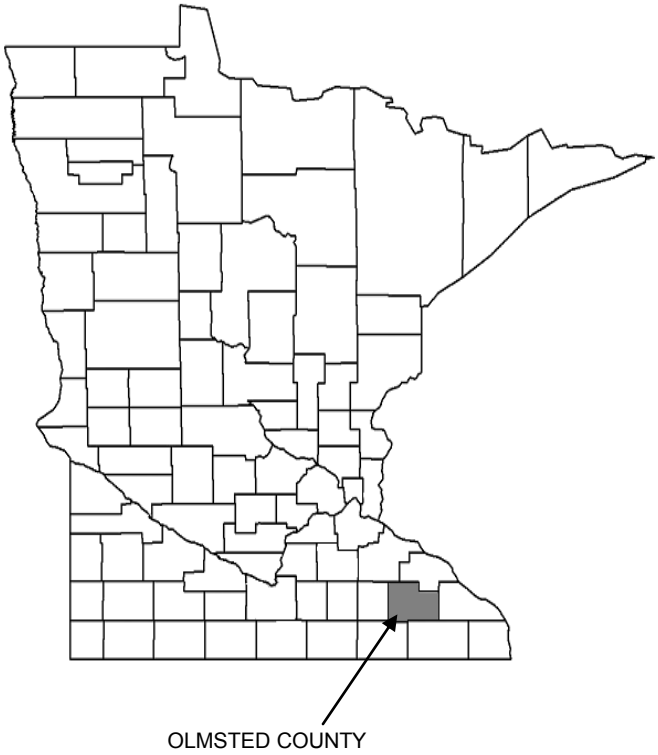
FLOOD INSURANCE STUDY

OLMSTED COUNTY, MINNESOTA
AND INCORPORATED AREAS

Community Name	*Community Number*
*BYRON, CITY OF	270751
CHATFIELD, CITY OF	270125
DOVER, CITY OF	270566
EYOTA, CITY OF	270329
OLMSTED COUNTY (UNINCORPORATED AREAS)	270626
ORONOCO, CITY OF	270330
PINE ISLAND, CITY OF	270145
ROCHESTER, CITY OF	275246
STEWARTVILLE, CITY OF	270332

*NO SPECIAL FLOOD HAZARD AREAS IDENTIFIED



Revised:

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
27109CV000A

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) report may not contain all data available within the Community Map Repository. Please contact the Community Map Repository for any additional data.

The Federal Emergency Management Agency (FEMA) may revise and republish part or all of this FIS report at any time. In addition, FEMA may revise part of this FIS report by the Letter of Map Revision process, which does not involve republication or redistribution of the FIS report. Therefore, users should consult with community officials and check the Community Map Repository to obtain the most current FIS report components.

Initial Countywide FIS Effective Date:	April 17, 1995
Revised Countywide Date:	February 4, 1998 To Be Determined

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FLOOD INSURANCE STUDY
OLMSTED COUNTY, MINNESOTA AND INCORPORATED AREAS

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 Olmsted County, including the Cities of Byron, Chatfield, Dover, Eyota, Oronco, Pine Island, Rochester, and Stewartville, and the unincorporated areas of Olmsted County (referred to collectively herein as Olmsted 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.

Please note that the City of Chatfield is geographically located in Olmsted and Fillmore Counties, and the City of Pine Island is geographically located in Olmsted and Goodhue Counties. See the separately published FIS report and Flood Insurance Rate Map (FIRM) for flood-hazard information.

Please note that the City of Byron is located on the watershed divide of Cascade Creek and the South Branch Middle Fork Zumbro River and has no mapped special flood hazard areas. This does not preclude future determinations of SFHAs that could be necessitated by changed conditions affecting the community (i.e., annexation of new lands) or the availability of new scientific or technical data about flood hazards.

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

The Digital Flood Insurance Rate Map (DFIRM) and FIS report for this countywide study have been produced in digital format. Flood hazard information was converted to meet the Federal Emergency Management Agency (FEMA) DFIRM database specifications and Geographic Information System (GIS) format requirements. The flood hazard information was created and is provided in a digital format so that it can be incorporated into a local GIS and be accessed more easily by the community.

1.2 Authority and Acknowledgments

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

Precountywide Analyses

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:

Chatfield, City of:	The hydrologic and hydraulic analyses for the FIS report dated February 2, 1982, were prepared by Toltz, King, Duvall, Anderson, and Associates, Inc., for FEMA, under Contract No. H-4706. That work was completed in March 1981 (FEMA, 1982a).
Dover, City of:	The hydrologic and hydraulic analyses for the FIS report dated October 15, 1981, were prepared by Toltz, King, Duvall, Anderson, and Associates, Inc., for FEMA, under Contract No. H-4706. That work was completed in July 1980 (FEMA, 1981a).
Eyota, City of	The hydrologic and hydraulic analyses for the FIS report dated June 15, 1981, were prepared by Toltz, King, Duvall, Anderson, and Associates, Inc., for the Federal Insurance Administration (FIA) under Contract No. H-4706. That work was completed in May 1980 (FIA, 1981).
Olmsted County (Unincorporated Areas):	The hydrologic and hydraulic analyses for the FIS report dated November 19, 1980, were prepared by Barr Engineering Company, for the FIA, under Inter-Agency Agreement No. IAA-H-9-77, Project Order No. 19, Amendment No. 1. That work was completed in February 1980 (FEMA, 1980b).

Oronco, City of	The hydrologic and hydraulic analyses for the FIS report dated May 4, 1981, were prepared by the U.S. Geological Survey (USGS), Water Resources Division, for the FIA, under Inter-Agency Agreement No. IAA-H-9-77, Project Order No. 19, Amendment No. 1. That work was completed in February 1980 (FEMA, 1981b).
Pine Island, City of	For the September 2, 1980, FIS report and March 2, 1981 FIRM, the hydrologic and hydraulic analyses for the original study were prepared by Edwards and Kelsey Inc. for the FIA under Contract No. H-4540. That work was completed in March 1979 (FEMA, 1980a). For the February 16, 1994, FIS revision, the hydrologic and hydraulic analyses were prepared by the U.S. Army Corps of Engineers (USACE), St. Paul District for FEMA under Inter-Agency Agreement No. EMW-90-E-3286, Project Order No. 3. This work was completed in January 1992 (FEMA, 1994).
Rochester, City of	The hydrologic and hydraulic analyses for the original FIS report dated August 4, 1980, were prepared by Barr Engineering Company, for the FIA, under Contract No. H-3799. That work was completed in November 1977. The hydraulic analysis for the FIS report dated August 4, 1987, was prepared by Barr Engineering Company (FEMA, 1987).
Stewartville, City of	The hydrologic and hydraulic analyses for the FIS report dated March 2, 1982, were prepared by Toltz, King, Duvall, Anderson, and Associates, Inc., for FEMA, under Contract No. H-4706. That work was completed in March 1981 (FEMA, 1982b).

The City of Byron has no previously printed FIS report.

April 17, 1995
Initial Countywide FIS Report

For the April 17, 1995, FIS, the updated hydrologic and hydraulic analyses were prepared by the USACE, St. Paul District, for the City of Rochester and were coordinated with FEMA. This work was completed in March 1993. Portions of approximate flood hazard boundaries were delineated by Dewberry & Davis under agreement with FEMA.

February 4, 1998
Countywide FIS Report

For the February 4, 1998, countywide revision, the hydrologic and hydraulic analyses for Bear Creek, Cascade Creek, North Run of the North Fork of Cascade Creek, South Run of the North Fork of Cascade Creek, the South Fork Zumbro River, and Willow Creek were updated to reflect the completion of the Rochester Flood Control Project. These analyses were prepared by the USACE, St. Paul District, and were completed in September 1995.

This Countywide FIS Report

For this revision, the hydrologic and hydraulic analyses for Badger Run, Carey Creek, Hadley Valley Creek, Hadley Valley Creek Split Flow, Mill Creek, North Branch Root River, Silver Creek, and South Fork Whitewater River were performed by Barr Engineering Company, for FEMA, under Contract No. EMC-2005-GR-7024, Project Order No. 2. The work was completed in June 2008.

The hydrologic and hydraulic analysis for Mill Creek was performed by Atkins, for FEMA, under Contract No. EMC-2005-GR-7024, Project Order No. 2. The work was completed on May 25, 2011.

Base map information shown on the FIRM was provided in digital format by Farm Services Administration. This information was photogrammetrically compiled at a scale of 1:12,000 from aerial photography dated 2011 or later. The projection used in the preparation of this map is Universal Transverse Mercator (UTM) Zone 15, and the horizontal datum used is the North American Datum of 1983 (NAD83), GRS80 Spheroid.

1.3 Coordination

An initial meeting is held with representatives from FEMA, the community, and the study contractor to explain the nature and purpose of a FIS, and to identify the streams to be studied or restudied. A final meeting is held with representatives from FEMA, the community, and the study contractor to review the results of the study.

Precountywide Analyses

The initial and final meeting dates for previous FIS reports for Olmsted County and its communities are listed in the following tabulation:

Community	FIS Date	Initial Meeting	Final Meeting
Chatfield, City of	February 2, 1982	May 1978	September 2, 1981
Dover, City of	October 15, 1981	April 1978	April 28, 1981
Eyota, City of	June 15, 1981	April 1978	January 20, 1981
Olmsted County (Unincorporated Areas)	November 19, 1980	March 1975	August 9, 1978
Oronoco, City of	May 4, 1981	January 17, 1977	November 24, 1980
Pine Island, City of	September 2, 1980	June 1, 1977	September 11, 1979
	February 16, 1994	January 14, 1992	January 25, 1993
Rochester, City of	August 4, 1980	July 1977	January 14, 1980
Stewartville, City of	March 2, 1982	March 1978	August 31, 1981

April 17, 1995
Initial Countywide FIS Report

For the April 17, 1995, initial countywide FIS, a final meeting was held on July 21, 1994, and was attended by representatives of the county, USACE, and FEMA.

February 4, 1998
Countywide FIS Report

For the February 4, 1998, countywide revision, a floodway coordination meeting was held on May 17, 1995, and was attended by representatives of the Minnesota Department of Natural Resources (MNDNR), the USACE, and the City of Rochester. At this meeting, the USACE presented preliminary study data and floodway alignments for the streams that were restudied by detailed methods. In addition, FEMA notified the City of Rochester by letter dated July 8, 1996, that a revision was being prepared using the data provided by the USACE.

This Countywide FIS Report

For this countywide revision, the initial meeting was held on August 12, 2005, and attended by representatives of FEMA, MNDNR, Olmsted County, and elected officials from townships, cities and county government in Olmsted County.

The results of the study were reviewed at the final meeting held on April 17, 2013, and attended by representatives of FEMA, MNDNR and STARR. All issues and/or concerns raised at that meeting have been addressed.

2.0 AREA STUDIED

2.1 Scope of Study

This FIS covers the geographic area of Olmsted County, Minnesota 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.

The following lakes and streams are studied by detailed methods in this FIS report:

Badger Run	Ponding Area 3
Bear Creek	Ponding Area 4
Carey Creek	Silver Creek
Cascade Creek	South Branch Middle Fork Zumbro River
East Fork of Willow Creek	South Fork of Bear Creek
Hadley Valley Creek	South Fork Whitewater River
Hadley Valley Creek Split Flow	South Fork of Willow Creek
Middle Fork Zumbro River	South Fork Zumbro River
Mill Creek	South Run of the North Fork of Cascade Creek
North Branch Root River	Southeast Branch of Willow Creek
North Run of the North Fork of Cascade Creek	Tributary B
	West Fork of Willow Creek
Ponding Area 1	West Tributary to Willow Creek
Ponding Area 2	Willow Creek

The limits of detailed study are indicated on the Flood Profiles (Exhibit 1) and on the FIRM (Exhibit 2).

April 17, 1995
Initial Countywide FIS Report

In the April 17, 1995, initial Countywide FIS, the flooding sources listed in Table 1 were revised.

Table 1 – Streams Studied by Detailed Methods for the Initial Countywide FIS

Bear Creek	From its confluence with the South Fork Zumbro River to a point approximately 200 feet upstream of the confluence of Willow Creek
Cascade Creek	From its confluence with the South Fork Zumbro River to a point approximately 50 feet downstream of County Highway 34
East Fork of Willow Creek	From its confluence with Willow Creek to County Highway 101/45th Street Southeast
Silver Creek	From its confluence with the South Fork Zumbro River to the walking bridge in Quarry Hill Nature Center (formerly known as Silver Creek Road)
South Fork Zumbro River	From a point approximately 1.1 miles downstream of 37th Street Northwest/County Highway 22 to Mayowood Road Southwest/County Highway 125
Willow Creek	From its confluence with Bear Creek to a point approximately 0.7 mile upstream of 11th Avenue Southwest

In addition, backwater elevations for the following streams were revised to reflect the updated hydraulic analysis for Willow Creek: South Fork of Willow Creek, Southeast Branch of Willow Creek, West Fork of Willow Creek, and West Tributary to Willow Creek.

In the April 17, 1995, FIS, portions of the following flooding sources were newly studied by approximate methods: Dry Run Creek, the Middle Fork Zumbro River, the North Branch Root River, the South Fork Whitewater River, the South Fork Zumbro River, and Tributary B.

The April 17, 1995, FIS reflected annexations by the Cities of Eyota, Oronoco, Rochester, and Stewartville and the unincorporated areas of Olmsted County as well as updated boundaries for the Richard J. Dorer Memorial Hardwood State Forest.

The April 17, 1995, FIS incorporated the determinations of Letters of Map Revision (LOMRs) issued by FEMA, which are shown in the following tabulation:

Stream Name	Community and Description	Date of Letter
Cascade Creek	City of Rochester Revised hydraulic analyses and topographic information	September 7, 1990
South Run of the North Fork of Cascade Creek	Unincorporated Areas Channel improvements, fill placement, and bridge relocation on the ROMAC plant site	December 26, 1991
North Run of the North Fork of Cascade Creek	City of Rochester Quest International property	July 21, 1994

Cascade Creek Split Flow was revised using the updated hydraulic analysis and topographic information submitted for the September 7, 1990, LOMR for Cascade Creek.

February 4, 1998
Countywide FIS Report

In the February 4, 1998, revision the flooding sources listed in Table 2 were restudied.

Table 2 – Streams Revised for the February 4, 1998, FIS

Stream Name	Limits of Revised or New Detailed Study
Bear Creek	From its confluence with the South Fork Zumbro River to a point approximately 265 feet upstream of the confluence of Badger Creek
Cascade Creek	From its confluence with the South Fork Zumbro River to County Highway 104
North Run of the North Fork of Cascade Creek	From its confluence with Cascade Creek to a point approximately 0.93 mile upstream of 19th Street Northwest
South Fork Zumbro River	From a point approximately 10,490 feet downstream of 37th Street Northwest/County Highway 22 to a point just upstream of Mayowood Road/County Highway 125

Table 2 – Streams Revised for the February 4, 1998, FIS (*Continued*)

Stream Name	Limits of Revised or New Detailed Study
South Run of the North Fork of Cascade Creek	From the confluence with Cascade Creek to a point approximately 1.1 miles upstream of Dakota, Minnesota, & Eastern (DME) Railroad
Willow Creek	From its confluence with Bear Creek to 11th Avenue Southwest/County Highway 147

Also in the 1998 revision, the Cascade Creek split flow delineation in the area of U.S. Highway 52 was removed. Water surface elevations along Cascade Creek were reduced to a point where flow in this area was no longer diverted.

This Countywide FIS Report

The rivers and streams listed in Table 3 were studied using detailed methods in this countywide FIS report.

Table 3 – Streams Studied by Detailed Methods in this Revision

Stream Name	Limits of Revised or New Detailed Study
Badger Run	From the confluence with Bear Creek to County Highway 36 / 50th Avenue Southeast
Carey Creek	From the confluence with the North Branch Root River to approximately 350 feet upstream of County Highway 6 / 6th Street Southwest
Hadley Valley Creek	From the crossing of East River Road to approximately 1.4 miles upstream of the crossing at Hadley Valley Road Northeast
Hadley Valley Creek Split Flow	From the downstream confluence with Hadley Valley Creek to the upstream confluence with Hadley Valley Creek
Mill Creek	From the Olmsted/Fillmore County Boundary to approximately 1 mile upstream of Pedestrian Bridge
North Branch Root River	From approximately 1 mile downstream of County Highway 120 / 15th Avenue Northeast to approximately 1.5 miles upstream of confluence with Carey Creek

Table 3 – Streams Studied by Detailed Methods in this Revision (*Continued*)

Stream Name	Limits of Revised or New Detailed Study
Silver Creek	From the walking bridge in Quarry Hill Nature Center in Rochester to approximately 1.68 miles upstream of Silver Creek Road Northeast
South Fork Whitewater River	From approximately 250 feet upstream of U.S. Highway 14 to the confluence of Tributary B

For this countywide revision, the FIS report and FIRM were converted to countywide format, and the flooding information for the entire county, including both incorporated and unincorporated areas, is shown. Also, the vertical datum was converted from the National Geodetic Vertical Datum of 1929 (NGVD) to the North American Vertical Datum of 1988 (NAVD). In addition, the Universal Transverse Mercator coordinates, previously referenced to the North American Datum of 1927, are now referenced to the NAD83.

The following flooding sources in the county were studied by approximate methods for this revision: South Branch Middle Fork Zumbro River, Middle Fork Zumbro River, Tributary A, Mill Creek, North Branch Root River, and South Fork Whitewater River.

The South Fork Zumbro River was studied by approximate methods for this revision from approximately 1,660 feet downstream of 90th Road Northeast to the Olmsted County boundary.

This work was performed by the MDNR in 2013 using the USACE's Hydrologic Engineering Center's (HEC) River Analysis System (RAS), Version 4.1.0 computer software. Cross section data was obtained from the 3-meter resolution Light Detection and Ranging (LiDAR). The area below the water surface was ignored in the cross-section geometry. The analyses included road crossings with high embankments, substantial bridge openings or with bridge details readily available from the Minnesota Department of Transportation hydraulic data site.

All or portions of the following flooding sources in the county were studied by approximate methods in previous revisions: Dry Run Creek, Plum Creek, Badger Run, and Tributary B.

The South Fork Zumbro River was studied by approximate methods in previous revisions from approximately 570 feet downstream of 55th Street Northeast, to approximately 1,660 feet downstream of 90th Road Northeast.

Approximate analyses were used to study those areas having low development potential or minimal flood hazards. The scope and methods of study were proposed to and agreed upon by FEMA and Olmsted County.

The following tabulation presents Letters of Map Change (LOMCs) incorporated into this countywide study:

LOMC	Case Number	Date Issued	Project Identifier
LOMR	97-05-265P	02/27/1998	South Fork of Willow Creek & Willow Creek – 2,400 feet downstream of U.S. Highway 63 to U.S. Highway 63
LOMR	98-05-313P	02/11/1999	South Fork Zumbro River – Bamber Valley Road Southwest to Mayowood Road
LOMR	01-05-746P	07/18/2002	West Tributary to Willow Creek & Willow Creek
LOMR	03-05-3988P	02/23/2004	North Run of the North Fork of Cascade Creek- Circle 19 Plaza
LOMR	05-05-1147P	07/28/2005	North Run of the North Fork of Cascade Creek- West 19th Development, LLC
LOMR	05-05-1180P	09/22/2005	Cascade Creek & South Run of the North Fork of Cascade Creek – Manorwoods Lake Development
LOMR	06-05-BR73P	10/30/2006	Southeast Branch of Willow Creek – Waterfront Business Park/Southern Woods Commercial Area
LOMR	06-05-B433P	02/14/2007	Cascade Creek – Meadow Lakes Golf Course
LOMR	07-05-4071P	03/28/2008	Willow Creek – U.S. Highway 63 Improvements
LOMR	08-05-3390P	10/31/2008	Middle Fork Zumbro River - U.S. Highway 52 Bridges
LOMR	09-05-1227P	05/15/2009	Mayowood Lake Floodway Revision
LOMR	10-05-2736P	09/23/2010	South Run of the North Fork of Cascade Creek – Csah 22/Th 14 Interchange
LOMR	12-05-4929P	03/21/2013	South Fork Zumbro River – Rochester Public Utilities 4th Street
LOMR	13-05-0422P	07/26/2013	Cascade Creek – Floodplain Remapping
LOMR	13-05-8106P	10/17/2014	Bear Creek Revision

*Letter of Map Revision (LOMR)

2.2 Community Description

Olmsted County is located in southeastern Minnesota. It is bordered by Mower County to the south and southwest, Fillmore County and the City of Chatfield to the south, Goodhue County and the City of Pine Island to the north, Wabash County to the north and northeast, Winona County and the City of St. Charles to the east, and Dodge County to the west. The county has a land area of 656 square miles. The population in 2000 for Olmsted County was 124,277 (U.S. Census Bureau, 2010).

The major highways crossing the county are: Interstate Highway 90 passing east-west through the southern portion of the county; U.S. Highway 14 passing through the central portion of the county; U.S. Highway 52 passes from the northwestern to the southeastern portion of the county; and, U.S. Highway 63 passes north-south through the center of the county. The Dakota, Minnesota, and Eastern Railroad, formerly the Chicago and Northwestern Railroad, crosses the county east-west along U.S. Highway 14.

The topography of Olmsted County varies from flat to gently rolling, with steep slopes and bluffs along portions of the South Fork Zumbro River, North Fork Root River and North Fork Whitewater River. Elevations range from 800 to 1,360 feet (NAVD). The drainage system in the county is a well-established dendritic type and was not significantly affected by the last glaciation that occurred in southern Minnesota. The South Fork Zumbro River watershed extends over much of Olmsted County. Outside of the City of Rochester many small tributaries to the South Fork Zumbro River meander through wide bottomlands separated by plateaus primarily west of the city. Bear Creek and Silver Creek, however, flow through wooded, relatively steep, basins. Some of the stream valleys are highly dissected with outcrops of limestone, shale and sandstone formations.

The land cover in Olmsted County is primarily agricultural cropland. Forest tracts of elm, maple, basswood, and oak trees are found on steeper side slopes in the northwestern, northeastern, and south central portions of the county, primarily along river corridors. Scattered wooded and brushy areas exist in the alluvial formations along many of the streams and in small wetlands located in upland settings in the county.

The Olmsted County Soil Survey reports that there are nine soil associations in four soil formation categories that describe distinct patterns of soils, topography and drainage patterns. The first group is a broad upland area dominated by soils formed in sediments and glacial till. The soil associations are remnants of previous glacial deposits located in the higher elevations in the county in the southwest, east central and northwestern portions of the county. These associations are upland areas that have low relief and many long narrow

drainageways and are well-drained to poorly-drained. This area includes gravel knolls and low gravel ridges and is located in the City of Oronoco.

Most of the county is covered by uplands in the southern and northern portions of the county and around the City of Rochester and are dominated by soils formed by windblown material, loess, which comprises the second group. These soil associations are generally well-drained to very poorly-drained areas with broad summits and narrow drainageways. One soil association is also located in floodplains along the floor of narrow ravines, some of which are tributaries that flow into the City of Rochester.

A third area is dominated by soils formed in a mantle of glacial till and residuum over bedrock located in upland areas in an east-west pattern through the southern portion of the county. The soil association is level to sloping and has numerous deep drainageways. Much of this area has bedrock located within five feet of the soil surface.

The fourth group of soil associations are the sandy, silty or loamy materials on terraces and outwash plains, exclusively located in the stream and river valleys within the county. Much of the older portion of the City of Rochester is developed within these terrace and outwash deposits. The major river valleys flow through these soil associations and in some cases, such as the Root River and Whitewater River, flow on the underlying bedrock.

Floodplain land use within all of the major watersheds in the unincorporated parts of the county are dominated by agricultural uses and more specifically dominated by cropland. Land use in the floodplain within the Cities of Eyota and Dover is undeveloped, although bounded by low intensity commercial/industrial uses. The floodplains in the Cities of Stewartville and the City of Chatfield are also generally less developed and include parkland uses. Lake Florence in Stewartville was removed due to a dam failure after the publication of the 1998 FIS. The floodplain in both communities is bounded by low intensity residential and commercial development. The City of Rochester is located on large terrace and alluvial deposits that extend upstream within all of the tributaries to the South Fork Zumbro River. The current floodplain is significantly narrower due to the completion of the flood control project in 1998. The city includes a mix of low to medium density residential areas and commercial and industrial development adjacent to the floodplain. Development adjacent to the Cascade Creek floodplain consists primarily of industrial and transportation uses.

The climatic classification of Olmsted County is humid continental characterized by large seasonal variations in temperature, normally sufficient rainfall, and moderate snowfall. Temperatures in the county range from an average high of 80 degrees Fahrenheit (°F) to an average low of 60°F in the summer, and from an average high of 20°F to an average low of 4°F in the winter. The average annual

precipitation is 31.4 inches, with the maximum average precipitation occurring in the month of July (The Weather Channel, 2010).

2.3 Principal Flood Problems

Flooding on the streams studied in Olmsted County occurs primarily as a result of spring runoff, although flooding has resulted from the occurrence of short-duration, high-intensity rainstorms.

Stream-flow records for the South Fork Zumbro River basin have been maintained by the USGS and the USACE. The USGS maintains a stream-flow gaging station on the South Fork Zumbro River at the City of Rochester. This station has a drainage area of approximately 304 square miles with records dating back to 1951. The gage was moved upstream 0.4 mile in 1981. The USGS also maintains four crest-stage, partial record stations on small tributaries on the South Fork Zumbro River.

Runoff from the South Fork Zumbro River basin is subject to seasonal variations in temperature and precipitation. The South Fork Zumbro River generally attains its highest peak in March and April from runoff caused by snowmelt and often augmented by rainfall. The months of May through September generally have high flows consistent with the monthly precipitation pattern. Drainage throughout the basin is well developed, and consequently the runoff is high and rapid. In the vicinity of Rochester, the rate of rise during floods can be rapid and the duration can be relatively short. At the USGS gaging station at Rochester, the South Fork Zumbro River rose to its crest in 15 hours during the flood of 1978 at an average rate of 1.3 feet per hour and a maximum rate of 3.25 feet per hour. The river remained above bank-full stage for 35 hours. Extreme discharges observed were a maximum of 30,500 cubic feet per second (cfs), with a gage height of 23.36 feet on July 6, 1978, and a minimum of 8.4 cfs with a gage height of 1.6 feet on December 7, 1955. The average discharge for 38 years was 166 cfs.

Descriptions of floods have been obtained from various sources such as gage records, flood reconnaissance, personal interviews, and newspaper files. From these sources, it has been possible to develop a history of the known floods on the South Fork Zumbro River covering the past 135 years. Stage and discharge data for past floods are available principally at the USGS gaging station on the river in the City of Rochester.

The following descriptions are based on newspaper accounts, historical records, field investigations, and other available data, and illustrate some of the flooding problems in the City of Rochester.

<u>October 1855</u>

Few records of the October 1855 flood are available. One newspaper account of the June 1908 flood referred to Mr. Thomas McCoy who remembered a major

flood that occurred in October 1855. He recalled that Rochester was isolated to such an extent that it could be reached from the southeast only by boat. Water overflowed the west banks of the South Fork Zumbro River and flowed down Broadway Avenue. He felt that this flood exceeded the one of June 1908, however, other accounts of the 1908 flood indicate that it was the largest that any residents living at the time could recall. Considering all available records, it has been determined that the October 1855 flood was essentially of the same proportions as the June 1908 occurrence. Subsequent hydraulic analysis determined that the discharges associated with these two historic flood events of 1855 and 1908 were 16,900 cfs, making them the fourth and fifth largest events at this location.

June 1908

The flood that crested in June 1908 was caused by heavy rainfall. The National Weather Service (NWS) station at the City of Rochester reported 4.1 inches of rain in 24 hours. At Grand Meadow, 24 miles south of the City of Rochester, 4.25 inches of rain fell in 24 hours and was preceded by 2.78 inches of rainfall 2 days earlier.

June 1942

The largest known flood on Cascade Creek occurred in June 1942 and approximated a 0.8-percent-annual-chance frequency event (USACE, 1958). A major local flood occurred on Cascade Creek on June 4 and 5, 1942. Floodwaters on Cascade Creek were up to 4 feet higher than any other known flood, while the South Fork Zumbro River and other tributaries experienced only moderate rises. Rainfall at the Rochester NWS station amounted to 2.33 inches on June 4, 1942, and totaled 3.76 inches on June 3-5, 1942. Hourly records show that 1.11 inches fell in 1 hour on June 4, 1942, and 0.97 inch of additional rain fell in the next 2 hours. The relative variation of runoff on the nearby streams indicates that much heavier rainfall occurred on the Cascade Creek watershed than on other nearby areas.

March 1965

As the result of runoff from spring snowmelt and generally light rainfall, a major flood occurred in March 1965 with the crest stage approximately 0.7 foot higher than the March 1962 flood at the USGS gaging station near Rochester. Another flood occurred in the spring of 1965, which peaked on April 6, 1965, at Rochester, with a crest stage almost 6 feet lower than the flood of March 1965.

Events preceding these floods included above normal precipitation in the fall of 1964 and below normal temperatures in December, which permitted deep frost penetration into the ground. Early in the winter, a freezing rain formed a layer of ice, sealing off the ground, and resulted in a high runoff rate from the subsequent snowfall. Temperatures averaged below normal and remained below the thawing point until late February, so there was little snowmelt runoff. In February, after heavy snowfall and temperatures remaining well below 32°F during most of the

month, the temperature rose rapidly on February 27, 1965, to approximately 45°F in the basin and remained above freezing for the next 2 days.

Steady but generally light precipitation, partly rainfall and partly snow, fell throughout March 1 and 2, 1965. Snowmelt runoff along with rainfall generated a rapid increase in stream flow, resulting in discharges of 19,600 cfs at the gaging station near Rochester. After this flood peaked, above-normal snowfalls in March produced accumulated snow depths of 7 inches at Rochester. Slowly rising temperatures after March 30th gradually melted the snow, but with nearly an inch of precipitation during this thawing period, the stream flow increased for several days, resulting in a peak discharge of 8,010 cfs at Rochester. At the gaging station, the flood of April had a smaller instantaneous peak discharge but a wider crest, a longer period of rise, a longer period of recession, and twice the volume of the March flood hydrograph.

July 1978

The largest known or recorded flood in the City of Rochester occurred on July 6, 1978. The largest known flood on Badger Run occurred in July 1978 (USGS, 1978). Floods exceeding a 1-percent-annual-chance frequency occurred on Silver and Bear Creeks in July 1978 (USGS, 1978). This flood was caused by an intense thunderstorm that produced a peak discharge of 30,500 cfs on the South Fork Zumbro River. This flash flood that claimed five lives and caused property losses to thousands of homes, hundreds of businesses, and numerous public properties resulted from heavy rains of 6 inches or more. The NWS station at the Rochester airport recorded 4.99 inches of rain in 3 hours. Total rain at the airport for this 8-hour storm was 6.74 inches, whereas the average weighted rain over the 304 square mile drainage area was calculated to be 5.65 inches. At the USGS gaging station at Rochester, the South Fork Zumbro River rose to its crest in 15 hours at an average rate of 1.3 feet per hour and a maximum rate of 3.25 feet per hour. The river remained above bank-full stage for 35 hours. Peak discharges on the tributaries were published by the USGS as follows: Cascade Creek, estimated 1,000 cfs; Silver Creek, 9,290 cfs; Bear Creek on Belt Line, 24,900 cfs; and the South Fork Zumbro River on Belt Line, 20,500 cfs.

No historic flood information is available for Willow Creek; West Tributary to Willow Creek; East, South, and West Forks of Willow Creek; Southeast Branch of Willow Creek; South Fork of Bear Creek; or the North and South Runs of the North Fork of Cascade Creek.

Flood damage occurs along virtually all the streams that are tributaries to the South Fork Zumbro River in Olmsted County because of the predominantly wide, gently sloping floodplains.

Flooding in the Cities of Dover and Eyota occurred in June of both 1974 and 1978 as a result of heavy rainfall. From conversations with local officials and residents of the City of Dover, homes near the confluence of Tributary B and the South

Fork Whitewater River and a home near the intersection of County Highway 10/Chatfield Street North and the Dakota, Minnesota, and Eastern Railroad experienced some minor flooding problems. Also, water reportedly seeped through the basement windows of a house at the north end of Sheek Street during the 1974 storm, and it was necessary to evacuate the occupants of a mobile home located across the street.

According to the City of Eyota utility superintendent, the intersection of Center Avenue North and U.S. Highway 14 was inundated during both storms and the box culvert on Center Avenue North was overtopped. The culverts carrying Tributary A under Fifth Street, Madison Street, and Second Street were also overtopped during both storms. The culvert under State Highway 42 near Second Street was washed out in the 1974 storm, causing damage to the road bed. Some of the businesses on Center and Front Streets suffered damage from basement seepage, but this was due to street runoff rather than flooding effects from the creek.

For the City of Dover, rainfall records from the NWS station in Rochester (located 17 miles west of Dover) indicate that the frequency of the 1974 storm was greater than a 0.2-percent-annual-chance flood event. The Minnesota Department of Transportation (DOT) established a high watermark on the roadside to the west of the Sheek Street house at an elevation of 1,144.7 feet (NAVD). The hydraulic analysis performed for the City of Dover determined the elevation of a 1-percent-annual-chance flood at this location to be 1,144.9 feet (NAVD).

Floods such as the storm or July 1978 have passed through the Cities of Chatfield and Stewartville, however, water damage has been limited by relatively steep banks or wide floodplain, and the lack of development in the floodplain.

June 2004

Heavy rains fell in two waves over southeast Minnesota on June 8 and 9, 2004. The remnants of the torrential rains that caused flooding and mudslides in the Mankato area drifted east over southeast Minnesota late on June 8 and into the early morning hours of June 9. Later in the morning of June 9, thunderstorms redeveloped over south central and southeast Minnesota and continued throughout the afternoon and early evening. The Rochester airport recorded 4.06 inches of rain on June 9, setting a record for the date. Another 0.20 inch had fallen on June 8, leading to a two-day total of 4.26 inches. By late in the evening of June 9, most of the heavy rain had moved into Wisconsin. The rains fell upon soil already saturated from the heavy rains of May 2004.

The deluge led to street flooding and wet basements in the City of Rochester. One apartment building had water flowing through the lowest floor. Numerous accounts of water overtopping roads were reported throughout the region.

September 2004

On September 14 and 15, 2004, a series of disturbances along a stalled frontal boundary dropped heavy rains in southern Minnesota with the heaviest rainfall occurring in Faribault and Freeborn Counties to the west and outside of the Zumbro, or Root River watersheds. The southeast and southwest corners of Olmsted County received 6 inches of rainfall, 5 inches over the center of the county and less than that over the northern portion of the county over a 24-hour period. There were numerous reports in southern Minnesota of stream flooding, urban flooding, mudslides, and road closures. Flash flood warnings were issued for 13 Minnesota counties including all counties within the Zumbro and Root River watersheds.

August 2007

A very moist warm air mass provided the fuel for showers and thunderstorms along a warm front extending from northern Iowa to central Illinois from August 18th to 19th. Thunderstorms developed on Saturday moving west to east along this line through southern Minnesota. Heavy rain persisted with rainfall rates of 1 to 2 inches per hour, common in southeastern Minnesota. Rochester International Airport received 7.05 inches of rain over the period of the storm from Saturday night into Sunday morning. Cascade Creek crested at 16.52 feet on Sunday morning above the flood stage of 13.0 feet. Over a 24-hour period, Cascade Creek received 10.45 inches, Silver Creek 10.17 inches, and Bear Creek 9.86 inches. This amount of rain surpasses the 6 inch rainfall for a given location for a 24-hour period that is said to be a 1-percent-annual-chance storm.

This storm event was one of the most extraordinary precipitation events in Minnesota's modern history according to the State Climatologist. During the event a new Minnesota 24-hour rainfall record was broken. The State Climate Extremes Committee agreed that the 15.10 inches total recorded on Sunday, August 19, 2007, at Hokah in Houston County is the largest 24-hour total ever measured at an official NWS observing station in Minnesota.

The effectiveness of the City of Rochester flood control project was evident as the City of Rochester saw some street flooding, water seepage into basements, some mudslides in the City of Rochester and in the unincorporated areas, and road closures but not large scale flooding of portions of the city as happened in 1978. The City of Eyota experienced basement flooding on a large scale that appears not to have been due to surface flows of floodwater but a high groundwater table. Some stream bank damage occurred on Cascade Creek within the City of Rochester that threatened the loss of accessory buildings but no residences were affected.

September 2010

On September 23 and 24, 2010, heavy rains led to the largest flood event to hit southern Minnesota since the flood of August 2007. Wave after wave heavy

thunderstorms brought over 11 inches of rain in some areas in a 24-hour period, a 6 inch rainfall for a location in this region over a 24-hour period is said to be a 1-percent-annual-chance storm. The large amount of rain, over such a wide area, in such a short amount of time, caused record flooding, with Lake Shady Dam overtopping in the City of Oronoco. Flood waters flowed over and around the north abutment and washed out the embankment and north roadway approach to the U.S. Highway 18 bridge. The buried reinforced concrete core wall at the north abutment was undermined, fractured and collapsed (Report, 2011). In the City of Pine Island, more than 100 homes were affected, with damage varying from water in the basements to water over the main floor structure. Additionally, more than 20 businesses were damaged and numerous roads and culverts were washed out (USGS, 2011).

The City of Oronoco has not experienced a severe flood and has no significant flooding problems. In investigating the flood situation, some homes were found to occasionally experience wet basements but this appears to be a water table situation rather than flooding from surface runoff. The problem in not having experienced high floods is that the fringes of the floodplain along Shady Lake are very attractive for residential development, but the rise anticipated in Shady Lake during a 1-percent-annual-chance flood is 10 feet. The lowlands adjacent to the river and Shady Lake are subject to overflow from the usual spring snowmelt or heavy spring and summer thunderstorms but nothing approaching a 1-percent-annual-chance flood has been experienced.

2.4 Flood Protection Measures

Floodplain development in the City of Rochester is controlled by the Rochester Zoning Ordinance and Land Development Manual (City of Rochester, 1975). The ordinance requires that plans for proposed structures in the floodplain meet regulations set by the MNDNR in the following report: Flood Plain Information, Supplemental Report on South Fork Zumbro River and Tributaries in the Vicinity of Rochester, Minnesota (State of Minnesota, 1975).

A small check dam on Cascade Creek near the confluence with the South Fork Zumbro River and dams on the South Fork Zumbro River in the City of Rochester do not provide significant flood protection.

The USACE developed a local flood control plan for the City of Rochester, the Rochester Flood Control Project, which is designed to reduce flood stages on the South Fork Zumbro River, Cascade Creek, and Bear Creek through the construction of a levee and floodwalls; alterations to bridges, sewers, and utilities in the floodplains; and channel modifications.

The Rochester Flood Control Project is multifaceted and includes the construction of seven Natural Resources Conservation Service (NRCS) (formerly the Soil Conservation Service (SCS)) reservoirs on Silver, Bear, Willow, and Cascade

Creeks that impound water and reduce downstream peak flows in the City of Rochester. All of the SCS reservoirs have been constructed and are operable.

The USACE's portion of the flood control project consisted of channel improvements and construction of floodwalls, a levee, and hydraulic structures. The USACE work was segmented into several stages and was completed in September 1995. FEMA specifies that all levees must have a minimum of 3-foot freeboard against a 1-percent-annual-chance flood in order to be considered a safe flood protection structure. The Bear Creek levee meets FEMA freeboard requirements. The February 4, 1998, FIS accounted for the following features of the Rochester Flood Control Project:

- modifications to the South Fork Zumbro River from the downstream end of the project upstream to the Fourth Street Southeast bridge and from upstream of the South Broadway bridge to the upstream limit of work, including widening and deepening the channel, low flow channel reaches, riprap lined channel and slope protection, vertical concrete walls, bridge modifications, drop structures, and U.S. Highway 14 bridge replacement;
- dam rehabilitation on Silver Lake;
- seven reservoirs located on Bear Creek, Silver Creek, Cascade Creek, Willow Creek, East Fork of Willow Creek, and South Run North Fork Cascade Creek; and
- a levee system is located along the Bear Creek upstream of U.S. Highway 14. Please refer to the corresponding Flood Insurance Rate Map panels for the protection status of this levee system.

There was a 70-acre lake, Lake Florence, that was small in relation to the 114 square mile drainage area of the North Branch Root River watershed at the dam; therefore, the dam at the outlet of Lake Florence had little to no effect on the flood flow peaks that pass through the City of Stewartville. The dam was removed due to a severe flood after the publication of the 1998 FIS report and the lake bottom is now a public park and the channel for the North Branch Root River.

There are no permanent flood protection structures in the City of Oronoco and none are proposed at this time. The volume available for floodwater storage in Shady Lake is insignificant in comparison to the runoff volume of significant flood events and no attenuation of the larger flood peaks occurs.

A holding pond on the West Fork of Willow Creek, approximately 1,000 feet west of County Highway 147, provides some flood protection during the lower frequency floods. A small check dam on Cascade Creek near its confluence with the South Fork Zumbro River does not serve as a flood protection structure.

Floodplain development in Olmsted County is controlled by the Olmsted County Zoning Ordinance (Olmsted County Board of Commissioners, 1970). The ordinance has four floodplain districts that set standards for grading and development within the floodplain. The ordinance requires that plans for proposed fill and structures in the flood fringe, and flood-prone soils, as defined by the SCS's Soil Survey for Olmsted County, be reviewed as conditional use permits. The other communities with FEMA designated floodplains also have zoning ordinance provisions that establish standards for development within the regulated floodplain.

There are no other permanent flood protection structures in the county, and none are proposed at this time.

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 are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10-, 2-, 1-, and 0.2-percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long-term, average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood that equals or exceeds the 1-percent-annual-chance (100-year) 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 community.

Badger Run

New hydrologic modeling was performed for Badger Run for this countywide analysis.

The Badger Run watershed is located in south central Olmsted County, southeast of the City of Rochester. The detailed study portion of Badger Run extends from County Highway 11 to the confluence with Bear Creek, with an average channel slope of 0.5% for the study reach. The watershed of the study area is 16.37 square

miles. Much of the watershed is currently undeveloped with the majority of the land being used for agricultural production. However, development has occurred along the Badger Run corridor for more than 40 years primarily consisting of low density residential subdivisions, and there is development occurring in the northwestern portion of the watershed within the City of Rochester.

Flow values for each of the reaches for the 10-, 2-, 1-, and 0.2-percent chance events were computed using the Environmental Protection Agency's Storm Water Management Model (SWMM), XP-SWMM, computer model (XP Software, 2005). The SCS Curve Number method was used to estimate peak runoff for each subwatershed (SCS, 1975).

General routing information was built into the hydraulics module within XP-SWMM to route runoff downstream and estimate peak flows. The hydraulic data included survey information of structures at road crossings as well as a surveyed cross section of the natural stream channel and extended cross section of the overbank area (floodplain) using the two-foot topographic data (Horizons, Inc., April 2006) provided by the City of Rochester.

Flows estimated by the XP-SWMM models for Badger Run were verified using regional regression methods (USGS, 1997). The National Flood Frequency Program (NFF) (USGS, 2002), which incorporates the USGS regression equations, was used to estimate flows for the 0.2-percent-annual-chance event for each of the three detailed study areas.

Bear Creek

Hydrology for Bear Creek upstream of a point approximately 265 feet upstream of the confluence of Badger Run was developed as part of a precountywide analysis. In the City of Rochester, the 10-, 2-, 1- and 0.2-percent-annual-chance frequency discharges were obtained from the Supplemental Report on South Fork Zumbro River and Tributaries in the Vicinity of Rochester, Minnesota (State of Minnesota, 1975). The SCS calculated these discharges using a 24-hour rainfall event and the unit hydrograph methods of the SCS TR-20 computer program (SCS, 1983). In the unincorporated areas, hydrographs for Bear Creek upstream of a point approximately 265 feet upstream of the confluence of Badger Run were developed using a 24-hour rainfall event and the unit hydrograph methods of the SCS TR-20 computer program (SCS, 1983). Times of concentration and curve numbers were estimated following procedures outlined in the SCS National Engineering Handbook, using USGS topographic maps, MNDNR high altitude aerial photographs, soil survey maps, and field inspection data (SCS, 1972a; USGS, various dates (a); USGS, 1955; State of Minnesota, 1969; SCS, 1972b; SCS, 1961;. SCS, 1928). The 10-, 2-, and 1-percent-annual-chance precipitation intensities were obtained from the National Weather Service (NWS) Technical Paper No. 40; the 0.2-percent-annual-chance precipitation intensity was estimated by extrapolating the 10-, 2-, and 1-percent-annual-chance precipitation intensities on probability paper (NWS, 1961). Stage-discharge and stage-storage relationships

were developed using USGS topographic maps, highway culvert data, stage-storage data and dike plans provided by the City of Rochester SCS, weir equations and coefficients from Design of Small Dams, and field inspection data (USGS, various dates (a); U.S. DOT, 1965; U.S. Department of the Interior, 1973).

The results from the hydrologic analyses of the South Fork Zumbro River basin for the April 17, 1995, countywide FIS, were incorporated into the February 4, 1998, revision and expanded to further subdivide the drainage area (FEMA, 1995). The analyses were updated to reflect the completed Rochester Flood Control Project, including the completion of the final three of seven SCS reservoirs. It was then calibrated to the computed pre-project discharge-frequency at the USGS gaging station, while storage-outflow relationships were incorporated in the model to determine the impact of the seven reservoirs. Peak flow discharges for Bear Creek from its confluence with the South Fork Zumbro River to a point approximately 265 feet upstream of the confluence of Badger Run were updated to reflect the completed flood control project (FEMA, 1998).

For this revision, the 1992 USACE "City of Rochester, Minnesota, Interim Flood Insurance Study, Hydrologic Analysis" is the source for discharges for Bear Creek at the confluence with the South Fork Zumbro River. The upstream discharges for Bear Creek were developed using the drainage area ratio method. The discharges for the new Bear Creek Zone AE reach weren't revised.

Carey Creek

The flows for Carey Creek were extracted from the existing TR-20 model for the North Branch of the Root River developed for a pre-countywide analysis. This hydrologic model was developed previously; however, the flows for Carey Creek were not used for a detailed study until this revision of the FIS.

Cascade Creek

Hydrology for Cascade Creek upstream of a point approximately 250 feet downstream of County Road 34 was developed as part of a pre-countywide analysis. In the City of Rochester, the 10-, 2-, 1- and 0.2-percent-annual-chance frequency discharges were obtained from the Supplemental Report on South Fork Zumbro River and Tributaries in the Vicinity of Rochester, Minnesota (State of Minnesota, 1975). The SCS calculated these discharges using a 24-hour rainfall event and the unit hydrograph methods of the TR-20 computer program (SCS, 1983). In the unincorporated areas, discharges for floods of the selected recurrence intervals for Cascade Creek upstream of a point approximately 250 feet downstream of County Highway 34 were obtained from the SCS study of the South Fork Zumbro River.

The results from the hydrologic model analyses of the South Fork Zumbro River basin for the April 17, 1995, countywide FIS, were incorporated into the February 4, 1998, revision and expanded to further subdivide the drainage area (FEMA, 1995). The analyses were updated to reflect the completed Rochester Flood

Control Project, including the completion of the final three of the seven SCS reservoirs. The model was calibrated to the computed pre-project discharge-frequency at the USGS gaging station, while storage-outflow relationships were incorporated in the model to determine the impact of the seven SCS reservoirs. Peak flow discharges for Cascade Creek from its confluence with the South Fork Zumbro River to a point approximately 250 feet downstream of County Highway 34 were updated to reflect the completed flood control project (FEMA, 1998).

East Fork of Willow Creek

As part of the April 17, 1995, FIS analyses, a discharge-frequency relationship was developed for the South Fork Zumbro River at Rochester based upon 38 years of continuous records from 1951 to 1988 at the USGS gage (No. 05372995) in the City of Rochester and from the information taken from Flood Control, South Fork Zumbro River at Rochester, Minnesota, Design Memorandum No. 1, Phase 2, General Project Design, published by the USACE, St. Paul District (USACE, 1982). Included in the analysis were the historic flood events of 1855 and 1908. The USACE HEC Computer Program, HEC-FFA (HEC, 1992) was used to develop the discharge-frequency relationships. A log-Pearson Type III analysis was used according to the guidelines outlined in U.S. Water Resources Council (WRC) Bulletin 17B (WRC, 1982).

Because of the existence of only one recording gage in the South Fork Zumbro River basin, it was necessary to develop a basin model capable of determining discharge-frequency relationships at several other locations in the watershed including East Fork Willow Creek.

The South Fork Zumbro River basin was divided into 20 subbasins, with boundaries partially dictated by seven SCS reservoirs. The necessary HEC-1 parameters were determined to allow the model to develop unit hydrographs for each of the various subbasins, apply an exponential loss rate to non-uniform rainfall events occurring over the subbasins, compute the local flow hydrographs, route the flood hydrographs downstream, and combine this runoff with other routed flows. The Clark method was used to develop unit hydrographs, and stream routing was accomplished by use of the modified Puls method using a stage-storage-outflow relationship.

Because the model is only representative of rainfall-runoff events, it was calibrated to the summer-season discharge-frequency curve at the USGS gage in the City of Rochester. A relationship was developed between the HEC-1 model summer-season discharges and the all-season (combined snowmelt, rainfall, and runoff) frequency curve discharges at the USGS gage. This relationship at the gage was then applied to other points within the basin for adjustment from summer-season conditions to the more critical all-season conditions. As indicated by this relationship, the amount of adjustment decreases for increasing discharges. At the

USGS gage in the City of Rochester, the adjusted model frequency curve matches the all-season instantaneous peak discharge-frequency curve.

Hadley Valley Creek and Hadley Valley Creek Split Flow

New hydrologic modeling was performed for Hadley Valley Creek and Hadley Valley Creek Split Flow for this countywide analysis.

The Hadley Valley Creek watershed is located in central Olmsted County, just east of the City of Rochester. The detailed study portion of Hadley Valley Creek extends from 1.25 miles directly east of the intersection of Hadley Valley Road Northeast/County Highway 124 and 48th Street Northeast/County Highway 124 to the crossing of East River Road Northeast, with an average channel slope of 1.1% for the study reach. The watershed of the study area is 8.82 square miles. Much of the watershed is currently undeveloped with the majority of the land being used for agricultural production. However, there is development occurring in the western portion of the watershed near U.S. Highway 63 within the City of Rochester.

Flow values for each of the reaches for the 10-, 2-, 1-, and 0.2-percent chance events were computed using the XP-SWMM, computer model (XP Software, 2005). The SCS Curve Number method was used to estimate peak runoff for each subwatershed (SCS, 1975).

General routing information was built into the hydraulics module within XP-SWMM to route runoff downstream and estimate peak flows. The hydraulic data included survey information of structures at road crossings as well as a surveyed cross section of the natural stream channel and extended cross section of the overbank area (floodplain) using the two-foot topographic data (Horizons, Inc., 2006) provided by the City of Rochester.

Flows estimated by the XP-SWMM models for Hadley Valley Creek and Hadley Valley Creek Split Flow were verified using regional regression methods (USGS, 1997). The NFF (USGS, 2002), which incorporates the USGS regression equations, was used to estimate flows for the 0.2-percent-annual-chance event for each of the three detailed study areas.

Middle Fork Zumbro River

As part of a pre-countywide analysis, the 1-percent-annual-chance flood frequency discharges for the Middle Fork Zumbro River were determined from a drainage area-discharge relationship developed by the USGS using stream gage data for the Cannon, Zumbro, and Root River basins and established by inter-agency agreement on March 1, 1977 (USGS, 1949-present; USGS, 1977). The 10-, 2-, and 0.2-percent-annual-chance discharge curves for the South Fork Zumbro River at Rochester were plotted on probability paper along with the 1-percent-annual-chance discharge for the Middle Fork Zumbro River. A line was drawn through the 1-percent-annual-chance discharge for the Middle Fork Zumbro River and

parallel to the frequency curve of the South Fork Zumbro River to obtain the 10-, 2-, and 0.2-percent-annual-chance discharges for the Middle Fork Zumbro River in the unincorporated areas. Discharge values for the 10-, 2-, and 0.2-percent-annual-chance discharges for the Middle Fork Zumbro River in the City of Oronoco were determined by ratio of other frequency flood discharges to the 1-percent-annual-chance discharge for studies of communities adjacent to the City of Oronoco.

Mill Creek

As part of a pre-countywide analysis, the flow-frequency relationships were determined using the TR-20 computer program, which uses the physical characteristics of a watershed such as area, slope, land use, and soil types to develop runoff hydrographs for the region (SCS, 1983). Design rainfall depths were obtained from the NWS Publication Technical Paper No. 40 (NWS, 1961).

For Mill Creek, watershed areas and slopes were obtained from USGS topographic maps, at a scale of 1:24,000, enlarged to 1:4,800, with a contour interval of 20 feet (USGS, 1972). Rating curves for structures and cross sections were obtained from field data and through manual calculations. A crest-stage gage is located approximately 3.4 miles upstream from the City of Chatfield on Mill Creek. The flow-frequency relationship for this gage was determined by the USGS by fitting a log-Pearson Type III frequency distribution to 14 observed annual peaks from the USGS gaging station No. 07040008, with a period of record from 1962 to 1976. The results of the analysis was used to calibrate the computer model that was developed for the entire watershed (USGS, 1977).

North Branch Root River

As part of a pre-countywide analysis, the flow-frequency relationships were determined using the TR-20 computer program (SCS, 1983). Design rainfall depths were obtained from the NWS Publication Technical Paper No. 40 (NWS, 1961).

For the North Branch Root River, the 24-hour duration rainfall from the NWS Publication Technical Paper No. 40 was found to be the critical event (NWS, 1961). Flood hydrographs were then developed and peak discharges found for the 10-, 2-, 1-, and 0.2-percent-annual-chance frequency rainfall events.

North Run of the North Fork of Cascade Creek

The results from the hydrologic analyses of the South Fork Zumbro River basin for the April 17, 1995, countywide FIS, were incorporated into the February 4, 1998, revision and expanded to further subdivide the drainage area (FEMA, 1995). The analyses were updated to reflect the completed Rochester Flood Control Project, including the completion of the final three of the seven SCS reservoirs. It was then calibrated to the computed pre-project discharge-frequency at the USGS gaging station, while storage-outflow relationships were incorporated in the model

to determine the impact of the seven SCS reservoirs. Peak flow discharges for North Run of the North Fork of Cascade Creek from its confluence with Cascade Creek to a point approximately 0.93 miles upstream of 19th Street Northwest were updated to reflect the completed flood control project (FEMA, 1998).

Silver Creek

As part of the April 17, 1995, countywide FIS analyses, a discharge-frequency relationship was developed for the South Fork Zumbro River at Rochester based upon 38 years of continuous records from 1951 to 1988 at the USGS gage (No. 05372995) in Rochester and from the information taken from Flood Control, South Fork Zumbro River at Rochester, Minnesota, Design Memorandum No. 1, Phase 2, General Project Design, published by the USACE, St. Paul District (USACE, 1982). Included in this analysis were the historic flood events of 1855 and 1908. The HEC-FFA computer program (HEC, 1992) was used to develop the discharge-frequency relationships. A log-Pearson Type III analysis was used according to the guidelines outlined in WRC Bulletin 17B (WRC, 1982).

Because of the existence of only one recording gage in the South Fork Zumbro River basin, it was necessary to develop a basin model capable of determining discharge-frequency relationships at several other locations in the watershed including Silver Creek from its confluence with the South Fork Zumbro River to the walking bridge in the Quarry Hill Nature Center.

The South Fork Zumbro River basin was divided into 20 subbasins, with boundaries partially dictated by the seven SCS reservoirs. The necessary HEC-1 parameters were determined to allow the model to develop unit hydrographs for each of the various subbasins, apply an exponential loss rate to non-uniform rainfall events occurring over the subbasins, compute the local flow hydrographs, route the flood hydrographs downstream, and combine the runoff with other routed flows. The Clark method was used to develop unit hydrographs, and stream routing was accomplished by use of the modified Puls method using a stage-storage-outflow relationship.

Because the model is only representative of rainfall-runoff events, it was calibrated to the summer-season discharge-frequency curve at the USGS gage in the City of Rochester. A relationship was developed between the HEC-1 model summer-season discharges and the all-season (combined snowmelt, rainfall, and runoff) frequency curve discharges at the USGS gage. This relationship at the gage was then applied to other points within the basin for adjustment from summer-season conditions to the more critical all-season conditions. As indicated by this relationship, the amount of adjustment decreases for increasing discharges. At the USGS gage in the City of Rochester, the adjusted model frequency curve matches the all-season instantaneous peak discharge-frequency curve.

New hydrologic modeling was performed for Silver Creek for this countywide FIS from the walking bridge in Quarry Hill Nature Center to approximately 1.33 miles upstream of the Silver Creek Road Northeast bridge crossing.

The Silver Creek watershed is located in central Olmsted County, just east of the City of Rochester. The detailed study length for this revision of Silver Creek falls between 40th Avenue Northeast and Silver Creek Road Northeast and the bridge crossing at the end of Silver Creek Drive Northeast, with an average channel slope of 0.4% for the study reach. The watershed of the study area is 17.59 square miles. Much of the watershed is currently undeveloped with the majority of the land being used for agricultural production. However, there has been limited development in the City of Rochester along the creek due to the large public sector land holdings.

For Silver Creek from the walking bridge in the Quarry Hill Nature Center to approximately 1.33 miles upstream of the Silver Creek Road Northeast bridge crossing, flow values for each of the reaches for the 10-, 2-, 1-, and 0.2-percent chance events were computed using the XP-SWMM computer model (XP Software, 2005). The SCS Curve Number method was used to estimate peak runoff for each subwatershed (SCS, 1975).

General routing information was built into the hydraulics module within XP-SWMM to route runoff downstream and estimate peak flows. The hydraulic data included survey information of structures at road crossings as well as a surveyed cross section of the natural stream channel and extended cross section of the overbank area (floodplain) using the two-foot topographic data (Horizons, Inc., 2006) provided by the City of Rochester.

Flows estimated by the XP-SWMM models for Silver Creek from the walking bridge in Quarry Hill Nature Center to approximately 1.33 miles upstream of the Silver Creek Road Northeast bridge crossing were verified using regional regression methods (USGS, 1997). The NFF (USGS, 2002), which incorporates the USGS regression equations, was used to estimate flows for the 0.2-percent-annual-chance event for each of the three detailed study areas.

For this revision, the 1992 USACE "City of Rochester, Minnesota, Interim Flood Insurance Study, Hydrologic Analysis" is the source for discharges for Silver Creek at the confluence with the South Fork Zumbro River. The upstream discharges for Silver Creek were developed using the drainage area ratio method.

South Branch Middle Fork Zumbro River

As part of a pre-countywide analysis, the 1-percent-annual-chance flood frequency discharges for the South Branch Middle Fork Zumbro River were determined from a drainage area-discharge relationship developed by the USGS using stream gage data for the Cannon, Zumbro, and Root River basins and established by inter-agency agreement on March 1, 1977 (USGS, 1949-present; USGS, 1977).

Discharge values for the 10-, 2-, and 0.2-percent-annual-chance discharges for the South Branch Middle Fork Zumbro River in the City of Oronoco were determined by ratio of other frequency flood discharges to the 1-percent-annual-chance discharge for studies of communities adjacent to the City of Oronoco.

South Fork of Bear Creek

As part of a pre-countywide analysis, in the unincorporated areas, discharges for floods of the selected recurrence intervals for South Fork of Bear Creek were obtained from the SCS study of the South Fork Zumbro River.

South Fork Whitewater River

As part of a pre-countywide analysis, the flow-frequency relationships were determined using the TR-20 computer program (SCS, 1983). Design rainfall depths were obtained from the NWS Publication Technical Paper No. 40 (NWS, 1961).

For the South Fork Whitewater River, watershed areas and slopes were obtained from USGS topographic maps (USGS, various dates(b)). Land use was determined from field inspection, aerial photographs, SCS Soils Atlas Sheets, and USGS topographic maps (Martinez Ortho-Mapping Corporation, 1979a; SCS, 1979; USGS, various dates (b)). Soil types were determined from SCS Soils Atlas Sheets for Olmsted County (SCS, 1979). Rating curves for structures and cross sections were obtained from field data and through the use of the SCS WSP-2 Water Surface Profile computer program (SCS, 1989). Decreasing discharges between County Highway 10 and the downstream corporate limits of Dover are caused by storage for peak flows available in overbank areas along the South Fork Whitewater River.

South Fork of Willow Creek

Hydrology for the South Fork of Willow Creek was developed as part of a pre-countywide analysis. Discharges were determined using drainage area-discharge relationships.

South Fork Zumbro River

As part of the April 17, 1995 FIS, hydrologic analyses, a discharge-frequency relationship was developed for the South Fork Zumbro River at the City of Rochester based upon 38 years of continuous records from 1951 to 1988 at the USGS gage (No. 05372995) in Rochester and from the information taken from Flood Control, South Fork Zumbro River at Rochester, Minnesota, Design Memorandum No. 1, Phase 2, General Project Design, published by the USACE, St. Paul District (USACE, 1982). Included in this analysis were the historic flood events of 1855 and 1908. The HEC-FFA computer program (HEC, 1992) was used to develop the discharge-frequency relationships. A log-Pearson Type III analysis was used according to the guidelines outlined in WRC Bulletin 17B (WRC, 1982).

The South Fork Zumbro River basin was divided into 20 subbasins, with boundaries partially dictated by the seven SCS reservoirs. The necessary HEC-1 parameters were determined to allow the model to develop unit hydrographs for each of the various subbasins, apply an exponential loss rate to non-uniform rainfall events occurring over the subbasins, compute the local flow hydrographs, route the flood hydrographs downstream, and combine this runoff with other routed flows. The Clark method was used to develop unit hydrographs, and stream routing was accomplished by use of the modified Puls method using a storage-outflow relationship.

Because the model is only representative of rainfall-runoff events, it was calibrated to the summer-season discharge-frequency curve at the USGS gage in the City of Rochester. A relationship was developed between the HEC-1 model summer discharges and the all-season (combined snowmelt, rainfall, and runoff) frequency curve discharges at the USGS gage. This relationship at the gage was then applied to other points within the basin for adjustment from summer-season conditions to the more critical all-season conditions. As indicated by this relationship, the amount of adjustment decreases for increasing discharges. At the USGS gage in Rochester, the adjusted model frequency curve matches the all-season instantaneous peak discharge-frequency curve.

The results from the hydrologic analyses of the South Fork Zumbro River basin for the April 17, 1995, countywide FIS, were incorporated into the February 4, 1998, revision and expanded to further subdivide the drainage area (FEMA, 1995). The analyses were updated to reflect the completed Rochester Flood Control Project, including the completion of the final three of the seven SCS reservoirs. It was then calibrated to the computed pre-project discharge-frequency at the USGS gaging station, while storage-outflow relationships were incorporated in the model to determine the impact of the seven SCS reservoirs. Peak flow discharges for the entire studied reach of the South Fork Zumbro River (from a point approximately 10,490 feet downstream of 37th Street Northwest to a point just upstream of Mayowood Road/County Highway 125) were updated to reflect the completed flood control project (FEMA, 1998).

For this revision, the 1992 USACE "City of Rochester, Minnesota, Interim Flood Insurance Study, Hydrologic Analysis" is the source for discharges for South Fork Zumbro River.

<u>South Run of the North Fork of Cascade Creek</u>

The results from the hydrologic analyses of the South Fork Zumbro River basin for the April 17, 1995, countywide FIS, were incorporated into the February 4, 1998, revision and expanded to further subdivide the drainage area (FEMA, 1995). The analyses were updated to reflect the completed Rochester Flood Control Project, including the completion of the final three of the seven SCS reservoirs. It was then calibrated to the computed pre-project discharge-frequency at the USGS gaging station, while storage-outflow relationships were incorporated in the model

to determine the impact of the seven SCS reservoirs. Peak flow discharges for South Run of the North Fork of Cascade Creek from the confluence with Cascade Creek to a point approximately 1.1 miles upstream of Dakota, Minnesota and Eastern Railroad were updated to reflect the completed flood control project (FEMA, 1998).

Southeast Branch of Willow Creek

Hydrology for the Southeast Branch of Willow Creek was developed as part of a pre-countywide analysis. Discharges were determined using drainage area-discharge relationships.

Tributary B

As part of a pre-countywide analysis, the flow-frequency relationships were determined using the TR-20 computer program (SCS, 1983). Design rainfall depths were obtained from the NWS Technical Paper No. 40 (NWS, 1961).

For the Tributary B, watershed areas and slopes were obtained from USGS topographic maps (USGS, various dates(b)). Land use was determined from field inspection, aerial photographs, SCS Soils Atlas Sheets, and USGS topographic maps (Martinez Ortho-Mapping Corporation, 1979a; SCS, 1979; USGS, various dates (b)). Soil types were determined from SCS Soils Atlas Sheets for Olmsted County (SCS, 1979). Rating curves for structures and cross sections were obtained from field data and through the use of the SCS WSP-2 Water Surface Profile computer program (SCS, 1989). Decreasing discharges between County Road 10 and the downstream corporate limits of the City of Dover are caused by storage for peak flows available in overbank areas along the South Fork Whitewater River.

West Fork of Willow Creek

As part of a pre-countywide analysis, in the unincorporated areas, hydrographs for West Fork of Willow Creek were developed using a 24-hour rainfall event and the unit hydrograph methods of the SCS TR-20 computer program (SCS, 1983). Times of concentration and curve numbers were estimated following procedures outlined in the SCS National Engineering Handbook, using USGS topographic maps, MNDNR high altitude aerial photographs, soil survey maps, and field inspection data (SCS, 1972a; USGS, various dates (a); USGS, 1955; State of Minnesota, 1969; SCS, 1972b; SCS, 1961;. SCS, 1928). The 10-, 2-, and 1-percent-annual-chance precipitation intensities were obtained from the NWS Technical Paper No. 40; the 0.2-percent-annual-chance precipitation intensity was estimated by extrapolating the 10-, 2-, and 1-percent-annual-chance precipitation intensities on probability paper (NWS, 1961). Stage-discharge and stage-storage relationships were developed using USGS topographic maps, highway culvert data, stage-storage data and dike plans provided by the Rochester SCS, weir equations and coefficients from Design of Small Dams, and field inspection data (USGS, various dates (a); U.S. DOT, 1965; U.S. Department of the Interior, 1973). Discharges were determined using drainage area-discharge relationships. Flood discharges for West Fork of Willow Creek are lower downstream of the

earth dam because of attenuation effects of the holding pond just upstream of the dam.

West Tributary to Willow Creek

Hydrology for the West Tributary to Willow Creek was developed as part of a pre-countywide analysis. Discharges were determined using drainage area-discharge relationships.

Willow Creek

As part of the April 17, 1995, FIS analyses, a discharge-frequency relationship was developed for the South Fork Zumbro River at the City of Rochester based upon 38 years of continuous records from 1951 to 1988 at the USGS gage (No. 05372995) in the City of Rochester and from the information taken from Flood Control, South Fork Zumbro River at the City of Rochester, Minnesota, Design Memorandum No. 1, Phase 2, General Project Design, published by the USACE, St. Paul District (USACE, 1982). Included in this analysis were the historic flood events of 1855 and 1908. The HEC-FFA computer program (HEC, 1992) was used to develop the discharge-frequency relationships. A log-Pearson Type III analysis was used according to the guidelines outlined in WRC Bulletin 17B (WRC, 1982).

Because of the existence of only one recording gage in the South Fork Zumbro River basin, it was necessary to develop a basin model capable of determining discharge-frequency relationships at several other locations in the watershed including Willow Creek upstream of 11th Avenue Southeast/County Highway 1.

The South Fork Zumbro River basin was divided into 20 subbasins, with boundaries partially dictated by seven SCS reservoirs. The necessary HEC-1 parameters were determined to allow the model to develop unit hydrographs for each of the various subbasins, apply an exponential loss rate to non-uniform rainfall events occurring over the subbasins, compute the local flow hydrographs, route the flood hydrographs downstream, and combine this runoff with other routed flows. The Clark method was used to develop unit hydrographs, and stream routing was accomplished by use of the modified Puls method using a storage-outflow relationship.

Because the model is only representative of rainfall-runoff events, it was calibrated to the summer-season discharge-frequency curve at the USGS gage in the City of Rochester. A relationship was developed between the HEC-1 model summer-season discharges and the all-season (combined snowmelt, rainfall, and runoff) frequency curve discharges at the USGS gage. This relationship at the gage was then applied to other points within the basin for adjustment from summer-season conditions to the more critical all-season conditions. As indicated by this relationship, the amount of adjustment decreases for increasing discharges. At the USGS gage in the City of Rochester, the adjusted model frequency curve matches the all-season instantaneous peak discharge-frequency curve.

The results from the hydrologic analyses of the South Fork Zumbro River basin for the April 17, 1995, countywide FIS, were incorporated into the February 4, 1998, revision and expanded to further subdivide the drainage area (FEMA, 1995). The analyses were updated to reflect the completed Rochester Flood Control Project, including the completion of the final three of the seven reservoirs. It was then calibrated to the computed pre-project discharge-frequency at the USGS gaging station, while storage-outflow relationships were incorporated in the model to determine the impact of the seven reservoirs. Peak flow discharges for Willow Creek from its confluence with Bear Creek to 11th Avenue Southeast/County Highway 1 were updated to reflect the completed flood control project (FEMA, 1998).

Peak discharge-drainage area relationships for each flooding source studied in detail are shown in Table 4.

Table 4 – Summary of Discharges

		Peak Discharges (cubic feet per 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
BADGER RUN					
At confluence with Bear Creek	16.37	1,376	2,335	3,070	5,661
At 30th Avenue Southeast	15.75	1,538	2,633	3,376	5,373
At 30th Street Southeast	13.40	1,739	3,512	4,543	7,132
At U.S. Highway 52	12.49	2,104	3,432	4,120	6,014
Approximately 2,800 feet Northwest of 50th Avenue Southeast/County Highway 11	9.72	1,801	2,867	3,465	4,998
At 50th Avenue Southeast / County Highway 11	7.98	1,806	2,789	3,357	4,839
BEAR CREEK					
At confluence with South Fork Zumbro River	76.60	4,000	7,200	8,900	14,000
Above confluence of Willow Creek	45.60	3,400	6,300	8,000	12,600
Above confluence of Badger Run	29.70	2,200	4,100	5,100	8,100
Approximately 2,150 feet upstream of County Highway 11/50th Street Southeast	5.64	1,040	1,930	2,430	3,950
Approximately 550 feet upstream of County Highway 19/ Chester Road Southeast	3.35	830	1,260	1,460	2,050
At Dakota, Minnesota, and Eastern Railroad	2.42	560	830	950	1,280
Approximately 1,400 feet downstream of Field Road	0.80	220	360	420	600
Approximately 1,450 feet upstream of Field Road	0.46	100	160	190	260
CAREY CREEK					
At confluence with North Branch Root River	18.25	2,624	3,939	4,773	6,466

Table 4 – Summary of Discharges *(continued)*

Flooding Source and Location	Drainage Area (square miles)	Peak Discharges (cubic feet per second) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
CASCADE CREEK					
At confluence with South Fork Zumbro River	38.50	1,850	3,500	4,400	7,000
At 16th Avenue Northwest	37.00	1,850	3,500	4,400	7,000
Above U.S. Highway 52	36.90	1,900	3,650	4,600	7,200
Above confluence of North Run of the North Fork of Cascade Creek	33.20	1,800	3,250	4,000	6,200
Above confluence of South Run of the North Fork of Cascade Creek	20.40	1,700	3,000	3,650	5,500
EAST FORK OF WILLOW CREEK					
At confluence with Willow Creek	7.10	670	1,350	1,700	2,750
At U.S. Highway 52	6.40	560	1,100	1,380	2,200
HADLEY VALLEY CREEK					
At East River Road	8.82	1,495	1,972	2,225	2,776
At U.S. Highway 63	8.23	1,434	1,897	2,141	2,673
At 48th Street Northeast/County Highway 124	7.92	1,434	1,897	2,141	2,673
Approximately 2,100 feet west of the crossing at Hadley Valley Road Northeast/County Highway 124	7.58	1,541	2,368	2,806	3,827
At Hadley Valley Road Northeast/County Highway 124	4.31	911	1,203	1,345	1,669
Upstream from study area (Approximately 6,600 feet east of the Intersection of Hadley Valley Road Northeast and 48th Street Northeast)	3.19	1,029	1,662	2,026	2,923
HADLEY VALLEY CREEK SPLIT FLOW					
Approximately 1,350 feet upstream of the downstream confluence with Hadley Valley Creek	*	883	1,175	1,317	1,641
Approximately 2,050 feet upstream of the downstream confluence with Hadley Valley Creek	*	551	748	850	1,130
MIDDLE FORK ZUMBRO RIVER					
Approximately 7,200 feet downstream of County Highway 18/Minnesota Avenue South	427.63	11,700	22,500	28,300	46,600
Below confluence of South Branch Middle Fork Zumbro River	425.00	11,700	22,500	28,300	46,600
Above confluence of South Branch Middle Fork Zumbro River	207.00	9,180	15,800	19,000	27,800
MILL CREEK					
At confluence with North Branch Root River	30.00	4,660	8,540	10,260	14,370

Table 4 – Summary of Discharges *(continued)*

Flooding Source and Location	Drainage Area (square miles)	Peak Discharges (cubic feet per second) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
NORTH BRANCH ROOT RIVER					
Approximately 1,100 feet upstream of U.S. Highway 63	114.00	10,540	15,640	18,680	25,210
NORTH RUN OF THE NORTH FORK OF CASCADE CREEK					
At confluence with Cascade Creek	3.70	570	1,350	1,850	3,400
Approximately 2,100 feet upstream of Seventh Street Northwest	3.10	530	930	1,150	1,700
Approximately 300 feet upstream of 19th Street Northwest	2.17	79	140	199	300
Approximately 2,200 feet upstream of 19th Street Northwest	1.62	21	74	90	93
SILVER CREEK					
Approximately 3,802 feet west of the 50th Avenue Northeast and Silver Creek Road Northeast intersection	11.68	1,665	2,484	2,997	4,223
At the railroad crossing south of Silver Creek Road Northeast crossing	16.79	1,731	2,651	3,246	4,727
At the East Circle Drive Northeast crossing	17.19	1,656	2,611	3,097	4,607
At the confluence with South Fork Zumbro River	17.80	1,500	2,700	3,450	5,600
SOUTH BRANCH MIDDLE FORK ZUMBRO RIVER					
At confluence with Middle Fork Zumbro River	218.00	9,370	16,200	19,400	28,800
SOUTH FORK OF BEAR CREEK					
At confluence with Bear Creek	22.60	2,660	5,080	6,450	11,000
SOUTH FORK WHITEWATER RIVER					
Approximately 1,830 feet upstream of U.S. Highway 14	21.40	2,150	3,110	3,650	4,580
At Dakota, Minnesota and Eastern Railroad	20.20	2,120	3,100	3,740	4,820
At County Road 10	20.10	2,130	3,210	3,850	4,910
At U.S. Highway 14	2.70	270	395	480	575
At Dakota, Minnesota and Eastern Railroad	2.50	225	315	350	420
At Center Avenue South	2.10	210	295	330	390
SOUTH FORK OF WILLOW CREEK					
At confluence with Willow Creek	1.00	440	790	1,000	1,120
At County Highway 20	0.60	340	620	780	1,070

Table 4 – Summary of Discharges *(continued)*

Flooding Source and Location	Drainage Area (square miles)	Peak Discharges (cubic feet per second) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
SOUTH FORK ZUMBRO RIVER					
At USGS gage	303.00	9,000	16,500	20,500	31,500
Above confluence of Cascade Creek	252.20	8,900	15,500	19,500	29,500
Above confluence of Silver Creek	233.20	8,300	15,000	19,000	29,000
Above confluence of Bear Creek	155.00	6,900	12,000	14,800	22,500
SOUTH RUN OF THE NORTH FORK OF CASCADE CREEK					
At confluence with Cascade Creek	11.70	1,260	1,580	1,750	2,200
At U.S. Highway 14	10.50	1,200	1,320	1,360	1,450
At Dakota, Minnesota, and Eastern Railroad	10.50	1,250	2,000	2,400	3,400
SOUTHEAST BRANCH OF WILLOW CREEK					
At confluence with Willow Creek	0.70	890	1,670	2,130	3,450
TRIBUTARY B					
At confluence with South Fork Whitewater River	10.00	1,330	2,070	2,530	3,300
WEST FORK OF WILLOW CREEK					
At confluence with Willow Creek	0.70	50	77	100	140
At Earth Dam	0.55	150	240	290	390
WEST TRIBUTARY TO WILLOW CREEK					
At confluence with Willow Creek	0.60	300	530	690	1,140
Approximately 2,100 feet upstream of confluence with Willow Creek	0.44	250	445	570	960
WILLOW CREEK					
At confluence with Bear Creek	28.40	2,200	4,100	5,100	8,200
Above confluence of West Tributary to Willow Creek	25.70	2,000	3,800	4,800	7,600
Above confluence of East Fork of Willow Creek	18.50	1,250	2,550	3,300	5,400
Above confluence of South Fork of Willow Creek	17.30	1,175	2,300	2,950	4,850
Above confluence of West Fork of Willow Creek	16.00	1,050	2,100	2,700	4,500
Above confluence of Southeast Branch of Willow Creek	11.20	520	1,025	1,300	2,100

Stillwater elevations for Olmsted County are shown in Table 5.

Table 5 - Summary of Stillwater Elevations

Flooding Source	Water Surface Elevations (Feet NAVD[1]) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
Ponding Area 1	*	*	1048.8	*
Ponding Area 2	*	*	1046.1	*
Ponding Area 3	*	*	1048.8	*
Ponding Area 4	*	*	1048.8	*

*Data Not Available
[1] North American Vertical Datum of 1988

3.2 Hydraulic Analyses

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

Badger Run

In a pre-countywide hydraulic analysis, the approximate 1-percent-annual-chance water-surface elevation for Badger Run, upstream of 50th Avenue Southeast/County Highway 11, was computed using HEC-2 and the 1-percent-annual-chance discharge obtained from the MNDNR (State of Minnesota, 1975).

For this countywide study, hydraulic analysis for Badger Run from the confluence with Bear Creek to 50th Avenue Southeast/County Highway 11 was performed using the USACE's computer program HEC-RAS, version 3.1.3 (HEC, 2005). The HEC-RAS model geometry was developed using Geographic Information Systems (GIS) applications within the USACE computer program HEC-GeoRAS, version 4.1.1 (HEC, 2006).

Cross section data for the hydraulic analyses for Badger Run were based on a Digital Terrain Model (DTM) of the area provided by Olmsted County. The DTM was certified to meet photogrammetric and aerial mapping standards. Surveyed channel data were also incorporated into the cross sections.

Bridge/culvert and roadway survey data were also incorporated into the HEC-RAS models. Survey points represented by stations and elevations were recorded in x-y-z format, and sketches derived from field measurements provided additional

structural dimensions for culverts and bridges. Digital photographs were taken during the survey.

Other parameters in the HEC-RAS model, including ineffective flow areas and expansion and contraction coefficients, were based on the detailed DTM of the study area. Starting water-surface elevations were determined using the water-surface elevations computed for Bear Creek at the confluence with Badger Run. Channel roughness factors (Manning's "n" values) used in the model were determined by both field reconnaissance and inspecting aerial photographs of the study area.

Bear Creek

As part of a pre-countywide analysis, cross section data for Bear Creek upstream of a point approximately 265 feet upstream of the confluence of Badger Run were obtained from the MNDNR (State of Minnesota, 1975). Data for the dry portions of the cross sections taken were obtained using photogrammetric methods with aerial photographs taken in May 1974 and May 1975, and below-water cross sections were obtained from field measurement (Mark Hurd Aerial Surveys, Inc.,

1974-1975). Water-surface elevations for floods of the selected recurrence intervals on Bear Creek upstream of a point approximately 265 feet upstream of the confluence of Badger Run in the unincorporated areas were obtained from the MNDNR (State of Minnesota, 1975). In the unincorporated areas, the starting water-surface elevations were obtained from the MNDNR (State of Minnesota, 1975). Roughness coefficients were chosen using field inspection data and aerial photographs taken in May 1974 and 1975 (Mark Hurd Aerial Surveys, Inc., 1974-1975).

As part of the February 4, 1998, revised countywide analysis, cross sections for Bear Creek from the confluence of South Fork Zumbro River to a point approximately 265 feet upstream of the confluence of Badger Run were obtained from a 1980 field survey. Water-surface elevations of floods of the selected recurrence intervals were computed using the USACE HEC-2 step-backwater computer program (HEC, 1991). The hydraulic analyses for all revised streams were updated to reflect completed construction of the Rochester Flood Control Project. The starting water-surface elevations for Bear Creek were determined from water-surface elevations computed for the South Fork Zumbro River at the respective confluences. Manning's "n" values used in the hydraulic computations for the revised streams in the February 4, 1998, revision were determined based upon the previous HEC-2 models developed for the FIS for the City of Rochester and the Rochester Flood Control Project (FEMA, 1987).

Carey Creek

For this countywide study, hydraulic analysis for Carey Creek was performed using the USACE's computer program HEC-RAS, version 3.1.3 (HEC, 2005). The HEC-RAS model geometry was developed using GIS applications within the USACE computer program HEC-GeoRAS, version 4.1.1 (HEC, 2006).

Cross section data for the hydraulic analysis for Carey Creek were based on full cross section surveys (channel and overbanks) at specific locations. For additional elevation points outside of the surveyed cross-sections and for floodplain mapping between cross-sections, the best available topography data (USGS DTM) was used.

Bridge/culvert and roadway survey data were also incorporated into the HEC-RAS models. Survey points represented by stations and elevations were recorded in x-y-z format, and sketches derived from field measurements provided additional structural dimensions for culverts and bridges. Digital photographs were taken during the survey.

Other parameters in the HEC-RAS model, including ineffective flow areas and expansion and contraction coefficients, were based on the detailed DTM of the study area. Starting water-surface elevations were determined using the water-surface elevations computed for North Branch Root River at its confluence with Carey Creek. Manning's "n" values used in the model were determined by both field reconnaissance and inspecting aerial photographs of the study area.

Cascade Creek

As part of a pre-countywide analysis, cross section data for Cascade Creek upstream of a point approximately 250 feet downstream of County Highway 34 were obtained from the MNDNR (State of Minnesota, 1975). Data for the dry portions of the cross sections taken were obtained using photogrammetric methods with aerial photographs taken in May 1974 and May 1975, and below-water cross sections were obtained from field measurement (Mark Hurd Aerial Surveys, Inc., 1974-1975). Water-surface elevations for floods of the selected recurrence intervals on Cascade Creek upstream of a point approximately 250 feet downstream of County Highway 34 in the unincorporated areas were obtained from the MNDNR (State of Minnesota, 1975). In the unincorporated areas, the starting water-surface elevations were obtained from the MNDNR (State of Minnesota, 1975). Roughness coefficients were chosen using field inspection data and aerial photographs taken in May 1974 and 1975 (Mark Hurd Aerial Surveys, Inc., 1974-1975).

As part of a pre-countywide analysis, depths for sheet flow areas were determined using topographic maps and by field survey (USGS, various dates (a)). There are areas of sheet flow with depths between 1 and 3 feet.

For the February 4, 1998, revised countywide analysis, cross sections for Cascade Creek from its confluence with the South Fork Zumbro River to a point approximately 250 feet downstream of County Highway 34 were obtained from a MNDNR floodplain information report (State of Minnesota, 1975). All bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry. The starting water-surface elevations were determined from water-surface elevations computed for the South Fork Zumbro River at the respective confluences. Roughness factors (Manning's "n") used in the hydraulic computations for the revised streams in the February 4, 1998, revision were determined based upon the previous HEC-2 models developed for the FIS of the City of Rochester and the Rochester Flood Control Project (FEMA, 1987).

East Fork of Willow Creek

For the April 17, 1995, initial countywide analysis, cross sections for East Fork Willow Creek were obtained from a MNDNR floodplain information report (State of Minnesota, 1975). All bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry. Water-surface elevations of floods of the selected recurrence intervals were computed using the USACE HEC-2 step-backwater computer program (HEC, 1991). The starting water-surface elevation for East Fork of Willow Creek was determined from the water-surface elevation computed for Willow Creek. Manning's "n" values used in the hydraulic computations were determined based upon the previous stream analyses for the FIS of the City of Rochester and the Rochester Flood Control Project (FEMA, 1987).

Hadley Valley Creek

For this countywide study, hydraulic analysis for Hadley Valley Creek was performed using the USACE's computer program HEC-RAS, version 3.1.3 (HEC, 2005). The HEC-RAS model geometry was developed using GIS applications within the USACE computer program HEC-GeoRAS, version 4.1.1 (HEC, 2006).

Cross section data for the hydraulic analysis were based on a DTM of the area provided by Olmsted County. Surveyed channel data were also incorporated into the cross sections. The cross sections were cut along each stream reach perpendicular to both the stream lines representing the centroids of overbank flow.

Bridge/culvert and roadway survey data were also incorporated into the HEC-RAS models. Survey points represented by stations and elevations were recorded in x-y-z format, and sketches derived from field measurements provided additional structural dimensions for culverts and bridges. Digital photographs were taken during the survey.

Other parameters in the HEC-RAS model, including ineffective flow areas and expansion and contraction coefficients, were based on a detailed DTM of the study area (and the Hawthorne Hills proposed grading plan in the case of Hadley Valley Creek). Starting water-surface elevations were determined using the normal depth

method in HEC-RAS based on the slope of the stream downstream of the study area. Manning's "n" values used in the models were determined by both field reconnaissance and inspecting aerial photographs of the study area.

Hadley Valley Creek Split Flow

For this countywide study, hydraulic analysis for Hadley Valley Creek Split Flow was performed using the USACE's computer program HEC-RAS, version 3.1.3 (HEC, 2005). The HEC-RAS model geometry was developed using GIS applications within the USACE computer program HEC-GeoRAS, version 4.1.1 (HEC, 2006).

Cross section data for the hydraulic analysis were based on a DTM of the area provided by Olmsted County. Surveyed channel data were also incorporated into the cross sections. The cross sections were cut along each stream reach perpendicular to both the stream lines representing the centroids of overbank flow.

Bridge/culvert and roadway survey data were also incorporated into the HEC-RAS models. Survey points represented by stations and elevations were recorded in x-y-z format, and sketches derived from field measurements provided additional structural dimensions for culverts and bridges. Digital photographs were taken during the survey.

Other parameters in the HEC-RAS model, including ineffective flow areas and expansion and contraction coefficients, were based on the detailed DTM of the study area (and the Hawthorne Hills proposed grading plan in the case of Hadley Valley Creek). Starting water-surface elevations were determined using the water-surface elevations computed for Hadley Valley Creek at the downstream confluence with Hadley Valley Creek Split Flow. Manning's "n" values used in the models were determined by both field reconnaissance and inspecting aerial photographs of the study area.

Middle Fork Zumbro River

As part of a pre-countywide analysis of the Middle Fork Zumbro River, in the unincorporated areas, data for the dry portions of the cross sections were obtained using photogrammetric methods with aerial photographs taken in May 1974 and May 1975, and below-water cross sections were obtained from field measurement (Mark Hurd Aerial Surveys, Inc., 1974-1975).

In the City of Oronoco, the starting water-surface elevations for the Middle Fork Zumbro River were obtained from the FIS for the unincorporated areas of Olmsted County (FEMA, 1980b). The starting water-surface elevations for the Middle Fork Zumbro River in the unincorporated areas were determined by critical depth.

Along certain portions of Shady Lake, a profile base line is shown on the maps to represent channel distances as indicated on the flood profiles and floodway data tables.

The approximate 1-percent-annual-chance water-surface elevation for Zumbro Lake was determined from the water-surface profiles developed for the Middle Fork Zumbro River.

Manning's "n" values for the Middle Fork Zumbro River in the City of Oronoco were assigned on the basis of past experience and field inspection of the channel and floodplain areas. In the unincorporated areas, roughness coefficients were chosen using field inspection data and aerial photographs taken in May 1974 and 1975 (Mark Hurd Aerial Surveys, Inc., 1974-1975).

Mill Creek

For this countywide study, hydraulic analysis for Mill Creek from the county boundary to approximately 1.83 miles upstream of the State Highway 30 bridge crossing was performed using the USACE's computer program HEC-RAS, version 3.1.3 (HEC, 2005). The HEC-RAS model geometry was developed using GIS applications within the USACE computer program HEC-GeoRAS, version 4.1.1 (HEC, 2006).

Cross section data for the hydraulic analysis for Mill Creek were based on full cross section surveys (channel and overbanks) at specific locations. For additional elevation points outside of the surveyed cross-sections and for floodplain mapping between cross-sections, the best available topography data (USGS DTM) was used.

Bridge/culvert and roadway survey data were also incorporated into the HEC-RAS models. Survey points represented by stations and elevations were recorded in x-y-z format, and sketches derived from field measurements provided additional structural dimensions for culverts and bridges. Digital photographs were taken during the survey.

Other parameters in the HEC-RAS model, including ineffective flow areas and expansion and contraction coefficients, were based on the detailed DTM of the study area. Starting water-surface elevations were determined using the normal depth method in HEC-RAS based on the slope of the stream downstream of the study area. Manning's "n" values used in the model were determined by both field reconnaissance and inspecting aerial photographs of the study area.

North Branch Root River

As part of a pre-countywide analysis, in the City of Stewartville, flood elevations for areas studied by approximate methods were determined by field observation and engineering judgment.

For this countywide study, hydraulic analysis for the North Branch of the Root River from approximately 1.1 miles downstream of the second County Highway 120/20th Street Northeast bridge crossing to approximately 2.4 miles upstream of the U.S. Highway 63 bridge crossing was performed using the USACE's computer

program HEC-RAS, version 3.1.3 (HEC, 2005). The HEC-RAS model geometry was developed using GIS applications within the USACE computer program HEC-GeoRAS, version 4.1.1 (HEC, 2006).

Cross section data for the hydraulic analysis for North Branch of the Root River were based on full cross section surveys (channel and overbanks) at specific locations. For additional elevation points outside of the surveyed cross-sections and for floodplain mapping between cross-sections, the best available topography data (USGS DTM) was used. A few cross sections for the North Branch of the Root River in Stewartville were extended using surveyed two-foot contour maps provided by Olmsted County.

Bridge/culvert and roadway survey data were also incorporated into the HEC-RAS models. Survey points represented by stations and elevations were recorded in x-y-z format, and sketches derived from field measurements provided additional structural dimensions for culverts and bridges. Digital photographs were taken during the survey.

Other parameters in the HEC-RAS model, including ineffective flow areas and expansion and contraction coefficients, were based on the detailed DTM of the study area. Starting water-surface elevations were determined using the normal depth method in HEC-RAS based on the slope of the stream downstream of the study area. Manning's "n" values used in the model were determined by both field reconnaissance and inspecting aerial photographs of the study area.

North Run of the North Fork of Cascade Creek

As part of a pre-countywide analysis, depths for sheet flow areas were determined using topographic maps and by field survey (USGS, various dates (a)). There are areas of sheet flow with depths less than 1 foot on the North Run of the North Fork of Cascade Creek. There are also areas of sheet flow with depths between 1 and 3 feet on the North Run of the North Fork of Cascade Creek. Weir equations and coefficients from Design of Small Dams were used in the hydraulic analysis of North Run of the North Fork of Cascade Creek in the areas of shallow flooding (U.S. Department of the Interior, 1973). The depths of those shallow flooding areas were developed using the weir equations and topographic information.

For the February 4, 1998, revised countywide analysis, cross sections for the North Run of the North Fork of Cascade Creek from its confluence with Cascade Creek to a point approximately 0.93 miles upstream of 19th Street Northwest were obtained from Barr Engineering. All bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry.

Water-surface elevations of floods of the selected recurrence intervals were computed using the USACE HEC-2 step-backwater computer program (HEC, 1991). The hydraulic analyses for all revised streams were updated to reflect the construction of the Rochester Flood Control Project.

The starting-water surface elevations for the North Run of the North Fork of Cascade Creek were determined from water-surface elevations computed for Cascade Creek at the confluences. Manning's "n" values used in the hydraulic computations were determined based upon the previous HEC-2 models developed for the FIS of the City of Rochester and the Rochester Flood Control Project (FEMA, 1987).

Silver Creek

For the April 17, 1995, initial countywide analysis, cross sections for Silver Creek from its confluence with the South Fork Zumbro River to the walking bridge in the Quarry Hill Nature Center were obtained from a MNDNR floodplain information report (State of Minnesota, 1975). All bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry. Water-surface elevations of floods of the selected recurrence intervals were computed using the USACE HEC-2 step-backwater computer program (HEC, 1991). The starting water-surface elevations were determined from water-surface elevations computed for the South Fork Zumbro River its confluence. Manning's "n" values used in the hydraulic computations were determined based upon the previous stream analyses for the FIS of the City of Rochester and the Rochester Flood Control Project (FEMA, 1987).

For this countywide study, hydraulic analysis for Silver Creek from the walking bridge in the Quarry Hill Nature Center to approximately 1.33 miles upstream of the Silver Creek Road Northeast bridge crossing was performed using the USACE's computer program HEC-RAS, version 3.1.3 (HEC, 2005). The HEC-RAS model geometry was developed using GIS applications within the USACE computer program HEC-GeoRAS, version 4.1.1 (HEC, 2006).

Cross section data for the hydraulic analysis were based on a DTM of the area provided by Olmsted County. Surveyed channel data were also incorporated into the cross sections. The cross sections were cut along each stream reach perpendicular to both the stream lines representing the centroids of overbank flow.

Bridge/culvert and roadway survey data were also incorporated into the HEC-RAS models. Survey points represented by stations and elevations were recorded in x-y-z format, and sketches derived from field measurements provided additional structural dimensions for culverts and bridges. Digital photographs were taken during the survey.

Other parameters in the HEC-RAS model, including ineffective flow areas and expansion and contraction coefficients, were based on the detailed DTM of the study area. Starting water-surface elevations were determined using the water-surface elevations computed as part of the 1995 FIS for Silver Creek at the walking bridge in the Quarry Hill Nature Center (formerly known as Silver Creek

Road). Manning's "n" values used in the model were determined by both field reconnaissance and inspecting aerial photographs of the study area.

South Branch Middle Fork Zumbro River

As part of a pre-countywide analysis of the South Branch Middle Fork Zumbro River, in the unincorporated areas, data for the dry portions of the cross sections were obtained using photogrammetric methods with aerial photographs taken in May 1974 and May 1975, and below-water cross sections were obtained from field measurement (Mark Hurd Aerial Surveys, Inc., 1974-1975).

The starting water-surface elevations for the South Branch Middle Fork Zumbro River were obtained from the water-surface elevations for the Middle Branch Zumbro River.

Manning's "n" values for the South Branch Middle Fork Zumbro River in the City of Oronoco were assigned on the basis of past experience and field inspection of the channel and floodplain areas.

South Fork of Bear Creek

As part of a pre-countywide analysis of the South Fork of Bear Creek, in the unincorporated areas, data for the dry portions of the cross sections were obtained using photogrammetric methods with aerial photographs taken in May 1974 and May 1975, and below-water cross sections were obtained from field measurement (Mark Hurd Aerial Surveys, Inc., 1974-1975). In the unincorporated areas, the starting water-surface elevations were obtained from the MNDNR (State of Minnesota, 1975). Roughness coefficients were chosen using field inspection data and aerial photographs taken in May 1974 and 1975 (Mark Hurd Aerial Surveys, Inc., 1974-1975).

South Fork Whitewater River

As part of a pre-countywide analysis of the portion of the South Fork Whitewater River within the limits of the City of Eyota, cross section data were obtained by field survey; data on the overbank sections were obtained by photogrammetric methods using aerial photographs (Martinez Ortho-Mapping Corporation, 1978; Martinez Ortho-Mapping Corporation, 1979a; Martinez Ortho-Mapping Corporation, 1979b). Starting water-surface elevations were determined using the slope/area method. Manning's "n" values were chosen by engineering judgment and based on field observations of the stream and floodplain areas.

For this countywide study, hydraulic analysis for the South Fork Whitewater River from approximately 0.04 miles upstream of U.S. Highway 42 to the confluence with Tributary B within the City of Dover, hydraulic analysis were performed using the USACE's computer program HEC-RAS, version 3.1.3 (HEC, 2005). The HEC-RAS model geometry was developed using GIS applications within the USACE computer program HEC-GeoRAS, version 4.1.1 (HEC, 2006).

Cross section data for the hydraulic analysis for the portion of the South Fork Whitewater River that is in the city of Dover was obtained from the original HEC-2 model. The HEC-2 model was converted to HEC-RAS and was updated to include new bridge survey data for County Highway 10.

Starting water-surface elevations were determined using the normal depth method in HEC-RAS based on the slope of the stream downstream of the study area. Manning's "n" values used in the models were determined by both field reconnaissance and inspecting aerial photographs of the study area.

South Fork of Willow Creek

As part of a pre-countywide analysis of the South Fork of Willow Creek, in the unincorporated areas, data for the dry portions of the cross sections were obtained using photogrammetric methods with aerial photographs taken in May 1974 and May 1975, and below-water cross sections were obtained from field measurement (Mark Hurd Aerial Surveys, Inc., 1974-1975). The starting water-surface elevations were obtained from the water-surface elevations for Willow Creek. Roughness coefficients were chosen using field inspection data and aerial photographs taken in May 1974 and 1975 (Mark Hurd Aerial Surveys, Inc., 1974-1975).

South Fork Zumbro River

As part of the hydraulic analysis for the February 4, 1998, revised countywide analysis, channel cross sections for the South Fork Zumbro River from a point approximately 10,490 feet downstream of 37th Street Northwest to a point just upstream of Mayowood Road/County Highway 125 were obtained from USACE construction drawings, and placed within the 1980 survey information that is used for the overbank areas (USACE, 1988a; USACE, 1988b; USACE, 1989a; USACE, 1989b; USACE, 1991; USACE, 1992; Mark Hurd Aerial Surveys, Inc., 1980). All bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry.

Water-surface elevations of floods of the selected recurrence intervals were computed using the USACE HEC-2 step-backwater computer program (HEC, 1991). The hydraulic analysis for all revised streams were updated to reflect the construction of the Rochester Flood Control Project.

The starting water-surface elevation for the South Fork Zumbro River was determined by a rating curve developed at the site of the old USGS gaging station.

Manning's "n" values used in the hydraulic computations were determined based upon the previous HEC-2 models developed for the FIS of the City of Rochester and the Rochester Flood Control Project (FEMA, 1987).

South Run of the North Fork of Cascade Creek

As part of a pre-countywide analysis, depths for sheet flow areas were determined using topographic maps and by field survey (USGS, various dates (a)). There are areas of sheet flow with depths between 1 and 3 feet on the South Run of the North Fork of Cascade Creek. Weir equations and coefficients from Design of Small Dams were used in the hydraulic analysis of South Run of the North Fork of Cascade Creek in the areas of shallow flooding (U.S. Department of the Interior, 1973). The depths of shallow flooding areas were developed using weir equations and topographic information.

As part of the hydraulic analysis for the February 4, 1998, revised countywide analysis, cross sections for the South Run of the North Fork of Cascade Creek from its confluence with Cascade Creek to a point approximately 1.1 miles upstream of Dakota, Minnesota and Eastern Railroad were obtained from the Minnesota DOT. All bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry.

Water-surface elevations of floods of the selected recurrence intervals were computed using the USACE HEC-2 step-backwater computer program (HEC, 1991). The hydraulic analysis was updated to reflect the construction of the Rochester Flood Control Project.

The starting-water surface elevations for the South Run of the North Fork of Cascade Creek were determined from water-surface elevations computed for Cascade Creek at the confluences.

Manning's "n" values used in the hydraulic computations were determined based upon the previous HEC-2 models developed for the FIS for the City of Rochester and the Rochester Flood Control Project (FEMA, 1987).

Southeast Branch of Willow Creek

As part of a pre-countywide analysis for the Southeast Branch of Willow Creek, in the unincorporated areas, data for the dry portions of the cross sections were obtained using photogrammetric methods with aerial photographs taken in May 1974 and May 1975, and below-water cross sections were obtained from field measurement (Mark Hurd Aerial Surveys, Inc., 1974-1975).

Depths for sheet flow areas were determined using topographic maps and by field survey (USGS, various dates (a)). There are areas of sheet flow with depths less than 1 foot on Southeast Branch of Willow Creek and North Run of the North Fork of Cascade Creek.

The starting water-surface elevations were obtained from the water-surface elevations for Willow Creek. Roughness coefficients were chosen using field inspection data and aerial photographs taken in May 1974 and May 1975 (Mark Hurd Aerial Surveys, Inc., 1974-1975).

Tributary B

As part of a pre-countywide analysis, stream cross sections for Tributary B were obtained by field survey; data on the overbank sections were obtained by photogrammetric methods using aerial photographs (Martinez Ortho-Mapping Corporation, 1978; Martinez Ortho-Mapping Corporation, 1979a; Martinez Ortho-Mapping Corporation, 1979b).

At their confluence, the South Fork Whitewater River and Tributary B have similar hydrologic and hydraulic characteristics; thus, the starting water-surface elevations for the tributary would equal those on the South Fork Whitewater River at the confluence. Accordingly, one continuous hydraulic model was developed for the City of Dover.

Starting water-surface elevations were determined using the slope/area method. Manning's "n" values were chosen by engineering judgment and based on field observations of the stream and floodplain areas.

West Fork of Willow Creek

As part of a pre-countywide analysis of the West Fork of Willow Creek, in the unincorporated areas, data for the dry portions of the cross sections taken were obtained using photogrammetric methods with aerial photographs taken in May 1974 and May 1975, and below-water cross sections were obtained from field measurement (Mark Hurd Aerial Surveys, Inc., 1974-1975).

The starting water-surface elevations were obtained from the water-surface elevations for Willow Creek. Roughness coefficients chosen using field inspection data and aerial photographs taken in May 1974 and May 1975 (Mark Hurd Aerial Surveys, Inc., 1974-1975).

West Tributary to Willow Creek

As part of a pre-countywide analysis of the West Tributary to Willow Creek, in the unincorporated areas, data for the dry portions of the cross sections taken were obtained using photogrammetric methods with aerial photographs taken in May 1974 and May 1975, and below-water cross sections were obtained from field measurement (Mark Hurd Aerial Surveys, Inc., 1974-1975).

The starting water-surface elevations were obtained from the water-surface elevations for Willow Creek. Roughness coefficients chosen using field inspection data and aerial photographs taken in May 1974 and May 1975 (Mark Hurd Aerial Surveys, Inc., 1974-1975).

Willow Creek

As part of the hydraulic analysis for the April 17, 1995, initial countywide analysis, cross sections for Willow Creek from 11th Avenue Southeast/County Highway 1 to a point approximately 0.7 mile upstream of County Road 147 were obtained from a MNDNR floodplain information report (State of Minnesota, 1975). All bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry. Water-surface elevations of floods of the selected recurrence intervals were computed using the USACE HEC-2 step-backwater computer program (HEC, 1991). The starting water-surface elevations were determined from water-surface elevations computed for the South Fork Zumbro River at the respective confluences. Manning's "n" values used in the hydraulic computations for the revised streams in the April 17, 1995, countywide FIS were determined based upon the previous stream analyses for the FIS of the City of Rochester and the Rochester Flood Control Project (FEMA, 1987).

As part of the hydraulic analysis for the February 4, 1998, revised countywide analysis, cross sections for Willow Creek from its confluence with Bear Creek to a point approximately 0.7 mile upstream of County Highway 147 were obtained from a MNDNR floodplain information report (State of Minnesota, 1975). All bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry.

Water-surface elevations of floods of the selected recurrence intervals were computed using the USACE HEC-2 step-backwater computer program (HEC, 1991). The hydraulic analyses for all revised streams were updated to reflect the construction of the Rochester Flood Control Project. The starting water-surface elevations for Willow Creek were adjusted to reflect revised Bear Creek flood elevations. Manning's "n" values used in the hydraulic computations were determined based upon the previous HEC-2 models developed for the FIS of the City of Rochester and the Rochester Flood Control Project (FEMA, 1987).

The Manning's "n" values for all detailed studied streams are presented in Table 6.

Table 6 – Summary of Roughness Coefficients

Stream	Channel "n"	Overbank "n"
Badger Run	0.035	0.035-0.100
Bear Creek	0.030-0.050	0.035-0.150
Carey Creek	0.035-0.050	0.035-0.100
Cascade Creek	0.030-0.050	0.035-0.150
East Fork of Willow Creek	*	*
Hadley Valley Creek	0.035-0.050	0.035-0.100
Hadley Valley Creek Split Flow	0.035	0.035-0.100
Middle Fork Zumbro River	0.030-0.050	0.035-0.090
Mill Creek	0.035-0.045	0.035-0.110
North Branch Root River	0.035-0.038	0.035-0.110
North Run of the North Fork of Cascade Creek	0.030-0.050	0.035-0.150
Silver Creek	0.030-0.050	0.035-0.150
South Branch Middle Fork Zumbro River	0.030-0.035	0.035-0.080
South Fork of Bear Creek	0.030-0.055	0.035-0.100

Stream	Channel "n"	Overbank "n"
South Fork Whitewater River	0.035-0.040	0.040-0.100
South Fork of Willow Creek	0.030-0.050	0.035-0.150
South Fork Zumbro River	0.030-0.050	0.035-0.150
South Run of the North Fork of Cascade Creek	0.030-0.050	0.035-0.150
Southeast Branch of Willow Creek	0.030-0.055	0.035-0.100
Tributary B	0.035-0.040	0.040-0.100
West Fork of Willow Creek	0.030-0.050	0.035-0.150
West Tributary to Willow Creek	0.030-0.050	0.035-0.150
Willow Creek	0.030-0.055	0.035-0.150

*Data a Not Available

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 4.2), selected cross section locations are also shown on the FIRM (Exhibit 2).

Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals.

The profile baselines depicted on the FIRM represent the hydraulic modeling baselines that match the flood profiles on this FIS report. As a result of improved topographic data, the profile baseline, in some cases, may deviate significantly from the channel centerline or appear outside the Special Flood Hazard Area.

Although flood elevations on the streams and lakes in Olmsted County can be raised by debris accumulation and ice jams at hydraulic structures, the hydraulic analyses for this FIS were based only on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail. Changes in existing bridge dimensions and elevations could also affect the given water-surface elevations.

3.3 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 in use for newly created or revised FIS reports and FIRMs was NGVD29. With the finalization of NAVD88, many FIS reports and FIRMs are being prepared using NAVD88 as the referenced vertical datum.

All flood elevations shown in this FIS report and on the FIRM are referenced to NAVD. Structure and ground elevations in the community must, therefore, be referenced to NAVD. It is important to note that adjacent communities may be referenced to NGVD. This may result in differences in Base Flood Elevations (BFEs) across the corporate limits between the communities. Some of the data used in this study were taken from the prior effective FIS reports and adjusted to

NAVD. The average conversion factor that was used to convert the data in this FIS report to NAVD was calculated using the U.S. Army Corps of Engineers Corpscon for Windows, Version 5.11.08 (USACE, 1997). The data points used to determine the conversion are listed in Table 7.

Table 7 – Vertical Datum Conversion

Quad Name	Corner	Latitude	Longitude	Conversion from NGVD to NAVD (Feet)
Pine Island	SE	44.125	92.625	0.10
Oronoco	SE	44.125	92.500	0.08
Zumbro Lake	SE	44.125	92.375	0.09
Millville	SE	44.125	92.250	0.07
Plainview	SE	44.125	92.125	0.04
Byron	SE	44.000	92.625	0.01
Douglas	SE	44.000	92.500	0.07
Rochester	SE	44.000	92.375	0.07
Chester	SE	44.000	92.250	0.07
Plainview SW	SE	44.000	92.125	0.03
Rock Dell	SE	43.875	92.625	0.10
Salem Corners	SE	43.875	92.500	0.09
Simpson	SE	43.875	92.375	0.05
Marion	SE	43.875	92.250	0.02
Eyota	SE	43.875	92.125	0.02
			Average:	**0.06**

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

Vertical Network Branch, N/CG13
National Geodetic Survey, NOAA
Silver Spring Metro Center 3
1315 East-West Highway
Silver Spring, Maryland 20910
(301) 713-3191

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 community. Interested individuals may contact FEMA to access these data.

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. Therefore, each FIS provides 1-percent-annual-chance (100-year) flood elevations and delineations of the 1- and 0.2-percent-annual-chance (500-year) floodplain boundaries and 1-percent-annual-chance floodway to assist communities in developing floodplain management measures. This information is presented on the FIRM and in many components of the FIS report, including Flood Profiles, Floodway Data Table, and Summary of Stillwater Elevations Table. Users should reference the data presented in the FIS report as well as additional information that may be available at the local map repository before making flood elevation and/or floodplain boundary determinations.

4.1 Floodplain Boundaries

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

For each stream studied by detailed methods, the 1- and 0.2-percent-annual-chance floodplain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using photogrammetrically compiled maps prepared from aerial photography, photogrammetric methods with aerial photographs, a photogrammetrically compiled planimetric map, topographic maps, flood profiles, and photogrammetric compilation (USGS, various dates (a); Mark Hurd Aerial Surveys, Inc., 1974-1975; Stanley Consultants, Inc., 1979; State of Minnesota, 1975; USGS, various dates (c), Mark Hurd Aerial Surveys, Inc., 1955; Martinez Ortho-Mapping Corporation, 1978; Mark Hurd Aerial Surveys, Inc., 1978; USGS, 1972; Martinez Ortho-Mapping Corporation, 1979a; Martinez Ortho-Mapping Corporation, 1979b). Floodplain boundaries for sheet flow areas were determined using topographic maps (USGS, various dates (a)).

For the streams revised in the April 17, 1995, countywide FIS and for the February 4, 1998, revision the boundaries were interpolated between cross sections using photogrammetric methods with aerial photographs, topographic maps, and cross section data (Mark Hurd Aerial Surveys, Inc., 1980; State of Minnesota, 1975; Mark Hurd Aerial Surveys, Inc., 1974-1975; USGS, various dates (c); Mark Hurd Aerial Surveys, Inc., 1955; USGS, various dates (d)).

For the streams revised during this countywide revision, the boundaries were based on the following:

- North Branch Root River: Two-foot topographic data was collected by Horizons in April of 1999, and mapped in November of 2001. The projection is Olmsted County HARN, and the vertical datum is NAVD88.

- North Branch Root River: Two-foot topographic survey by Yaggy Colby Associates compiled by stereophotogrammetric method from aerial photography taken on December 19, 1984.
- Hadley Valley Creek: Two-foot contours provided by Yaggy Colby Associates March, 2008.
- USGS (quad maps) with a contour interval of ten-feet was used for Mill Creek, South Fork Whitewater River, Carey Creek, and portions of the North Branch Root River
- Rochester two-foot topography was used for Silver Creek, Badger Run, and portions of Hadley Valley Creek.

For the streams studied by approximate methods, the 1-percent-annual-chance floodplain boundaries were delineated using photogrammetrically compiled maps prepared from aerial photographs and approximate analysis, topographic maps, photogrammetric methods with aerial photographs, historic records, field observations, Flood Hazard Boundary Maps, and USGS Flood-prone quadrangles (Martinez Ortho-Mapping Corporation, 1979b; USGS, 1955; Mark Hurd Aerial Surveys, Inc., 1974-1975; FIA, 1976; FIA, 1981; USGS, 1975; USGS, various dates (e)).

The 0.1- 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, and AO), and the 0.2-percent-annual-chance floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 1- 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 (Exhibit 2).

4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the NFIP, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 1-percent-annual-chance floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the 1-percent-annual-chance flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1 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. In Minnesota, however, floodplain encroachment is limited by Minnesota Regulations to that which would cause a 0.5-foot increase in flood heights above pre-floodway conditions at any point (MNDNR, 1977). Floodways having no more than 0.5-foot surcharge were delineated for this FIS. The floodway can be adopted directly or that can be used as a basis for additional floodway studies.

The floodways presented in this FIS report and on the FIRM were computed for certain stream segments on the basis of equal-conveyance reduction from each side of the floodplain. Floodway widths were computed at cross sections. Between cross sections, the floodway boundaries were interpolated. The results of the floodway computations have been tabulated for selected cross sections (Table 8). In cases where the floodway and 1-percent-annual-chance floodplain boundaries are either close together or collinear, only the floodway boundary has been shown.

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
BADGER RUN								
A	134	447	2,958	1.0	1,016.6	1,016.6	1,016.6	0.0
B	810	516	2,949	1.0	1,017.4	1,017.4	1,017.4	0.0
C	2,561	560	1,929	1.6	1,018.9	1,018.9	1,019.0	0.1
D	3,853	580	957	3.2	1,019.6	1,019.6	1,020.1	0.5
E	4,573	547	659	4.7	1,020.5	1,020.5	1,020.6	0.1
F	7,139	730	944	3.3	1,023.6	1,023.6	1,024.1	0.5
G	9,715	690	2,535	1.3	1,029.0	1,029.0	1,029.4	0.4
H	11,017	480	1,380	2.5	1,030.1	1,030.1	1,030.4	0.3
I	12,039	455	1,413	2.4	1,031.8	1,031.8	1,032.3	0.5
J	12,929	680	1,961	1.7	1,033.1	1,033.1	1,033.5	0.4
K	14,564	610	1,387	2.4	1,034.3	1,034.3	1,034.8	0.5
L	15,286	440	940	3.6	1,036.2	1,036.2	1,036.3	0.1
M	16,654	388	1,077	3.1	1,038.7	1,038.7	1,039.2	0.5
N	17,562	335	1,120	3.0	1,039.7	1,039.7	1,040.2	0.5
O	18,768	372	1,087	3.1	1,041.6	1,041.6	1,041.7	0.1
P	20,288	520	2,438	1.9	1,046.5	1,046.5	1,046.7	0.2
Q	21,472	454	1,434	3.2	1,046.8	1,046.8	1,047.1	0.3
R	23,024	356	1,295	3.2	1,048.8	1,048.8	1,049.0	0.2
S	24,388	491	1,331	3.1	1,051.7	1,051.7	1,051.9	0.2
T	26,202	120	439	9.4	1,056.2	1,056.2	1,056.2	0.0
U	26,804	130	649	5.3	1,059.3	1,059.3	1,059.6	0.3
V	27,300	158	649	5.3	1,060.4	1,060.4	1,060.5	0.1

[1]Feet above confluence with Bear Creek

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

BADGER RUN

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
BADGER RUN (CONTINUED)								
W	28,673	292	1,142	3.0	1,062.1	1,062.1	1,062.3	0.2
X	30,003	376	1,056	3.3	1,063.1	1,063.1	1,063.3	0.2
Y	31,887	292	657	5.1	1,067.1	1,067.1	1,067.6	0.5
Z	33,432	380	727	4.6	1,070.9	1,070.9	1,071.3	0.4

[1]Feet above confluence with Bear Creek

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

BADGER RUN

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE-FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
BEAR CREEK								
A	106	144	1,204	7.4	986.1	982.2[2]	982.5[2]	0.0
B	792	133	1,107	8.0	986.1	983.6[2]	983.6[2]	0.0
C	1,267	101	866	10.3	988.4	988.4	988.4	0.0
D	2,006	115	1,067	8.3	992.6	992.6	992.6	0.0
E	2,587	122	1,029	8.7	994.0	994.0	994.0	0.0
F	3,326	154	1,213	7.3	996.0	996.0	996.0	0.0
G	4,858	178	1,307	6.8	998.7	998.7	998.7	0.0
H	5,861	178	1,306	6.8	1,000.7	1,000.7	1,000.7	0.0
I	6,706	171	1,252	7.1	1,001.5	1,001.5	1,001.5	0.0
J	8,870	799	3,173	3.0	1,006.9	1,006.9	1,006.9	0.0
K	10,613	808	3,555	2.9	1,007.8	1,007.8	1,007.9	0.1
L	14,000	936	4,287	2.1	1,011.2	1,011.2	1,011.2	0.0
M	14,337	851	3,959	2.3	1,011.6	1,011.6	1,011.8	0.2
N	17,369	738	3,276	1.6	1,017.0	1,017.0	1,017.4	0.4
O	19,559	459	2,134	2.4	1,019.1	1,019.1	1,019.4	0.3
P	20,775	641	2,061	2.5	1,021.5	1,021.5	1,021.8	0.3
Q	23,179	890	5,200	1.4	1,029.5	1,029.5	1,029.7	0.2
R	24,974	500	2,680	2.8	1,029.9	1,029.9	1,030.4	0.5
S	27,667	910	2,530	3.2	1,034.9	1,034.9	1,034.9	0.0
T	31,363	510	1,610	4.6	1,040.2	1,040.2	1,040.4	0.2
U	33,528	395	2,740	2.7	1,046.7	1,046.7	1,047.1	0.4

[1]Feet above confluence with South Fork Zumbro River

[2]Elevation computed without consideration of backwater effects from South Fork Zumbro River

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

BEAR CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE-FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
BEAR CREEK (CONTINUED)								
V	40,234	200	2,620	0.9	1,066.4	1,066.4	1,066.4	0.0
W	41,976	185	380	5.1	1,066.7	1,066.7	1,066.7	0.0
X	43,560	110	510	3.8	1,073.7	1,073.7	1,073.7	0.0
Y	44,880	65	400	4.8	1,077.6	1,077.6	1,077.6	0.0
Z	47,098	30	200	9.6	1,088.4	1,088.4	1,088.4	0.0
AA	48,259	75	350	5.5	1,095.7	1,095.7	1,095.7	0.0
AB	49,526	150	500	2.9	1,098.9	1,098.9	1,098.9	0.0
AC	51,110	410	1,310	1.1	1,107.0	1,107.0	1,107.0	0.0
AD	54,806	430	2,150	0.3	1,141.6	1,141.6	1,141.6	0.0
AE	55,968	20	300	2.8	1,142.2	1,142.2	1,142.2	0.0
AF	57,869	20	60	8.3	1,163.0	1,163.0	1,163.0	0.0
AG	60,509	60	70	7.1	1,188.0	1,188.0	1,188.0	0.0
AH	62,198	30	60	7.0	1,207.2	1,207.2	1,207.2	0.0
AI	65,102	55	40	4.6	1,262.5	1,262.5	1,262.5	0.0

[1]Feet above confluence with South Fork Zumbro River

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

BEAR CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
CAREY CREEK								
A	719	550	5,349	0.9	1,200.0	1,200.0	1,200.3	0.3
B	1,983	591	4,781	1.0	1,200.6	1,200.6	1,200.9	0.3

[1]Feet above confluence with North Branch Root River

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

CAREY CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE-FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
CASCADE CREEK								
A	995	92	546	8.1	980.5	980.5	980.5	0.0
B	1,545	111	730	6.1	981.9	981.9	981.9	0.0
C	2,125	137	786	5.6	983.0	983.0	983.0	0.0
D	2,810	103	745	5.9	984.1	984.1	984.1	0.0
E	3,640	102	533	8.3	985.0	985.0	985.0	0.0
F	4,365	113	643	6.9	988.7	988.7	988.7	0.0
G	4,910	226	1,144	5.8	990.5	990.5	990.5	0.0
H	5,845	110	792	5.6	991.6	991.6	991.6	0.0
I	6,690	191	712	8.6	994.1	994.1	994.1	0.0
J	7,415	277	868	8.1	996.3	996.3	996.3	0.0
K	8,030	107	523	9.3	997.9	997.9	997.9	0.0
L	8,545	140	824	6.7	1,000.5	1,000.5	1,000.5	0.0
M	9,065	91	680	6.9	1,001.0	1,001.0	1,001.1	0.1
N	9,392	119	1,041	6.6	1,004.1	1,004.1	1,004.1	0.0
O	11,072	320	1,518	4.2	1,004.2	1,004.2	1,004.3	0.1
P	13,718	216	1,968	2.1	1,005.7	1,005.7	1,005.9	0.2
Q	15,429	169	1,573	2.3	1,008.0	1,008.0	1,008.1	0.1
R	17,764	58	288	12.9	1,008.8	1,008.8	1,008.9	0.1
S	21,545	1,119	1,913	4.4	1,025.8	1,025.8	1,025.8	0.0
T	26,170	905	2,595	1.5	1,035.5	1,035.5	1,035.6	0.1
U	28,145	330	485	5.8	1,036.9	1,036.9	1,036.9	0.0

[1]Feet above confluence with South Fork Zumbro River

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

CASCADE CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE-FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
CASCADE CREEK (CONTINUED)								
V	29,775	230	785	3.5	1,043.6	1,043.6	1,043.6	0.0
W	32,205	245	685	4.1	1,049.0	1,049.0	1,049.0	0.0
X	36,545	330	745	3.8	1,056.5	1,056.5	1,056.5	0.0

[1]Feet above confluence with South Fork Zumbro River

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

CASCADE CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE-FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
EAST FORK OF WILLOW CREEK								
A	1,550	470	705	2.4	1,027.5	1,027.5	1,027.5	0.0
B	4,804	380	1,352	0.9	1,044.9	1,044.9	1,045.1	0.2
C	9,924	508	637	2.0	1,065.2	1,065.2	1,065.2	0.0

[1]Feet above the confluence with Willow Creek

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

EAST FORK OF WILLOW CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
HADLEY VALLEY CREEK								
A	1,046	245	1,660	1.3	976.5	976.5	977.0	0.5
B	1,565	216	871	2.5	977.2	977.2	977.6	0.4
C	2,045	189	794	2.7	979.3	979.3	979.7	0.4
D	2,509	179	554	3.9	980.7	980.7	981.1	0.4
E	3,065	70	452	4.7	983.0	983.0	983.4	0.4
F	4,401	280	1,141	2.5	991.8	991.8	992.2	0.4
G	5,265	178	1,035	2.7	993.0	993.0	993.3	0.3
H	5,568	308	1,284	2.2	993.5	993.5	993.8	0.3
I	5,931	245	1,067	2.6	993.6	993.6	993.9	0.3
J	6,295	253	1,102	2.6	994.3	994.3	994.5	0.2
K	4,322	210	790	3.6	994.5	994.5	994.7	0.2
L	6,829	197	593	4.7	994.8	994.8	995.0	0.2
M	7,720	12	19	1.5	997.4	997.4	997.5	0.1
N	8,024	10	15	1.8	997.9	997.9	998.0	0.1
O	8,403	9	9	3.1	999.6	999.6	999.7	0.1
P	8,690	9	14	2.0	1,003.6	1,003.6	1,003.7	0.1
Q	8,832	22	18	1.6	1,004.0	1,004.0	1,004.1	0.1
R	9,380	161	218	2.3	1,007.2	1,007.2	1,007.4	0.2
S	10,393	600	1,368	1.5	1,012.9	1,012.9	1,013.4	0.5
T	11,000	303	346	5.9	1,015.4	1,015.4	1,015.4	0.0
U	10,774	326	563	3.6	1,019.3	1,019.3	1,019.7	0.4
V	12,240	211	351	5.8	1,022.8	1,022.8	1,023.1	0.3

[1]Feet above Limit Detailed Study (Limit of Detailed Study is approximately 512 feet downstream of East River Road Northeast)

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

HADLEY VALLEY CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
HADLEY VALLEY CREEK (CONTINUED)								
W	12,961	351	553	3.7	1,027.8	1,027.8	1,028.2	0.4
X	13,559	355	415	4.9	1,031.7	1,031.7	1,032.0	0.3
Y	14,155	251	402	5.0	1,036.5	1,036.5	1,036.7	0.2
Z	15,311	317	470	4.3	1,044.0	1,044.0	1,044.3	0.3
AA	16,289	287	402	5.0	1,051.3	1,051.3	1,051.6	0.3
AB	16,585	241	367	5.5	1,053.8	1,053.8	1,054.1	0.3
AC	17,124	286	550	3.7	1,057.2	1,057.2	1,057.5	0.3

[1]Feet above Limit of Detailed Study (Limit of Detailed Study is approximately 512 feet downstream of East River Road Northeast)

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

HADLEY VALLEY CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
HADLEY VALLEY CREEK SPLIT FLOW								
A	7,208	93	172	7.6	1,000.4	1,000.4	1,000.5	0.1
B	7,512	122	320	4.1	1,002.5	1,002.5	1,002.9	0.4
C	7,891	200	2,483	0.5	1,002.8	1,002.8	1,003.2	0.4
D	8,178	332	4,541	0.3	1,002.8	1,002.8	1,003.2	0.4
E	8,320	240	3,497	0.4	1,002.8	1,002.8	1,003.2	0.4
F	8,868	187	2,665	0.3	1,002.8	1,002.8	1,003.2	0.4

[1]Feet above East River Road Northeast

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

HADLEY VALLEY CREEK SPLIT FLOW

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE-FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
MIDDLE FORK ZUMBRO RIVER								
A	24,725	320	4,085	6.9	937.5	937.5	937.5	0.0
B	25,485	400	6,875	4.1	938.5	938.5	938.5	0.0
C	27,005	160	3,850	7.4	938.7	938.7	938.7	0.0
D	28,620	400	2,640	10.7	940.2	940.2	940.2	0.0
E	30,010	172	2,623	10.8	945.4	945.4	945.9	0.5
F	31,100	470	6,123	4.6	947.7	947.7	948.2	0.5
G	31,839	197	3,043	9.3	947.8	947.8	948.3	0.5
H	32,051	205	3,444	8.2	959.8	959.8	959.8	0.0
I	32,579	240	4,053	7.0	960.4	960.4	960.5	0.1
J	33,001	820	11,672	1.6	961.2	961.2	961.4	0.2
K	34,057	1,471	22,954	0.8	961.3	961.3	961.4	0.1
L	34,796	915	12,323	1.5	961.3	961.3	961.4	0.1
M	35,694	495	7,176	2.7	961.3	961.3	961.4	0.1
N	36,222	527	8,180	2.3	963.4	963.4	963.5	0.1
O	37,753	1,049	14,880	1.3	963.5	963.5	963.7	0.2
P	38,809	856	10,056	1.9	964.0	964.0	964.1	0.1
Q	39,495	1,493	15,215	1.3	964.1	964.1	964.1	0.0

[1]Feet above the confluence with Zumbro River

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

MIDDLE FORK ZUMBRO RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE-FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
MILL CREEK								
A	1,392	160	1,403	7.3	975.3	975.3	975.4	0.1
B	3,695	475	3,522	2.9	978.5	978.5	978.8	0.3
C	5,490	440	1,792	5.7	980.3	980.3	980.5	0.2
D	5,642	595	2,253	4.6	982.8	982.8	983.2	0.4
E	8,015	695	2,776	3.7	986.4	986.4	986.6	0.2
F	11,445	510	2,202	4.7	992.5	992.5	992.9	0.4

[1]Feet above County Boundary

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

MILL CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
NORTH BRANCH ROOT RIVER								
A	146,253	296	3,274	5.7	1,176.0	1,176.0	1,176.2	0.2
B	147,156	380	4,381	4.3	1,176.9	1,176.9	1,177.1	0.2
C	149,220	1,350	9,885	1.9	1,178.5	1,178.5	1,178.7	0.2
D	150,334	1,450	8,680	2.2	1,178.7	1,178.7	1,179.1	0.4
E	153,306	1,250	10,389	1.8	1,184.4	1,184.4	1,184.4	0.0
F	154,613	1,328	9,734	1.9	1,184.6	1,184.6	1,184.6	0.0
G	156,659	1,150	8,680	2.2	1,185.3	1,185.3	1,185.5	0.2
H	159,234	630	3,712	5.0	1,187.0	1,187.0	1,187.2	0.2
I	159,607	650	4,759	3.9	1,188.1	1,188.1	1,188.4	0.3
J	161,514	688	5,257	3.6	1,190.6	1,190.6	1,190.8	0.2
K	163,874	426	3,538	5.3	1,195.1	1,195.1	1,195.3	0.2
L	164,328	351	3,111	6.0	1,195.5	1,195.5	1,195.7	0.2
M	166,100	406	3,659	5.1	1,198.1	1,198.1	1,198.2	0.1
N	166,597	370	3,454	5.4	1,198.6	1,198.6	1,198.8	0.2
O	167,377	626	5,797	3.2	1,200.0	1,200.0	1,200.3	0.3
P	168,789	1,213	6,919	2.7	1,200.9	1,200.9	1,201.2	0.3
Q	170,581	1,207	8,489	2.2	1,202.3	1,202.3	1,202.5	0.2
R	171,278	1,181	6,746	2.8	1,202.6	1,202.6	1,202.8	0.2
S	172,532	1,106	6,364	2.9	1,203.3	1,203.3	1,203.8	0.5
T	173,635	891	5,628	3.3	1,204.4	1,204.4	1,204.7	0.3
U	174,930	533	3,971	4.7	1,206.3	1,206.3	1,206.6	0.3
V	175,581	359	3,300	5.7	1,207.2	1,207.2	1,207.4	0.2

[1]Feet above Olmsted/Dodge County Boundary

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

NORTH BRANCH ROOT RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE-FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
NORTH RUN OF THE NORTH FORK OF CASCADE CREEK								
A	345	335	2,296	1.3	1,006.7	1,006.7	1,006.7	0.0
B	795	210	936	3.0	1,006.7	1,006.7	1,006.7	0.0
C	1,430	86	462	4.0	1,007.3	1,007.3	1,007.4	0.1
D	2,050	85	502	3.7	1,007.6	1,007.6	1,008.0	0.4
E	2,760	119	413	4.8	1,008.9	1,008.9	1,009.2	0.3
F	3,420	440	1,337	1.7	1,009.8	1,009.8	1,010.1	0.3
G	4,240	510	1,513	1.8	1,012.0	1,012.0	1,012.5	0.5
H	5,150	380	590	5.2	1,012.5	1,012.5	1,013.0	0.5
I	6,220	452	417	5.0	1,015.1	1,015.1	1,015.1	0.0
J	7,400	422	401	5.8	1,018.3	1,018.3	1,018.6	0.3
K	8,000	370	497	3.7	1,020.4	1,020.4	1,020.8	0.4
L	8,570	400	384	3.5	1,022.0	1,022.0	1,022.1	0.1
M	9,795	43	49	4.1	1,023.0	1,022.9	1,023.0	0.0
N	11,114	105	735	0.3	1,030.2	1,030.2	1,030.3	0.1
O	12,214	61	170	0.5	1,030.3	1,030.3	1,030.3	0.0
P	12,714	36	49	1.9	1,030.3	1,030.3	1,030.4	0.1
Q	13,584	30	28	3.2	1,033.8	1,033.8	1,033.8	0.0

[1]Feet above confluence with Cascade Creek

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

NORTH RUN OF THE NORTH FORK OF CASCADE CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
SILVER CREEK								
A	745	107	694	5.0	982.7	982.7	982.7	0.0
B	2,365	135	570	6.1	985.5	985.5	985.5	0.0
C	2,555	149	708	4.9	986.5	986.5	986.5	0.0
D	3,435	220	794	4.3	988.6	988.6	988.6	0.0
E	4,485	386	1,051	3.3	992.1	992.1	992.2	0.1
F	5,085	312	905	3.8	994.6	994.6	994.6	0.0
G	6,785	96	313	11.0	1,003.9	1,003.9	1,003.9	0.0
H	6,985	128	934	3.7	1,007.2	1,007.2	1,007.2	0.0
I	8,845	286	551	6.3	1,010.5	1,010.5	1,010.5	0.0
J	9,395	200	924	3.4	1,015.1	1,015.1	1,015.1	0.0
K	10,294	192	744	4.2	1,018.1	1,018.1	1,018.6	0.5
L	10,824	140	601	5.2	1,020.6	1,020.6	1,020.8	0.2
M	11,241	99	469	6.6	1,022.2	1,022.2	1,022.3	0.1
N	11,623	121	722	4.3	1,025.1	1,025.1	1,025.1	0.0
O	12,394	240	944	3.4	1,026.1	1,026.1	1,026.1	0.0
P	13,254	335	1,004	3.2	1,028.3	1,028.3	1,028.3	0.0
Q	14,084	232	704	4.6	1,032.3	1,032.3	1,032.3	0.0
R	14,986	296	919	3.5	1,036.0	1,036.0	1,036.3	0.3
S	15,771	290	840	3.9	1,039.0	1,039.0	1,039.5	0.5
T	16,343	255	657	4.6	1,041.0	1,041.0	1,041.3	0.3
U	16,685	253	1,003	3.0	1,045.9	1,045.9	1,045.9	0.0
V	17,624	122	428	7.0	1,050.3	1,050.3	1,050.3	0.0

[1]Feet above confluence with South Fork Zumbro River

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

SILVER CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
SILVER CREEK (CONTINUED)								
W	18,297	156	639	4.7	1,055.3	1,055.3	1,055.5	0.2
X	18,855	86	513	5.8	1,059.2	1,059.2	1,059.2	0.0
Y	19,643	129	661	4.5	1,065.1	1,065.1	1,065.1	0.0
Z	20,841	165	612	4.9	1,072.4	1,072.4	1,072.7	0.3
AA	21,686	190	529	5.7	1,076.8	1,076.8	1,076.9	0.1
AB	22,442	165	657	4.6	1,080.8	1,080.8	1,081.1	0.3
AC	23,227	153	440	6.8	1,084.6	1,084.6	1,085.1	0.5
AD	24,215	200	588	5.1	1,092.3	1,092.3	1,092.7	0.4
AE	24,852	113	387	7.8	1,095.7	1,095.7	1,096.2	0.5
AF	25,433	87	432	6.9	1,099.4	1,099.4	1,099.5	0.1
AG	26,403	124	585	5.1	1,104.3	1,104.3	1,104.7	0.4

[1]Feet above confluence with South Fork Zumbro River

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

SILVER CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
SOUTH FORK WHITEWATER RIVER								
A	11,923	228	1,077	3.5	1,133.7	1,133.7	1,133.7	0.0
B	13,368	300	1,579	2.3	1,135.8	1,135.8	1,136.1	0.3
C	14,563	442	1,680	2.2	1,136.8	1,136.8	1,137.2	0.4
D	15,873	147	515	7.1	1,138.2	1,138.2	1,138.5	0.3
E	16,591	246	1,527	2.5	1,143.3	1,143.3	1,143.4	0.1
F	17,346	554	2,966	1.3	1,143.4	1,143.4	1,143.7	0.3
G	17,886	525	2,497	1.5	1,143.5	1,143.5	1,143.8	0.3
H	18,656	564	2,449	1.5	1,143.6	1,143.6	1,143.9	0.3
I	19,968	100	507	7.6	1,145.1	1,145.1	1,145.4	0.3
J	45[2]	44	161	3.0	1,220.4	1,220.4	1,220.5	0.1
K	340[2]	70	161	2.8	1,222.0	1,222.0	1,222.0	0.0
L	1,535[2]	48	87	4.0	1,224.8	1,224.8	1,225.2	0.4
M	2,600[2]	70	129	2.7	1,228.5	1,228.5	1,228.5	0.0
N	2,945[2]	50	81	4.2	1,229.4	1,229.4	1,229.5	0.1
O	3,625[2]	21	71	4.8	1,231.1	1,231.1	1,231.6	0.5
P	4,180[2]	32	106	3.2	1,232.4	1,232.4	1,232.9	0.5
Q	4,355[2]	25	70	4.7	1,232.7	1,232.7	1,233.1	0.4
R	4,680[2]	31	82	4.0	1,234.2	1,234.2	1,234.3	0.1

[1]Feet above Olmsted / Winona County Boundary
[2]Feet above U.S. Highway 14

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

SOUTH FORK WHITEWATER RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE-FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
SOUTH BRANCH MIDDLE FORK ZUMBRO RIVER								
A	306	807	10,309	2.8	961.2	961.2	961.4	0.2
B	1,098	735	10,363	1.9	963.8	963.8	963.9	0.1
C	2,048	725	9,910	2.0	963.9	963.9	964.0	0.1
D	3,051	860	11,100	1.8	964.0	964.0	964.1	0.1
E	3,686	418	4,721	4.1	964.0	964.0	964.3	0.3
F	5,005	602	6,840	2.8	964.6	964.6	964.7	0.1
G	5,427	153	10,979	1.8	964.8	964.8	964.9	0.1
H	6,325	972	9,769	2.0	964.9	964.9	965.1	0.2

[1]Feet above confluence with Middle Fork Zumbro

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

SOUTH BRANCH MIDDLE FORK ZUMBRO RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE-FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
SOUTH FORK OF BEAR CREEK								
A	2,350	600	2,080	3.1	1,052.8	1,052.8	1,052.9	0.1
B	3,105	815	5,720	1.1	1,056.4	1,056.4	1,056.4	0.0
C	5,180	500	2,170	3.0	1,057.1	1,057.1	1,057.1	0.0
D	6,640	450	1,310	4.9	1,062.1	1,062.1	1,062.5	0.4
E	8,275	490	2,780	2.3	1,065.6	1,065.6	1,065.7	0.1
F	9,895	495	2,410	2.7	1,067.5	1,067.5	1,067.7	0.2
G	12,115	605	2,110	3.1	1,071.6	1,071.6	1,071.9	0.3
H	15,115	350	2,130	3.0	1,077.8	1,077.8	1,078.1	0.3

[1]Feet above confluence with Bear Creek

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

SOUTH FORK OF BEAR CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE-FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
SOUTH FORK OF WILLOW CREEK								
A	2,025	239	1,432	0.6	1,046.6	1,046.6	1,046.6	0.0
B	2,720	53	53	4.4	1,049.5	1,049.5	1,049.5	0.0

[1]Feet above confluence with Willow Creek

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

SOUTH FORK OF WILLOW CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE-FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
SOUTH FORK ZUMBRO RIVER								
A	4,730	466	6,213	5.2	968.9	968.9	969.3	0.4
B	7,700	346	4,579	5.2	971.1	971.1	971.5	0.4
C	9,660	389	5,496	4.3	972.1	972.1	972.4	0.3
D	10,905	430	4,952	5.4	972.9	972.9	973.1	0.2
E	12,665	722	7,344	4.8	974.0	974.0	974.2	0.2
F	14,170	792	6,193	4.7	974.8	974.8	975.0	0.2
G	15,810	682	7,186	5.9	975.5	975.5	975.7	0.2
H	17,615	503	4,249	6.8	976.3	976.3	976.5	0.2
I	18,615	265	3,840	5.3	977.1	977.1	977.3	0.2
J	18,945	264	4,550	4.5	977.6	977.6	977.8	0.2
K	19,850	301	4,609	4.5	977.9	977.9	978.1	0.2
L	20,730	253	4,041	4.8	978.2	978.2	978.3	0.1
M	21,140	222	3,209	6.1	978.1	978.1	978.3	0.2
N	21,450	234	2,647	7.4	979.0	979.0	979.0	0.0
O	22,950	872	8,045	2.4	980.8	980.8	980.8	0.0
P	24,375	301	3,517	5.5	980.9	980.9	980.9	0.0
Q	25,070	311	3,569	5.5	981.6	981.6	981.6	0.0
R	26,115	171	2,271	8.6	982.2	982.2	982.2	0.0
S	26,430	186	2,285	8.5	983.0	983.0	983.0	0.0
T	27,055	206	2,678	7.3	984.2	984.2	984.2	0.0
U	27,500	189	2,673	7.1	984.7	984.7	984.7	0.0

[1]Feet above Limit of Detailed Study (Limit of Detailed Study is approximately 10,490 feet downstream of 37th Street Northwest/County Highway 22)

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

SOUTH FORK ZUMBRO RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE-FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
SOUTH FORK ZUMBRO RIVER (CONTINUED)								
V	28,170	350	2,929	6.7	985.5	985.5	985.5	0.0
W	28,730	219	2,680	5.5	986.3	986.3	986.3	0.0
X	29,515	178	2,564	5.8	987.0	987.0	987.0	0.0
Y	30,530	122	1,568	9.3	988.5	988.5	988.6	0.1
Z	31,210	110	1,643	9.0	990.6	990.6	990.6	0.0
AA	31,790	114	1,772	8.4	992.4	992.4	992.5	0.1
AB	32,420	184	2,194	6.7	994.0	994.0	994.0	0.0
AC	32,910	153	1,619	9.1	994.4	994.4	994.4	0.0
AD	33,258	153	1,671	8.9	995.5	995.5	995.5	0.0
AE	33,545	326	2,254	6.9	996.5	996.5	996.5	0.0
AF	33,990	375	3,067	5.2	997.6	997.6	997.6	0.0
AG	34,715	112	1,776	8.3	997.6	997.6	997.6	0.0
AH	35,520	155	1,474	10.0	998.5	998.5	998.5	0.0
AI	35,800	151	1,480	10.0	999.4	999.4	999.5	0.1
AJ	36,020	248	2,820	5.3	1,001.3	1,001.3	1,001.3	0.0
AK	38,520	312	3,472	4.3	1,003.3	1,003.3	1,003.3	0.0
AL	39,190	287	3,222	4.6	1,003.6	1,003.6	1,003.6	0.0
AM	41,825	192	2,382	6.2	1,011.5	1,011.5	1,011.6	0.1
AN	45,320	490	3,120	5.8	1,015.2	1,015.2	1,015.7	0.5

[1]Feet above Limit of Detailed Study (Limit of Detailed Study is approximately 10,490 feet downstream of 37th Street Northwest/County Highway 22)

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

SOUTH FORK ZUMBRO RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE-FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
SOUTH FORK ZUMBRO RIVER (CONTINUED)								
AO	48,590	1,446	4,840	4.4	1,019.2	1,019.2	1,019.3	0.1
AP	54,650	864	3,977	5.0	1,027.8	1,027.8	1,028.0	0.2

[1]Feet above Limit of Detailed Study (Limit of Detailed Study is approximately 10,490 feet downstream of 37th Street Northwest/County Highway 22)

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

SOUTH FORK ZUMBRO RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE-FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
SOUTH RUN OF THE NORTH FORK OF CASCADE CREEK								
A	1,670	113	280	6.9	1,010.5	1,010.5	1,010.5	0.0
B	2,175	50	282	6.2	1,012.0	1,012.0	1,012.0	0.0
C	3,200	142	700	3.3	1,014.0	1,014.0	1,014.0	0.0
D	4,885	559	1,068	4.0	1,016.0	1,016.0	1,016.1	0.1
E	6,385	85	361	5.5	1,019.2	1,019.2	1,019.4	0.2
F	8,150	260	605	6.5	1,023.7	1,023.7	1,023.7	0.0
G	8,455	211	502	8.2	1,024.5	1,024.5	1,024.8	0.3
H	9,405	126	566	4.4	1,026.7	1,026.7	1,027.1	0.5
I	10,015	130	908	2.9	1,030.0	1,030.0	1,030.0	0.0
J	10,575	166	809	3.0	1,030.4	1,030.4	1,030.4	0.0
K	12,215	311	1,098	1.9	1,035.4	1,035.4	1,035.9	0.5

[1]Feet above confluence with Cascade Creek

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

SOUTH RUN OF THE NORTH FORK OF CASCADE CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE-FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
SOUTHEAST BRANCH OF WILLOW CREEK								
A	1,400	229	610	3.5	1,080.6	1,080.6	1,080.9	0.3
B	2,475	53	459	4.6	1,089.1	1,089.1	1,089.2	0.1
C	3,745	77	252	8.5	1,094.7	1,094.7	1,094.8	0.1
D	5,180	220	980	2.2	1,105.7	1,105.7	1,105.7	0.0
E	6,045	180	245	8.7	1,107.3	1,107.3	1,107.7	0.4
F	6,795	135	465	4.6	1,111.9	1,111.9	1,112.3	0.4

[1]Feet above confluence with Willow Creek

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

SOUTHEAST BRANCH OF WILLOW CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE-FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
TRIBUTARY B								
A	120	155	492	5.1	1,145.3	1,145.3	1,145.3	0.0
B	180	206	576	4.4	1,145.6	1,145.6	1,145.6	0.0
C	825	584	1,785	1.4	1,146.1	1,146.1	1,146.1	0.0

[1]Feet above confluence with South Fork Whitewater River

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

TRIBUTARY B

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE-FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
WEST FORK OF WILLOW CREEK								
A	715	700	650	0.1	1,068.1	1,068.1	1,068.2	0.1
B	1,515	310	30	3.2	1,080.6	1,080.6	1,080.6	0.0
C	2,540	190	805	0.4	1,101.4	1,101.4	1,101.4	0.0

[1]Feet above confluence with Willow Creek

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

WEST FORK OF WILLOW CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE-FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
WEST TRIBUTARY TO WILLOW CREEK								
A	2,120	345	411	1.5	1,023.7	1,022.0[2]	1,023.7	0.0

[1]Feet above confluence with Willow Creek

[2]Elevation computed without consideration of flooding controlled by Willow Creek

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

WEST TRIBUTARY TO WILLOW CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE-FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD)	WITHOUT FLOODWAY (FEET NAVD)	WITH FLOODWAY (FEET NAVD)	INCREASE (FEET)
WILLOW CREEK								
A	5,016	810[2]	2,818	1.8	1,019.6	1,019.6	1,019.7	0.1
B	11,352	500	2,936	1.1	1,033.0	1,033.0	1,033.4	0.4
C	16,526	1,060[3]	710	4.2	1,040.2	1,040.2	1,040.2	0.0
D	19,272	267	920	5.5	1,051.2	1,051.2	1,051.2	0.0
E	22,334	615	1,372	4.9	1,056.5	1,056.5	1,056.8	0.3
F	26,136	646	1,106	3.9	1,066.8	1,066.8	1,067.1	0.3
G	32,604	298	253	5.1	1,086.3	1,086.3	1,086.3	0.0

[1]Feet above confluence with Bear Creek
[2]Combined West Tributary to Willow Creek/Willow Creek Floodway
[3]Combined South Fork of Willow Creek/Willow Creek Floodway

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN
AND INCORPORATED AREAS

FLOODWAY DATA

WILLOW CREEK

The area between the floodway and 1-percent-annual-chance floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the WSEL of the 1-percent-annual-chance 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 1.

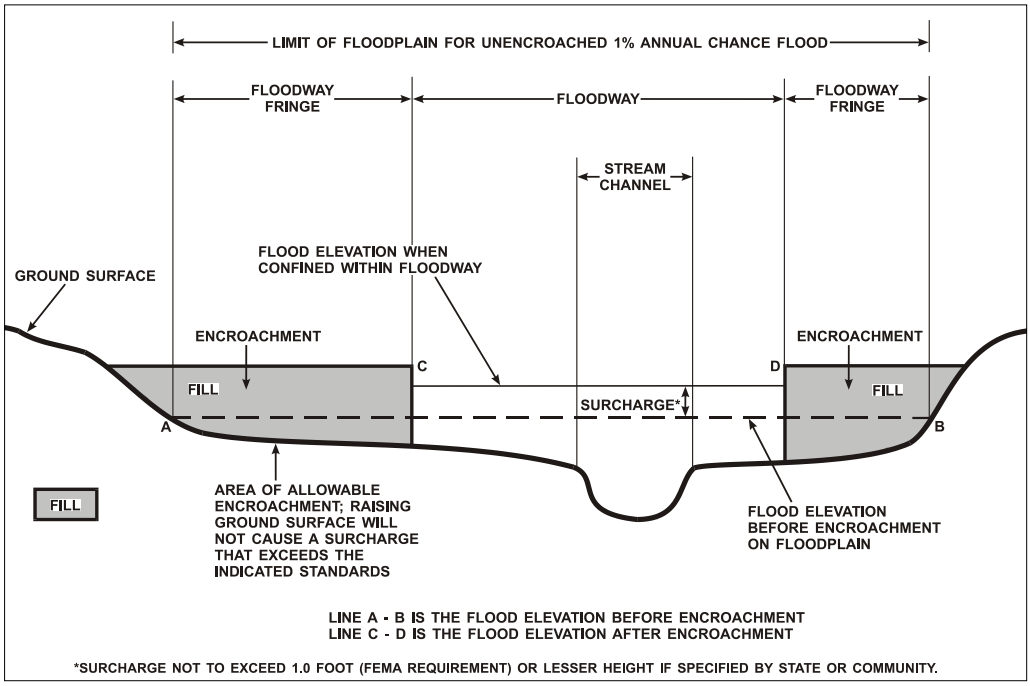

Figure 1 - Floodway Schematic

5.0 INSURANCE APPLICATIONS

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

Zone A

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

Zone AE

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

Zone AO

Zone AO is the flood insurance risk zone that corresponds to the 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 base flood depths derived from the detailed hydraulic analyses are shown within this zone.

Zone X

Zone X is the flood insurance risk 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, and areas protected from the 1-percent-annual-chance flood by levees. No BFEs or base flood depths are shown within this zone.

Zone D

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

6.0 FLOOD INSURANCE RATE MAP

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

For flood insurance applications, the map designates flood insurance risk 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 the 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 Olmsted County. Previously, FIRMs were prepared for each incorporated community and the unincorporated areas of the County identified as flood-prone. Historical data relating to the maps prepared for each community are presented in Table 9.

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDAY MAP REVISION DATE	FIRM EFFECTIVE DATE	FIRM REVISION DATE
Byron, City of[1,2]	N/A	None	N/A	None
Chatfield, City of	August 13, 1976	None	August 2, 1982	None
Dover, City of	November 1, 1974	October 17, 1981	April 15, 1982	None
Eyota, City of	April 12, 1974	October 17, 1975	December 15, 1981	None
Olmsted County (Unincorporated Areas)	May 19, 1981	None	May 19, 1981	August 1, 1983
Oronoco, City of	May 10, 1974	June 11, 1976	November 4, 1981	None
Pine Island, City of	May 24, 1974	August 8, 1975	March 2, 1981	None
Rochester, City of	March 27, 1971	None	March 27, 1971	July 1, 1974 February 13, 1976 February 4, 1981 August 4, 1987
Stewartville, City of	May 3, 1974	December 20, 1974	September 2, 1982	None

[1]No special flood hazard areas identified
[2]This community does not have map history prior to the first countywide mapping

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN
AND INCORPORATED AREAS

COMMUNITY MAP HISTORY

7.0 OTHER STUDIES

This report either supersedes or is compatible with all previous studies on streams studied in this report and should be considered authoritative for 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, Federal Insurance and Mitigation Division, 536 South Clark Street, Sixth Floor, Chicago, Illinois 60605.

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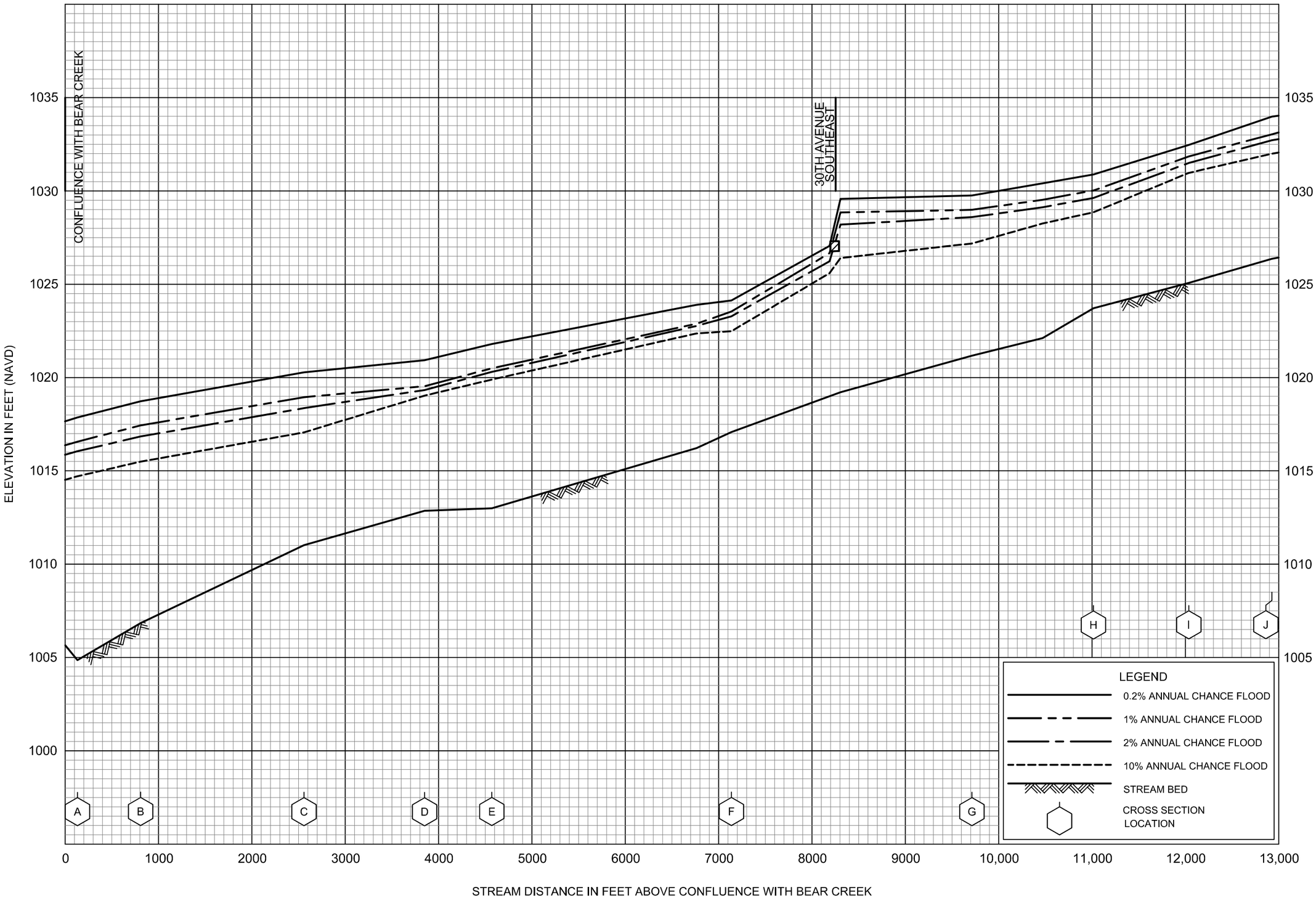

FLOOD PROFILES

BADGER RUN

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS

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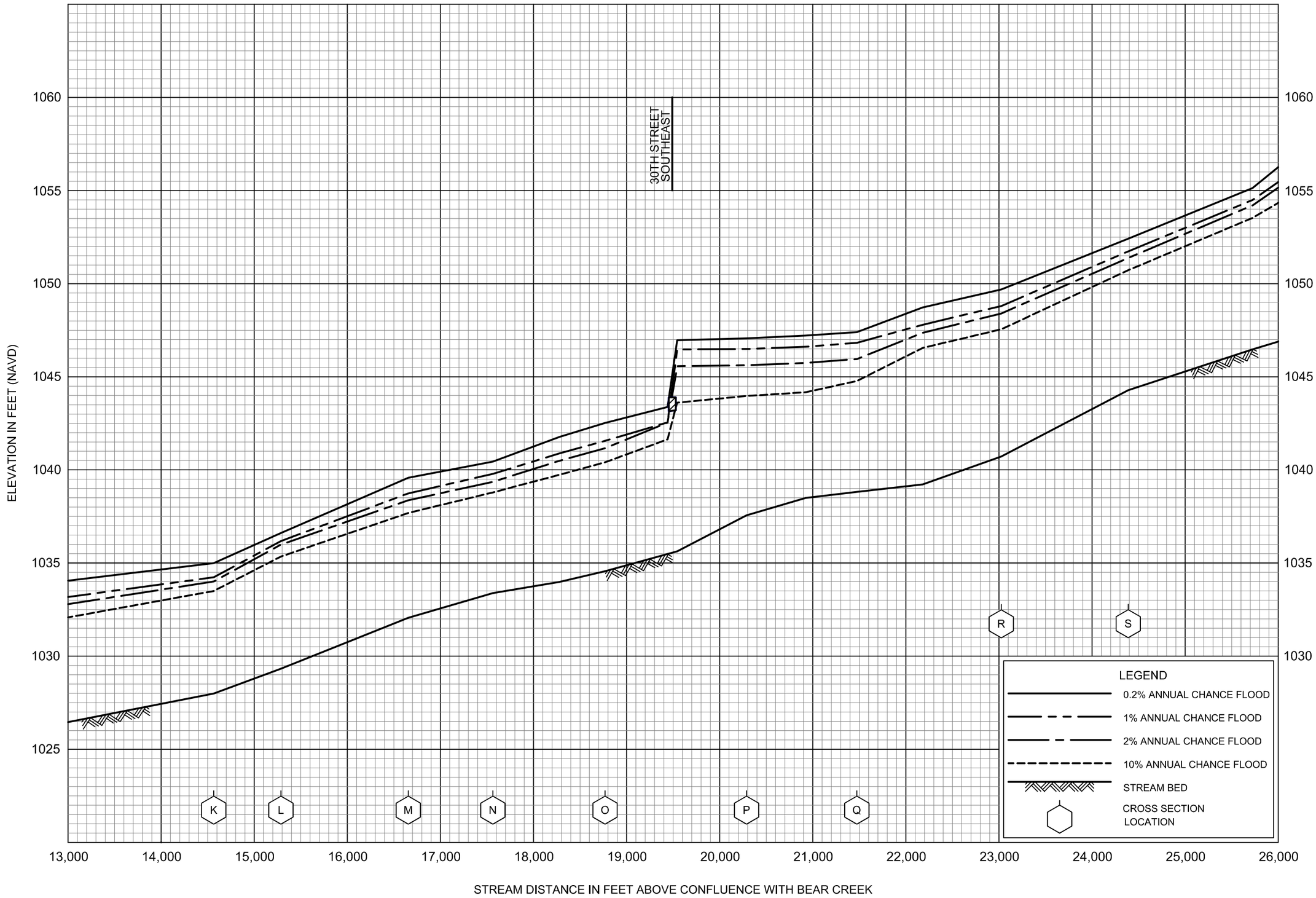


FLOOD PROFILES

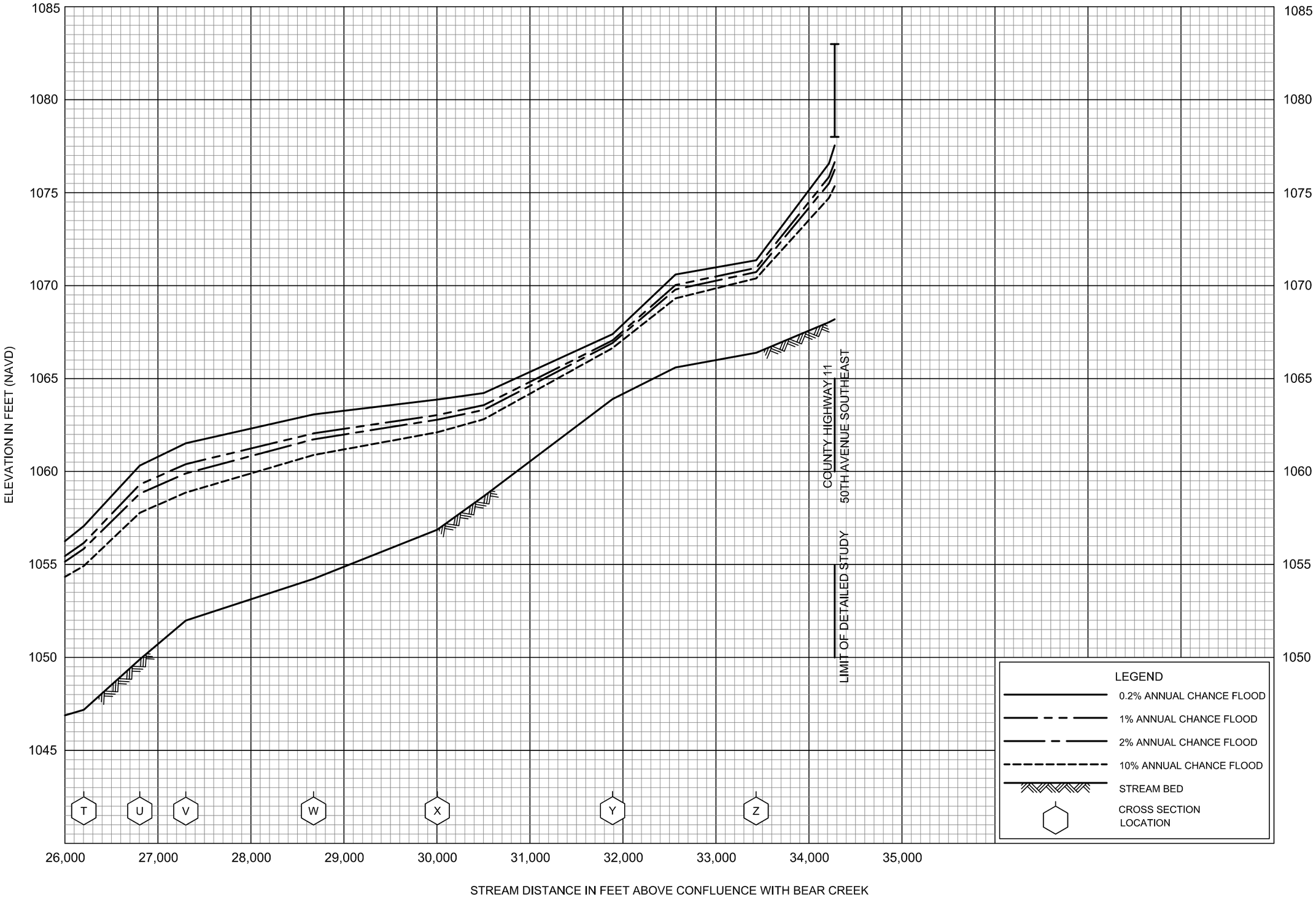
BADGER RUN

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS

02P



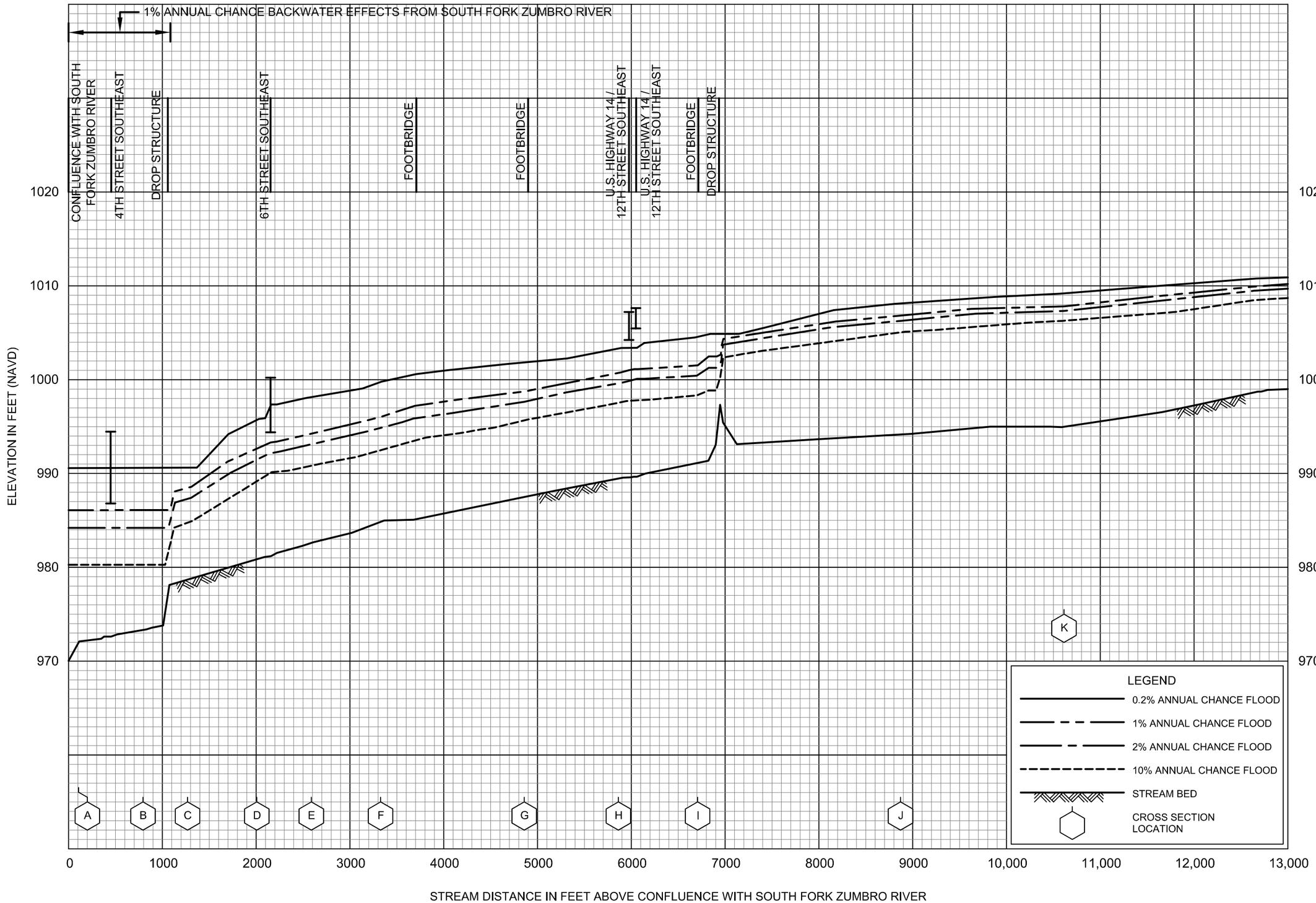
FLOOD PROFILES

BADGER RUN

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



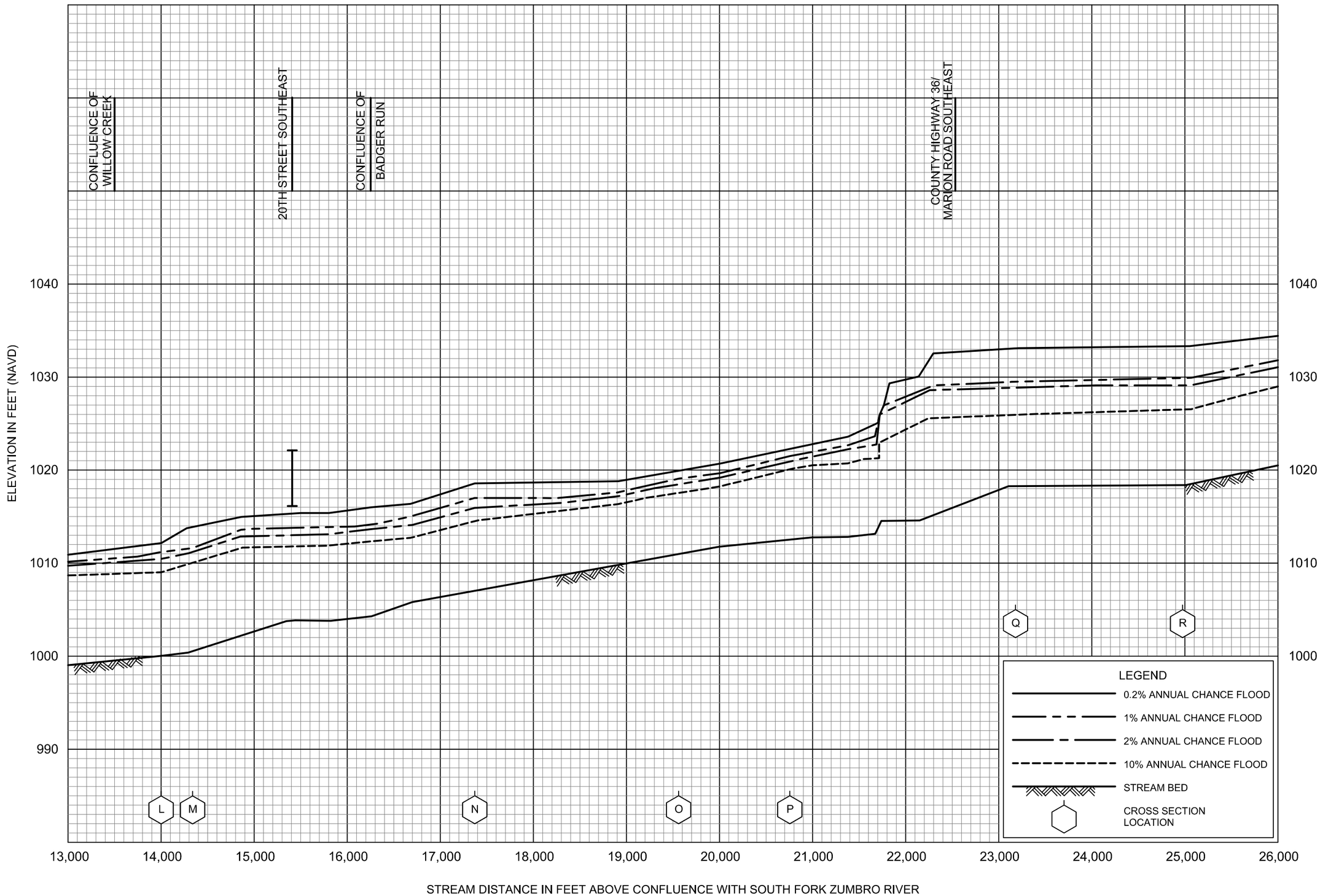
FLOOD PROFILES

BEAR CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



FLOOD PROFILES

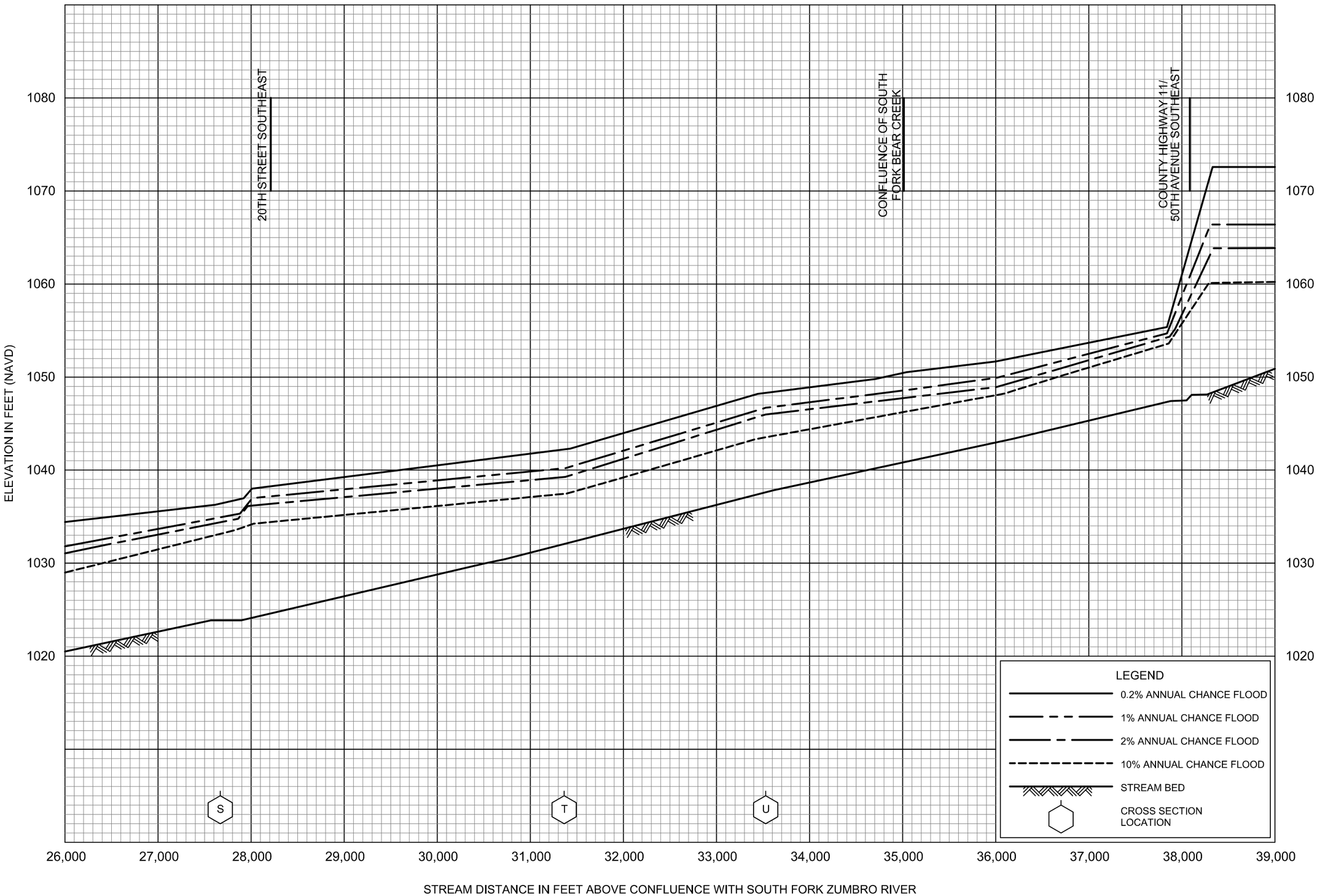
BEAR CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS

05P



FLOOD PROFILES

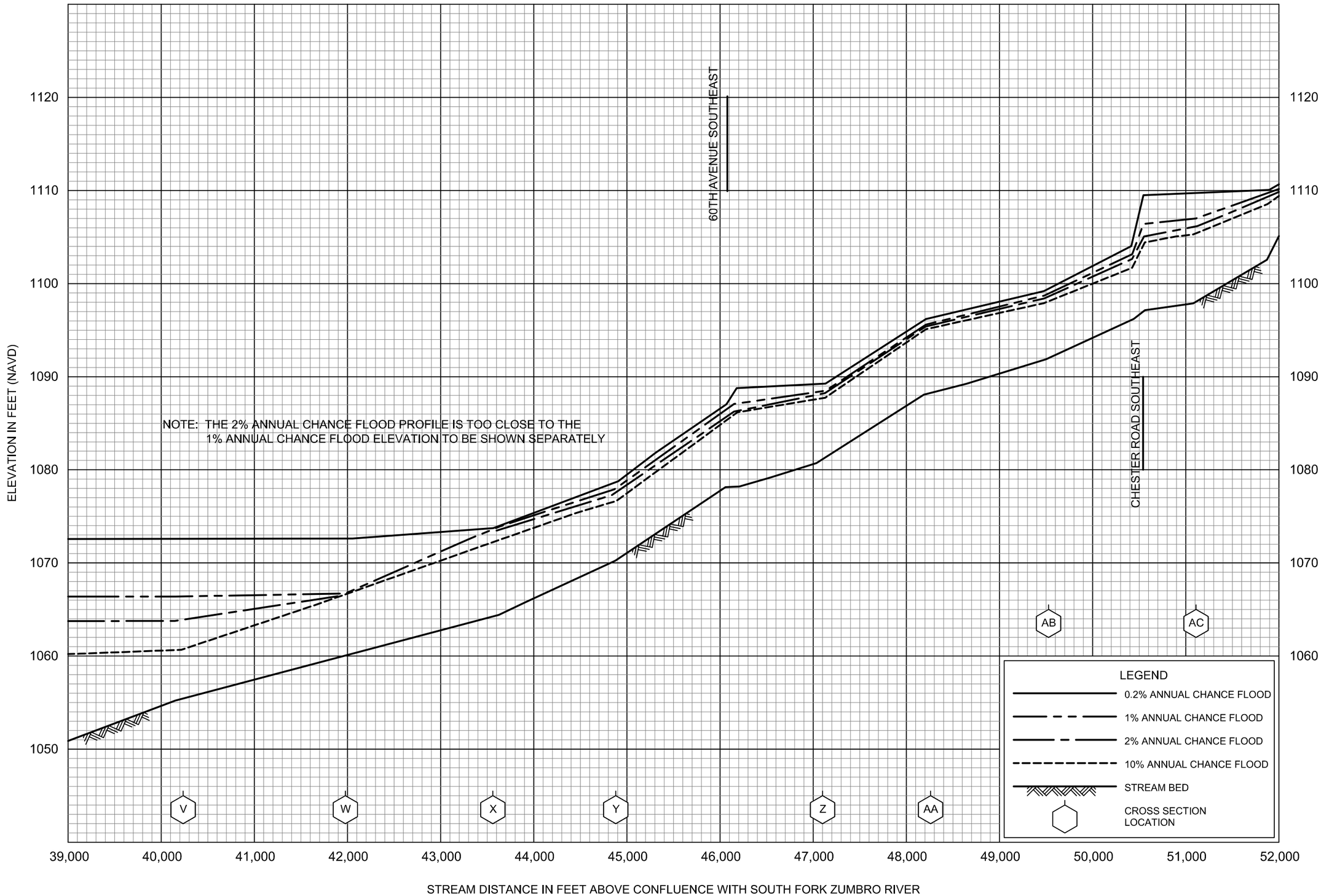
BEAR CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS

06P



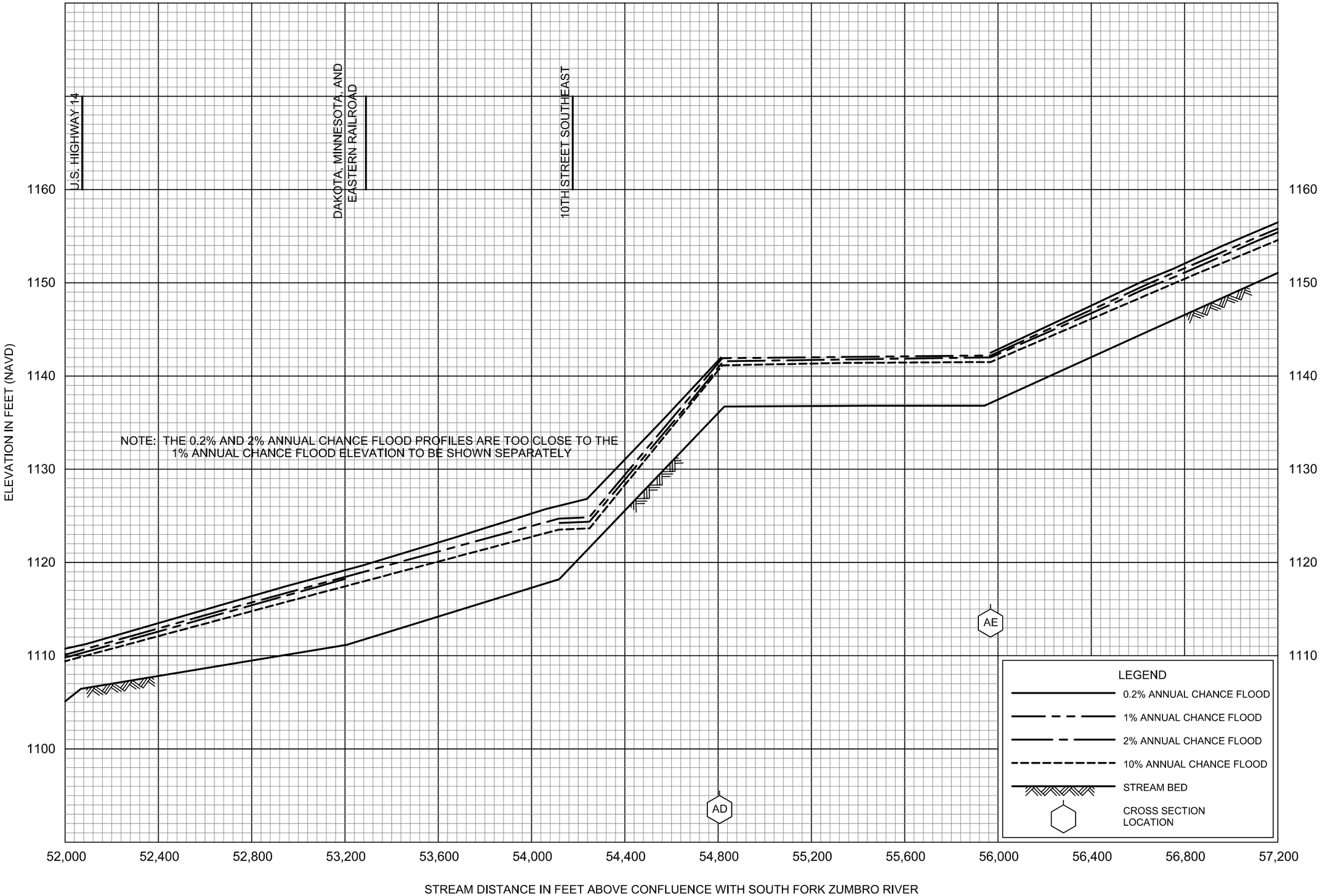
FLOOD PROFILES

BEAR CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



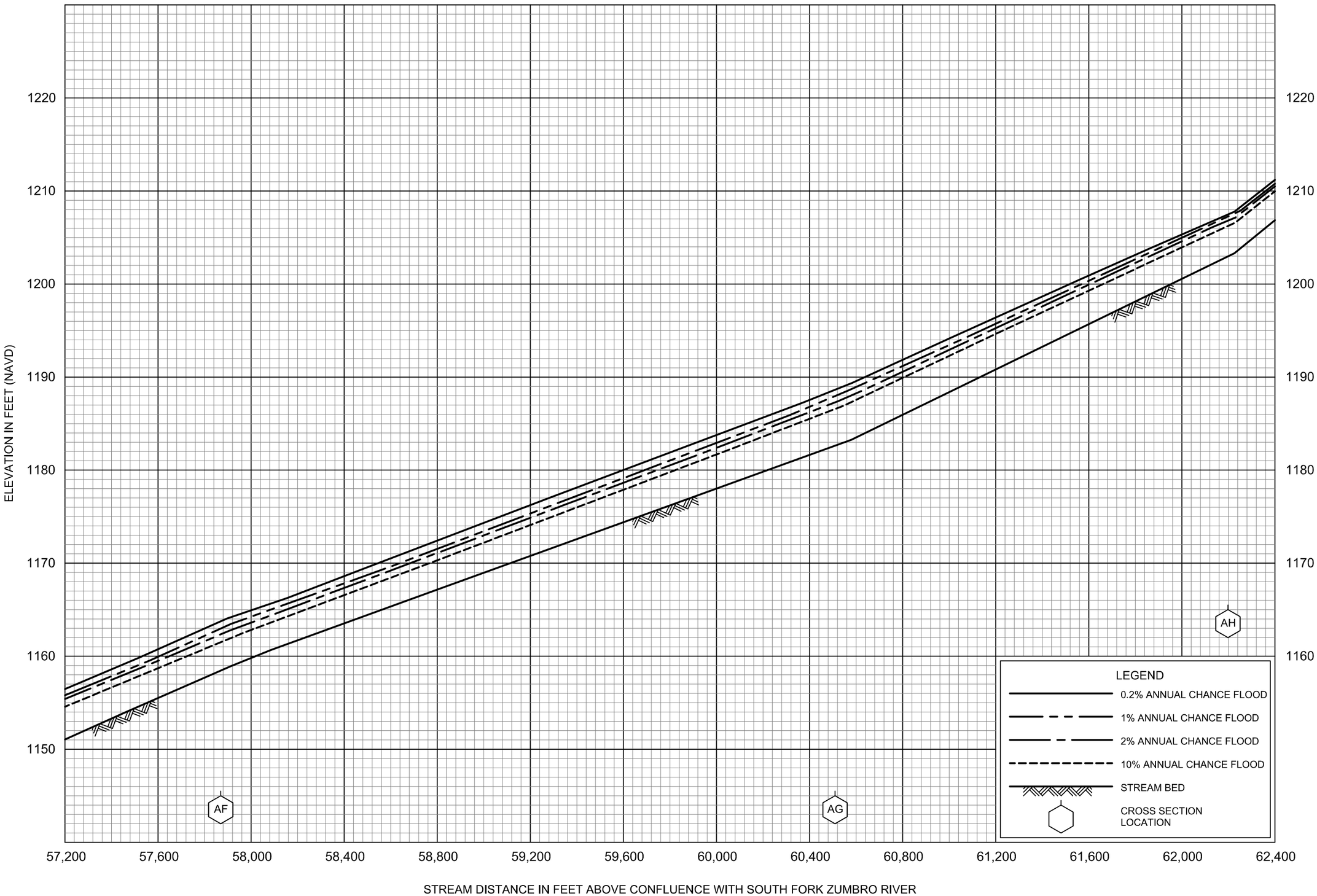
FLOOD PROFILES

BEAR CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



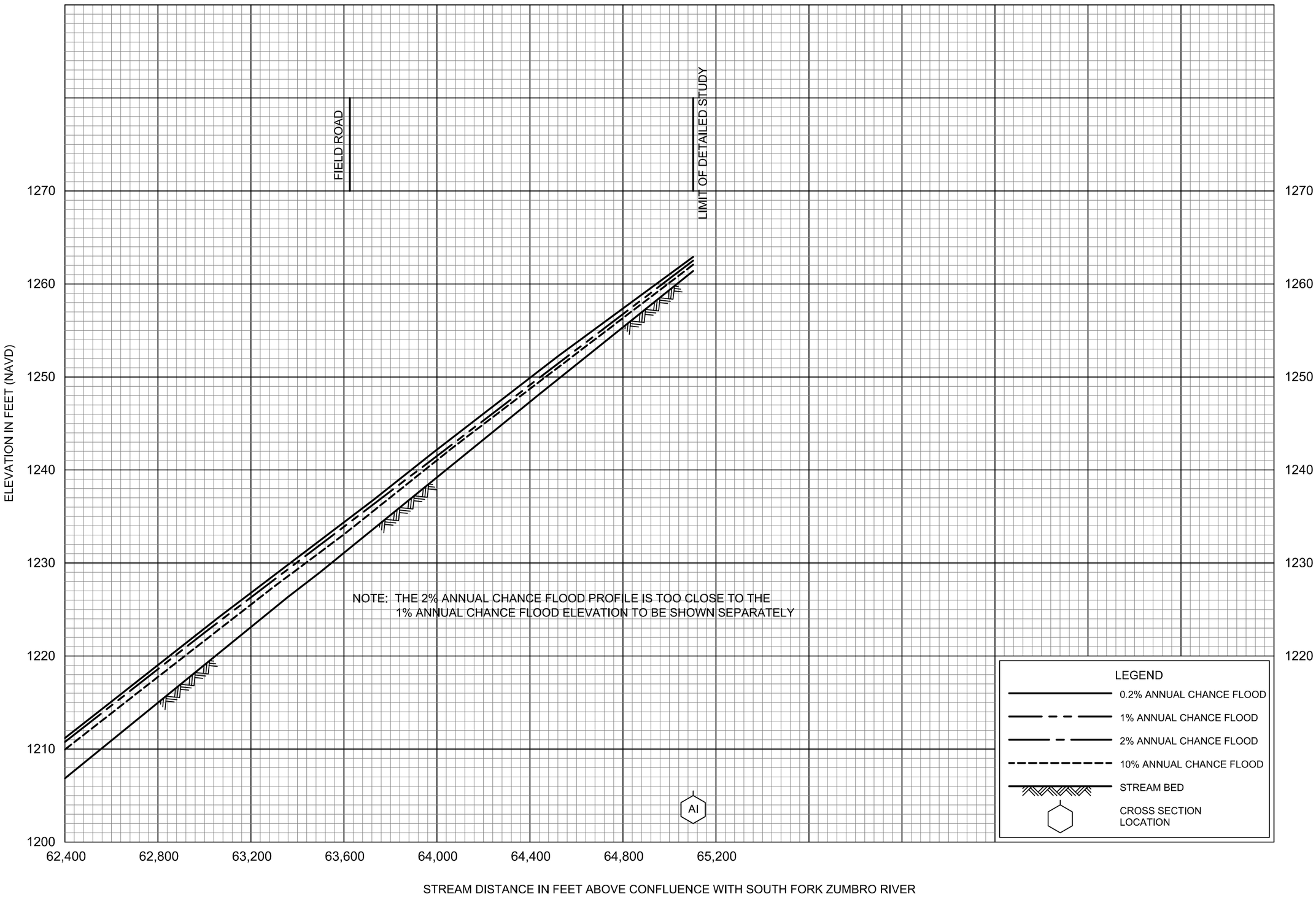
FLOOD PROFILES

BEAR CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



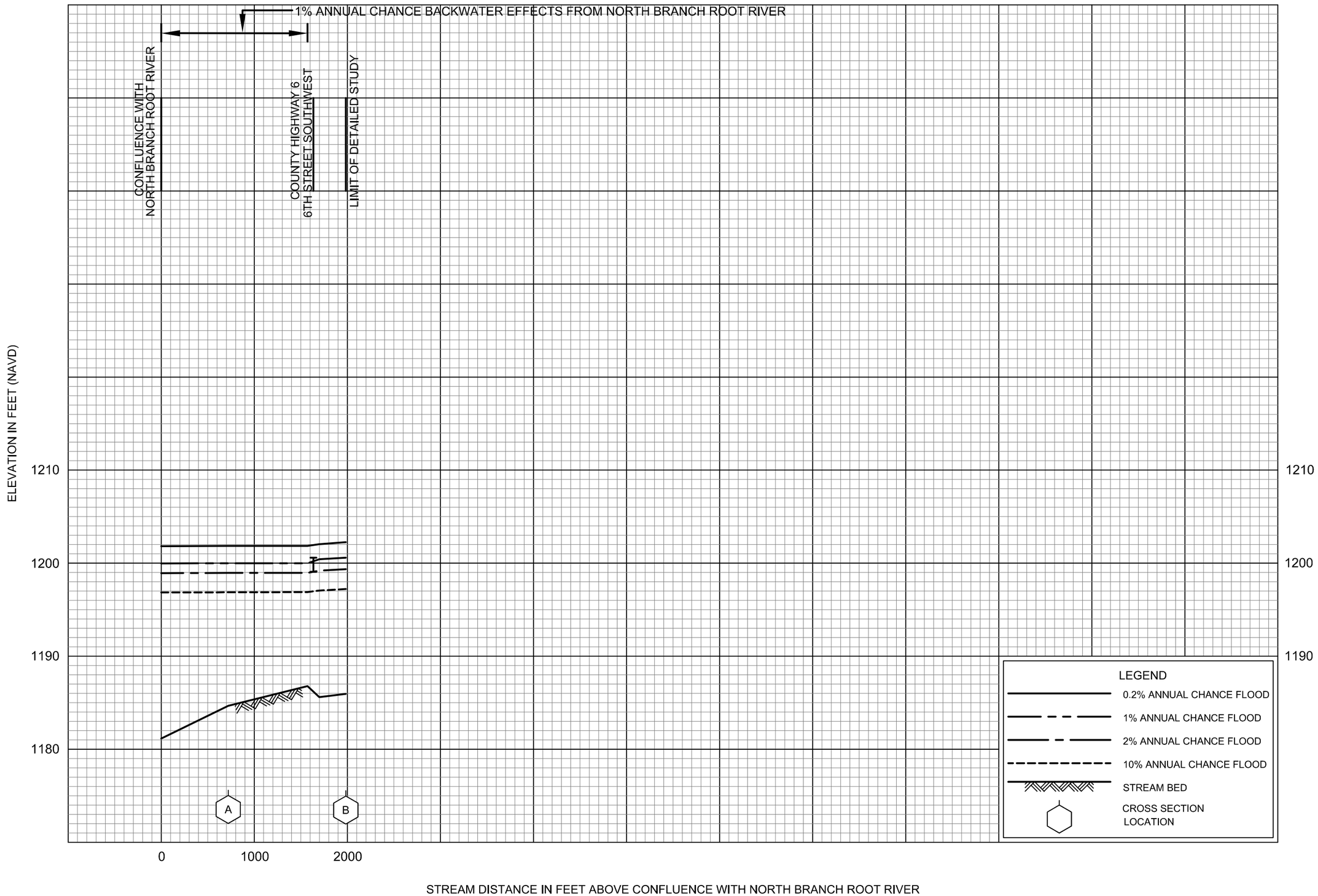
FLOOD PROFILES

BEAR CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



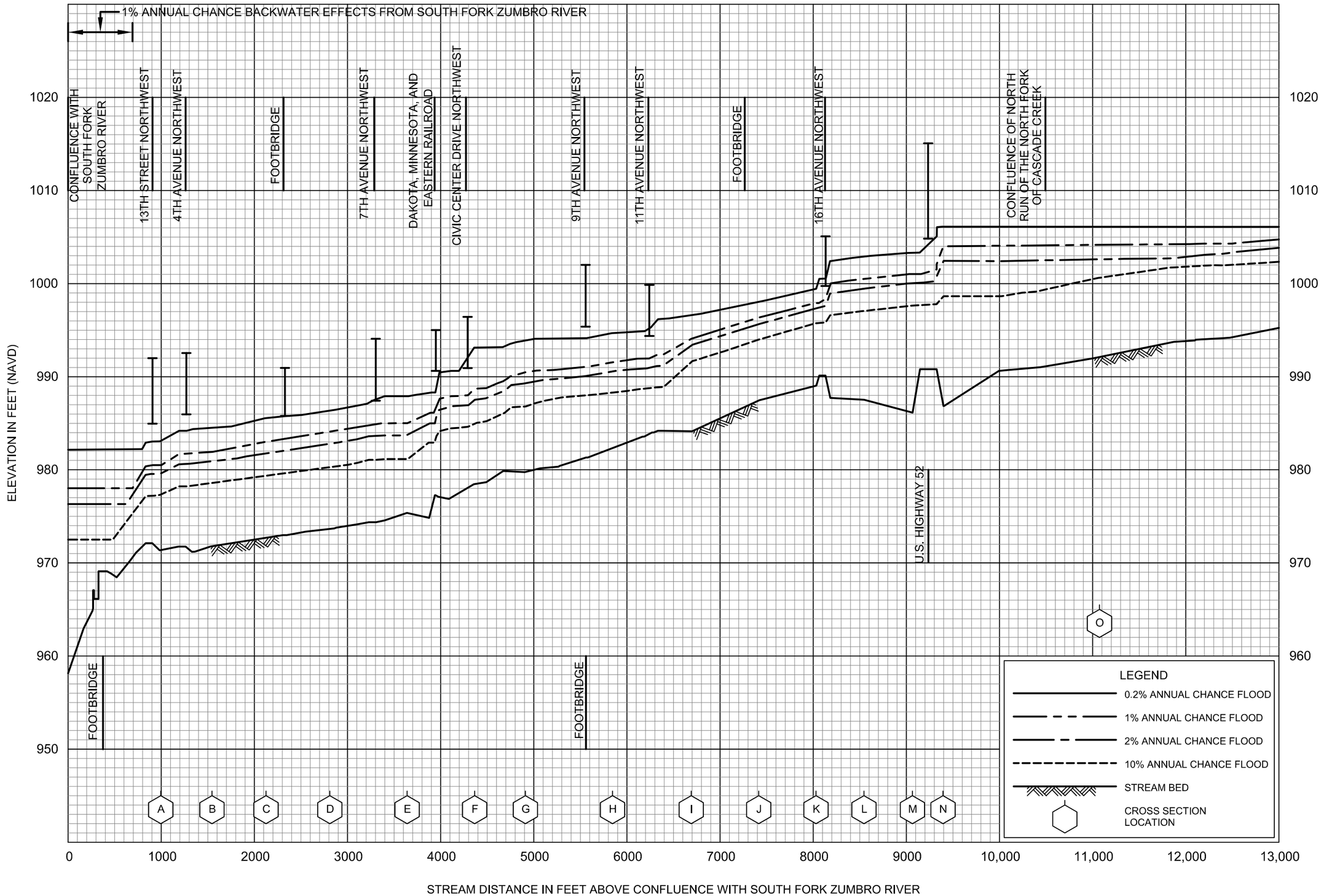
FLOOD PROFILES

CAREY CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



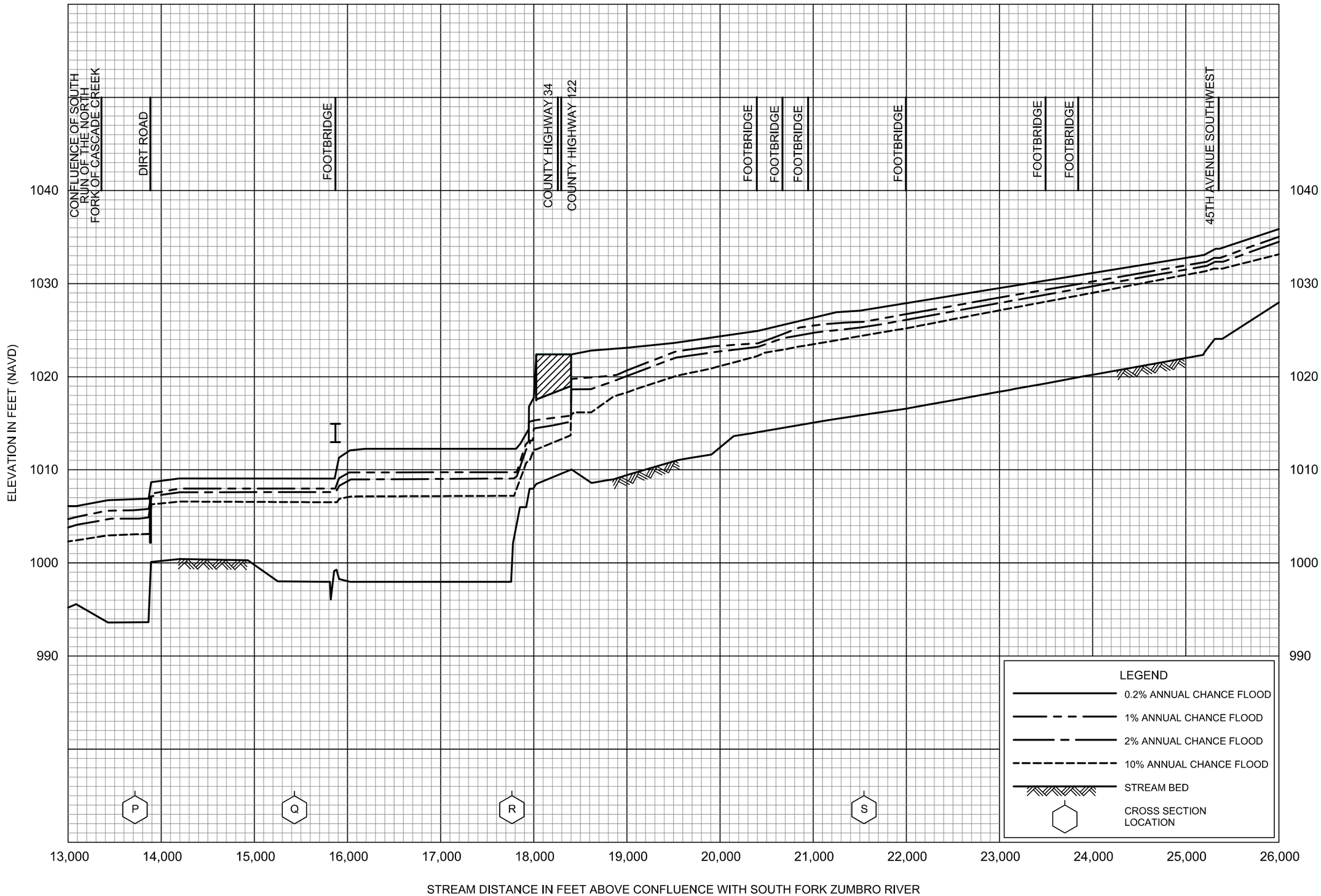
FLOOD PROFILES

CASCADE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



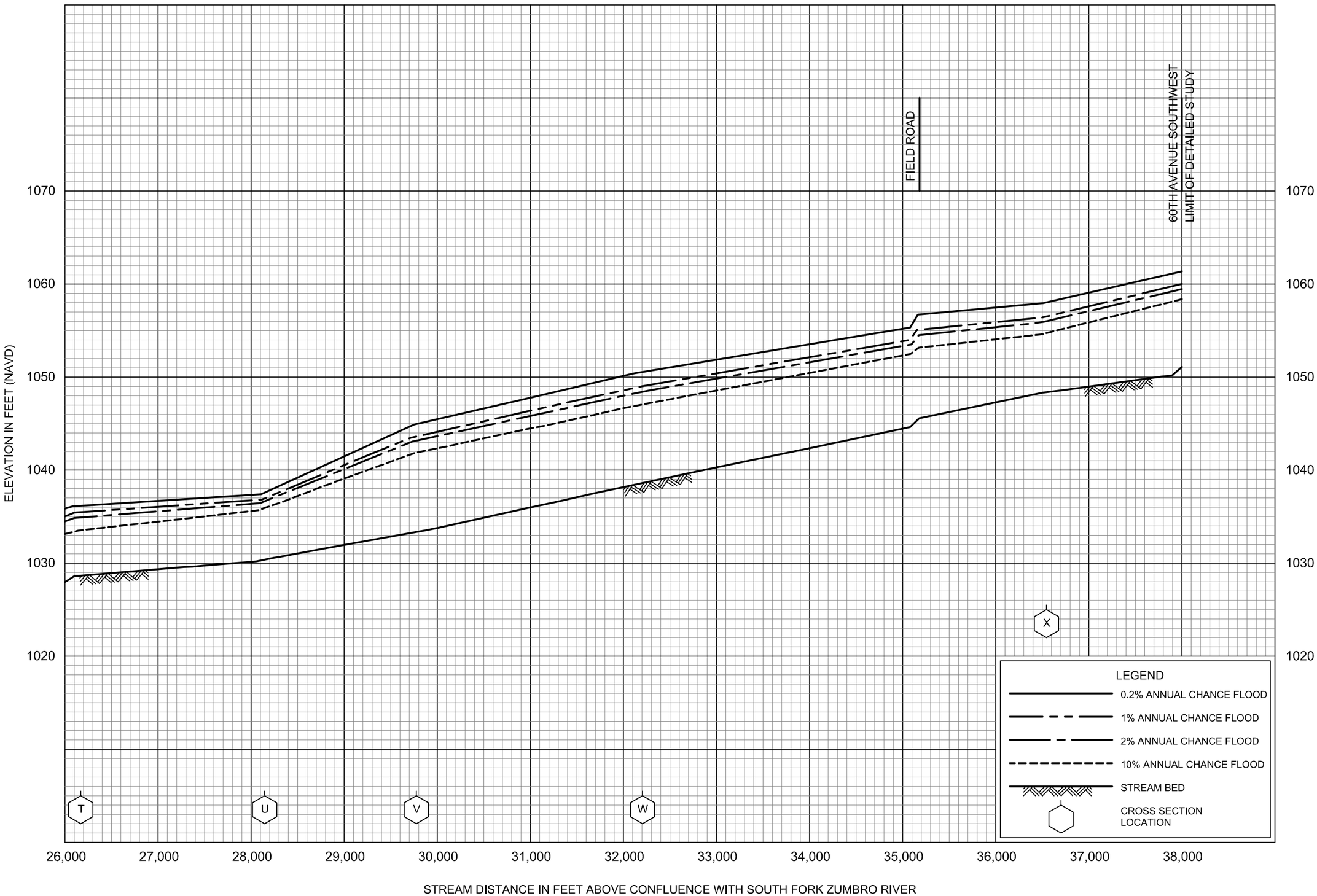
FLOOD PROFILES

CASCADE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



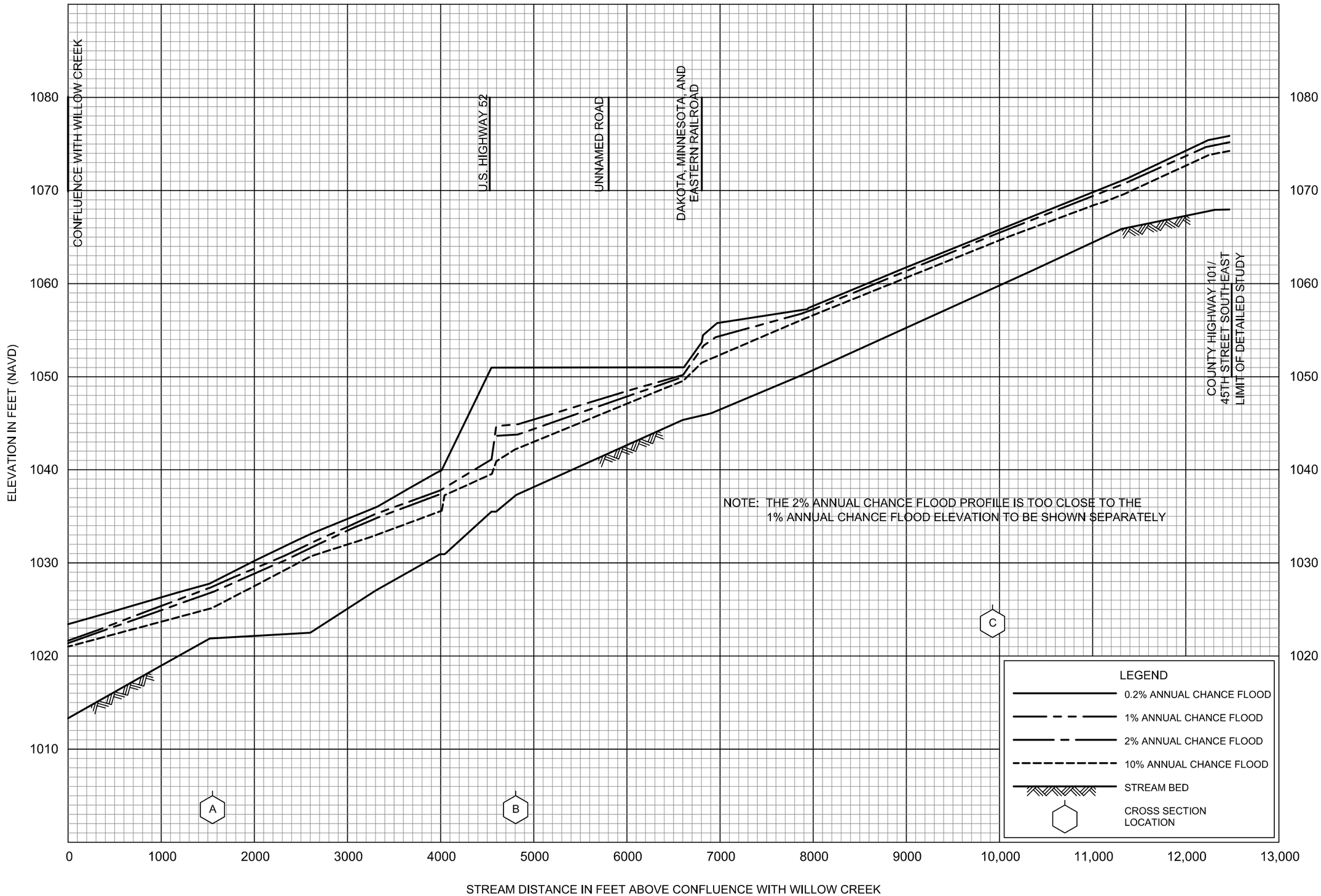
FLOOD PROFILES

CASCADE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



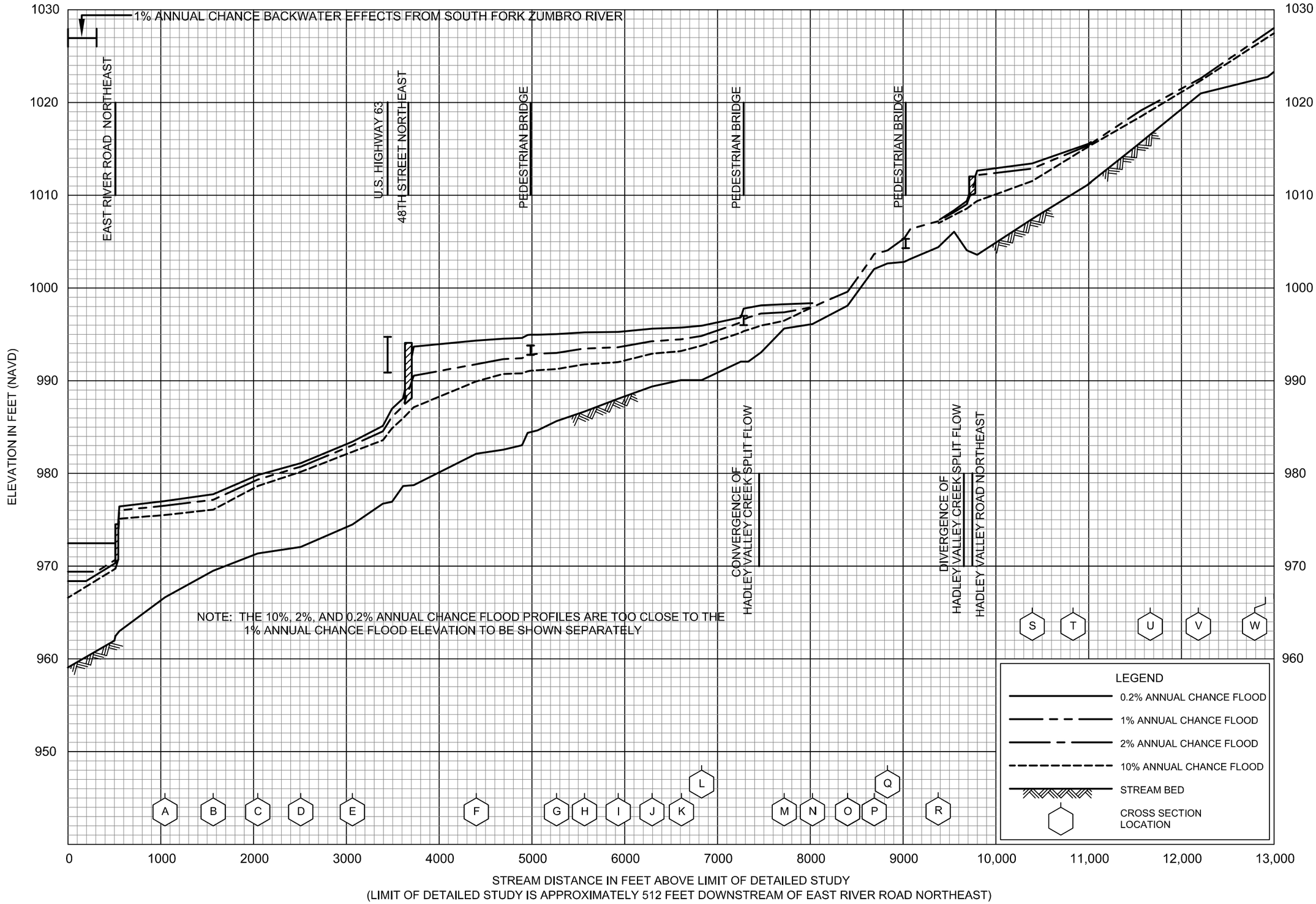
FLOOD PROFILES

EAST FORK OF WILLOW CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



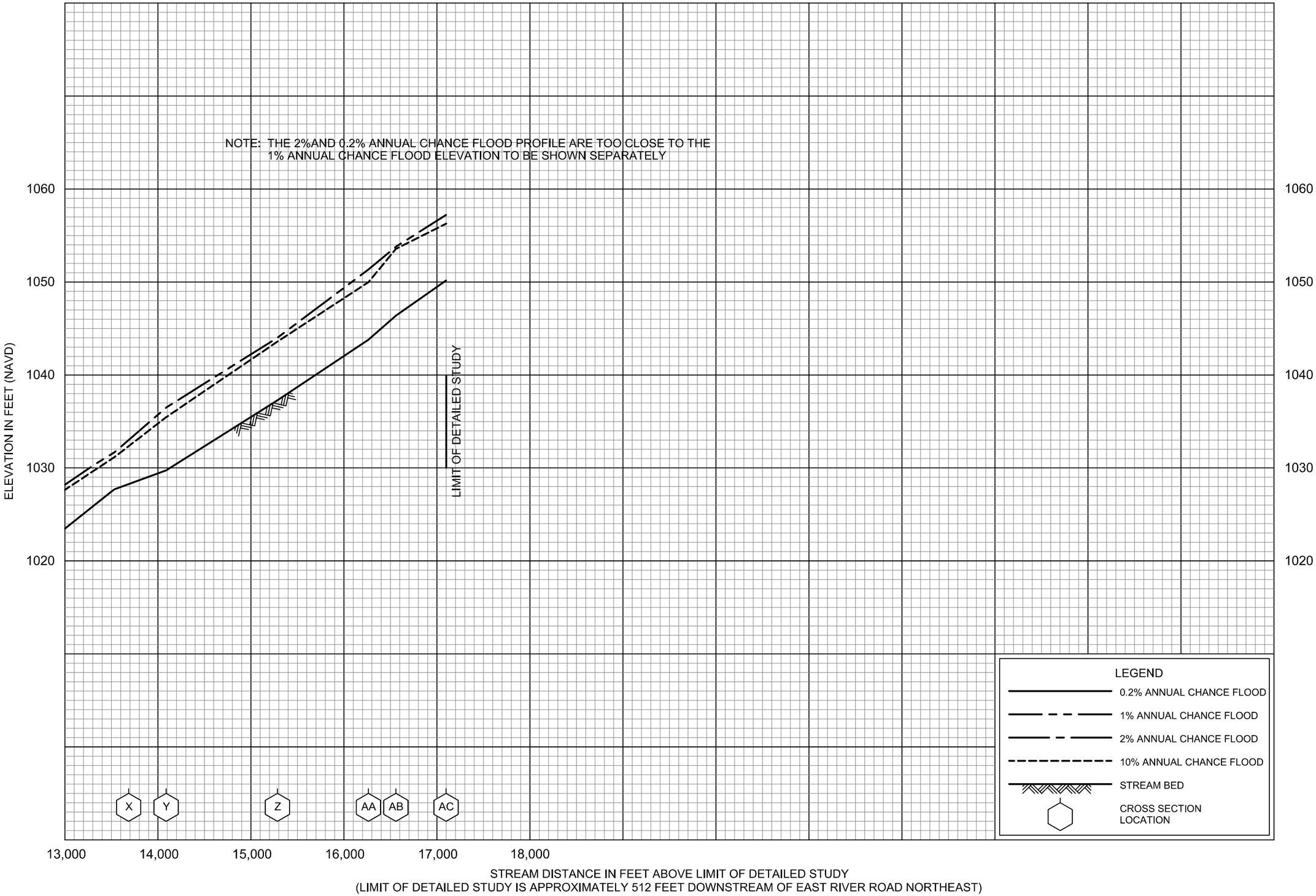
FLOOD PROFILES

HADLEY VALLEY CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



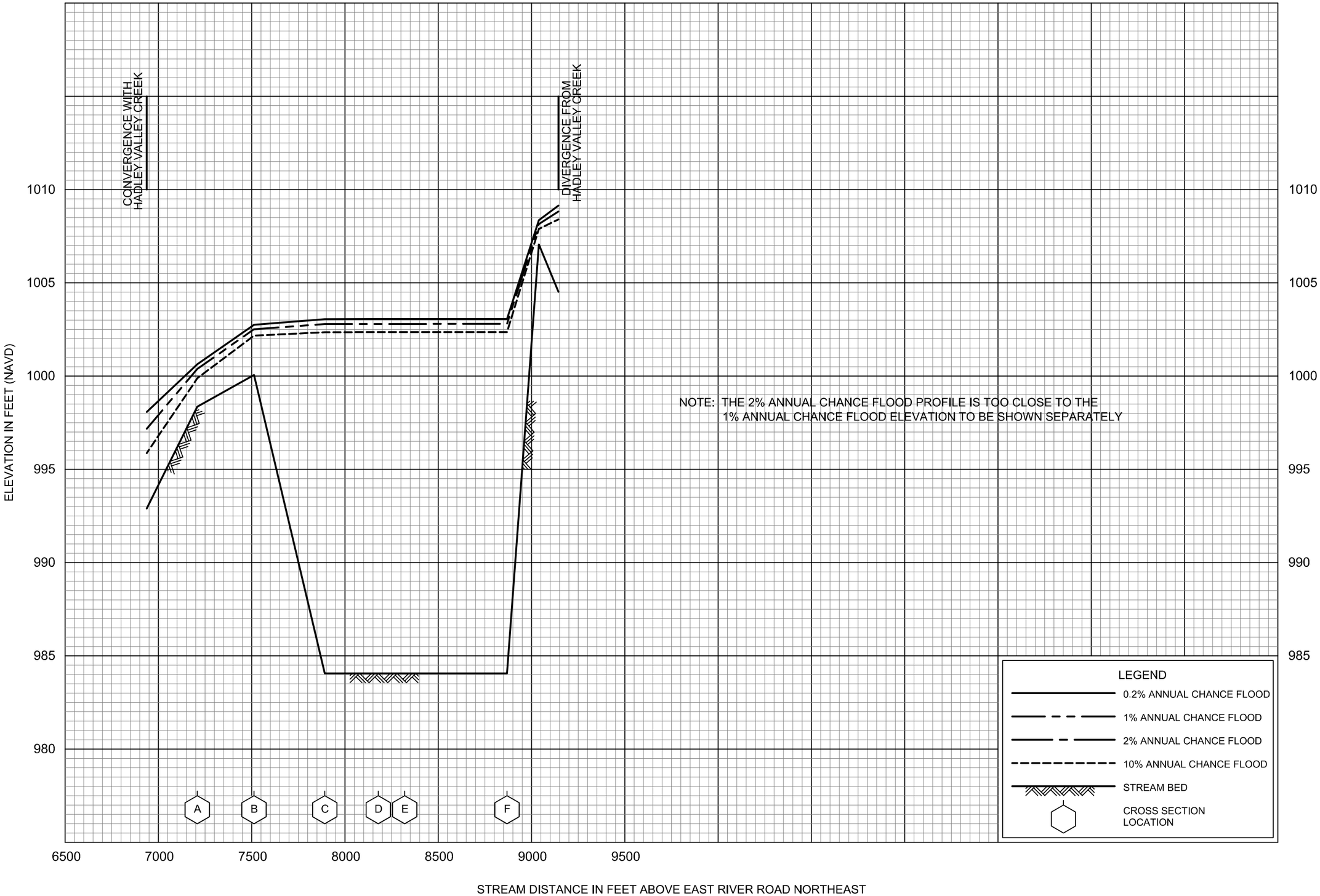
FLOOD PROFILES

HADLEY VALLEY CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



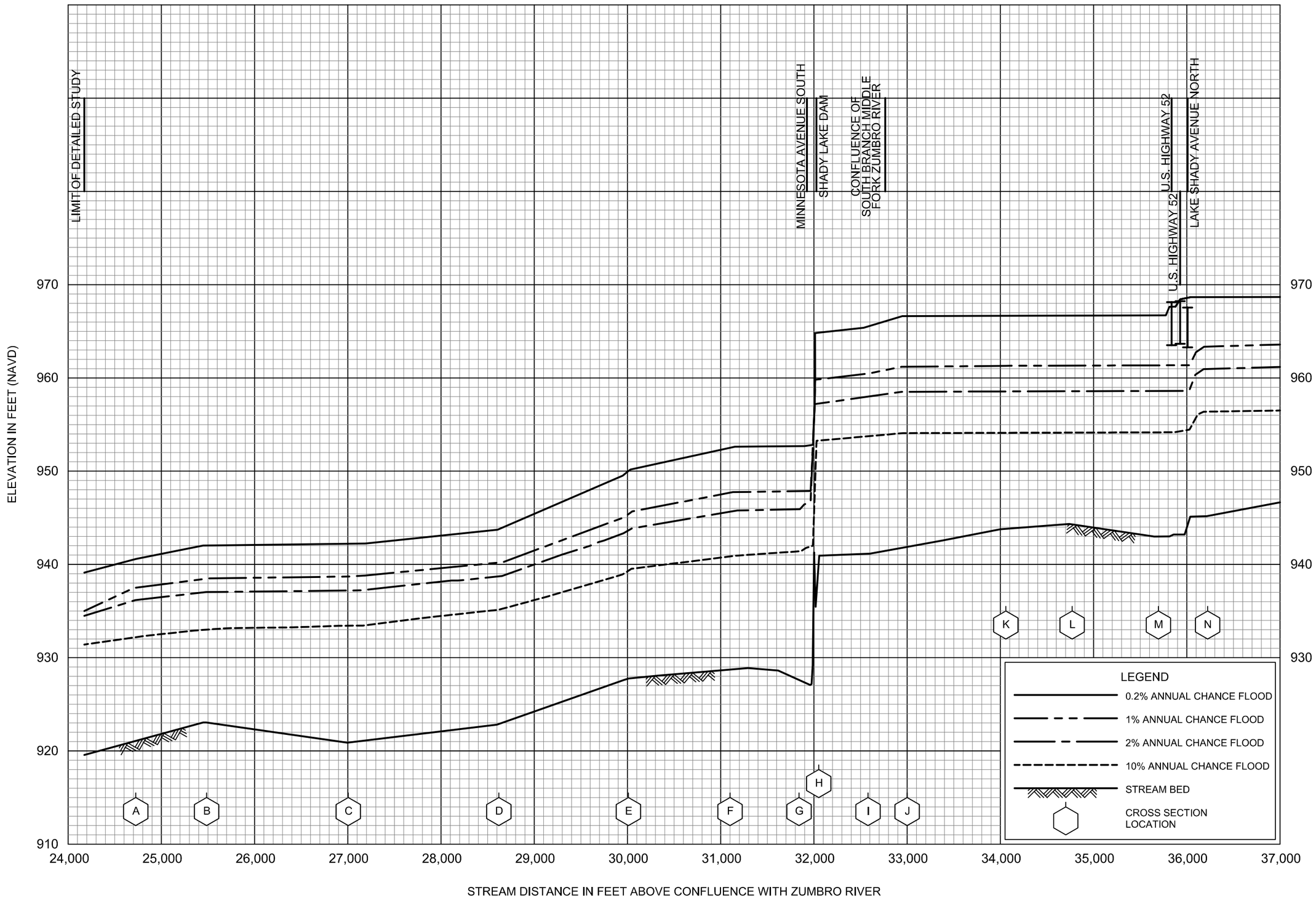
FLOOD PROFILES

HADLEY VALLEY CREEK SPLIT FLOW

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



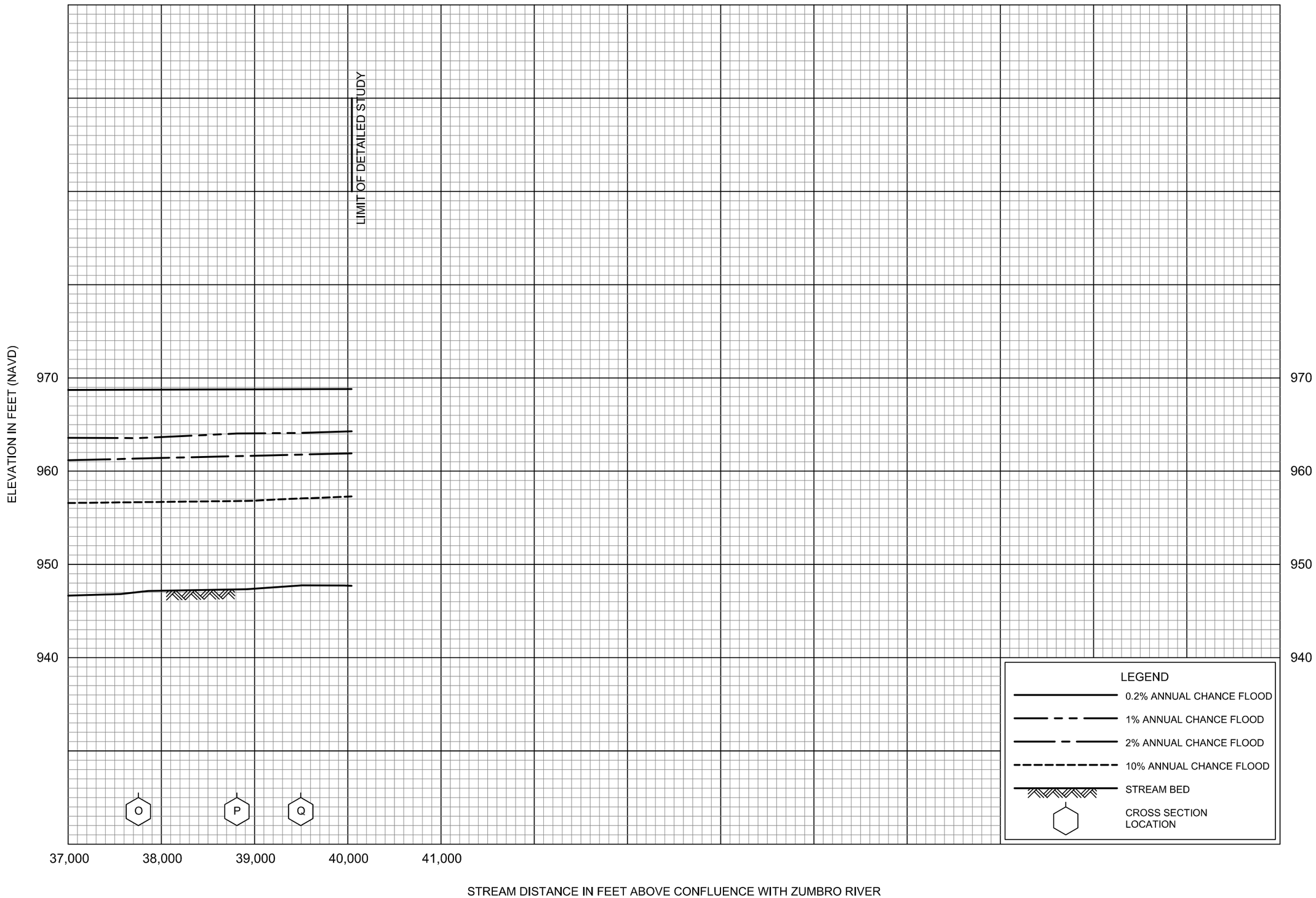
FLOOD PROFILES

MIDDLE FORK ZUMBRO RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



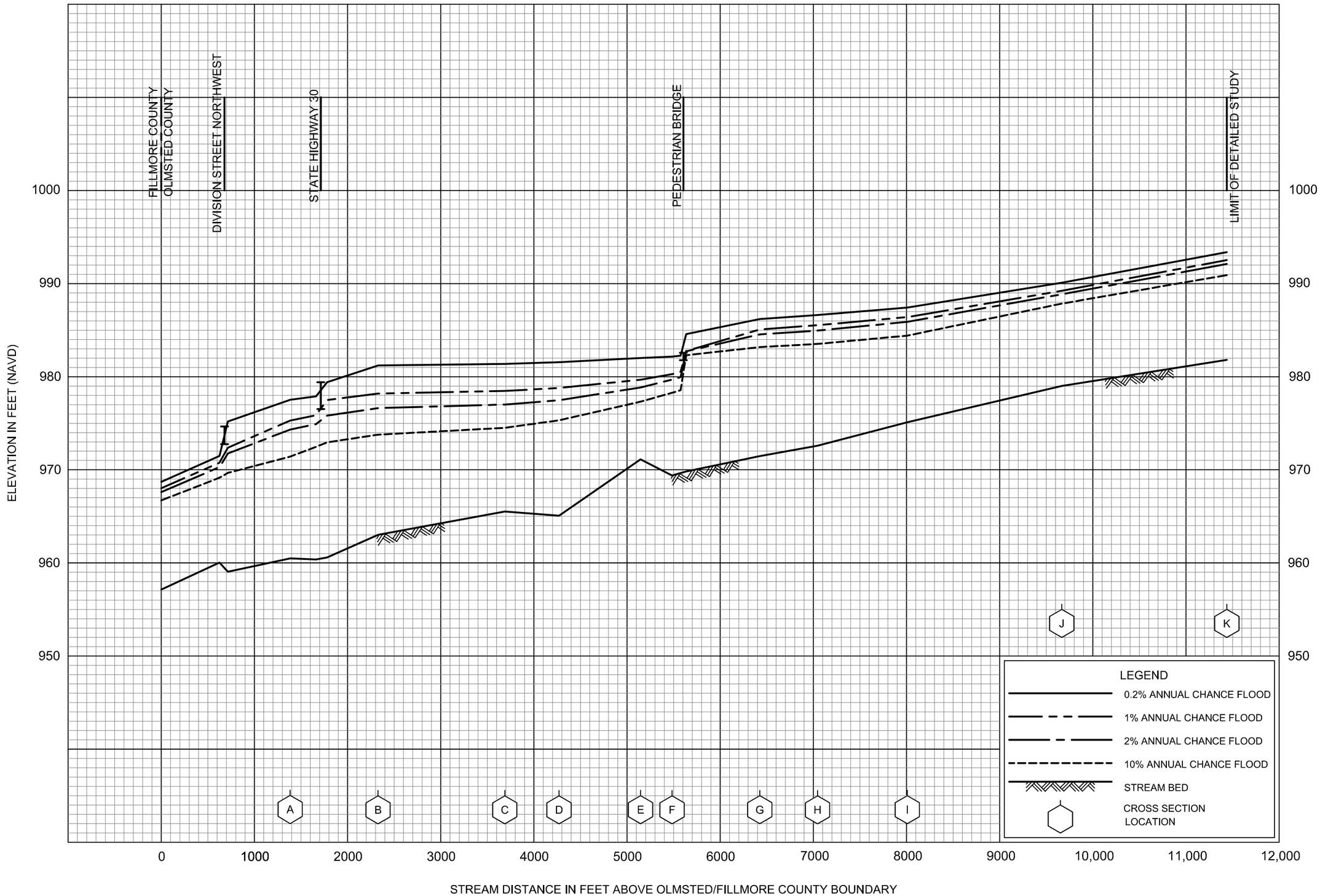
FLOOD PROFILES

MIDDLE FORK ZUMBRO RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



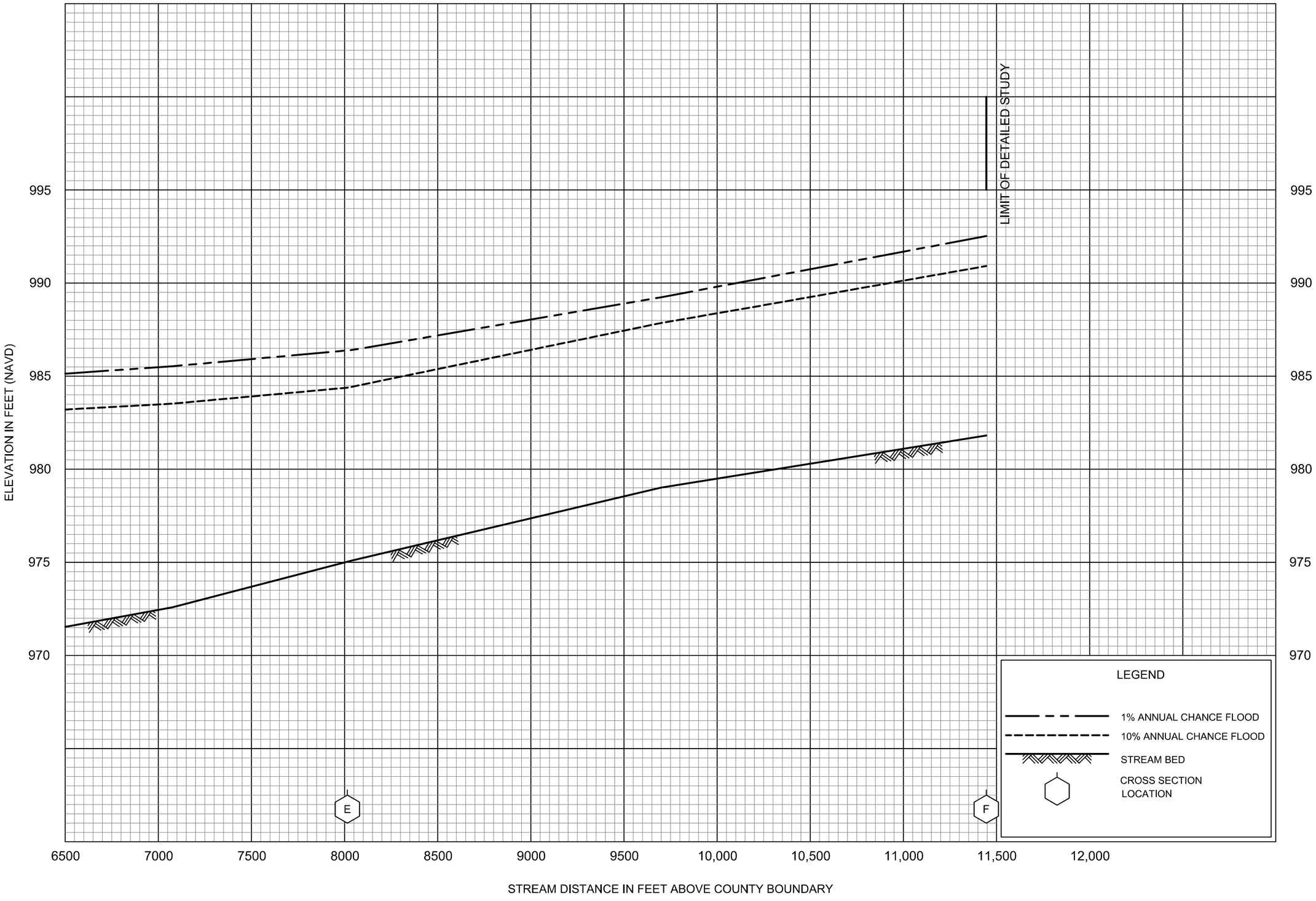
FLOOD PROFILES

MILL CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



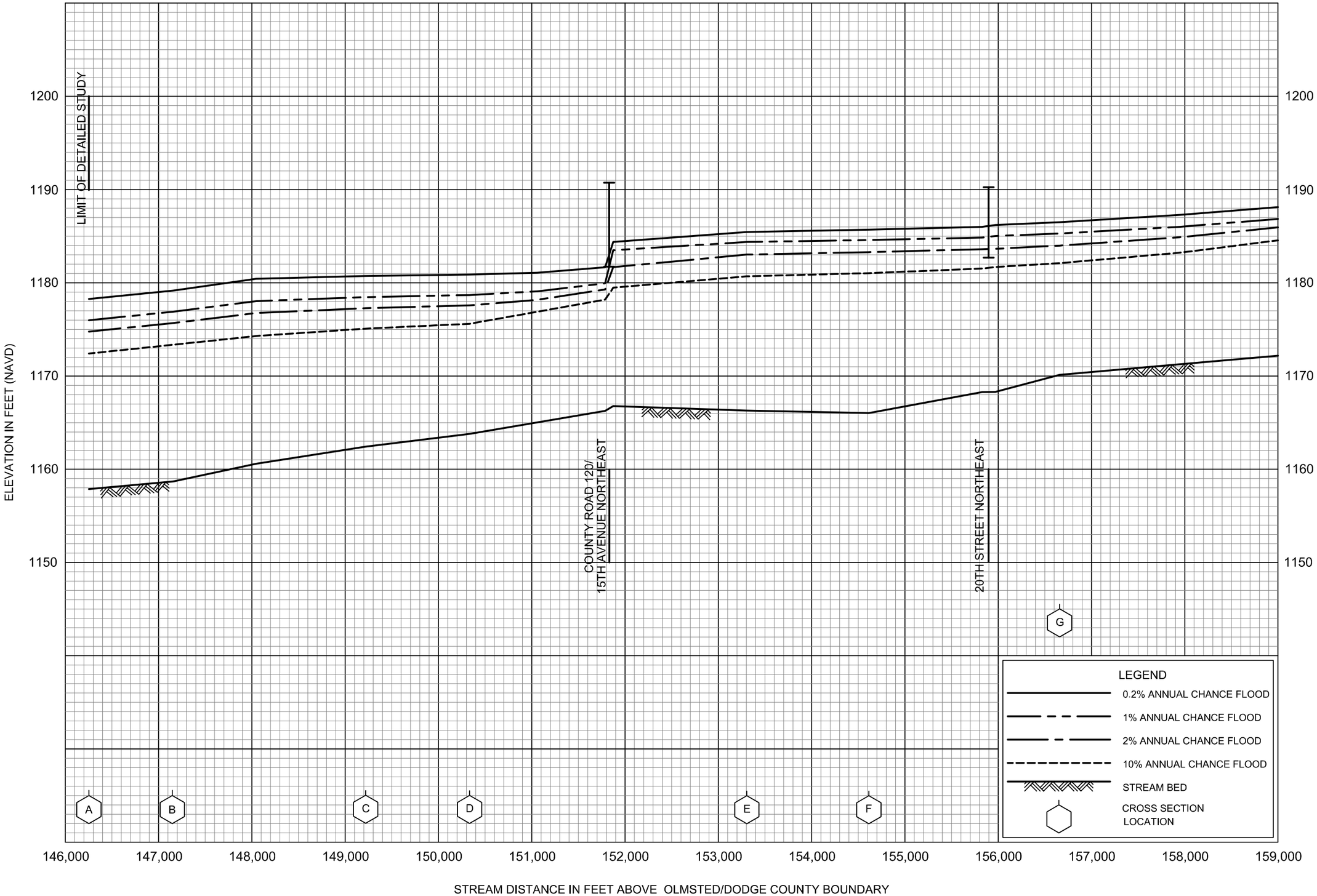
FLOOD PROFILES

MILL CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



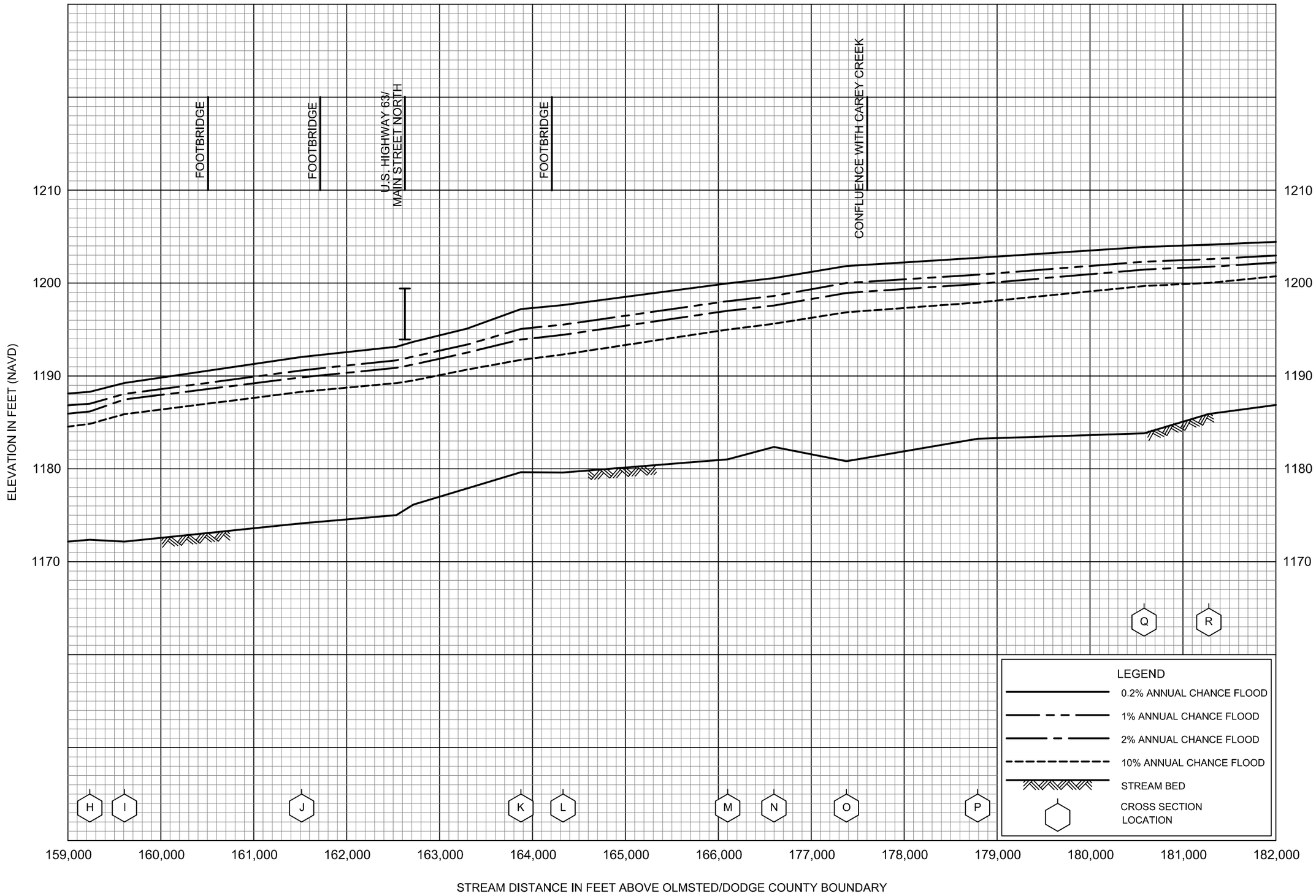
FLOOD PROFILES

NORTH BRANCH ROOT RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



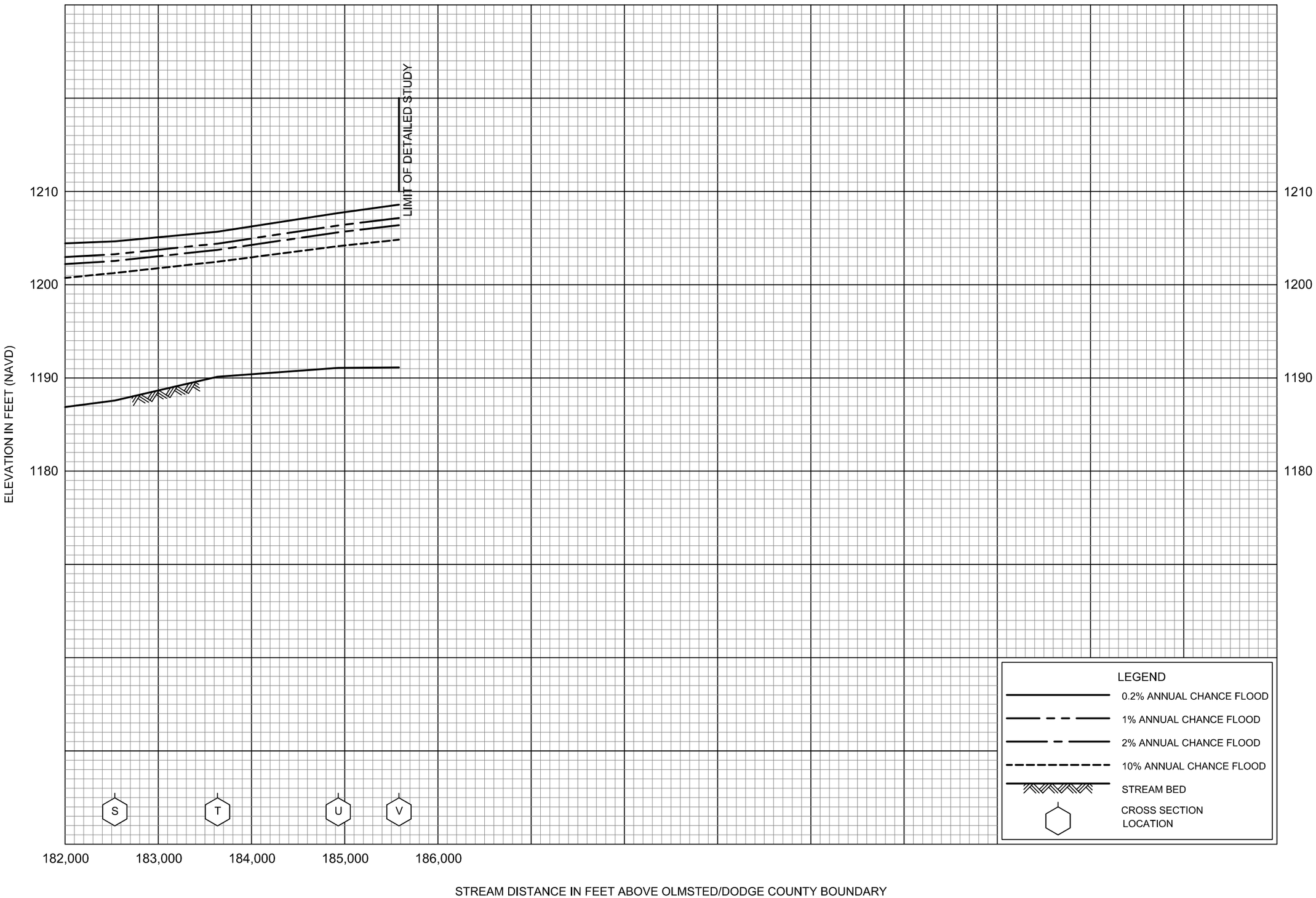
FLOOD PROFILES

NORTH BRANCH ROOT RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



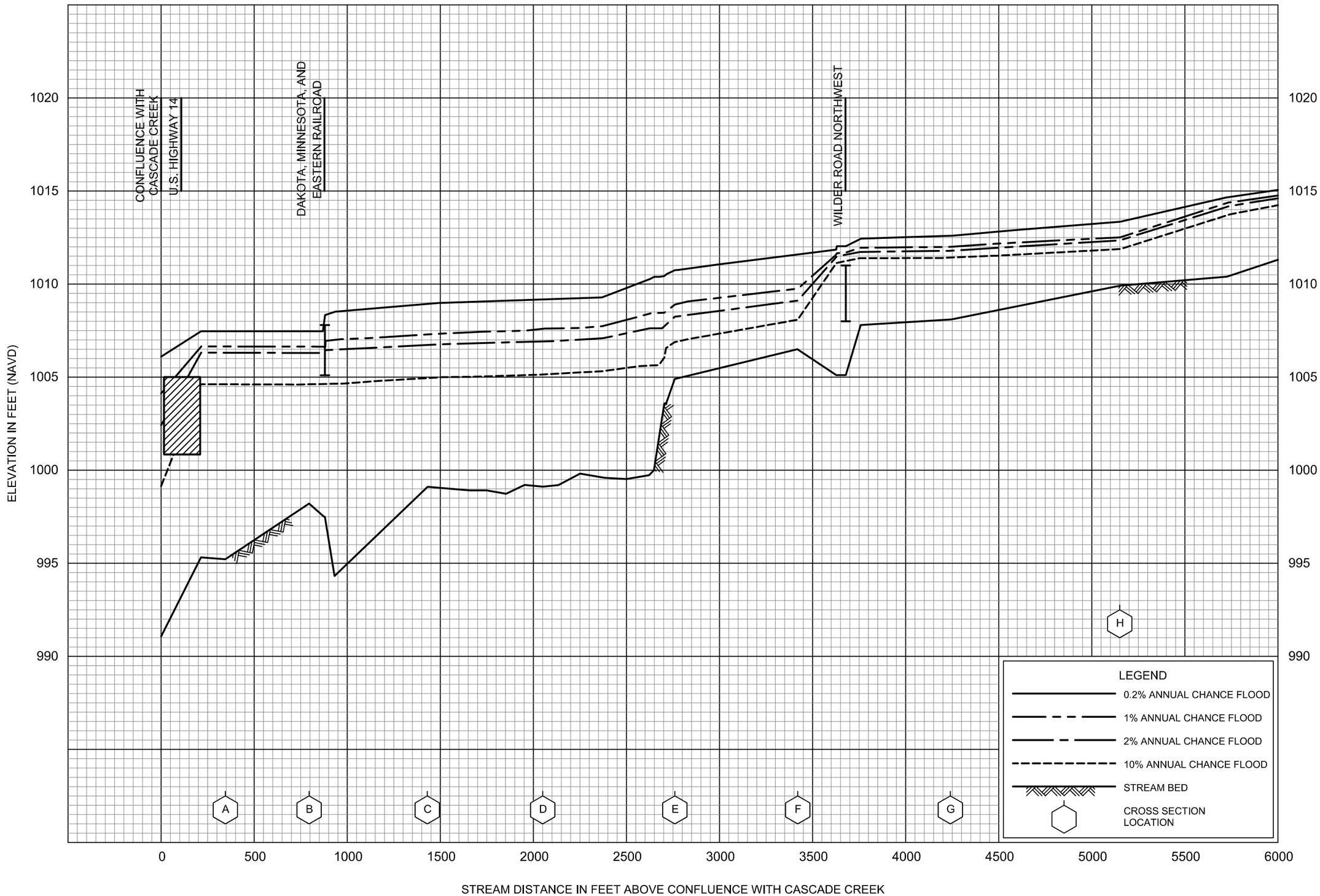
FLOOD PROFILES

NORTH BRANCH ROOT RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



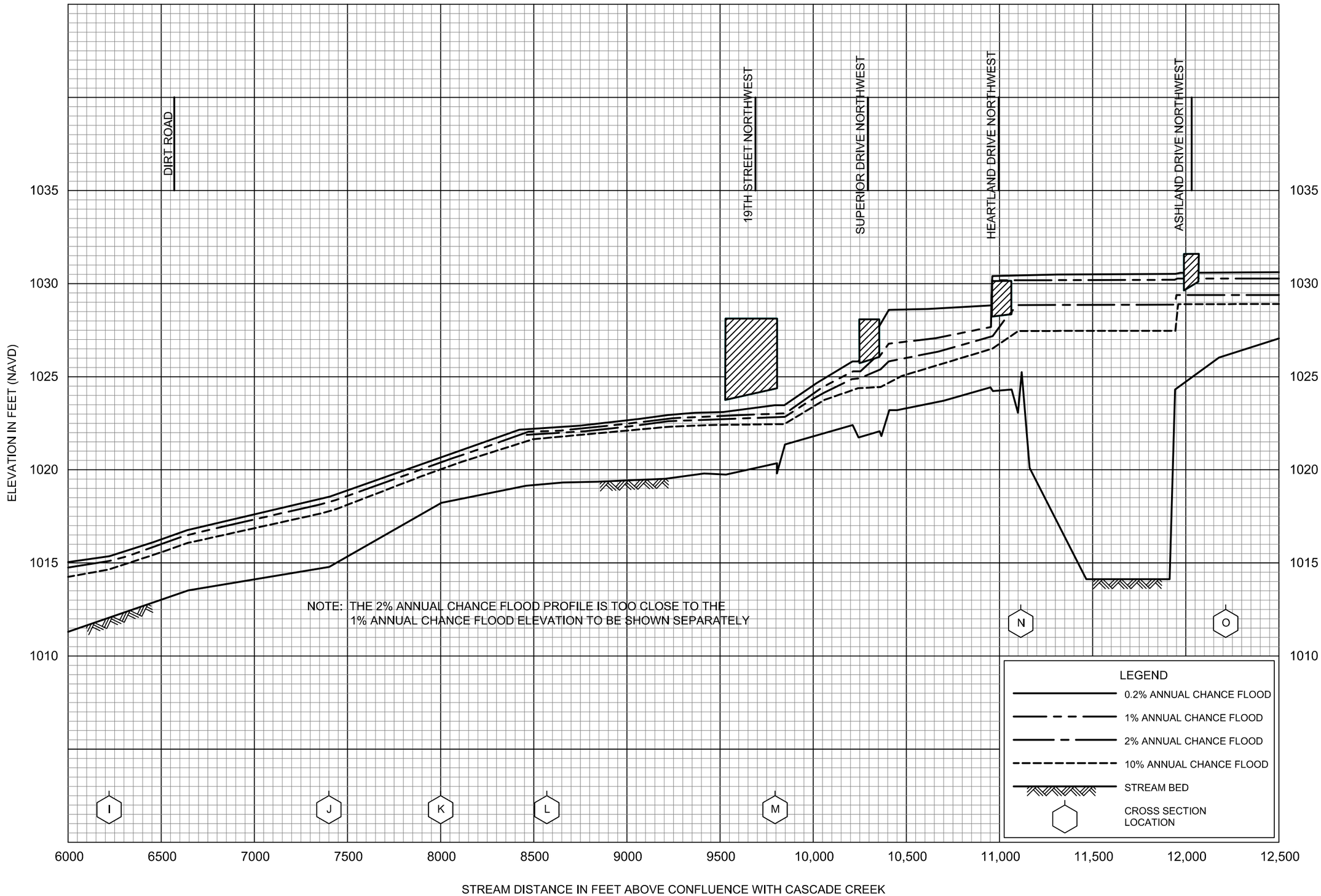
FLOOD PROFILES

NORTH RUN OF THE NORTH FORK OF CASCADE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



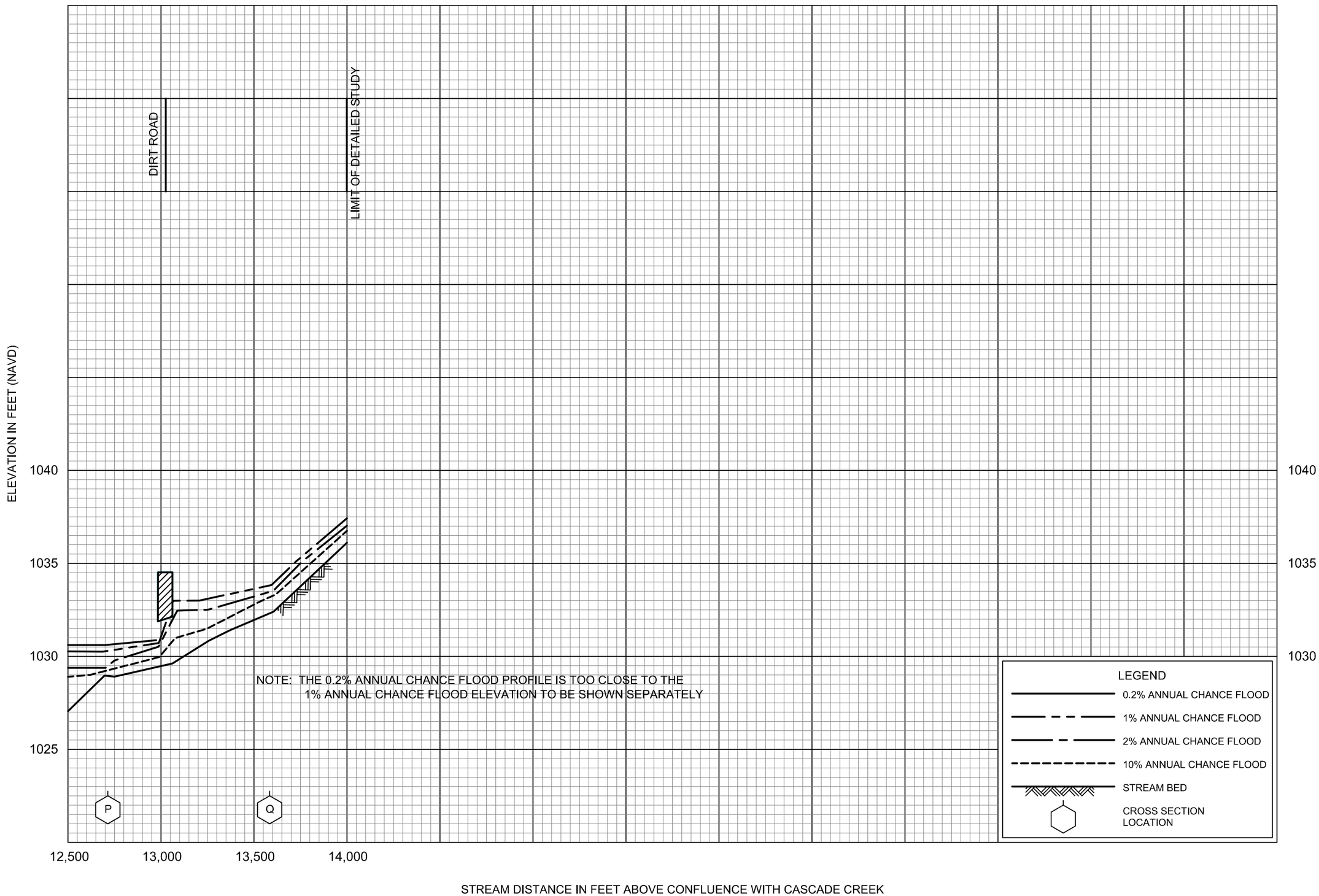
FLOOD PROFILES

NORTH RUN OF THE NORTH FORK OF CASCADE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



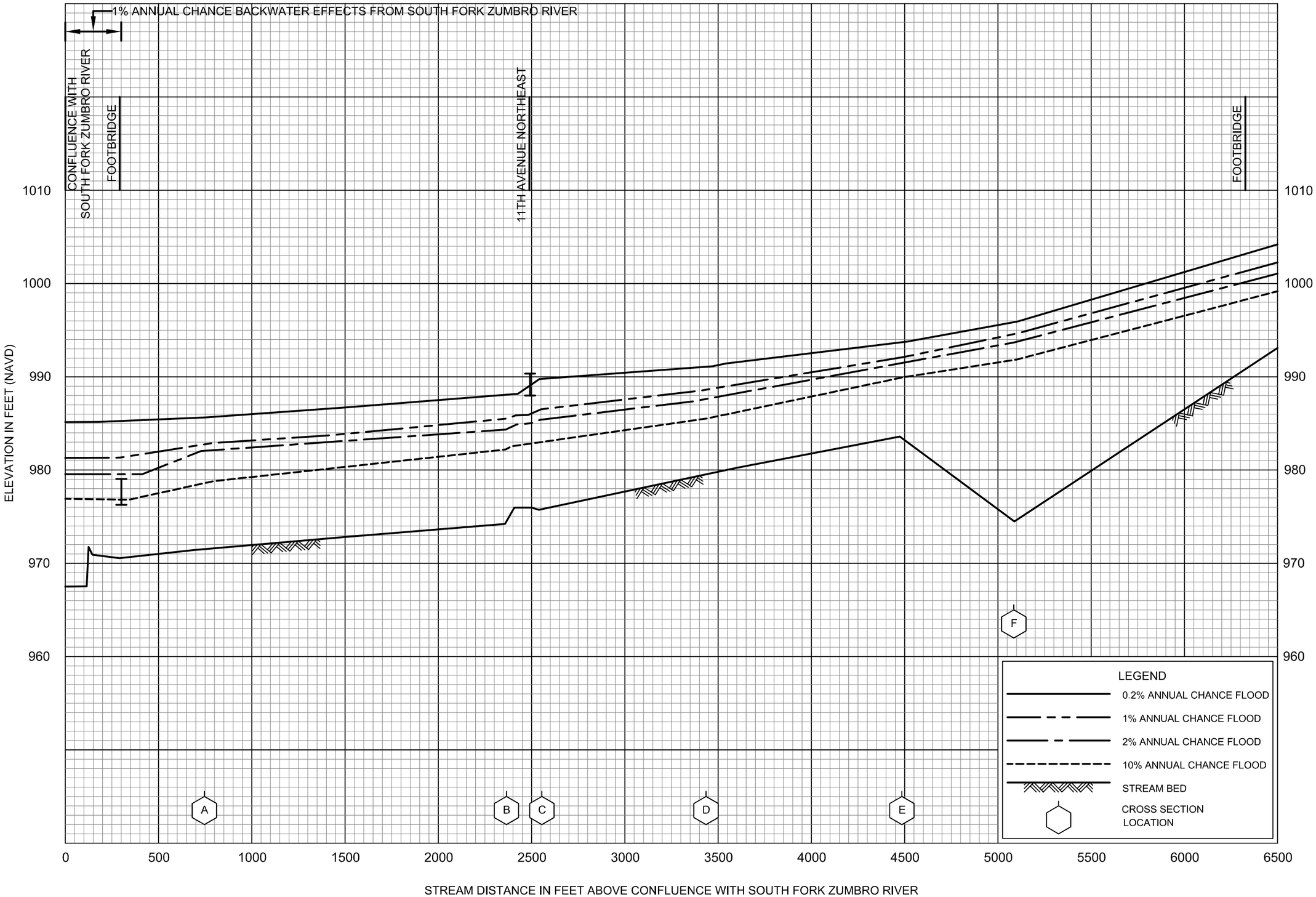
FLOOD PROFILES

NORTH RUN OF THE NORTH FORK OF CASCADE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



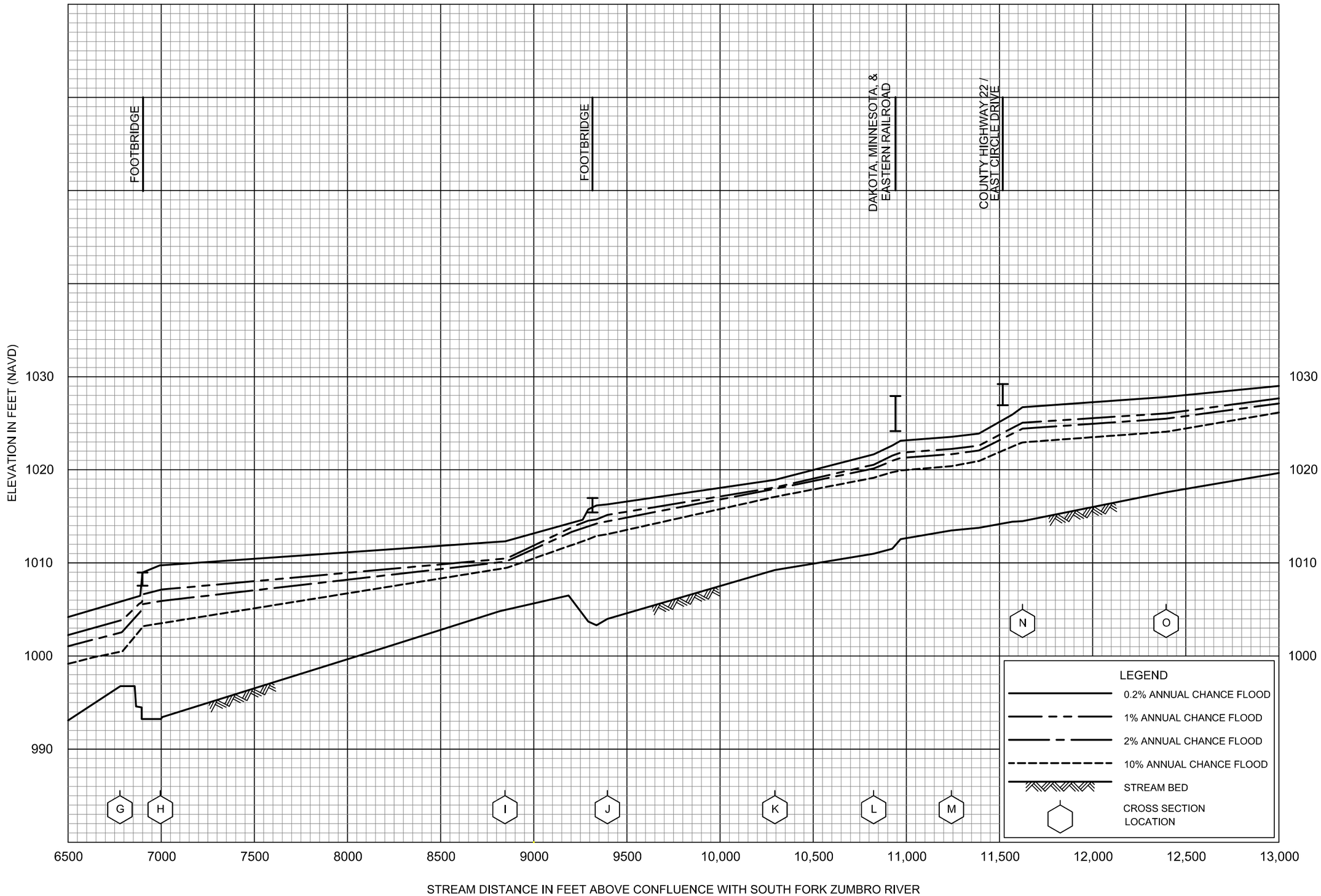
FLOOD PROFILES

SILVER CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND UNINCORPORATED AREAS



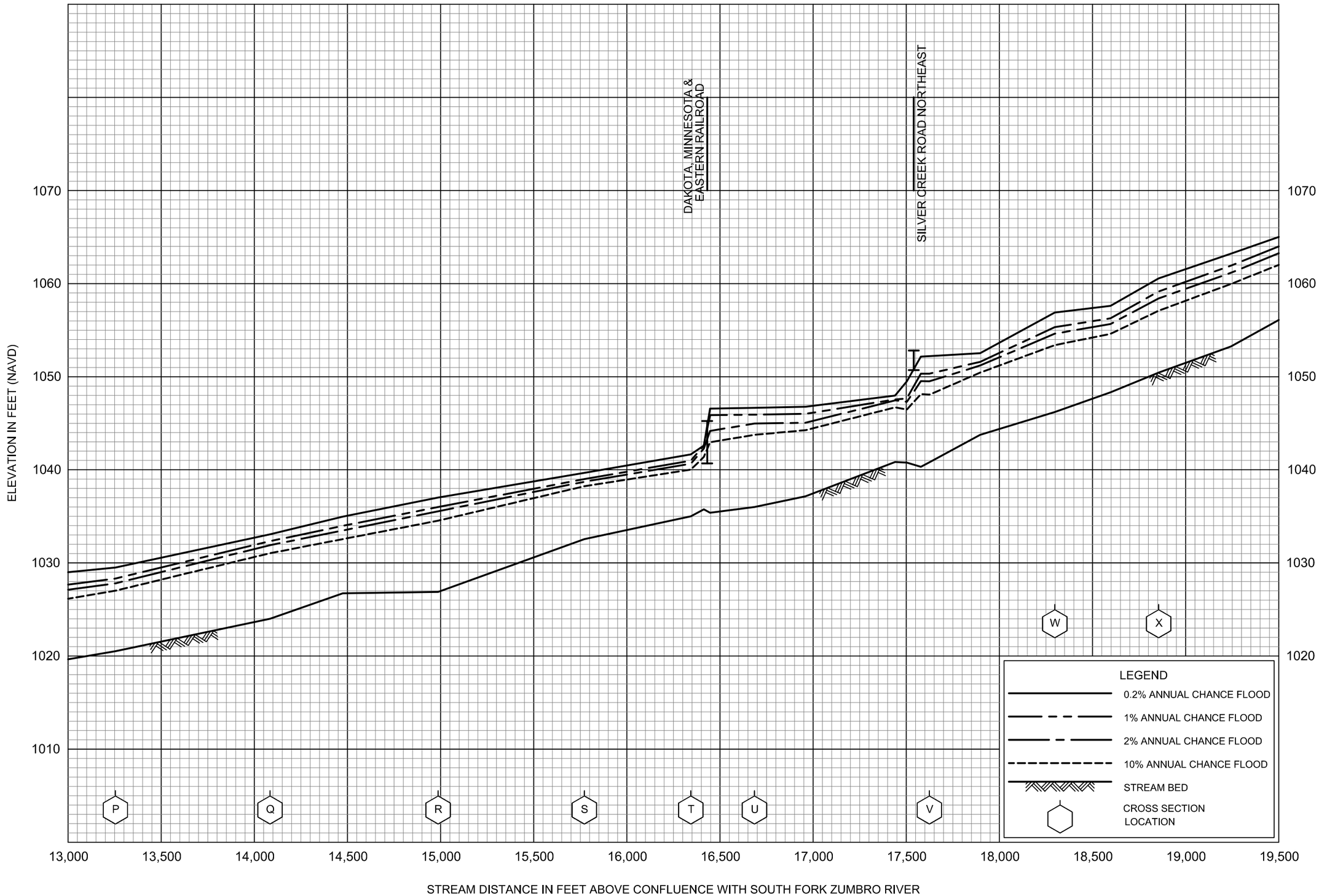
FLOOD PROFILES

SILVER CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



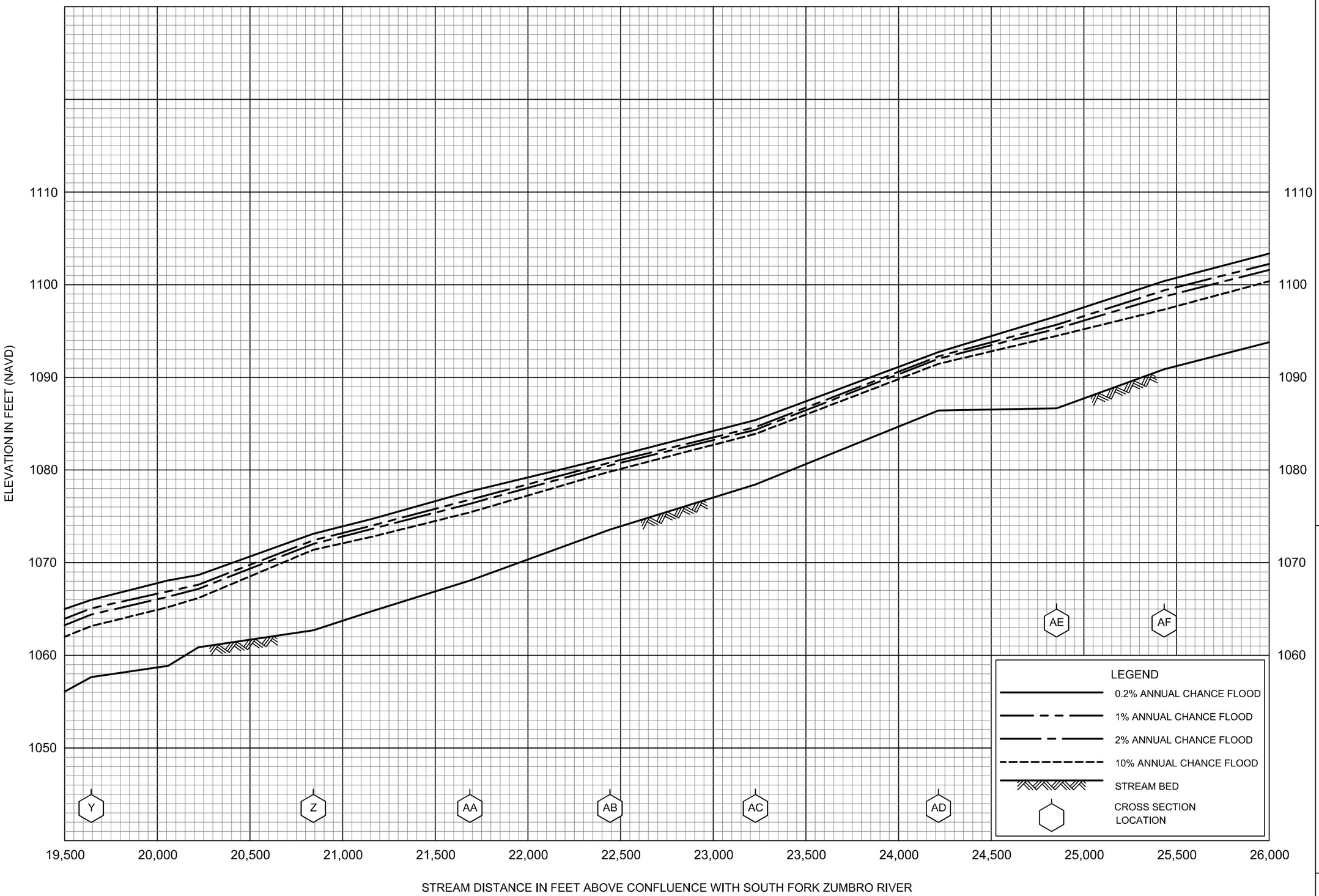
FLOOD PROFILES

SILVER CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



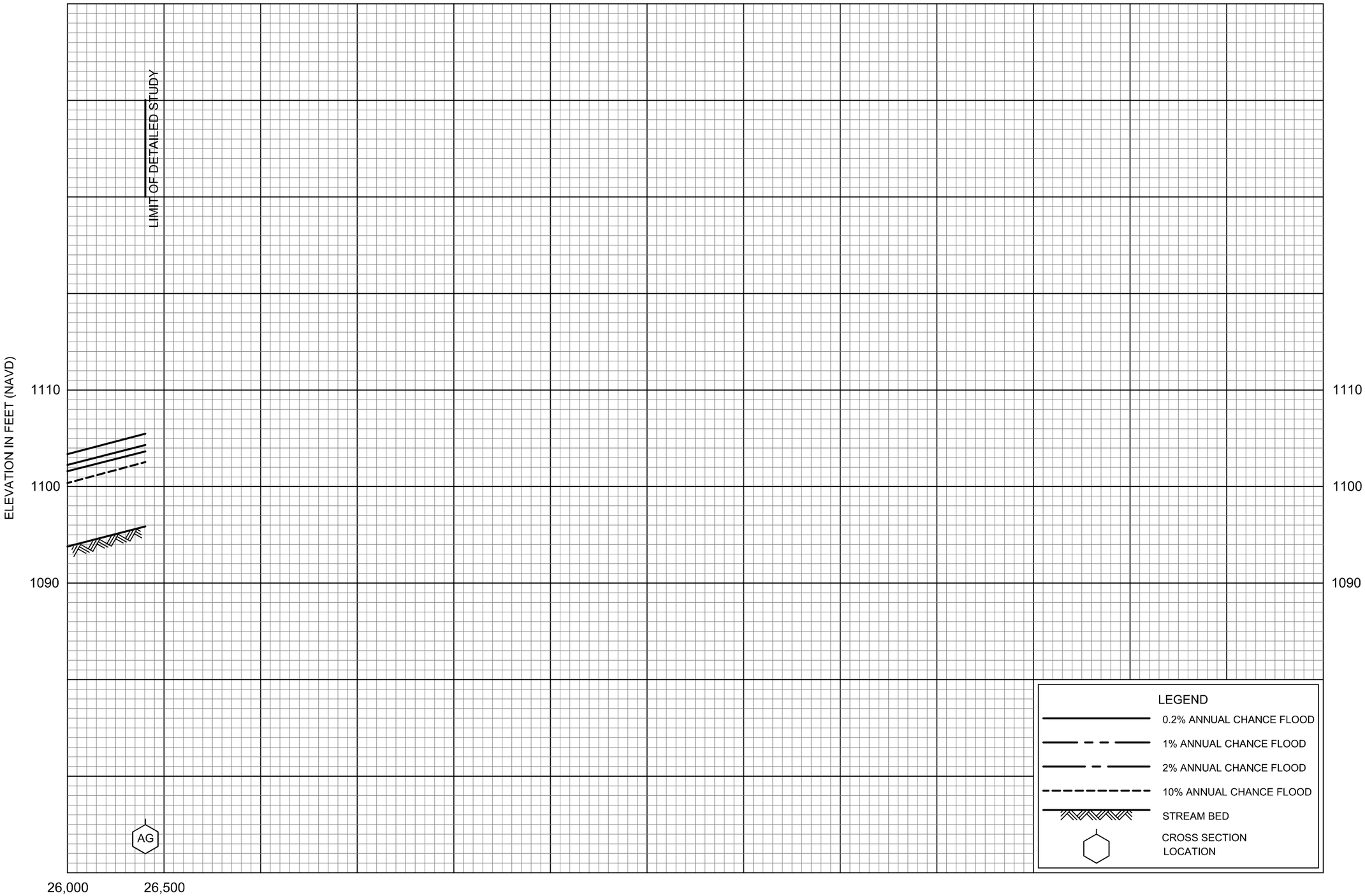
FLOOD PROFILES

SILVER CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



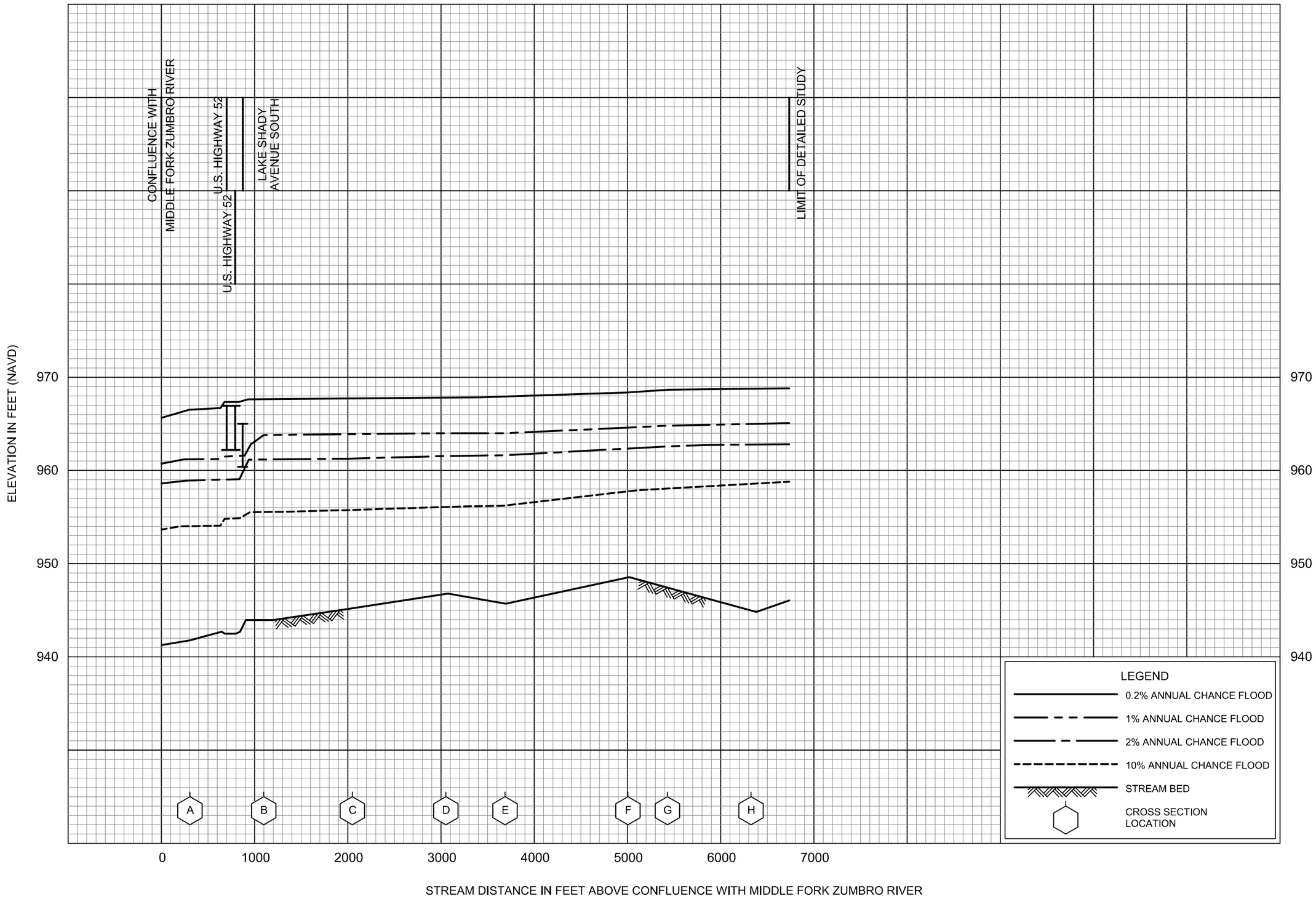
FLOOD PROFILES

SILVER CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



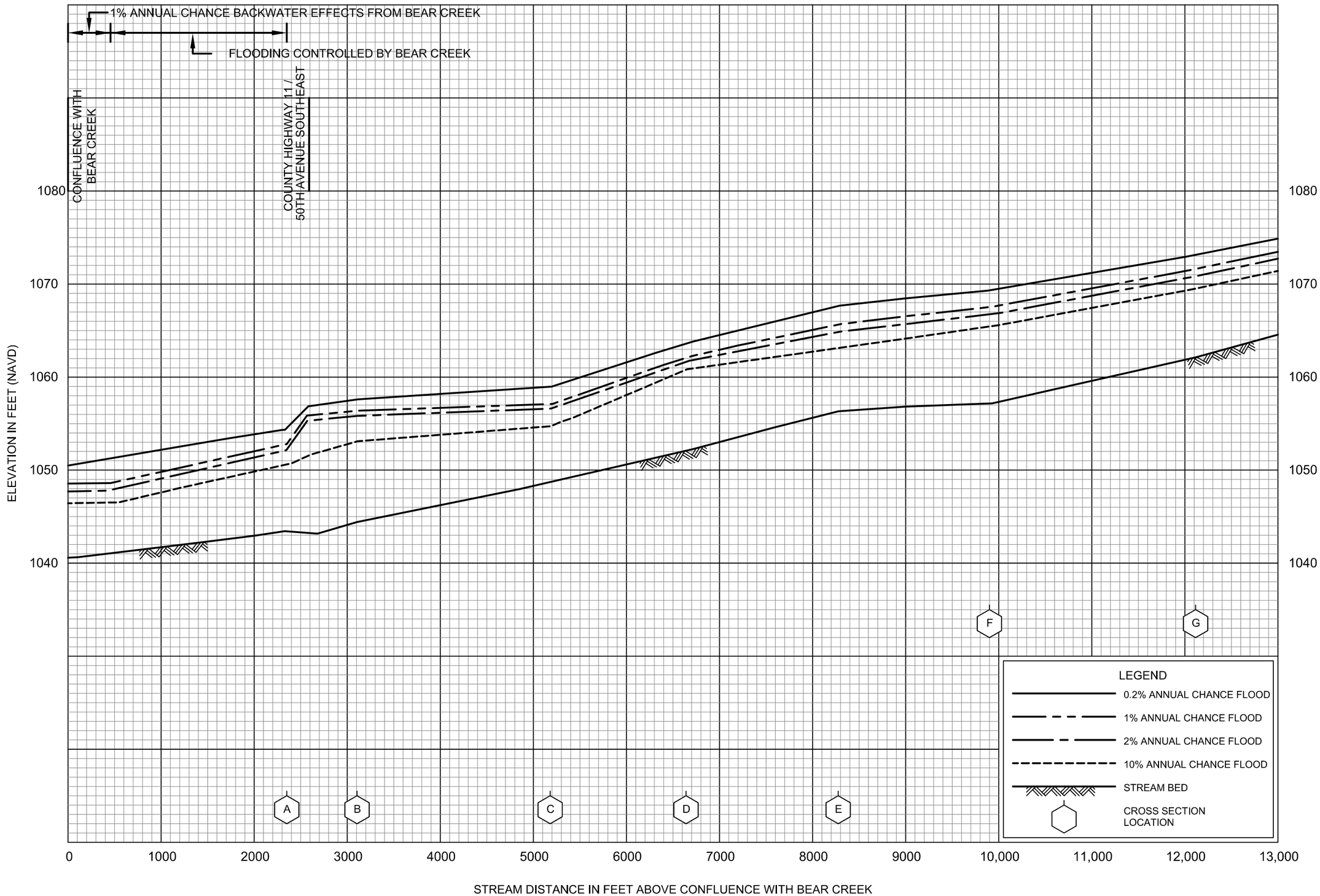
FLOOD PROFILES

SOUTH BRANCH MIDDLE FORK ZUMBRO RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



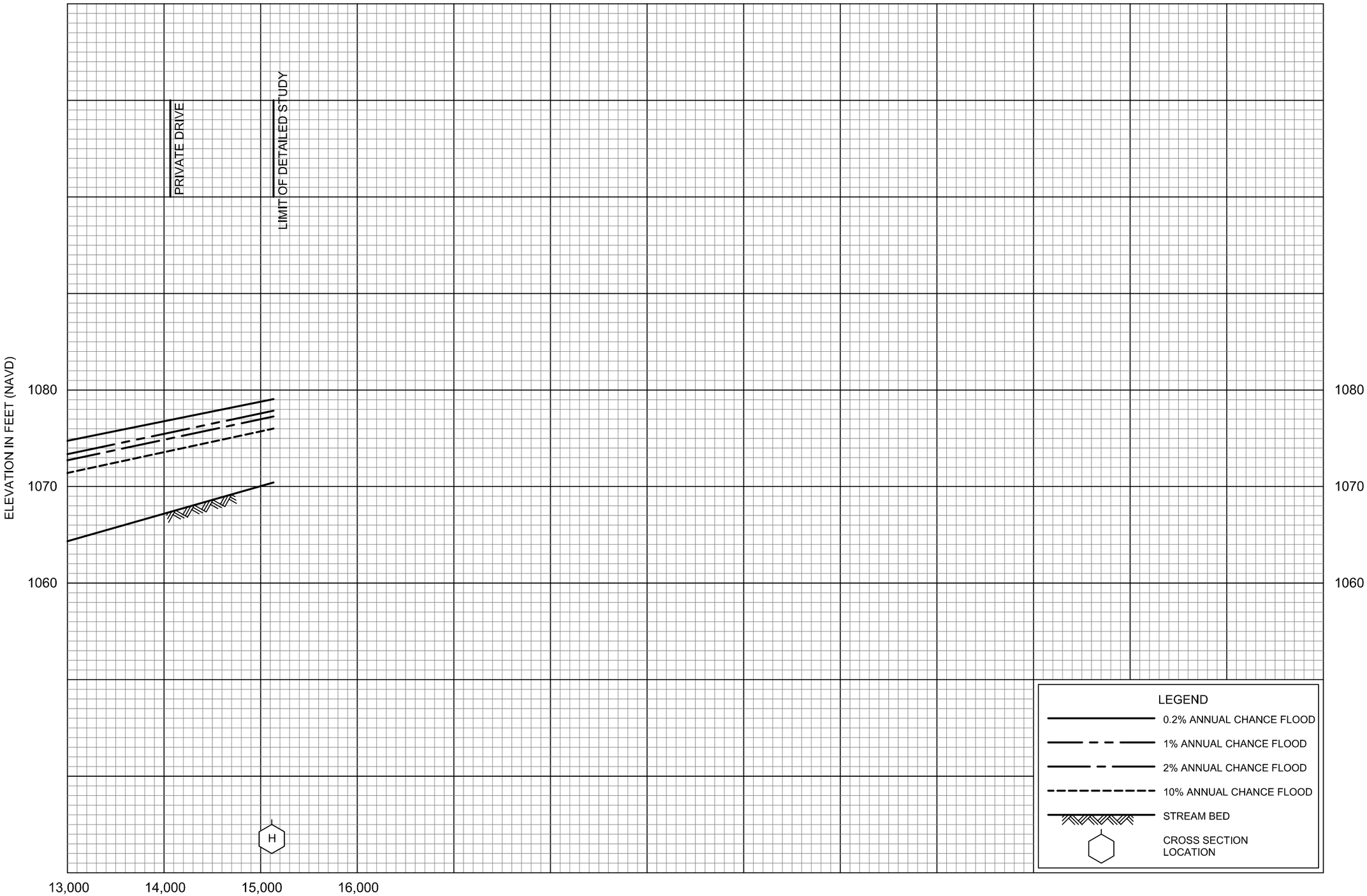
FLOOD PROFILES

SOUTH FORK OF BEAR CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



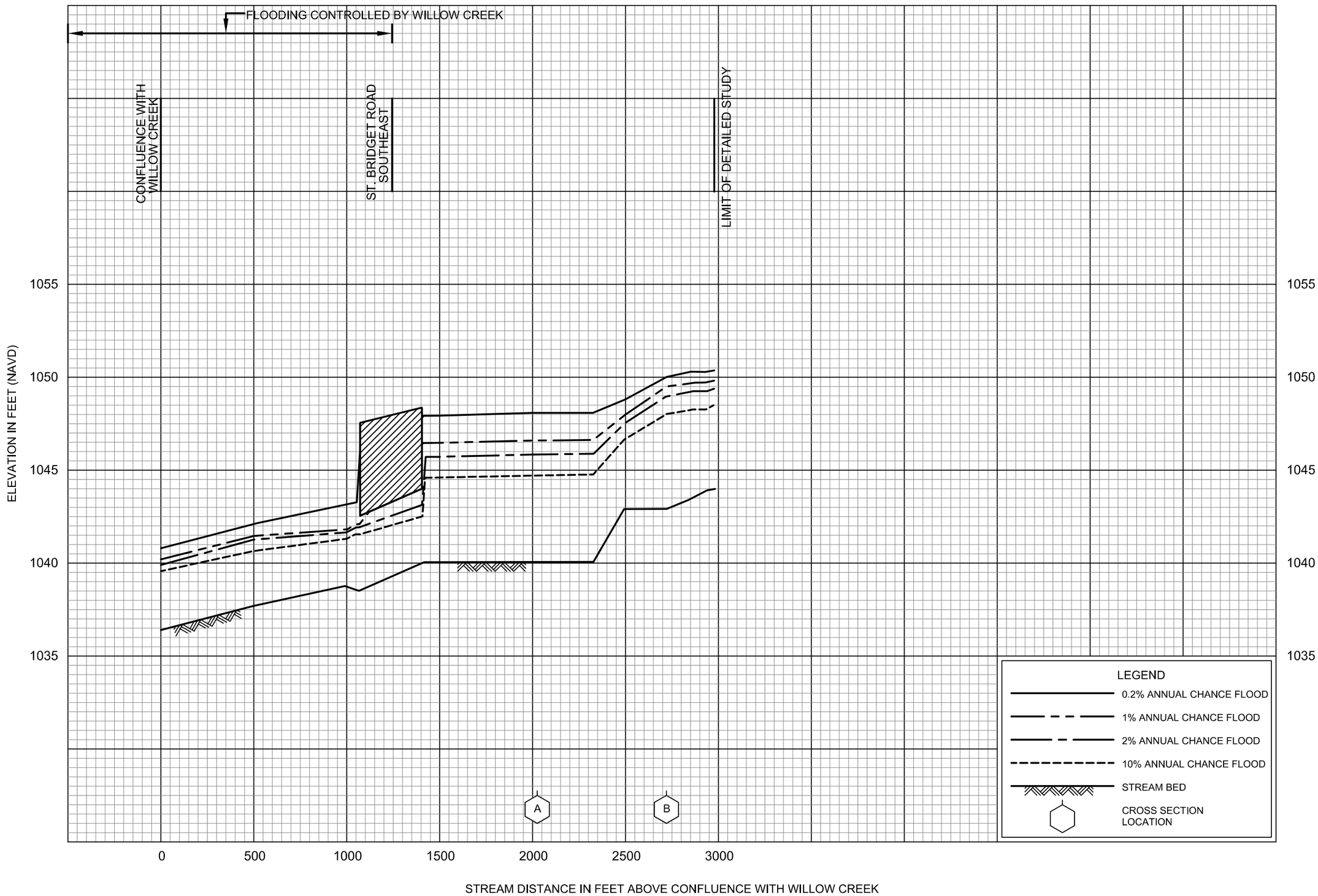
FLOOD PROFILES

SOUTH FORK OF BEAR CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



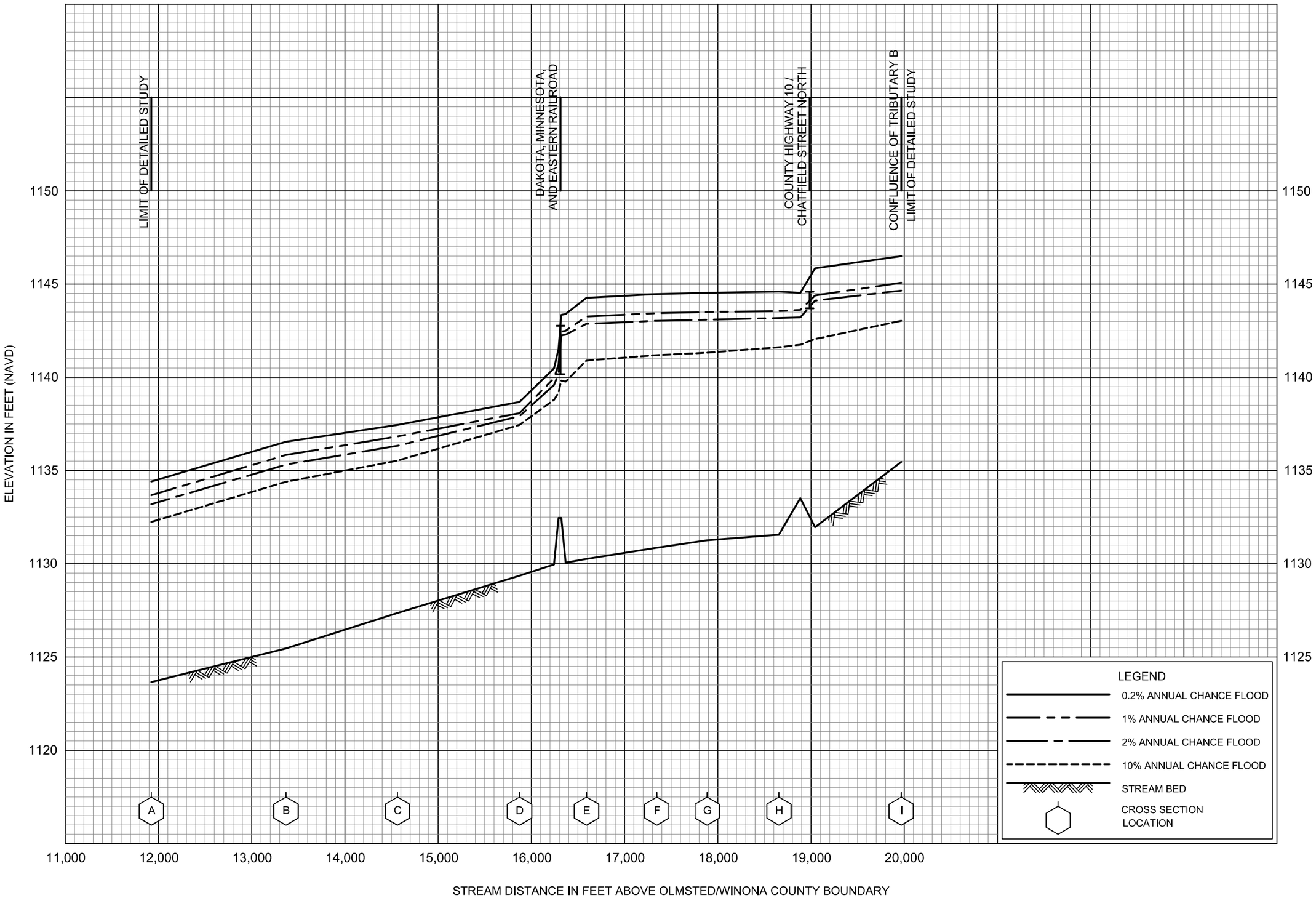
FLOOD PROFILES

SOUTH FORK OF WILLOW CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



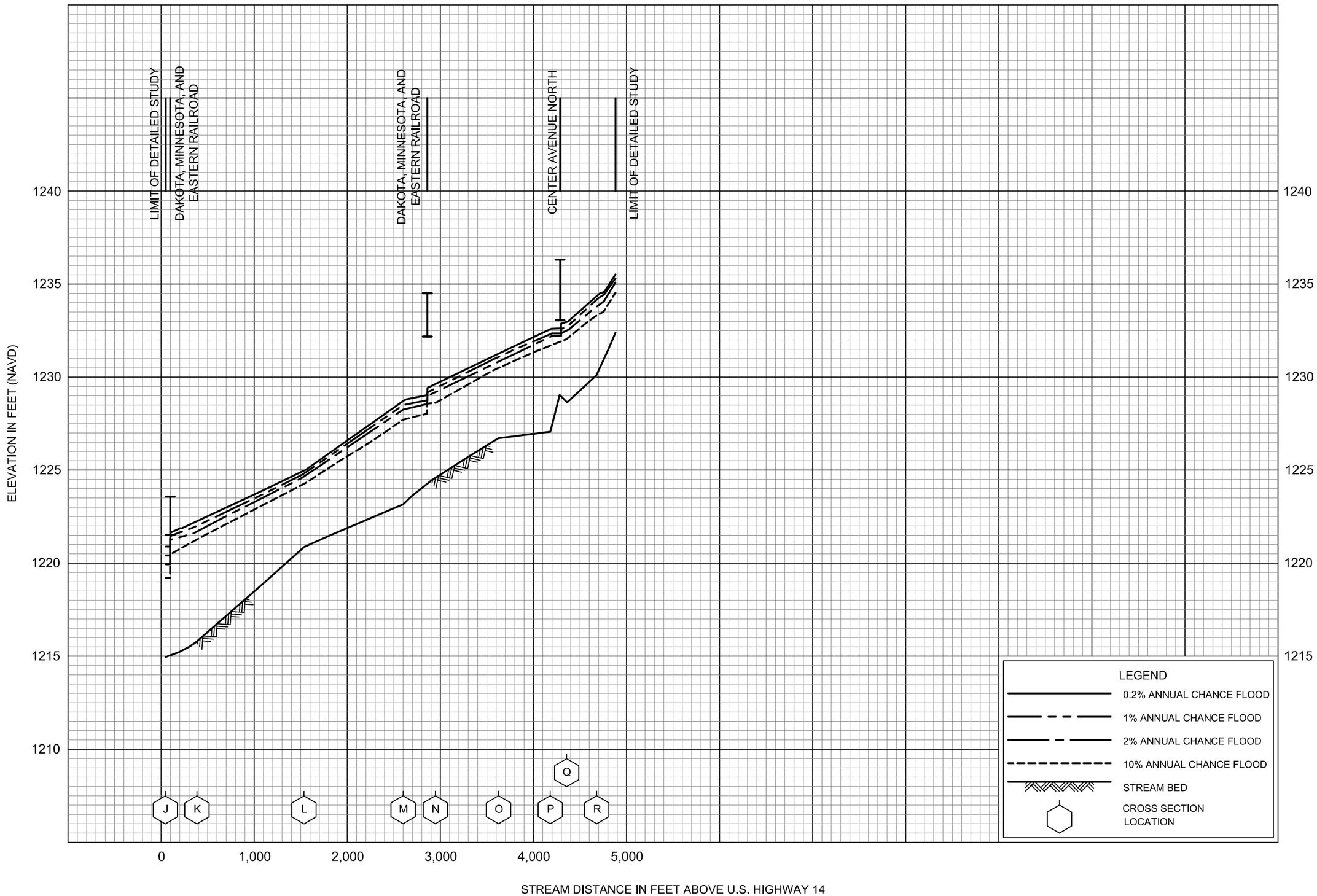
FLOOD PROFILES

SOUTH FORK WHITEWATER RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



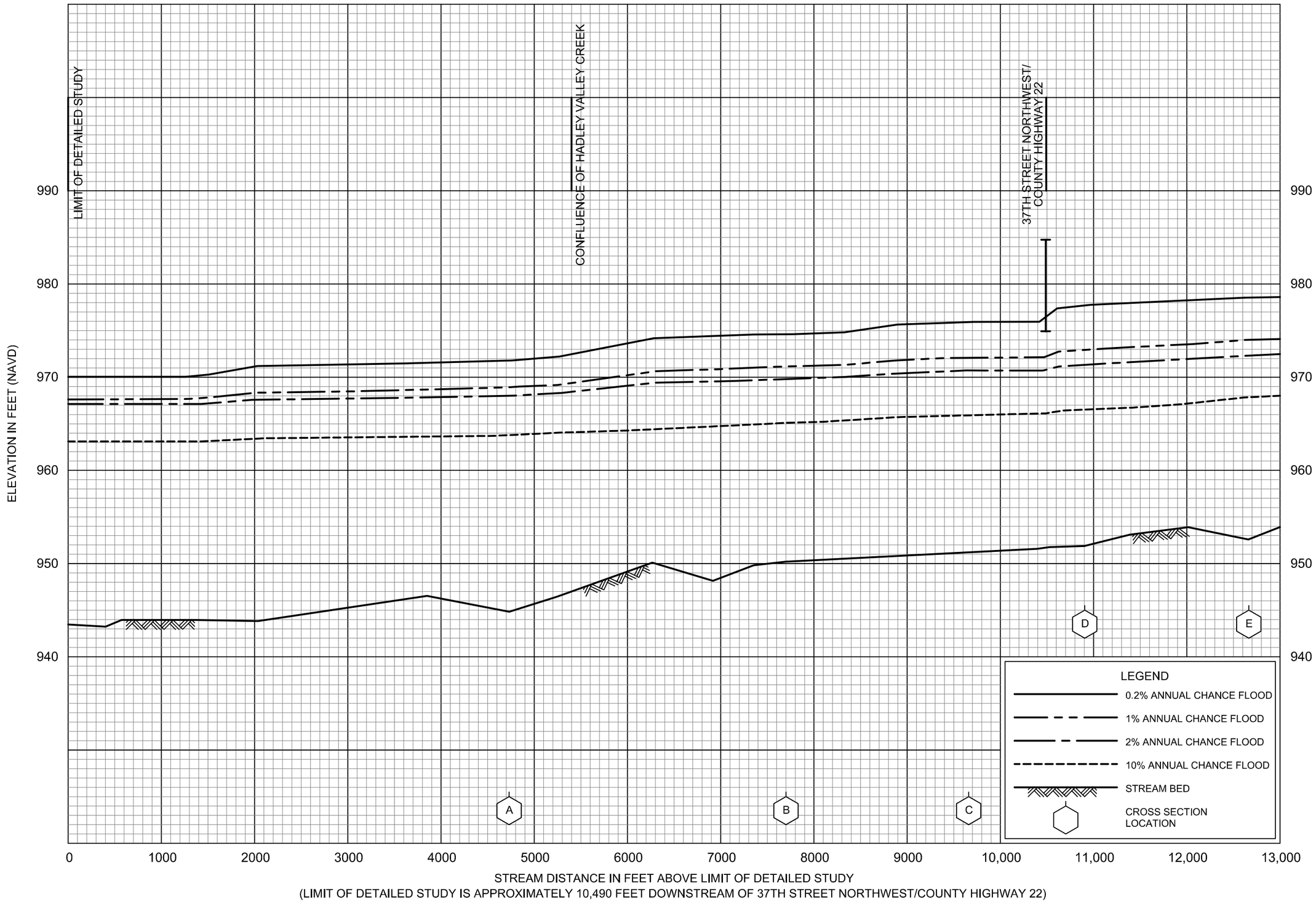
FLOOD PROFILES

SOUTH FORK WHITEWATER RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



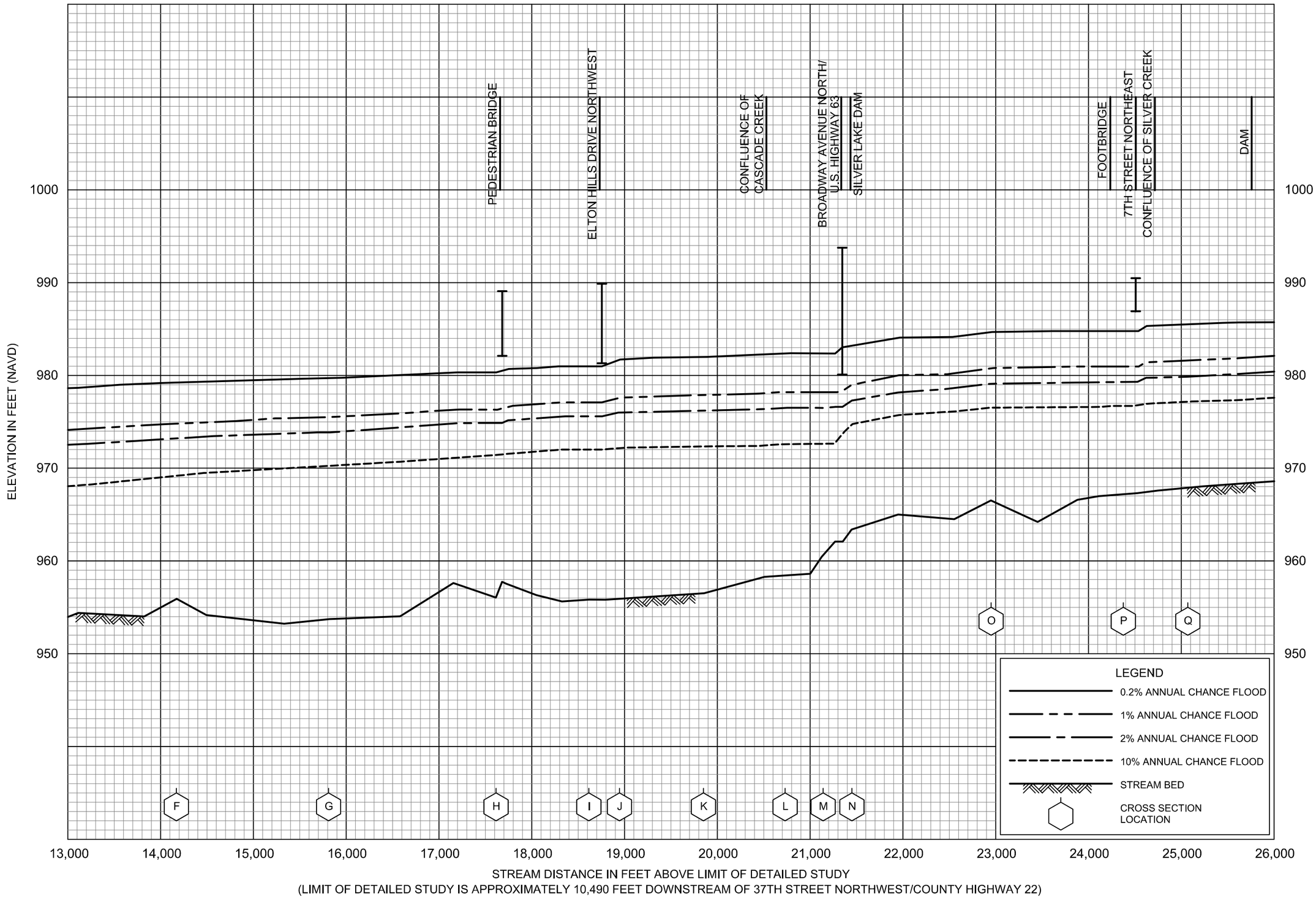
FLOOD PROFILES

SOUTH FORK ZUMBRO RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



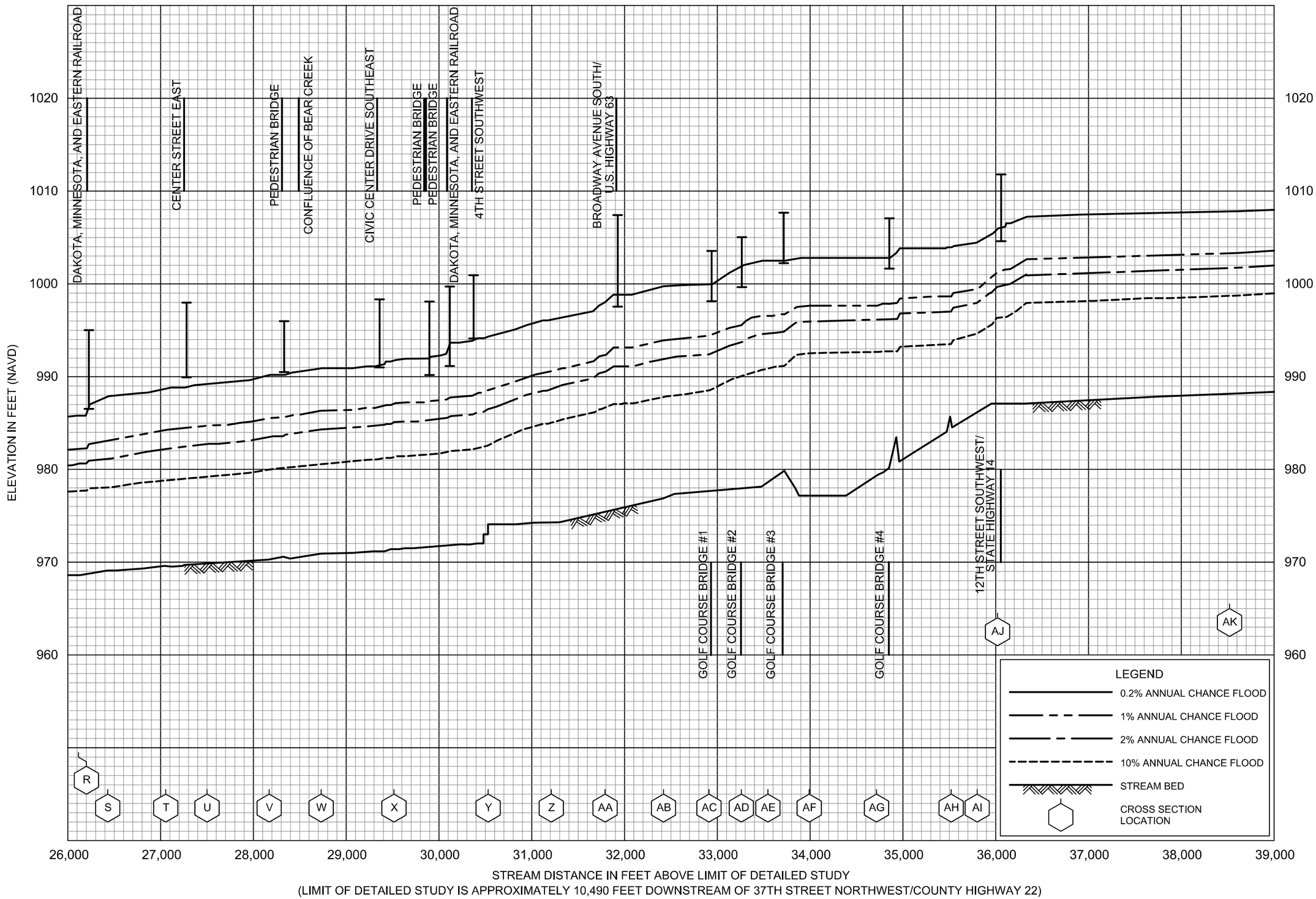
FLOOD PROFILES

SOUTH FORK ZUMBRO RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



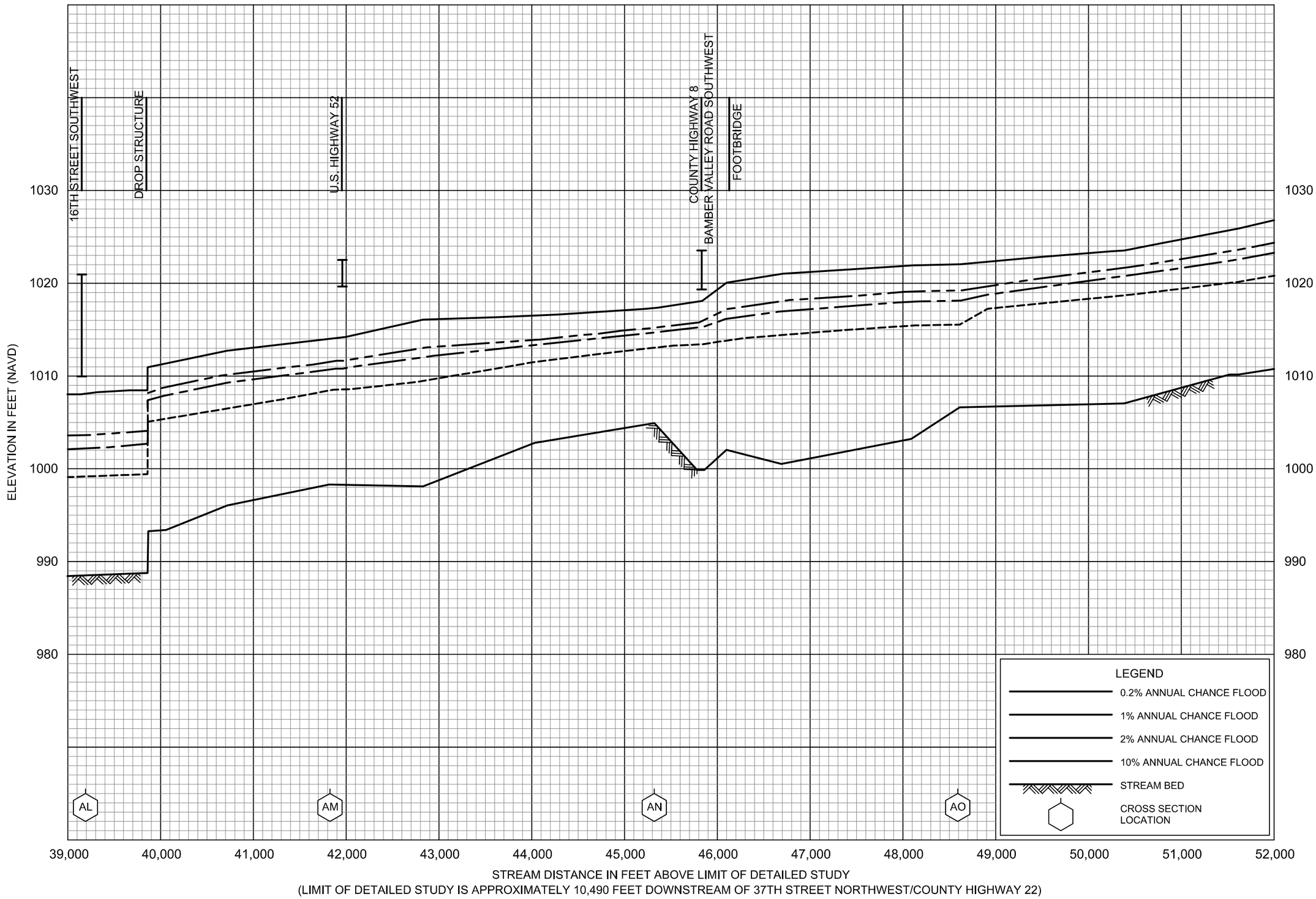
FLOOD PROFILES

SOUTH FORK ZUMBRO RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



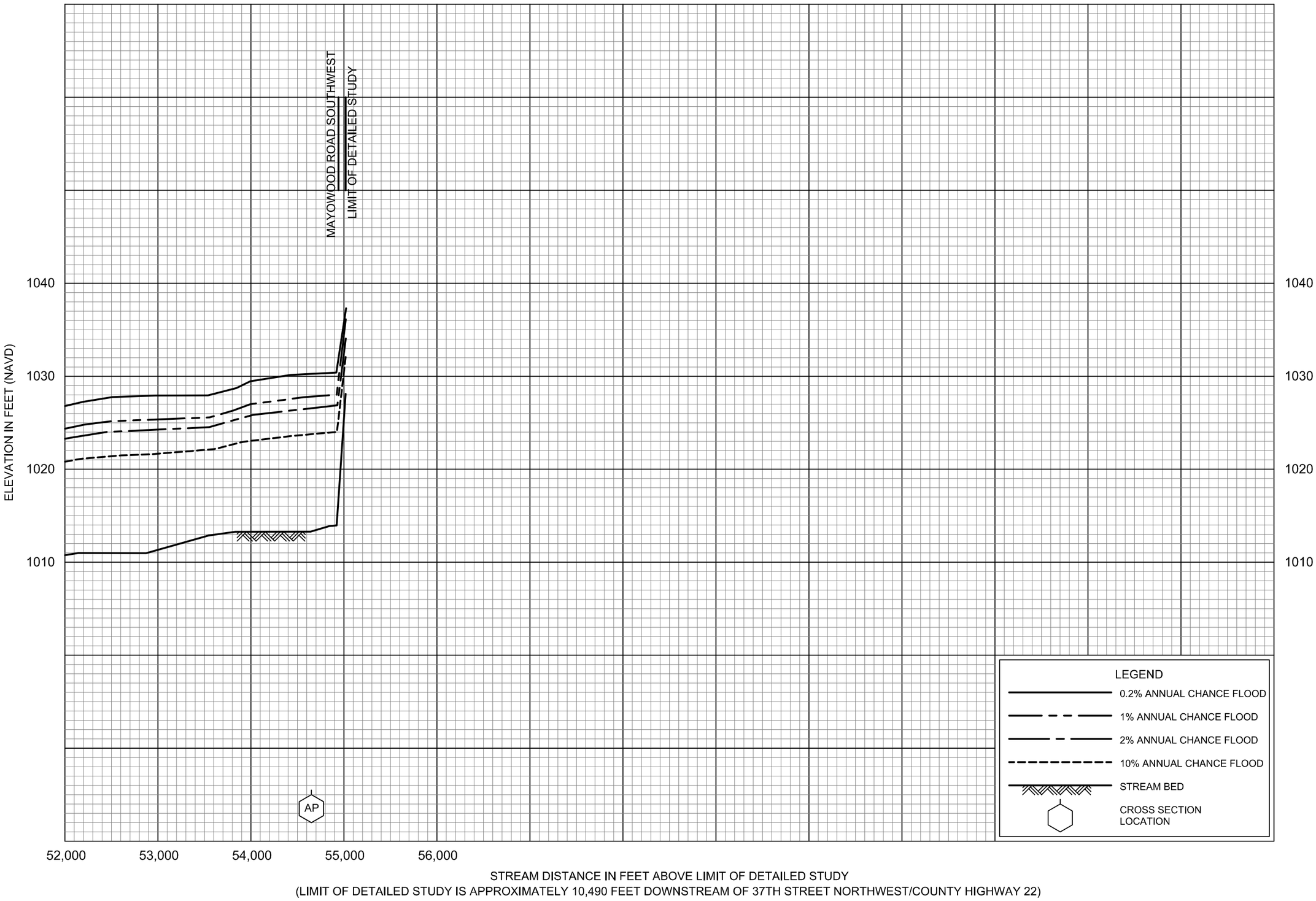
FLOOD PROFILES

SOUTH FORK ZUMBRO RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



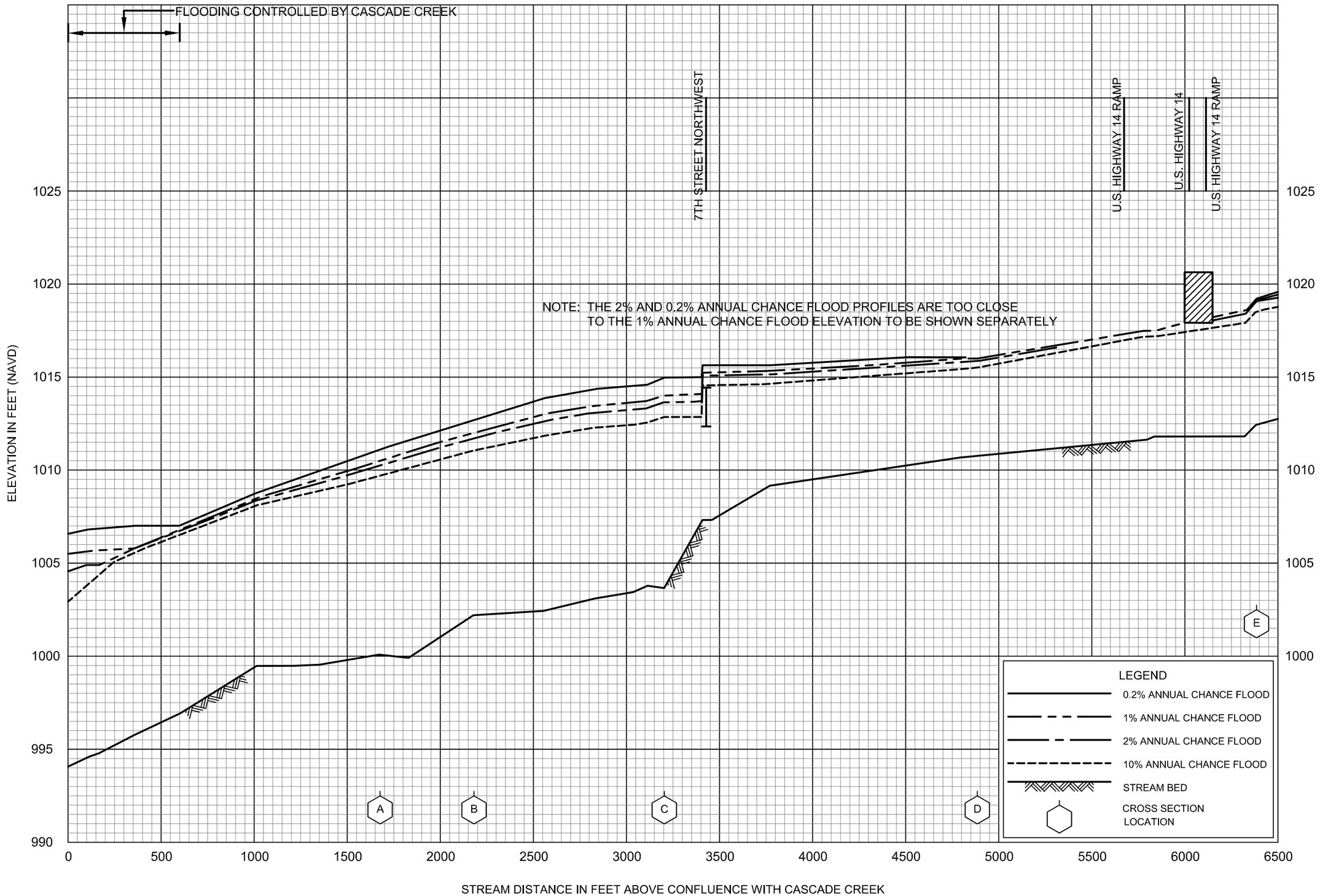
FLOOD PROFILES

SOUTH FORK ZUMBRO RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



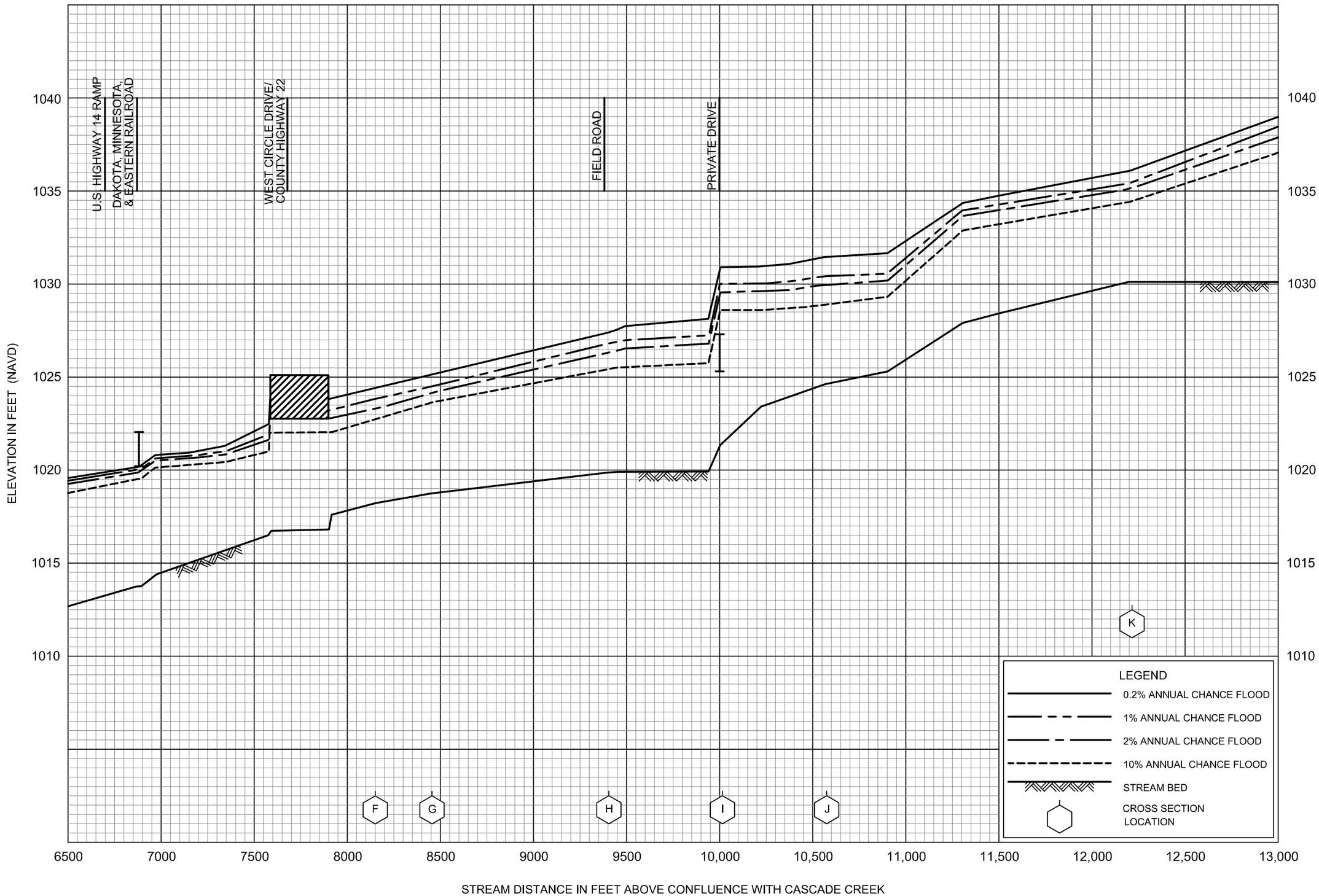
FLOOD PROFILES

SOUTH RUN OF THE NORTH FORK OF CASCADE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



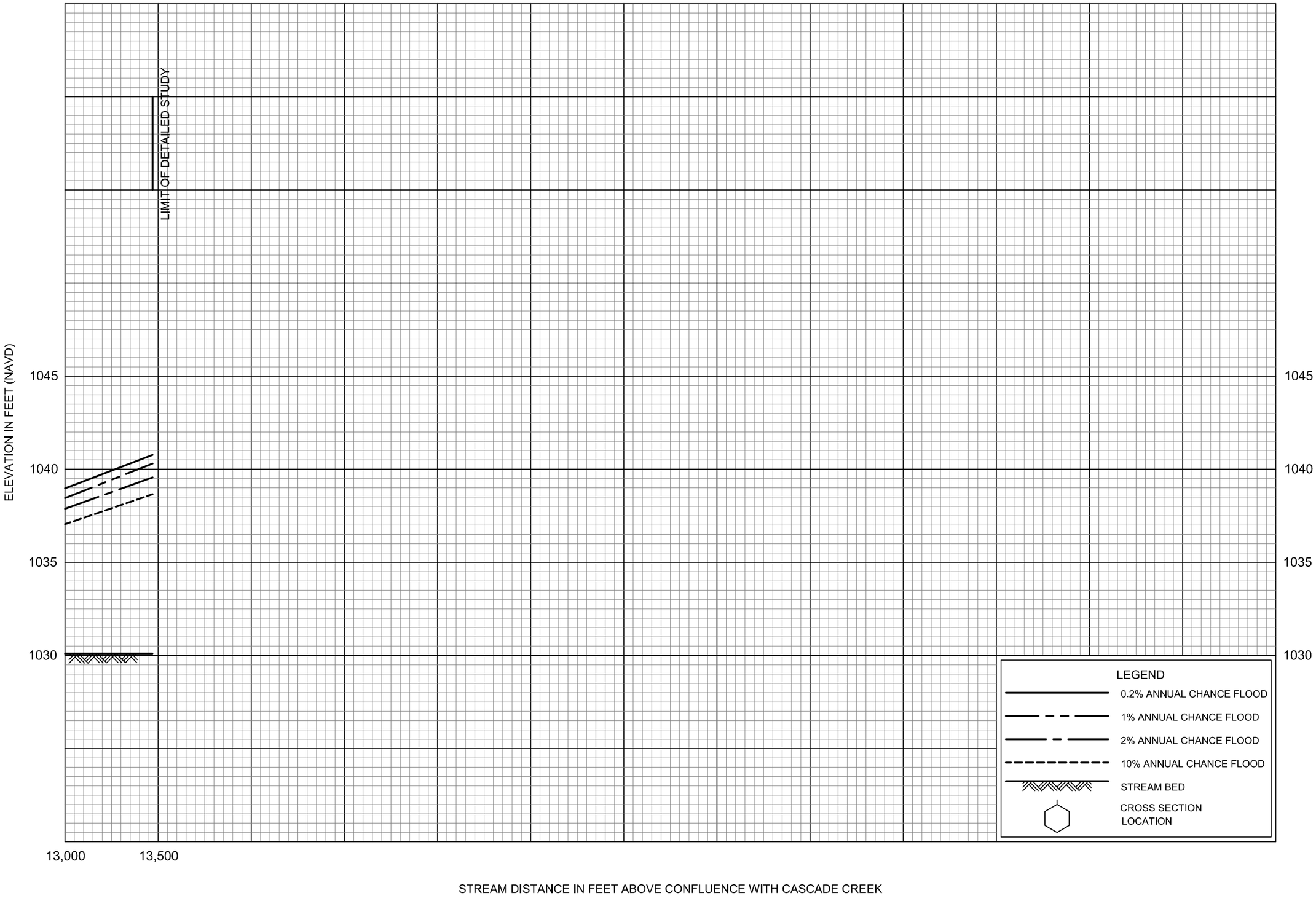
FLOOD PROFILES

SOUTH RUN OF THE NORTH FORK OF CASCADE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



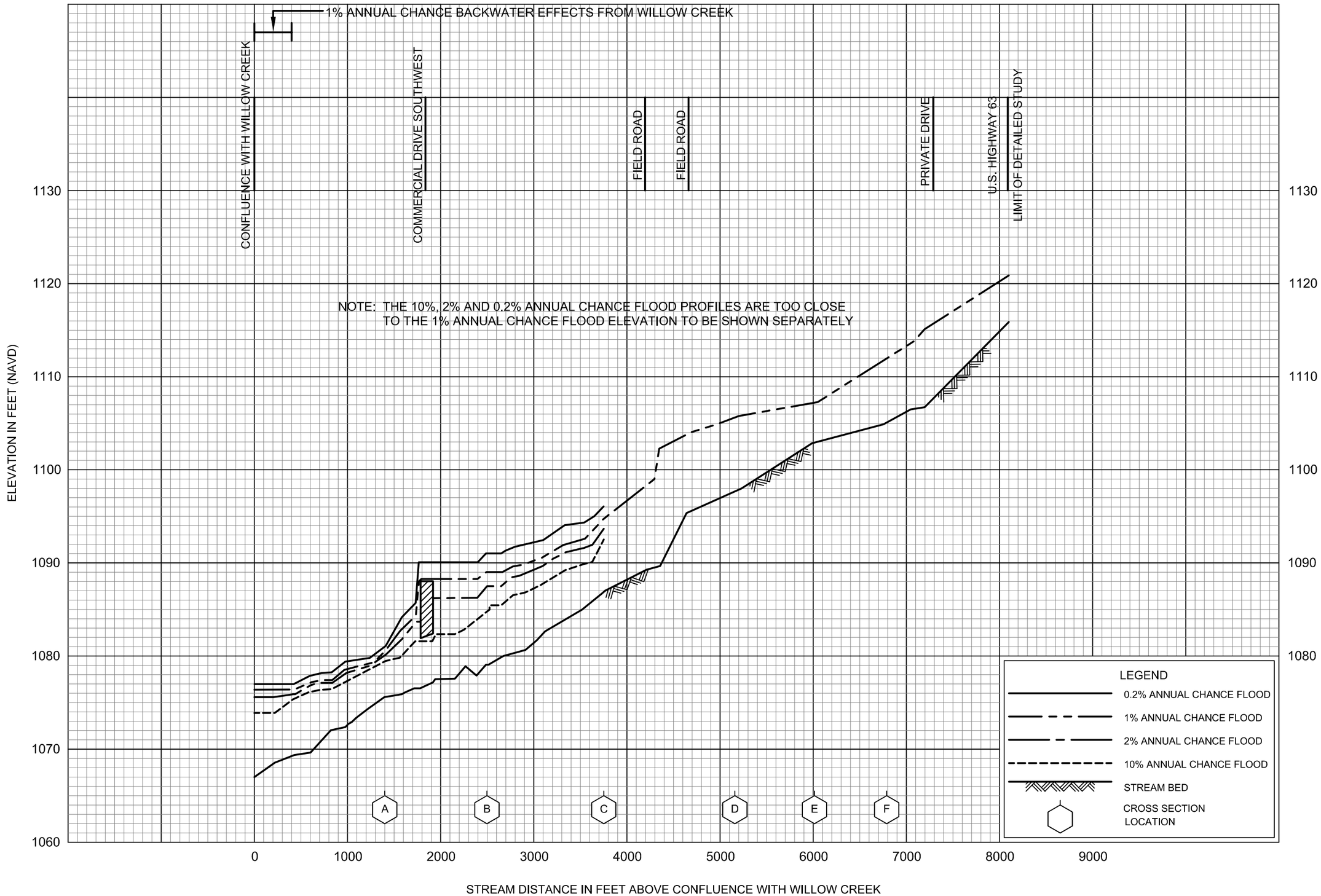
FLOOD PROFILES

SOUTH RUN OF THE NORTH FORK OF CASCADE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



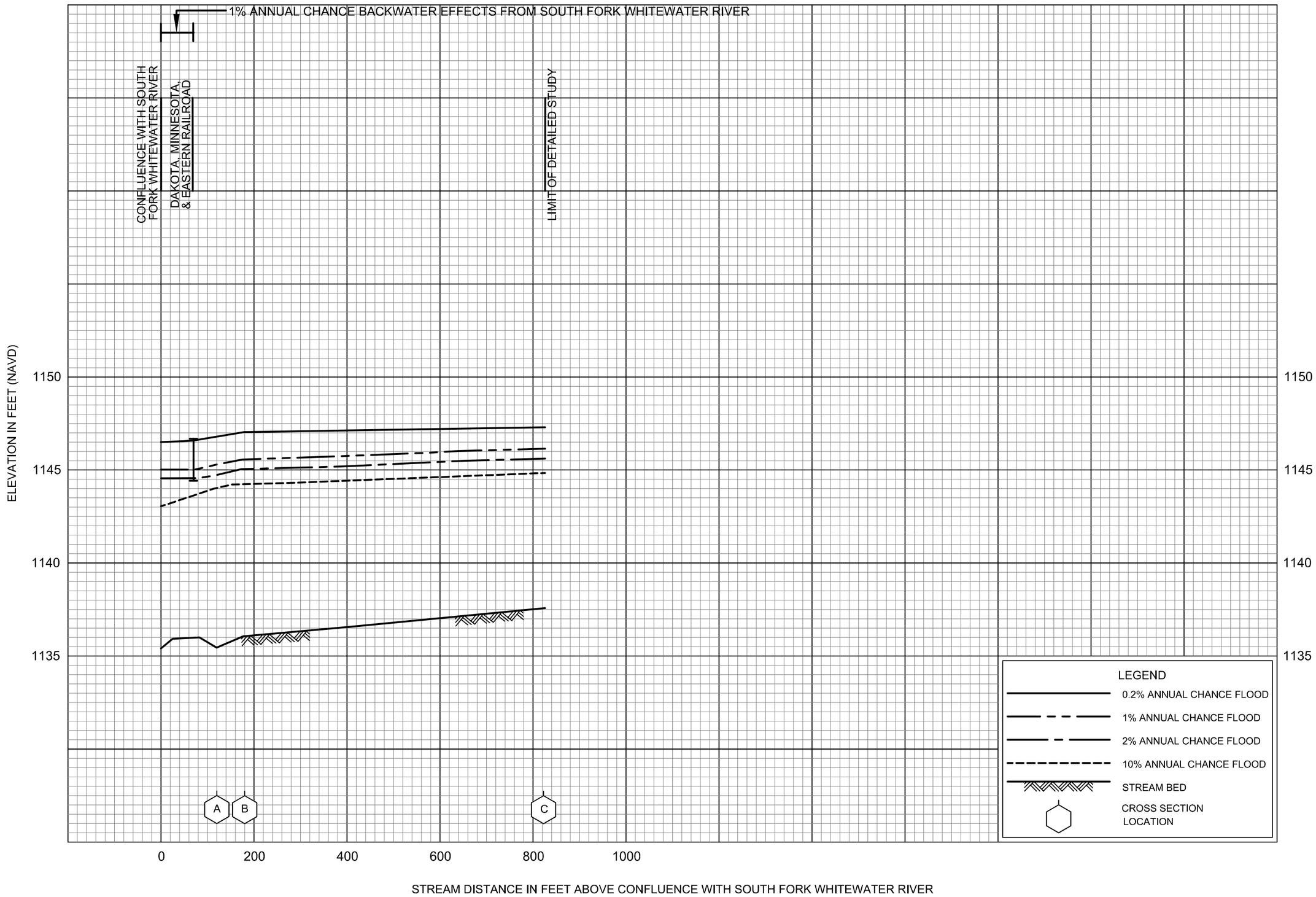
FLOOD PROFILES

SOUTHEAST BRANCH OF WILLOW CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



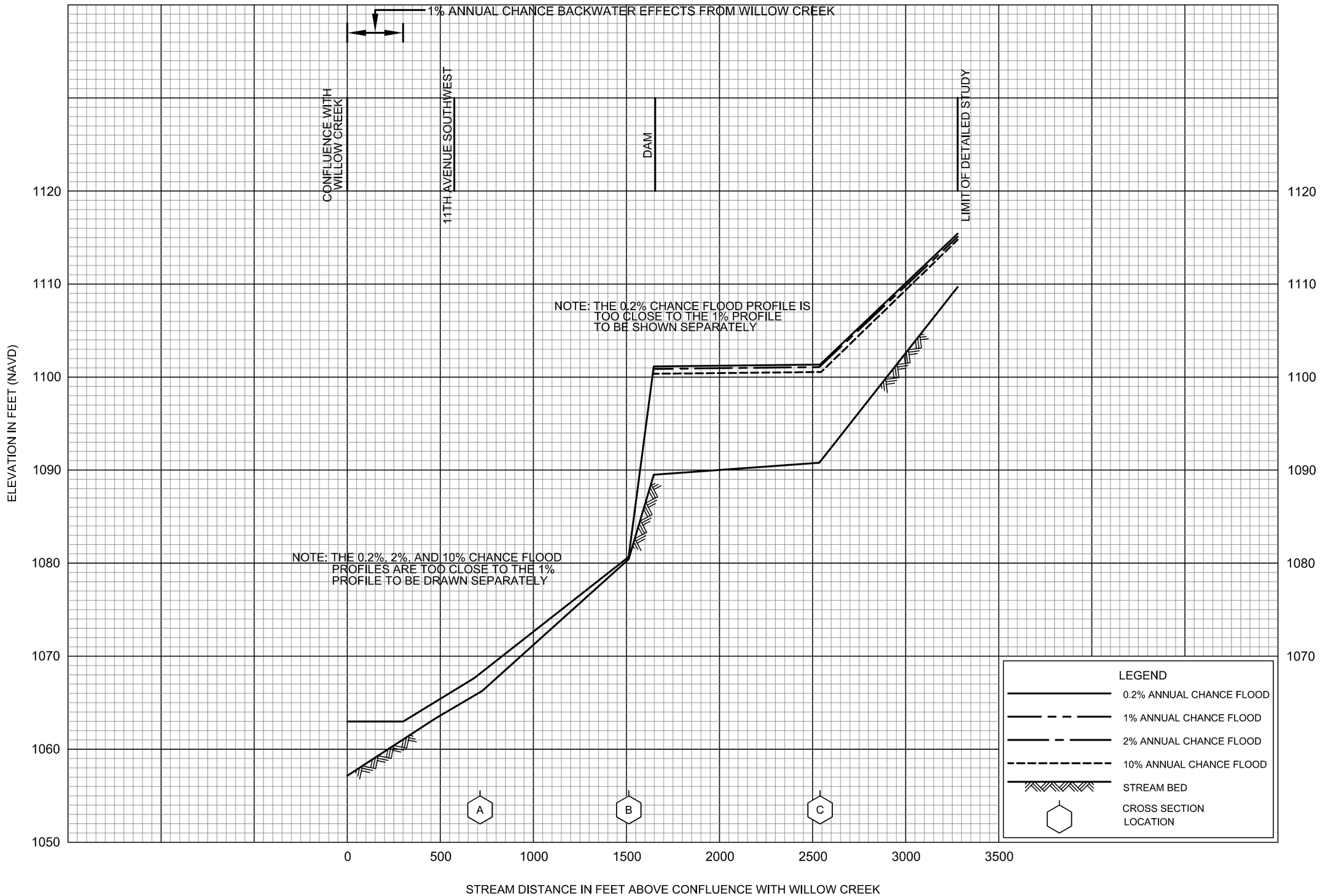
FLOOD PROFILES

TRIBUTARY B

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



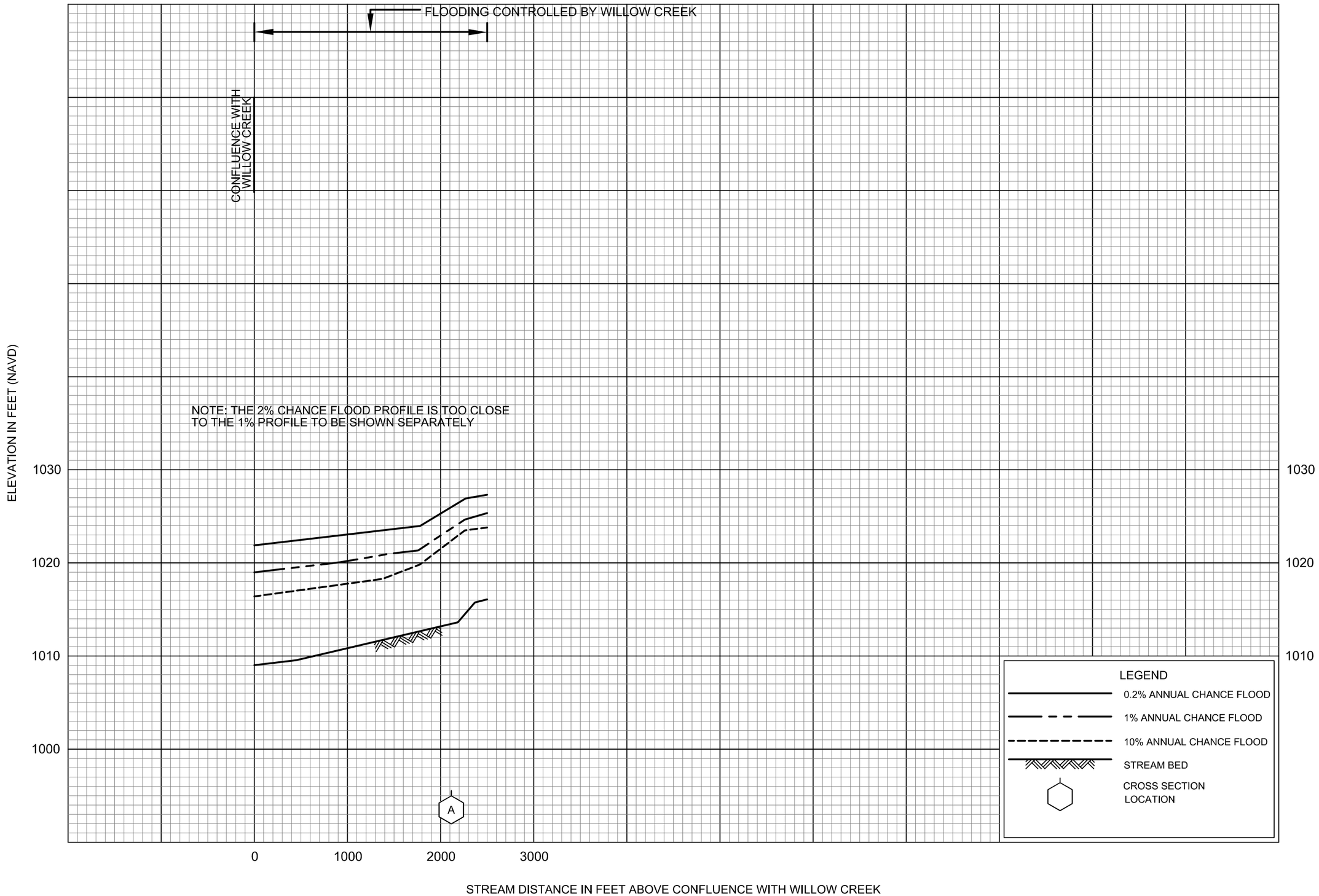
FLOOD PROFILES

WEST FORK OF WILLOW CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



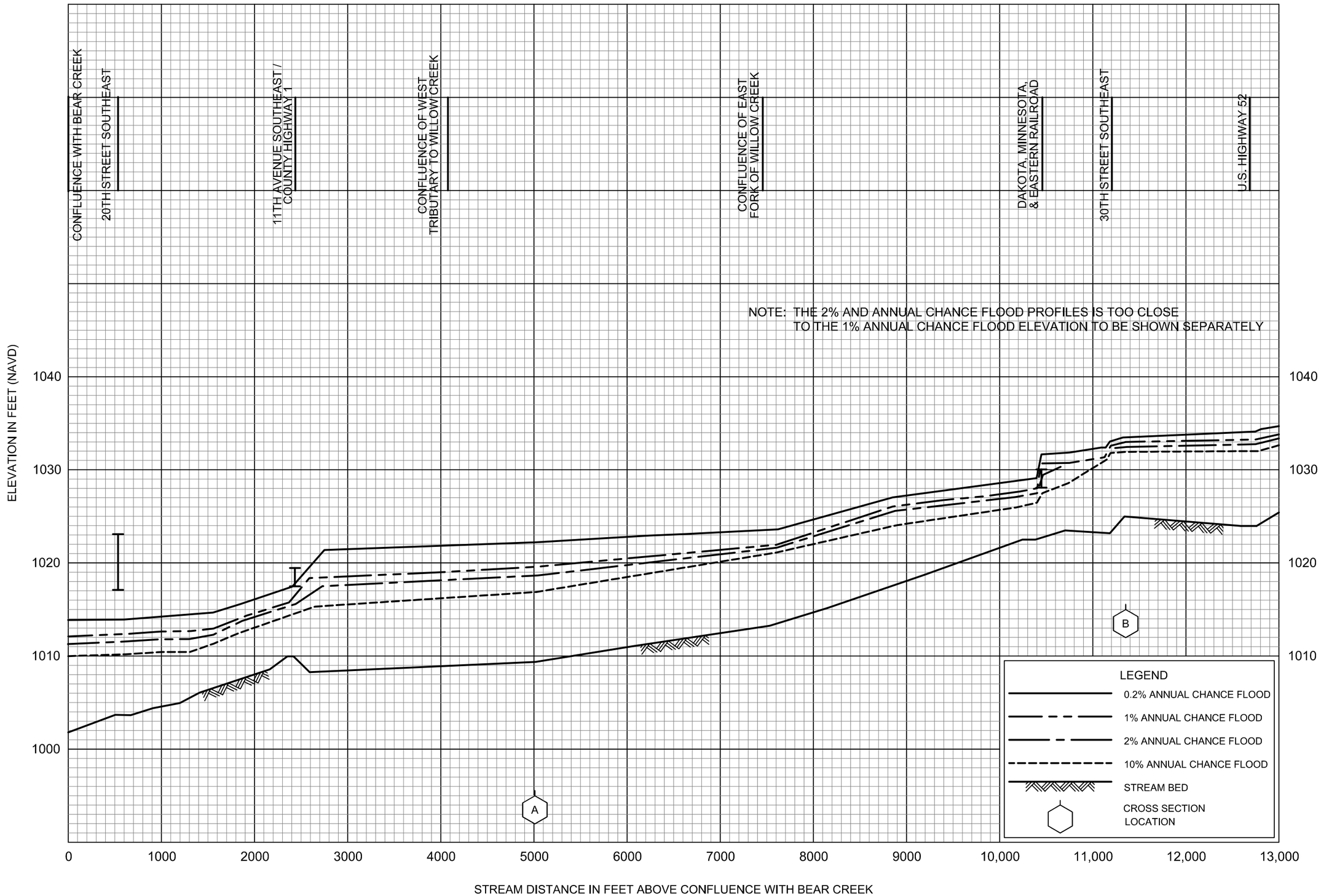
FLOOD PROFILES

WEST TRIBUTARY TO WILLOW CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



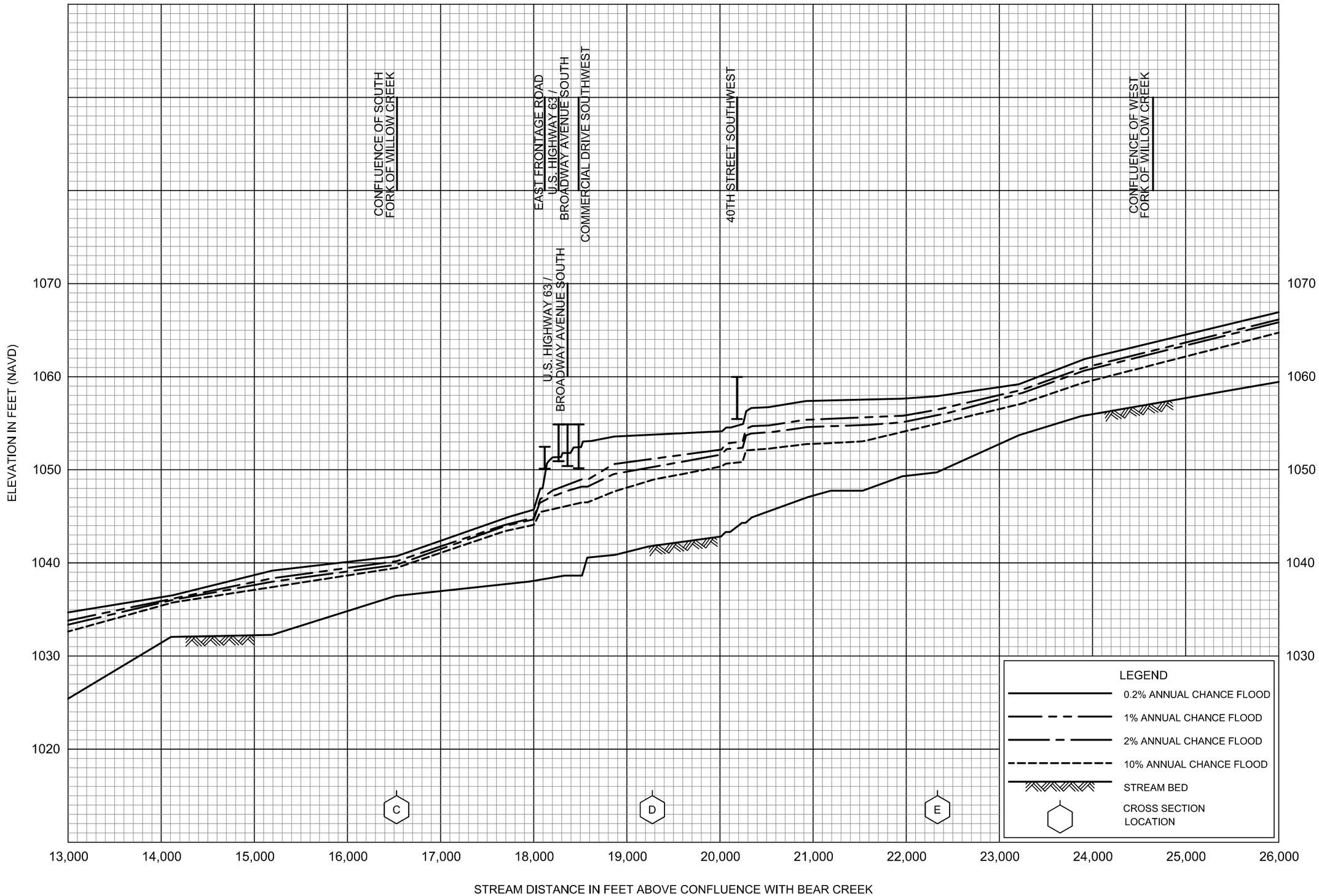
FLOOD PROFILES

WILLOW CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



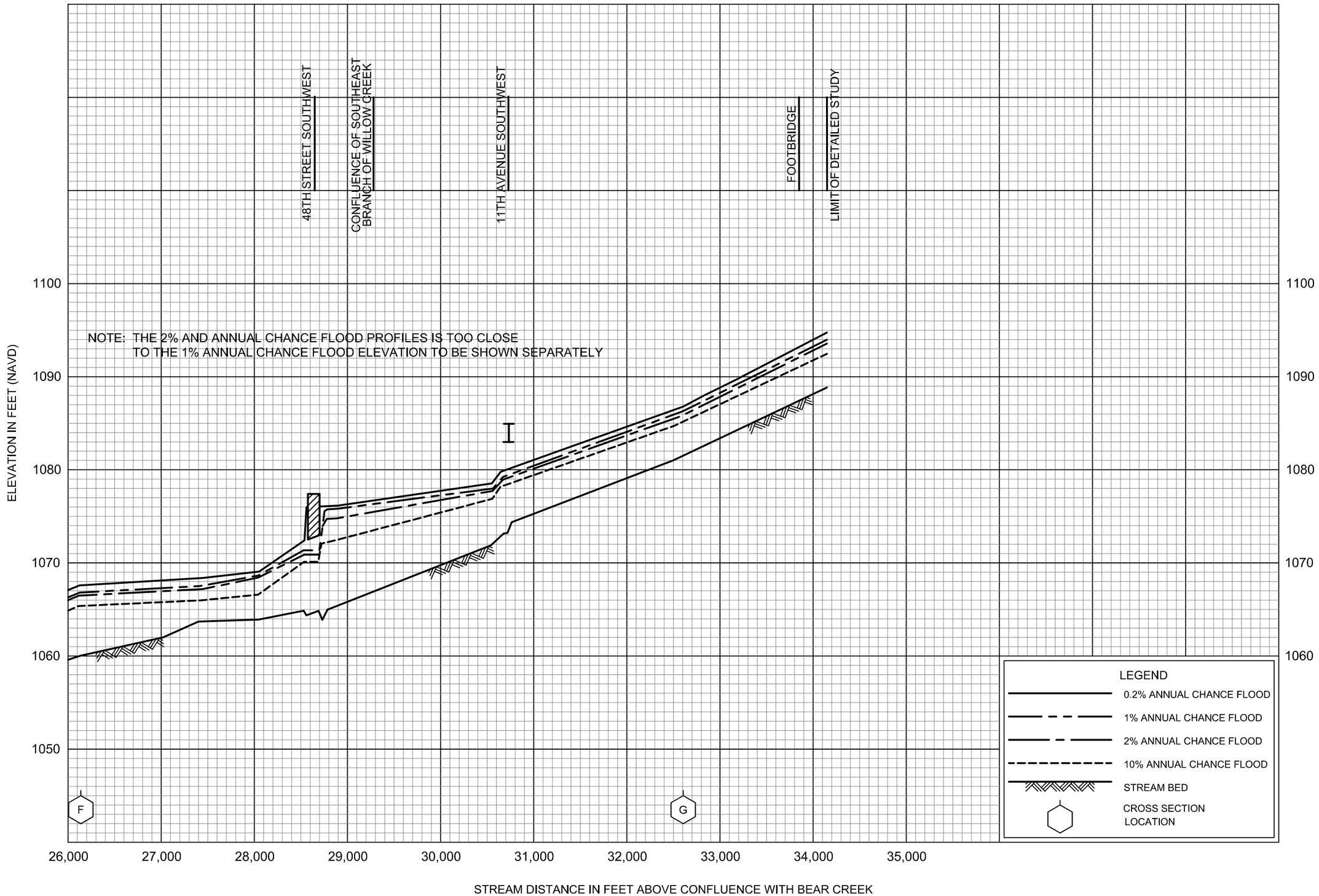
FLOOD PROFILES

WILLOW CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS



FLOOD PROFILES

WILLOW CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

OLMSTED COUNTY, MN

AND INCORPORATED AREAS