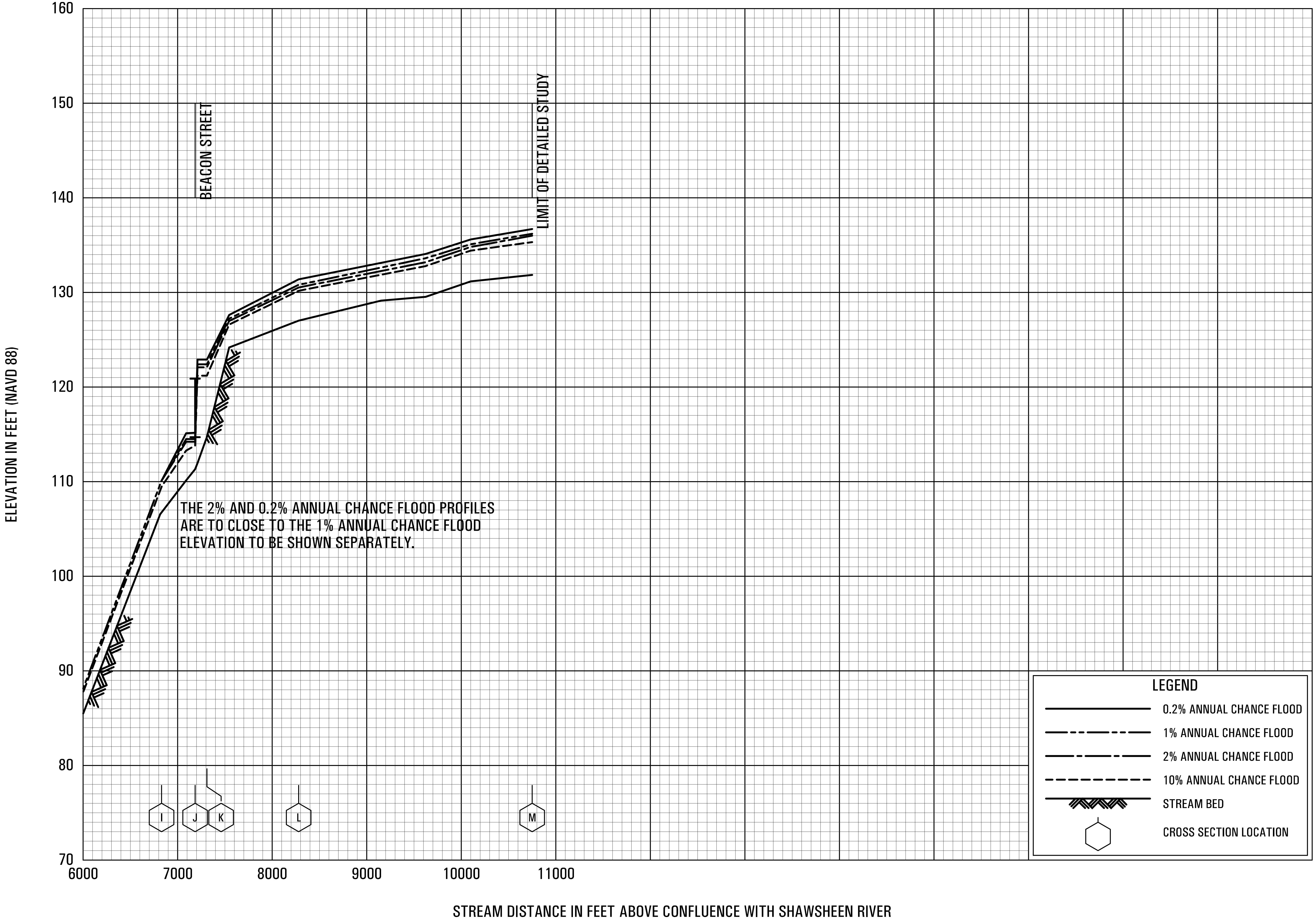
FLOOD PROFILES

HUSSEY BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



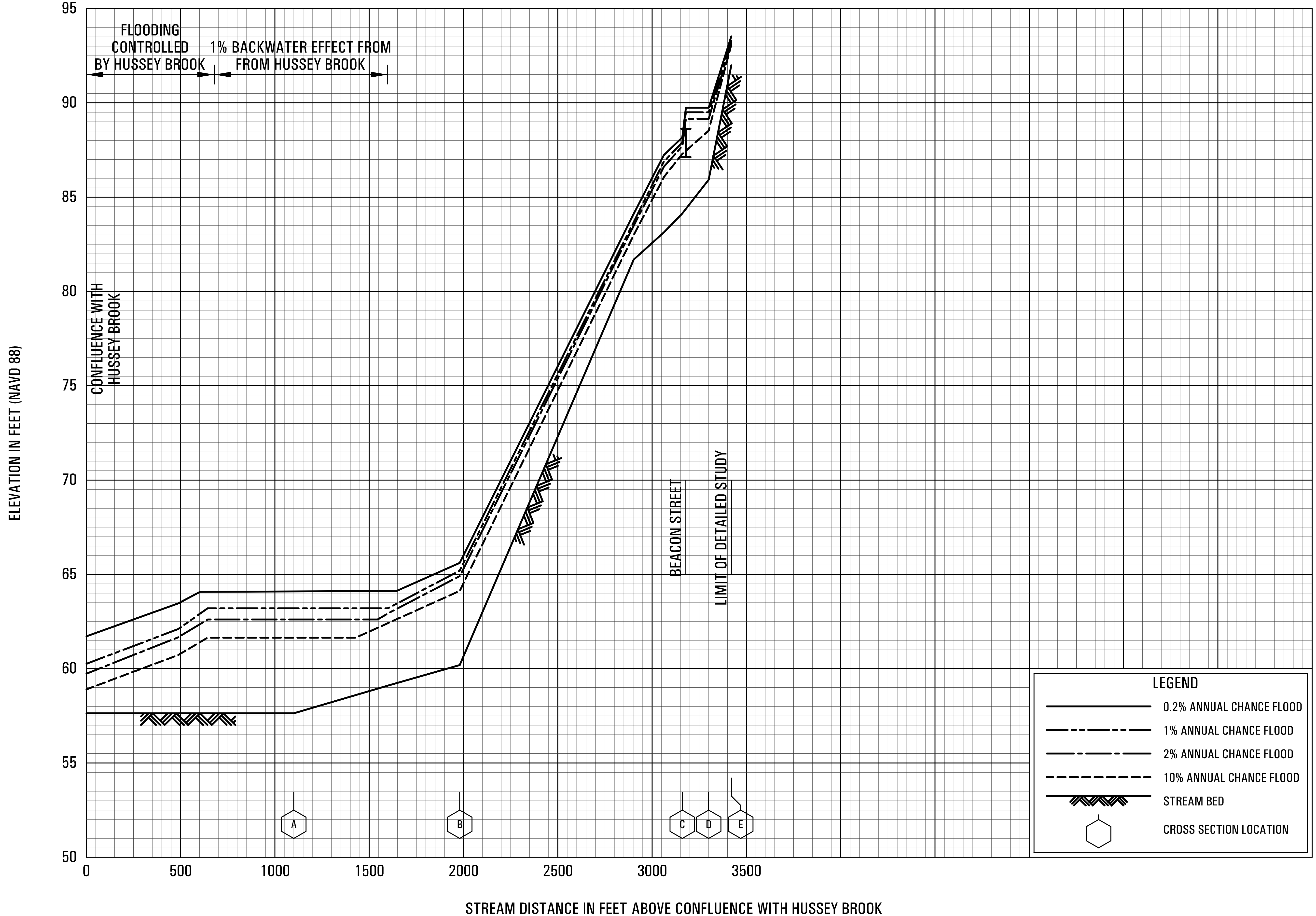
FLOOD PROFILES

HUSSEY BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



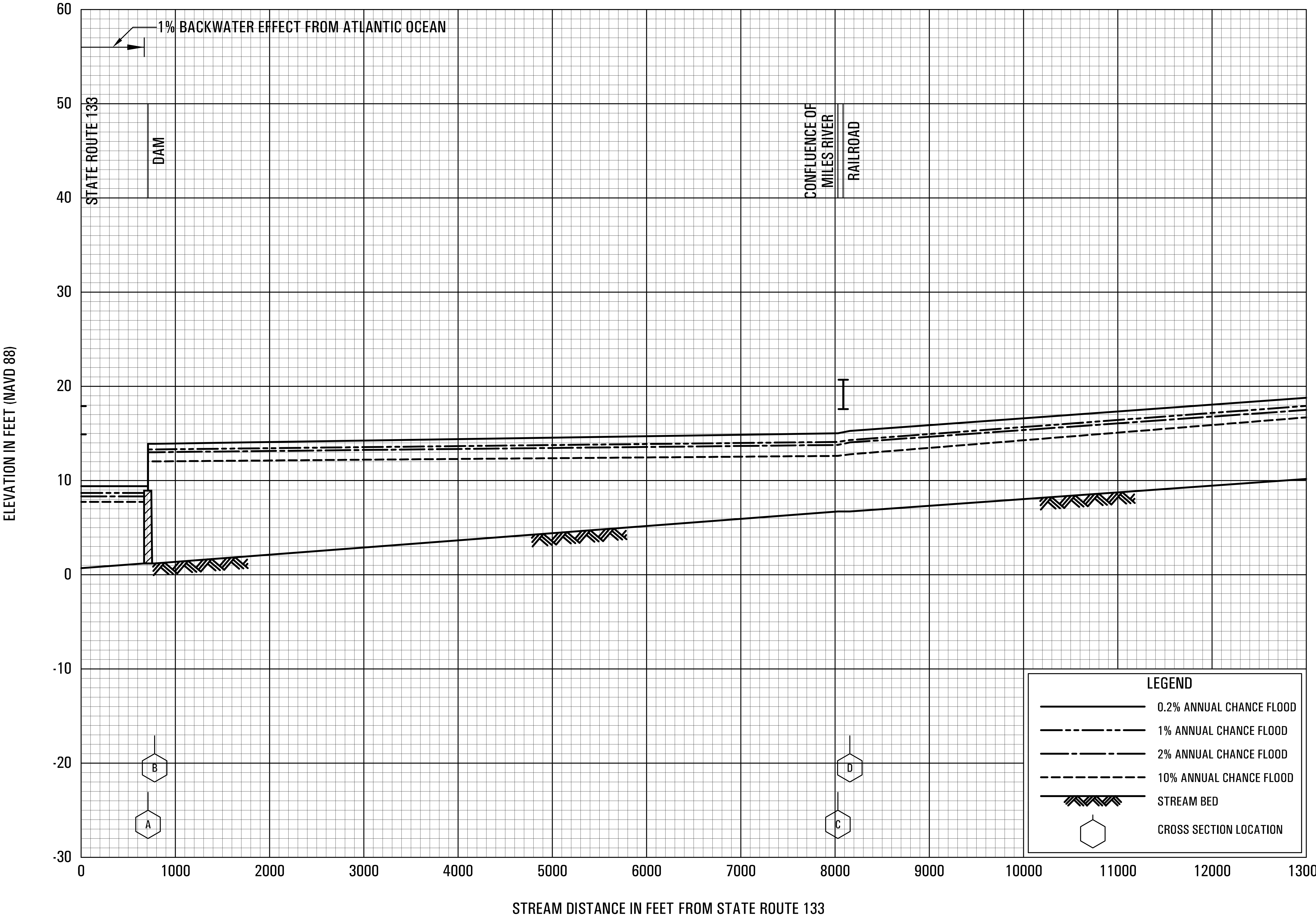
FLOOD PROFILES

HUSSEY BROOK TRIBUTARY

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



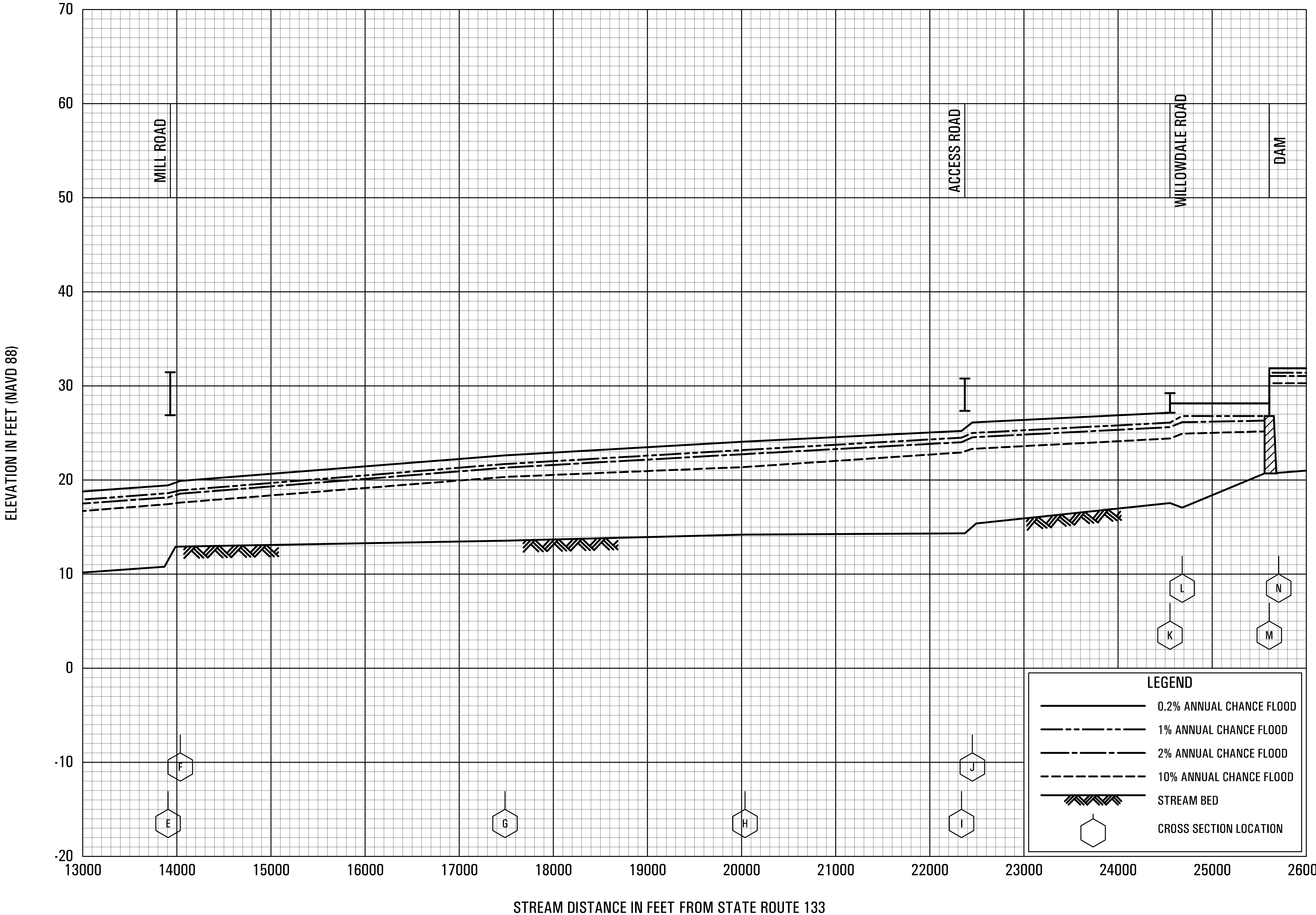
FLOOD PROFILES

IPSWICH RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



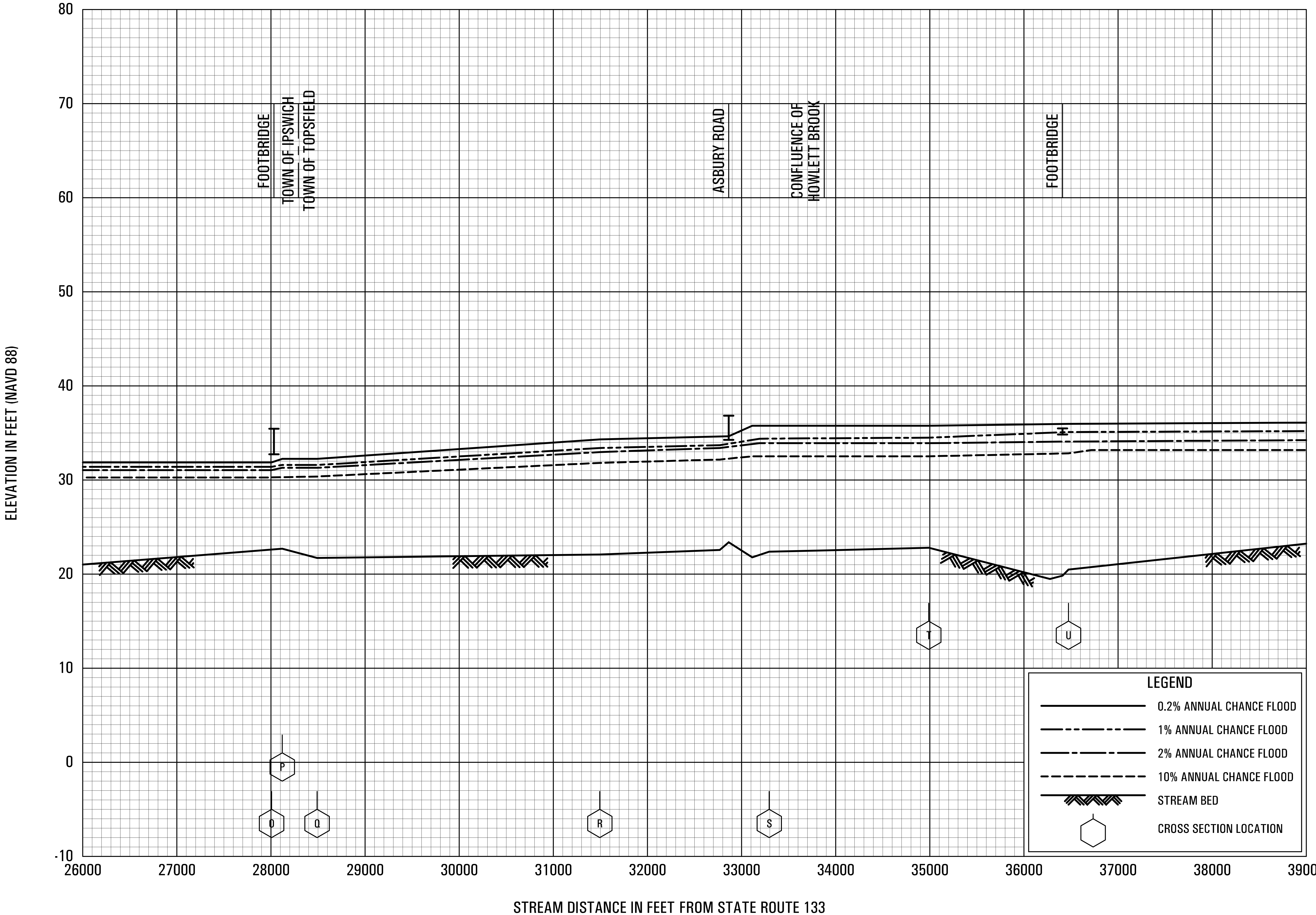
FLOOD PROFILES

IPSWICH RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA
(ALL JURISDICTIONS)

60P



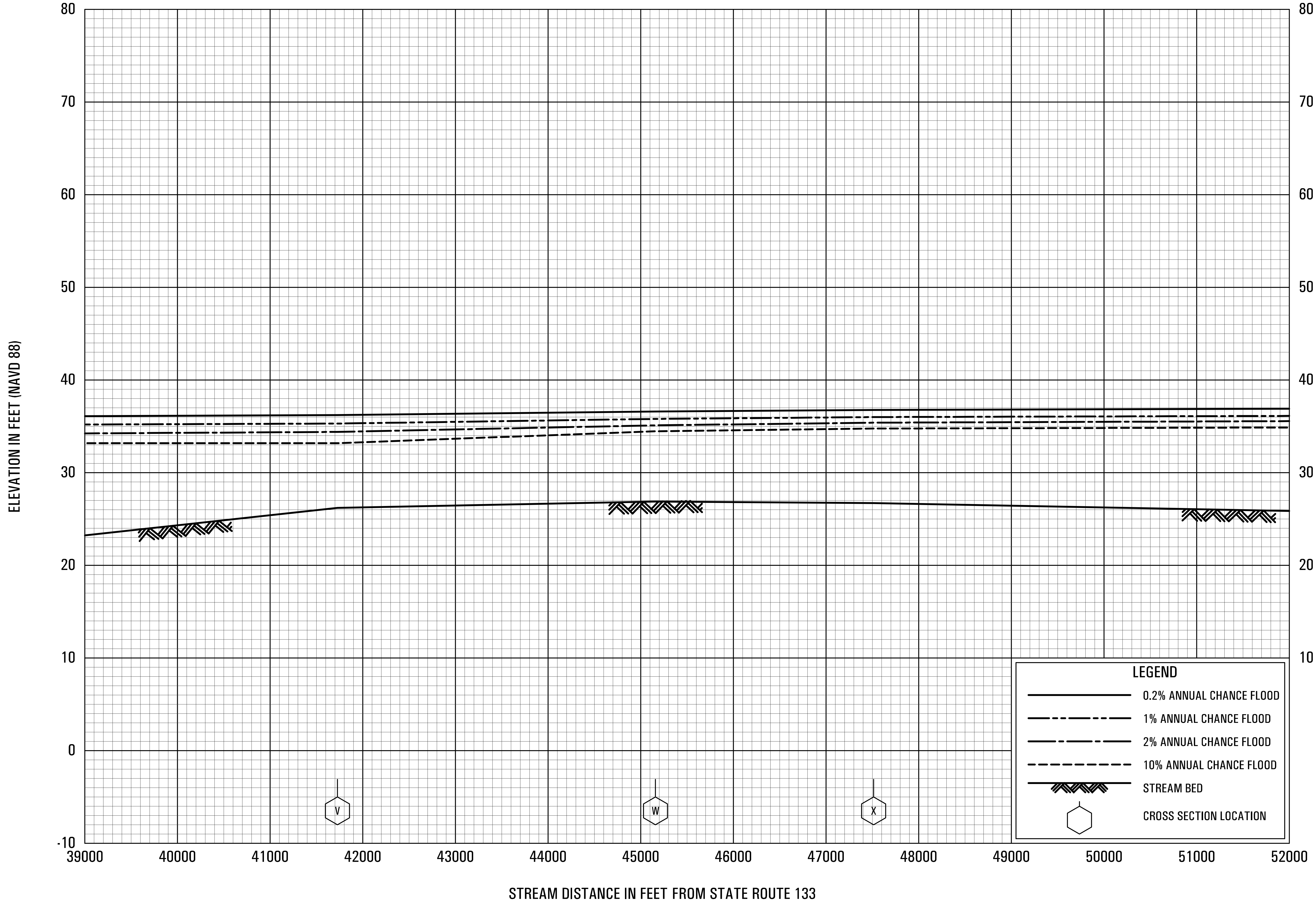
FLOOD PROFILES

IPSWICH RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



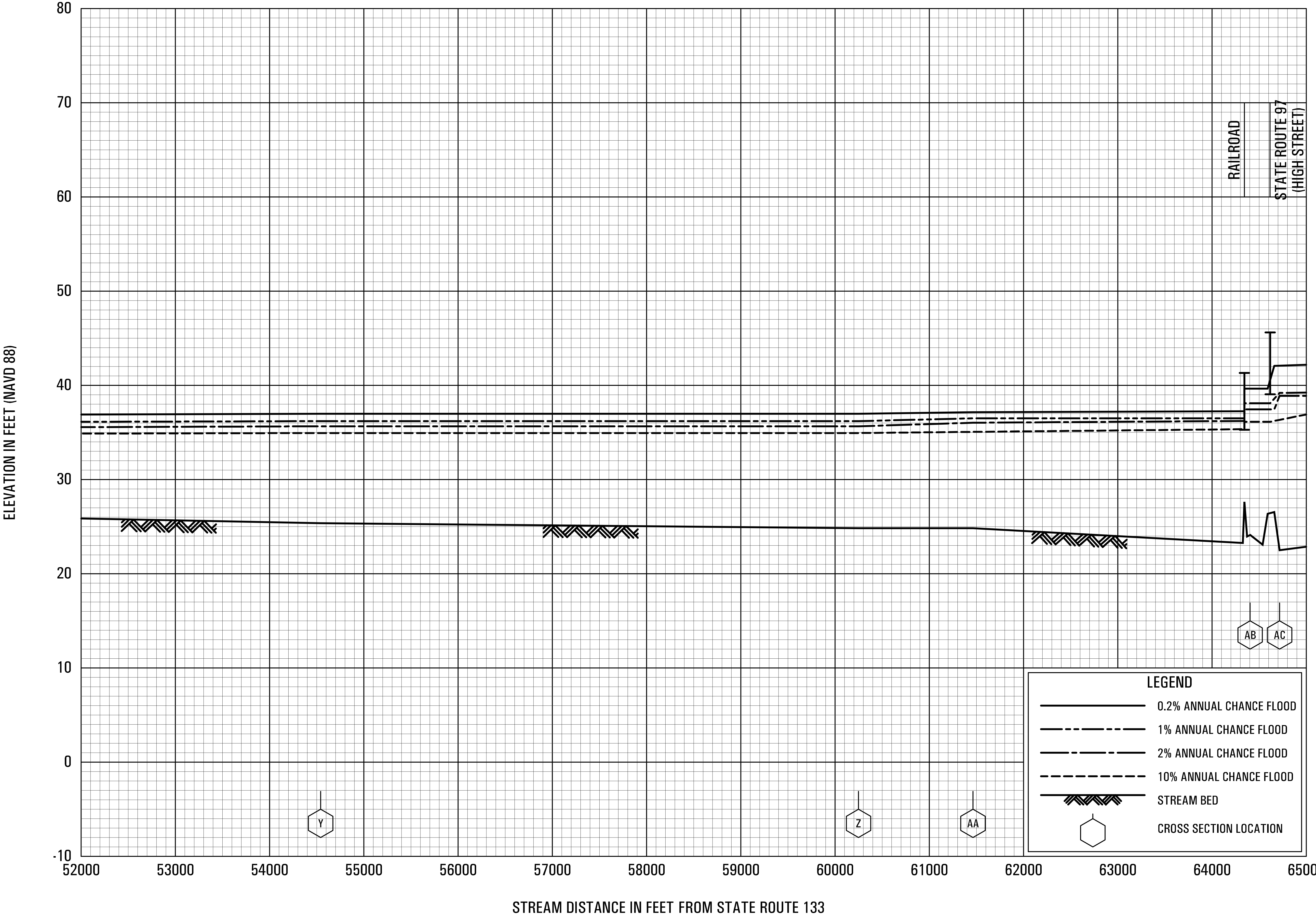
FLOOD PROFILES

IPSWICH RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



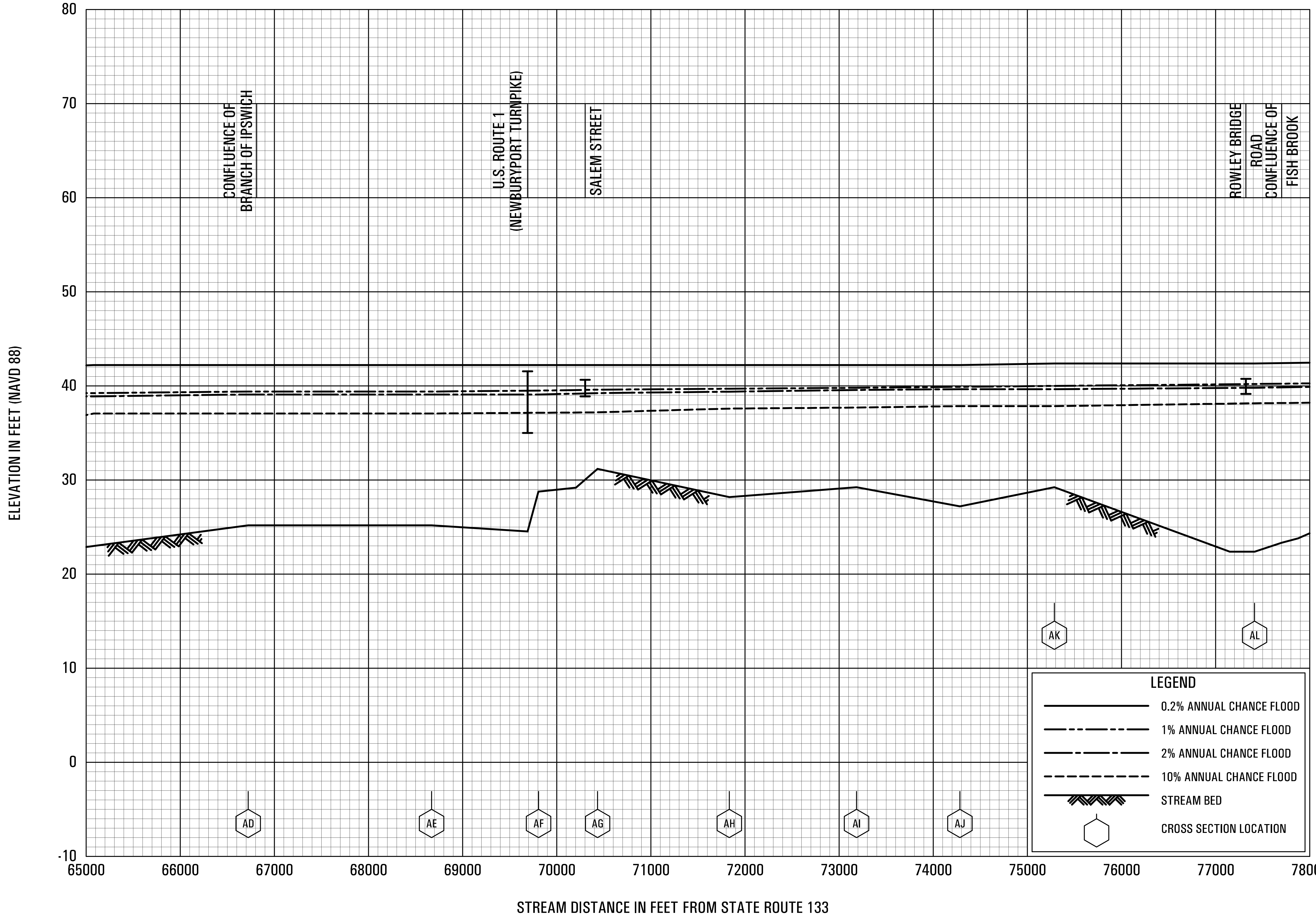
FLOOD PROFILES

IPSWICH RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



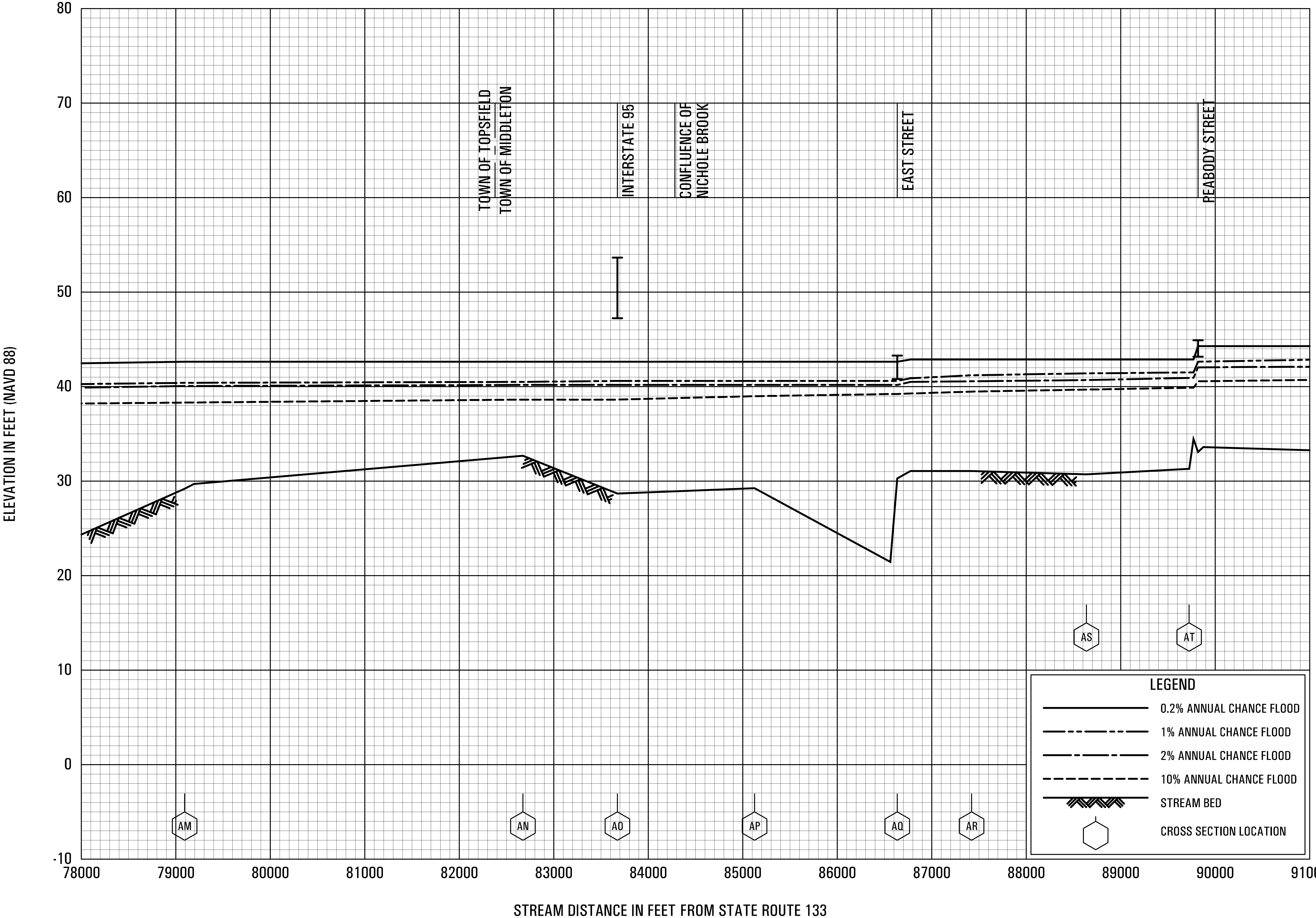
FLOOD PROFILES

IPSWICH RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



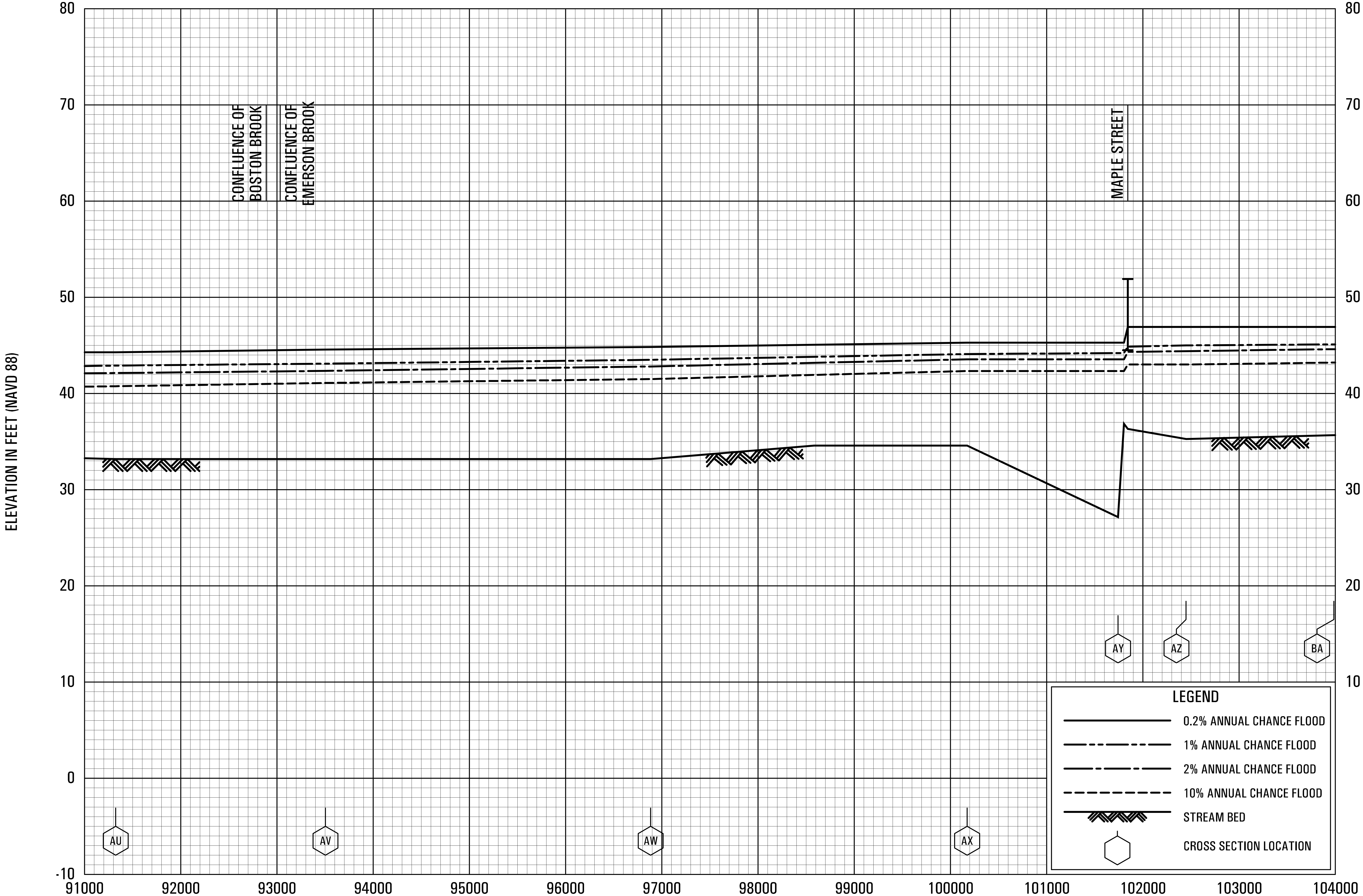
FLOOD PROFILES

IPSWICH RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



STREAM DISTANCE IN FEET FROM STATE ROUTE 133

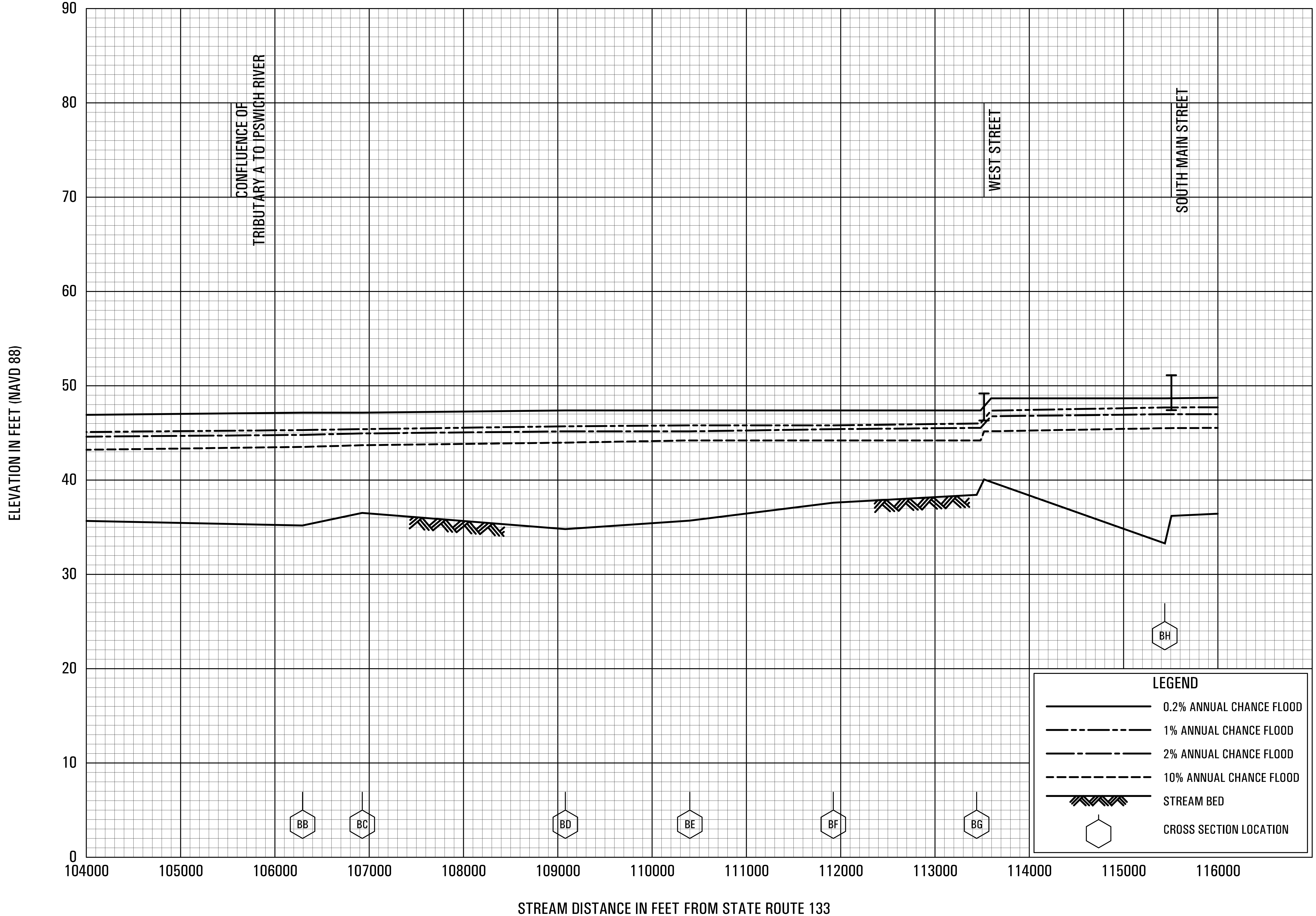
FLOOD PROFILES

IPSWICH RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



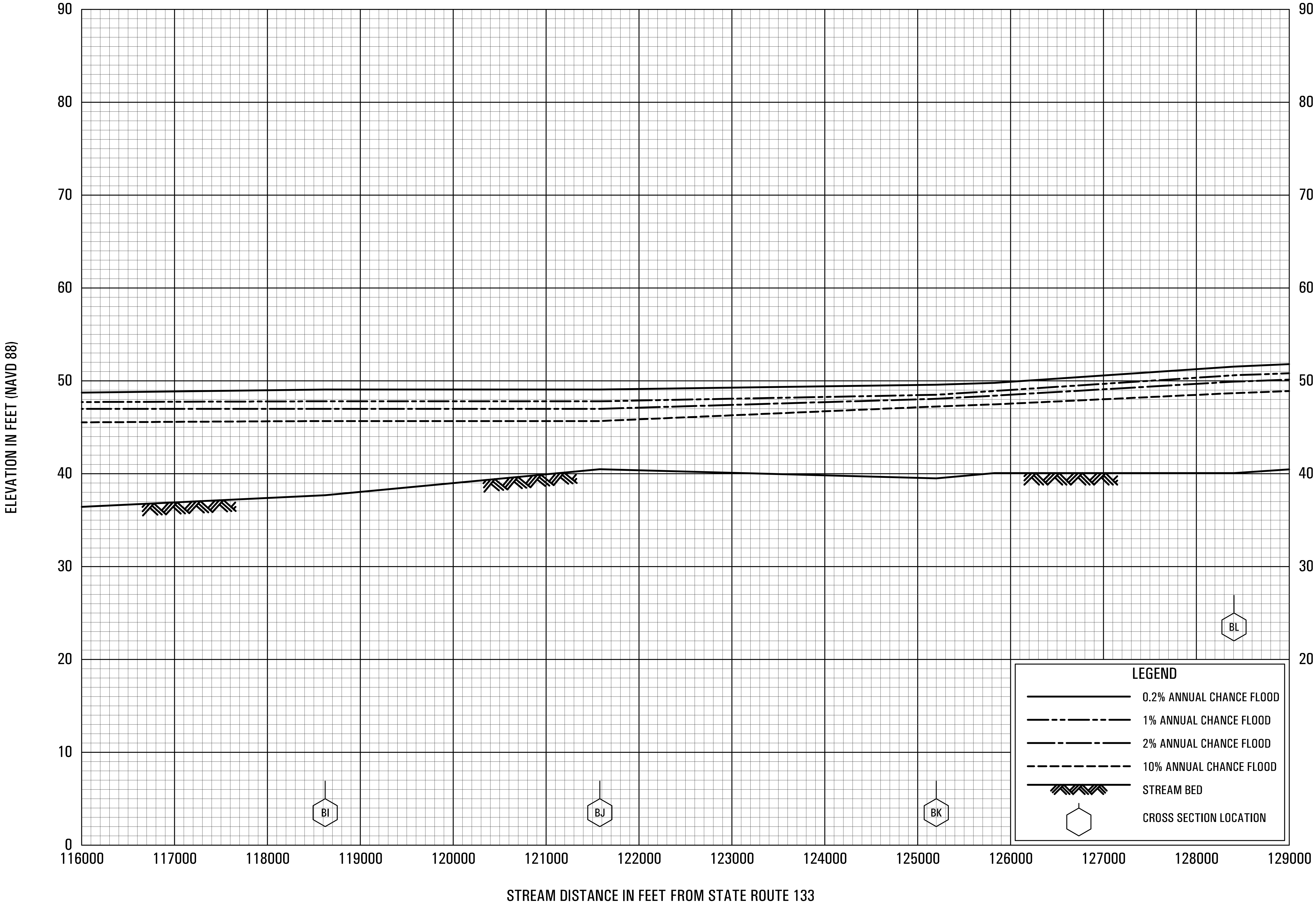
FLOOD PROFILES

IPSWICH RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



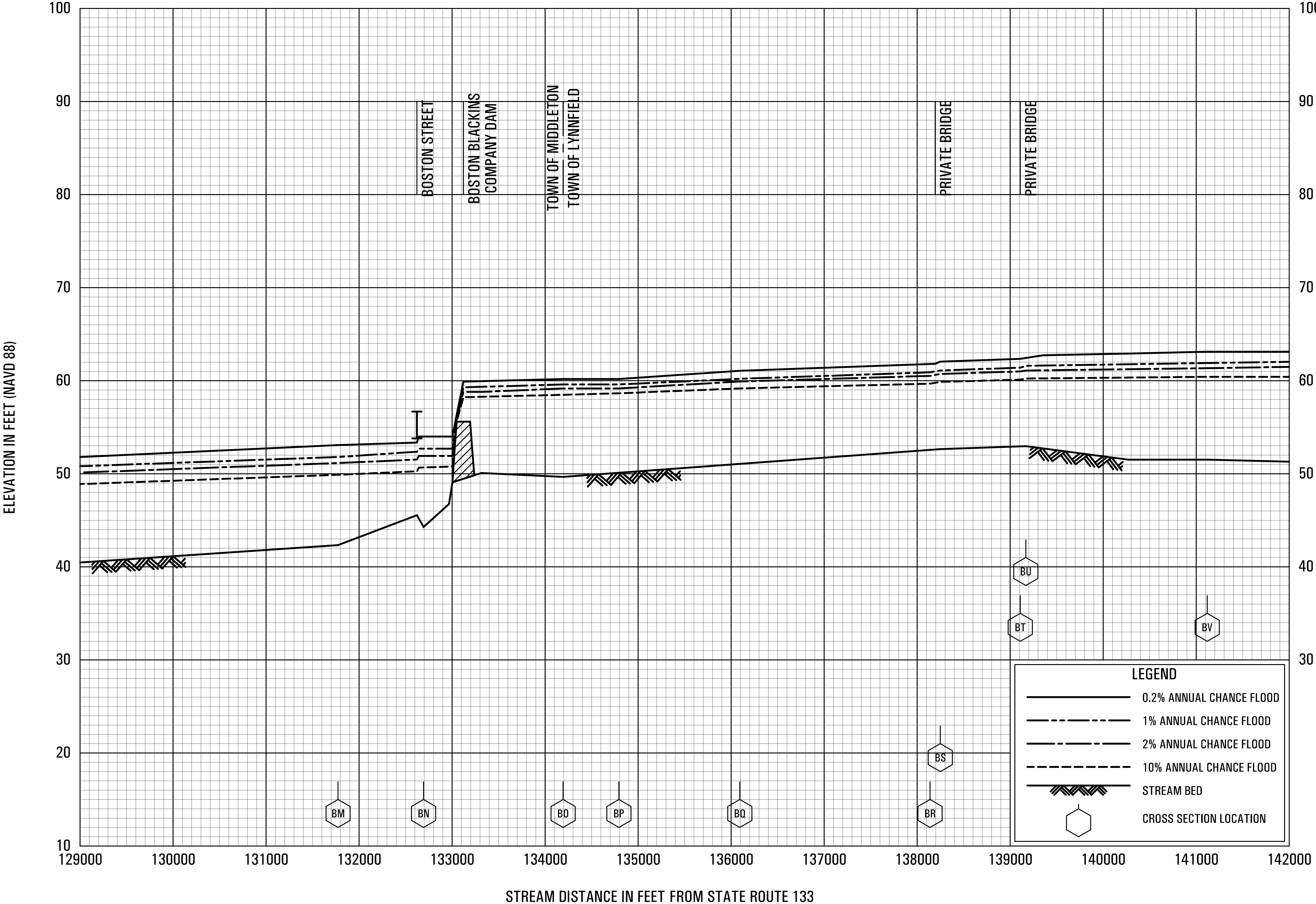
FLOOD PROFILES

IPSWICH RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

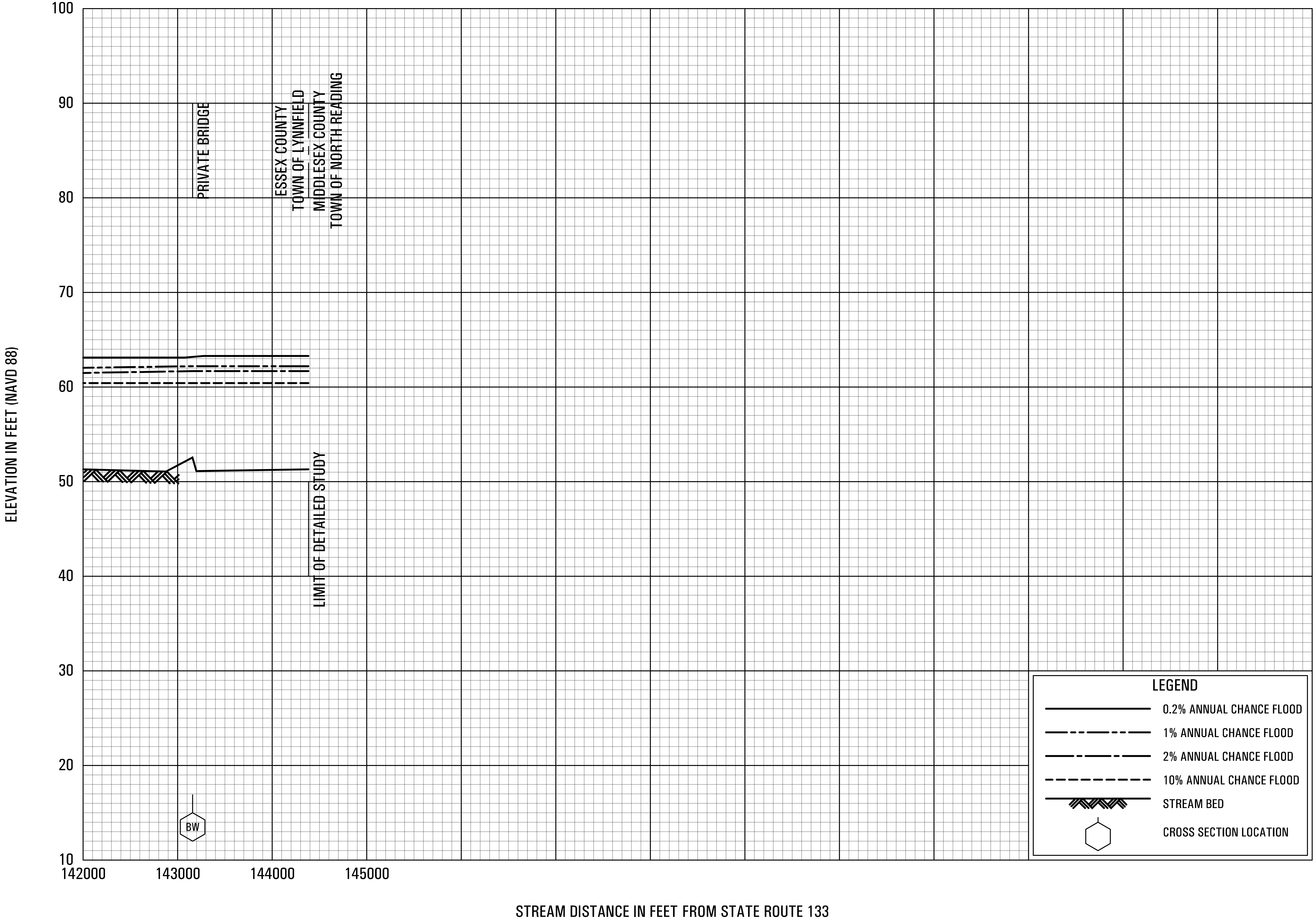


FLOOD PROFILES

IPSWICH RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA
(ALL JURISDICTIONS)



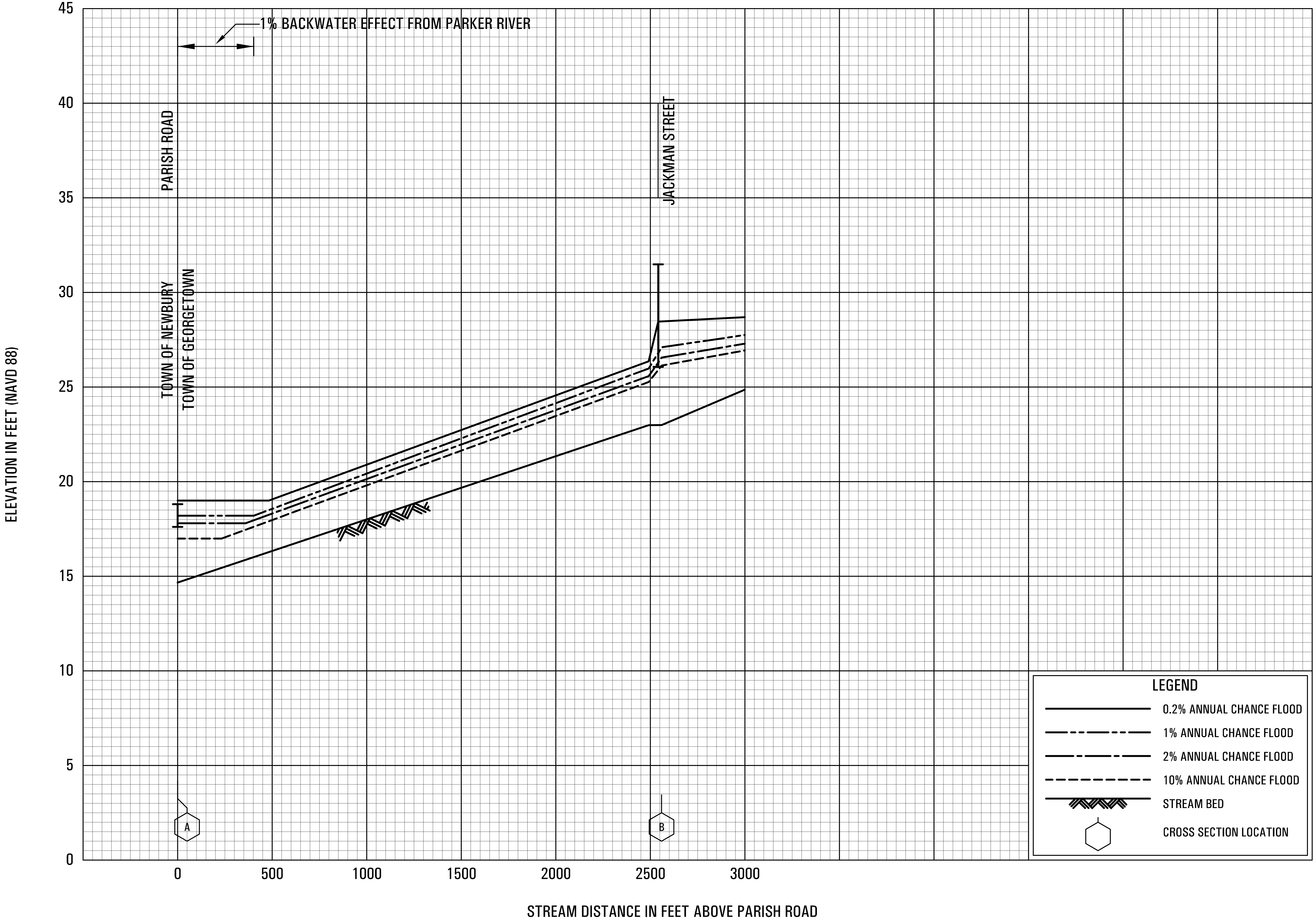
FLOOD PROFILES

IPSWICH RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



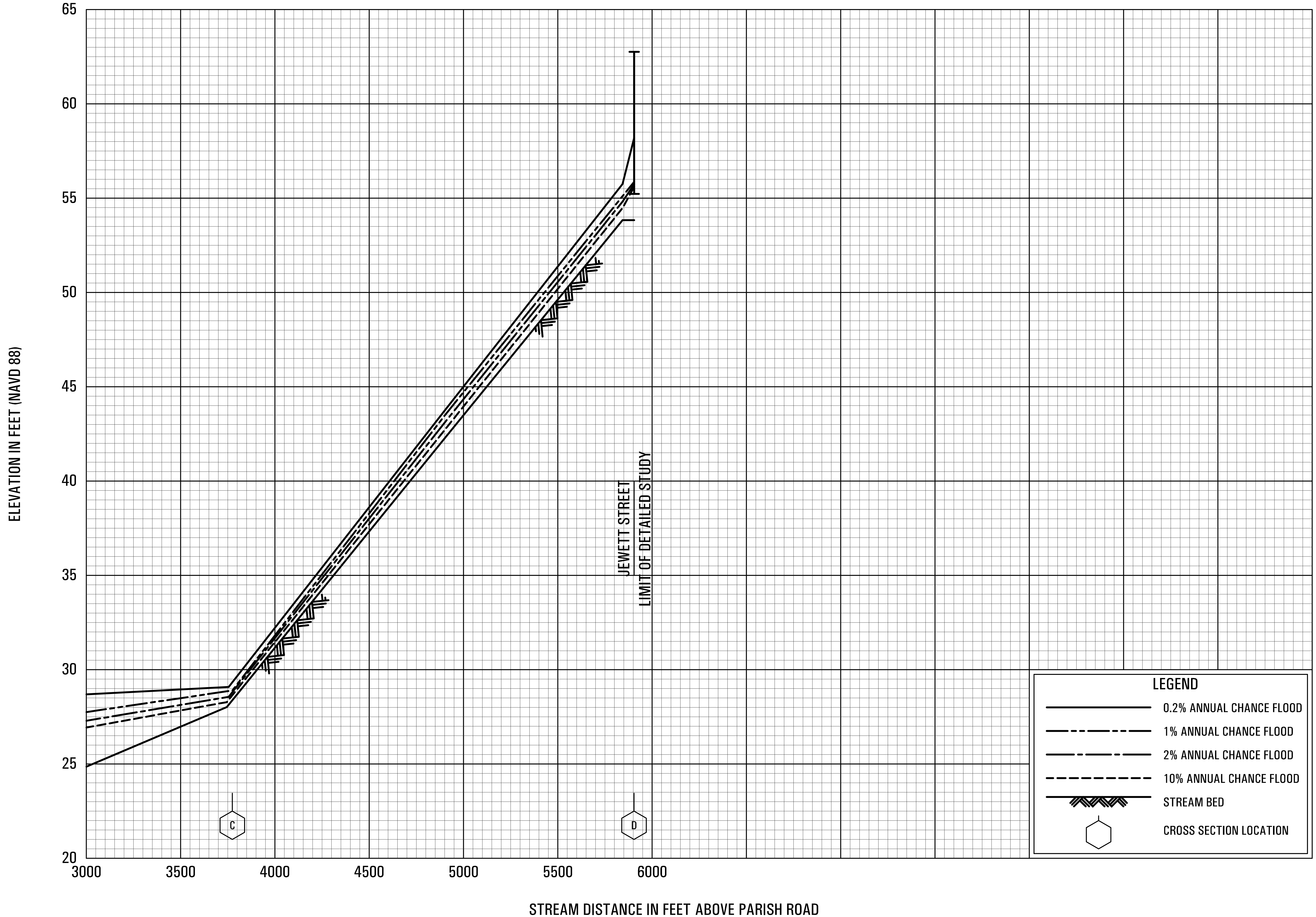
FLOOD PROFILES

JACKMAN BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



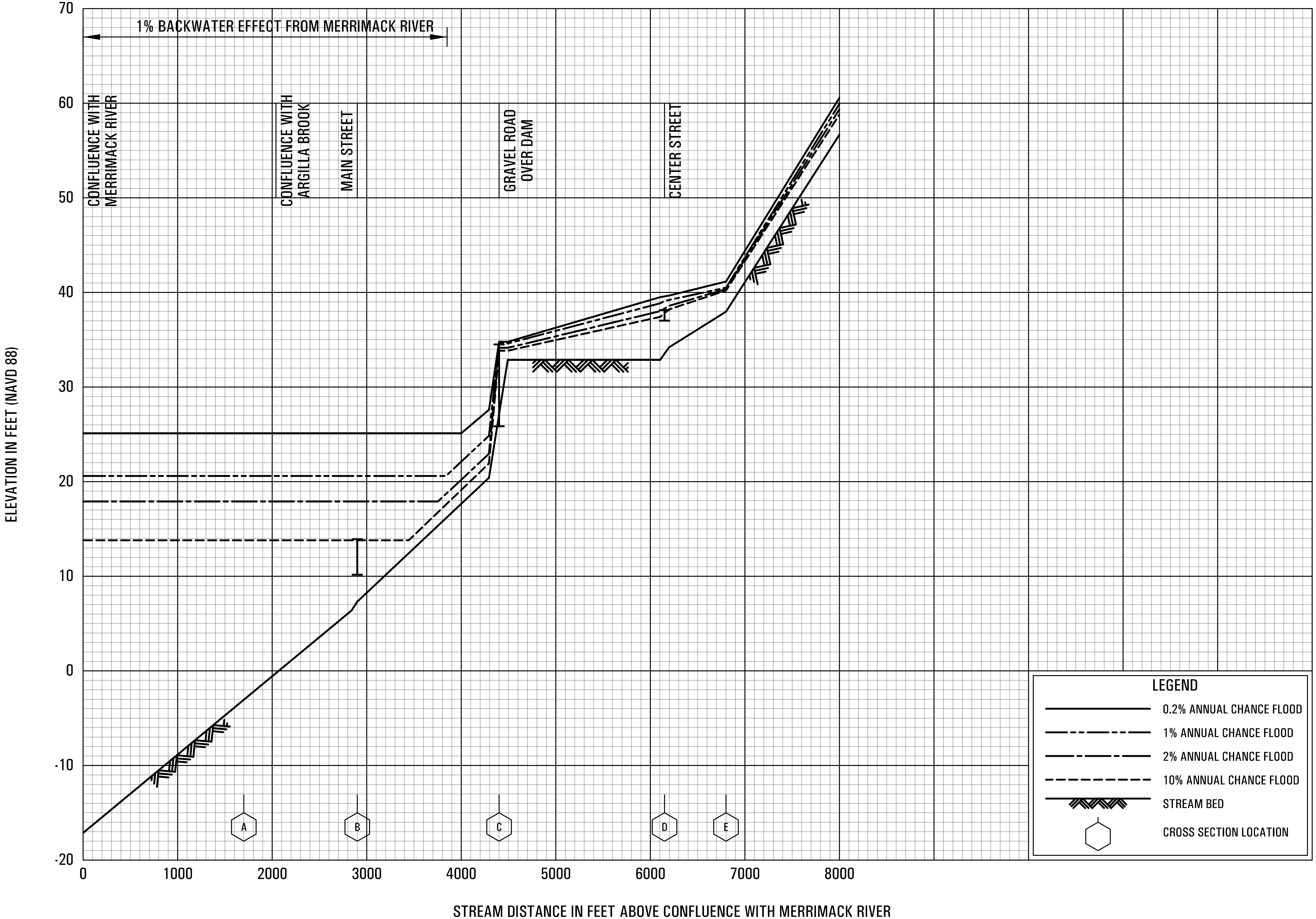
FLOOD PROFILES

JACKMAN BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



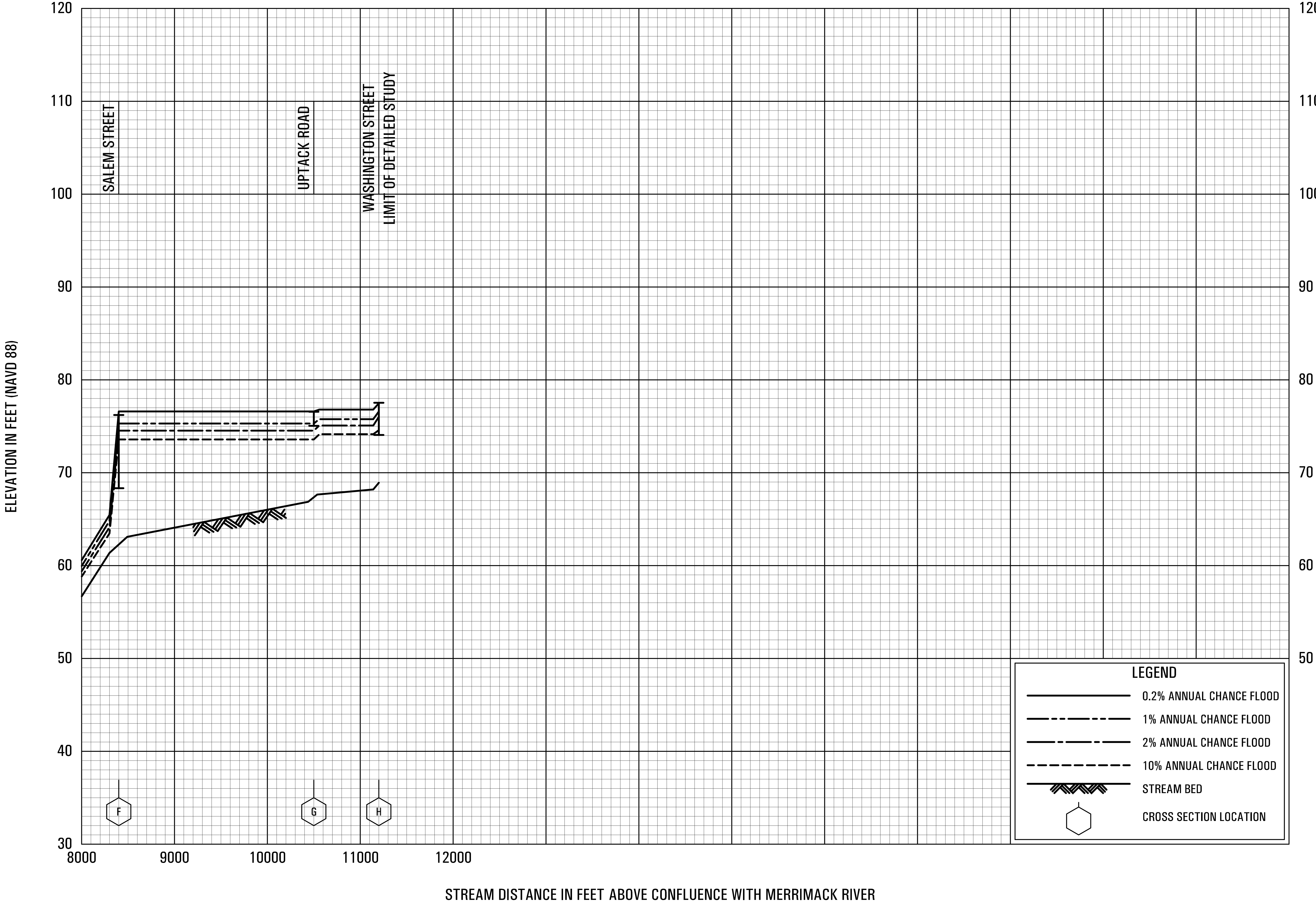
FLOOD PROFILES

JOHNSON CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



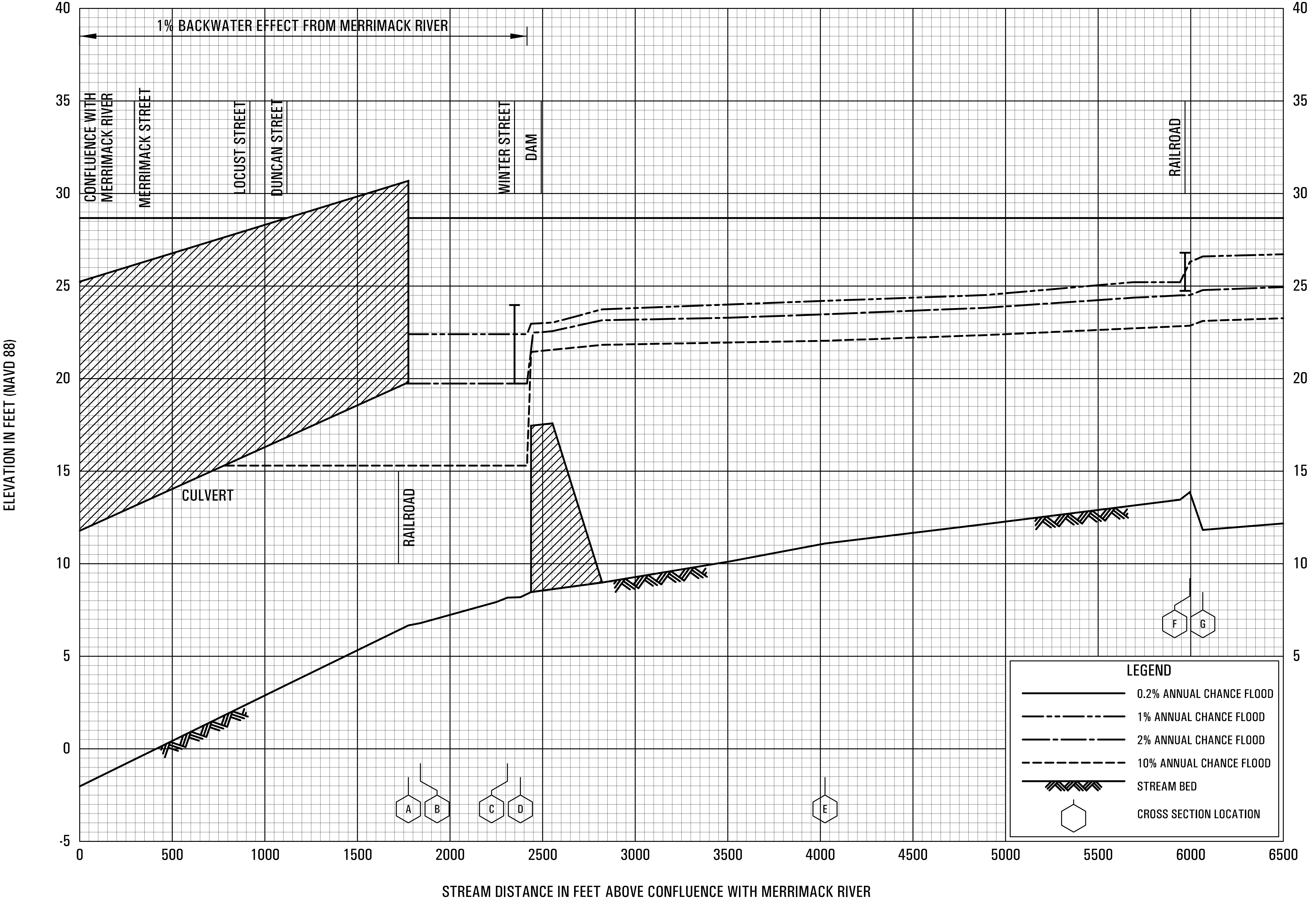
FLOOD PROFILES

JOHNSON CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



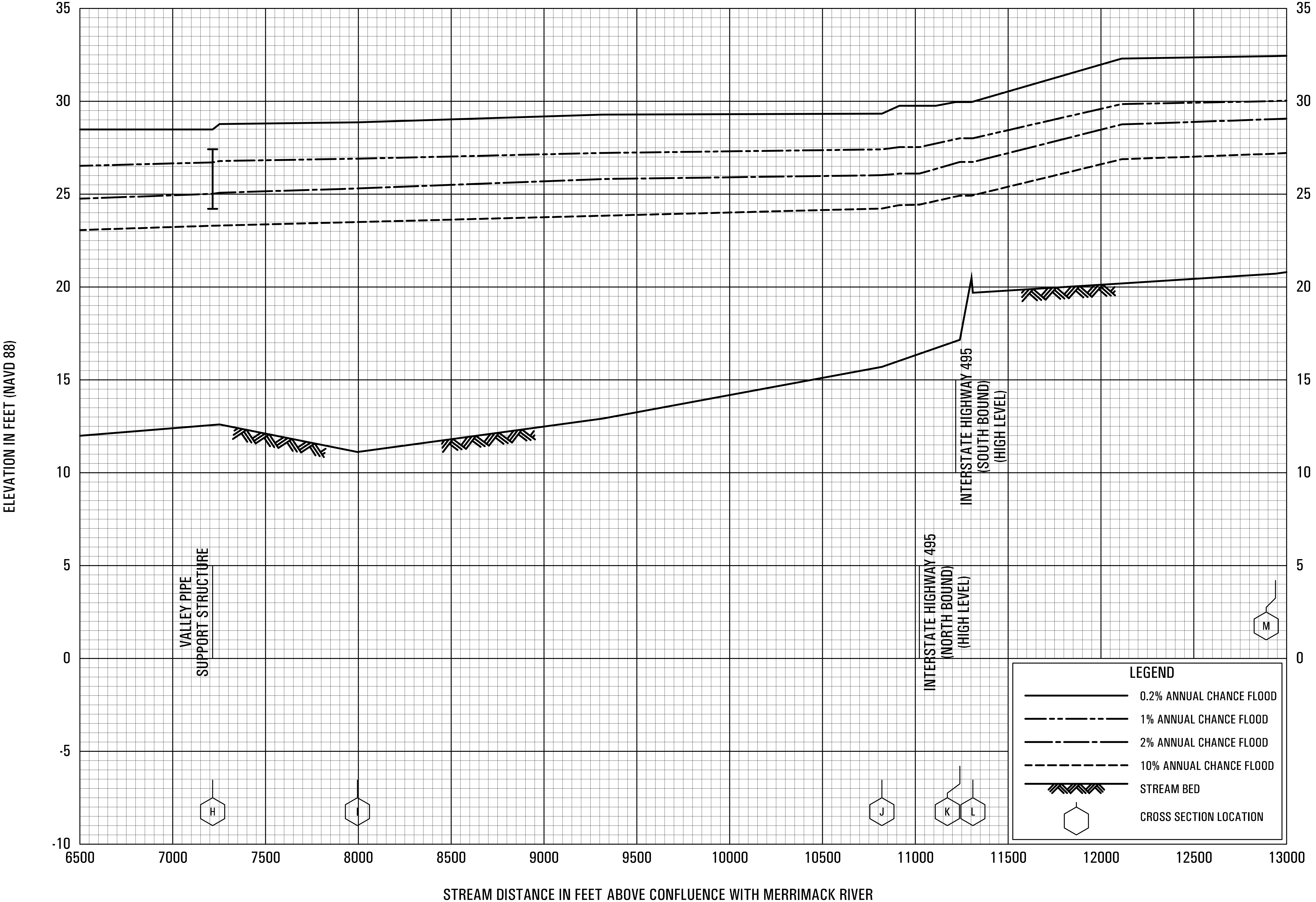
FLOOD PROFILES

LITTLE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



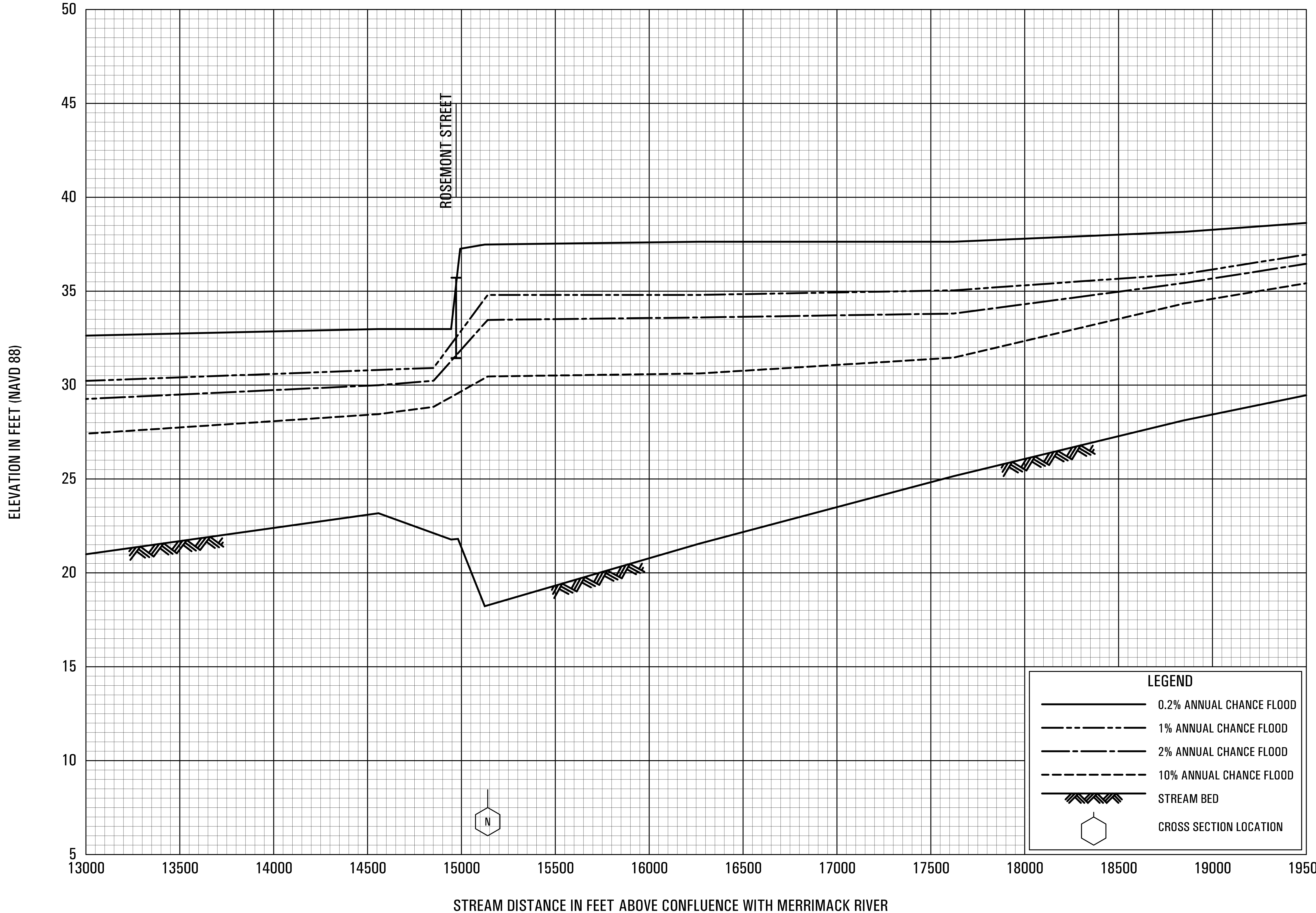
FLOOD PROFILES

LITTLE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



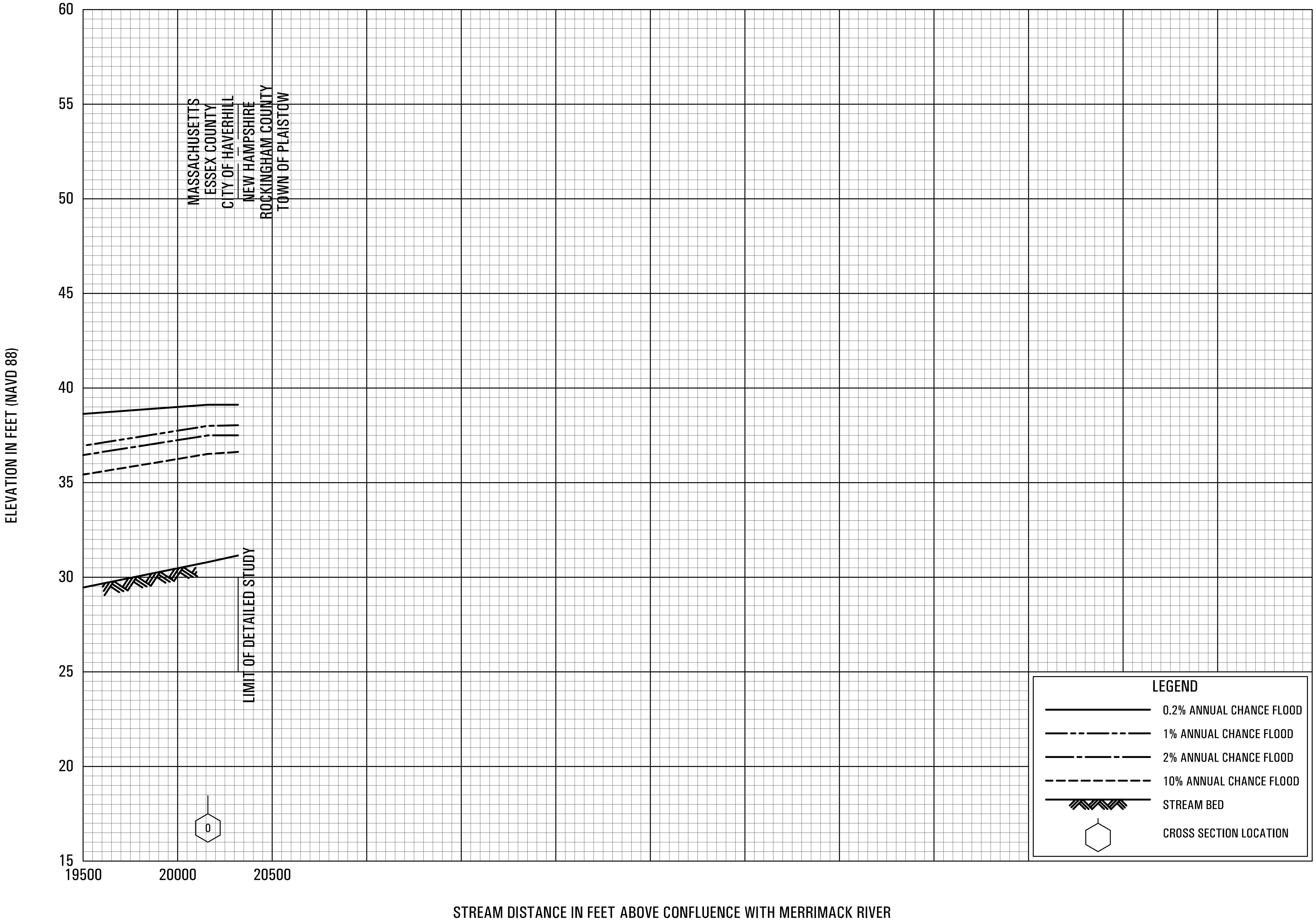
FLOOD PROFILES

LITTLE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



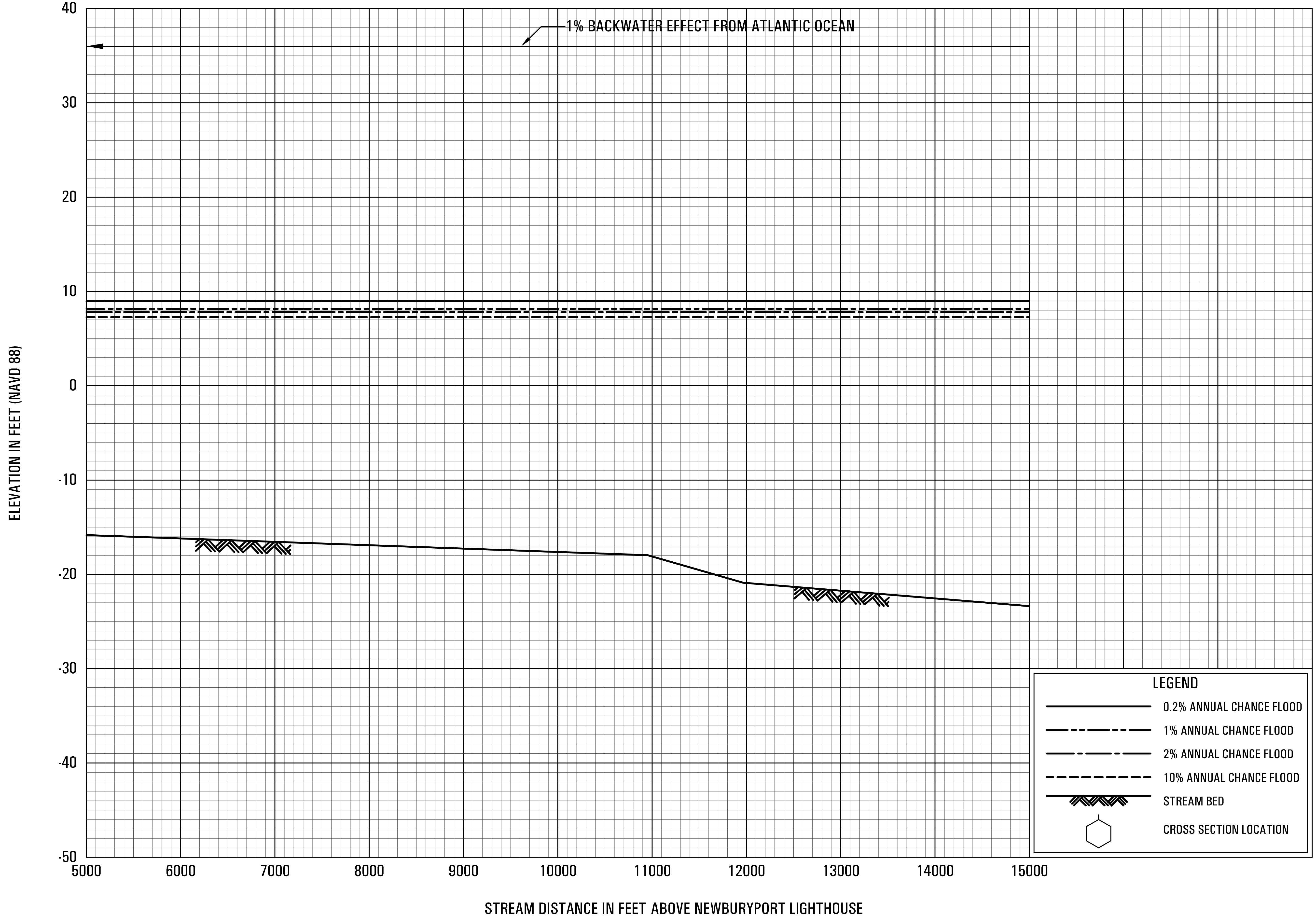
FLOOD PROFILES

LITTLE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



FLOOD PROFILES

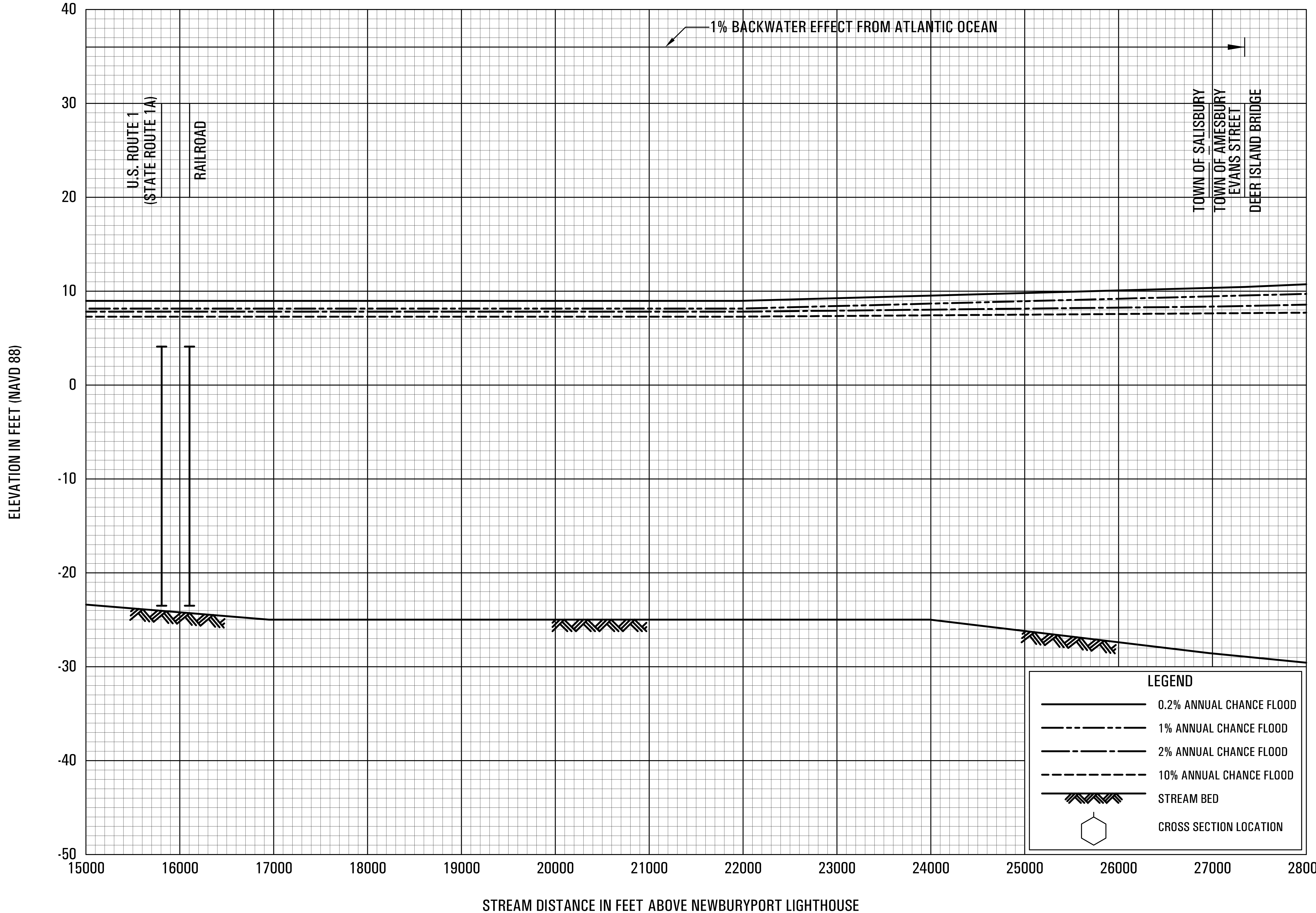
MERRIMACK RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

79P



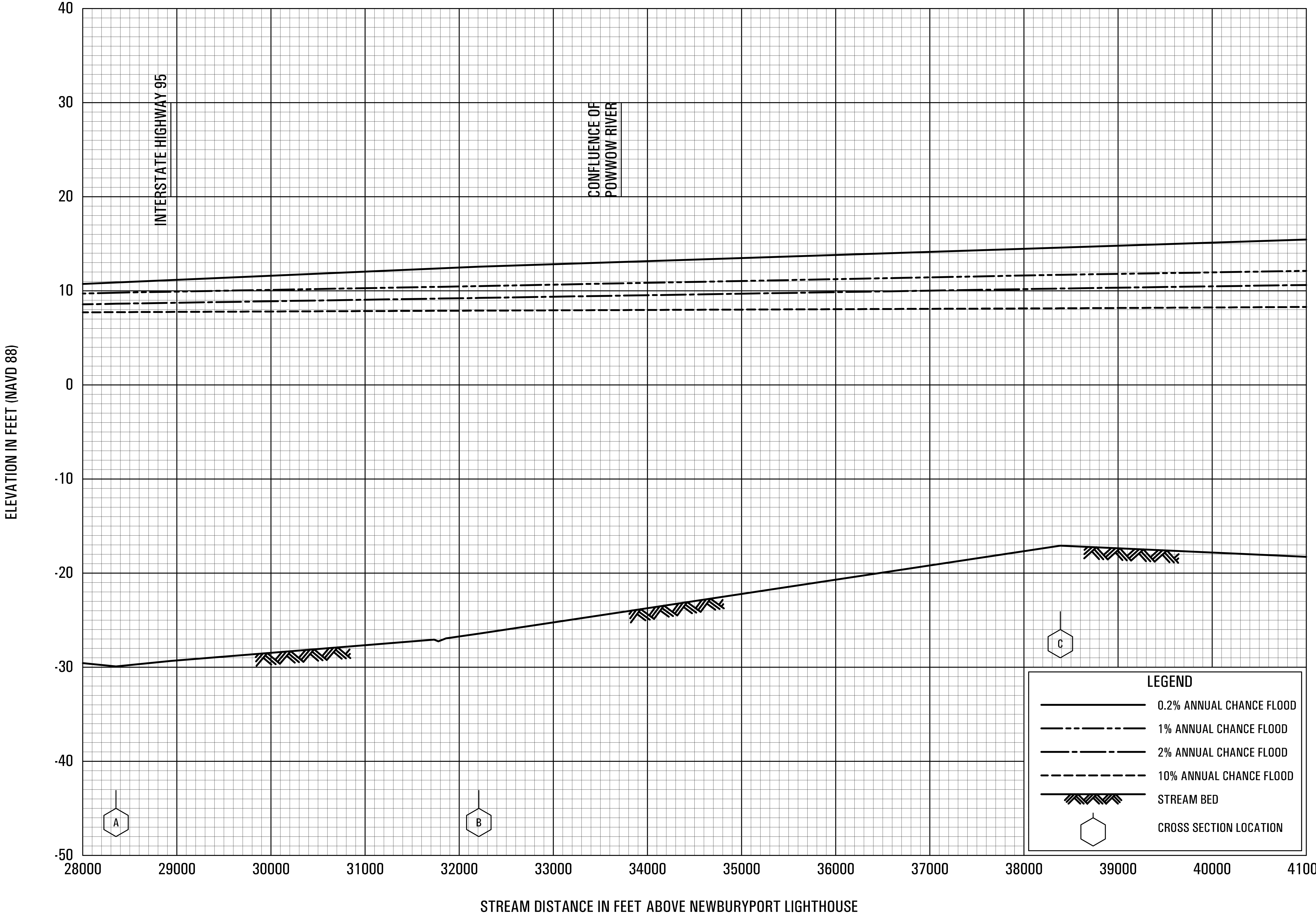
FLOOD PROFILES

MERRIMACK RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



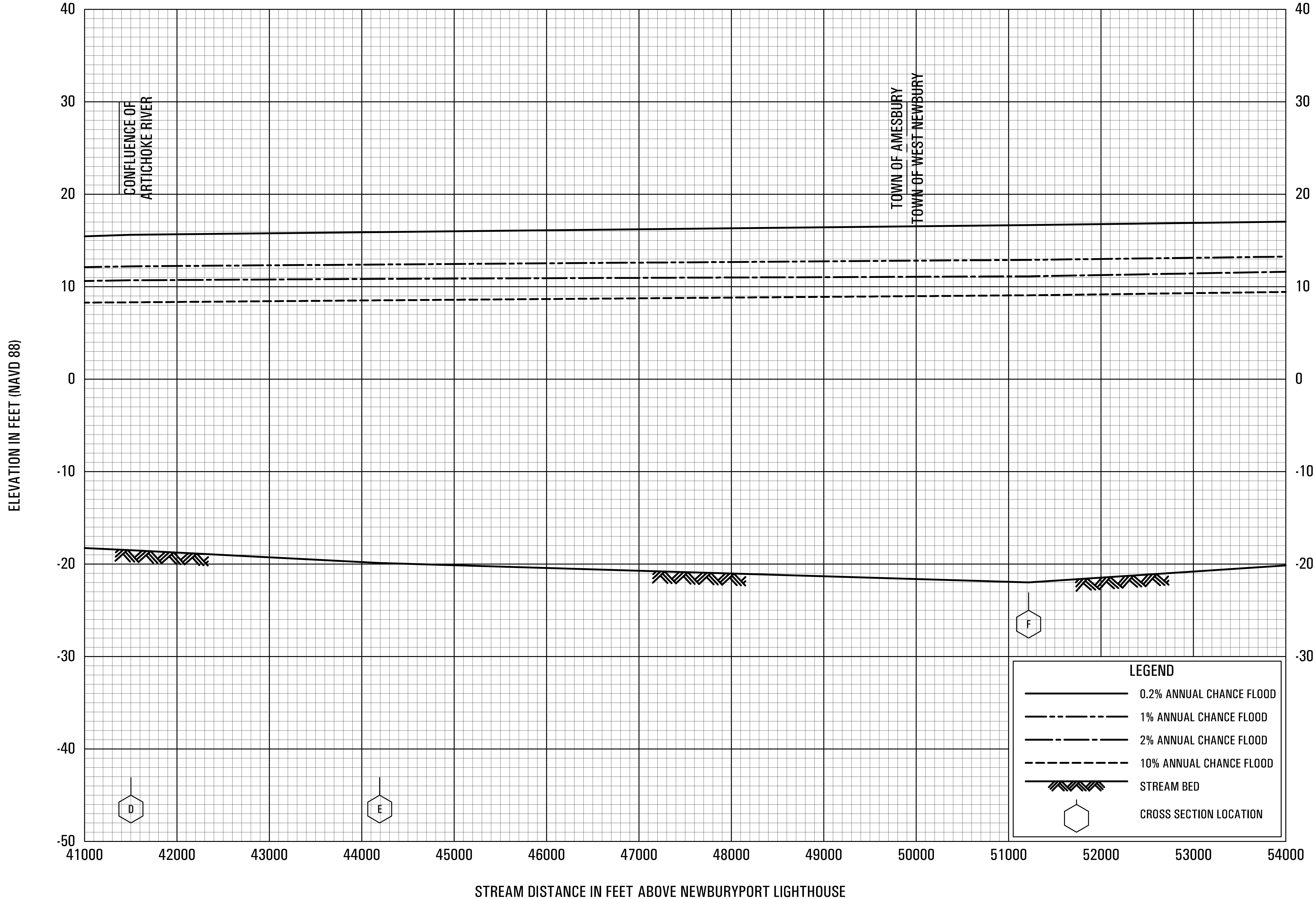
FLOOD PROFILES

MERRIMACK RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



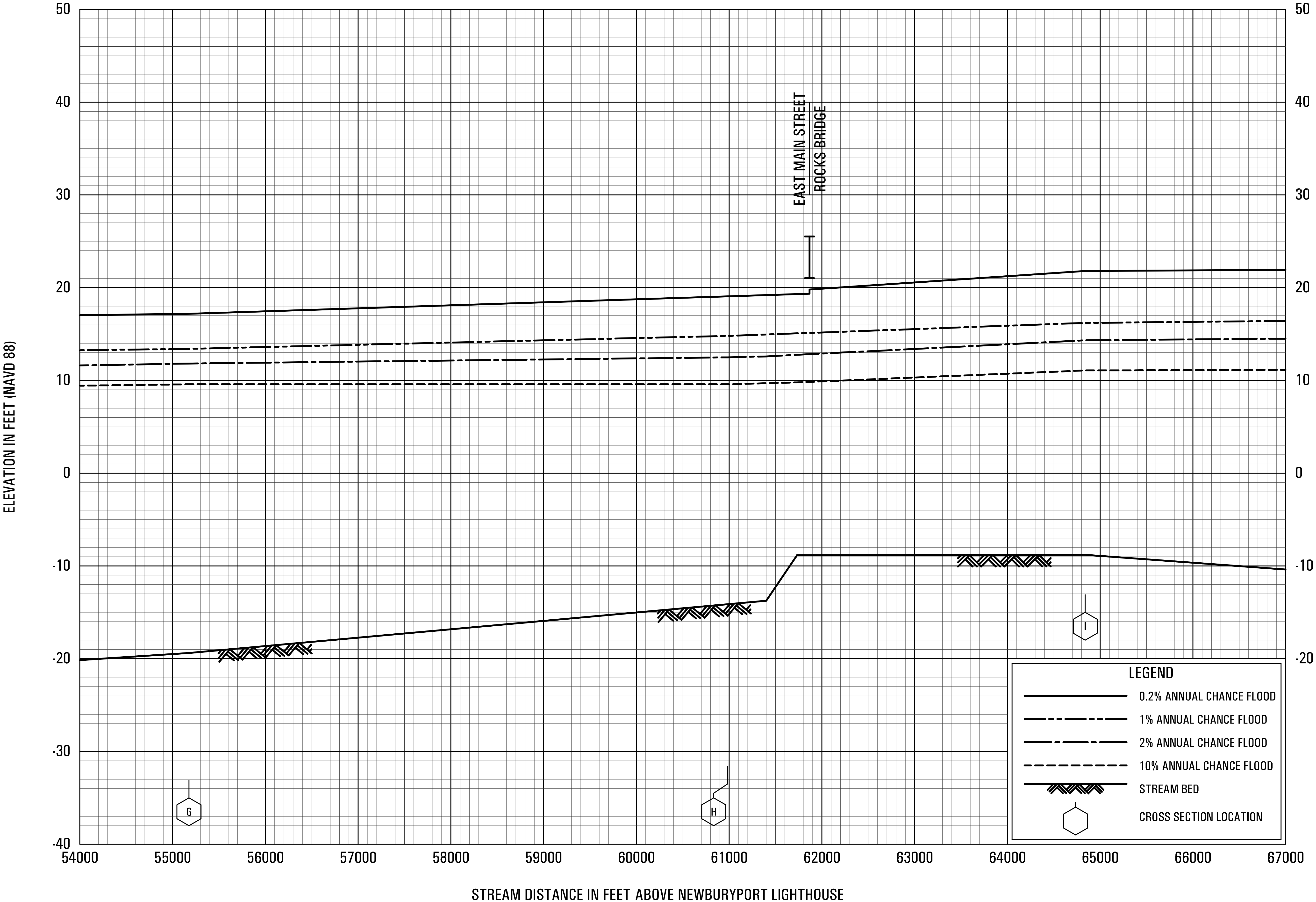
FLOOD PROFILES

MERRIMACK RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



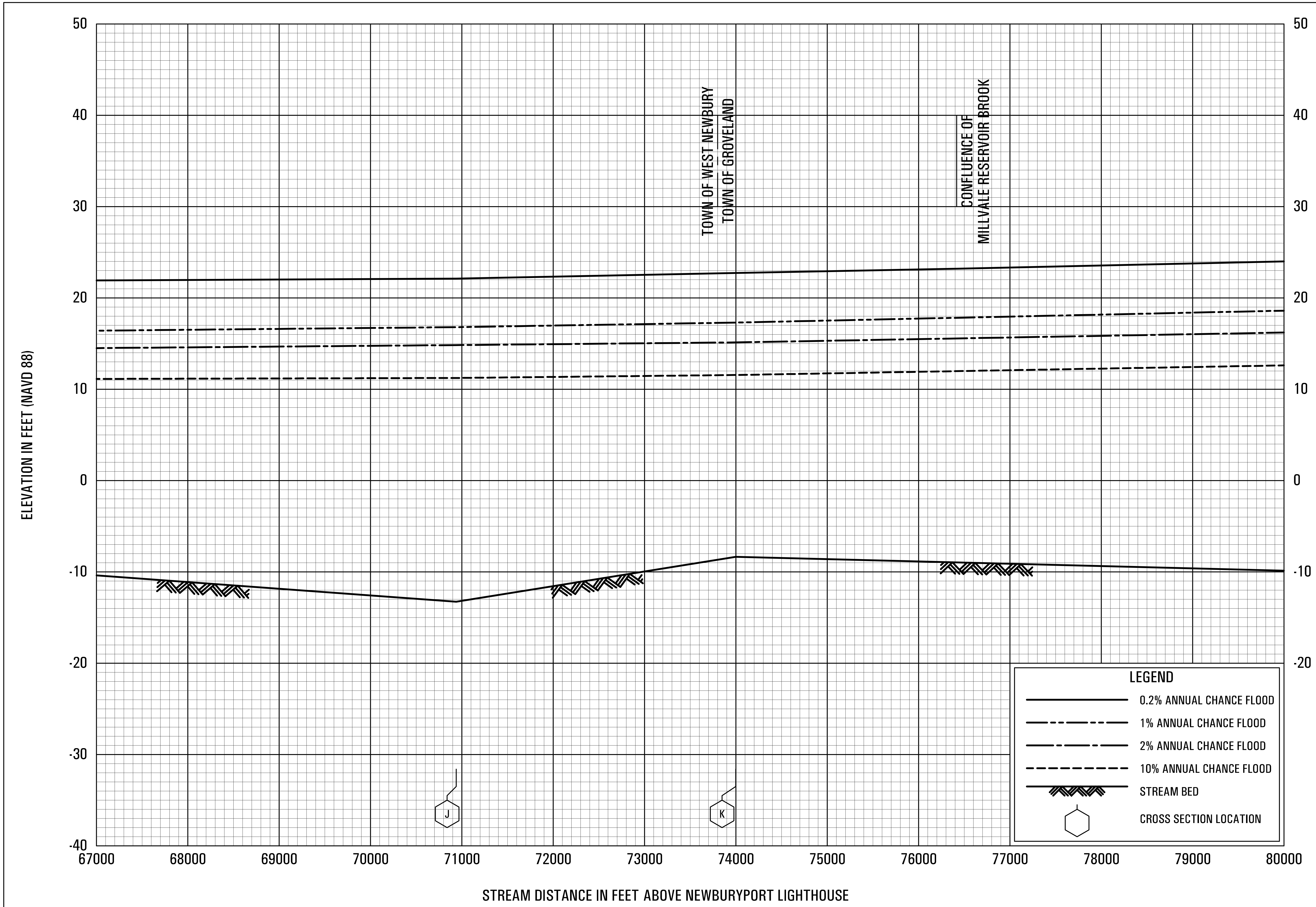
FLOOD PROFILES

MERRIMACK RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



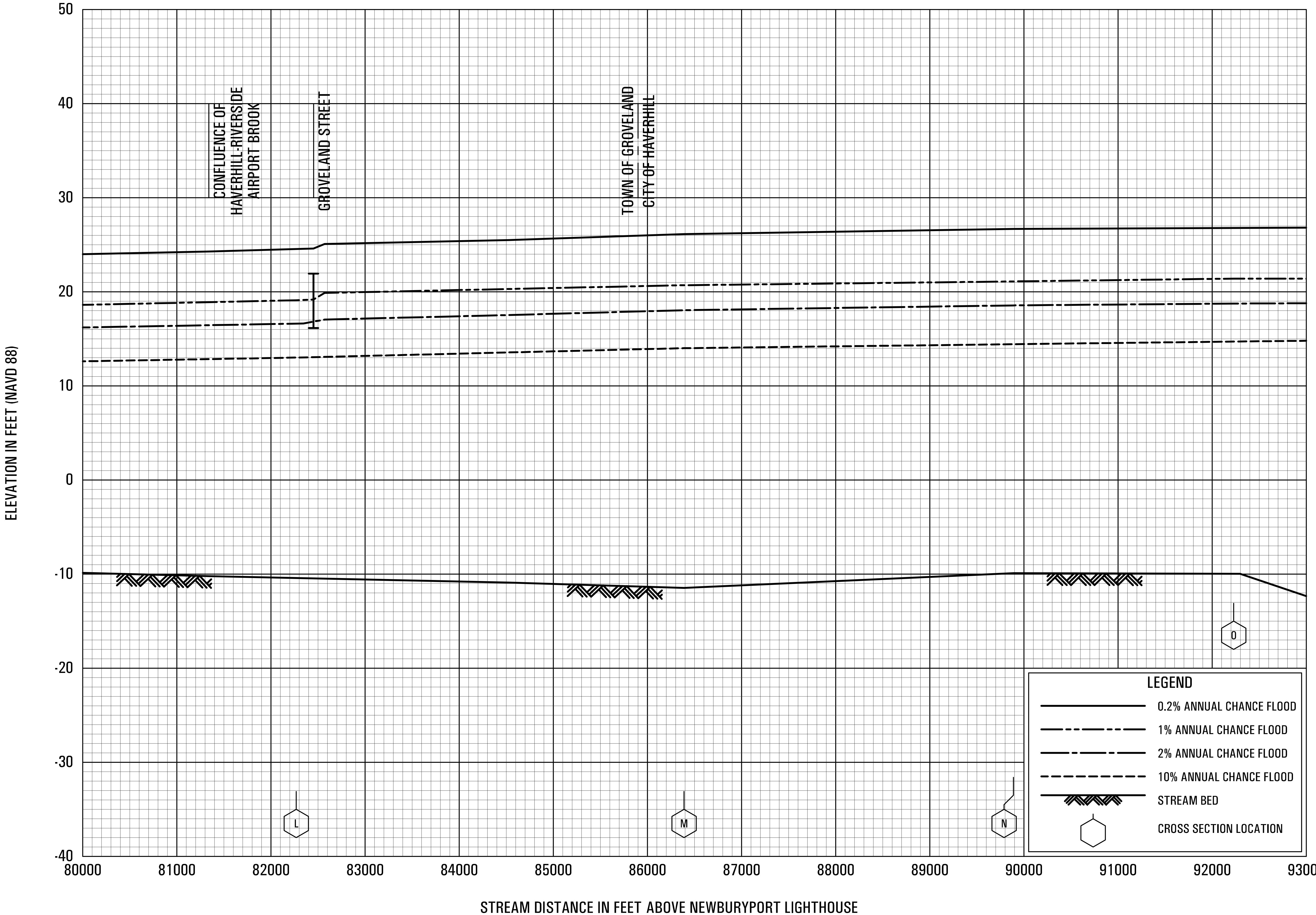
FLOOD PROFILES

MERRIMACK RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

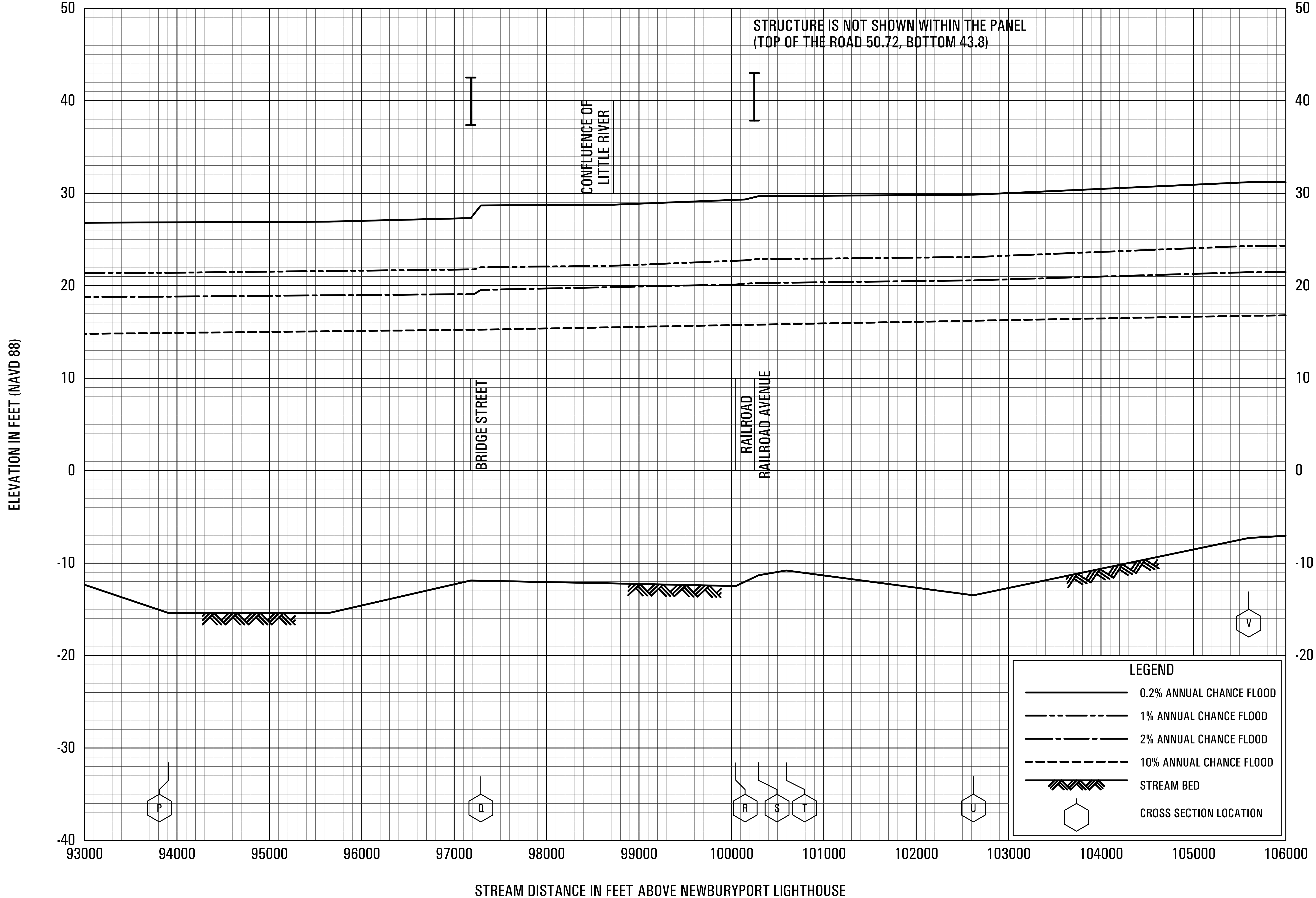


FLOOD PROFILES

MERRIMACK RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA
(ALL JURISDICTIONS)



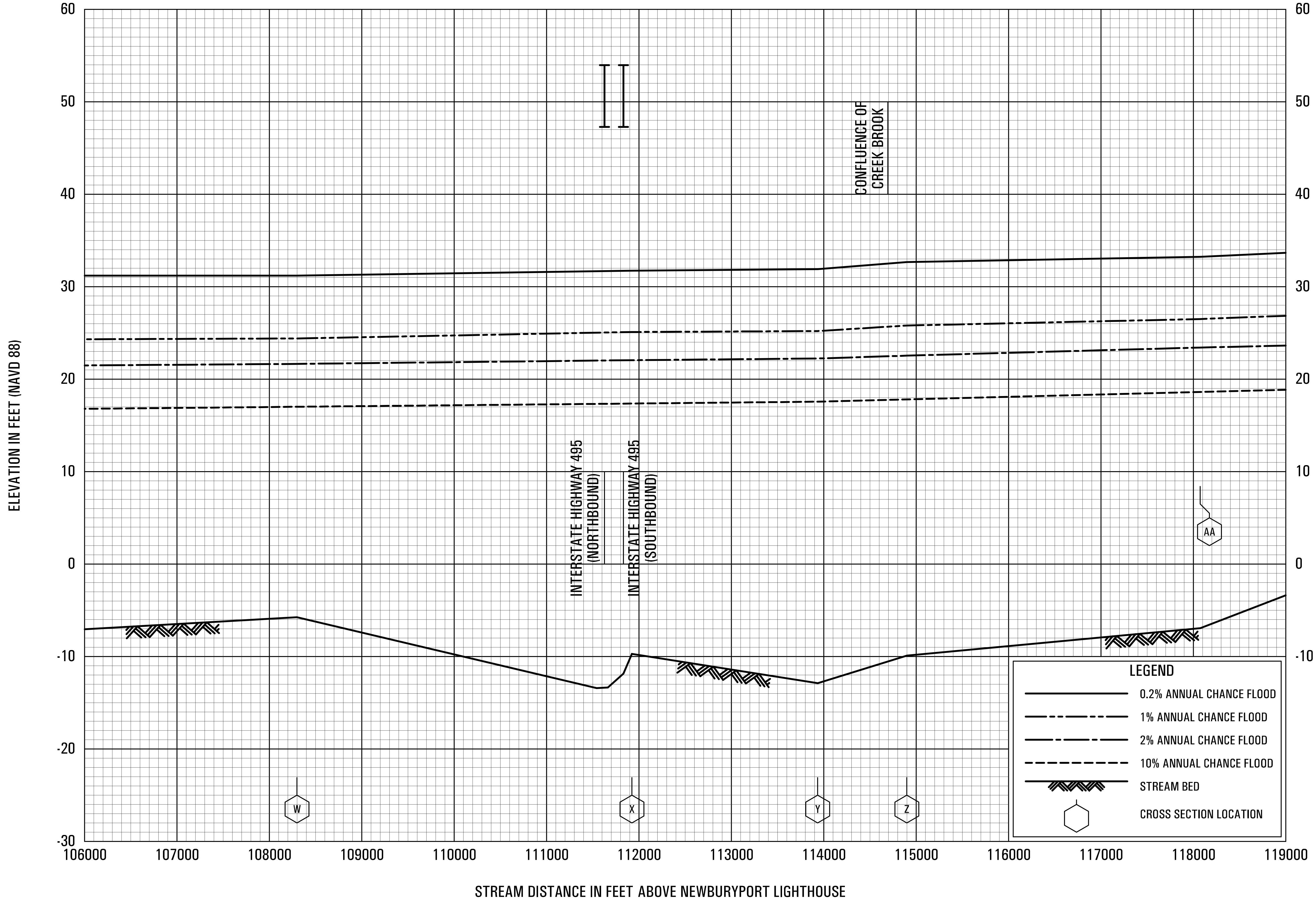
FLOOD PROFILES

MERRIMACK RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



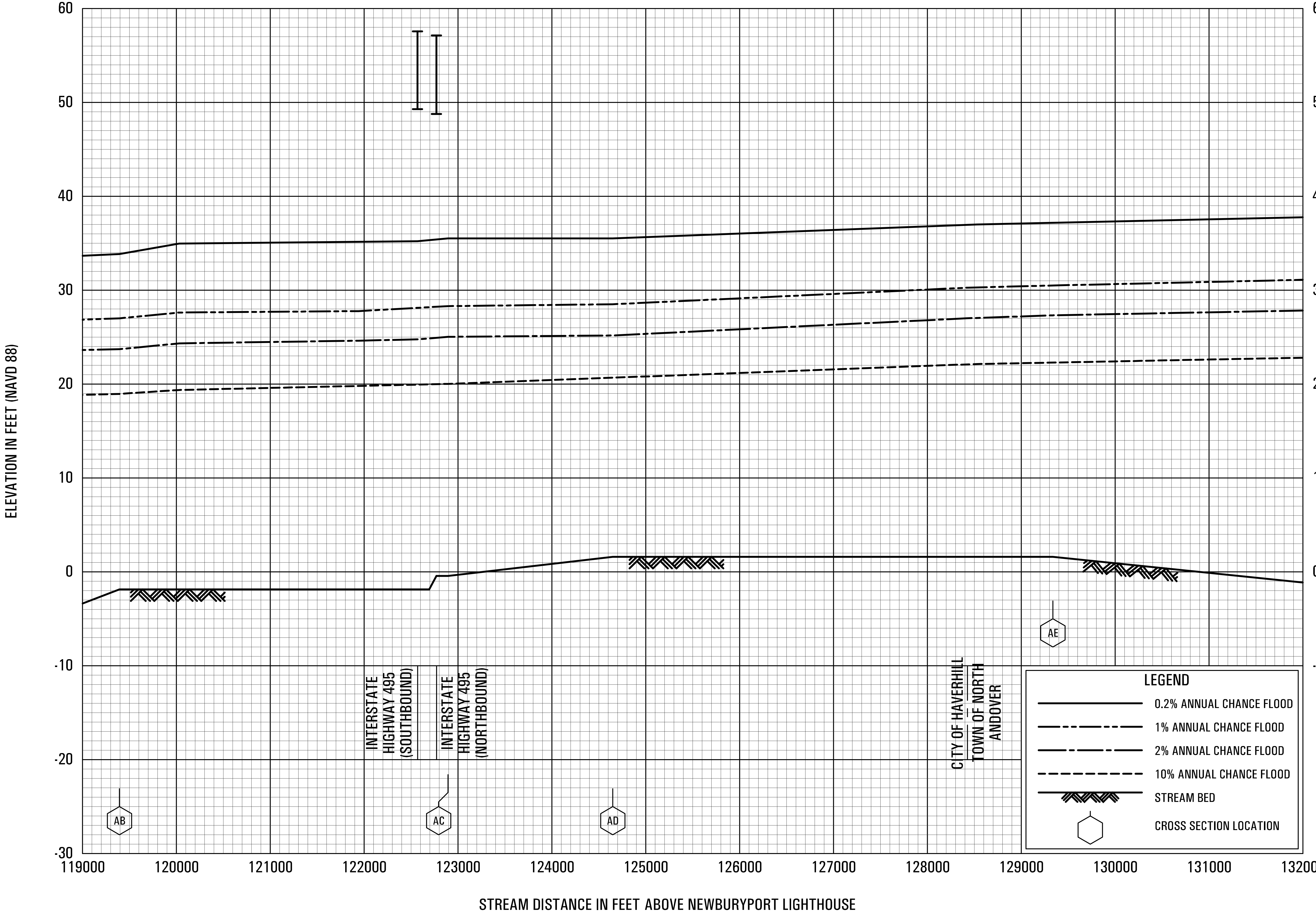
FLOOD PROFILES

MERRIMACK RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



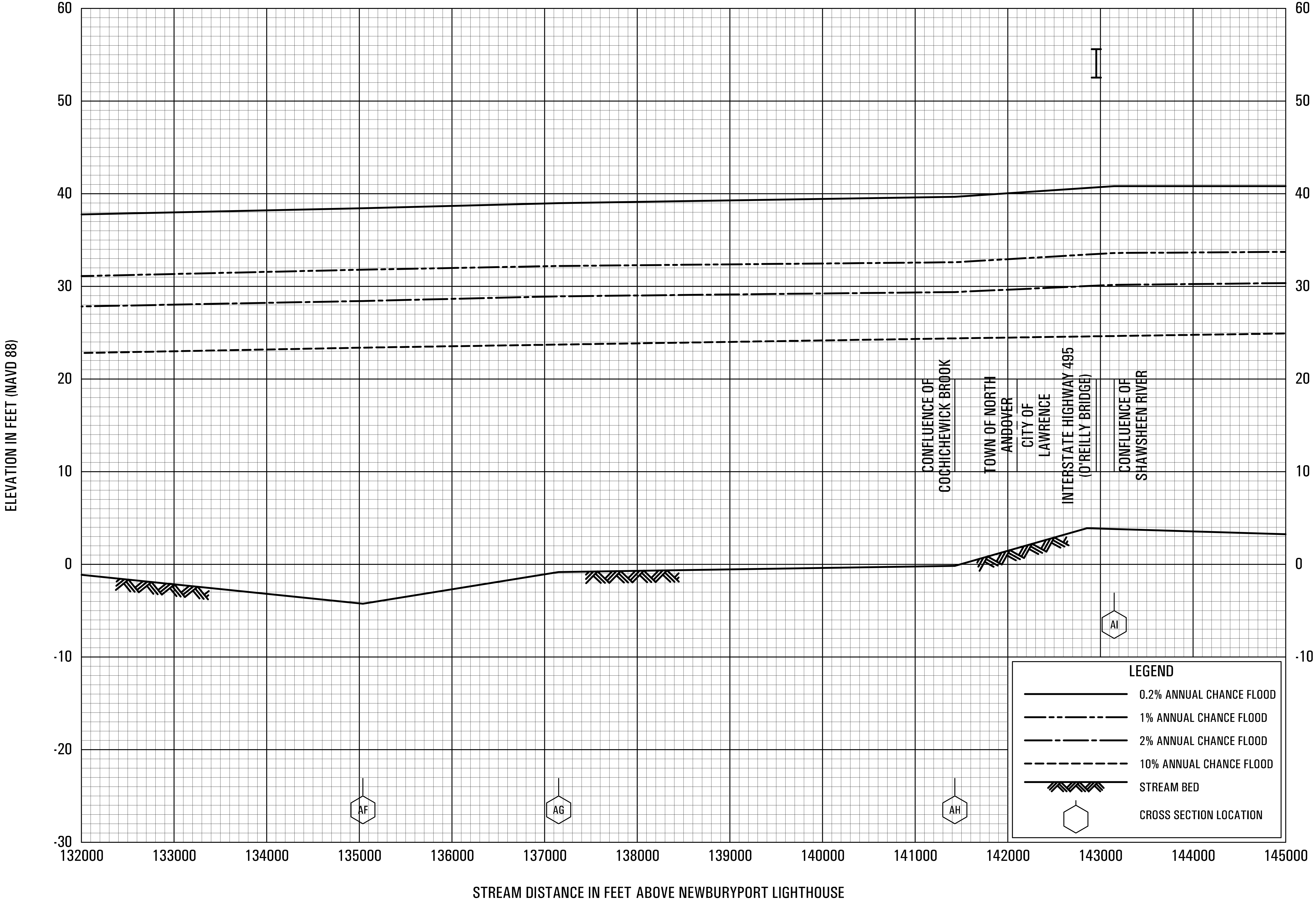
FLOOD PROFILES

MERRIMACK RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



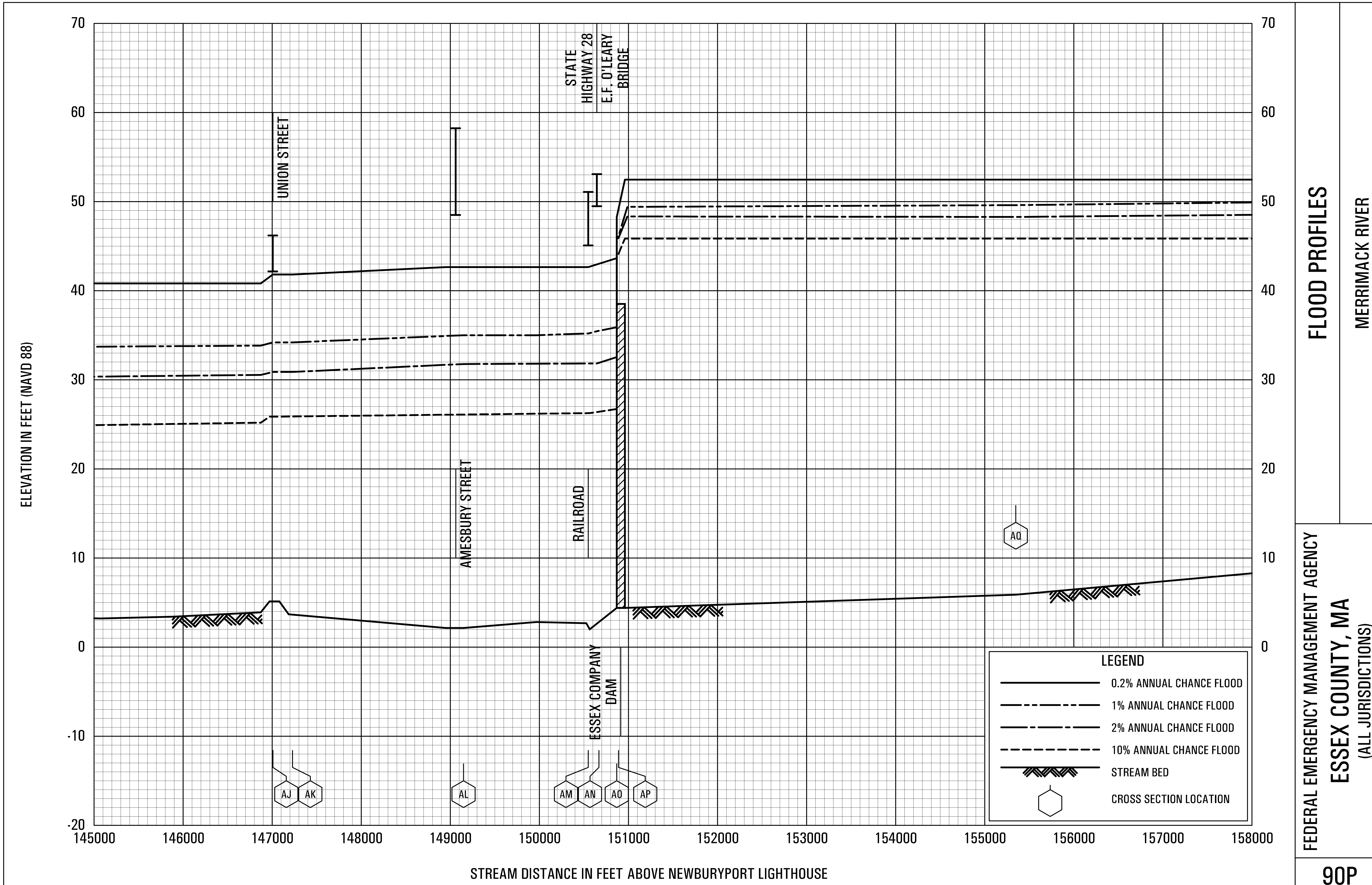
FLOOD PROFILES

MERRIMACK RIVER

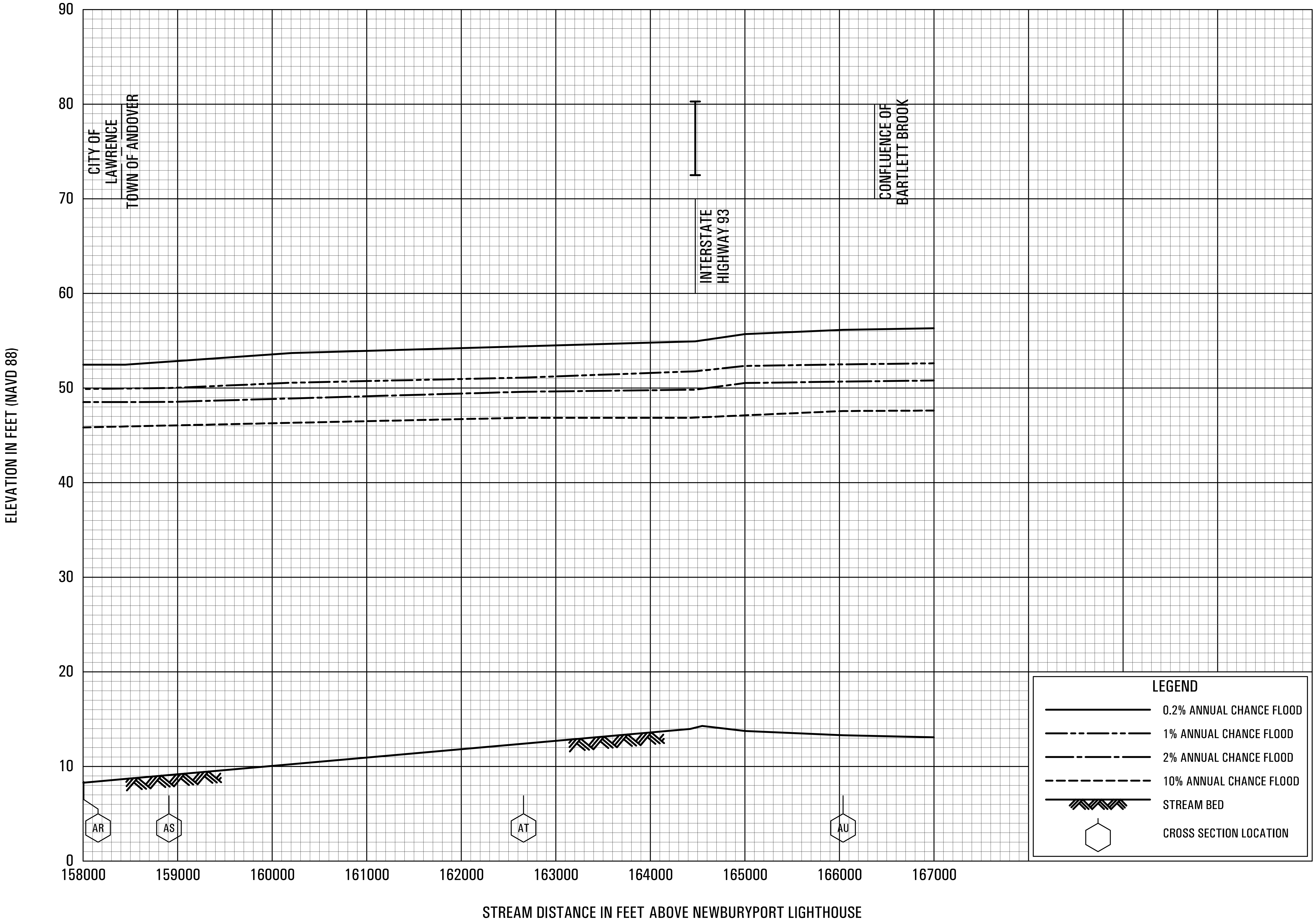
FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



FLOOD PROFILES
MERRIMACK RIVER
FEDERAL EMERGENCY MANAGEMENT AGENCY
ESSEX COUNTY, MA
(ALL JURISDICTIONS)
90P
ELEVATION IN FEET (NAVD 88)
STREAM DISTANCE IN FEET ABOVE NEWBURYPORT LIGHTHOUSE
UNION STREET
AMESBURY STREET
RAILROAD
STATE HIGHWAY 28 E.F. O'LEARY BRIDGE
ESSEX COMPANY DAM
AJ
AK
AL
AM
AN
AO
AP
AQ
LEGEND
0.2% ANNUAL CHANCE FLOOD
1% ANNUAL CHANCE FLOOD
2% ANNUAL CHANCE FLOOD
10% ANNUAL CHANCE FLOOD
STREAM BED
CROSS SECTION LOCATION

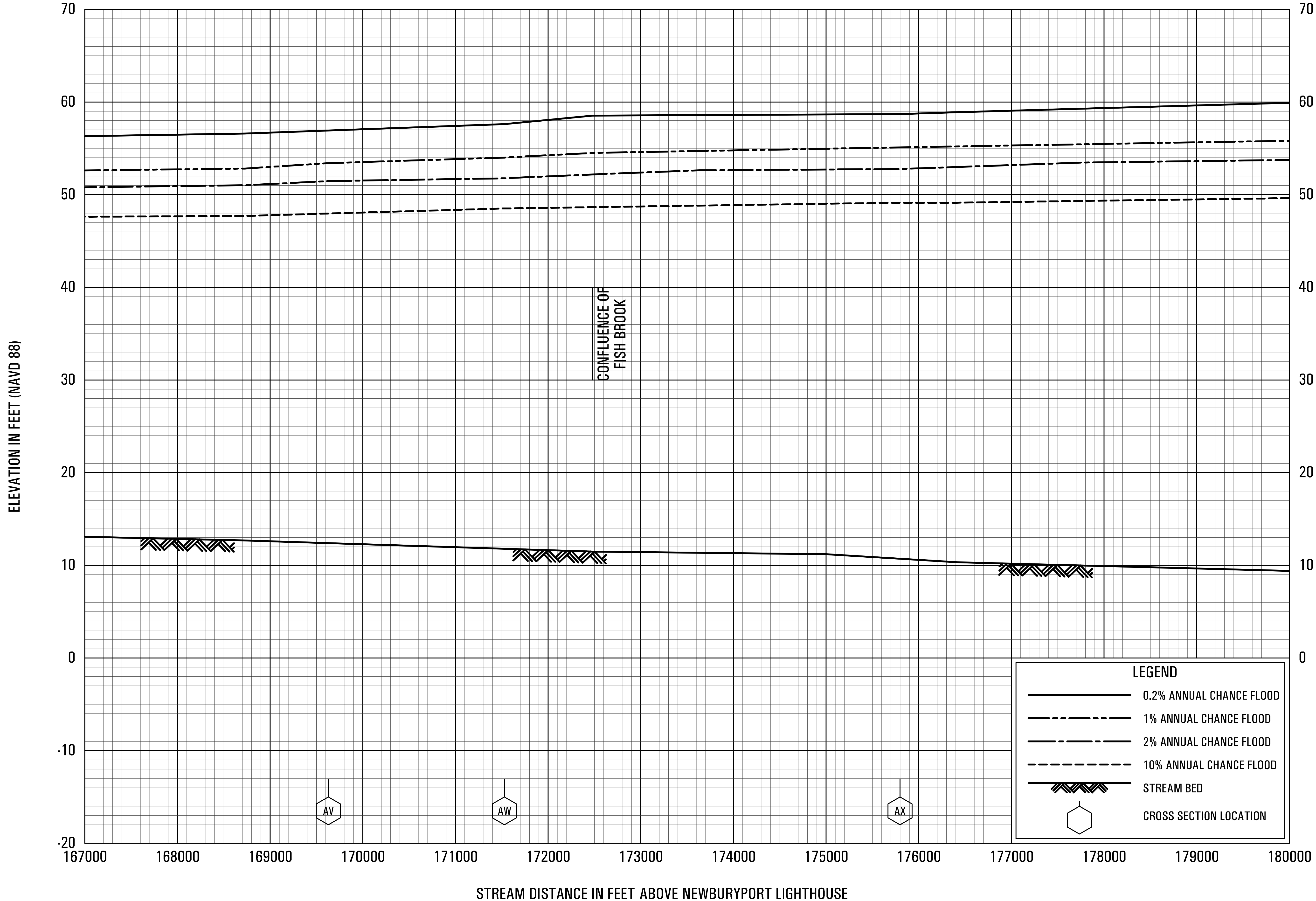


FLOOD PROFILES

MERRIMACK RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA
(ALL JURISDICTIONS)



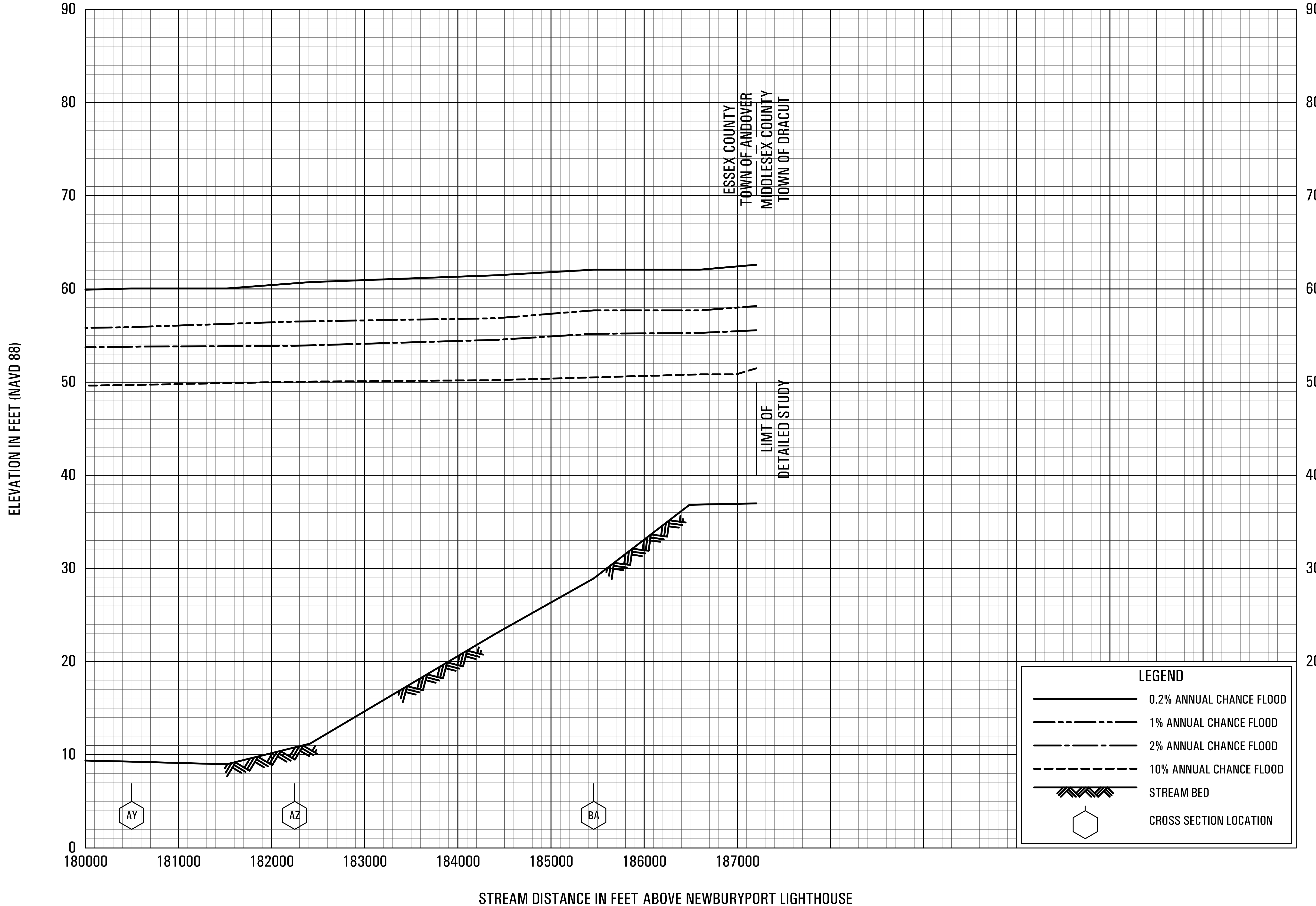
FLOOD PROFILES

MERRIMACK RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



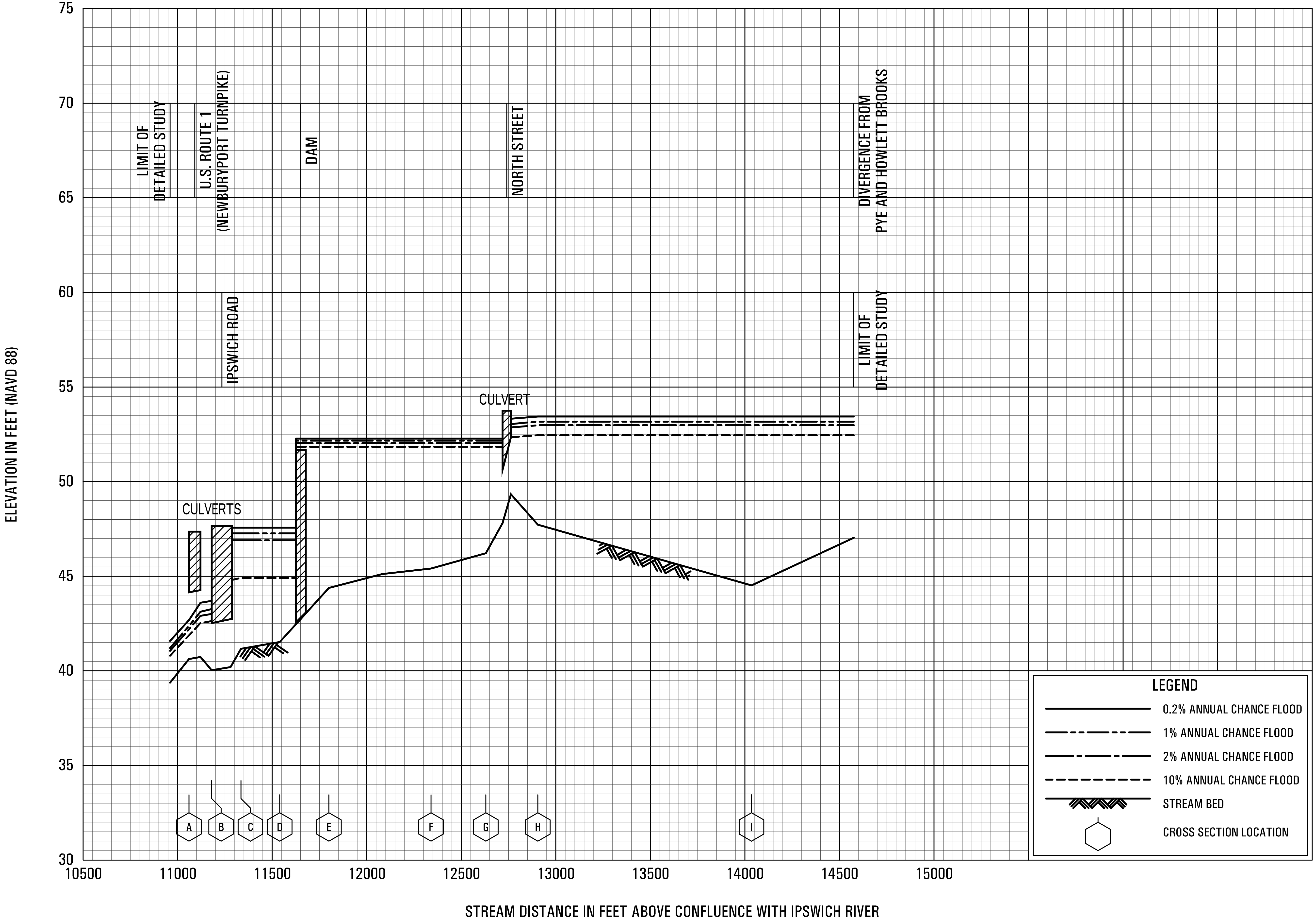
FLOOD PROFILES

MERRIMACK RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



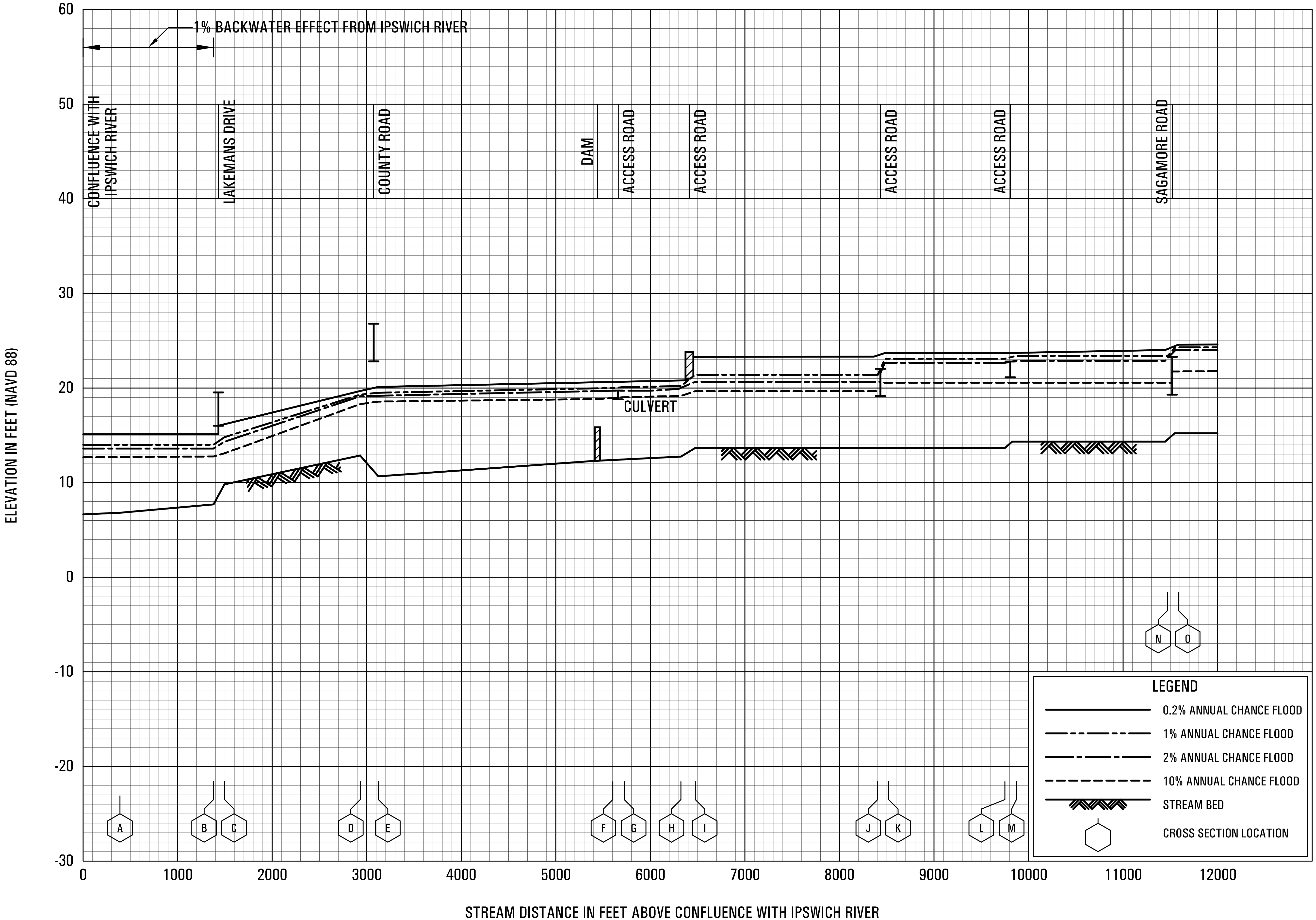
FLOOD PROFILES

MILE BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

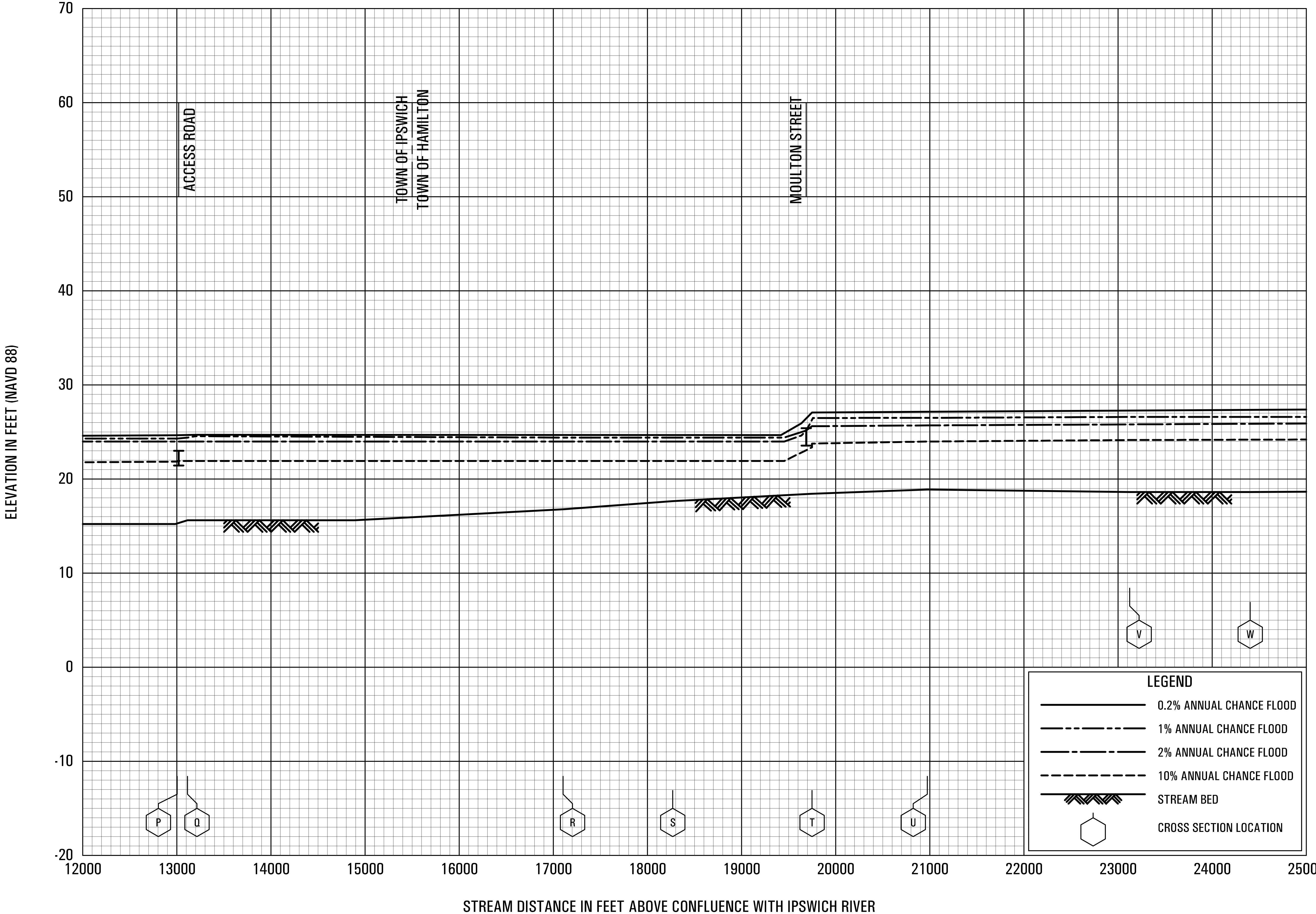


FLOOD PROFILES

MILES RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA
(ALL JURISDICTIONS)



FLOOD PROFILES

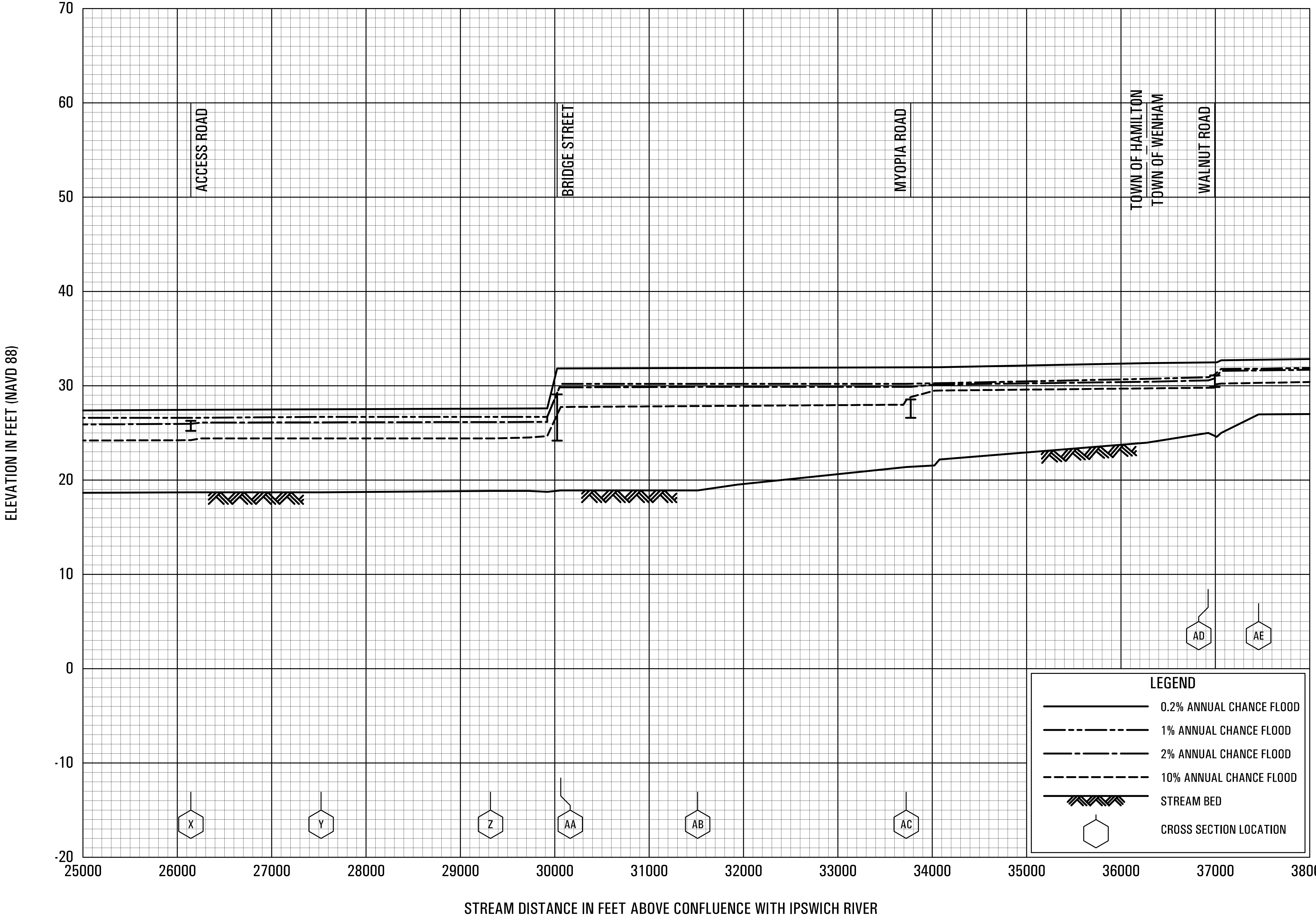
MILES RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

96P



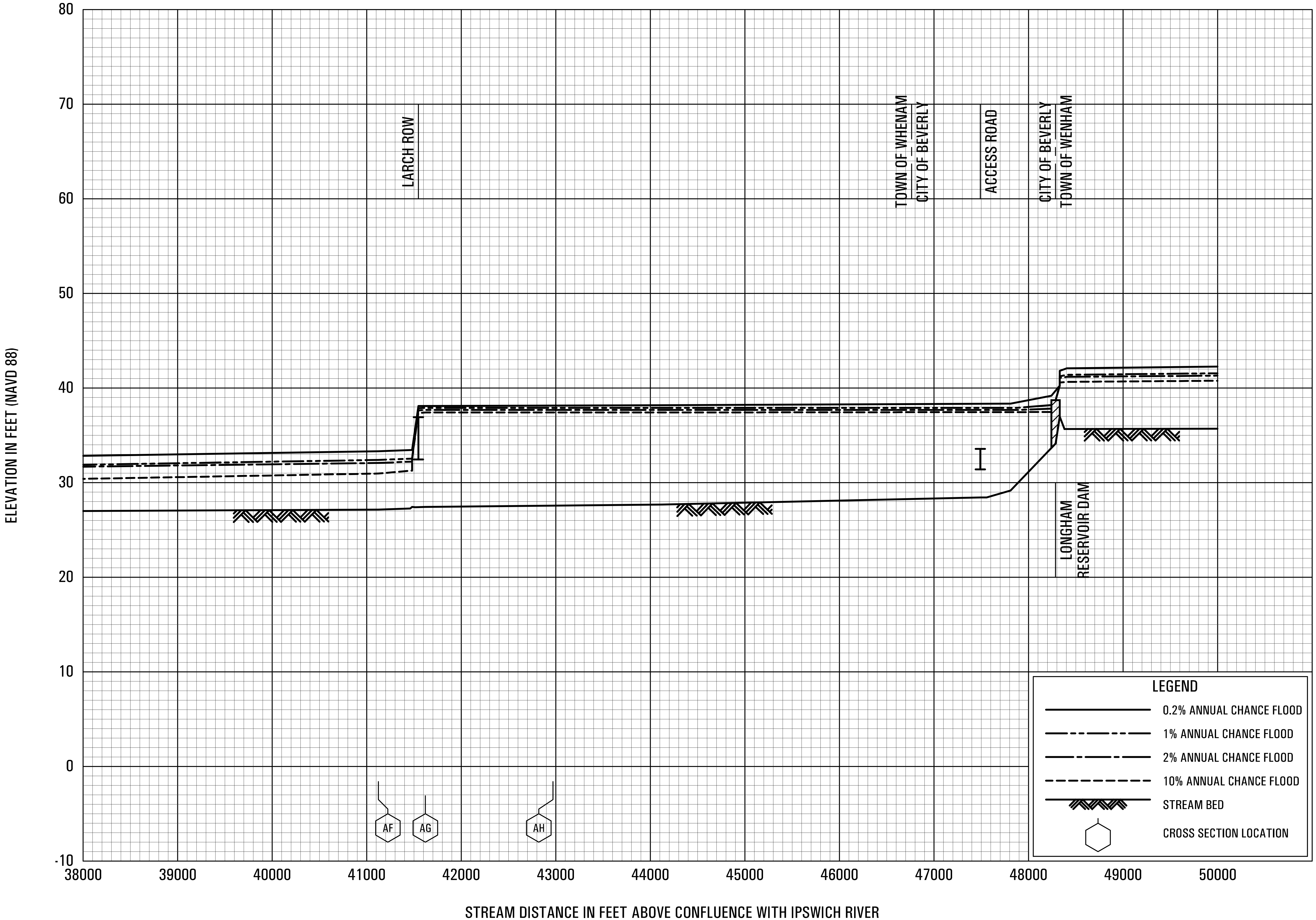
FLOOD PROFILES

MILES RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



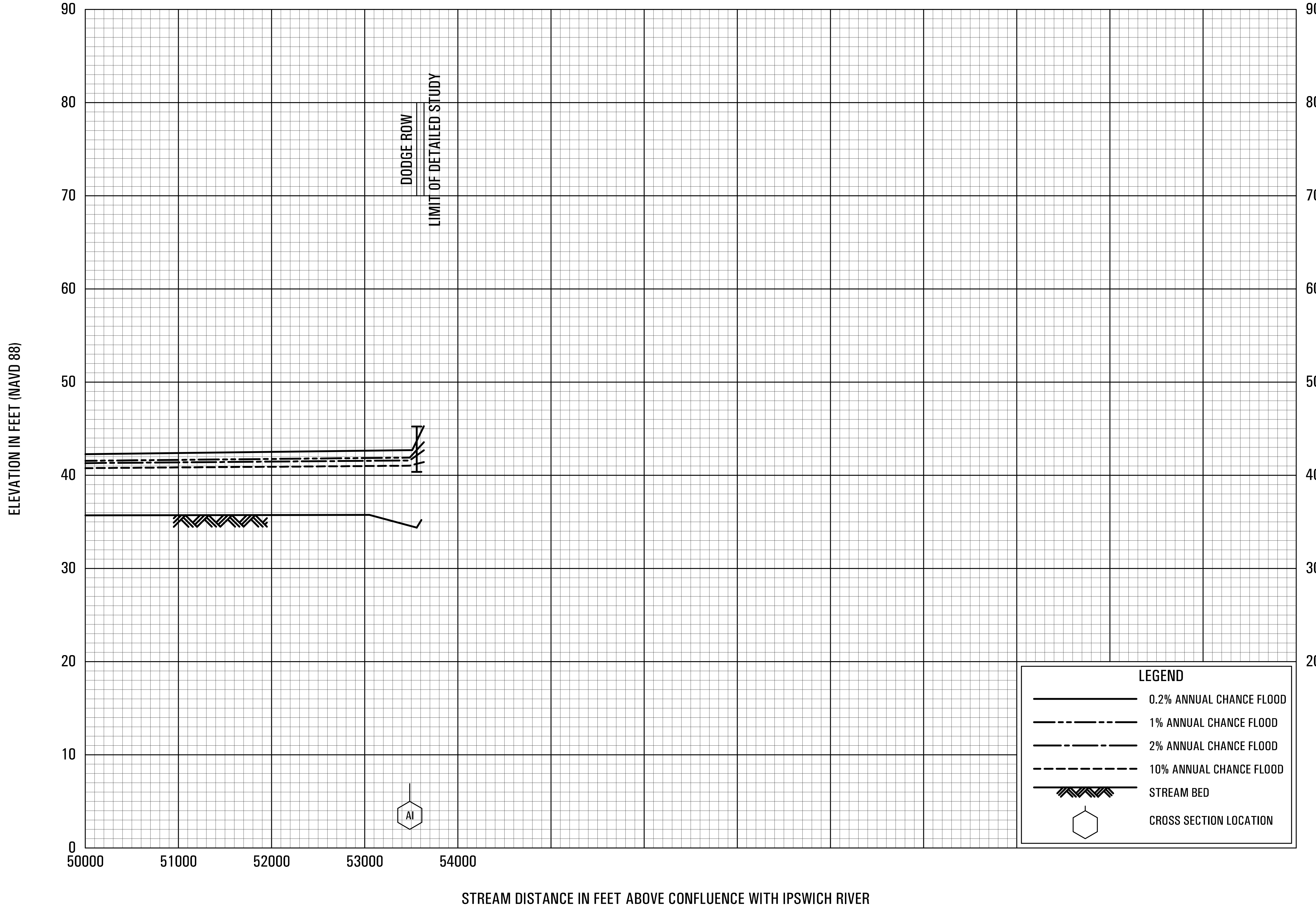
FLOOD PROFILES

MILES RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



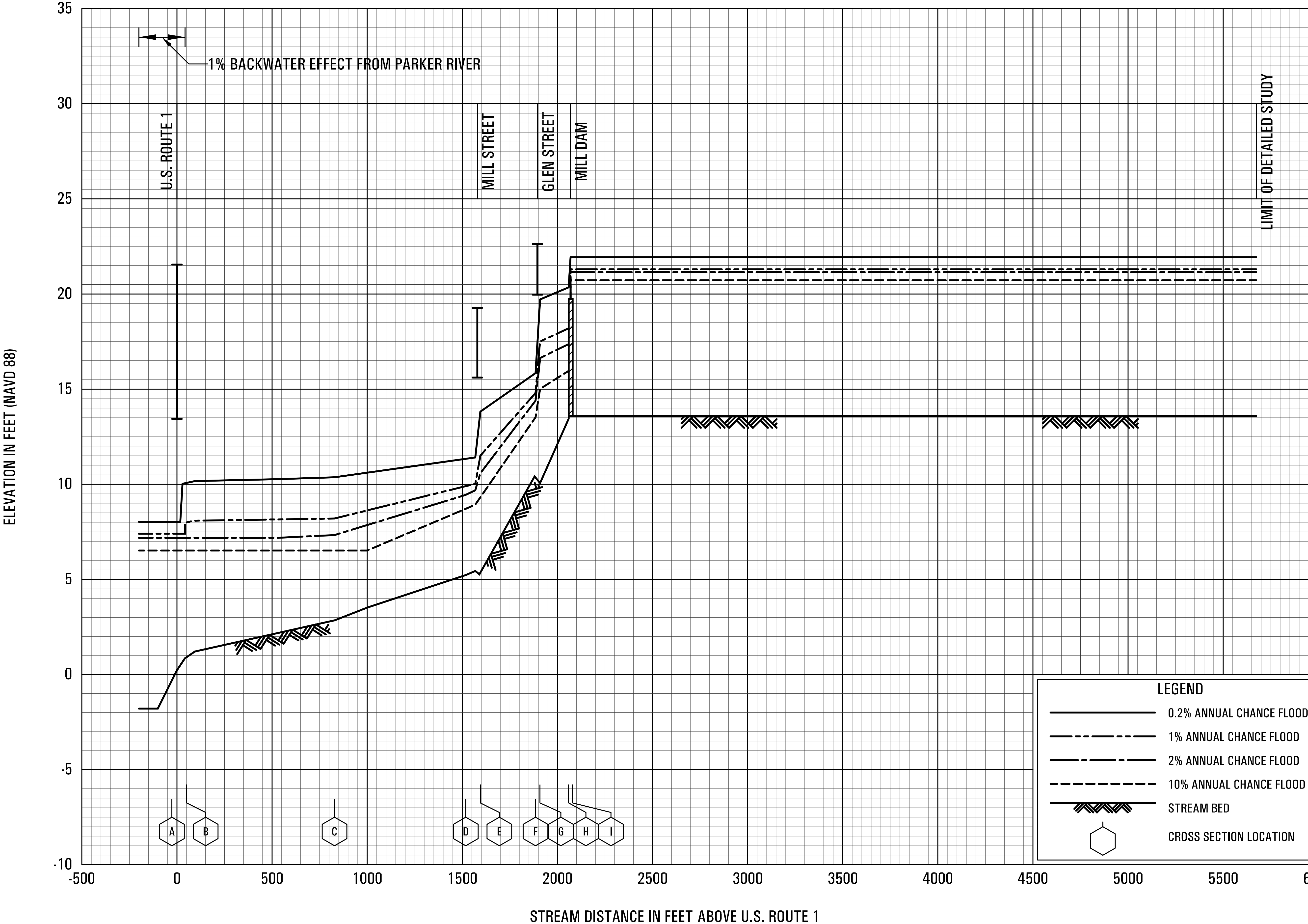
FLOOD PROFILES

MILES RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



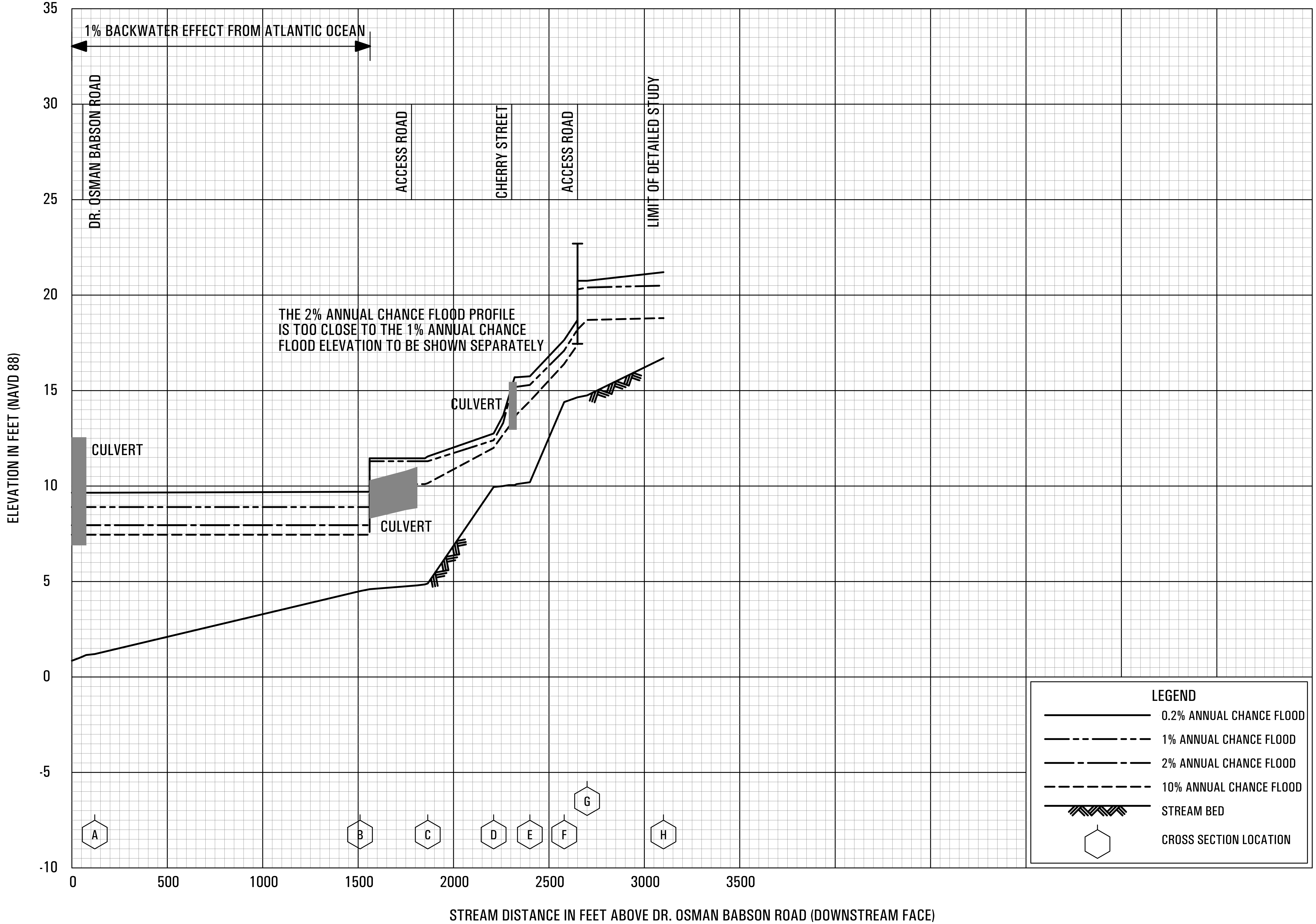
FLOOD PROFILES

MILL RIVER (TOWN OF ROWLEY)

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



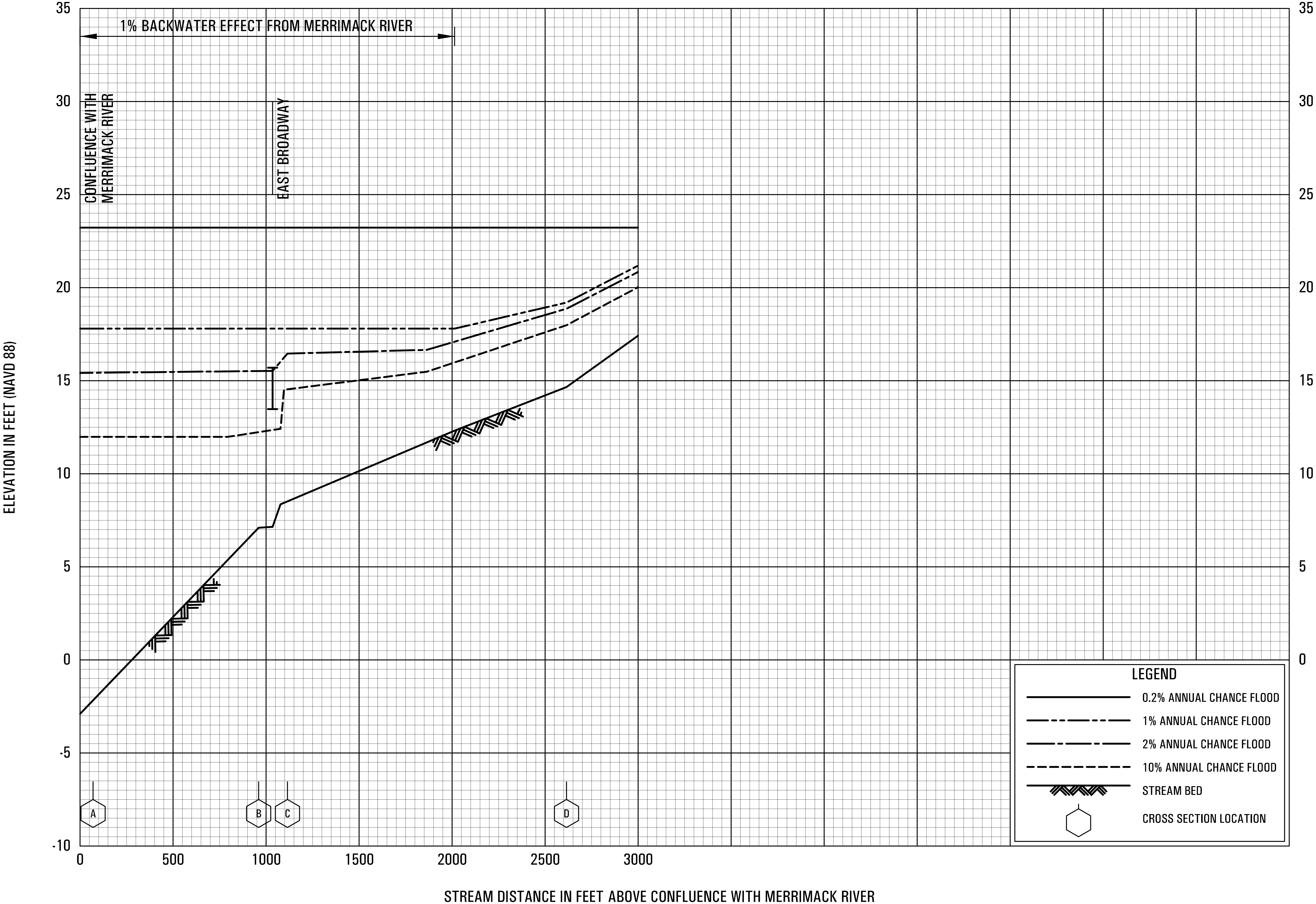
FLOOD PROFILES

MILL RIVER (TOWN OF GLOUCESTER)

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



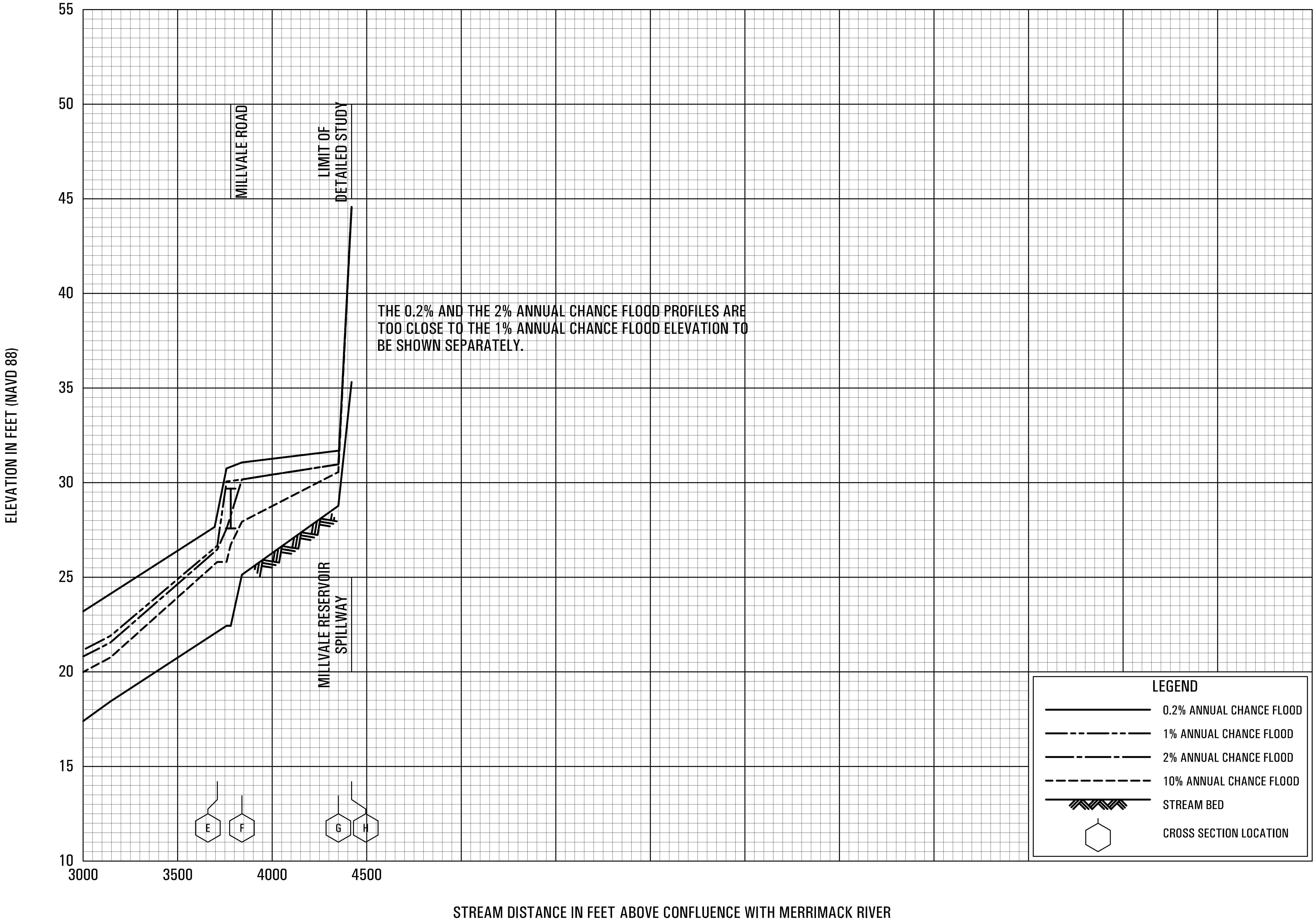
FLOOD PROFILES

MILLVALE RESERVOIR BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



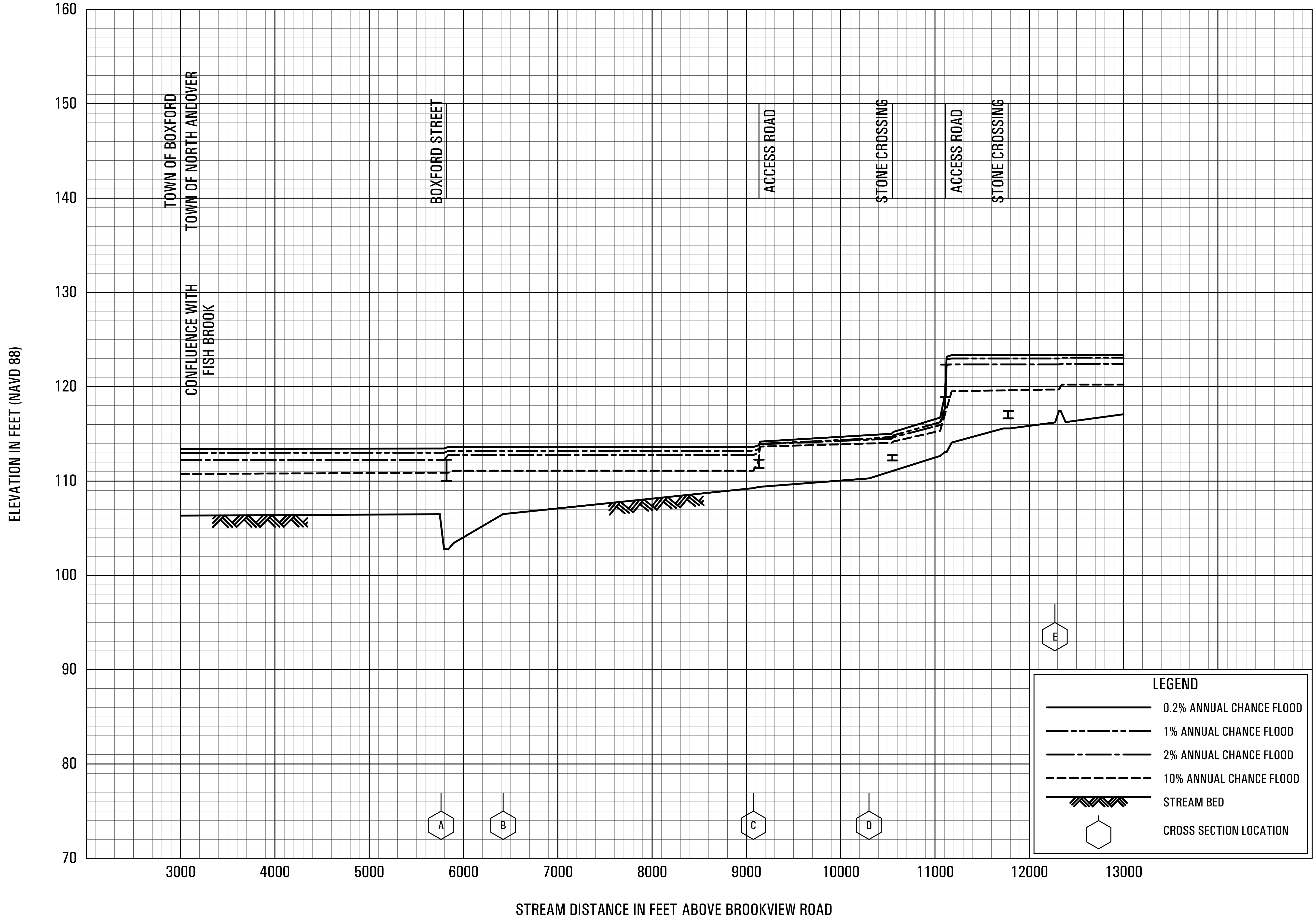
FLOOD PROFILES

MILLVALE RESERVOIR BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



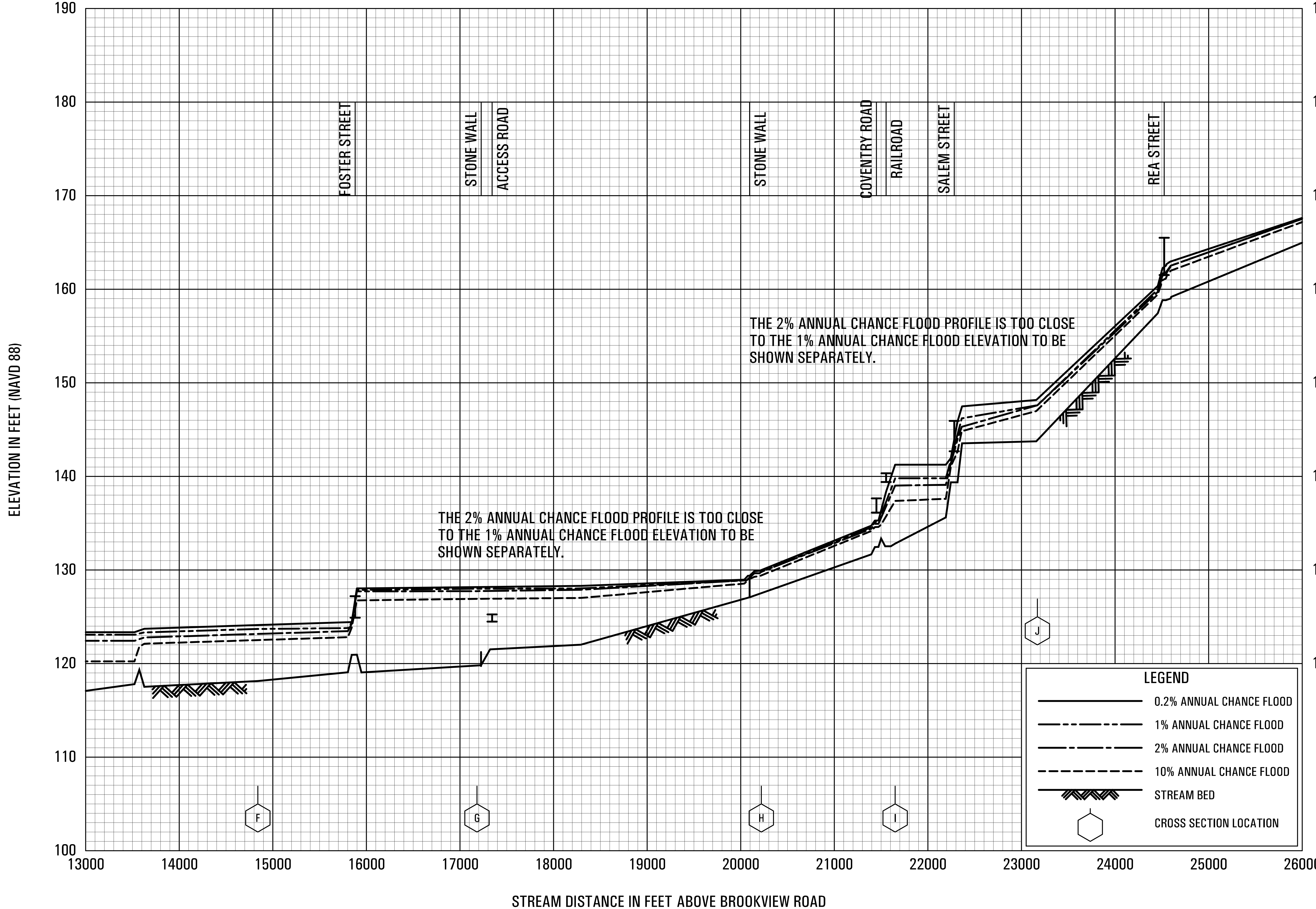
FLOOD PROFILES

MOSQUITO BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



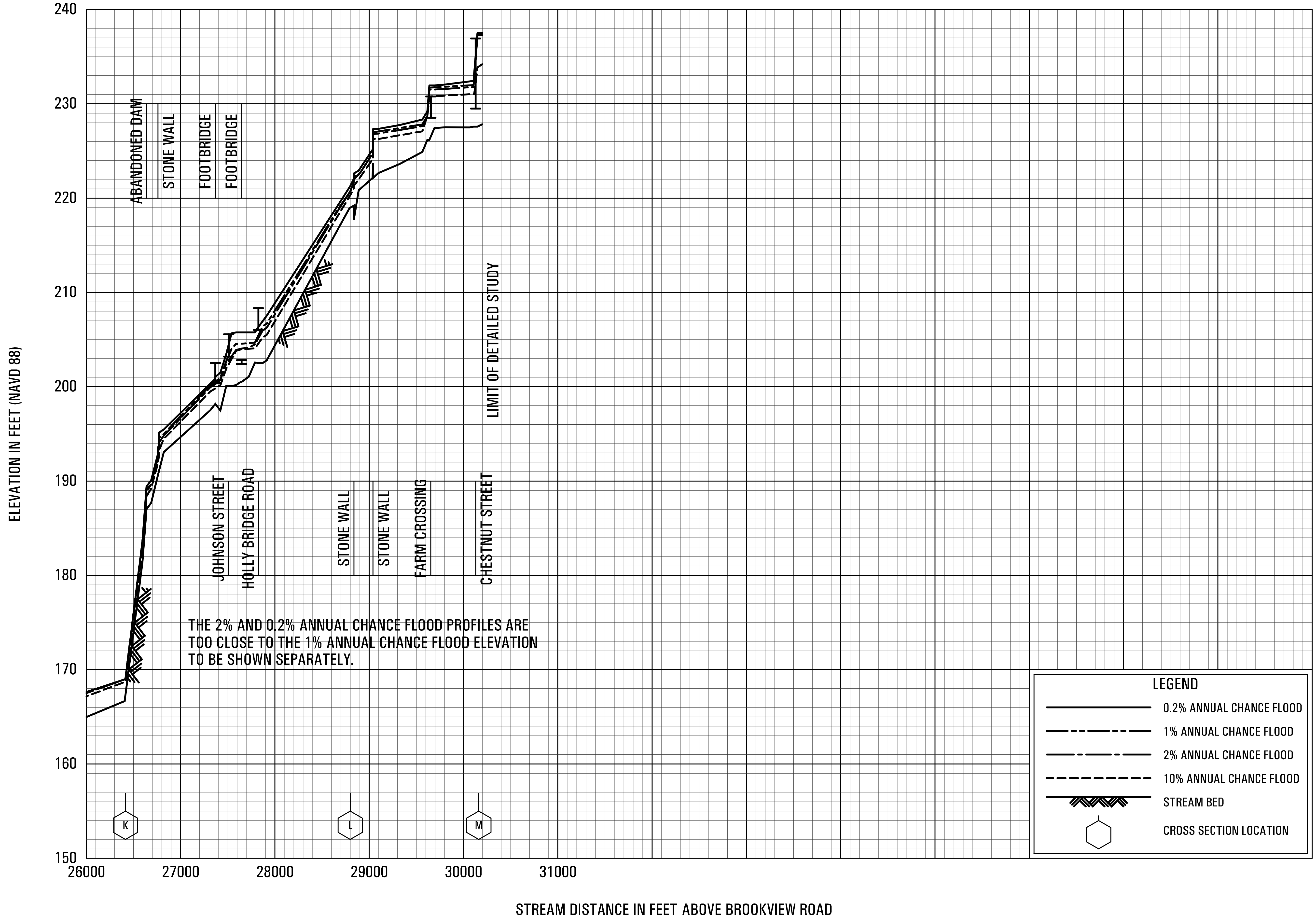
FLOOD PROFILES

MOSQUITO BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



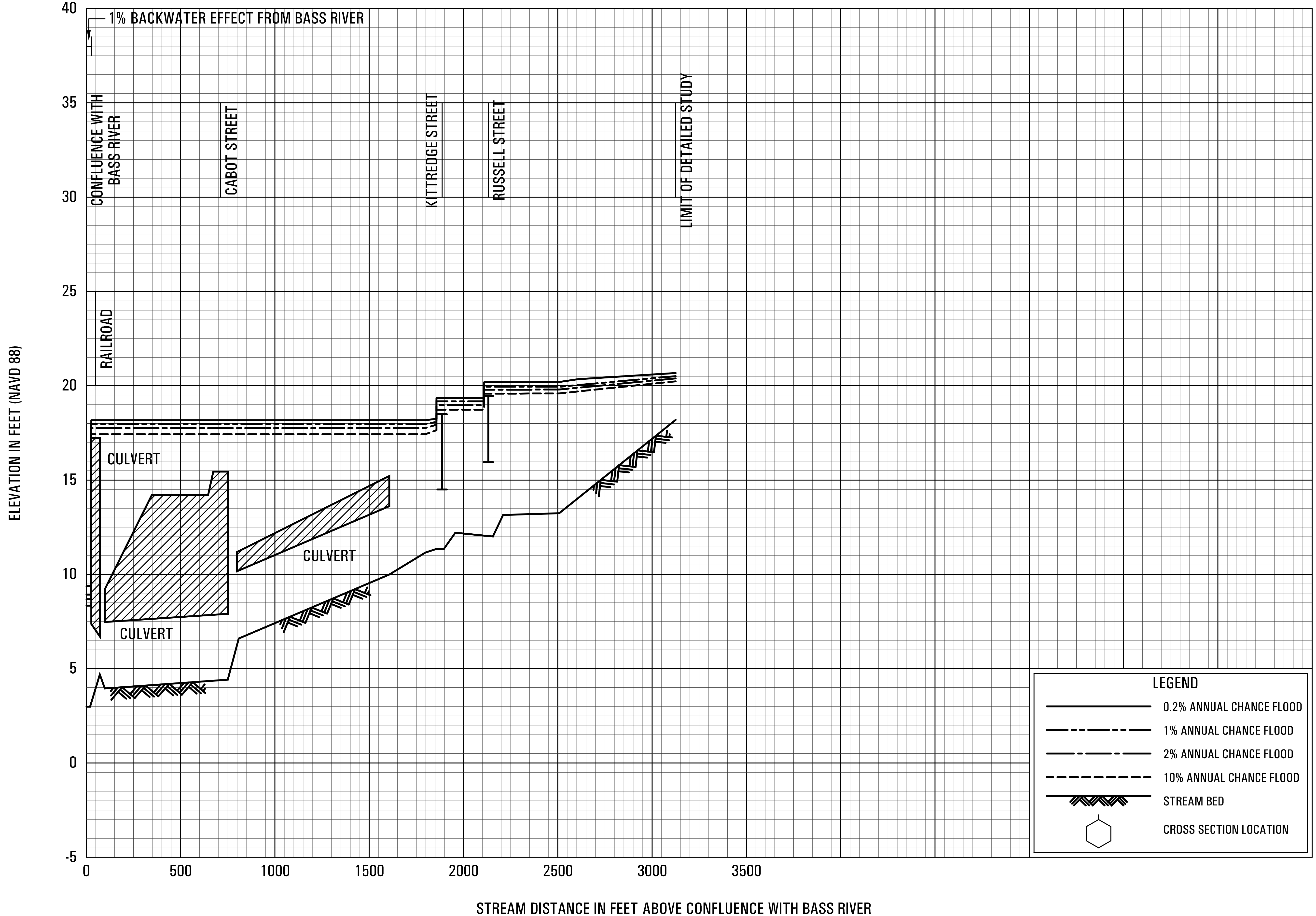
FLOOD PROFILES

MOSQUITO BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



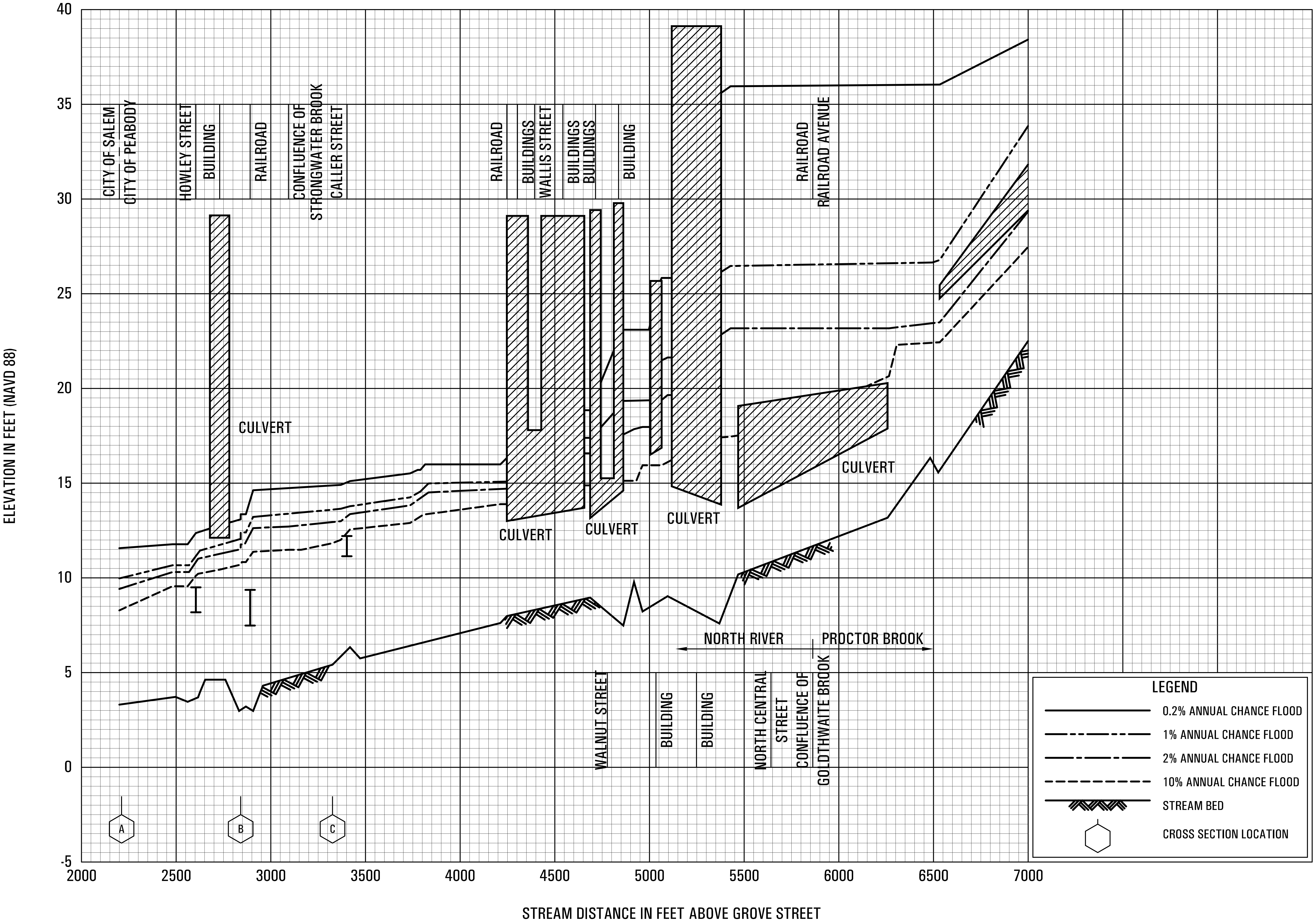
FLOOD PROFILES

NORTH BEVERLY DRAINAGE DITCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



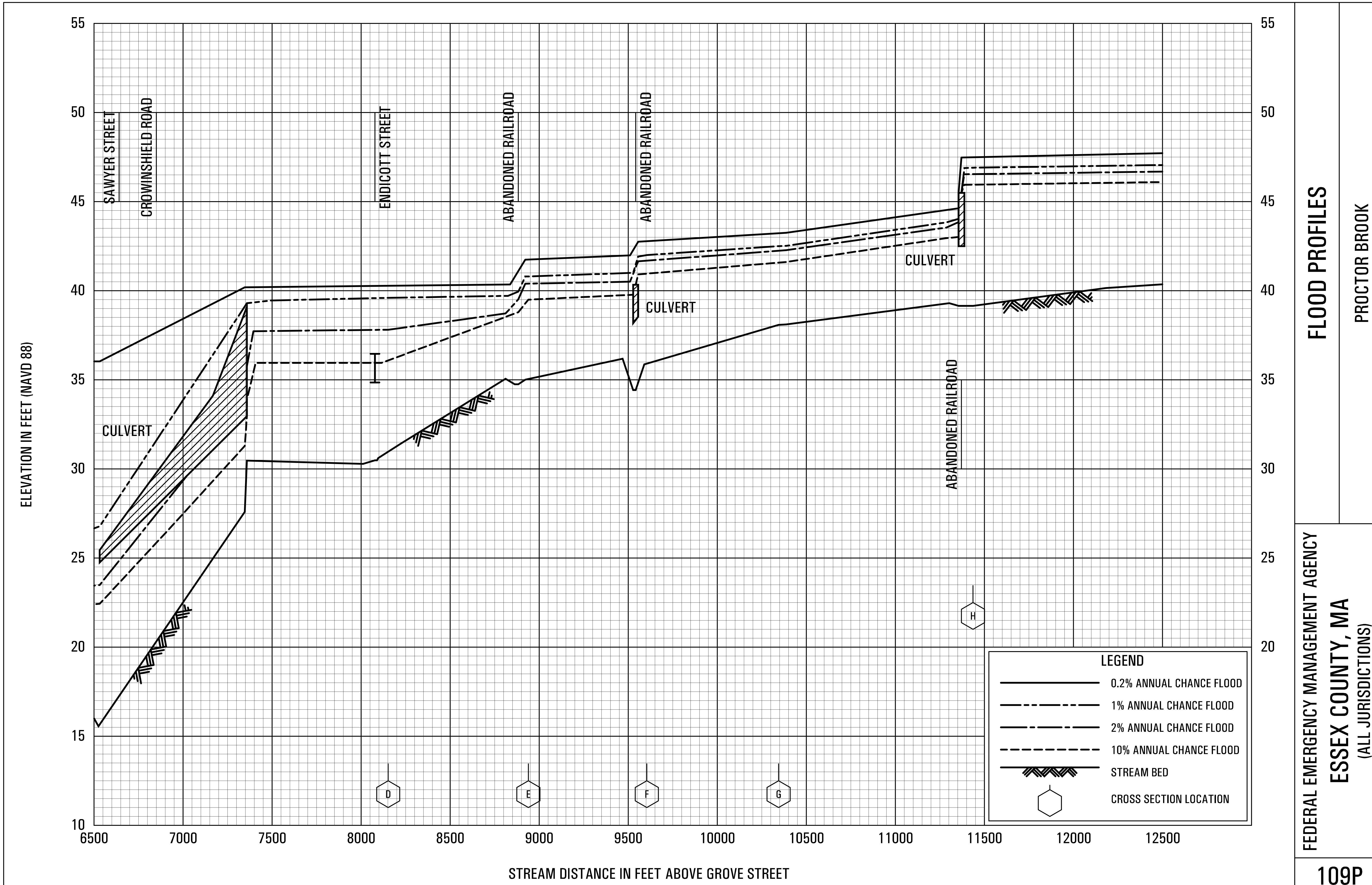
FLOOD PROFILES

NORTH RIVER AND PROCTOR BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



FLOOD PROFILES
PROCTOR BROOK
FEDERAL EMERGENCY MANAGEMENT AGENCY
ESSEX COUNTY, MA
(ALL JURISDICTIONS)
109P
ELEVATION IN FEET (NAVD 88)
STREAM DISTANCE IN FEET ABOVE GROVE STREET
SAWYER STREET
CROWINSHIELD ROAD
ENDICOTT STREET
ABANDONED RAILROAD
ABANDONED RAILROAD
ABANDONED RAILROAD
CULVERT
CULVERT
CULVERT
D
E
F
G
H
LEGEND
0.2% ANNUAL CHANCE FLOOD
1% ANNUAL CHANCE FLOOD
2% ANNUAL CHANCE FLOOD
10% ANNUAL CHANCE FLOOD
STREAM BED
CROSS SECTION LOCATION
10
15
20
25
30
35
40
45
50
55
6500
7000
7500
8000
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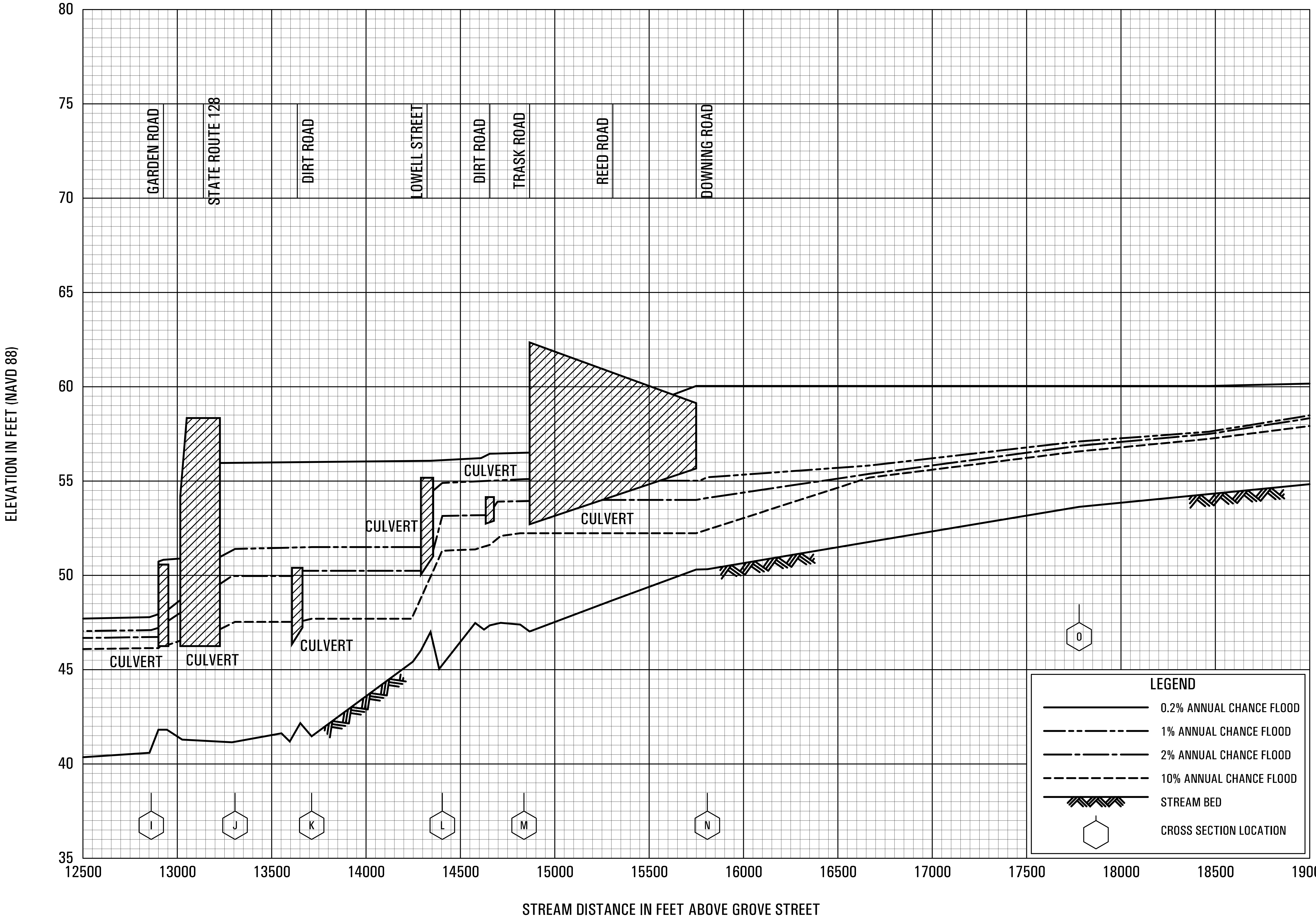


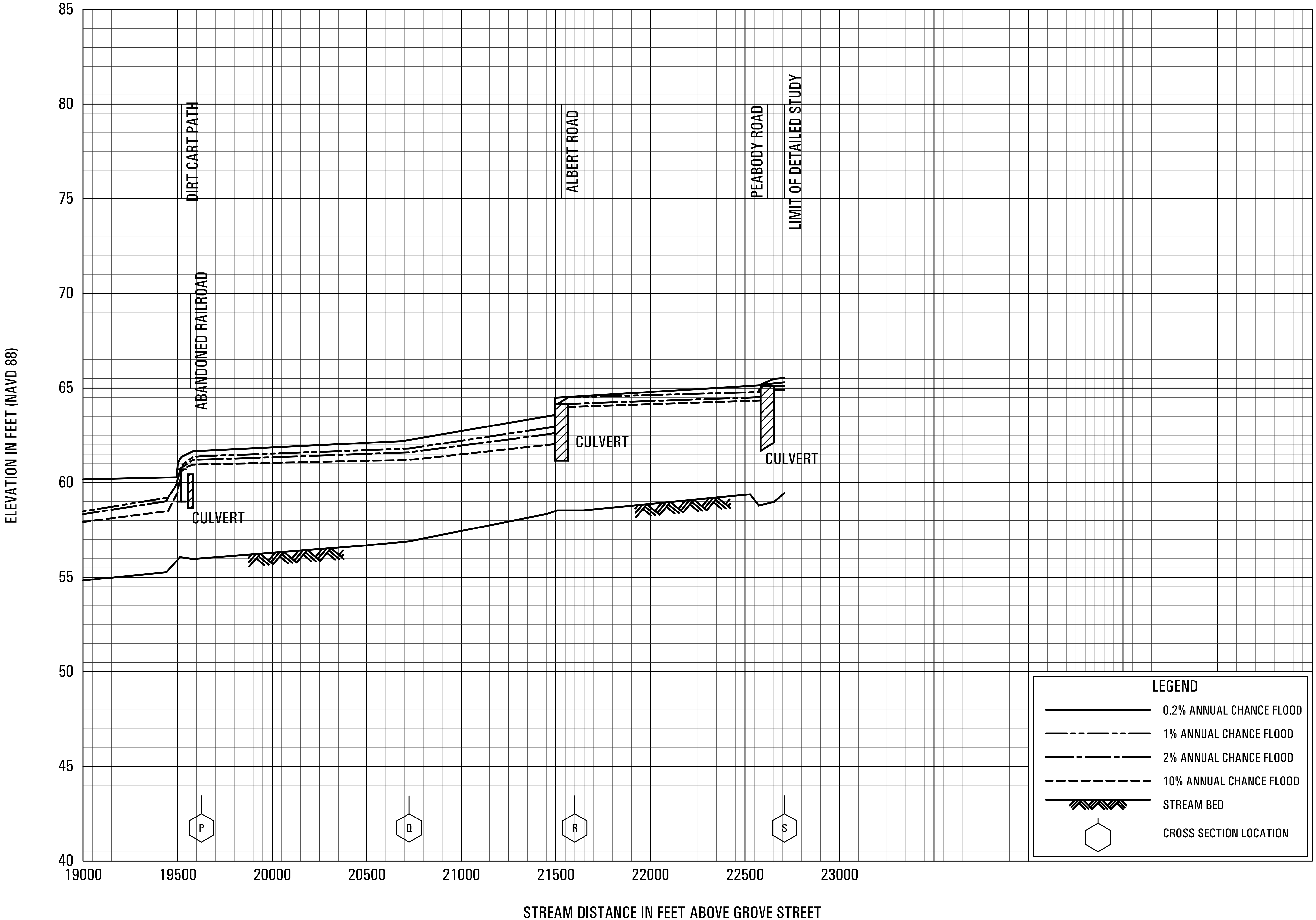
FLOOD PROFILES

PROCTOR BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



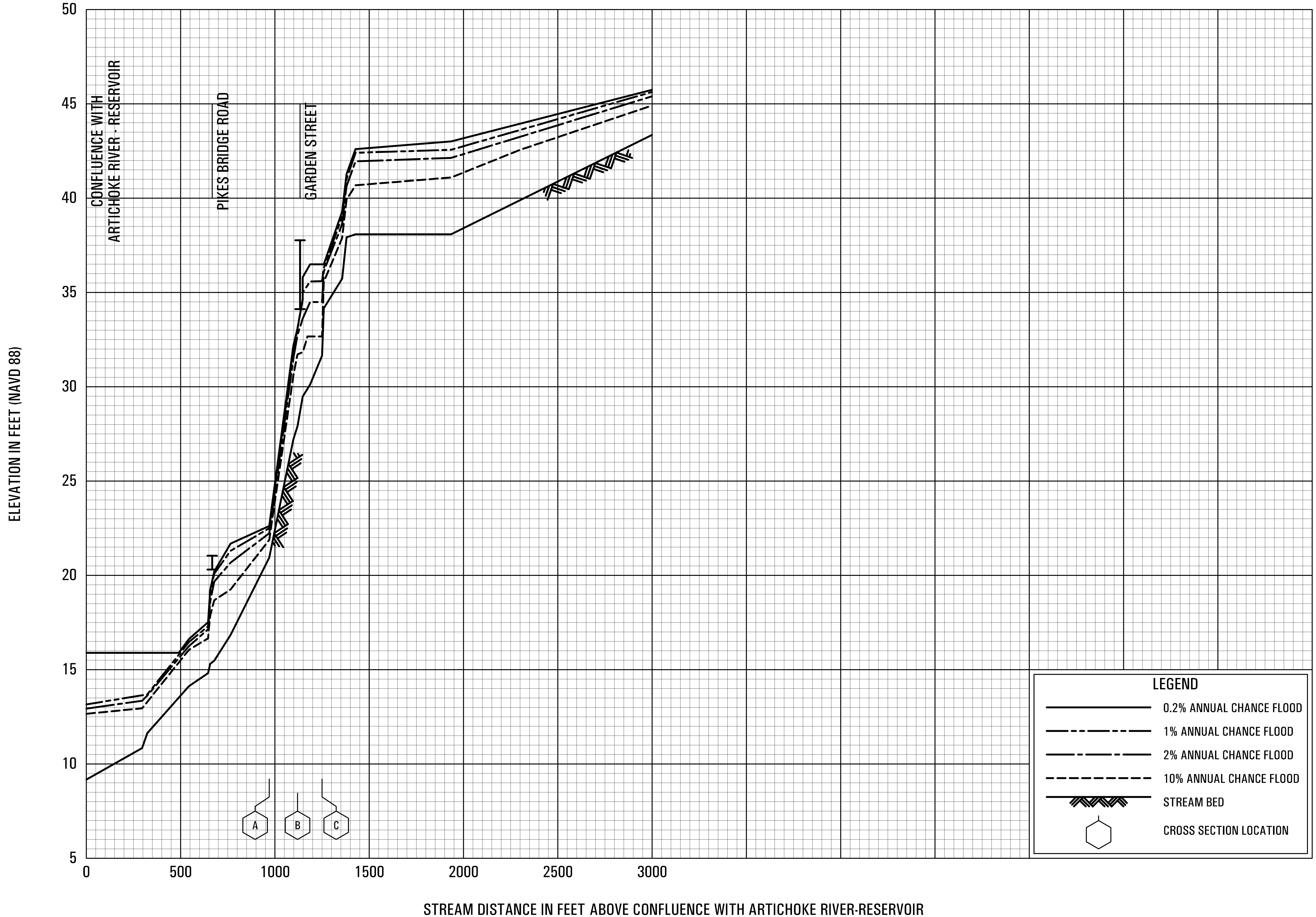
FLOOD PROFILES

PROCTOR BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

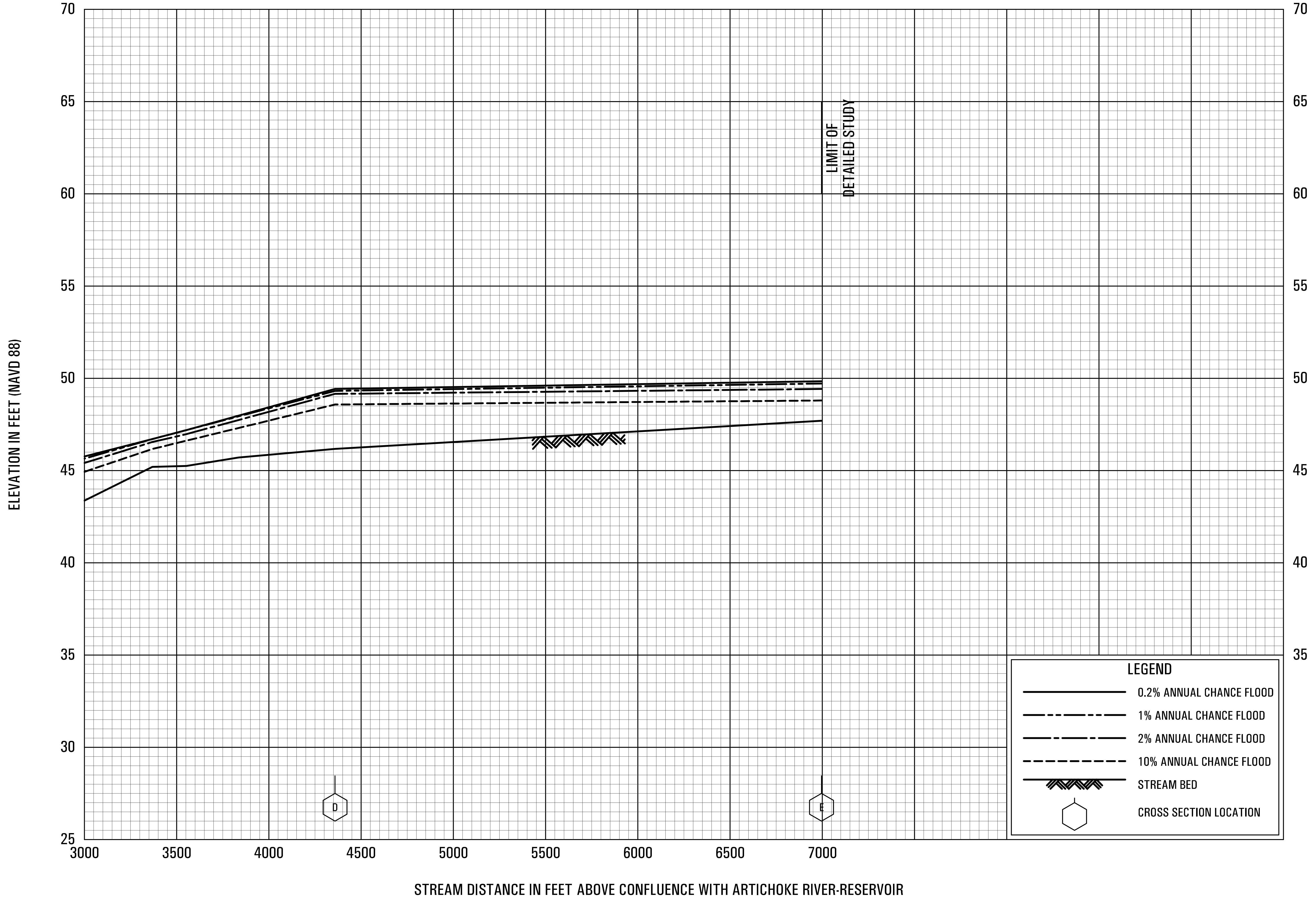


FLOOD PROFILES

NORTH TRIBUTARY BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA
(ALL JURISDICTIONS)



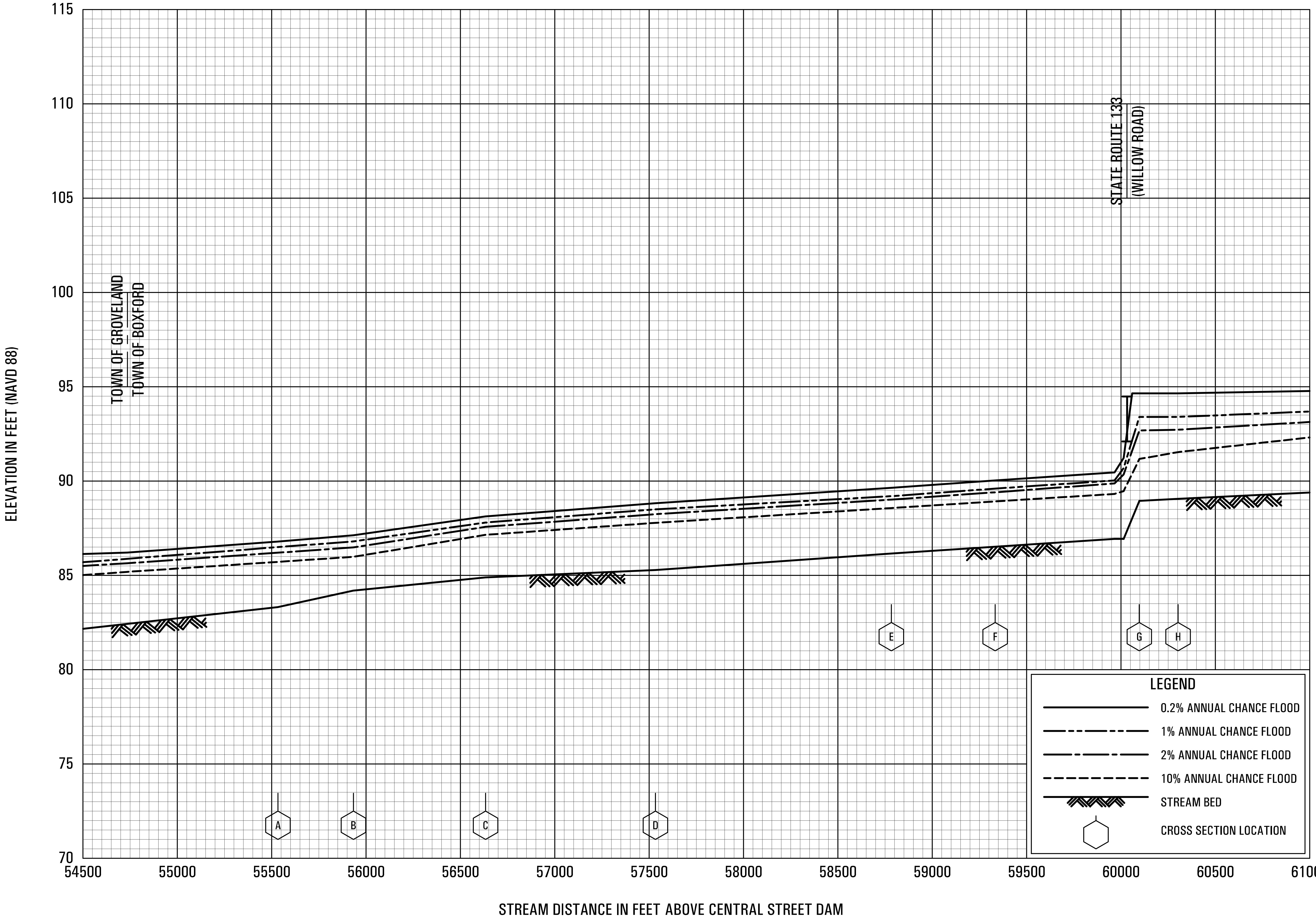
FLOOD PROFILES

NORTH TRIBUTARY BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



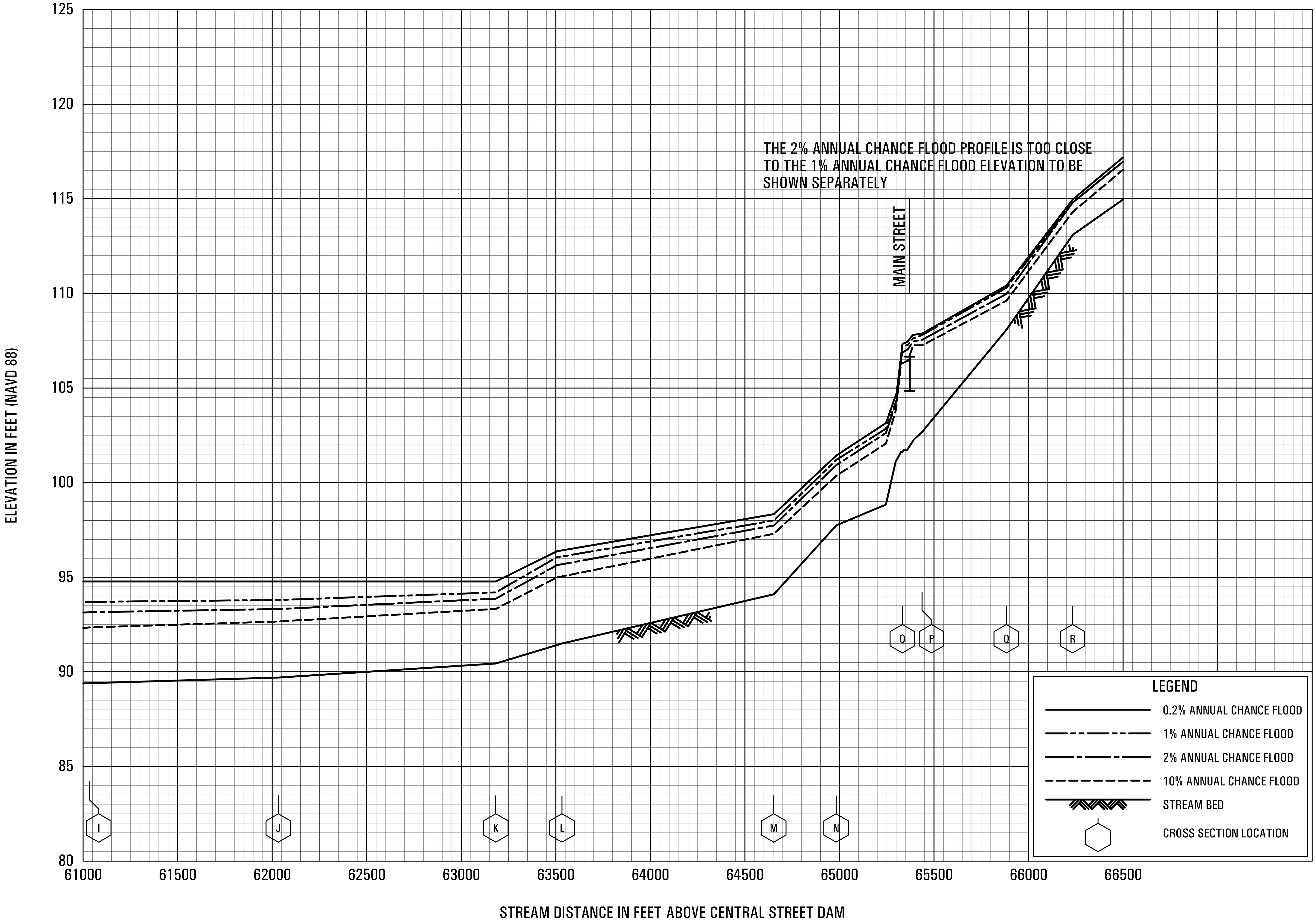
FLOOD PROFILES

PARKER RIVER (TOWN OF BOXFORD)

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



FLOOD PROFILES

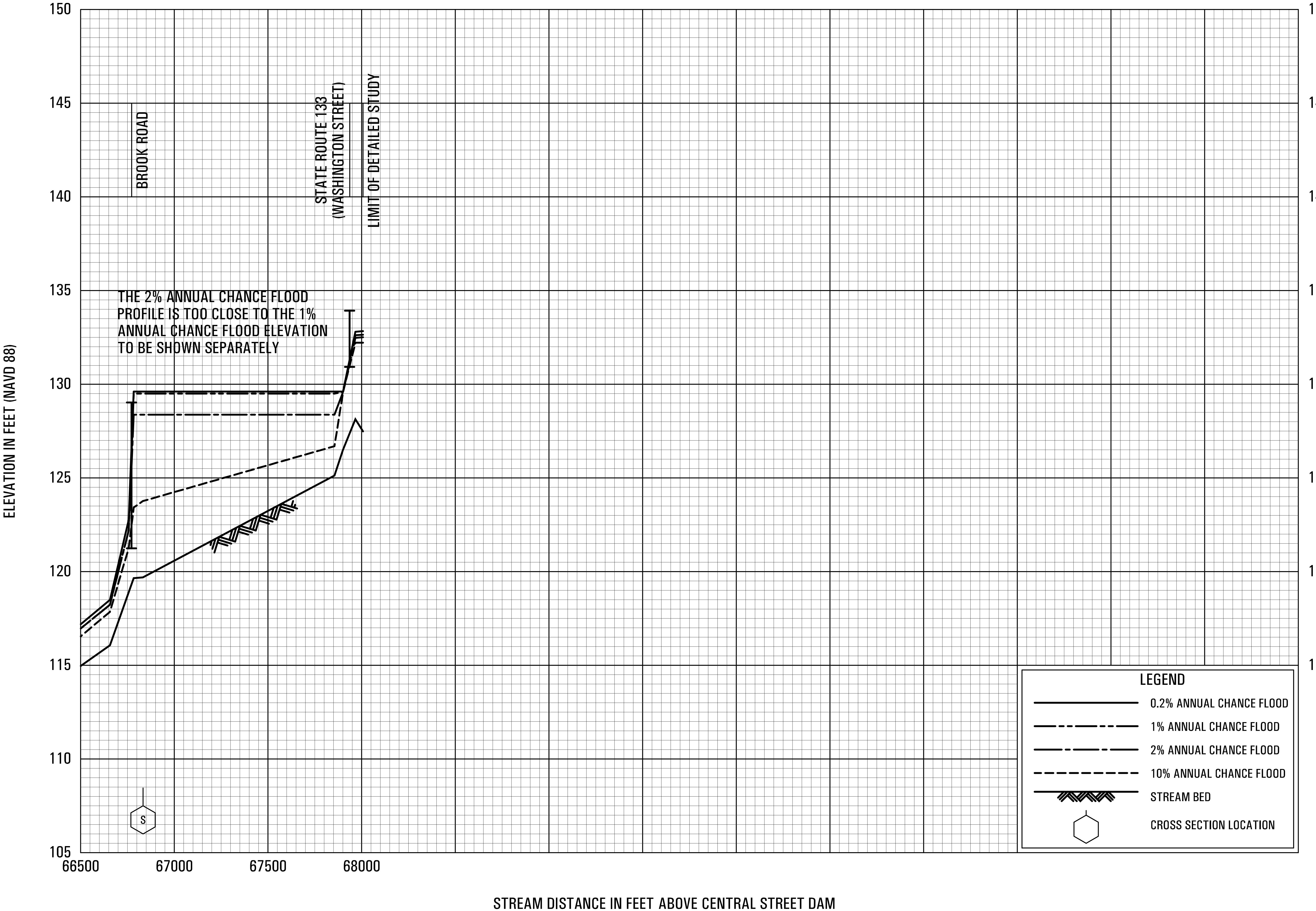
PARKER RIVER (TOWN OF BOXFORD)

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

115P



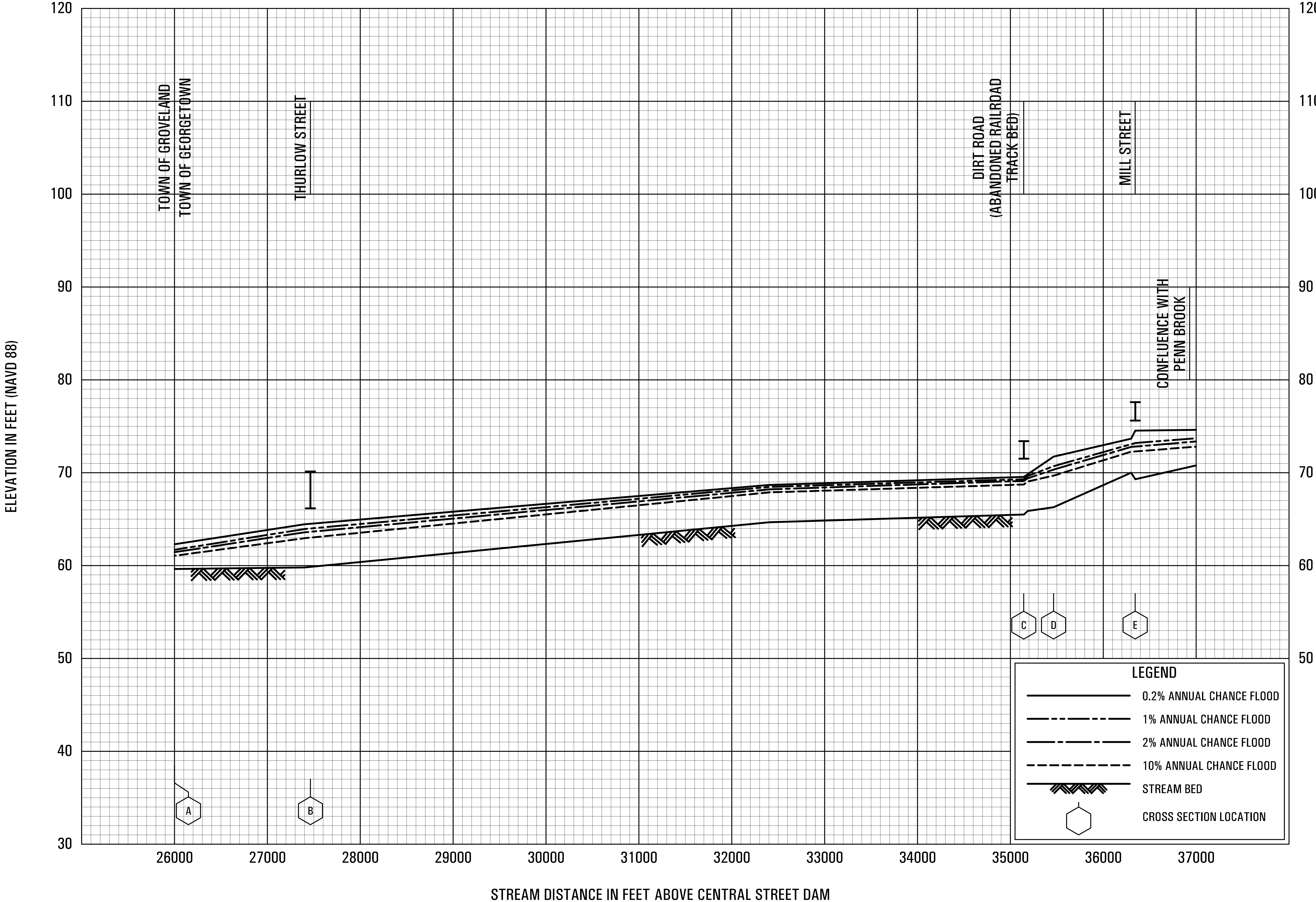
FLOOD PROFILES

PARKER RIVER (TOWN OF BOXFORD)

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



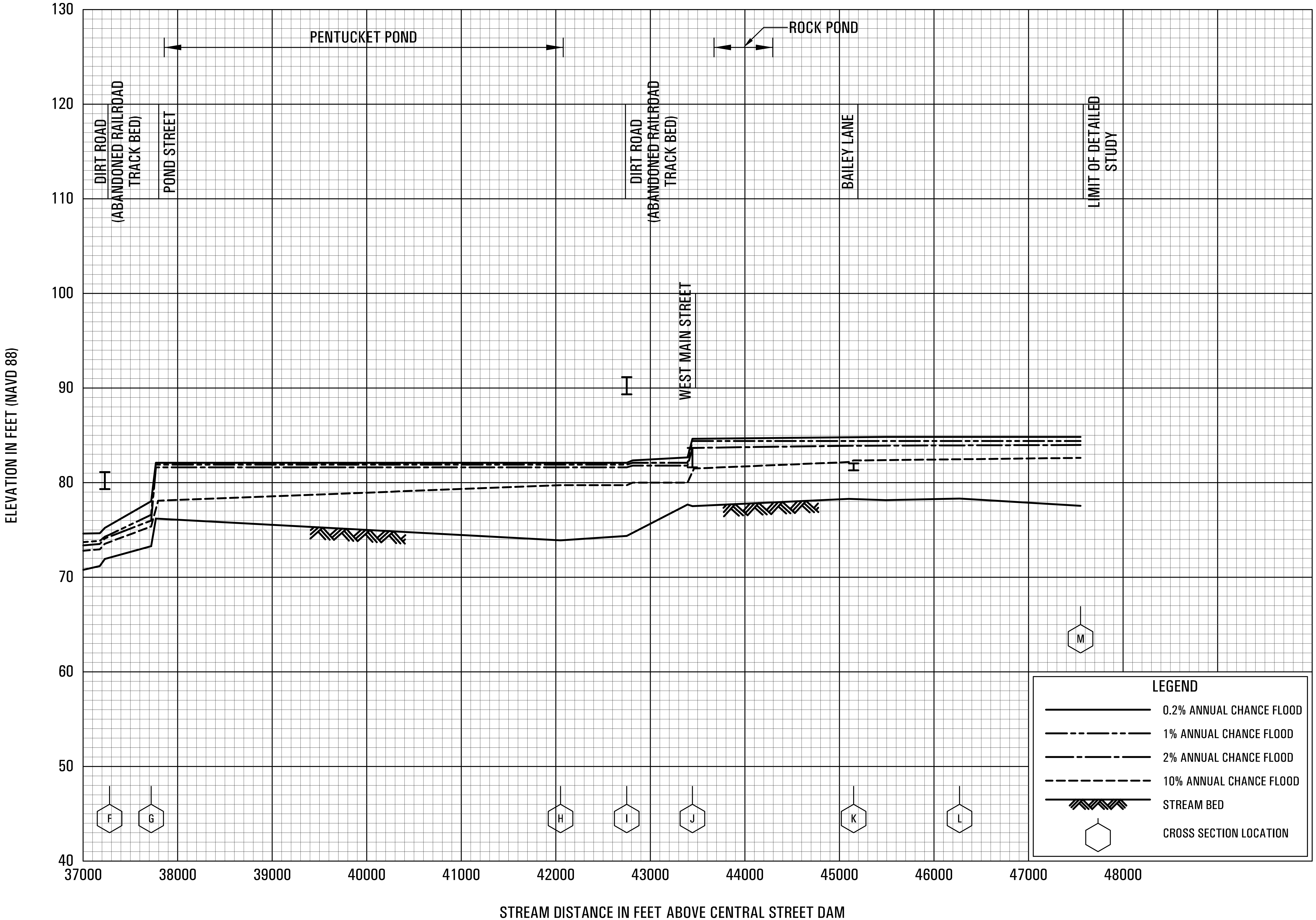
FLOOD PROFILES

PARKER RIVER (TOWN OF GEORGETOWN)

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



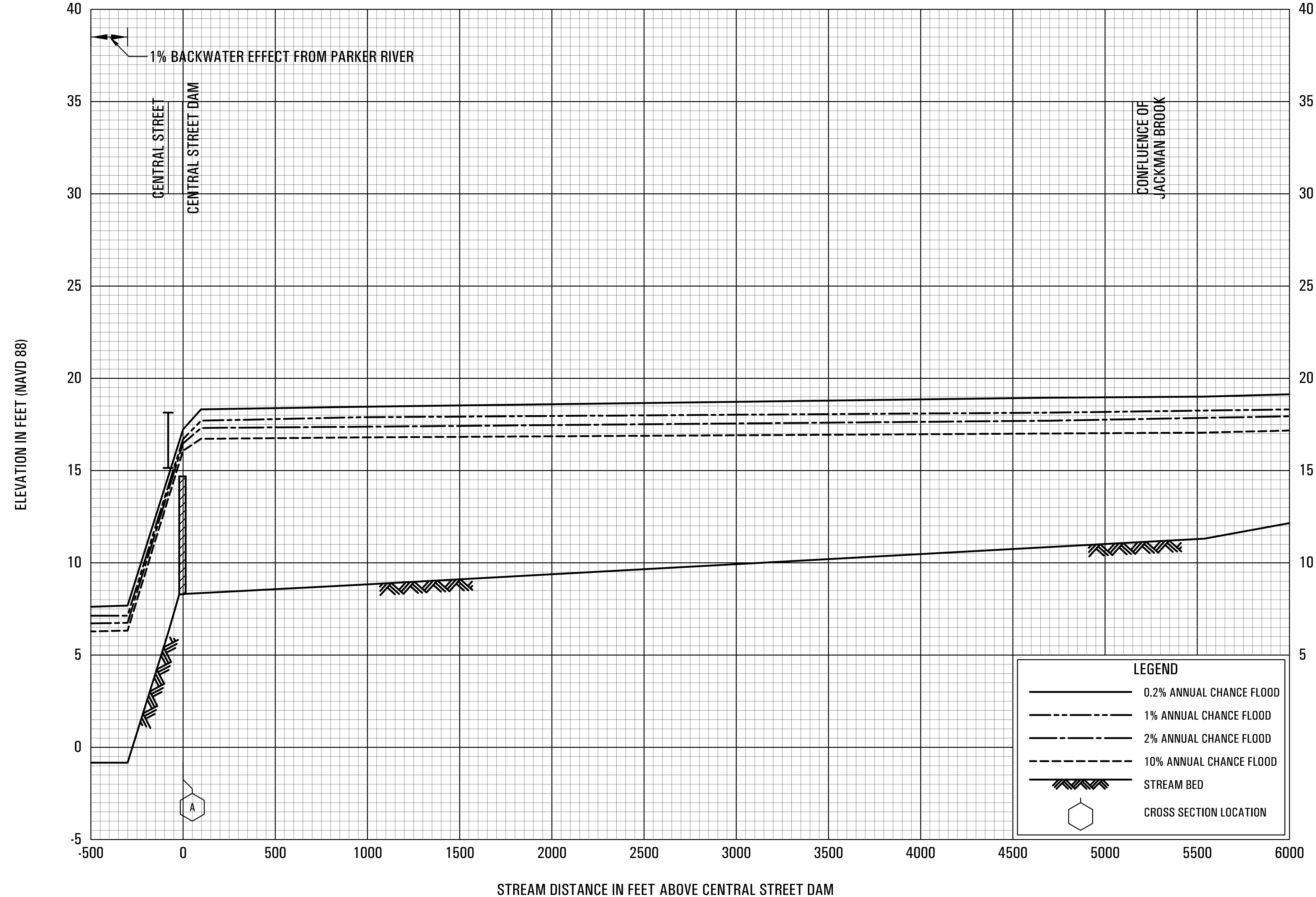
FLOOD PROFILES

PARKER RIVER (TOWN OF GEORGETOWN)

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



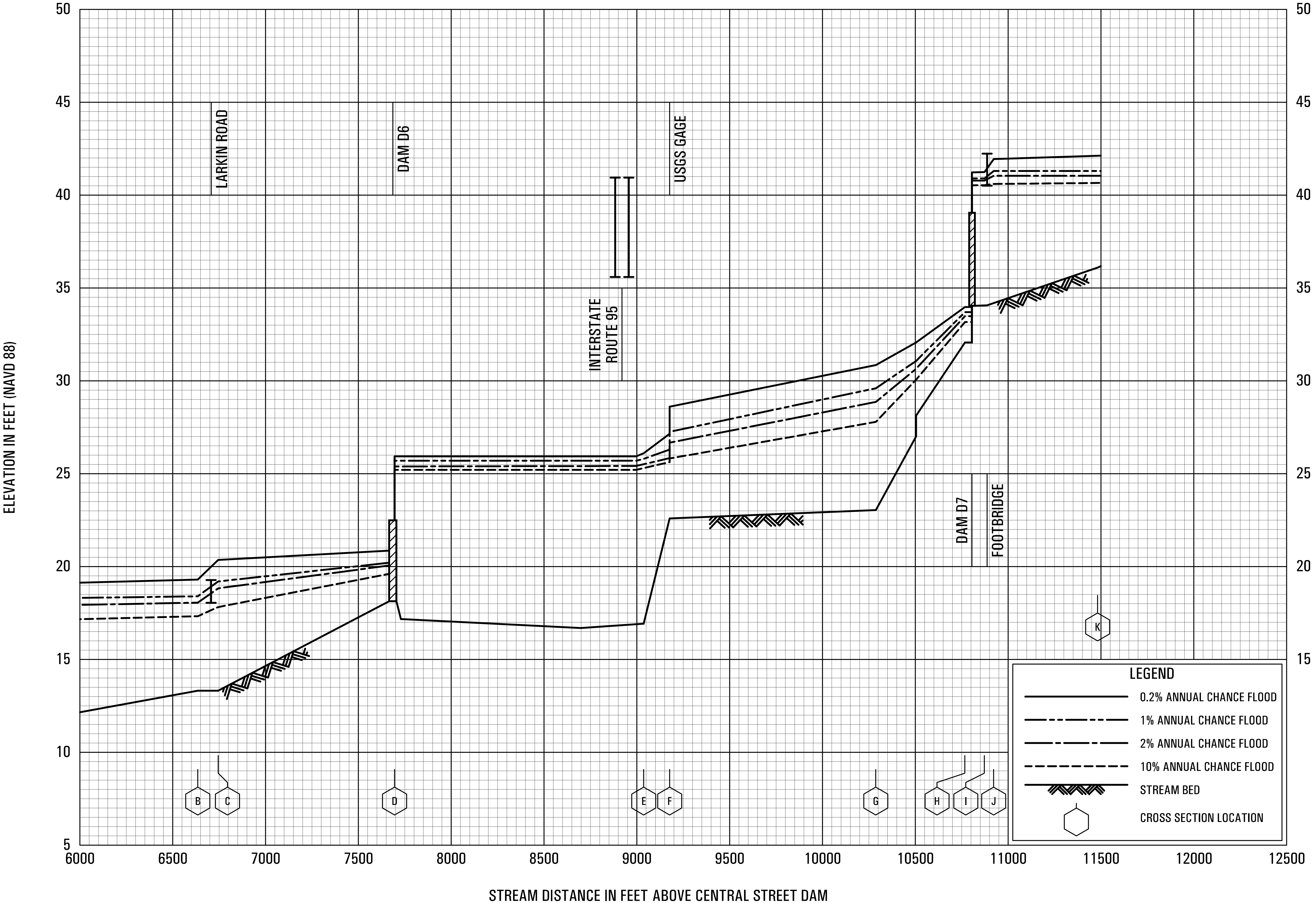
FLOOD PROFILES

PARKER RIVER (TOWN OF NEWBURY)

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



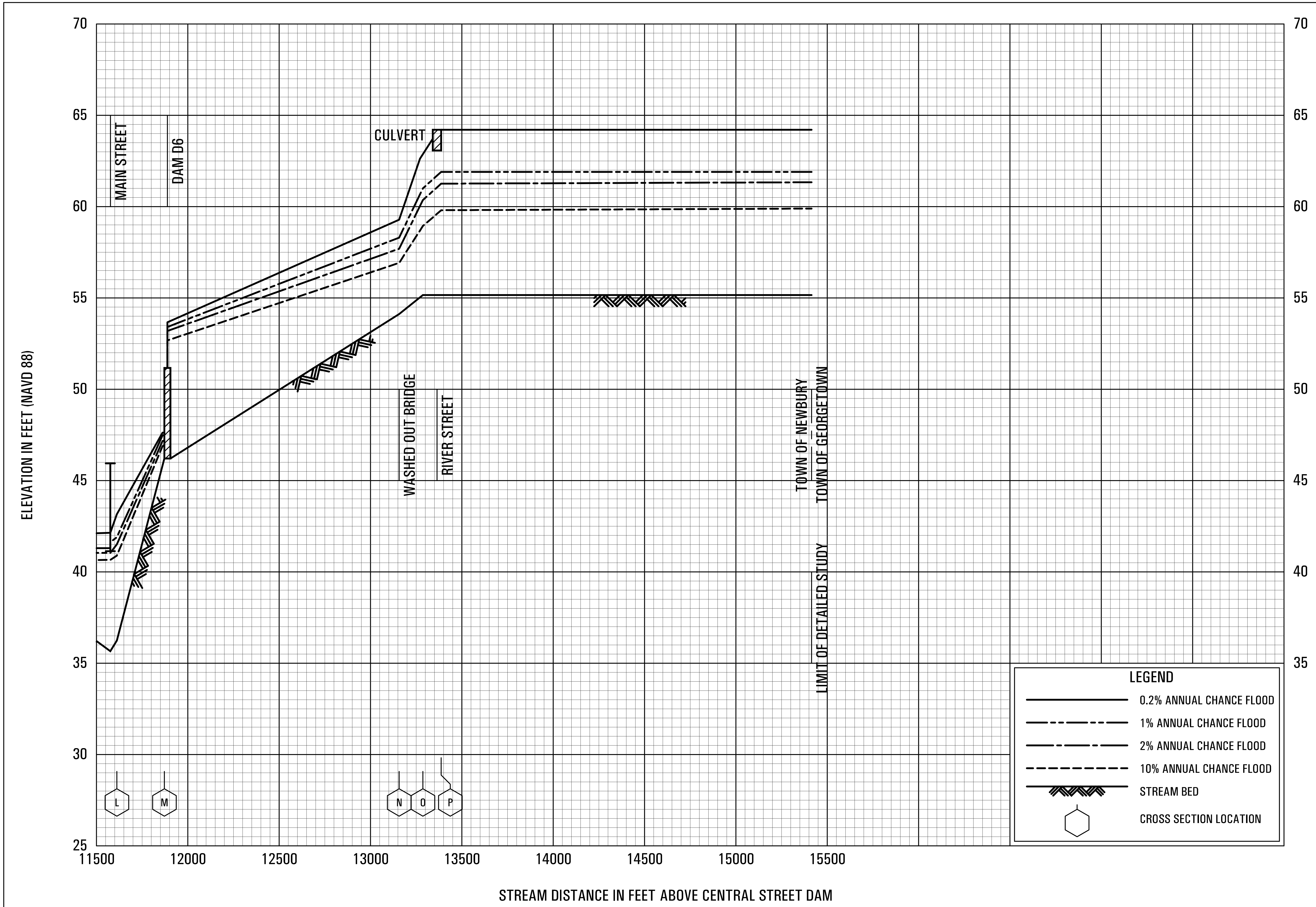
FLOOD PROFILES

PARKER RIVER (TOWN OF NEWBURY)

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



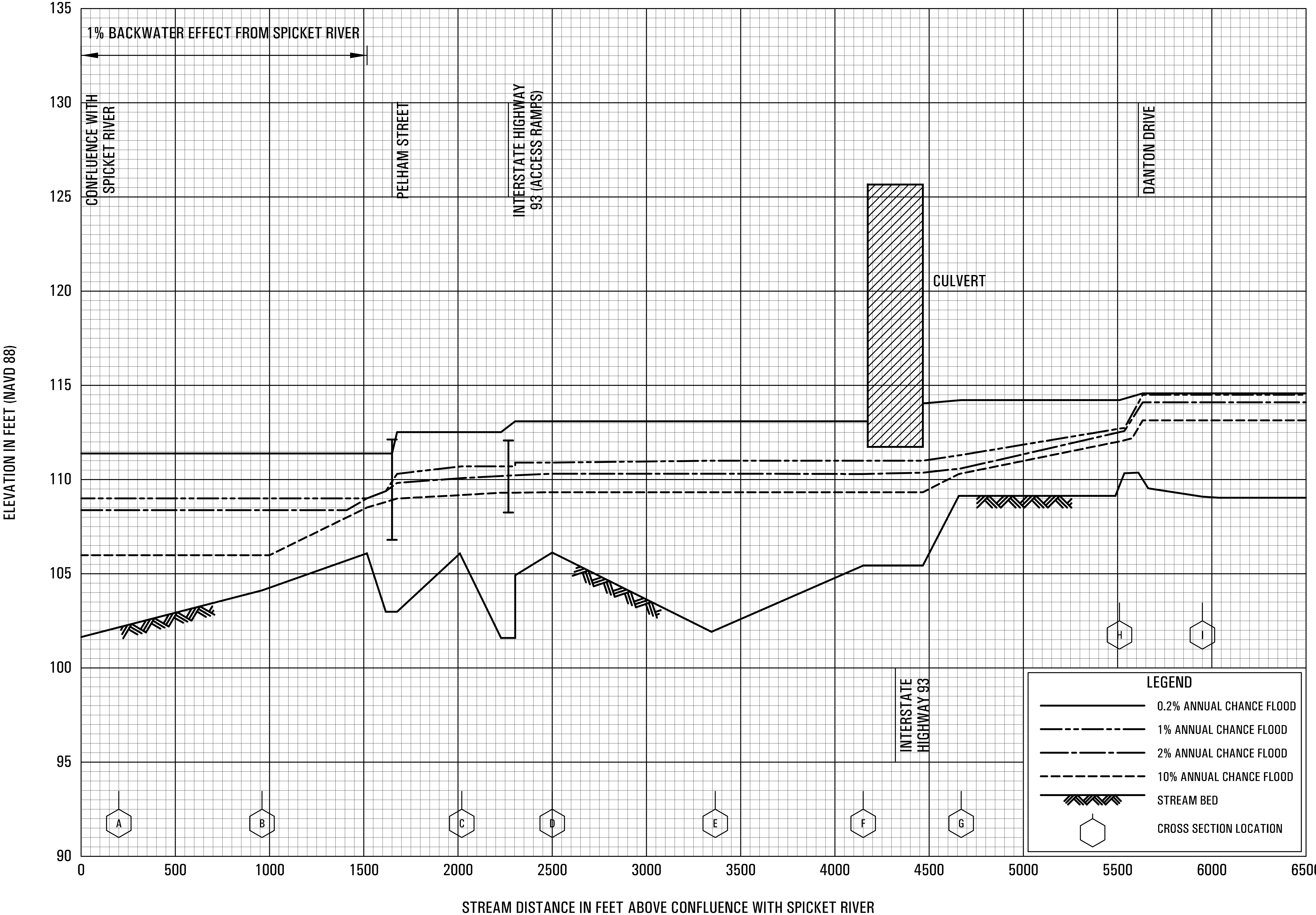
FLOOD PROFILES

PARKER RIVER (TOWN OF NEWBURY)

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

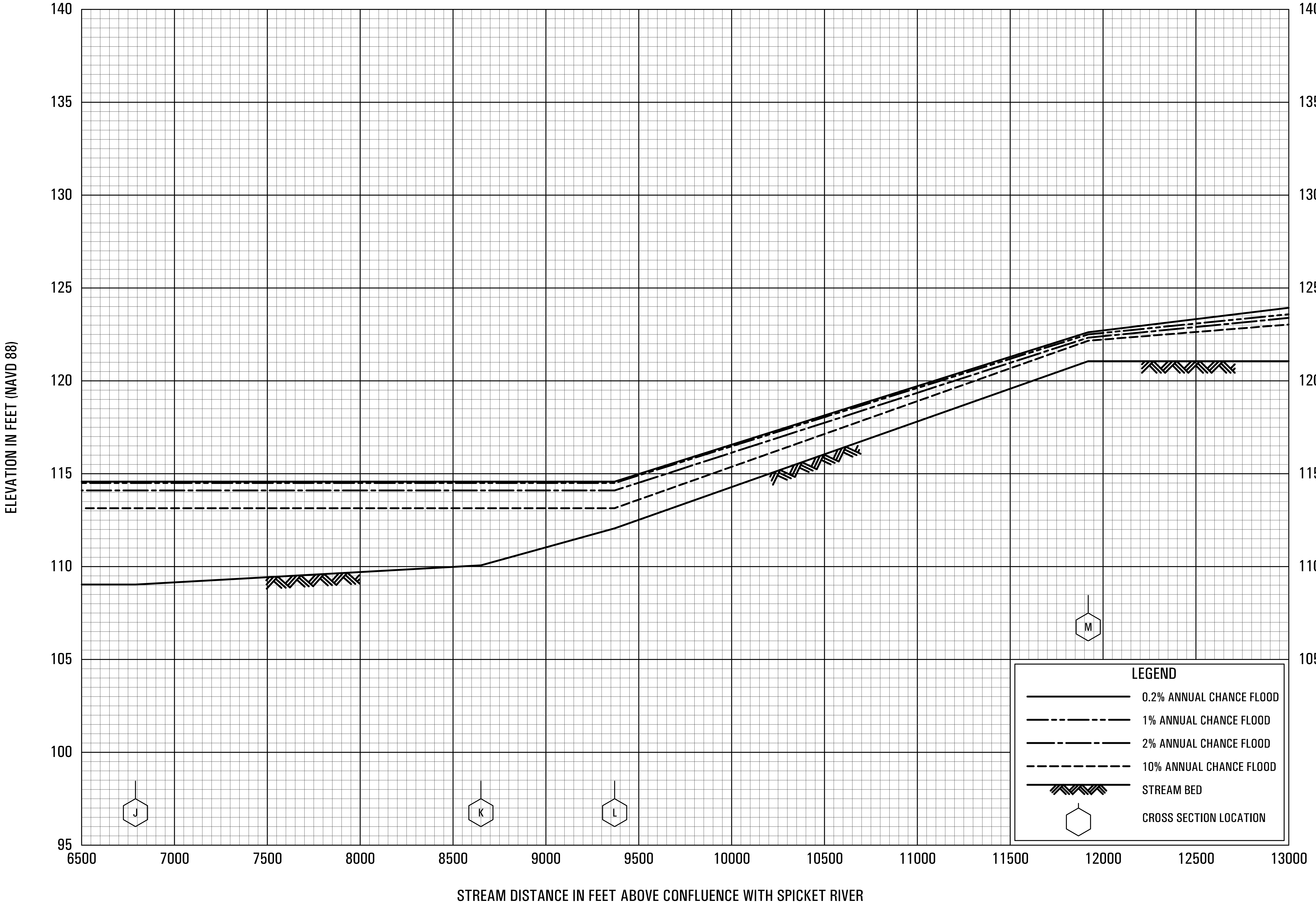


FLOOD PROFILES

PEAT MEADOW BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA
(ALL JURISDICTIONS)



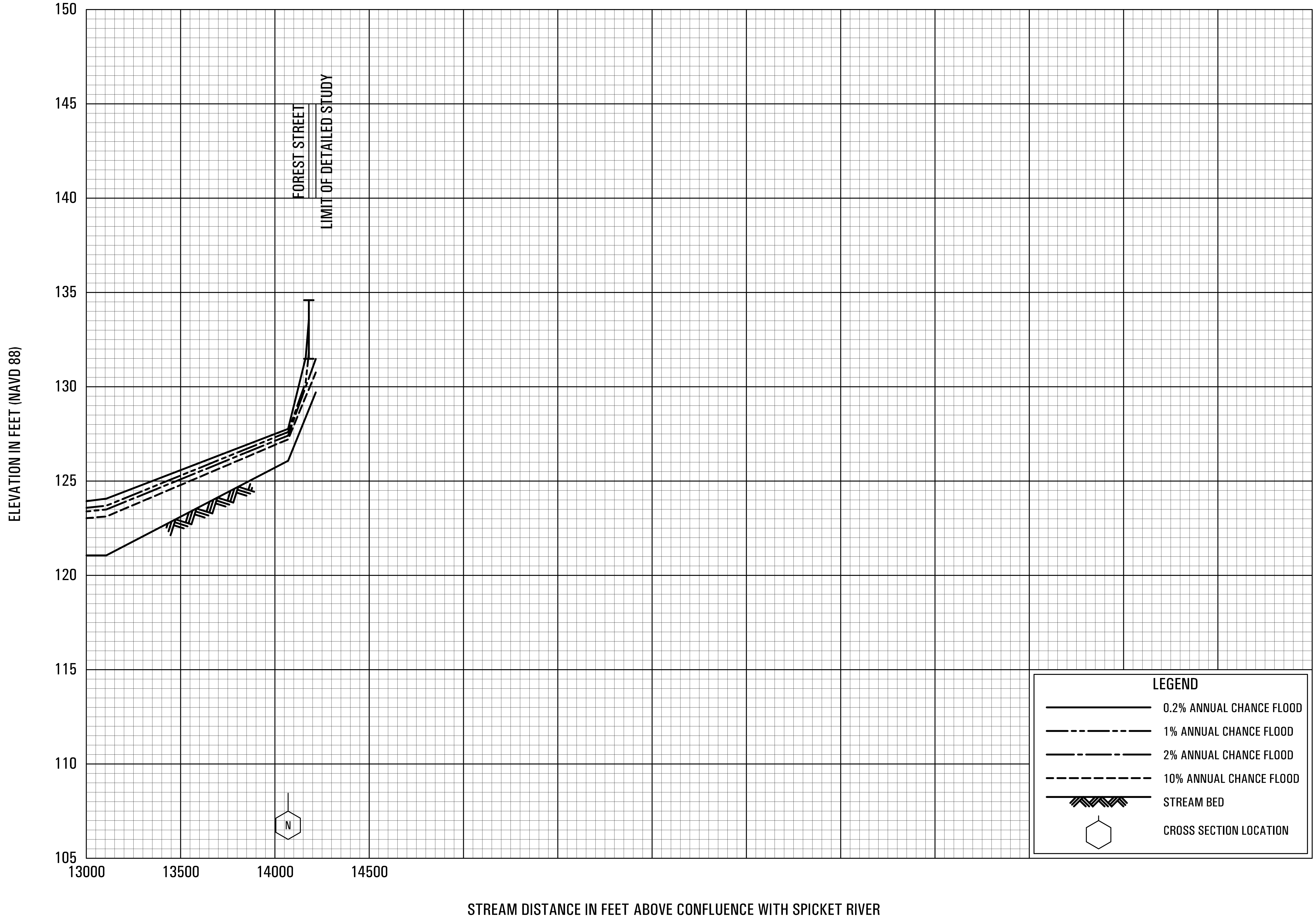
FLOOD PROFILES

PEAT MEADOW BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



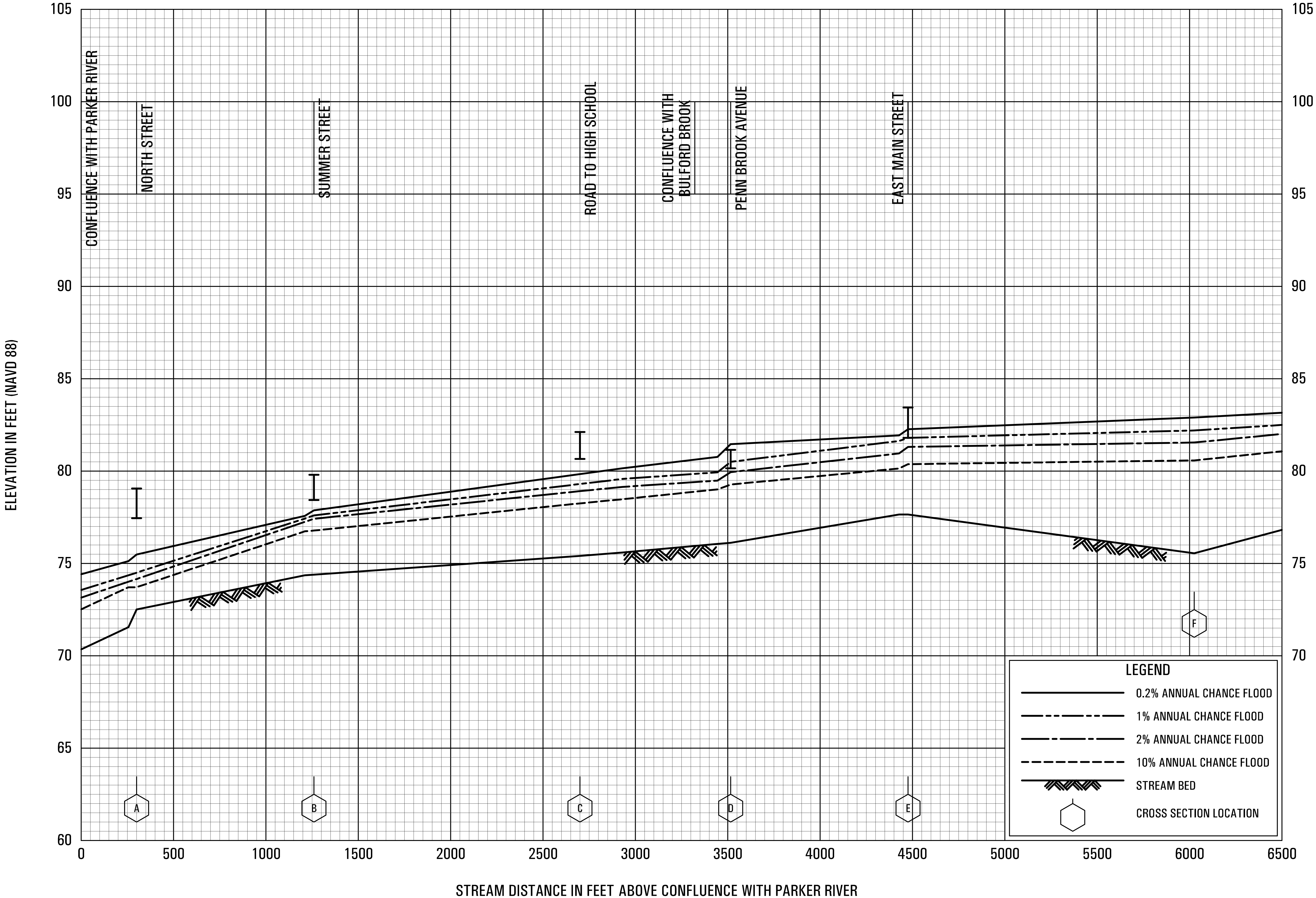
FLOOD PROFILES

PEAT MEADOW BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



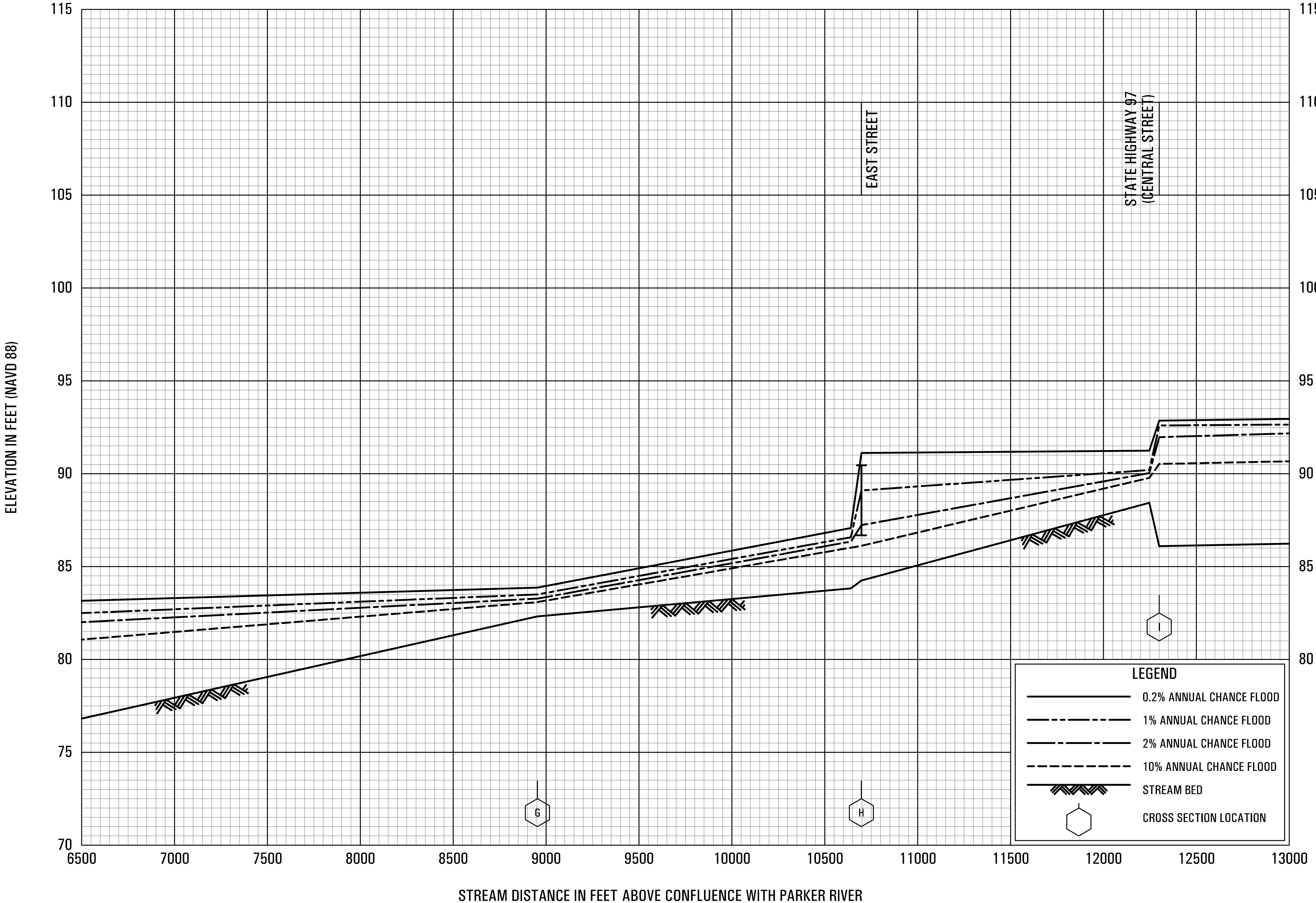
FLOOD PROFILES

PENN BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



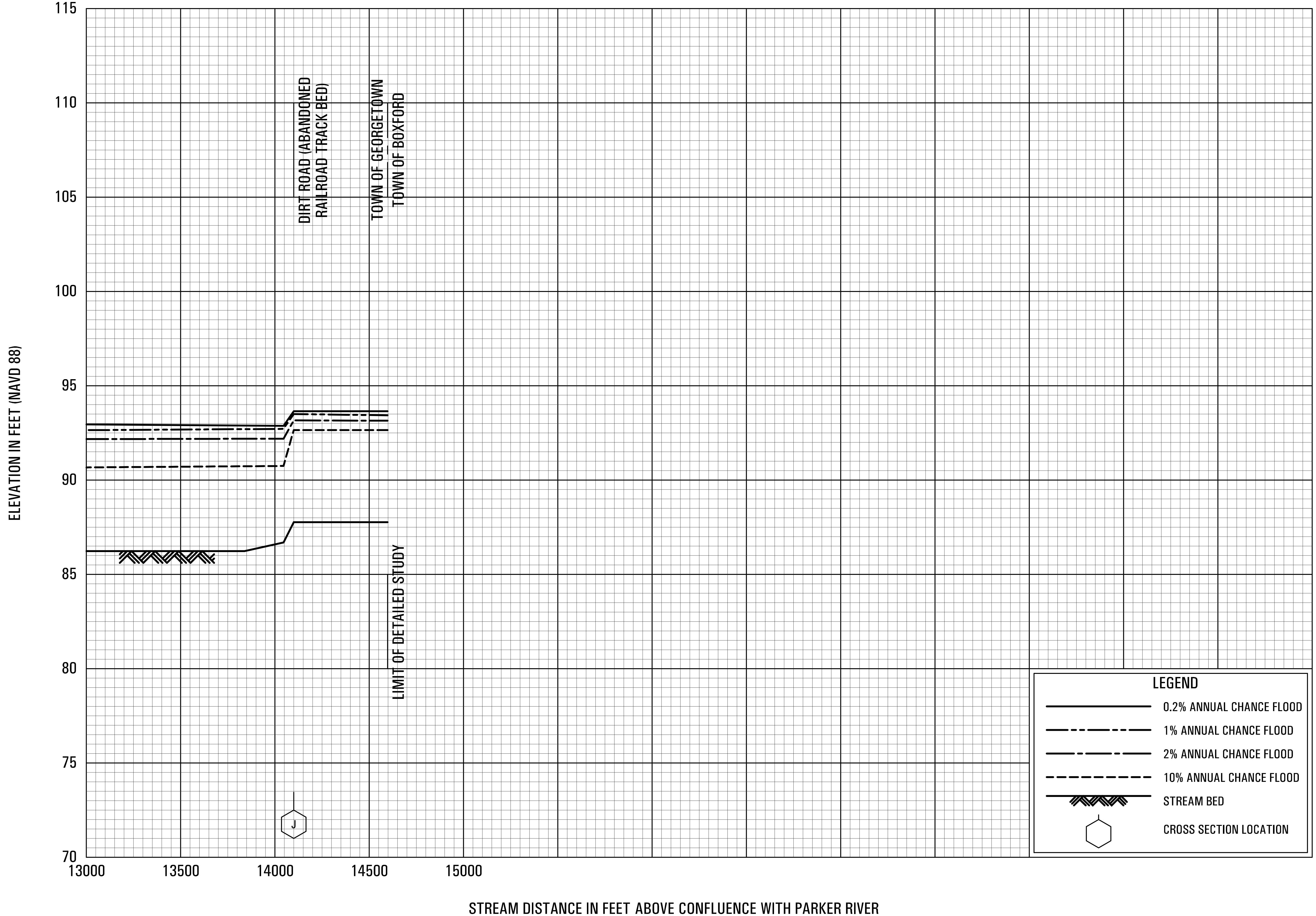
FLOOD PROFILES

PENN BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



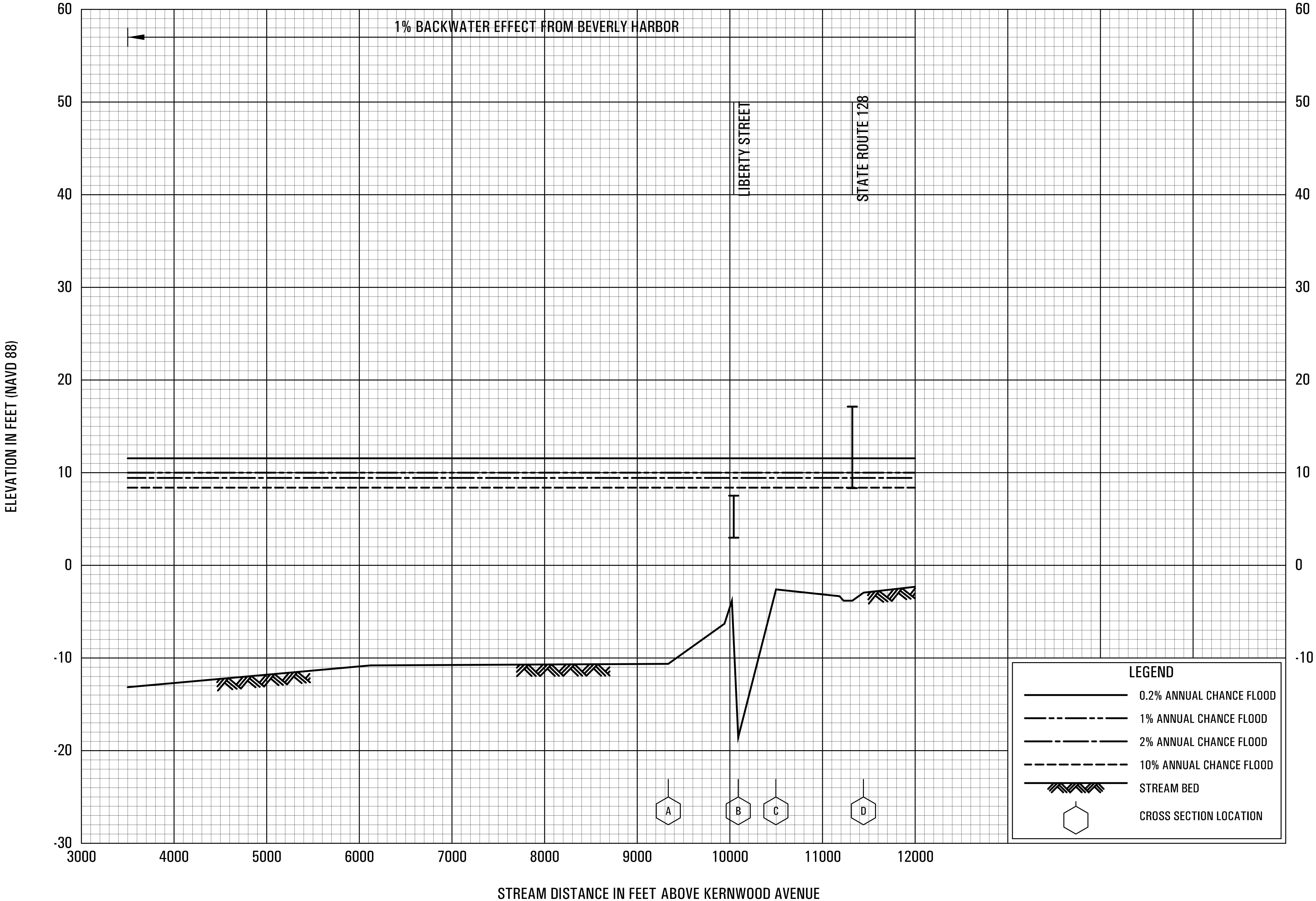
FLOOD PROFILES

PENN BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



FLOOD PROFILES

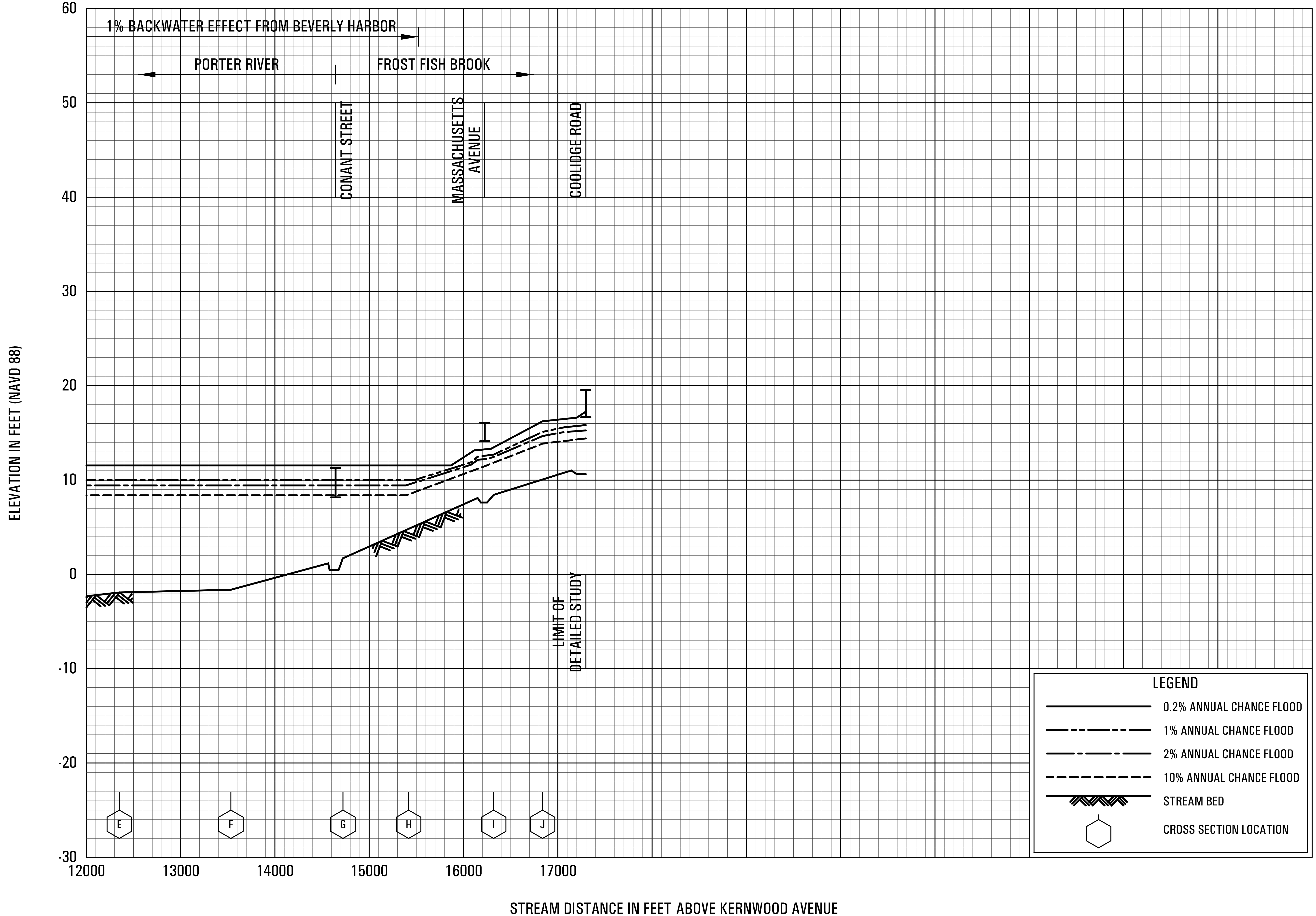
PORTER RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

128P

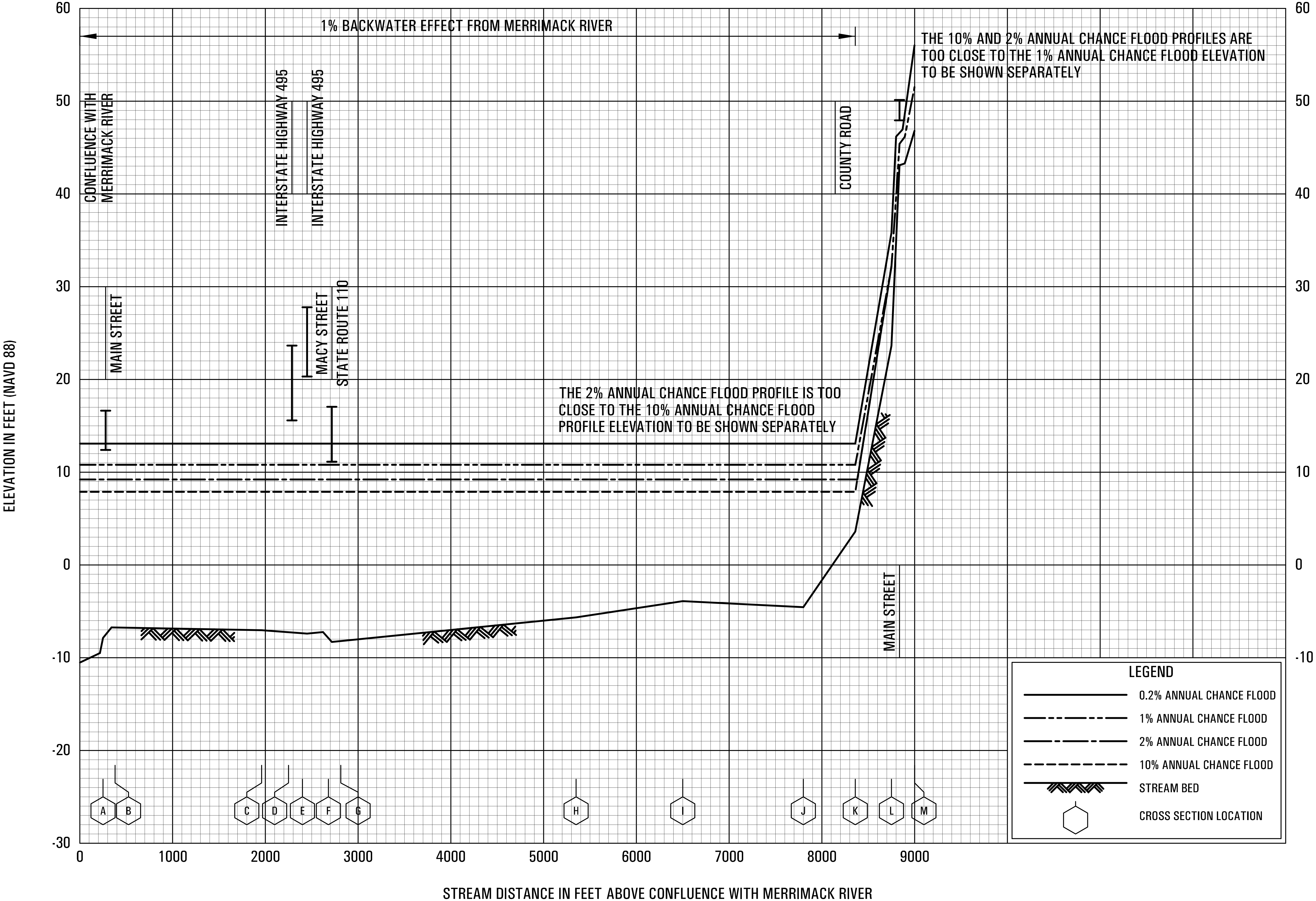


FLOOD PROFILES

PORTER RIVER AND FROST FISH BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA
(ALL JURISDICTIONS)



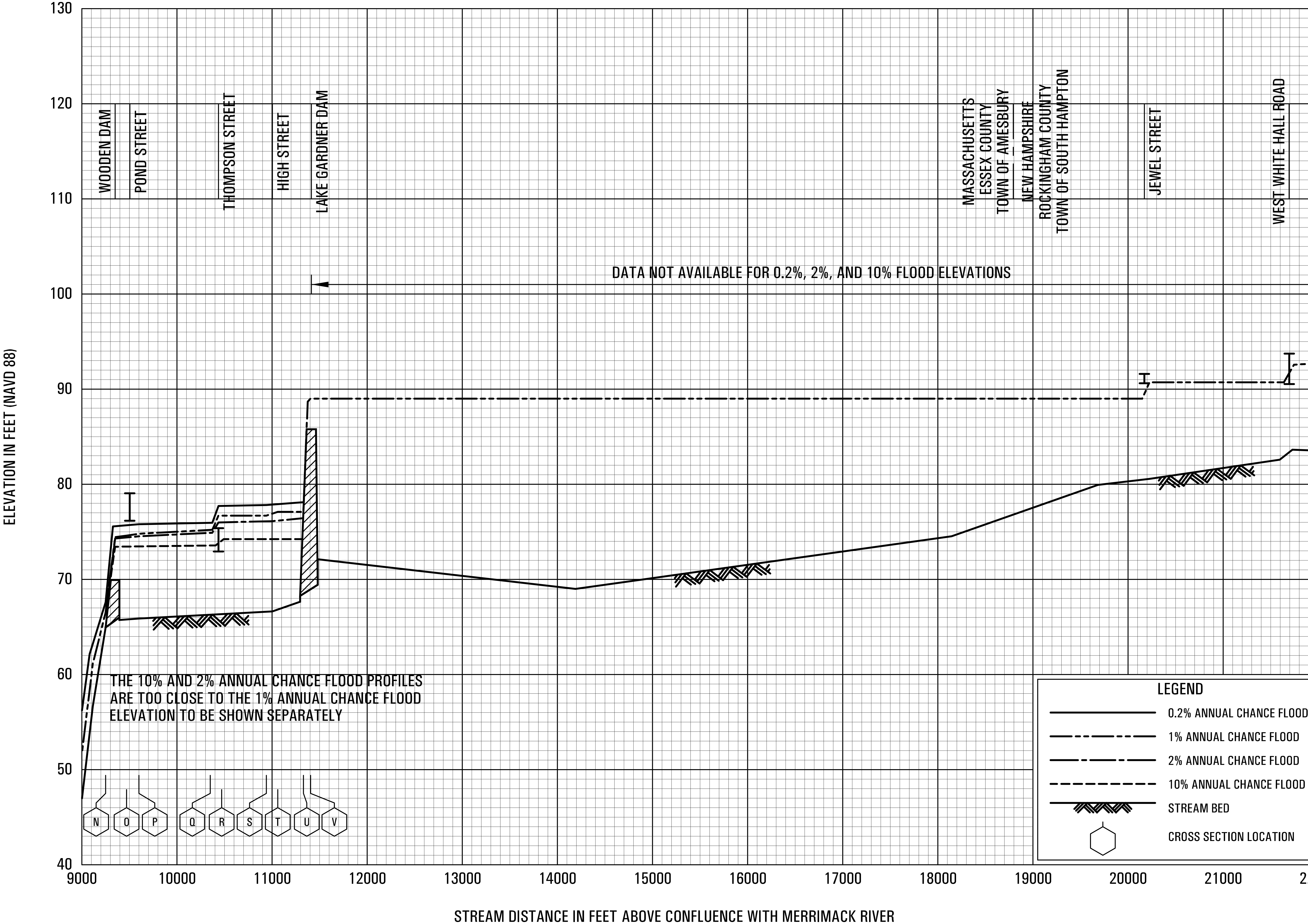
FLOOD PROFILES

POWWOW RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



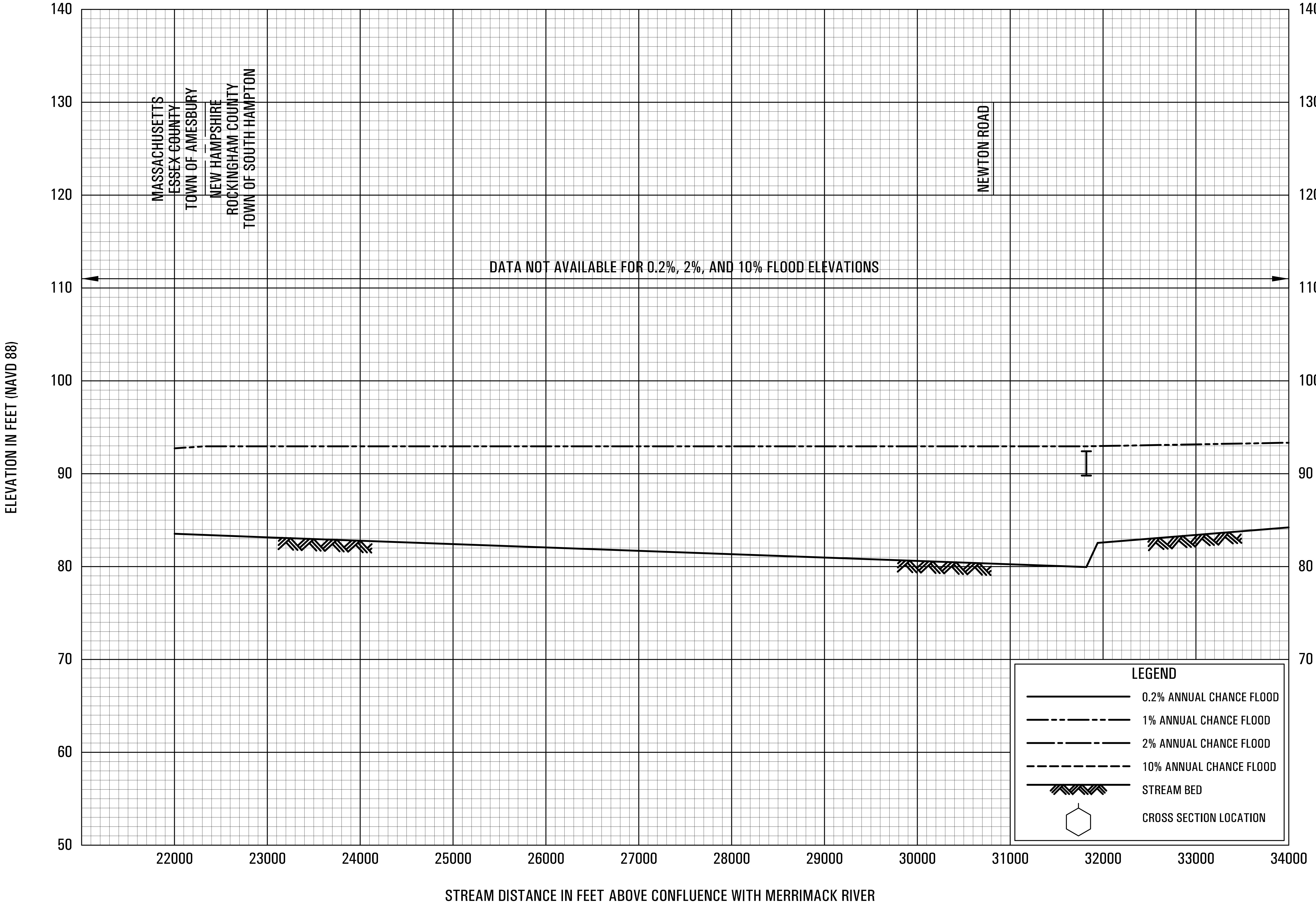
FLOOD PROFILES

POWWOW RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



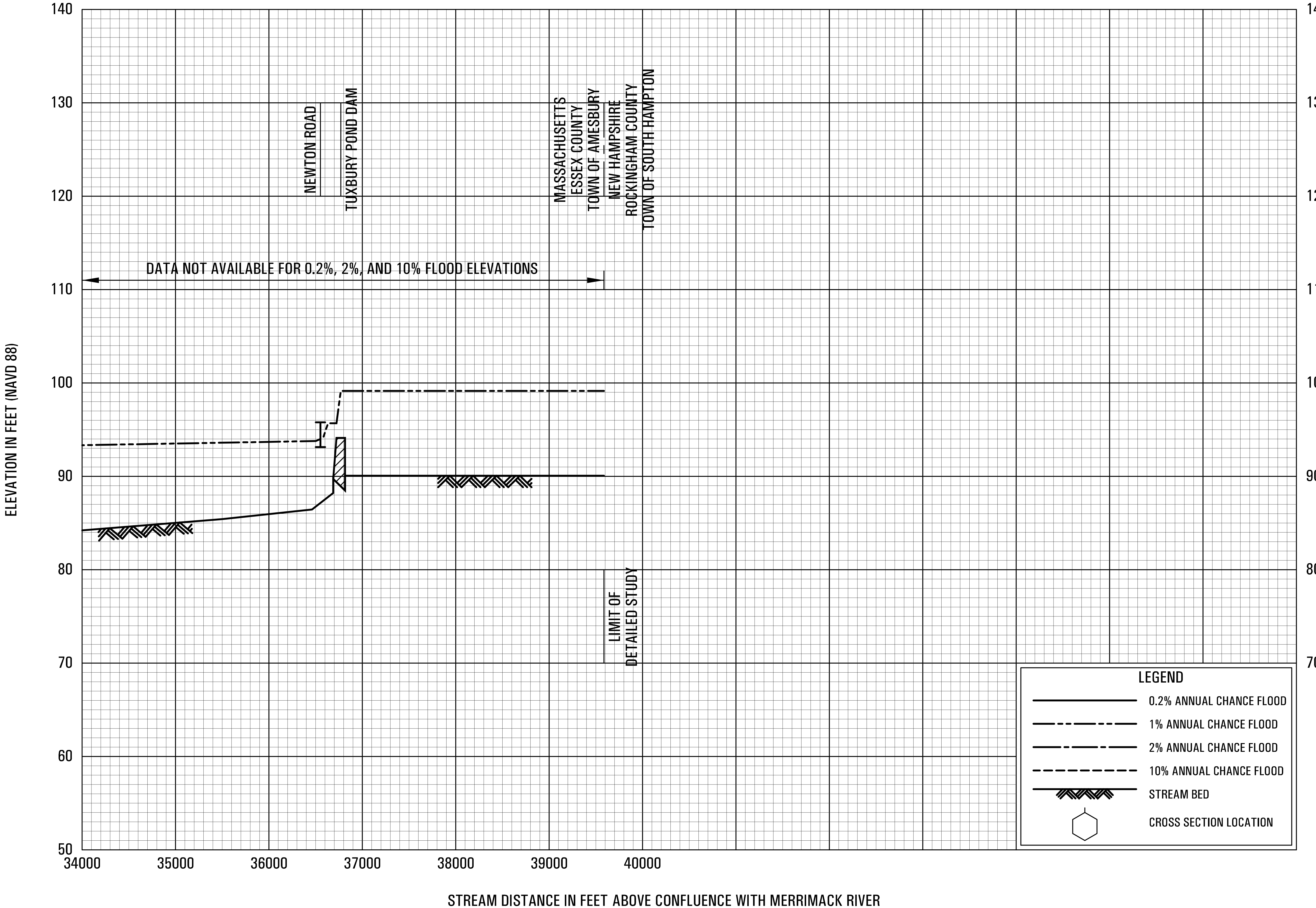
FLOOD PROFILES

POWWOW RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



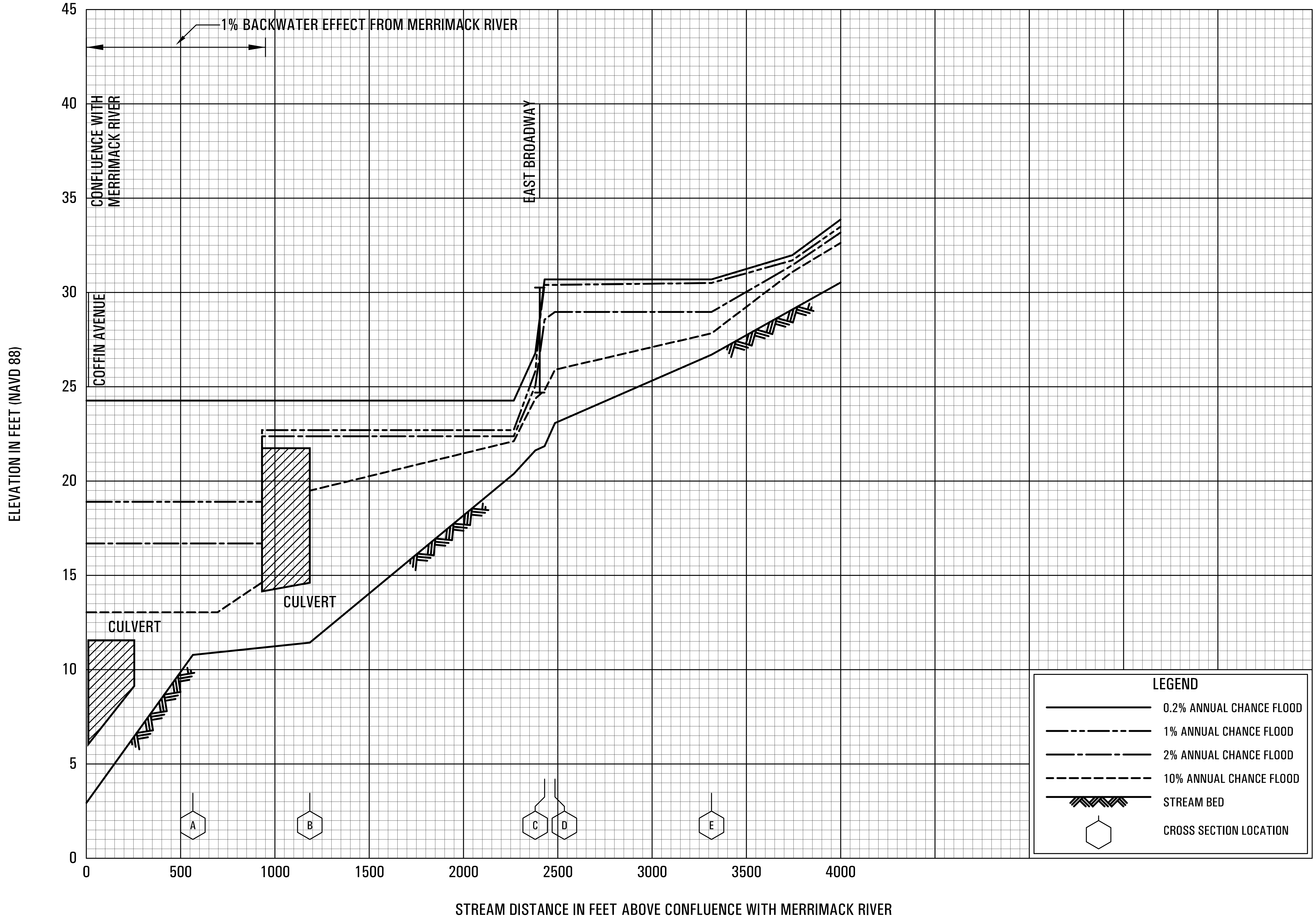
FLOOD PROFILES

POWWOW RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



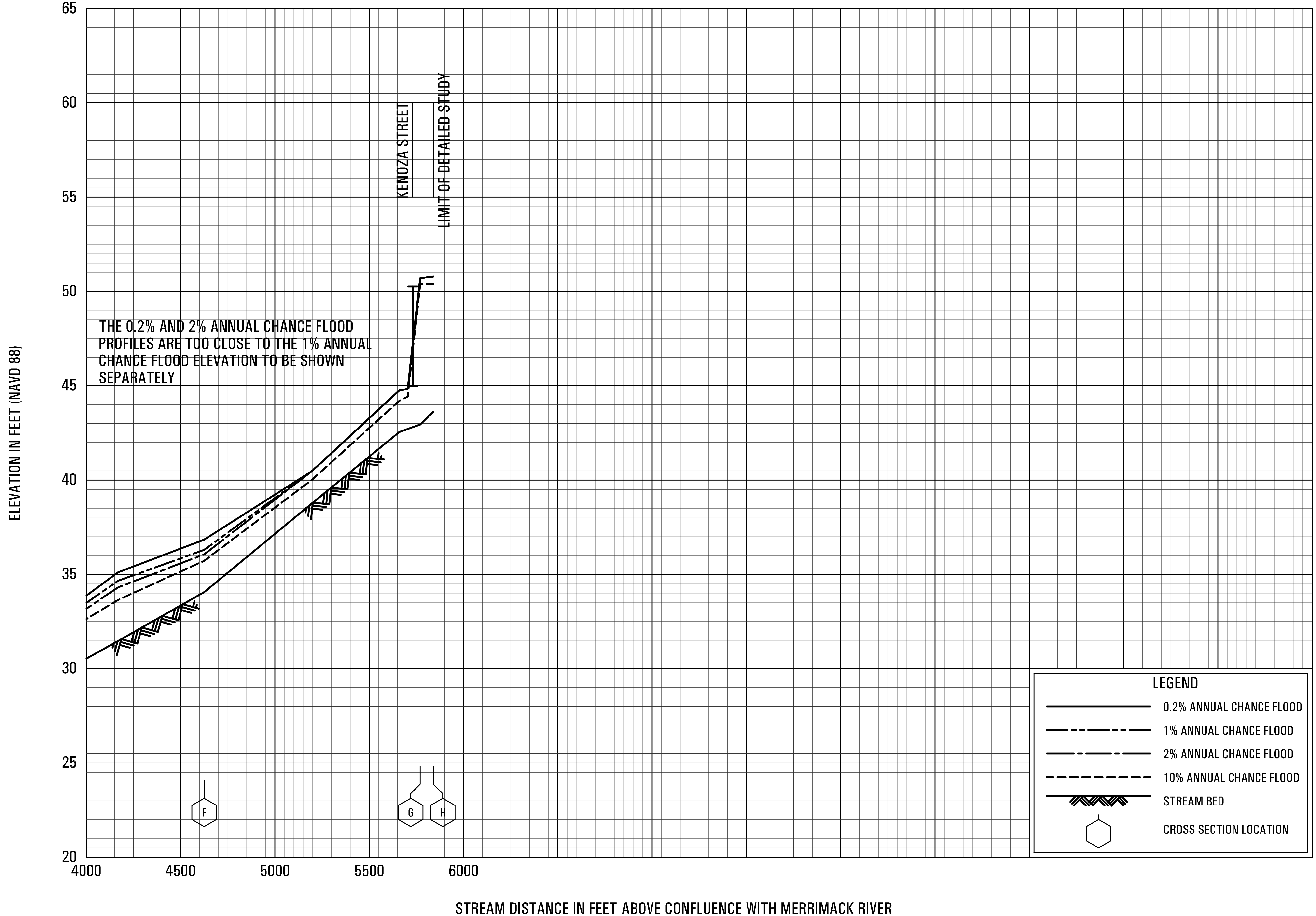
FLOOD PROFILES

RIVERSIDE AIRPORT BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



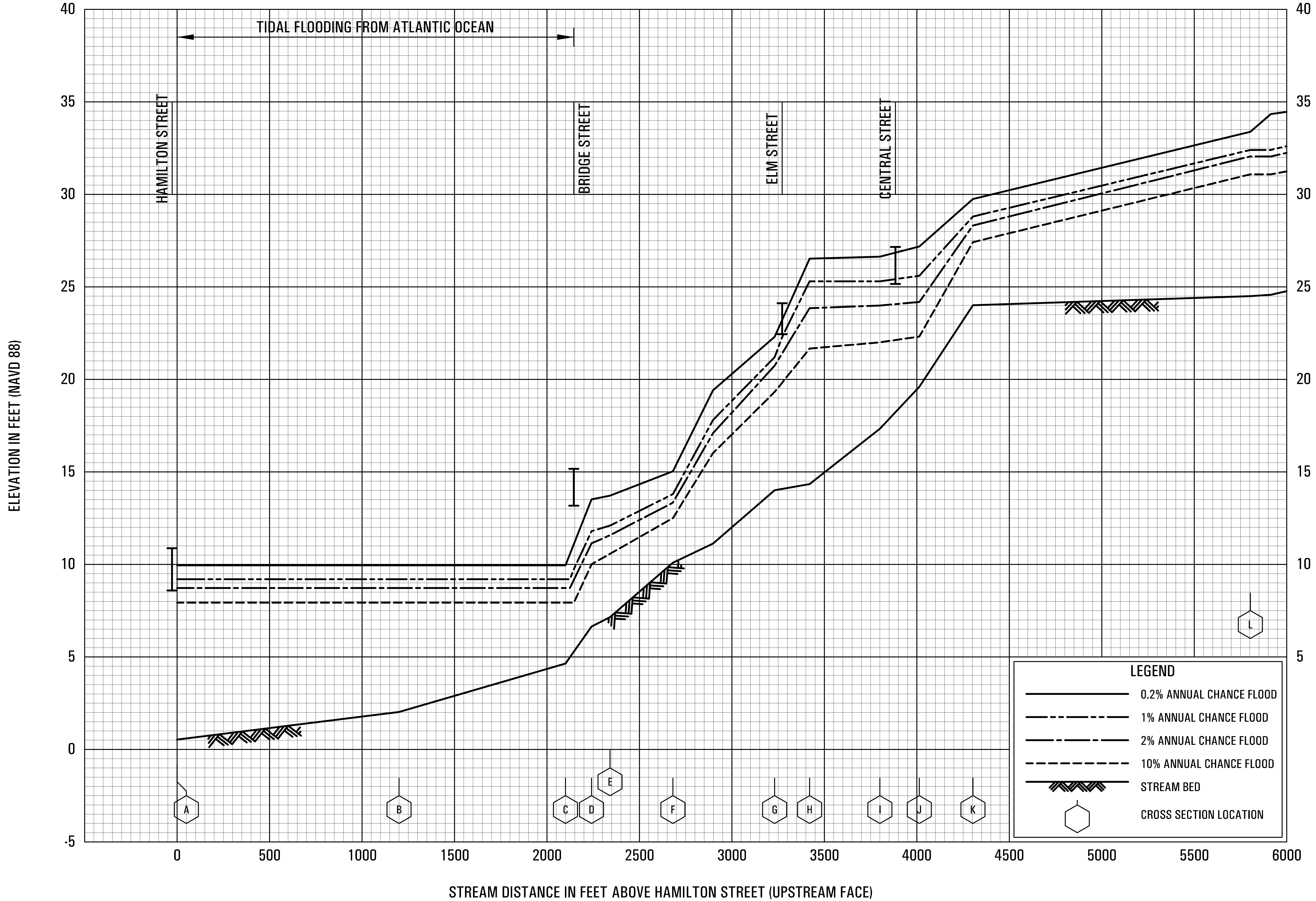
FLOOD PROFILES

RIVERSIDE AIRPORT BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



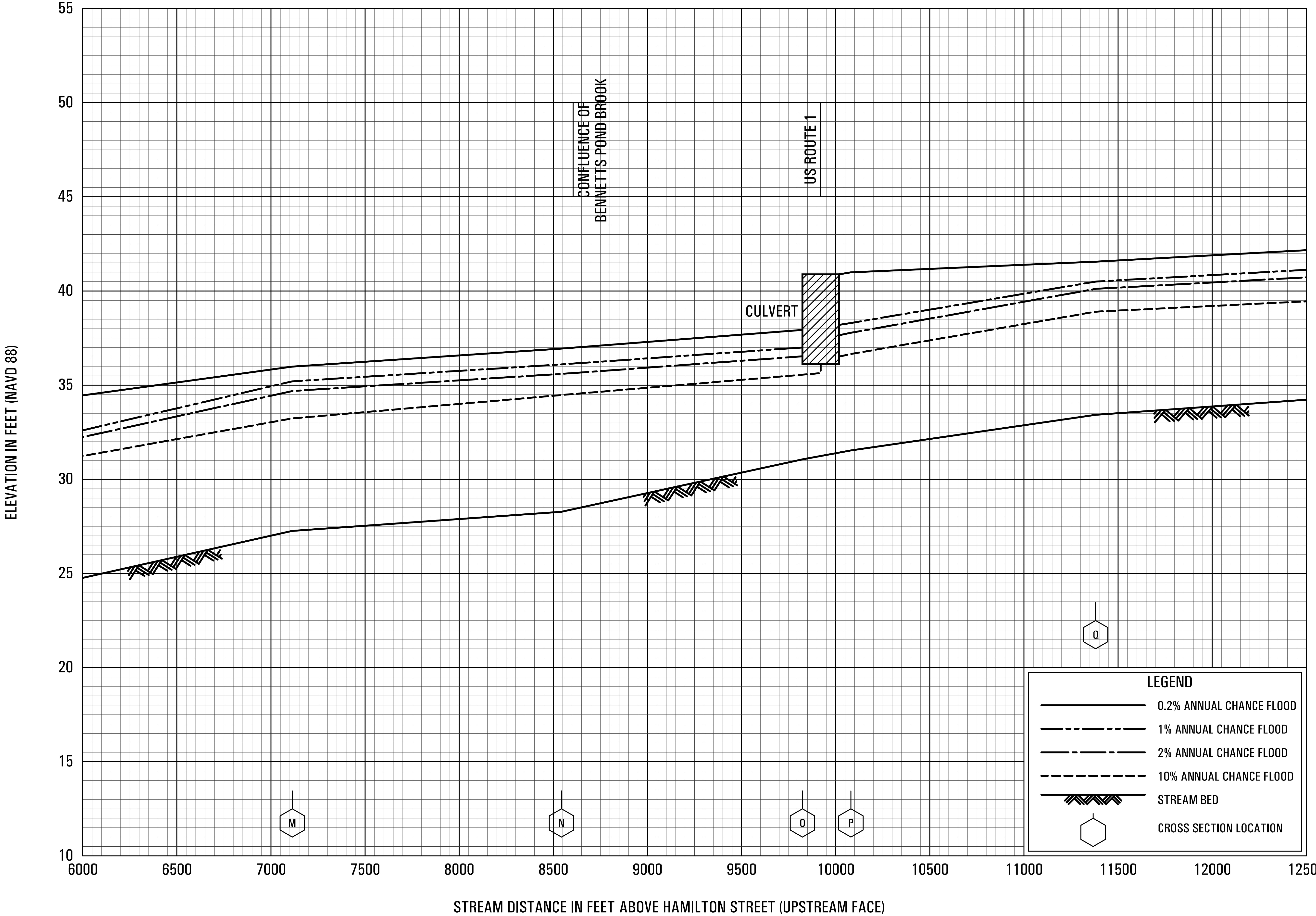
FLOOD PROFILES

SAUGUS RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



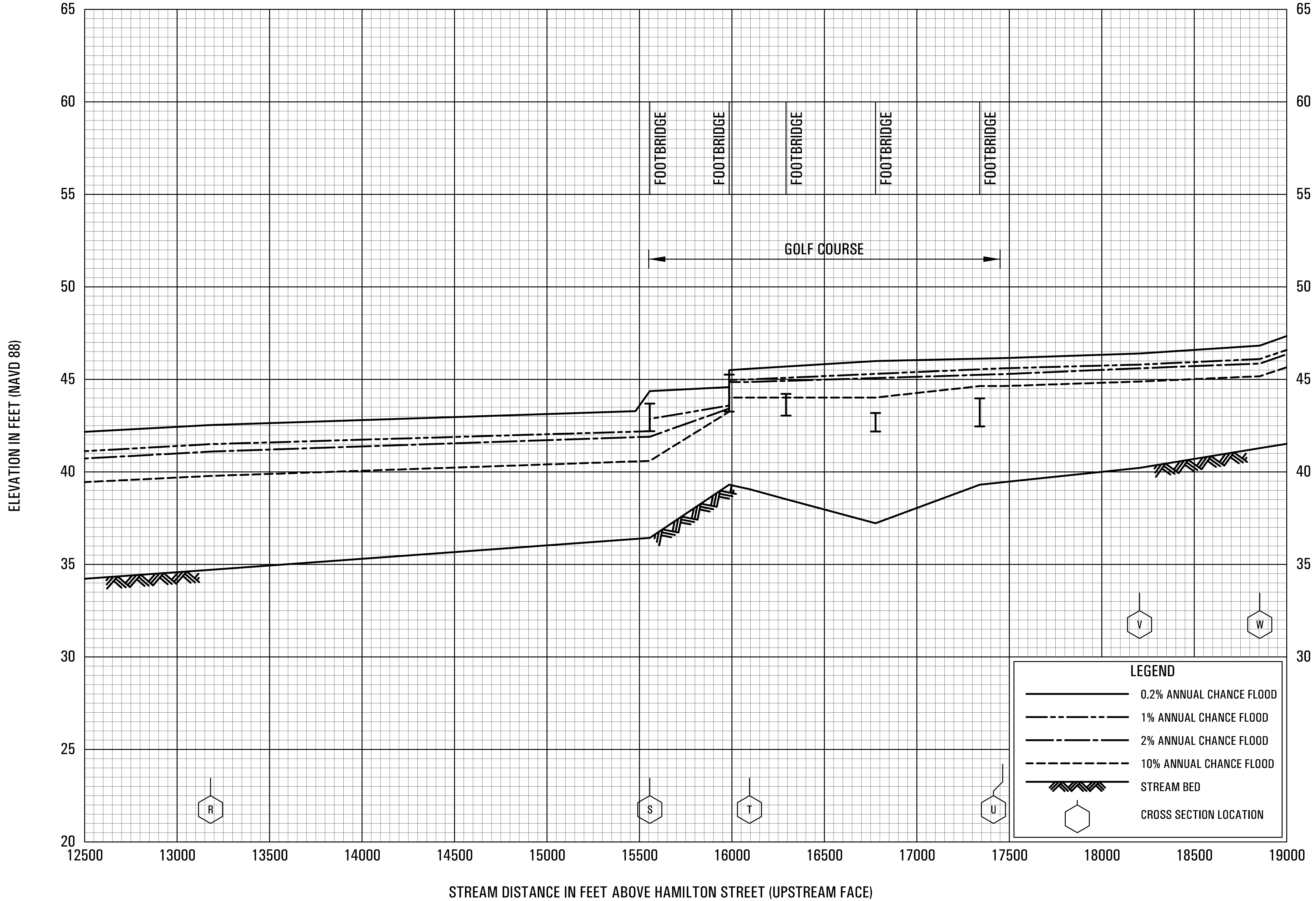
FLOOD PROFILES

SAUGUS RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



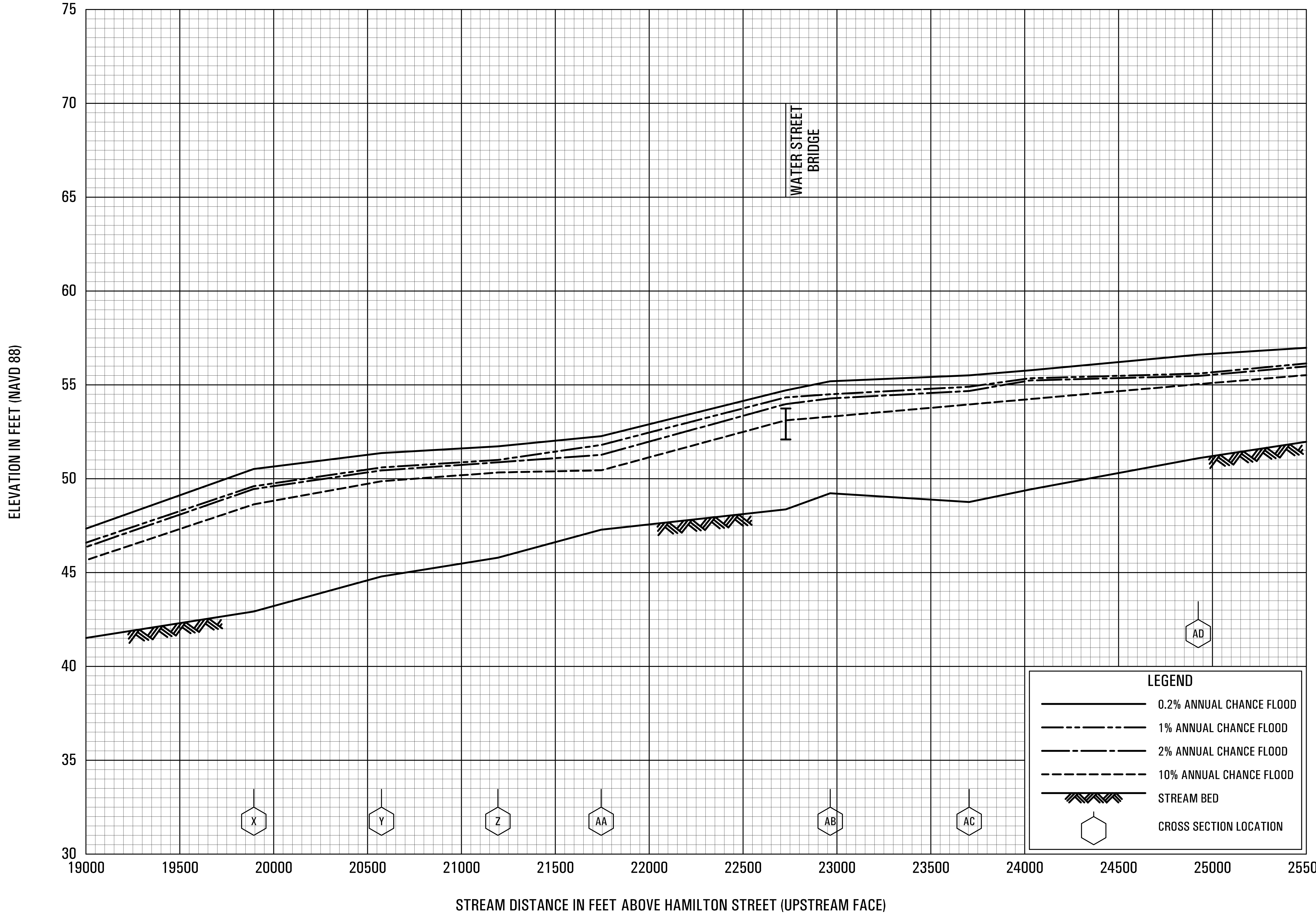
FLOOD PROFILES

SAUGUS RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



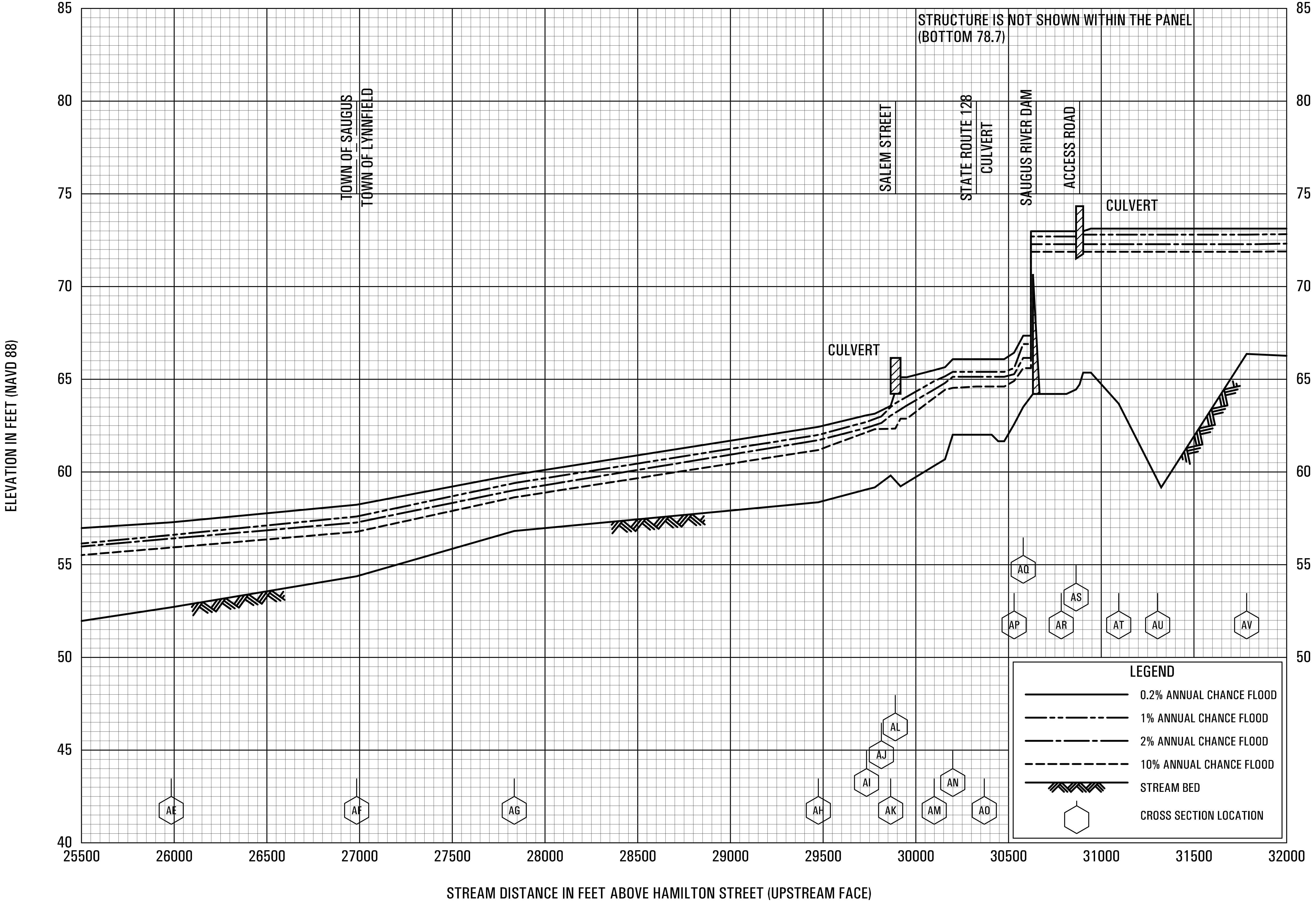
FLOOD PROFILES

SAUGUS RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



FLOOD PROFILES

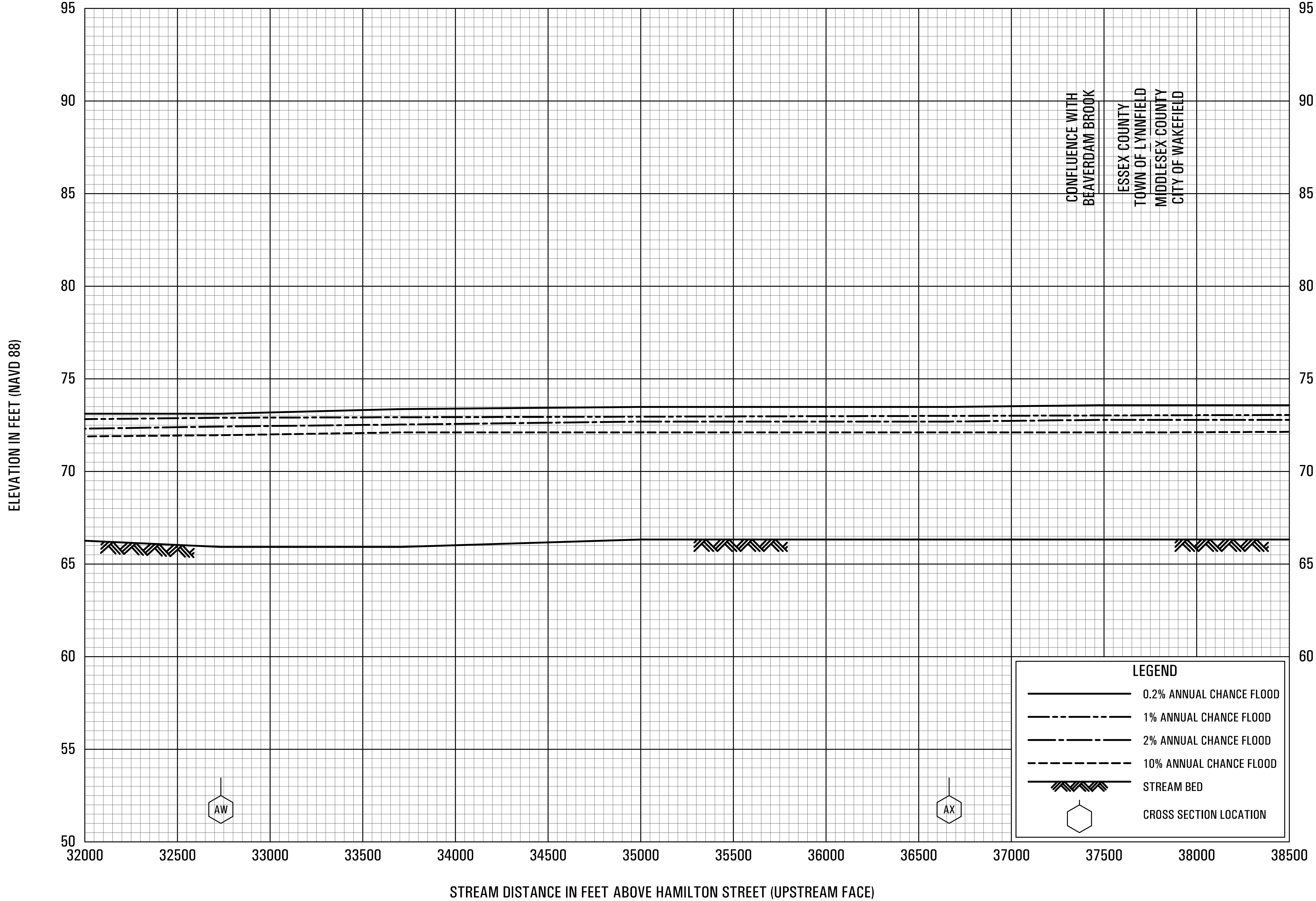
SAUGUS RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

140P



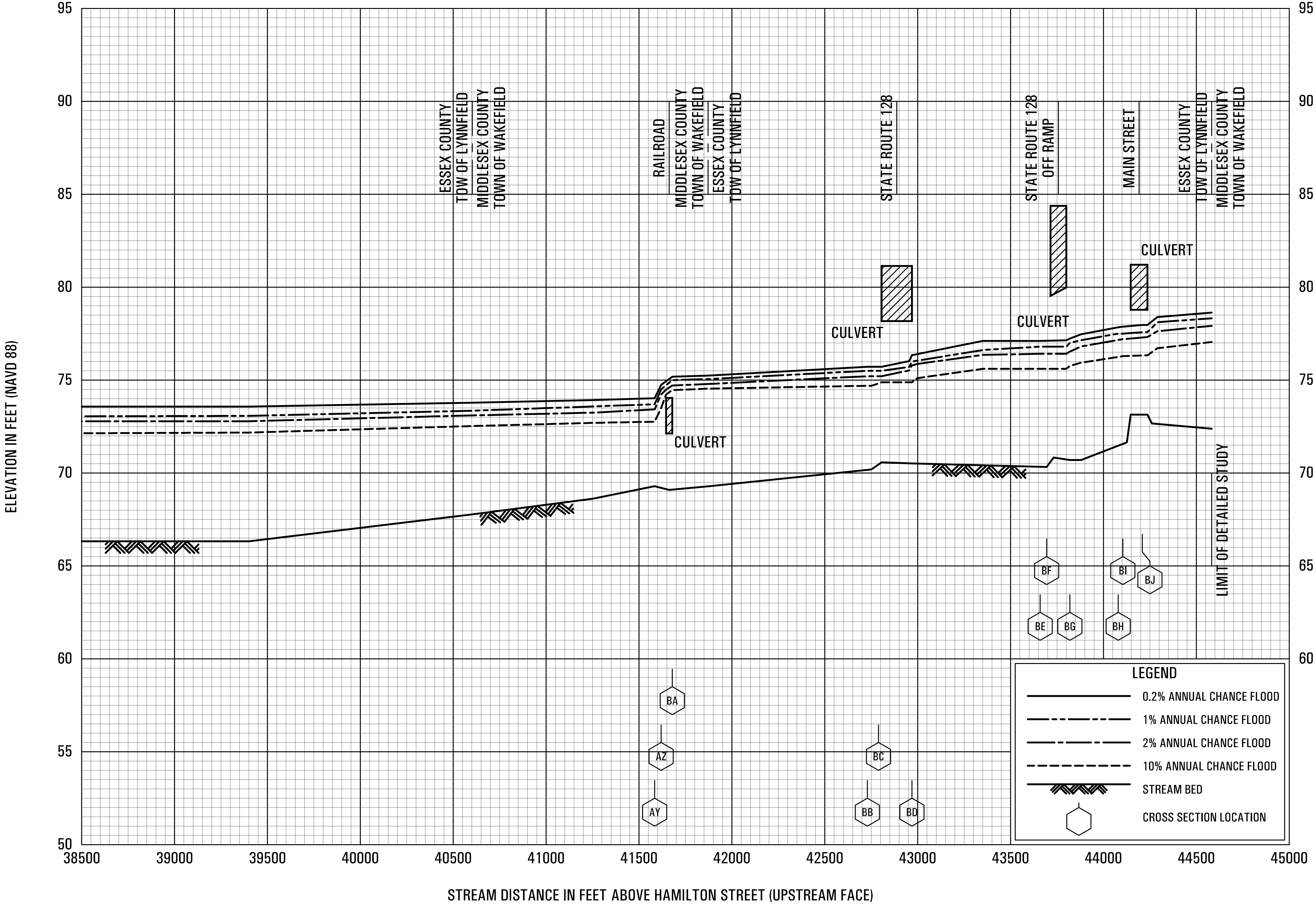
FLOOD PROFILES

SAUGUS RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



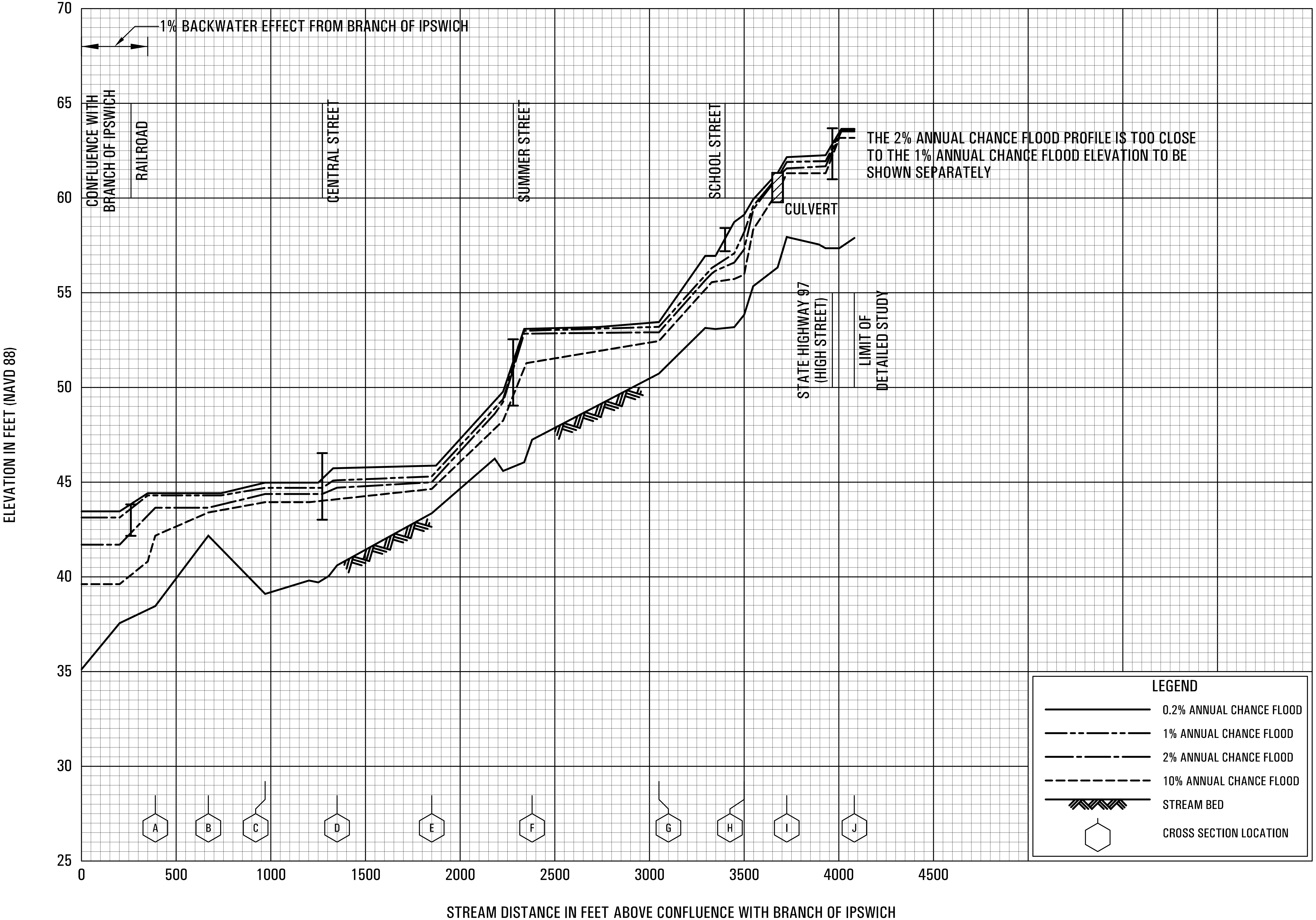
FLOOD PROFILES

SAUGUS RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



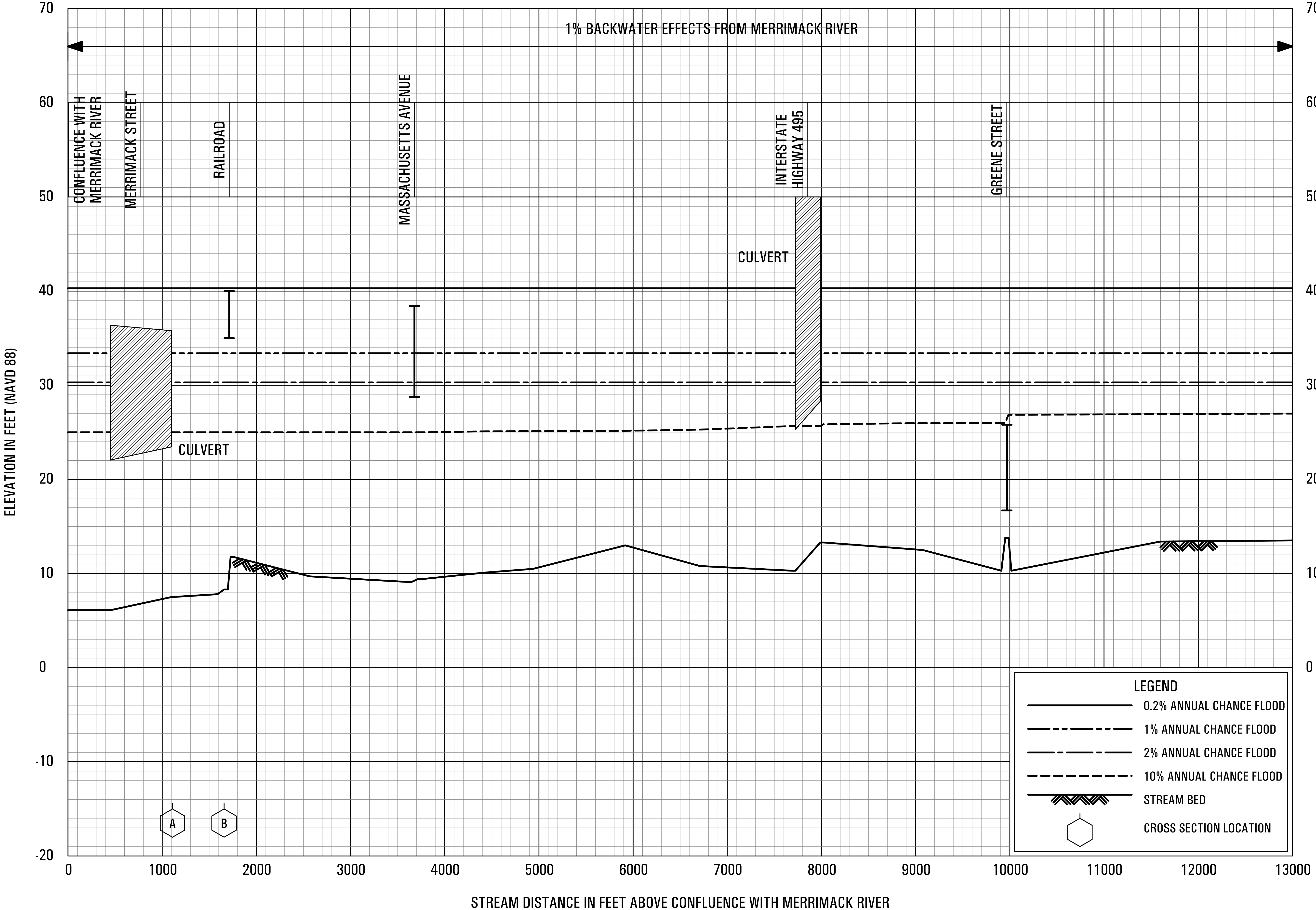
FLOOD PROFILES

SCHOOL BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



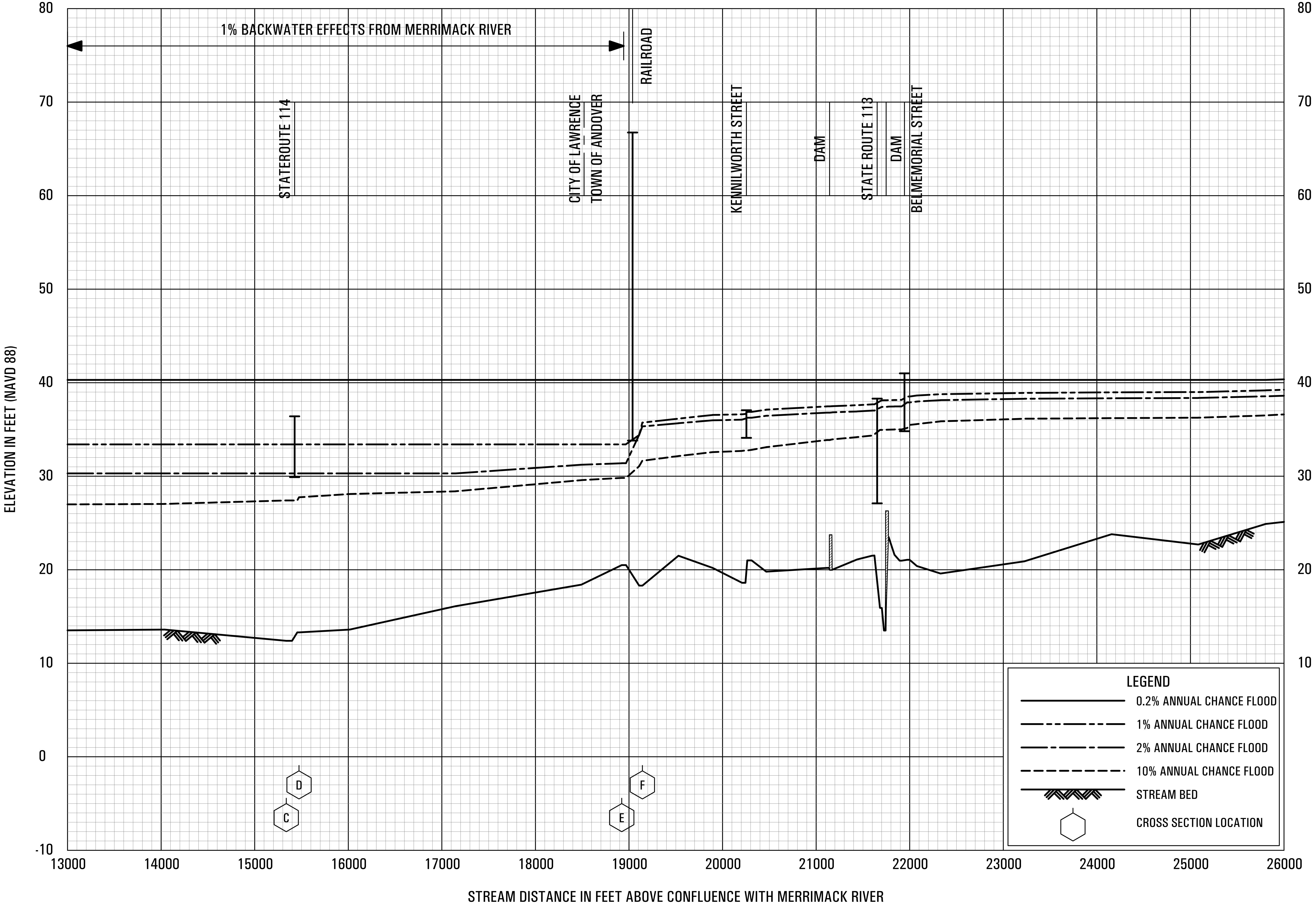
FLOOD PROFILES

SHAWSHEEN RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



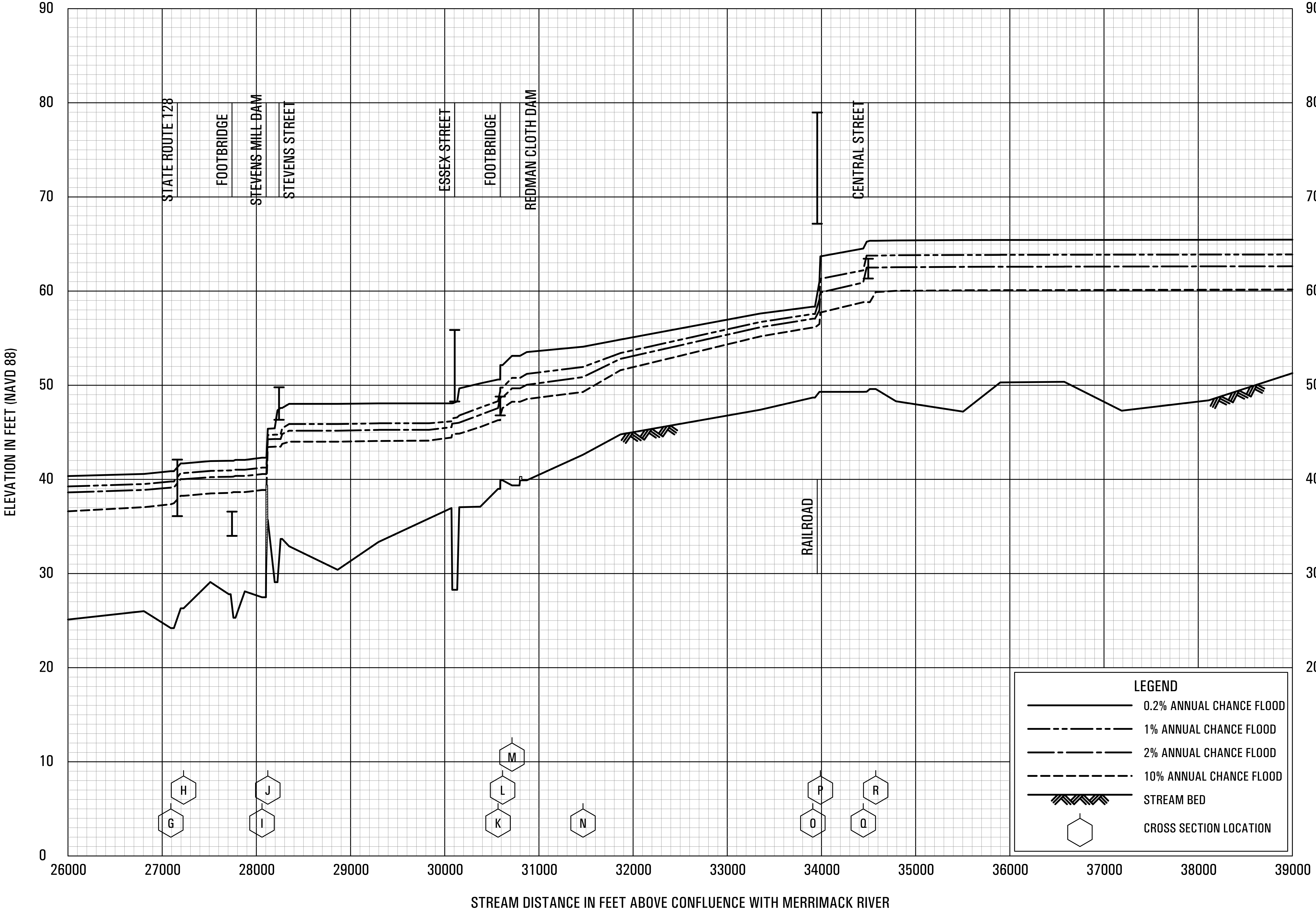
FLOOD PROFILES

SHAWSHEEN RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



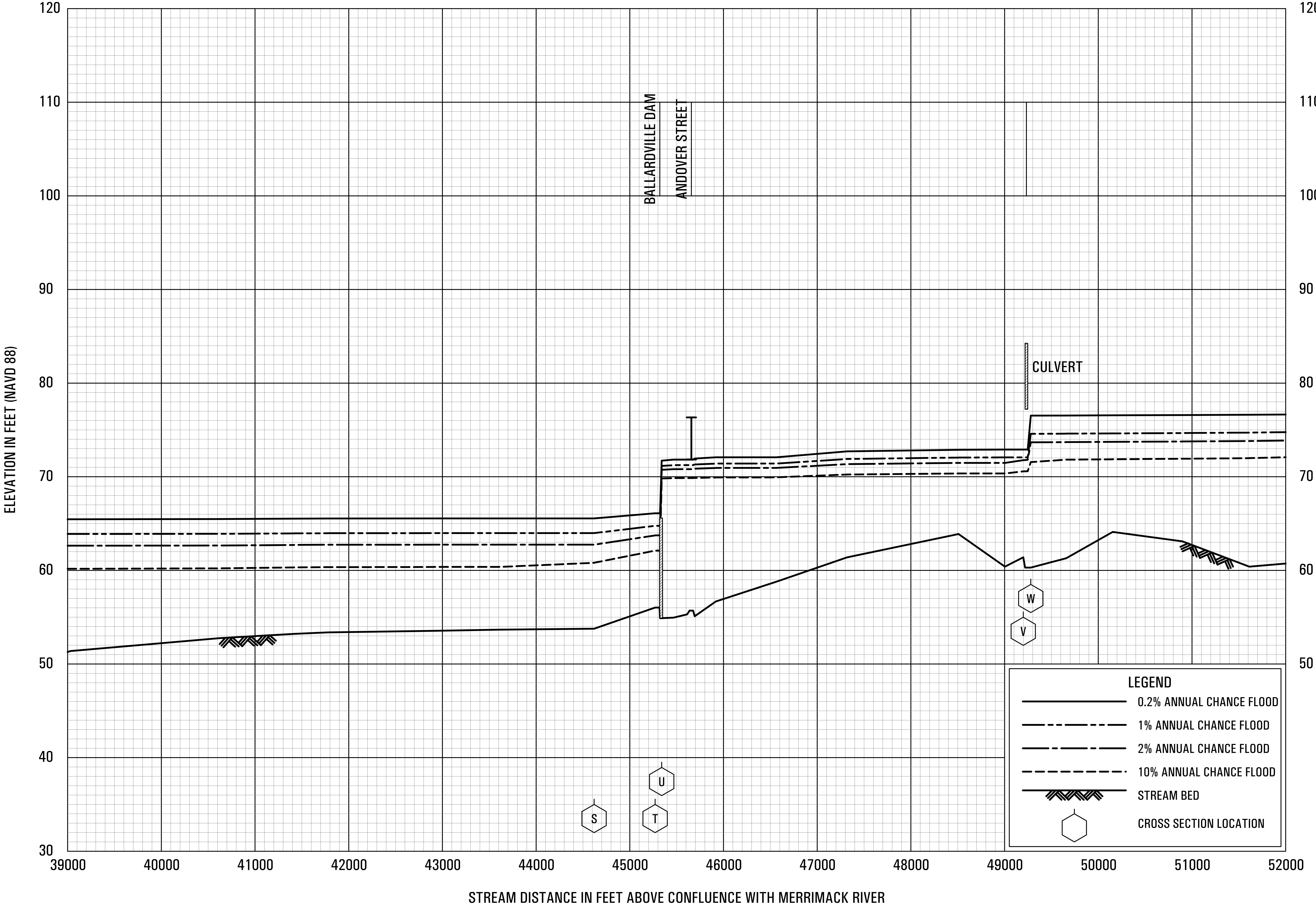
FLOOD PROFILES

SHAWSHEEN RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



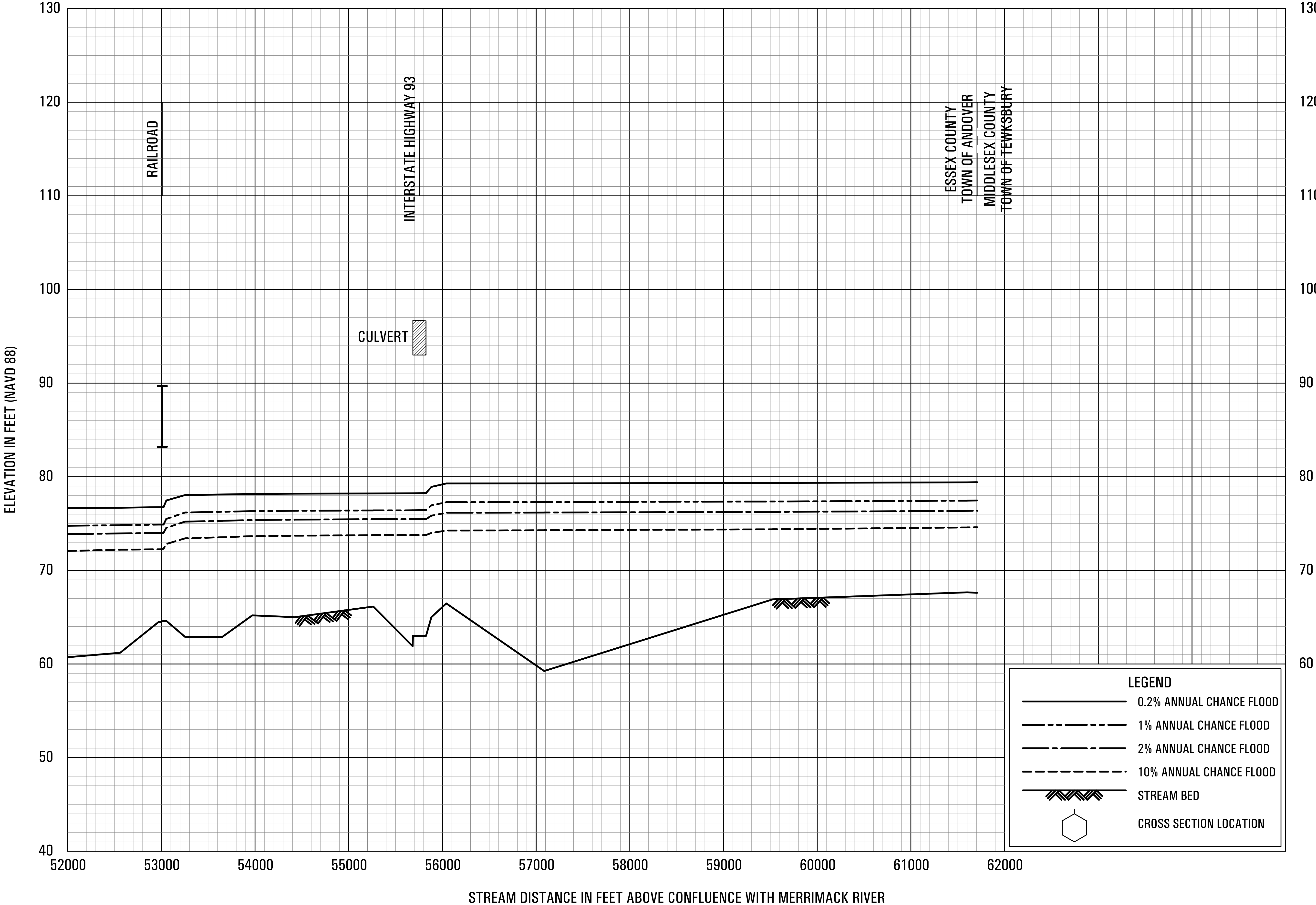
FLOOD PROFILES

SHAWSHEEN RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



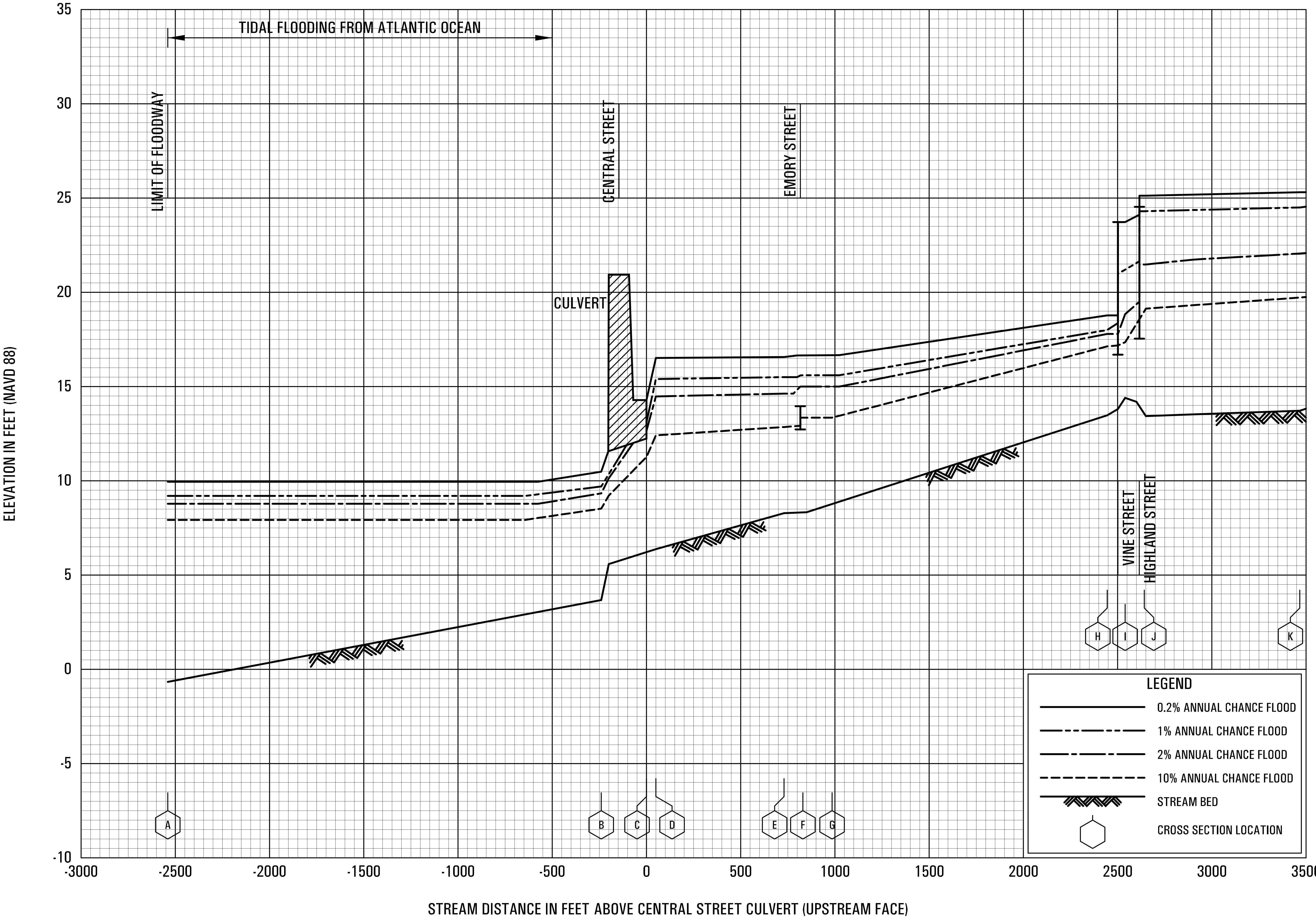
FLOOD PROFILES

SHAWSHEEN RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



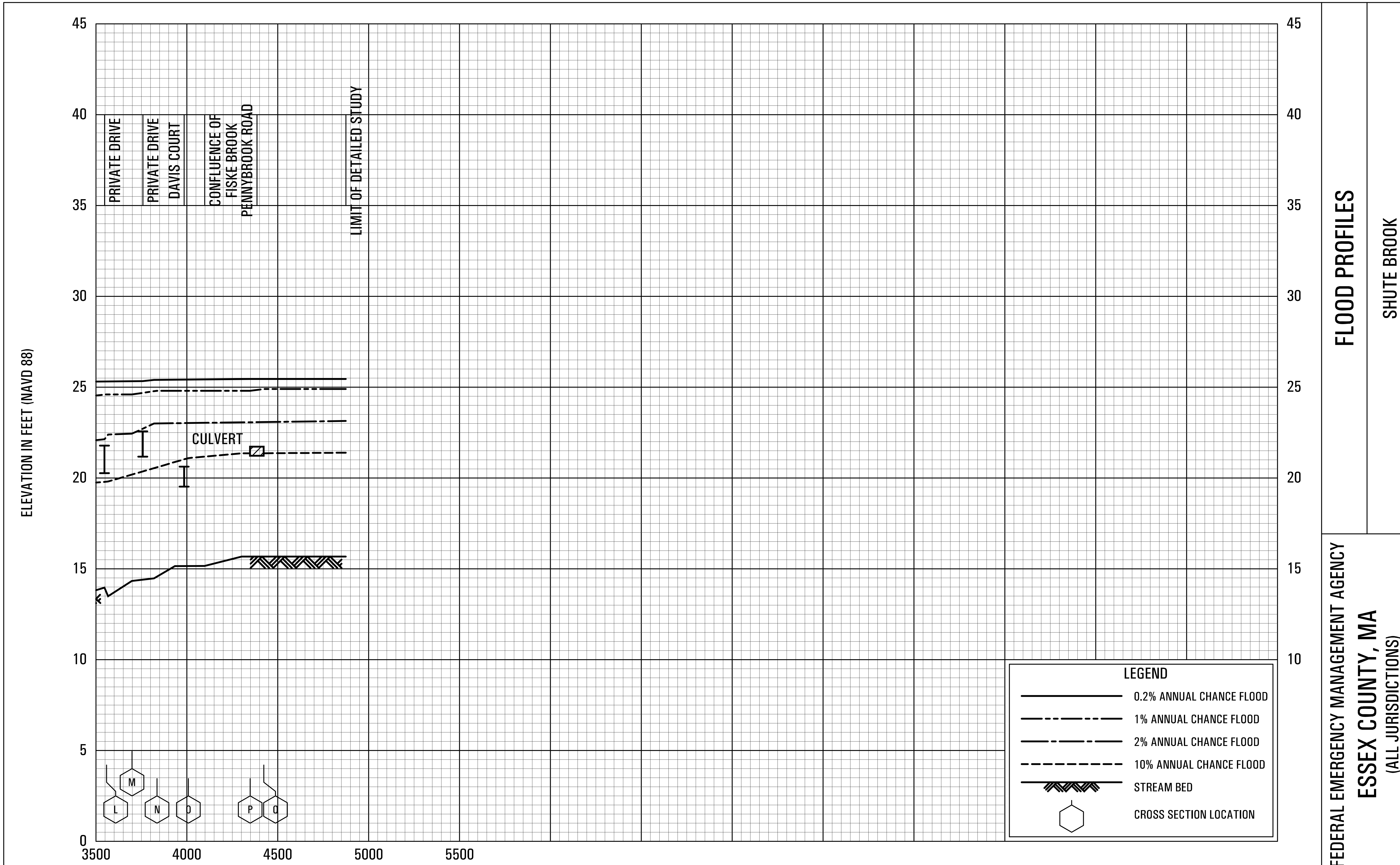
FLOOD PROFILES

SHUTE BROOK

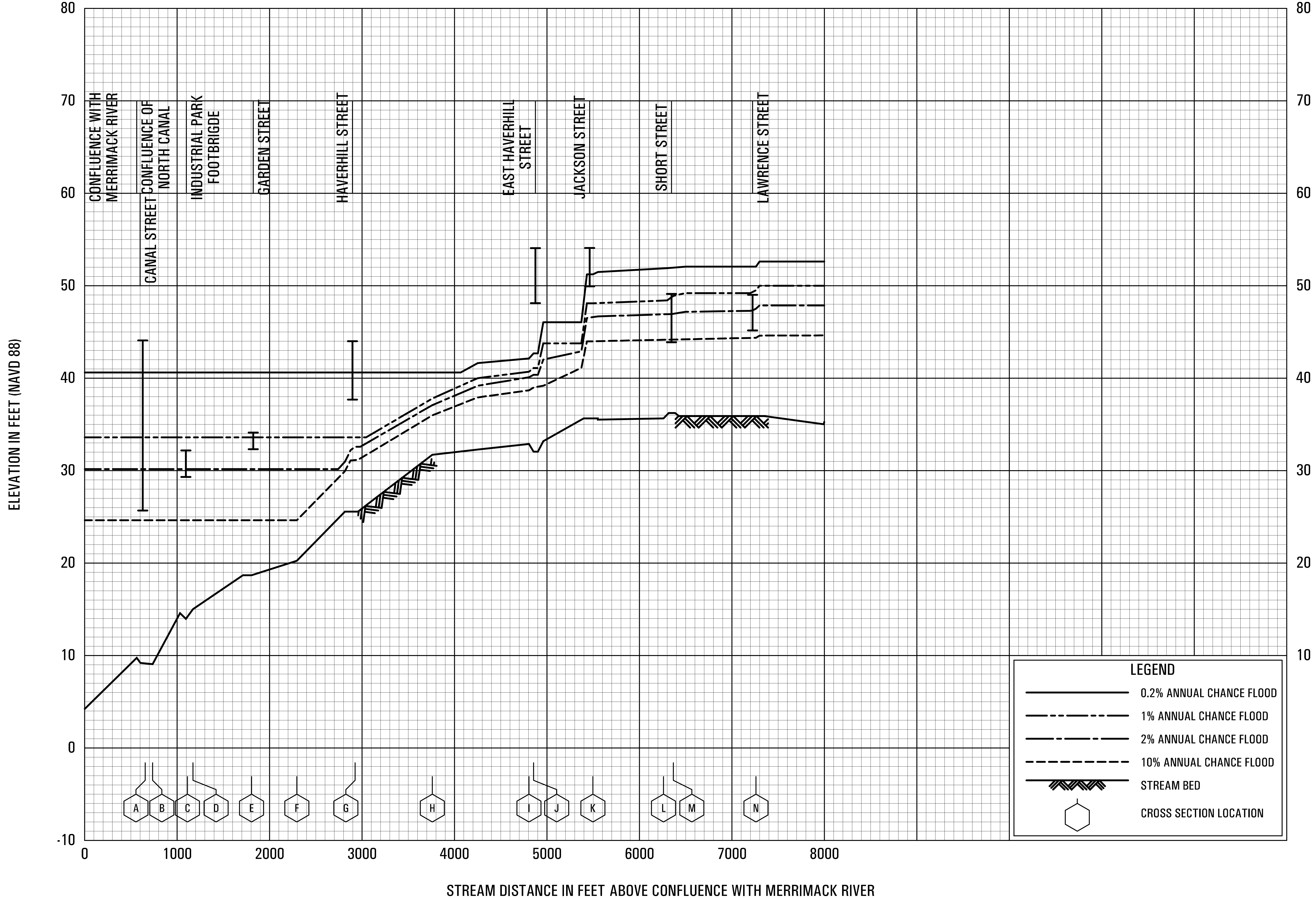
FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



PRIVATE DRIVE
PRIVATE DRIVE
DAVIS COURT
CONFLUENCE OF
FISKE BROOK
PENNYBROOK ROAD
LIMIT OF DETAILED STUDY
CULVERT
ELEVATION IN FEET (NAVD 88)
STREAM DISTANCE IN FEET ABOVE CENTRAL STREET CULVERT (UPSTREAM FACE)
45
40
35
30
25
20
15
10
5
0
3500
4000
4500
5000
5500
L
M
N
O
P
Q
LEGEND
0.2% ANNUAL CHANCE FLOOD
1% ANNUAL CHANCE FLOOD
2% ANNUAL CHANCE FLOOD
10% ANNUAL CHANCE FLOOD
STREAM BED
CROSS SECTION LOCATION
FLOOD PROFILES
SHUTE BROOK
FEDERAL EMERGENCY MANAGEMENT AGENCY
ESSEX COUNTY, MA
(ALL JURISDICTIONS)



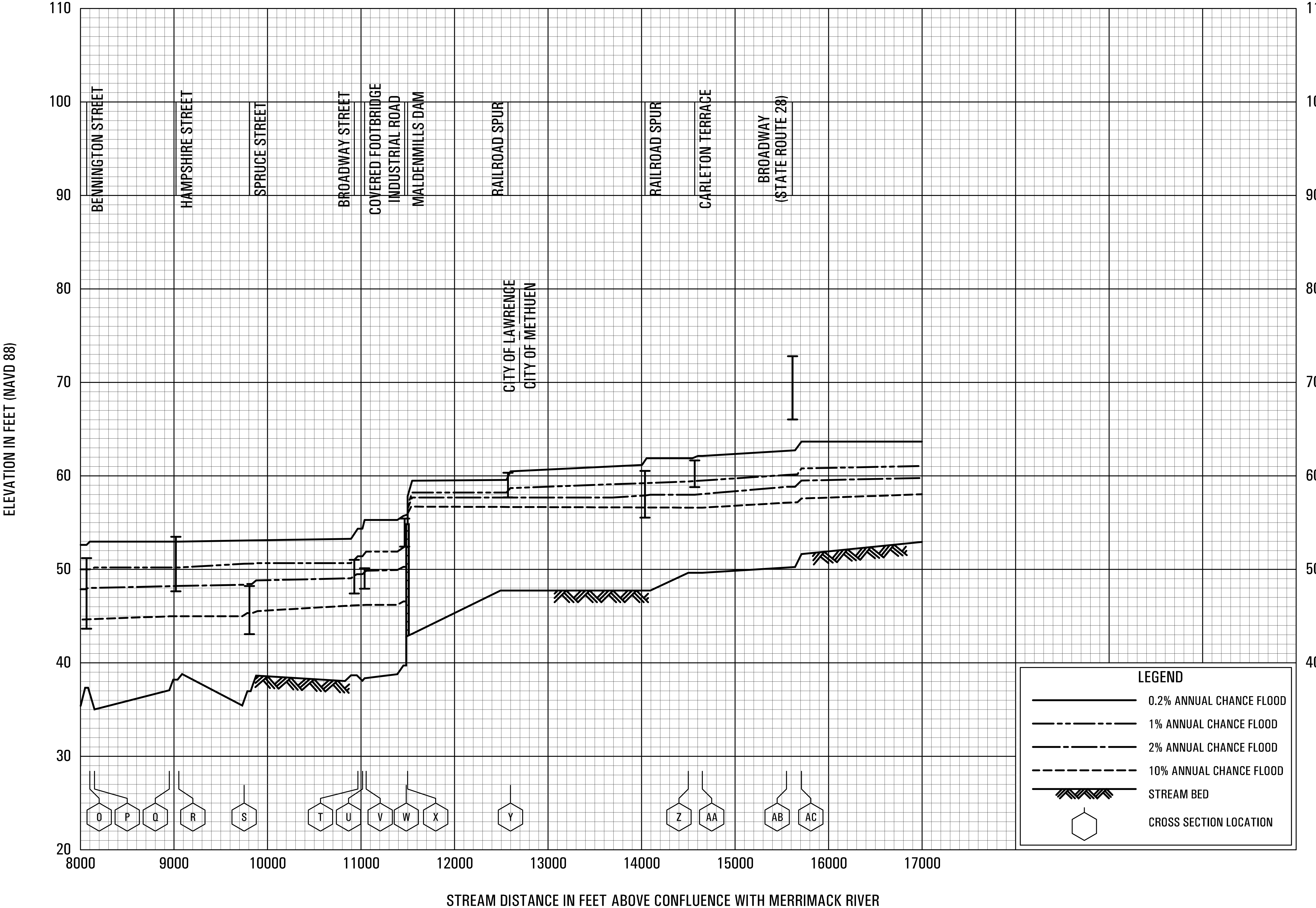
FLOOD PROFILES

SPICKET RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



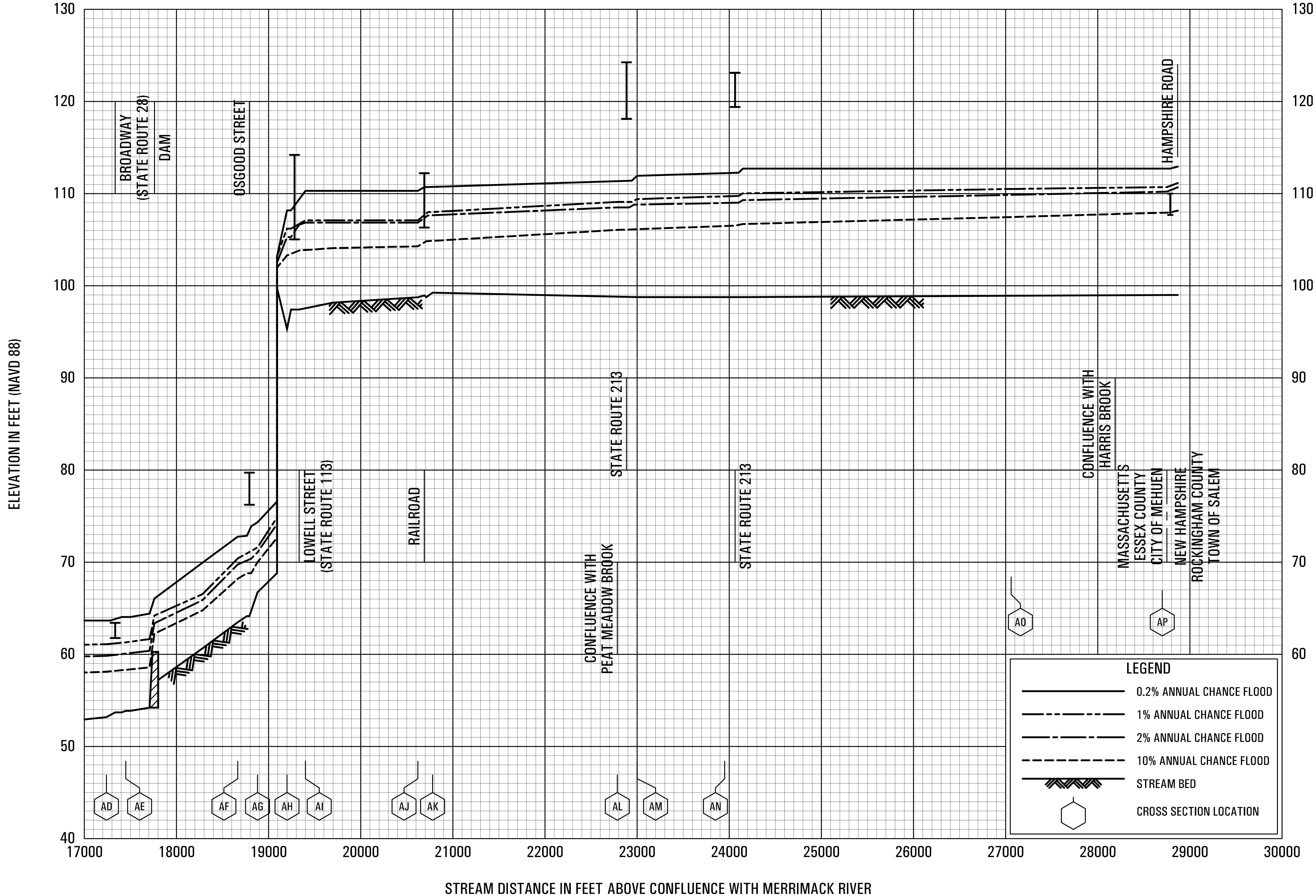
FLOOD PROFILES

SPICKET RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



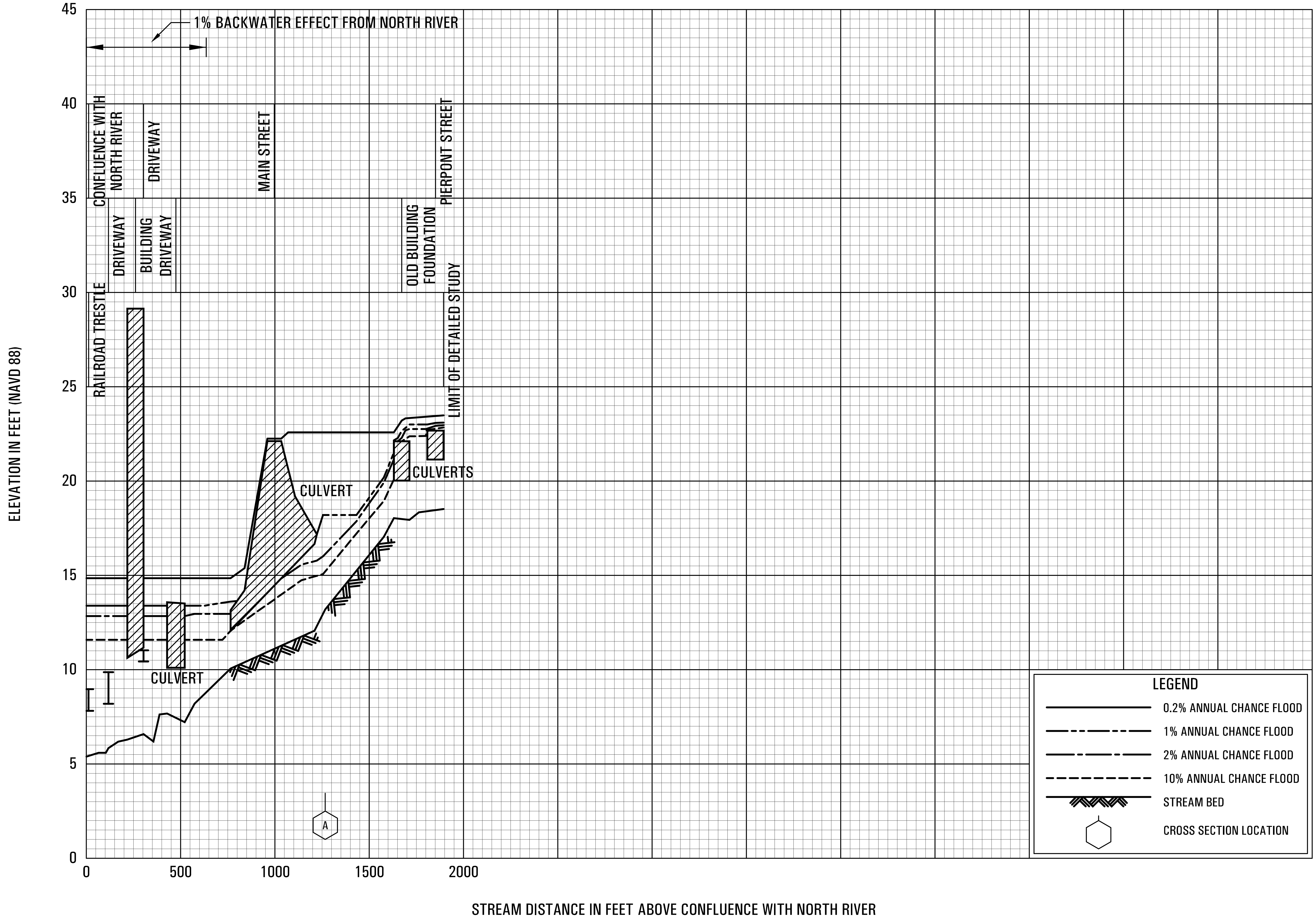
FLOOD PROFILES

SPICKET RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



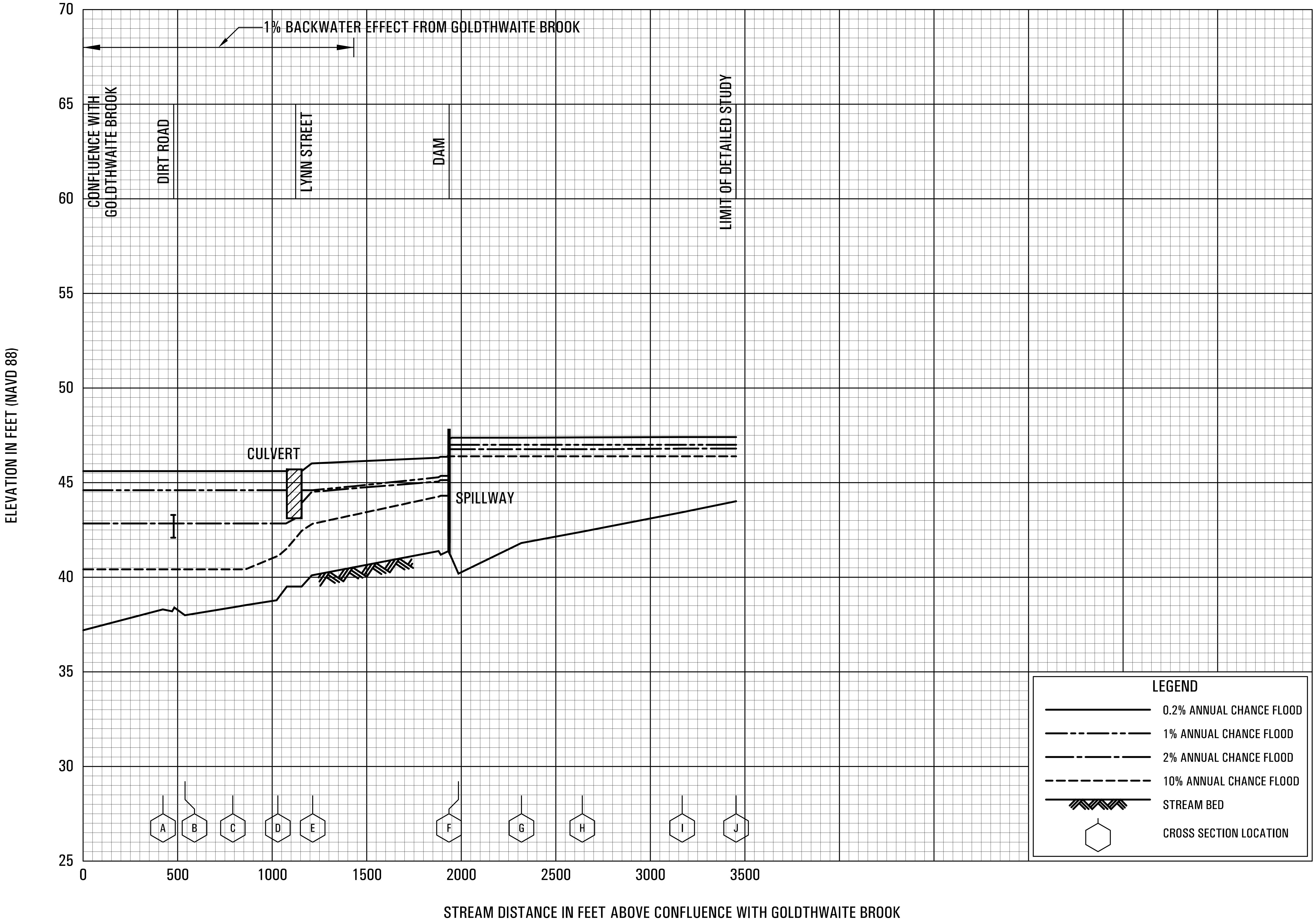
FLOOD PROFILES

STRONGWATER BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



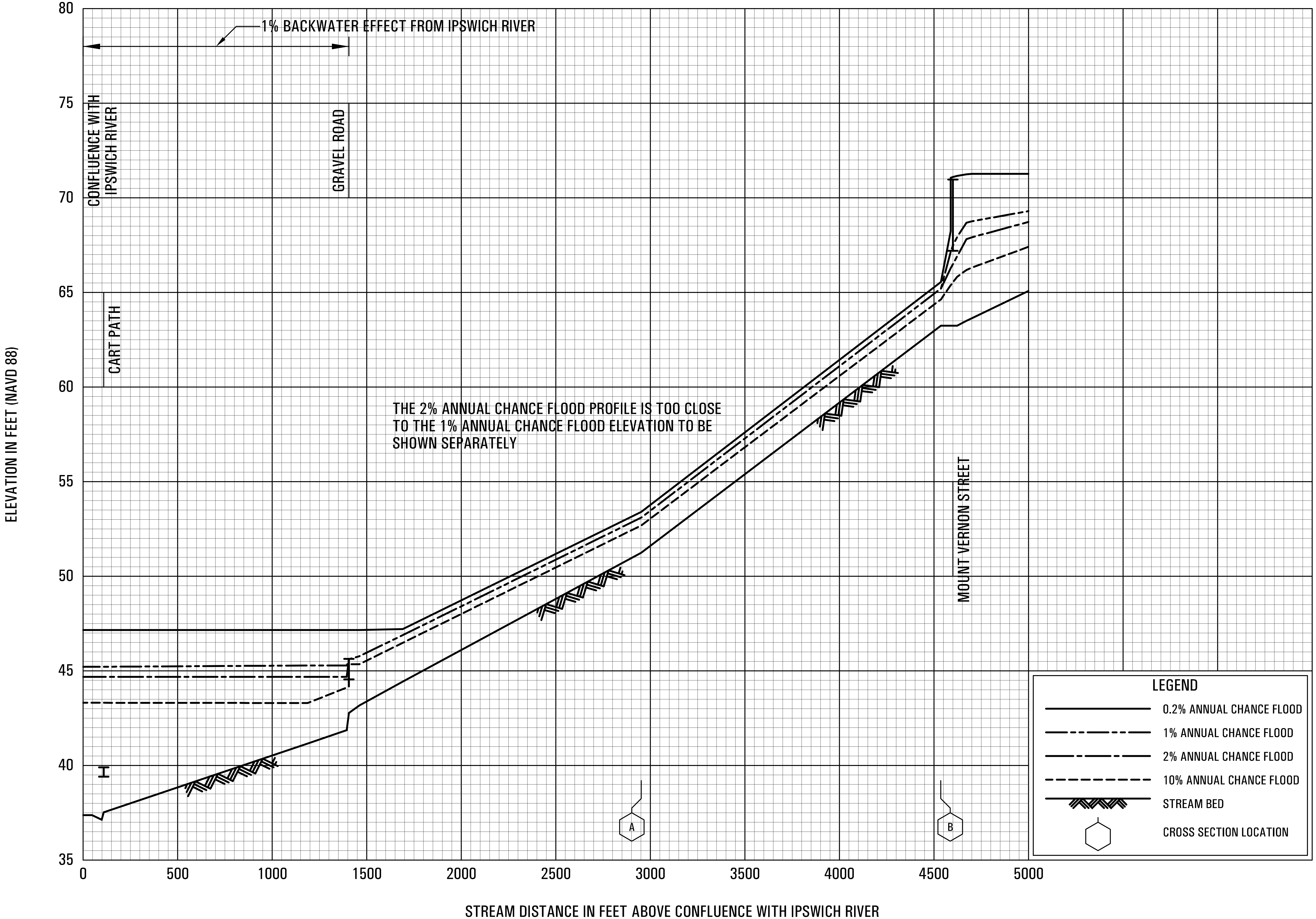
FLOOD PROFILES

TAPLEY BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



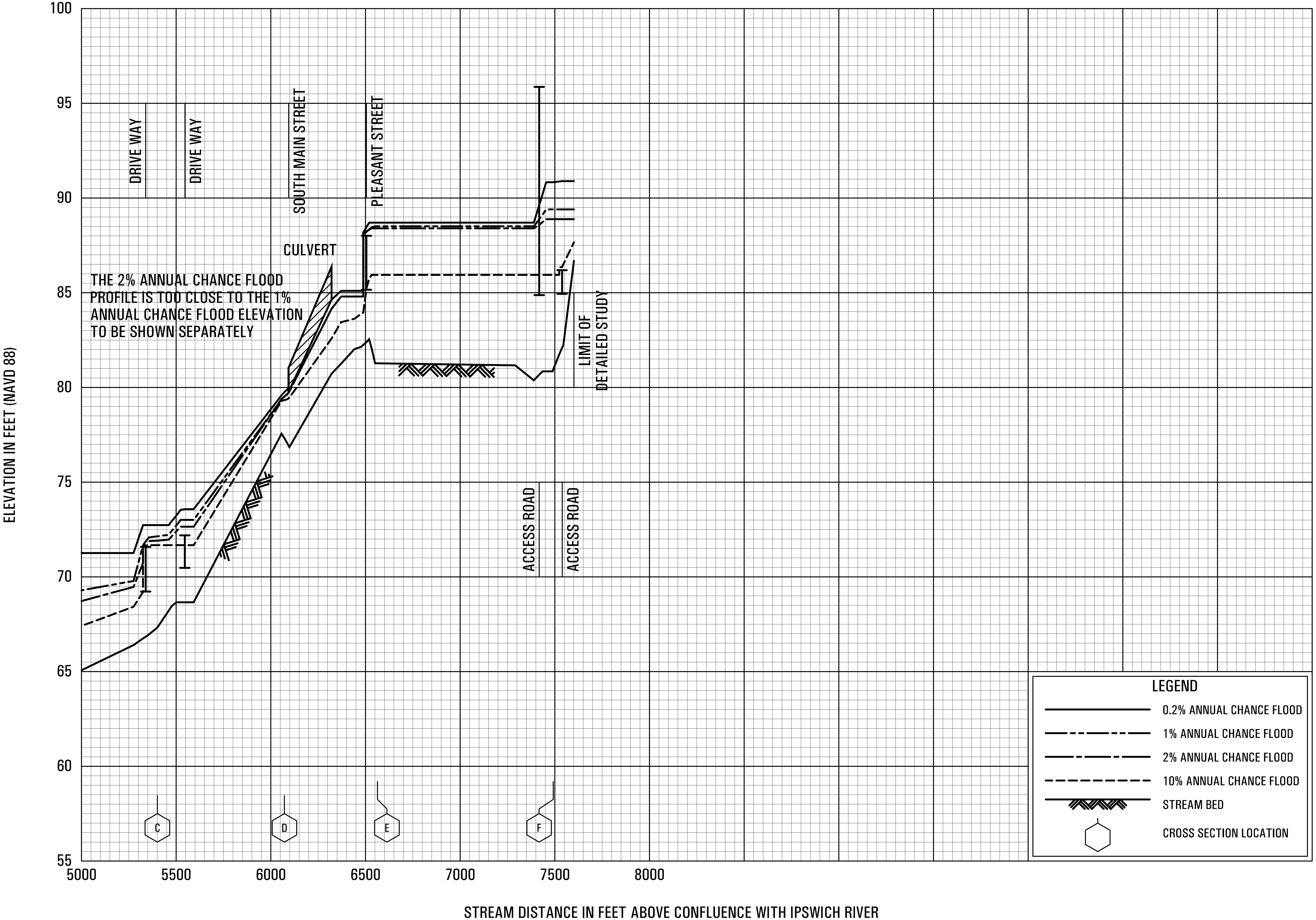
FLOOD PROFILES

TRIBUTARY A TO IPSWICH RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



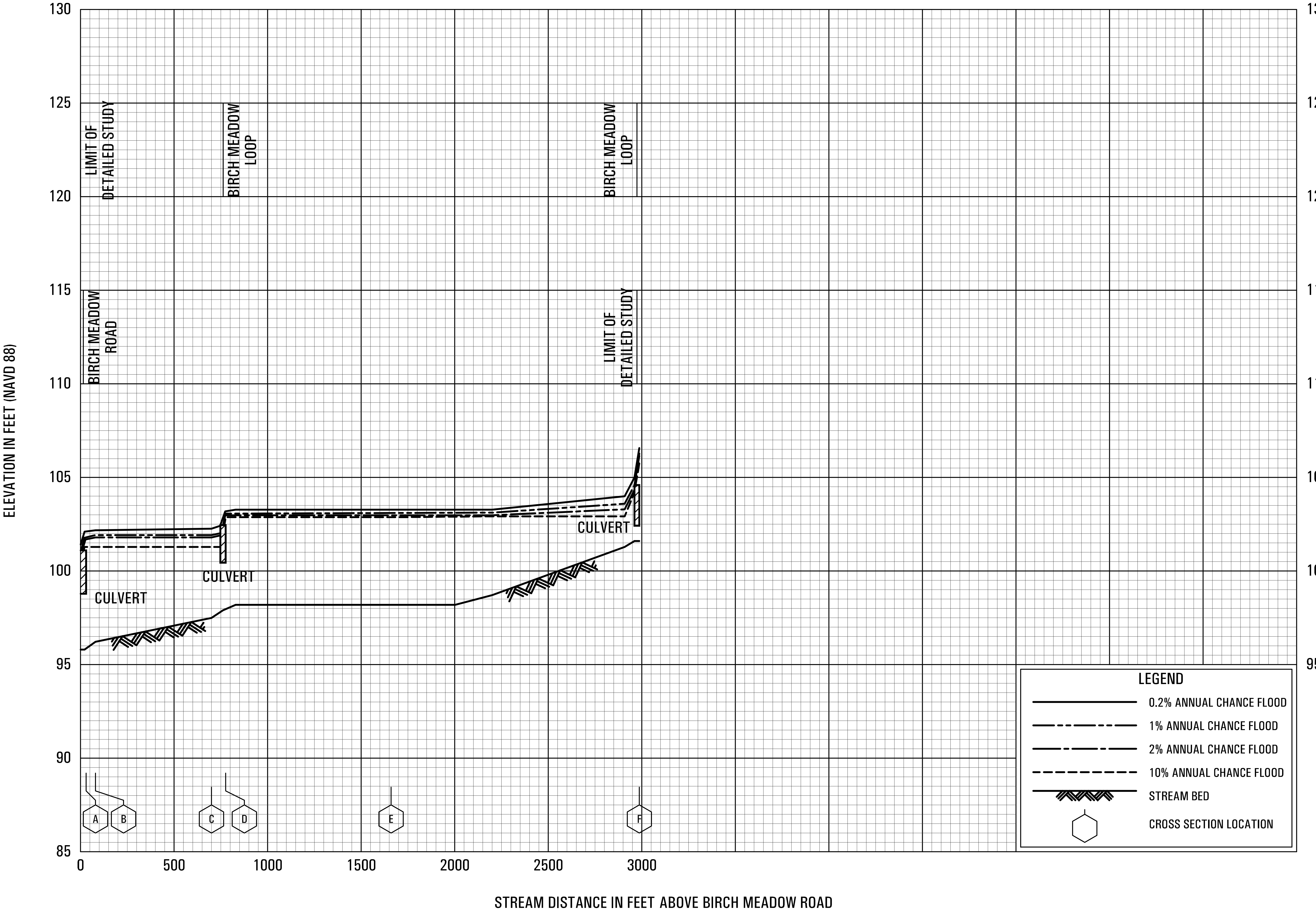
FLOOD PROFILES

TRIBUTARY A TO IPSWICH RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



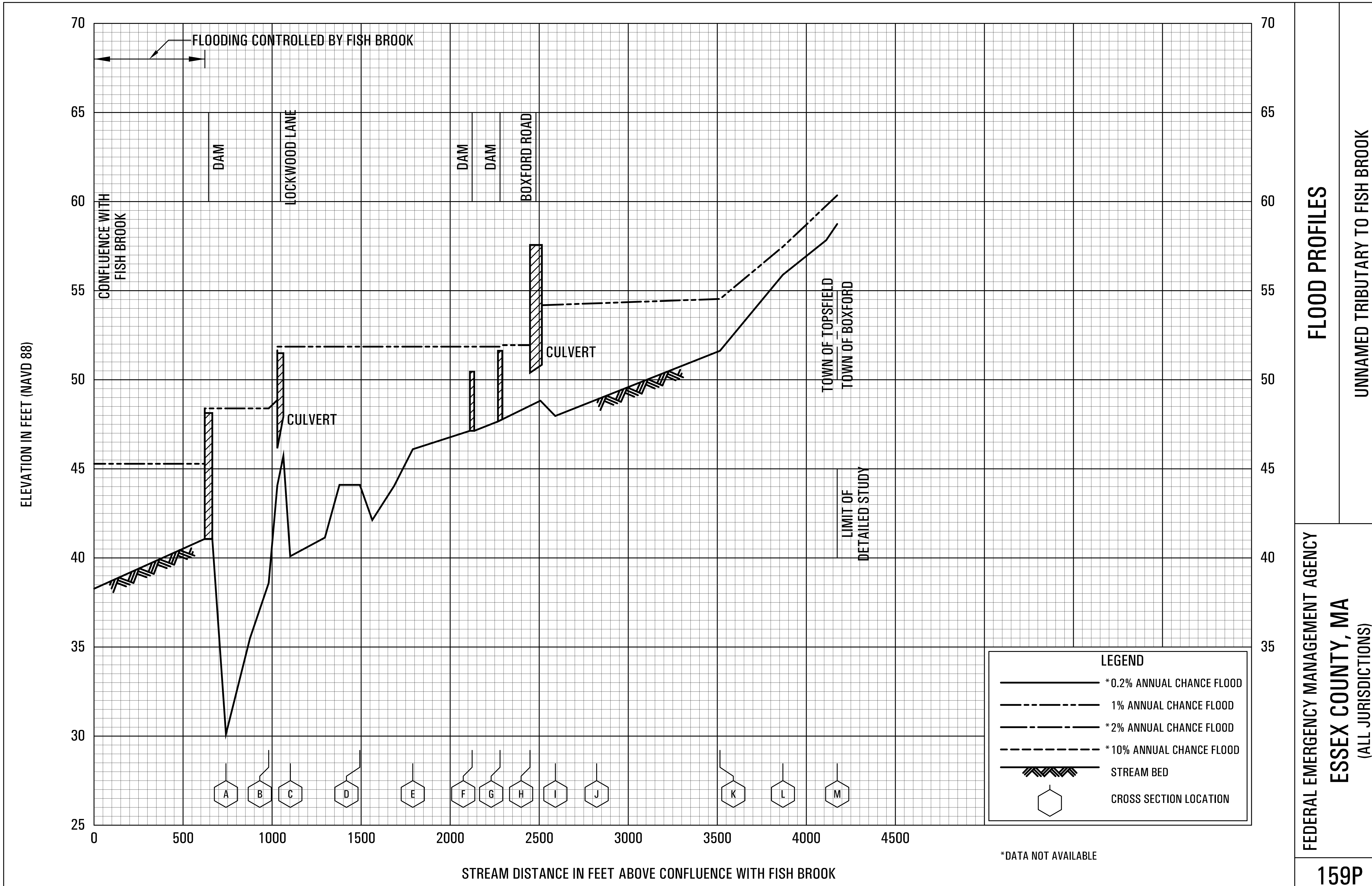
FLOOD PROFILES

TRIBUTARY TO NEAL POND

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)


FLOODING CONTROLLED BY FISH BROOK
CONFLUENCE WITH FISH BROOK
DAM
LOCKWOOD LANE
DAM
DAM
BOXFORD ROAD
CULVERT
CULVERT
TOWN OF TOPSFIELD
TOWN OF BOXFORD
LIMIT OF DETAILED STUDY
ELEVATION IN FEET (NAVD 88)
70
65
60
55
50
45
40
35
30
25
0
500
1000
1500
2000
2500
3000
3500
4000
4500
STREAM DISTANCE IN FEET ABOVE CONFLUENCE WITH FISH BROOK
A
B
C
D
E
F
G
H
I
J
K
L
M
LEGEND
*0.2% ANNUAL CHANCE FLOOD
1% ANNUAL CHANCE FLOOD
*2% ANNUAL CHANCE FLOOD
*10% ANNUAL CHANCE FLOOD
STREAM BED
CROSS SECTION LOCATION
*DATA NOT AVAILABLE
FLOOD PROFILES
UNNAMED TRIBUTARY TO FISH BROOK
FEDERAL EMERGENCY MANAGEMENT AGENCY
ESSEX COUNTY, MA
(ALL JURISDICTIONS)
159P