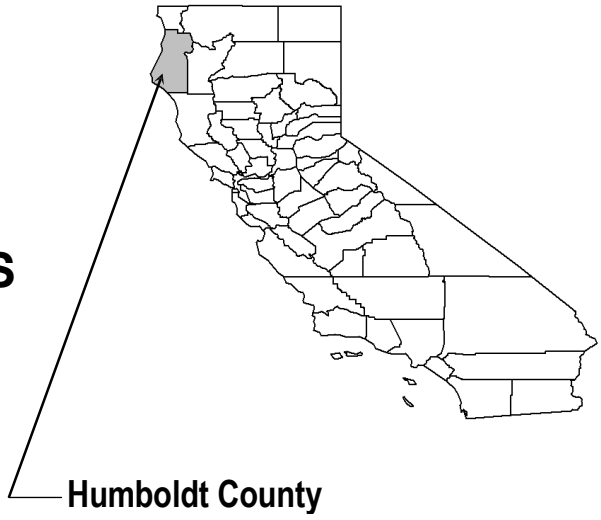
FLOOD INSURANCE STUDY

HUMBOLDT COUNTY, CALIFORNIA
AND INCORPORATED AREAS



COMMUNITY NAME	COMMUNITY NUMBER
ARCATA, CITY OF	060061
BLUE LAKE, CITY OF	060438
EUREKA, CITY OF	060062
FERNDALE, CITY OF	060445
FORTUNA, CITY OF	060063
HUMBOLDT COUNTY (UNINCORPORATED AREAS)	060060
RIO DELL, CITY OF	060064
TRINIDAD, TOWN OF*	060436

*NOT PARTICIPATING IN THE NFIP

PRELIMINARY
JANUARY 9, 2015

Federal Emergency Management Agency
FLOOD INSURANCE STUDY NUMBER
06023CV000A

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.

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

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

Initial Countywide FIS Effective Date:

Revised Countywide FIS Date:

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FLOOD INSURANCE STUDY
HUMBOLDT COUNTY, CALIFORNIA AND INCORPORATED AREAS

1.0 INTRODUCTION

1.1 Purpose of Study

This countywide Flood Insurance Study (FIS) investigates the existence and severity of flood hazards in, or revises and updates previous FISs/Flood Insurance Rate Maps (FIRMs) for the geographic area of Humboldt County, California, including: the Cities of Arcata, Blue Lake, Eureka, Ferndale, Fortuna, and Rio Dell, and the unincorporated areas of Humboldt County (hereinafter referred to collectively as Humboldt County).

Humboldt County also includes the Town of Trinidad, which is not participating in the National Flood Insurance Program.

This FIS aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This FIS has developed flood risk data for various areas of the county that will be used to establish actuarial flood insurance rates. This information will also be used by Humboldt County to update existing floodplain regulations as part of the Regular Phase of the National Flood Insurance Program (NFIP), and will also be used by local and regional planners to further promote sound land use and floodplain development. Minimum floodplain management requirements for participation in the NFIP are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some States or communities, floodplain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. 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 the unincorporated areas of, and incorporated communities within, Humboldt County in a countywide format. Information on the authority and acknowledgments for each jurisdiction included in this countywide FIS, as compiled from their previously printed FIS reports, is shown below.

Arcata, City of: the hydrologic and hydraulic analyses from the original FIS report dated November 5, 1997, were performed by Anderson-Nichols and Company, Inc., for the Federal Emergency Management Agency (FEMA), under Contract No. H-4821. That work, which was completed in July 1980,

covered all significant flooding sources affecting Arcata.

In the November 5, 1997, revision, the hydrologic and hydraulic analyses were prepared by Ensign & Buckley Consulting Engineers, the study contractor, for FEMA, under Contract No. EMW-90-C-3133.

Blue Lake, City of: the hydrologic and hydraulic analyses from the original FIS report were performed by Anderson-Nichols and Company, Inc., for FEMA, under Contract No. H-4821. That work, which was completed in August 1980, covered all significant flooding sources affecting Blue Lake.

In the May 5, 1997, revision, the hydraulic analyses were prepared for FEMA by Ensign & Buckley, Consulting Engineers, under Contract No. EMW-90-C-3133. Information previously shown on the Flood Insurance Rate Map (FIRM) and Flood Boundary and Floodway Map (FBFM) has been combined. All essential information previously shown on the FIRM and FBFM has been incorporated into the new FIRM.

In 2014, the Mad River detailed study consists of approximately 3 miles of the Mad River and approximately 1.1 miles of the North Fork (NF) Mad River (Figure 1), near the City of Blue Lake. The study area includes the approximate 1.5-mile long Mad River levee located along the right bank (facing downstream) of the Mad River and NF Mad River near their confluence (Figure 1).

Eureka, City of: In the original FIS, the hydrologic and hydraulic analyses were performed by Anderson-Nichols and Company, Inc., for FEMA, under Contract No. H-4821. That study was completed in September 1980.

In the June 17, 1986, revision, detailed analysis for Humboldt Bay were performed by Ott Water Engineers, Inc., for FEMA, under Contract No. EMW-83-C-1175. That work was completed in August 1984.

Ferndale, City of: the hydrologic and hydraulic analyses from the FIS report dated January 7, 1998, were

performed by Ensign & Buckley Consulting Engineers, the study contractor, for FEMA, under Contract No. EMW-90-C-3133.

Fortuna, City of:

The hydrologic and hydraulic analyses from the FIS report dated November 3, 1981, were performed by Anderson-Nichols and Company, Inc., for FEMA, under Contract No. H-4821. That work, which was completed in September 1980, covered all significant flooding sources affecting Fortuna.

The 2013 Rohner Creek study area is located within the incorporated limits of the City of Fortuna, CA and within the Rohner Creek watershed (Figure 1). The project reach encompasses approximately 5,300 feet of the Rohner Creek channel and 2,300 feet of the Hillside Creek channel as well as portions of the Rohner Creek floodplain. The overall project watershed area at Rohner Creek's confluence with Strongs Creek is approximately 4.5 square miles and ranges in elevation from 25-feet to 1,600-feet (NAVD88). This area includes Hillside Creek, the largest tributary to Rohner Creek. The upper portion of the watershed is predominately comprised of second and third-growth redwood forest, whereas the mid-portion consists of rural residential areas. The lower portion of the watershed is comprised of a mix of residential, commercial, and industrial land uses.

Humboldt County (Unincorporated Areas):

the hydrologic and hydraulic analyses for the original study were performed by Anderson-Nichols and Company, Inc., for FEMA, under Contract No. H-4821. That work was completed in December 1980.

In the February 8, 1999, revision, coastal analyses for Humboldt Bay were conducted by Ott Water Engineers, Inc., for FEMA, under Contract No. EMW-83-C-1175. That work was completed in August 1984. The hydraulic analysis for Mad River was prepared for FEMA by Ensign & Buckley, under Contract No. EMW- 90-C-3133. The hydrologic and hydraulic analyses for Janes Creek were prepared for FEMA by Ensign & Buckley, under Contract No. EMW-90-C-3133.

Studied again in 2014, the Mad River detailed study area/reach is located in Humboldt County and consists of approximately 3 miles of the Mad River and approximately 1.1 miles of the North Fork (NF) Mad River (Figure 1), near the City of Blue Lake. The study area includes the approximate 1.5-mile long Mad River levee located along the right bank (facing downstream) of the Mad River and NF Mad River near their confluence (Figure 1).

Rio Dell, City of: the hydrologic and hydraulic analyses from the FIS report dated November 3, 1981, were performed by Anderson-Nichols and Company, Inc., for FEMA, under Contract No. H-4821. That work, which was completed in December 1980, covered all significant flooding sources affecting Rio Dell.

On selected FIRM panels, planimetric base map information was provided in digital format. Additional information was derived from U.S. Geological Survey (USGS) Digital Line Graphs. Additional information may have been derived from other sources. Users of this FIRM should be aware that minor adjustments may have been made to specific base map features.

The coordinate system used for the production of this FIRM is Universal Transverse Mercator (UTM) Zone 10, North American Datum of 1983 (NAD 83), GRS 80 spheroid. Corner coordinates shown on the FIRM are in latitude and longitude referenced to the UTM projection, NAD 83. Differences in the datum and spheroid used in the production of FIRMs for adjacent counties may result in slight positional differences in map features at the county boundaries. These differences do not affect the accuracy of information shown on the FIRM.

1.3 Coordination

Consultation Coordination Officer's (CCO) meetings may be held for each jurisdiction in this countywide FIS. An initial 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 the streams to be studied by detailed methods. A final CCO meeting is held typically with representatives of FEMA, the community, and the study contractor to review the results of the study.

The dates of the initial and final CCO meetings held for Humboldt County and the incorporated communities within its boundaries are shown in Table 1, "Initial and Final CCO Meetings."

TABLE 1 - INITIAL AND FINAL CCO MEETINGS

Community	For FIS Dated	Initial CCO Date	Final CCO Date
Arcata, City of	November 5, 1997	June 1, 1977	May 20, 1981
		July 16, 1980	September 24, 1996
Blue Lake, City of	May 5, 1997	June 1, 1977	November 18, 1981
		July 16, 1980	April 5, 1996
		August 4, 1992	
Eureka, City of	June 17, 1986	June 1, 1977	May 21, 1981
		July 17, 1980	
Ferndale, City of	January 7, 1998	August 5, 1992	August 12, 1996
Fortuna, City of	November 3, 1981	June 1, 1977	May 20, 1981
		July 16, 1980	
Humboldt County	July 19, 1982	June 1997	August 28, 1981
		November 19, 1980	
	February 8, 1999	May 24, 25, and 27, 1983	April 5, 1996
		August 4, 1992	February 26, 1998
Rio Dell, City of	November 3, 1981	June 1, 1977	May 20, 1981
		November 20, 1980	

2.0 AREA STUDIED

2.1 Scope of Study

This FIS covers the geographic area of Humboldt County, California.

All or portions of the flooding sources listed in Table 2, "Flooding Sources 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 - FLOODING SOURCES STUDIED BY DETAILED METHODS

Dave Power's Creek Eastside Channe	MadRiver
Eel River	Martin Slough
Eel River–Ferndale to Fortuna	Martin Slough Tributary C
Eel River–Rio Dell to Holmes	McDaniel Slough
Francis Creek	North Folk Mad River
Freshwater Creek	Rohner Creek
Hillside Creek	South Fork Eel River
Humboldt Bay	Strongs Creek
Jacoby Creek	Trinity River
Janes Creek	Van Duzen River
Jolly Giant Creek	Williams 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.

All or portions of 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. The scope and methods of study were proposed to, and agreed upon by, FEMA and Humboldt County.

2.2 Community Description

Humboldt County occupies an area of 36,070 square miles in north coastal California. It is bounded on the north by Del Norte County, on the east by Trinity and Siskiyou Counties, on the south by Mendocino County, and on the west by the Pacific Ocean. Within Humboldt County are the seven communities, including Cities of Blue Lake, Arcata, Eureka, Fortuna, Ferndale, Rio Dell, and the Town of Trinidad (Winzler and Kelly Consulting Engineers, Phase 1, 1970). The population of Humboldt County was 126,518 according to the 2000 U.S. Census.

The major economic activities in the county involve lumber, agriculture, commercial fishing, and tourism. The county ranked first in California in the production of lumber and wood products. The lumber industry is concentrated in Eureka and Arcata, and at Scotia on Eel River. Dairy farms are prevalent in the valleys of the Eel and Mad Rivers, making this form of agriculture the most prosperous in the county. Commercial fishing is concentrated around the bay and ocean waters adjacent to the City of Eureka. Recreation and tourism are important facets of the economy of Humboldt County and are expected to show significant future growth (Winzler and Kelly Consulting Engineers, Phase 2, 1970).

Several small communities are situated in floodplains or adjacent to floodplains. As a result, a significant number of structures in Humboldt County are susceptible to flooding.

The predominant topographic features of Humboldt County are the mountain ranges throughout the area and the Pacific Ocean, which forms its western boundary. The land ranges in elevation from below sea level to nearly 7,000 feet. The mountains of the area are particularly rugged in the eastern section of the county, but are more gentle with wider valleys near the coast (Winzler and Kelly Consulting Engineers, Phase 2, 1970).

Drainage in the Klamath Mountains province is dendritic, differing from the trellis drainage patterns in the Coast Range province. The Trinity River is in the Klamath Mountains province, whereas the other streams studied in detail are in the Coast Range. The rocks in the area of the Trinity River are both metasedimentary and granitic. The Coast Range province contains clastic sedimentary and igneous rocks mostly from the Franciscan Formation. Northwest-trending folds and faults control the drainage patterns in the Coast Range province, leading to a fairly uniform

orientation of rivers (Winzler and Kelly Consulting Engineers, Phase 2, 1970).

Eastside Channel breaks out from Francis Creek near Rose Avenue and ends at the south side of the intersection of Van Ness Avenue and Market Street.

The Eel River has a total drainage area of approximately 3,620 square miles and drains a largely mountainous area in the southern part of the county. The river flows through a narrow canyon from its junction with the Middle Fork Eel River downstream to its confluence with the Van Duzen River. This 100-mile segment upstream of the Van Duzen River includes the detailed-study area between Rio Dell and Holmes. Downstream of its confluence with the Van Duzen River, the Eel River meanders through a wide coastal plain between Fortuna and the Pacific Ocean (U.S. Department of the Interior, 1964). The South Fork Eel River flows through steep-walled canyons for most of its length, including the detailed-study area near Redway (USACE, 1969). The Van Duzen River drains approximately 430 square miles at its confluence with the Eel River near Alton. The floodplain is narrow for most of the river's length, widening only in the downstream portions (USACE, 1973). The detailed study was performed in the area of this wider Van Duzen River floodplain.

Power's Creek is a small stream originating in the mountains to the northeast of Blue Lake. It flows westerly through the center of the city and into Mad River at a point outside the western corporate limits of Blue Lake (Winzler and Kelly Consulting Engineers, Phase 2, 1970).

The Mad River drains approximately 500 square miles at its confluence with the Pacific Ocean. The river flows through fairly narrow canyons for most of its 100-mile length. In the detailed-study area, the river enters its wide coastal floodplain just north of Arcata (U.S. Department of the Interior, 1964).

Martin Slough has its headwaters in Eureka just south of Harris Street, and Martin Slough Tributary C has its headwaters just outside the southern corporate limits, at the Eureka Municipal Golf Course. Martin Slough Tributary C flows northwesterly through the southern corporate limits and empties into Martin Slough just upstream of the Fairway Drive bridge (Clair A. Hill & Associates, 1969).

Freshwater Creek drains a small coastal basin of 34 square miles before entering Ryan Slough. Ryan Slough flows into Eureka Slough, a brackish-water stream, which in turn empties into Arcata Bay just north of Eureka (USACE, 1975). The area of Freshwater Creek studied in detail consists of a moderately wide floodplain situated between the narrow stream course in the mountains and the wide coastal floodplain.

Strongs Creek drains an area northeast of Fortuna and flows along the eastern corporate limits of the city before turning westward near the southern corporate limits and emptying into Eel River. Rohner Creek originates north into Strongs Creek just upstream of Eel River.

Jacoby Creek is a coastal stream just north of Freshwater Creek. It also originates

in the Coast Range and flows westerly into Arcata Bay. The creek drains a total of 16 square miles at its mouth (U.S. Department of the Interior, 1964). This study includes detailed study of the lower segments of Jacoby Creek, where the stream meanders through the coastal plain of Arcata Bay.

Janes and Jolly Giant Creeks originate in the mountains near the eastern extremity of Arcata.

Janes Creek flows southwesterly through Arcata and leaves the city downstream of 11th Street. Jolly Giant Creek flows due west through an abandoned city water supply reservoir near its headwaters. This reservoir has a pipe outlet which is permanently locked open. It then flows down a steep grade until it enters a long culvert which permits the creek to flow beneath the campus of Humboldt State University and U.S. Highway 101. The stream emerges as an open channel on the west side of U.S. Highway 101, and flows southerly to Arcata Bay through a series of very long culverts beneath urbanized portions of Arcata. Jolly Green Creek flows into the bay near the Municipal Sewage Treatment Plant (U.S. Department of the Interior, 1972; Humboldt County Board of Supervisors, 1970; Arcata Department of Public Works, Sheets 1 through 32, 1967; Arcata Department of Public Works, Sheets 33 through 61, 1967).

The Trinity River, draining an area of 2,969 square miles, is the largest tributary of the Klamath River. The Trinity River flows through a mountainous and heavily forested area in the eastern portion of Trinity County (U.S. Department of the Interior, 1964). The area of detailed study is in a mountain valley downstream of the confluence with the South Fork Trinity River, in the northeastern corner of Humboldt County.

Francis Creek originates in the Wildcat Ridge Mountains to the south of the City of Ferndale and flows southerly through the downtown area before joining the Salt River along the City of Ferndale's northern boundary. Most of the development in the City of Ferndale is concentrated along Francis Creek, between Berding and Van Ness Avenues.

The climate of Humboldt County varies somewhat with location, but generally exhibits seasonal precipitation and moderate temperatures. On the coast, the average temperature is approximately 55 degrees Fahrenheit (°F) year round. Fog is prevalent in the summer on the coast and for several miles inland up coastal river valleys. In the higher elevations of the eastern part of the county, there is a greater seasonal temperature range. Average annual precipitation varies from 40 to 100 inches throughout the county (Winzler and Kelly Consulting Engineers, Phase 2, 1970). Approximately 75 percent of the precipitation in Humboldt County occurs from November to March. Snow remains on the ground for significant periods of time only at elevations above 4,000 feet, although snow does fall at elevations above 2,000 feet in moderate amounts (U.S. Department of the Interior, 1964). Average annual precipitation values for the entire drainage areas upstream of the given locations for several of the detailed-study streams (U.S. Department of the Interior, 1964) are as follows:

Stream/Location	Annual Precipitation (Inches)
Eel River at mouth	59
South Fork Eel River at mouth	70
Van Duzen River at mouth	64
Mad River at mouth	64
Jacoby Creek at Freshwater	54
Trinity River at mouth	55

The configuration of Humboldt Bay protects its coastal communities from direct exposure to storm flooding. Samoa Peninsula and South Spit block the effects of normal storm waves and sea swells. A single channel, defined by jetties and seawalls, provides passage for water into or out of Humboldt Bay.

The unincorporated community of King Salmon is located on an artificially constructed peninsula along the eastern margin of Humboldt Bay. Old channel dredging were stockpiled on the site until 1948, when the residential development was constructed. A small housing development and a trailer park occupy the King Salmon study area. The elevation of King Salmon is a few inches higher than the normal maximum high tide. As a result, flooding occurs during unusually high tides accompanied by storm surges (Ott Water Engineers, Inc., 1984).

2.3 Principal Flood Problems

The major floods in unincorporated areas of Humboldt County have resulted from a succession of intense winter rainstorms from November to March. Flooding on several of the streams studied in detail has been extensively documented by gage records, high-water marks, damage surveys, and personal accounts.

Two gages measure flooding on the Eel River in the areas of detailed study. The USGS gaging station at Scotia (No. 11477000) has recorded discharges and stages since 1911. Floods measured at this gage accurately reflect the relative severity of flooding on the Eel River throughout the study areas between Ferndale and Holmes. The flood of record at the gage occurred on December 23, 1964, with a measured peak discharge of 752,000 cubic feet per second (cfs) and an estimated recurrence interval of 290 years. Other large floods measured at the Scotia gage are as follows:

Date	Discharges (cfs)	Recurrence Interval (years)
December 22, 1955	541,000	59
January 16, 1974	387,000	16
February 2, 1915	351,000	11

The assignment of recurrence intervals to the discharges of historic floods on the Eel River is of value as a rough comparison among the 10-, 2-, 1-, and 0.2-percent annual chance floods developed in this study and actual floods experienced on the

river. However, recurrence intervals assigned on the basis of discharges measured at a gage may not be applicable to flood elevations observed away from the gaging site. The recurrence intervals presented previously are based on the data analysis performed at the time this study was conducted and will change as more data become available. Downstream of Fortuna, at Fernbridge, the National Weather Service has operated a gaging station since 1938. This gage measures river stage with no measurement of discharge. The stage of the December 1964 flood was the highest measured, and the flood of December 1955 was the next highest stage.

The USACE collected and tabulated elevations of high-water marks from the 1964 flood on the Eel River throughout the detailed-study areas (USACE, 1965; USACE, December 1965). The locations and elevations of some of these marks are as follows:

Location	Elevation (feet)
Eel River Near Fortuna	
Near intersection of U.S. Highway 101 and Southern Pacific Railroad	44.40
Near intersection of U.S. Highway 101 and 3rd Street	44.87
Eel River Near Fortuna - continued	
Near Fortuna Sewage Treatment Plant	47.27 46.87 47.09
Near northern end of Sandy Prairie Levee	52.07
Near Fortuna Wood Products Mill	54.74
Downstream of western end of Drake Hill Road	56.96 56.81
Ferndale to Fortuna Segment	
Junction of Cannibal Road and road leading north to Hogpen Slough	18.20
End of Dungan Road near river	19.59
On Centerville Road between Fern Cottage and Meridian Road	19.80
Junction of Dillon Road and Camp Weott Road	21.97
Junction of Goble and Nissen Lanes	22.97
South end of Loleta near railroad trestle	22.07
South of Loleta, at end of dirt road paralleling old U.S. Highway 101, north bank of river	25.02
On Fulmor Road, north of Goble Lane at intersection with dirt road	26.67
Center of Arlynda Corners	25.09

Location	Elevation (feet)
Intersection of Union and Sage Road and Centerville Road	32.94
On old U.S. Highway 101, north bank of river, approximately 2,500 feet downstream of bridge at Fernbridge	34.86
Intersection of Kelly Lane and Coffee Creek Road	36.27
200 feet downstream of bridge at Fernbridge	36.27
60 feet upstream of bridge at Fernbridge	37.42
On Waddington Road, 1,300 feet north of intersection with Lawson Lane	38.75
On U.S. Highway 101, north bank of river, near Palmer Creek Road	41.77
On Waddington Road, 0.7 mile north of junction with Grizzly Bluff Roads	43.81
Intersection of Waddington and Grizzly Bluff Roads	50.17
Fortuna Wood Products sawmill at end of Ross Hill Road	54.74
Intersection of U.S. Highway 101 and Drake Hill Road	59.36
Near Grizzly Bluff School	57.48

Rio Dell to Holmes Segment

On pier of U.S. Highway 101 northbound bridge	95.01
In Rio Dell, on Riverside Drive	99.98
In Rio Dell, at end of Painter Street, beside river	104.06
180 feet downstream of Wildwood Avenue bridge	112.70
100 feet upstream of Wildwood Avenue bridge	114.14
Near Bridge Street in Scotia	113.43
Southwest end of Pacific Lumber Company lumberyard	124.92
50 feet downstream of U.S. Highway 101 bridge at Stafford	128.48
100 feet upstream of U.S. Highway 101 bridge at Stafford	132.90
On Stafford Road in Stafford	135.79
On U.S. Highway 101 at Jordan Creek	142.09
On Redwood Highway at Pepperwood	144.27
Near intersection of U.S. Highway 101 and Shively Flat Road	147.17
Near center of Shively	147.57
Between Shively and Holmes	150.67
At end of Tierney Road in Holmes, beside river	151.39
At Holmes Flat Road bridge	153.47
On maple tree between Woodland Drive and Eel River	92.55
On pier of U.S. Highway 101 northbound bridge	95.01
On Riverside Drive	99.98
At end of Painter Street beside river	104.06

Location	Elevation (feet)
Near end of Davis Street	110.07
On Edwards Drive	109.59

The USGS gaging station on the Wildwood Avenue bridge recorded a 1964 flood height of 111.77 feet (NAVD 88).

On the Van Duzen River, the USGS gaging station near Bridgeville (No. 11478500) has recorded discharges and stages since 1940. This gage (drainage area 222 square miles) is located upstream of the limit of detailed study but its measurements give an indication of the severity of historic floods on the Van Duzen River in the study area. The three largest floods measured are as follows:

Date	Discharge (cfs)	Recurrence Interval (years)
December 22, 1964	48,000	90
December 22, 1955	43,500	40
January 16, 1974	34,600	12

These assigned recurrence intervals are roughly estimated and should not be used to predict flood elevations away from the gage.

The USACE collected and tabulated elevations of high-water marks from the 1964 flood on the Van Duzen River throughout the detailed-study area (USACE, 1965; USACE, December 1965). The locations and elevations of some of these marks are as follows:

Location	Elevation (feet)
Downstream of U.S. Highway 101 bridge	70.47
Near center of Alton	69.73
75 feet upstream of northbound U.S. Highway 101 bridge	68.67
Approximately 1 mile east of Alton on lane off State Highway 36	73.48
Near Barber Creek bridge on Poverty Flat Road	80.08
East end of Poverty Flat Road	90.45
West of Carlotta, at south end of Gould Logging Road	104.89
On road off State Highway 36, south of Carlotta	121.51
On State Highway 36, near intersection with road to Cuddeback Union School	132.26
On State Highway 36, 0.3 mile east of road to Cuddeback Union School	137.49
On State Highway 36, near crossing of Fiedler Creek	143.65
West of Cummings Creek Camp on State Highway 36	149.63
Near Cummings Creek Camp	162.77

Flood stages and discharges have been measured on the South Fork Eel River

near Miranda (USGS gaging station No. 11476500) since 1941. This gage is located a short distance downstream of Redway and gives a good indication of the severity of historic floods in the detailed-study area at Redway. The three largest floods measured are as follows:

Date	Discharge (cfs)	Recurrence Interval (years)
December 22, 1964	199,000	210
December 22, 1955	173,000	100
January 16, 1974	122,600	15

The assigned recurrence intervals are based on discharges measured at the gage and may not be applicable to flood elevations observed at Redway.

The USACE collected and tabulated elevations of high-water marks from the 1964 flood on the South Fork Eel River throughout the detailed-study area (USACE, 1965; USACE, December 1965). The locations and elevations of some of these marks are as follows:

Location	Elevation (feet)
On north side of Redway, approximately 2,000 feet downstream of Redway-Briceland Road bridge	306.27
150 feet downstream of Briceland Thorne Road bridge	311.43
100 feet upstream of Briceland Thorne Road bridge	312.37
Approximately 2,000 feet upstream of Briceland Thorne Road bridge	314.35
Western end of Lower River Road	316.02
Near eastern end of Redway	320.17

Several publications have described the floods of December 1955 and December 1944 in the Eel River basin (Winzler and Kelly Consulting Engineers, 1970; State of California, 1965; U.S. Department of the Interior, 1969; U.S. Department of the Interior, 1963; State of California, 1956; U.S. Department of the Interior, 1963; USACE, 1965; USACE, 1956; U.S. Department of the Interior, 1965). Damage estimates from these two floods in several areas along the Eel, Van Duzen, and South Fork Eel Rivers are as follows (Winzler and Kelly Consulting Engineers, 1970; USACE, 1973):

	Total Damage[1]	
Location	1955 Flood	1964 Flood
EEL RIVER		
Mouth to confluence with Van Duzen River	$6,960,000	$13,300,000
Confluence with Van Duzen River to confluence with South Fork Eel River	$5,090,000	$30,700,000

VAN DUZEN RIVER		
Entire basin	[2]	$4,000,000
SOUTH FORK EEL RIVER		
Entire basin in Humboldt County	[2]	$11,000,000

[1]1967 Prices and Conditions
[2]Data not available

The flood of December 1955 caused extensive damage in the Eel River basin. An estimated 43,000 acres of agricultural, urban, and industrial property were flooded. The communities of Stafford, Pepperwood, Elinor, Shively, South Fork, Weott, Myers Flat, Phillipsville, and Bull Creek suffered severe damage. Damage to dairy farms, lumber mills, highways, and railroad tracks was particularly great. Casualties included 2 lives lost and 27 persons injured in the basin (U.S. Department of the Interior, 1963). The Eel River basin also suffered catastrophic damage as a result of the flood of December 1964. Record high discharges were measured in all of the detailed-study areas of the basin. The communities of Pepperwood and Myers Flat were destroyed. Severe damage occurred in Weott, South Fork, Holmes, Stafford, Shively, Scotia, Alton, and Phillipsville. Homes, livestock, farm equipment, commercial buildings, lumber mills, railways, and highways were destroyed throughout the basin. Nineteen people lost their lives because of the flooding along the river. The Pacific Lumber Company at Scotia lost an estimated 41 million board feet of lumber and prime redwood logs. The following highway bridges in the basin were washed out: U.S. Highway 101 north of Rio Dell, U.S. Highway 101 at Rio Dell-Scotia, U.S. Highway 101 north of Rio Dell, U.S. Highway 101 at Rio Dell-Scotia, U.S. Highway 101 at Stafford, and State Highway 36 over the Van Duzen River. The Northwestern Pacific Railroad (now Southern Pacific Railroad) tracks were destroyed by slides, washouts, and trestle losses at several locations along Eel River; and railroad service from San Francisco to Humboldt County was interrupted for 177 days (U.S. Department of the Interior, 1969).

For the Mad River basin, extensive information on historic floods is also available. The USGS gaging station near Arcata (No. 11481000) has recorded discharges on the Mad River for the 1911-1913 and 1951-1980 periods. This gaging station is within the detailed-study segment analyzed in this study. The flood of record at the gage occurred on December 22, 1964, with a measured peak discharge of 81,000 cfs and an estimated recurrence interval of 50 years. Other large floods measured at the gage are as follows:

Date	Discharge (cfs)	Recurrence Interval (years)
December 22, 1964	77,800	44
January 17, 1953	75,000	34
March 2, 1972	54,000	8

The USACE collected and tabulated elevations of high-water marks from the 1964 flood on the Mad River. The locations and elevations of some of these marks are as follows:

Location	Elevation (feet)
On Jackson Ranch Road, 0.15 mile north of Samoa Boulevard	9.94
On Jackson Ranch Road, 1.8 miles north and east of Samoa Boulevard	12.47
On south bank of Mad River, downstream of U.S. Highway 101 bridge, near Canal School	25.62
On south bank of river, downstream of U.S. Highway 101 bridges, near Canal School	25.62
On pier of downstream face of southbound U.S. Highway 101 bridge	32.47 32.67
On River Road approximately 0.7 mile upstream of U.S. Highway 101 bridges	36.74
Near Blue Lake Sewage Treatment Plant	76.26
Blue Lake Mobile Home Park	77.37
Near western end of Mad River Levee on outside of levee	79.06 81.27
On east side of western end of Mad River Levee	83.46 82.64 79.1
Near abandoned pump house of lumber mill adjacent to	85.14
Hatchery Road Bridge over Mad River	90.49
0.2 mile north of Guintoli Road approximately 0.35 mile east of U.S. Highway 101	38.98
On Guintoli Road approximately 0.55 mile east of U.S.Highway 101	38.95
On North River Road near intersection with Hunts Road	41.42
On pier of State Highway 299 bridge	44.63 43.51

The USGS gaging station on the Mad River is 100 feet upstream of the State Highway 299 bridge. The gage recorded a 1964 peak flood elevation of 46.77 feet (NAVD 88).

Several publications have described the floods of January 1953, December 1955, and December 1964 in the Mad River basin (Winzler and Kelly Consulting Engineers, 1970; State of California, 1965; U.S. Department of the Interior, 1969; U.S. Department of the Interior, 1963; State of California, 1956; USACE, 1965; USACE, 1956; U.S. Department of the Interior, 1965; USACE, 1953). Damage estimates from two of these floods in the segment of the Mad River from Blue

Lake downstream to the mouth are as follows (Winzler and Kelly Consulting Engineers, 1970):

Flood Date	Total Damage[1]
January 1953	$1,564,000
December 1955	$1,728,000[2]
December 1964	$3,780,000

[1]1964 Prices and Conditions
[2]Damage to Blue Lake Levee Not Included

During the flood of 1955, Mad River changed its course in the Blue Lake area with the result that the confluence of Mad River and North Fork Mad River moved upstream. The two rivers now join approximately 0.4 mile farther upstream along North Fork Mad River, and Mad River itself bends sharply after flowing directly toward the Blue Lake levee. Mad River rose to the crest of the levee in 1955, but, with sandbagging at a few locations, the levee was not overtopped. Some erosion on the end of the levee near Dave's Creek did occur as a result of Mad River flooding, but the levee sustained no other significant damage. No lives were lost as a result of the 1955 flood in the Mad River basin. Flooding of agricultural lands and lumber mills in the Blue Lake area was reported (USACE, 1956).

The magnitude of the peak discharge on Mad River during the flood of 1964 was attenuated due to the storage capacity of the Ruth Reservoir constructed in 1962. The levee at Blue Lake contained most of the Mad River floodwaters; however, a break in the levee occurred on December 23, 1964, causing the flooding of numerous structures. Flood damage was reported by lumber mills and farms (U.S. Department of the Interior, 1969).

A flood occurred in December 1861 – January 1862 that was reported to be as severe as the flood of 1955 in the north coastal area of California. Specific data on this flood in the Mad River basin are not available (U.S. Department of the Interior, 1963).

The flood of 1955 washed out the north approach to the U.S. Highway 101 bridge over the Mad River (U.S. Department of the Interior, 1963). The magnitude of the peak discharge on the river during the flood of 1964 was attenuated as a result of storage in Ruth Reservoir, constructed in 1962; however, the peak discharge recorded in 1964 still exceeded that measured in 1955. The flooding of agricultural land and the loss of dairy cattle were severe in the Mad River delta during the flood of 1964 (U.S. Department of the Interior, 1969).

A flood occurred from December 1861 to January 1862 which was reported to have been as severe as the flood of 1955. Specific data on this event in the Mad River basin are not available, so a direct comparison of this flood and the floods of 1955 and 1964 in the Arcata area is not possible (U.S. Department of the Interior, 1963).

Past flooding problems on Janes Creek and Jolly Giant Creek are not documented by gage records or published high-water marks. Debris blockage and undersized culverts have been cited by local officials as contributory factors in flooding problems on these streams.

The USACE collected and tabulated high-water mark elevations from the 1964 flood on Powers Creek (USACE, 1964; USACE, December 1965). The locations and elevations of some of these marks are as follows:

Location	Elevation (feet)
On Dave's Creek upstream of Log Bridge south of Blue Lake Rancheria Road	74.23
Railroad Avenue bridge over Dave's Creek (downstream face)	88.74
First Avenue bridge over Dave's Creek (upstream face)	93.8

Martin Slough traverse areas of very low ground elevations as it travels through the Eureka Municipal Golf Course. During the rainy season, the golf course remains flooded for extended periods. Similar problems exist in the downstream reaches of Cooper Canyon and Eureka Slough Tributary A. As all areas subject to this long-term stream flooding are sparsely developed, flood damage is not significant (Baruth & Yoder, 1971).

A gaging station (No. 11480000) was operated on Jacoby Creek by the USGS from 1954 to 1972, and in 1974. Records at this station give an indication of the relative magnitudes of historic floods on Freshwater Creek, as well as on Jacoby Creek, due to the similarity of the Jacoby Creek and Freshwater Creek basins in size, location, and geology (USACE, 1974). There are no gages on Freshwater Creek with which to make a direct analysis of the discharges experienced in that basin. The Jacoby Creek gage is upstream of the detailed-study area on Jacoby Creek at a location draining 6.05 square miles. The largest flood discharges measured at the gage are as follows:

Date	Discharge (cfs)	Recurrence Interval (years)
March 2, 1972	2,510	94
December 30, 1954	1,670	15
December 22, 1964	1,530	11
December 21, 1955	1,490	10

The recurrence intervals are assigned on the basis of discharges measured at the gage. Although this method gives a rough estimate of relative flood magnitudes in the general area, it may not be applicable to flood elevations measured on Freshwater Creek or on Jacoby Creek downstream of the gage.

Francis Creek was reported to have overflowed at several locations as the result of a January 22, 1981, storm (Spencer Engineering, 1990). According to the City of Ferndale, overtopping upstream, near Shaw and Fern Avenues, has been

observed.

The City of Ferndale has identified the low-drainage swale, located approximately 2,000 feet east of Francis Creek, as a primary area of concern because of the flooding experienced during past major rainfall events. This area can flood from local drainage, as well as overtopping from Francis Creek (Spencer Engineering, 1990).

After the flood of December 1964 in the Freshwater Creek basin, the USACE collected high-water mark data in the detailed-study area (USACE, 1965; USACE, December 1965). The locations and elevations of these marks are as follows:

Location	Elevation (feet)
FRESHWATER CREEK BASIN	
Downstream face of Myrtle Avenue bridge	12.18
On private road leading to a home off Freshwater-Kneeland Road, 1.1 miles from Myrtle Avenue intersection	26.83
Off Freshwater-Kneeland Road near Horseshoe Bend Ranch	36.57
Howard Heights Road bridge	41.64
On McCready Creek at Freshwater-Kneeland Road crossing	46.51
At confluence of Freshwater Creek and Little Freshwater Creek	49.19
STRONGS CREEK	
Upstream side of U.S. Highway 101	53.59
At confluence with Jameson Creek	61.2
Near Brazil Bridge	65.52
At Rohnerville Road (upstream side)	72.37
Near Cemetery on Newburg Road	84.28
ROHNER CREEK	
Near Sunnybrook Road	47.15
At Alder Drive (upstream side)	57.07
75 feet upstream of Main Street	71.11
At downstream crossing of Carson Woods Road (upstream side)	78.27

No high-water mark data were found for floods on Jacoby Creek. In addition, reports of flood damage in either the Freshwater Creek or Jacoby Creek basins were not found.

A flood occurred in December 1861-January 1862 that was reported to be as severe as the flood of 1955 in the north coastal area of California. Specific data on this flood on Eel River were not found; therefore, a direct comparison

of this flood and the floods of 1955 and 1964 in the Fortuna area is not possible (U.S. Department of the Interior, 1963).

Storm drainage reports describe flooding on Strongs Creek, Rohner Creek, Jameson Creek, and Hillside Creek in Fortuna (Winzler and Kelly Consulting Engineers, Part A, 1974; Winzler and Kelly Consulting Engineers, Part B, 1974). On Strongs Creek, dense willow tree growth near the channel is cited as a contributory cause of flood problems. Flooding in the Rohner Creek basin is reported to be most severe in the Alder Drive area. Minor flooding is reported on Jameson Creek upstream of its confluence with Strongs Creek. An undersized culvert on Hillside Creek at Fortuna Boulevard results in flooding in the Smith Lane-Fortuna Boulevard area. Increased development in Fortuna has aggravated flooding problems on these small watersheds due to increasing amounts of runoff from newly created impervious areas.

The flood history of the Trinity River in the Willow Creek area can be traced by referring to measurements taken at the USGS gaging station at Hoopa (No. 11530000). This gage is downstream of the area of detailed study at a location draining 2,854 square miles. The greatest flood discharges during the period of operation of the gage (1911-1914, 1916-1918, 1931-2007) are as follows:

Date	Discharge (cfs)	Recurrence Interval (years)
December 22, 1964	231,000	238
December 22, 1955	190,000	93
January 16, 1974	145,000	29

The recurrence intervals assigned on the basis of the discharges measured at the gage are of value as an indicator of the relative magnitude of the 10-, 2-, 1-, and 0.2-percent annual chance floods used in this study and historic floods experienced in the area. However, recurrence intervals assigned on the basis of discharges measured at the gage may not be applicable to flood elevations observed in the study area.

High-water mark data in the detailed-study area on the Trinity River were searched for during the preparation of this study but none were found.

Some brief descriptions of historic floods in Humboldt County along the Trinity River are available (Winzler and Kelly Consulting Engineers, 1970; State of California, 1956; U.S. Department of the Interior, 1965; USACE, 1971). During the flood of 1955, the State Highway 96 bridge over Willow Creek (a tributary of the Trinity River) was destroyed. Outside of the detailed-study area at Hoopa and at Douglas City, bridges over the Trinity River were also destroyed (State of California, 1956). The flood of 1964 caused severe damage in Willow Creek (U.S. Department of the Interior, 1965). Reports of damage indicate more extensive destruction in Hoopa Valley, downstream of Willow Creek, than in the Willow Creek area. Damage estimates for Hoopa Valley totaled $12.3 million as a result of the flood of 1964. Roads, bridges,

and lumber mills sustained most of the damage reported (Winzler and Kelly Consulting Engineers, 1970).

A flood in December 1861-January 1862 was reportedly as severe as the flood of December 1955 in the northern coastal area of California. Specific data on this event along the detailed-study streams are not available, so a direct comparison of this flood and the floods of 1955, 1964, and 1974 in the unincorporated areas is not possible (U.S. Department of the Interior, 1965).

Unincorporated areas of Humboldt County are subject to flooding from storm tides. The estimated highest tidal surge height in Humboldt Bay occurred on February 4, 1958, and was 6.5 feet. The nearest long-term tide gage is at Crescent

City, north of Humboldt County. The highest tide measured at Crescent City since 1933 occurred on February 4, 1958, with a height of 10.1 feet above mean lower low water (approximately 6.4 feet elevation) (U.S. Department of Commerce, undated).

Extreme storm events overtopped the Samoa Peninsula and South Spit during the winters of 1978 and 1983. The winter of 1983 brought an extremely unusual series of high tides, storm surges, and storm waves. Virtually all of the U.S. Coast Guard mooring docks were destroyed. In King Salmon, homes were flooded with 6 to 12 inches of water.

Tsunami constitute the greatest threat to public safety and property on the open coast. However, Humboldt Bay inlet constrictions prevent tsunami from having a significant influence on water levels in the bay (Ott Water Engineers, Inc., 1984).

2.4 Flood Protection Measures

There are no flood-control structures on the Van Duzen River, on the South Fork Eel River, or on Jacoby Creek.

An abandoned water-supply reservoir near the headwaters of Jolly Giant Creek reduces the peak flood discharges experienced downstream. As the reservoir is not operated for flood control purposes, its attenuation of floods is not planned or controlled.

There are no flood control structures on Janes Creek.

Near the headwaters of the Eel River, water is impounded by Scott Dam in Lake Pillsbury. The flood attenuation effect of this dam on the lower Eel River is small. Built in 1921, the dam regulates flow from only 288 of the 3,620 square miles of the total Eel River basin (State of California, 1965; U.S. Department of the Interior, 1963). Near the mouth of the Eel River, moderate flood-control benefits are

provided by the Sandy Prairie levee in the Fortuna area. This project consists of 3 miles of levee on the eastern bank of the Eel River and 1 mile of levee on the southern bank of Strongs Creek. The levees were constructed in 1959 by the USACE at a cost of $960,000 (Winzler and Kelly Consulting Engineers, 1970).

Sandy Prairie levee consists of 3 miles of levee on the east bank of Eel River and 1 mile of levee on the south bank of Strongs Creek outside the western limits of Fortuna. The levee provides a moderate amount of protection against major floods.

On the South Fork Eel River, Benbow Dam is used to store water during the summer recreation season. The dam, located upstream of Redway, therefore provides no flood-control benefits.

A levee protects the City of Blue Lake from the floodwaters of Mad River and North Fork Mad River. A portion of this levee was built in 1954-1955 by the USACE. This project consisted of a 3,000-foot levee along the right bank of Mad River and was intended to protect industrial and agricultural development in the Blue Lake Valley. To further protect a lumber mill in Blue Lake, local interests extended the levee downstream. In 1963, the levee was realigned, rehabilitated, and extended farther (Winzler and Kelly Consulting Engineers, 1970; USACE, 1956). The levee reduces the extent of flooding within Blue Lake.

Two water-supply dams exist in the Mad River basin upstream of the detailed-study area. The older of these two structures, Sweasey Dam, was constructed on the Mad River in 1938 as a water-supply source for the City of Eureka. The reservoir originally impounded 1,500 acre-feet, but has now become completely silted in. Sweasey Dam therefore provides no flood-control benefits. The Ruth Dam and Reservoir was constructed in 1962 for water-supply purposes and is owned by the Humboldt Bay Municipal Water District. The 51,000 acre-foot gross storage capacity of this reservoir reduces flood peaks on the Mad River in the Arcata area by approximately 5 to 15 percent. Because the dam does not operate for flood-control purposes, the extent of its flood attenuation varies with each flood event and depends on the level of the reservoir at the time of the flood (Winzler and Kelly Consulting Engineers, 1970). A system of levees has been constructed in the Blue Lake area as protection against flooding from the Mad and North Fork Mad Rivers. A portion of this levee was built in 1954-1955 by the USACE.

The Mad River Levee does not comply with Section 65.10 of the NFIP Regulations. As such, the FIRM panels will be revised at a later date to update the flood hazard information associated with this structure. The flood hazard data which have been re-published from the May 5, 1997 FIRM for the City of Blue Lake should continue to be used until the FIRM panels are revised to update the flood hazard information associated with the Mad River Levee.

There are no flood-control structures on Martin Slough in Eureka. A tidal flap gate has been placed on the downstream end of the Myrtle Avenue culvert of Eureka Slough Tributary A. This flap gate prevents tidal flooding upstream of the Myrtle Avenue culvert. Tide gates constructed beneath the Southern Pacific Railroad dock at Humboldt Bay prevent tidal flooding to the interior lands and permit internal

drainage of inland areas during periods of low tide (Ott Water Engineers, Inc., 1984).

Francis Creek has been channelized with concrete-bank protection for approximately 300 feet upstream and 150 feet downstream of Shaw Avenue and for approximately 1,000 feet downstream of Arlington Road. The remainder of the stream is a natural channel.

Local interests have constructed a levee on the southern bank of Freshwater Creek, extending for approximately 1 mile upstream of Myrtle Avenue (USACE, 1975). This levee provides little protection from severe floods. There are no other flood-control structures in the Freshwater Creek basin.

The Trinity River diversion project was completed in November 1963 by the U.S. Bureau of Reclamation. Trinity and Lewiston Dams in Trinity County combine to greatly reduce the peak discharge from the 692 square miles of drainage area upstream of the diversion project. Areas immediately downstream of this project were provided with considerable flood protection during the 1964 flood. However, areas on the Trinity River downstream of the confluence with the South Fork Trinity River reported significant flood damage during the 1964 flood even though these areas are downstream of the diversion project. The detailed-study area near Willow Creek is downstream of the South Fork Trinity River. At Willow Creek, approximately 700 feet of a total 2,735 square miles of drainage area are affected by the diversion project (Humboldt County, undated).

The Humboldt County Planning Department has established floodplain and floodway zones that control development in areas subject to flooding from tidal and riverine waters (Humboldt County, undated).

Several State and Federal agencies are cooperating on a shore protection project for King Salmon at Buhne Point. Extensions of existing breakwater walls and additional beaches are underway. When completed, this project will prevent wave damage, but not flooding caused by Stillwater (Ott Water Engineers, Inc., 1984).

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 FIS. 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 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 which equals or exceeds the 100-year flood (1-percent chance of annual exceedence) 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 FIS. Maps and flood elevations will be amended periodically to reflect future changes.

In northern California bays and harbors protected from open ocean waves, the flood hazards are generated by storm and/or tsunami, and the degree of hazard depends on the water-surface elevations of the astronomical tide at the time of storm or tsunami occurrence. To evaluate the flood hazards from Humboldt Bay, detailed engineering studies separately defined the magnitude and frequency of the storm plus tide impacts and the magnitude and frequency of tsunami plus tides, and then statistically combined the storm and tsunami components to determine a comprehensive evaluation of the coastal flood hazard.

3.1 Hydrologic Analyses

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

Flood-frequency estimates for the Mad River are based on Bulletin 17B procedures using peak flow data from the U.S. Geological Survey (USGS) Mad River near Arcata, CA gaging station (station no. 11481000); a 64-year record of annual-peak discharges. The flood frequency estimates for the Mad River near Arcata were scaled to the Mad River above and below the confluence with the NF Mad River using the National Streamflow Statistics Program (Kimley-Horn and Associates, Inc. et al, 2013).

Flood-frequency estimates for the NF Mad River are based on Bulletin 17B procedures using peak flow data from the USGS NF Mad River near Korbel, CA gaging station (station no. 1140800). The peak discharges recorded at the gaging station were reported for 9 years. The peak discharges were extended using the MOVE1 technique and data from the USGS gaging station at Little River near Trinidad, CA (No. 11481200). Fifty-seven annual peak discharges were recorded at the Little River station. The NF Mad River annual-peak discharge record was extended to 56 years (WY 1956-2011) using the MOVE1 technique and the long record from the Little River. The flood frequency estimates for the NF Mad River near Korbel were scaled to the NF Mad River above the confluence with the Mad River following the National Streamflow Statistics Program (Kimley-Horn and Associates, Inc. et al, 2013).

Flood-frequency estimates for Redwood Creek are based on Bulletin 17B procedures were determined for the U.S. Geological Survey (USGS) Redwood Creek at Orick, CA gaging station (station no. 1148250) using the 65-year record of annual-peak discharges (Northern Hydrology & Engineering et al, 2014).

For the Rohner Creek two-dimensional model, version 3.3 of the United States Army Corps of Engineers (USACE) Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS) software was utilized to compute peak flows at

specific locations within the Rohner Creek watershed. The HEC-HMS precipitation-runoff and routing processes generated storm hydrographs later used in the hydraulic models developed to analyze flooding on Rohner Creek. To further refine the HEC-HMS model, the City and its consultants initiated continuous streamflow and crest gage monitoring in Rohner Creek near Beech Street. The streamflow data was used for model calibration and validation purposes. Graham Matthews Associates (GMA) operated the streamgage from November 1, 2009 through April 2011 and the resultant flow data was used in the calibration of the HEC-HMS model. The streamflow monitoring data represents the total runoff from storm events that occur in the contributing subbasins upstream of the Rohner Creek gaging station (Perry, 2013).

A 48-foot corrugated-metal-pipe storm drain, approximately 360 feet in length, conveys a portion of the Eastside Channel flow under Van Ness Avenue and private property. With a slope of 0.00278, the capacity of the storm drain flowing full is approximately 41 cfs. The 1-percent annual chance discharge at this location is 180 cfs, based on a split-flow analysis for Francis Creek. It is assumed that the pipe and the downstream channel can carry 40 cfs. The remaining 140 cfs overtops the pipe and Van Ness Avenue and flows in a northeasterly direction causing shallow flooding. The average depth of flooding is less than 1 foot.

Pre-countywide Analyses

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

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

For application in the study segment from Ferndale to Fortuna on Eel River, the 10-, 2-, 1-, and 0.2-percent annual chance peak discharges for the mouth of the river were determined using data from three USGS gages.

Gage	Period of Record	Drainage Area (Square Miles)
Eel River at Scotia (No. 11477000)	1911-1980	3,113
Eel River at Fort Seward (No. 11475000)	1956-1980	2,107
Eel River Below Dos Rios (No. 11474000)	1912-1966	1,484

Before determining discharges near the mouth of the river, the gage records at Fort Seward and below Dos Rios were extended to cover the longer period of record at Scotia by performing two-station comparisons (U.S. Water Resources Council, 1977). The peak data at each of the gages for the years 1911-1977 were then analyzed in separate log-Pearson Type III distributions (U.S. Water Resources

Council, 1977). The 10-, 2-, 1-, and 0.2-percent annual chance discharges determined at each gage site were transposed to the river mouth using the following relationship:

$$\frac{Q}{Q_g} = \left[\frac{A}{A_g}\right]^{0.9}$$

Where Q and Q_g are the discharges at the river mouth and at the gage, respectively, and A and A_g are the drainage areas at these locations (U.S. Department of the Interior, 1977). The value of the transposition exponent (0.9) was adopted after analyzing discharge-drainage area relationships at several sites in Humboldt County. Before determining the final discharges of the Eel River at its mouth, a fourth set of flows was derived by applying regional flood-frequency equations (U.S. Department of the Interior, 1977). These equations relate discharges with return periods of 10-, 2-, and 1-percent annual chance to drainage area, mean annual precipitation, and altitude index. A 0.2-percent annual chance discharge was calculated by extrapolation from the other three frequency data points. The four sets of 10-, 2-, 1-, and 0.2-percent annual chance discharges derived for the Eel River at its mouth (three sets from gage data and one set from regional equations) were weighted to determine the 10-, 2-, 1-, and 0.2-percent annual chance discharges used in this study segment. The weighting of the gage and regional equation data was based on the period of record of the data and the relative distances of the gages from the river basin (U.S. Department of the Interior, 1975).

For the Eel River study segment from Rio Dell to Holmes, the 1- and 0.2-percent annual chance peak discharges used in this study were taken directly from a USACE Flood Plain Information report (USACE, 1970). The 10- and 2-percent annual chance discharges used in this study segment were derived by performing the same method of analysis applied in calculating discharges for the Ferndale to Fortuna study segment, as previously described. As before, the records of three Eel River gages were used, but the results of the gage data analyses were transposed to Scotia instead of to the river mouth. Similarly, the regional equations were applied at Scotia before the final 10- and 2-percent annual chance discharges for the Rio Dell to Holmes study segment were calculated by weighting the four sets of 10- and 2-percent annual chance discharges.

The 10-, 2-, 1-, and 0.2-percent annual chance discharges used in the detailed study of the Van Duzen River were taken directly from a USACE Flood Plain Information report (USACE, 1973).

The 1- and 0.2-percent annual chance discharges used in the detailed study of the South Fork Eel River were taken directly from a USACE Flood Plain Information report (USACE, 1969). The 10- and 2-percent annual chance peak discharges were determined by weighting gage data and the results from applying regional flood-frequency equations. A log-Pearson Type III frequency analysis (U.S. Water Resources Council, 1977) was performed on data from the USGS gaging station near Miranda (No. 11476500; drainage area 537 square miles; period of record 1941-1980).

The 10- and 2-percent annual chance discharges determined at the gage site were transposed to Redway by using the following relationship:

$$\frac{Q}{Q_g} = \left[\frac{A}{A_g}\right]^{0.9}$$

Where Q and Q_g are the discharges at Redway and at the gage, respectively, and A and A_g are the drainage areas at these locations (U.S. Water Resources Council, 1977). A second set of 10- and 2-percent annual chance discharges at Redway was calculated by applying regional flood-frequency equations (U.S. Water Resources Council, 1977). The two sets of 10- and 2-percent annual chance discharges were weighted to determine the final 10- and 2-percent annual chance peak discharges used in this study (U.S. Department of the Interior, 1975).

The effective discharges for Janes Creek were used in this study (FEMA, 1983). The 1-percent annual chance peak discharges used in studying Janes Creek were generated by applying regional flood-frequency equations (U.S. Department of the Interior, 1977). The equations were derived by applying multiple regression techniques to the flow data and basin characteristics of several gaging stations in the north coast region of California.

Evaluation of available stream-gage data resulted in the selection of Jacoby Creek, located west of Eureka, as a hydrologic model for Francis Creek. A HEC-1 model was prepared for Jacoby Creek using Natural Resources Conservation Service (NRCS), formerly the Soil Conservation Service, parameters. Because there has not been an NRCS soil survey of the Jacoby Creek Watershed, U.S. Forest Service Soil Vegetation Maps (U.S. Forest Service, 1968) were obtained and used for determination of hydrologic soil groups and Curve Numbers (CNs). Watershed areas were defined using USGS quadrangle mapping (U.S. Department of the Interior, 1979).

Hydrologic analyses were carried out to establish peak discharge-frequency relationships for each flooding source studied by detailed methods affecting the community. The 1-percent annual chance peak discharge for Francis Creek at Grizzly Bluff Road was estimated by the NRCS as part of its Salt River study, using NRCS Technical Release No. 20, “Project Formulation – Hydrology” computer program. The hydrologic parameters utilized by the NRCS for Francis Creek included the NRCS unit graph, time of concentration (Tc), rainfall depth and distribution, and loss rate.

The NRCS data, with some minor modifications, were input into the USACE HEC-1 computer program to develop new 1-percent annual chance discharges along Francis Creek (USACE, 1990). The following data and parameters were used in this study:

Watershed areas were determined using USGS quadrangle mapping (U.S. Department of the Interior, 1959). The watershed was divided into two subbasins. Land uses were defined based on NRCS data and field reconnaissance. Watershed soil types were determined from the NRCS data. Total precipitation was

determined from National Oceanic and Atmospheric Administration isohyetal maps (U.S. Department of Commerce, 1972). Rainfall distribution was based on NRCS 24-hour Type 1A distribution, with an increment of 30 minutes (U.S. Department of Agriculture, 1986). Infiltration losses were determined using the NRCS CN method, with CN values determined based on watershed soil types (U.S. Forest Service, 1968) and NRCS guidelines (U.S. Department of Agriculture, 1986). The NRCS unit-hydrograph option in the HEC-1 computer program was used. TCs and basin lag times were determined using the NRCS methodology for small urban watersheds (U.S. Department of Agriculture, 1986). This method consists of estimating travel times for the sheet, shallow concentrated, and channel-flow segments of the runoff. Channel routing was performed using the HEC-1 Modified-Puls method. The storage-discharge relationships were determined using multiple-discharge hydraulic computations.

The results of the initial hydrologic analyses were consistent with the NRCS studies performed in its Salt River Watershed study. Hydraulic analyses using these discharges indicated the 1-percent annual chance discharges for both Francis and Williams Creeks were essentially contained. Review of available reports and consultation with the City of Ferndale City Engineer indicated that Francis Creek had overflowed during past storm events.

In accordance with FEMA guidelines and Water Resources Council (WRC) Bulletin No. 17B, "Guidelines for Determining Flood Flow Frequency," the WRC weighted-skew estimate was adopted.

Jacoby Creek has a drainage area of 5.8 square miles. Data were obtained from the USGS WATSTORE system (U.S. Department of the Interior, 1994) for Jacoby Creek for the years 1955 through 1991, with 6 years of missing records. A peak-flow frequency analysis was performed by the USGS WATSTORE system.

The HEC-1 model to determine the 1-percent annual chance peak discharges for Jacoby Creek was calibrated with the gage data (flow-frequency analysis) by adjusting the CN values. The same percentage of adjustment in the CN values was then applied to the Francis Creek HEC-1 model.

The calibration study resulted in an increase in peak discharges of approximately 50 percent, as compared to original NRCS values. The discharge agrees closely with the value calculated by the North Coast Regional Regression equation as developed by the USGS.

The 10-, 2-, 1-, and 0.2-percent annual chance discharges used in studying Freshwater Creek were taken directly from a USACE Flood Plain Information report (USACE, 1975).

The 10-, 2-, 1-, and 0.2-percent annual chance discharges used in the detailed study of Jacoby Creek were determined using data from the USGS gaging station near Freshwater Creek (No. 1148000). The peak discharges for 19 years (1954-1972, 1974) were analyzed in a log-Pearson Type III distribution (U.S. Water Resources Council, 1977) to determine peak discharges at the gage for the four selected flood

frequencies.

A HEC-1 model (USACE, 1990) was prepared for Jacoby Creek, a gaged watershed, using SCS parameters in order to calibrate the Williams Creek model. Because no SCS soil survey of the Jacoby Creek Watershed has been published, U.S. Forest Service Soil Vegetation Maps were obtained and used for determination of hydrologic soil groups and curve-number (CN) methodology. Watershed areas were defined using USGS quadrangle maps (U.S. Department of the Interior, 1979).

The HEC-1 model used to determine the 1-percent annual chance peak discharges for Jacoby Creek was calibrated with the gage data (flow-frequency analysis) by adjusting the CN values. The same percentage of adjustment in the CN values was then applied to the Williams Creek HEC-1 model. The other hydrologic parameters needed to estimate the 1-percent annual chance peak discharges for Williams Creek were modified slightly from the original SCS study (U.S. Department of Agriculture, 1993).

The 10-, 2-, 1-, and 0.2-percent annual chance flood discharges used in studying Martin Slough and Martin Slough Tributary C were generated by applying regional flood-frequency equations (U.S. Department of the Interior, 1977). These equations relate discharges with return periods of 10-, 2-, and 1-percent annual chance to drainage area, mean annual precipitation, and altitude index. The equations were derived by applying multiple-regression techniques to the flow data and basin characteristics of several gaging stations in the northern California coast region. The 10-, 2-, and 1-percent annual chance peak discharges at several sites on Martin Slough and Martin Slough Tributary C were calculated from the regional equations. A 0.2-percent annual chance peak discharge was calculated for each site by extrapolation from the other three frequency data points.

The discharges thus obtained were increased by augmentation factors to account for increased runoff in the basin due to urbanization effects. This urbanization adjustment, developed by the USGS (U.S. Department of the Interior, 1977), derives augmentation factors as a function of the percentage of the basin that has been developed and the percentage of the main stream channel which has been lined, paved, or replaced by pipe.

A Modifed-Puls hydrologic reservoir routing was performed on Eureka Slough Tributary A to determine the extent of approximate flooding. This tributary originates near Harris and Buhne Streets, and flows northerly into Eureka Slough between the city sewage treatment plant and the KIEM radio towers. The 1-percent annual chance flood discharge determined for the stream by applying regional equations (U.S. Department of the Interior, 1977) was routed through the culvert under Myrtle Avenue to determine the flooding upstream of Myrtle Avenue.

Revised Analyses

Information on the methods used to determine peak discharge-frequency relationships for the streams restudied as part of this countywide FIS is shown below.

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

TABLE 3 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISHCARGES (CFS)			
		10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
DAVE'S CREEK	-				
Downstream of Tributary near Hatchery Road	2.6	580	890	1,000	1,260
Upstream of Tributary near Hatchery Road	2.3	520	800	900	1,130
EASTSIDE CHANNEL					
Upstream of Van Ness Avenue	1	*	*	140	*
EEL RIVER					
At mouth	3,620	390,000	601,000	695,000	924,000
At USGS Gaging Station at Scotia (No. 11477000)	3,113	331,000	521,000	680,000	820,000
FRANCIS CREEK					
Grizzly Bluff Road to confluence with Salt River	3.21	*	*	831	*
FRESHWATER CREEK					
At Myrtle Avenue	32.4	5,400	8,600	10,000	14,200
Downstream of confluence of Little Freshwater Creek	28.5	5,100	8,000	9,500	13,200
Upstream of confluence of Little Freshwater Creek	20.9	4,050	6,400	7,400	10,700
HILLSIDE CREEK	-				
At confluence with Rohner Creek	-	-	-	249	-
JACOBY CREEK					
At Myrtle Avenue	16.6	3,110	4,560	5,070	6,290
JANES CREEK					
At upper limit of detailed study	2.96	520	800	900	1,120
At Q Street	3.51	610	920	1,030	1,290

*Data not available

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISHCARGES (CFS)			
		10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
JOLLY GIANT CREEK					
At Alliance Road	0.98	180	270	310	380
At 11th Street	1.08	200	300	340	420
MAD RIVER					
At USGS Gaging Station near Arcata (No. 11481000)	485	58,360	81,270	90,960	113,480
Downstream of confluence with North Fork Mad River	443	53,790	74,910	83,840	104,600
Below confluence of North Fork Mad River	-	47,500	66,900	74,700	92,100
Above confluence of North Fork Mad River	-	42,900	60,500	67,600	83,300
NORTH FORK MAD RIVER	-				
Above confluence with Mad River	-	12,700	18,300	20,500	26,000
REDWOOD CREEK					
At Orick, CA	-	39,000	52,600	57,700	68,000
At USGS Gaging Station at Orick (No. 11482500)	280	40,563	54,044	58,868	68,395
ROHNER CREEK					
Upstream of Strongs Creek	4.2	760	1,150	1,290	1,620
Upstream of Hillside Creek	3.5	640	980	1,100	1,380
At corporate limits	2.9	550	840	940	1,180
At City Limits	-	-	-	852	-
At Carson Woods Rd.	-	-	-	871	-
At Main St.	-	-	-	958	-
At confluence of Hillside Creek	-	-	-	1149	-
At confluence of Strongs Creek	-	-	-	1292	-
SOUTH FORK EEL RIVER					
At Redway	507	104,000	159,000	166,000	213,000
STRONGS CREEK					
At Southern Pacific Railroad	12.4	1,990	3,000	3,350	4,210
Upstream of Mill Creek	10.1	1,660	2,510	2,810	3,520
Downstream of Jameson Creek	9.8	1,620	2,440	2,730	3,430
Upstream of Jameson Creek	8	1,350	2,050	2,290	2,880
Downstream of Loop Road Drainage	7.5	1,280	1,940	2,170	2,720
Upstream of Loop Road Drainage	7.4	1,260	1,910	2,140	2,690

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISHCARGES (CFS)			
		10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
TRINITY RIVER					
Downstream of confluence with Kirkham Creek	2,016	98,800	158,000	184,000	250,000
VAN DUZEN RIVER					
At mouth	429	60,000	84,000	94,000	117,000
Upstream of confluence with Yaeger Creek	280	39,000	54,000	60,000	75,000
WILLIAMS CREEK					
At Grizzly Bluff Road, at confluence with Salt River	5.57	*	*	1985	*

*Data not available

The stillwater elevations have been determined for the 10-, 2-, 1-, and 0.2-percent-annual-chance floods for the flooding sources studied by detailed methods and are summarized in Table 4, "Summary of Stillwater Elevations."

TABLE 4 - SUMMARY OF STILLWATER ELEVATIONS

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	ELEVATION (feet NAVD))			
		10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
HUMBOLDT BAY					
At Eureka (southwestern corporate limits)	8.87	9.27	9.37	9.67	
At King Salmon	8.87	9.27	9.37	9.67	

The 10-, 2-, 1-, and 0.2-percent annual chance discharges determined at the gage were transposed to the study area using the following relationships:

$$\frac{Q}{Q_g} = \left[\frac{A}{A_g}\right]^{0.9}$$

Where Q and Q_g are the discharges in the study area and at the gage, respectively, and A and A_g are the drainage areas at these locations (U.S. Department of the Interior, 1977). A second set of discharges at the study area was determined from regional flood-frequency equations (U.S. Department of the Interior, 1977). The final 10-, 2-, 1-, and 0.2-percent annual chance discharges used were calculated by weighting the two sets of discharges (U.S. Department of the Interior, 1975).

The 10-, 2-, 1-, and 0.2-percent annual chance peak discharges for Powers Creek, Rohner Creek, and Strongs Creek were generated by applying regional flood- frequency equations (U.S. Department of the Interior, 1977). These equations relate discharges with return periods of 10-, 2, and 1-percent

annual chance to drainage area, mean annual precipitation, and altitude index. The equations were derived by applying multiple regression techniques to the flow data and basin characteristics of several gaging stations in the north coast region of California. The 10-, 2-, and 1-percent annual chance discharges at two sites on Dave's Creek were calculated with the regional equations. A 0.2-percent annual chance discharge was calculated at each site by extrapolation from the other three data points.

The discharges used in the detailed study of the Trinity River were based on data from the USGS gaging station at Hoopa (No. 11530000; drainage area 2,854 square miles; period of record 1911-1914, 1916-1918, and 1931-1980). The peak flows measured at the Hoopa gage were reduced to account for flood storage at the Trinity River diversion project upstream. According to information provided by the USACE, the Trinity and Lewiston Dams are adopting operating procedures that will allow only 200 cfs to enter the river downstream of the diversion project during large floods. Therefore, each flood discharge measured at Hoopa was reduced by an amount equal to the flood discharge measured at the USGS gaging station at Lewiston (No. 11525500, at the diversion project site) for the same flood, less 200 cfs. This adjustment alters the discharge record at Hoopa to account for the present flood-control capabilities on the Trinity River. A log- Pearson Type III distribution (U.S. Water Resources Council, 1977) was performed on the reduced Hoopa gage data to determine the 10-, 2-, 1-, and 0.2- percent annual chance discharges at the gage site. The gage-based discharges were then transposed to the detailed-study area according to the following formula:

$$\frac{Q}{Q_g} = \left[\frac{A}{A_g}\right]^{0.9}$$

Where Q and Q_g are the discharges at Willow Creek and at the gage, respectively, and A and A_g are the drainage areas at these locations (U.S. Department of the Interior, 1977).

The 1-percent annual chance peak discharge for Williams Creek at Grizzly Bluff Road was estimated by the SCS as part of their Salt River study (U.S. Department of Agriculture, 1993) using Technical Release No. 2, "Project Formulation – Hydrology," computer program. The hydrologic parameters used by the SCS for Williams Creek included the SCS unit hydrograph, time of concentration, rainfall depth and distribution, and loss rate.

The calibration study resulted in an increase in the 1-percent annual chance peak discharge for Williams Creek of approximately 35 percent, as compared to the original SCS values (U.S. Department of Agriculture, 1993). The discharge agrees closely with the value calculated by the north coast regional regression equation as developed by the USGS (U.S. Department of the Interior, 1977).

Watershed areas were determined using USGS quadrangle maps (U.S. Department of the Interior, 1959). The watershed was divided into two

subbasins. Land uses were defined based on SCS data (U.S. Department of Agriculture, 1993) and field reconnaissance. Watershed soil types were determined from the SCS data. Total precipitation was determined from National Oceanic and Atmospheric Administration isohyetal maps (U.S. Department of Commerce, 1972). Rainfall distribution was based on SCS 24-hour Type 1A distribution, with 30-minute increments (U.S. Department of Agriculture, 1986). Infiltration losses were determined using SCS CN methodology with the CN values determined based on the watershed soil types (U.S. Department of the Interior, 1975) and SCS guidelines (U.S. Department of Agriculture, 1986). Times of concentration and basin lag times were determined using SCS methodology for small urban watersheds (U.S. Department of Agriculture, 1986). Channel routing was performed using the HEC-1 Modifed-Puls method. The storage discharge relationships were determined using multiple-discharge hydraulic computations.

The results of the initial hydrologic analyses for Williams Creek were consistent with the SCS Salt River Watershed study.

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the source 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. For construction and/or floodplain management purposes, users are encouraged to use the flood elevation data presented in this FIS in conjunction with the data shown on the FIRM.

A one-dimensional hydraulic model was developed for Mad River and North Fork Mad River using the U.S. Army Corps of Engineers HEC-RAS modeling system. The HEC-RAS model calculates one-dimensional water surface profiles and average channel velocities for both steady gradually varied flow and unsteady flow through a channel. For this analysis, steady flow modeling was used to predict flood levels within the project area/reach for the 10-, 4-, 1- and 0.2-percent annual chance discharges for the Mad River and the NF Mad River (Kimley-Horn and Associates, Inc. et al, 2013).

A one-dimensional hydraulic model was developed for Redwood Creek using the U.S. Army Corps of Engineers HEC-RAS modeling system. The HEC-RAS model calculates one-dimensional water surface profiles and average channel velocities for both steady gradually varied flow and unsteady flow through a channel. For this analysis, steady flow modeling was used to predict flood levels within the project area/reach for the 10-, 4-, 1- and 0.2-percent annual chance discharges for Redwood Creek (Northern Hydrology & Engineering et al, 2014).

The Rohner Creek analysis was developed using MIKE. A 1-dimensional model (MIKE 11) has the ability to be dynamically coupled with a 2-dimensional model (MIKE 21) to simulate interactions between the one-dimensional channels and a

two-dimensional floodplain. When M11 is coupled with M21, it is also known as MIKE FLOOD. Rohner Creek was modeled in metric units. Inputs and outputs were converted as necessary using the conversion 3937 feet per 1200 meters (Perry, 2014).

Water-surface elevations of Eastside Channel and Francis Creek were computed through the use of the USACE HEC-2 computer program (USACE, 1990).

Channel and overbank cross sections of Eastside Channel and Francis Creek were determined from surveyed channel cross sections and City of Ferndale 200-foot horizontal-scale topographic mapping with 2-foot contour intervals (Geonex, Inc., 1993), as well as field measurements of structures.

The Manning's "n" roughness values were established based on field observations and USACE and USGS guidelines (Geonex, Inc., 1993; Chow, V. T., 1959).

In accordance with USACE guidelines, contraction and expansion coefficients of 0.1 and 0.3 were used for open-channel sections. Contraction coefficients at culverts and bridges ranged from 0.3 to 0.5, depending on configuration. An expansion coefficient of 0.5 was used at culverts and bridges. HEC-2 bridge and culvert routines were used to model the existing road crossings. All culverts and bridges were analyzed based on the surveyed dimensions and were assumed to be unobstructed. The downstream starting water-surface elevation was based on the HEC-2 slope/area method. Although supercritical flow conditions can occur in some channel reaches, subcritical analyses were conducted to determine BFEs for all stream reaches.

Split-flow routines were used to determine discharges for overbank flow paths that are hydraulically separated from the main channel. Split flows were based on a weir coefficient of 2.75.

A separate HEC-2 analysis was performed to determine the depth of the 1-percent annual chance flood and BFEs in the overbank areas where the calculated average depths are less than 1 foot are designated Zone X on the work map. Where the calculated average depth was greater than 1 foot, BFEs have been determined.

The 1-percent annual chance water-surface elevations from the Eel River affecting the City of Ferndale were determined by inputting six cross sections and the 1- percent annual chance discharge of 695,000 cfs from the Humboldt County FIS into the HEC-2 model. The 1-percent annual chance floodplain boundary and BFE of the Eel River were plotted within the corporate limits and shown on the FIRM.

Cross sections used in this study were obtained from survey work by the USACE on the following detailed-study segments:

Eel River-Ferndale to Fortuna (Clair A. Hill & Associates, 1967) Eel River-Stafford to Holmes (USACE, 1970)
Van Duzen River (USACE, 1973) South Fork Eel River (USACE, 1969)
Freshwater Creek (USACE, 1975)

In the Fortuna segment of the Eel River study from Ferndale to Fortuna, on the Eel River from Rio Dell to Stafford, on Jacoby Creek, and on the Trinity River, cross- section data located within the limits of the stream channel were obtained by field surveys conducted for this study. On these four study segments, the overbank portions of the cross sections were obtained from topographic mapping that was prepared photogrammetrically (Clair A. Hill & Associates, 1967; Towill, Inc., 1979; Clair A. Hill & Associates, August-September 1969; Winzler and Kelly Consulting Engineers, 1967). Bridge plans were used to obtain elevation data and structural geometry for bridges over the streams modeled by the study contractor. Bridges and culverts were surveyed where plans were unavailable or out-of-date.

Cross sections for the backwater analyses were located at close intervals above and below structures to compute the significant backwater effects of these structures in the developed areas. In long reaches between structures, appropriate valley cross sections were also included in the backwater analyses.

Water-surface elevations were computed through the use of the USACE HEC-2 computer program (USACE, 1990). The downstream starting water-surface elevations were based on the slope/area method.

Supercritical flow conditions can occur in some channel reaches. In accordance with FEMA guidelines, subcritical analyses were conducted to determine BFEs for all stream reaches. Split-flow routines were used to determine discharges for overbank flow paths that are hydraulically separated from the main channel.

Water-surface elevations presented in this study that were obtained from work done by the USACE include:

Study Segment	Profiles
Eel River-Stafford to Holmes	1- and 0.2-percent annual chance floods (USACE, 1970)
Van Duzen River	1- and 0.2-percent annual chance floods (USACE, 1973)
South Fork Eel River	1- and 0.2-percent annual chance floods (USACE, 1969)
Freshwater Creek	2, 1-, and 0.2-percent annual chance floods (USACE, 1975)

The downstream starting water-surface elevation was based on a stage-storage relationship, determined by routing the Janes Creek 1-percent annual chance graph through the storage area between Samoa Road and the dikes surrounding Arcata Bay. The stage downstream of the Arcata Bay tide gates

was assumed to be at normal mean tide (U.S. Department of Commerce, 1945-1983) at the time of the 1- percent annual chance discharge in Janes Creek. Water-surface elevations were computed through the use of the USACE HEC-2 computer program (USACE, 1990).

Channel and overbank cross sections were determined from surveyed channel profiles and City of Arcata horizontal-scale topographic mapping at a scale of 1"=200', with 2-foot contour intervals (City of Arcata horizontal-scale topographic mapping, 1989), in addition to field measurements of structures. The cross sections derived from the topographic mapping were adjusted based on a detailed profile survey of the channel invert and existing structures.

The floodway boundary for Janes Creek was determined by using Methods 1 and 4 encroachment analyses of the USACE HEC-2 computer program. Encroachment limits were based on equal-conveyance reduction from each side of the floodplain, which would produce a maximum 1-foot surcharge in the 1-percent annual chance water-surface elevations.

Water-surface elevations of the 10-, 2-, 1-, and 0.2-percent annual chance floods were computed on Powers Creek through the use of the USACE HEC-2 step-backwater computer program (USACE, 1979).

The overbank portions of the cross-section data for Powers Creek were obtained from topographic mapping prepared photogrammetrically (Oscar Larson & Associates, 1974). Portions of most cross sections located within the stream channels were obtained by field survey. All bridges and culverts within the detailed study limits of Powers Creek were surveyed to obtain elevation data and structural geometry.

Cross sections for the backwater analysis of Powers Creek are located at close intervals above and below structures in order to compute the significant backwater effects of these structures in the developed areas. In long reaches between structures, appropriate valley cross sections were also included in the backwater analysis.

The overbank portions of the cross-section data for Martin Slough and Martin Slough Tributary C were obtained from topographic mapping prepared photogrammetrically (Clair A. Hill & Associates, August-September 1969). Data for those portions of the cross sections located within the limits of the stream channel of Martin Slough were obtained by field survey. Topographic mapping and field surveys were supplemented by digitized cross sections prepared from aerial photographs of the Martin Slough basin. On Martin Slough Tributary C, the digitized cross sections for the stream channel were read from aerial photographs taken during extreme low-flow periods, when the channel was practically dry.

Bridge plans were utilized to obtain elevation data and structural geometry for bridges over the streams studied in detail. Bridges and culverts were surveyed where plans were unavailable or out of date.

Cross sections for the backwater analyses were located at close intervals upstream and downstream of structures in order to compute the significant backwater effects of these structures in the developed areas. In long reaches between structures, appropriate valley cross sections were also included in the backwater analyses.

Starting water-surface elevations on Martin Slough were determined by the slope/area method, an option in the HEC-2 program (USACE, 1979). For Martin Slough Tributary C, starting water-surface elevations were obtained from the main stem.

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

The overbank portions of the cross-section data for Strongs Creek and Rohner Creek were obtained from topographic mapping prepared photogrammetrically (Clair A. Hill & Associates, 1967; Winzler & Kelly Consulting Engineers, 1978). Those portions of the cross sections located within the limits of the stream channels were obtained by field survey. Bridge plans were used to obtain elevation data and structural geometry for bridges over the streams studied in detail. Bridges and culverts were surveyed where plans were unavailable or out of date.

Cross sections for the backwater analyses were located at close intervals above and below structures in order to compute the significant backwater effects of these structures in the developed areas. In long segments between structures, appropriate valley cross sections were also included in the backwater analyses.

The coefficients employed in the Eel River analysis were adjusted to calibrate the results of the computer modeling to extensive high-water marks from the December 1964 flood (USACE, 1965).

Starting water-surface elevations for Strongs Creek and Rohner Creek were also determined by the slope/area method.

Roughness coefficients (Manning's "n") were estimated from data provided by the USACE on the Eel River from Stafford to Holmes, on the Van Duzen River, on the South Fork Eel River, and on Freshwater Creek. On the Eel River from Ferndale to Fortuna, on the Eel River from Rio Dell to Stafford, and on the Mad River, the roughness coefficients used were chosen to calibrate the results of the computer modeling to extensive high-water marks from the December 1964 flood (USACE, 1965; USACE, December 1965; USACE, 1965; USACE, December 1965) and to the rating curves of two USGS gaging stations in the detailed-study areas. On Jacoby Creek and on the Trinity River, roughness coefficients were estimated by field inspection.

Water-surface elevations for Williams Creek were computed through the use of the USACE HEC-2 computer program (USACE, 1990). The downstream starting water-surface elevation was based on the HEC-2 slope/area method.

Channel and overbank cross sections for Williams Creek were determined from channel cross sections surveyed by the SCS, City of Ferndale 200-foot horizontal- scale topographic mapping with 2-foot contour intervals (Geonex, Inc., 1993), and field measurements of structures.

The Manning's "n" roughness values were established based on field observations and USACE and USGS guidelines (Chow, V. T., 1959; U.S. Department of the Interior, 1987).

Contraction and expansion coefficients of 0.1 and 0.3 were used for open-channel sections. Contraction coefficients at culverts and bridges ranged from 0.3 to 0.5, depending on configuration. An expansion coefficient of 0.5 was used at culverts and bridges. HEC-2 special bridge and culvert routines were used to model the existing road crossings. All culverts and bridges were analyzed based on the surveyed dimensions and were assumed to be unobstructed.

Although supercritical flow conditions can occur in some channel reaches, subcritical analyses were conducted to determine BFEs for all stream reaches.

Split-flow routines were used to determine discharges for overbank flow paths that are hydraulically separated from the main channel. Split flows were based on a weir coefficient of 2.75.

A separate HEC-2 analysis was performed to determine the depth of the 1-percent annual chance flood and BFEs in the overbank areas. Where the calculated average depths are less than 1 foot, BFEs have not been determined. Where the calculated average depth was greater than 1 foot, BFEs have been determined. Floodplain boundaries were based on critical depth.

The floodplain boundaries, as determined by the hydrologic and hydraulic analyses, have been delineated for Williams Creek using 1:2,400-scale topographic mapping, with 2-foot contour intervals (photoenlarged to 1"=700'), and USACE Eel River topography at a scale of 1:4,800, with 5-foot contour intervals (USACE, 1968).

It was determined that if the split flows are confined to the main flow path, the computed rise in water-surface elevation due to the increase in discharge would exceed 1 foot. Therefore, it was not possible to define a regulatory floodway along this reach of Williams Creek.

The numerous streams studied by approximate methods were analyzed based on a review of the following information: the Flood Hazard Boundary Map (FEMA, 1982); the results of HEC-2 computer backwater runs in adjacent detailed-study areas; the floodplain delineations previously developed in FISs in Arcata, Blue Lake, Eureka, Fortuna, and Rio Dell (FEMA, 1983; FEMA, 1982; FEMA, 1982; FEMA; FEMA, 1982; FEMA, 1982, respectively); high-water mark data gathered by the USACE after the flood of December 1964 (USACE, 1965; USACe, December 1965; USACE, 1965; USACE, December

1965); and the results of a waterway management plan performed on the Van Duzen River (State of California, 1977).

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

The hydraulic analyses for this FIS 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.

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

Roughness factors (Manning's "n") used in the hydraulic computations were chosen by engineering judgment and were based on field observations of the streams and floodplain areas. Roughness factors for all streams studied by detailed methods are shown in Table 5, "Manning's "n" Values."

TABLE 5 - MANNING'S "n" VALUES

Stream	Channel "n"	Overbank "n"
Eastside Channel	0.025 – 0.085	0.050 – 0.100
Eel River	0.028 – 0.110	0.040 – 0.150
Francis Creek	0.025 – 0.085	0.050 – 0.100
Freshwater Creek	0.028 – 0.110	0.040 – 0.150
Janes Creek	0.020 – 0.100	0.025 – 0.075
Mad River	0.032	0.032 – 0.150
Mad River at Blue Lake	0.05	0.065
Martin Slough	0.040 – 0.065	0.055 – 0.070
Martin Slough Tributary C	0.040 – 0.065	0.055 – 0.070
North Fork Mad River	0.032	0.032 – 0.150
Dave Power's Creek	0.040 – 0.050	0.080 – 0.100
Redwood Creek	0.032	0.025 – 0.150
Rohner Creek	0.050	0.100
South Fork Eel River	0.028 – 0.110	0.040 – 0.150
Strongs Creek	0.033 – 0.075	0.055 – 0.120
Van Duzen River	0.028 – 0.110	0.040 – 0.150
Williams Creek	0.020 – 0.100	0.040 – 0.075

3.3 Coastal Hazard Analyses

Storm-generated components of the coastal flood hazard were evaluated by a three-step analysis. The first step determined the magnitude and frequency of storm surge, or the superelevation of the water level above the astronomical tide that is caused by low barometric pressure and by wind stresses. The second step convoluted storm-surge probabilities with astronomical tide characteristics to define the stillwater elevations and frequency relation. Finally, wave impacts were defined and added to stillwater elevations.

The storm surge on Humboldt Bay was defined by a two-dimensional, finite- element computer model (James R. Pagenkopf, 1976). Applicability of the model had been tested by using long-term climatic records for San Francisco to synthesize a long-term record of storm-surge hydrographs for San Francisco Bay. The close match of the synthesized data to available long-term tidal records confirmed the usability of the model for California conditions. For Humboldt Bay, the model synthesized a record of storm surge data on windspeed, wind direction, and barometric pressures, from 1955 to 1983, as determined from North American Surface Weather Maps (U.S. Department of Commerce, 1955-1983). The frequency and magnitude of storm surges were defined from the synthesized storm-surge record.

Astronomical tide elevations can be precisely defined for Humboldt Bay from previous studies (U.S. Department of Commerce, 1945-1983). These tide characteristics were convoluted with the storm-surge magnitude and frequency to define the magnitude and frequency of stillwater elevations-the water-surface elevation with no wave impacts.

Because of inlet constrictions, Humboldt Bay was assumed to be sheltered

from the influence of offshore storm-generated waves, but the magnitudes of locally generated wind waves were investigated using methods from the Shore Protection Manual (USACE, 1977). Based on wind magnitude and frequency data from the National Climatic Data Center (U.S. Department of Commerce, 1955-1983), measured fetch lengths, and beach profiles determined from the National Ocean Survey (U.S. Department of Commerce, 1981), the wave heights were found to be generally less than 3 feet and to provide only limited runup above the stillwater elevation. Hence, wave action was considered insignificant to flood hazards in Humboldt County.

Beach transects along the shore of Humboldt Bay provided a generalized representation of the beach profiles that control the magnitude of wave runup. In coastal-study areas, beach transects were oriented perpendicular to the shoreline and were strategically located along the shore to represent reaches with similar characteristics. Data were primarily obtained from offshore bathymetry maps supplemented with 1978 USACE survey data (USACE, 1978). Figure 1, "Transect Schematic," represents a sample transect.

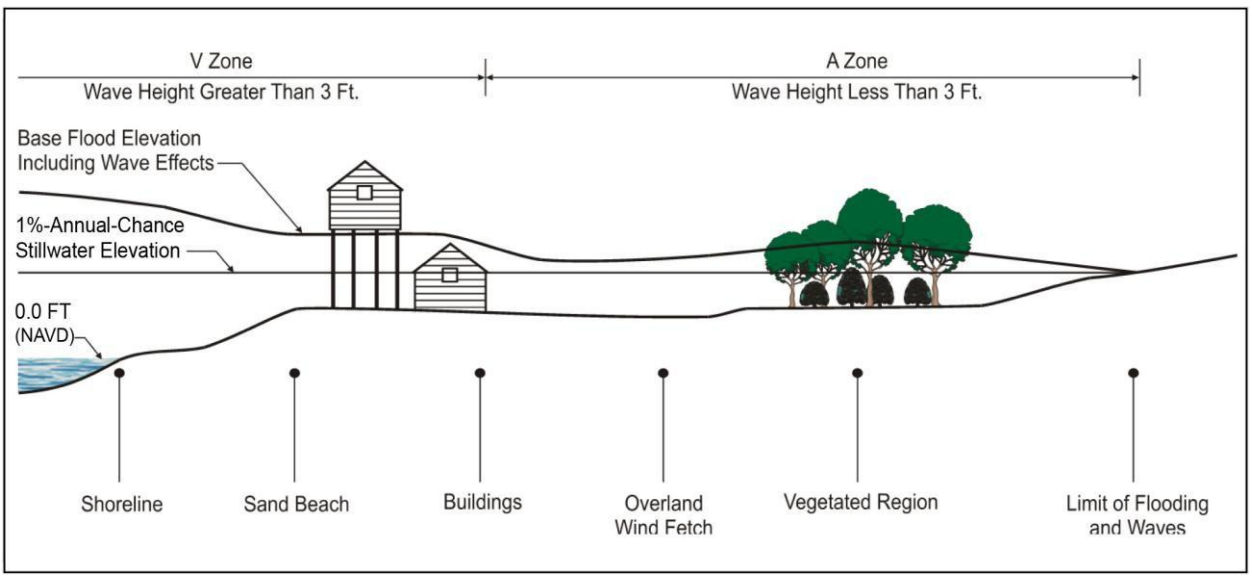

Figure 1 - TRANSECT SCHEMATIC

Tsunami plus astronomical tide elevations having 1- and 0.2-percent annual chance recurrence intervals have been defined for the northern California coastal areas in previous studies (USACE, 1978; USACE, 1974; USACE, 1979). Study of the Humboldt Bay inlet conveyance capacity determined that tsunami waves would have only an insignificant impact on the flood hazard in Humboldt County.

Approximate study was carried out for certain areas subject to tidal flooding and wave attack along the Pacific Ocean, Humboldt Bay, and Arcata Bay. The boundary of the 1-percent annual chance tidal storm surge was based on the delineation shown on the Flood Hazard Boundary Map (U.S. Department of Housing and Urban Development, 1977) and on the tidal flood delineations used in the FISs for Arcata and Eureka.

3.4 Vertical Datum

All FISs and FIRMs are referenced to a specific vertical datum. The vertical datum provides a starting point against which flood, ground, and structure elevations can be referenced and compared. Until recently, the standard vertical datum in use for newly created or revised FISs and FIRMs was the National Geodetic Vertical Datum of 1929 (NGVD 29). With the finalization of the North American Vertical Datum of 1988 (NAVD 88), many FIS reports and FIRMs are being prepared using NAVD 88 as the referenced vertical datum.

All flood elevations shown in this 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 the corporate limits between the communities.

Prior versions of the FIS report and FIRM were referenced to NGVD 29. When a datum conversion is effected for an FIS report and FIRM, the Flood Profiles, base flood elevations (BFEs) and ERMs reflect the new datum values. To compare structure and ground elevations to 1-percent annual chance flood elevations shown in the FIS and on the FIRM, the subject structure and ground elevations must be referenced to the new datum values.

As noted above, the elevations shown in the FIS report and on the FIRM for Humboldt 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 was determined to be 3.27 feet where an elevation of 0.00 feet NGVD 29 is equal to and elevation of 3.27 feet NAVD 88.

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

For more information on NAVD 88, see Converting the National Flood Insurance Program to the North American Vertical Datum of 1988, FEMA Publication FIA-20/June 1992, or contact the Spatial Reference System Division, National

Geodetic Survey, NOAA, Silver Spring Metro Center, 1315 East-West Highway, Silver Spring, Maryland 20910 (Internet address http://www.ngs.noaa.gov).

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound floodplain management programs. To assist in this endeavor, each FIS provides 1-percent annual chance floodplain data, which may include a combination of the following: 10-, 2-, 1-, and 0.2-percent annual chance flood elevations; delineations of the 1- and 0.2-percent annual chance floodplains; and 1-percent annual chance floodway. This information is presented on the FIRM and in many components of the FIS, including Flood Profiles, Floodway Data tables, and Summary of Stillwater Elevation tables. Users should reference the data presented in the FIS as well as additional information that may be available at the local community map repository before making flood elevation and/or floodplain boundary determinations.

4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1-percent annual chance flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent annual chance flood is employed to indicate additional areas of flood risk in the county. For the streams studied in detail, the 1% and 0.2% floodplain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps as follows:

Detailed-Study Reach	Map Scale	Contour Interval (feet)
Eastside Channel	1:2,400	2
Eel River-Ferndale to Fortuna	1:4,800	5
Eel River-Rio Dell to Holmes	1:4,800	5
Freshwater Creek	1:4,800	5
Jacoby Creek	1:4,800	5
Janes Creek	1:2,400	2
Mad River	1:4,800	5
Martin Slough	1:6,000	10
Martin Slough Tributary C	1:6,000	10
Powers Creek	1:1,200	2
Rohner Creek	1:4,800	5
South Fork Eel River	1:4,800	5
Strongs Creek	1:4,800	5
Trinity River	1:6,000	10
Van Duzen River	1:4,800	5
Williams Creek	1:4,800	5

Detailed-study floodplain boundaries along Humboldt Bay were delineated using topographic maps at a scale of 1:4,800, with a contour interval of 4 feet, developed from aerial photographs (USACE, 1968).

For the flooding sources studied by approximate methods, the boundaries of the 1-percent annual chance floodplains were delineated using topographic maps taken from the previously printed FIS reports, FHBMs, and/or FIRMs for all of the incorporated and unincorporated jurisdictions within Humboldt County.

The 1- and 0.2-percent annual chance floodplain boundaries are shown on the FIRM (Exhibit 2). On this map, the 1-percent annual chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A 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 elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

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

4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the NFIP, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 1-percent annual chance floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the 1-percent annual chance flood can be carried without substantial increases in flood heights. Minimum federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this FIS 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 floodways for this study were determined using Method 1 and Method 6 encroachment analysis of the USACE HEC-2 computer program (USACE, 1979). No-encroachment limits were based on equal-conveyance reduction, which would produce a surcharge in water surface related to a corresponding maximum 1.0-foot surcharge in energy gradeline or water-surface elevation. Because of the effects of downstream encroachment on energy gradeline and water-surface elevations upstream, there may be numerous cross sections where minimal encroachment can be permitted.

As an example, encroachment under certain flow conditions can result in a localized lowering of the water-surface elevation and an increase in velocity. However, this increase in velocity usually results in an increase in water-surface elevation at some point upstream. Encroachment at some cross sections must

therefore be limited so that rises greater than 1.0 foot in either the water-surface elevation or energy gradeline do not result at upstream cross sections.

No floodways were determined for Eastside Channel because it was determined that if the split flows are confined to the main flow path, the computed rise in water-surface elevation due to the increase in discharge would exceed 1 foot. Therefore, it was not possible to define a regulatory floodway along this reach of Eastside Creek.

No floodways have been determined on the Van Duzen and South Fork Eel Rivers, on Eastside Channel, Francis Creek, Williams Creek, and Freshwater Creek, or on the Eel River from Stafford to Holmes. No floodway was computed on the Eel River from the downstream limit of study at Rio Dell to the Fleisher Memorial Bridge (U.S. Highway 101) at Stafford because of very high velocities; therefore, no encroachment should be allowed within the 1-percent annual chance floodplain.

A floodway has been designated for a shore segment of Rohner Creek in the Fortuna area. The floodway was computed for the Fortuna FIS (FEMA, 1982); supporting data for the floodway are included in that study.

The floodways presented in this FIS were computed for certain stream segments on the basis of equal conveyance reduction from each side of the floodplain.

Floodway widths were computed at cross sections. Between cross sections, the floodway boundaries were interpolated. The results of the floodway computations are tabulated for selected cross sections (Table 6). The computed floodways are 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.

Encroachment into areas subject to inundation by floodwaters having hazardous velocities aggravates the risk of flood damage, and heightens potential flood hazards by further increasing velocities. A listing of stream velocities at selected cross sections is provided in Table 6, "Floodway Data." In order to reduce the risk of property damage in areas where the stream velocities are high, the community may wish to restrict development in areas outside the floodway.

The area between the floodway and 1-percent annual chance floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation 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 2.

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Dave Power's Creek								
A	915[1]	57	133	8.2	74.8	74.8	75.2	0.4
B	1,245[1]	150	649	1.5	76.4	76.4	77.4	1.0
C	1,520[1]	155	630	1.6	76.6	76.6	77.6	1.0
D	1,850[1]	65	534	1.9	77.1	77.1	78.1	1.0
E	2,100[1]	51	203	4.9	78.4	78.4	78.8	0.4
F	2,261[1]	150	365	2.7	82.1	82.1	82.6	0.5
G	2,578[1]	200	525	1.9	82.8	82.8	83.3	0.5
H	2,792[1]	60	265	3.7	82.8	82.8	83.5	0.7
I	3,032[1]	85	365	2.7	83.7	83.7	84.2	0.5
J	3,490[1]	30	105	8.5	84.3	84.3	84.6	0.3
K	3,737[1]	30	110	8.0	87.3	87.3	87.5	0.2
L	3,813[1]	50	190	4.7	88.8	88.8	89.6	0.8
M	3,886[1]	40	150	6.1	89.4	89.4	89.9	0.5
N	4,141[1]	187	125	7.2	94.1	94.1	94.1	0.0
Eel River								
A	30,305[2]	14,000	113,500	6.1	28.5	28.5	28.9	0.4
B	36,800[2]	16,000	152,005	4.6	36.3	36.3	36.5	0.2
C	48,560[2]	13,000	160,625	4.3	43.5	43.5	44.4	0.9
D	56,130[2]	8,500	75,200	9.2	47.4	47.4	48.0	0.6
E	62,810[2]	8,500	91,255	7.6	57.9	57.9	58.7	0.8

[1]Feet above confluence with Mad River
[2]Feet above mouth

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

DAVE POWER'S CREEK – EEL RIVER(FERNDALE TO FORTUNA)

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Jacoby Creek								
A	-60[1]	1,090	2,615	1.9	21.7	21.7	22.7	1.0
B	2,240[1]	400	765	6.6	28.8	28.8	29.4	0.6
C	3,000[1]	600	1,790	2.8	34.0	34.0	34.1	0.1
D	3,114[1]	600	2,250	2.3	35.6	35.6	35.6	0.0
E	9,590[1]	170	860	5.9	62.8	62.8	63.5	0.7
F	13,190[1]	60	505	10.0	89.2	89.2	89.2	0.0
G	13,600[1]	90	870	5.8	92.9	92.9	93.4	0.5
Janes Creek								
A	45[2]	21	156	6.6	9.8	8.2	9.1	0.9
B	187[2]	44	351	2.9	9.8	8.8	9.8	1.0
C	817[2]	120	565	1.8	9.8	9.3	10.3	1.0
D	1,432[2]	80	448	2.3	9.8	9.8	10.8	1.0
E	1,917[2]	70	384	2.7	10.3	10.3	11.3	1.0
F	2,704[2]	20	139	7.4	13.6	13.6	13.6	0.0
G	3,354[2]	60	320	3.2	14.3	14.3	15.2	0.9
H	3,810[2]	70	363	2.8	14.9	14.9	15.9	1.0
I	4,337[2]	65	366	2.8	16.3	16.3	17.3	1.0
J	4,627[2]	100	471	2.2	16.6	16.6	17.6	1.0
K	5,437[2]	45	418	2.5	22.5	22.5	22.8	0.3
L	5,987[2]	65	323	3.2	22.6	22.6	23.5	0.9
M	6,272[2]	45	421	2.4	25.8	25.8	25.8	0.0
N	6,717[2]	60	302	3.4	26.1	26.1	27.1	1.0
O	6,997[2]	65	310	3.3	27.5	27.5	28.5	1.0
P	7,609[2]	40	239	4.3	28.4	28.4	29.4	1.0

[1]Feet above Old Arcata Road
[2]Feet above centerline of Samoa Boulevard

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

JACOBY CREEK – JANES CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Janes Creek (continued)								
Q	8,047[1]	60	529	1.9	32.0	32.0	32.3	0.3
R	8,562[1]	90	794	1.3	32.8	32.8	33.7	0.9
S	9,143[1]	230	1,191	0.8	32.9	32.9	33.9	1.0
T	9,697[1]	230	732	1.2	32.9	32.9	33.9	1.0
U	9,987[1]	230	776	0.9	33.2	33.2	34.2	1.0
V	10,337[1]	220	731	1.0	33.3	33.3	34.3	1.0
W	10,832[1]	150	719	1.0	33.4	33.4	34.3	0.9
X	11,203[1]	149	869	0.8	33.6	33.6	34.5	0.9
Y	11,533[1]	106	194	3.6	33.8	33.8	34.5	0.7
Z	11,948[1]	27	127	5.5	35.2	34.2	35.3	0.1
AA	12,619[1]	80	218	4.1	37.2	37.2	38.0	0.8
AB	12,997[1]	77	372	2.4	38.0	38.0	39.0	1.0
Mad River								
A	-850[2]	3,930	46,605	2.0	33.5	33.5	34.5	1.0
B	-50[2]	3,330	43,850	2.1	33.7	33.7	34.7	1.0
C	175[2]	3,180	35,160	2.6	35.7	35.7	36.3	0.6
D	3,070[2]	4,500	53,440	1.7	35.9	35.9	36.7	0.8
E	6,705[2]	2,300	25,210	3.6	36.6	36.6	37.3	0.7
F	9,010[2]	670	12,900	7.1	38.0	38.0	38.6	0.6
G	10,195[2]	320	7,930	11.5	40.1	40.1	40.8	0.7
H	13,850[2]	520	13,050	7.0	45.6	45.6	46.4	0.8
I	14,194[2]	300	7,580	12.0	48.7	48.7	48.9	0.2

[1]Feet above centerline of Samoa Boulevard
[2]Feet from southbound U.S. Highway 101 Bridge

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

JANES CREEK (CONTINUED) – MAD RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY[2]	WITHOUT FLOODWAY[3]	WITH FLOODWAY	INCREASE
Mad River at Blue Lake								
J	14,186	1,073	9,786	7.6	55.1 / 55.1	55.1	55.7	0.6
K	15,365	1,315	14,083	5.3	58.1 / 58.1	58.1	58.8	0.7
L	16,513	1,278	13,200	5.7	60.4 / 60.4	60.4	61.1	0.7
M	17,128	1,434	13,735	5.4	61.4 / 61.4	61.4	62.2	0.8
N	17,643	1,458	14,118	5.3	62.0 / 62.0	62.0	62.8	0.8
O	18,432	1,712	17,329	4.3	63.2 / 63.2	63.2	64.0	0.8
P	18,845	1,712	16,221	4.6	63.7 / 63.7	63.7	64.4	0.7
Q	20,056	1,882	11,394	6.6	65.5 / 65.5	65.5	66.0	0.5
R	20,602	1,860	8,947	8.3	66.7 / 66.7	66.7	67.0	0.3
S	21,233	2,175	7,471	10.0	68.3 / 68.3	68.3	68.6	0.3
T	21,871	2,201	12,344	6.1	71.0 / 71.0	71.0	71.8	0.8
U	22,514	1,688	13,332	5.6	72.2 / 72.2	72.2	73.2	1.0
V	23,244	1,369	12,240	6.1	73.2 / 73.2	73.2	74.2	1.0
W	23,876	1,172	10,164	7.3	74.3 / 74.3	74.3	75.1	0.8
X	24,654	1,587	14,652	5.1	76.1 / 76.1	76.1	76.7	0.6
Y	25,527	1,661	14,600	5.1	77.4 / 77.4	77.4	77.8	0.4
Z	26,082	1,555	12,976	5.8	77.9 / 77.9	77.9	78.2	0.3
AA	26,633	1,656	11,613	6.4	78.9 / 78.9	78.9	79.1	0.2
AB	27,820	697	8,571	8.7	82.3 / 82.3	82.2	82.3	0.1

[1]Feet above State Highway 299
[2]Riverward of levee / landward of levee
[3]Elevations computed without consideration of levee

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

MAD RIVER AT BLUE LAKE

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Martin Slough								
A	2,486[1]	300	1,875	0.7	13.0	13.0	14.0	1.0
B	2,640[1]	250	1,120	1.1	13.1	13.1	14.1	1.0
C	4,800[1]	75	329	1.8	13.2	13.2	13.2	0.0
D	8,000[1]	28	95	5.9	16.2	16.2	16.2	0.0
Martin Slough Tributary C								
A	466[2]	13	38	8.9	17.4	17.4	17.5	0.1
B	886[2]	41	60	5.8	24.9	24.9	25.1	0.2
C	1,596[2]	27	50	7.2	31.0	31.0	31.3	0.3
Rohner Creek								
A	501[3]	61	230	5.6	45.8	41.3[4]	42.1[4]	0.8
B	1,459[3]	40	290	4.4	50.8	45.7[4]	46.5[4]	0.8
C	2,404[3]	47	445	2.9	55.3	55.6	55.7	0.1
D	2,634[3]	42	530	2.1	56.7	58.1	58.9	0.8
E	3,231[3]	65	450	2.5	61.5	59.8	60.1	0.3
F	4,720[3]	40	310	3.5	72.2	72.2	72.2	0.0
G	5,893[3]	35	185	6.0	78.1	78.1	78.1	0.0
H	7,878[3]	20	95	10.1	92.7	92.7	92.9	0.2
I	7,992[3]	25	145	6.4	102.0	102.0	102.0	0.0
J	8,170[3]	35	125	7.5	105.8	105.8	105.9	0.1

[1]Feet above Limit of Detailed Study
[2]Feet above confluence with Martin Slough
[3]Feet above 12TH Street
[4]Floodway computed without consideration of backwater effects from Eel River

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

MARTIN SLOUGH - MARTIN SLOUGH TRIBUTARY C - ROHNER CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Strongs Creek								
A	60[1]	250	1,710	2.0	51.5	51.5	51.8	0.3
B	530[1]	250	1,610	2.1	51.8	51.8	52.2	0.4
C	860[1]	450	2,320	1.4	52.0	52.0	52.6	0.6
D	1,041[1]	350	1,290	2.2	52.1	52.1	52.9	0.8
E	1,546[1]	100	850	3.3	53.5	53.5	53.7	0.2
F	5,190[1]	100	600	3.8	64.2	64.2	65.2	1.0
G	7,150[1]	85	620	3.5	71.4	71.4	72.2	0.8
Trinity River								
A	-1,150[2]	525	20,250	9.0	424.6	424.6	425.6	1.0
B	7,310[2]	720	21,880	8.4	430.4	430.4	431.4	1.0
C	10,490[2]	485	14,850	12.4	432.6	432.6	433.3	0.7
D	16,405[2]	715	16,590	11.1	445.6	445.6	446.1	0.5

[1]Feet above Northwestern Pacific Railroad
[2]Feet from confluence of Kirkham Creek

TABLE 6

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

STRONGS CREEK – TRINITY RIVER

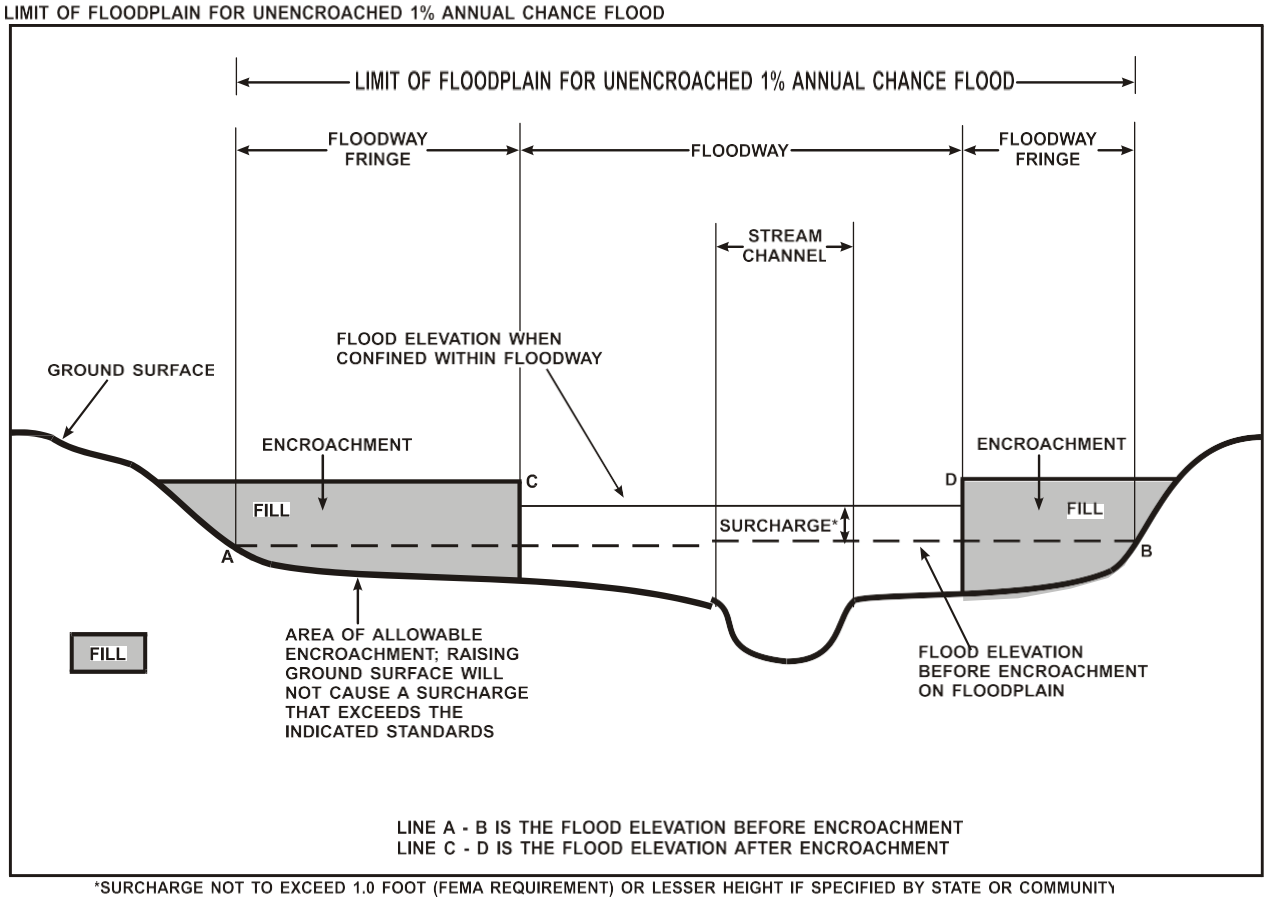

Figure 2 - FLOODWAY SCHEMATIC

5.0 INSURANCE APPLICATIONS

For flood insurance rating purposes, flood insurance zone designations are assigned to a community based on the results of the engineering analyses. The 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 AR

Area of special flood hazard formerly protected from the 1-percent annual chance 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 base flood elevations 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 base flood elevations 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 base flood elevations 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, 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 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 of Humboldt County. 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 (FBFMs), where applicable. Historical data relating to the maps prepared for each community, up to and including this countywide FIS, are presented in Table 7, "Community Map History."

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE	FIRM EFFECTIVE DATE	FIRM REVISIONS DATE
Arcata, City of	June 28, 1974	December 5, 1975 September 12, 1978 July 1, 1980	May 2, 1983	November 5, 1997
Blue Lake, City of	January 17, 1975	None	September 30, 1982	May 5, 1997
Eureka, City of	May 24, 1974	November 14, 1975	June 1, 1982	June 17, 1986
Ferndale, City of	December 20, 1974	March 26, 1976	December 1, 1993	January 7, 1998
Fortuna, City of	July 19, 1977	None	May 3, 1982	None
Humboldt County (Unincorporated Areas)	September 13, 1977	None	July 19, 1982	August 5, 1986 February 8, 1999
Rio Dell, City of	May 24, 1974	January 2, 1976	May 3, 1982	None
Trinidad, Town of	May 14, 1976	None	None	None

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA AND INCORPORATED AREAS

COMMUNITY MAP HISTORY

7.0 OTHER STUDIES

Information pertaining to revised and unrevised flood hazards for each jurisdiction within Humboldt County has been compiled into this FIS. Therefore, this FIS supersedes all previously printed FIS Reports, FHBMs, FBFMs, and FIRMs for all of the incorporated and unincorporated jurisdictions within Humboldt County.

FISs have been conducted for the Cities of Arcata (FEMA, 1983), Blue Lake (FEMA, 1982), Eureka (FEMA, 1982), Fortuna (FEMA, 1982), and Rio Dell (FEMA, 1982).

The USACE has published Flood Plain Information reports on the Eel River from Stafford to Holmes (USACE, 1970), on the Van Duzen River from Alton to upstream of Cummings Creek Camp (USACE, 1973), on the South Fork Eel River from Phillipsville to Garberville (USACE, 1969), and on Freshwater Creek from Myrtle Avenue upstream to the confluence with Graham Gulch (USACE, 1975).

The USACE has determined discharges on the Eel River at Fernbridge. These discharges were based on an analysis of data gathered at the Scotia gage prior to 1968 and transposed to the Fernbridge site (Winzler and Kelly Consulting Engineers, 1970). The discharges determined by the USACE are as follows:

Discharge (cfs)	Recurrence Interval (years)
745,000	100
620,000	50
470,000	20
370,000	10
280,000	5
165,000	2

The State of California has prepared Van Duzen-Waterway Management Plan (State of California, 1977), which presents a 1-percent annual chance floodplain boundary from the mouth of the river to Maple Grove.

The USACE also published a Flood Plain Information report on the South Fork Eel River from Weott to Myers Flat (USACE, 1968). The 1-percent annual chance floodplain boundary delineation in the Flood Plain Information report is contained within Humboldt Redwoods State Park, an area that was not included in this study.

Discharge-frequency curves have been developed by the USACE for the records at the Mad River gage near Arcata (USACE, 1968). The discharges at the gage were calculated using data from 1911-1913 and 1951-1965 adjusted to conditions that reflect the effects of Ruth Dam. In this study, data were analyzed for additional years, 1966-1977. The USACE discharge-frequency values are as follows:

Return Period (years)	Discharge (cfs)
10	60,000
50	89,000
100	100,000
Standard Project Flood	140,000

A report published in 1971 presented a series of storm-drainage master plans for the mid-Humboldt County area (Baruth and Yoder, 1971). In that report, various improvements were proposed in the Jacoby Creek and Freshwater Creek basins. The 1-percent annual chance discharge determined on Freshwater Creek in the area near Myrtle Avenue ranged from 9,300 to 9,800 cfs. On Jacoby Creek, a 1-percent annual chance discharge of 6,700 cfs was determined for the reach from Arcata Bay to Myrtle Avenue.

The U.S. Bureau of Reclamation has published a Flood Plain Information report showing an approximate 1-percent annual chance flood boundary on Trinity River from Junction City to Weithpec (U.S. Department of the Interior, 1979). The detailed-study reach on the Trinity River in this FIS shows a 1-percent annual chance floodplain that is generally more extensive than that shown in the Flood Plain Information report over the same area. A 1-percent annual chance peak discharge of 195,000 cfs and a 1-percent annual chance flood elevation of 456 feet were developed at Willow Creek in the U.S. Bureau of Reclamation report.

The USACE performed hydrologic analysis, hydraulic analysis, and floodplain mapping for FEMA Task Order #0002: Digital FIRM Production Support, Redwood Creek Restudy, and was completed in March of 2009. The hydrologic analysis was performed by the USACE in September 2007 and is documented in the report "Redwood Creek Humboldt County Design Flow Re-Analysis." Hydraulic analysis and floodplain mapping were conducted from its confluence with the Pacific Ocean to a point approximately 3.5 miles upstream near Orick, California for the 10-percent, 2-percent, 1-percent, and 0.2-percent-annual-chance discharge events, using the Hydrologic Engineering Center's River Analysis System (HEC-RAS Version 4.0) program, the Hydrologic Engineering Center's GeoRAS (Version 4.1.1) program, and ESRI's ArcMap (Version 9.2) program. Data was acquired from Humboldt County Public Works, the California Department of Transportation (Caltrans), and the National Park Service (NPS) in order to create hydraulic models in HEC-RAS and plot floodplains in ArcMap. (USACE, 2009)

8.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this FIS can be obtained by contacting FEMA, Federal Insurance and Mitigation Division, 1111 Broadway, Suite 1200, Oakland, California 94607-4052.

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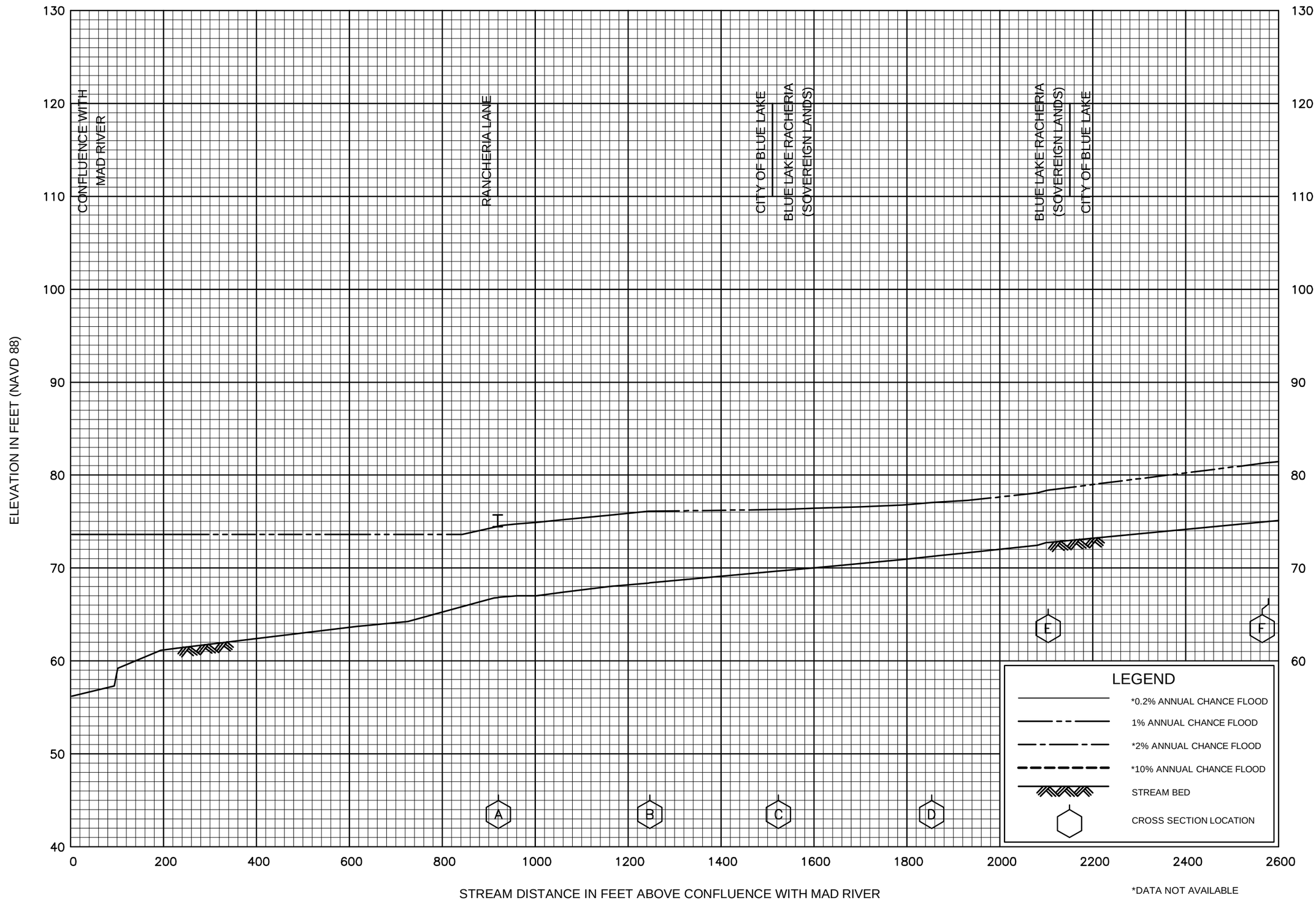


FLOOD PROFILES

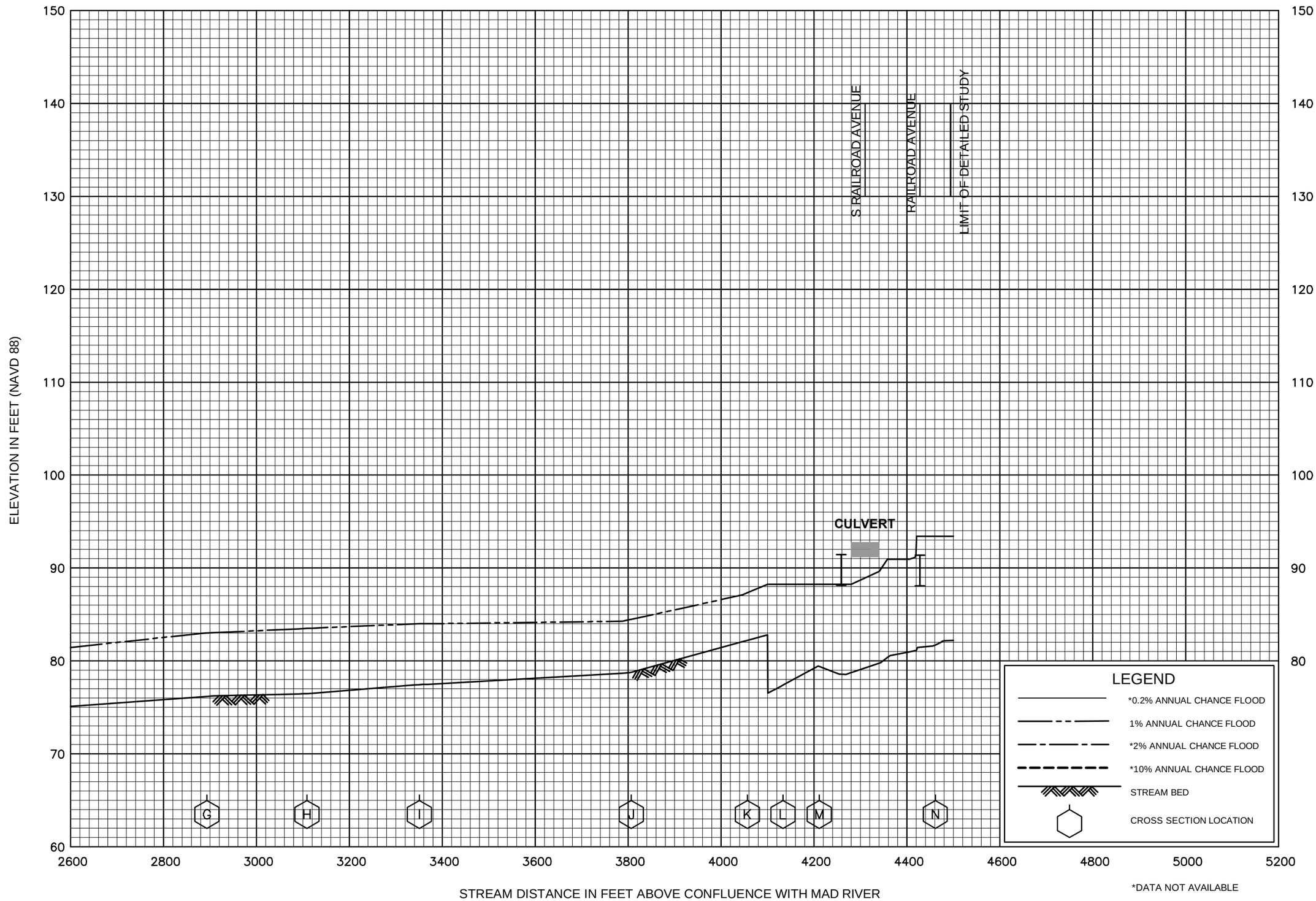
DAVE POWER'S CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS

01P



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FLOOD PROFILES

DAVE POWER'S CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS

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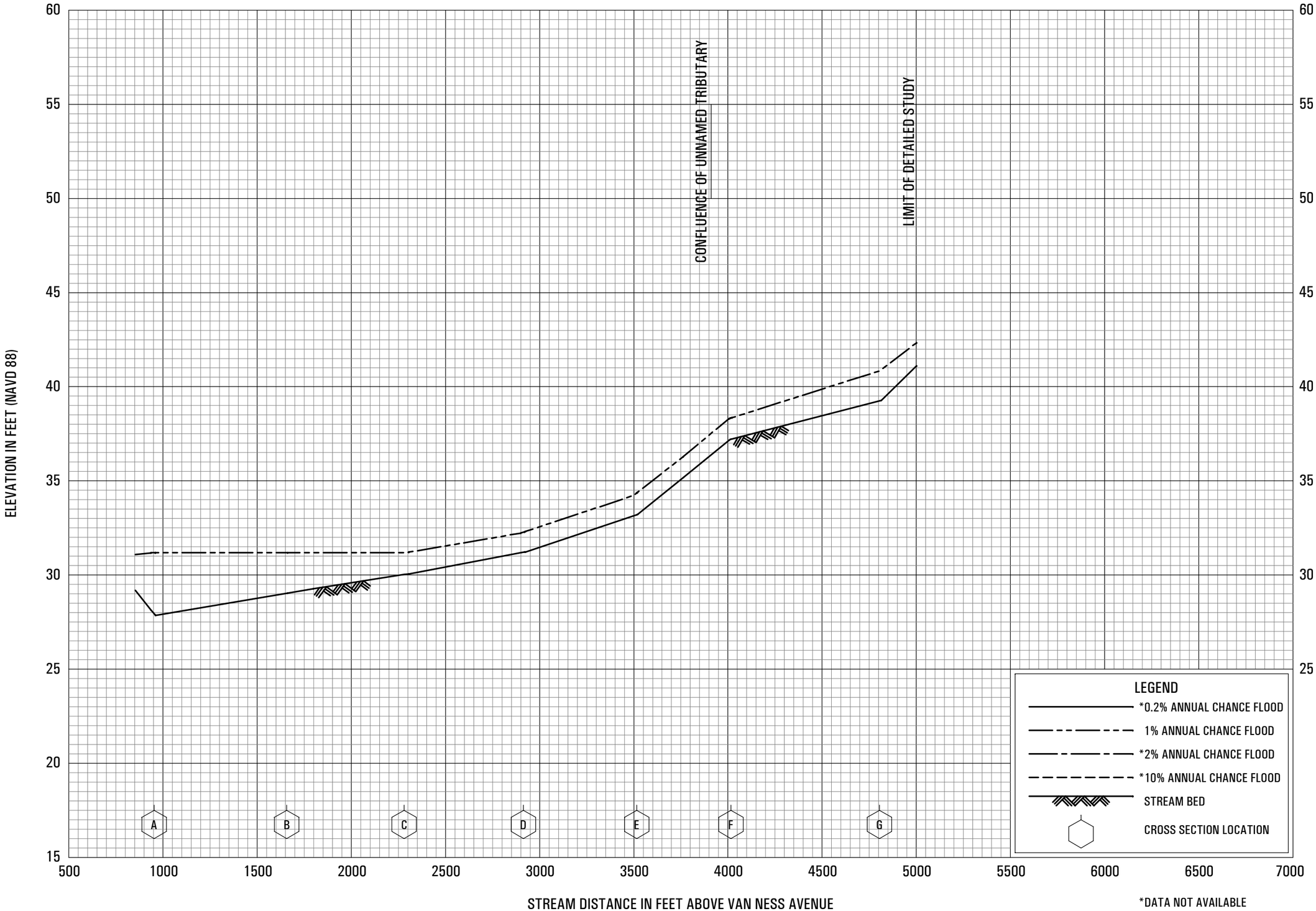

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FLOOD PROFILES

EASTSIDE CHANNEL

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS

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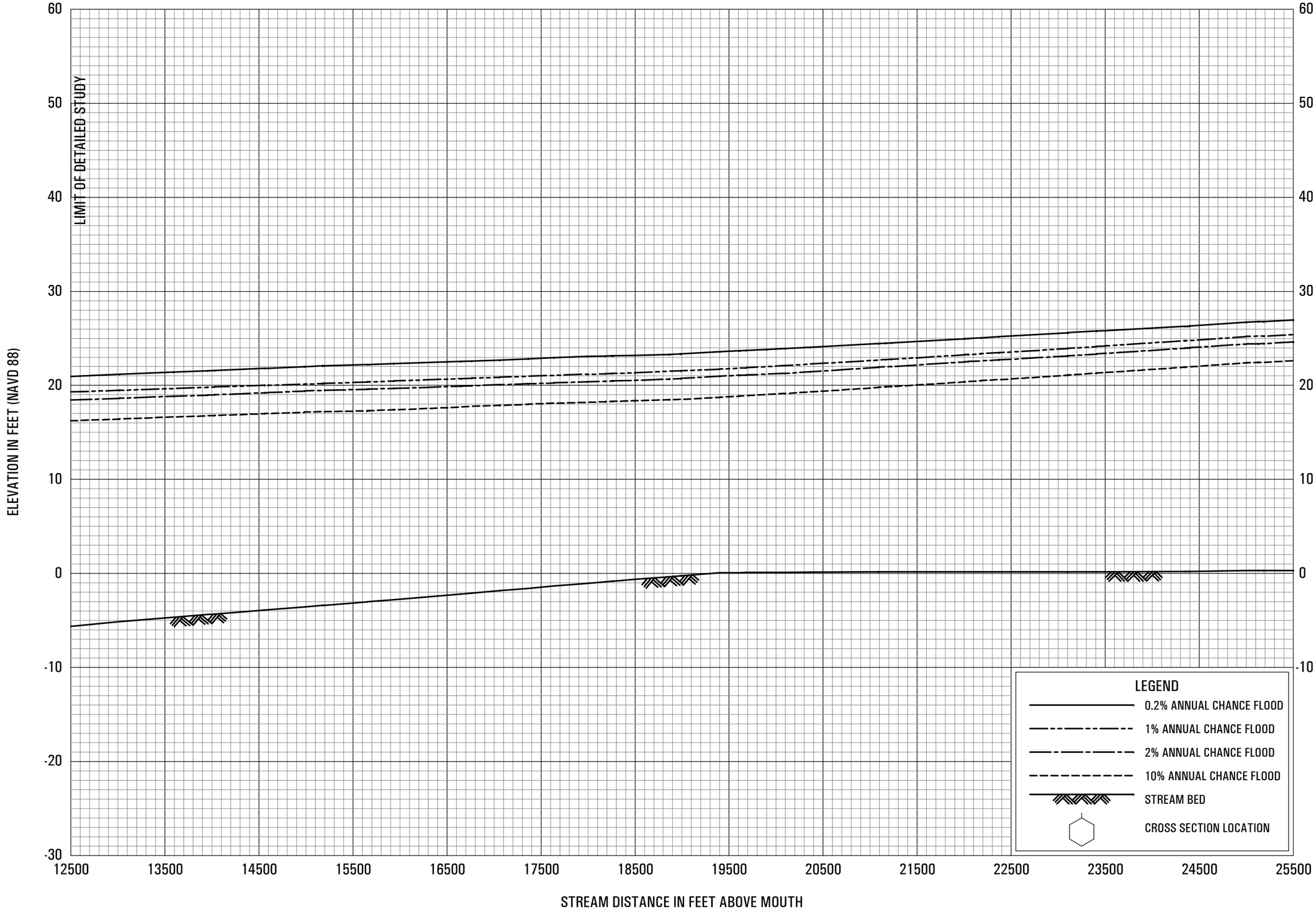


FLOOD PROFILES

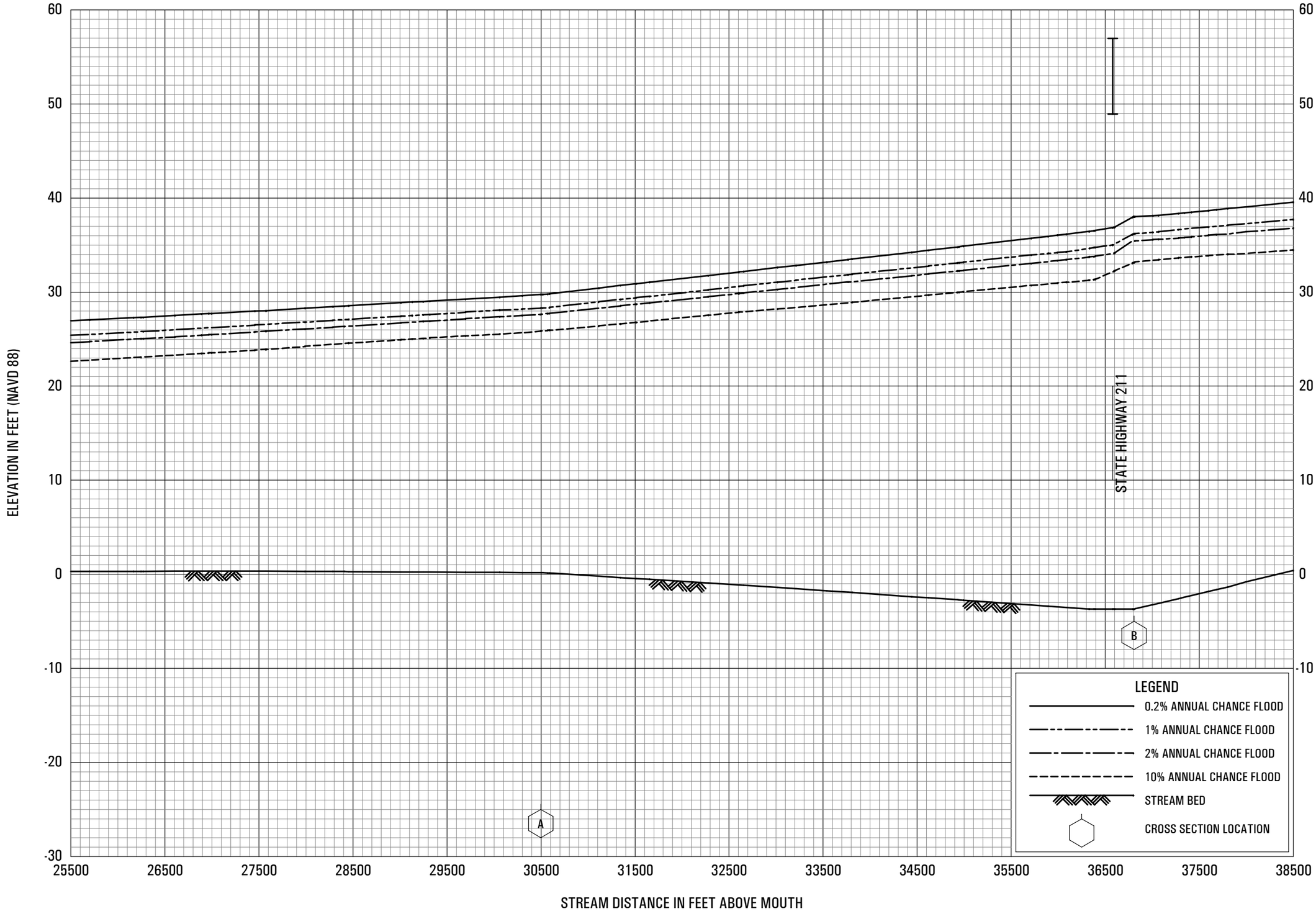
EEL RIVER (FERNDALE TO FORTUNA)

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS

04P



FLOOD PROFILES

EEL RIVER (FERNDALE TO FORTUNA)

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS

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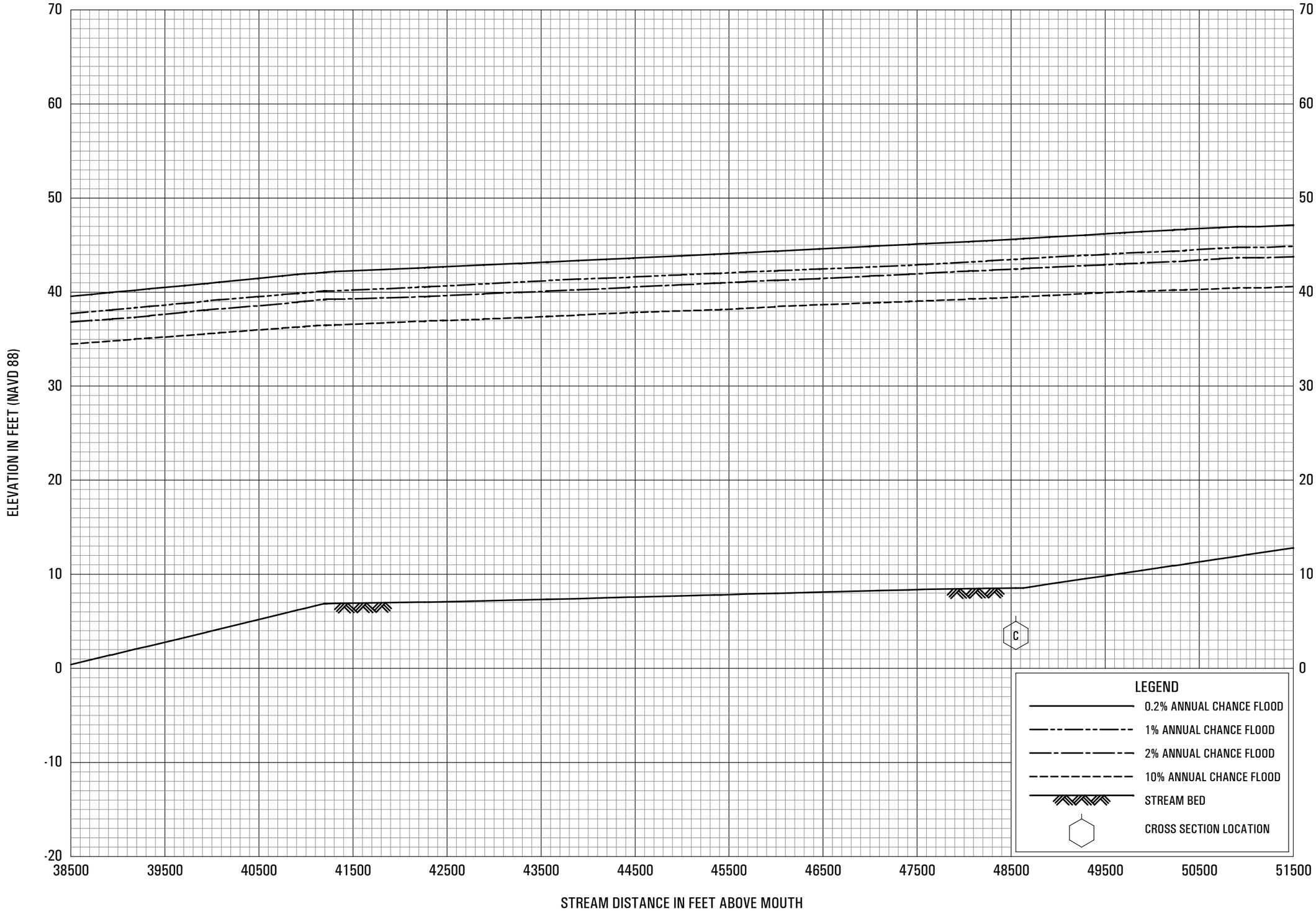

FLOOD PROFILES

EEL RIVER (FERNDALE TO FORTUNA)

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS

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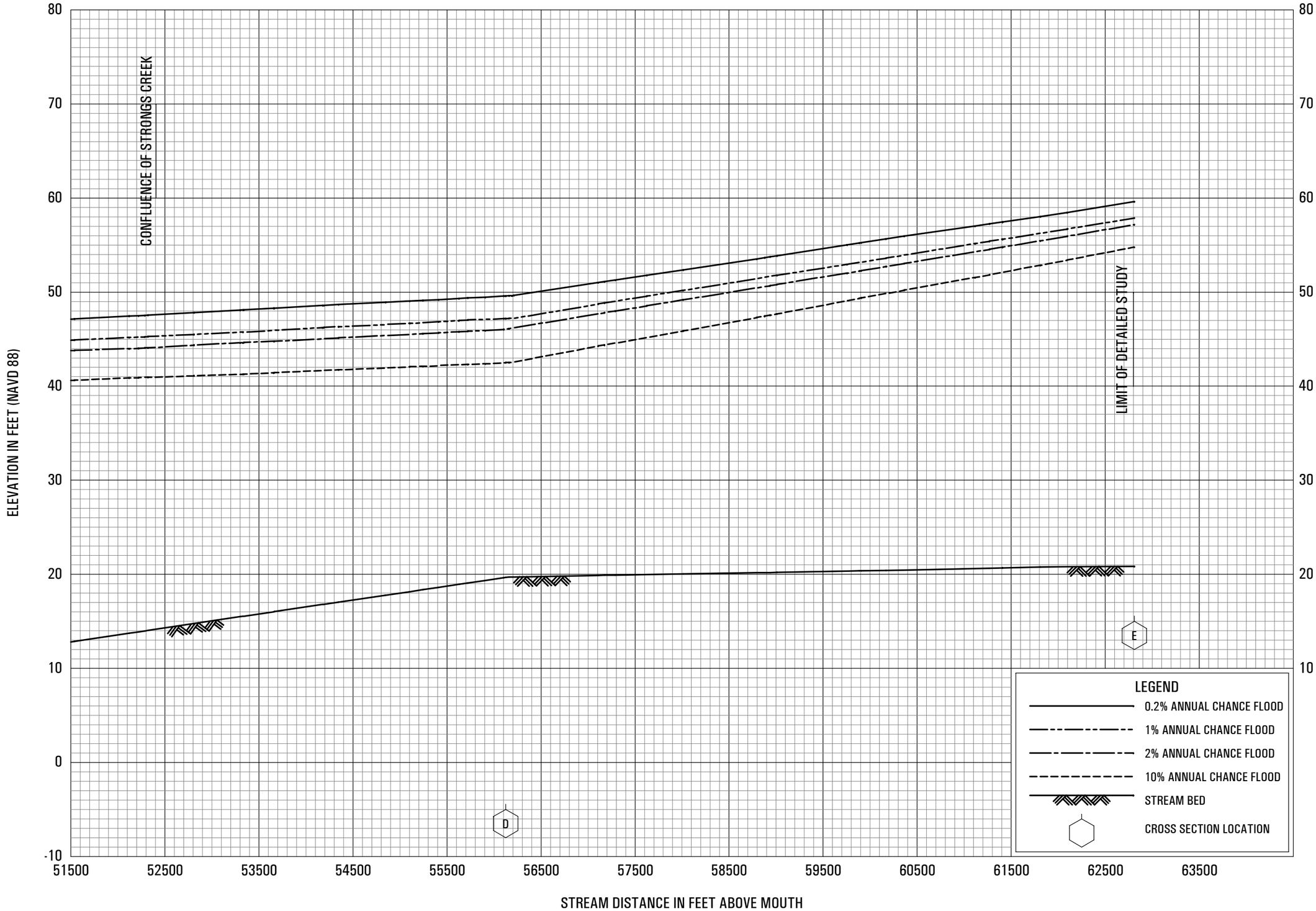

FLOOD PROFILES

EEL RIVER (FERNDALE TO FORTUNA)

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS

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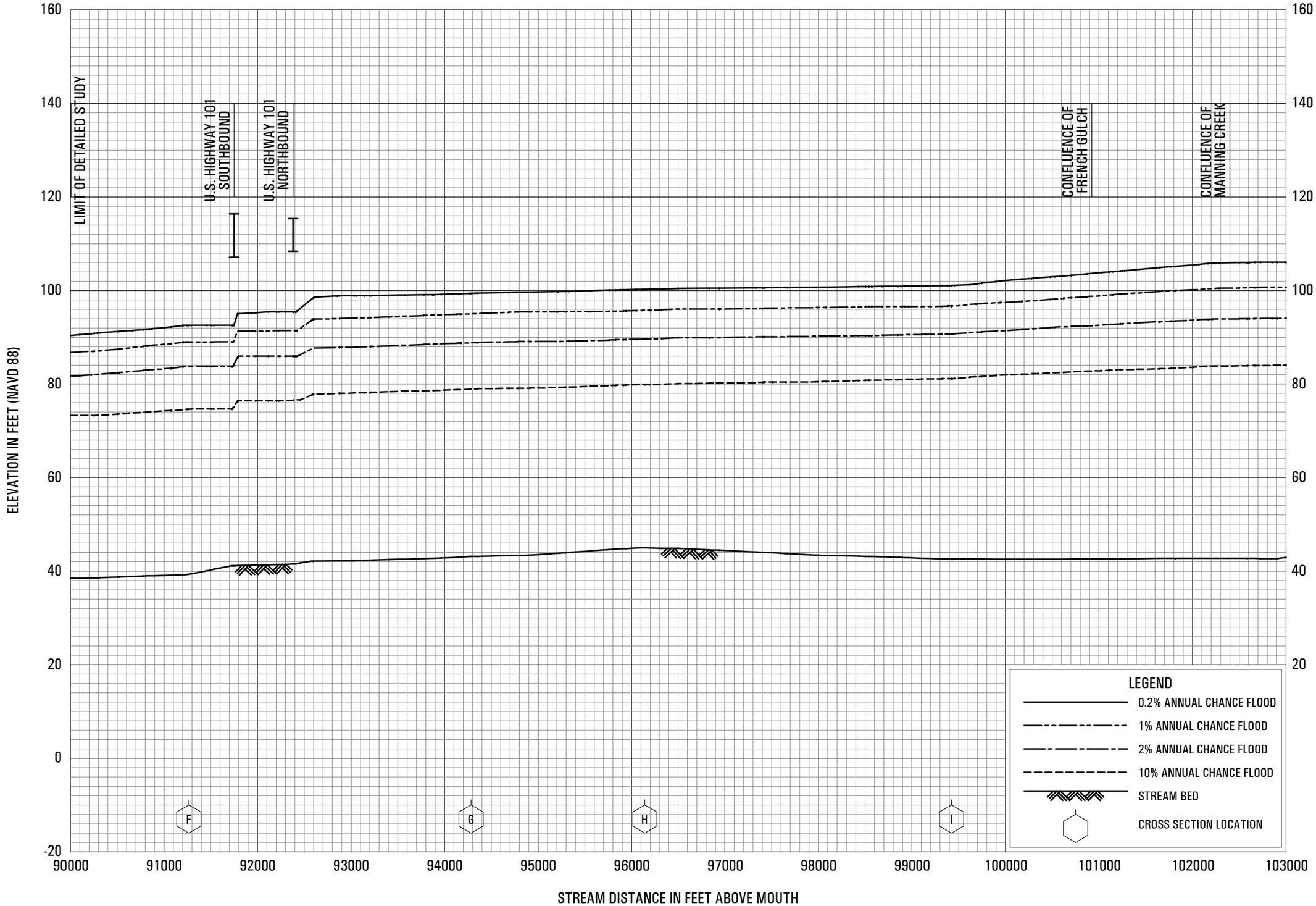

FLOOD PROFILES

EEL RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS

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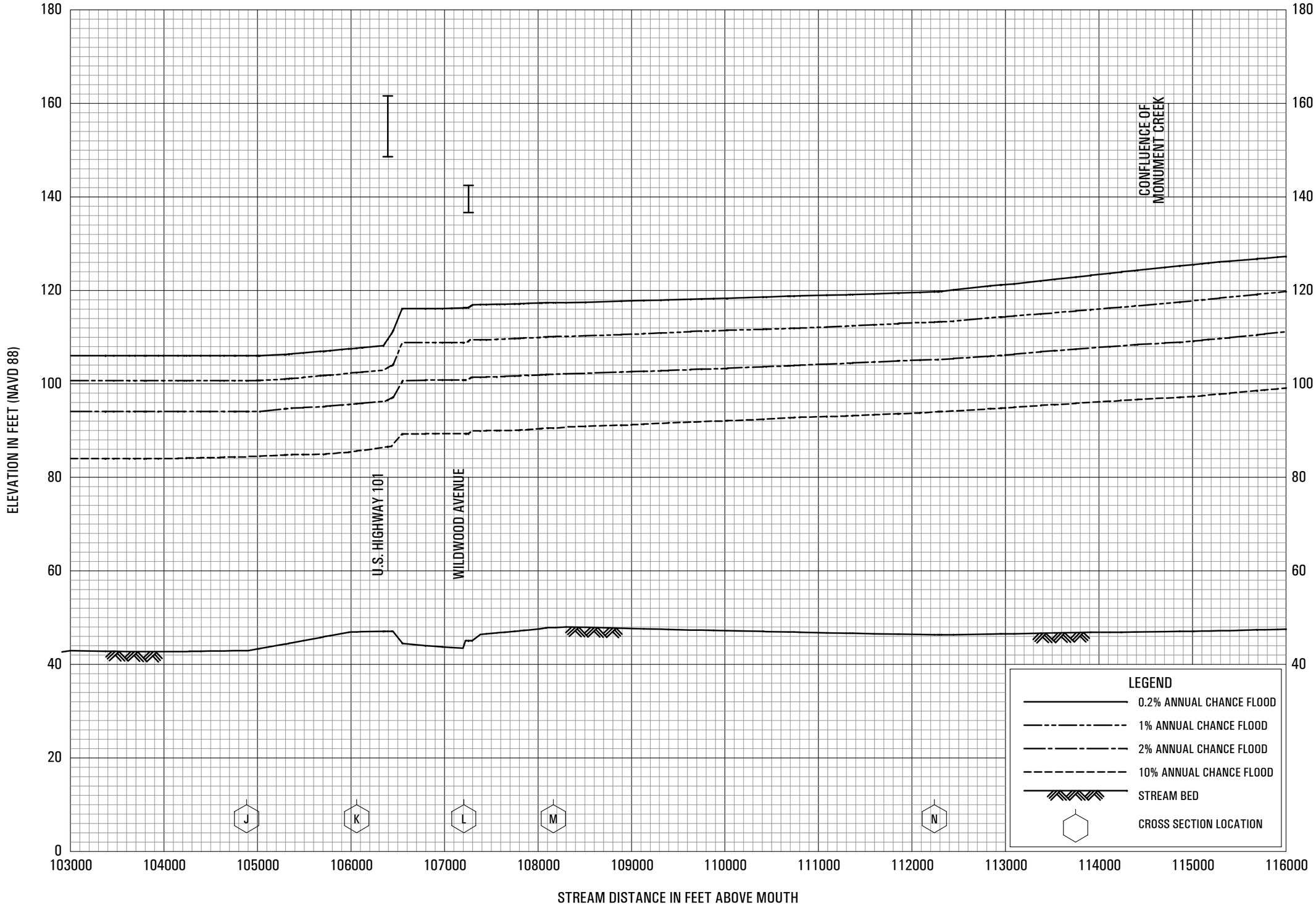

FLOOD PROFILES

EEL RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS

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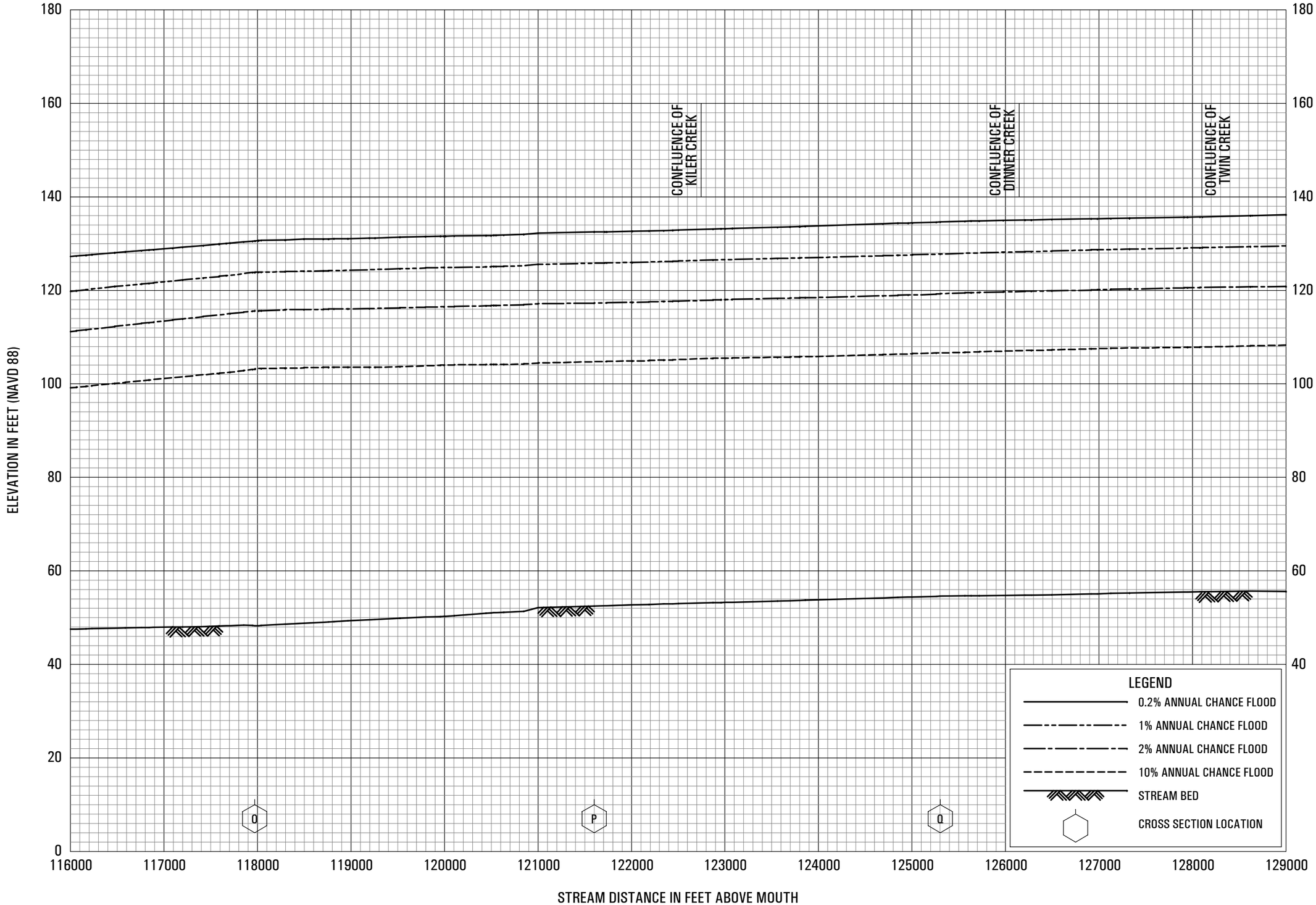

FLOOD PROFILES

EEL RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

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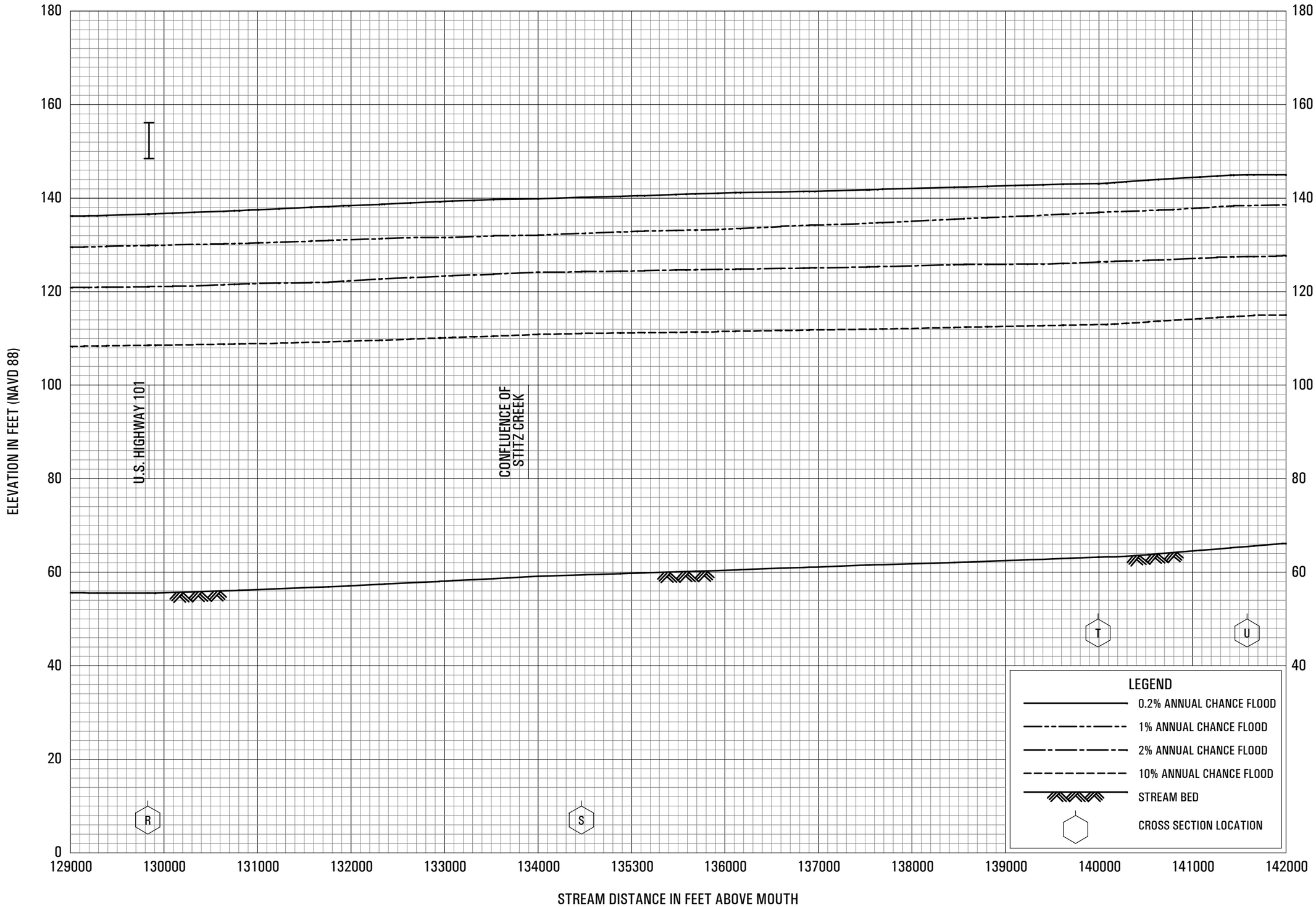

FLOOD PROFILES

EEL RIVER

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HUMBOLDT COUNTY, CA

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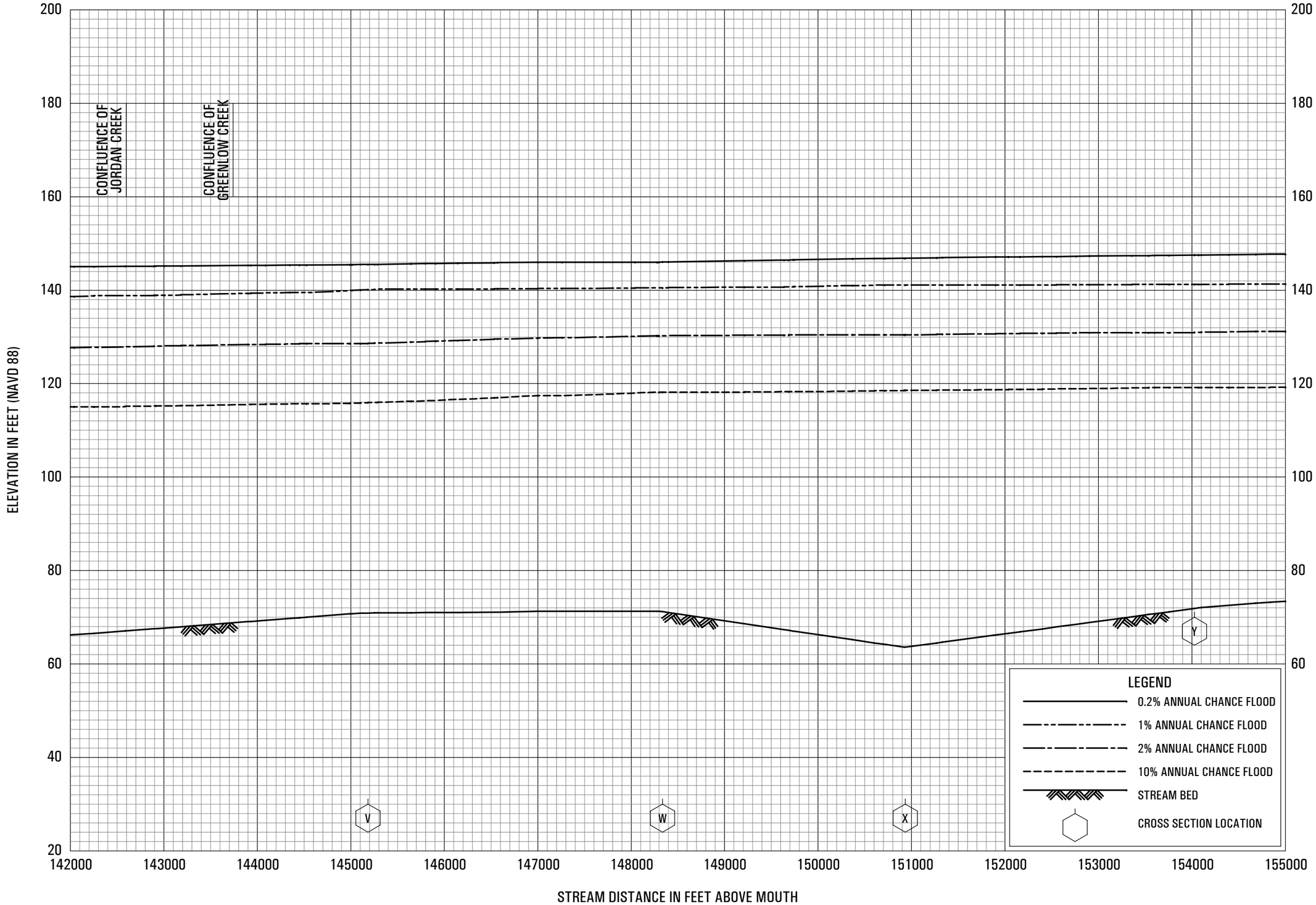

FLOOD PROFILES

EEL RIVER

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HUMBOLDT COUNTY, CA

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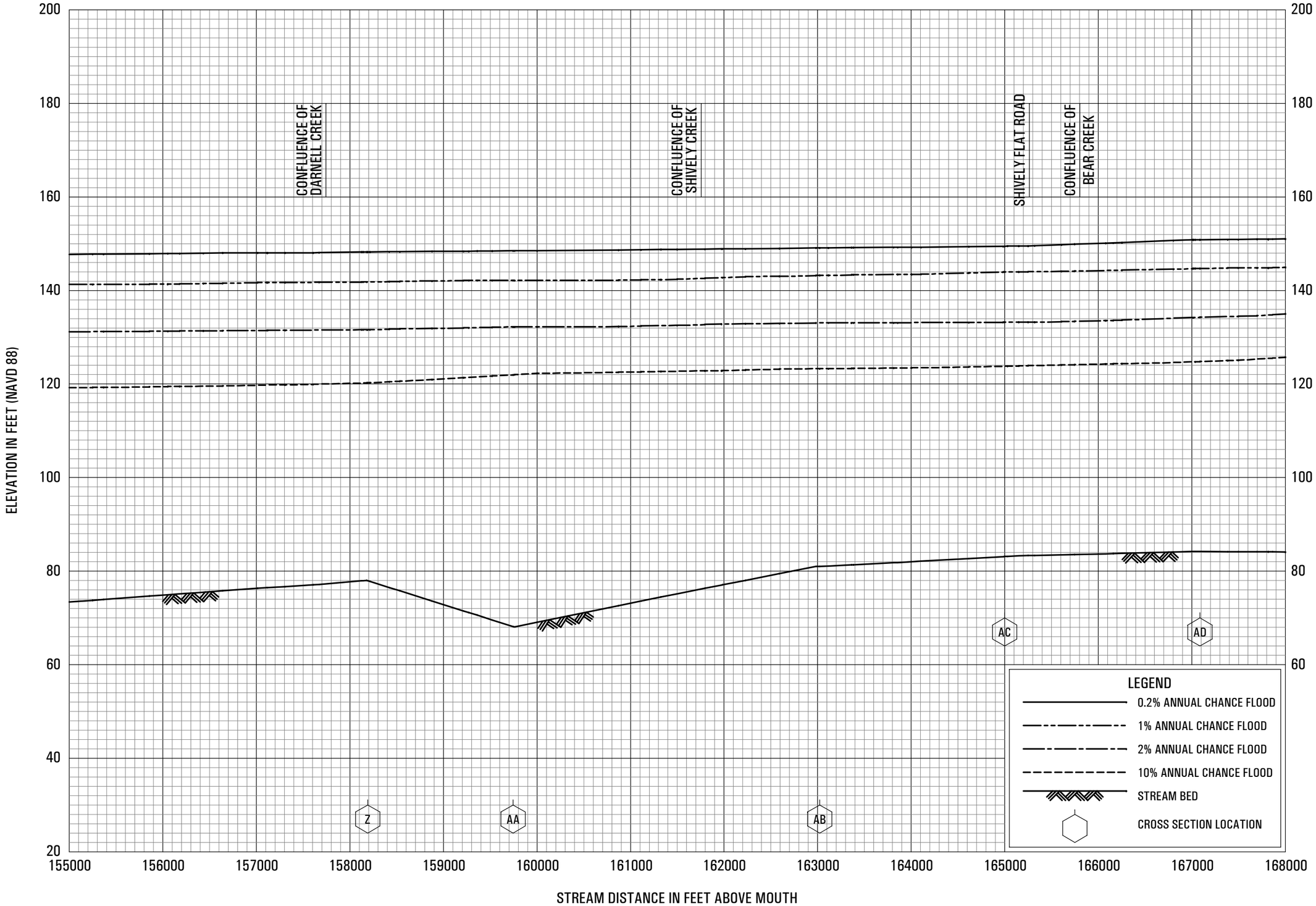

FLOOD PROFILES

EEL RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

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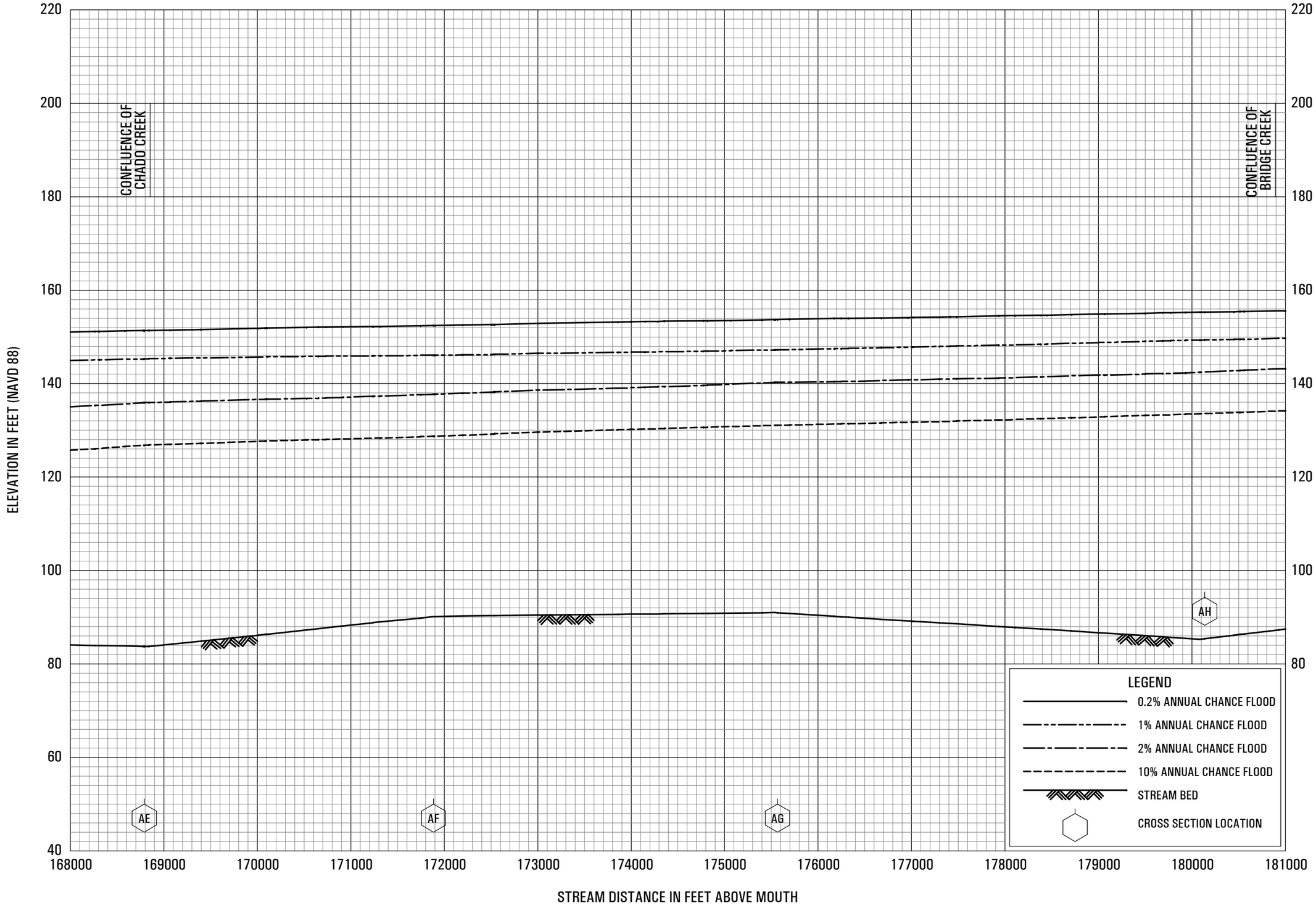

FLOOD PROFILES

EEL RIVER

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HUMBOLDT COUNTY, CA

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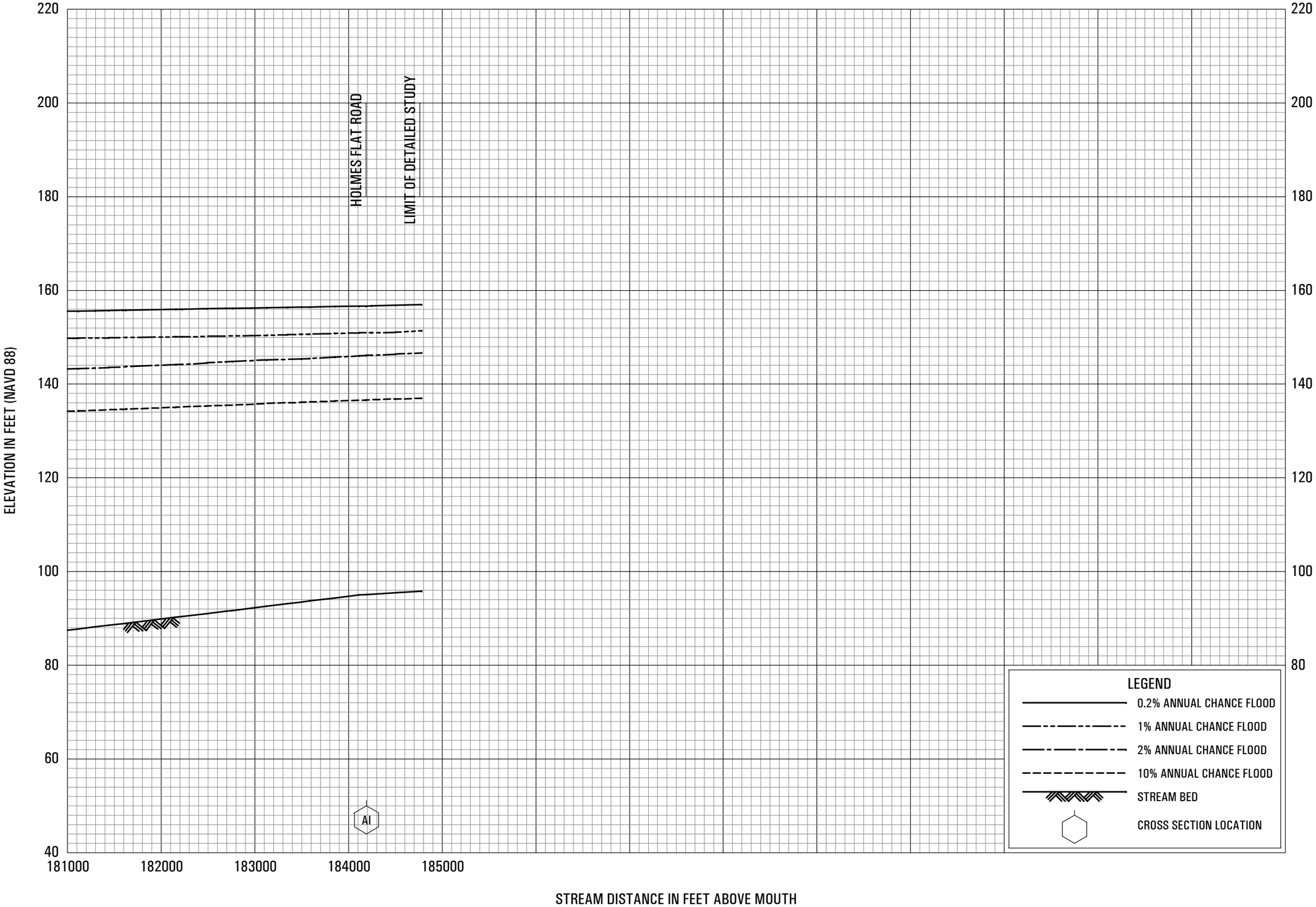


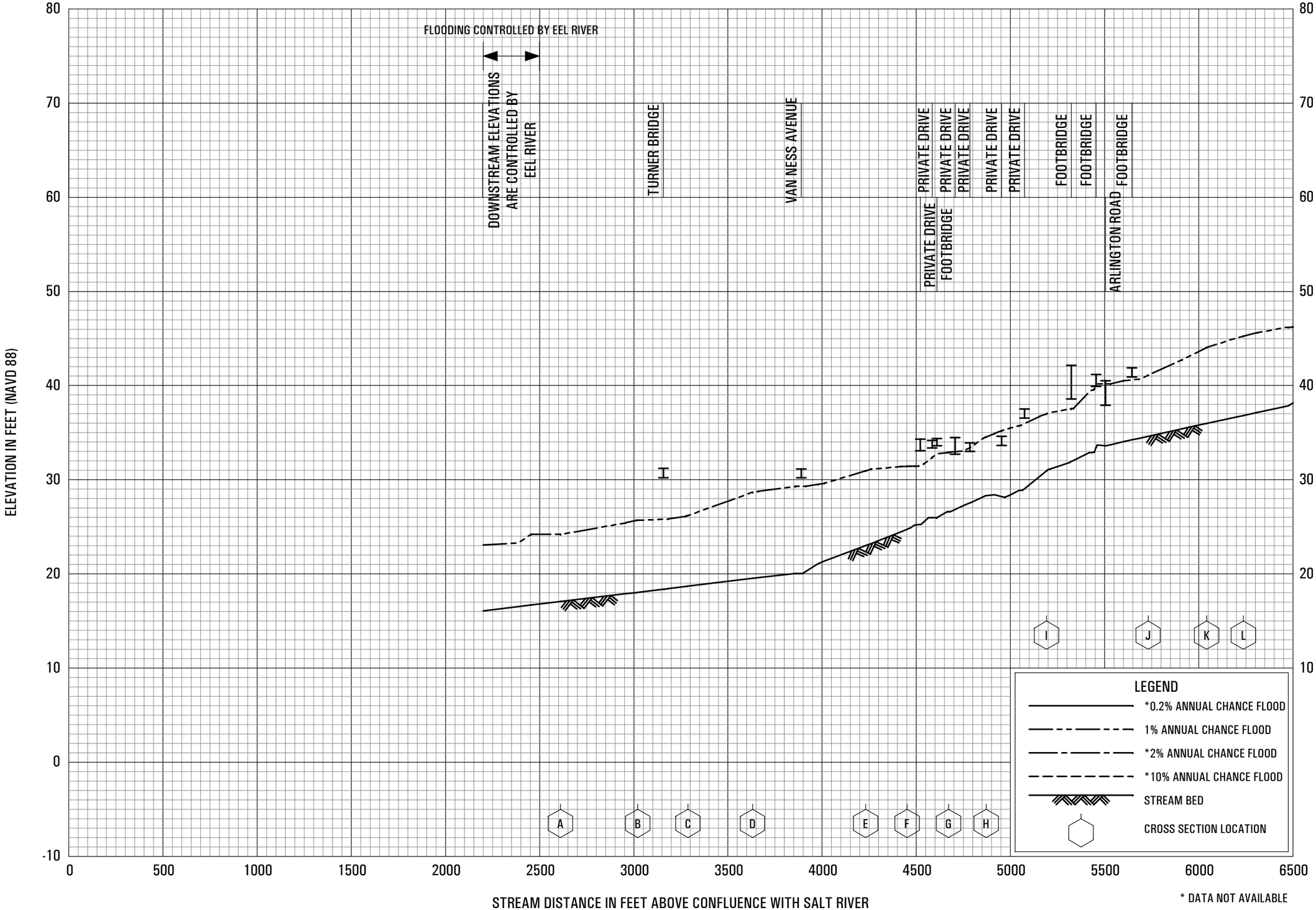
FLOOD PROFILES

EEL RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS



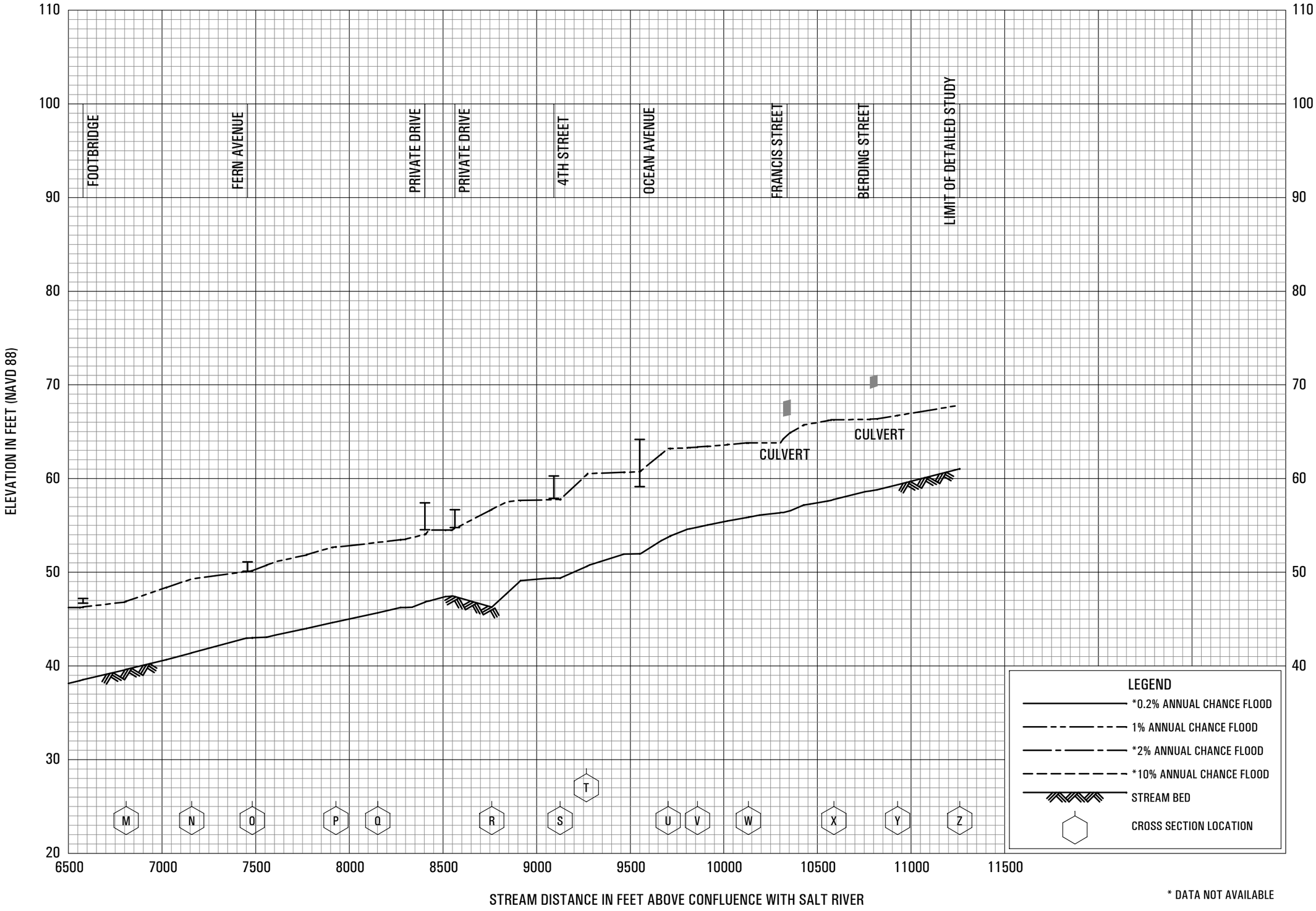
FLOOD PROFILES

FRANCIS CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS



* DATA NOT AVAILABLE

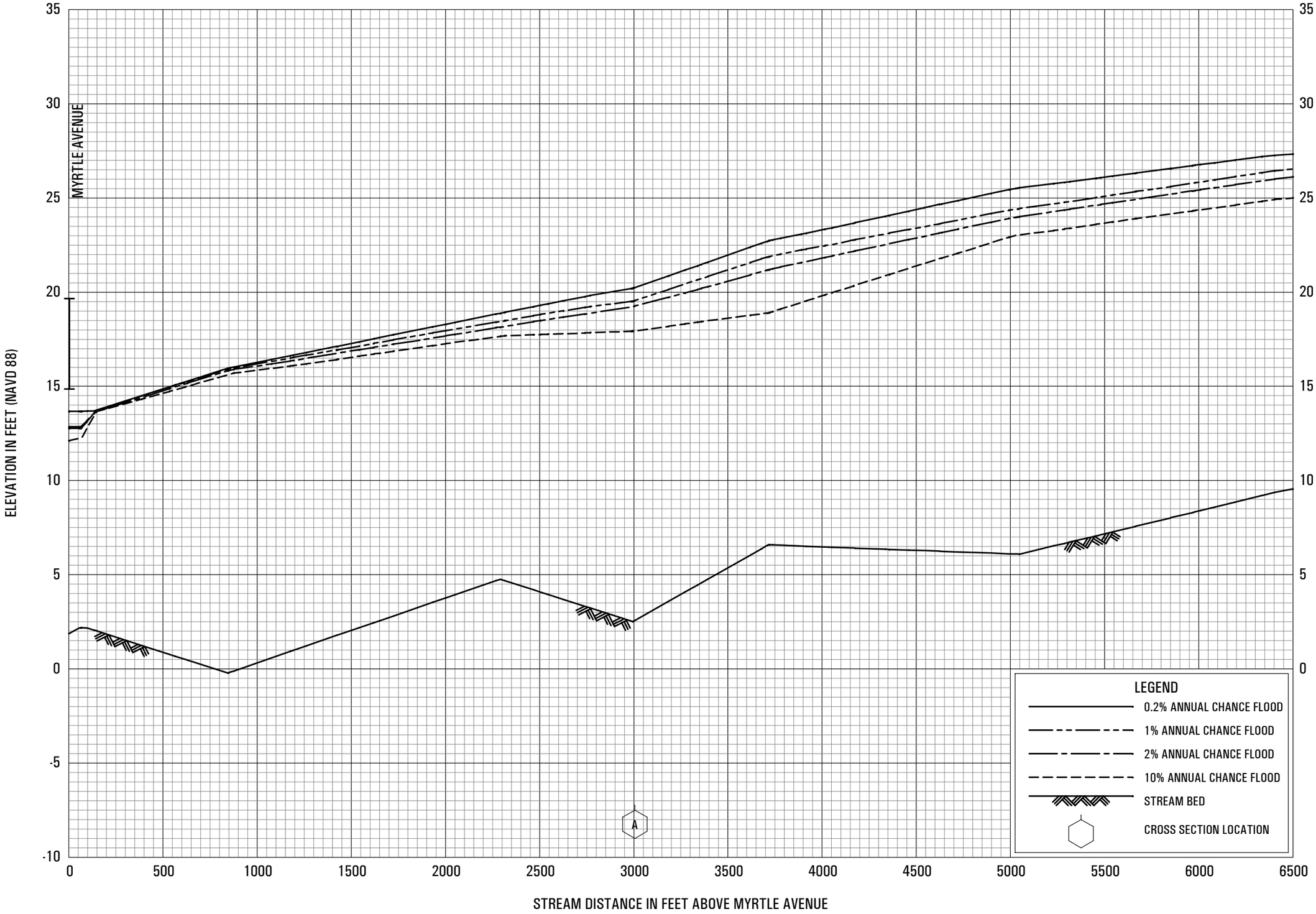
FLOOD PROFILES

FRANCIS CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS



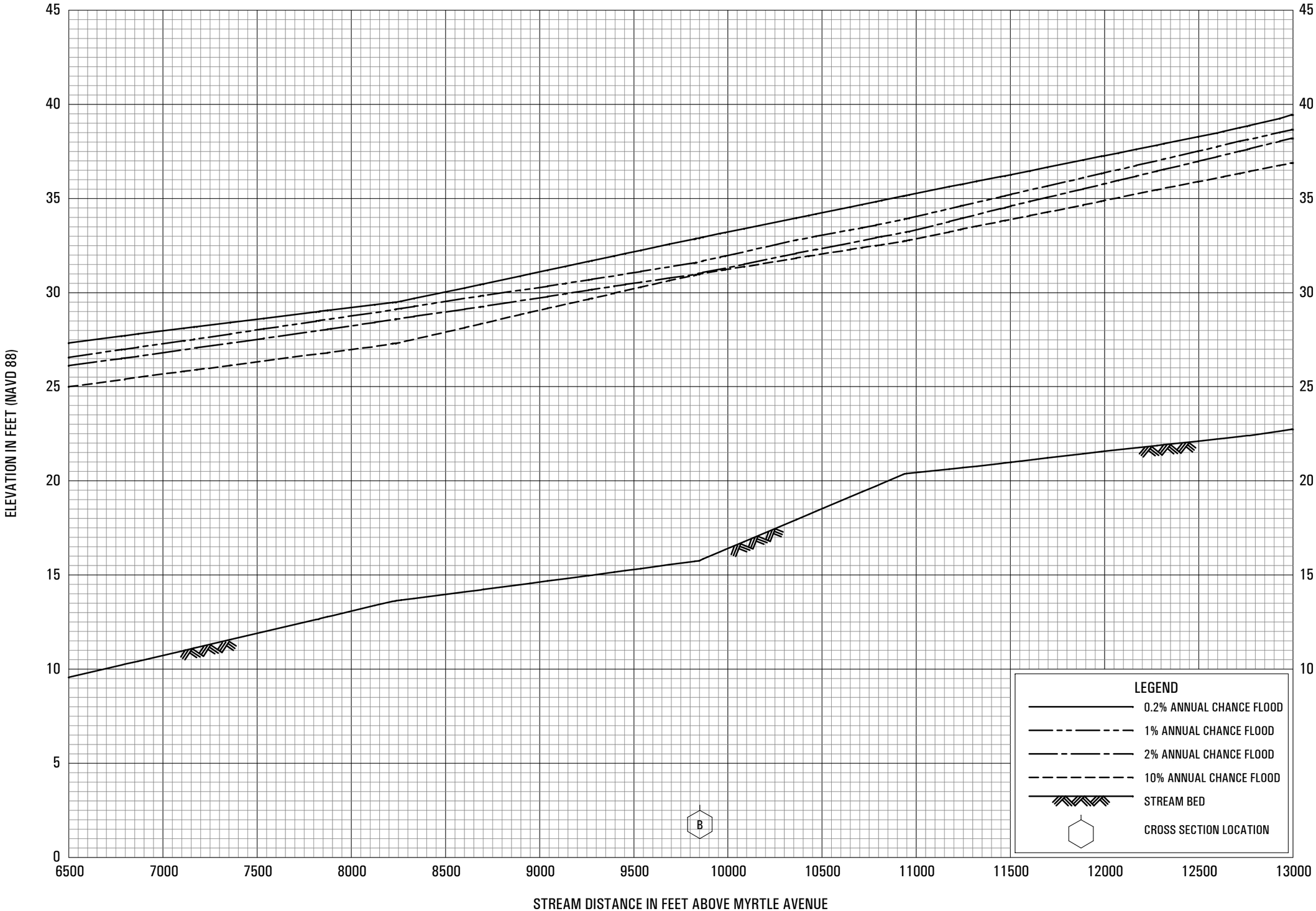
FLOOD PROFILES

FRESHWATER CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS



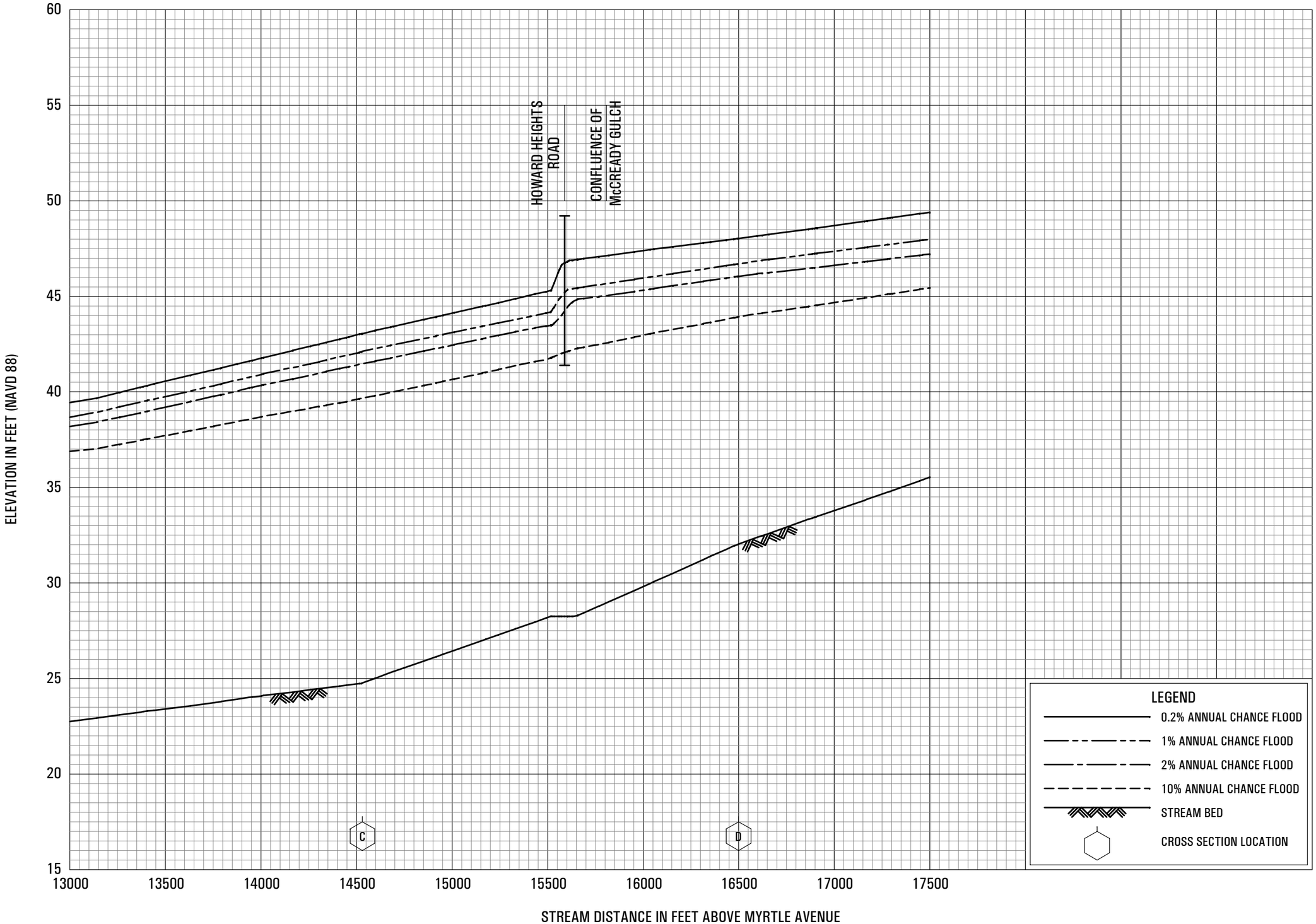
FLOOD PROFILES

FRESHWATER CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS



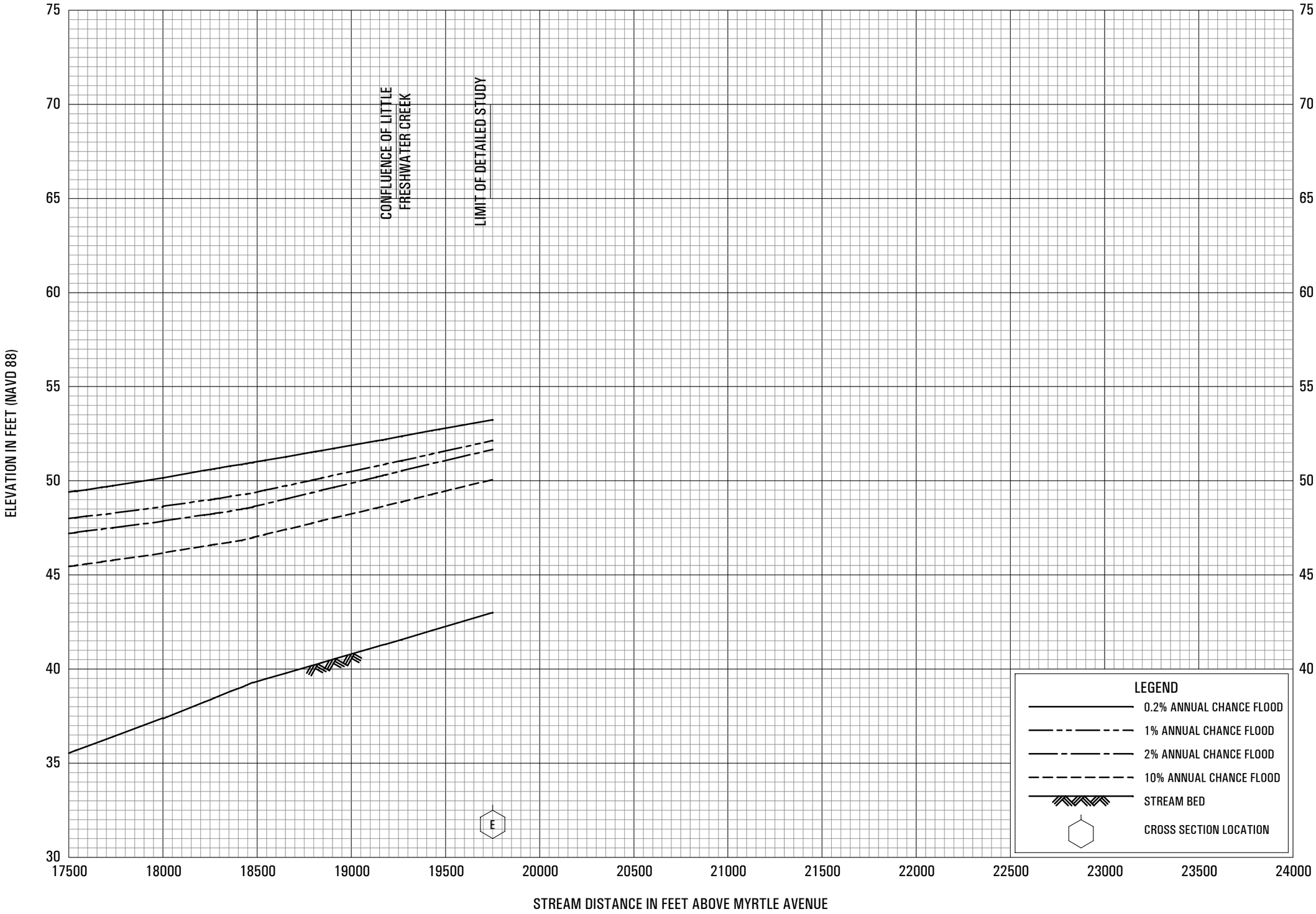
FLOOD PROFILES

FRESHWATER CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS



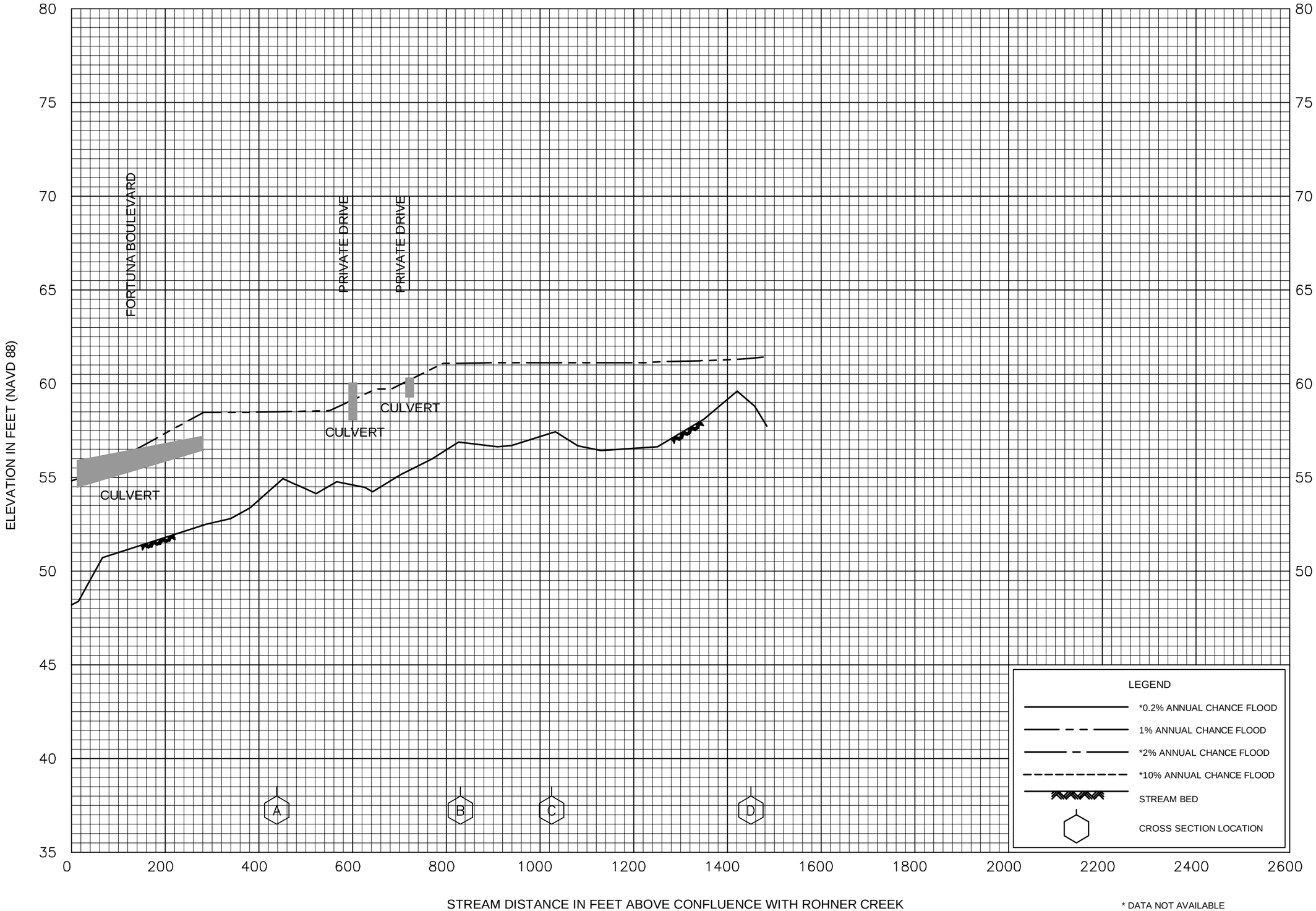
FLOOD PROFILES

FRESHWATER CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS



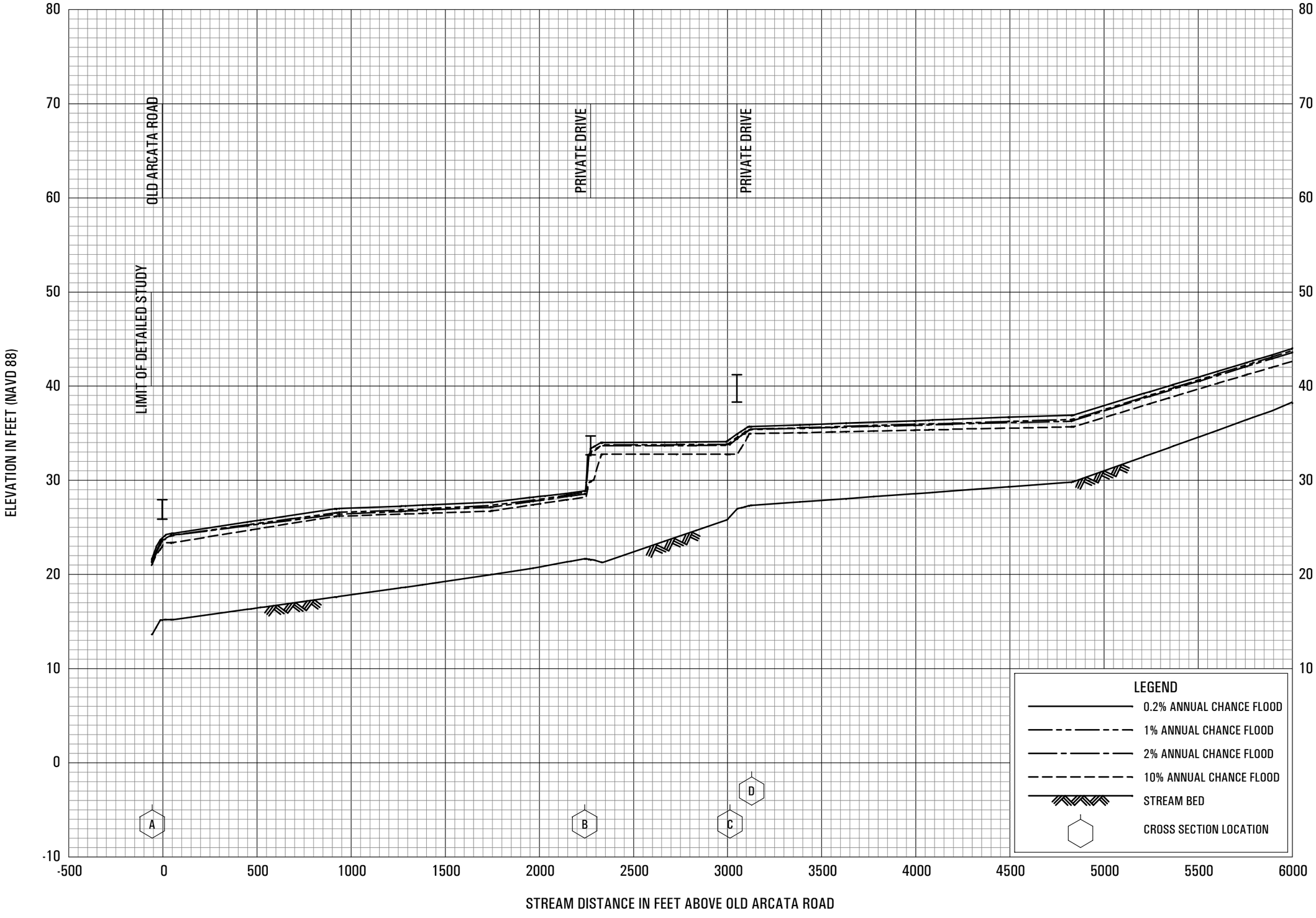
FLOOD PROFILES

HILLSIDE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS



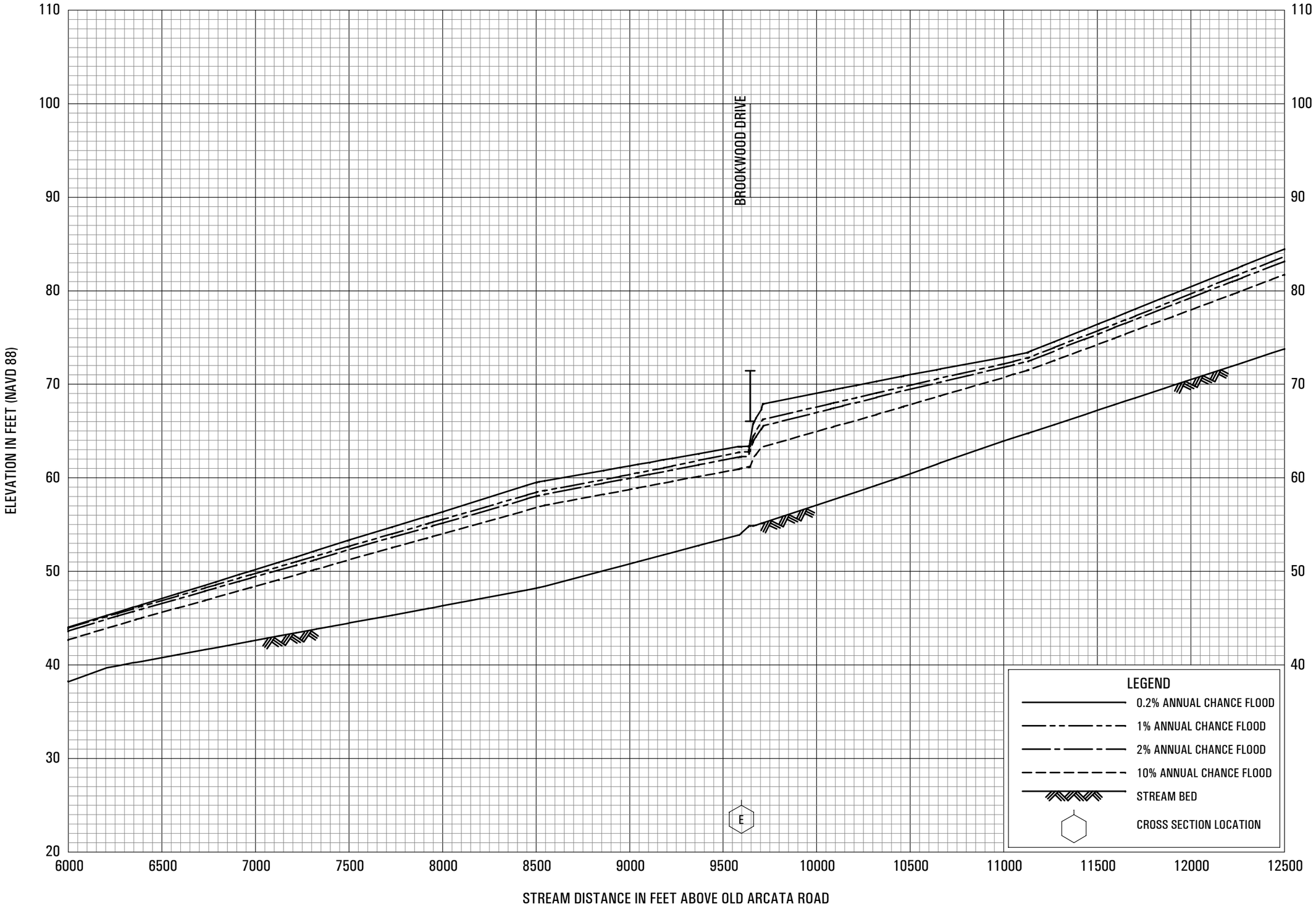
FLOOD PROFILES

JACOBY CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS



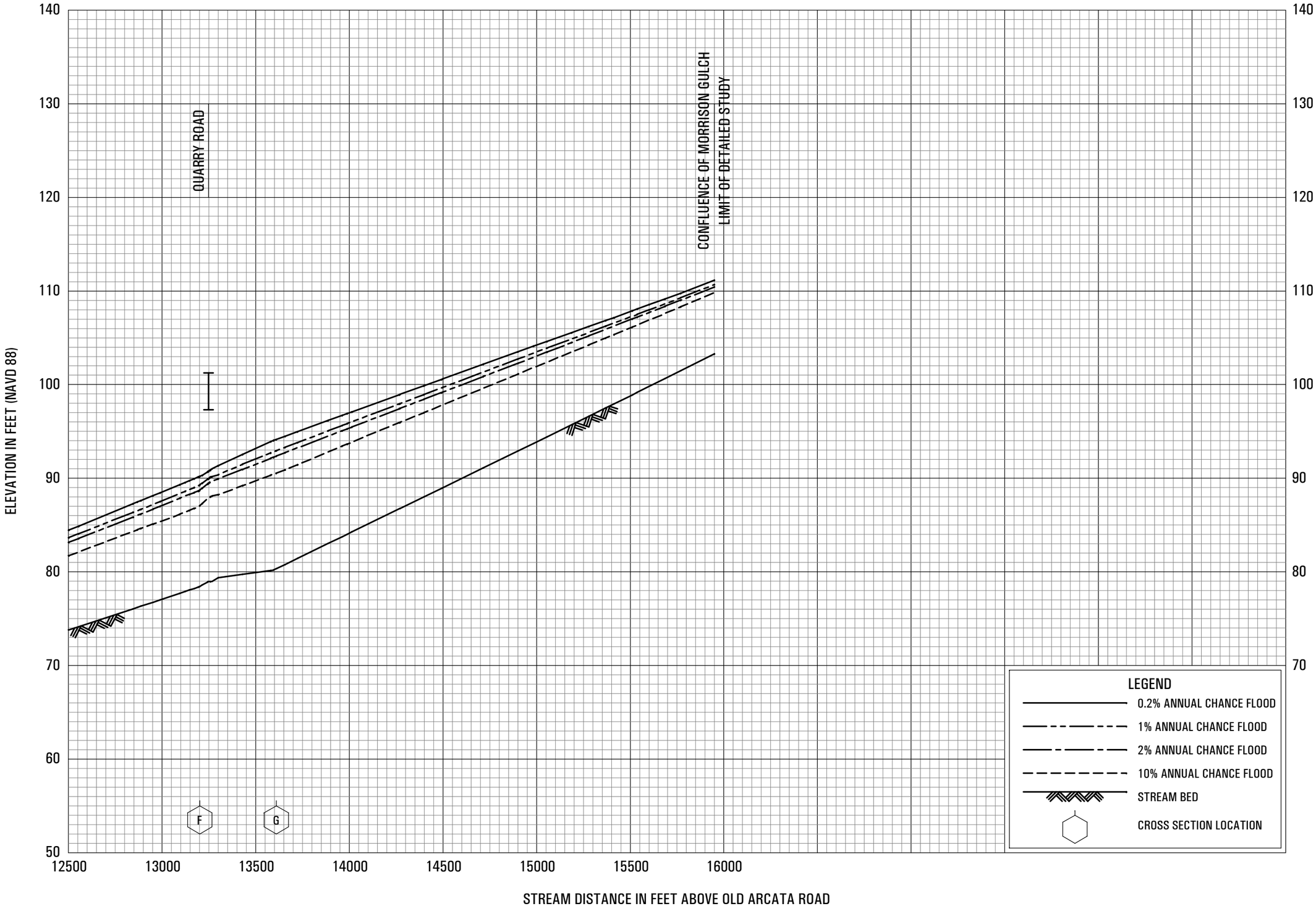
FLOOD PROFILES

JACOBY CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS



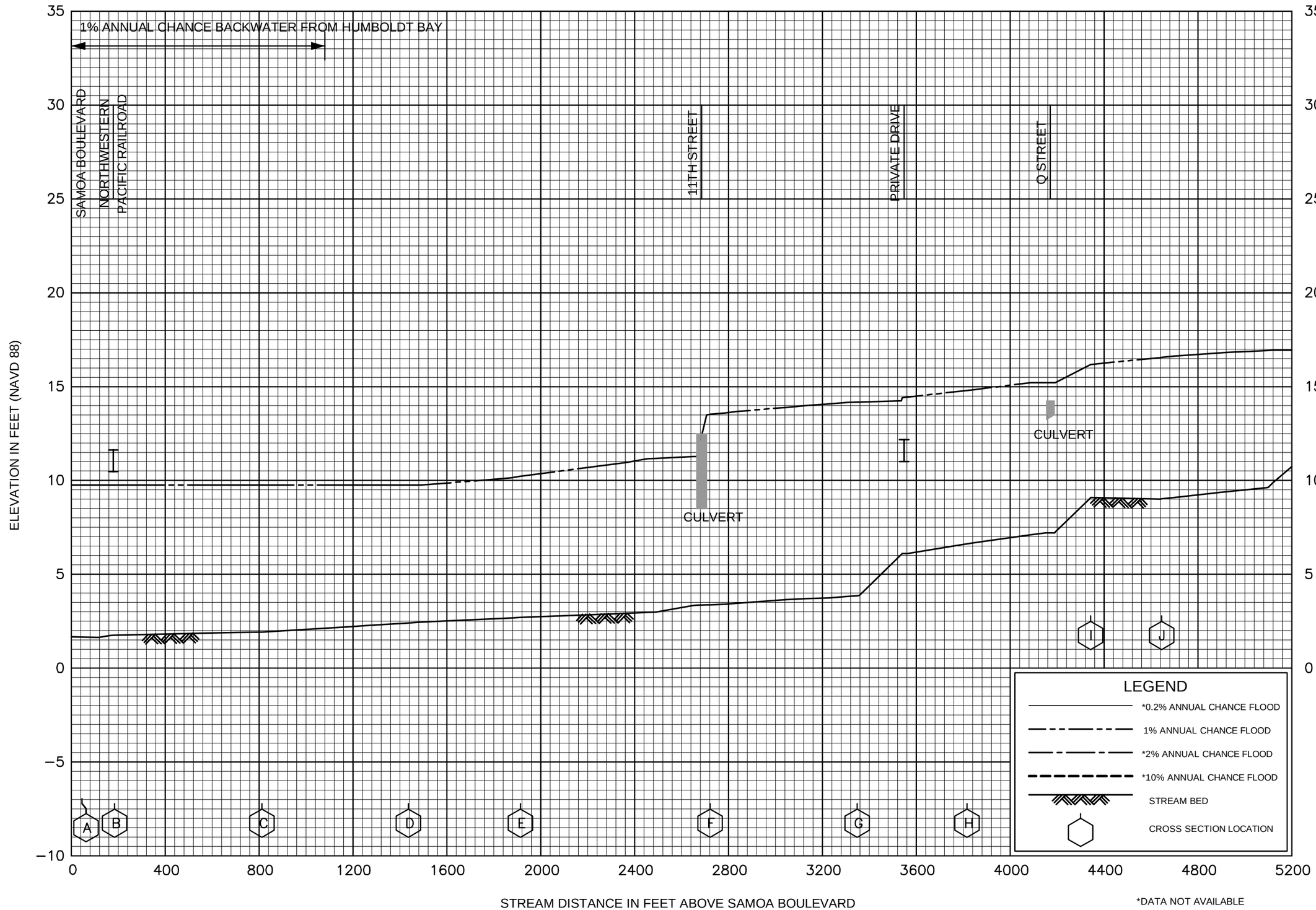
FLOOD PROFILES

JACOBY CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS



*DATA NOT AVAILABLE

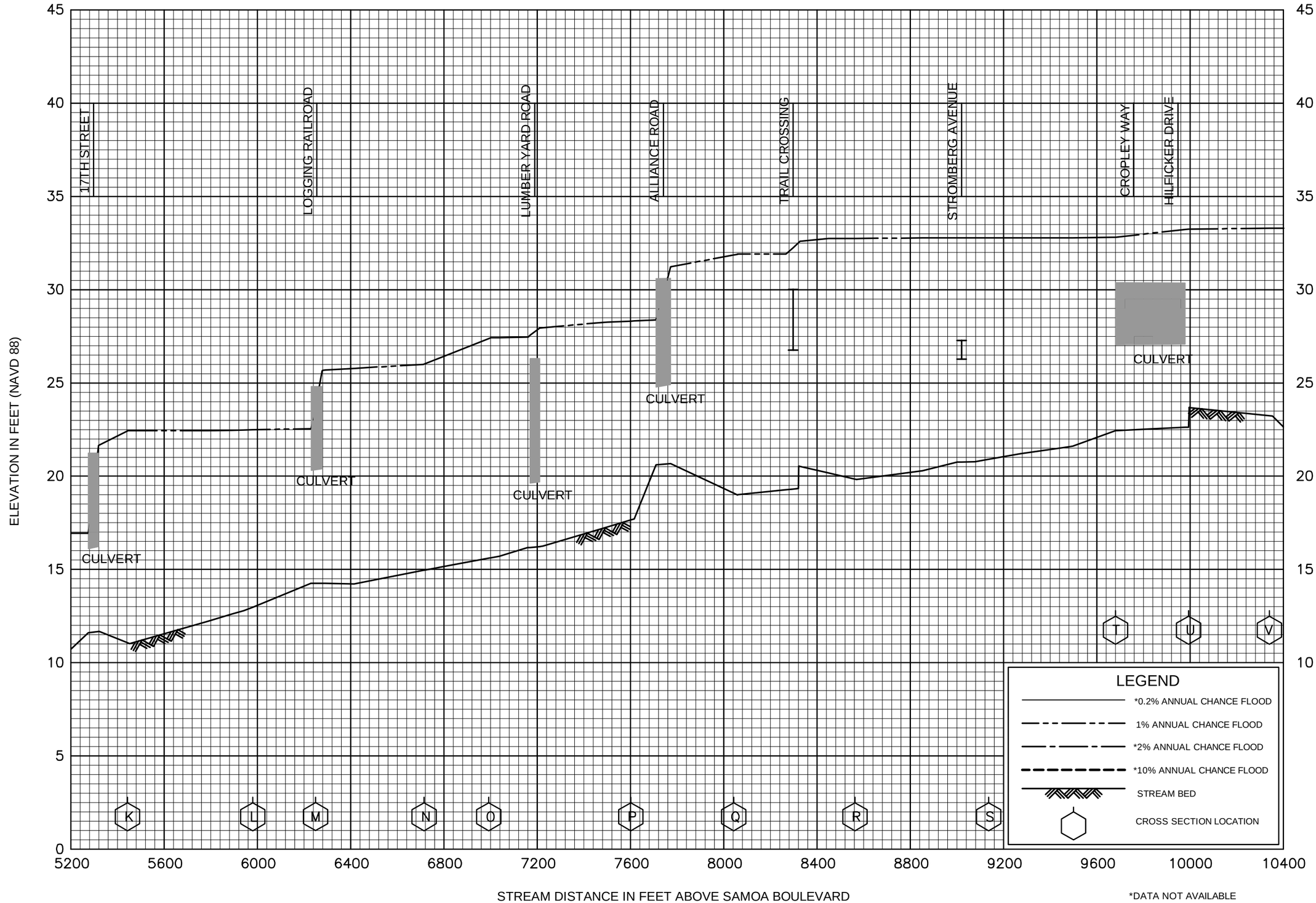
FLOOD PROFILES

JANES CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED ARES



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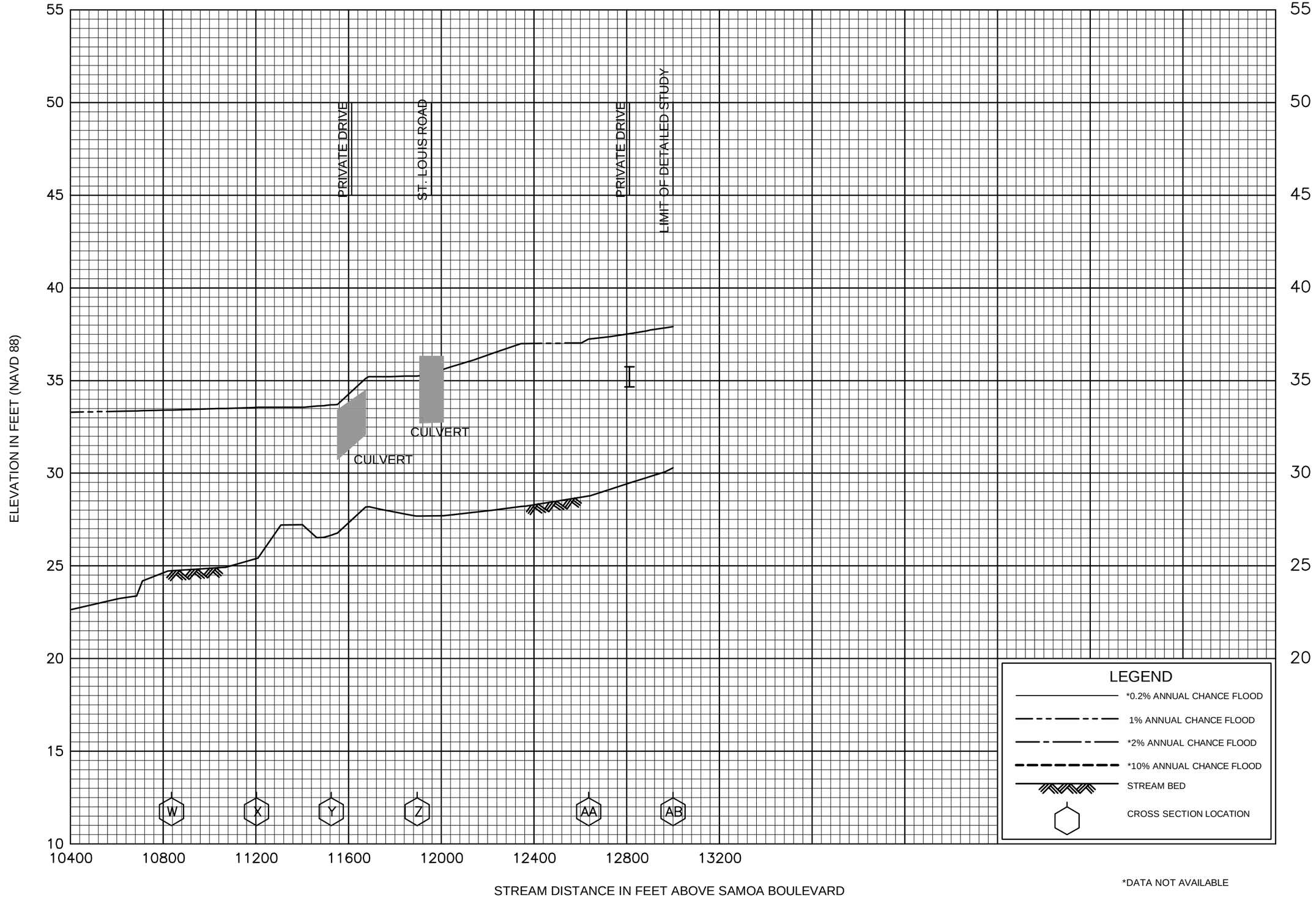
FLOOD PROFILES

JANES CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED ARES



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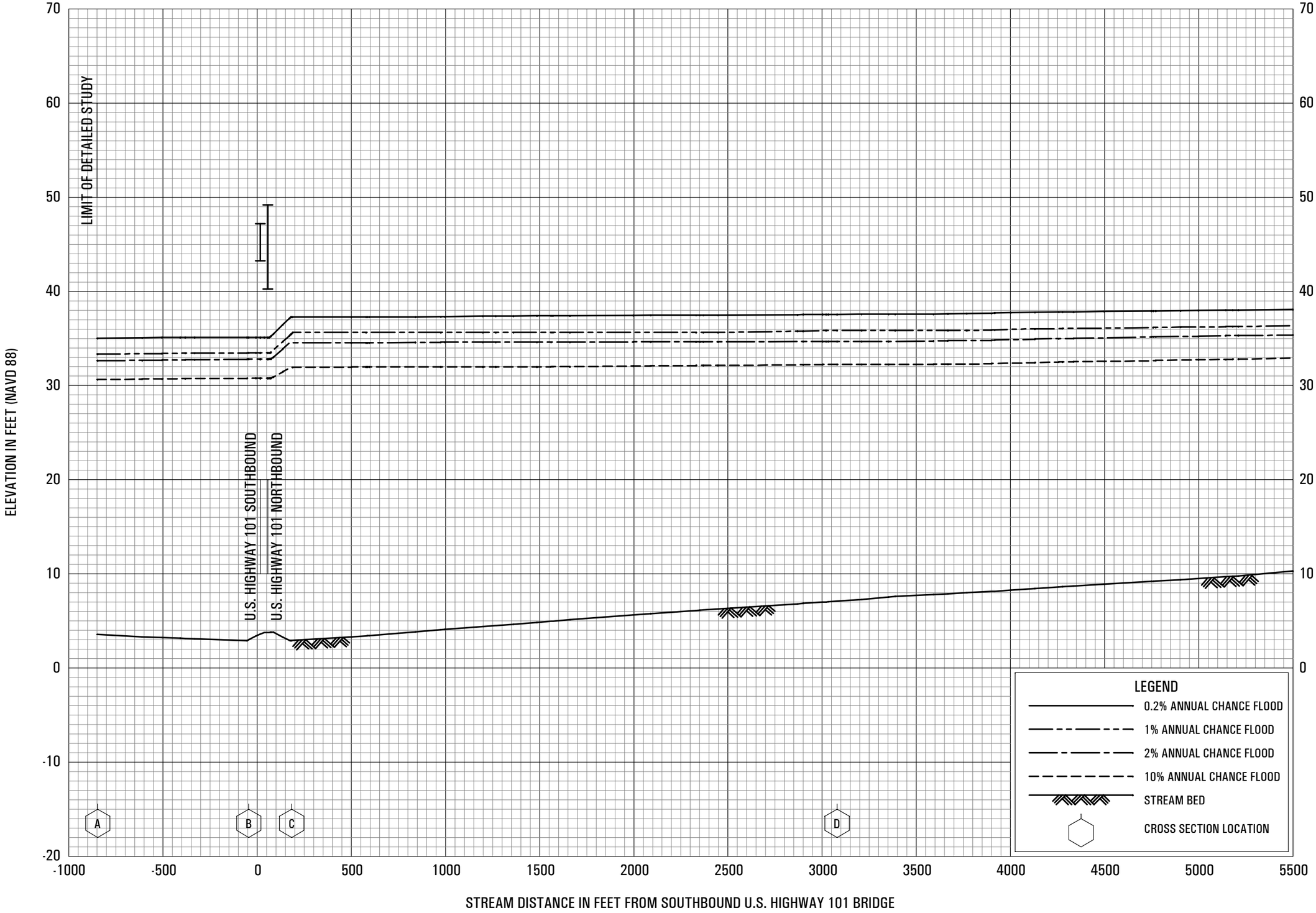
FLOOD PROFILES

JANES CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED ARES



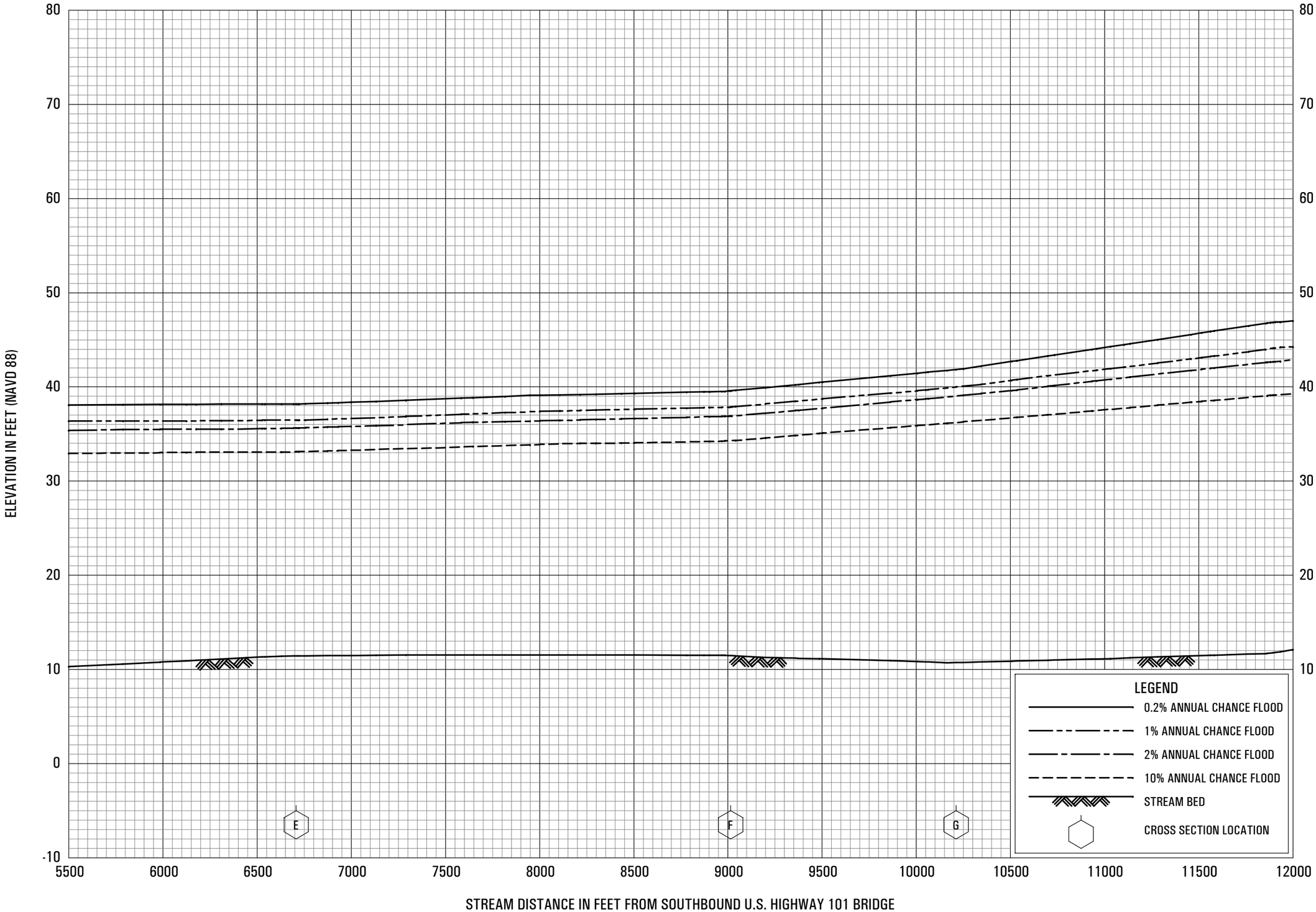
FLOOD PROFILES

MAD RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS



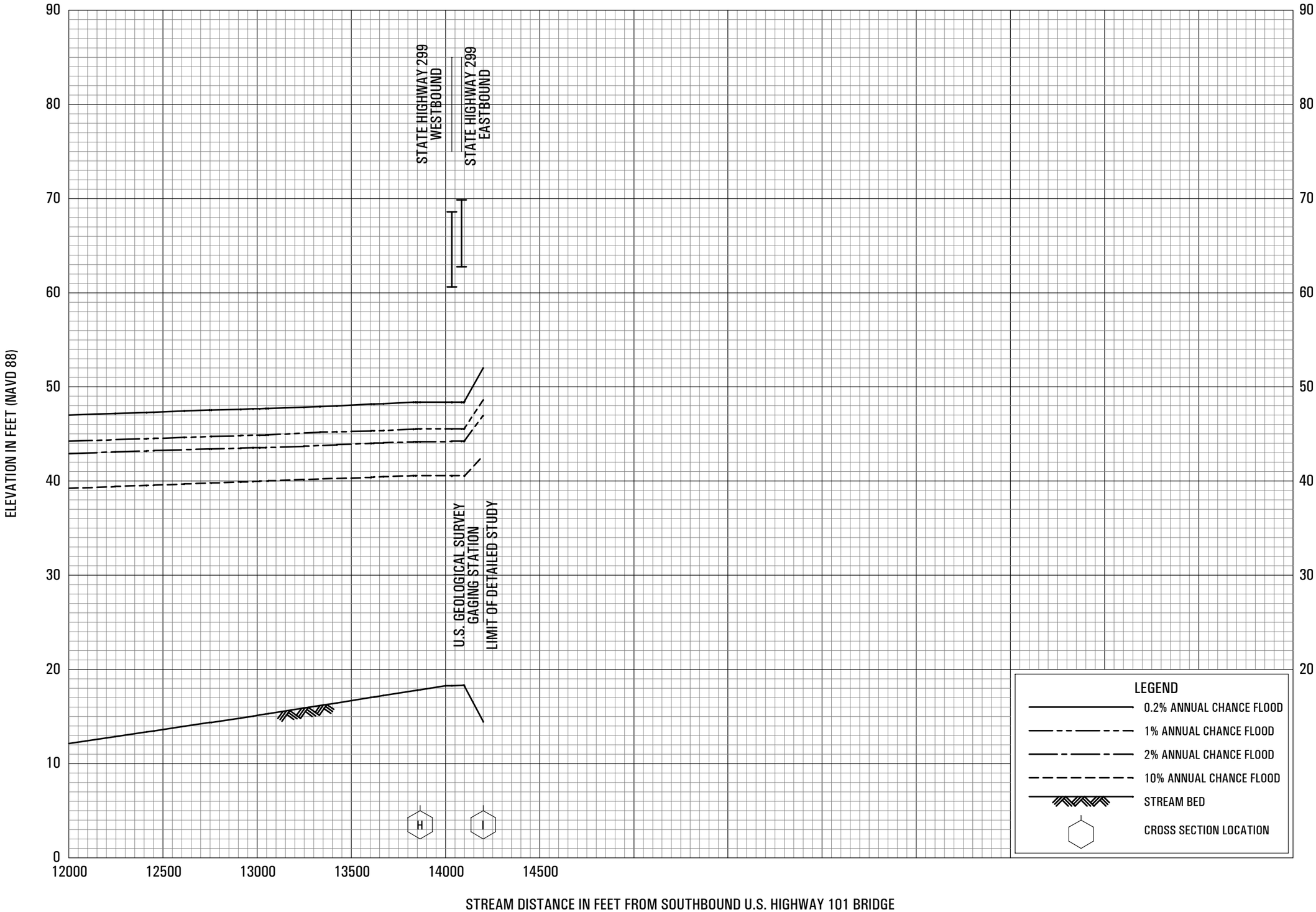
FLOOD PROFILES

MAD RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS



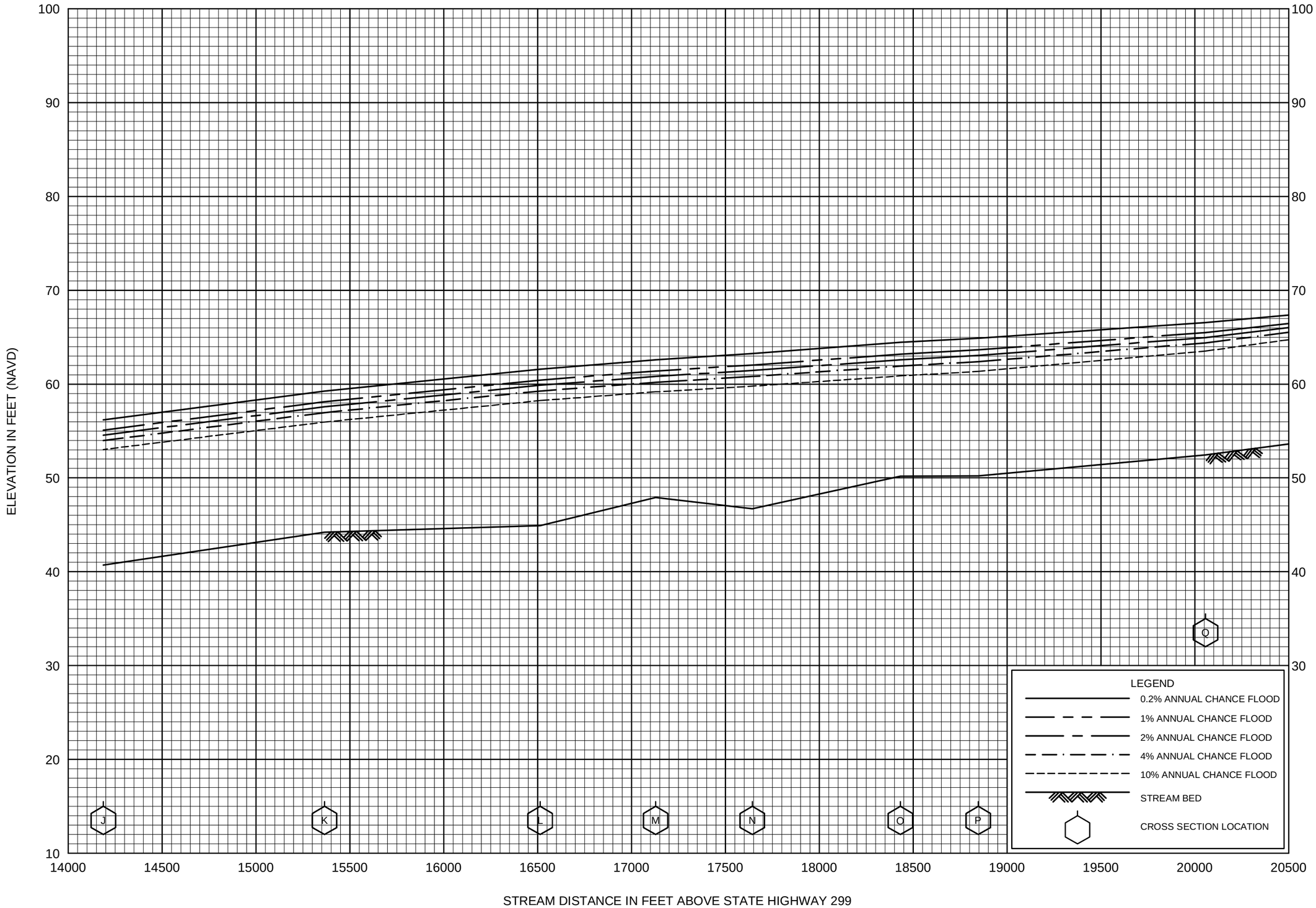
FLOOD PROFILES

MAD RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS



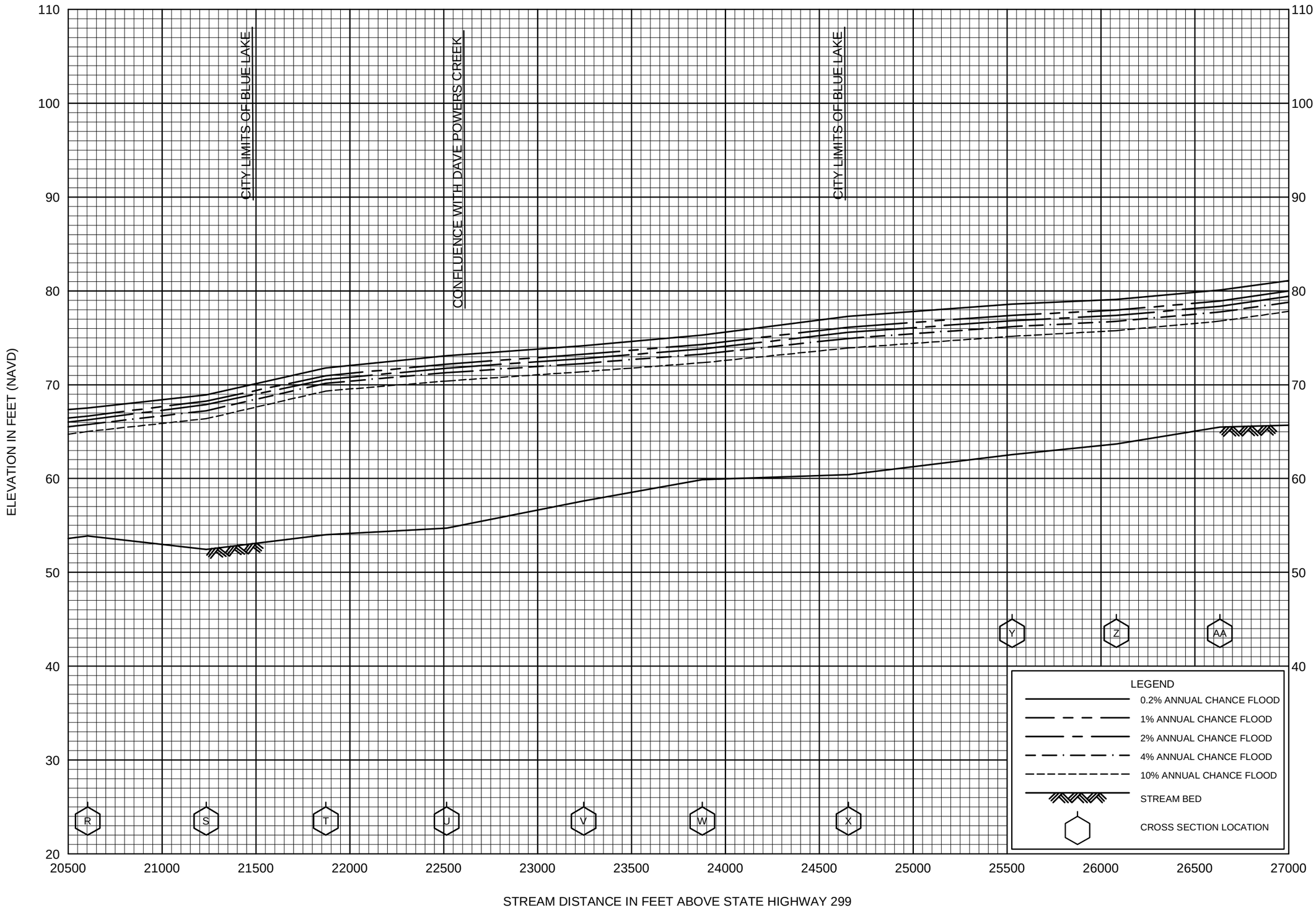
FLOOD PROFILES

MAD RIVER AT BLUE LAKE

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND ENCORPORATED AREAS



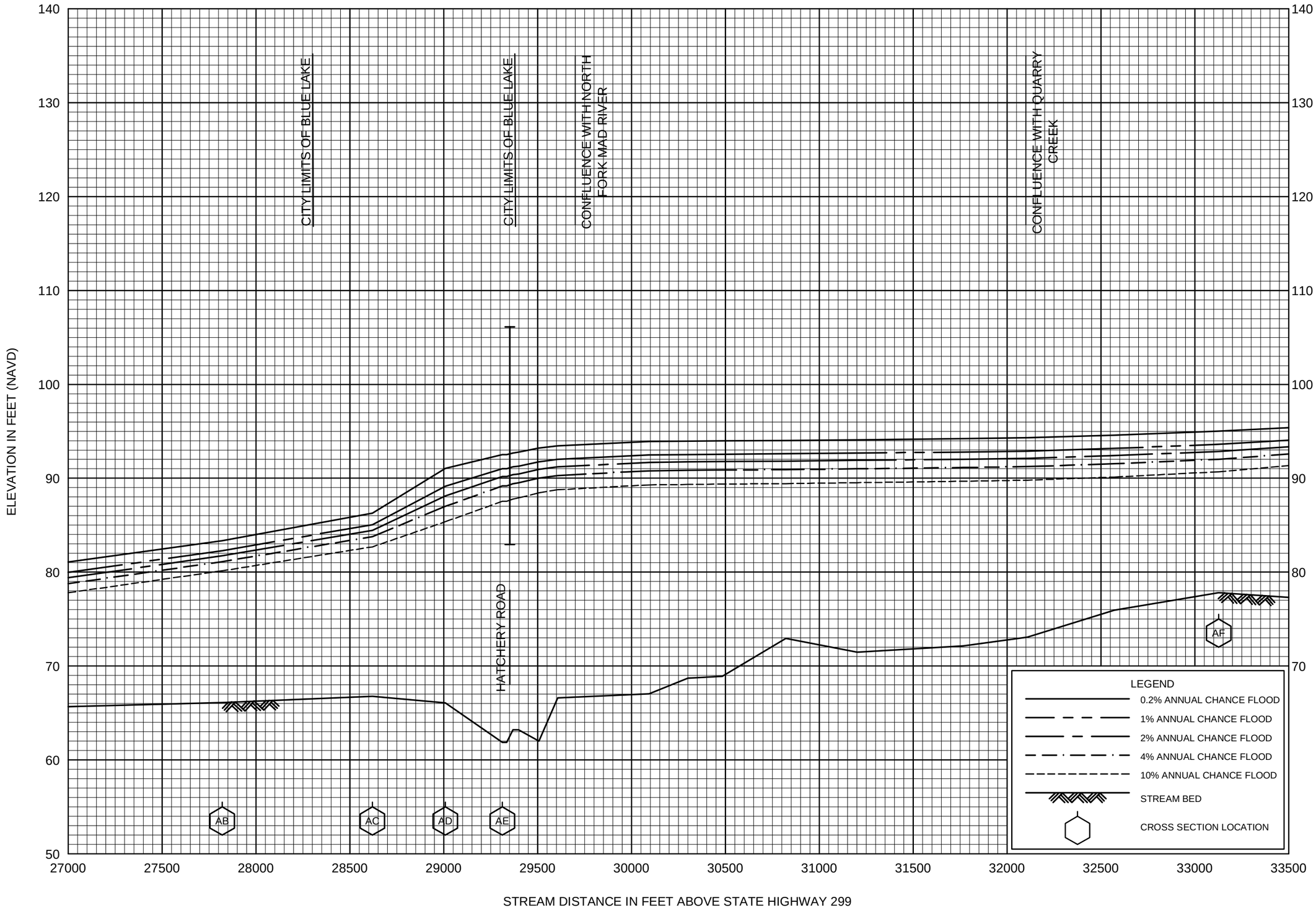
FLOOD PROFILES

MAD RIVER AT BLUE LAKE

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND ENCORPORATED AREAS



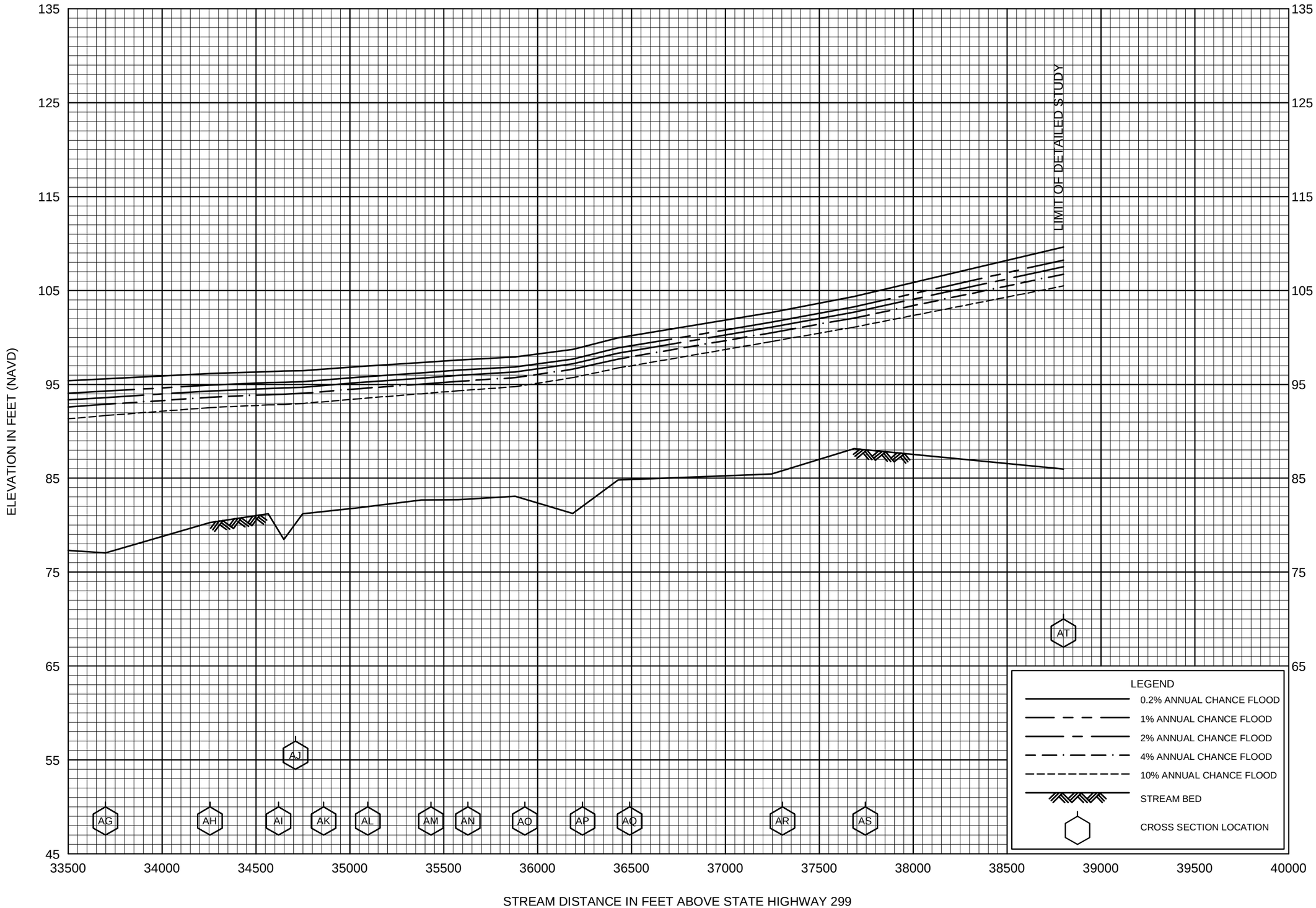
FLOOD PROFILES

MAD RIVER AT BLUE LAKE

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND ENCORPORATED AREAS



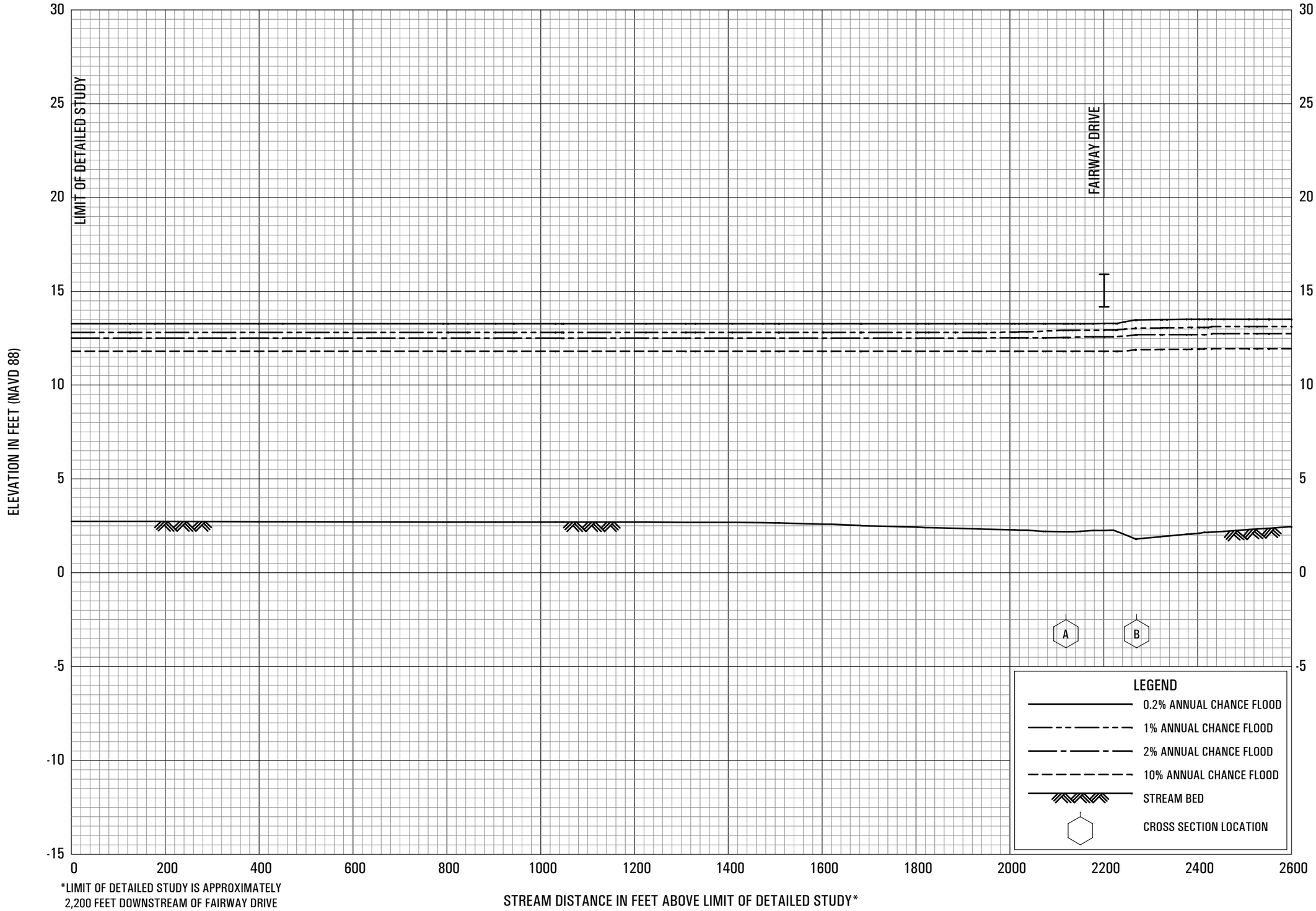
FLOOD PROFILES

MAD RIVER AT BLUE LAKE

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND ENCORPORATED AREAS



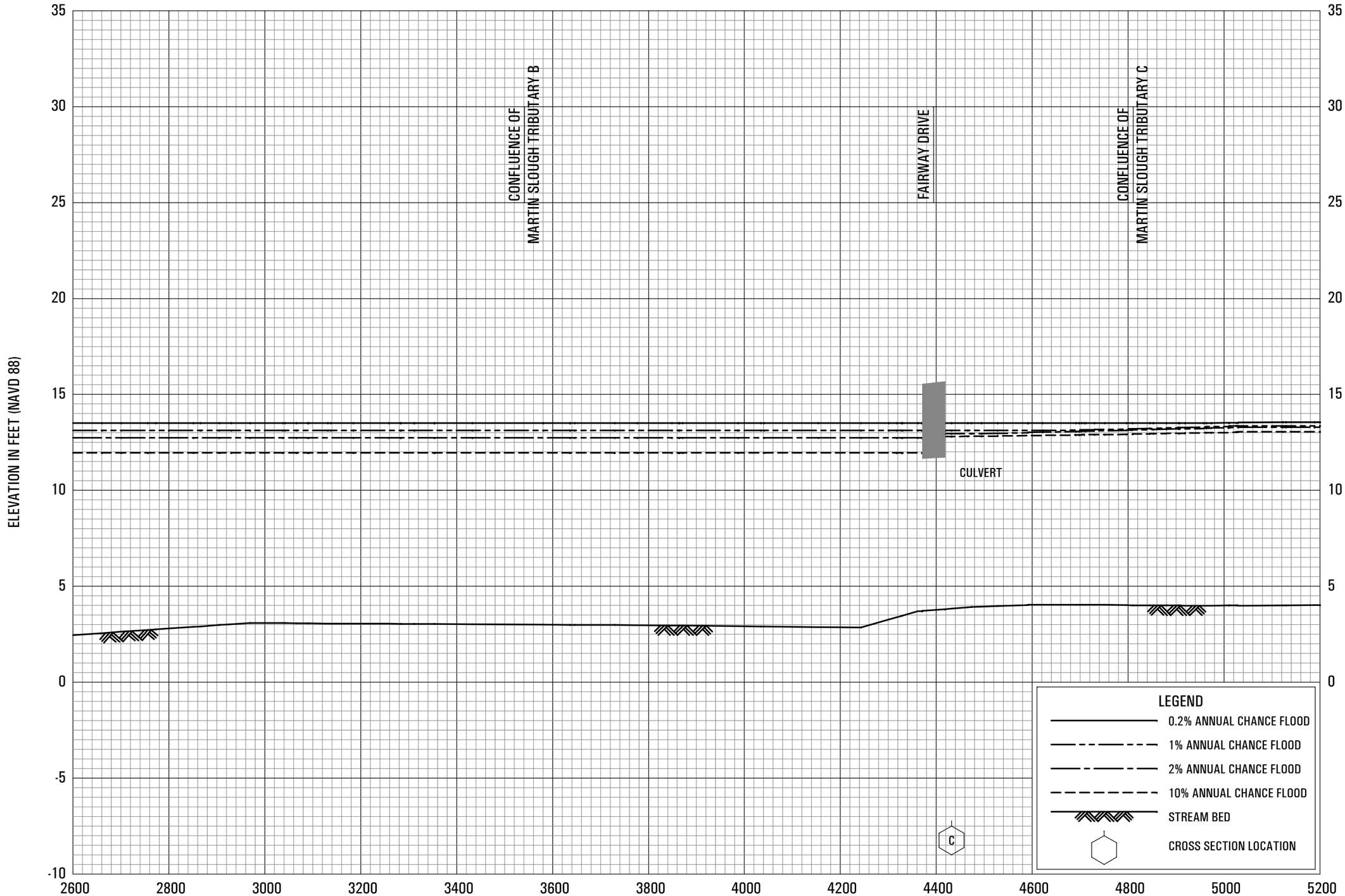
FLOOD PROFILES

MARTIN SLOUGH

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS



*LIMIT OF DETAILED STUDY IS APPROXIMATELY
2,200 FEET DOWNSTREAM OF FAIRWAY DRIVE

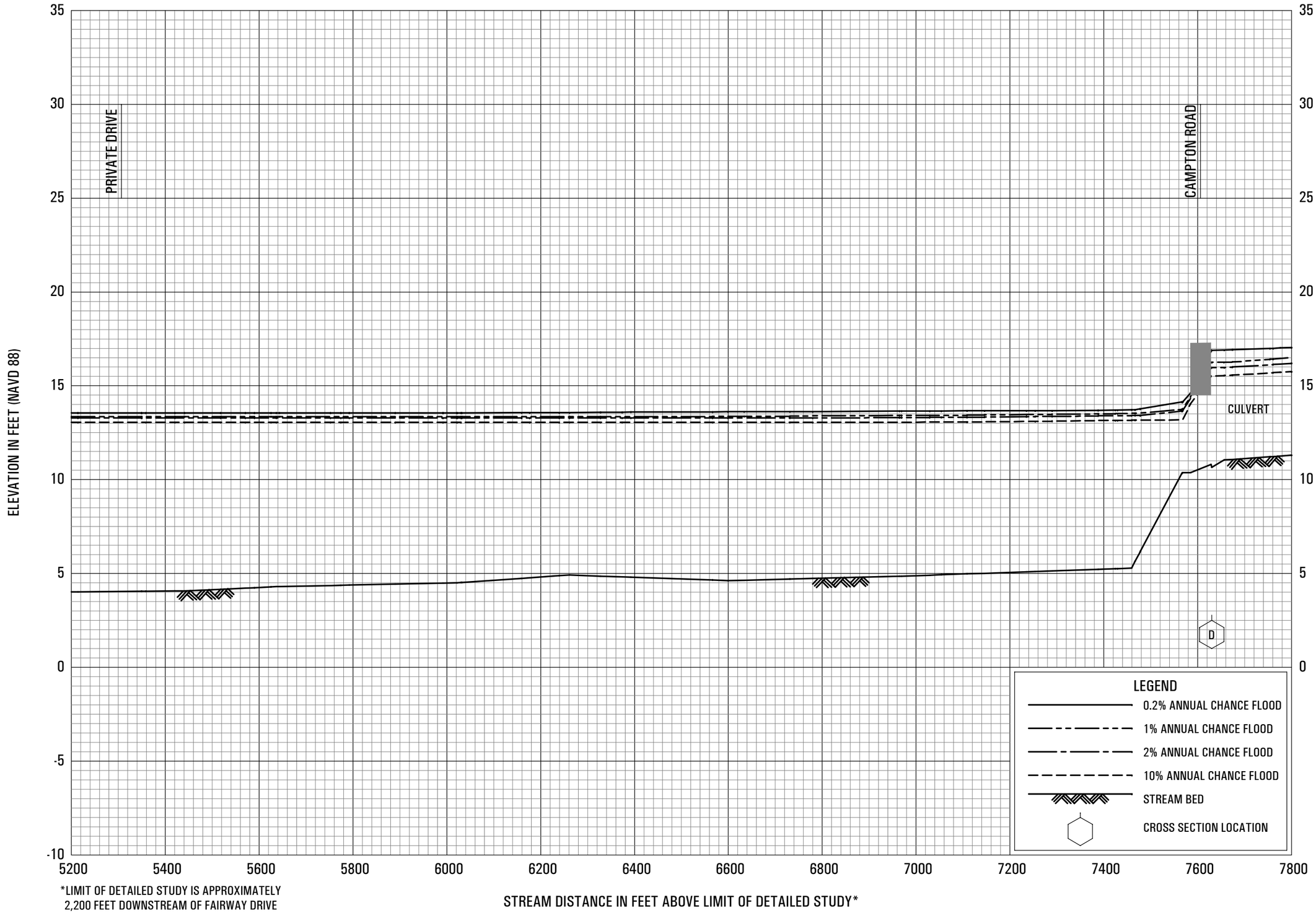
FLOOD PROFILES

MARTIN SLOUGH

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS



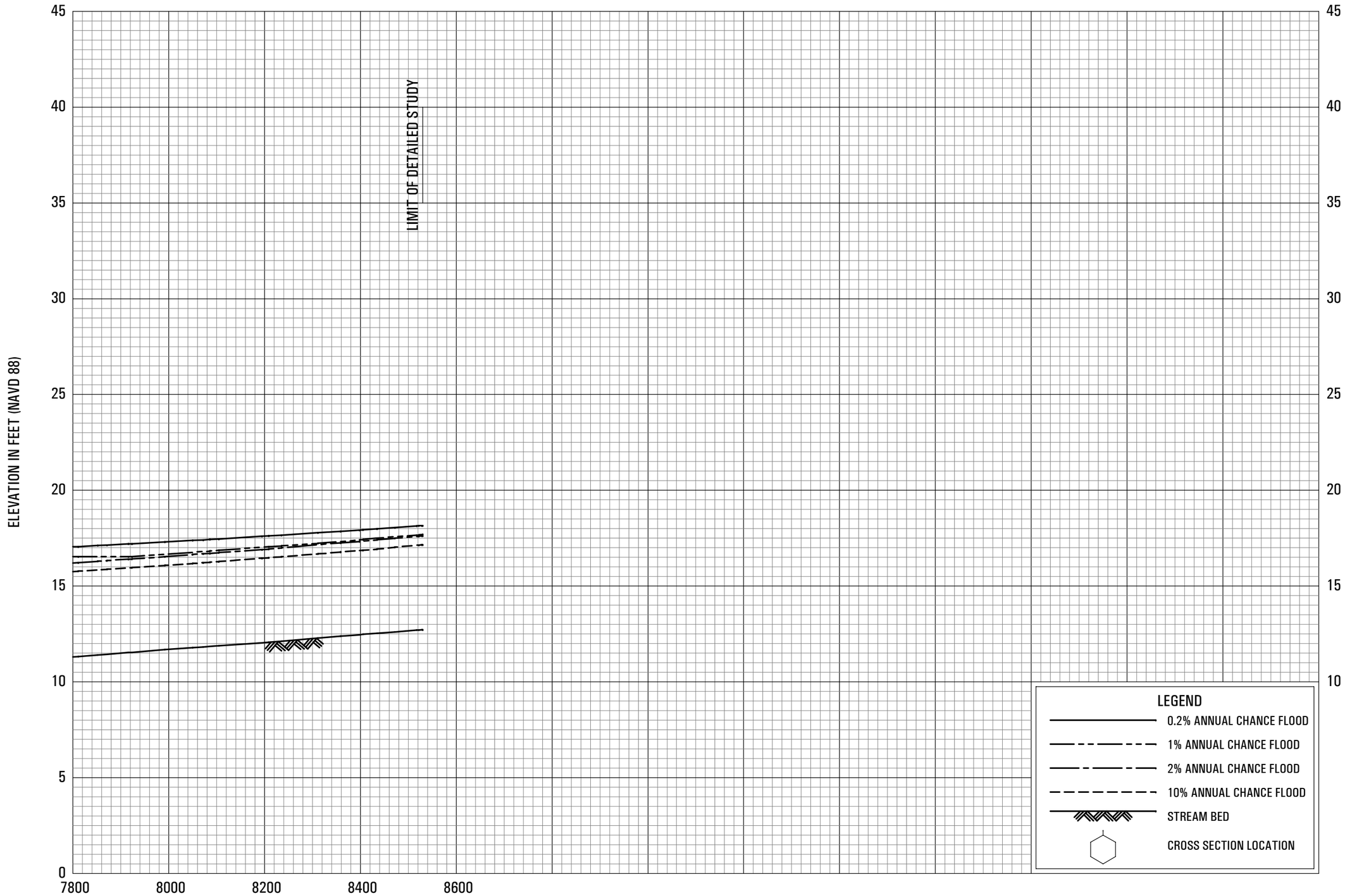
FLOOD PROFILES

MARTIN SLOUGH

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS



*LIMIT OF DETAILED STUDY IS APPROXIMATELY 2,200 FEET DOWNSTREAM OF FAIRWAY DRIVE

STREAM DISTANCE IN FEET ABOVE LIMIT OF DETAILED STUDY*

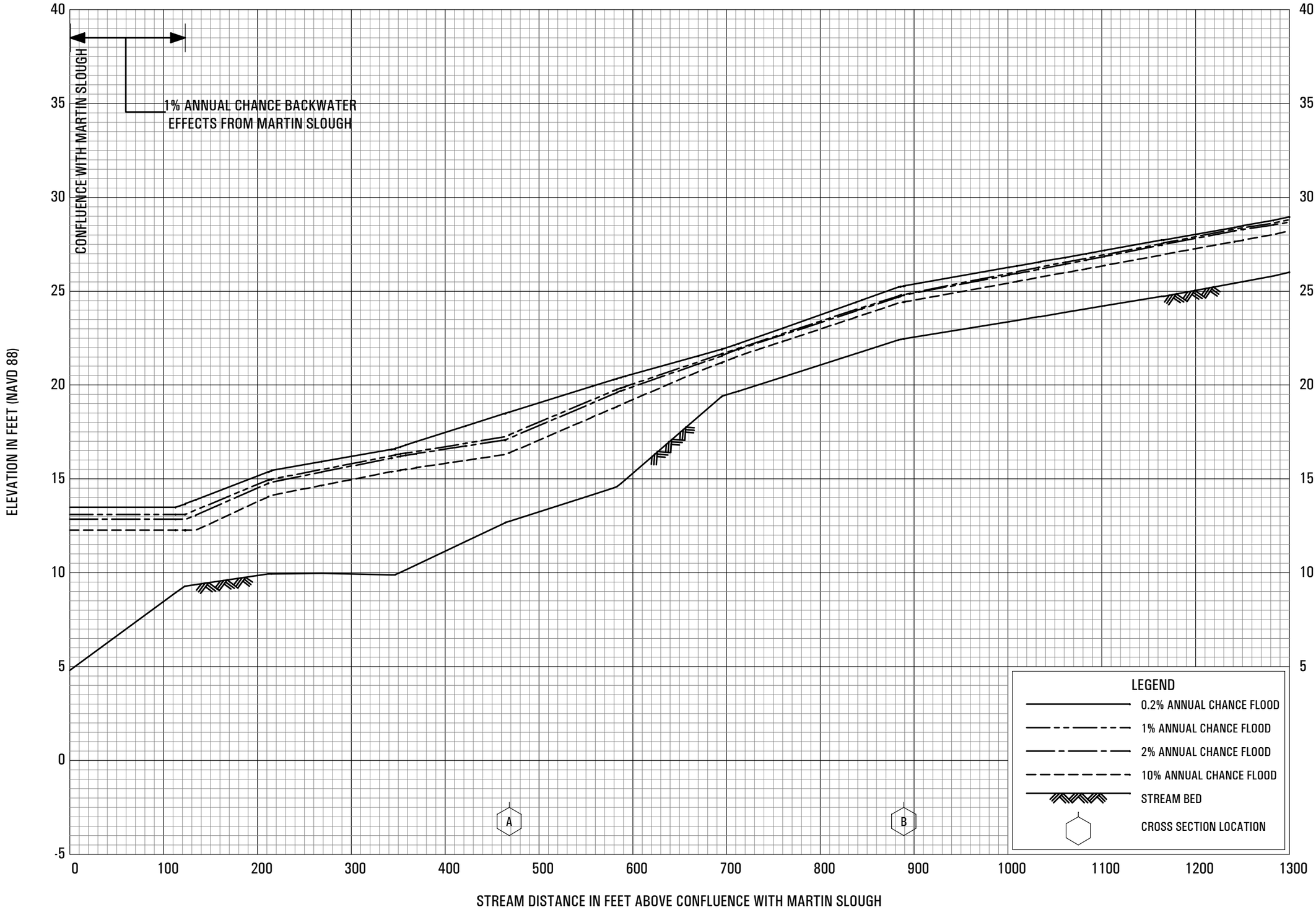
FLOOD PROFILES

MARTIN SLOUGH

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS



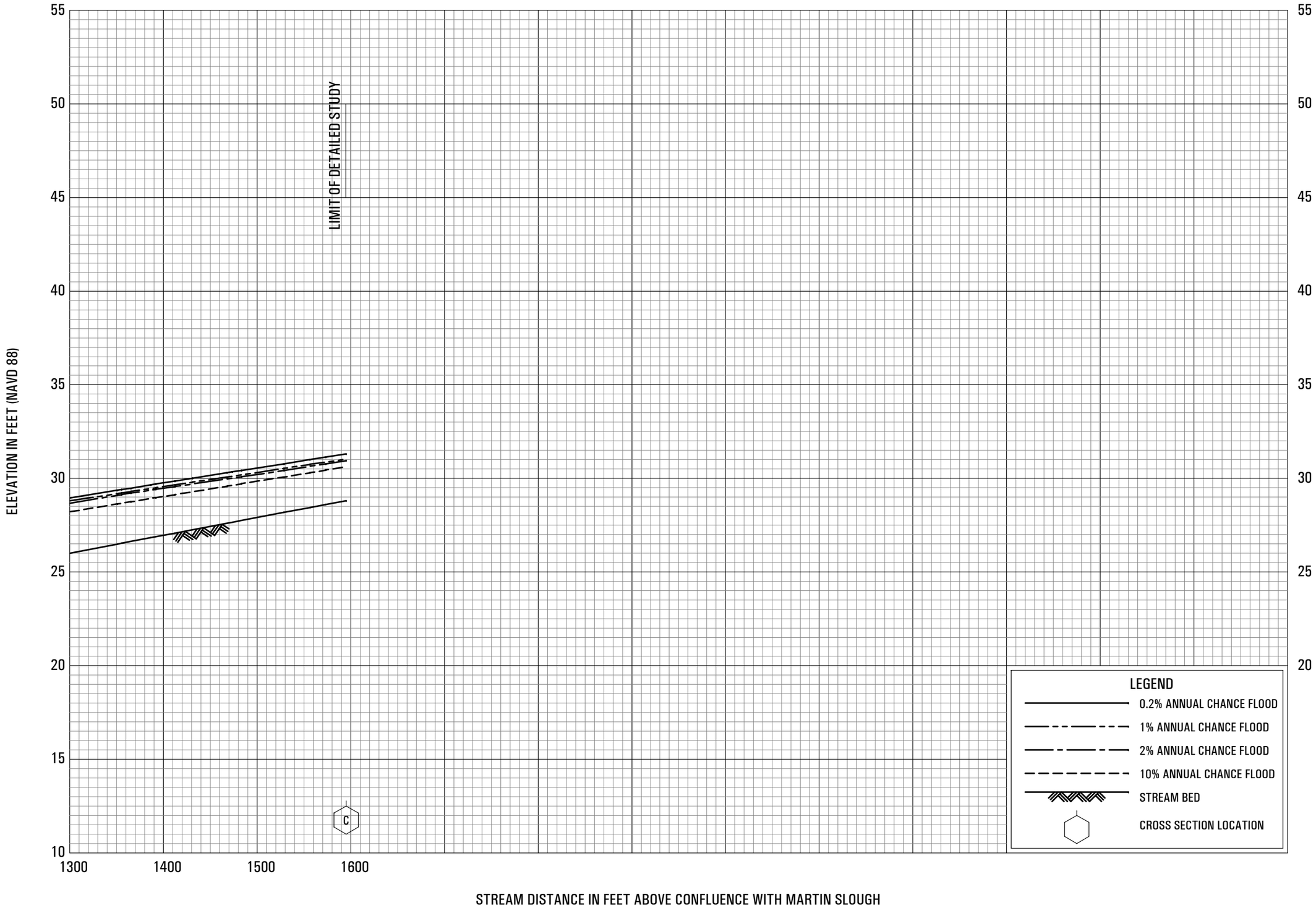
FLOOD PROFILES

MARTIN SLOUGH TRIBUTARY C

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS



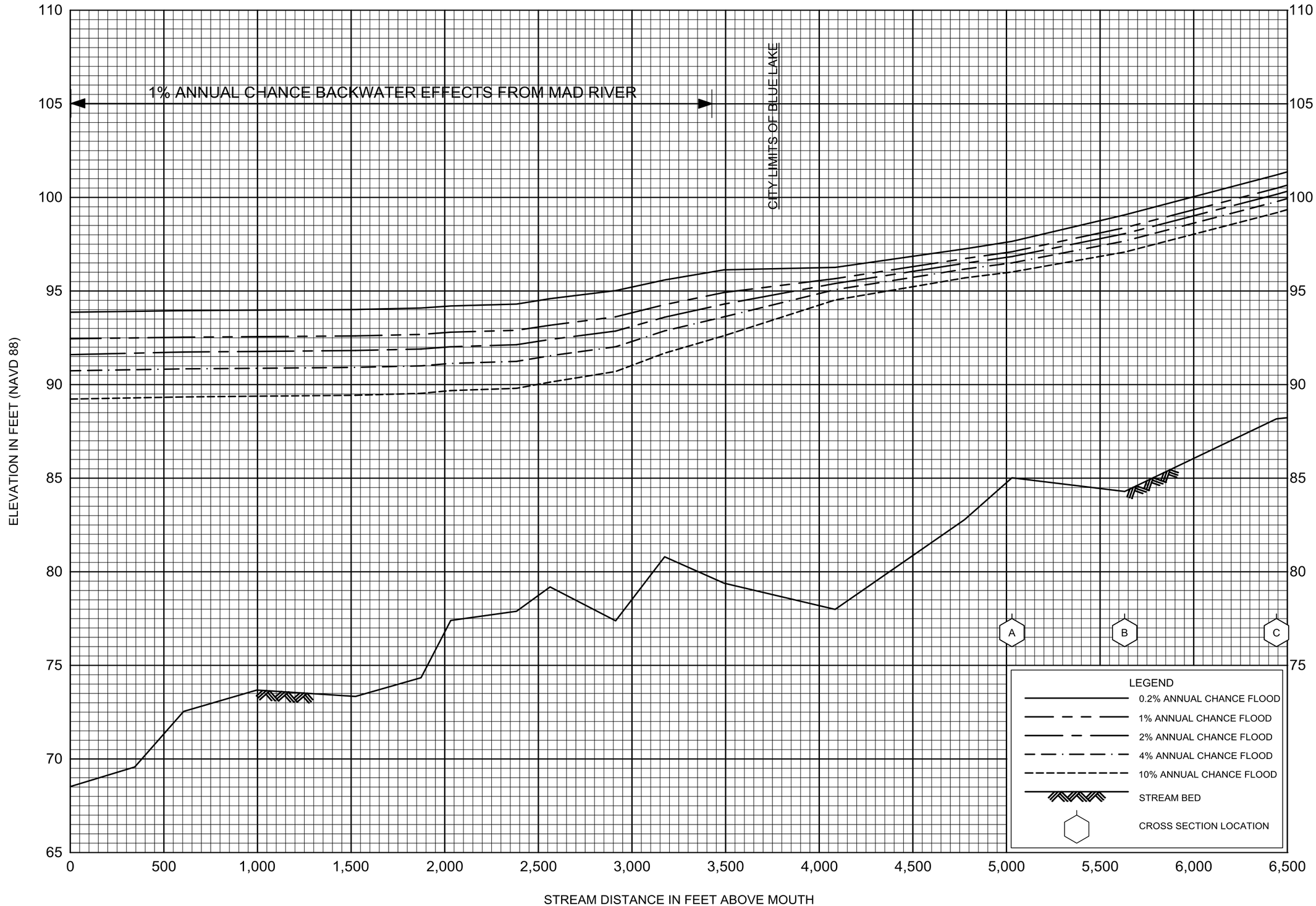
FLOOD PROFILES

MARTIN SLOUGH TRIBUTARY C

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS



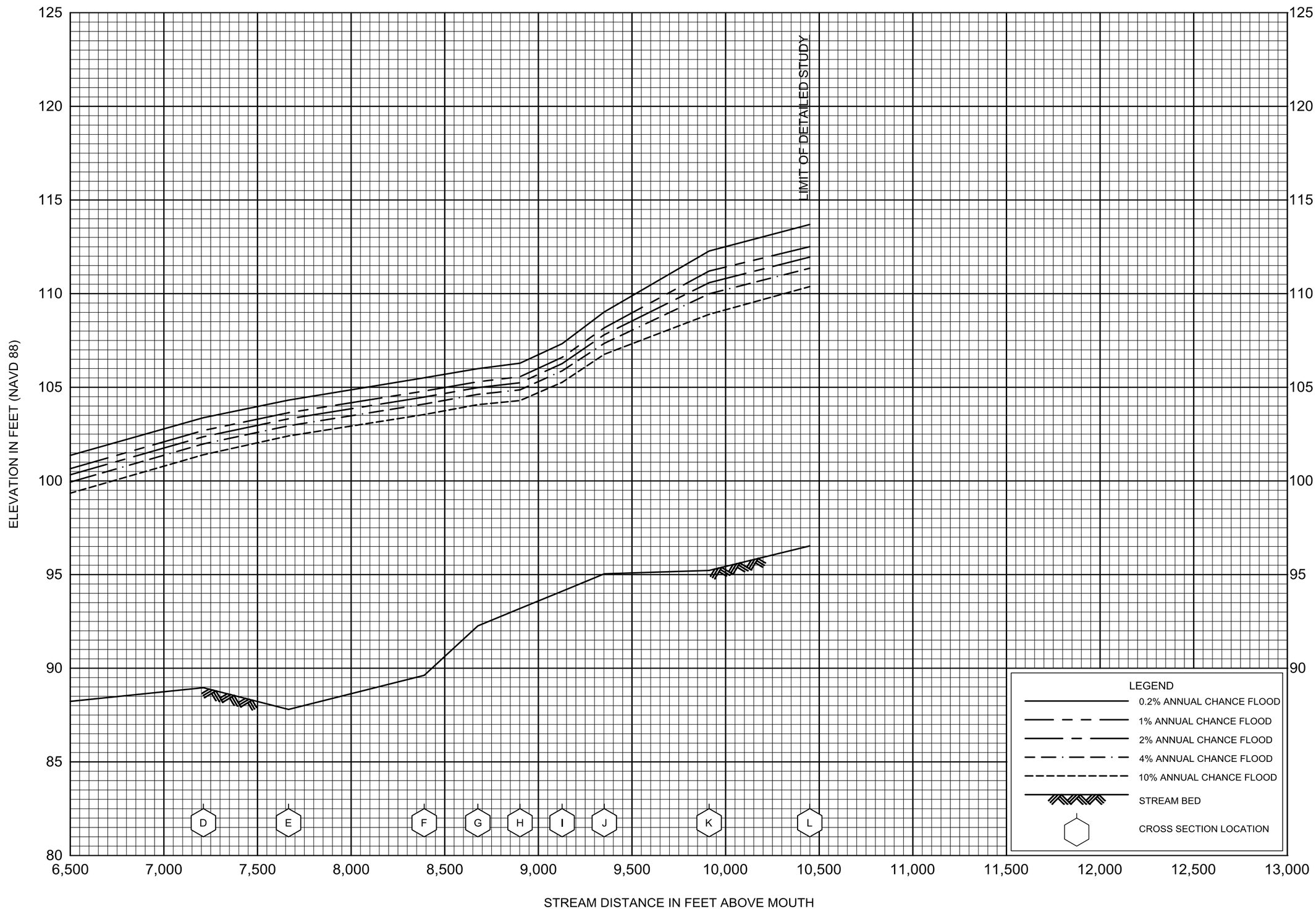
FLOOD PROFILES

NORTH FORK MAD RIVER (WITH LEVEE)

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS



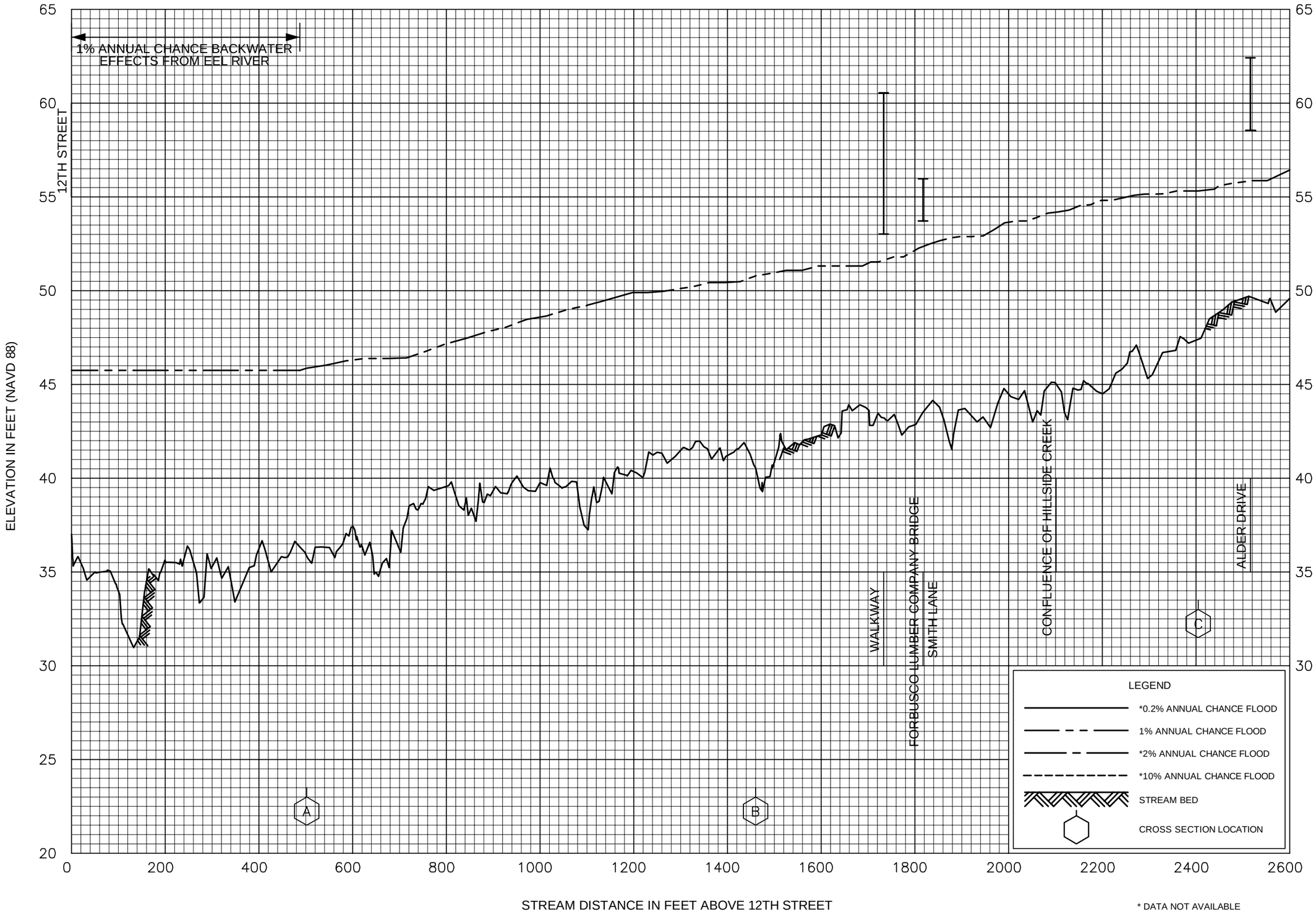
FLOOD PROFILES

NORTH FORK MAD RIVER (WITH LEVEE)

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS



* DATA NOT AVAILABLE

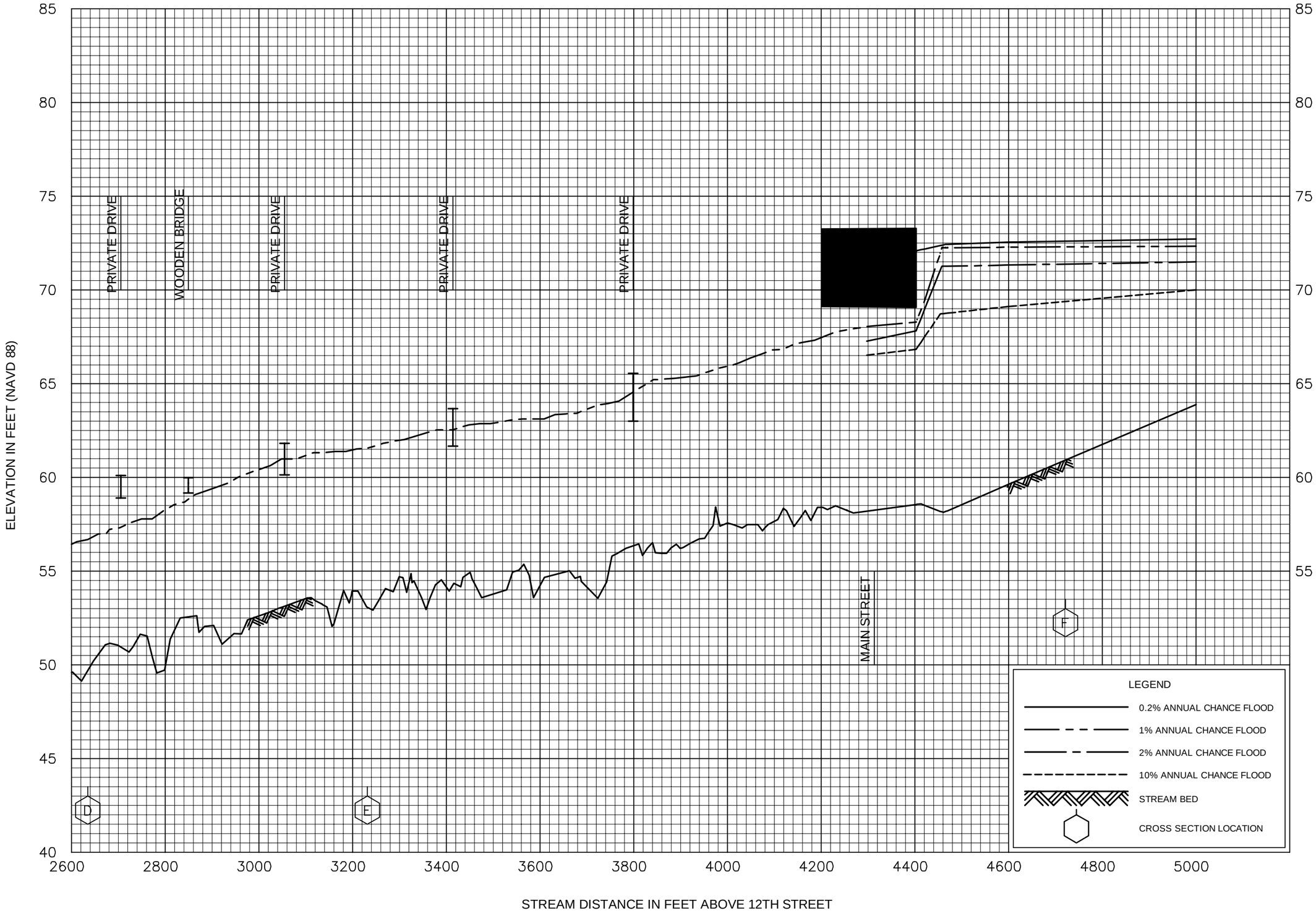
FLOOD PROFILES

ROHNER CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS



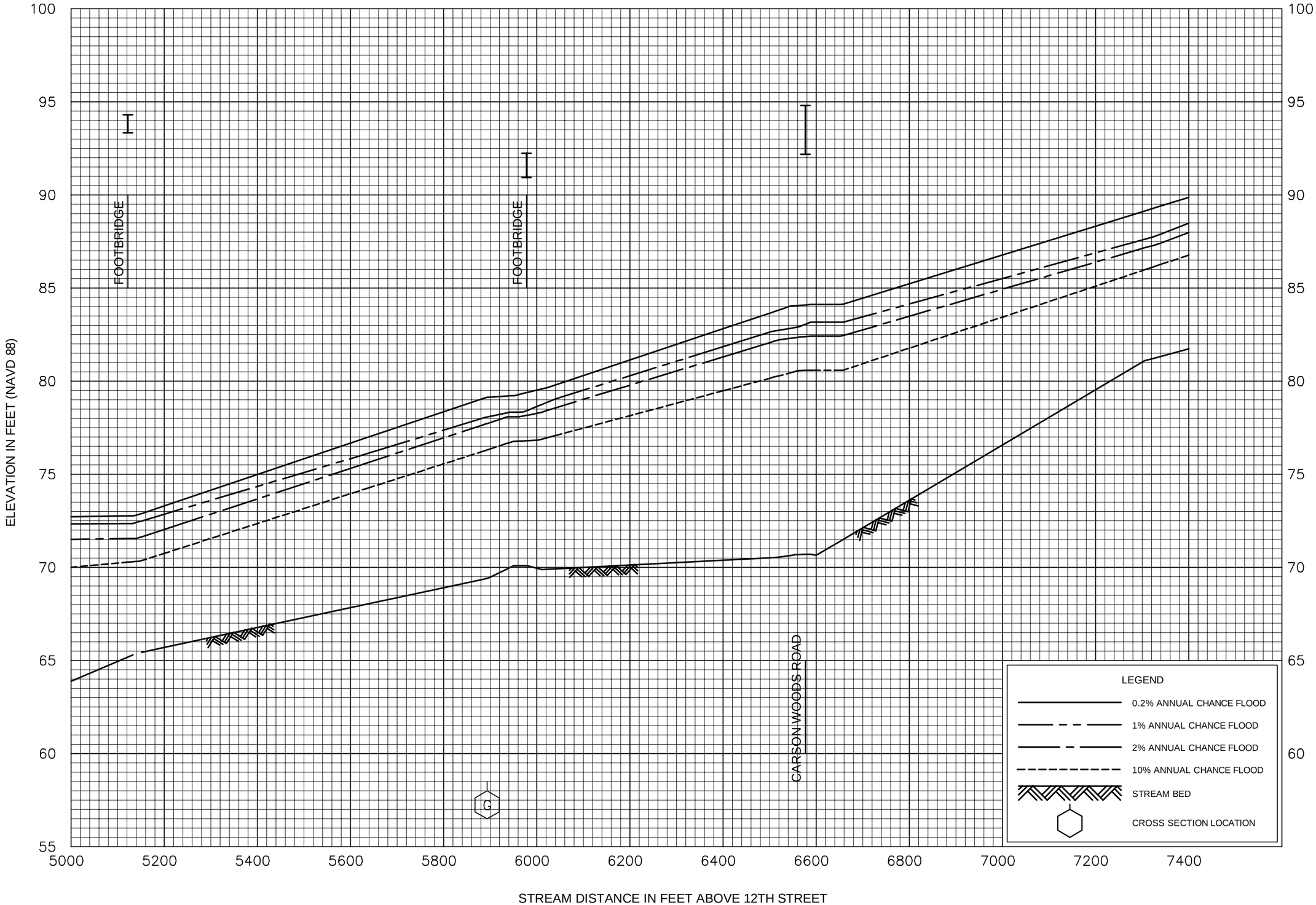
FLOOD PROFILES

ROHNER CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS



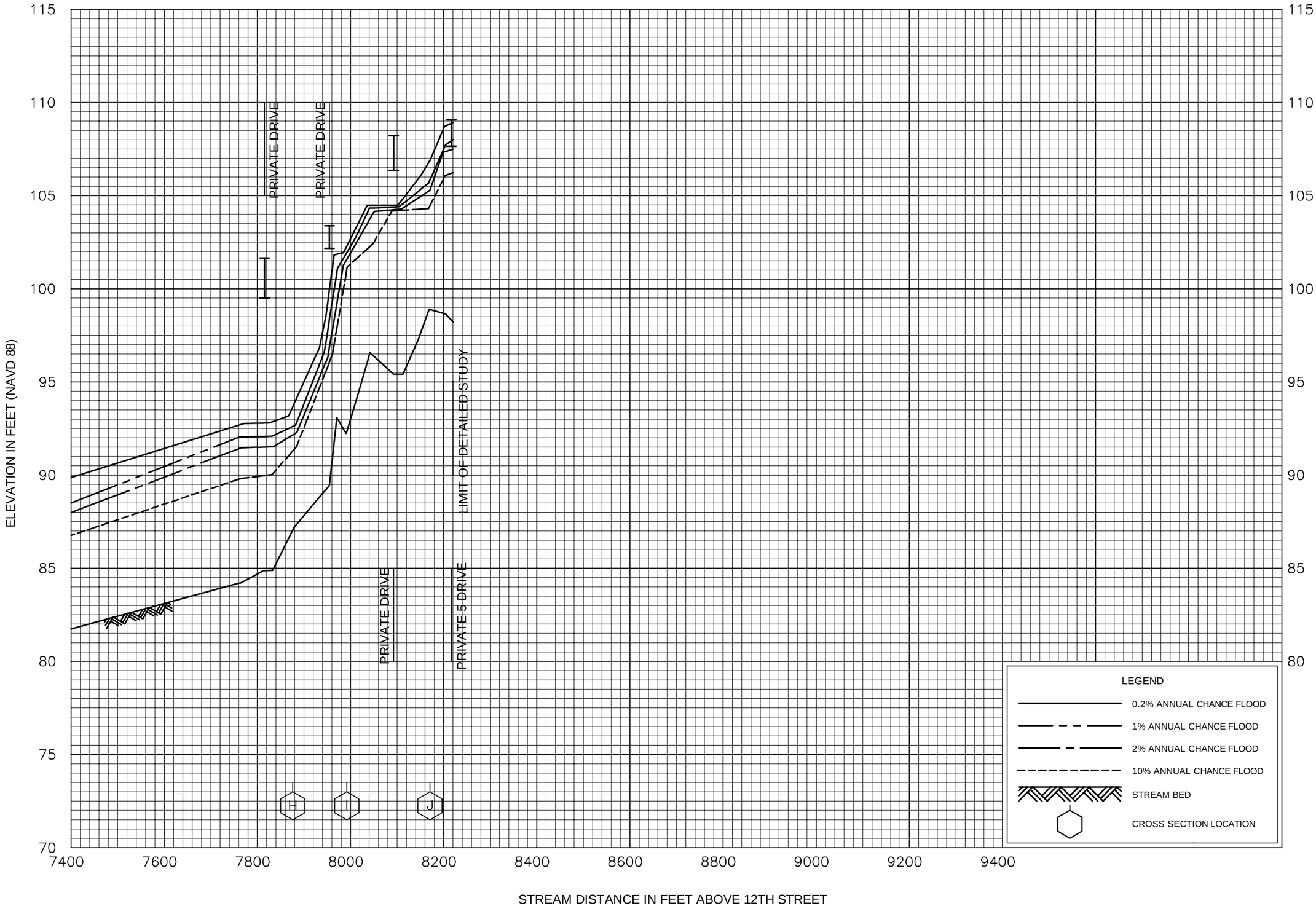
FLOOD PROFILES

ROHNER CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS



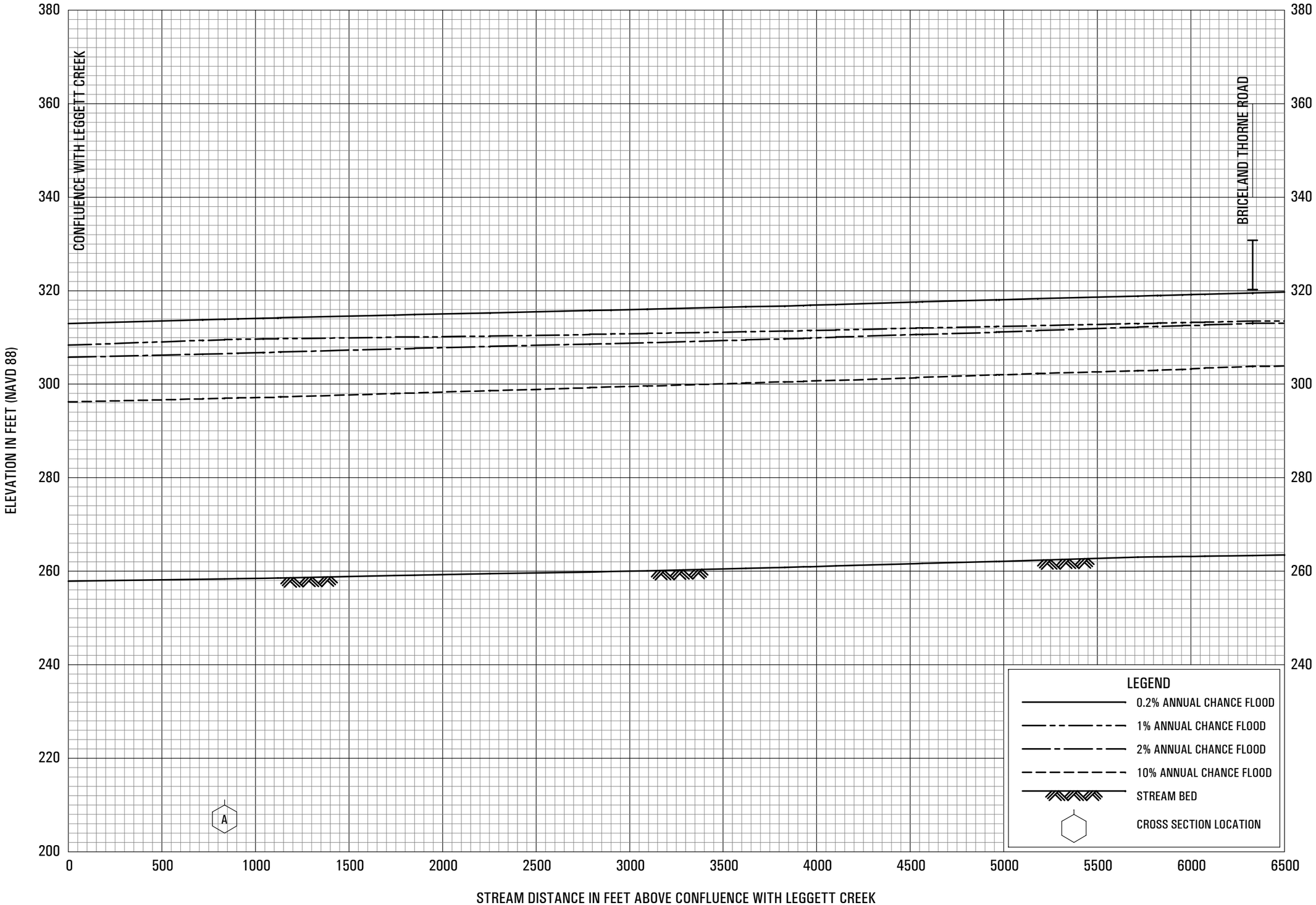
FLOOD PROFILES

ROHNER CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS



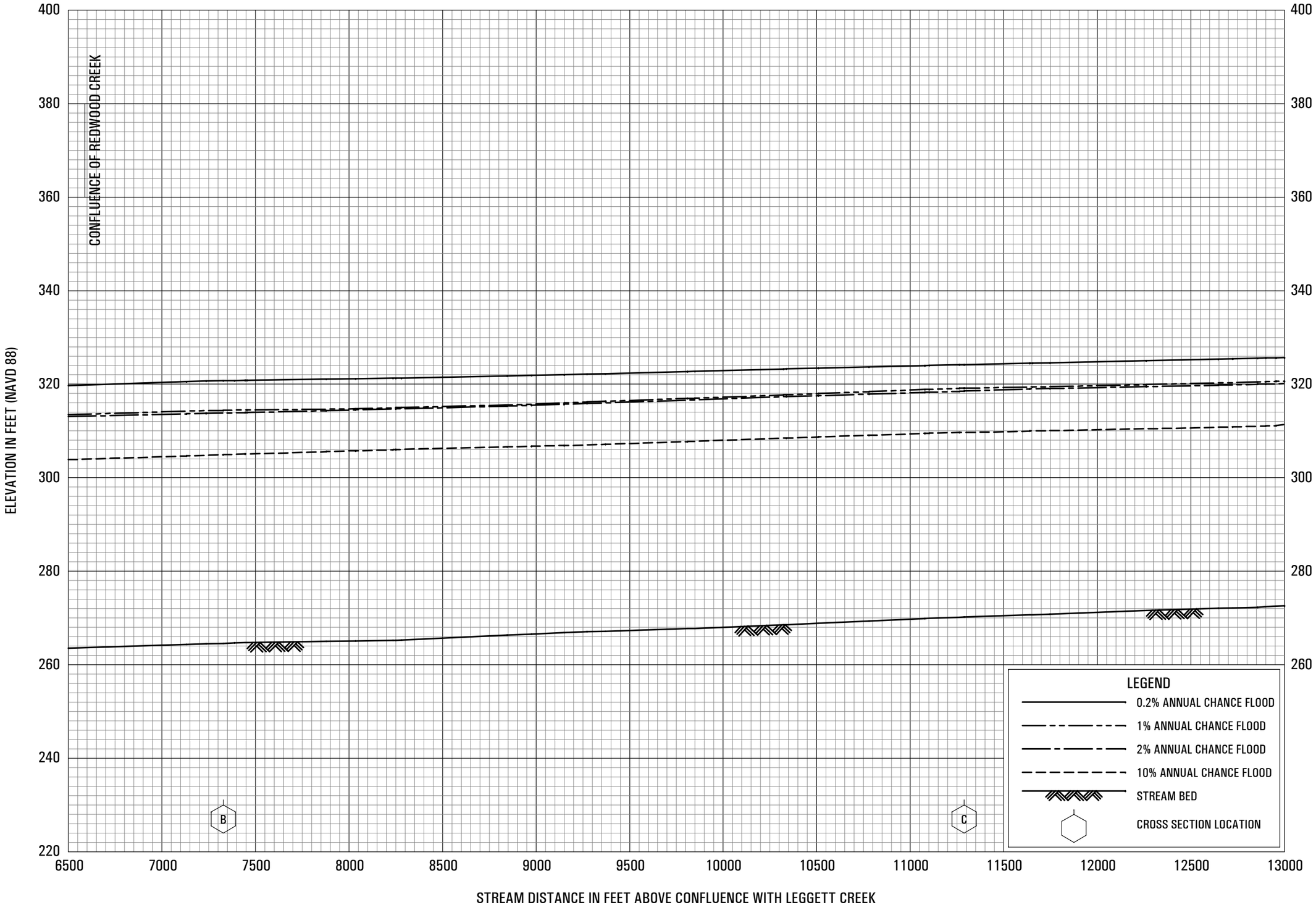
FLOOD PROFILES

SOUTH FORK EEL RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS



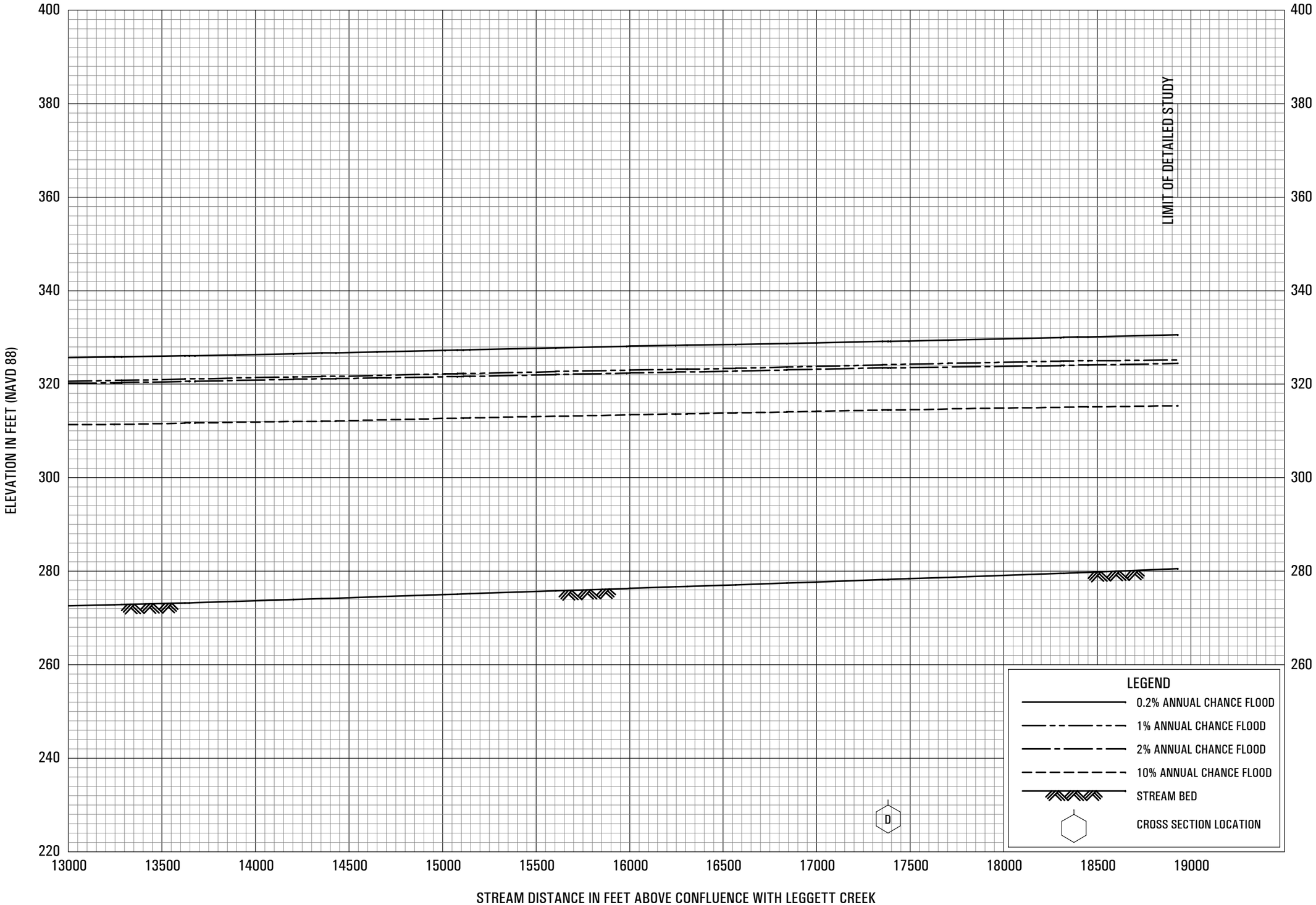
FLOOD PROFILES

SOUTH FORK EEL RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS



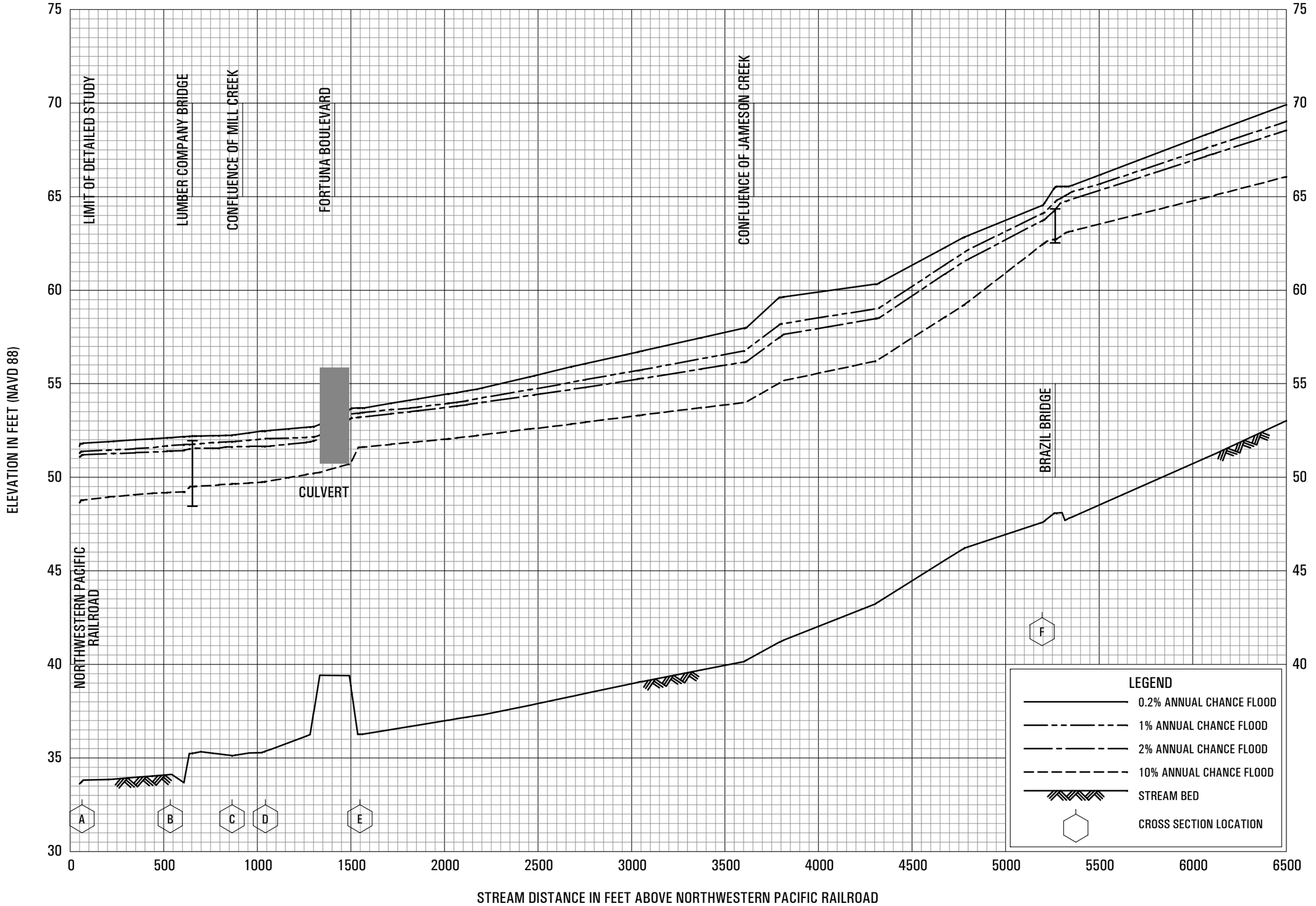
FLOOD PROFILES

SOUTH FORK EEL RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS



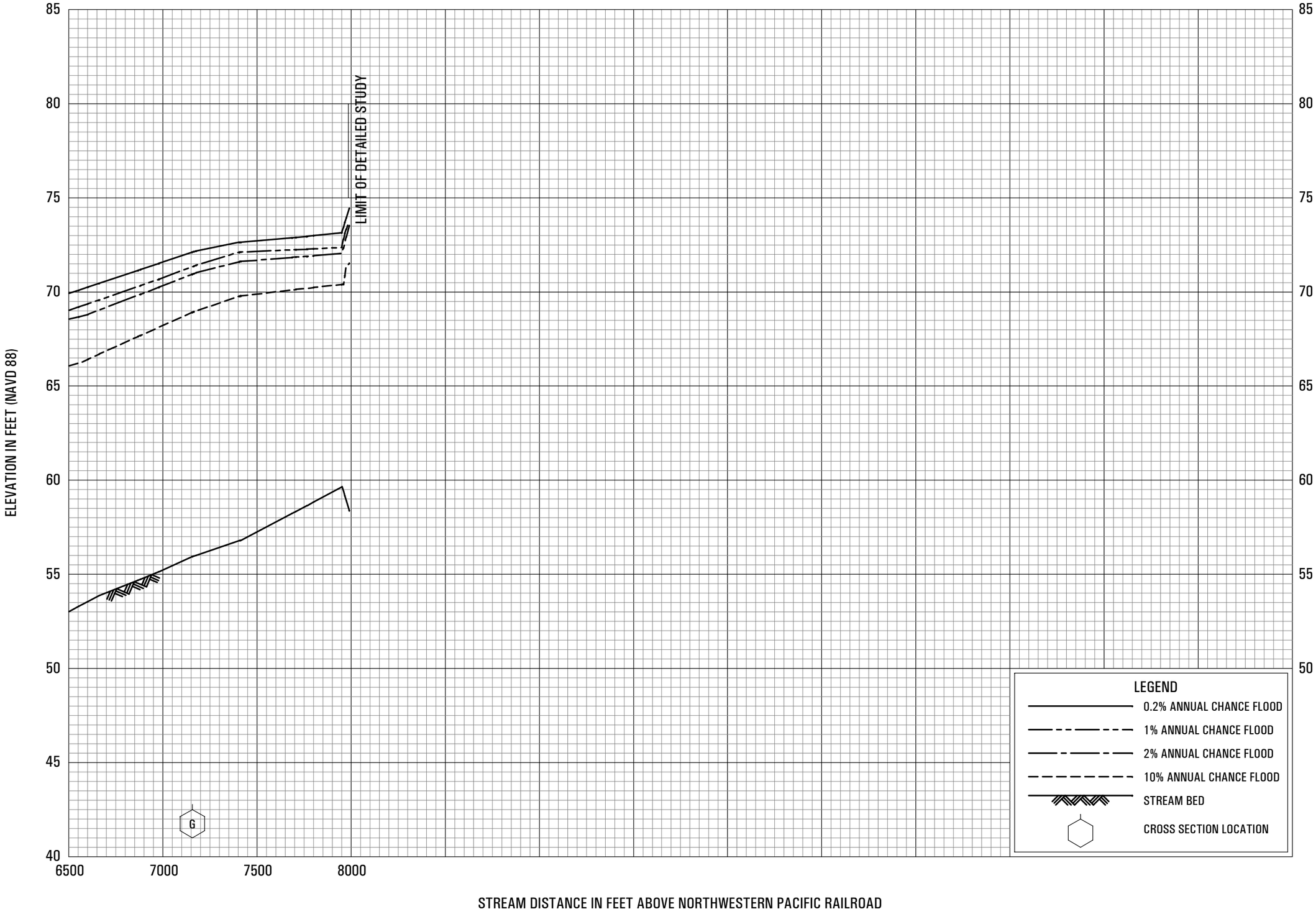
FLOOD PROFILES

STRONGS CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS



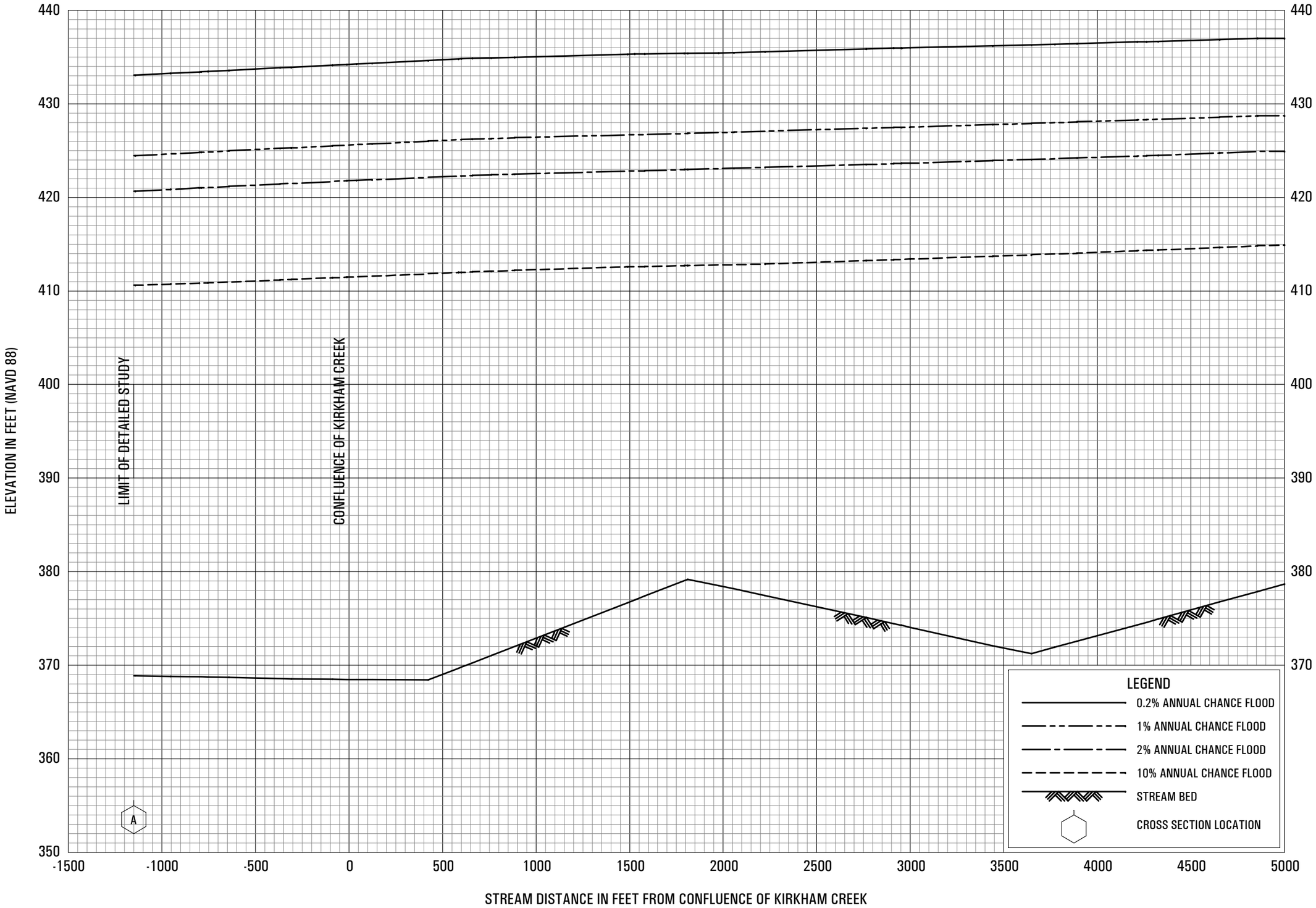
FLOOD PROFILES

STRONGS CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS



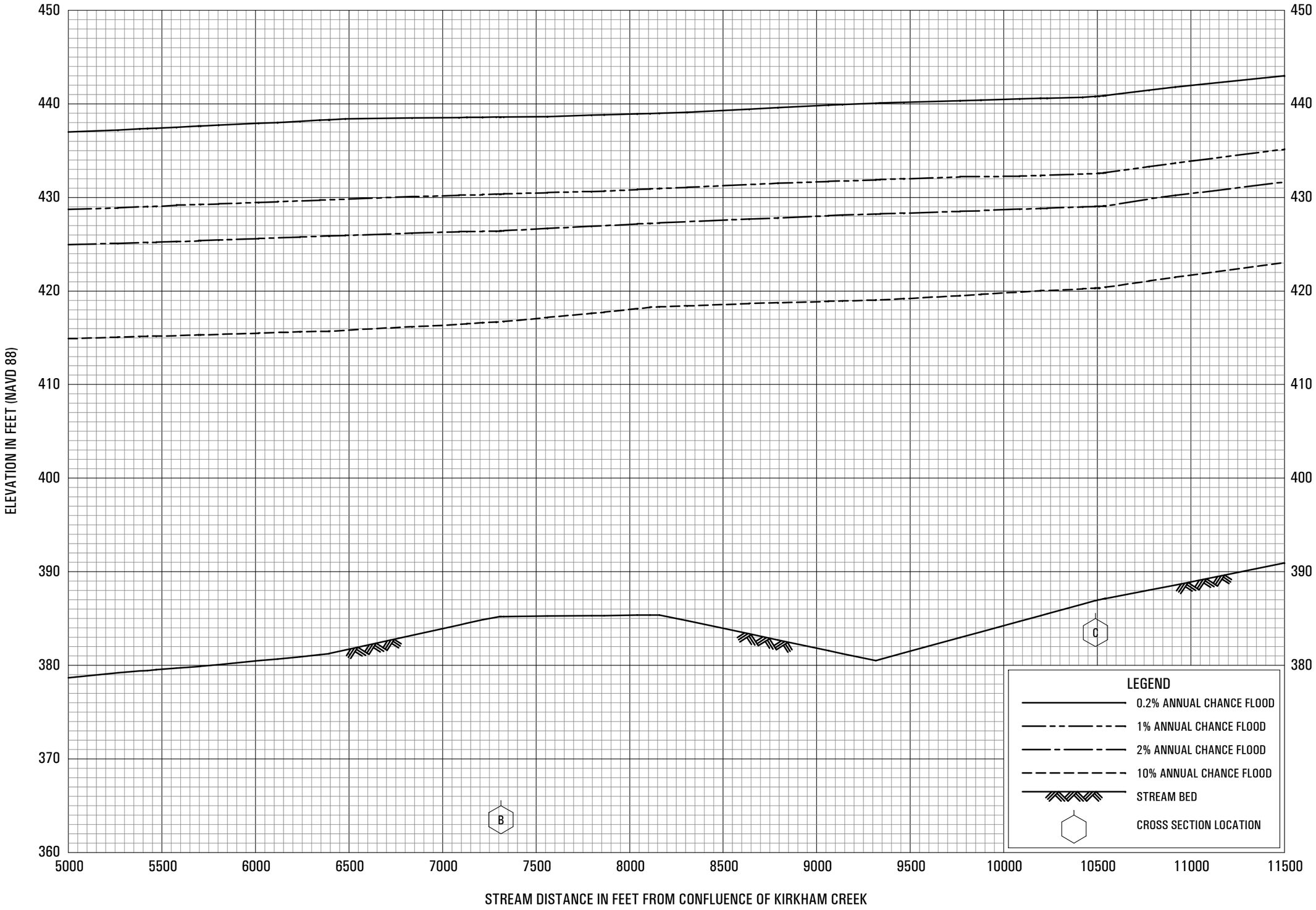
FLOOD PROFILES

TRINITY RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS



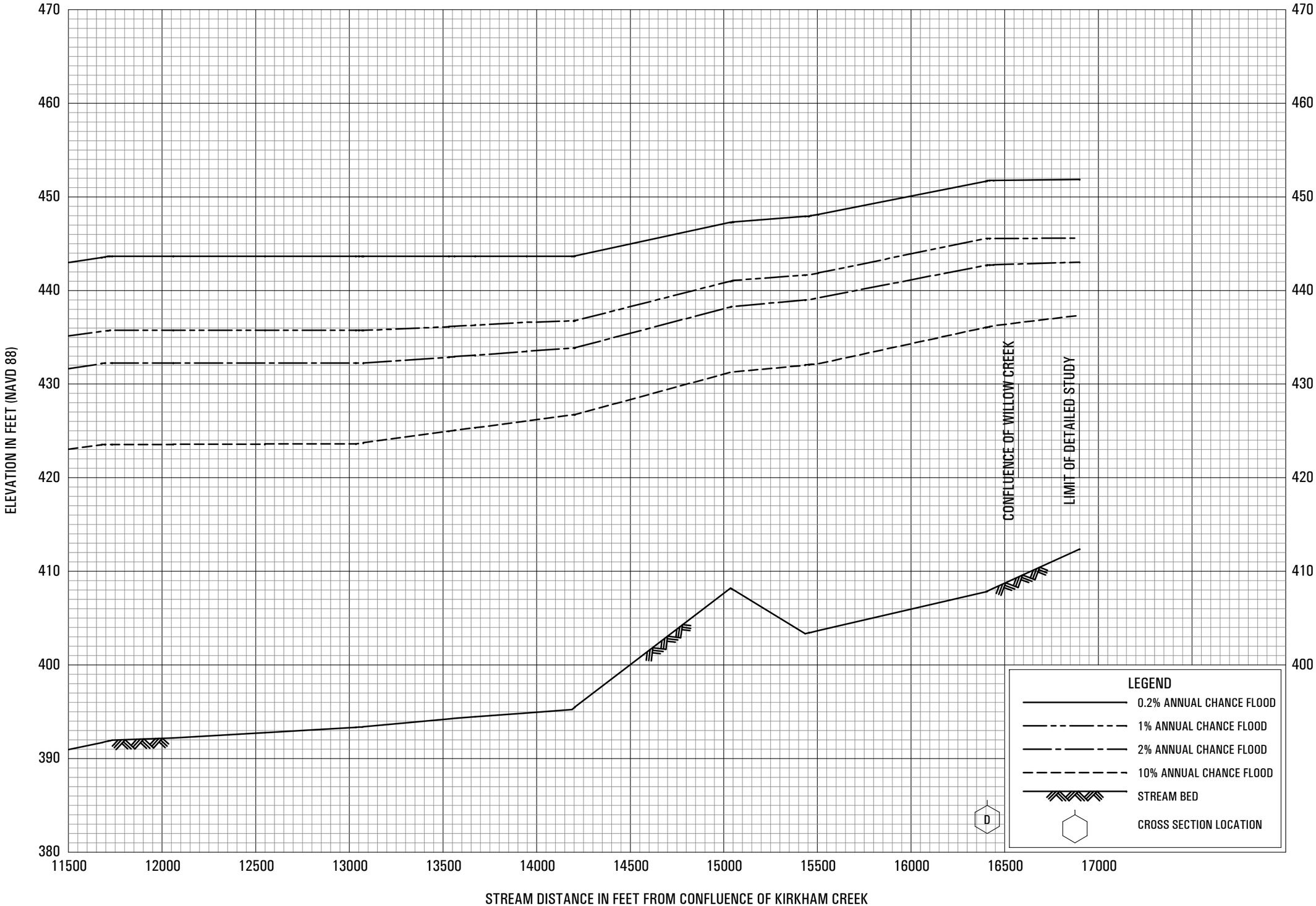
FLOOD PROFILES

TRINITY RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS



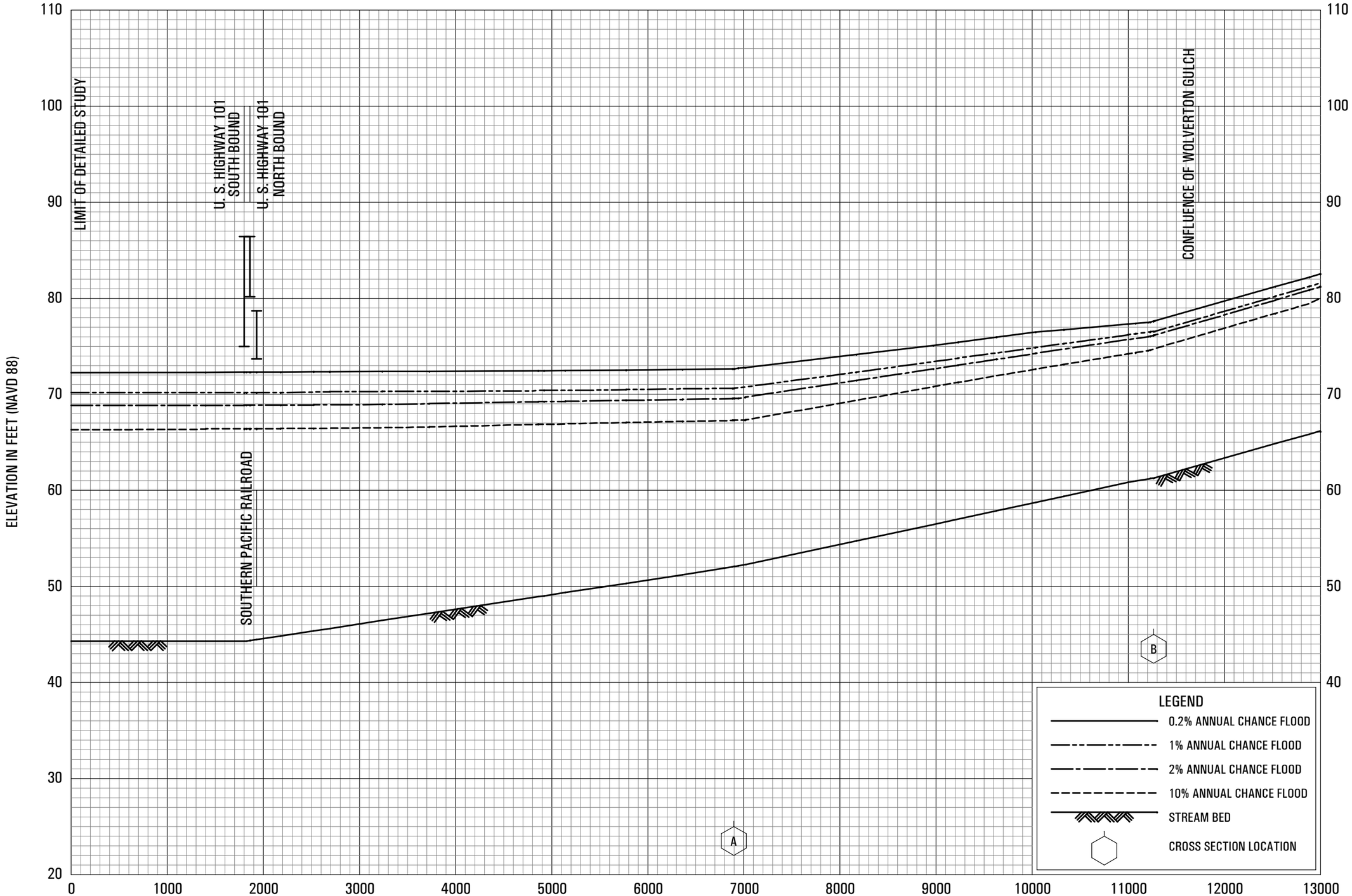
FLOOD PROFILES

TRINITY RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS



*LIMIT OF DETAILED STUDY IS APPROXIMATELY 1,800 FEET DOWNSTREAM OF U.S. HIGHWAY 101 SOUTHBOUND

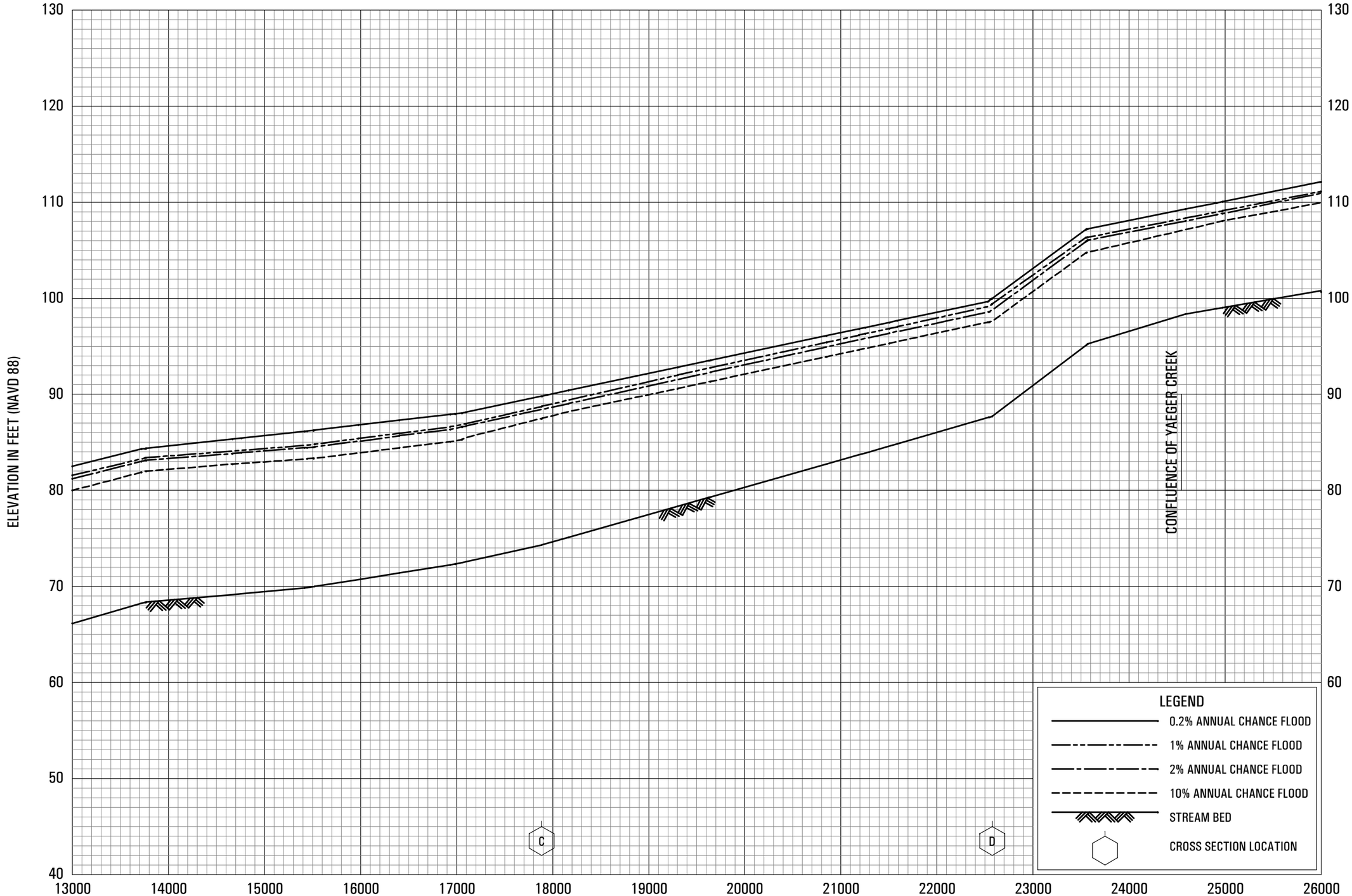
FLOOD PROFILES

VAN DUZEN RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS



*LIMIT OF DETAILED STUDY IS APPROXIMATELY 1,800 FEET DOWNSTREAM OF U.S. HIGHWAY 101 SOUTHBOUND

STREAM DISTANCE IN FEET ABOVE LIMIT OF DETAILED STUDY*

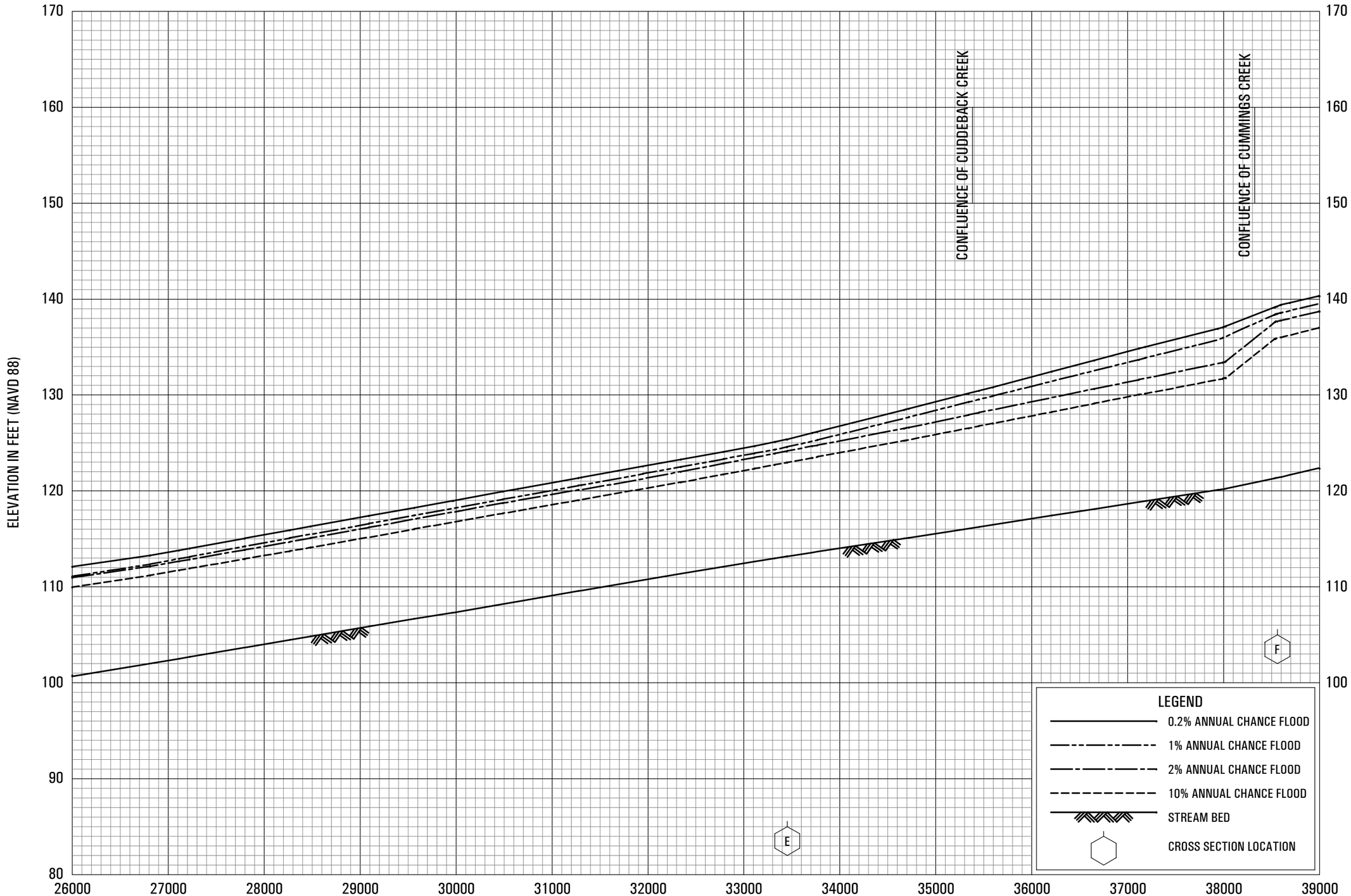
FLOOD PROFILES

VAN DUZEN RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS



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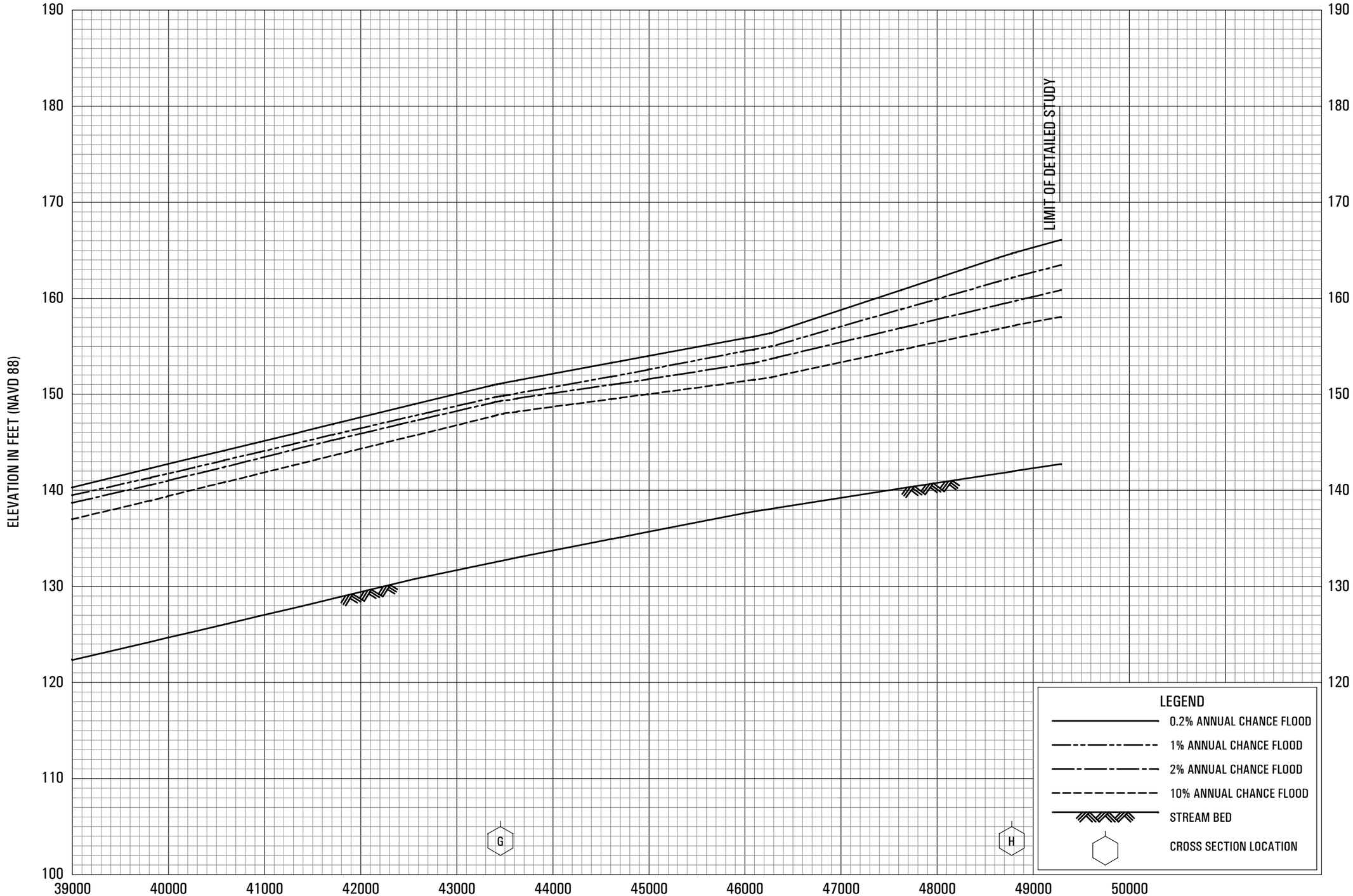
FLOOD PROFILES

VAN DUZEN RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS



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STREAM DISTANCE IN FEET ABOVE LIMIT OF DETAILED STUDY*

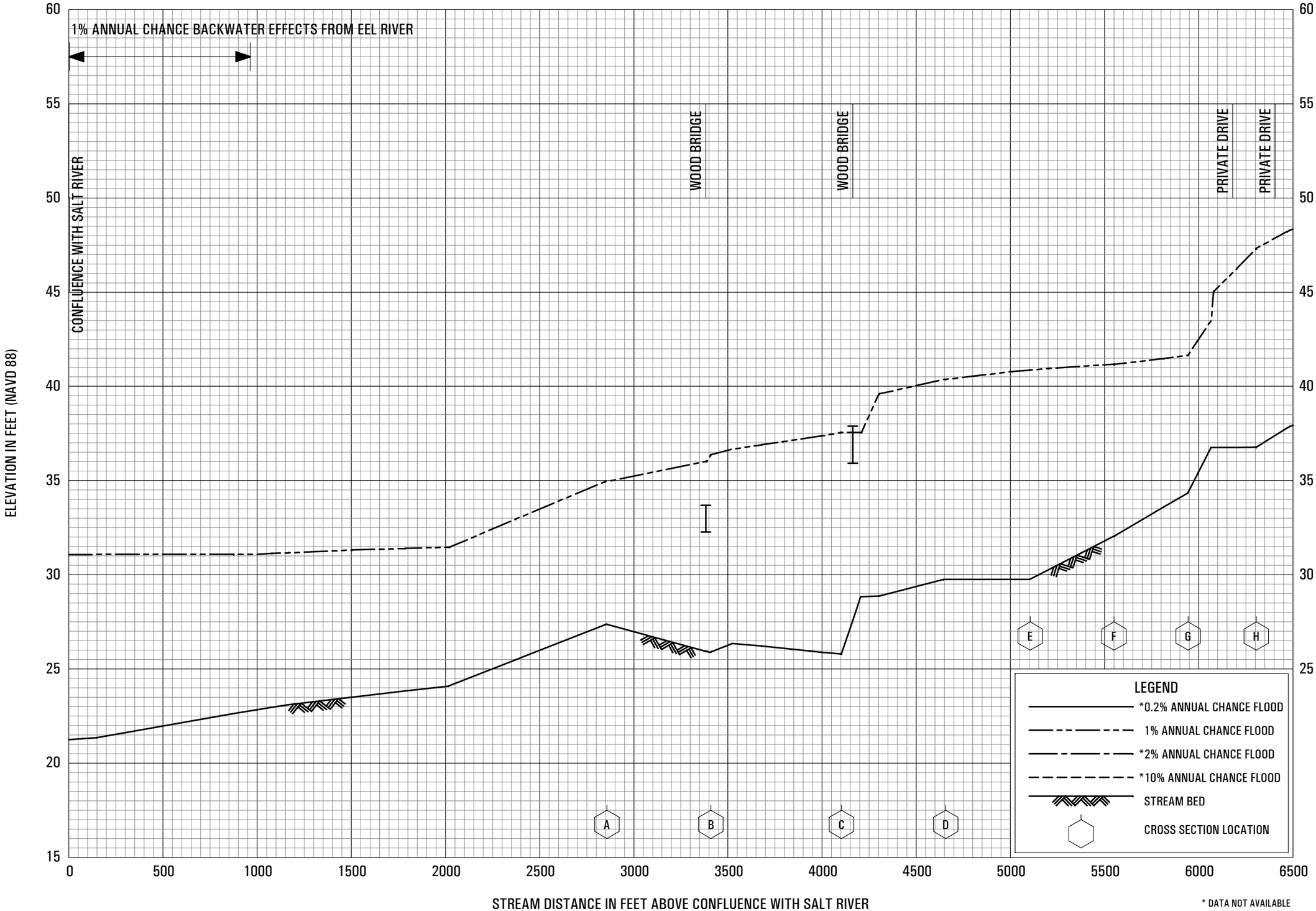
FLOOD PROFILES

VAN DUZEN RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS



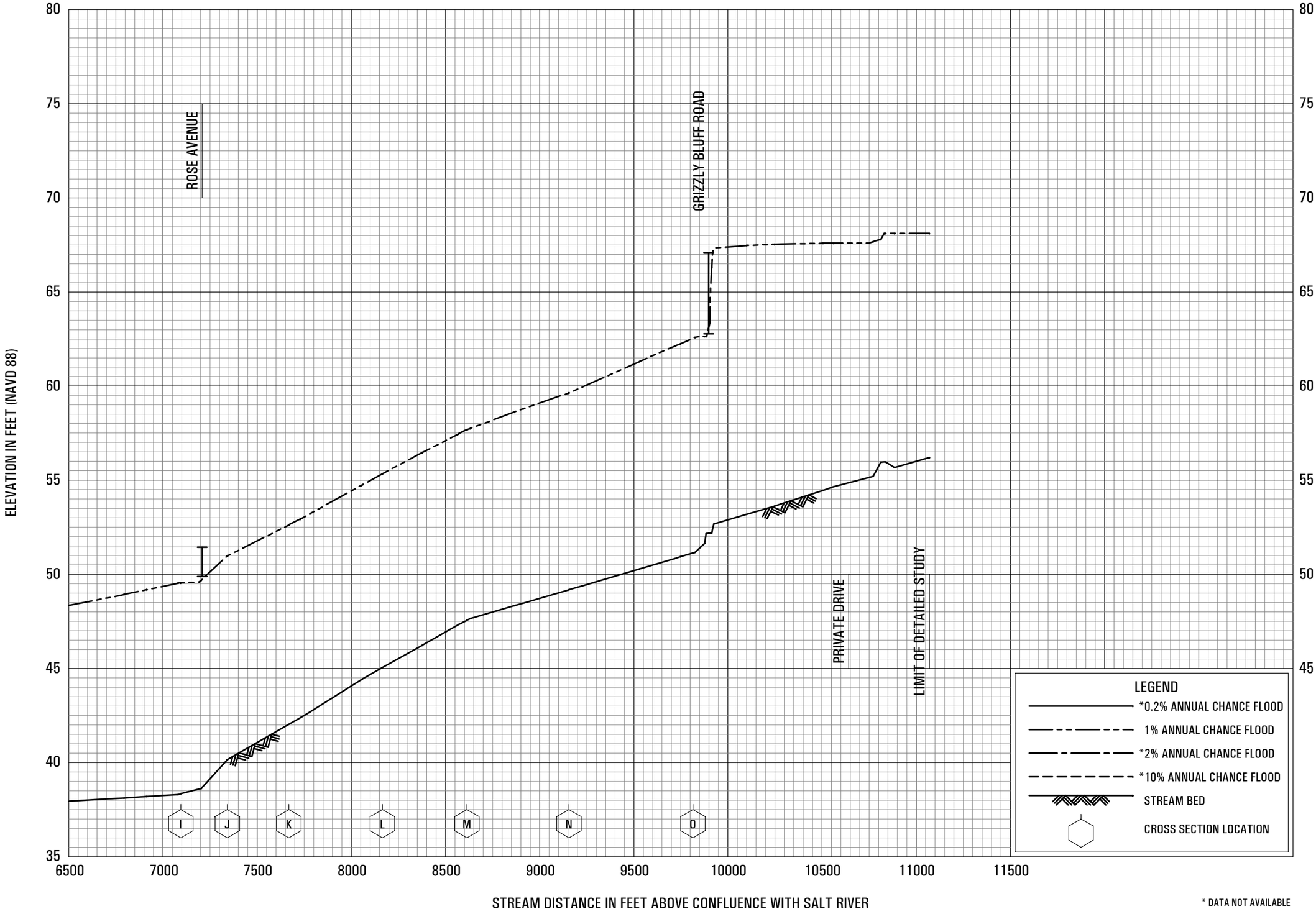
FLOOD PROFILES

WILLIAMS CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS



* DATA NOT AVAILABLE

FLOOD PROFILES

WILLIAMS CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

HUMBOLDT COUNTY, CA

AND INCORPORATED AREAS