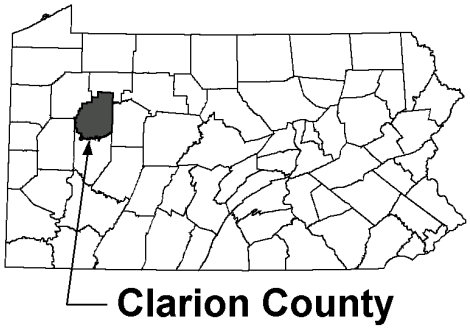
FLOOD INSURANCE STUDY

CLARION COUNTY, PENNSYLVANIA
(ALL JURISDICTIONS)



COMMUNITY NAME	COMMUNITY NUMBER	COMMUNITY NAME	COMMUNITY NUMBER
ASHLAND, TOWNSHIP OF	422361	MILLCREEK, TOWNSHIP OF	422371
BEAVER, TOWNSHIP OF	422362	MONROE, TOWNSHIP OF	422372
BRADY, TOWNSHIP OF	422363	NEW BETHLEHEM, BOROUGH OF	420296
CALLENSBURG, BOROUGH OF	422364	PAINT, TOWNSHIP OF	422373
CLARION, BOROUGH OF	421500	PERRY, TOWNSHIP OF	421509
CLARION, TOWNSHIP OF	421507	PINEY, TOWNSHIP OF	422374
EAST BRADY, BOROUGH OF	421501	PORTER, TOWNSHIP OF	421510
ELK, TOWNSHIP OF	422365	REDBANK, TOWNSHIP OF	421511
FARMINGTON, TOWNSHIP OF	422366	RICHLAND, TOWNSHIP OF	422375
FOXBURG, BOROUGH OF	421502	RIMERSBURG, BOROUGH OF*	422693
HAWTHORN, BOROUGH OF	421503	SALEM, TOWNSHIP OF	422376
HIGHLAND, TOWNSHIP OF	421508	SHIPPENVILLE, BOROUGH OF*	422694
KNOX, BOROUGH OF*	421504	SLIGO, BOROUGH OF	421506
KNOX, TOWNSHIP OF	422367	ST. PETERSBURG, BOROUGH OF*	422695
LICKING, TOWNSHIP OF	422368	STRATTANVILLE, BOROUGH OF*	422696
LIMESTONE, TOWNSHIP OF	422369	TOBY, TOWNSHIP OF	422377
MADISON, TOWNSHIP OF	422370	WASHINGTON, TOWNSHIP OF	422378

* No Special Flood Hazard Areas Identified

December 2, 2011

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
42031CV000A

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 Community Map Repository. Please contact the Community Map Repository for any additional data.

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

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. floodway boundaries, cross sections). In addition, former flood hazard zone designations have been changed as shown:

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

Initial Countywide FIS Effective Date: December 2, 2011

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Flood Insurance Rate Map

FLOOD INSURANCE STUDY
CLARION COUNTY, PENNSYLVANIA (ALL JURISDICTIONS)

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study (FIS) report investigates the existence and severity of flood hazards in the geographic area of Clarion County, Pennsylvania, including the Boroughs of Callensburg, Clarion, East Brady, Foxburg, Hawthorn, Knox, New Bethlehem, Rimersburg, Shippenville, Sligo, St. Petersburg, and Strattanville; and the Townships of Ashland, Beaver, Brady, Clarion, Elk, Farmington, Highland, Knox, Licking, Limestone, Madison, Millcreek, Monroe, Paint, Perry, Piney, Porter, Redbank, Richland, Salem, Toby, and Washington (referred to collectively herein as Clarion County), and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood-risk data for various areas of the community that will be used to establish actuarial flood insurance rates and to assist the community in its efforts to promote sound floodplain management. Minimum floodplain management requirements for participation in the National Flood Insurance Program (NFIP) are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

Please note that on the effective date of this study, the Boroughs of Knox, Rimersburg, Shippenville, St. Petersburg, and Strattanville have no mapped special flood hazard areas identified. This does not preclude future determinations of Special Flood Hazard Areas (SFHA) that could be necessitated by changed conditions affecting the community (i.e. annexation of new lands) or the availability of new scientific or technical data about flood hazards.

Please note that the Borough of Emlenton is geographically located in Clarion and Venango Counties. See these separately published FIS reports and Flood Insurance Rate Maps (FIRMs) for countywide map dates and flood hazard information outside of Clarion County.

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

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

1.2 Authority and Acknowledgments

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

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

Foxburg, Borough of:	In the September 30, 1987 study, the hydrologic and hydraulic analyses for this study were prepared by the U.S. Army Corps of Engineers (USACE), Pittsburgh District, during the preparation of a Flood Plain Information Report on the Allegheny River (Reference 1). This work was completed in June 1974.
Madison, Township of:	In the September 30, 1987 study, the hydrologic and hydraulic analyses for this study were prepared by the USACE, Pittsburgh District, during the preparation of a Flood Plain Information Report on the Allegheny River (Reference 2). This work was completed in June 1974.
New Bethlehem, Borough of:	In the August 15, 1990 study, the hydrologic and hydraulic analyses for this study were prepared by the USACE, Pittsburgh District, for the Federal Emergency Management Agency (FEMA), under Inter-Agency Agreement No. EMW-87-E-2509, Project Order No. 3 (Reference 3). This work was completed in January 1989.
Sligo, Borough of:	In the August 15, 1990 study, the hydrologic and hydraulic analyses for this study were prepared by the USACE, Pittsburgh District, for FEMA under Inter-Agency Agreement No. EMW-87-E-2509, Project Order No. 3 (Reference 4). This work was completed in January 1989.

There are no previous FISs or FIRMs for the Boroughs of Knox, Rimersburg, Shippenville, St. Petersburg, and Strattanville; and no previous FISs for the Boroughs of Callensburg, Clarion, East Brady, Hawthorn; and the Townships of Ashland, Beaver, Brady, Clarion, Elk, Farmington, Highland, Knox, Licking, Limestone, Millcreek, Monroe, Paint, Perry, Piney, Porter, Redbank, Richland, Salem, Toby, and Washington; therefore, the previous authority and acknowledgement information for these communities is not included in this FIS. These communities may not appear in the Community Map History table (Section 6.0).

For this countywide FIS, the Digital Flood Insurance Rate Map (DFIRM) database and mapping were prepared for FEMA by GG3, a joint venture between Gannett Fleming, Inc, Camp Hill, Pennsylvania, and Greenhorne & O'Mara, Inc., Laurel, Maryland under the Joint Venture Contract No. EMP-2003-CO-2606, Task Order Number 10. The December 2, 2011, countywide FIS does not include new detailed hydrologic and hydraulic analyses, but rather redelineation and digitizing of effective flood hazard information and new approximate analyses. This work was completed in March 2010.

The orthophotography base mapping was provided by the PAMAP Program, PA Department of Conservation and Natural Resources, Bureau of Topographic and Geologic Survey. This information was photogrammetrically compiled at a scale of 1:2,400 from aerial photography dated April 2006. The digital countywide FIRM was

produced in Pennsylvania State Plane North Zone coordinate system (FIPS zone with a Lambert Conformal Conic projection, units in feet, and referenced to the North American Datum of 1983, GRS80 spheroid. Differences in datum and spheroid used in the production of the 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 this FIRM.

1.3 Coordination

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

The initial and final meeting dates for the previous FIS reports for Clarion County and its communities are listed in Table 1, "Initial and Final CCO Meetings."

TABLE 1 – INITIAL AND FINAL CCO MEETINGS

Community Name	Initial CCO Date	Final CCO Date
Foxburg, Borough of	September 3, 1986	December 4, 1986
Madison, Township of	September 29, 1986	December 4, 1986
New Bethlehem, Borough of	December 4, 1985	September 20, 1989
Sligo, Borough of	December 4, 1985	September 20, 1989

The results of the countywide study were reviewed at the final CCO meeting held on June 23, 2010, and attended by FEMA, State NFIP Coordinator, the Mapping Partner, and Clarion County community representatives. All problems raised at that meeting have been addressed in this study.

2.0 AREA STUDIED

2.1 Scope of Study

This FIS covers the geographic area of Clarion County, Pennsylvania, including incorporate communities listed in Section 1.1.

All or portions of the streams in Table 2, "Streams Studied by Detailed Methods," were studied by detailed methods. Limits of detailed study are indicated on the Flood Profiles (Exhibit 1) and on the FIRM (Exhibit 2).

TABLE 2 – STREAMS STUDIED BY DETAILED METHODS

Allegheny River	Little Licking Creek
Leisure Run	Redbank Creek
Licking Creek	

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.

At the time of this revision no known Letters of Map Revision (LOMRs) were available for incorporation into the countywide FIS for Clarion County.

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

2.2 Community Description

Clarion County is in west-central Pennsylvania. It is bordered by Venango County, Pennsylvania to the west; Forest County, Pennsylvania to the north; Butler County, Pennsylvania to the southwest; Jefferson County, Pennsylvania to the east; and Armstrong County, Pennsylvania to the south. The County encompasses an area of approximately 609 square miles (Reference 5). The population of the County was 41,765 in 2000 (Reference 6). The climate in the vicinity of the County is temperate, with seasonal variation in temperature. Clarion County is located within a region of both polar and tropical air-mass activity, subjected to continental and maritime invasion. The weather is usually moderate, but may have occasional rapid changes resulting from frontal air-mass movements. The mean daily temperature is 47 degrees Fahrenheit (°F), with mean January temperatures of 23.5°F and July of 69°F. The highest recorded temperature was 101°F in 1991, and the lowest recorded temperature was -26°F in 1961 (Reference 7). Average annual precipitation is 46.7 inches (Reference 7).

The 11,778 square mile drainage area of the Allegheny River basin lies between the headwaters in the western slopes of the Appalachian Mountains in Potter County in northwestern Pennsylvania and its confluence with the Monongahela and Ohio Rivers in the City of Pittsburgh. It flows generally in a northwest direction from its source until it reaches Portville, New York, near the New York-Pennsylvania state boundary; it then flows generally in a western direction to Salamanca, New York; then southward into Pennsylvania; and to its confluence with the Ohio River. The average bed slope of the Allegheny River within the Clarion County reach is 2.0 feet per mile, with valley floor widths ranging from 0.2 to 0.7 mile. Local relief varies from 600 to 700 feet to an average hilltop elevation of approximately 1,600 feet (Reference 1).

The floodplain of the 25.3 mile reach of the Allegheny River through Clarion County is generally narrow and undeveloped. The scarce existing development is essentially residential, either seasonal or permanent. The main line of the old Penn Central railroad, now the railroad, parallels the river along the entire study reach except for a 6 mile stretch at East Brady Borough. The main line bypasses Brady's Bend through a 0.5 mile tunnel with portals at miles 65.2 and 71.2. A spur line does run partially into East Brady Borough, leaving the main line at mile 65.2 and paralleling the river for approximately 3.6 miles upstream to mile 68.8. The floodplain ties riverward of the railroad tracks (Reference 1).

Leisure Run, with a total drainage area of 6.47 square miles at its mouth, joins Redbank Creek on the right bank within the County. It flows towards the south from its source near Spaces Corner. The average slope of Leisure Run is 25 feet per mile. Local relief

above the stream varies from a low of 1,044 feet to an average hilltop elevation of 1,200 feet. The valley floor width varies from 100 to 500 feet wide (Reference 3).
Licking Creek, with a total drainage area of 51.9 square miles at its mouth, joins the Clarion River on the left bank, at river mile 16.2, in the Borough of Callensburg. It flows towards the northwest from its source near the Township of Piney. The average slope of Licking Creek within the County is 38 feet per mile. Local relief above the stream varies from a low of 1,079 feet to an average hilltop elevation of 1,300 feet. The valley floor varies from 100 to 500 feet wide (Reference 4).

Little Licking Creek, with a total drainage area of 4.27 square miles at its mouth, joins Licking Creek on the left bank within the County. It flows towards the northwest from its source approximately three miles south of the Borough of Sligo. The average slope of Little Licking Creek within the County is 45 feet per mile. Local relief above the stream varies from a low of 1,100 feet to an average hilltop elevation of 1,500 feet. The valley floor varies from 100 to 500 feet wide (Reference 4).

Redbank Creek, with a total drainage area of 573 square miles at its mouth, joins the Allegheny River at river mile 64, in the upper pool of Lock and Dam No. 9, and flows towards the southwest from its source at the confluence of Sandy Lick Creek and North Fork Redbank Creek in the Borough of Brookville, Jefferson County, Pennsylvania. The average slope of Redbank Creek within the County is five feet per mile. Local relief above the stream varies from a low of 1,042 feet to an average hilltop elevation of 1,200 feet. The valley floor varies from 500 to 1,500 feet wide (Reference 2).

2.3 Principal Flood Problems

Major floods have occurred during all seasons of the year. The main flood season is usually December through April. Most of the floods during this period are the result of heavy rain and snowmelt. The flood of June 1972 as a result of Tropical Storm Agnes was of considerable magnitude even after the large reductions achieved by the upstream control dams and reservoirs (Reference 2).

There is one bridge crossing the Allegheny River within the Borough of Foxburg, the combined State Route 58 and the railroad bridge. The bridge is not a serious obstruction to flood flows and is sufficiently high enough to pass major floods with negligible pier interference (Reference 1).

Although summer floods are rare on the Allegheny River, ice jam development is historically a problem in the area of the Allegheny River and has caused major flood crest elevations from relatively minor flood flows. In addition, large flood flows have coincided with ice jams, causing even higher flood crest elevations. Major floods occur when the river stage at the City of Parker in Armstrong County, Pennsylvania, exceeds 20 feet. The maximum recorded flood level at the city resulted from heavy rain and snowmelt coincident with ice jamming. In January 1959, the maximum flood flow during the period of record occurred in March 1913, which was 1.2 times larger than that of January 1959. The March 1913 flood crested 2.4 feet below the January 1959 level. The historical flood of March 1865 is known to have exceeded the March 1913 flood level, having an estimated flood flow of approximately 1.4 times that of January 1959. The March 1865 flood crested an estimated 0.2-foot below the January 1959 flood crest.

Listed below are flood crest stages, elevations, and rated discharges for the largest floods known to have occurred on the Allegheny River at Parker Gage at river mile 83.4. It does not reflect the reductions that would have been provided had all five upstream dams and reservoirs, presently in operation, been in operation at the time of occurrence, with the exception of the June 1972 flood. The June 1972 flood reached a stage of 22.2 feet at the Parker Gage, 2.2 feet over flood stage but actually an estimated 6.3 feet lower that what would have occurred without the five upstream dams and reservoir.

Table 3, "Historical Floods on the Allegheny River at Parker Gage," shows twelve major floods of record as measured at the Parker Gage (River Mile 83.4).

TABLE 3 – HISTORICAL FLOODS ON THE ALLEGHENY RIVER AT PARKER GAGE

Date of Crest	Stage[1] (ft)	Elevation (ft)	Discharge (cfs)
January 21, 1959[2]	29.6	874.2	182,000 (ice)
March 17, 1865	29.4	874.0	250,000
March 26, 1913	27.2	871.8	221,000
February 27, 1936	25.8	870.4	78,000 (ice)
March 5, 1934	25.8	870.4	65,000 (ice)
March 20, 1940[2]	24.9	869.5	47,000 (ice)
January 30, 1968[2]	24.2	868.8	60,000 (ice)
March 20, 1905	23.4	868.0	176,000
February 28, 1917	23.4	868.0	81,000 (ice)
March 10, 1964[2]	23.3	867.9	174,000
March 13, 1920	23.2	867.8	172,600
June 23, 1972[2]	22.2	866.8	161,000

[1]Flood stage = 20.0 feet; Gage zero elevation = 844.61 feet
[2]Includes partial or full reduction from the Flood Control Projects

The hazards imposed by the storage of floatable materials or structures such as tanks within the confines of the floodplain are many and varied. Floatable material being carried along in fast moving floodwater not only endangers life but also can subject structures such as buildings and bridges to abnormally high stresses and result in structural failure. Partially filled inadequately anchored storage tanks can become buoyant, non-guided missiles capable of causing serious damage to other structures. In addition, a ruptured storage tank, depending on its contents, can result in pollution, fire and explosion, or perhaps even the emission of poisonous fumes. Although industrial and commercial development on the floodplains of the Allegheny River in Clarion County is scarce, potential sources of floatable material exist on the right bank and on scattered upstream sites.

The first and only stream gaging station in the Clarion County portion of the Allegheny River was established in 1885 when the National Weather Service installed a staff gage on the bridge at Parker's Landing. Daily river stages were read until January 1940. In October 1932, the U.S. Geological Survey (USGS) installed a recording gage 500 feet downstream of the present Parker Highway Bridge and 50 feet downstream of the staff gage.

Staff gage records from the upper and lower lock walls at Lock and Dam No. 9 extend from November 1938 to the present. Lock and Dam No. 9 is located at Mile 62.2, 1.7 miles downstream of the Clarion County boundary and is the last navigation structure on the Allegheny River. It maintains a normal pool elevation of 821 feet which extends approximately 2.5 miles upstream of the East Brady Highway Bridge, or approximately at Mile 72 (Reference 8).

The highest known flood to have occurred on Leisure Run was in June 1975. Floods on Leisure Run occur primarily in the summer months and are usually the result of high-intensity, short duration storms.

Although major floods may occur on Licking Creek and Little Licking Creek at various times of the year, most floods occur in the summer months. These floods are typically the result of high-intensity, short duration storms. The largest flood known to have occurred on Licking and Little Licking Creeks was on June 23, 1975.

The largest known flood on Redbank Creek occurred in March 1936, with a discharge of approximately 37,500 cubic feet per second (cfs); measured at the USACE wire weight gage located on the State Route 28/66 bridge. The approximate elevation of this flood event, estimated from a high-water mark near the bridge, was 1,065 feet. A large flood on Redbank Creek occurred in June 1972, with a discharge measured at the same bridge of 31,800 cfs and a corresponding high water elevation of 1,062 feet. Other severe floods occurred in October 1911 and March 1964.

2.4 Flood Protection Measures

There are five flood control dams and reservoirs in the Allegheny River basin. These were built and are operated and maintained by the USACE. Of the 25.3 miles of the Allegheny River bordering Clarion County, only the 20.6 miles from Redbank Creek to the Clarion River are affected by all five structures. The remaining 4.7 miles upstream from the mouth of the Clarion River, which includes the Borough of Foxburg, are affected by four of these structures.

Table 4, "Dams and Reservoirs in the Allegheny River Basin," shows pertinent data for these five flood control structures.

TABLE 4 – DAMS AND RESERVOIRS IN THE ALLEGHENY RIVER BASIN

Dam and Reservoir	Miles Upstream from Parker Gage	Drainage Area (Sq. Miles)	Date Placed in Operation
Tionesta Dam, Tionesta Lake	69	478	December 1940
East Branch Dam, East Branch Clarion River Lake	107	72	June 1952
Kinzua Dam, Allegheny Reservoir	115	2,180	January 1967
Union City Dam, Union City Reservoir	114	222	October 1970
Woodcock Dam, Woodcock Creek Lake	82	46	January 1974

A river forecasting service for the entire Pittsburgh District is provided by the National Weather Service of the National Oceanic and Atmospheric Administration (NOAA). Approximately 50 daily reports of river levels and precipitation amounts from a network of observers established by the National Weather Service and the USACE are used in preparing general river forecasts. During a flood, the National Weather Service issues river stage forecasts for the Allegheny River at Parker and East Brady Boroughs. In 1955, the Commonwealth of Pennsylvania established an efficient Civil Defense Organization on a state-wide basis for the dissemination of flood warnings.

There are no formal flood fighting or emergency evacuation plans in effect at the local level in Clarion County. Provisions for alerting area residents and coordinating operations of public service agencies such as, the local civil defense, firemen, and police in time of emergency are accomplished through the Clarion County Civil Defense Office. The local Red Cross has the capacity to provide for the welfare of flood victims.

3.0 ENGINEERING METHODS

For the flooding sources studied by detailed methods in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude that are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10-, 2-, 1-, and 0.2-percent-annual-chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long-term, average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood that equals or exceeds the 1-percent-annual-chance (100-year) flood in any 50-year period is approximately 40 percent (4 in 10); for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

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

Pre-countywide Analyses

Natural discharge-frequency curves for Allegheny River and Redbank Creek were developed following the standard log-Pearson Type III analysis (Reference 9).

The stage-discharge records used in the analysis of the Allegheny River were obtained at Lock and Dam No. 7 at Kittanning with five years of record. A staff gage located on the upper lock wall at Lock and Dam No. 7 has been maintained by the USACE since January 1931. In 1939, the USGS installed a recording gage on the upstream lock wall. Prior to 1931, a non-recording gage was maintained downstream of Lock and Dam No. 7. To supplement the gage records at Parker and Lock and Dam No. 9, newspaper files and

historical records were searched. In addition to interviewing local residents along the stream, high-water data were obtained by actual field observation.

There are no stream gage or flow records for Leisure Run. Flows for the 1-percent-annual-chance flood on Leisure Run were developed using average values of the multiple regression formulas based on the factors of drainage area, stream slope, and basin shape (References 9 and 10).

There are no stream gage or flow records for Licking and Little Licking Creeks. Flows for the 1-percent-annual-chance flood on Licking Creek were developed through the use of multiple regression formulas based on the factors of drainage area, stream slope, and basin shape, which were determined from a USACE study of flood frequencies on small streams in the Pittsburgh District (Reference 11). On Little Licking Creek, the 1-percent-annual-chance flood flows were developed by averaging the values computed by using multiple regression formulas developed for ungaged streams by the USACE study, Federal Highway Administration, and USGS (References 11, 12, and 13).

The stage discharge records used in for the analysis of Redbank Creek were obtained at the USACE gage located in the Borough of New Bethlehem and the USGS Gaging Station No. 03032500 located approximately three miles west of New Bethlehem at St. Charles. The 1-percent-annual-chance flood frequency discharge values on Redbank Creek developed at the St. Charles gage were modified to reflect any major changes in the drainage area.

Peak discharge-drainage area relationships for the 10-, 2-, 1-, and 0.2-percent-annual-chance floods for each stream studied by detailed methods are presented in Table 5, "Summary of Discharges."

Countywide Analyses

No new hydrologic analyses were conducted as part of this countywide FIS.

TABLE 5 – SUMMARY OF DISCHARGES

Flooding Source and Location	Drainage Area (square miles)	Peak Discharges (cubic feet per second) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
ALLEGHENY RIVER					
At Lock and Dam No. 7	8,982	152,000	196,000	215,500	261,000
At USGS Gaging Station No. 03031500	7,671	*	*	173,000	209,000
LEISURE RUN					
At confluence with Redbank Creek	6.7	*	*	1,960	*
LICKING CREEK					
At confluence with Clarion River	24.1	*	*	4,600	*

*Data Not Available

TABLE 5 – SUMMARY OF DISCHARGES - continued

Flooding Source and Location	Drainage Area (square miles)	Peak Discharges (cubic feet per second) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
LICKING CREEK (continued)					
Upstream of confluence with Anderson Run	19.3	*	*	4,120	*
Upstream of confluence with Mineral Run	17.2	*	*	3,890	*
Upstream of confluence with Little Licking Creek	12.7	*	*	2,700	*
LITTLE LICKING CREEK					
At confluence with Licking Creek	4.3	*	*	1,190	*
Upstream of confluence with Unnamed Tributary to Little Licking Creek	3.2	*	*	1,030	*
REDBANK CREEK					
Approximately 650 feet upstream of West Broad Street (SR-28/66/839)	502.0	*	*	35,200	*

*Data Not Available

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals. Users should be aware that flood elevations shown on the FIRM represent rounded whole-foot elevations and may not exactly reflect the elevations shown on the Flood Profiles or in the Floodway Data 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 computed water-surface elevations to an accuracy of 0.5-foot 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 is computed (Section 4.2), selected cross-section locations are also shown on the FIRM (Exhibit 2).

The hydraulic analyses for these studies were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

All elevations shown on the Flood Profiles and FIRM (Exhibits 1 and 2) are referenced to the North American Vertical Datum of 1988 (NAVD 88).

Pre-countywide Analyses

Water-surface elevations for Allegheny River; Leisure Run; Licking Creek; Little Licking Creek; and Redbank Creek were computed using the USACE HEC-2 step-backwater computer program (Reference 14).

Starting water-surface elevations for the Allegheny River were based on stage-discharge relationships at the downstream corporate limits that were obtained by a continuation of profile computations starting in the City of Pittsburgh.

The Allegheny River valley is such that ice gorges commonly occur. Huge jams of broken ice form temporary but effective dams across the river, resulting in localized flood stages that can exceed those of the 0.2-, and 1-percent-annual-chance floods. The January 1959 flood is an example of this condition.

The starting water-surface elevations for Leisure Run were obtained from a cross section located on Redbank Creek immediately downstream of the mouth of Leisure Run. Use of this method incorporates backwater flow from Redbank Creek into the profile for Leisure Run.

The starting water-surface elevations for Licking Creek were determined using normal depth calculations. The starting water-surface elevations for Little Licking Creek were assumed to be at critical depth and were obtained from a cross section located on Licking Creek downstream of the mouth of Little Licking Creek. Use of this method incorporates backwater flow from Licking Creek into the profile for Little Licking Creek.

The starting water-surface elevations for Redbank Creek were derived from the rating curve and the verification of flood profiles.

Cross section data for the Allegheny River were taken from the Flood Plain Information Report for Clarion County (Reference 8).

Cross section data for Leisure Run were obtained by field measurements taken in October 1987.

Cross section data for Licking Creek and Little Licking Creek were obtained by field measurement.

Cross section data for Redbank Creek were obtained from a USACE Reconnaissance Report on Flood Protection dated March 1978 (Reference 15).

All bridges, dams, and culverts along detailed studied streams in Clarion County were field surveyed to obtain elevation data and structural geometry.

Channel and overbank roughness factors (Manning's "n") used in the hydraulic computations were estimated by engineering judgment and based on field observation at each cross-section and adjusted with known high-water marks and stream gage rating curves where possible. Table 6, "Manning's "n" Values," shows the channel and overbank "n" values for the streams studied by detailed methods.

TABLE 6 – MANNING'S "n" VALUES

Stream	Channel	Overbank
Allegheny River	0.028	0.050 - 0.080
Leisure Run	0.030 - 0.045	0.050
Licking Creek	0.045	0.080
Little Licking Creek	0.035 - 0.040	0.080
Redbank Creek	0.030	0.050

Countywide Analyses

No new detailed hydraulic analyses were conducted as part of this countywide FIS; however for flooding sources studied with approximate methods, the 1-percent-annual-chance flood elevations were determined using USGS Regression Equations (Reference 16) and the USACE HEC-RAS computer program (Reference 17). The peak flood discharges from the regression equations were input into a HEC-RAS model that included cross sections extracted from PAMAP LiDAR data collected in 2006. Because this cross section information was not supplemented with field survey data and the models did not include bridge and culvert information, the resulting floodplain boundaries are considered approximate. Approximately 330 stream miles in the County were analyzed using this approach.

Qualifying bench marks within a given jurisdiction are cataloged by the National Geodetic Survey (NGS) and entered into the National Spatial Reference System (NSRS). First or Second Order Vertical bench marks that have a vertical stability classification of A, B, or C are shown and labeled on the FIRM with their 6-character NSRS Permanent Identifier.

Bench marks cataloged by the NGS and entered into the NSRS vary widely in vertical stability classification. NSRS vertical stability classifications are as follows:

Stability A: Monuments of the most reliable nature, expected to hold position/elevation well (e.g., mounted in bedrock)

Stability B: Monuments which generally hold their position/elevation well (e.g., concrete bridge abutments)

Stability C: Monuments which may be affected by surface ground movements (e.g., concrete mounted below frost line)

Stability D: Mark of questionable or unknown vertical stability (e.g., concrete monument above frost line, or steel witness post)

In addition to NSRS bench marks, the FIRM may also show vertical control monument established by a local jurisdiction; these monuments will be shown on the FIRM with the appropriate designations. Local monuments will only be placed on the FIRM if the community has requested that they be included, and if the monuments meet the aforementioned NSRS inclusion criteria.

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

It is important to note that temporary vertical monuments are often established during the preparation of a flood hazard analysis for the purposes of establishing local vertical control. Although these monuments are not shown on the digital FIRM, they may be found in the Technical Support Data Notebook associated with this FIS and FIRM. Interested individuals may contact FEMA to access this data.

3.3 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 29). With the completion of the NAVD 88, many FIS reports and FIRMs are now prepared using NAVD 88 as the referenced vertical datum.

For this countywide FIS, all flood elevations shown in the FIS report and on the FIRM are referenced to NAVD 88. Structure and ground elevations in the community must, therefore, be referenced to NAVD 88. It is important to note that adjacent communities may be referenced to NGVD 29. This may result in differences in base flood elevations across corporate limits between the communities.

As noted above, the elevations shown in the FIS report and on the FIRM for Clarion County are referenced to NAVD 88. Ground, structure, and flood elevations may be compared and/or referenced to NGVD 29 by applying a standard conversion factor. The conversion factor from NGVD 29 to NAVD 88 for Clarion County is -0.528 foot. The locations used to establish the conversion factor were USGS 7.5-minute topographic quadrangle corners that fell within the County, as well as those that were within 2.5 miles outside the County. The bench marks are referenced to NAVD 88.

Conversion locations and values for Clarion County are shown below in Table 7, "Vertical Datum Conversion Values."

TABLE 7 – VERTICAL DATUM CONVERSION VALUES

USGS 7.5-MINUTE Quadrangle Name	Corner	Longitude (Decimal Degrees)	Latitude (Decimal Degrees)	Conversion from NGVD 29 to NAVD 88 (foot)
Clarion	SE	41.125	-79.375	-0.518
Cranberry	SE	41.250	-79.625	-0.518
Emlenton	SE	41.125	-79.625	-0.561
Fryburg	SE	41.250	-79.375	-0.509
Knox	SE	41.125	-79.500	-0.541
Kossuth	SE	41.250	-79.500	-0.522

TABLE 7 – VERTICAL DATUM CONVERSION VALUES - continued

USGS 7.5-MINUTE Quadrangle Name	Corner	Longitude (Decimal Degrees)	Latitude (Decimal Degrees)	Conversion from NGVD 29 to NAVD 88 (foot)
Lucinda	SE	41.250	-79.250	-0.476
New Bethlehem	SE	41.000	-79.250	-0.528
Parker	SE	41.000	-79.625	-0.581
President	SE	41.375	-79.500	-0.518
Rimersburg	SE	41.000	-79.500	-0.564
Sligo	SE	41.000	-79.375	-0.554
Strattanville	SE	41.125	-79.250	-0.535

Average Conversion from NGVD 29 to NAVD 88 = -0.528 feet

The Base Flood Elevations (BFEs) shown on the FIRM represent whole-foot rounded values. For example, a BFE of 102.4 will appear as 102 on the FIRM and 102.6 will appear as 103. Therefore, users that wish to convert the elevations in this FIS to NGVD 29 should apply the conversion factor (+**0.528** foot) to elevations shown on the Flood Profiles and supporting data tables in this FIS report, which are shown at a minimum to the nearest 0.1 foot.

For more information regarding conversion between NGVD 29 and NAVD 88, see *Converting the National Flood Insurance Program to the North American Vertical Datum of 1988* (Reference 79) or contact NGS Information Services, NOAA, N/NGS 12, National Geodetic Survey, SSMC-3, #9202, 1315 East-West Highway, Silver Spring, MD 20910-3282, (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 FIS provides 1-percent-annual-chances 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. This information is presented on the FIRM and in many components of the FIS report, including Flood Profiles and Floodway Data Table. Users should reference the data presented in the FIS report as well as additional information that may be available at the local map repository before making flood elevation and/or floodplain boundary determinations.

4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1-percent-annual-chance flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent-annual-chance flood is employed to indicate additional areas of flood risk in the community. For the streams studied in detail, the 1- and 0.2-percent-annual-chance floodplain boundaries have been delineated using the flood elevations determined at each cross section. The boundaries were interpolated between cross sections and delineated in a GIS environment using PAMAP LiDAR data collected in 2006 (Reference 18).

The 1-percent-annual-chance floodplain boundaries are shown on the FIRM (Exhibit 2). On this map, the 1-percent-annual-chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A and AE) 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 elevation but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

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

4.2 Floodways

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

The area between the floodway and the 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 of the 1-percent-annual-chance flood by more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 1, “Floodway Schematic”.

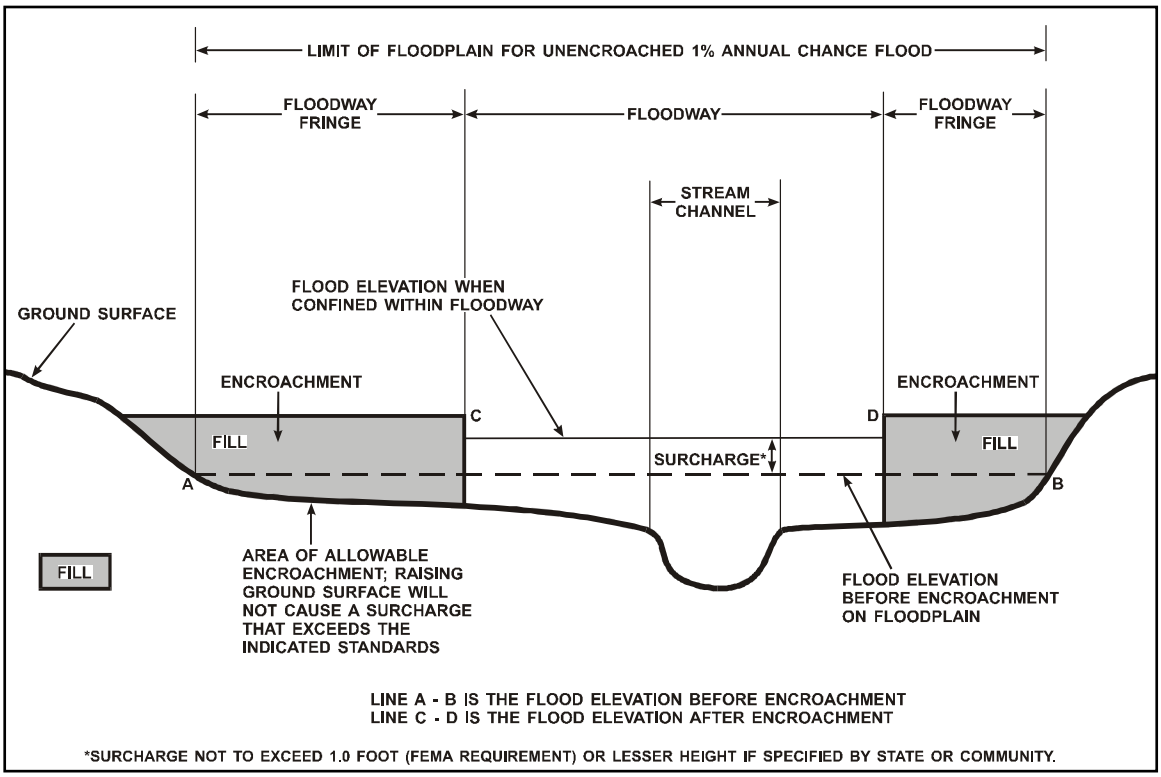

Figure 1 - Floodway Schematic

No floodways were computed as part of this FIS, and therefore no floodways are presented in this FIS.

Along streams where floodways have not been computed, the community must ensure that the cumulative effect of development in the floodplains will not cause more than a 1.0-foot increase in the BFEs at any point within the community.

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 BFEs or depths are shown within this zone.

Zone AE

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

Zone AH

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

Zone AO

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

Zone AR

Zone AR is the flood insurance risk zone that corresponds to an area of special flood hazard formerly protected from the base flood event by a flood-control system that was subsequently decertified. Zone AR indicates that the former flood-control system is being restored to provide protection from the 1-percent-annual-chance or greater flood event.

Zone A99

Zone A99 is the flood insurance rate zone that corresponds to areas of the 1-percent-annual-chance floodplain that will be protected by a Federal flood protection system where construction has reached specified statutory milestones. No BFEs or depths are shown within this zone.

Zone V

Zone V is the flood insurance rate zone that corresponds to the 1-percent-annual-chance coastal floodplains that have additional hazards associated with storm waves. Because approximate hydraulic analyses are performed for such areas, no BFEs are shown within this zone.

Zone VE

Zone VE is the flood insurance rate zone that corresponds to the 1-percent-annual-chance coastal floodplains that have additional hazards associated with storm waves. Whole-foot BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone X

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

Zone X (Future Base Flood)

Zone X (Future Base Flood) is the flood insurance risk zone that corresponds to the 1-percent-annual-chance floodplains that are determined based on future-conditions hydrology. No BFEs or base flood 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 risk zones as described in Section 5.0 and, in the 1-percent-annual-chance floodplains that were studied by detailed methods, shows selected whole-foot BFEs or average depths. Insurance agents use the zones and BFEs in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

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

The current FIRM presents flooding information for the entire geographic area of Clarion County. Previously, separate Flood Hazard Boundary Maps and/or FIRMs were prepared for each incorporated community with identified flood hazard areas. Historical map dates relating to pre-countywide maps prepared for each community are presented in Table 8, "Community Map History."

7.0 OTHER STUDIES

Information pertaining to revised and unrevised flood hazards for each jurisdiction within Clarion County has been compiled into this countywide FIS. Therefore, this FIS either supersedes or is compatible with all previous studies published on streams studied in this report and should be considered authoritative for the purposes of the NFIP. Countywide FIS reports for the adjacent counties of Armstrong County, Pennsylvania; Butler County, Pennsylvania; Jefferson County, Pennsylvania; and Venango County, Pennsylvania have been issued preliminary. The countywide FIS report for Forest County, Pennsylvania has been issued effective. Since the Borough of Emlenton is being shown in its entirety in Venango County, which is currently being restudied, effective information may be found using the FIRM dated June 30, 1976 (Reference 19).

8.0 LOCATION OF DATA

Information concerning the pertinent data used in preparation of this study can be obtained by contacting FEMA, Federal Insurance and Mitigation Division, One Independence Mall, Sixth Floor, 615 Chestnut Street, Philadelphia, Pennsylvania 19106-4404.

COMMUNITY NAME	INITIAL NFIP MAP DATE	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE	INITIAL FIRM DATE	FIRM REVISIONS DATE
Ashland, Township of	January 10, 1975	July 25, 1980	January 17, 1985	
Beaver, Township of	January 24, 1975	May 23, 1980	January 17, 1985	
Clarion, Borough of	November 29, 1974	None	November 1, 1986	
Clarion, Township of	November 29, 1974	February 4, 1977	November 1, 1986	
Elk, Township of	January 31, 1975	None	July 3, 1985	
Farmington, Township of	January 17, 1975	January 25, 1980	July 3, 1985	
Foxburg, Borough of	December 20, 1974	None	September 30, 1987	
Hawthorn, Borough of	December 27, 1974	None	May 1, 1986	
Highland, Township of	December 6, 1974	May 16, 1980	May 1, 1986	
Knox, Township of	April 4, 1975	None	January 3, 1985	
Licking, Township of	January 24, 1975	None	January 3, 1985	
Limestone, Township of	February 21, 1975	None	January 3, 1985	
Madison, Township of	January 10, 1975	None	September 30, 1987	
Millcreek, Township of	October 15, 1976	None	January 3, 1985	
Monroe, Township of	January 3, 1975	None	May 1, 1986	

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARION COUNTY, PA
(ALL JURISDICTIONS)

COMMUNITY MAP HISTORY

COMMUNITY NAME	INITIAL NFIP MAP DATE	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE	INITIAL FIRM DATE	FIRM REVISIONS DATE
New Bethlehem, Borough of	June 28, 1974	May 14, 1976	August 15, 1990	
Paint, Township of	January 24, 1975	None	January 3, 1985	
Perry, Township of	November 15, 1974	None	May 1, 1986	
Piney, Township of	January 17, 1975	None	January 3, 1985	
Porter, Township of	September 6, 1974	May 14, 1976	October 1, 1986	
Redbank. Township of	January 17, 1975	None	May 1, 1986	
Richland, Township of	January 17, 1975	None	October 1, 1986	
Salem, Township of	January 10, 1975	None	January 3, 1985	
Sligo, Borough of	November 8, 1974	None	August 15, 1990	
Toby, Township of	October 22, 1976	None	January 3, 1985	
Washington, Township of	January 17, 1975	None	February 1, 1985	

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARION COUNTY, PA
(ALL JURISDICTIONS)

COMMUNITY MAP HISTORY

9.0 BIBLIOGRAPHY AND REFERENCES

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4. Federal Emergency Management Agency, Flood Insurance Study, Borough of Sligo, Clarion County, Pennsylvania, Washington, D.C., August 15, 1990.

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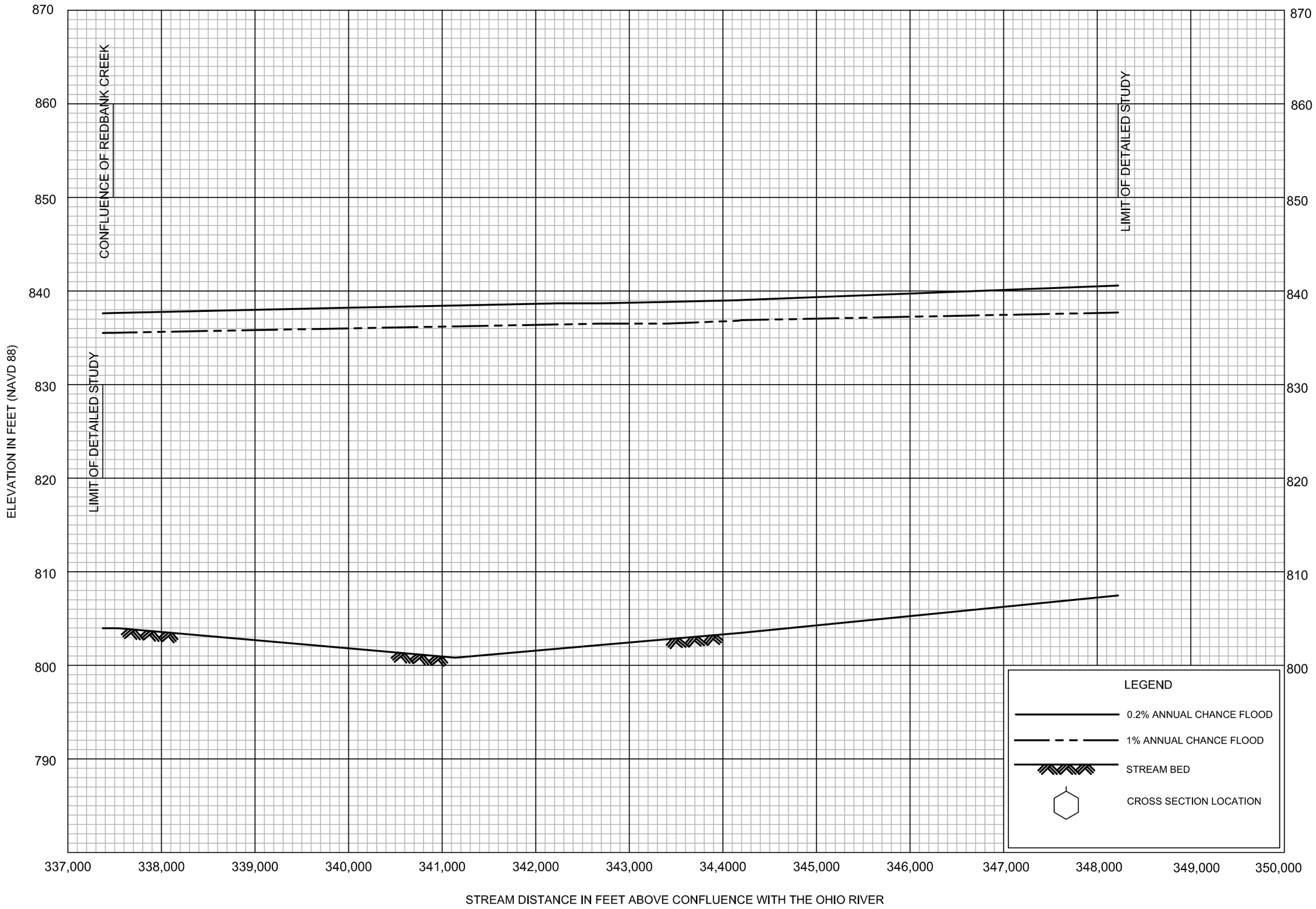


FLOOD PROFILES

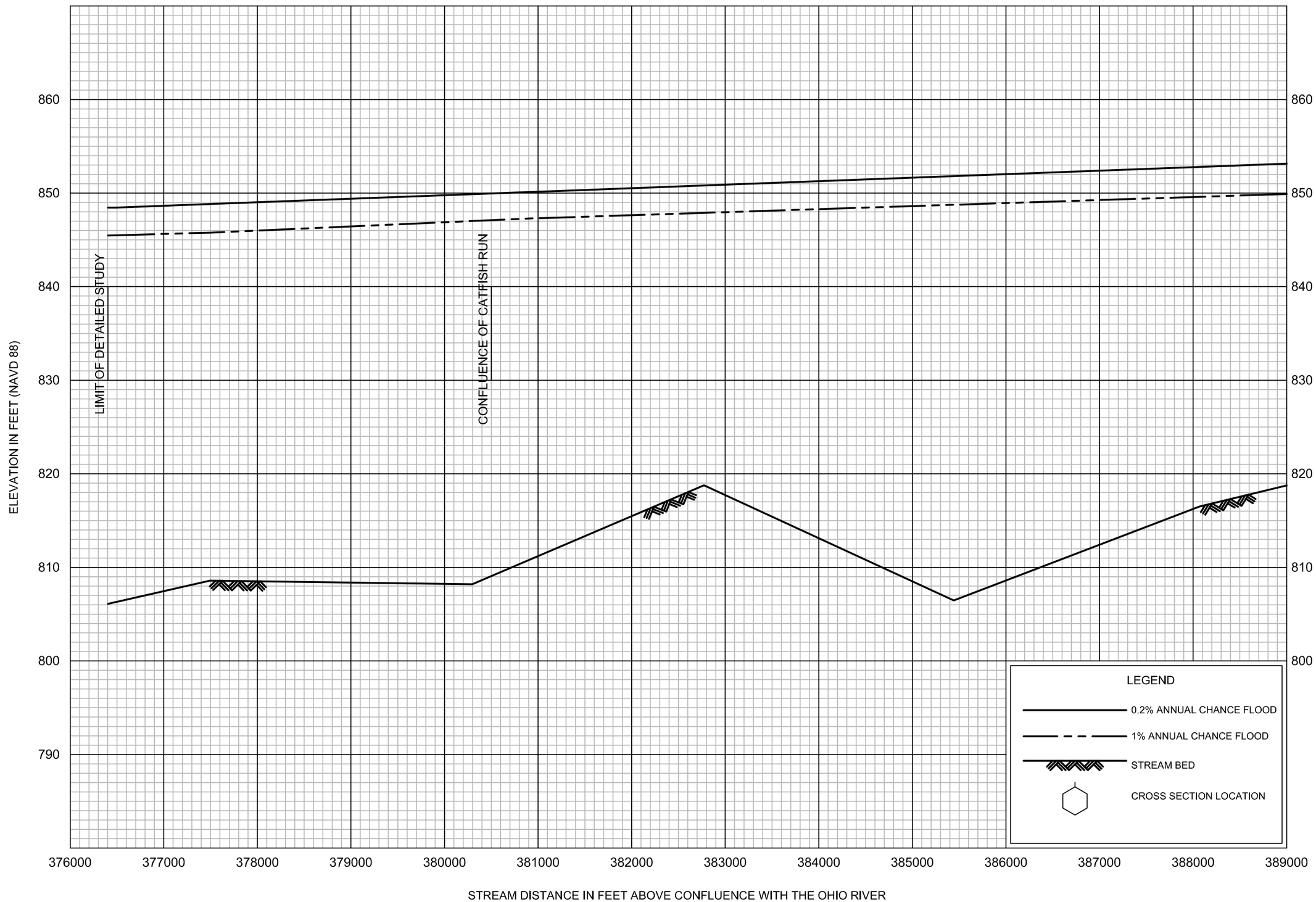
ALLEGHENY RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARION COUNTY, PA

(ALL JURISDICTIONS)

01P



FLOOD PROFILES

ALLEGHENY RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARION COUNTY, PA

(ALL JURISDICTIONS)

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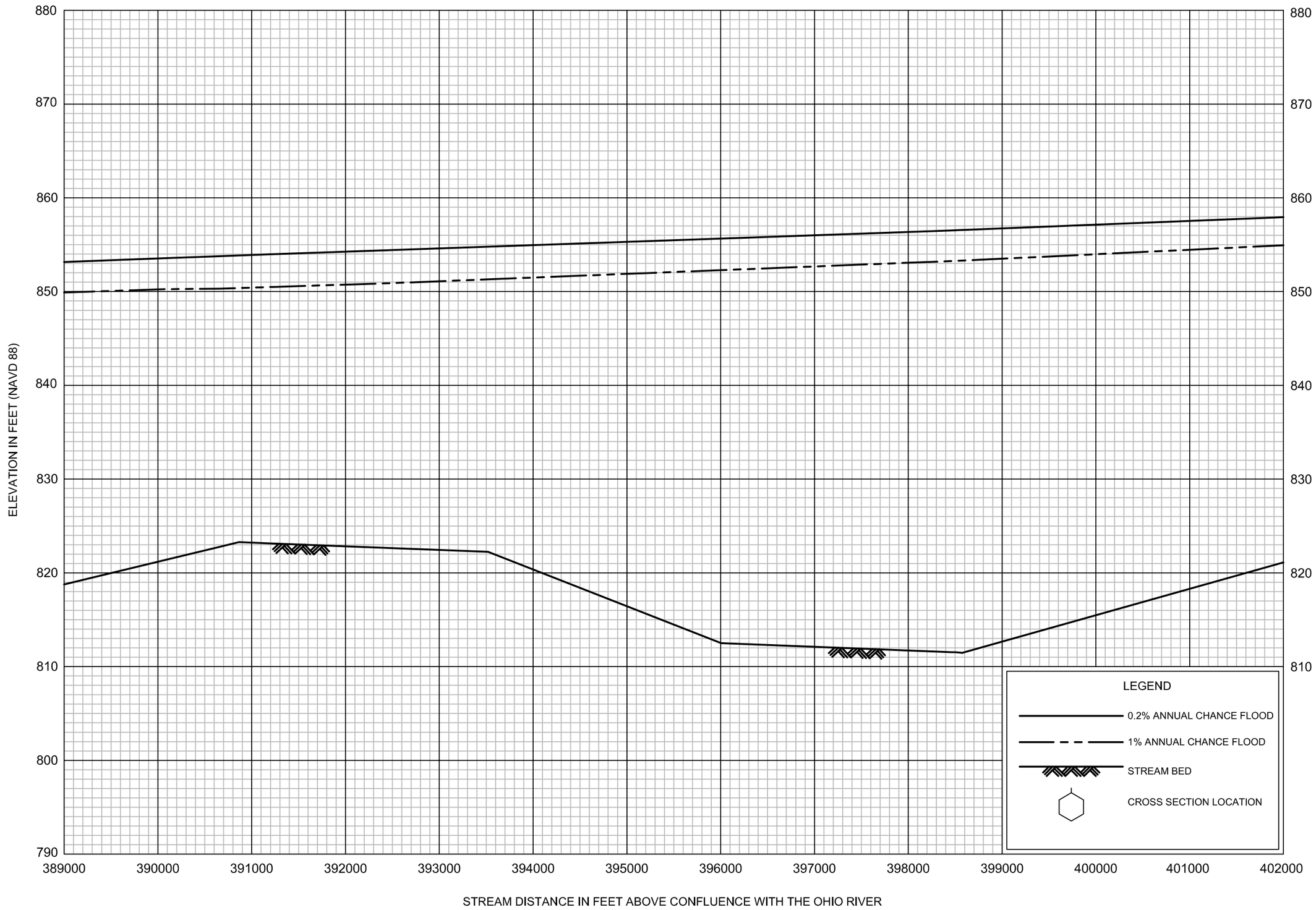

FLOOD PROFILES

ALLEGHENY RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARION COUNTY, PA

(ALL JURISDICTIONS)

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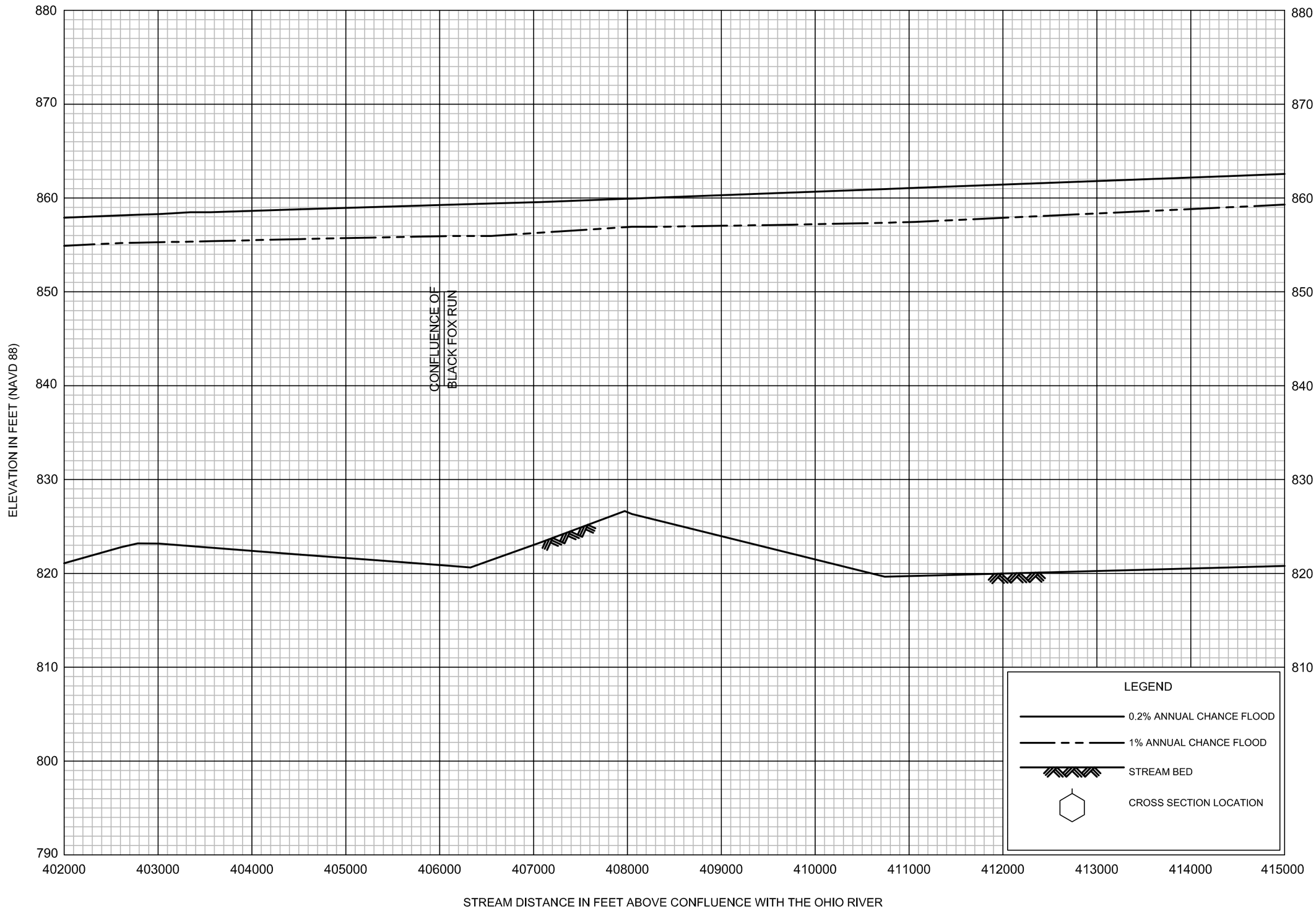

FLOOD PROFILES

ALLEGHENY RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARION COUNTY, PA

(ALL JURISDICTIONS)

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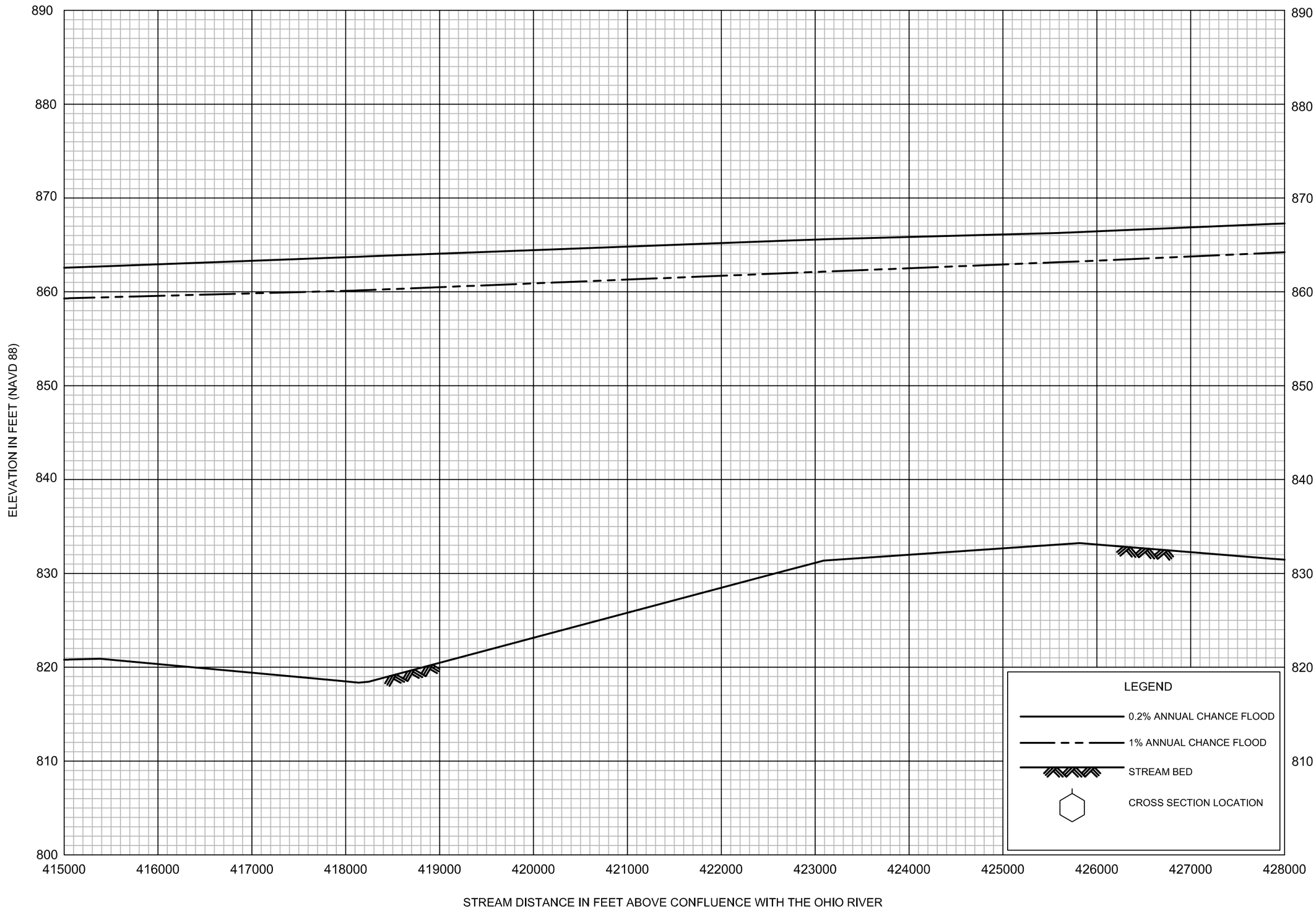

FLOOD PROFILES

ALLEGHENY RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARION COUNTY, PA

(ALL JURISDICTIONS)

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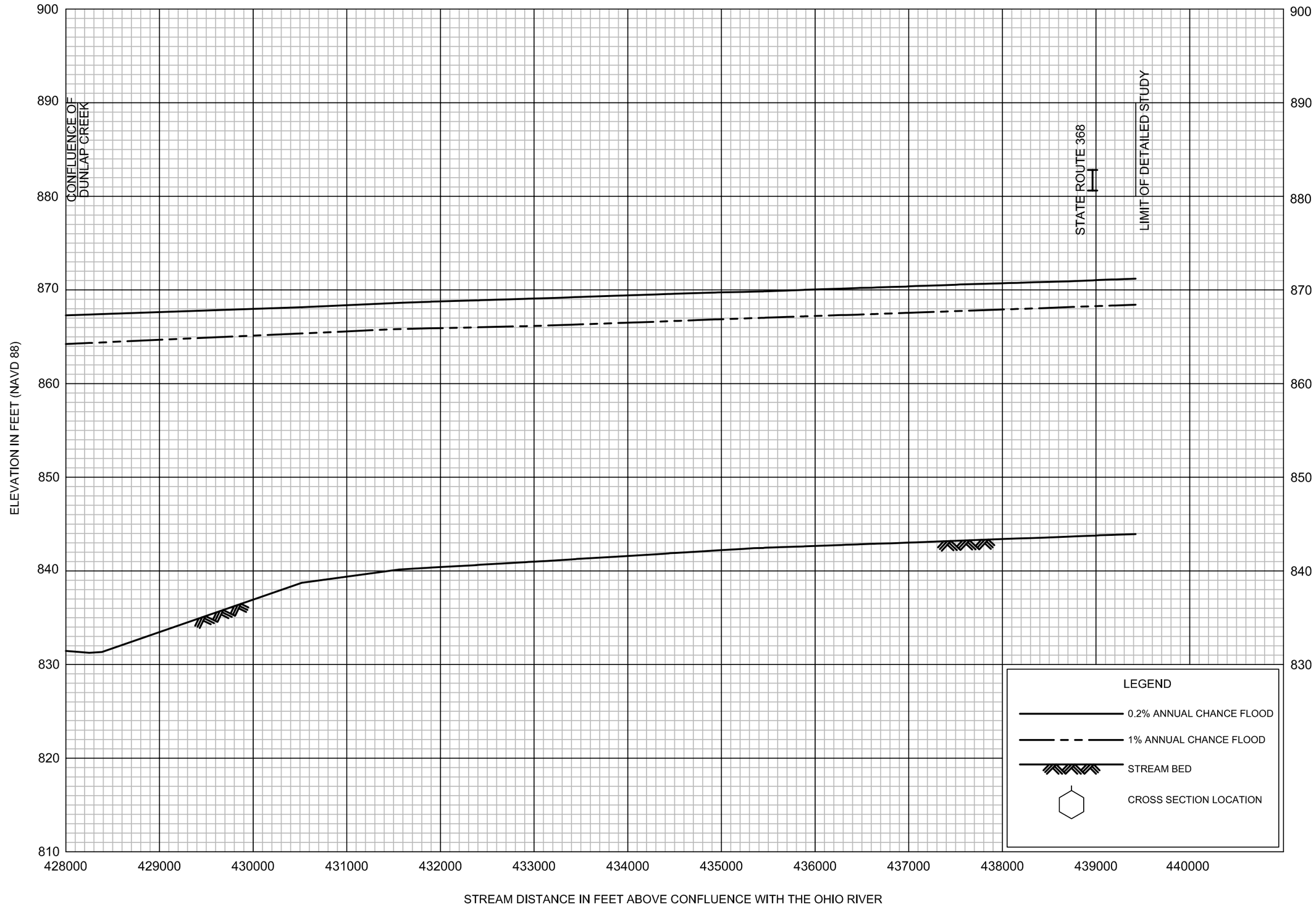

FLOOD PROFILES

ALLEGHENY RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARION COUNTY, PA

(ALL JURISDICTIONS)

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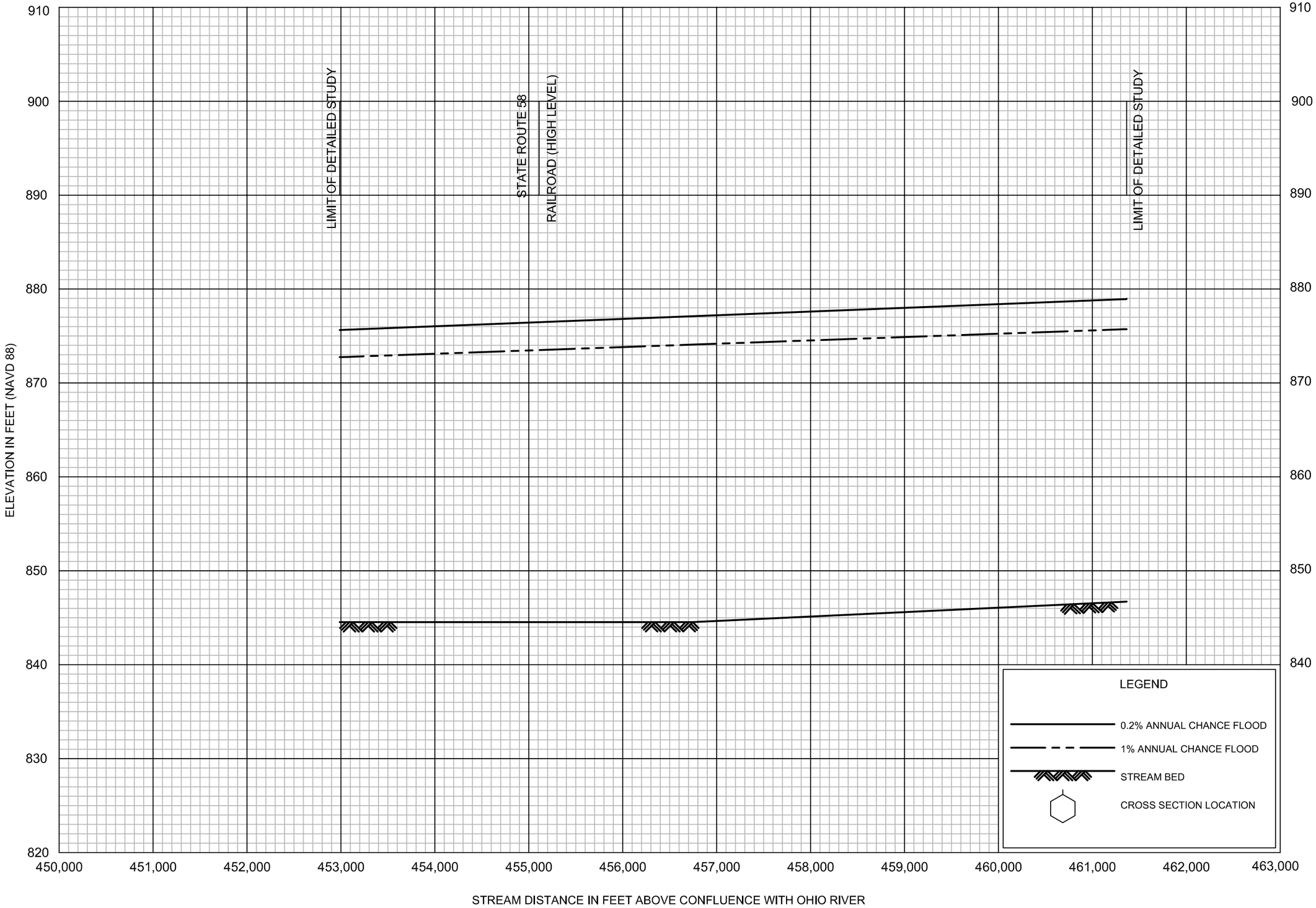


FLOOD PROFILES

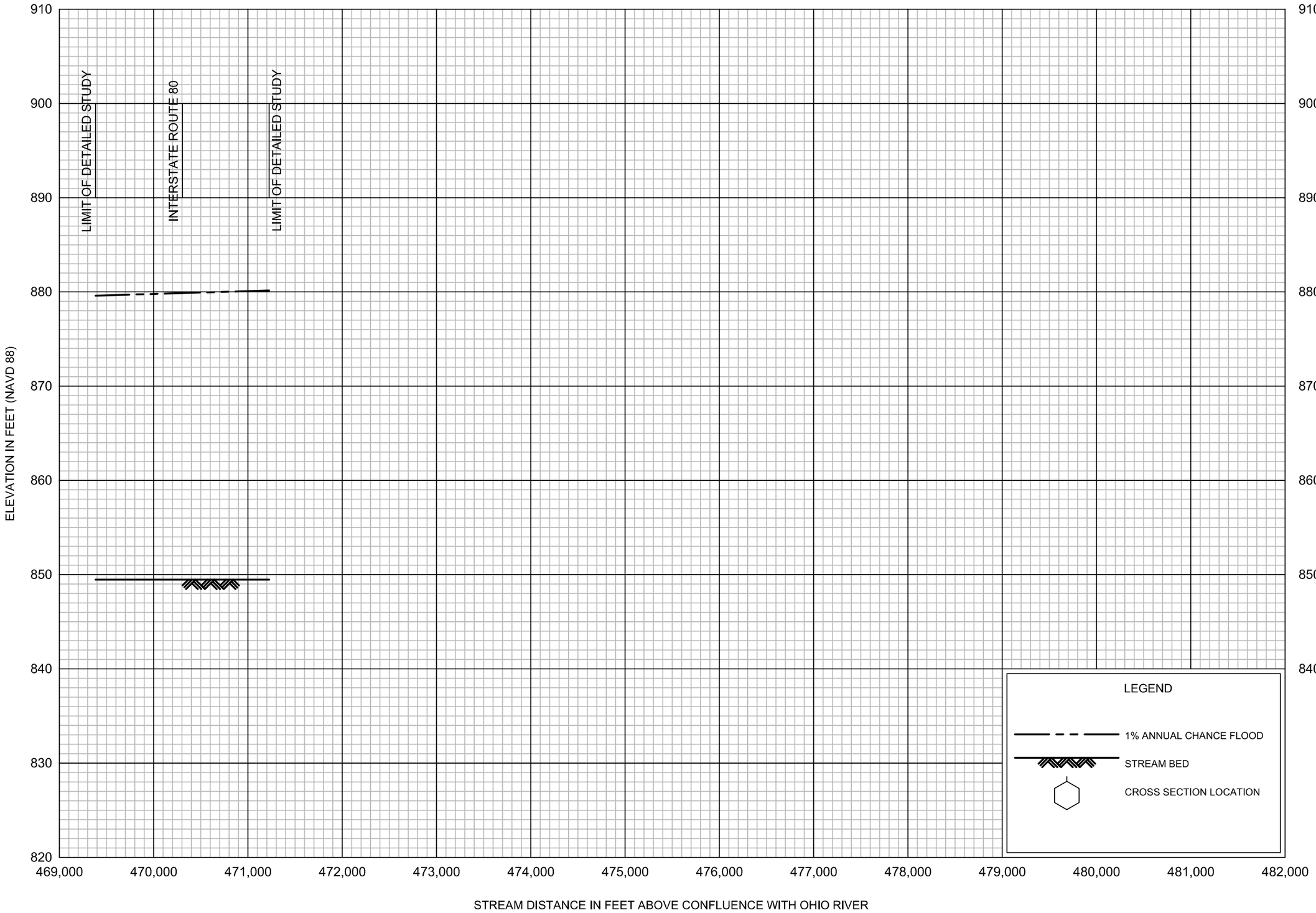
ALLEGHENY RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARION COUNTY, PA

(ALL JURISDICTIONS)

07P



FLOOD PROFILES

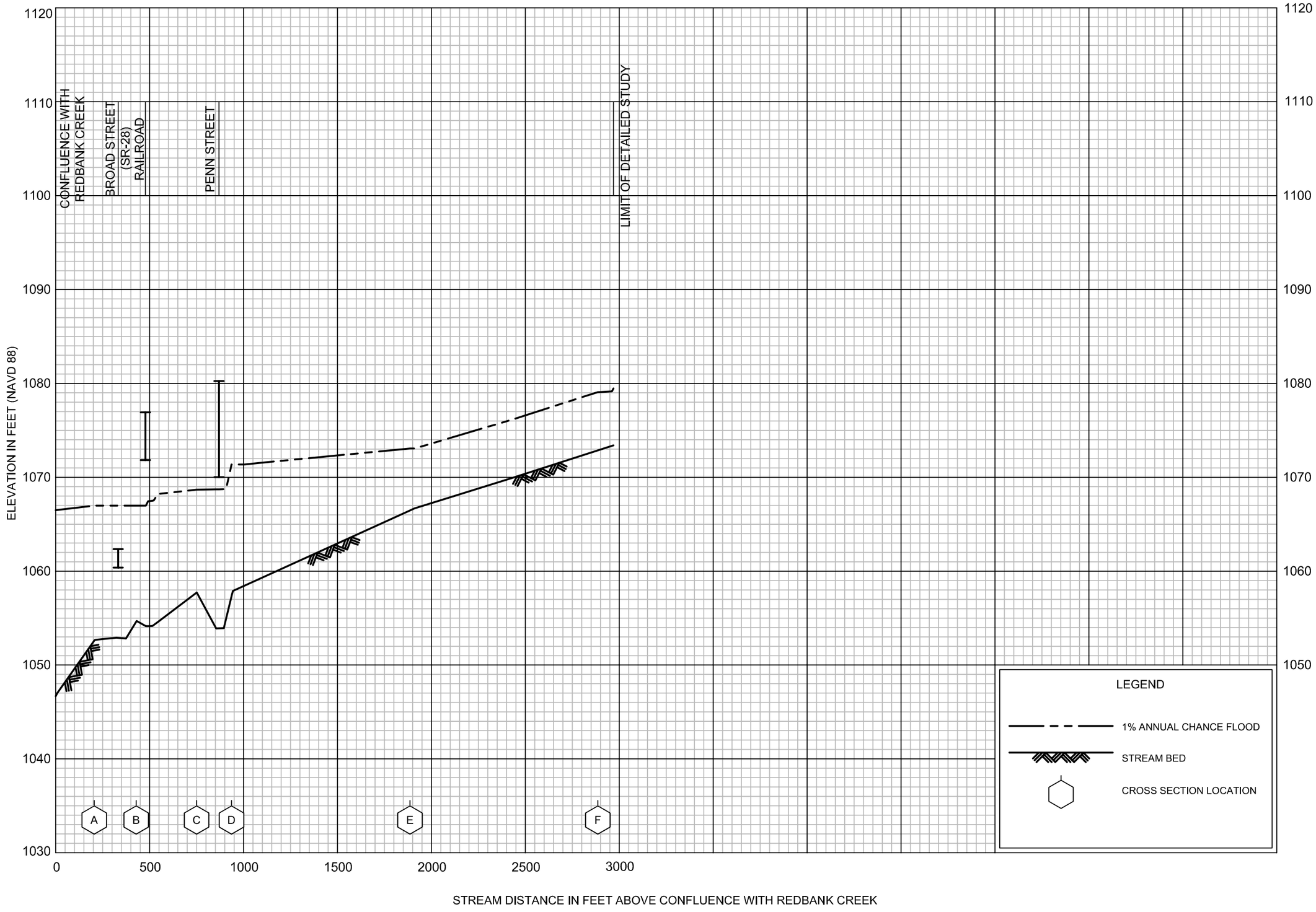
ALLEGHENY RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARION COUNTY, PA

(ALL JURISDICTIONS)

08P



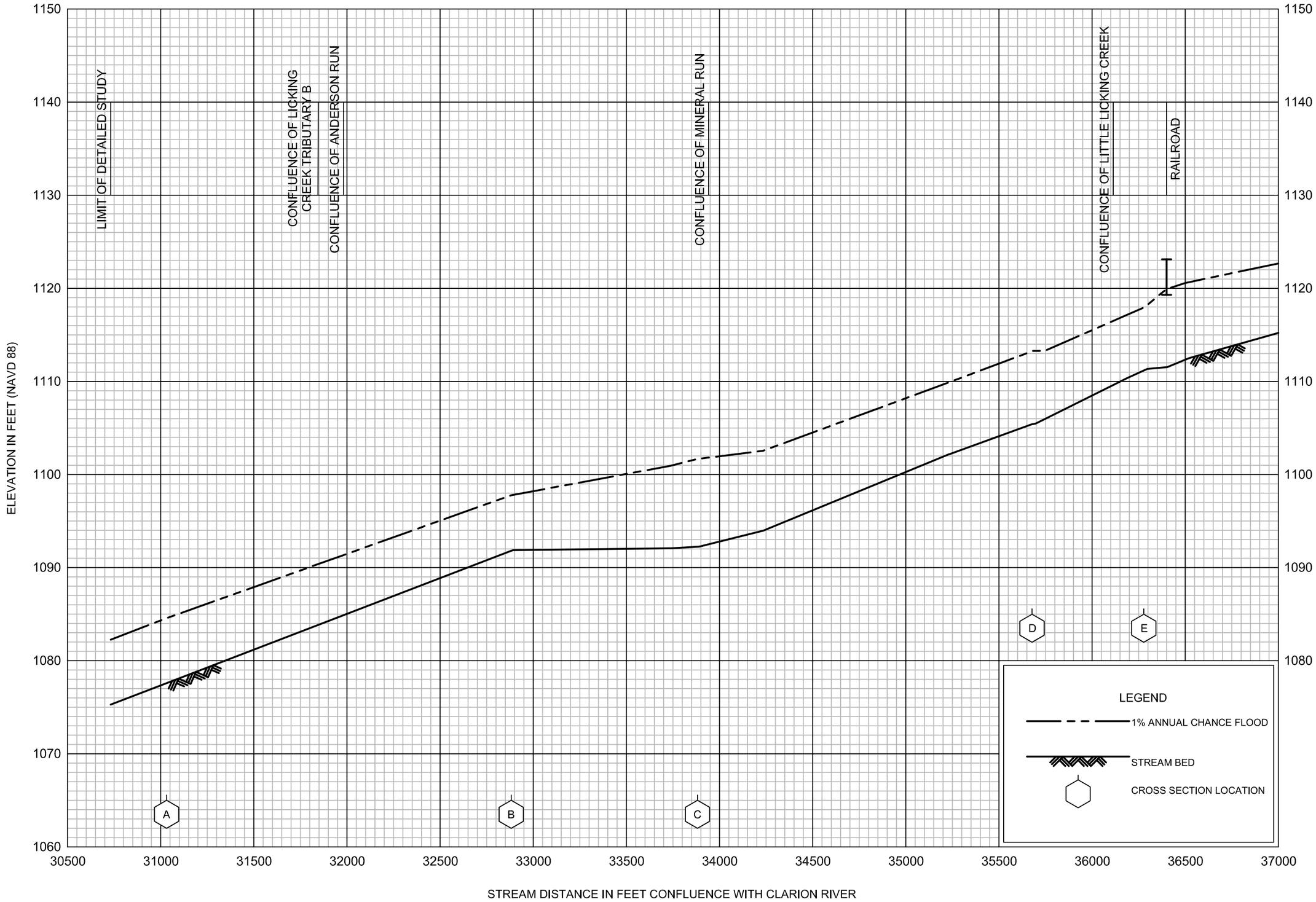
FLOOD PROFILES

LEISURE RUN

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARION COUNTY, PA

(ALL JURISDICTIONS)



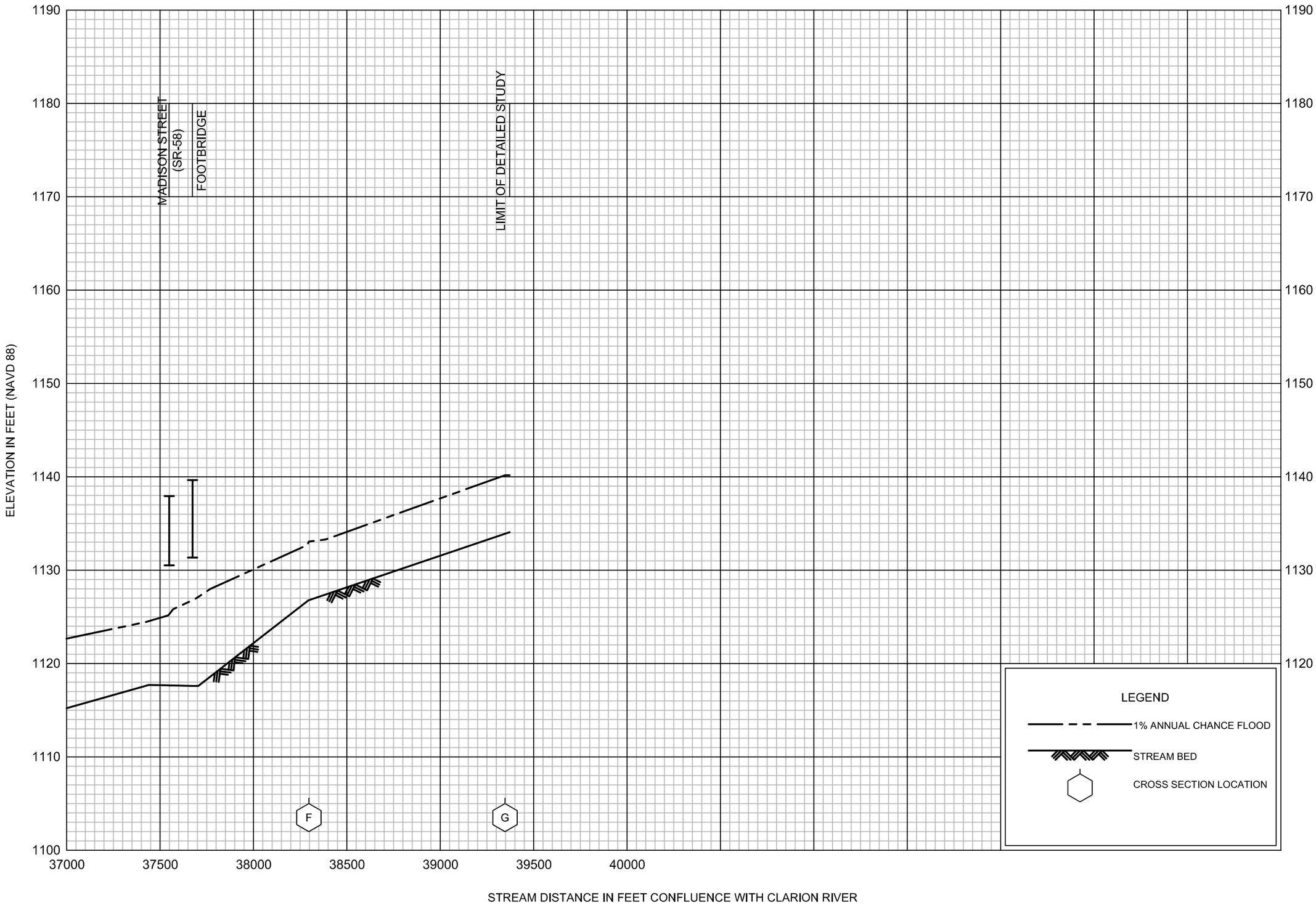
FLOOD PROFILES

LICKING CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARION COUNTY, PA

(ALL JURISDICTIONS)



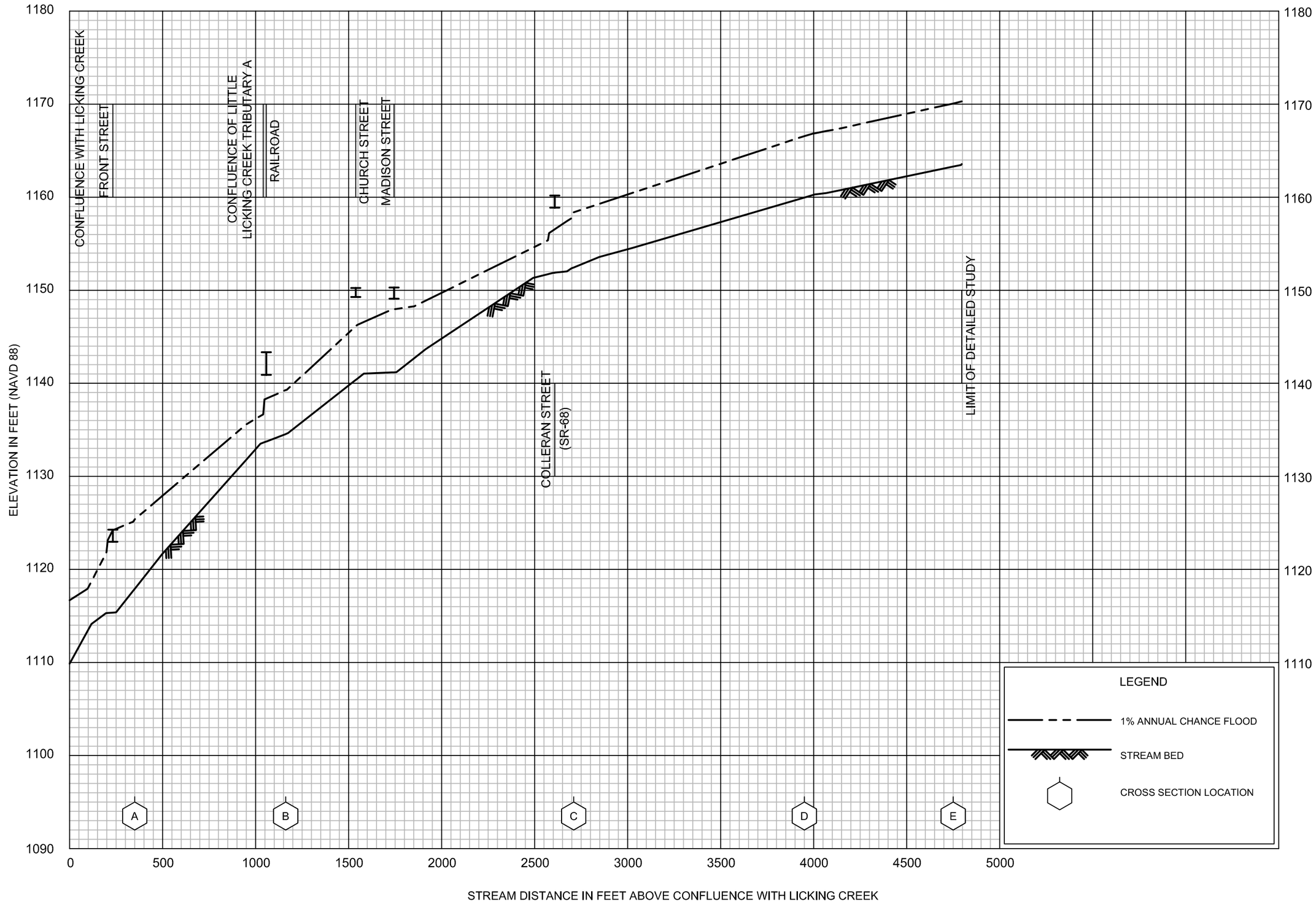
FLOOD PROFILES

LICKING CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARION COUNTY, PA

(ALL JURISDICTIONS)



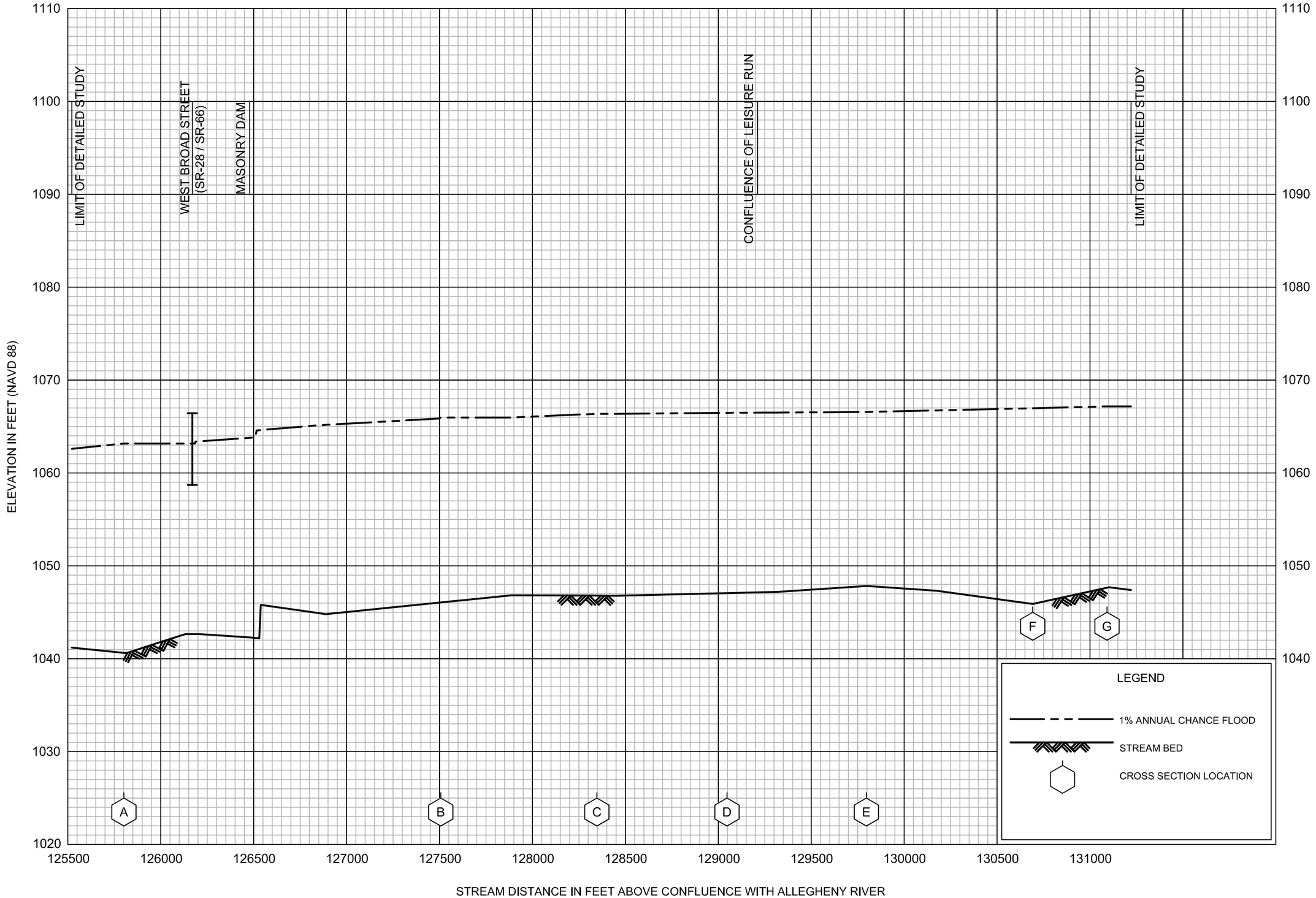
FLOOD PROFILES

LITTLE LICKING CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARION COUNTY, PA

(ALL JURISDICTIONS)



FLOOD PROFILES

REDBANK CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARION COUNTY, PA

(ALL JURISDICTIONS)