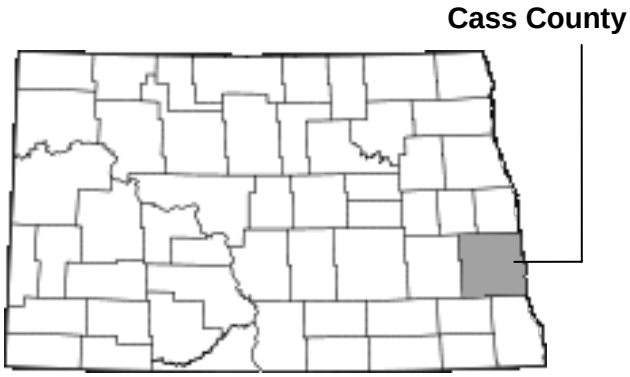
# FLOOD INSURANCE STUDY

# CASS COUNTY, NORTH DAKOTA
## ALL JURISDICTIONS




| Community Name | Community Number |
|---|---|
| ALICE, CITY OF[1] | 380363 |
| AMENIA, CITY OF[1] | 380019 |
| AMENIA, TOWNSHIP OF[1] | 380686 |
| ARGUSVILLE, CITY OF[2] | 380639 |
| ARTHUR, CITY OF[2] | 380156 |
| BARNES, TOWNSHIP OF | 380256 |
| BERLIN, TOWNSHIP OF[2] | 380620 |
| BRIARWOOD, CITY OF | 380651 |
| BUFFALO, CITY OF[1] | 380160 |
| CASS COUNTY (UNINCORPORATED AREAS) | 385362 |
| CASSELTON, CITY OF[2] | 380020 |
| DAVENPORT, CITY OF[1] | 380717 |
| DAVENPORT, TOWNSHIP OF[1] | 380690 |
| DURBIN, TOWNSHIP OF[2] | 380325 |
| EMPIRE, TOWNSHIP OF[1] | 380366 |
| ENDERLIN, CITY OF[2] | 385363 |
| FARGO, CITY OF | 385364 |
| FRONTIER, CITY OF | 380347 |
| GARDNER, CITY OF[1] | 385412 |
| GARDNER, TOWNSHIP OF[1] | 380266 |
| HARWOOD, CITY OF | 380338 |
| HARWOOD, TOWNSHIP OF[2] | 380259 |
| HORACE, CITY OF | 380022 |
| HUNTER, CITY OF[2] | 380181 |
| KINDRED, CITY OF[1] | 380182 |
| [1]Area not Included (ANI) Community | |
| [2]Separately Published FIRMs | |

| Community Name | Community Number |
|---|---|
| LEONARD, CITY OF[1] | 380185 |
| MAPLETON, CITY OF[2] | 380023 |
| MAPLETON, TOWNSHIP OF[2] | 380262 |
| NOBLE, TOWNSHIP OF[2] | 380268 |
| NORMANNA, TOWNSHIP OF[2] | 380264 |
| NORTH RIVER, CITY OF | 380623 |
| OXBOW, CITY OF | 380681 |
| PAGE, CITY OF[1] | 380193 |
| PLEASANT, TOWNSHIP OF | 380263 |
| PRAIRIE ROSE, CITY OF | 380655 |
| RAYMOND, TOWNSHIP OF[2] | 380261 |
| REED, TOWNSHIP OF | 380257 |
| REILES ACRES, CITY OF | 380324 |
| STANLEY, TOWNSHIP OF | 380258 |
| TOWER CITY, CITY OF[1] | 380210 |
| WALBURG, TOWNSHIP OF[2] | 380652 |
| WARREN, TOWNSHIP OF[2] | 380265 |
| WEST FARGO, CITY OF | 380024 |
| WISER, TOWNSHIP OF[2] | 380267 |
| [1]Area not Included (ANI) Community | |
| [2]Separately published FIRMs | |


**Federal Emergency Management Agency**

FLOOD INSURANCE STUDY NUMBER
38017CV000A

**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 may not contain all data available within the repository. It is advisable to contact the community repository for any additional data.

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

| Old Zone | New Zone |
|---|---|
| A1 through A30 | AE |
| B | X |
| C | X |

This preliminary Flood Insurance Study contains profiles presented at a reduced scale to minimize reproduction costs. All profiles will be included and printed at full scale in the final published report.

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

Initial Countywide FIS Effective Date:

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| County Drain 21 | Panels | 04P |
| County Drain 45 | Panel | 05P-06P |
| Drain 53 Breakout | Panels | 07P-11P |
| Red River of the North | Panels | 12P-17P |
| Sheyenne River | Panels | 18P-20P |
| Wild Rice River | Panels | 21P-37P |

Exhibit 2 – Flood Insurance Rate Map Index (Published Separately)
Flood Insurance Rate Maps (Published Separately)

**FLOOD INSURANCE STUDY**

**CASS COUNTY, NORTH DAKOTA ALL JURISDICTIONS**

## 1.0 INTRODUCTION

### 1.1 Purpose of Study

This Flood Insurance Study (FIS) revises and updates information on the existence and severity of flood hazards in the geographic area of Cass County, including the Cities of Briarwood, Fargo, Frontier, Harwood, Horace, North River, Oxbow, Prairie Rose, Reiles Acres, and West Fargo; and the Townships of Barnes, Pleasant, Reed, and Stanley, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This revision is a partial countywide revision, and the City of Argusville as well as the Townships of Harwood, Mapleton, Raymond, and Warren are only partially covered by this study. Other communities within Cass County are not included in this revision. 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.

The City of Riverside, which was formerly a participating community, has been incorporated into the City of West Fargo.

(ANI) communities with no published flood maps include the Cities of Alice, Amenia, Buffalo, Davenport, Gardner, Kindred, Leonard, Page and Tower City and the Townships of Empire and Gardner. Special Flood Hazard Areas in these communities are not shown in Cass County.

The Special Flood Hazard Area (SFHA) information for the City of Argusville Extra-territorial jurisdictions (ETJs) is partially included in the Digital Flood Insurance Rate Map (DFIRM) panels for Cass County and in the Flood Insurance Rate Map (FIRM) panels for the Township of Berlin and the Township of Harwood.

Users must use the separately published FIRMs and Flood Insurance Studies (FISs) for all communities not mentioned above, including the Cities of Argusville, Arthur, Casselton, Enderlin, Hunter and Mapleton and the Townships of Berlin, Durbin, Harwood, Mapleton, Noble, Normanna, Raymond, Walburg, Warren and Wiser.

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 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 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 report are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

This update includes an effort to combine communities into a partial countywide FIS, as compiled from previously published FIRMs and FISs. In addition to merging communities into a partial countywide FIS, this report also details revised analyses performed on Drain 10 Breakout, Drain 53, the Red River of the North, and the Wild Rice River. These revised analyses were completed in October 2007 by Houston Engineering, Inc.

Base map information for Cass County and all incorporated communities within Cass County was provided in digital format by Cass County GIS Department, January 2009. This information was compiled from digital data sources.

The coordinate system used for producing this FIRM is NAD 1983 State Plane North Dakota South FIPS 3302 Feet. Corner coordinates shown on the FIRM are in latitude and longitude referenced to the UTM projection, NAD 83. Differences in the datum and spheroid used in the production of FIRMs for adjacent counties may result in slight positional differences in map features at the county boundaries. These differences do not affect the accuracy of information shown on the FIRM.

## 1.3 Coordination

An initial Consultation Coordination Officer (CCO) meeting (also occasionally referred to as the Scoping meeting) is held with representatives of the communities, FEMA, and the study contractors to explain the nature and purpose of the FIS and to identify the streams to be studied. A final CCO meeting (often also referred to as the Preliminary DFIRM Community Coordination, or PDCC, meeting) is held with representatives of the communities, FEMA, and the study contractors to review the results of the study.

Initial coordination for this partial countywide FIS began in May 2002. Between 2002 and 2010, eight coordination meetings were held and were attended by representatives of FEMA, BakerAECOM, LLC, community officials, and the State NFIP Coordinator.

The final CCO meeting was held on _____ to review and accept the results of this FIS. Those who attended this meeting included representatives of_____, the Study Contractor, FEMA, and the communities. All problems raised at that meeting have been addressed in this study.

The dates of the historical initial and final CCO meetings held for the communities within this partial countywide revision are shown in Table 1, “Historical CCO Meeting Dates.”

**Table 1: Historical CCO Meeting Dates**

| Community Name | Initial CCO Date | Final CCO Date |
|---|---|---|
| Fargo, City of (revision) | [2] | August 17, 1999 |
| Fargo, City of | June 14, 1983 | [2] |
| Harwood, City of (revision) | [2] | August 19, 1999 |
| Harwood, City of (Red River of the North) | [2] | March 22, 1983 |
| Harwood, Township of (Red River of the North) | [2] | March 22, 1983 |
| Harwood, Township of (Sheyenne River) | June 30, 1981 | June 14, 1983[1] |
| Horace, City of | August 13, 1984 | [2] |
| Pleasant, Township of | [2] | August 13, 1980 |
| Raymond , Township of | [2] | [2] |
| Reed, Township of (Red River of the North) | [2] | November 19, 1981(preliminary); March 22, 1983 |
| Reed, Township of (Sheyenne River and County Drain 21) | [2] | August 17, 1999 |
| Reed, Township of (Sheyenne River and County Drain 21) | June 30, 1981 | June 14, 1983[1] |
| Riverside, City of | July 3, 1981 | June 15, 1983[1] |
| Stanley, Township of (Red River) | [2] | November 19, 1981 (preliminary); January 3, 1984 |
| Stanley, Township of (Sheyenne and Wild Rice Rivers) | June 30, 1981 | June 15, 1983 |
| West Fargo, City of (revision) | [2] | August 17, 1999 |
| West Fargo, City of | July 3, 1981 | June 15, 1983[1] |

[1] Interim coordination meeting
[2] Date not available

## 2.0 AREA STUDIED

### 2.1 Scope of Study

This FIS report covers parts of the geographic area of Cass County, North Dakota,

including the incorporated communities listed in Section 1.1. The scope and methods of this study were proposed to, and agreed upon, by FEMA, Cass County, and the study contractors.

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 scope and methods of study were proposed to and agreed upon by FEMA and Cass County. The flooding sources studied by detailed methods within this partial countywide area are the Red River of the North, Sheyenne River, Wild Rice River, County Drain 21, County Drain 45, County Drain 51, Drain 10 Breakout, and Drain 53 Breakout.

Numerous areas were studied by approximate methods. Approximate analyses were used to study those areas having a low development potential or minimal flood hazards.

Floodplain boundaries for all flooding sources within the study area have been mapped based upon the most up-to-date topographic data available.

## 2.2 Community Description

Cass County is located in eastern North Dakota, approximately 120 miles south of the Canadian border. Cass County is bordered on the north by Traill and Steele Counties; on the east Norman and Clay Counties, Minnesota; on the south by Richland and Ransom Counties; and on the west by Barnes County. The county is almost square, with an average east-west width of approximately 42 miles, a north-south length of 42 miles, and an area of 1,768 square miles with 3 square miles of water. The Red River of the North makes up the eastern boundary of Cass County.

Cass County has a continental climate, with warm summers and cold winters. Average monthly temperatures at Fargo, North Dakota, vary from 6.8 degrees Fahrenheit (°F) in January to 70.6°F in July, with extreme monthly averages ranging from -10.3°F to 80.2°F (Reference 1). Average annual precipitation for Fargo is 21.19 inches per month. The average yearly snowfall for Fargo is 40.0 inches. The wettest months of the year are May through August with average rainfall of over 2.50 inches.

Cass County includes two general physiographic areas: a glacial lake plain and a glacial moraine. The lake plain, located in the eastern half of the county, was formed when glacial melt waters ponded to form Lake Agassiz and sediments from tributary streams were deposited in the lake. This area is extremely flat, sloping only a few feet per mile eastward near the Red River of the North, which forms the eastern border of Cass County (Reference 2). The basin is very flat due to the uniform deposition of sediment from glacial Lake Agassiz (Reference 3). The flat land surface and small capacity of natural channels results in slow runoff and flooding (Reference 2).

The moraine, located in the western half of the county, is largely an area of gently rolling hills. The streams in the morainal area generally have better defined channels and steeper gradients than those in the lake plain (Reference 2).

The glacial lake deposits consist of sorted stratified clay and silt, creating highly productive farmland (Reference 1). The agricultural land surrounding developed areas is devoted primarily to crops such as sugar beets, wheat, pinto beans, soybeans, and potatoes. Open-space areas are characterized by grassland prairie dominated by bluegrass

and native trees are rare. In the developed parts of the county, vegetation consists of urban-residential landscaping with native species of ash and American elm trees.

In 2008 health care and social assistance was the largest of 20 major economic sectors in Cass County. The year 2000 population of Cass County was reported to be 143,339, giving Cass County the largest population of any county in North Dakota (Reference 4). The population for the county grew by 67.2% in the last three decades of the 1900s. Cass County is served by Interstates 29 and 94; U.S. Highways 10, 52, and 81; and State Highways 18, 38 and 46.

The City of Fargo, located in the east-central portion of the county, is the county seat of Cass County and the largest city in North Dakota. Community characteristics for this city and selected other cities and townships within Cass County are shown in Table 2.

**Table 2: Community Characteristics**

| Community | Total Population (2000) [1] | Total Area (sq. mi.) [2] | Geographic/ Topographic Description | Predominant Soil Types [3] |
|---|---|---|---|---|
| Argusville, City of | 147 | 4.0 | • northeast<br>• lake plain | Fargo-Hegne Association |
| Cass County | 143,339 | 1,765 (land) | • southeastern border of North Dakota, 120 miles south of Canadian border | Fargo-Hegne Association; Hamerly-Tonka-Wyard Association in west; in floodplains, Fairdale-LaPrairie-LaDelle Association or Bearden-Perella-Overly Association |
| Fargo, City of | 90,599 | 48.1 | • east-central, on the Red River of the North<br>• lake plain | Fargo-Hegne Association |
| Harwood, City of | 607 | 1.2 | • eastern border, Red River of the North<br>• lake plain | Fargo-Hegne Association; in Sheyenne floodplain, Fairdale-LaPrairie-LaDelle Association |
| Harwood, Township of | 291 | 33.7 | • eastern border, on the Red River of the North<br>• lake plain<br>• includes part of Argusville | Fargo-Hegne Association; in Sheyenne floodplain, Fairdale-LaPrairie-LaDelle Association |
| Horace, City of | 915 | 10.9 | • southeast, on Sheyenne River<br>• lake plain | Fairdale-LaPrairie-LaDelle Association |

## Table 2: Community Characteristics (cont.)

| Community | Total Population (2000) [1] | Total Area (sq. mi.) [2] | Geographic / Topographic Description | Predominant Soil Types [3] |
|---|---|---|---|---|
| Mapleton, Township of | 251 | 36.1 | • east central in county<br>• lake plain<br>• includes parts of Mapleton and West Fargo | Fargo-Hegne Association; in floodplain, Bearden-Perella-Overly Association; some areas of Hegne-Bearden-Fargo Association |
| Pleasant, Township of | 426 | 38.3 | • eastern border, on the Red River of the North<br>• lake plain<br>• includes Oxbow | Fargo-Hegne Association |
| Raymond , Township of | 270 | 35.7 | • east central<br>• lake plain<br>• includes part of Mapleton and West Fargo | Fargo-Hegne Association, which are characteristically deep, nearly level, poorly drained, fine-textured soils formed in clayey lacustrine sediments; some have lime at shallow depths (Reference 4) |
| Reed, Township of | 1,224 | 39.3 | • eastern border, between the Red River of the North and the Sheyenne River<br>• lake plain<br>• includes part of Cities of Fargo and Harwood, all of Reiles Acres and North River | Fargo-Hegne Association - deep, level and nearly level, poorly drained, fine-textured soils; in floodplain, Fairdale-LaPrairie-LaDelle Association – deep, level and nearly level, moderately well-drained, medium textured and moderately fine textured soils |
| Stanley, Township of | 2,296 | 39.6 | • southeastern border, on the Red River of the North<br>• lake plain<br>• includes parts of Horace, Frontier, and all of Briarwood | Fargo-Hegne Association - deep, level and nearly level, poorly drained, fine-textured soils; in floodplain, Fairdale-LaPrairie-LaDelle Association – deep, level and nearly level, moderately well-drained, medium textured and moderately fine textured soils |
| Warren, Township of | 133 | 36.1 | • southeastern in county<br>• lake plain<br>• includes parts of Horace | Fargo-Hegne Association; in floodplain, Bearden-Perella-Overly Association or Fairdale-LaPrairie-LaDelle Association |

| | | | | |
|---|---|---|---|---|
| West Fargo, City of | 14,940 | 14.7 | • eastern in county<br>• lake plain | Fargo-Hegne Association; in Sheyenne floodplain, Fairdale-LaPrairie-LaDelle Association |

[1] (Reference 4)
[2] (Reference 5)
[3] (Reference 6)

The entire area of Cass County lies within the basin of the Red River of the North. This river is formed at the confluence of the Otter Tail and Bois de Sioux Rivers at Breckenridge, Minnesota, and Wahpeton, North Dakota. From this point, the Red River of the North flows northward along the Minnesota-North Dakota boundary for a distance of 394 miles to the international boundary. At Emerson, Manitoba, on the international boundary, the river drains an area of approximately 40,070 square miles. The Red River of the North then flows north-northeastward 155 miles, discharging into Lake Winnipeg, which is then drained by the Nelson River into Hudson Bay (Reference 3). The Red River of the North serves as the common border between Cass County and Clay County, Minnesota.

The Sheyenne River is one of the major tributaries of the Red River of the North. The Sheyenne River originates north of McClusky, North Dakota, in Sheridan County and then flows eastward through Wells, Benson, Eddy, and Nelson Counties before flowing south through Griggs, Barnes and Ransom Counties. To the east of the City of Lisbon in Ransom County, it curves northeastward through the Sheyenne National Grassland and flows in a northern direction into Cass County near the City of Kindred. Above Kindred the Sheyenne River has a total drainage area of approximately 5,070 square miles. The Sheyenne River flows north in Cass County to joins the Red River of the North just north of Fargo. Streambanks along the Sheyenne River are generally higher than the surrounding flat lake plain.

## 2.3 Principal Flood Problems

Floods in Cass County occur mainly in the spring and are attributed to spring snowmelt and runoff from high-intensity rainfall.

Damages include flooding of agricultural and residential buildings, damage to roads, disruption of utilities service, and damage to agricultural land.

Red River of the North

The Red River of the North basin exhibits a number of unusual characteristics which make it particularly susceptible to flooding. Because the basin is so flat, it allows water to spread out and inundate vast areas adjacent to the river. The northward direction of flow is a unique and important element in the overall flood pattern of the river. The melting season begins in the southern sections and progresses slowly northward, tending to synchronize the flood peak on the Red River of the North with peaks of its tributaries, progressively increasing flood stages. Also, as the spring runoff moves northward, it often encounters sections on the river which are locked by ice, causing minor localized increases in flood stages (Reference 3).

Numerous large floods have occurred in the Red River of the North basin since the inception of flood data collection, the largest of these being the floods of 1882, 1897,

1969, 1997, 2001, 2009, and 2010. (Reference 3). The maximum recorded flood occurred on March 28, 2009. This flood achieved a gage height of 40.84 feet at the Fargo gage.

Sheyenne River

Flooding on the Sheyenne River is mainly caused by downstream backwater effects from the Red, Rush, and Maple Rivers. Low channel capacity combined with several flow-constraining railroad and roadway embankments causes the flooding to resemble a lake. During larger floods, a significant portion of the flow is in the overbank areas.

Additional flooding occurs because of breakout, or diversion, flows between Horace and West Fargo. Overland or breakout flows have occurred during high water due to the perched condition of the Sheyenne River; that is, the riverbanks are higher than the surrounding countryside. The effects of breakout flow are further compounded by the construction of temporary agricultural levees along the Sheyenne River. These breakout flows have occurred at different locations depending on the strength of agricultural levees along the riverbanks. Further flooding occurs because of backwater caused by flow-constraining roadway and railroad embankments. Damage includes flooding of agricultural and residential buildings and roads, disruption of utility services, and damage to agricultural land.

The highest floods on record for the Sheyenne River occurred in 1996, 1997, 2009, and 2010. The 1997 flood was the highest on record, with a measured gage height of 22.68 feet in West Fargo.

Wild Rice River

The highest flood on record on the Wild Rice River occurred in 2009 – 27.78 feet above the gage in Abercrombie, North Dakota.

## 2.4 Flood Protection Measures

Red River of the North

Federal flood damage reduction measures that benefit Fargo are the Orwell Reservoir on the Ottertail River, a tributary to the Red River of the North at Wahpeton-Breckenridge, and the Lake Traverse Reservoir at the headwaters of the Bois de Sioux River (generally considered the source of the Red River of the North). Both reservoirs provide floodwater storage and are operated to reduce peak discharges downstream on the Red River of the North (Reference 7).

In the City of Fargo, levees provide the community with some degree of protection from flooding. Dike West, located on the west bank of the Red River of the North upstream of Main Avenue in Fargo, is one such levee. Another levee that may provide protection is a ring levee that encircles the sewage lagoons in the vicinity of 64$^{th}$ Avenue North. These two levees are mapped as Provisionally Accredited Levees. This designation will remain in place during the 2 year period while levee certification verification is underway.

Sheyenne River

The Baldhill Dam, built in 1950, forms Lake Ashtabula Reservoir and is operated to alleviate downstream flooding and provide minimum flow requirements. The USACE

had proposed to raise the Baldhill Dam in 1984. By 2003 much of the Baldhill Dam improvements had been completed. The dam now has a flood storage capacity of 70,000 acre-feet for spring flood events and 31,000 acre-feet for summer flooding events (Reference 8).

The construction of the Horace to West Fargo Diversion Channel (HWFDC) and the levees on both sides of the diversion channel caused a portion of the 1-percent-annual-chance discharge to be diverted from the Sheyenne River to the HWFDC. The base flood elevations (BFEs) along the Sheyenne River decreased from approximately 5,000 feet south of 1-94 to just upstream of the West Fargo Diversion Channel (WFDC) inlet structure. The portion of the 1-percent-annual-chance discharge that is still conveyed by the Sheyenne River is now contained within the river banks. The construction of the WFDC, the levees on both sides of the diversion channel, and the north and south tie back levees diverted the remaining 1-percent-annual-chance discharge from the Sheyenne River. The BFEs decreased from the WFDC inlet structure to approximately 2,600 feet north of 12th Avenue West. Both the HWFDC levees and the WFDC levees are mapped as Provisionally Accredited Levees. This designation will remain in place during the 2 year period while levee certification verification is underway.

Temporary agricultural levees have been constructed along both banks of the Sheyenne River to protect certain areas from flooding. However, they do not meet the technical specifications or elevation requirements for a properly designed 1-percent-annual-chance levee. These levees are composed of earthen material and vegetation.

Other Areas

Drainage in many parts of the lake plain has been modified by ditches, channel modifications, and diversions (References 9; 10; 11).

## 3.0 ENGINEERING METHODS

For the flooding sources studied by detailed methods in the community, standard hydrologic and hydraulic study methods were used to determine the flood-hazard data required for this study. Flood events of a magnitude that is expected to be equaled or exceeded once on the average during any 10-, 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 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

For this partial countywide study, hydrologic analyses were carried out to establish peak discharge frequency relationships for each flooding source studied by detailed methods

affecting the community. A summary of peak discharge-drainage area relationships for streams studied by detailed methods is shown in Table 3, "Summary of Discharges."

Red River of the North

The hydrology for the revised portion of the Red River of the North (South of 29th Street Southeast) was developed by the United States Army Corps of Engineers (USACE), St. Paul District, in their "Final Hydrology Report" dated September 2001 (Reference 12). This analysis was performed using available USGS gage data from various gages along the Red River of the North through 2001. The discharge-frequency relationships were calculated in accordance with Bulletin 17B, "Guidelines for Determining Flood Flow Frequency" of the Interagency Advisory Committee on Water Data.

Hydrologic analysis for the unrevised portion of Red River of the North (North of 29th Street Southeast) was also performed by the USACE, St. Paul District, and established in their "Letter Regarding Red River Hydrology", dated May 1979. This analysis was performed using USGS gage data that was available at that time. Two computer programs were utilized: *Flood Flow Frequency Analysis* and *Regional Frequency Computation*. The flows from these programs were compared with those obtained from *U.S. Water Resources Council Bulletin 17* (References 13; 14; 15). The USGS performed a log Pearson Type III flood-frequency analysis with adjustments. This information was then used to develop a discharge-drainage area relationship for the Red River of the North.

Wild Rice River

Hydrologic analysis for the Wild Rice River was performed by Houston Engineering, Inc., in their "Interim Report" dated December 2004. The analysis was performed using gage data from the gage in Abercrombie, North Dakota. The HEC-FFA program was used to perform a Log-Pearson type III analysis, which utilizes methods outlined in Bulletin 17B, "Guidelines for Determining Flood Flow Frequency" of the Interagency Advisory Committee on Water Data.

Discharges at the Abercrombie gage were transferred to the study area using the drainage area ratio method outlined in USGS Water Resources Investigation Report 92-4020, "Techniques for Estimating Peak-Flow Frequency Relations for North Dakota Streams".

Two timing studies of the Red River of the North and the Wild Rice River found that, during most flood events, the rivers will not experience their peak flows on the same day and thus could be analyzed separately. Although the two rivers peak flows will likely not be coincident, the timing studies did find that the water levels of the Red River of the North can impact the lower Wild Rice River which can then impact the breakout flows from the Wild Rice River (Reference 12). These breakouts either re-enter the Wild Rice River further downstream or enter the Red River of the North. The breakouts that re-enter the Wild Rice River include the County Road 18 breakout, a portion of County Road 16 breakout, and the County Road 81 North breakout. The other breakouts, the remaining portion of County Road 16 breakout, the County Road 81 South breakout, the County Road 53 breakout and the 76th Avenue breakout, enter the Red River of the North via overland flow, county drains or Rose Coulee. Rating curves for the overflow corridors were generated in HEC-RAS utilizing the lateral structure function.

Sheyenne River

Hydrologic analysis for the Sheyenne River in the area of the West Fargo Diversion Channel (WFDC), the Horace to West Fargo Diversion Channel (HWFDC) was performed by the USACE, St. Paul District, in their "General Reevaluation and Environmental Impact Statement for Flood Control and Related Purposes, Sheyenne River, North Dakota", dated August 1982. The HEC-1 computer program was used. All discharges are updated to account for the construction of the HWFDC and the WFDC. Using the diversion option of HEC-1, flows were routed through the diversion structures of the WFDC, the HWFDC, and the County Drain 21 Outlet Structure using the split of flows determined by hydraulics. The flows in the WFDC and HWFDC were then routed using the normal depth option of HEC-1. The flows in the Sheyenne River and County Drain 21 were routed using the routing values from the existing hydrologic analysis.

Peak discharges along the Sheyenne River upstream of its confluence with the Maple River were taken from the information developed by the USACE. Peak discharges along the Sheyenne River between its confluence with Maple River, and County Highway 22 were obtained by using the hydrologic information developed for the 1991 FIS adjusted to account for several breakout flows from the Sheyenne River which flow towards County Drain 45. The area where County Drain 45 crosses Interstate 29 acts as a storage area for the flows which break out of the Sheyenne River. This storage area was used to determine peak discharges for County Drain 45. The sum of discharges in the Sheyenne River and County Drain 45 equal the peak discharge in the Sheyenne River prior to any breakout from the Sheyenne River. The discharges for County Drain 45 downstream of County Road 20 were determined using a number of iterations, subtracting portions of flow from the discharge of the Sheyenne River, diverting these discharges to County Drain 45 until the resulting water-surface elevations for both the Sheyenne River and County Drain 45 equalize at Interstate 29. Peak discharges for County Drain 45 upstream of County Road 20 are based on regional run-off relationships developed by the USGS (Reference 16).

Hydrologic information for the lower reach of the Sheyenne River downstream of its confluence with the Maple River was provided by the USACE from a study of coincidental flows on the Red River of the North and the Sheyenne River. The peak discharge values were computed by routing flows, using the USACE HEC-1 computer program for the period from 1950 to 1975 and for 1979 (Reference 17). The data were then analyzed using Bulletin 17B, "Guidelines for Determining Flood Flow Frequency" of the Interagency Advisory Committee on Water Data, and a bivariate method to account for coincidental flows (References 15; 18). In Harwood Township, the flood elevations on the Red River of the North were found to be dominant on the Sheyenne River in the reach below U.S. Highway 81; however, the Sheyenne River is dominant upstream of U.S. Highway 81.

Drain 53 Breakout and Drain 10 Breakout

Peak discharge-frequency relationships for Drain 53 and Drain 10 were established using hydraulic methods within the HEC-RAS computer modeling program. Drain 53 and Drain 10 break out from flow from the Wild Rice River and Red River of the North, respectively.

**Table 3: Summary of Detailed Discharges**

| Flooding Source and Location | Drainage Area (Square miles) | Peak Discharges (Cubic Feet per Second) 10-percent | 2-percent | 1-percent | 0.2-percent |
|---|---|---|---|---|---|
| DRAIN 10 BREAKOUT | * | * | 307 | 1,492 | 11,404 |
| COUNTY DRAIN 21 | | | | | |
| Upstream of confluence with Sheyenne River | * | 800 | 1,290 | 1,480 | 1,870 |
| COUNTY DRAIN 45 | | | | | |
| Just downstream of 52nd Avenue | * | 450 | 3,350 | 6,100 | 13,700 |
| Just upstream of Breakout Floodway Corridor B | * | 450 | 1,800 | 3,600 | 8,500 |
| Just upstream of Breakout Floodway Corridor C | * | 155 | 530 | 600 | 1,000 |
| Just upstream of Breakout Floodway Corridor D | * | 155 | 255 | 300 | 410 |
| DRAIN 53 | * | * | 165 | 2,199 | 9,027 |
| RED RIVER OF THE NORTH | | | | | |
| Approximately 3.6 miles upstream of Cass County Highway 18 | 2,715 | 7,648 | 12,307 | 14,173 | 21,818 |
| Approximately 2.3 miles upstream of Cass County Highway 16 | * | 7,850 | 13,967 | 17,606 | 27,466 |
| Approximately 2.9 miles downstream of Cass County Highway 16 | * | 10,125 | 21,468 | 25,137 | 33,764 |
| Approximately 15 miles downstream of Cass County Highway 16 | 4,625 | 10,300 | 22,300 | 29,300 | 50,500 |
| SHEYENNE RIVER | | | | | |
| Approximately 2,900 feet upstream of 54th Street SE | * | 3,441 | 5,408 | 6,366 | 7,215 |
| Approximately 9,300 feet downstream of 50 1/2th R Street SE | * | 3,234 | 4,859 | 5,713 | 6,636 |

**Table 3: Summary of Detailed Discharges (cont.)**

| Flooding Source and Location | Drainage Area (Square Miles) | Peak Discharges (Cubic Feet per Second) | | | |
|---|---|---|---|---|---|
| | | 10-percent | 2-percent | 1-percent | 0.2-percent |
| Approximately 5,350 feet upstream of 168th R Avenue | * | 3,075 | 4,086 | 4,576 | 5,310 |
| At 88th Avenue S | 5,070 | 1,710 | 1,980 | 2,080 | 2,180 |
| Approximately 1,780 feet upstream of 76th Avenue S | 5,070 | 3,050 | 4,175 | 4,600 | 5,075 |
| Upstream of confluence with Maple River | 5,100 | 3,200 | 3,745 | 3,980 | 4,780 |
| At 52nd Avenue N | 6,600 | 5,850 | 10,700 | 12,400 | 17,700 |
| At the confluence with Red River of the North | 6,900 | 6,300 | 13,600 | 17,500 | 28,900 |
| Approximately 620 feet upstream of 5th Street N | 3.25 | 62 | 153 | 203 | 341 |
| Approximately 1,000 feet upstream of confluence with Swan Creek | 3.82 | 78 | 187 | 247 | 412 |
| WILD RICE RIVER | | | | | |
| Downstream of 76th Avenue | * | 5,222 | 8,543 | 9.249 | 9,801 |
| Approximately 2,180 feet downstream of 25th Street South | * | 5,222 | 8,662 | 9,574 | 10,259 |
| Approximately 200 feet upstream of Southbound I-29 | * | 5,222 | 11,016 | 13,300 | 15,878 |
| At Mouth | 1,640 | 5,222 | 11,016 | 13,963 | 21,610 |

## 3.2 Hydraulic Analyses

Hydraulic analyses were performed to estimate the elevation of flooding during the base flood event. Users should be aware that flood elevations shown on the FIRM represent rounded whole-foot elevations and may not exactly reflect the elevations shown on the Flood Profiles or in the Floodway Data tables in the FIS report. Flood elevations shown on the FIRM are primarily intended for flood insurance rating purposes. For construction and/or floodplain management purposes, users are cautioned to use the flood elevation data presented in this FIS in conjunction with the data shown on the FIRM.

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

Roughness Coefficients (Manning's "n") were chosen by engineering judgment and based on field observation of the channel and floodplain areas. Table 4, "Summary of Roughness Coefficients," contains the channel and overbank "n" values for the streams studied by detailed methods.

**Table 4: Manning's "n" Values**

| Flooding Source | Channel | Overbanks |
|---|---|---|
| County Drain 10 Breakout | 0.045 | 0.045 |
| County Drain 45 | 0.045 | 0.060 |
| Drain 53 | 0.045 | 0.045-0.06 |
| Red River of the North | 0.030–0.150 | 0.030–0.180 |
| Sheyenne River | 0.038–0.040 | 0.025–0.110 |
| Wild Rice River | 0.035-0.12 | 0.06-0.12 |

* Data not available

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

Red River of the North

Hydraulic analysis for the revised portion of the Red River of the North (South of 29th Street Southeast) was developed by Houston Engineering, Inc., and was finalized in February 2009. This analysis uses the USACE HEC-RAS version 3.1.3 backwater computer program (Reference 19). Starting water-surface elevations were based on known water-surface elevations. Cross section data was obtained from a combination of

existing cross sectional data, new survey data and LIDAR topography. Manning's roughness Coefficients (Manning's "n" values) were determined by field observation and are shown in Table 4.

Hydraulic analysis for the unrevised portion of the Red River of the North (North of 29th Street Southeast) was completed by the USACE in 1985. Water-surface elevations for floods of the selected recurrence intervals on the Red River of the North were determined using the USACE HEC-2 step-backwater computer program (Reference 20). Manning's "n" values were chosen based on engineering judgment and on a combination of field observations of the flood plain areas and aerial photographs of the streams (Reference 21). The Manning's "n" Coefficients were adjusted to match observed water-surface elevations of the 1969 flood as closely as possible (Reference 22). The values are shown in Table 4.

Wild Rice River

Hydraulic analysis for the Wild Rice River was completed by Houston Engineering, Inc. in February 2009. The USACE HEC-RAS version 3.1.3 backwater computer program (Reference 19) was used. Starting water-surface elevations were based on normal depth calculations with a value of 0.000065. Cross section data was obtained from a combination of existing cross sectional data, new survey data and LIDAR topography. Manning's roughness Coefficients (Manning's "n" values) were determined by field observation and are shown in Table 4.

County Drain 10 Breakout

The discharges and hydraulics for County Drain 10 Breakout were computed by Houston Engineering in their Red River of the North HEC-RAS hydraulic model (Reference 23). Cross section data was obtained from a combination of existing cross sectional data, new survey data and LIDAR topography. Manning's roughness Coefficients (Manning's "n" values) were determined by field observation and are shown in Table 4.

County Drain 53 Breakout

A hydraulic model of Drain 53 in Cass County was developed by Houston Engineering, Inc., using the USACE HEC-RAS version 3.1.3 backwater computer program (Reference 19). The Drainage 53 flows were determined using HEC-RAS version 3.1 as a lateral structure off of Wild Rice River. Starting water-surface elevations were based on known water-surface elevations from the Red River of the North Cross section data was obtained from LIDAR based topography. Manning's roughness Coefficients (Manning's "n" values) were determined by field observation and are shown in Table 4.

Sheyenne River and County Drain 45

The FIS reports for the Cities of Fargo, Harwood, West Fargo, Reiles Acres, and the Township of Reed were revised in 2002 to incorporate updated hydraulic analyses of the Sheyenne River and County Drain 45. The hydraulic analyses to determine water-surface elevations were performed using the USACE HEC-2 step backwater computer program

(Reference 24). Starting water-surface elevations were obtained from elevations computed downstream of the restudy area. Cross sections for the flooding sources studied were field surveyed from June 1995 to January 1996. The cross-section locations were selected to represent typical channel geometry. The dimensions of all hydraulic structures including bridges were field measured. Channel and overbank roughness coefficients (Mannings "n") for the Sheyenne River and County Drain 45 were determined by field observation and engineering judgment and calibrated as necessary using high water marks from previous floods. Roughness values are shown in Table 4.

## 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 used for newly created or revised FIS reports and FIRMs was the National Geodetic Vertical Datum of 1929 (NGVD). With the completion of the North American Vertical Datum of 1988 (NAVD), many FIS reports and FIRMs are now prepared using NAVD as the referenced vertical datum.

Flood elevations shown in this FIS report and on the FIRM are referenced to the NAVD. These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. It is important to note that adjacent counties may be referenced to NGVD, which may result in differences in base flood elevations across county lines.

Some of the data used in this revision were taken from the prior effective FIS reports and FIRMs and adjusted to NAVD. The datum conversion factor from NGVD to NAVD in Cass County is 1.06 feet.

For more information regarding conversion between the NGVD and NAVD, see the FEMA publication entitled *Converting the National Flood Insurance Program to the North American Vertical Datum of 1988* (Reference 25), visit the National Geodetic Survey website at www.ngs.noaa.gov, or contact the National Geodetic Survey at the following address:

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

Temporary vertical monuments are often established during the preparation of a flood hazard analysis for the purpose of establishing local vertical control. Although these monuments are not shown on the FIRM, they may be found in the Technical Support Data Notebook associated with the FIS report and FIRM for this 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. To assist in this endeavor, each FIS report provides 1-percent-annual-chance floodplain data, which may include a combination of the following: 10-, 2-, 1-, and 0.2-percent-annual-chance flood elevations; delineations of the 1- and 0.2-percent-annual-chance floodplains; and a 1-percent-annual-chance floodway. This information is presented on the FIRM and in many components of the FIS report, including Flood Profiles, Floodway Data tables, and Summary of Stillwater Elevation tables. Users should reference the data presented in the FIS report as well as additional information that may be available at the local community map repository before making flood elevation and/or floodplain boundary determinations.

### 4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1-percent-annual-chance flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent-annual-chance flood is employed to indicate additional areas of flood risk in the community. For each stream studied by detailed or limited detailed methods, the 1- and 0.2-percent-annual-chance floodplain boundaries have been delineated using the flood elevations determined at each cross section.

The 1- and 0.2-percent-annual-chance floodplain boundaries for streams studied by detailed methods are shown on the FIRM. On this map, the 1-percent-annual-chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A and AE), and the 0.2-percent-annual-chance floodplain boundary corresponds to the boundary of areas of moderate flood hazards (Zone X). 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 each stream studied by detailed methods, the floodplain boundaries have been delineated using the flood elevations at each cross-section. Between cross-sections, the boundaries were interpolated using two-foot contours developed from LiDAR data (Reference 26).

For each stream studied by approximate methods, the 1-percent-annual-chance floodplain boundaries are shown on the FIRM (Exhibit 2). The boundaries were delineated using two-foot contours developed from LiDAR data (Reference 26).

### 4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the

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

In North Dakota, floodplain encroachment on the boundary waters between North Dakota and Minnesota is limited to a 0.75-foot increase in flood heights above preflood conditions at any point. The 0.75-foot surcharge was determined from the allowable 0.5-foot floodway on the North Dakota side and the allowable 0.25-foot floodway on the Minnesota side. The 0.75-foot surcharge was rounded to the nearest 0.1 foot, or 0.80 foot. The floodway for the Red River of the North was incorporated into the USACE HEC-RAS computer models to evaluate the effects of possible future flood plain encroachment. The Red River of the North floodway presented in this study reflects a community-selected alignment that has been coordinated with and agreed upon by the NDSWC, MDNR, FEMA, and the City of Moorhead, Minnesota (Fargo FIS). The results of these computations were tabulated at selected cross sections for each stream segment for which a floodway was computed (Table 6).

Administrative Floodway Breakout Corridors

After consultation with representatives of the NDSWC, floodways were selected for the detailed-study portions of the Sheyenne River and County Drain 21, based on existing development and legal, economic, political, and hydraulic factors. The selected floodways were incorporated into the computer model to evaluate the effects of community-selected floodways and possible future floodplain encroachment.

In addition, the NDSWC, in cooperation with Cass County and the other impacted communities, has established breakout floodway corridors for breakout flows from the Sheyenne River flowing to County Drain 45 from just upstream of the Burlington Northern Railroad to just upstream at Interstate Highway 29. These floodway corridors are necessary to control future development in this area from blocking the paths that the water currently follows. It was decided during the CCO meetings that the floodway corridors should follow the natural course of breakout flows, but that detailed surveying or hydraulic calculations are not necessary.

The widths and locations of these administrative floodways were determined from aerial maps provided by Moore Engineering, Inc., topographic maps, photographs, and several individuals' observations of flow conditions during the April 1997 flood. With a letter dated January 30, 2001, Mr. Curtis Skarphol, Houston Engineering, Inc., provided photographs and information on the depths and widths of breakout flows across roadways during the April 1997 flood (Reference 5).

The major split flow for Corridor C across County Road No. 17 just south of County Road No. 20 was based on a split-flow HEC-2 model provided by Houston Engineering, Inc. Using the location of the breakout flows as identified by Houston Engineering, Inc., the other breakout flows were estimated from iterative HEC-2 computations on the Sheyenne River and County Drain 45. The breakout flows were verified by using a combination of road overflow and normal depth computations. The road overflow computations were based on widths and depths of flow observed by Mr. Curtis Skarphol in the April 1997 flood. The normal depth computations were based on rectangular cross sections, widths equal to the breakout floodway corridor, differences in base flood elevations between the Sheyenne River and County Drain 45, and flow depths based on available topographic data and engineering judgment.

The flood discharges for each corridor are given in Table 5, "Summary of Breakout Floodway Discharges." The corridors are labeled on the FIRM panels. The panel number and community affected by the breakout flow are also summarized in Table 5. These discharges are considered reasonable given the level of data available. However, there is significant uncertainty in these discharges due to the lack of detailed hydraulic data (Reference 27).

**Table 5: Summary of Breakout Floodway Discharges**

| Breakout Flooding | Community(ies) Effected | Community Panel Nos. | 1-percent-annual-chance Peak Discharge (CFS) |
|---|---|---|---|
| Corridor A | City of Harwood | 38017C0557G | 1,500 |
| Corridor B | Township of Reed<br>City of Fargo | 38017C0559G | 2,500 |
| Corridor C | Township of Reed<br>City of Fargo | 38017C0566G<br>38017C0567G | 3,000 |
| Corridor D | City of West Fargo<br>City of Fargo | 38017C0566G<br>38017C0567C | 300 |

The results of the floodway computations are tabulated at selected cross sections (Table 6). 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.

The floodways presented in this study were computed for certain stream segments on the basis of equal-conveyance reduction from each side of the floodplain. Floodway widths were computed at cross sections. Between cross sections, the floodway boundaries were interpolated. The results of the floodway computations are tabulated for selected cross sections and provided in Table 6, “Floodway Data Table.” The computed floodway is shown on the FIRM (Exhibit 2). In cases where the floodway and 1-percent-annual-

chance floodplain boundaries are either close together or collinear, only the floodway boundary is shown on the FIRM.

The area between the floodway and 1-percent-annual-chance floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation (WSEL) of the base flood more than 0.80 feet at any point along the Red River of the North and more than 1.0 feet at any point along all other flooding sources. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 1.

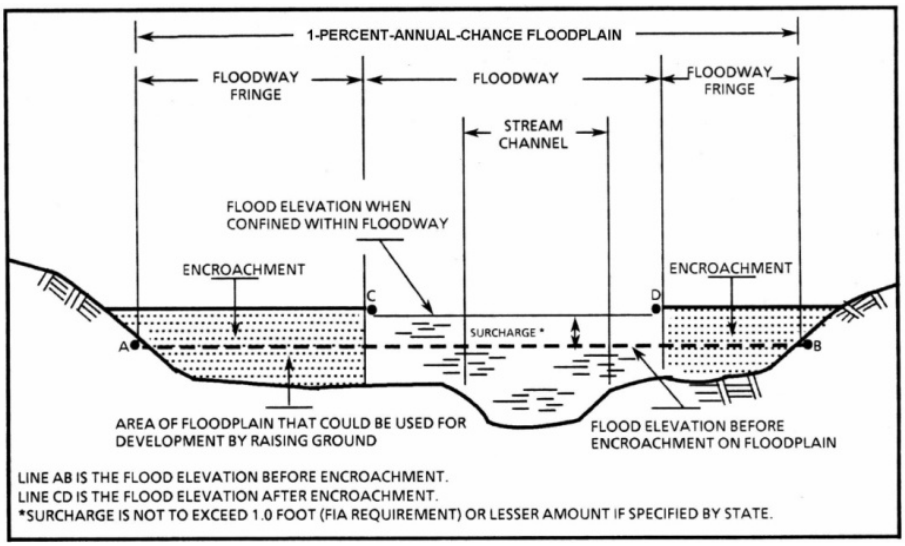


**Figure 1. Floodway Schematic**

| FLOODING SOURCE | | FLOODWAY | | | BASE FLOOD | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE[1] | WIDTH (FEET) | SECTION AREA (SQUARE FEET) | MEAN VELOCITY (FEET PER SECOND) | REGULATORY | WITHOUT FLOODWAY | WITH FLOODWAY | INCREASE |
| | | | | | | FEET (NAVD) | | |
| COUNTY DRAIN 10 BREAKOUT | | | | | | | | |
| A | 838 | 3,140 | 10,880 | 0.1 | 891.7 | 891.7 | 892.1 | 0.5 |
| B | 2,194 | 3,445 | 16,240 | 0.1 | 891.7 | 891.7 | 892.1 | 0.5 |
| C | 3,570 | 2,275 | 11,520 | 0.1 | 891.7 | 891.7 | 892.1 | 0.5 |
| D | 5,202 | 620 | 3,124 | 0.4 | 891.7 | 891.7 | 892.2 | 0.5 |
| E | 7,002 | 540 | 3,011 | 0.4 | 891.7 | 891.7 | 892.2 | 0.4 |
| F | 9,641 | 770 | 2,143 | 0.6 | 891.7 | 891.7 | 892.4 | 0.7 |
| G | 10,912 | 790 | 2,412 | 0.5 | 893.0 | 893.0 | 893.2 | 0.2 |
| H | 14,165 | 775 | 937 | 1.4 | 893.0 | 893.0 | 893.4 | 0.4 |
| I | 15,779 | 610 | 3,563 | 0.4 | 893.0 | 893.0 | 893.5 | 0.5 |

1 Stream distance in feet above confluence with Red River of the North

| FLOODING SOURCE | | FLOODWAY | | | BASE FLOOD | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE[1] | WIDTH (FEET) | SECTION AREA (SQUARE FEET) | MEAN VELOCITY (FEET PER SECOND) | REGULATORY | WITHOUT FLOODWAY | WITH FLOODWAY | INCREASE |
| | | | | | (FEET NAVD) | | | |
| COUNTY DRAIN 21 | | | | | | | | |
| A | 381 | 940 | [2] | [2] | 899.0 | 899.0 | 900.0 | 1.0 |
| B | 1,277 | 900 | 6,565 | 0.2 | 899.0 | 899.0 | 900.0 | 1.0 |
| C | 2,988 | 175 | 1,513 | 1.0 | 899.0 | 899.0 | 900.0 | 1.0 |
| D | 4,420 | 100 | 1,132 | 1.3 | 899.1 | 899.1 | 900.0 | 0.9 |
| E | 5,317 | 100 | 1,068 | 1.4 | 899.2 | 899.2 | 900.0 | 0.8 |
| F | 6,946 | 100 | 1,166 | 1.3 | 899.4 | 899.4 | 900.3 | 0.9 |
| G | 9,262 | 100 | 1,055 | 1.4 | 899.7 | 899.7 | 900.5 | 0.8 |

1 Stream distance in feet above confluence with Sheyenne River

2 Data not Available

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

**CASS COUNTY, ND**

**ALL JURISDICTIONS**

FLOODWAY DATA

**COUNTY DRAIN 21**

| FLOODING SOURCE | | FLOODWAY | | | BASE FLOOD | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE[1] | WIDTH (FEET) | SECTION AREA (SQUARE FEET) | MEAN VELOCITY (FEET PER SECOND) | REGULATORY | WITHOUT FLOODWAY | WITH FLOODWAY | INCREASE |
| | | | | | | FEET (NAVD) | | |
| COUNTY DRAIN 45 | | | | | | | | |
| A | 1,530 | 1,800 | 12,064 | 0.5 | 893.5 | 893.5 | 894.5 | 1.0 |
| B | 3,380 | 1,700 | 10,781 | 0.6 | 893.5 | 893.5 | 894.5 | 1.0 |
| C | 5,220 | 1,300 | 8,735 | 0.7 | 893.5 | 893.5 | 894.5 | 1.0 |
| D | 5,700 | 1,050 | 7,720 | 0.8 | 893.5 | 893.5 | 894.5 | 1.0 |
| E | 7,120 | 750 | 7,428 | 0.8 | 893.7 | 893.7 | 894.7 | 1.0 |
| F | 11,363 | 800 | 7,059 | 0.5 | 893.8 | 893.8 | 894.8 | 1.0 |
| G | 12,792 | 508 | 4,226 | 0.9 | 893.9 | 893.9 | 894.9 | 1.0 |
| H | 13,913 | 390 | 3,484 | 1.0 | 893.9 | 893.9 | 894.9 | 1.0 |
| I | 15,400 | 680 | 5,895 | 0.1 | 894.6 | 894.6 | 895.4 | 0.8 |
| J | 17,028 | 550 | 3,749 | 0.2 | 894.6 | 894.6 | 895.4 | 0.8 |
| K | 18,152 | 479 | 3,336 | 0.2 | 894.6 | 894.6 | 895.4 | 0.8 |
| L | 19,563 | 500 | 2,804 | 0.2 | 894.6 | 894.6 | 895.4 | 0.8 |
| M | 23,089 | 100 | 888 | 0.3 | 894.7 | 894.7 | 895.7 | 1.0 |
| N | 26,485 | 100 | 690 | 0.4 | 895.1 | 895.1 | 895.7 | 0.6 |

1 Stream distance in feet above Interstate 29-southbound lane

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

**CASS COUNTY, ND**

**(AND INCORPORATED AREAS)**

FLOODWAY DATA

**COUNTY DRAIN 45**

| FLOODING SOURCE | | FLOODWAY | | | BASE FLOOD WATER SURFACE ELEVATION | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE[1] | WIDTH (FEET) | SECTION AREA (SQUARE FEET) | MEAN VELOCITY (FEET PER SECOND) | REGULATORY | WITHOUT FLOODWAY | WITH FLOODWAY | INCREASE |
| | | | | | | FEET (NAVD) | | |
| RED RIVER OF THE NORTH | | | | | | | | |
| T | 295.61 | 2,510 | 23,729 | 1.6 | 884.7 | 884.7 | 885.5 | 0.8 |
| U | 296.38 | 1,700 | 12,285 | 3.1 | 885.2 | 885.2 | 886.0 | 0.8 |
| V | 297.78 | 3,830 | 14,552 | 2.6 | 887.0 | 887.0 | 887.8 | 0.8 |
| W | 299.14 | 3,390 | 22,310 | 1.7 | 888.2 | 888.2 | 888.9 | 0.7 |
| X | 300.91 | 9,510 | 40,604 | 0.9 | 889.2 | 889.2 | 889.9 | 0.7 |
| Y | 301.67 | 3,920 | 23,004 | 1.3 | 889.4 | 889.4 | 890.0 | 0.6 |
| Z | 301.91 | 4,570 | 30,837 | 0.9 | 889.4 | 889.4 | 890.0 | 0.6 |
| AA | 302.35 | 3,960 | 23,489 | 1.1 | 889.5 | 889.5 | 890.2 | 0.7 |
| AB | 303.77 | 2,270 | 17,270 | 1.6 | 889.8 | 889.8 | 890.5 | 0.7 |
| AC | 304.95 | 4,120 | 20,410 | 1.3 | 890.3 | 890.3 | 891.0 | 0.7 |
| AD | 305.68 | 850 | 13,414 | 2.0 | 891.1 | 891.1 | 891.6 | 0.5 |
| AE | 306.95 | 639 | 13,056 | 2.0 | 891.8 | 891.8 | 892.3 | 0.5 |
| AF | 307.12 | 1,150 | 20,017 | 1.3 | 892.0 | 892.0 | 892.5 | 0.5 |
| AG | 307.90 | 1,408 | 18,900 | 1.4 | 892.2 | 892.2 | 892.7 | 0.4 |
| AH | 309.63 | 665 | 12,882 | 2.0 | 893.0 | 893.0 | 893.4 | 0.4 |
| AI | 310.34 | 3,030 | 18,053 | 1.5 | 893.4 | 893.4 | 893.8 | 0.4 |
| AJ | 311.23 | 1,050 | 15,097 | 1.7 | 893.9 | 893.9 | 894.3 | 0.4 |
| AK | 312.06 | 550 | 10,978 | 2.4 | 894.4 | 894.4 | 894.8 | 0.4 |
| AL | 312.74 | 950 | 14,659 | 1.8 | 894.9 | 894.9 | 895.3 | 0.4 |
| AM | 312.94 | 566 | 11,588 | 2.2 | 895.0 | 895.0 | 895.4 | 0.4 |
| AN | 313.59 | 990 | 16,247 | 1.6 | 895.3 | 895.3 | 895.7 | 0.4 |
| AO | 313.81 | 1,400 | 22,676 | 1.1 | 895.5 | 895.5 | 895.8 | 0.4 |
| AP | 314.80 | 1,310 | 19,797 | 1.3 | 895.7 | 895.7 | 896.0 | 0.4 |
| AQ | 315.41 | 2,420 | 40,624 | 0.6 | 895.8 | 895.8 | 896.2 | 0.4 |
| AR | 315.89 | 3,043 | 29,770 | 1.0 | 896.0 | 896.0 | 896.3 | 0.4 |
| AS | 316.65 | 1,622 | 19,189 | 1.5 | 896.3 | 896.3 | 896.6 | 0.3 |

[1] Stream distance in miles above Mouth

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

**CASS COUNTY, ND**

**(AND INCORPORATED AREAS)**

FLOODWAY DATA

**RED RIVER OF THE NORTH**

| FLOODING SOURCE | | FLOODWAY | | | BASE FLOOD WATER SURFACE ELEVATION | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE[1] | WIDTH (FEET) | SECTION AREA (SQUARE FEET) | MEAN VELOCITY (FEET PER SECOND) | REGULATORY | WITHOUT FLOODWAY | WITH FLOODWAY | INCREASE |
| | | | | | | FEET (NAVD) | | |
| RED RIVER OF THE NORTH (CONTINUED) | | | | | | | | |
| AU | 318.43 | 802 | 12,477 | 2.4 | 896.7 | 896.7 | 897.0 | 0.3 |
| AV | 318.60 | 1,711 | 28,750 | 1.0 | 896.9 | 896.9 | 897.2 | 0.3 |
| AW | 319.33 | 2,257 | 31,490 | 0.9 | 897.0 | 897.0 | 897.3 | 0.3 |
| AX | 319.95 | 792 | 14,821 | 2.0 | 897.3 | 897.3 | 897.5 | 0.3 |
| AY | 320.29 | 1,389 | 20,324 | 1.4 | 897.5 | 897.5 | 897.8 | 0.3 |
| AZ | 320.66 | 716 | 13,965 | 2.1 | 897.7 | 897.7 | 897.9 | 0.2 |
| BA | 321.03 | 1,085 | 18,420 | 1.6 | 897.9 | 897.9 | 898.1 | 0.2 |
| BB | 321.62 | 1,002 | 14,082 | 2.1 | 898.3 | 898.3 | 898.6 | 0.2 |
| BC | 322.14 | 1,205 | 16,497 | 1.8 | 898.6 | 898.6 | 899.0 | 0.4 |
| BD | 322.37 | 711 | 12,802 | 2.3 | 898.9 | 898.9 | 899.3 | 0.4 |
| BE | 322.88 | 1,499 | 20,274 | 1.5 | 899.3 | 899.3 | 899.6 | 0.4 |
| BF | 323.25 | 1,104 | 15,577 | 1.9 | 899.5 | 899.5 | 899.9 | 0.4 |
| BG | 323.45 | 1,857 | 25,645 | 1.1 | 899.7 | 899.7 | 900.0 | 0.4 |
| BH | 324.12 | 996 | 17,151 | 1.7 | 900.0 | 900.0 | 900.3 | 0.3 |
| BI | 324.45 | 616 | 11,252 | 2.6 | 900.3 | 900.3 | 900.6 | 0.3 |
| BJ | 324.83 | 771 | 14,965 | 2.0 | 900.9 | 900.9 | 901.3 | 0.4 |
| BK | 325.11 | 505 | 9,383 | 3.1 | 901.2 | 901.2 | 901.6 | 0.4 |
| BL | 325.51 | 554 | 11,239 | 2.6 | 901.6 | 901.6 | 902.0 | 0.5 |
| BM | 325.50 | 972 | 17,281 | 1.7 | 902.0 | 902.0 | 902.5 | 0.5 |
| BN | 326.42 | 724 | 14,604 | 2.0 | 902.3 | 902.3 | 902.8 | 0.4 |
| BO | 327.27 | 2,705 | 26,207 | 1.1 | 902.7 | 902.7 | 903.1 | 0.4 |
| BP | 328.01 | 2,115 | 25,939 | 1.1 | 903.1 | 903.1 | 903.5 | 0.4 |
| BQ | 328.42 | 1,126 | 19,738 | 1.5 | 903.3 | 903.3 | 903.7 | 0.3 |
| BR | 328.77 | 584 | 12,495 | 2.3 | 903.5 | 903.5 | 903.8 | 0.3 |
| BS | 329.17 | 2,231 | 28,297 | 1.0 | 903.7 | 903.7 | 904.1 | 0.3 |

[1] Stream distance in miles above mouth

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

**CASS COUNTY, ND**

**ALL JURISDICTIONS**

FLOODWAY DATA

**RED RIVER OF THE NORTH**

| FLOODING SOURCE | | FLOODWAY | | | BASE FLOOD WATER SURFACE ELEVATION | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE[1] | WIDTH (FEET) | SECTION AREA (SQUARE FEET) | MEAN VELOCITY (FEET PER SECOND) | REGULATORY | WITHOUT FLOODWAY | WITH FLOODWAY | INCREASE |
| | | | | | | FEET (NAVD) | | |
| RED RIVER OF THE NORTH (CONTINUED) | | | | | | | | 0.0 |
| BT | 329.60 | 1,445 | 20,303 | 1.4 | 904.0 | 904.0 | 904.3 | 0.3 |
| BU | 330.00 | 1,449 | 22,318 | 1.3 | 904.2 | 904.2 | 904.5 | 0.3 |
| BV | 330.18 | 1,046 | 16,360 | 1.8 | 904.2 | 904.2 | 904.6 | 0.4 |
| BW | 330.71 | 1,267 | 20,062 | 1.5 | 904.5 | 904.5 | 904.9 | 0.4 |
| BX | 331.23 | 710 | 11,928 | 2.5 | 904.7 | 904.7 | 905.1 | 0.4 |
| BY | 331.66 | 2,394 | 32,031 | 0.9 | 905.0 | 905.0 | 905.4 | 0.4 |
| BZ | 333.17 | 699 | 13,324 | 2.2 | 905.6 | 905.6 | 906.1 | 0.5 |
| CA | 333.58 | 1,128 | 16,183 | 1.6 | 906.0 | 906.0 | 906.5 | 0.5 |
| CB | 334.17 | 855 | 15,887 | 1.6 | 906.3 | 906.3 | 906.9 | 0.5 |
| CC | 334.90 | 1,070 | 18,754 | 1.3 | 906.8 | 906.8 | 907.4 | 0.6 |
| CD | 335.06 | 902 | 15,951 | 1.6 | 906.8 | 906.8 | 907.5 | 0.7 |
| CE | 335.63 | 1,523 | 20,808 | 1.2 | 907.1 | 907.1 | 907.8 | 0.7 |
| CF | 336.66 | 1,045 | 16,205 | 1.5 | 907.6 | 907.6 | 908.3 | 0.6 |
| CG | 337.23 | 1,096 | 17,436 | 1.4 | 908.0 | 908.0 | 908.6 | 0.6 |
| CH | 337.60 | 1,460 | 16,172 | 1.6 | 908.2 | 908.2 | 908.9 | 0.7 |
| CI | 338.14 | 3,080 | 28,075 | 0.9 | 908.5 | 908.5 | 909.2 | 0.7 |
| CJ | 338.93 | 1,571 | 20,015 | 1.3 | 908.8 | 908.8 | 909.5 | 0.7 |
| CK | 339.61 | 1,625 | 18,293 | 1.4 | 909.1 | 909.1 | 909.8 | 0.7 |
| CL | 340.55 | 2,570 | 29,052 | 0.9 | 909.5 | 909.5 | 910.2 | 0.7 |
| CM | 341.28 | 2,599 | 34,989 | 0.7 | 909.7 | 909.7 | 910.4 | 0.7 |
| CN | 342.02 | 3,261 | 38,459 | 0.7 | 909.9 | 909.9 | 910.6 | 0.7 |
| CO | 342.94 | 3,280 | 29,505 | 0.9 | 910.1 | 910.1 | 910.8 | 0.7 |
| CP | 343.35 | 4,641 | 32,596 | 0.8 | 910.2 | 910.2 | 910.9 | 0.7 |
| CQ | 343.87 | 4,715 | 29,978 | 0.5 | 910.3 | 910.3 | 911.0 | 0.7 |
| CR | 344.65 | 3,800 | 25,239 | 0.6 | 910.4 | 910.4 | 911.1 | 0.7 |

1 Stream distance in miles above Mouth

| FLOODING SOURCE | | FLOODWAY | | | BASE FLOOD WATER SURFACE ELEVATION | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE[1] | WIDTH (FEET) | SECTION AREA (SQUARE FEET) | MEAN VELOCITY (FEET PER SECOND) | REGULATORY | WITHOUT FLOODWAY | WITH FLOODWAY | INCREASE |
| | | | | | | FEET (NAVD) | | |
| RED RIVER OF THE NORTH (CONTINUED) | | | | | | | | |
| CT | 345.87 | 1,593 | 18,466 | 0.8 | 910.5 | 910.5 | 911.2 | 0.7 |
| CU | 346.62 | 1,275 | 14,814 | 1.0 | 910.7 | 910.7 | 911.4 | 0.7 |
| CV | 347.48 | 1,522 | 18,243 | 1.0 | 911.0 | 911.0 | 911.7 | 0.7 |
| CW | 347.83 | 654 | 11,606 | 1.5 | 911.1 | 911.1 | 911.8 | 0.7 |
| CX | 347.87 | 686 | 10,593 | 1.7 | 911.2 | 911.2 | 911.9 | 0.7 |
| CY | 348.34 | 1,781 | 17,916 | 1.0 | 911.4 | 911.4 | 912.1 | 0.7 |
| CZ | 349.08 | 968 | 10,883 | 1.6 | 911.7 | 911.7 | 912.4 | 0.7 |
| DA | 349.47 | 2,327 | 21,501 | 0.8 | 911.9 | 911.9 | 912.6 | 0.7 |
| DB | 350.19 | 2,959 | 21,400 | 0.8 | 912.1 | 912.1 | 912.8 | 0.7 |
| DC | 350.85 | 1,220 | 12,084 | 1.2 | 912.3 | 912.3 | 913.0 | 0.7 |
| DD | 351.42 | 1,327 | 17,575 | 0.8 | 912.5 | 912.5 | 913.3 | 0.7 |
| DE | 351.90 | 1,364 | 14,747 | 1.0 | 912.8 | 912.8 | 913.6 | 0.8 |
| DF | 352.69 | 1,035 | 14,372 | 1.0 | 913.1 | 913.1 | 913.9 | 0.7 |
| DG | 353.05 | 702 | 12,790 | 1.1 | 913.2 | 913.2 | 914.0 | 0.7 |
| DH | 353.58 | 1,950 | 17,917 | 0.8 | 913.4 | 913.4 | 914.2 | 0.8 |
| DI | 354.43 | 1,509 | 18,229 | 0.8 | 913.7 | 913.7 | 914.4 | 0.7 |
| DJ | 355.72 | 1,707 | 15,338 | 0.9 | 914.1 | 914.1 | 914.7 | 0.7 |
| DK | 356.34 | 1,132 | 14,365 | 1.0 | 914.3 | 914.3 | 914.9 | 0.6 |
| DL | 357.15 | 1,050 | 9,326 | 1.5 | 915.1 | 915.1 | 915.8 | 0.7 |
| DM | 357.98 | 1,902 | 22,702 | 0.6 | 915.7 | 915.7 | 916.4 | 0.6 |
| DN | 359.20 | 1,465 | 25,569 | 0.6 | 915.9 | 915.9 | 916.6 | 0.7 |
| DO | 359.25 | 1,589 | 24,520 | 0.6 | 915.9 | 915.9 | 916.6 | 0.7 |
| DP | 359.68 | 785 | 12,540 | 1.1 | 916.0 | 916.0 | 916.7 | 0.7 |
| DQ | 360.05 | 613 | 10,318 | 1.4 | 916.1 | 916.1 | 916.8 | 0.7 |
| DR | 360.45 | 420 | 9,400 | 1.5 | 916.4 | 916.4 | 917.0 | 0.7 |
| DS | 361.11 | 740 | 13,023 | 1.1 | 916.9 | 916.9 | 917.5 | 0.6 |
| DT | 361.65 | 642 | 9,386 | 1.5 | 917.3 | 917.3 | 918.0 | 0.6 |

1 Stream distance in miles above Mouth

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

**CASS COUNTY, ND**

**ALL JURISDICTIONS**

FLOODWAY DATA

**RED RIVER OF THE NORTH**

| FLOODING SOURCE | | FLOODWAY | | | BASE FLOOD WATER-SURFACE ELEVATION | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE[1] | WIDTH (FEET) | SECTION AREA (SQUARE FEET) | MEAN VELOCITY (FEET PER SECOND) | REGULATORY | WITHOUT FLOODWAY | WITH FLOODWAY | INCREASE |
| | | | | | | FEET (NAVD) | | |
| **SHEYENNE RIVER** | | | | | | | | |
| A | [2] | [2] | [2] | [2] | [2] | [2] | [2] | [2] |
| B | 55,740 | [2] | [2] | [2] | 891.9 | [2] | [2] | [2] |
| C | 58,275 | 400 | 7,770 | 2.2 | 892.3 | 892.3 | 893.2 | 0.9 |
| D | 59,345 | 550 | 7,294 | 2.2 | 892.4 | 892.4 | 893.3 | 0.9 |
| E | 61,045 | 400 | 6,114 | 2.3 | 892.5 | 892.5 | 893.4 | 0.9 |
| F | 61,895 | 400 | 8,361 | 1.9 | 892.6 | 892.6 | 893.5 | 0.9 |
| G | 63,530 | 450 | 6,827 | 2.2 | 892.7 | 892.7 | 893.7 | 1.0 |
| H | 65,230 | 400 | 5,432 | 2.2 | 892.9 | 892.9 | 893.8 | 0.9 |
| I | 67,500 | 350 | 4,426 | 2.8 | 893.0 | 893.0 | 894.0 | 1.0 |
| J | 68,710 | 375 | 5,940 | 1.4 | 893.3 | 893.3 | 894.1 | 0.8 |
| K | 69,555 | 872 | 9,163 | 0.9 | 893.4 | 893.4 | 894.4 | 1.0 |
| L | 76,540 | 1,350 | 9,780 | 1 | 894.1 | 894.1 | 895.0 | 0.9 |
| M | 77,596 | 1,350 | 7,925 | 1.2 | 894.2 | 894.2 | 895.1 | 0.9 |
| N | 78,380 | 1,397 | 7,180 | 1.4 | 894.3 | 894.3 | 895.1 | 0.8 |
| O | 79,237 | 1,600 | 9,748 | 1 | 894.5 | 894.5 | 895.4 | 0.9 |

[1] Feet above confluence with Red River of the North

[2] Data not available

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

# CASS COUNTY, ND
AND INCORPORATED AREAS

# FLOODWAY DATA

# SHEYENNE RIVER

| FLOODING SOURCE | | FLOODWAY | | | BASE FLOOD WATER-SURFACE ELEVATION | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE[1] | WIDTH (FEET) | SECTION AREA (SQUARE FEET) | MEAN VELOCITY (FEET PER SECOND) | REGULATORY | WITHOUT FLOODWAY | WITH FLOODWAY | INCREASE |
| | | | | | | FEET (NAVD) | | |
| **SHEYENNE RIVER** | | | | | | | | |
| P | 80,110 | 1,490 | 7,803 | 1.6 | 894.6 | 894.6 | 895.5 | 0.9 |
| Q | 81,759 | 1,010 | 5,805 | 2.1 | 894.8 | 894.8 | 895.8 | 1.0 |
| R | 83,980 | 750 | 5,341 | 2.3 | 895.9 | 895.9 | 896.9 | 1.0 |
| S | 86,500 | 940 | 6,939 | 1.8 | 896.6 | 896.6 | 897.5 | 0.9 |
| T | 87,046 | 1,594 | 9,436 | 1.3 | 896.8 | 898.8 | 897.8 | 1.0 |
| U | 87,515 | 1,500 | 8,321 | 1.5 | 896.9 | 896.9 | 897.9 | 1.0 |
| V | 89,972 | 2,000 | 12,834 | 1 | 897.3 | 897.3 | 898.3 | 1.0 |
| W | 91,998 | 1,950 | 11,659 | 1.1 | 897.5 | 897.5 | 898.5 | 1.0 |
| X | 92,847 | 1,900 | 11,075 | 1.1 | 897.6 | 897.6 | 898.6 | 1.0 |
| Y | 95,351 | 2,550 | 14,379 | 0.9 | 897.9 | 897.9 | 898.9 | 1.0 |
| Z | 102,810 | 582 | 4,781 | 0.8 | 898.6 | 898.6 | 899.6 | 1.0 |
| AA | 105,720 | 630 | 4,660 | 0.9 | 898.8 | 898.8 | 899.8 | 1.0 |
| AB | 111,931 | 350 | 2,600 | 1.2 | 899.1 | 899.1 | 900.1 | 1.0 |
| AC | 113,607 | 350 | 2,935 | 1.1 | 899.1 | 899.1 | 900.1 | 1.0 |
| AD | 115,013 | 400 | 4,232 | 0.7 | 899.2 | 899.2 | 900.2 | 1.0 |
| AE | 117,115 | 300 | 2,598 | 1.2 | 899.3 | 899.3 | 900.3 | 1.0 |

[1] Feet above confluence with Red River of the North

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

# CASS COUNTY, ND

AND INCORPORATED AREAS

# FLOODWAY DATA

# SHEYENNE RIVER

| FLOODING SOURCE | | FLOODWAY | | | BASE FLOOD WATER SURFACE ELEVATION | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE[1] | WIDTH (FEET) | SECTION AREA (SQUARE FEET) | MEAN VELOCITY (FEET PER SECOND) | REGULATORY | WITHOUT FLOODWAY | WITH FLOODWAY | INCREASE |
| | | | | | | FEET (NAVD) | | |
| WILD RICE RIVER | | | | | | | | |
| A | 4,770 | 365 | 6,987 | 1.4 | 910.2 | 908.4 [2] | 909.2 [2] | 0.9 |
| B | 10,599 | 2,756 | 20,387 | 0.5 | 910.2 | 908.6 [2] | 909.5 [2] | 0.9 |
| C | 15,722 | 830 | 9,404 | 1.0 | 910.2 | 908.7 [2] | 909.6 [2] | 0.9 |
| D | 18,163 | 1,040 | 9,924 | 1.0 | 910.2 | 908.8 [2] | 909.7 [2] | 0.9 |
| E | 21,325 | 1,340 | 11,186 | 0.9 | 910.2 | 908.9 [2] | 909.8 [2] | 0.9 |
| F | 24,064 | 800 | 7,806 | 1.2 | 910.2 | 909.1 [2] | 910.0 [2] | 0.9 |
| G | 26,261 | 468 | 6,408 | 1.5 | 910.2 | 909.3 [2] | 910.1 [2] | 0.9 |
| H | 26,444 | 613 | 8,144 | 1.2 | 910.2 | 909.3 [2] | 910.2 [2] | 0.9 |
| I | 27,495 | 480 | 5,772 | 1.7 | 910.2 | 909.3 [2] | 910.2 [2] | 0.9 |
| J | 28,355 | 700 | 8,819 | 1.1 | 910.2 | 909.4 [2] | 910.3 [2] | 0.9 |
| K | 28,992 | 520 | 6,359 | 1.6 | 910.2 | 909.5 [2] | 910.4 [2] | 0.9 |
| L | 35,505 | 1,420 | 8,672 | 1.1 | 910.2 | 910.0 [2] | 911.0 [2] | 1.0 |
| M | 36,562 | 1,450 | 9,815 | 1.0 | 910.2 | 910.1 [2] | 911.1 [2] | 1.0 |
| N | 38,734 | 2,800 | 10,449 | 1.0 | 910.2 | 910.2 | 911.2 | 1.0 |
| O | 42,654 | 2,300 | 11,792 | 0.8 | 910.6 | 910.6 | 911.6 | 1.0 |
| P | 42,921 | 1,439 | 6,530 | 1.5 | 910.7 | 910.7 | 911.6 | 0.9 |
| Q | 44,565 | 2,088 | 10,433 | 1.0 | 910.8 | 910.8 | 911.8 | 1.0 |
| R | 46,725 | 1,026 | 7,657 | 1.3 | 911.0 | 911.0 | 912.0 | 1.0 |
| S | 53,139 | 700 | 7,322 | 1.3 | 911.7 | 911.7 | 912.6 | 0.9 |
| T | 54,539 | 797 | 10,289 | 0.9 | 911.8 | 911.8 | 912.7 | 0.9 |
| U | 54,979 | 743 | 8,087 | 1.2 | 911.9 | 911.9 | 912.8 | 0.9 |
| V | 57,608 | 642 | 4,931 | 2.0 | 912.2 | 912.2 | 913.1 | 0.9 |
| W | 59,558 | 327 | 3,983 | 3.4 | 912.9 | 912.9 | 913.7 | 0.8 |
| X | 60,058 | 634 | 7,113 | 1.9 | 913.7 | 913.7 | 914.5 | 0.8 |
| Y | 61,599 | 1,468 | 8,110 | 1.7 | 914.1 | 914.1 | 914.8 | 0.7 |
| Z | 65,099 | 1,381 | 8,577 | 1.6 | 915.0 | 915.0 | 915.9 | 0.9 |

[1] Stream distance in feet above confluence with Red River

[2] Elevation computed without consideration of Backwater from Red River

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

**CASS COUNTY, ND**

**(AND INCORPORATED AREAS)**

FLOODWAY DATA

**WILD RICE RIVER**

| FLOODING SOURCE | | FLOODWAY | | | BASE FLOOD WATER SURFACE ELEVATION | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE[1] | WIDTH (FEET) | SECTION AREA (SQUARE FEET) | MEAN VELOCITY (FEET PER SECOND) | REGULATORY | WITHOUT FLOODWAY | WITH FLOODWAY | INCREASE |
| | | | | | | FEET (NAVD) | | |
| WILD RICE RIVER (CONTINUED) | | | | | | | | |
| AA | 65,178 | 1,091 | 4,723 | 3.0 | 915.0 | 915.0 | 915.9 | 0.9 |
| AB | 65,465 | 987 | 7,248 | 1.9 | 915.5 | 915.5 | 916.2 | 0.7 |
| AC | 66,377 | 725 | 5,934 | 1.8 | 915.6 | 915.6 | 916.4 | 0.8 |
| AD | 66,597 | 754 | 6,355 | 1.7 | 916.0 | 916.0 | 916.6 | 0.6 |
| AE | 68,027 | 700 | 7,177 | 1.5 | 916.1 | 916.1 | 916.9 | 0.8 |
| AF | 70,106 | 2,373 | 13,817 | 0.8 | 916.2 | 916.2 | 917.1 | 0.9 |
| AG | 74,928 | 3,611 | 18,758 | 0.7 | 916.4 | 916.4 | 917.4 | 1.0 |
| AH | 76,399 | 4,100 | 19,526 | 0.7 | 916.5 | 916.5 | 917.5 | 1.0 |
| AI | 76,851 | 4,800 | 24,021 | 0.6 | 916.5 | 916.5 | 917.5 | 1.0 |
| AJ | 77,463 | 5,600 | 26,454 | 0.5 | 916.5 | 916.5 | 917.5 | 1.0 |
| AK | 78,921 | 5,600 | 22,757 | 0.6 | 916.6 | 916.6 | 917.6 | 1.0 |
| AL | 80,332 | 2,386 | 10,503 | 1.2 | 916.7 | 916.7 | 917.7 | 1.0 |
| AM | 81,261 | 1,344 | 8,342 | 1.5 | 916.9 | 916.9 | 917.8 | 0.9 |
| AN | 82,346 | 554 | 5,865 | 2.1 | 917.2 | 917.2 | 918.1 | 0.9 |
| AO | 82,799 | 1,051 | 7,557 | 1.6 | 917.8 | 917.8 | 918.6 | 0.8 |
| AP | 83,558 | 1,420 | 9,598 | 1.3 | 917.9 | 917.9 | 918.8 | 0.9 |
| AQ | 85,030 | 445 | 5,957 | 2.0 | 918.1 | 918.1 | 919.0 | 0.9 |
| AR | 87,283 | 420 | 5,484 | 2.2 | 918.5 | 918.5 | 919.4 | 0.9 |
| AS | 89,038 | 451 | 6,209 | 2.0 | 918.9 | 918.9 | 919.8 | 0.9 |
| AT | 90,127 | 1,100 | 8,827 | 1.4 | 919.2 | 919.2 | 920.1 | 0.9 |
| AU | 92,874 | 1,750 | 11,415 | 1.1 | 919.5 | 919.5 | 920.4 | 0.9 |
| AV | 95,932 | 1,127 | 7,989 | 1.5 | 920.1 | 920.1 | 920.9 | 0.8 |
| AW | 97,302 | 415 | 6,133 | 2.3 | 920.3 | 920.3 | 921.1 | 0.8 |
| AX | 98,461 | 796 | 7,820 | 1.8 | 920.5 | 920.5 | 921.3 | 0.8 |
| AY | 99,351 | 855 | 9,847 | 1.4 | 920.8 | 920.8 | 921.6 | 0.8 |

[1] Stream distance in feet above confluence with Red River

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

**CASS COUNTY, ND**

**(AND INCORPORATED AREAS)**

FLOODWAY DATA

**WILD RICE RIVER**

| FLOODING SOURCE | | FLOODWAY | | | BASE FLOOD WATER SURFACE ELEVATION | | | |
|---|---|---|---|---|---|---|---|---|
| **CROSS SECTION** | **DISTANCE[1]** | **WIDTH (FEET)** | **SECTION AREA (SQUARE FEET)** | **MEAN VELOCITY (FEET PER SECOND)** | **REGULATORY** | **WITHOUT FLOODWAY** | **WITH FLOODWAY** | **INCREASE** |
| | | | | | | FEET (NAVD) | | |
| WILD RICE RIVER (CONTINUED) | | | | | | | | 0.0 |
| AZ | 103,867 | 1,230 | 9,734 | 1.4 | 921.8 | 921.8 | 922.8 | 1.0 |
| BA | 105,119 | 724 | 8,150 | 1.7 | 922.2 | 922.2 | 923.1 | 0.9 |
| BB | 106,616 | 895 | 9,399 | 1.5 | 922.5 | 922.5 | 923.5 | 1.0 |
| BC | 108,792 | 778 | 9,029 | 1.6 | 922.9 | 922.9 | 923.8 | 0.9 |

1 Stream distance in feet above confluence with Red River

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

**CASS COUNTY, ND**

**(AND INCORPORATED AREAS)**

FLOODWAY DATA

**WILD RICE RIVER**

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

Zone AE

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

Zone X

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

## 6.0 FLOOD INSURANCE RATE MAP

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

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

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

The countywide FIRM presents flooding information for the entire geographic area of Cass County. Previously, FIRMs were prepared for each incorporated community identified as flood-prone. This countywide FIRM also includes flood-hazard information that was presented separately on Flood Boundary and Floodway Maps (FBFMs), where applicable. Historical data relating to the maps prepared for each community are presented in Table 7, “Community Map History.”

## Table 7: Community Map History

| Community Name | Initial Identification | Flood Hazard Boundary Map Revision Date(s) | Flood Insurance Rate Map Effective Date | Flood Insurance rate Map Revision Date(s) |
|---|---|---|---|---|
| City of Argusville | September 30, 1980 | -- | February 19, 1986 | -- |
| Township of Barnes | December 1, 1981 | -- | September 27, 1985 | -- |
| City of Briarwood | September 27, 1985 | -- | September 27, 1985 | -- |
| City of Fargo | April 10, 1970 | -- | May 1, 1971 | July 1, 1974<br>April 23, 1976<br>December 1, 1978<br>January 19, 1982<br>February 19, 1987<br>September 4, 2002 |
| City of Frontier | -- | -- | -- | -- |
| City of Harwood | September 30, 1980 | -- | September 30, 1980 | August 19, 1991<br>September 4, 2002 |
| Township of Harwood | October 15, 1980 | April 17, 1984 | December 18, 1985 | -- |
| City of Horace | November 29, 1974 | -- | July 2, 1981 | September 27, 1985 |
| Township of Mapleton | December 8, 1981 | December 8, 1981 | October 1, 1986 | -- |

| Table 7 | FEDERAL EMERGENCY MANAGEMENT AGENCY<br>CASS COUNTY, ND<br>ALL JURISDICTIONS | COMMUNITY MAP HISTORY |
|---|---|---|

**Table 7: Community Map History (cont.)**

| Community Name | Initial Identification | Flood Hazard Boundary Map Revision Date(s) | Flood Insurance Rate Map Effective Date | Flood Insurance rate Map Revision Date(s) |
|---|---|---|---|---|
| City of North River | September 27, 1985 | -- | September 27, 1985 | -- |
| City of Oxbow | -- | -- | -- | -- |
| Township of Pleasant | February 3, 1982 | -- | February 3, 1982 | -- |
| City of Prairie Rose | -- | -- | -- | -- |
| Township of Raymond | December 8, 1981 | -- | October 1, 1986 | January 4, 2002 |
| Township of Reed | October 15, 1980 | -- | October 15, 1980 | May 1, 1984<br>December 18, 1985<br>September 4, 2002 |
| City of Reiles Acres | February 2, 1982 | -- | September 30, 1987 | September 4, 2002 |
| Township of Stanley | July 5, 1982 | -- | July 5, 1982 | September 27, 1985<br>February 2, 1995 |
| Township of Warren | November 24, 1981 | -- | May 1, 1986 | |
| City of West Fargo | June 7, 1974 | August 29, 1975 | April 17, 1978 | May 18, 1982<br>September 27, 1985<br>February 2, 1995 |
| Table 7 (cont.) | FEDERAL EMERGENCY MANAGEMENT AGENCY<br>CASS COUNTY, ND<br>ALL JURISDICTIONS | | COMMUNITY MAP HISTORY | |

## 7.0 OTHER STUDIES

Because of its more detailed and updated analysis, this Flood Insurance Study supercedes previously published Flood Insurance Studies for the Cities of Briarwood, Fargo, Frontier, Harwood, Horace, North River, Oxbow, Prairie Rose, Reiles Acres, and West Fargo; and the Townships of Pleasant, Reed, and Stanley and partially supercedes Flood Insurance Studies for the City of Argusville as well as the Townships of Harwood, Mapleton, Normanna, Raymond, and Warren.

The Red River of the North has been studied many times using varying methodologies.

- In 1985, the USACE, St. Paul District, prepared a *Fargo-Moorhead Urban Study* (Reference 28). The report presented flood profiles and flooded outlines for portions of the Fargo, North Dakota, and Moorhead, Minnesota, area.

- In 1982, a study of the Red River of the North was performed in conjunction with a FIS for Clay County, Minnesota, in which a detailed study was proposed for portions of the Red River of the North (Reference 29). Because the Red River of the North serves as a common boundary between North Dakota and Minnesota, the analysis required for the Minnesota study was extended to include contiguous areas in Harwood. That data was used to develop previous FIS reports for the City of Briarwood and the Townships of Harwood, Reed, Stanley, and Wiser.

- The USACE published the *Red River of the North, Post Flood Report, 1978* and the *Red River of the North and Sioux River, Post Flood Report, 1979* to provide a reference for information related to flood-fighting procedures prior, during and subsequent to floods (References 30; 31). Elevation-discharge readings contained in these reports were used to calibrate the hydraulic models used in several previous FIS studies.

- In September 1972, the USACE published flood plain information for the Red River of the North for Fargo, North Dakota, and Moorhead, Minnesota (Reference 32).

- A 1971 regional flood analysis report, *Red River of the North Regional Flood Analysis*, prepared by the NDSWC and the Minnesota Department of Natural Resources, presented approximate 1-percent-annual-chance flood profiles for the Red River of the North as extrapolated from existing rating curves (Reference 3).

- The *Type-15 Flood Insurance Study for Cass County, North Dakota* prepared by the SCS in 1971 comprised all of the areas within the extraterritorial jurisdiction of Riverside (now part of West Fargo) and surrounding areas (Reference 33). That study did not contain published discharges for the Sheyenne River or County Drain 21.

Several previous reports were also published for the Sheyenne River.

- In August 1982, the USACE published a general revision and revised environmental impact statement for the Sheyenne River flood control measures (Reference 16)

- In January 1982, the USACE prepared a general design memorandum and environmental impact statement that outlined numerous flood control measures for the Sheyenne River

(Reference 34). Extensive hydrologic and hydraulic analyses were conducted as a part of the memorandum and represented the best available information on the Sheyenne River. Discharge-frequency and elevation-discharge relationships for several locations on the Sheyenne River were presented in that report. No flood profiles were generated for the study area. Major recommendations for flood control within the West Fargo and Riverside area were: (1) construction of a diversion channel around West Fargo and Riverside to the west of the cities to carry peak flows; (2) a diversion channel from Horace to West Fargo; and (3) raising Baldhill Dam 5 feet to increase its capacity to store floodwaters. These flood control measures have all been implemented.

- The USACE published field books describing surveys of the Sheyenne River in 1940 (Reference 35).

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

## 8.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting Federal Insurance and Mitigation Division, FEMA Region VIII, Denver Federal Center, Building 710, Box 25267, Denver, Colorado 80225-0267.

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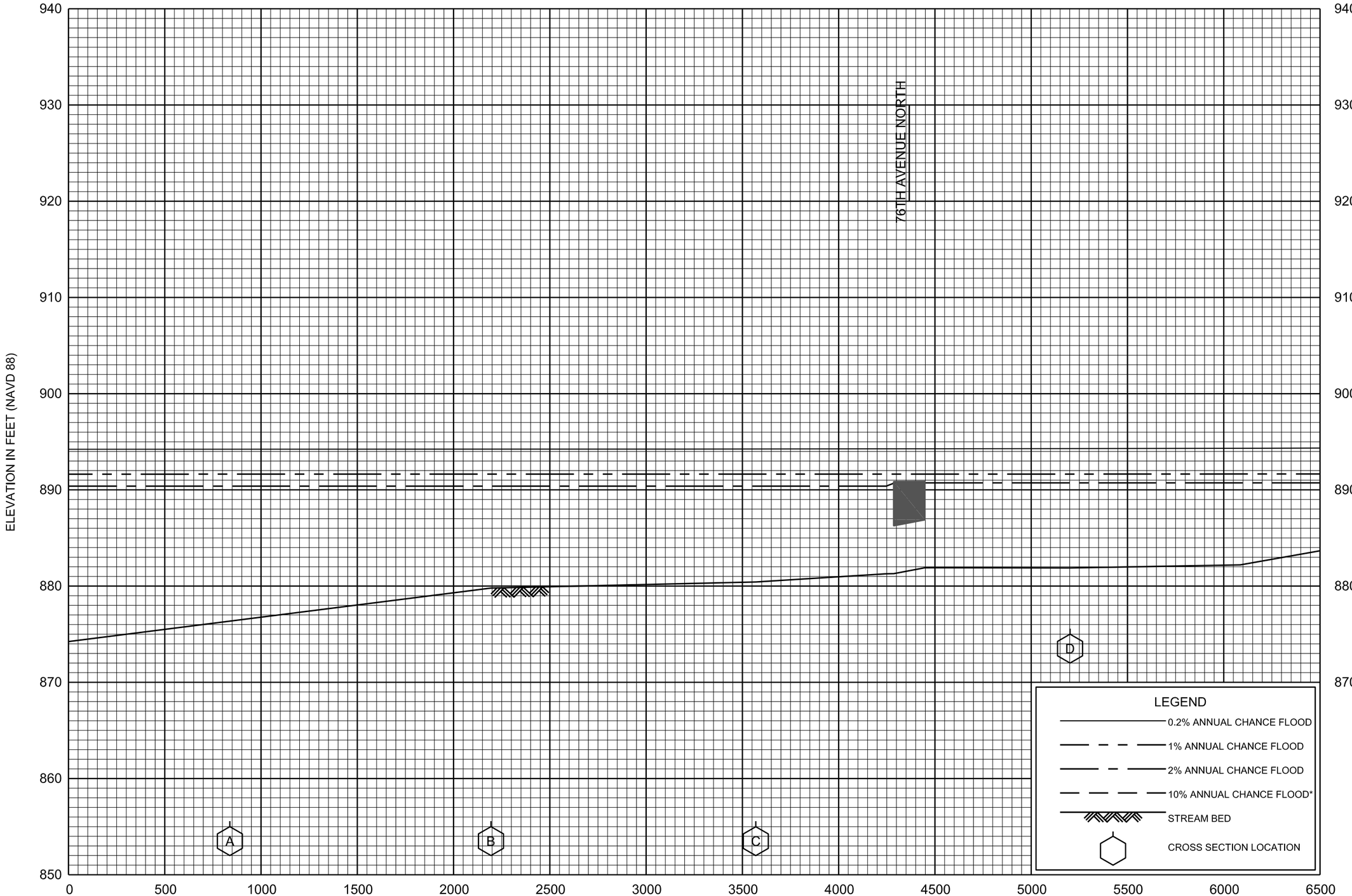



ELEVATION IN FEET (NAVD 88)

STREAM DISTANCE IN FEET ABOVE CONFLUENCE WITH RED RIVER OF THE NORTH

*DATA NOT AVAILABLE

# FLOOD PROFILES

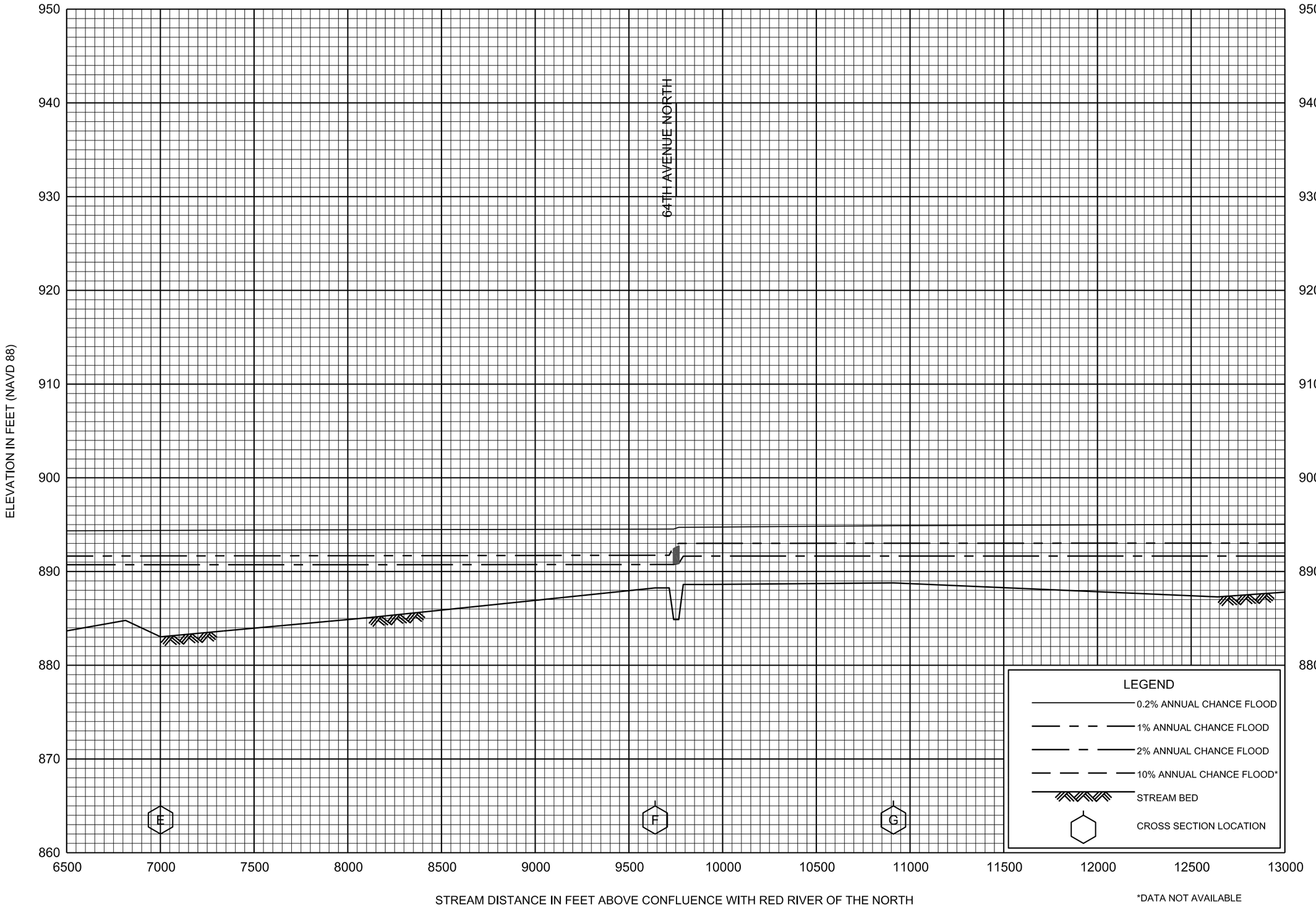
COUNTY DRAIN 10 BREAKOUT

FEDERAL EMERGENCY MANAGEMENT AGENCY

CASS COUNTY, ND

ALL JURISDICTIONS

01P




# FLOOD PROFILES

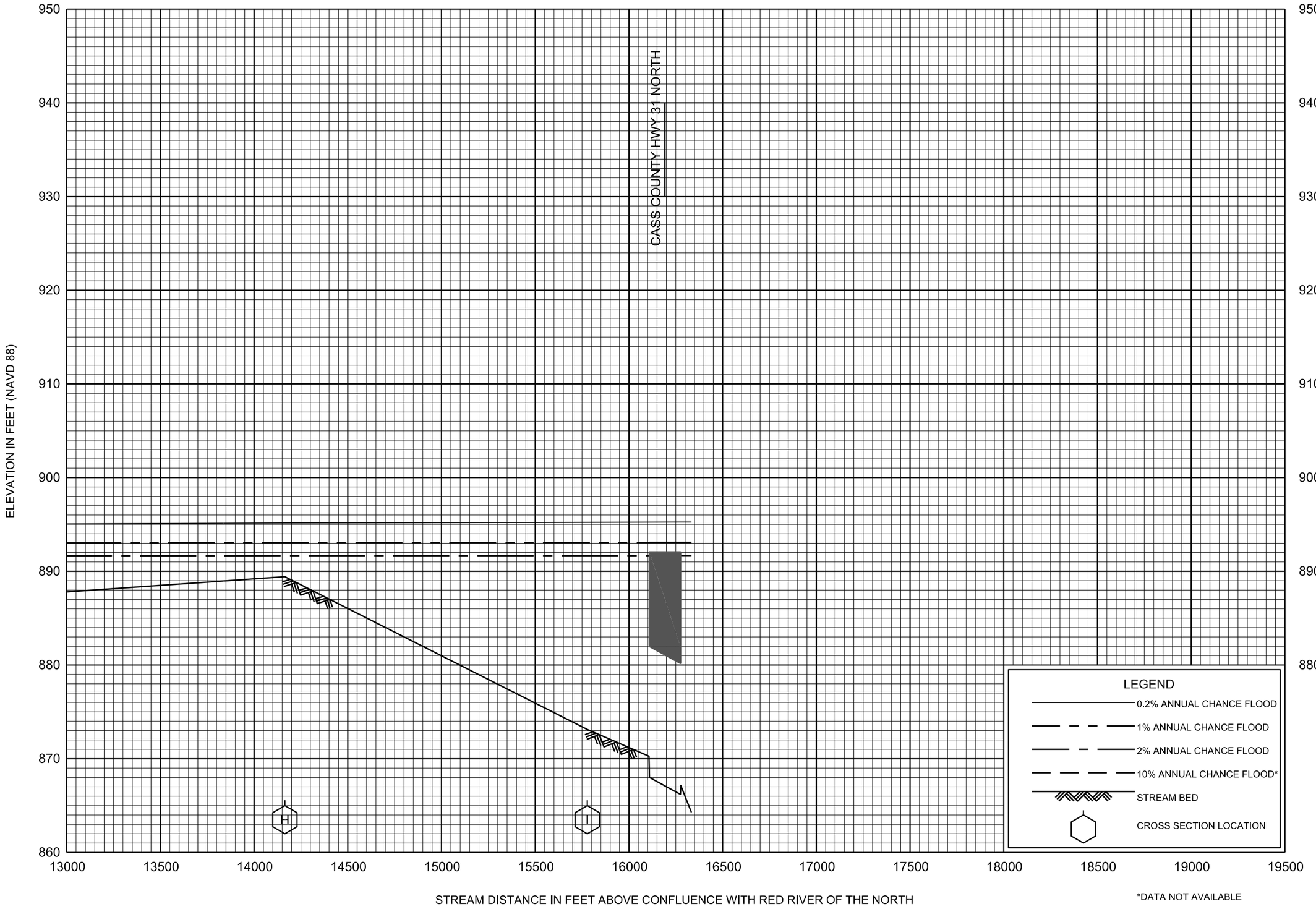
## COUNTY DRAIN 10 BREAKOUT

FEDERAL EMERGENCY MANAGEMENT AGENCY

CASS COUNTY, ND

ALL JURISDICTIONS

02P




# FLOOD PROFILES

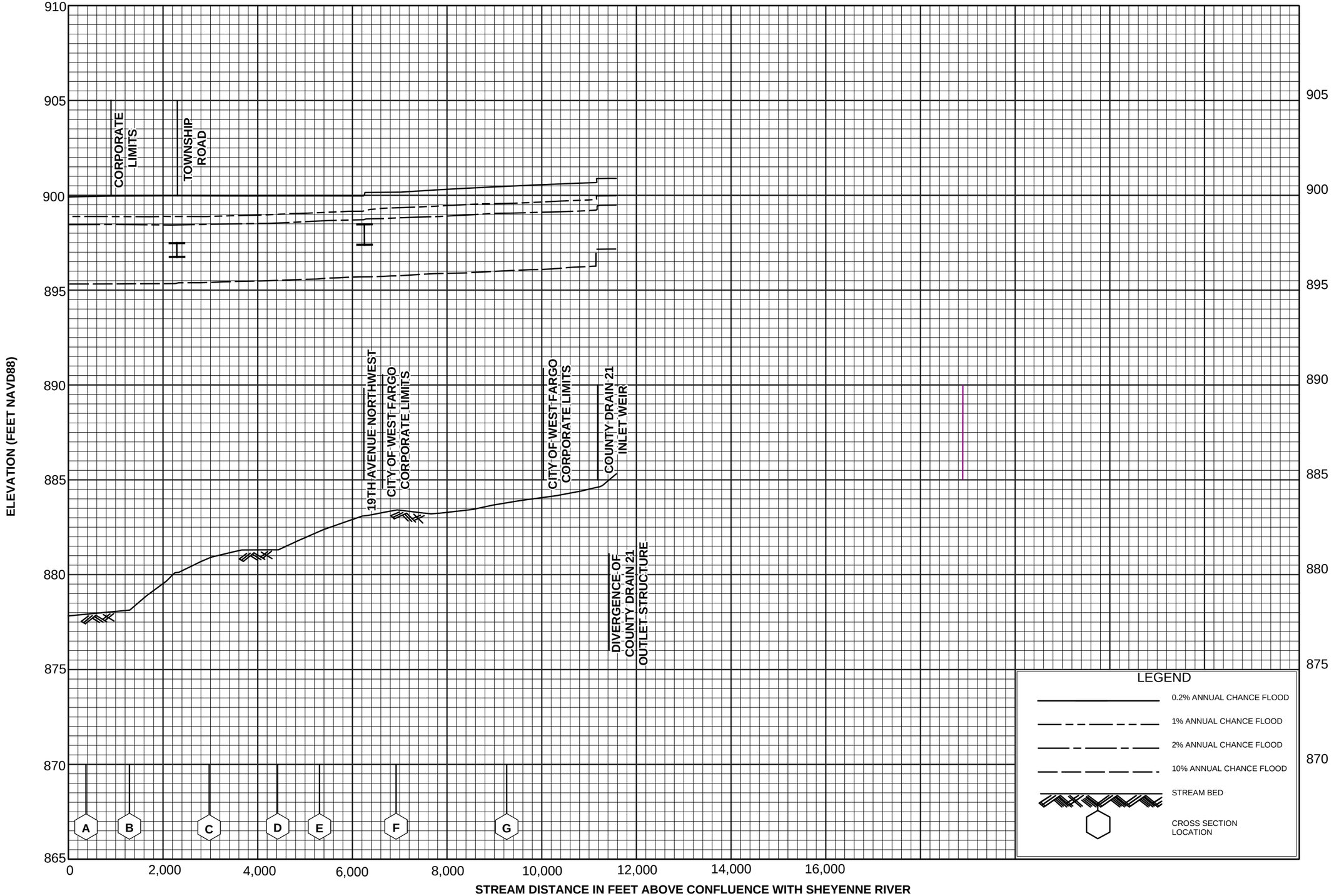
COUNTY DRAIN 10 BREAKOUT

FEDERAL EMERGENCY MANAGEMENT AGENCY

CASS COUNTY, ND

ALL JURISDICTIONS

03P



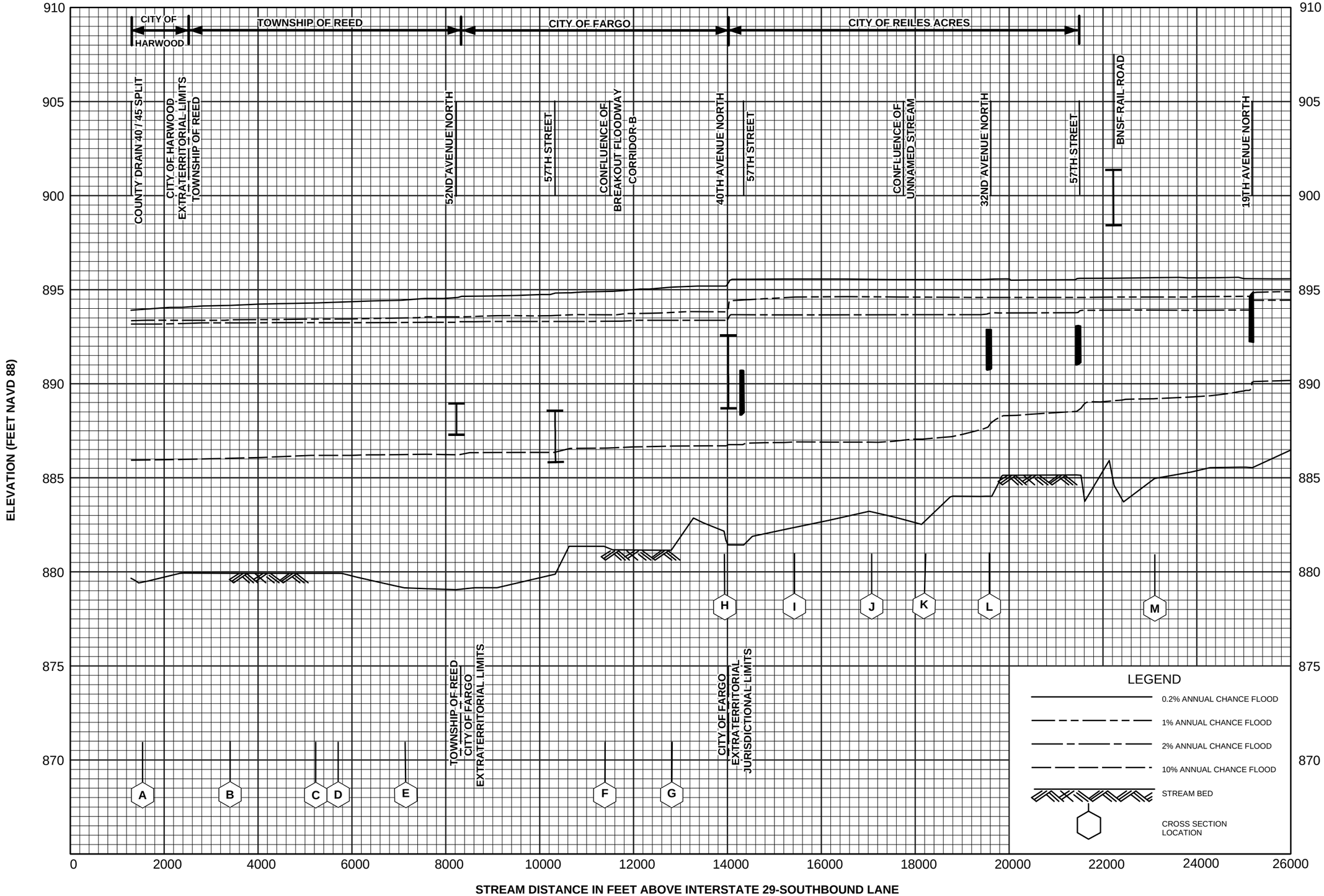

# FLOOD PROFILES

## COUNTY DRAIN 21

FEDERAL EMERGENCY MANAGEMENT AGENCY

**CASS COUNTY, ND**
ALL JURISDICTIONS

**04P**



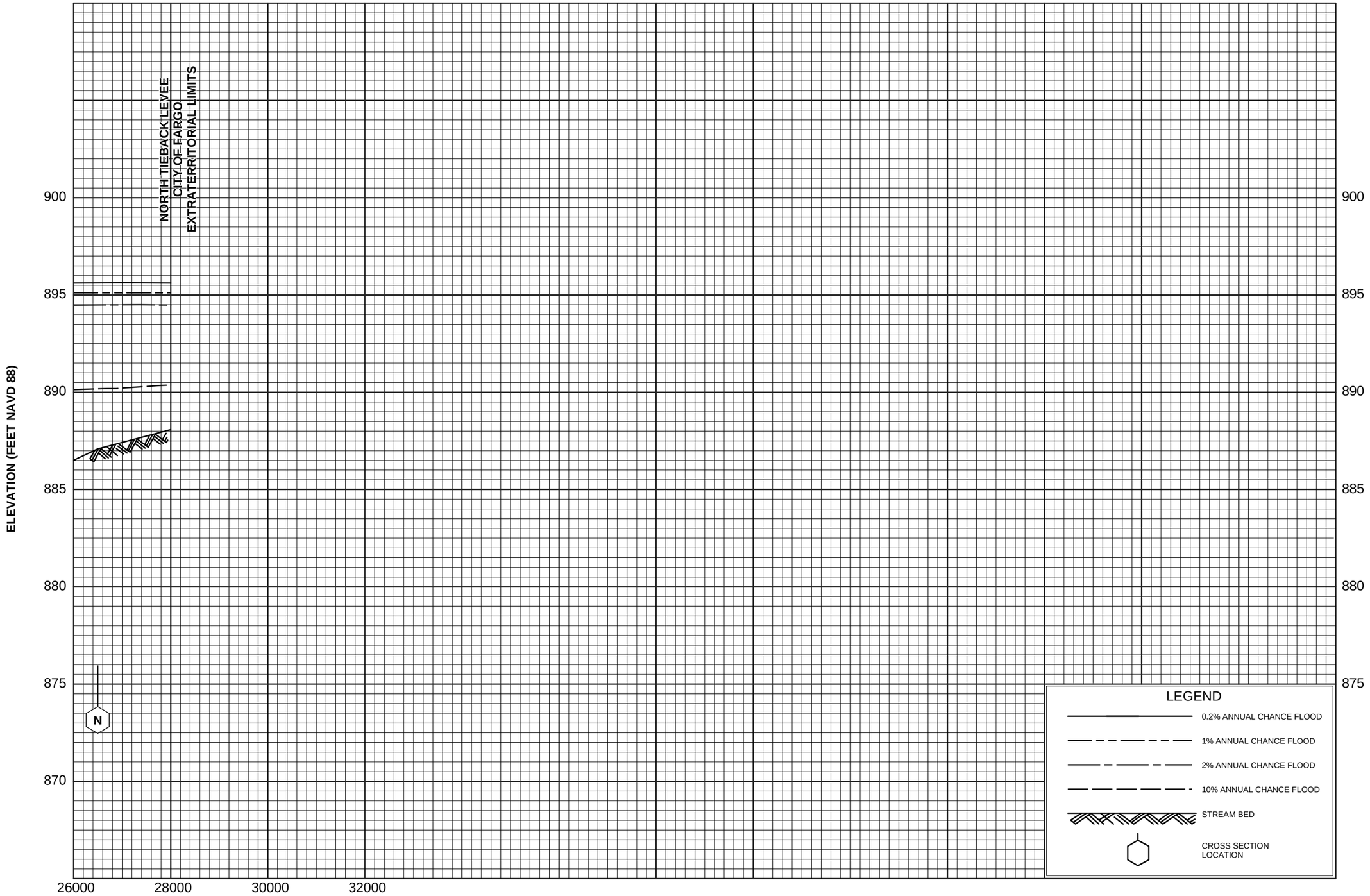

FLOOD PROFILES

COUNTY DRAIN 45

FEDERAL EMERGENCY MANAGEMENT AGENCY

CASS COUNTY, ND
ALL JURISDICTIONS

05P




STREAM DISTANCE IN FEET ABOVE INTERSTATE 29-SOUTHBOUND LANE

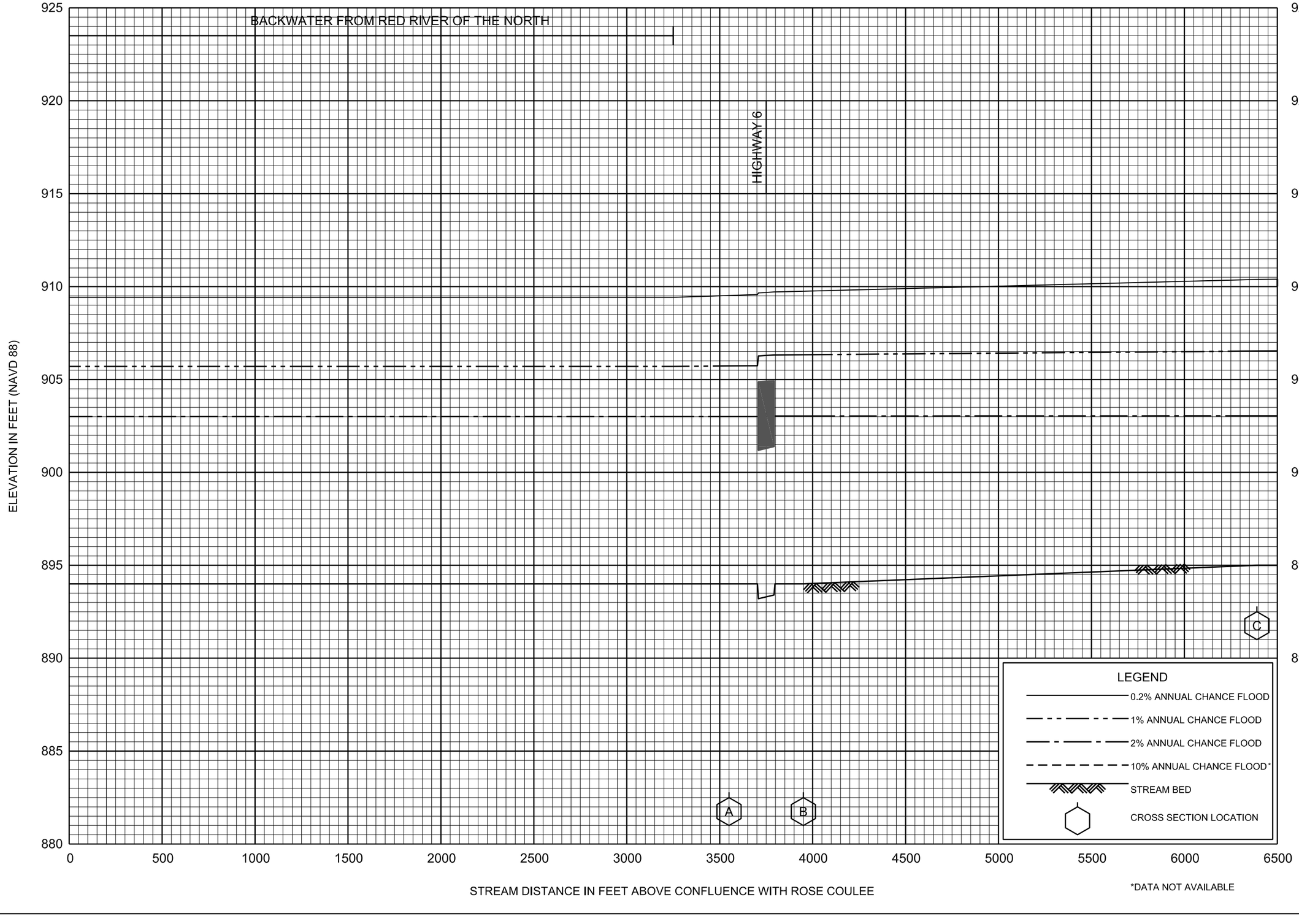
FLOOD PROFILES

COUNTY DRAIN 45

FEDERAL EMERGENCY MANAGEMENT AGENCY

**CASS COUNTY, ND**
**ALL JURISDICTIONS**

**06P**




FLOOD PROFILES

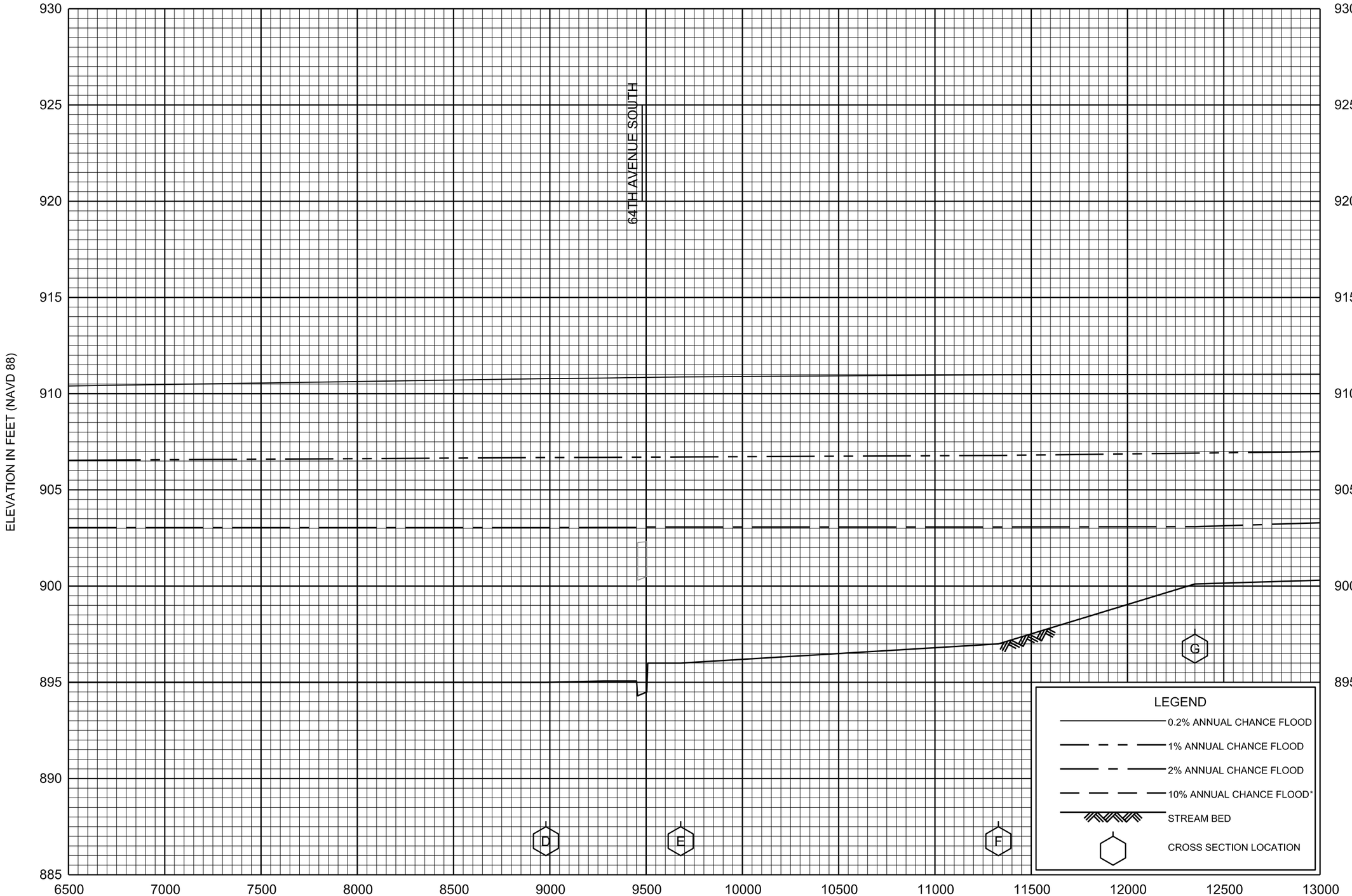
DRAIN 53 BREAKOUT

FEDERAL EMERGENCY MANAGEMENT AGENCY

CASS COUNTY, ND

ALL JURISDICTIONS

07P




FLOOD PROFILES

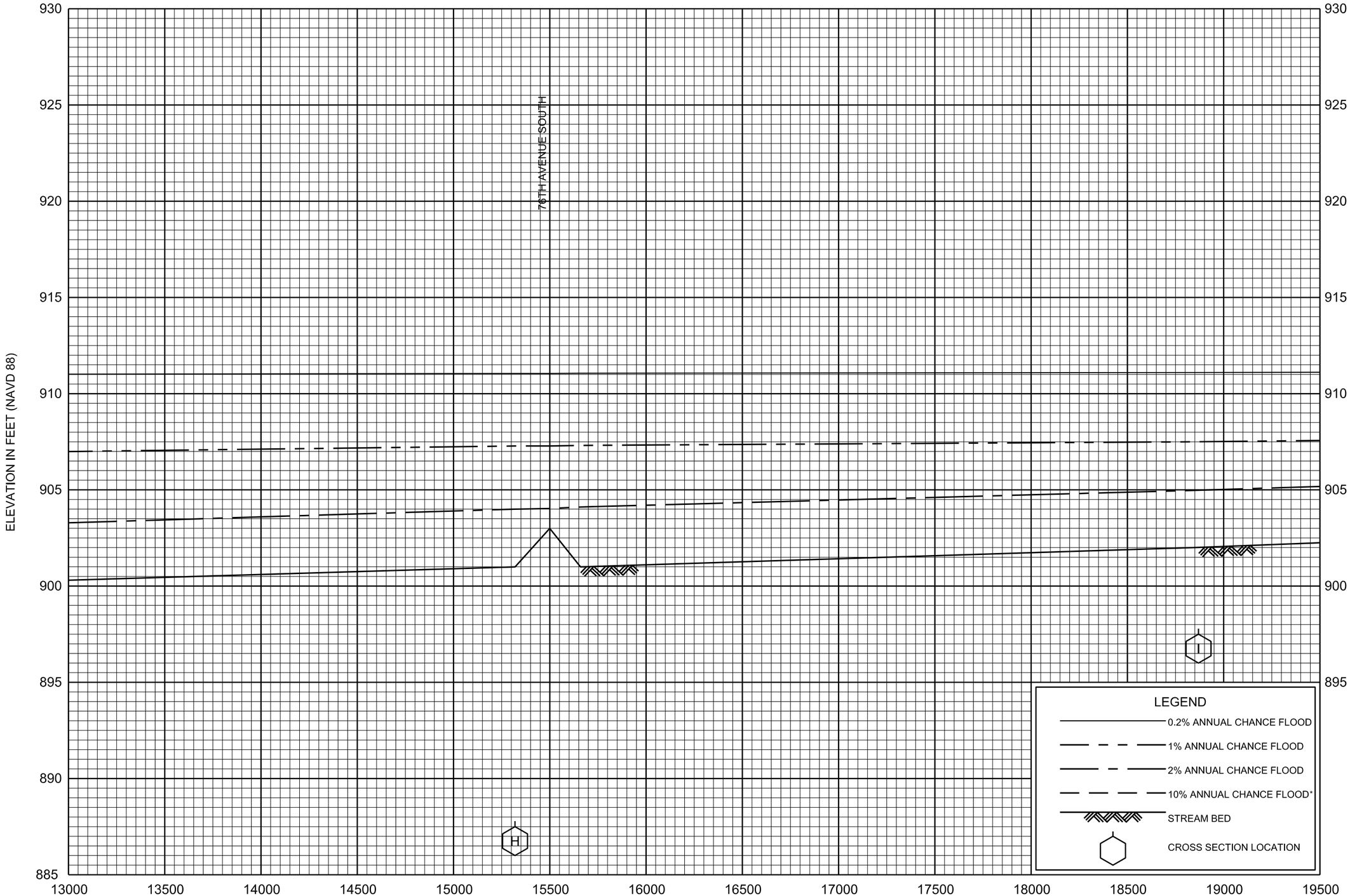
DRAIN 53 BREAKOUT

FEDERAL EMERGENCY MANAGEMENT AGENCY

CASS COUNTY, ND

ALL JURISDICTIONS

08P




ELEVATION IN FEET (NAVD 88)

STREAM DISTANCE IN FEET ABOVE CONFLUENCE WITH ROSE COULEE

*DATA NOT AVAILABLE

FLOOD PROFILES

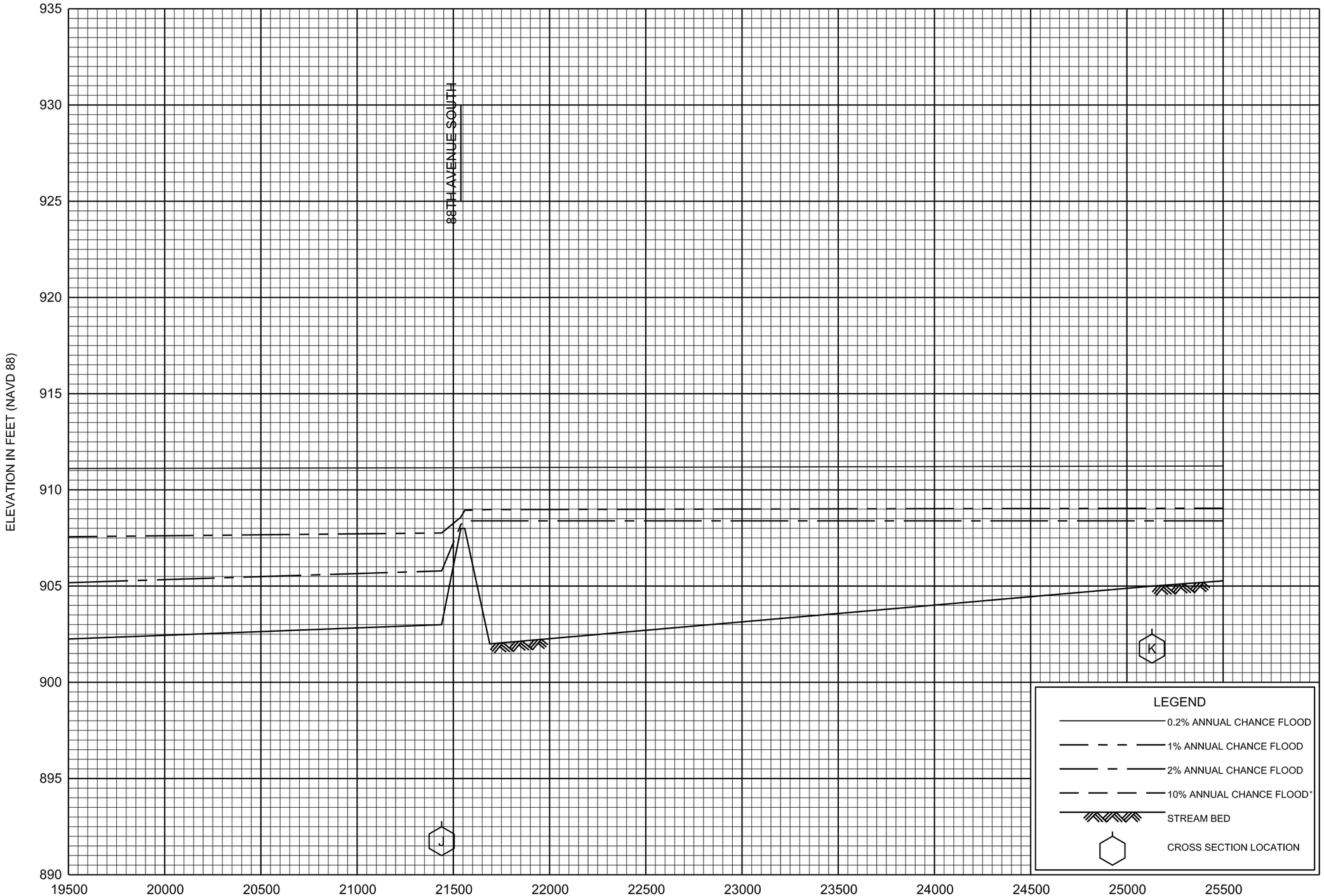
DRAIN 53 BREAKOUT

FEDERAL EMERGENCY MANAGEMENT AGENCY

CASS COUNTY, ND

ALL JURISDICTIONS

09P




FLOOD PROFILES

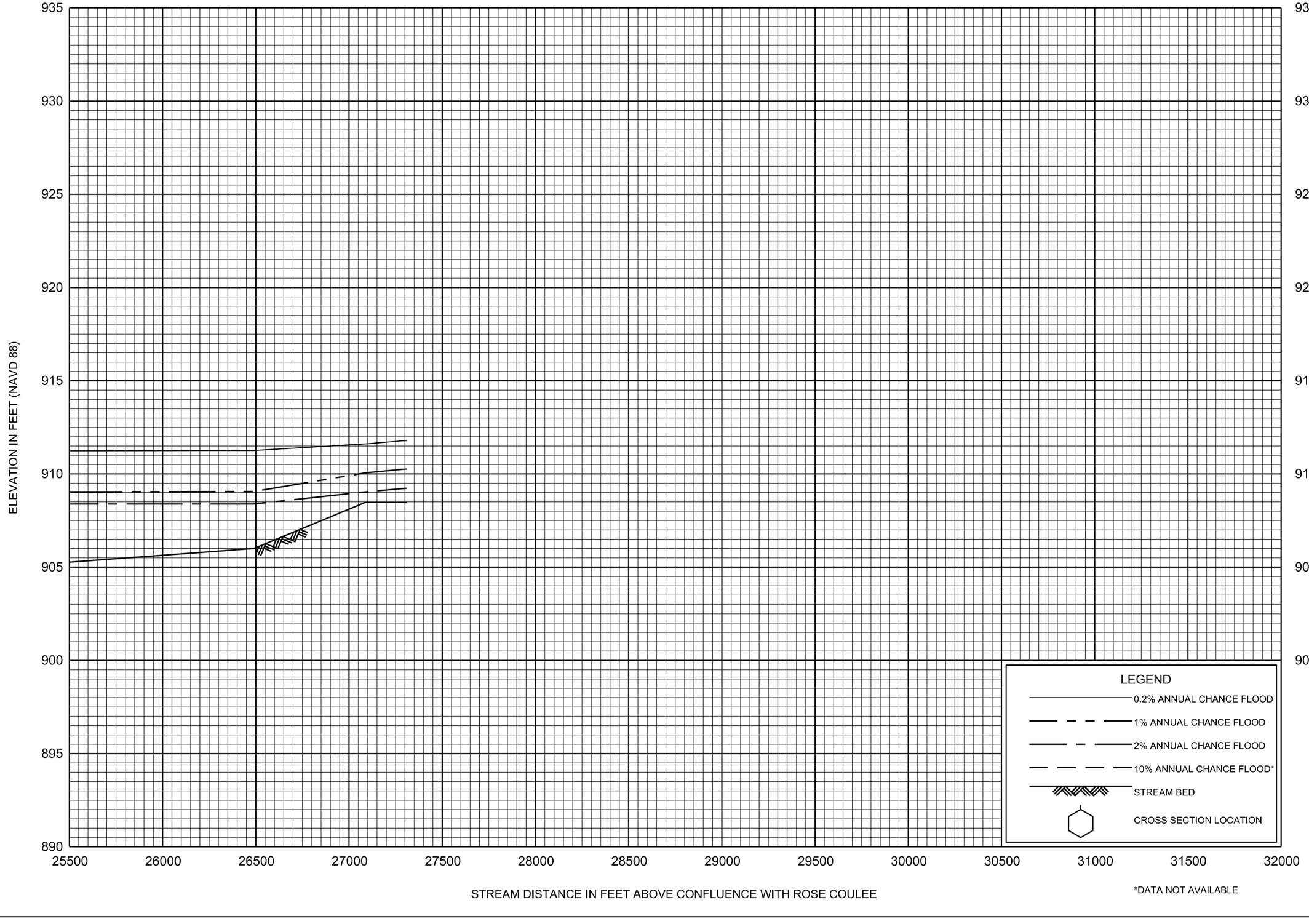
DRAIN 53 BREAKOUT

FEDERAL EMERGENCY MANAGEMENT AGENCY

CASS COUNTY, ND

ALL JURISDICTIONS

10P




FLOOD PROFILES

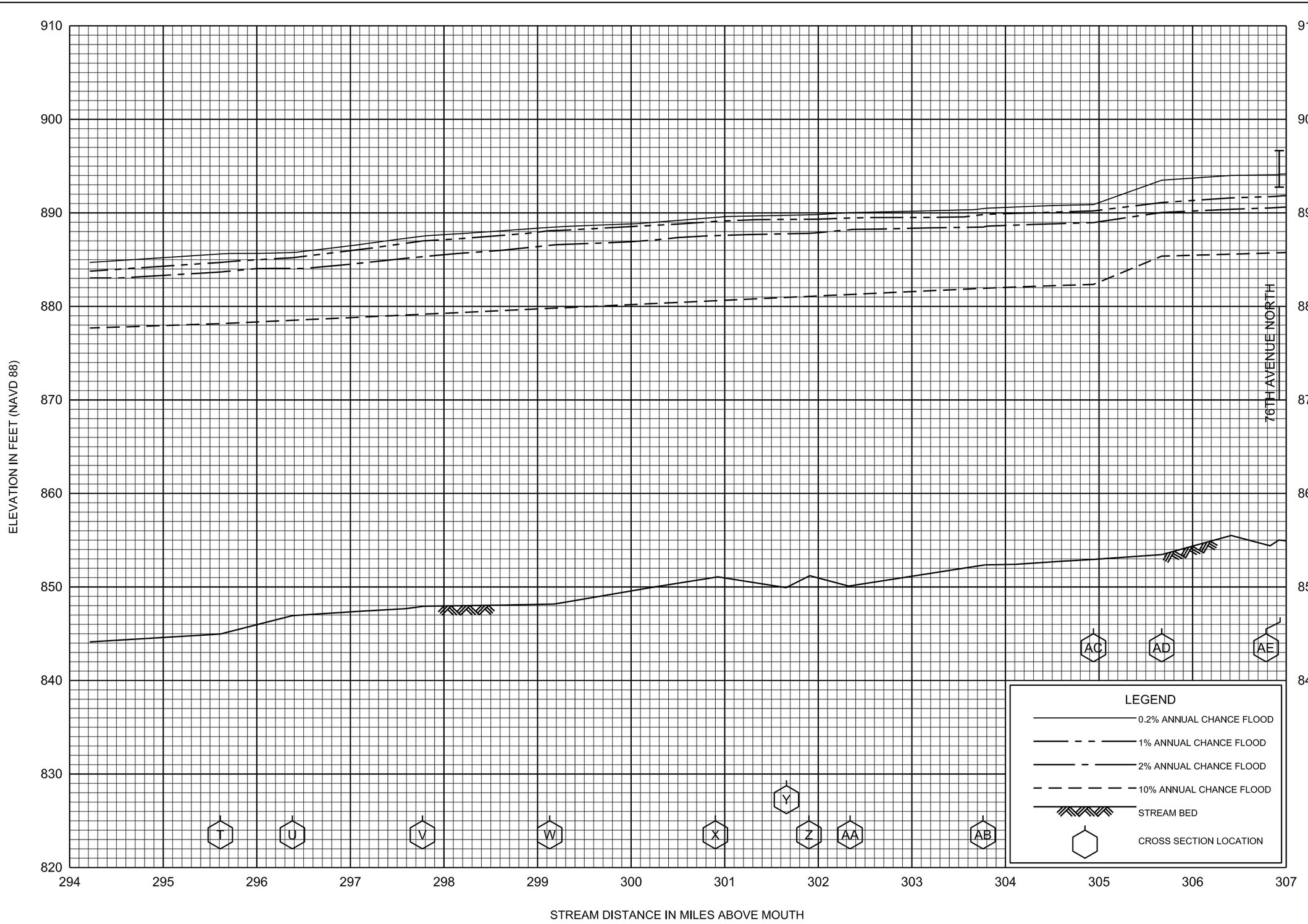
DRAIN 53 BREAKOUT

FEDERAL EMERGENCY MANAGEMENT AGENCY

CASS COUNTY, ND

ALL JURISDICTIONS

11P




FLOOD PROFILES

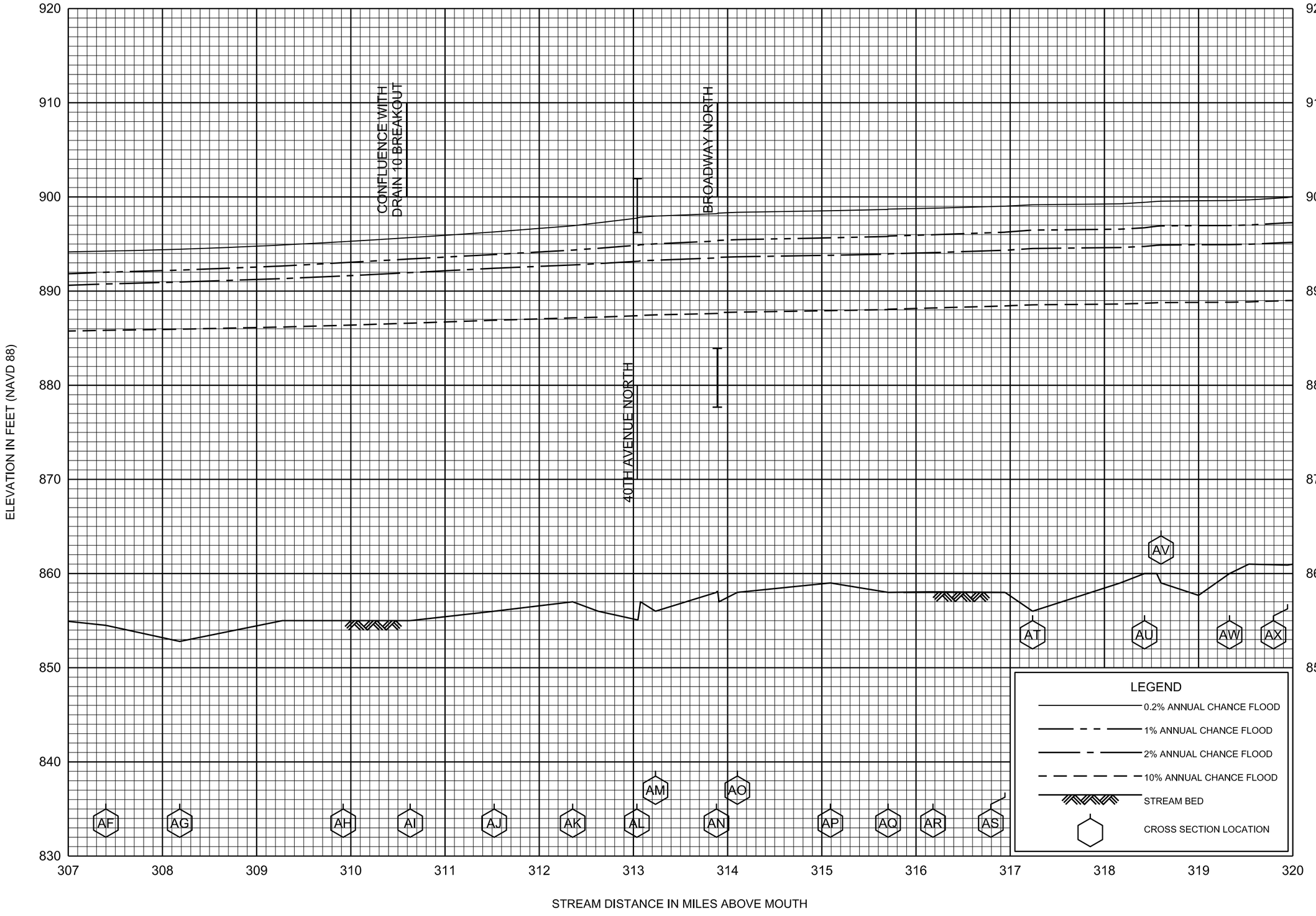
RED RIVER OF THE NORTH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CASS COUNTY, ND

ALL JURISDICTIONS

12P




FLOOD PROFILES

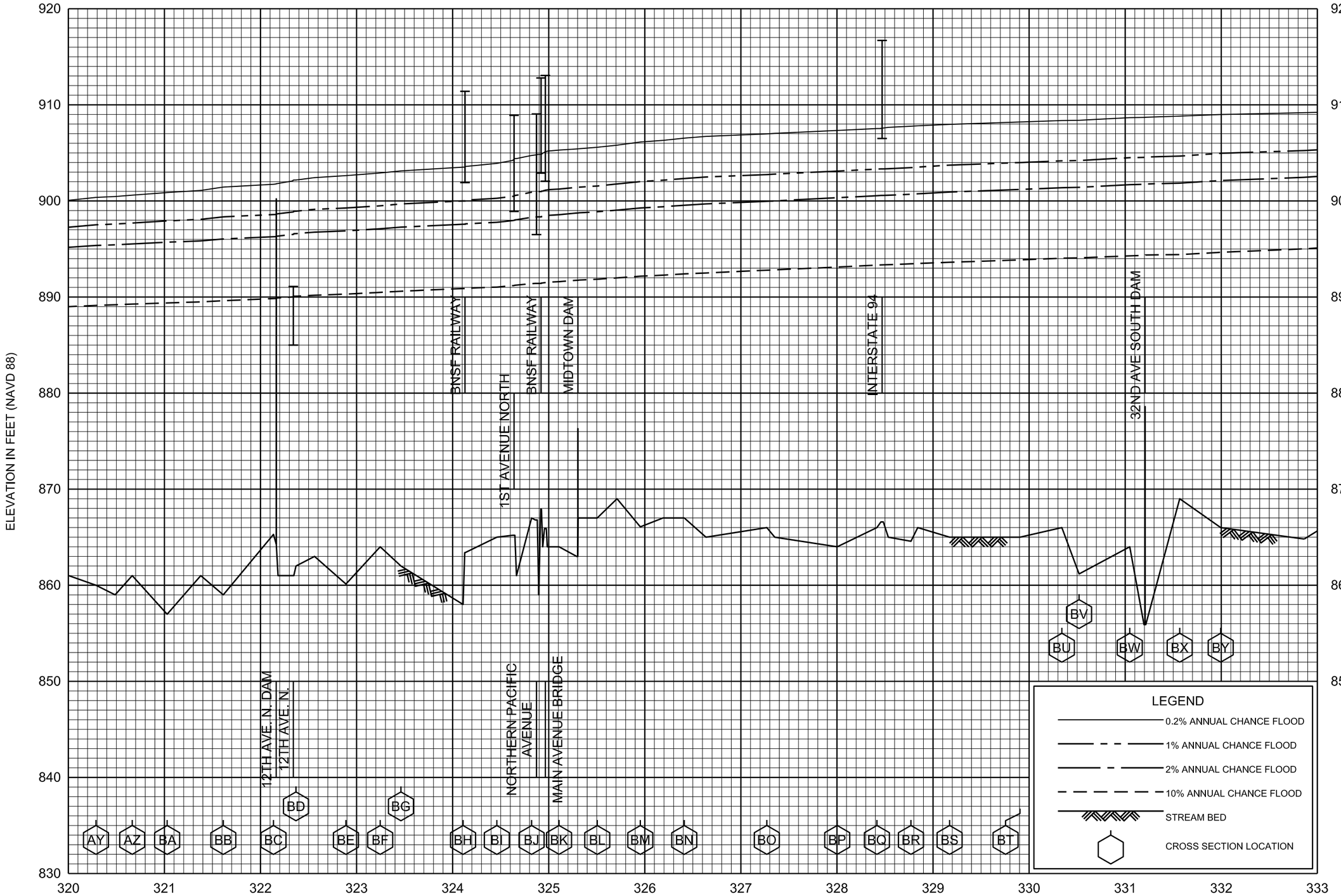
RED RIVER OF THE NORTH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CASS COUNTY, ND

ALL JURISDICTIONS

13P



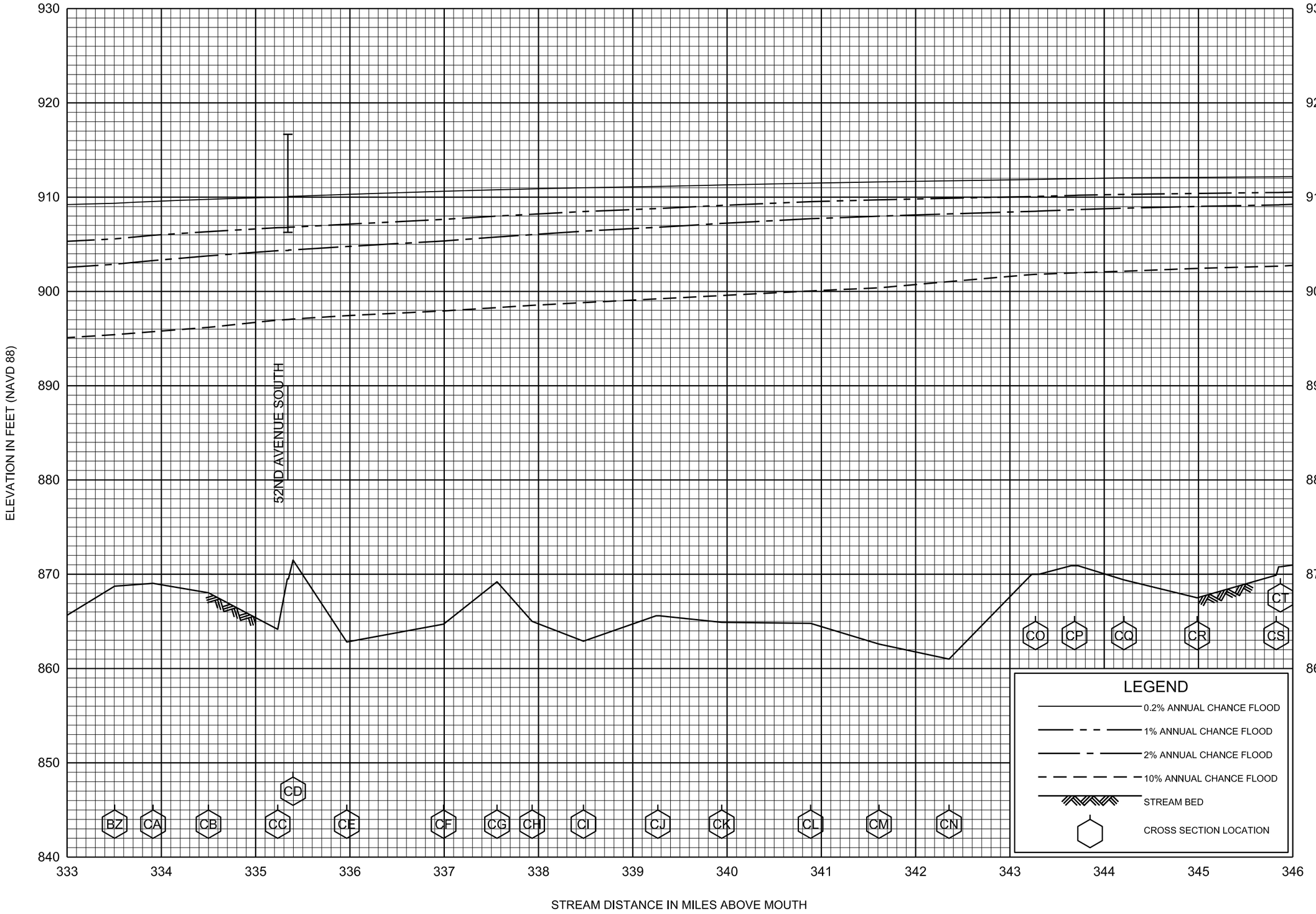

# FLOOD PROFILES

## RED RIVER OF THE NORTH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CASS COUNTY, ND

ALL JURISDICTIONS




FLOOD PROFILES

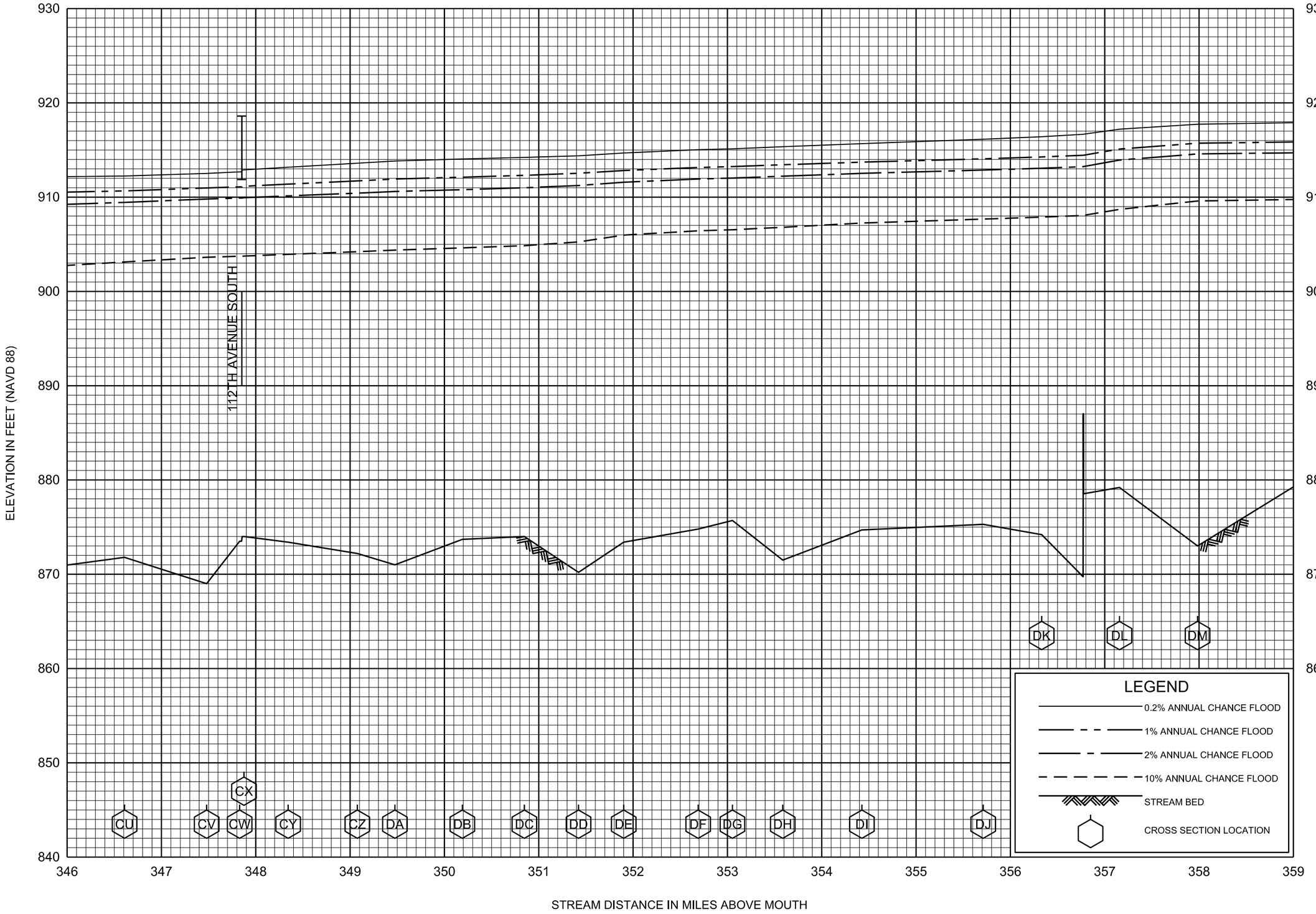
RED RIVER OF THE NORTH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CASS COUNTY, ND

ALL JURISDICTIONS

15P




FLOOD PROFILES

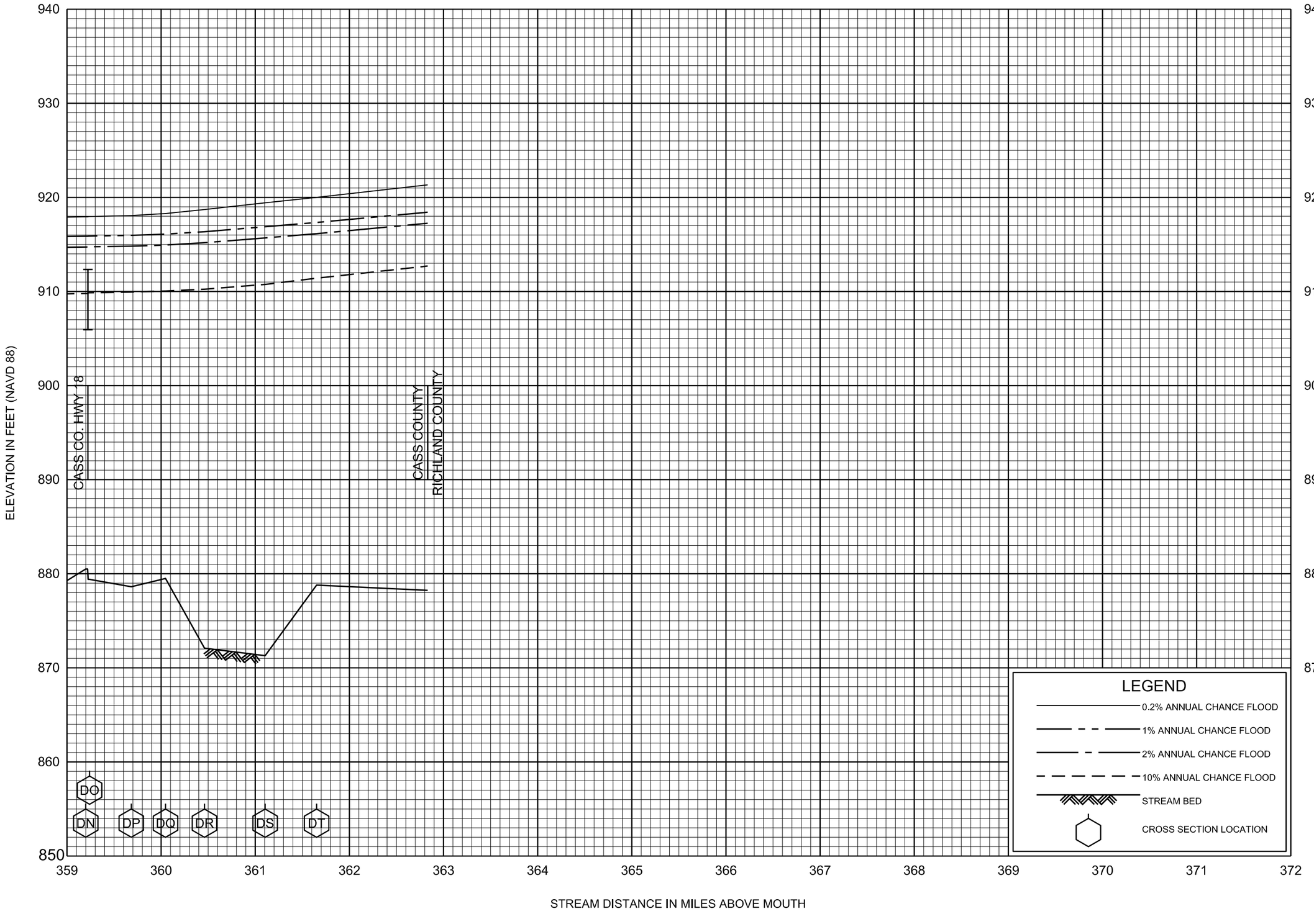
RED RIVER OF THE NORTH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CASS COUNTY, ND

ALL JURISDICTIONS

16P




FLOOD PROFILES

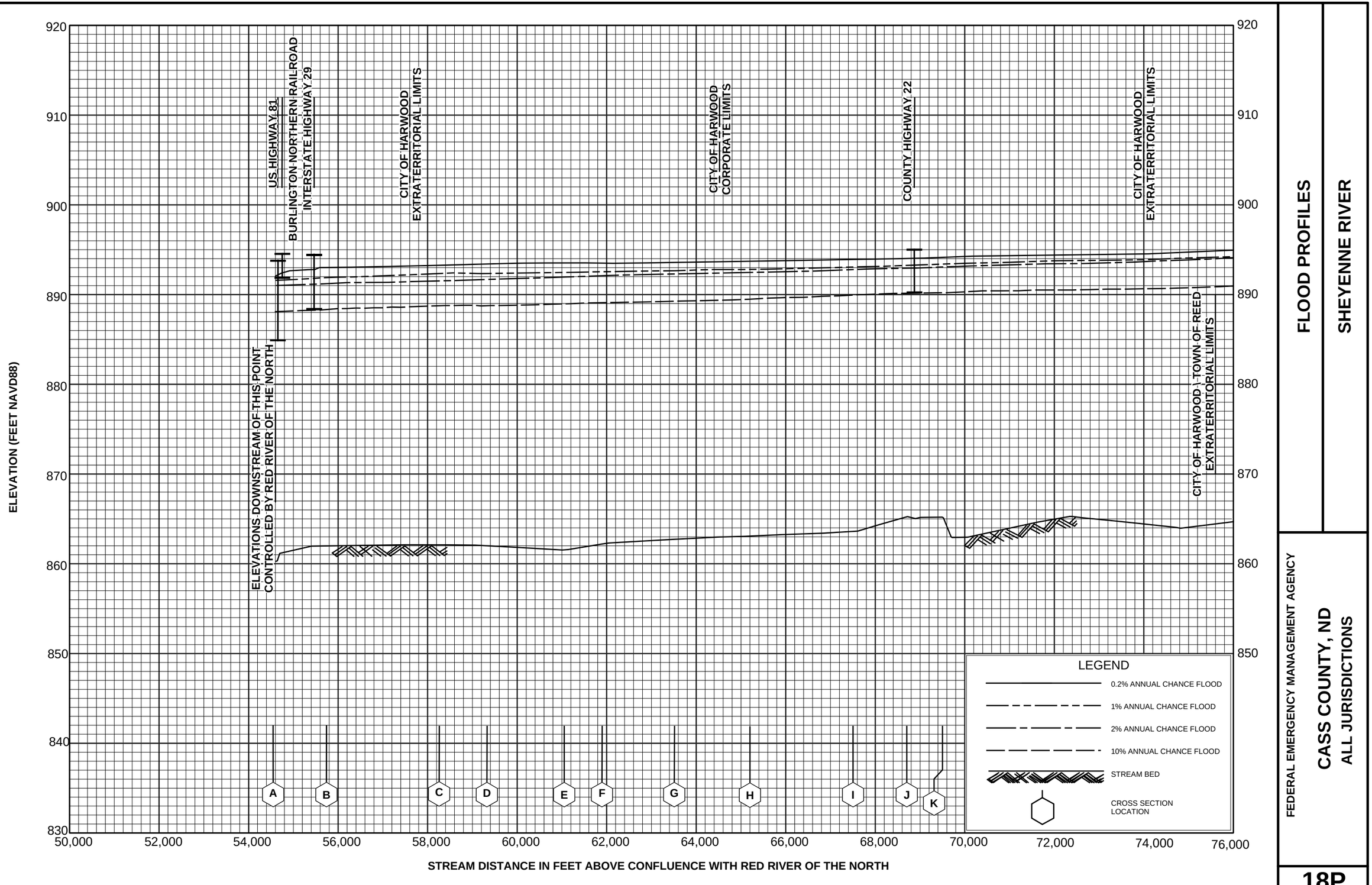
RED RIVER OF THE NORTH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CASS COUNTY, ND

ALL JURISDICTIONS

17P



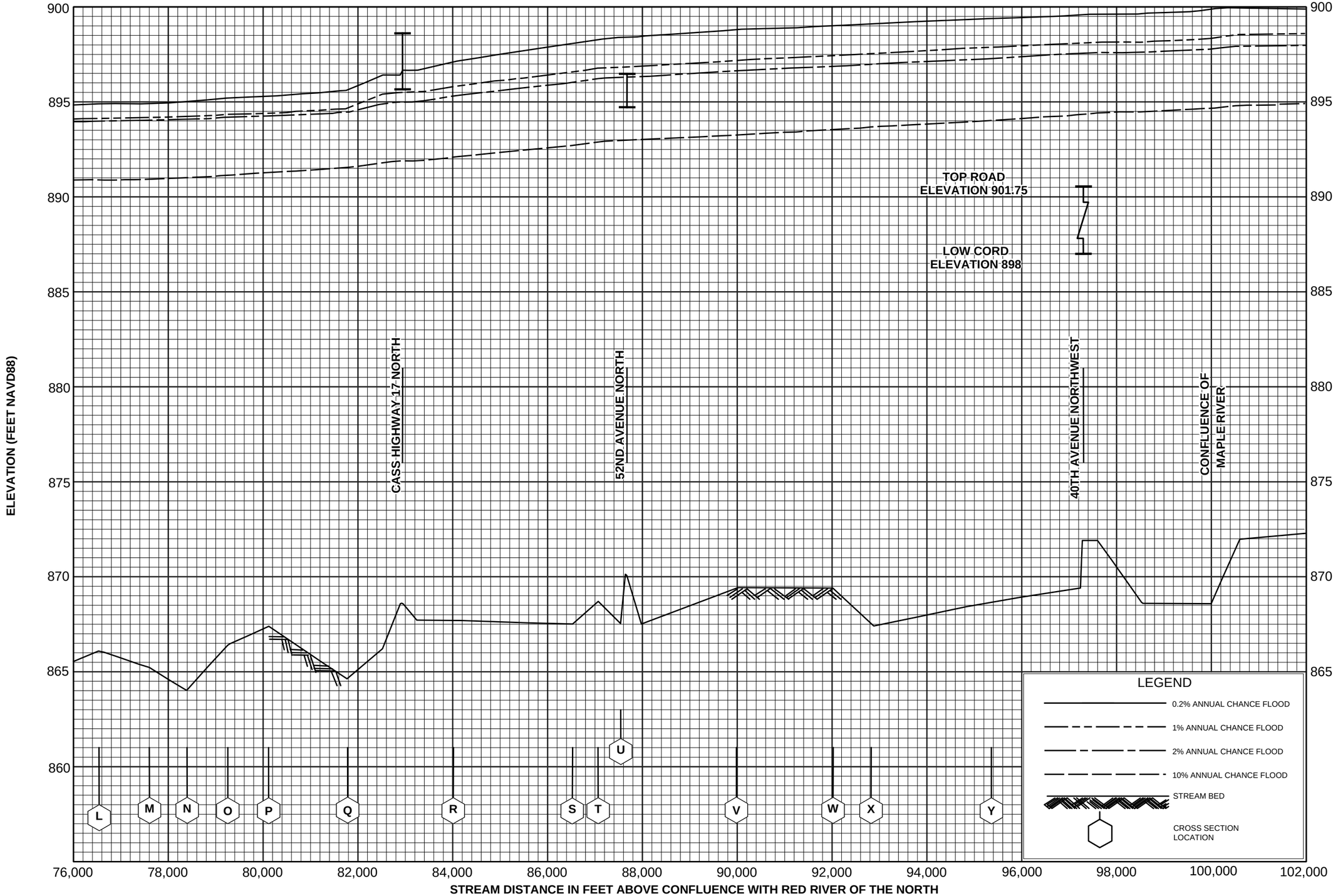

**FLOOD PROFILES**

**SHEYENNE RIVER**

FEDERAL EMERGENCY MANAGEMENT AGENCY

**CASS COUNTY, ND**
**ALL JURISDICTIONS**

**18P**



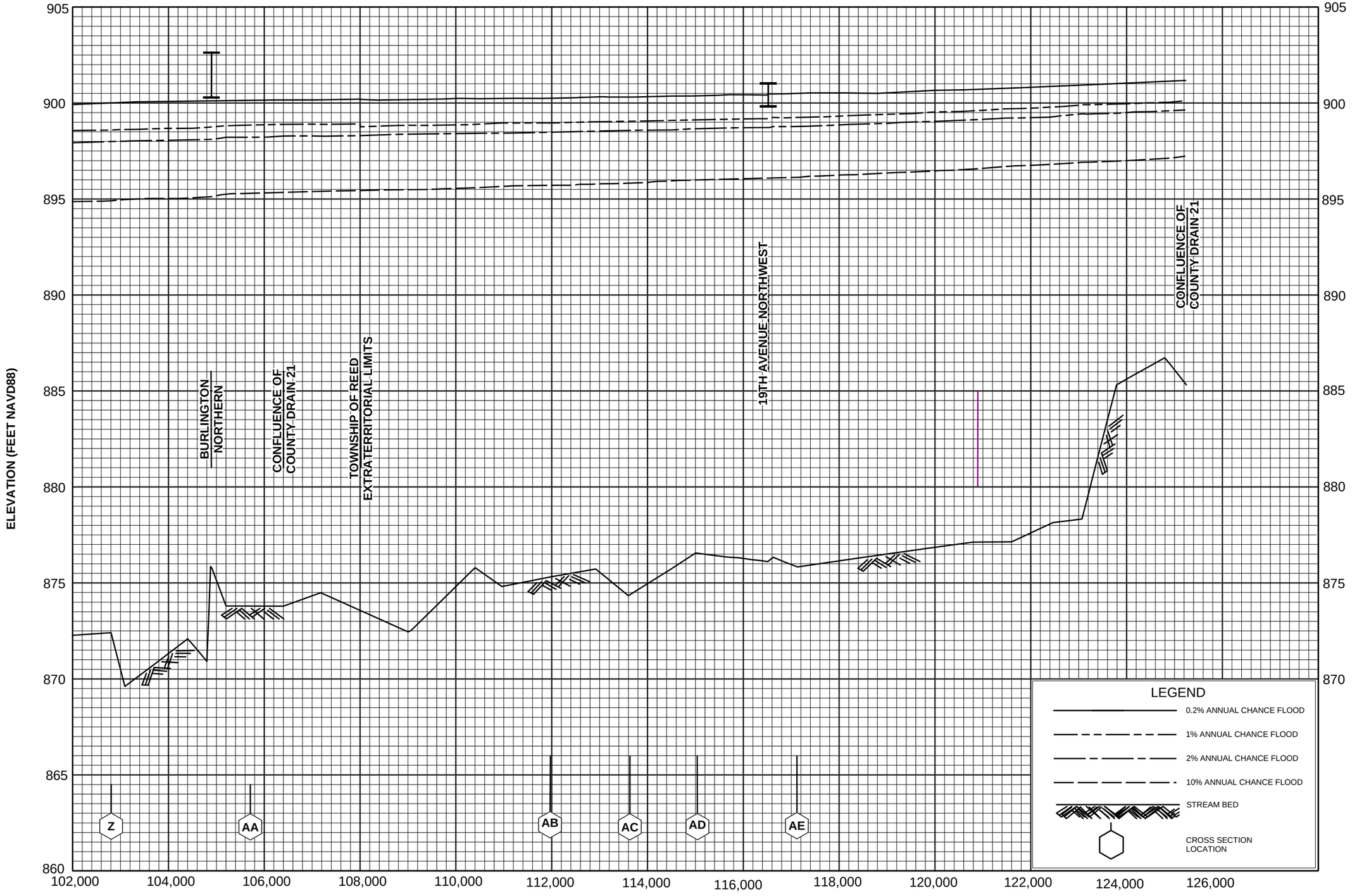

FLOOD PROFILES

SHEYENNE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CASS COUNTY, ND
ALL JURISDICTIONS

19P

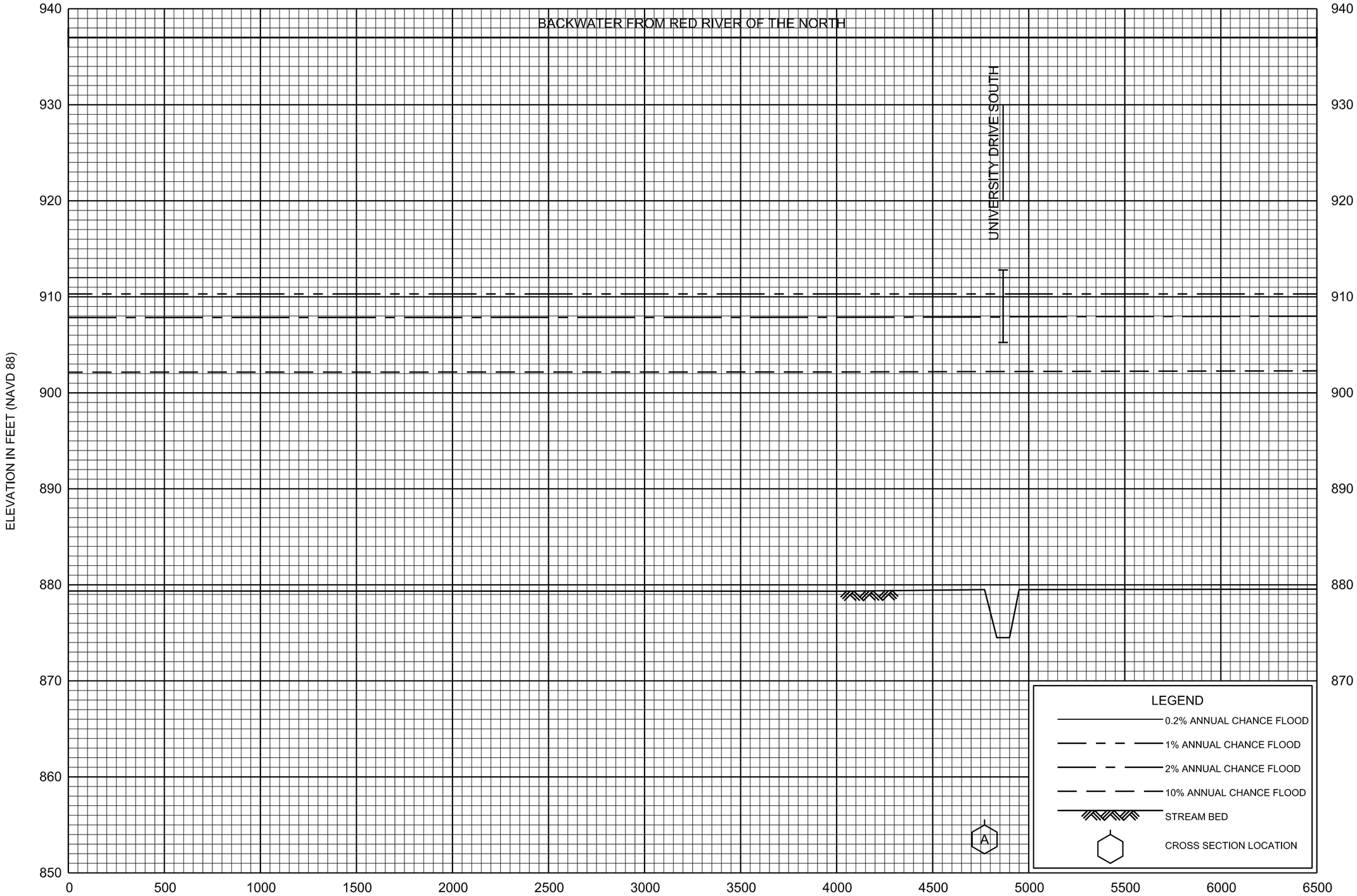



# FLOOD PROFILES

## SHEYENNE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CASS COUNTY, ND
ALL JURISDICTIONS




FLOOD PROFILES

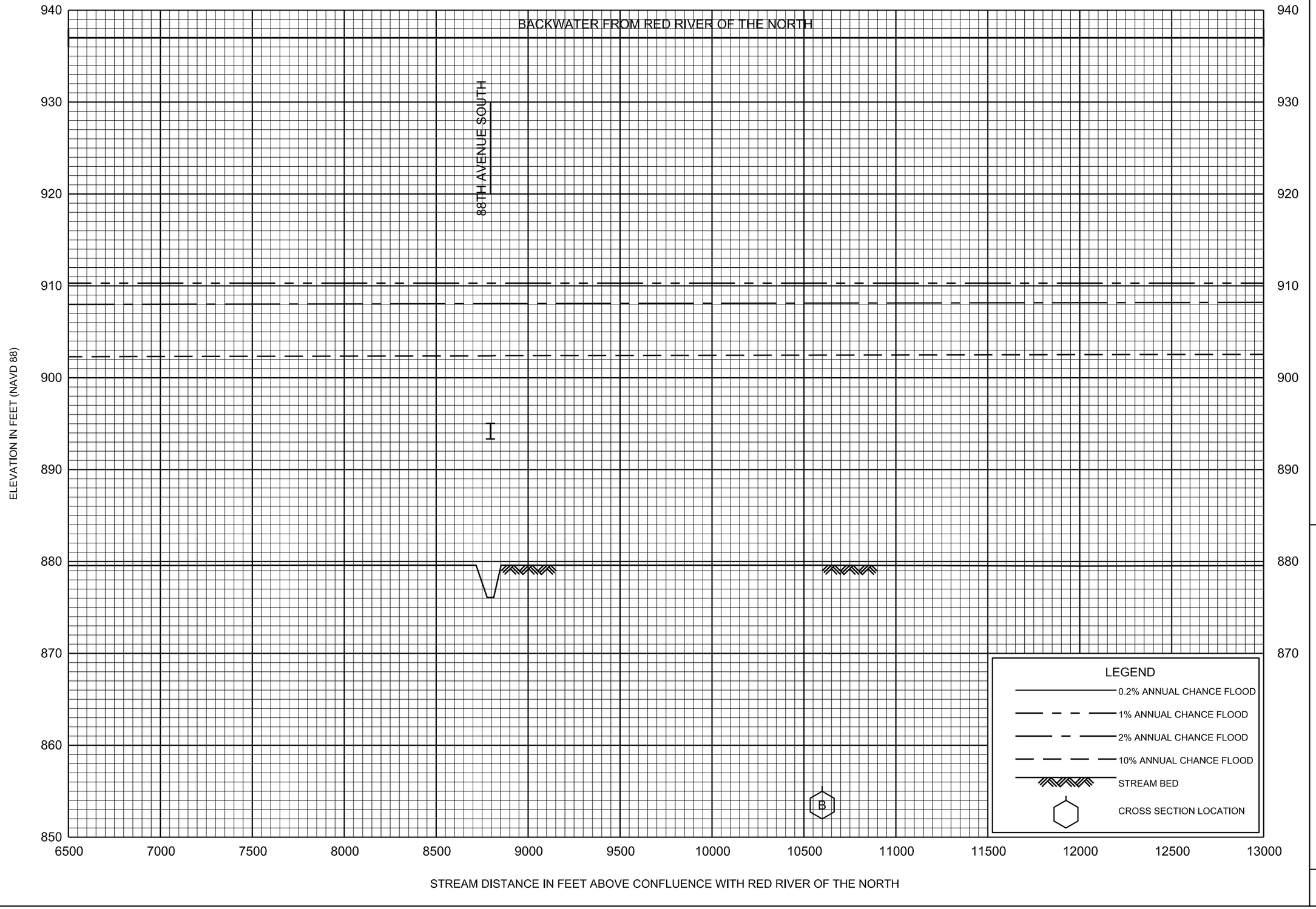
WILD RICE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CASS COUNTY, ND

ALL JURISDICTIONS

21P




FLOOD PROFILES

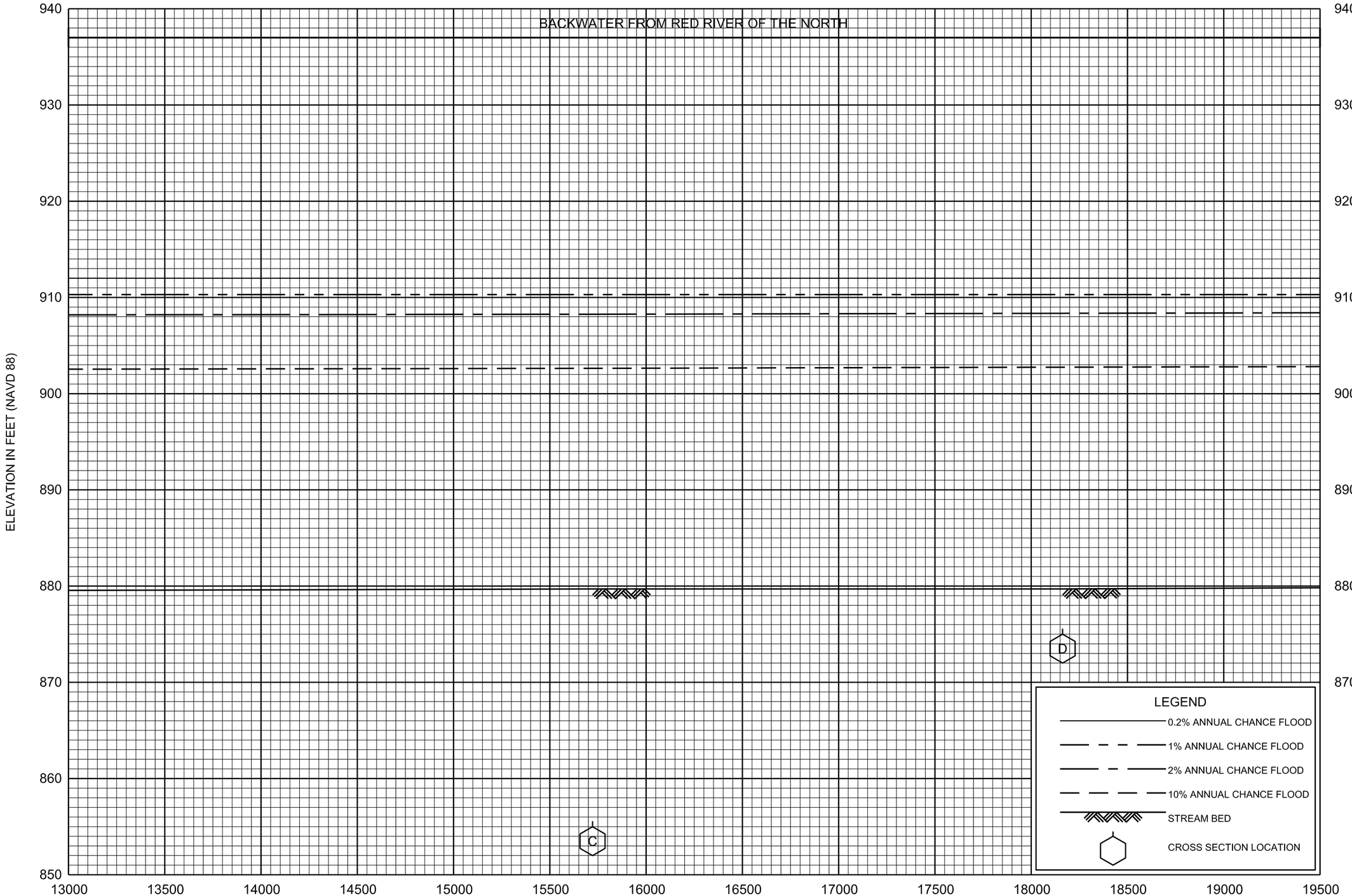
WILD RICE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CASS COUNTY, ND

ALL JURISDICTIONS

22P




FLOOD PROFILES

WILD RICE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CASS COUNTY, ND

ALL JURISDICTIONS

23P

BACKWATER FROM RED RIVER OF THE NORTH

ELEVATION IN FEET (NAVD 88)

950
940
930
920
910
900
890
880
870
860

19500 20000 20500 21000 21500 22000 22500 23000 23500 24000 24500 25000 25500 26000

STREAM DISTANCE IN FEET ABOVE CONFLUENCE WITH RED RIVER OF THE NORTH

E

F

LEGEND

- 0.2% ANNUAL CHANCE FLOOD
- 1% ANNUAL CHANCE FLOOD
- 2% ANNUAL CHANCE FLOOD
- 10% ANNUAL CHANCE FLOOD
- STREAM BED
- CROSS SECTION LOCATION

FLOOD PROFILES

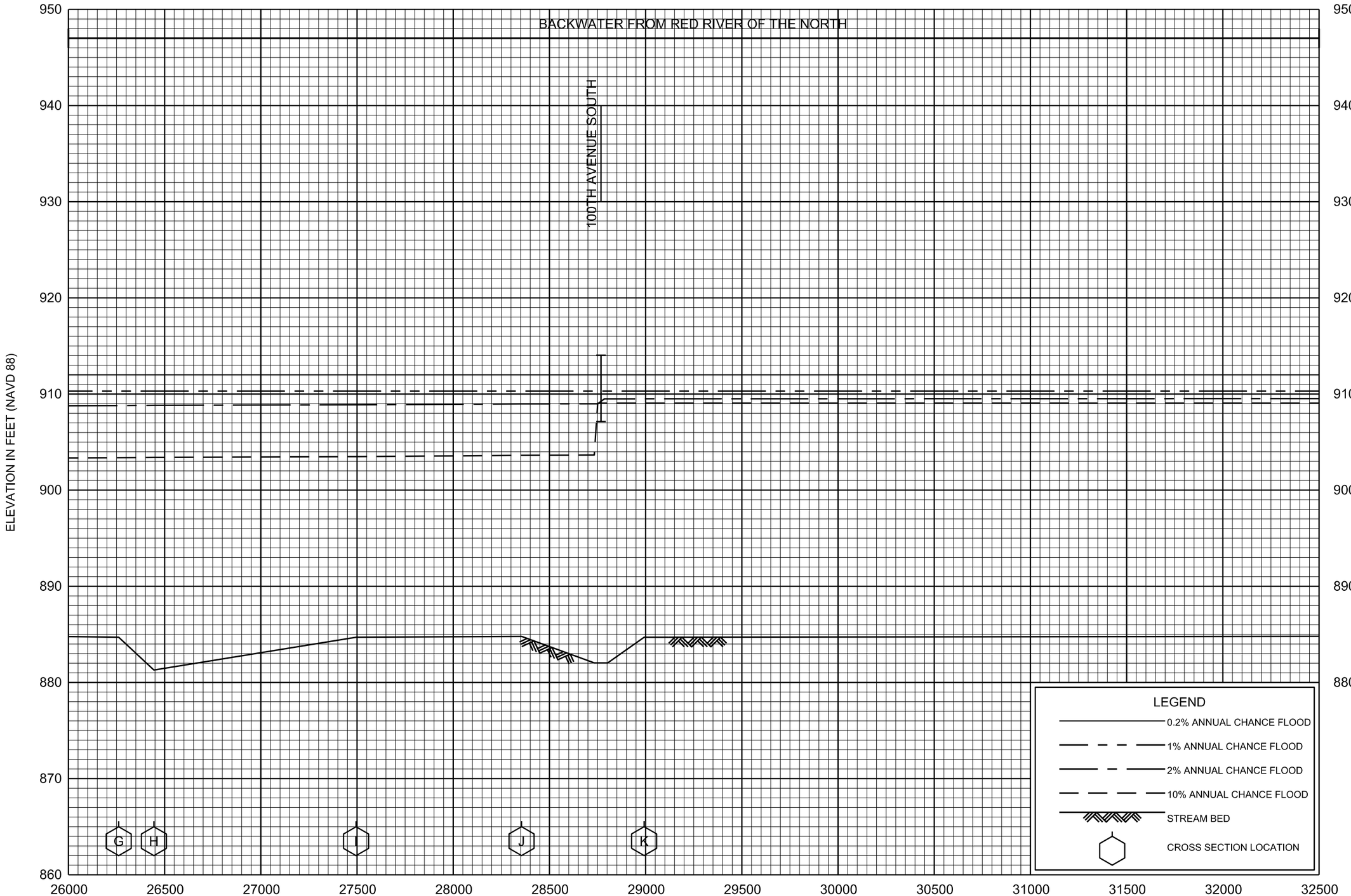
WILD RICE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CASS COUNTY, ND

ALL JURISDICTIONS

24P




FLOOD PROFILES

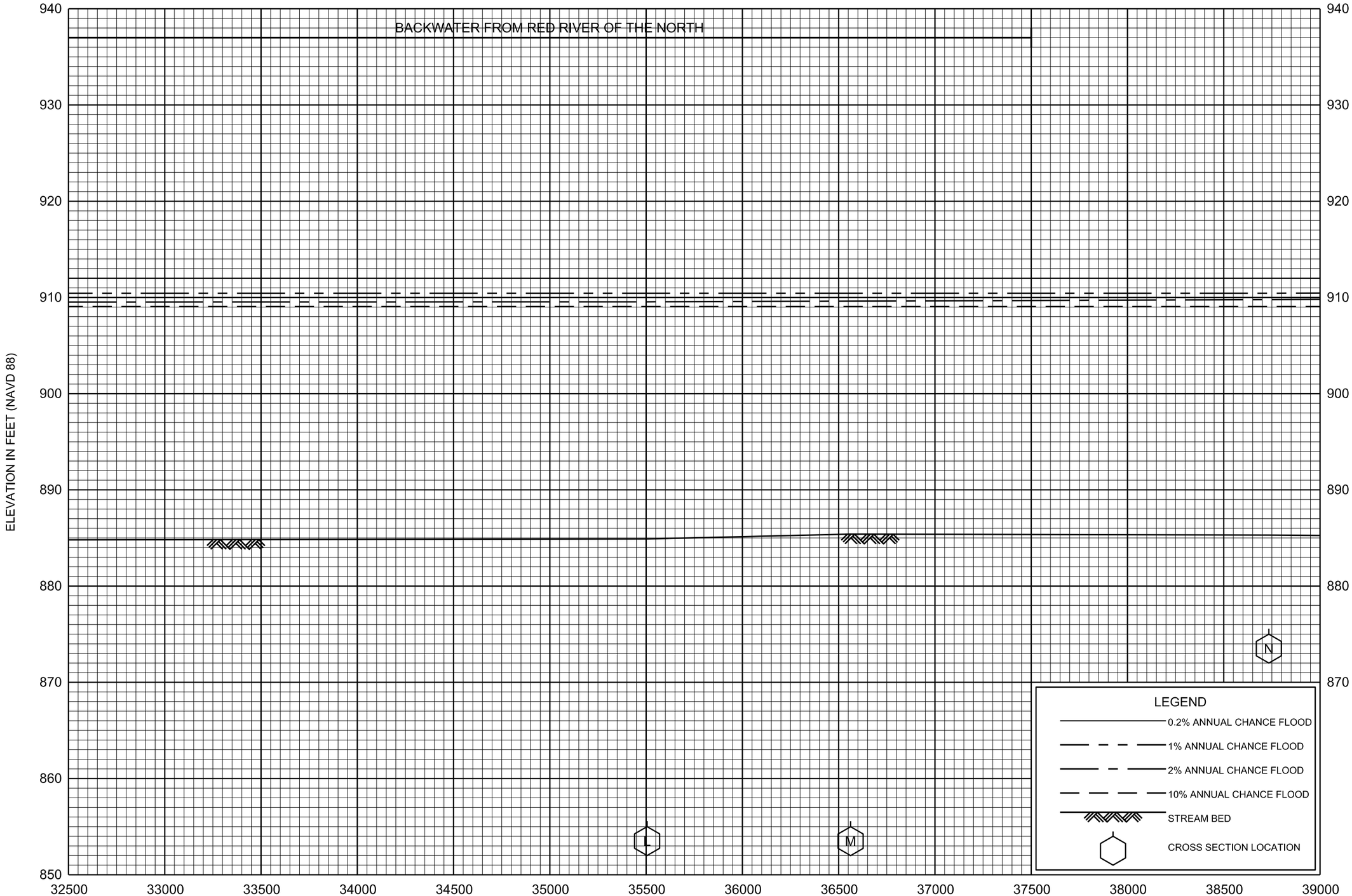
WILD RICE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CASS COUNTY, ND

ALL JURISDICTIONS

25P




FLOOD PROFILES

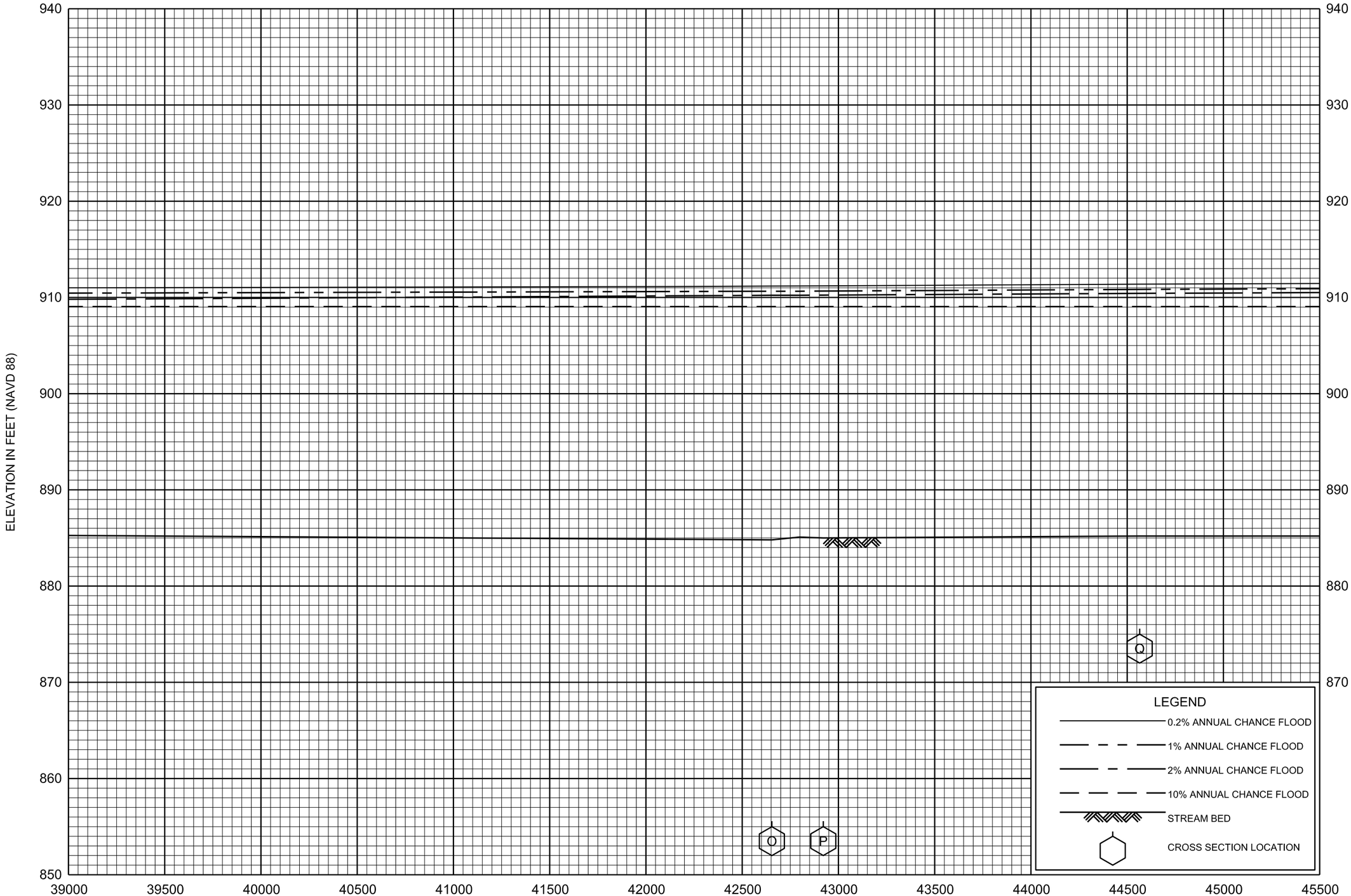
WILD RICE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CASS COUNTY, ND

ALL JURISDICTIONS

26P




FLOOD PROFILES

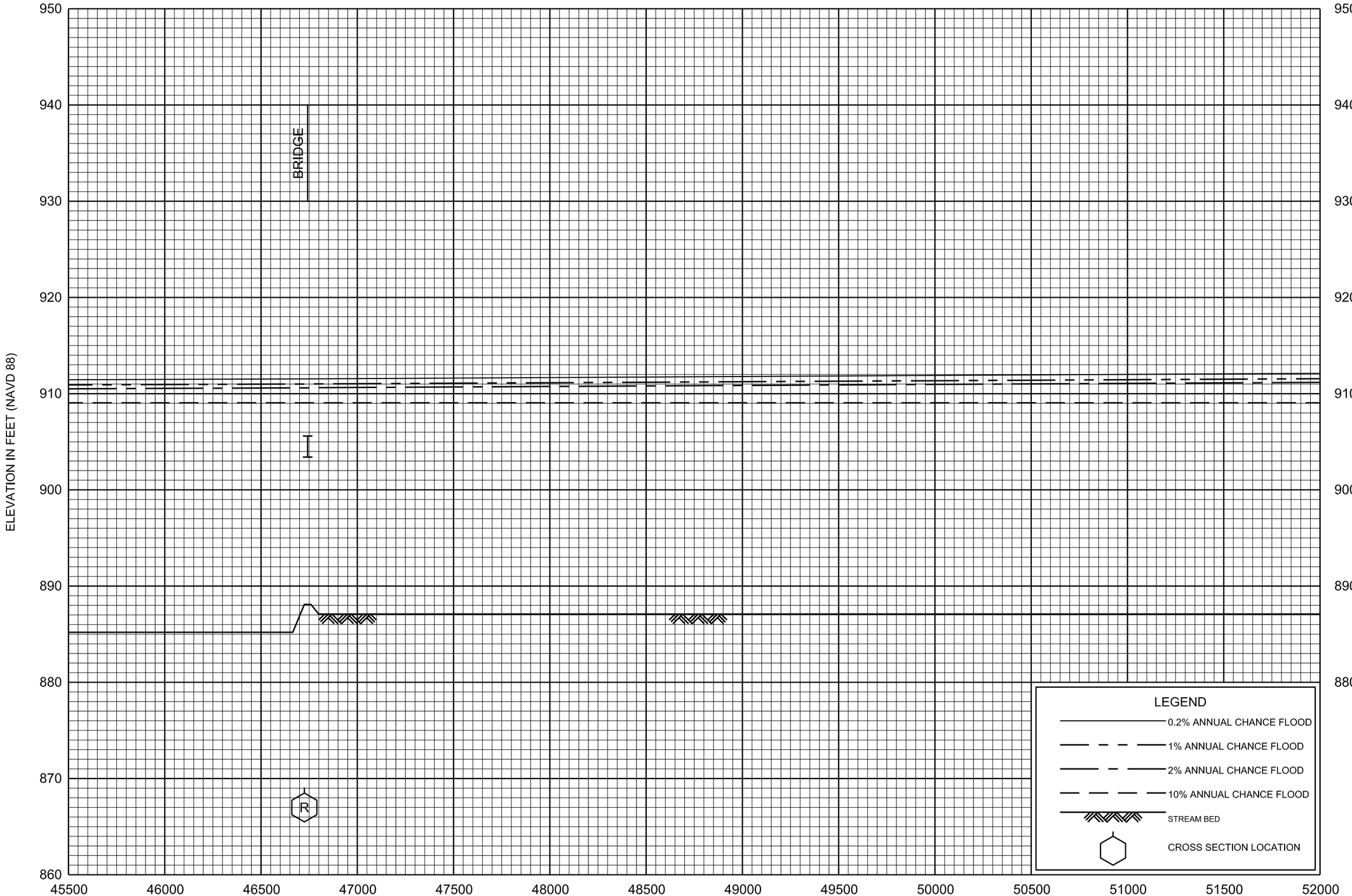
WILD RICE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CASS COUNTY, ND

ALL JURISDICTIONS

27P




FLOOD PROFILES

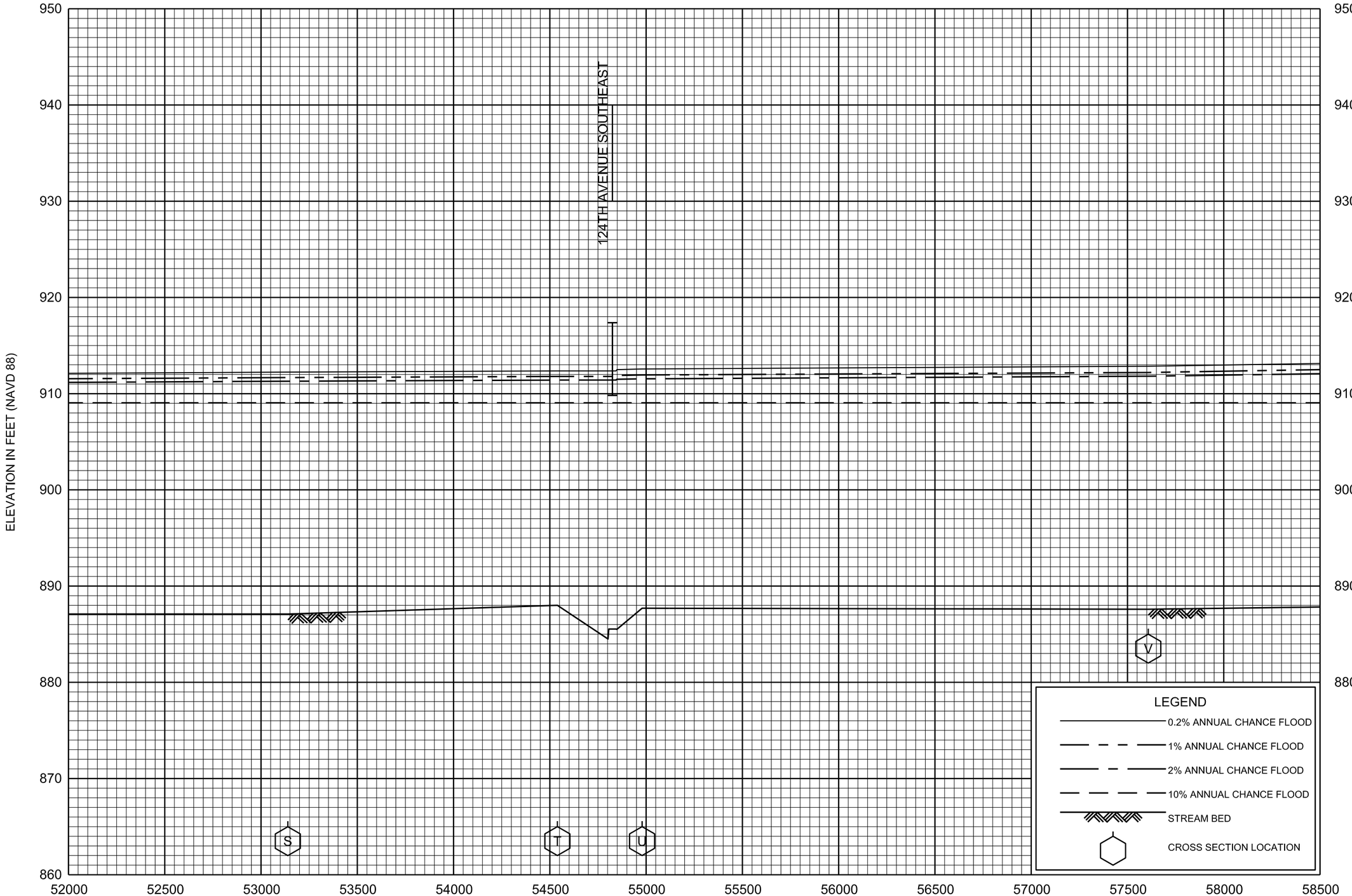
WILD RICE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CASS COUNTY, ND

ALL JURISDICTIONS

28P




FLOOD PROFILES

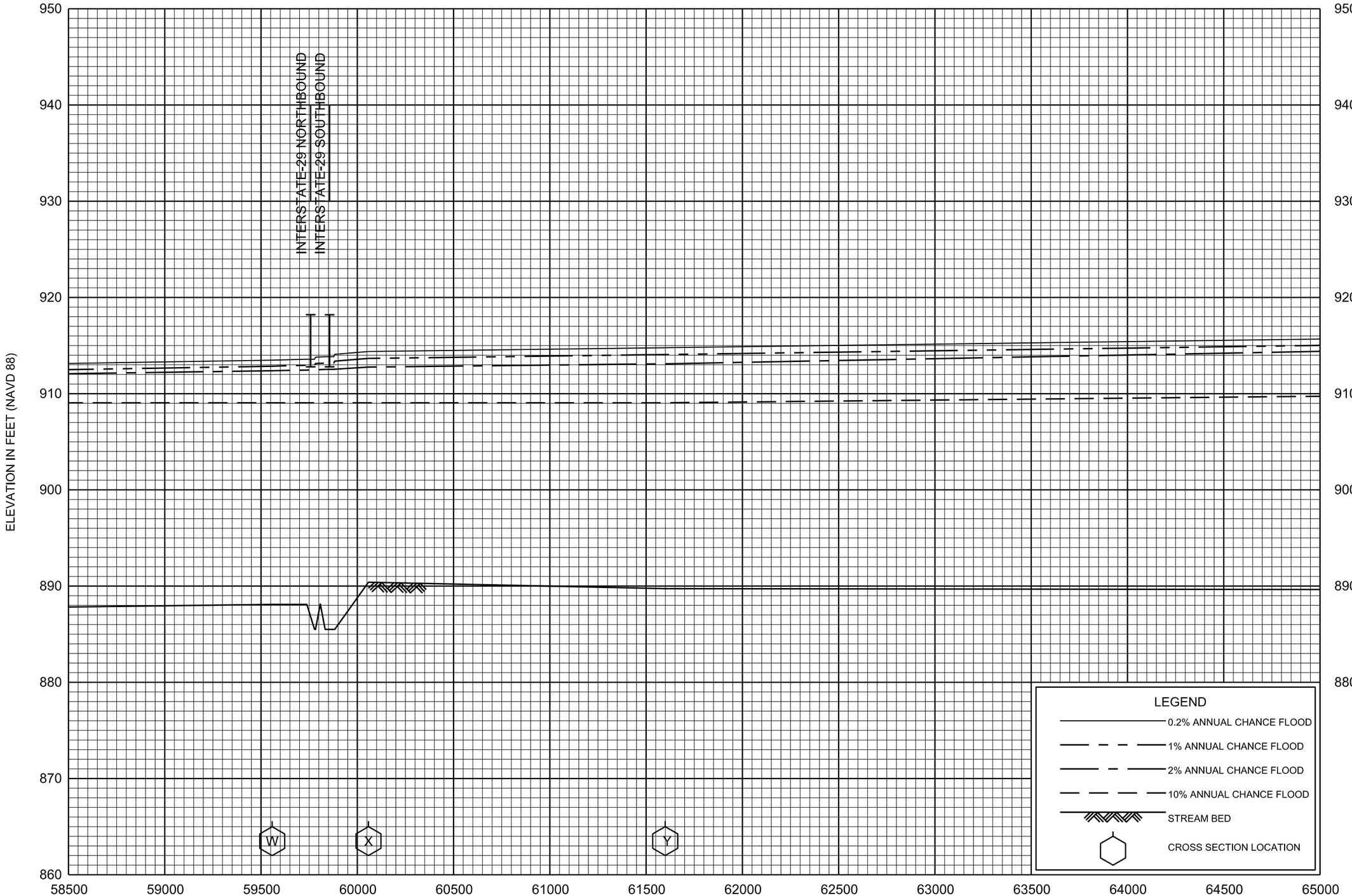
WILD RICE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CASS COUNTY, ND

ALL JURISDICTIONS

29P




FLOOD PROFILES

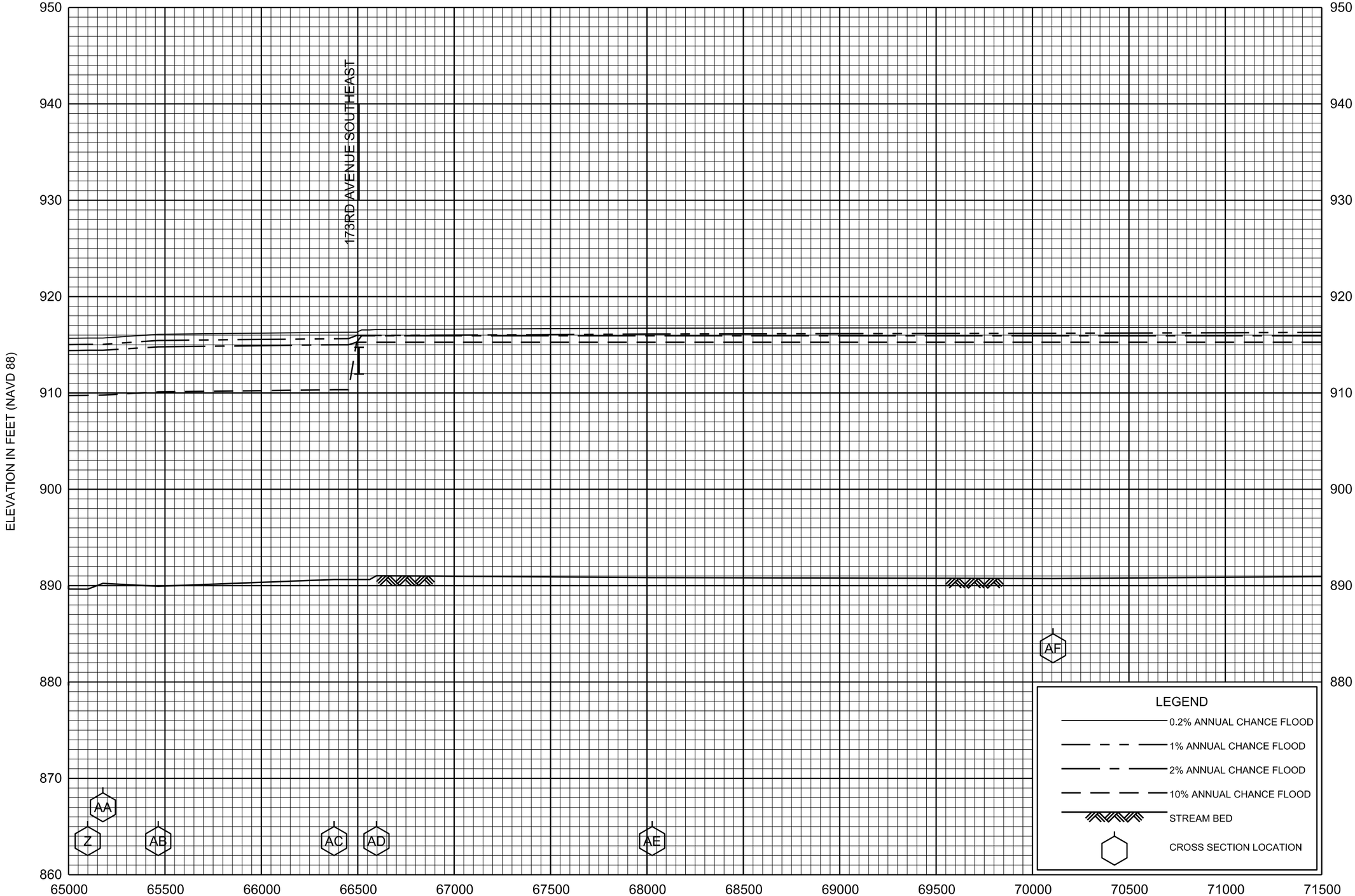
WILD RICE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CASS COUNTY, ND

ALL JURISDICTIONS

30P




FLOOD PROFILES

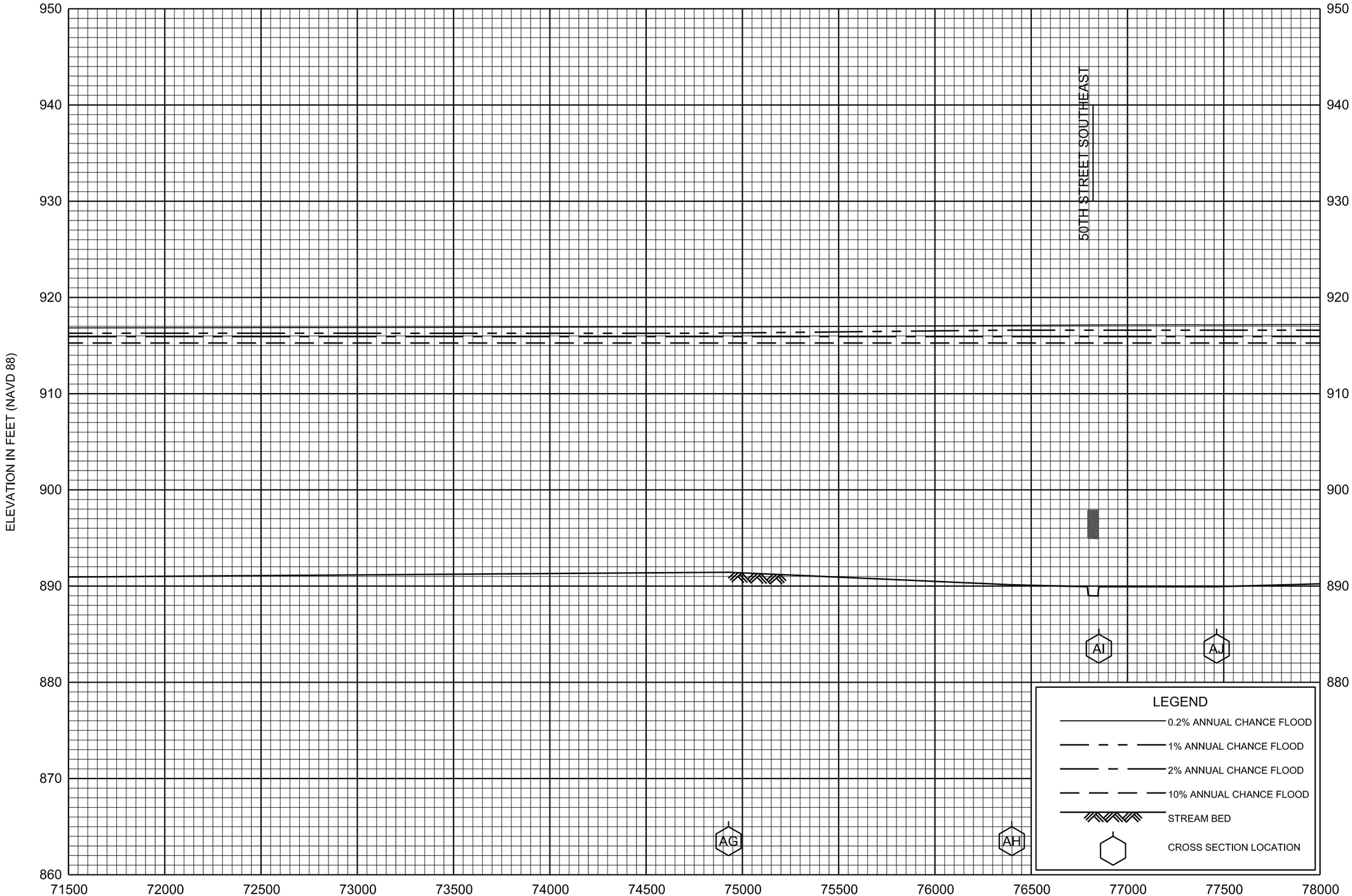
WILD RICE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CASS COUNTY, ND

ALL JURISDICTIONS

31P




FLOOD PROFILES

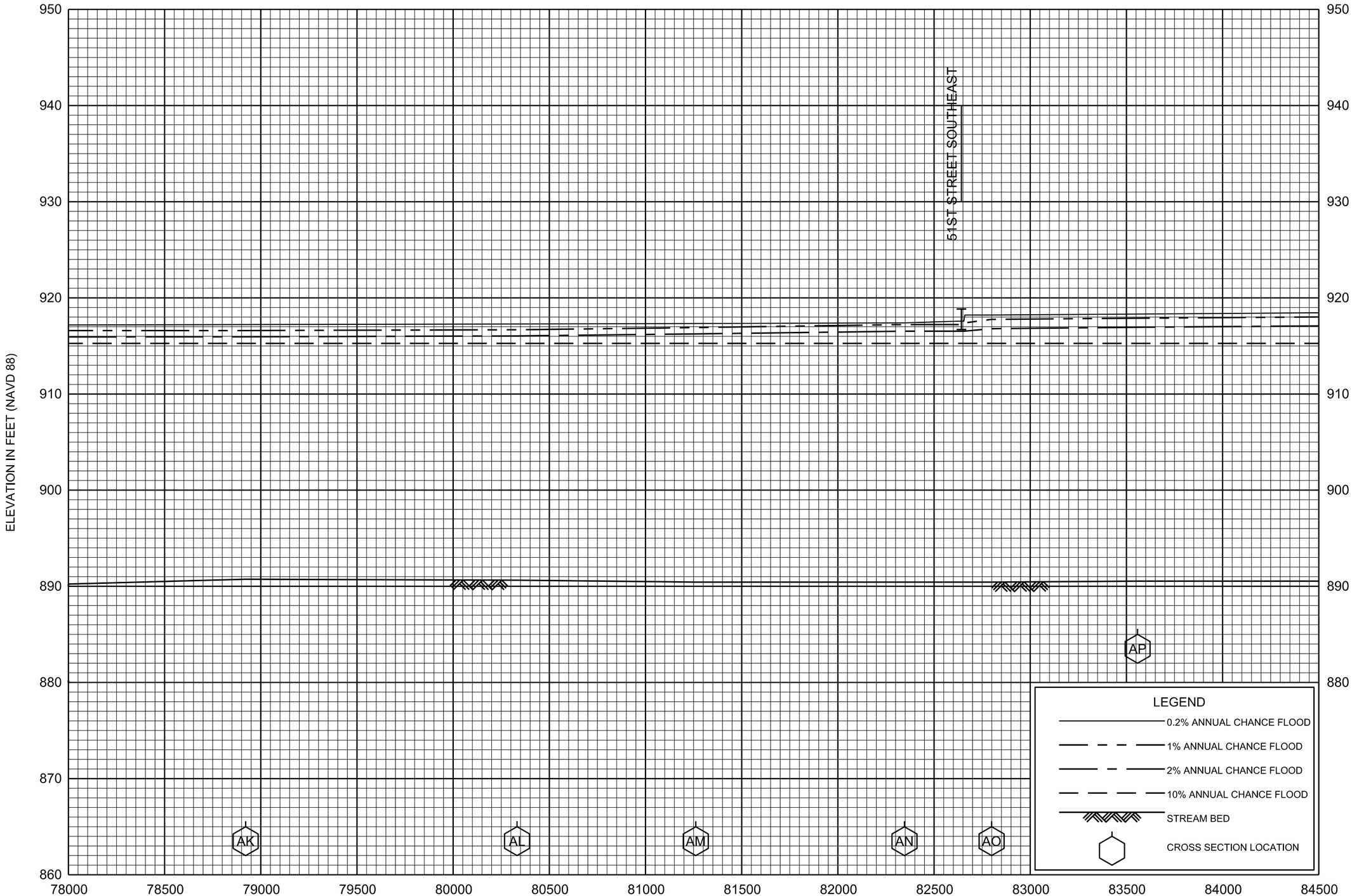
WILD RICE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CASS COUNTY, ND

ALL JURISDICTIONS

32P




FLOOD PROFILES

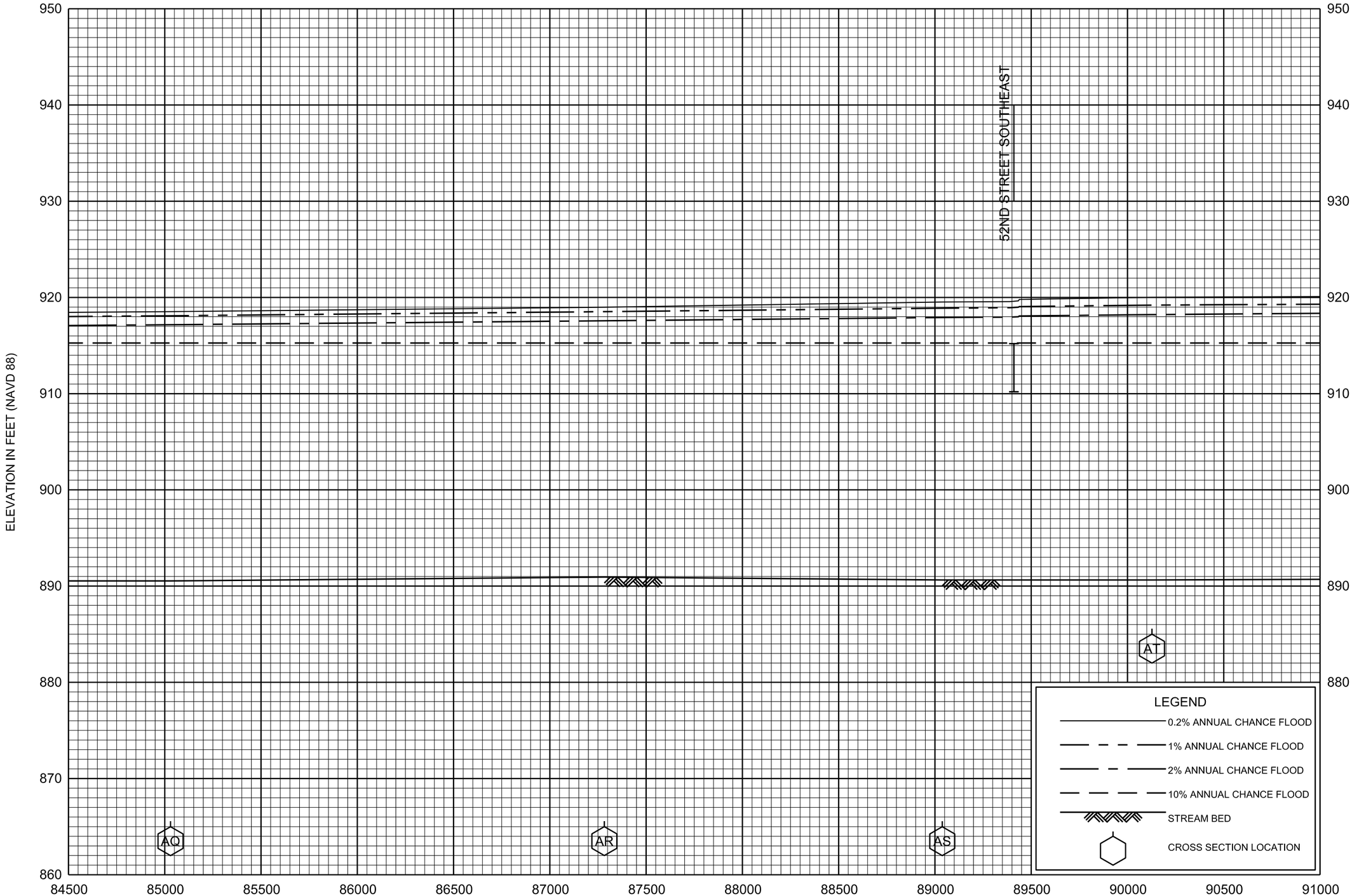
WILD RICE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CASS COUNTY, ND

ALL JURISDICTIONS

33P




FLOOD PROFILES

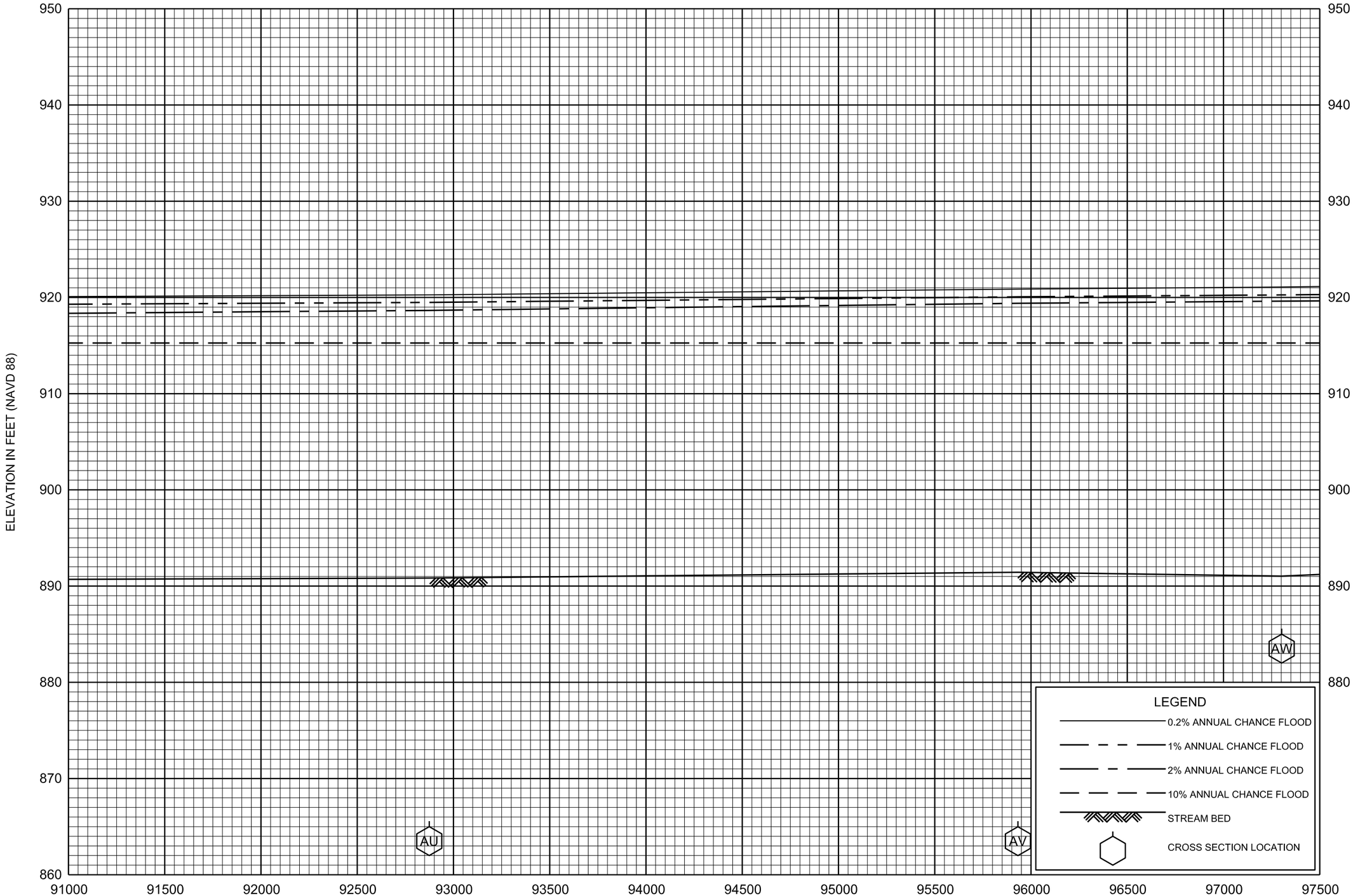
WILD RICE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CASS COUNTY, ND

ALL JURISDICTIONS

34P




FLOOD PROFILES

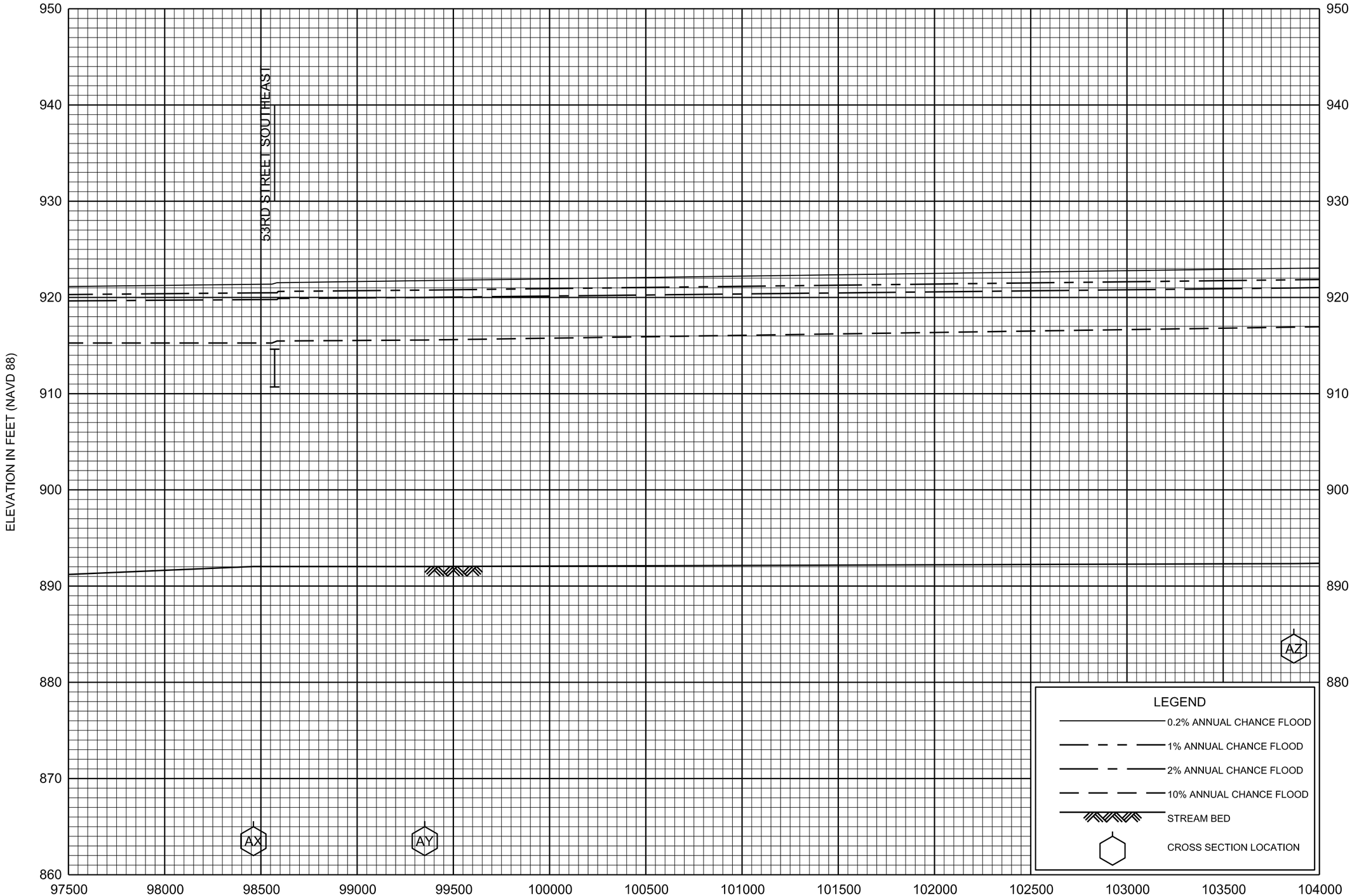
WILD RICE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CASS COUNTY, ND

ALL JURISDICTIONS

35P




FLOOD PROFILES

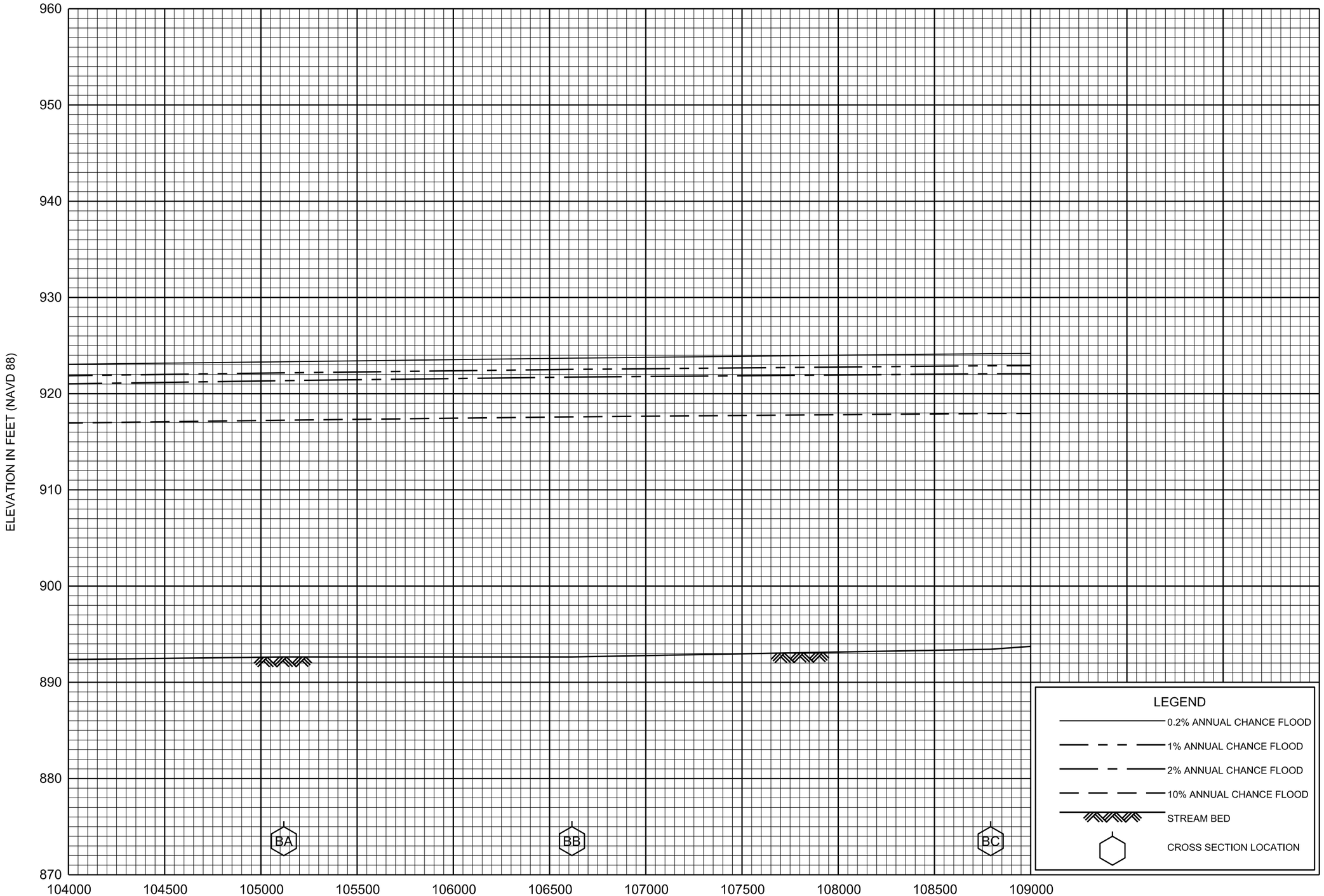
WILD RICE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CASS COUNTY, ND

ALL JURISDICTIONS

36P




FLOOD PROFILES

WILD RICE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CASS COUNTY, ND

ALL JURISDICTIONS

37P