FLOOD INSURANCE STUDY

MORGAN COUNTY, MISSOURI

AND INCORPORATED AREAS
VOLUME 1 OF 1

Community Name	Community Number
*BARNETT, CITY OF	290974
GRAVOIS MILLS, TOWN OF	290245
LAURIE, CITY OF	290976
MORGAN COUNTY (UNINCORPORATED AREAS)	290244
STOVER, CITY OF	290875
*SYRACUSE, CITY OF	290975
VERSAILLES, CITY OF	290247

* Non-flood Prone Community

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
29141CV000B

NOTICE TO
FLOOD INSURANCE STUDY USERS

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

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

Initial Countywide FIS Effective Date: May 4, 2009
Revised Countywide FIS Date: TBD - Revised to change Special Flood Hazard Areas and updated topographic information

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FLOOD INSURANCE STUDY
MORGAN COUNTY, MISSOURI AND INCORPORATED AREAS

1.0 INTRODUCTION

1.1 Purpose of Study

This countywide Flood Insurance Study (FIS) revises previous FISs/Flood Insurance Rate Maps (FIRMS) for the geographic area of Morgan County, Missouri, including the villages, towns, and cities of Barnett, Gravois Mills, Laurie, Stover, Sunrise Beach, Syracuse, Versailles, and the unincorporated areas of Morgan County (hereinafter referred to collectively as Morgan County). This FIS aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates. This information will also be used by Morgan County to update existing floodplain regulations as part of the Regular Phase of the National Flood Insurance Program (NFIP), and by local and regional planners to further promote sound land use and floodplain development. Minimum floodplain management requirements for participation in the National Flood Insurance Program are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

Please note that the City of Sunrise Beach is geographically located in Morgan and Camden Counties and is shown as an Area Not Included for this study.

Please note that the Cities of Barnett and Syracuse are non-floodprone.

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.

1.2 Authority and Acknowledgments

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

This FIS was prepared to include incorporated communities within Morgan County in a countywide FIS. Information on the authority and acknowledgements for each jurisdiction included in this countywide FIS was compiled from their previously printed FIS reports and is show below.

For this Physical Map Revision FIS, the hydrologic and hydraulic analyses were prepared by STARR2. These analyses were completed on November 13, 2015. Under Contract Number HSFE60-15-D-0005, Task Order HSFE60-15-J-0002.

Base map files were provided by the National Agriculture Imagery Program (NAIP) in the form of

7.5-Minute Series Digital Orthophoto Quarter Quadrangles (DOQQs). The DOQQs utilized are grayscale images with a 1-meter ground resolution. The DOQQs are referenced to the North American Datum of 1983 (NAD83) and cast on the Universal Transverse Mercator (UTM) projection, Zone 15 North in Meters.

1.3 Coordination

An initial Consultation Coordination Officer's (CCO) meeting is held with representatives of the communities, FEMA, and USACE, the study contractor, to explain the nature and purpose of the FIS, and to identify the streams to be studied by detailed methods. A final CCO meeting is held with representatives of the communities, FEMA, and the study contractors to review the results of the study.

For this countywide FIS, an initial CCO meeting will be held on a date TBD.

2.0 AREA STUDIED

2.1 Scope of Study

This countywide FIS covers the geographic area of Morgan County, Missouri. All or portions of the following flooding sources were studied by detailed methods: Lake of the Ozarks, Gravois Arm, and the Osage River in the southwestern county near the mouth of the Big Buffalo cove (mile marker 70.5) to near Posey Point (mile marker 51.5) and then again from Sunrise Beach (mile marker 9) to Dry Branch Cove (mile marker 4) in the southeastern corner of the county. The Gravois Arm of the Lake of the Ozarks was studied from mile marker 6.5 of the Lake of the Ozarks northward to Gravois Mills.

Limits of detailed study are indicated on the Flood Profiles (Exhibit 1) and/or on the FIRM (Exhibit 2). The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development and proposed construction.

All or portions of the following flooding sources with watersheds of one square mile or more were studied by approximate methods: Beard Creek, Big Buffalo Creek, Brushy Branch, Buck Creek, Flat Creek, Gabriel Creek, Gracey Creek, Gravois Creek, Indian Creek, Lake Creek, Little Gravois Creek, Little Haw Creek, McNeal Branch, Middle Richland Creek, Mill Creek, Minnow Branch, Prairie Hollow, Proctor Creek, Richland Creek, Soap Creek, Straight Fork Moreau Creek, and Wilkes Creek. These watersheds added 615 square miles of new approximate study to Morgan County. Approximate analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to, and agreed upon by, FEMA and Morgan County.

2.2 Community Description

Morgan County is located in central Missouri, and is largely rural, except for rapid development along the shoreline of Lake of the Ozarks and its arms. Morgan County has a total land area within the county limits of approximately 615 square miles, where 597 square miles is land and 18 square miles is water. The county is bordered by Cooper County to the north, Moniteau County to the northeast, Miller County to the southeast, Camden County to the south, Benton County to the west, and Pettis County to the northwest. In the 2000 census, Morgan County had a population of 19,309.

The principal flooding source, the Osage River, is a right bank tributary of the Missouri River. The Osage River is the largest stream in the county and is controlled by two large hydropower dam projects that operate to meet peak power need of the state. These dams are Bagnell Dam located at the lower end in Miller County and Harry S. Truman Dam located upstream of Warsaw, Missouri in Benton County.

In the area surrounding the major streams, the topography consists mainly of steeply sloped hillsides that tend to produce flash flooding. Soils in Morgan County are generally stony, and tend to consist of lean, silty, and fat clays and loams that are very erodible and have high runoff potential.

Most of the unincorporated areas are devoted to agriculture, with scattered residential development and numerous state parks. Accordingly, vegetation in the area ranges between forest, cropland, and pastureland. Tourism and commercial development are prevalent along the shore of the Lake of the Ozarks. Morgan County is served by U.S. Route 50, Route 5, Route 7, Route 52, and Route 135.

The climate of Morgan County is a humid continental climate. Weather changes in this area between summer and winter are generally subtle rather than extreme. However this climate can have very unpredictable fluctuations in temperature, precipitation, and humidity. Variable weather patterns and a large seasonal temperature variance can be as great as 55-70 degrees Fahrenheit. In the summer, the average high temperature is 90 degrees F with a low temperature of 68 degrees F. In the winter, the average high temperature is 40 degrees with a low temperature of 18 degrees F. The warmest month is July with the highest recorded

temperature of 108 degrees F in 1986. The coldest month is January with the lowest recorded temperature of -20 degrees F in 1989. The maximum average precipitation occurs usually in May with over 5 inches of rain. Rainfall totals average 40.38 inches annually.

2.3 Principal Flood Problems

Flood problems in Morgan County can be attributed to high releases from the Harry S. Truman Reservoir dam or by high-intensity, short-duration rainfalls. Pool levels in the Lake of the Ozarks will only reach flood levels on rare occasions, especially when Harry S. Truman dam is making high releases. Harry S. Truman Reservoir acts as a buffer and is the major source of flood protection for the Lake of the Ozarks. Other flood protection reservoirs upstream of Harry S. Truman Reservoir include Stockton, Pomme De Terre, Hillsdale, Pomona, and Melvern. By contrast flooding on smaller streams is caused by high-intensity, short-duration rainfalls.

Normal rainfall patterns are greatest during two distinct periods: 1) during spring from April through June, and 2) during the fall months of September through November. Rainfall during the spring months is caused primarily from southward moving cold fronts weakening and becoming stationary over the area. Warm tropical air moving north from the Gulf of Mexico will cause periods of intense rainfall both in duration and quantity along and near the stationary cold front. During the fall months, slow and southward moving cold air from Canada will interact with an existing warm and humid air mass causing another period of potentially heavy rain.

2.4 Flood Protection Measures

FEMA specifies that all levees must have a minimum of three foot of freeboard against the 100-year flood to be considered for FEMA certification. No levees are indicated within Morgan County.

Federal and State funded protection measures are being employed in Morgan County with the construction of the Harry S. Truman Reservoir dam.

3.0 ENGINEERING METHODS

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

and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the county at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

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

3.1.1 Detailed Methods

A hydrologic analysis was conducted to establish peak 1-percent annual chance discharges for each flooding source studied in the community. Separate Hydrologic analyses were conducted for the Lake of the Ozarks and the major streams where detailed hydraulic analyses were performed.

The following steps were taken to complete the hydrology for the streams studied by detailed hydraulic methods:

a. The HEC ArcHydro program was utilized to delineate 57 sub-basins that flow into the Lake of the Ozarks. Area and slope were by GeoHMS for each sub-basin.
b. Areas and slopes from Step "a" were used to calculate the 10-, 2-, 1- and 0.2-percent annual chance flows at various locations in the basins using USGS regression equations.
c. Soil Conservation Service (SCS) Dimensionless Unit Hydrographs were then developed for the mainstem and each major tributary.

TABLE 1: 1-PERCENT ANNUAL CHANCE MAINSTEM UNIT HYDROGRAPH PEAKS

Upper Osage	85,000 cfs @ 28 hrs
Middle Osage	8,200 cfs @ 8 hrs
Lower Osage	13,000 cfs @ 11 hrs

d. USACE, Kansas City District Water Management Section determined that the 1-percent annual chance release for Harry S Truman Reservoir Dam under typical flood conditions would be 80,000 cfs. Therefore, a base flow of 80,000 cfs was used for all model runs on the Osage River below Harry S. Truman Reservoir Dam.
e. A Flood Frequency Analysis (FFA) was performed for the St. Thomas gauge just downstream of Bagnell Dam as a way of double checking the flows at the dam. Gauge records were obtained for the years 1932 through 1997. Regulated flows were used for the pre-Harry S Truman Reservoir era (before 1976), and actual flows were used for the post-Harry S Truman Reservoir time period, or 1977 and after. Ten-percent annual chance flows at the dam were determined to be 81,300-cfs, 50-year 125,000 cfs, and 1-percent annual chance flows were confirmed at 150,000 cfs.

Table 2 presents the 10-, 2-, 1-, and 0.2-annual chance discharges for each of the streams studied.

TABLE 2: SUMMARY OF DISCHARGES (CFS)

Osage River	0.2-Percent Annual Chance	1-Percent Annual Chance	2-Percent Annual Chance	10-Percent Annual Chance
Mile 0.0- 6.2	190,000	150,000	125,000	81,300
Mile 6.2-18.8	190,000	149,000	125,000	81,000
Mile 8.8-31.2	190,000	137,000	114,000	81,000
Mile 31.2-40.0	112,000	88,000	80,000	80,000
Mile 40.0-50.0	108,000	81,000	80,000	80,000
Mile 50.0-60.0	85,000	80,000	80,000	80,000
Mile 60.0-70.0	84,000	80,000	80,000	80,000
Mile 70.0-80.0	83,000	80,000	80,000	80,000
Mile 80.0-92.0	81,000	80,000	80,000	80,000

Gravois Creek	0.2-Percent Annual Chance	1-Percent Annual Chance	2-Percent Annual Chance	10-Percent Annual Chance
Mile 0.0-3.0	58,000	42,000	36,000	23,000
Mile 3.0-6.0	38,000	31,000	27,000	17,000
Mile 6.0-9.0	26,000	19,000	16,000	10,000
Mile 9.0-11.0	19,000	14,000	12,000	7,800

3.1.2 Approximate Methods

The 1-percent annual chance discharge was calculated as follows for all watersheds with drainage areas greater than 1 square mile for all streams studied by approximate hydraulic methods:

The hydrologic analysis for the approximate zones of the study used USGS regression equations for central Missouri to estimate the 1-percent annual chance discharges. The main equation used is shown below.

Q1-percent-annual-chance = 170 * A^0.794 * S^0.471

The drainage areas and slopes used to populate this equation were calculated using ArcHydro in GIS. Starting from the raw 10-meter DEMs, the tools within ArcHydro were used to delineate basins, define all streams with drainage areas 1 square mile or greater, calculate subbasin areas, locate the longest flow path for each basin or flow change location, and calculate the applicable slope between the 10 and 85% points on the longest flow path. The slopes and areas generated through this process were then imported into spreadsheets and used to populate the Q1-percent-annual-chance discharge equation for each flow change location.

3.2 Hydraulic Analyses

The hydraulic characteristics of floodplains in the county were studied to estimate the limits of flooding as a result of the 1-percent annual chance flood event.

3.2.1 Detailed Method

The HEC-RAS hydraulic model was utilized to perform the detailed hydraulic analysis. Cross-sectional data for all streams studied were obtained both from GIS mapping and a survey conducted by the USACE, Kansas City District. A hydrographic survey was utilized to obtain data for portions of the cross sections below Lake of the Ozarks elevation 656-ft. GIS mapping and GPS survey methods were utilized to obtain cross-sectional data above the 656-ft contour. Cross sections were located at close intervals upstream and downstream of bridges and culverts in order to compute the possible backwater effect of these structures. Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments with a computed floodway, selected cross-section locations are shown on the Flood Boundary and Floodway Map (Exhibit 2).

Roughness factors, or Manning's "n" values, for studied streams were determined by field inspection, aerial photography, and calibration. Roughness coefficients used for all rivers are summarized in the following table.

TABLE 3: MANNING'S "N" VALUES

Stream Name	"n" Value Channel	"n" Value Flood Plain
Osage River	0.026	0.045
Gravois Creek	0.035	0.05-0.10

All elevations are referenced from North American Vertical Datum of 1988 (NAVD 88); elevation reference marks used in the study are shown on the maps.

A sensitivity analysis showed that Manning's "n" values have little effect on water surface profiles in the main body of the lake. This is due to the low velocity heads of 1 ft/sec or less. Hydraulic models were also checked for sensitivity to bridge expansion and contraction coefficients. In the main body of the lake, large variations of bridge coefficients resulted in infinitesimal changes in water surface. Therefore, expansion and contraction coefficients were held constant in the lake at 0.3 and 0.1, respectively. Expansion and contraction coefficients around bridges upstream of the lake on the tributaries were set to 0.5 and 0.3, respectively, as suggested in the HEC-RAS Manual.

The Osage-arm HEC-RAS model was calibrated to the October 15, 1986 discharge event. On that day, releases from Harry S. Truman Reservoir dam totaled 70,067-cfs, and the five major arms of Lake of the Ozarks contributed an additional 450 cfs. Stage measurements of 667.36-ft and 660.08-ft were recorded in the Harry S. Truman dam afterbay and at Bagnell dam, respectively, for a total drop of 7.28-ft in 93 miles across the lake. Manning's n values

were globally increased in the HEC-RAS model until the model water surface matched the stage measurements within a quarter-foot.

There were no data available to calibrate the other tributaries.

In order to obtain starting water surface elevations, historic records of Bagnell dam releases were analyzed for the years 1932-1997. A plot of pool elevation vs. release was constructed and the following averages determined:

TABLE 4: BAGNELL DAM POOL ELEVATIONS

FREQUENCY	RELEASE	POOL ELEV
10-PERCENT	81,300 cfs	662.17
2-PERCENT	125,000 cfs	663.12
1-PERCENT	150,000 cfs	663.88
0.2-PERCENT	190,000 cfs	664.21

Pool elevations in Table 4 were used for starting water surface at Bagnell Dam, except for the 1-percent annual chance floodway computations on tributary streams where a starting elevation of 658.5-ft was used for each tributary. The tributary floodways were started at the lower elevation so that the floodways could be mapped to represent the 1-percent annual chance flow on the tributary when the lake was at a normal pool level. This results in a floodway that extends farther downstream. Flood profiles were plotted showing computed water-surface elevations to an accuracy of 0.5 foot for the 1-percent annual chance flood event (Exhibit 1).

The hydraulic analyses in this study were based on an assumption of unobstructed flow. Accordingly, flood elevations shown on the profiles are considered valid only if hydraulic structures remain unobstructed and channel and overbank conditions remain essentially the same as ascertained during this study.

3.2.2 Approximate Method

A Digital Terrain Model (DTM) was created from USGS 10 meter topographic data for all areas to be studied using approximate methods. Cross sections were created from DTM at one half to one mile intervals along streams to be studied and contour lines with a 10 foot contour interval were created to assist in placing the cross sections and evaluating the accuracy of the DTMs. A simplified HEC-RAS model was developed for each stream.

The water surface data was exported using HEC-GeoRAS software and approximate 1-percent annual chance flooded areas were created.

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 NAVD88. These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. Some of the data used in this revision were taken from the prior effective FIS reports and FIRMs and adjusted to NAVD88.

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

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

Temporary vertical monuments are often established during the preparation of a flood hazard analysis for the purpose of establishing local vertical control. Although these monuments are not shown on the FIRM, they may be found in the Technical Support Data Notebook associated with the FIS report and FIRM for this community. Interested individuals may contact FEMA to access these data.

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

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound floodplain management programs. Therefore, each Flood Insurance Study provides 1-percent annual chance flood elevations and delineations of the 1- and 0.2-percent annual chance floodplain boundaries and 1-percent annual chance floodway to assist communities in developing floodplain management measures.

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 the stream studied in detail, the 1- and 0.2-percent annual chance floodplains have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using digital topographic maps

with a contour interval of 4 feet for areas mapped by detailed methods and 10-foot contours for areas mapped by approximate methods.

The 1- and 0.2-percent annual chance flood boundaries are shown on the FIRM (Exhibit 2). On this map, the 1-percent annual chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A, AE, AH, and AO) and the 0.2-percent annual chance floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 1- and 0.2-percent annual chance floodplain boundaries are close together, only the 1-percent annual chance floodplain boundary has been shown. Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

For the streams studied by approximate methods, only the 1-percent annual chance floodplain boundary is shown on the FIRM (Exhibit 2).

4.2 Floodways

Encroachment on floodplains by man-made 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 a portion of the floodplain set aside to limit the effects of encroachment on flood heights. The floodway is a tool to assist local communities in managing floodplain development. Under this concept, the area of the 1-percent annual chance floodplain is divided into a floodway and a floodway fringe. A floodway is the channel of a stream, plus any adjacent floodplain areas that must be kept free of encroachment so that the 1-percent annual chance flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1 foot, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as minimum standards that can either be adopted directly or used as a basis for additional floodway studies.

The floodway presented in this FIS was 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 (Table 5, "Floodway Data"). 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.

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

LOCATION		FLOODWAY			1% ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION (Feet NAVD88)			
CROSS SECTION	DISTANCE[1]	WIDTH (Feet)	SECTION AREA (Square Feet)	MEAN VELOCITY (FEET / SECOND)	REGULATORY[2]	WITHOUT [3] FLOODWAY	WITH [3] FLOODWAY	INCREASE
A-Z[4]								
AA	9.83	575	4,003	5.0	665.7	665.0	665.2	0.2
AB	9.97	214	2,517	7.9	666.2	665.7	666.0	0.3
AC	10.08	253	2,892	6.9	666.9	666.4	666.9	0.5
AD	10.32	170	2,093	9.6	668.3	668.1	668.8	0.7
AE	10.63	170	2,017	9.9	671.8	671.8	672.2	0.4
AF	10.83	178	2,317	8.6	673.9	673.9	674.4	0.5
AG	11.10	175	2,097	9.5	676.2	676.2	676.8	0.6
AH	11.29	171	2,147	9.3	678.3	678.3	678.9	0.6
AI	11.47	170	2,384	8.4	680.3	680.6	681.2	0.6
AJ	11.54	180	2,397	8.3	681.4	680.8	681.4	0.6

[1]Stream distance in miles above confluence with Osage River
[2]Elevations computed based on a downstream starting elevation at the 1% chance flood elevation for the Osage River Arm of the Lake of the Ozarks
[3]Elevations computed based on normal depth
[4]Floodway data not computed
[5]Cross section distances are rounded to the nearest hundredth of a mile

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

MORGAN COUNTY, MISSOURI

AND INCORPORATED AREAS

FLOODWAY DATA

FLOODING SOURCE: GRAVOIS CREEK

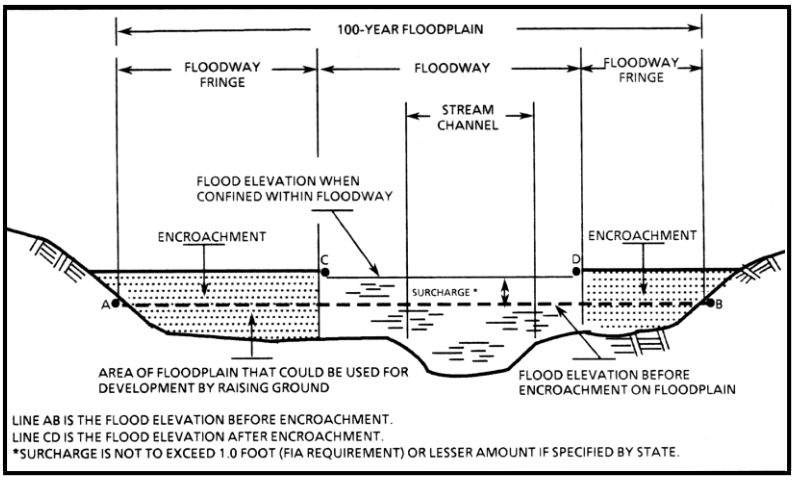


FIGURE 1: FLOODWAY SCHEMATIC

A starting elevation of 658.5 was assumed for all 100-year floodway runs. No floodways were computed for the main body of the Lake of the Ozarks, or portions of the lake below the 1-percent annual chance flood elevation of 663.88-ft at Bagnell Dam.

5.0 INSURANCE APPLICATION

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

Zone A

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

Zone AE

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

Zone AH

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

Zone AO

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

Zone X

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

Zone D

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

6.0 FLOOD INSURANCE RATE MAP

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

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

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

The current FIRM presents flooding information for the entire geographic area Morgan County, Missouri. Previously, separate Flood Hazard Boundary Maps and/or FIRMs were prepared for each identified flood-prone incorporated community and the unincorporated areas of the county. This countywide FIRM also includes flood hazard information that was presented separately on Flood Boundary and Floodway Maps, where applicable. Historical data relating to the maps prepared for each community up to and including this countywide FIS are presented in Table 6, “Community Map History.”

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE	FIRM EFFECTIVE DATE	FIRM REVISIONS DATE
*Barnett, City of	N/A	-	N/A	-
Gravois Mills, Town of	May 4, 2009	-	May 4, 2009	-
Laurie, City of	May 4, 2009	-	May 4, 2009	-
Morgan County (Unincorporated Areas)	September 30, 1983	-	May 4, 2009	-
Stover, City of	May 4, 2009	-	May 4, 2009	-
*Syracuse, City of	N/A	-	N/A	-
Versailles, City of	April 5, 1974	January 16, 1976	May 4, 2009	

*Non-floodprone Community

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

MORGAN COUNTY, MO AND INCORPORATED AREAS

COMMUNITY MAP HISTORY

7.0 OTHER STUDIES

Because it is based on more up-to-date analyses, this countywide FIS supersedes any previously printed FISs within Morgan County.

8.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting FEMA Region VII, Mitigation Division, 9221 Ward Parkway, Suite 300, Kansas City, MO 64114-3372

9.0 BIBLIOGRAPHY AND REFERENCES

1. U.S. Department of Commerce, Bureau of the Census, 2000 Census of Population, Number of Inhabitants, Missouri, Washington, D.C., 2000
2. Midwestern Regional Climate Center, http://mcc.sws.uiuc.edu
3. U.S. Department of Agriculture, Soil Conservation Service, Soil Surveys, for Camden, Morgan, and Benton Counties.
4. U.S. Army Corps of Engineers Hydrologic Engineering Center, HEC-GEORAS 3.1 River Analysis System, October 2002.
5. U.S. Geological Survey, Technique for Estimating the Magnitude and Frequency of Missouri Floods, 1974.
6. U.S. Army Corps of Engineers Hydrologic Engineering Center, HEC-RAS 3.1 River Analysis System, *May 2003.*
7. United States Geological Survey, Techniques for Estimating the 2- to 500-Year Flood Discharges on Unregulated Streams in Rural Missouri by the USGS Water-Resources Investigations Report #95-4231 Region II (Ozark Plateaus) 1995.
8. United States Geological Survey, 7.5-Minute Series Digital Orthophoto Quarter Quadrangles (DOQQs), Reference North American Datum of 1983 (NAD83) and cast on the Universal Transverse Mercator (UTM) projection, Zone 15 North in Meters.

10.0 REVISIONS DESCRIPTION

This section has been added to provide information regarding significant revisions made since the original FIS report and FIRM were printed. Future revisions may be made that do not result in the republishing of the FIS report. All users are advised to contact the Community Map Repository at the address below to obtain the most up-to-date flood hazard data provided in Table 7.

Table 7: Map Repositories

Community	Address	City	State	Zip Code
BARNETT, CITY OF	COUNTY COMMISSIONER 100 EAST NEWTON	VERSAILLES	MO	65084
GRAVOIS MILLS, TOWN OF	City Office 154 HIGHWAY 5	GRAVOIS MILLS	MO	65037
LAURIE, CITY OF	CITY OFFICE 724 NORTH MAIN	LAURIE	MO	65037
MORGAN COUNTY	COUNTY OFFICE 100 EAST NEWTON	VERSAILLES	MO	65084
STOVER, CITY OF	CITY OFFICE 503 WEST SECOND STREET	STOVER	MO	65078
SYRACUSE, CITY OF	COUNTY COMMISSIONER 100 EAST NEWTON	VERSAILLES	MO	65084
VERSAILLES, CITY OF	CITY HALL 104 N FISHER	VERSAILLES	MO	65084

10.1 First Revision (Revised TBD)

a. Acknowledgements
The hydrologic and hydraulic analyses for this revision were completed by STARR under contract with FEMA Contact HSFE60-15-D-0005.

b. Coordination
   i) A Flood Risk Review meeting was held on March XX, 2016 to review the draft result of this study.
   ii) A final CCO meeting was held on May XX, 2016 to review the revisions to the Flood Insurance Study for Camden County, MO.

c. Scope
The revision included revised detail analysis for the Gravois Creek from the confluence with the Lake of the Ozarks to the county boundary.

d. Hydrologic Analysis

Hydrologic analyses were carried out to establish the peak elevation-frequency relationships for floods of the selected recurrence intervals for each flooding source studied. Hydrologic analyses are typically performed at the watershed level. Depending on factors such as watershed size and shape, land use and urbanization, and natural or man-made storage, various models or methodologies may be applied. Greater detail (including assumptions, analysis, and results) is available in the archived project documentation.

A summary of the discharges is provided in Table 8. The peak discharges reported in this table are derived from regression equations.

Table 8: Summary of Discharges (Study Revision)

Flooding Source	Location	Drainage Area (Sq Mile)	Peak Discharge (cfs)			
			10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Gravois Creek	Mile 0.0 - 3.0	173.1	22,600	38,200	45,000	60,800
Gravois Creek	Mile 3.0 - 6.0	145.2	20,300	34,400	40,000	54,700
Gravois Creek	Mile 6.0 - 9.0	98.3	15,400	26,100	31,000	41,600
Gravois Creek	Mile 9.0 - 11.0	57.5	9,900	16,700	20,000	26,600

e. Hydraulic Analysis

Hydraulic analyses were carried out providing estimates of flooding elevations for the selected recurrence intervals. The 1-percent annual chance floodway computations on tributary streams used a starting pool elevation of 658.5-ft so that the floodway could be mapped to represent the 1-percent annual chance discharge on the tributary when the lake was at a normal pool level. This results in a floodway that extends further downstream.

Roughness factors, or Manning's "n" values, were determined by field inspection, aerial photography, and calibration. Roughness coefficients from streams restudied by detailed methods are summarized in Table 10.

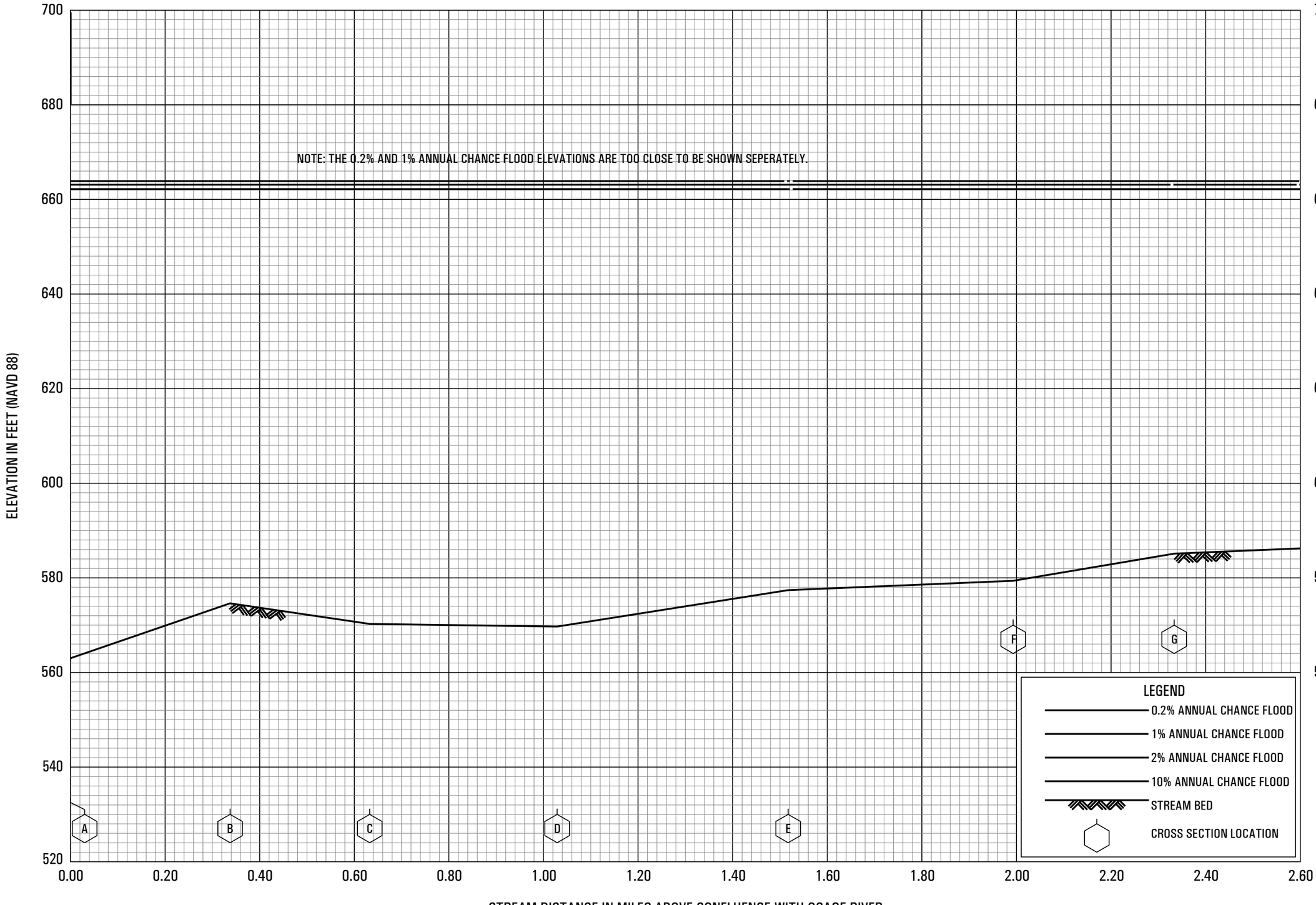
They hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the Flood Profiles (Exhibit 1) are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail. A summary of stillwater elevations developed for Bagnell Dam is provided in Table 9. Channel roughness coefficients are provided in Table 10.

Table 9: Summary of Stillwater Elevations (Study Revision)

Flooding Source	Elevation (Feet NAVD)			
	10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
Bagnell Dam	662.17	663.12	663.88	664.21

Table 10: Summary of Roughness Coefficients (Study Revision)

Flooding Source	Roughness Coefficients	
	Channel	Overbanks
Gravois Creek	0.035	0.05 – 0.10



FLOOD PROFILES

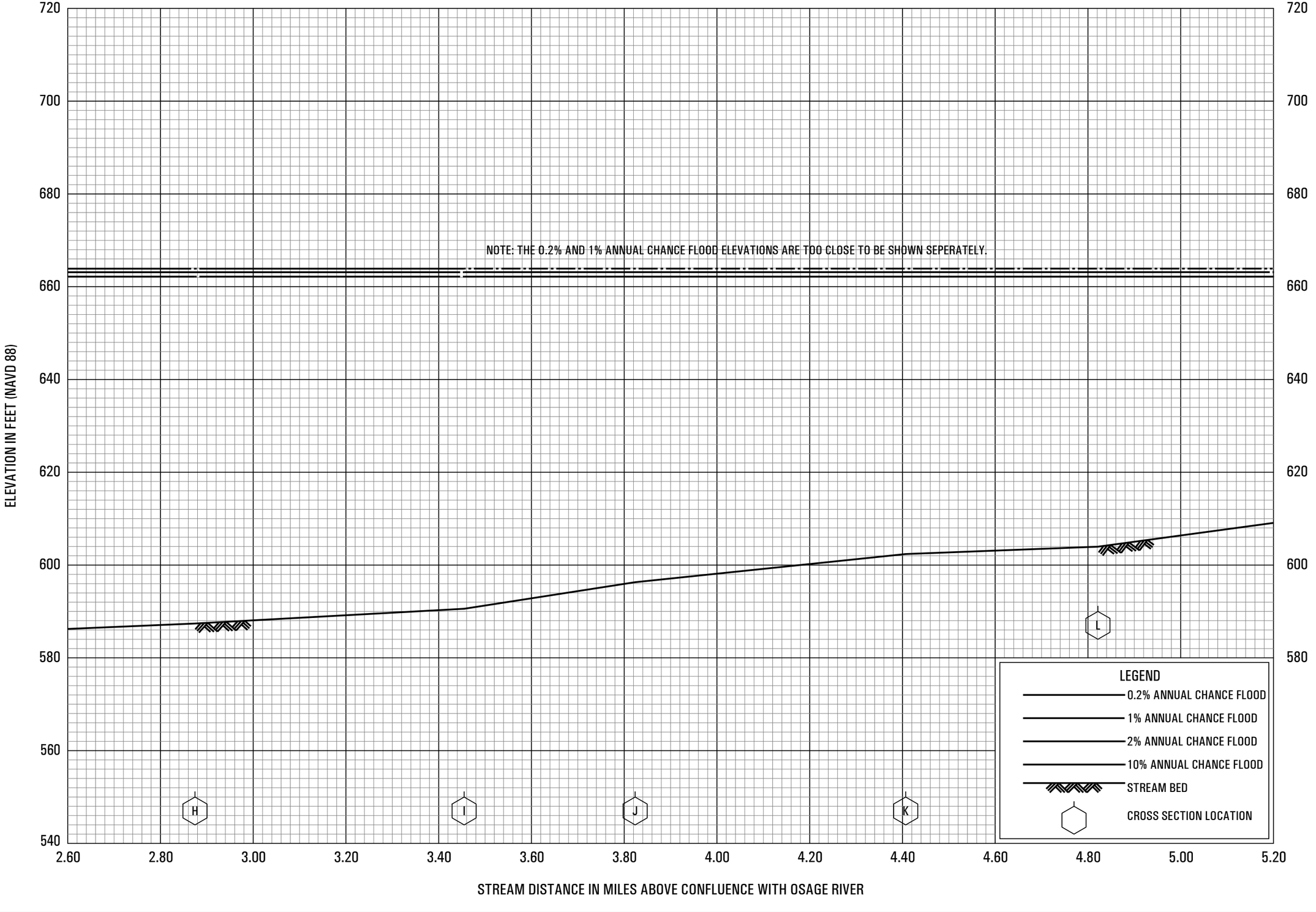
GRAVOIS CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

MORGAN COUNTY, MO

AND INCORPORATED AREAS

01P



FLOOD PROFILES

GRAVOIS CREEK

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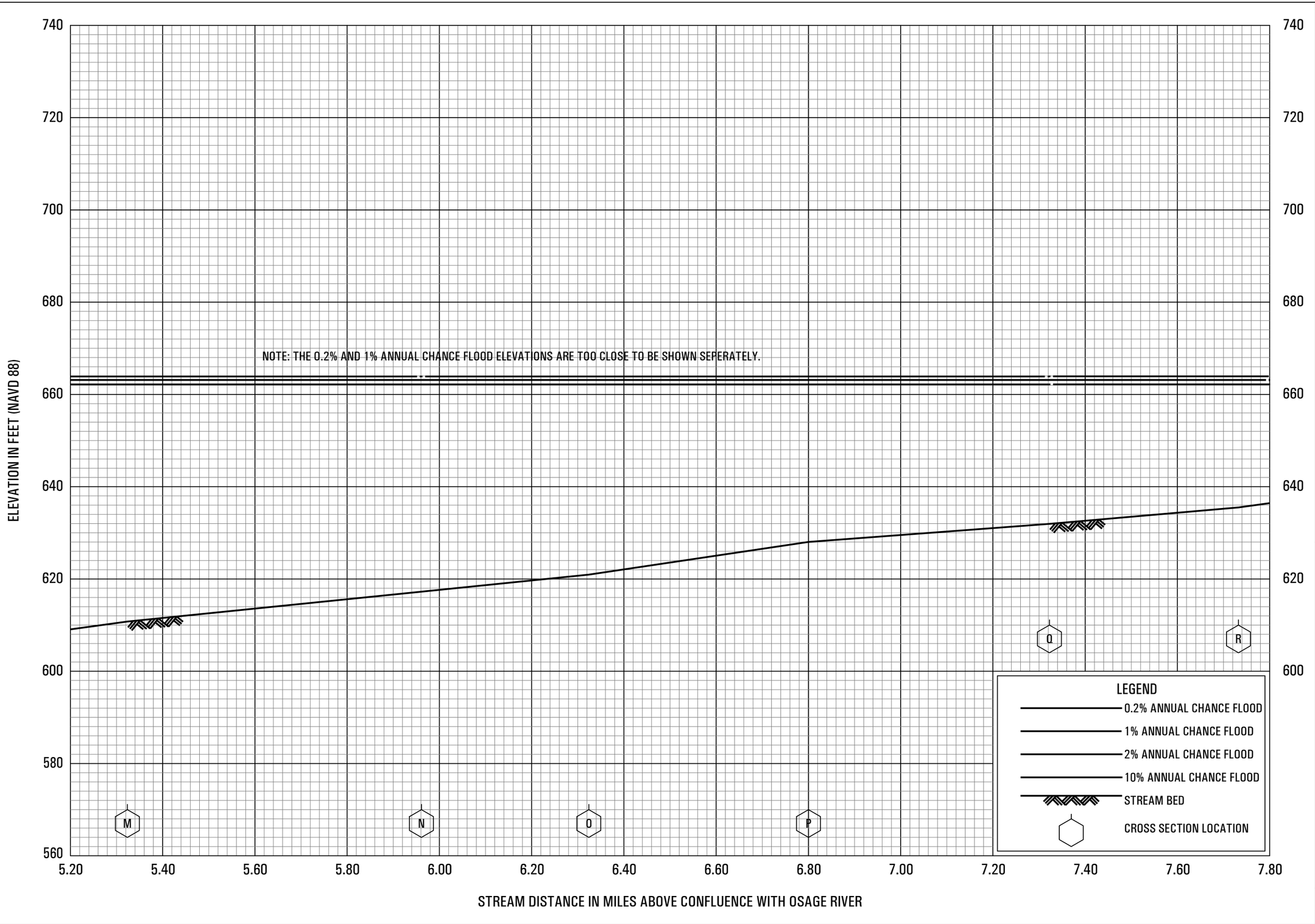

FLOOD PROFILES

GRAVOIS CREEK

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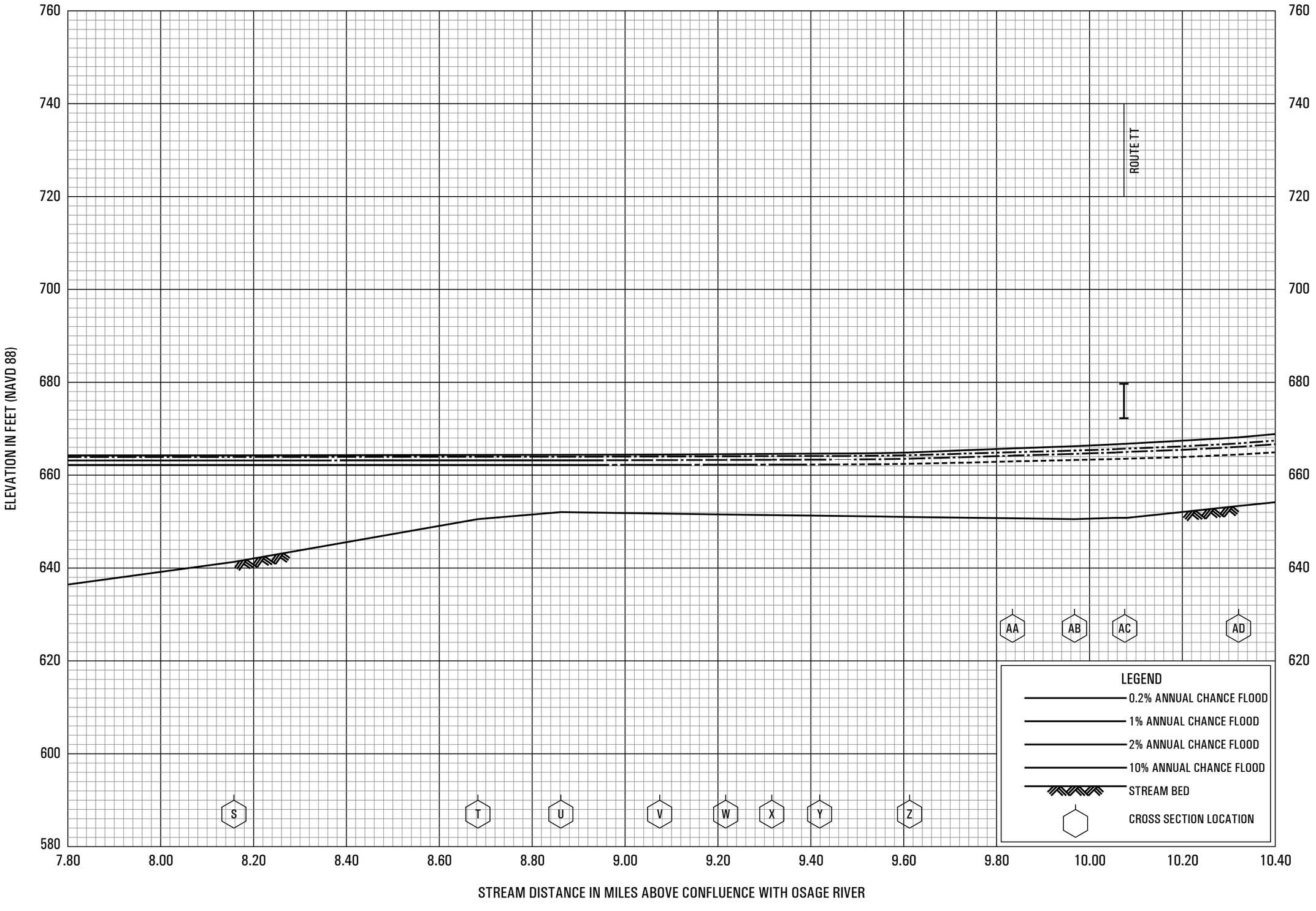

FLOOD PROFILES

GRAVOIS CREEK

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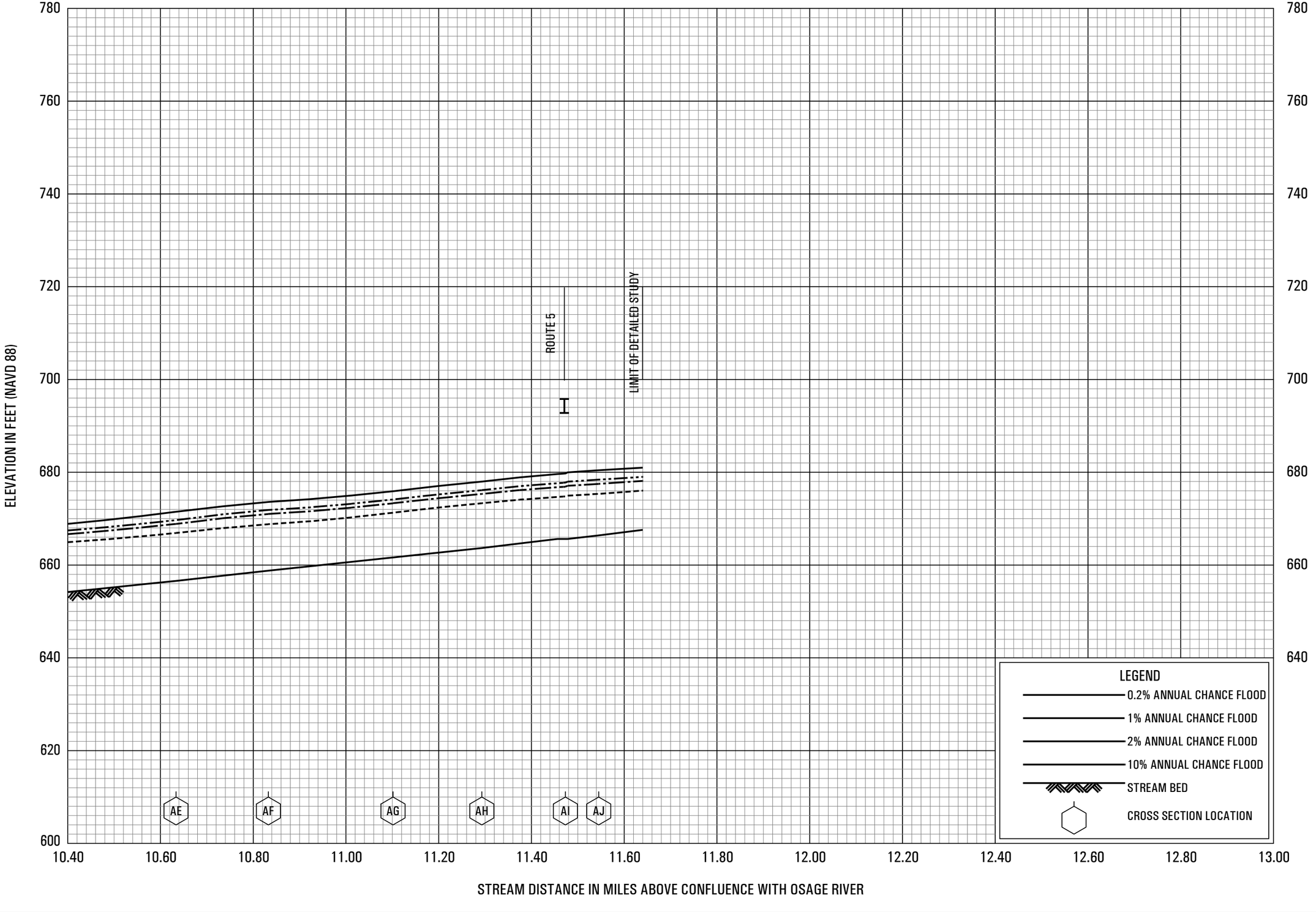

FLOOD PROFILES

GRAVOIS CREEK

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MORGAN COUNTY, MO

AND INCORPORATED AREAS

05P

NOTE: 0.2% AND 1% ANNUAL CHANCE FLOOD PROFILES ARE TOO CLOSE TO BE SHOWN SEPERATELY

LIMIT OF FLOODING AFFECTING COMMUNITY

ELEVATION IN FEET (NAVD 88)

680
660
640
620
600
580
560
540
520
500

3.25 3.50 3.75 4.00 4.25 4.50 4.75 5.00 5.25 5.50 5.75 6.00 6.25 6.50

STREAM DISTANCE IN MILES ABOVE BAGNELL DAM

E F G

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

OSAGE RIVER

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MORGAN COUNTY, MO

AND INCORPORATED AREAS

06P

NOTE: 0.2% AND 1% ANNUAL CHANCE FLOOD PROFILES ARE TOO CLOSE TO BE SHOWN SEPERATELY

LIMIT OF FLOODING AFFECTING COMMUNITY

ELEVATION IN FEET (NAVD 88)

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620
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520
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STREAM DISTANCE IN MILES ABOVE BAGNELL DAM

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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

OSAGE RIVER

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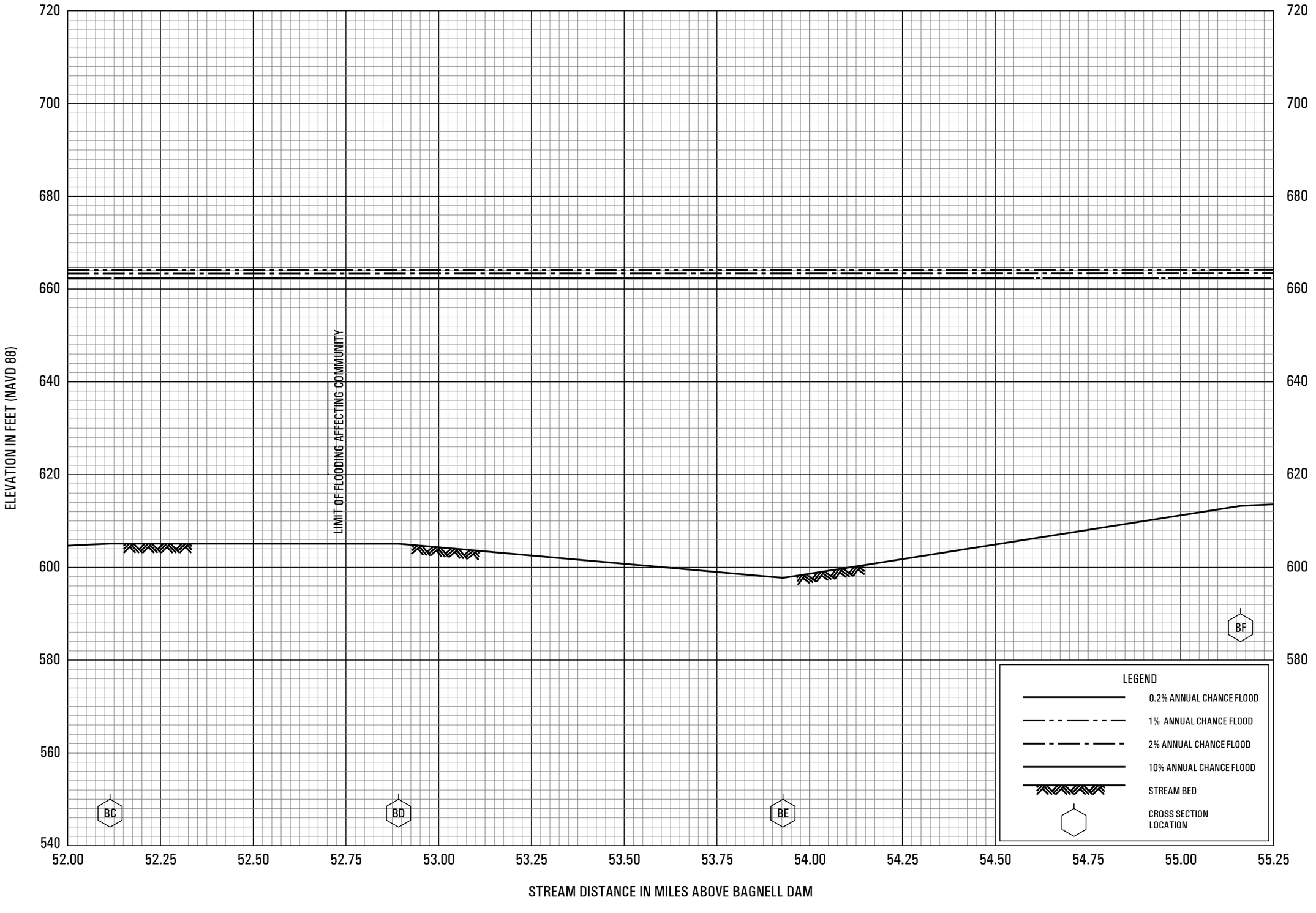

FLOOD PROFILES

OSAGE RIVER

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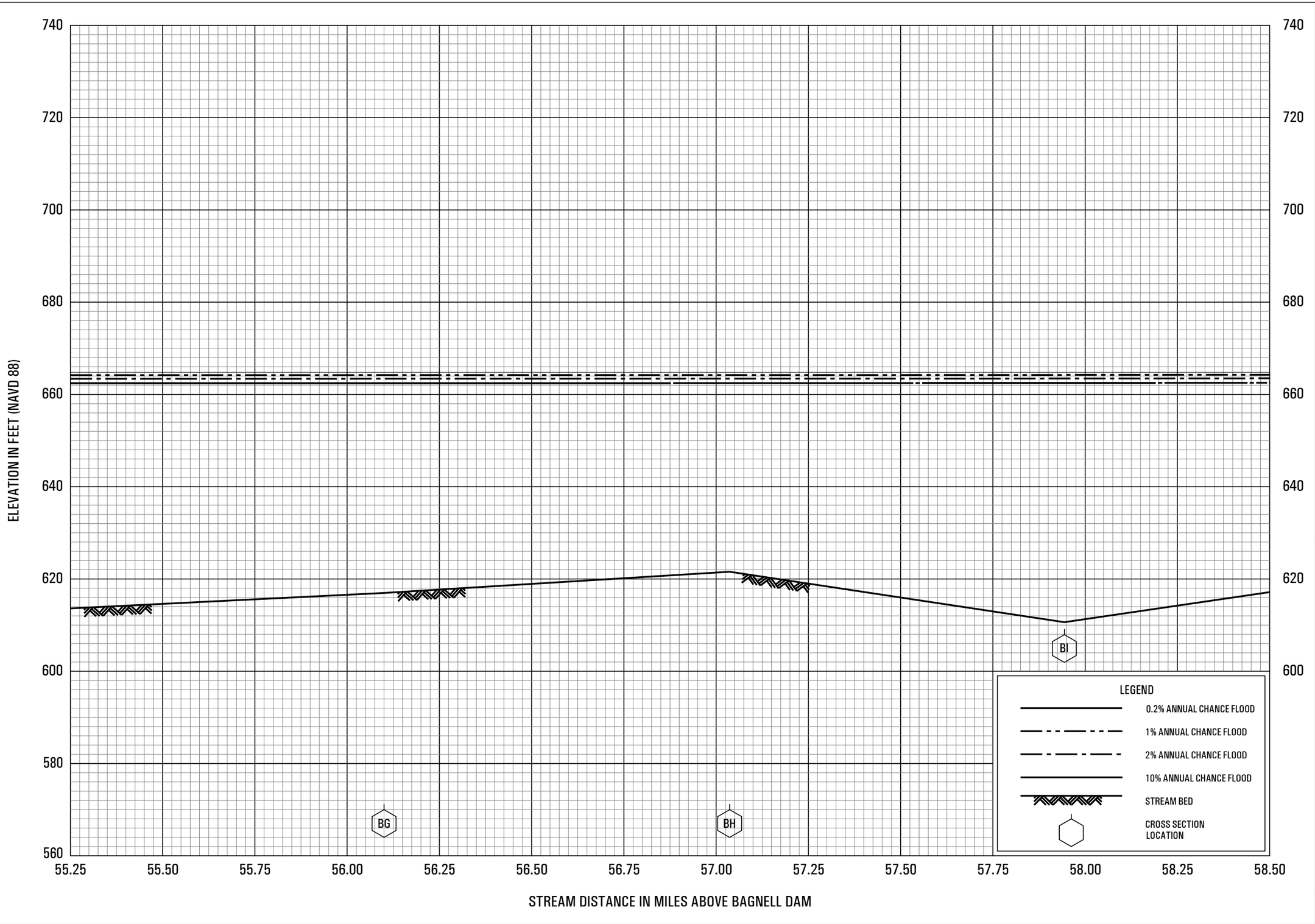

FLOOD PROFILES

OSAGE RIVER

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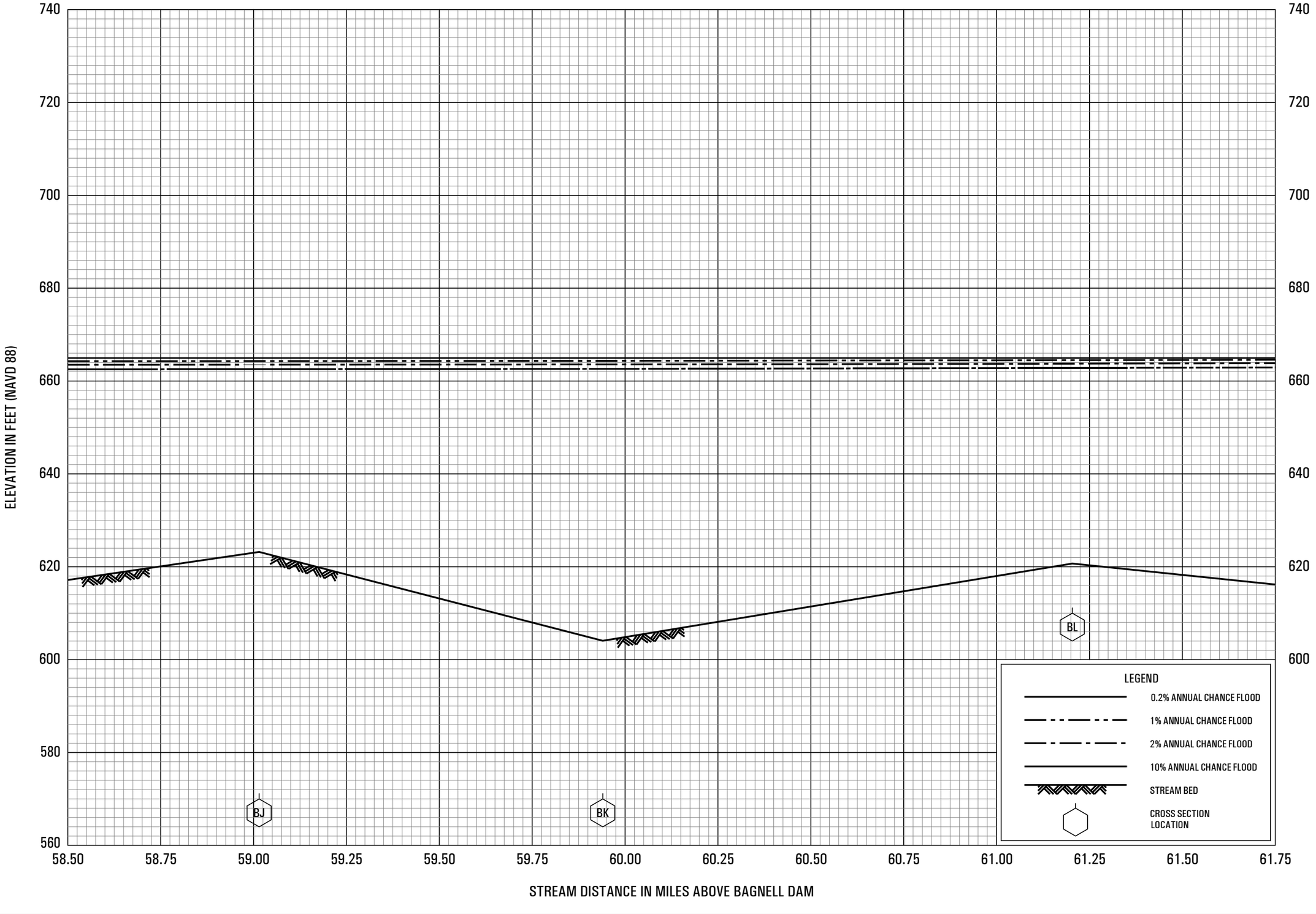

FLOOD PROFILES

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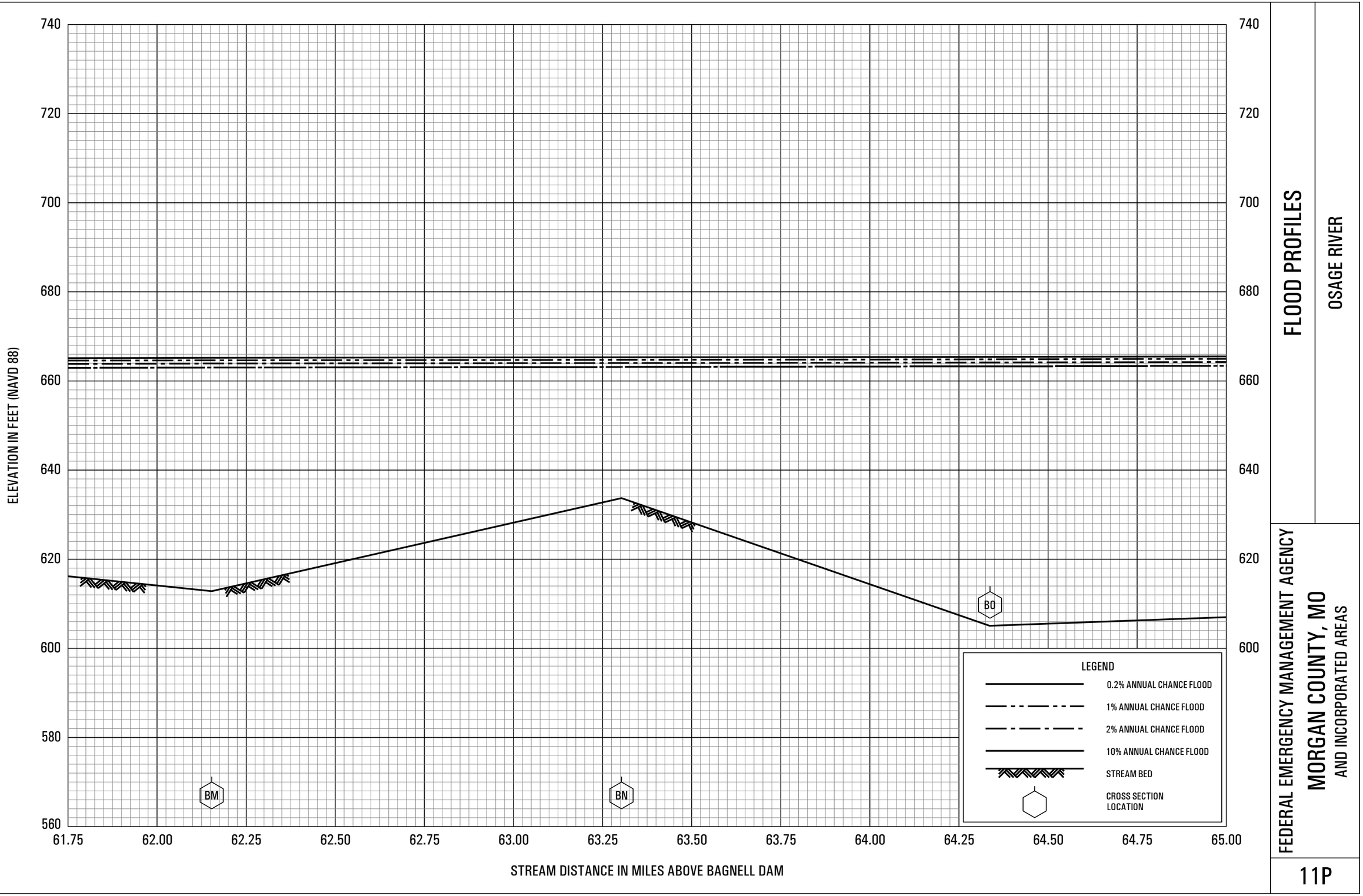

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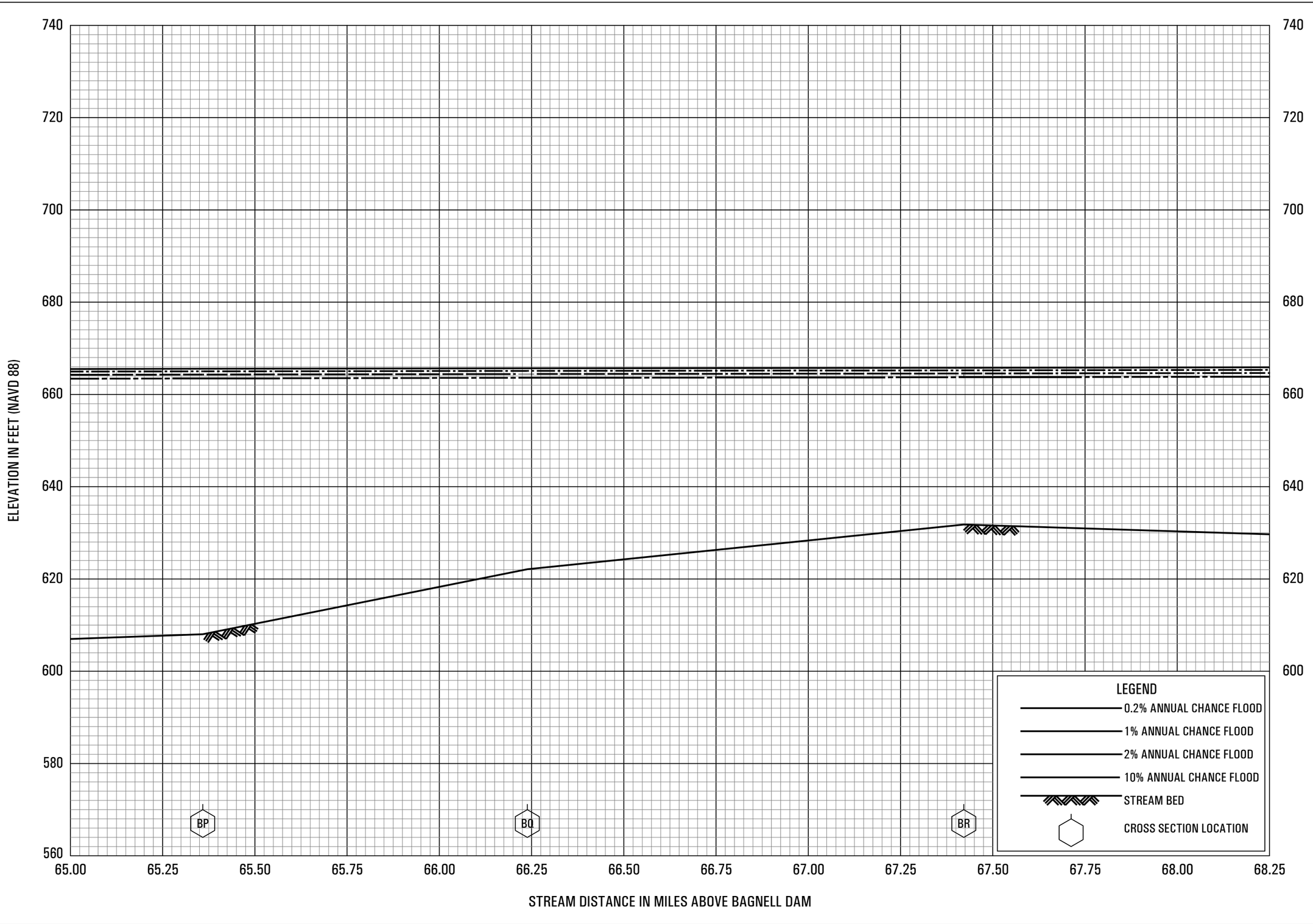

FLOOD PROFILES

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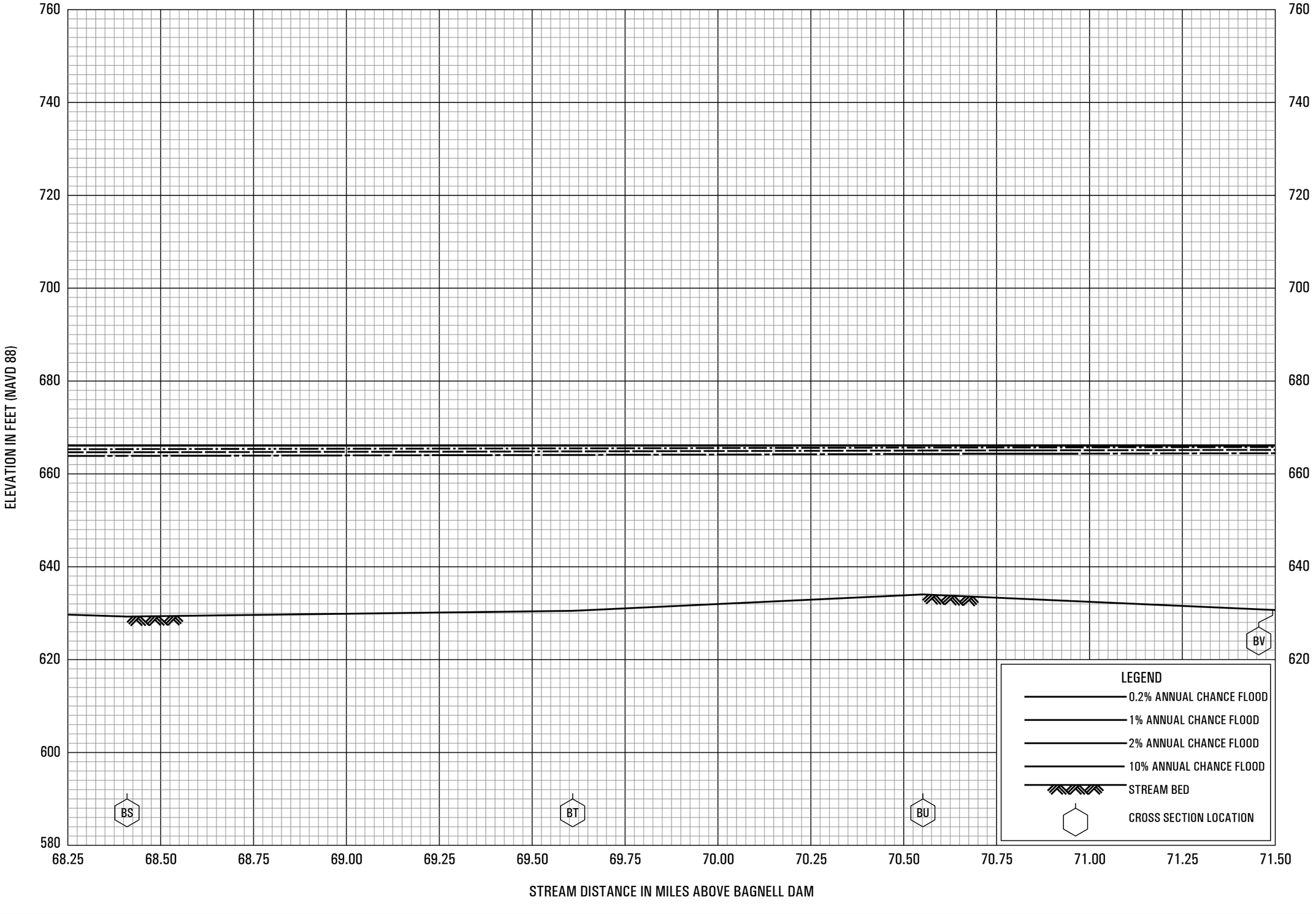

FLOOD PROFILES

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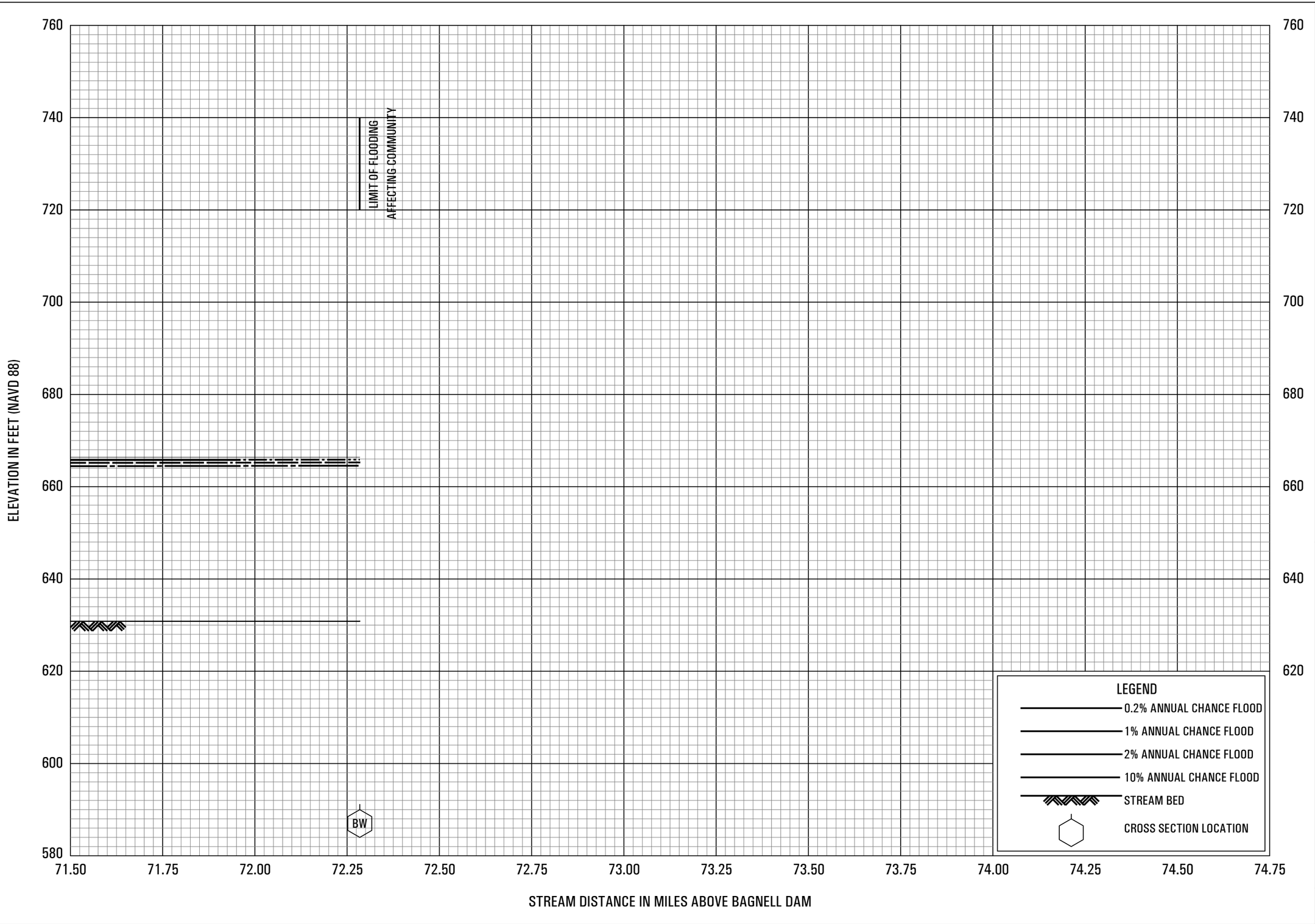

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