FLOOD INSURANCE STUDY

YUBA COUNTY, CALIFORNIA
AND INCORPORATED AREAS

COMMUNITY NAME	COMMUNITY NUMBER
MARYSVILLE, CITY OF	060428
WHEATLAND, CITY OF	060460
YUBA COUNTY (UNINCORPORATED AREAS)	060427

EFFECTIVE DATE:
FEBRUARY 18, 2011

Federal Emergency Management Agency
FLOOD INSURANCE STUDY NUMBER
06115CV000A

NOTICE TO
FLOOD INSURANCE STUDY USERS

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

Selected Flood Insurance Rate Map panels for the community contain former flood hazard zone designations have been changed as follows:

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

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

Initial Countywide FIS Effective Date: February 18, 2011

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FLOOD INSURANCE STUDY
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1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study (FIS) revises and updates information on the existence and severity of flood hazards in the geographic area of Yuba County, including the Cities of Marysville, Wheatland; and the unincorporated areas of Yuba County (referred to collectively herein as Yuba County), and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood-risk data for various areas of the community that will be used to establish actuarial flood insurance rates and to assist the community in its efforts to promote sound floodplain management. Minimum floodplain management requirements for participation in the National Flood Insurance Program (NFIP) are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

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 and incorporated areas within Yuba County in a countywide format. Information on the authority and acknowledgements of each jurisdiction included in this countywide FIS, as compiled from their previously print FIS reports, is shown below.

The hydrologic and hydraulic analyses for the original City of Marysville study, dated December 1976, was performed by the U.S. Army Corps of Engineers (USACE), Sacramento District, for the Federal Insurance Administration, under Inter-Agency Agreement Nos.. IAA-H-16-75 and IAA-H-7-76, Project Order Nos. 17 and 1, respectively. This work, which was completed in April 1976, covered all flooding sources affecting the City of Marysville.

The hydrologic and hydraulic analyses for the original Yuba County (Unincorporated Areas), study dated November 17, 1981, were performed by the U.S. Geological Survey (USGS), for the Federal Emergency Management Agency (FEMA), under Inter-Agency Agreement No. IAA-H-17-75, Project Order No. 12. This work, which was completed in July 1980, covered significant flooding sources affecting the unincorporated areas of Yuba County.

This countywide FIS incorporates the Lower Feather River (LFR) study performed by the USACE Sacramento District, for the State of California, Department of Water Resources (DWR). The LFR study included an analysis of the Lower Feather River, Bear River, Dry Creek, Western Pacific Intercept Canal (WPIC), and Best Slough. This study also included analysis of levee failure and overland flow from these flooding sources. This work was completed in February 2005. The LFR study was revised and completed by MBK Engineers in March 2010.

This countywide FIS also incorporates the California State Reclamation District 784 (RD 784) interior drainage analysis, prepared by MHM Engineers, completed in March 2010, and the City of Wheatland Floodplain Limited Detailed Study, prepared by MBK Engineers, completed in March 2010.

Base map information shown on this FIRM was provided in digital format by Yuba County Information Technology Division. This information was photogrammetrically compiled at a scale of 1:5000 from aerial photography dated 2007.

The projection used in the preparation of this map was Universal Transverse Mercator (UTM) zone 10. The horizontal datum was NAD83, GRS80 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent counties may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of information shown on this 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 initial CCO countywide meeting was held on August 14, 2006, and attended by representatives of Yuba County, City of Wheatland, DWR, RELIA, MBK Engineering, FEMA and Michael Baker Jr. Inc. All problems raised at the meeting have been addressed in this study.

The results of the study were reviewed at the final countywide CCO meeting held on November 18, 2008, and attended by representatives of FEMA, City of Wheatland, Yuba County, TRLIA, RD 784, USACE, City of Marysville, MHM Inc., DWR, MBK Engineers, and Michael Baker Jr. Inc. All problems raised at that meeting have been addressed in this study.

Below is a summary of the community coordination prior to the countywide FIS.

<u>Yuba County</u>

For the original 1981 study, the following were contacted to obtain maps, information, and data pertinent to the study: the Yuba County Public Works Department; the Yuba County Water Agency; California State Reclamation District 784; the State of California, Division of Transportation; the State of California Reclamation Board; the USACE; the U.S. Soil Conservation Service (SCS); the Western Pacific and Southern Pacific Railroads; and the St. Maurice-Helmkamp-Musser consulting firm of the City of Marysville.

Identification of areas for detailed study and selection of base map materials were accomplished in a preliminary coordination meeting attended by representatives of the study contractor, FEMA, the State of California, and Yuba County on March 12, 1975. Alterations to both the detailed and approximate study areas were made as the study progressed. During the course of the study, flood boundaries were reviewed with county officials. On March 6, 1980, the results of the study were reviewed at an Intermediate/Final meeting attended by representatives of the study contractor, FEMA, and county officials. Minor changes in the flood map were made at this time.

In fall 2002, representatives of local Reclamation District (RD) 1001, RD 784, RD 2103, and the Marysville Levee Commission were contacted by USACE staff to obtain accounts of historical flooding. On May 28, 2003, the DWR held a meeting in Marysville of local agency representatives to alert local agencies that the lower Feather River study was in progress and that many levees in the study might be determined to not meet FEMA certification criteria. Represented agencies included the USACE, DWR, State Reclamation Board, RD 1001, RD 784, RD 817, RD 718, LD 1, Yuba County Water Agency (YCWA), Yuba County, Sutter County, City of Marysville and City of Wheatland. Subsequent meetings were held in response to requests from local agencies to meet with DWR and USACE staff to discuss issues pertaining to levee certification.

The results of this study were reviewed at the final Consultation Coordination Officer Meeting held on August 14, 2006, and attended by representatives of Yuba County, the City of Wheatland, DWR, the National Service Provider, and FEMA. All problems raised at that meeting have been addressed in this study.

Marysville

In April 1975, a notice of study initiation, which contained a request for pertinent information, was sent to a standardized list of interagency addresses. About one-third of the agencies expected to respond did so, and the productive leads obtained were followed-up during the course of the study.

Direct contacts were made with the City of Marysville, the California Departments of Transportation and Water Resources, the California State Reclamation Board, the USGS, the Western Pacific Railroad Company, the Southern Pacific Transportation Company and St. Maurice, Helmkamp, Musser, Consulting Engineers.

A preliminary coordination meeting was held on November 20, 1974 to determine areas for detailed study. Intermediate coordination meetings were held on April 15, 1975, and April 9, 1976. A final public coordination meeting was held on September 20, 1976. City officials and representatives of the Federal Insurance Administration and the USACE Sacramento District attended the meetings. Local interests had no objections to the study as presented at the final coordination meeting.

2.0 AREA STUDIED

2.1 Scope of Study

This FIS covers the geographic area of Yuba County, California, including the incorporated cities of Marysville and Wheatland.

Based on an agreement between the City of Marysville, the Federal Insurance Administration, and the USACE, all flooding sources near the City of Marysville would be studied by detailed methods because of the extent of development within the community. The Feather River, the Yuba River, Jack Slough, Ellis Lake, and East Park Lake were studied in detail. These areas were chosen with consideration given to expected development through 1981.

For the November 17, 1981 work, the Feather River was studied by detailed methods in the vicinity of Marysville, from the confluence with Yuba River to a point approximately 2.5 miles upstream.

The Yuba River was studied in detail from its confluence with the Feather River to the dredger tailings above Hallwood Road (approximately 9 miles). The area north of Marysville that is drained by Jack and Simmerly Sloughs, which are tributaries to the Feather River at the northern corporate limits of Marysville, was studied in detail. Hereafter, this area is referred to as Jack-Simmerly Slough.

Linda Drain, Olivehurst Drain, and the portion of Plumas Lake east of State Highway 70 were studied by detailed methods, with the agreement of Yuba County and FEMA, because both drains pass through unincorporated urbanized areas of Yuba County, and terminate in Plumas Lake.

Approximate study areas include sections of the Bear River, Dry Creek, Reeds Creek, Hutchinson Creek, the Upper Yuba River, Linda Drain, Olivehurst Drains, and the Feather River, an unnamed tributary to Plumas Lake, and RD 10 between the eastern levee of the Feather River and the Western Pacific Railroad. 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 Yuba County.

The Lower Feather River (LFR) study, completed by the USACE in February 2005, analyzes flooding from the Feather River downstream of the Yuba River confluence to the mouth of the Feather River at the Sacramento River. It also analyzes flooding from the Bear River, Dry Creek, the Western Pacific Intercept Canal (WPIC), and Best Slough.

Streams studied by detailed methods are listed in Table 1.

Table 1. Streams Studied by Detailed Methods

Stream	Downstream to Upstream Study Limits	Reach Length (Miles)
Bear River	From the confluence with Feather River to approximately 1.0 mile upstream of the confluence of Dry Creek	6.6
Best Slough	From the confluence with Western Pacific Intercept Canal (WPIC) to approximately 1.2 miles upstream of the confluence with WPIC	1.3
Butler Ditch	From the confluence with Upper Linda Drain to approximately 0.5 miles upstream of the confluence with Upper Linda Drain	0.5
Country Club Park Ditch	From the confluence with Edgewater Ditch to its divergence from Upper Linda Drain	0.4
Dry Creek	From the confluence with Bear River to just downstream of Highway 65	5.2
Edgewater Ditch	From the confluence with Olivehurst Interceptor to approximately 0.2 miles upstream of Maywood Drive	1.4
Feather River	From approximately 1.5 miles downstream of the confluence of Bear River to just upstream of the Western Pacific Railroad	16.3
Jack-Simmerly Slough	From the confluence with the Feather River to approximately 0.6 miles upstream of Woodruff Lane	7.8
Olivehurst Interceptor	From the confluence with Reeds Creek to its divergence from County Club Park Ditch	4.2
Upper Linda Drain	From its confluence with Olivehurst Interceptor to approximately 0.9 miles upstream of Linda Avenue	1.4
Upper Olivehurst Drain	From the confluence with Olivehurst Interceptor to approximately 0.5 miles upstream of Olivehurst Interceptor	0.5
Western Pacific Intercept Canal (WPIC)	From the confluence with the Bear River to approximately 2.7 miles upstream of the confluence of Best Slough	4.9
Yuba River	From the confluence with the Feather River to approximately 5.9 miles upstream of Simpson Lane	7.4

2.2 Community Description

Yuba County

Yuba County, in north-central California, is located approximately 110 miles northeast of the City of San Francisco and 45 miles north of the City of Sacramento, the State capital. The county is bordered by Butte and Plumas Counties to the northwest, Sutter and Placer Counties to the west and south, and Nevada and Sierra Counties to the east. Yuba County has a land area of 637 square miles and is largely agricultural. The main urban areas are the City of Marysville, the county seat, located at the confluence of the Yuba and Feather Rivers; and the City of Wheatland, located 13 miles southeast of Marysville. The population of Yuba County was 60,219 in 2000, 58,228 in 1990 and 49,733, in 1980 (Reference 1).

The Feather River forms the western boundary of Yuba County; South Honcut Creek forms part of the northern boundary; the Yuba River forms a portion of the eastern boundary; and the Bear River flows along the southern boundary of Yuba County.

Approximately one-half of the county lies in the mountainous uplands and foothills of the Sierra Nevada and is used primarily for grazing and timber harvesting. The western half of the county lies in the Sacramento Valley and, excluding the urban and suburban areas, is devoted to agriculture consisting primarily of irrigated field crops and orchards.

The county drains to the Feather River, an integral part of the Sacramento River Flood Control Project. Its major tributary, the Yuba River, is also an important part of the project. Both the Feather and Yuba Rivers are perennial streams, having their sources in the lakes, springs, and snowfields near the 10,000-foot level of the Sierra Nevada. The drainage area to these streams is approximately 5,300 square miles on the eastern side of the Central Valley of California (Reference 2). They drain to the Pacific Ocean via Sacramento River, the principal stream in Northern California.

Approximately one-third of the higher elevations of the county drain into the Yuba River. Jack-Simmerly Slough and South Honcut Creek drain the northern area of the county, and the Bear River drains the southern portion of the county via the Western Pacific Interceptor Canal.

The climate in the mountainous portions of Yuba County varies widely; minimum temperatures are below freezing in the winter and there are warm days and cool nights during the summer. In the lower valley portion of the county, temperatures are usually mild, but extremes can vary from a low of 17 degrees Fahrenheit (°F) in winter to a high of 114°F in summer. Annual rainfall ranges from 18 inches on the valley floor to 80 inches in the higher elevations (Reference 3). Precipitation is primarily of frontal origin with 85 percent occurring from October through March.

Soils in the nearly level western portion of Yuba County are sandy to loamy along the Feather, Bear, and Yuba Rivers. To the east of these areas that are adjacent to the Feather River in Jack-Simmerly Slough, Linda Drain, Olivehurst Drain, Reeds Creek, and Hutchinson Creek drainages, the soils are clayey and underlain by hardpan. Grains, grasses, and pasture are the primary agricultural uses in these areas. The remainder of the county northeast of Browns Valley consists of deep rocky soils on steep slopes underlain by basic igneous or metamorphic rock.

Vegetation in the valley area consists of native grasses and minor stands of oak, cottonwood, and willow. Stands of pine, oak, and various hardwoods can be found in the foothill areas, and the higher mountainous areas contain extensive forests of mixed conifers and fir.

Marysville

Marysville is centrally located at the western edge of the county, which is situated in the north-central sector of the state. The city is located at the confluence of the Feather and Yuba Rivers, which form portions of its boundaries. Flowing from the north, the Feather River forms a portion of the westerly boundary and the Yuba River, flowing from the east, forms portions of the boundary on the south and east. Jack Slough and its principal tributary, Simmerly Slough, drain an area adjoining the city on the north and northeast. Jack Slough is a direct tributary to the Feather River.

With the exception of the northeasterly sector of the city, and some riverine areas not protected by flood control levees, Marysville is entirely urbanized. The northeasterly sector of the city (as it is presently constituted) is the only area where further development is expected.

Marysville is located at elevations ranging from 57-67 feet (NAVD) on the flat alluvial floor of the Sacramento Valley, the northern portion of the Central Valley of California. The city is directly across the Feather River from Yuba City to the west, and across the Yuba River from the unincorporated community of Linda to the southeast. The nearest metropolitan center is Sacramento, which is 45 miles to the south. There are numerous small towns and cities in the region, but no other major urban centers within 100 miles by principal highways. In general, Marysville is in agricultural surroundings, with orchards and croplands stretching away to the west, south, and east from the Marysville-Yuba City-Linda urban-suburban complex, and the Jack-Simmerly Slough area to the north and northeast. This area is largely devoted to irrigated cultivation and wildfowl hunting. A hydraulic mining debris area comprising sterile windrows of cobbles lies a short distance to the east.

Marysville (together with Yuba City) is the natural distribution, service, and retail trade center of a strong agri-business, mineral producing, and lumbering region. Agriculture, however, dominates the economy of the surrounding area, which is largely devoted to production of a variety of row, field, and orchard crops. The city and county government establishments, Beale Air Force Base, and the California Department of Transportation also contribute significantly to employment in Marysville. The principal industrial activities in the areas include manufacturing mobile homes, processing food products, and processing lumber products. Recreation is increasingly important in the economy because Marysville is central to a region offering extensive opportunities for hunting waterfowl and upland game birds, and for water-oriented activities on the rivers and lakes nearby.

Economic and areal growth in Marysville is presently limited because the city is bounded on three sides by rivers and the only direction for expansion is into the Jack-Simmerly Slough area to the north and northeast. This area, however, is presently unsuitable for urban development due to lack of flood protection. There is only a small amount of undeveloped land inside the ring levee. Consequently, limited future growth or economic development can be expected. Since 1960, the population of Marysville has risen from approximately 9,000 in 1960 to 11,921 in 2,000 (Reference 1).

As noted, Marysville is located on flat, low-lying land at elevations ranging from approximately 57 to 67 feet NAVD at the confluence of the Feather and Yuba Rivers. Past floods have reached a stage of 81.2 feet NAVD at this location and the Marysville Levee Commission has adopted that elevation as the official design elevation for the ring levee protecting the city. Therefore, the entire city is in the historical flood plain. Small parts of the city are outside the ring levee and in the floodways of the Feather and Yuba Rivers. However, development in these areas is not significant.

Marysville is served by State Highways 20 and 70, and by the Southern Pacific, Western Pacific, and Sacramento Northern Railroads. One commuter type airline maintains week-day flights to Yuba County Airport. National-Pacific Greyhound provides inter- and intrastate bus service.

The Feather and Yuba Rivers are perennial streams that have their sources in high mountain springs, glacial lakes, and long-lived or perpetual snowfields. The drainage area tributary to these streams above Marysville totals approximately 5,300 square miles of mountain, foothill, and valley terrain on the east side of the Central Valley of California. They drain to the Pacific Ocean via the Sacramento River, the principal stream in northern California.

The Feather River, the largest eastside tributary to the Sacramento River, rises at approximately 10,000 feet NAVD in the northern portion of the Sierra Nevada cordillera. Its drainage area above the foothill line is approximately 3,600 square miles, of which approximately 1,500 square miles lie on the exposed western slope and 2100 square miles lie in a series of sheltered valleys east of the main crest. Approximately 300 square miles of drainage area lie below the foothill line. The river has three principal headwater tributaries, which, in order of importance, are the North, Middle, and South Forks. They flow in a general southwesterly direction in deep, narrow gorges to their confluence in Lake Oroville. The main stem flows on a westerly course from Oroville Dam to Oroville, thence on a southerly course to Marysville and its terminus at the Sacramento River.

The Yuba River rises on the western slope of the Sierra Nevada at an elevation of approximately 9,000 feet NAVD. The main stem is formed in the foothill zone by the junctions of the three principal tributaries, the North, Middle, and South Yuba Rivers. In total, the river drains approximately 1,350 square miles, of which 90 percent comprises foothills and rugged mountains.

Jack-Simmerly Slough drains a 55 square mile area of valley floor and foothills adjoining the lower Yuba River Basin on the north. Topography of the area is gentle, except for a low range of hills along the eastern boundary. Elevations range from 50 to approximately 925 feet NAVD.

There are numerous natural and manmade bodies of water in the Feather and Yuba River Basins. They aggregate approximately 2,000,000 acre-feet of storage for hydroelectric power generation, irrigation, domestic water supply, recreation, and control of hydraulic mining debris. They provide incidental reduction of flood flows if they happen to be at low storage levels at the beginning of flood runoff.

The climatology of Marysville proper is not a significant factor in its flood problems, which are principally generated many miles away in the watersheds of the Feather and Yuba Rivers. Climate in these regions varies widely, with marked differences in temperature and precipitation within short distances in areas where rugged topography exerts modifying influences on the movement of air masses. In mountain areas, winter temperatures are moderately severe with minimums usually below freezing during the period from early November to the end of March. Warm days and cool nights characterize the summer months in the mountain area, and frosts may occur in any month of the year at high elevations. Climate in valley floor areas is generally mild without extreme temperature variations. However, a maximum summer temperature of 114F and a minimum winter temperature of 17F have been recorded.

Normal annual precipitation ranges from approximately 18 inches in valley floor areas to approximately 90 inches in the highest headwater areas and less than 15 inches in sheltered valleys east of the main crest of the Sierra Nevada. Normal annual precipitation in Marysville is 20.6 inches. Most of the annual precipitation occurs during the period from October through April, with maximum storm intensities during December, January, February, and March. A large part of the annual precipitation in the Feather River and Yuba River Basins occurs as snow and a deep snowpack normally accumulates.

2.3 Principal Flood Problems

Flood losses due to levee failures in the area is well documented (References 4, 5, 6, 7, and 8). Since the completion of Oroville Dam in 1964, the two most significant floods in the study area occurred in 1986 and 1997. In 1986 the left levee of the Yuba River failed just upstream of the Feather River confluence. The communities of Linda and Olivehurst in Yuba County were inundated, resulting in one death, 895 destroyed homes, and 150 destroyed businesses. In 1997, the left levee of the Feather River failed near Arboga, killing one person, destroying 180 homes and businesses, and prompting evacuation of about 15,000 people from Linda and Olivehurst. Nearly 50,000 people from Yuba City, Marysville, and surrounding areas were evacuated because of fears of additional levee breaks (Reference 5). Both the 1986 and 1997 levee breaks occurred within RD 784. RD 784 has been actively working with the USACE Sacramento District to strengthen the levees in the area.

The February 2005 USACE LFR study was calibrated to flooding that occurred during the January 1997 event.

Floods can occur in the study area anytime during the period from November through April. Floods result from prolonged heavy rainfall and are characterized by high peak flows of moderate duration and by a large volume of runoff. Flooding is more severe when antecedent rainfall has resulted in saturated ground conditions. The severity of flooding on all the streams studied is intensified by backwater conditions between stream systems. Floodwater elevations are increased in the lower portions of tributary streams due to the backwater effect from main streams reducing hydraulic gradients and flow-storage areas. During this time there will be a high degree of coincidental flood flows on waterways.

Backwater from the Feather River during flood stage inundates a large area along Jack-Simmerly Slough north of Marysville (Reference 6). High stages on the Feather River and its tributary, the Bear River, create a backwater condition that extends up Western Pacific Interceptor Canal, Plumas Lake, and into Linda and Olivehurst Drains, which causes flooding in the town of Olivehurst and Linda southeast of Marysville (Reference 7).

Major floods on the Feather and Yuba Rivers can occur anytime during the period from October through June. Two types of flooding, rain and snowmelt, have occurred on these streams. Snowmelt floods usually occur in the late spring or early summer, April through June, and are characterized by long periods of runoff, large volume of flow, moderate peak flows, and diurnal fluctuation in flow. Rainfloods can occur during the period from October through March. Rainflooding is characterized by high peak flows of short duration, and is more severe when snowmelt augments runoff. Rainfloods usually continue for 3 to 5 days with the flood crest occurring during a 12-hour period in the middle of the flood producing storm. Rainfloods can be expected in the Jack-Simmerly Slough area during the period from

October through March. However, this source of flooding in itself does not constitute a significant flood threat to Marysville. The major flood problem in the slough area arises from Feather River floodwater, which has repeatedly backed into the area through a gap left in the project levees near the mouth of Jack Slough and collected against the levee protecting the city on the north. The area serves to store Feather River floodwater temporarily, thus providing a small measure of relief to the river channel downstream. Marysville is also subject to ponding and flooding from heavy general rain or cloudburst storms over the city itself.

As noted, Marysville is situated in the natural flood plains of the Feather and Yuba Rivers and Jack Slough. Prior to completion of the ring levee and the Oroville and New Bullards Bar projects, large floods caused levee failures and resulted in severe flood damage in the Marysville area, Now, levee failure by overtopping is extremely unlikely. There is, however, the remote possibility of levee failure from seepage or erosion. Therefore, the only areas of Marysville with significant flood problems are those outside the levees and in the floodways of the Feather and Yuba Rivers, or those subject to Feather River backwater in the lower Jack Slough area. Barring the unlikely event of failure of the ring levee, or floods greater than existing projects are designed to control, the flood threat to the protected area of Marysville is minimal.

Ten flood periods on the Feather and Yuba Rivers (1805, 25-26, 49-50, 52-53, 59, 61-62, 74-75, 79, 80, and 81) are documented in the 19th century. Marysville was last flooded in 1875 when 10 to 12 feet of floodwater stood in the western part of the city. Nine major floods have been recorded since 1900 (1904, 1907, 1909, 1928, 1937, 1950, 1955, 1963, and 1964). Marysville was seriously threatened in December 1955 when sustained high flows severely damaged the levees. Extensive flood fighting by many citizens and hundreds of airmen from Beale Air Force Base was required to save the city, which had been entirely evacuated. At the peak of the flood, water was coming through the levees at a number of locations and the levees might have failed if a major break downstream on the Feather River had not served to relieve the pressure. In December 1964, another great flood occurred on the Feather and Yuba Rivers. Had it not been for available storage and reduced flow conditions afforded by the partially completed Oroville Lake Project, and reconstruction of the ring levee after the 1955 flood, combined flow of the rivers at Marysville could have resulted in the most disastrous flood ever known in that area. It is estimated that the 1955 and 1964 floods on the Feather River at Marysville both had a recurrence frequency of once in 200 years. The 1955 and 1964 floods on the Yuba River at Marysville both had frequencies estimated at once in 140 years and once in 160 years, respectively.

2.4 Flood Protection Measures

The first efforts at flood protection occurred in the early 1860s when a ring levee was built around Marysville. After that time, various extensions and improvements were made, and in 1917, these levees were incorporated into the Sacramento River Flood Control Project (Reference 2). Also included in the project are levees on the Feather River, the Bear River, the Yuba River, Dry Creek, South Honcut Creek, Jack-Simmerly Slough, and the Western Pacific Interceptor Canal.

Lake Oroville on the Feather River near Oroville and New Bullards Bar Reservoir on the North Yuba River are major flood control structures which are operated under coordinated operating procedures to control total flows in the valley reaches of the Sacramento River Flood Control Project.

New Bullards Bar Reservoir and Lake Oroville would be expected to lessen an 1%-annual-chance flood and significantly decrease downstream discharges in a 0.2%-annual-chance flood on the Yuba River and the Feather River, respectively. The Marysville Lake project on lower Yuba River, 12 miles east of Marysville, was authorized for construction by the USACE in 1966 as the final segment of the three dam system that includes Lake Oroville and New Bullards Bar Reservoir.

Flooding in the Plumas Lake area south of Olivehurst is caused by levee failure along the Feather River as well as high stages in the Bear River restricting outflow from the Western Pacific Interceptor Canal. Flowage easements in the Plumas Lake area have been acquired by the California State Reclamation Board. Ponding in Plumas Lake will cause some backwater along Linda and Olivehurst Drains south of Sixth Avenue during the 1%-annual-chance flood.

Flood protection is afforded Marysville by Lake Oroville on the Feather River, New Bullards Bar Reservoir on the North Yuba River, and by levees that encircle almost all of the city. A storm drain system provides a low degree of protection against ponding and flooding from intense rainfall over the area inside the ring levee. Flood protection to Marysville will was enhanced by Marysville Lake, a multiple-purpose project authorized for construction by the USACE on the mainstem Yuba River.

In the early years, 1851-1861, the main part of Marysville was surrounded by sloughs that served as drainage channels. During periods of highwater, however, flow backed up sloughs and spilled into the city, and overflow from the rivers inundated large areas. Following the severe floods of 1861-62, the City Council began a serious effort to protect the city with levees, and a low ring levee was completed in January 1869. In spite of many improvements during the ensuing 5 years, the levee failed during a flood that occurred in 1874-75. A new levee was planned and completed in November 1875. In some locations it followed differing alignments than the 1869 levee, but the principal improvements comprised raising the crown elevation to 65.5 feet and increasing the width of the crown and base. In addition to the levee encircling the city, the system included a levee section that extends approximately 4 miles north-easterly from the city. Its principal purpose is to prevent Yuba River floodwater from commingling with Feather River floodwater in the Jack-Simmerly Slough area. Subsequent to 1875, the Marysville levees were further strengthened and raised a number of times and in 1917, were incorporated into the Sacramento River Flood Control Project (a federally-sponsored project comprising a comprehensive system of levees, overflow weirs and bypass channels, improved channels, and other works along the lower 184 miles of the Sacramento River and the lower reaches of its principal direct and indirect tributaries). Further improvements comprising new embankment, stone protection, levee surfacing, and miscellaneous other work have been completed since 1934 to bring the levees to project structural specifications and their present principal crown elevation of 84 feet. The ring levee is maintained to prescribed Federal standards by the Marysville Levee Commission under assurances given to the State Reclamation Board, which has the primary legal responsibility for maintaining facilities of the Sacramento River Flood Control Project.

Lake Oroville and New Bullards Bar Reservoir were built by local interests with Federal contributions toward their costs in recognition of the potential flood control capability. Projects built under this arrangement, which must be authorized by the Congress, are known as "Partnership Projects" and, pursuant to Section 7 of the 1944 Flood Control Act, must be operated for flood control according to regulations established by the USACE. Pertinent data on Lake Oroville and New Bullards Bar Reservoir follow.

Marysville Lake was the final project in a three-dam system that includes Oroville Lake and New Bullards Bar Reservoir. Coordinated operation of this system contemplates releases that will not exceed levee project design capacities. If a major flood should occur on the local contributing area between Lake Oroville and Marysville at the same time that large flood control releases were being made; releases would be so regulated that Feather River flow would not exceed the objective flow of 180,000 cubic feet per second at Marysville. Objective flow is defined as the maximum flow, at critical control points downstream from flood control dams, that will not be exceeded so long as it is possible to regulate releases, giving consideration to local or tributary inflow between the dam and the control point. That flow would be adequately contained in the floodway. Until Marysville Lake is completed, it may be necessary to prolong encroachment into the flood control reservation at Lake Oroville and hold back outflow so that the combined flow in the Feather and Yuba Rivers will not exceed objective flow of 300,000 cubic feet per second in the Feather River downstream from Marysville.

The municipal storm drain system, provided to protect Marysville from heavy downpours over the city itself, consists of an underground collection system that discharges into Ellis and East Park Lakes and two sump areas, one in the southern sector of the city and one in the northeastern sector. Excess drainage is pumped over the ring levee and into the rivers. The system is considered to provide 10%-annual-chance flood protection in residential areas and 4%-annual-chance flood protection in other areas of the city.

The Marysville zoning plan does not provide for flood zones. However, the portions of the city on the water side of levees are classified as open space districts. The regulations provide that these areas may be utilized as wildlife sanctuaries or natural areas (including waterway frontages), or used for agriculture, transmission lines, canals, highways and wastewater treatment plants. The Feather River has been included in the designated floodway program of the State of California. Under this program, the State Reclamation Board has statutory authority to regulate uses of and construction in designated floodways in such a way that passage of flood flows is not impaired.

3.0 ENGINEERING METHODS

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

For flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Floods having recurrence intervals of 10, 50, 100, and 500 years have been selected as having special significance for flood plain management and for flood insurance premium rates. The analyses reported here reflect current conditions in the watersheds of the streams.

3.1 Hydrologic Analyses

Yuba County

Hydrologic analyses were carried out for the original Yuba County (Unincorporated Areas) to establish peak discharge-frequency relationships for each flooding source studied by detailed methods affecting the community.

Flood conditions in Yuba County are primarily caused by backwater resulting from high stages on the Feather River. This is particularly severe south of Marysville when high Feather River stages and Bear River flows combine to restrict outflows from the Western Pacific Interceptor Canal and cause flooding in the Plumas Lake area and the lower areas of Olivehurst. The original study hydrographs and peak flows on the Feather River, the Yuba River, and Jack-Simmerly Slough were based on previous floodplain information studies in the area by the USACE (References 10, 11, and 12). Results of the studies were focused in a Floodplain Information report published in 1968 (Reference 12). The hydrology was re-evaluated by the USACE for the FIS for the City of Marysville (Reference 2) by use of updated hydrology for the Yuba River system, approved operating criteria for Lake Oroville and New Bullards Bar Reservoir (References 13 and 14), and improved methods of hydrologic analyses. These latest analyses for Yuba River, Feather River, and Jack-Simmerly Slough were adopted for use in this study. The estimated floodflows for Jack-Simmerly Slough (unregulated) were verified using the regression equations of Waananen and Crippen (Reference 15).

The remaining portion of the detailed study is in the urbanized areas of Linda and Olivehurst, southeast of Marysville. Flood flows in these areas are conveyed to the Plumas Lake storage area and then discharged to the Bear River via the Western Pacific Interceptor Canal. Peak discharge-frequency relationships for the Linda-Olivehurst study area were computed by methods used by the SCS (Reference 16). Unit hydrographs for each drainage considered were computed using basin characteristics of watershed slope, length, and runoff potential as determined from the soil cover complexes for Yuba County (Reference 17). Estimated depths of runoff for the selected recurrence intervals are based on a Type-I storm distribution of the 24-hour precipitation depths for the study area (Reference 18). The 0.2%-annual-chance depth was obtained by logarithmic extrapolation. Application of these runoff depths to the computed unit hydrographs produced the flood hydrograph for each selected recurrence interval.

Routing of the flood hydrographs for Linda Drain, Olivehurst Drain, Reeds Creek, Hutchinson Creek, and one unnamed tributary to Plumas Lake was accomplished by the reservoir storage method (Reference 17) to obtain outflows to the Western Pacific Interceptor Canal and Plumas Lake elevations for the selected recurrence intervals.

Marysville

Hydrologic analyses were carried out to establish the peak discharge frequency relationship for floods of the selected recurrence intervals for each stream studied in detail in the community.

As indicated earlier, flood conditions in the City of Marysville can originate from high flows in the Feather and Yuba Rivers, or from ponding within the confines of the levee system surrounding the city due to rainfall excesses that cannot be removed by the existing storm drain system.

Hydrographs and peak flows for the 10%-, 2%-, 1%-, and 0.2%-annual-chance floods on the Yuba and Feather Rivers and various tributaries were based primarily on previous studies of the area by the USACE (References 10,11, and 19). Briefly, the procedures used included the USACE standard project rainfall and flood concept, the unit hydrograph method of analysis, a statistical analysis of streamflow data, and current operating criteria for the upstream reservoirs (References 13 and 14). Standard project rainfall was based on criteria presented in either Reference 20 or 21.

Unit hydrographs, loss rates, and streamflow routing characteristics were based primarily on reconstitutions of historical events. A statistical analysis of available streamflow data was made to develop natural condition (no regulation by upstream reservoirs) flow frequency curves at the following locations:

Location	Approximate Drainage Area (square miles)	Period Used in Analysis
Yuba River at Smartville	1,195	1904-1972
Yuba River at mouth	1,350	1944-1972
Feather River at Oroville	3,611	1903-1972

These natural condition flow-frequency curves in conjunction with routings of the standard protect, 10%-, 2%-, 1.33%-, 1%-, 0.2%-, and 0.1%-annual-chance floods through the existing upstream reservoirs were used to develop existing condition flow-frequency curves and flood hydrographs at Marysville.

Rainfall excesses for the 10%-, 2%-, 1%-, and 0.2%-annual-chance floods were computed for that portion of the city confined by levees by subtracting infiltration and ponding losses from storm amounts. Ninety-six hour general rainstorm amounts were based on an analysis of annual maximum 4-day precipitation amounts at the Marysville precipitation gage (period of record 1921 - 1970). The hourly distribution of these storm amounts was based on data presented in Reference 22. Losses for the area were estimated from previous studies in the area (Reference 19) and were modified to account for the imperviousness of the area.

The computational methods and techniques used are generally accepted for hydrologic analyses and produced results considered reasonable for the Marysville area. Unexpected results were not encountered in carrying out the hydrologic analyses for this flood insurance study.

Yuba Countywide:

Feather River Hydrology - The hydrologic analysis for the Lower Feather River extended from the confluence with the Yuba River down to the confluence of the Sacramento River. While the Lower Feather River hydrology made extensive use of data developed for the Sacramento and San Joaquin River Basins Comprehensive Study (Comp Study) prepared by the USACE in 2003, none of the synthetic storms developed for the Comp Study were centered at locations along the Feather River within the study area. Thus, two hypothetical storm centerings were developed for the most upstream and downstream locations within the study reach: the Shanghai Bend centering and the Latitude of Verona storm centering.

The hypothetical storm patterns were generated using methods and procedures documented in Rain Flood Flow Frequency Analysis, Feather and Yuba Rivers, California (Reference 23), by the USACE in 1999, which was approved by FEMA. The hydrographs were constructed following the methods described in the Comp Study.

There are twenty-six reservoirs within the Yuba-Feather-Sacramento River system. The reservoir routing for the Feather River system was accomplished using both HEC-5 and ResSim modeling packages. A HEC-5 model was constructed for the entire Sacramento River Basin as part of the Comp Study. The HEC-5 Feather-Yuba sub-watershed models developed for the Comp Study were converted to a ResSim model for the Lower Feather River study. The ResSim model was used to model the Feather River system from Oroville down to Nicolaus. ResSim models incorporating both the Shanghai Bend and the Latitude of Verona storm centerings were developed. The Shanghai Bend centering produced the maximum channel stages on the Feather River and the lower Bear River and thus, only the Shanghai Bend storm centering was used in the final hydrologic models.

While a number of ResSim model runs were developed to incorporate a forecast uncertainty component to the local flow contributions downstream of a reservoir, the 10-, 2- and 1%-annual-chance final models assumed complete certainty in local flow contributions. The 0.2%-annual-chance model incorporated a 20 percent contingency in the local flow contribution.

The model was calibrated using the 1997 flood event and the peak flows results were reasonably close to the stream gage data. The reservoir operational strategies were built in ResSim for the Feather River and the model results are reasonable.

The Comprehensive Study HEC-5 model was used to model the Sacramento River System down to the confluence with the Feather River (near Verona). The HEC-5 model for the Sacramento River System was not included in the USACE submittal to FEMA.

Bear River Hydrology - The Bear River storm centering produced maximum stages in the upper Bear River and lower reaches of Dry Creek and Yankee Slough (tributaries to the Bear River) located in Yuba County. As part of the Bear River hydrology, data was also developed for the case of a storm centered over the Bear River tributaries. This case produced maximum stages in the upper reaches of Dry Creek and Yankee Slough. Hydrographs were developed for the 10%-, 2%-, 1%-, and 0.2%-annual-chance flood events, and were used for the one dimensional channel hydraulic models. Four separate Hydrologic Modeling System (HMS) models were created for this Lower Feather River study:

- Bear River above Wheatland gage
- Dry Creek above Jasper Lane
- UP Intercept Canal above Plumas Lake
- Yankee Slough above Swetzer Road

The Bear River and Dry Creek HMS models were calibrated to the January 1997 flood event. The following scenarios were modeled in HMS: a) the 10%-, 2%-, 1%-, and 0.2%- annual-chance exceedence events for the event centered on the Bear River along with coincident flow from the tributaries that would produce a 10%-, 2%-, 1%-, and 0.2%-annual-chance exceedence flow at the confluence of the Bear and the Feather River, b) the 10%-, 2%-, 1%-, and 0.2%-annual-chance exceedence events for a storm centered on each major tributary (Dry Creek, UP Intercept and Yankee Slough).

The discharges for the channels within RD 784 were determined using a HEC-1 rainfall runoff modeling, with both the 24 hour and 10 day 1%-annual-chance storm events. Though the Special Flood Hazard Area (SFHA) delineations in RD 784 are all Zone A, the delineations were based on detailed hydrologic and hydraulic analyses.

Peak discharge-drainage area relationships for the streams studied by detailed methods are shown in Table 2.

Table 2. Summary of Peak Discharges

Flooding Source and Location	Drainage Area (sq mi)	Peak Discharge (Cubic Feet Per Second)			
		10-percent annual-chance	2-percent-annaul-chance	1-percent-annaul-chance	0.2-percent-annaul-chance
Bear River At Wheatland	292	*	*	*	*
Best Slough At Western Pacific Interceptor Canal	9.7	*	*	*	*
Dry Creek Above Best Slough Split At Jasper Lane	82 101	*	*	*	*
Feather River Upstream from confluence with Yuba River	3,980	*	*	*	*
Jack-Simmerly Slough At Woodruff Lane At Confluence with Feather River	50.0 55.0	2,800 3,000	5,300 5,700	6,700 7,000	10,000 10,500
Olivehurst Interceptor Immediately downstream of Erle Road	5.8	330	446	466	517
Upper Linda Drain At North Beale Road	5.3	150	186	234	329
Upper Olivehurst Drain At Confluence with Olivehurst Interceptor	3.2	81	115	163	224
Western Pacific Intercept Channel At Plumas Lake	87.2	*	*	*	*
Yuba River At confluence with Feather River	1,350	*	*	*	*

*Peak discharge does not apply. Stream reaches were studied using HEC-RAS unsteady state models.

3.2 Hydraulic Analyses

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

<u>Yuba County</u>

Flood elevations along the Feather River were previously determined as part of the FIS for the City of Marysville. The elevations were developed through use of the USACE HEC-2 water-surface profile computer program (Reference 25). Cross section information for the

Feather River was developed from topographic data furnished by the DWR (Reference 26). Supplementary data were derived from USACE maps (Reference 27) and a USGS topographic map (Reference 28). Field observations were made to supplement available topographic data. Elevations for floods on the Yuba River and Jack-Simmerly Slough were previously determined near the confluence with the Feather River as part of the FIS for the City of Marysville (Reference 2). These elevations, which were developed through use of the USACE HEC-2 computer program were verified and extended to include the reaches within this study area using computer program E-431 (Reference 29). On the Yuba River, data for 22 cross sections were developed from field survey information provided by the State Reclamation Board, the State Department of Transportation, Western Pacific and Southern Pacific Railroad bridge plans, and the USACE. Two additional cross sections were obtained from field surveys. On Jack-Simmerly Slough, nine cross sections were developed from field survey data supplied by the USACE, the State Department of Transportation, and the Western Pacific and Southern Pacific Railroads. Nine additional cross sections were obtained by field surveys.

For Linda Drain and Olivehurst Drain, WSELs for floods of the selected recurrence intervals were computed using 11 culvert surveys and 49 cross sections on the two streams in the Linda-Olivehurst study area and USGS computer programs E-431 (Reference 29). All data for these computations were obtained by field surveys. Topographic data used to delineate shallow overflow in some areas was provided by the State Department of Transportation.

Starting WSELs for the step-backwater computations on the Feather River were developed from stage-discharge data provided by the DWR. Starting WSELs for the step-backwater computations on the Yuba River and Jack-Simmerly Slough are those at the confluence with the Feather River.

Maximum WSELs in the Jack-Simmerly Slough area occur with maximum stages on the Feather River. A major portion of the study area will be inundated by flows of the selected recurrence intervals.

Starting WSELs for Linda Drain were those computed for Plumas Lake and described in Section 3.1. Starting WSELs for Olivehurst Drain were those computed at the confluence with Linda Drain.

Main channel roughness factors (Manning's "n") for these computations were assigned on the basis of field inspection and ranged from 0.025 to 0.045 for Jack-Simmerly Slough, from 0.030 to 0.050 for Yuba River, 0.030 for the Feather River and O1ivehurst Drain, and 0.035 for Linda Drain. Roughness factors for overbank areas ranged from 0.030 to 0.055 for Jack-Simmerly Slough, Linda Drain, and Olivehurst Drain, from 0.040 to 0.060 for the Feather River, and from 0.040 to 0.065 for Yuba River.

Flooding in the Linda area, for flows of the selected recurrence intervals, is a result of the limited channel capacity of Linda Drain and restrictive hydraulic structures. Major overflows will occur to the west, overflowing North Beale Road and moving to the general area northeast of the Southern Pacific Railroad between North Beale Road and Rupert Siding. A railroad bridge at Rupert Siding and the North Beale Road Underpass provide the only flow paths under the Southern Pacific Railroad. Floodwaters passing the railroad barrier will flow over State Highway 70 to the Western Pacific Railroad. Openings through the railroad occur only at Feather River Boulevard Underpass and culverts south of Grand Avenue. The areas west of the Western Pacific Railroad comprise RD 784 and are not included in the detailed study area.

Flows contained in the Linda Drain channel downstream of the North Beale Road area are conveyed to the Southern Pacific Railroad south of Erle Road. Some ponding will occur upstream of the railroad and State Highway 70. Downstream from the highway, Linda Drain flows westward to the Western Pacific Railroad and then southerly, along the railroad, to Plumas Lake. Olivehurst Drain floodwaters will pond upstream from the Southern Pacific Railroad and State Highway 70. Floodflows passing under the highway, together with Linda Drain flows, will inundate areas of Olivehurst. The inundation results from limited channel capacities caused by flat slopes, restrictive hydraulic structures, and the backwater effects from Plumas Lake.

Marysville

Analyses of the hydraulic characteristics of streams and lakes in the City of Marysville were carried out to provide estimates of the elevations of floods of the selected recurrence intervals along each flooding source studied in detail.

Flood elevations along the Feather and Yuba Rivers and Jack Slough were determined through use of the USACE HEC-2 water-surface profile computer program (Reference 25).

Stream cross sections for hydraulic analysis were located at representative locations throughout the study area. Additional cross sections were located in the vicinity of bridges to determine the backwater effect of these structures. Cross section information for the Feather River was developed from topographic data furnished by the California Department of Water Resources (Reference 26). Cross section information for the Yuba River consisted primarily of data developed by the State Reclamation Board (References 37 and 38). Cross sections for Jack Slough were developed from bridge plans furnished by the California Department of Transportation and the Western Pacific Railroad Company (References 39 and 40). Supplementary data were derived from USACE maps (Reference 27) and a USGS quadrangle map (Reference 28). Field observations were made to supplement available topographic data. The locations of selected cross sections are shown on the Flood Boundary and Floodway Map.

Hydraulic roughness coefficients (Manning's "n" values) were determined from stream gage data and field observations. The coefficients used ranged from 0.030 to 0.040 for channels and from 0,030 to 0.060 for overbank areas.

Flood profiles were drawn showing computed water-surface elevations to an accuracy of 0.5 foot for floods of the selected recurrence intervals (Exhibit 1). A flood profile was developed for Jack Slough but has not been included in this report because the entire stream segment studied was influenced by backwater from the Feather River. Starting elevations for the Feather and Yuba Rivers were developed from stage-discharge data provided by the California Department of Water Resources. Area-volume relationships necessary to analyze Ellis and East Park Lakes were derived from available topographic mapping, (Reference 28) supplemented by field observations. Pump capacities and other characteristics of the city storm drain system were provided by the City of Marysville and St. Maurice, Helmkamp, Musser, Consulting Engineers, Marysville.

The hydraulic analyses reflect unobstructed flow conditions. Flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed and existing dams, levees, and pumping facilities previously described operate properly and do not fail.

Yuba Countywide

The survey data on which the hydraulic models and floodplain mapping were based is listed in Table 3.

Table 3. Survey Data Summary

Model Name	Model Type	Data Source	Survey Year	Contour Interval
Channel	HEC-RAS	Comprehensive Study - Photogrammetric & Bathymetric Data[1]	1997	2 foot
Sutter Basin	FLO-2D	Comprehensive Study Photogrammetric	1997	2 foot

[1]Bathymetric data was not available for Bear River and tributaries (Dry Creek, Yankee Slough). Cross section inverts in these reaches reflect low flow water surface elevations at time of photogrammetric survey.

Table 4 lists bridges represented in the model within the Lower Feather River study area and data sources for dimensions. For bridges in which field measurements were used to obtain dimensions, elevations were obtained by estimating the vertical distance between top of levee and bridge deck. Top of levee elevations from the survey data were then used to estimate elevations of bridge features.

Table 4. Bridge Data

River/Stream	HEC-RAS River Mile	Crossing	Data Source
Feather River	9.270	HWY 99	As-Built Drawing
Feather River	27.955	UPRR	Field Measurements
Feather River	27.970	5th Street	As-Built Drawing
Feather River	28.321	HWY 20	As-Built Drawing
Bear River	3.565	HWY 70	As-Built Drawing
Bear River	4.066	UPRR	Field Measurements
Bear River	6.925	Pleasant Grove Rd.	As-Built Drawing
Bear River	11.540	HWY 65	As-Built Drawing
Bear River	11.568	UPRR	Field Measurements

The starting point for developing the channel hydraulic model was a UNET (Reference 33) model developed for the Comprehensive Study (References 34 and 35). River alignments and cross section geometry from this model were imported into HEC-RAS (Reference 30).

Manning's n values were initially taken from the UNET model, but were later adjusted during calibration.

Downstream boundary conditions consisted of a stage-discharge rating curves at the Verona stream gage on the Sacramento River and at the "Near Woodland" gage in the Yolo Bypass near Interstate 5.

The channel model was calibrated to the 1997 storm event. The model was calibrated by adjusting Manning's n values to provide a reasonable fit to observed peak stages. Peak stage data was available in the form of recorded stage hydrographs at gages, and observed high water marks collected in the weeks following the flood event. The calibrated model closely reproduced stage hydrographs at gage locations. Table 5 summarizes observed and computed peak stages at the stream gage locations bounding the Lower Feather River study area. Observed high water marks are included in the hydraulic model, and can be plotted using HEC-RAS.

Table 5. 1997 Peak Stages at Stream Gage Locations

River	River Mile	Gage Location	Operating Agency	1997 Recorded Stage (ft, NGVD29)	1997 Computed Stage (ft, NGVD29)
Feather River	27.5	Yuba City	DWR	75.2	75.2
Feather River	8.0	Nicolaus	DWR	47.3	47.2
Yuba River	6.1	Near Marysville	DWR	88.6	88.7
Bear River	6.9	Pleasant Grove Road	DWR	70.8	70.7

The City of Wheatland is located between Dry Creek and the Bear River. Highway 65 and the railroad run primarily north-south and bisect the city. The SFHA delineation within the City of Wheatland is based on two levee failure scenarios added to the LFR unsteady HEC-RAS models, failure of the Bear River north levee upstream of the railroad/Highway 65 crossing (RM 14.63 – 11.57) and failure of the Dry Creek south levee upstream of the railroad/Highway 65 crossing (RM 7.59 – 5.20), respectively. The best available topographical data for the study area was USGS 30-meter DEM, as such, the results were incorporated as approximate Zone A areas.

The SFHA delineations within RD 784 are based on three separate unsteady flow HEC-RAS hydraulic models, completed by MHM Engineers. RD 784 was divided into sub-basins A, B, and C, considering scenarios of possible overflows between basins, and potential impacts of pumping failure. Though the SFHA boundaries are based on detailed analyses, the results were incorporated as approximate Zone A areas.

Model Simulations

Twelve simulations were performed with no levee failures. These correspond to the combination of three storm centerings (Shanghai-Yuba, Bear River, and Bear River Tributaries) and four event magnitudes (the 10%-, 2%-, 1%-, and 0.2%-annual-chance flood events).

Sixteen additional simulations were performed for the 1%-annual-chance events to identify combinations of levee failures that produce increased stages at locations throughout the Feather River, the Bear River and the Bear River tributaries, where the levees have not been strengthened or certified to provide protection from the 1%-annual-chance flood. The Bear River tributaries can become flooded when Bear River levees fail, allowing additional water into the tributaries. The lower Bear River can become flooded if a levee fails on the Feather River right bank. Table 6 lists the channel model simulations that were run along with the HEC-RAS short identifications (short IDs). The short IDs are useful for identifying output data in the HEC-RAS project. As an example, the short ID "100-BR-A" indicates the 1%-annual-chance Bear River centering with levee failure scenario A. The other short IDs are SHY for the Shanghai Bend storm centering, and BRT for the Bear River Tributary storm centering. The different scenarios were developed for the purpose of identifying the maximum 1%-annaul-chance composite water-surface profile in the channel. The final base flood elevation(BFE)for each stream cross section in the lower Feather River system is a composite using the highest calculated 1%-annual-chance WSEL among all the modeled scenarios, except for those cross sections where the highest WSEL exceeds the top elevation of the levee. In these instances, the top-of-levee elevation is to be used to determine the 1%-annual-chance WSEL (Scenario MIN TOL).

The levee failure scenarios were represented in HEC-RAS models by specifying lateral weirs at the overbank ground elevation to simulate the absence of the levee.

Flood profiles generated for Yankee Slough, and the Feather and Bear Rivers for the 10%-, 2%-, 1%-, and 0.2%-annual-chance events. For each of these four events, the profile is the maximum of the three storm centerings evaluated and plotted. Note that the 1%-annual-chance profile is the maximum of the non-failure water-surface elevations and all levee failure scenarios considered these elevations. The model simulation which yielded the maximum water surface at each location for the 1%-annual-chance event is indicated by the HEC-RAS short ID.

HEC-RAS unsteady models were also used to determine overbank level pool elevations, and outflow hydrographs at locations of levee failures. Two two-dimensional (2-D) models were used to model overland flow over alluvial floodplains. The models were developed and run using the software package FLO-2D (Reference 31). Each 2-D model used levee failure hydrographs from the channel model as inflows at the levee failure locations. The two general areas covered by the 2-D models are Sutter Basin and Nicolaus.

The 2-D models were used to designate the limit of an approximate (Zone A) SFHA. This SFHA is indicative of levee failure scenarios.

Areas subject to shallow flooding were studied using field investigations, engineering judgment, and hand calculations based on normal depths.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1).

Analyses of the hydraulic characteristics of streams and lakes in the community were carried out to provide estimates of the elevations of floods of the selected recurrence intervals along each flooding source studied in detail.

Flood elevations along the Feather and Yuba Rivers and Jack Slough were determined through use of the USACE HEC-2 water-surface profile computer program (Reference 13). Elevations for Ellis and East Park Lakes were computed through USACE interior drainage flood routing computer program (Reference 14).

Stream cross sections for hydraulic analysis were located at representative locations throughout the study area. Additional cross sections were located in the vicinity of bridges to determine the backwater effect of these structures. Cross section information for the Feather River was developed from topographic data furnished by the California Department of Water Resources (Reference 16). Cross section information for the Yuba River consisted primarily of data developed by the State Reclamation Board (References 17 and 18). Cross sections for Jack Slough were developed from bridge plans furnished by the California Department of ran sport at ion and the Western Pacific Railroad Company (References 24 and 25). Supplementary data were derived from USACE maps (Reference 26) and a USGS quadrangle map (Reference 27). Field observations were made to supplement available topographic data.

Hydraulic roughness coefficients (Manning's "n" values) were determined from stream gage data and field observations. The coefficients used ranged from 0.030 to 0.040 for channels and from 0,030 to 0.060 for overbank areas.

Flood profiles were drawn showing computed water-surface elevations to an accuracy of 0.5 foot for floods of the selected recurrence intervals (Exhibit 1). A flood profile was developed for Jack Slough but has not been included in this report because the entire stream segment studied was influenced by backwater from the Feather River. Starting elevations for the Feather and Yuba Rivers were developed from stage-discharge data provided by the California Department of Water Resources. Area-volume relationships necessary to analyze Ellis and East Park Lakes were derived from available topographic mapping, (Reference 27) supplemented by field observations. Pump capacities and other characteristics of the city storm drain system were provided by the City of Marysville and St. Maurice, Helmkamp, Musser, Consulting Engineers, Marysville.

The hydraulic analyses reflect unobstructed flow conditions. Flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed and existing dams, levees, and pumping facilities previously described operate properly and do not fail.

In May of 2010, Three Rivers Levee Improvement Authority submitted a certification package for the RD 784 Levee System. This certification was made in accordance with the requirements, definitions, and descriptions in the Code of Federal Regulations, Title 44-Emergency Management and Assistance, Part 65, and has been accredited by FEMA.

Table 6. 1-Percent-Annual-Chance Model Simulations

HEC-RAS Short ID	Modeled Levee Failure Locations
100-SHY	No levee failures
100-BR	No levee failures
100-BT	No levee failures
100-BR-A	Bear River (L) RM 11.50-7.00, 6.916-6.00, 3.85-3.58, 3.00-1.01; Yankee S1ough (L) RM 6.37-5.71, 5.38-4.34, 4.26-3.56, 3.25-2.00, 1.75-1.00; Dry Creek. (L) RM 4.44-4.00, 5.16-4.70
100-BR-B	Bear River (R)RM 11.50-7.98; Dry Creek (R) RM 2.85-2.38, 2.23-2.05, 1.87-1.00
100-SHY -C	Bear River (L) RM 3.00-1.01
100-SHY-D3	Feather River (R) RM 22.50-20.00
100-BR-E	Bear River (L)RM 11.50-10.00
100-BR-F	Bear River (L) RM 8.75-8.25
100-SHY-G	WPIC (R) RM 1.25-0.25; Dry Creek (L) RM 2.23-2.05, 1.87-1.00
100-BR-H	WPIC (R) RM 1.25-0.25; Dry Creek (L) RM 2.23-2.05, 1.87-1.00
100-BR-I	Bear River (R)RM 11.50-7.00; Dry Creek (L) RM 4.60-3.75,3.50-2.24, 1.87-1.00
100-BR-J	Bear River (R) RM 5.49-4.37; WPIC (L) RM 1.25-0.25; Best S1ough (L) RM 1.00-0.25
100-BR-K	Bear River (R) RM 5.49-4.37; WPIC (L) RM 4.75-2.75; Best S1ough (L) RM 1.00-0.25; Best S1ough (R) RM 1.00-0.25
100-BR-Q	Bear River (R)RM 11.25-7.25
100-BT-R	Dry Creek (L) RM 5.09-3.25
100-SHY-Y	Yuba River (L) 6.9-5.4
100-BT-W1	Bear River (R) RM 14.63-11.57
100-BT-W2	Dry Creek (L) RM 7.59-5.20

Levee Hazard Analysis

Some flood hazard information presented in prior FIRMs and in prior FIS reports for Yuba County and its incorporated communities was based on flood protection provided by levees. Based on the information available and the mapping standards of the National Flood Insurance Program at the time that the prior FISs and FIRMs were prepared, FEMA accredited the levees as providing protection from the flood that has a 1%-chance of being equaled or exceeded in any given year. For FEMA to continue to accredit the identified levees with providing protection from the base flood, the levees must meet the criteria of the Code of Federal Regulations, Title 44, Section 65.10 (44 CFR 65.10), titled “Mapping of Areas Protected by Levee Systems.”

On August 22, 2005, FEMA issued Procedure Memorandum No. 34 - Interim Guidance for Studies Including Levees. The purpose of the memorandum was to help clarify the responsibility of community officials or other parties seeking recognition of a levee by providing information identified during a study/mapping project. Often, documentation regarding levee design, accreditation, and the impacts on flood hazard mapping is outdated or missing altogether. To remedy this, Procedure Memorandum No. 34 provides interim guidance on procedures to minimize delays in near-term studies/mapping projects, to help our mapping partners properly assess how to handle levee mapping issues.

While 44 CFR Section 65.10 documentation is being compiled, the release of more up-to-date FIRM panels for other parts of a community or county may be delayed. To minimize the impact of the levee recognition and certification process, FEMA issued Procedure Memorandum No. 43 titled “Guidelines for Identifying Provisionally Accredited Levees” on March 16, 2007. These guidelines will allow issuance of preliminary and effective versions of FIRMs while the levee owners or communities are compiling the full documentation required to show compliance with 44 CFR Section 65.10. The guidelines also explain that preliminary FIRMs can be issued while providing the communities and levee owners with a specified timeframe to correct any maintenance deficiencies associated with a levee and to show compliance with 44 CFR Section 65.10.

FEMA contacted the communities within Yuba County to obtain data required under 44 CFR 65.10 to continue to show the levees as providing protection from the flood that has a 1%-chance of being equaled or exceeded in any given year.

FEMA understood that it might take time to acquire and/or assemble the documentation necessary to fully comply with 44 CFR 65.10. Therefore, FEMA put forth a process to provide the communities with additional time to submit all the necessary documentation. For a community to avail itself of the additional time, it had to sign an agreement with FEMA. Levees for which such agreements were signed are shown on the final effective FIRM as providing protection from the flood that has a 1 %-chance of being equaled or exceeded in any given year and labeled as a Provisionally Accredited Levee (PAL). Communities have two years from the date of FEMA’s initial coordination to submit to FEMA final accreditation data for all PALs. Following receipt of final accreditation data, FEMA will revise the FIS and FIRM as warranted.

FEMA coordinated with the USACE, the local communities, and other organizations to compile a list of levees that exist within Yuba County. Table 7, “Levees Requiring Flood Hazard Revisions” lists all levees shown on the FIRM, to include PALs, for which corresponding flood hazard revisions were made.

Approximate analyses of “behind levee” flooding were conducted for all the levees in Table 7 to indicate the extent of the “behind levee” floodplains. The approximate levee analysis was conducted using information from existing hydraulic models (where applicable) and USGS topographic maps.

Approximate behind levee analysis for the Dry Creek and the Bear River Levees surrounding the City of Wheatland was also conducted using information from topographic data obtained from MBK, Inc.

Table 7. Levees Requiring Flood Hazard Revisions

Community	Flood Source	Levee Inventory ID (Lat./Long. Coordinates. ; FIRM panel)	USACE Levee
Yuba County	Feather River	Levee ID 6103 (121 37 3.4 W, 39 18 3.4 N - 121 34 11.3 W, 39 17 54.4 N; Panel 06115C0225D)	Yes
Yuba County	Honcut Creek	Levee ID 6037 (121 34 11.3 W, 39 17 51.4 N - 121 33 30.0 W, 39 17 51.4 N; Panel 06115C0225D)	Yes
Yuba County	Feather River	Levee ID 6058 (121 34 11.3 W, 39 17 51.4 N - 121 35 8.7 W, 39 10 5.4 N; Panels 06115C0225D, 06115C0330D, 06115C0340D)	Yes
Yuba County	Feather River	Levee ID 6059 (121 35 8.7 W, 39 10 5.4 N - 121 35 49.3 W, 39 9 40.0 N; Panel 06115C0340D)	Yes
Yuba County	Feather River	Levee ID 6062 (121 35 49.3 W, 39 9 40.0 N - 121 36 36.7 W - 39 9 49.2 N; Panel 06115C0340D)	Yes
Yuba County	Feather River	Levee ID 6023 (121 36 36.7 W - 39 9 49.2 N - 121 37 3.4 W, 39 18 3.4 N; Panels 06115C0225D, 06115C0330D, 06115C0340D)	Yes
Yuba County and City of Marysville	Yuba River	Levee ID 6021 (121 30 35.0 W, 39 12 24.4 N - 121 33 34.9 W, 39 9 49.3 N; Panels 06115C0335D, 06115C0345D)	Yes

Table 7. Levees Requiring Flood Hazard Revisions (Continued)

Community	**Flood Source**	**Levee Inventory ID (Lat./Long. Coordinates. ; FIRM panel)**	**USACE Levee**
Yuba County	Yuba River	Levee ID 6069 (121 34 54.0 W, 39 8 35.3 N - 121 35 6.6 W, 39 7 47.7 N; Panel 06115C0405D, 06115C0410D)	Yes
Yuba County	Feather River	Levee ID 6070 (121 35 6.6 W, 39 7 47.7 N - 121 36 3.1 W, 39 3 47.0 N, Panels 06115C0340D, 06115C0405D)	Yes
Yuba County	Feather River	Levee ID 6071 (121 36 3.1 W, 39 3 47.0 N - 121 34 28.9 W, 38 57 18.3 N; Panels 06115C0415D, 06115C0480D)	Yes
Yuba County	Bear River	Levee ID 6087 (121 34 28.9 W, 38 57 18.3 N - 121 32 40.9 W, 38 58 23.4 N; Panels 06115C0480D, 06115C0485D)	Yes
Yuba County	Feather River	Levee ID 6085 (121 32 40.9 W, 38 58 23.4 N - 121 32 6.2 W, 38 58 29.9 N; Panel 06115C0485D)	Yes
Yuba County	WPIC	Levee ID 6084 (121 32 6.2 W, 38 58 29.9 N - 121 32 23.3 W, 39 0 0.7 N; Panel 06115C0485D)	Yes
Yuba County	WPIC	Levee ID 6072 (121 32 23.3 W, 39 0 0.7 N - 121 33 3.1 W, 39 3 30.7 N; Panel 06115C0420D)	Yes
Yuba County	Best Slough	Levee ID 6075 (121 30 33.0 W, 39 1 14.7 N - 121 32 19.5 W, 39 0 21.7 N; Panel 06115C0420D)	Yes
Yuba County	WPIC	Levee ID 6120 (121 32 19.5 W, 39 0 21.7 N - 121 32 15.2 W, 39 0 0.1 N; Panel 06115C0420D)	Yes
Yuba County	WPIC	Levee ID 6006 (121 32 15.2 W, 39 0 0.1 N - 121 31 56.7 W, 38 58 27.7 N; Panel 06115C0485D)	Yes

Table 7. Levees Requiring Flood Hazard Revisions (Continued)

Community	**Flood Source**	**Levee Inventory ID (Lat./Long. Coordinates. ; FIRM panel)**	**USACE Levee**
Yuba County	Bear River	Levee ID 6083 (121 32 15.2 W, 39 0 0.1 N - 121 29 18.8 W, 38 59 56.2 N; Panels 06115C0485D, 06115C0505D)	Yes
Yuba County	Bear River	Levee ID 6007 (121 29 36.1 W, 38 559 6.8 N - 121 30 21.8 W, 38 59 5.3 N; Panels 06115C0485D, 06115C0505D)	Yes
Yuba County	Bear River	Levee ID 6002 (121 30 21.8 W, 38 59 5.3 N - 121 26 13.3 W, 39 1 33.8 N; Panels 06115C0445D, 06115C0485D)	Yes
Yuba County	Bear River	Levee ID 6121 (121 26 13.3 W, 39 1 33.8 N - 121 24 8.4 W, 39 2 6.6 N; Panel 06115C0445D)	Yes
Yuba County	Bear River	Levee ID 6094 (121 24 8.4 W, 39 2 6.6 N - 121 24 6.5 W, 39 1 51.7 N; Panel 06115C0445D)	Yes
Yuba County	Bear River	Levee ID 6093 (121 24 0.2 W, 39 1 57.2 N - 121 24 7.9 W, 39 2 9.2 N; Panel 06115C0445D)	Yes
Yuba County	Bear River	Levee ID 6091 (121 24 7.9 W, 39 2 9.2 N - 121 23 38.1 W, 39 2 29.9 N; Panel 06115C0445D)	Yes

Several levees within Yuba County and its incorporated communities meet the criteria of the Code of Federal Regulations, Title 44, Section 65.10 (44 CFR 65.10), titled “Mapping of Areas Protected by Levee Systems.” Table 8, “Certified and Accredited Levees” lists all levees shown on the FIRM the meet requirements of 44 CFR 65.10 and have been determined to provide protection from the flood that has a 1-percent-chance of being equaled or exceeded in any given year.

Table 8. Certified and Accredited Levees

Community	Flood Source	Levee Inventory ID (Lat./Long. Coordinates. ; FIRM panel)	USACE Levee
Yuba County	Yuba River	Levee ID 6069 (121 33 9.88 W, 39 8 4.72 N - 121 35 8.52 W, 39 7 47.91 N; Panel 06115C0340D, 06115C0345D)	Yes
Yuba County	Feather River	Levee ID 6070 (121 35 8.52 W, 39 7 47.91 N - 121 35 31.93W, 39 3 46.21 N; Panel 06115C0340D, 06115C0405D)	Yes
Yuba County	Feather River	Levee ID 6071 (121 35 31.93W, 39 3 46.21 N - 121 34 29.53 W 38 57 19.94 N; Panel 06115C0415D, 06115C480D)	Yes
Yuba County	Western Pacific Interceptor Canal	Levee ID 6072 (121 32 22.94 W, 38 59 59.17 N - 121 33 1.93 W, 39 3 31.01 N; Panel 06115C0420D)	Yes
Yuba County	Western Pacific Interceptor Canal	Levee ID 6084 (121 32 6.21 W, 38 58 29.56 N - 121 32 22.94 W 38 59 59.17 N; Panel 06115C0485D)	Yes
Yuba County	Bear River	Levee ID 6085 (121 32 41.4 W 38 58 23.66 N - 121 32 6.21 W 38 58 29.56 N; Panel 06115C0485D)	Yes
Yuba County	Bear River	Levee ID 6087 (121 34 29.53 W 38 57 19.94 N - 121 32 41.4 W 38 58 23.66 N; Panel 06115C0480D, 06115C0485D)	Yes

Several levees within Yuba County and its incorporated communities meet the criteria of the Code of Federal Regulations, Title 44, Section 65.10 (44 CFR 65.10), titled "Mapping of Areas Protected by Levee Systems." Table 9, "Provisionally Accredited Levees" lists all levees shown on the FIRM the meet requirements of 44 CFR 65.10 and have been determined to provide protection from the flood that has a 1-percent-chance of being equaled or exceeded in any given year.

Table 9. Provisionally Accredited Levees

Community	Flood Source	Levee Inventory ID (Lat./Long. Coordinates. ; FIRM panel)	USACE Levee
City of Maryville	Yuba River, Feather River, and Jack Simmerly Slough	Levee IDs 6046, 6060 6064, 6065, 6066 (Levee surrounding the City of Marysville; Panel 0340D)	Yes
Yuba County	Yuba River	Levee ID 6019 (121 31 54.0 W, 39 8 35.1 N - 121 30 9.4 W, 39 9 42.8 N; Panel 06115C0345D)	Yes

3.3 Vertical Datum

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

Flood elevations shown in this FIS report and on the FIRM are referenced to the NAVD. These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. For information regarding vertical datum, visit the National Geodetic Survey website at www.ngs.noaa.gov, or contact the National Geodetic Survey at the following address:

NGS Information Services, NOAA, N/NGS12
National Geodetic Survey SSMC-3, #9202
1315 East-West Highway, Silver Spring, MD 20910-3282
Fax: (301) 713-4172, Telephone: (301) 713-3242

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

The conversion factor between NGVD and NAVD for all the detailed studied streams in Yuba County is +2.3 feet.

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%-annual-chance floodplain data, which may include a combination of the following: 10%-, 2%-, 1%-, and 0.2%-annual-chance flood elevations; delineations of the 1%- and 0.2%-annual-chance floodplains; and 1%-annual-chance floodway. This information is presented on the FIRM and in many components of the FIS, including Flood Profiles, and Floodway Data 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.

A prime purpose of the National Flood Insurance Program is to encourage state and local governments to adopt sound flood plain management programs. Each Flood Insurance Study, therefore, includes a flood boundary map designed to assist communities in developing sound flood plain management measures.

4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1%-annual-chance (100-year) flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2 %-annual-chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For each stream studied by detailed methods, the 1%- and 0.2 %-annual-chance floodplain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps.

Shallow flooding areas were delineated using topographic maps (Reference 26 and 27), field surveys, and topographic data furnished by the State Department of Transportation (Reference 28), in conjunction with computed depths for sheet flow and computed elevations for ponding.

Approximate 1%-annual-chance floodplain boundaries in some portions of the study area were taken directly from the previously effective FIRM for Yuba County, California (Unincorporated Areas) (Reference 36). Some of those approximate flood boundaries taken from the previously effective FIRM were taken from the Flood Hazard Boundary Map (FHBM) (Reference 32). Modifications to these boundaries and additional approximate flood boundaries were delineated based upon field surveys and observations.

The 1%- and 0.2%-annual-chance floodplain boundaries are shown on the FIRM. On this map, the 1%-annual-chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A, AE, and AH), and the 0.2%-annual-chance floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 1%-annual-chance and 0.2%-annual-chance floodplain boundaries are close together, only the 1%-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.

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%-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%-annual-chance flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1 foot, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

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

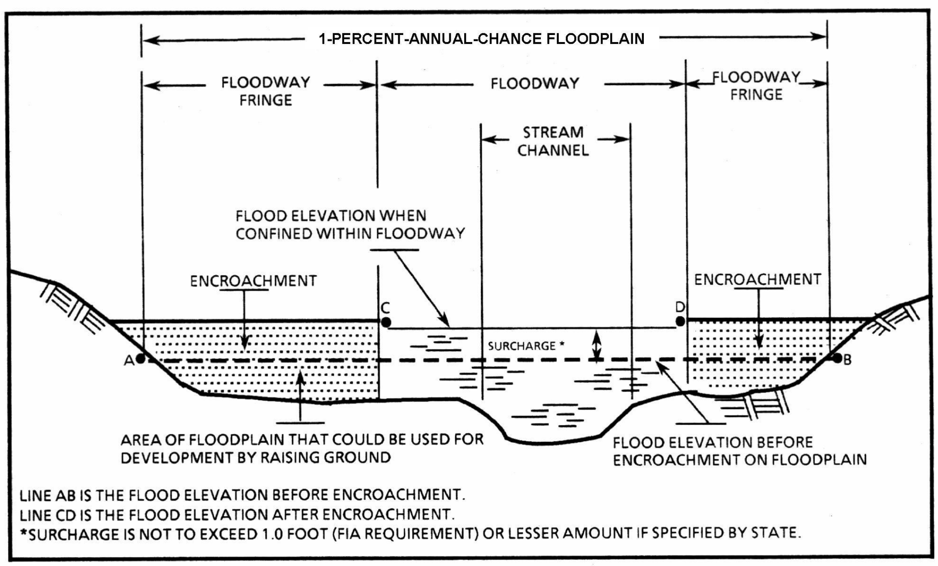

Figure 1. Floodway Schematic

At Marysville and the surrounding unincorporated areas of Yuba County, the project levees confining the streams under study comprise the boundary of the 1%-annual-chance flood. These levees were adopted as floodway limits for this flood insurance study. Floodway data for the Feather River, Jack-Simmerly Slough, and the Yuba River are shown in Table 9.

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY FEET (NAVD88)	WITH FLOODWAY	INCREASE
FEATHER RIVER								
BN	114,999	2,150	46,900	3.3	74.6	74.6	74.6	0.0
BO	145,781	1,650	50,650	3.1	74.8	74.8	74.8	0.0
BP	148,685	2,100	52,950	2.9	75.0	75.0	75.0	0.0
BQ	149,160	2,130	53,050	2.9	75.1	75.1	75.1	0.0
BR	150,163	2,280	63,400	2.4	75.2	75.2	75.2	0.0
BS	152,381	1,270	61,250	2.5	75.3	75.3	75.3	0.0
YUBA RIVER								
A	2,746	3,150	45,500	3.0	74.9	74.9	74.9	0.0
B	4,488	2,150	38,300	3.5	75.1	75.1	75.1	0.0
C	5,174	2,360	47,900	2.8	75.2	75.2	75.2	0.0
D	7,022	5,540	47,700	2.8	75.5	75.5	75.5	0.0
E	8,554	7,460	54,000	2.5	76.0	76.0	76.0	0.0
F	10,190	8,230	36,600	3.7	76.3	76.3	76.3	0.0
JACK SLOUGH								
A	5,914	3,610	56,600	0.1	75.7	75.7	75.7	0.0
B	8,184	2,470	28,600	0.2	75.7	75.7	75.7	0.0
C	8,976	2,450	19,750	0.3	75.7	75.7	75.7	0.0
D	9,504	2,450	10,400	0.7	75.7	75.7	75.7	0.0

[1] In Feet Above Mouth

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

YUBA COUNTY, CA

AND INCORPORATED AREAS

FLOODWAY DATA

FEATHER RIVER - YUBA RIVER - JACK SLOUGH

5.0 INSURANCE APPLICATION

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

Zone A

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

Zone AE

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

Zone AH

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

Zone X

Zone X is the flood insurance rate zone that corresponds to areas outside the 0.2%-annual-chance floodplain, areas within the 0.2%-annual-chance floodplain, areas of 1%-annual-chance flooding where average depths are less than 1 foot, areas of 1%-annual-chance flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 1%-annual-chance flood by levees. No BFEs 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%-annual-chance floodplains that were studied by detailed methods, shows selected whole-foot BFEs or average depths. Insurance agents use the zones and BFEs in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

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

The countywide FIRM presents flooding information for the entire geographic area of Yuba County. Previously, FIRMs were prepared for each incorporated community and the unincorporated areas of the County identified as flood-prone. This countywide FIRM also includes flood-hazard information that was presented separately on Flood Boundary and Floodway Maps (FBFMs), where applicable. Historical data relating to the maps prepared for each community are presented in Table 10, "Community Map History."

7.0 OTHER STUDIES

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

8.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting the Federal Emergency Management Agency, Region IX, Federal Insurance and Mitigation Division, 1111 Broadway, Suite 1200, Oakland, California 94607-4052.

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISION DATE(S)	FLOOD INSURANCE RATE MAP EFFECTIVE DATE	FLOOD INSURANCE RATE MAP REVISION DATE(S)
Marysville, City of	November 2, 1973	October 22, 1976	January 19, 1978	August 10, 1982
Wheatland, City of	May 2, 1975	None	September 29, 1986	None
Yuba County Unincorporated Areas	September 6, 1977	None	May 17, 1982	September 15, 1983

TABLE 11

FEDERAL EMERGENCY MANAGEMENT AGENCY

YUBA COUNTY, CALIFORNIA
AND INCORPORATED AREAS

COMMUNITY MAP HISTORY

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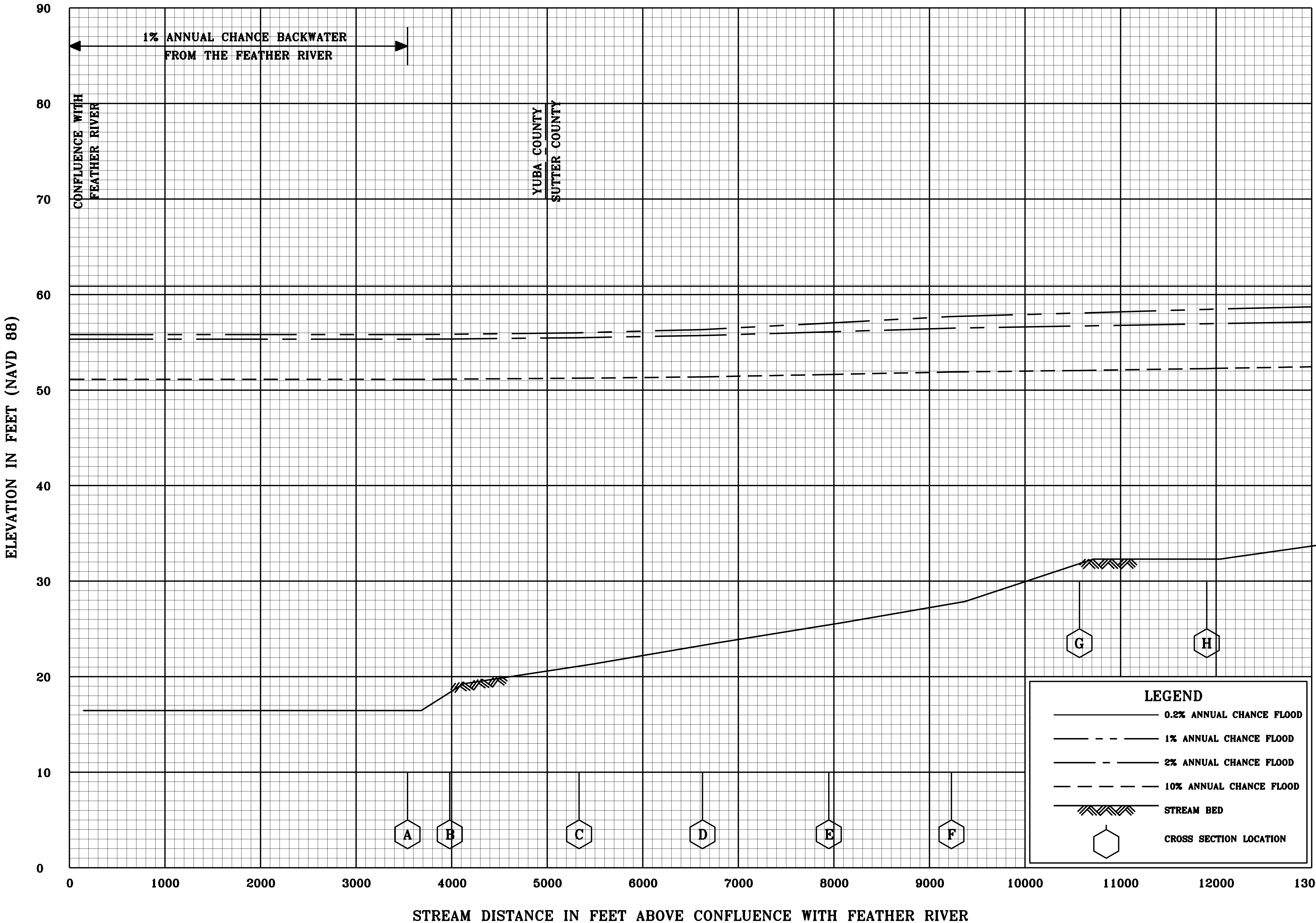


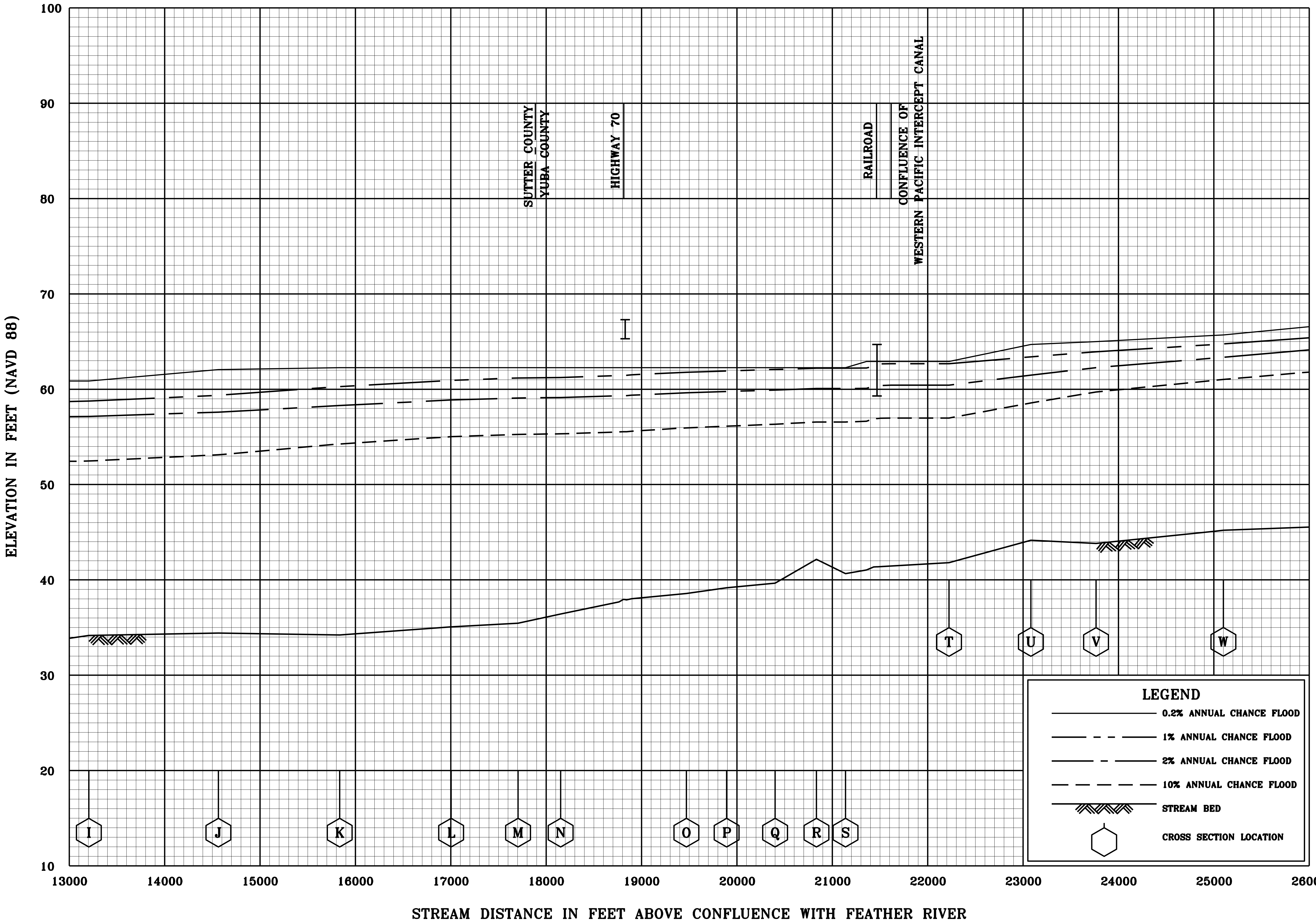
FLOOD PROFILES

BEAR RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

YUBA COUNTY, CA
AND INCORPORATED AREAS

01P



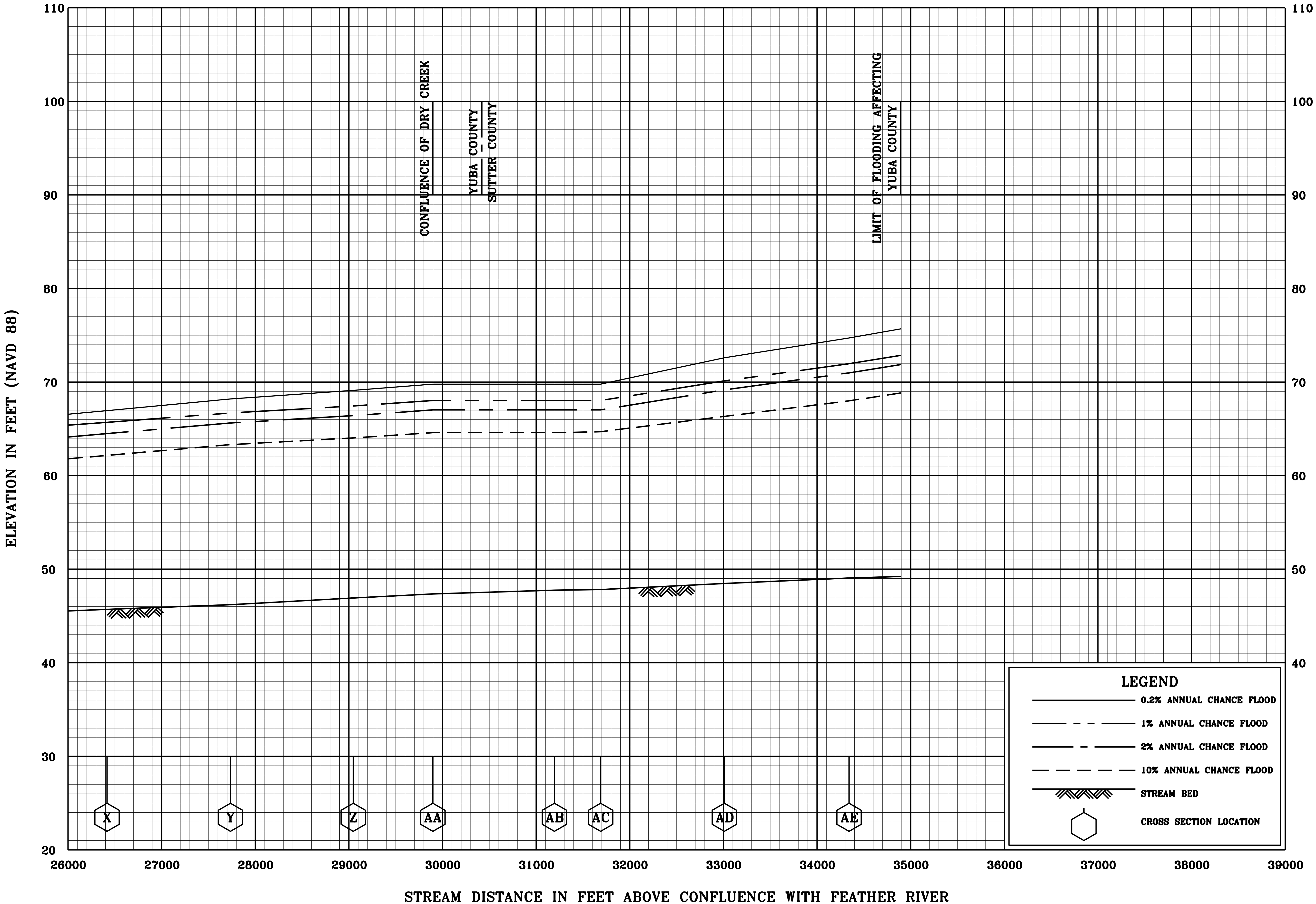
FLOOD PROFILES

BEAR RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

YUBA COUNTY, CA
AND INCORPORATED AREAS

02P



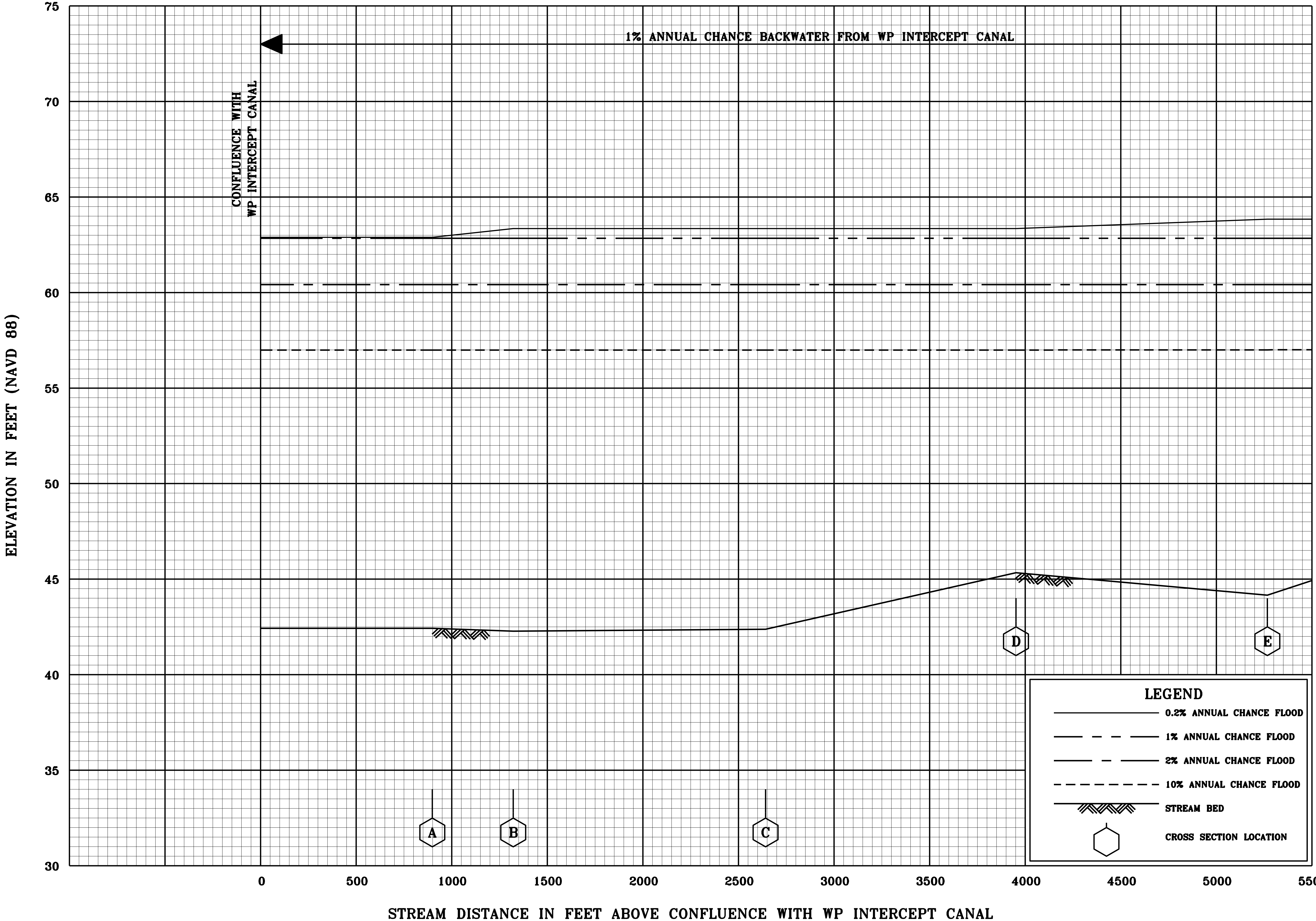
FLOOD PROFILES

BEAR RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

YUBA COUNTY, CA AND INCORPORATED AREAS

03P



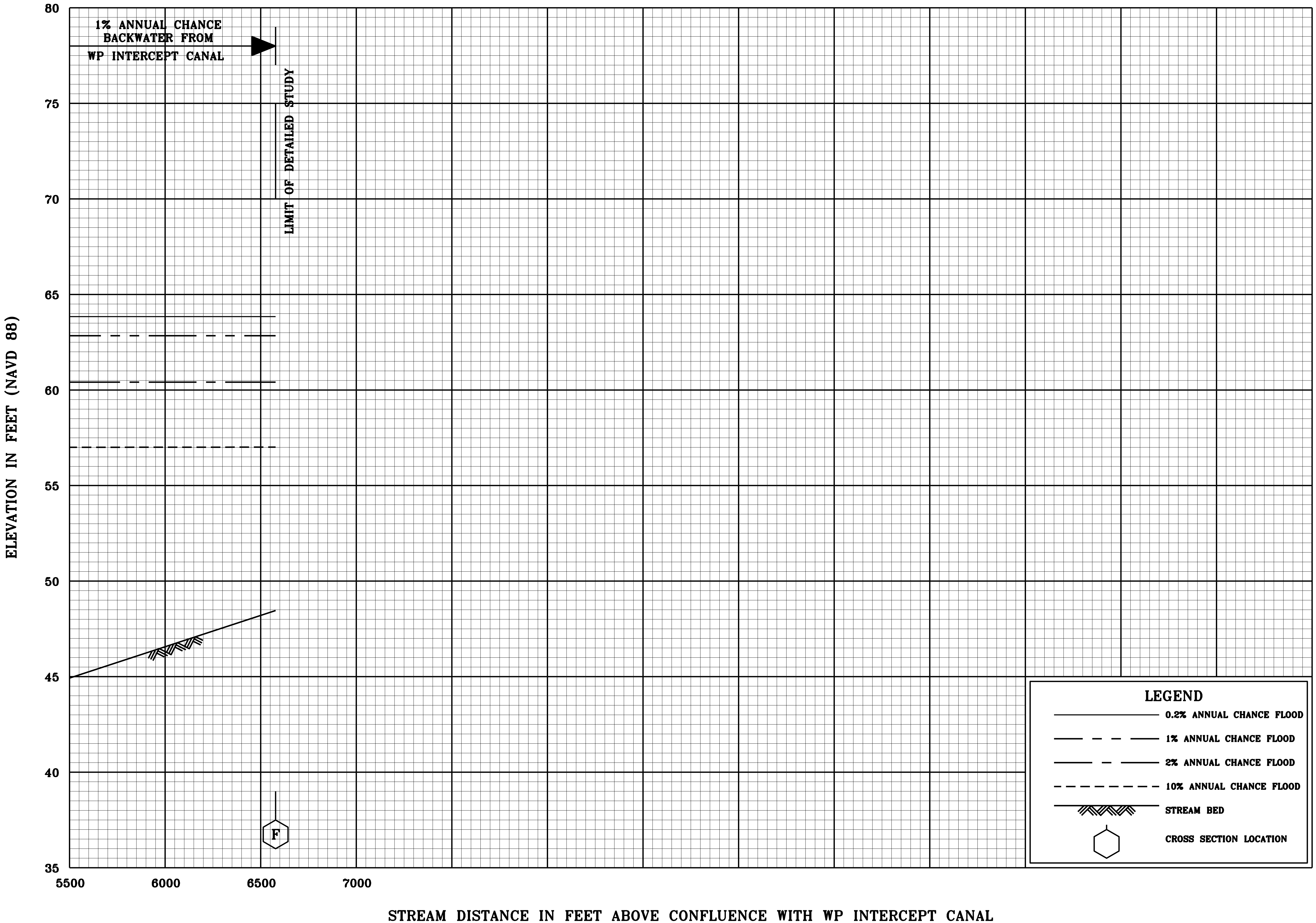
FLOOD PROFILES

BEST SLOUGH

FEDERAL EMERGENCY MANAGEMENT AGENCY

YUBA COUNTY, CA AND INCORPORATED AREAS

04P



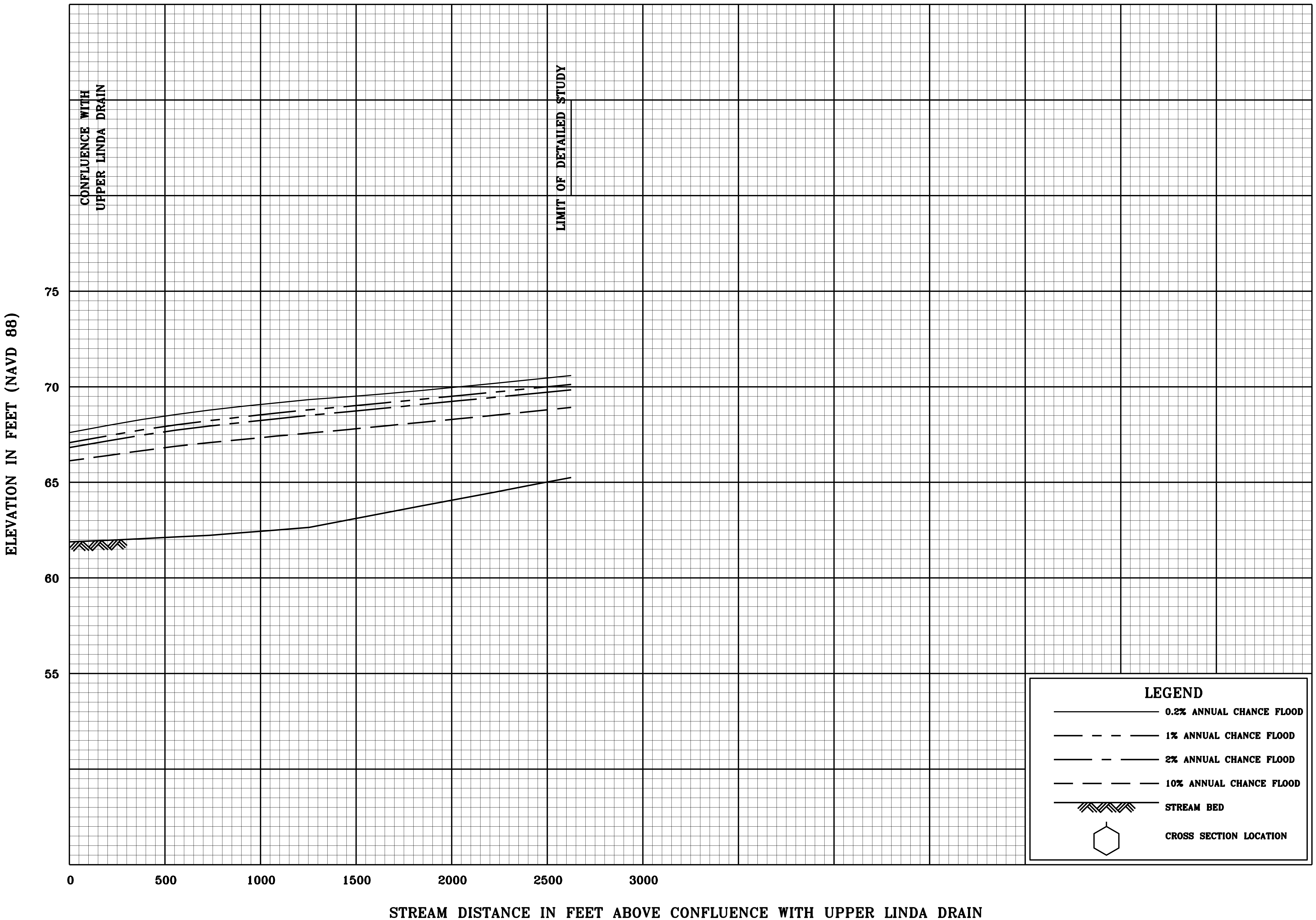
FLOOD PROFILES

BEST SLOUGH

FEDERAL EMERGENCY MANAGEMENT AGENCY

YUBA COUNTY, CA
AND INCORPORATED AREAS

05P



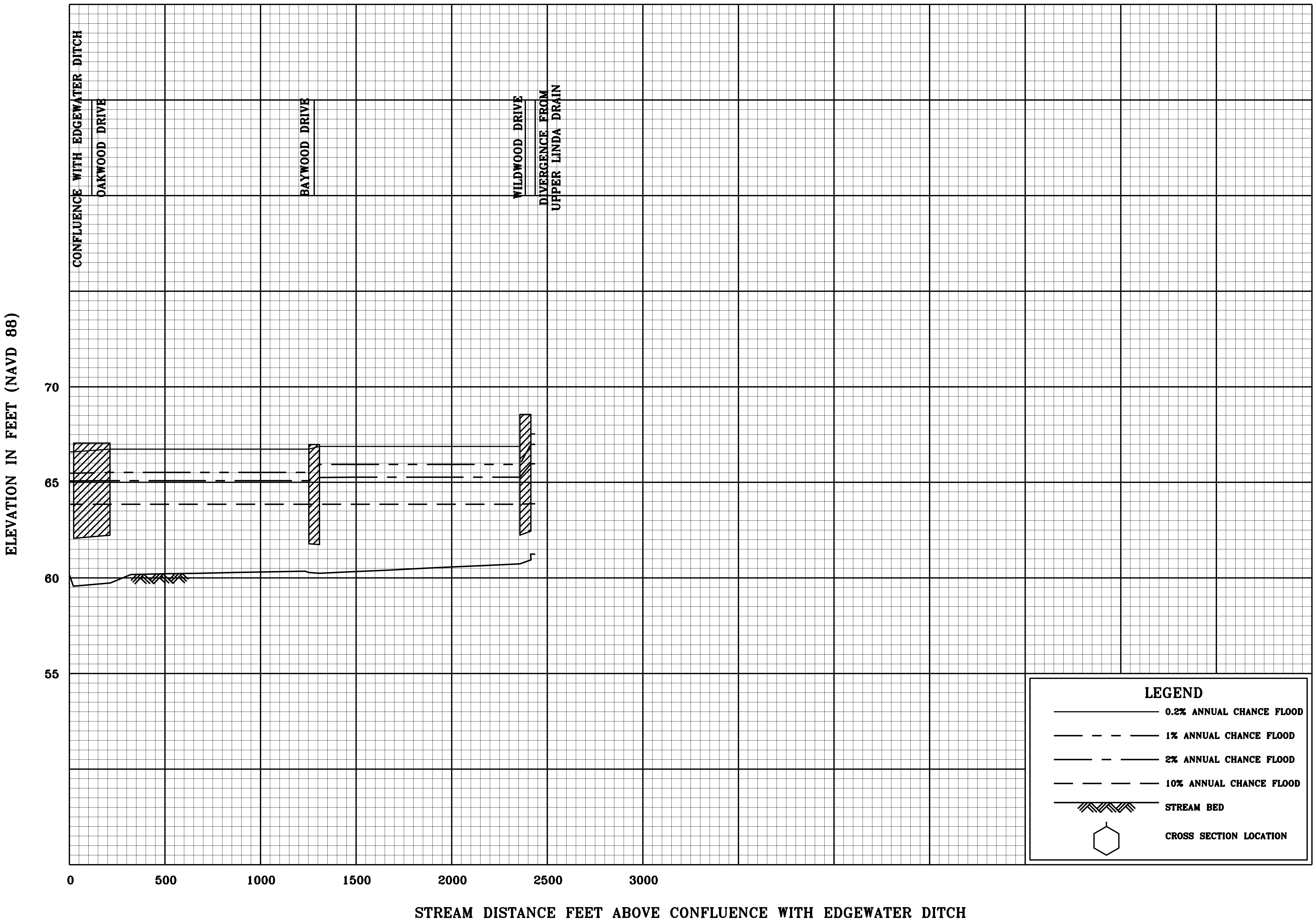
FLOOD PROFILES

BUTLER DITCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

YUBA COUNTY, CA
AND INCORPORATED AREAS

06P



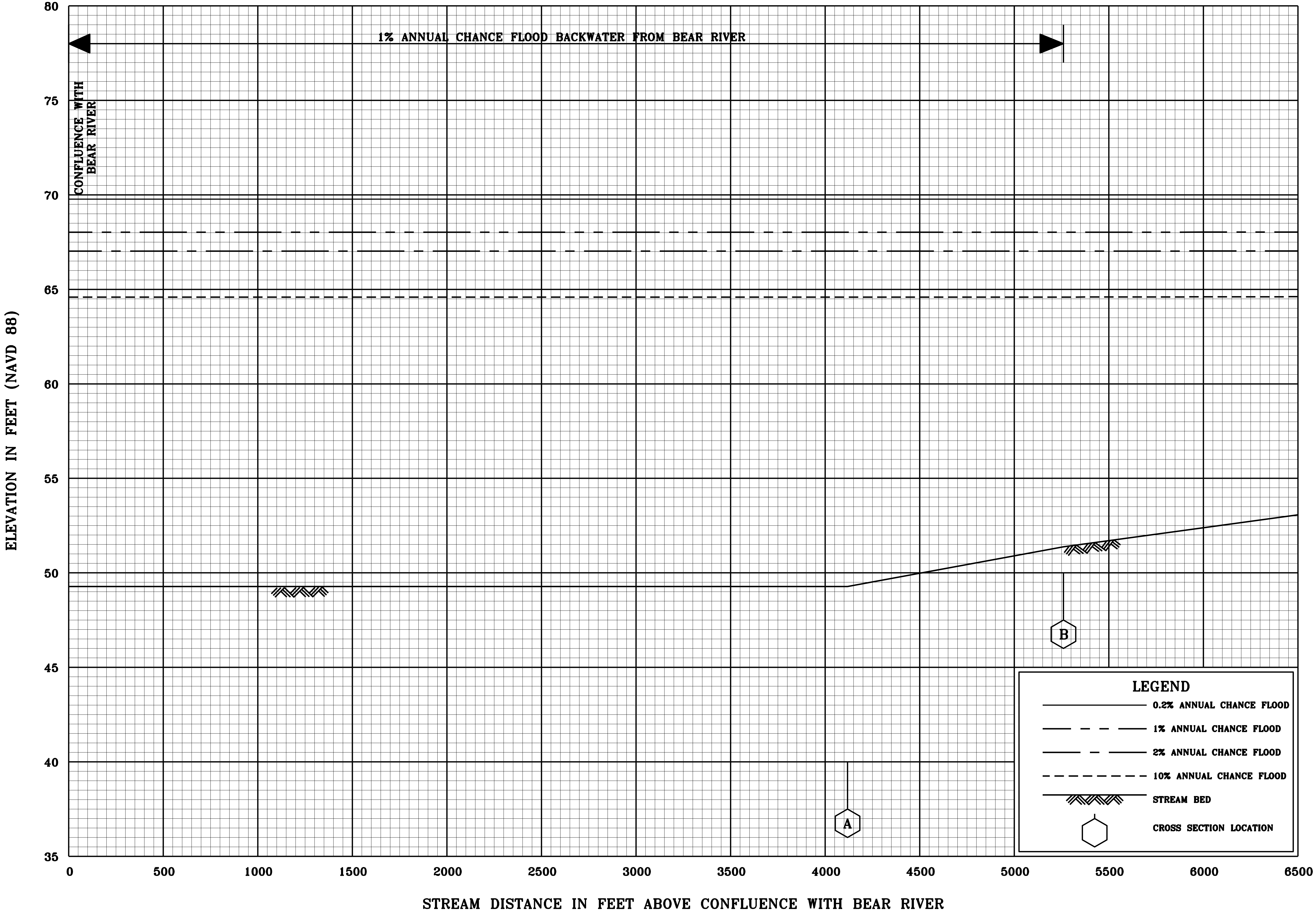
FLOOD PROFILES

COUNTRY CLUB PARK DITCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

YUBA COUNTY, CA
AND INCORPORATED AREAS

07P



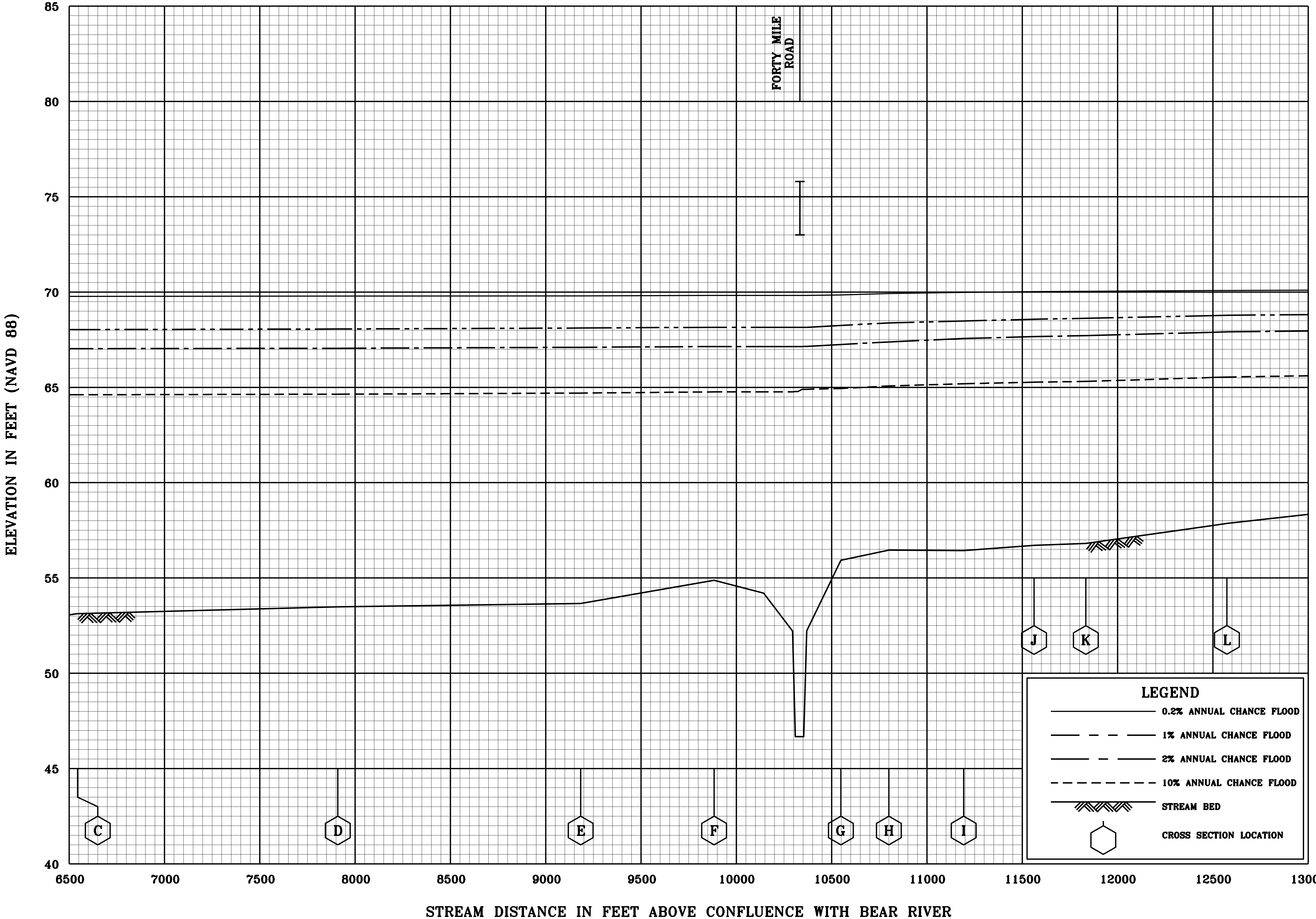
FLOOD PROFILES

DRY CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

YUBA COUNTY, CA
AND INCORPORATED AREAS

08P



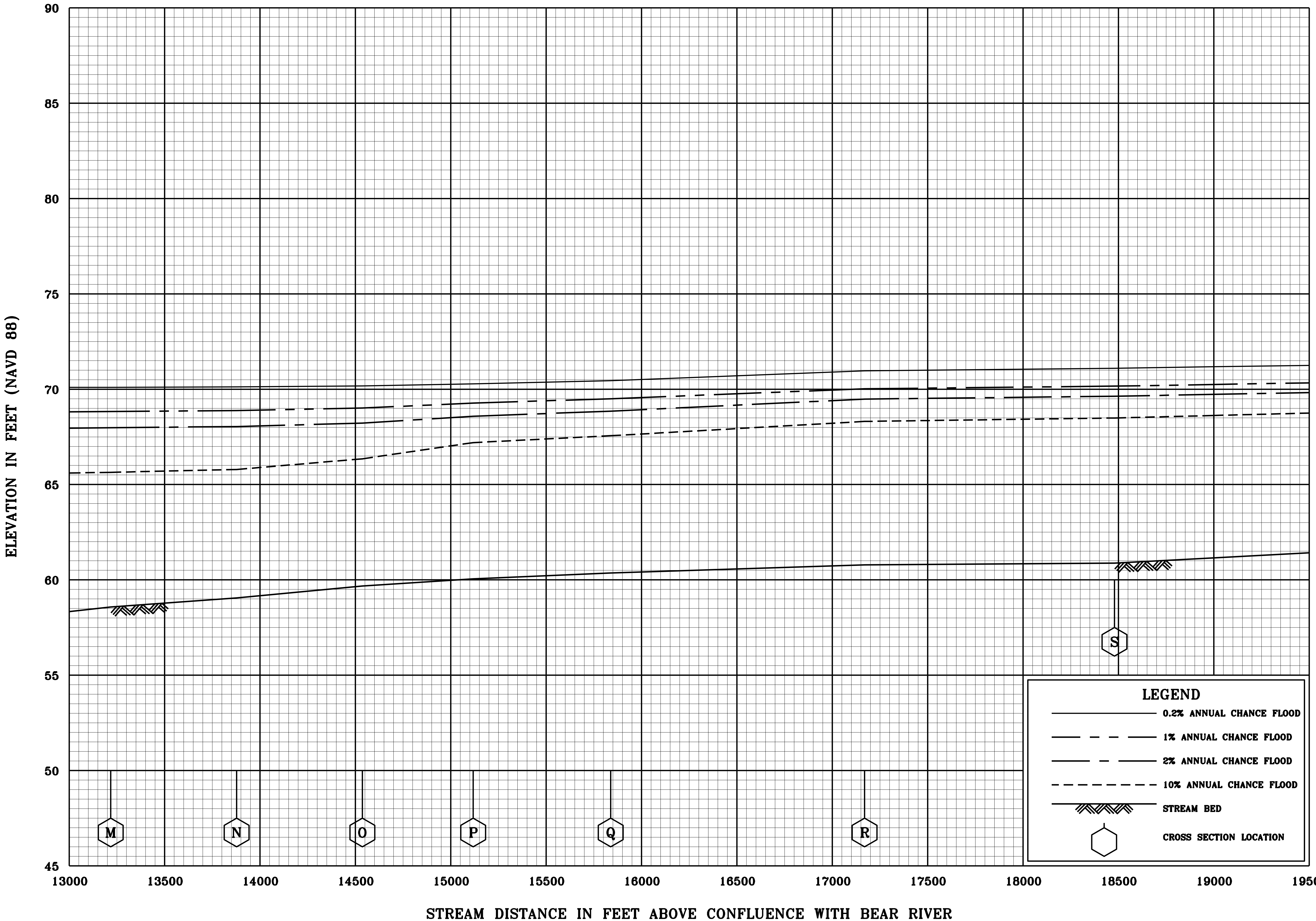
FLOOD PROFILES

DRY CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

YUBA COUNTY, CA AND INCORPORATED AREAS

09P



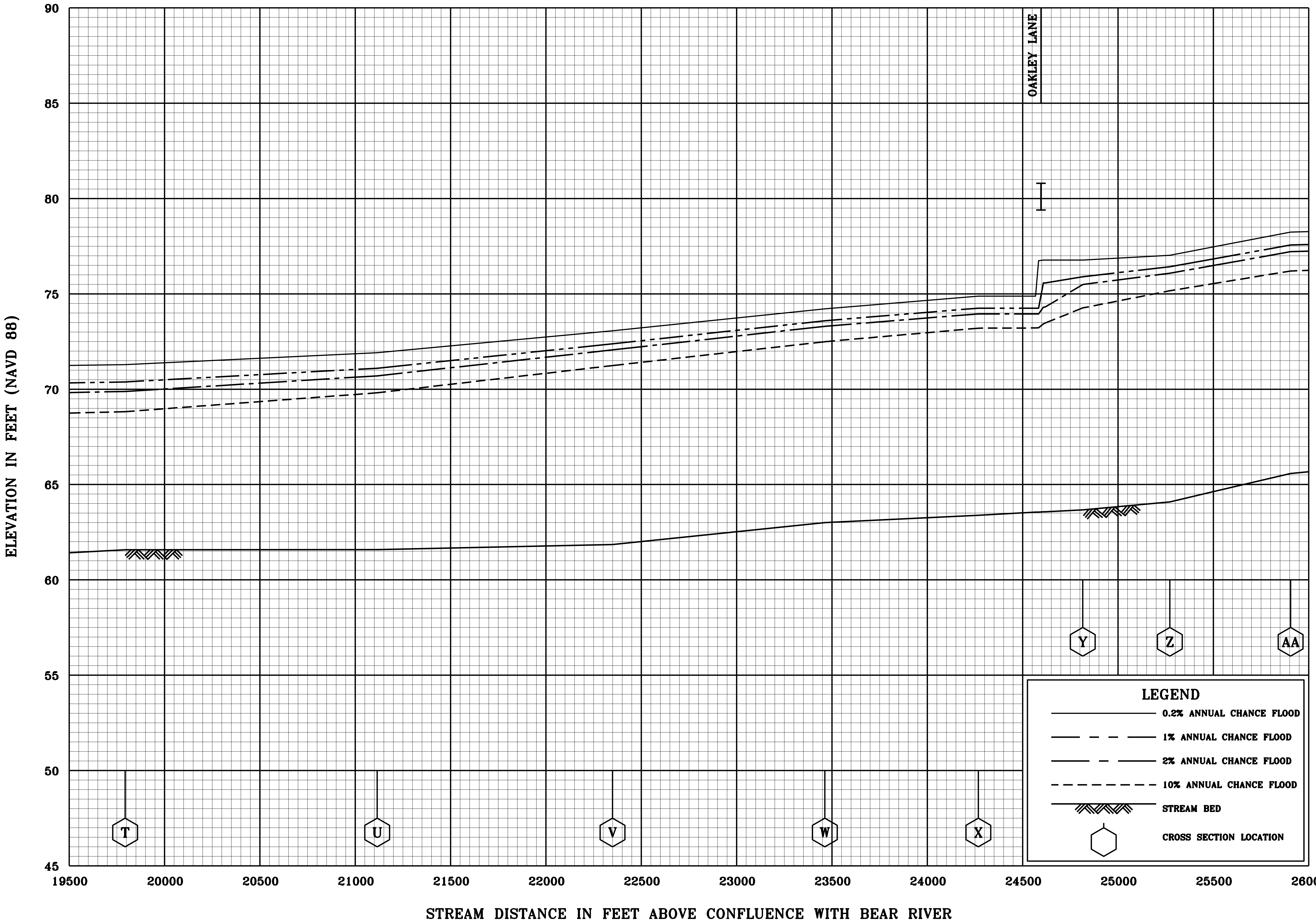
FLOOD PROFILES

DRY CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

YUBA COUNTY, CA AND INCORPORATED AREAS

10P

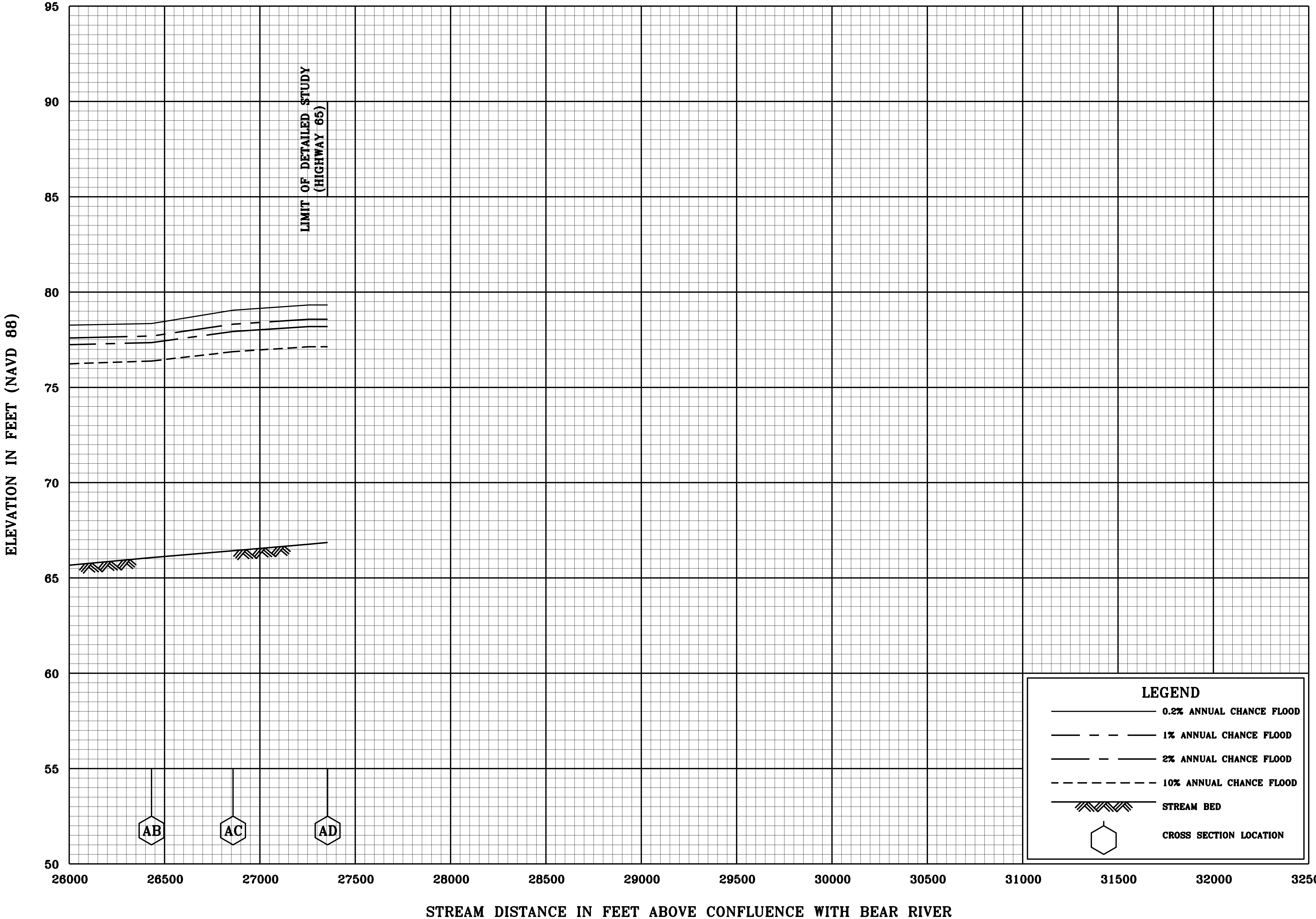


FLOOD PROFILES

DRY CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

YUBA COUNTY, CA
AND INCORPORATED AREAS

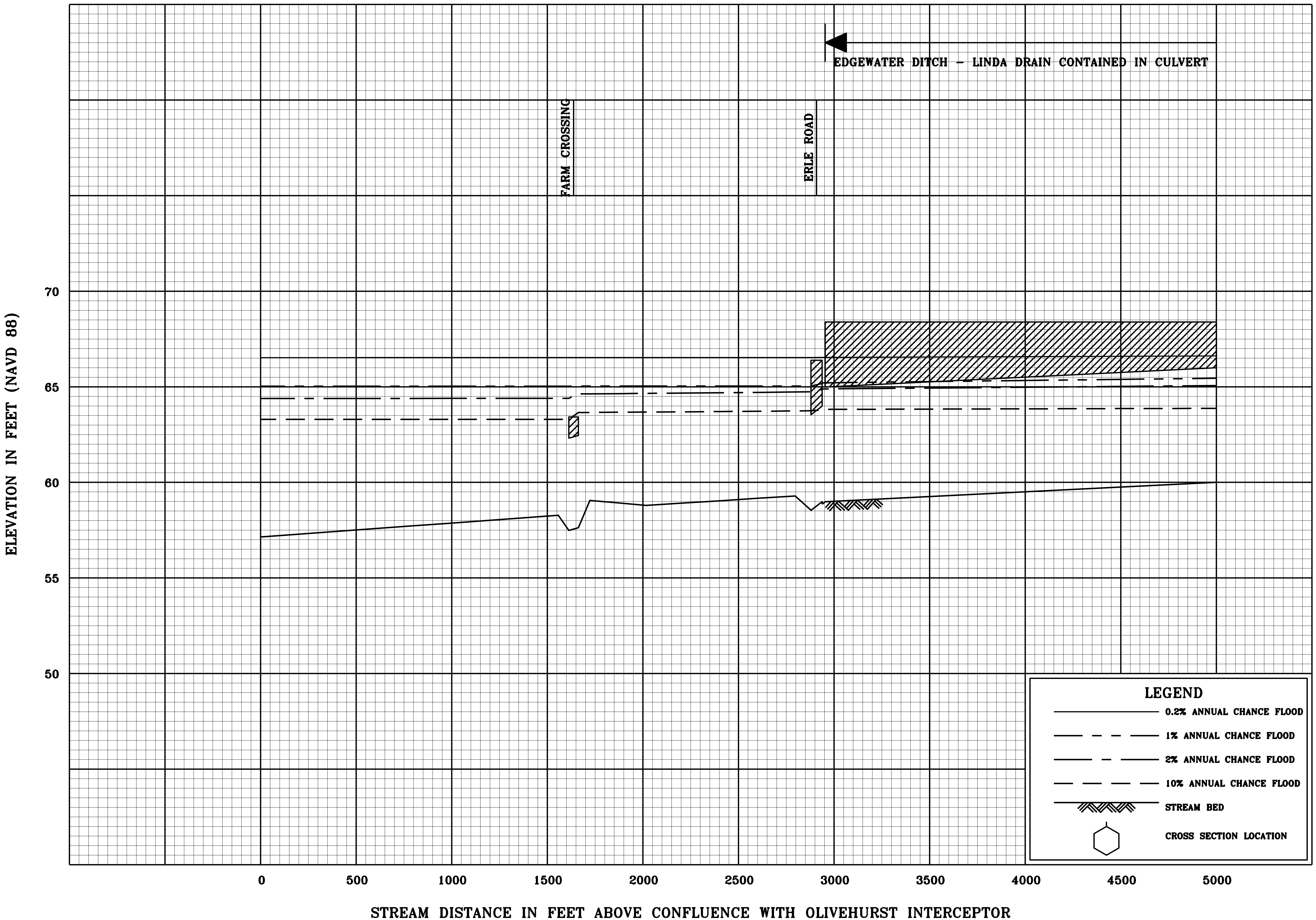


FLOOD PROFILES

DRY CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

YUBA COUNTY, CA
AND INCORPORATED AREAS

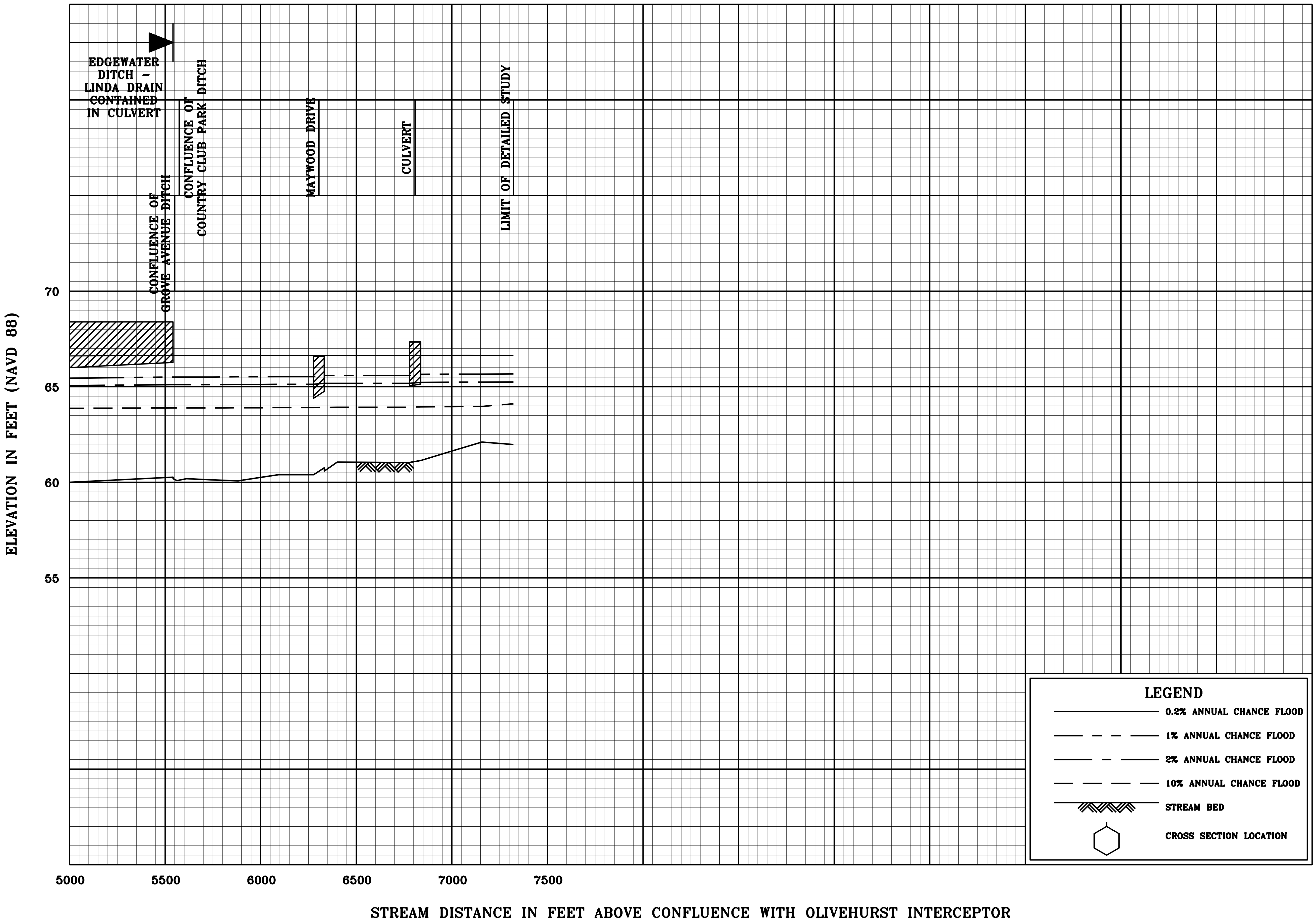


FLOOD PROFILES

EDGEWATER DITCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

YUBA COUNTY, CA
AND INCORPORATED AREAS

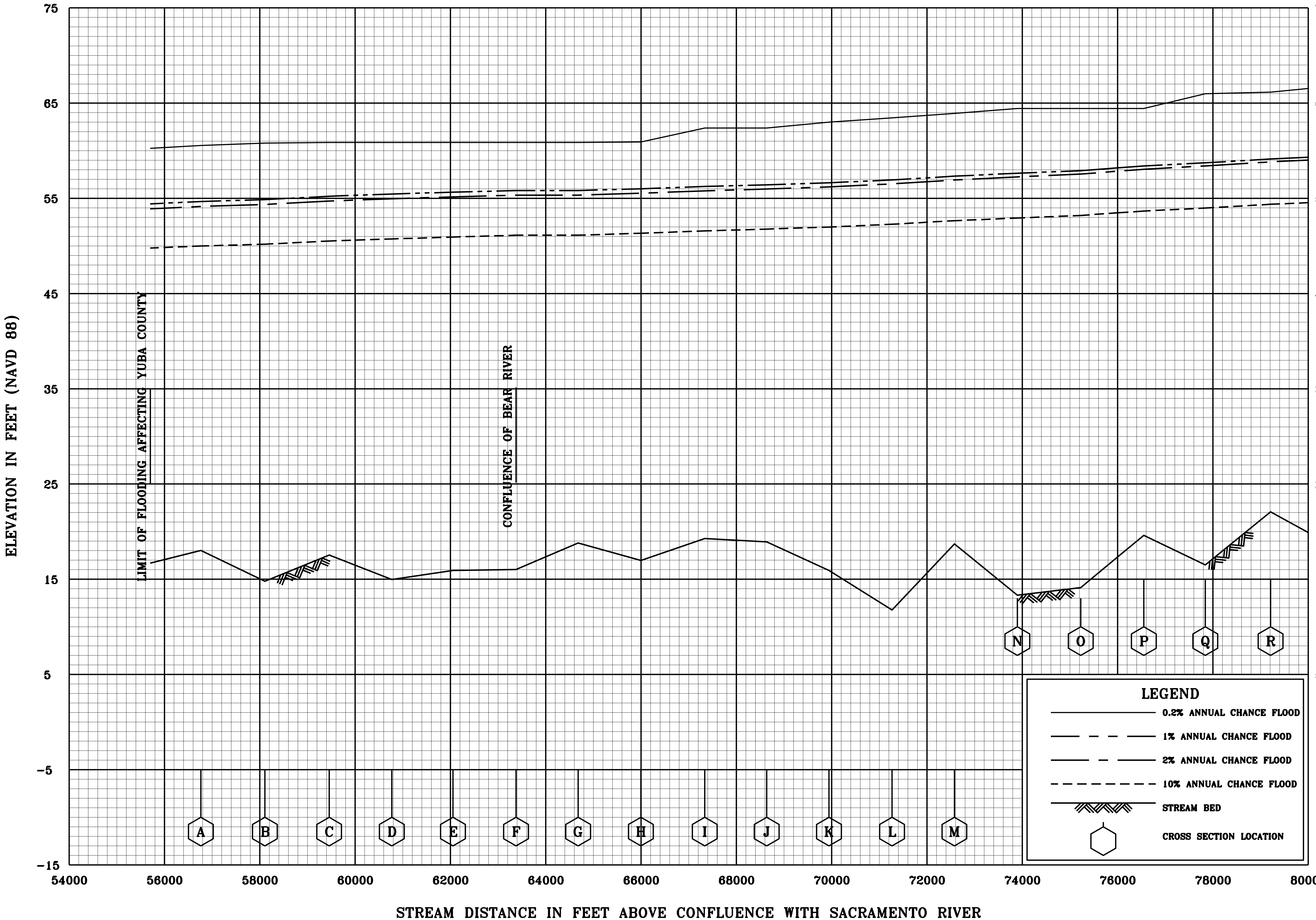


FLOOD PROFILES

EDGEWATER DITCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

YUBA COUNTY, CA
AND INCORPORATED AREAS

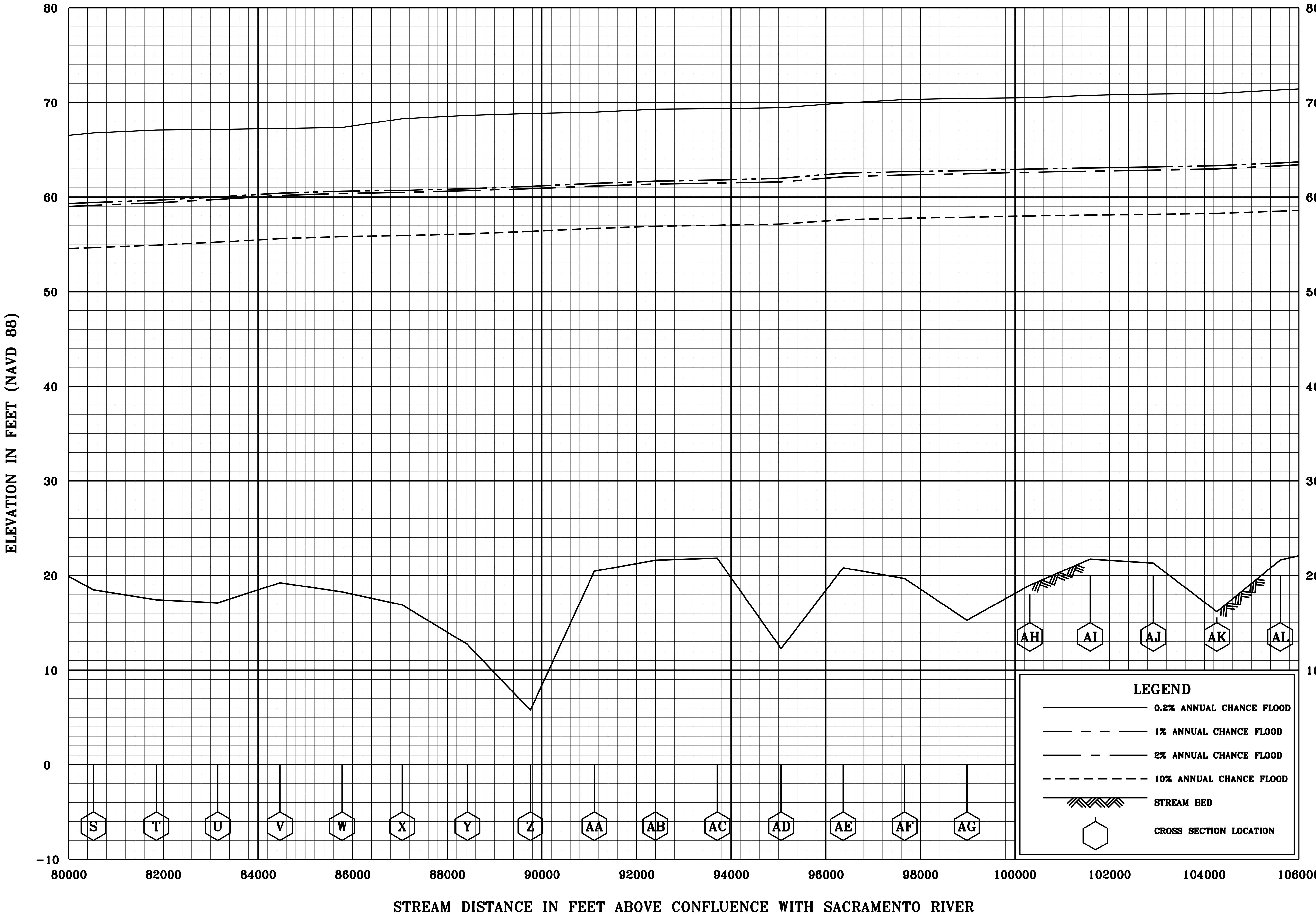


FLOOD PROFILES

FEATHER RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

YUBA COUNTY, CA
AND INCORPORATED AREAS



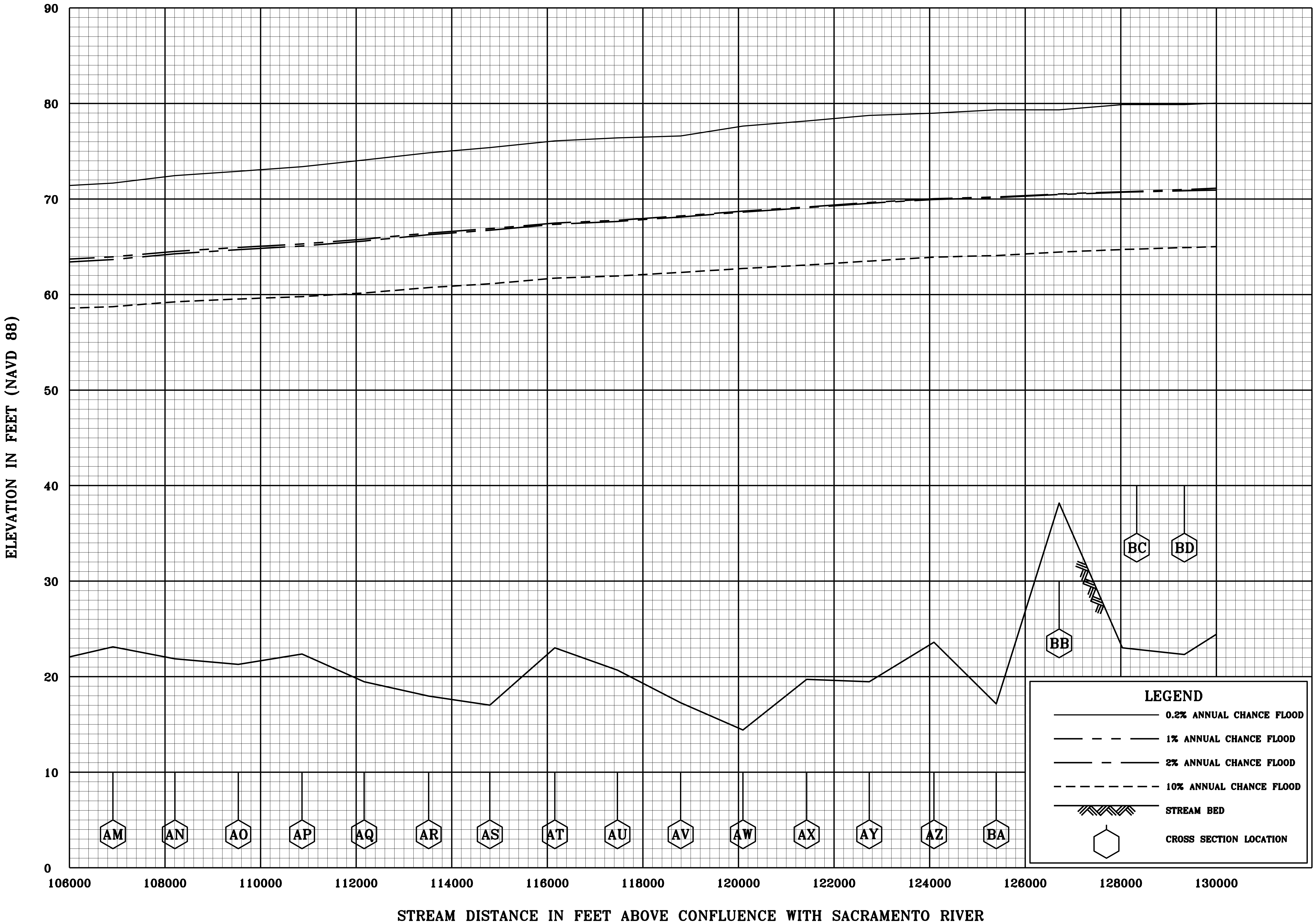
FLOOD PROFILES

FEATHER RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

YUBA COUNTY, CA
AND INCORPORATED AREAS

16P



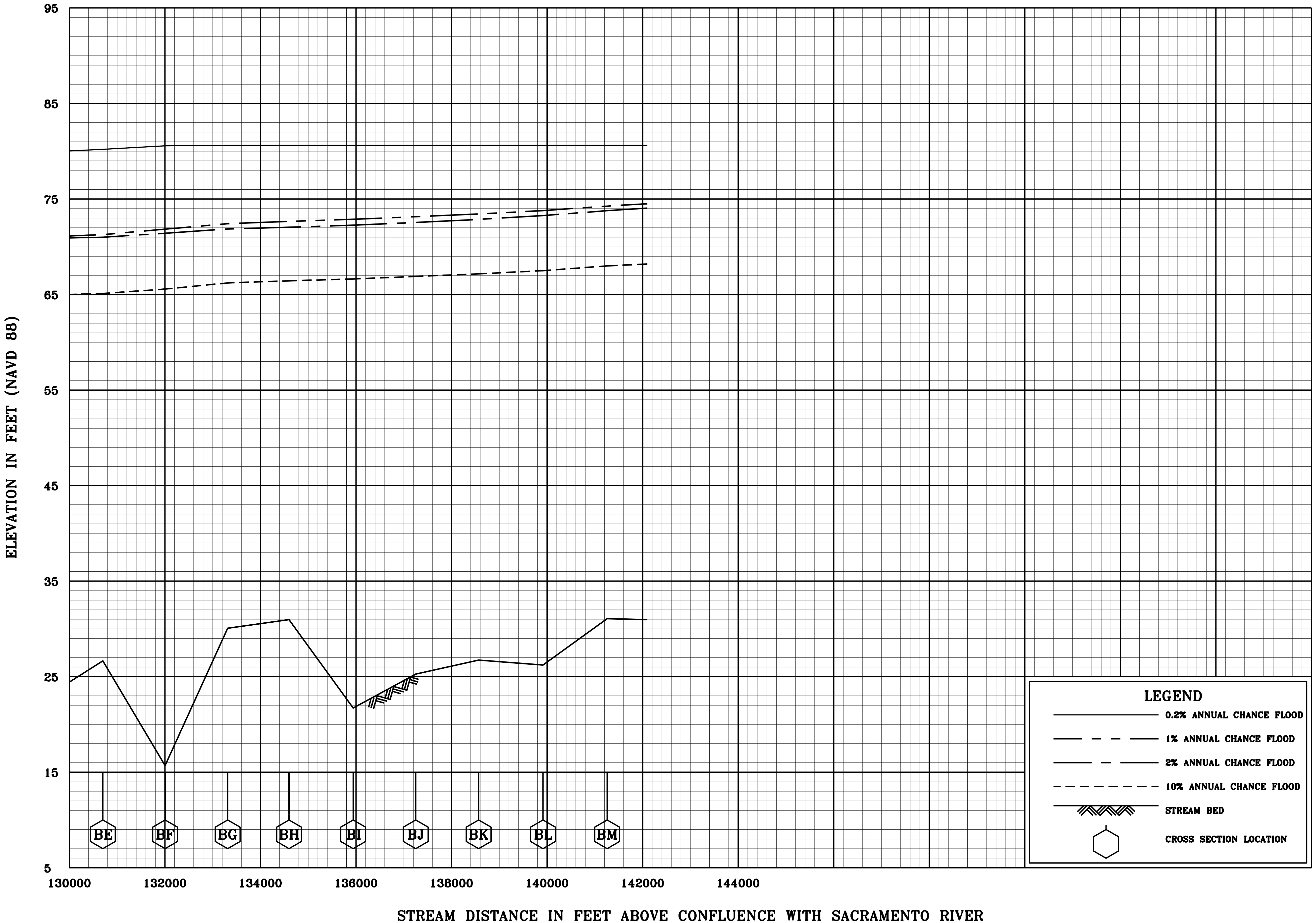
FLOOD PROFILES

FEATHER RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

YUBA COUNTY, CA
AND INCORPORATED AREAS

17P

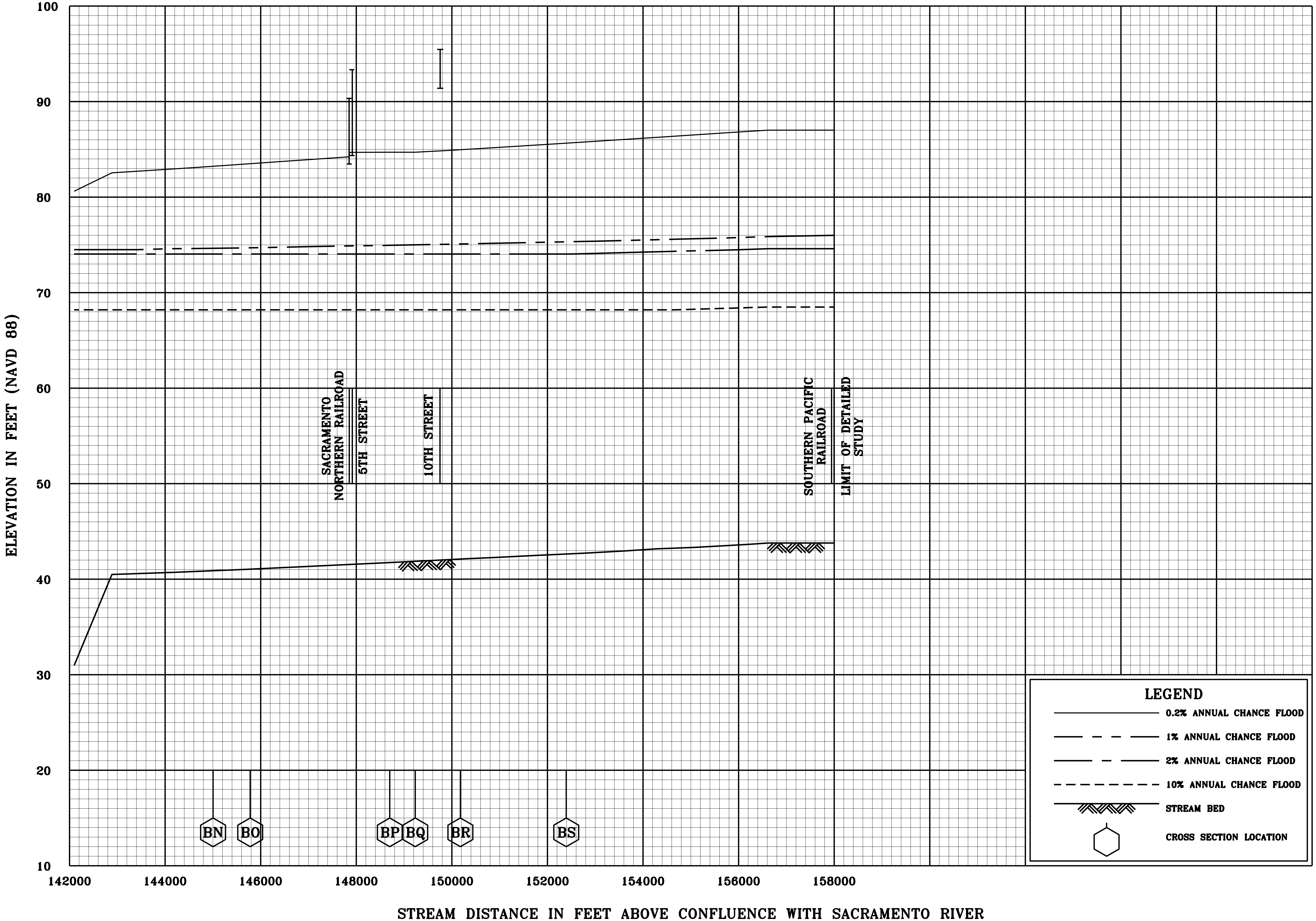


FLOOD PROFILES

FEATHER RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

YUBA COUNTY, CA AND INCORPORATED AREAS

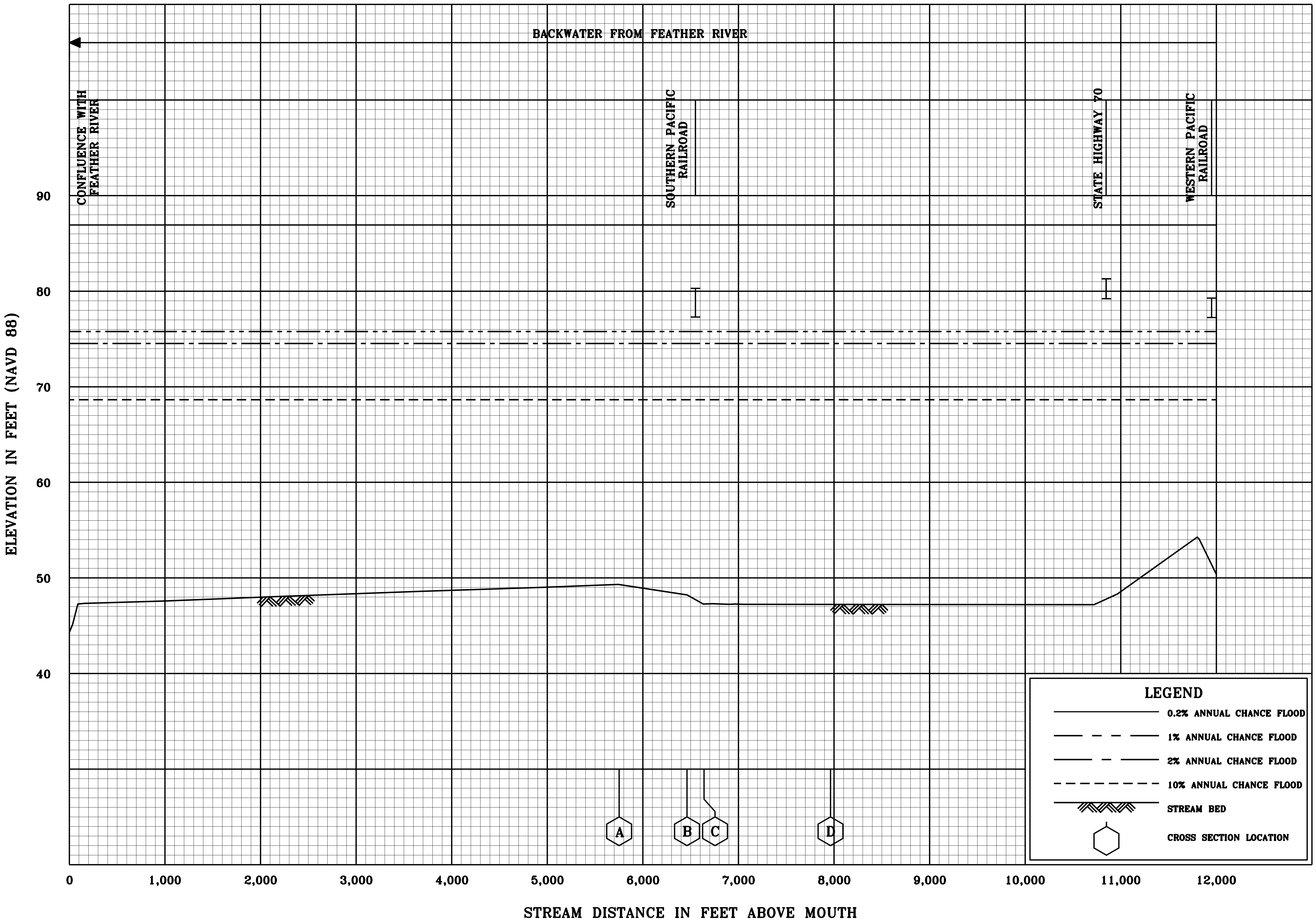


FLOOD PROFILES

FEATHER RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

YUBA COUNTY, CA AND INCORPORATED AREAS



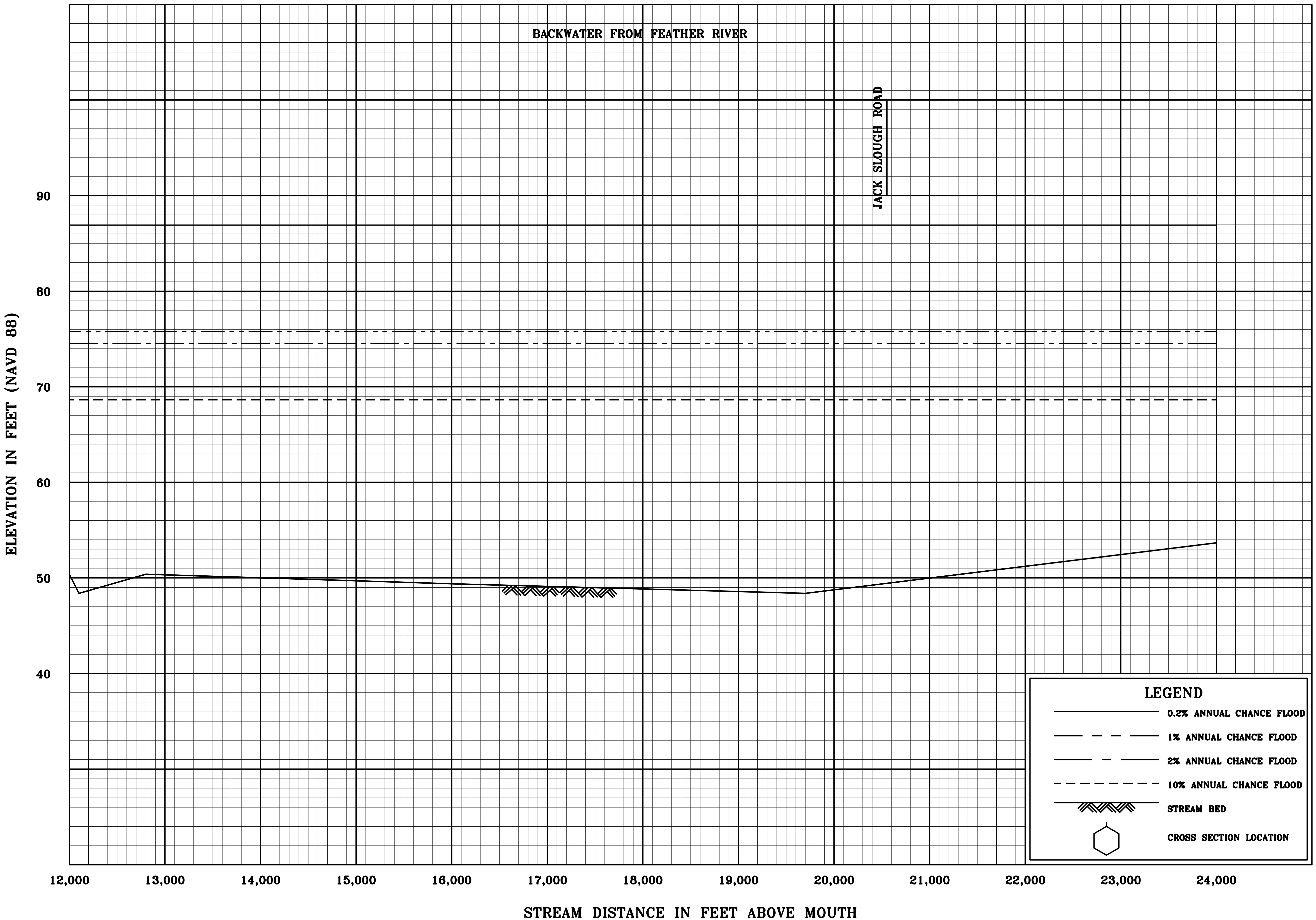
FLOOD PROFILES

JACK SIMMERLY SLOUGH

FEDERAL EMERGENCY MANAGEMENT AGENCY

YUBA COUNTY, CA AND INCORPORATED AREAS

20P

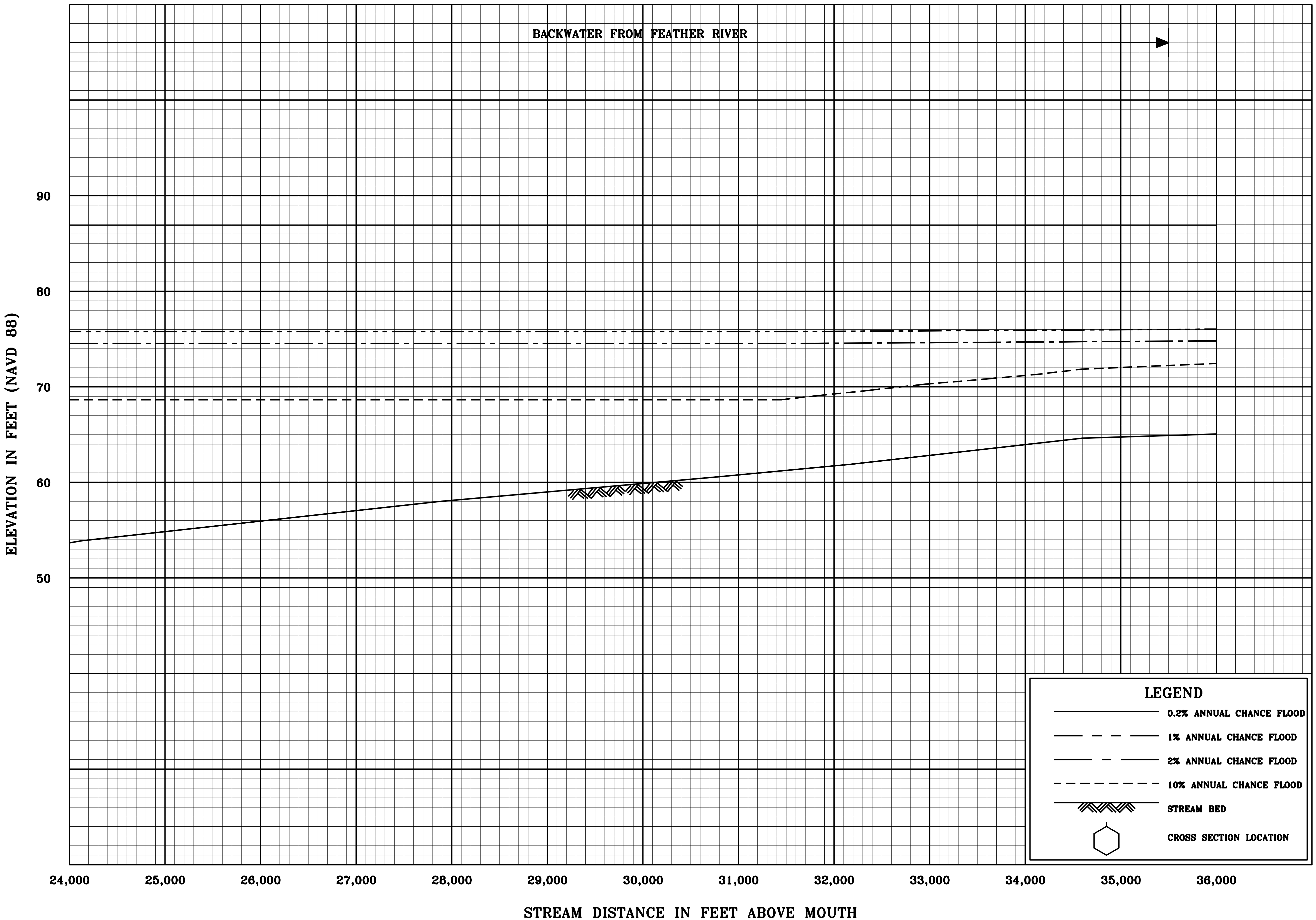


FLOOD PROFILES

JACK SIMMERLY SLOUGH

FEDERAL EMERGENCY MANAGEMENT AGENCY

YUBA COUNTY, CA
AND INCORPORATED AREAS

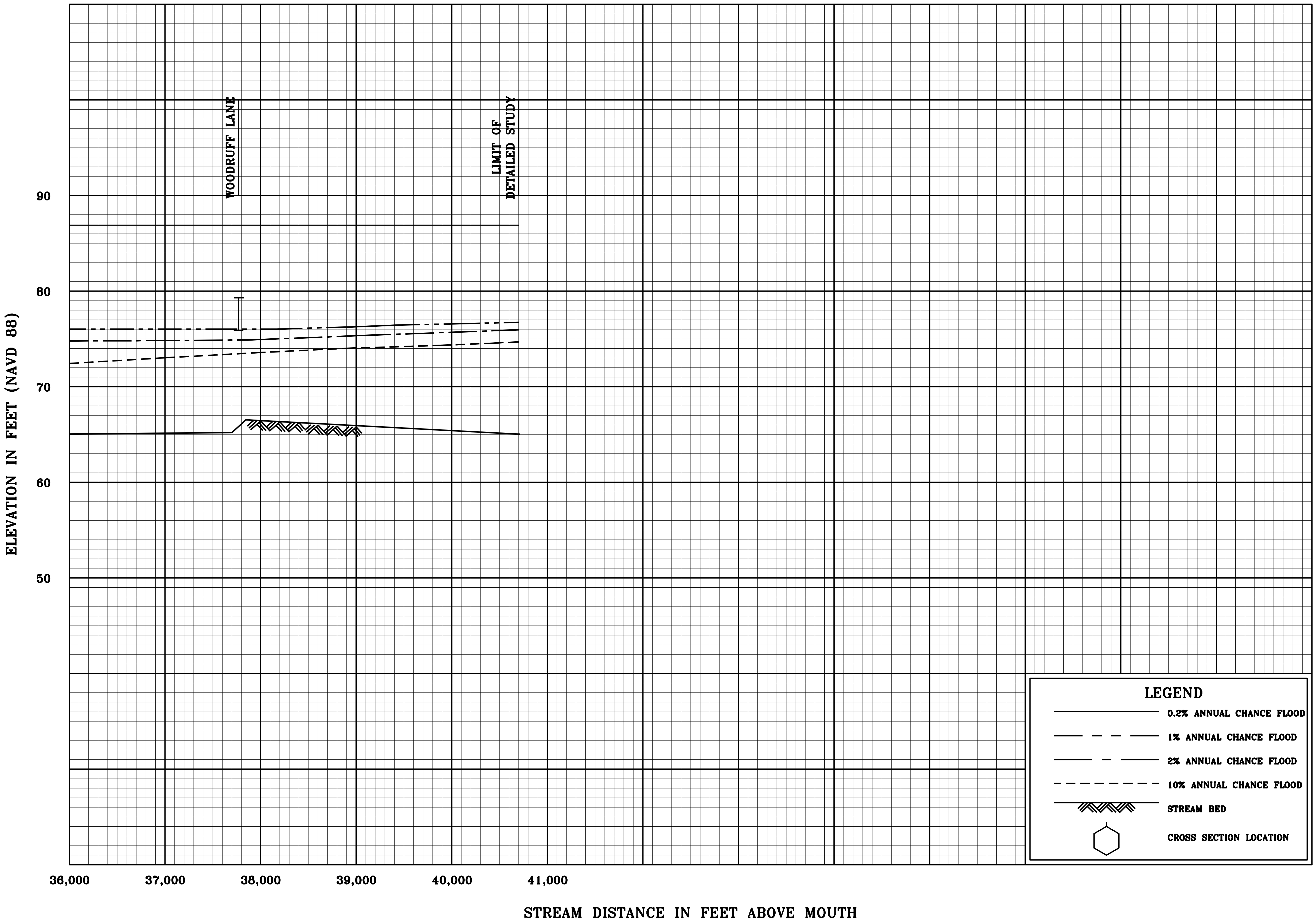


FLOOD PROFILES

JACK SIMMERLY SLOUGH

FEDERAL EMERGENCY MANAGEMENT AGENCY

YUBA COUNTY, CA
AND INCORPORATED AREAS

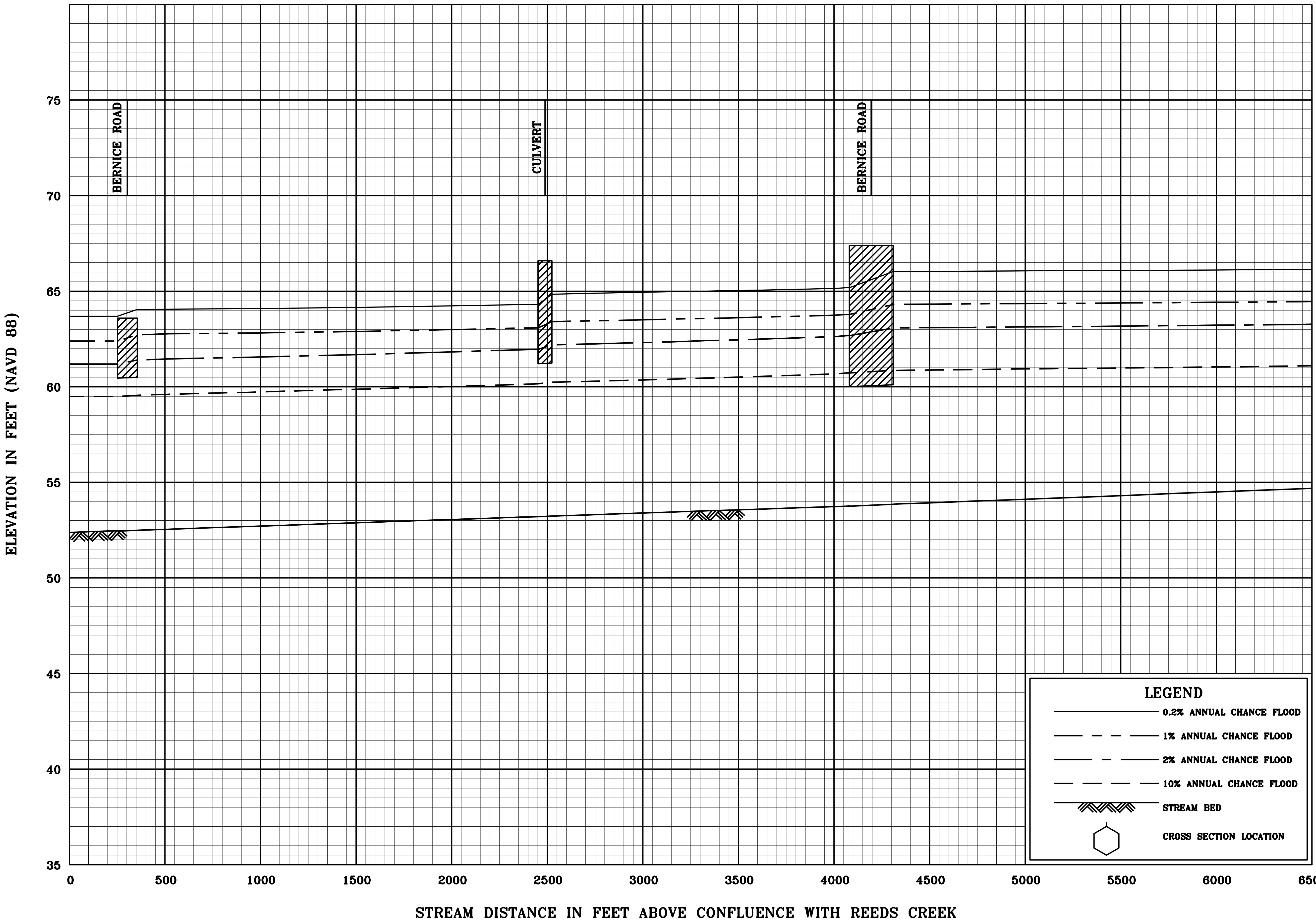


FLOOD PROFILES

JACK SIMMERLY SLOUGH

FEDERAL EMERGENCY MANAGEMENT AGENCY

YUBA COUNTY, CA AND INCORPORATED AREAS



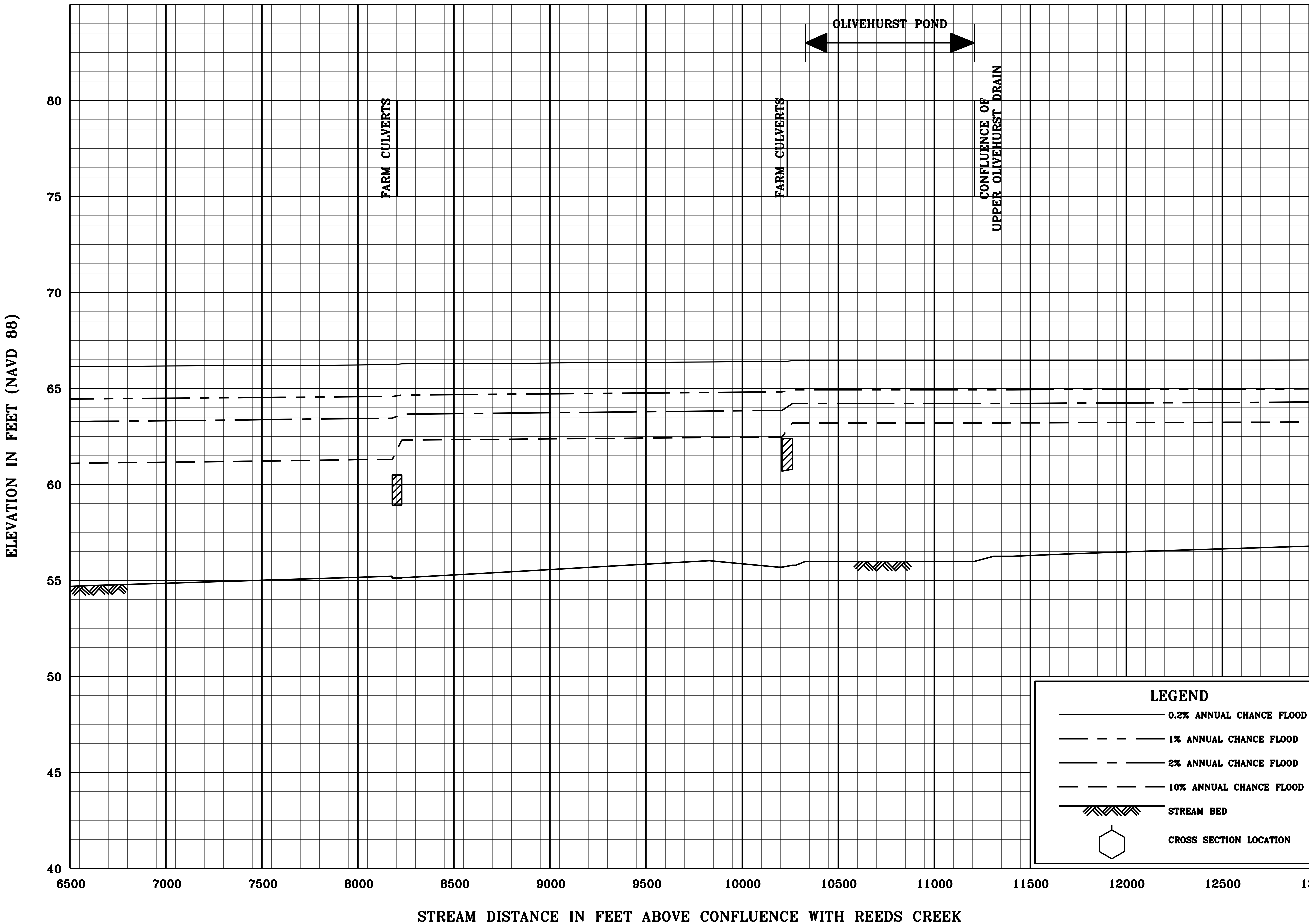
FLOOD PROFILES

OLIVEHURST INTERCEPTOR

FEDERAL EMERGENCY MANAGEMENT AGENCY

YUBA COUNTY, CA
AND INCORPORATED AREAS

24P

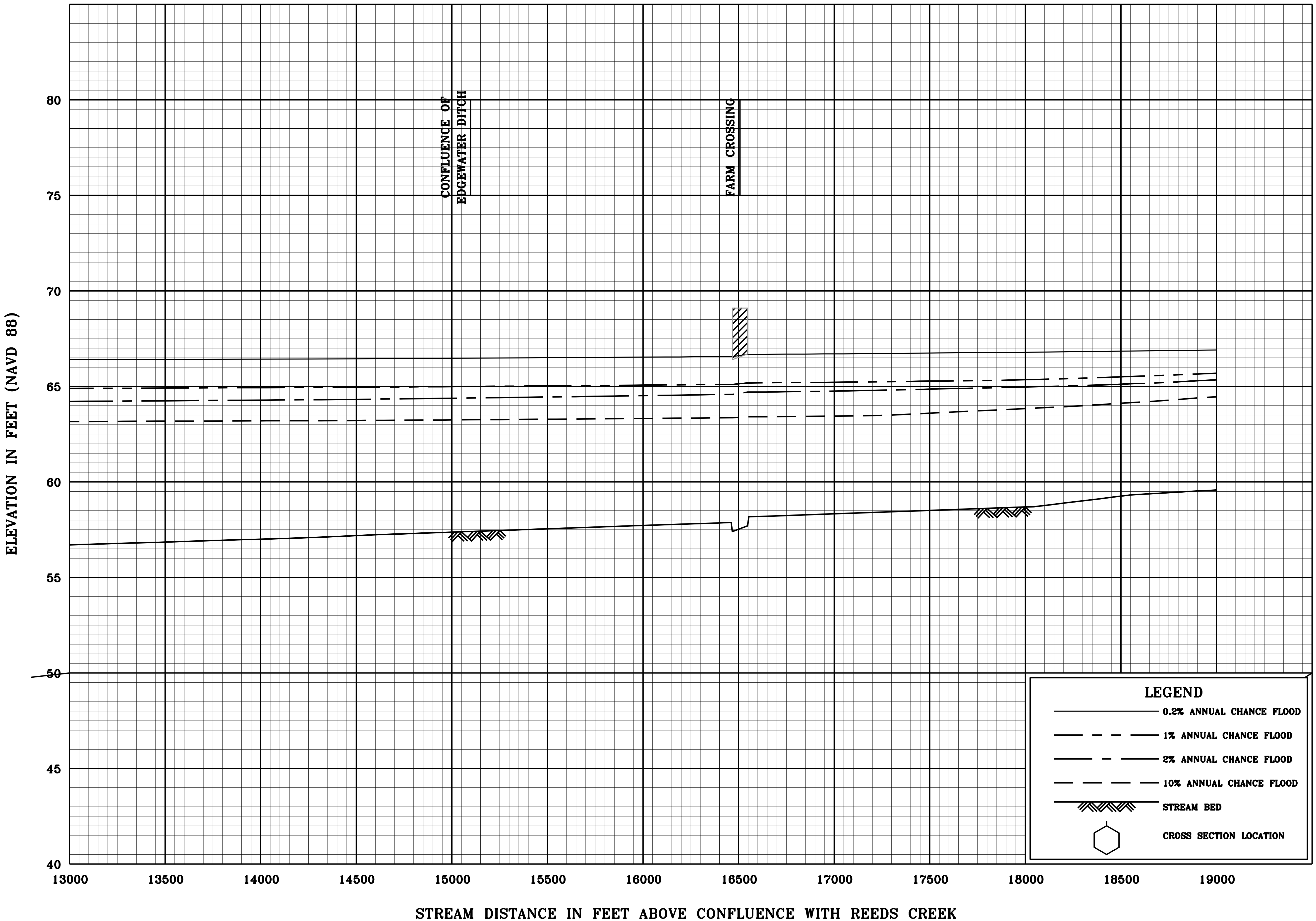


FLOOD PROFILES

OLIVEHURST INTERCEPTOR

FEDERAL EMERGENCY MANAGEMENT AGENCY

YUBA COUNTY, CA AND INCORPORATED AREAS



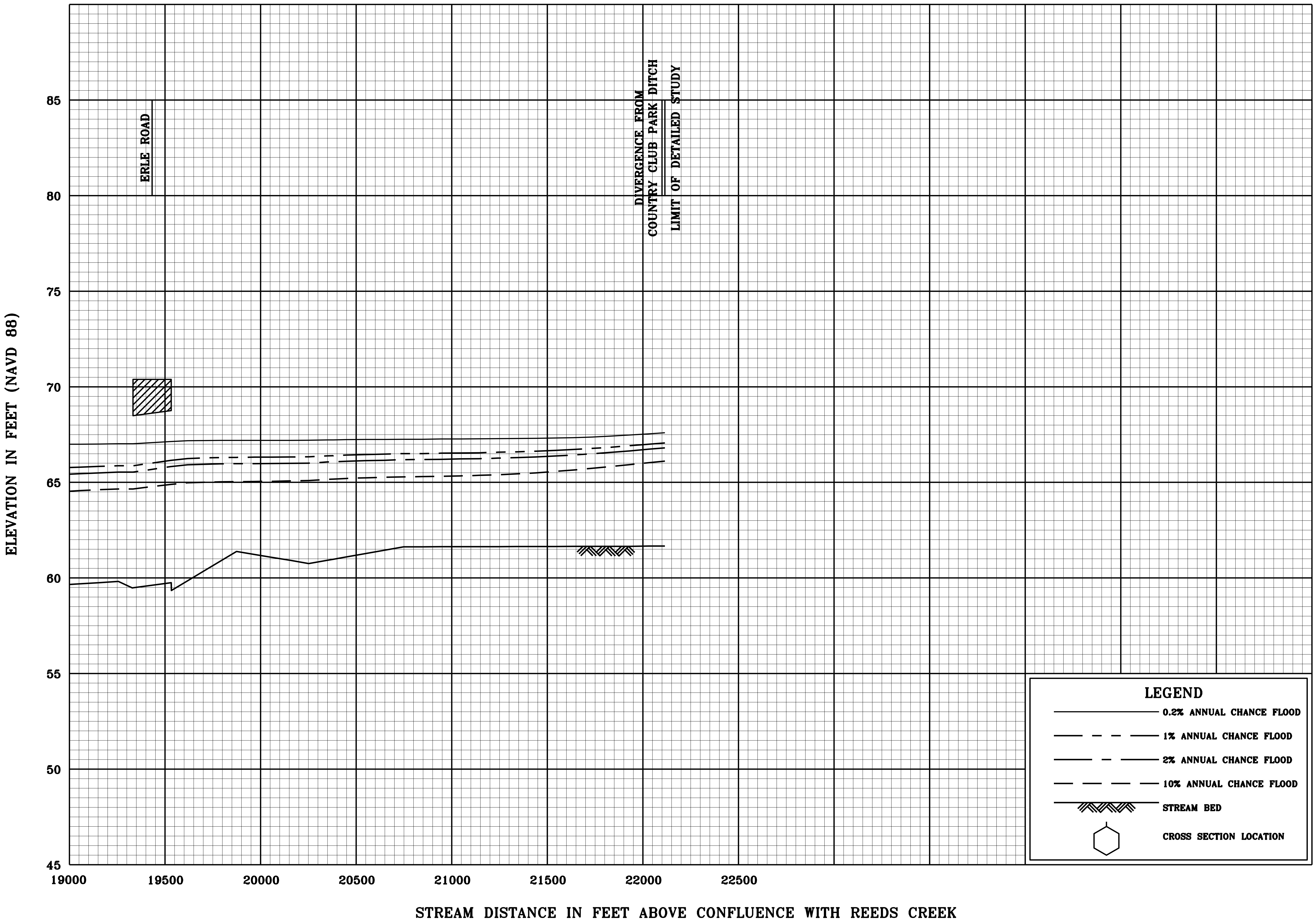
FLOOD PROFILES

OLIVEHURST INTERCEPTOR

FEDERAL EMERGENCY MANAGEMENT AGENCY

YUBA COUNTY, CA AND INCORPORATED AREAS

26P

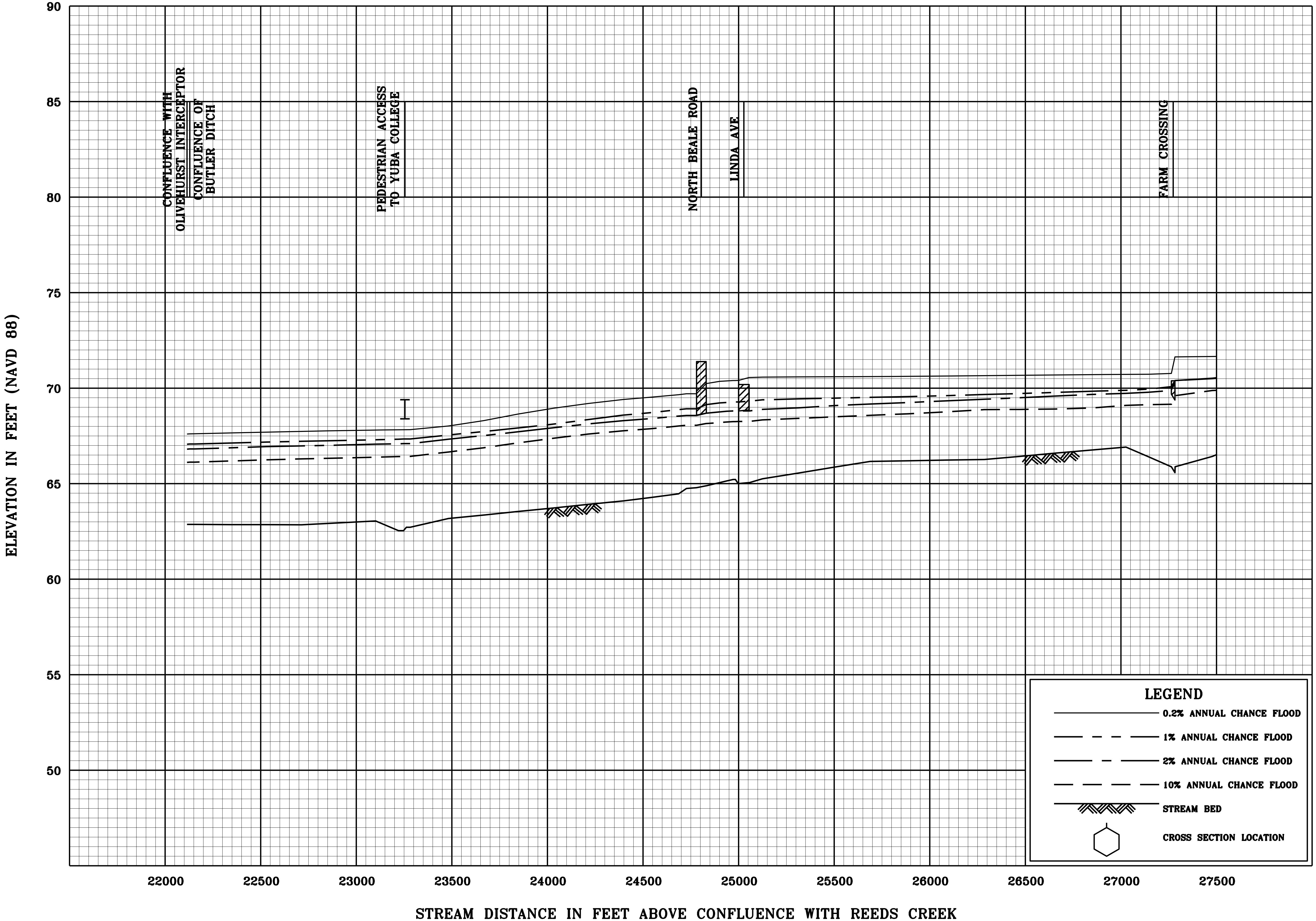


FLOOD PROFILES

OLIVEHURST INTERCEPTOR

FEDERAL EMERGENCY MANAGEMENT AGENCY

YUBA COUNTY, CA
AND INCORPORATED AREAS

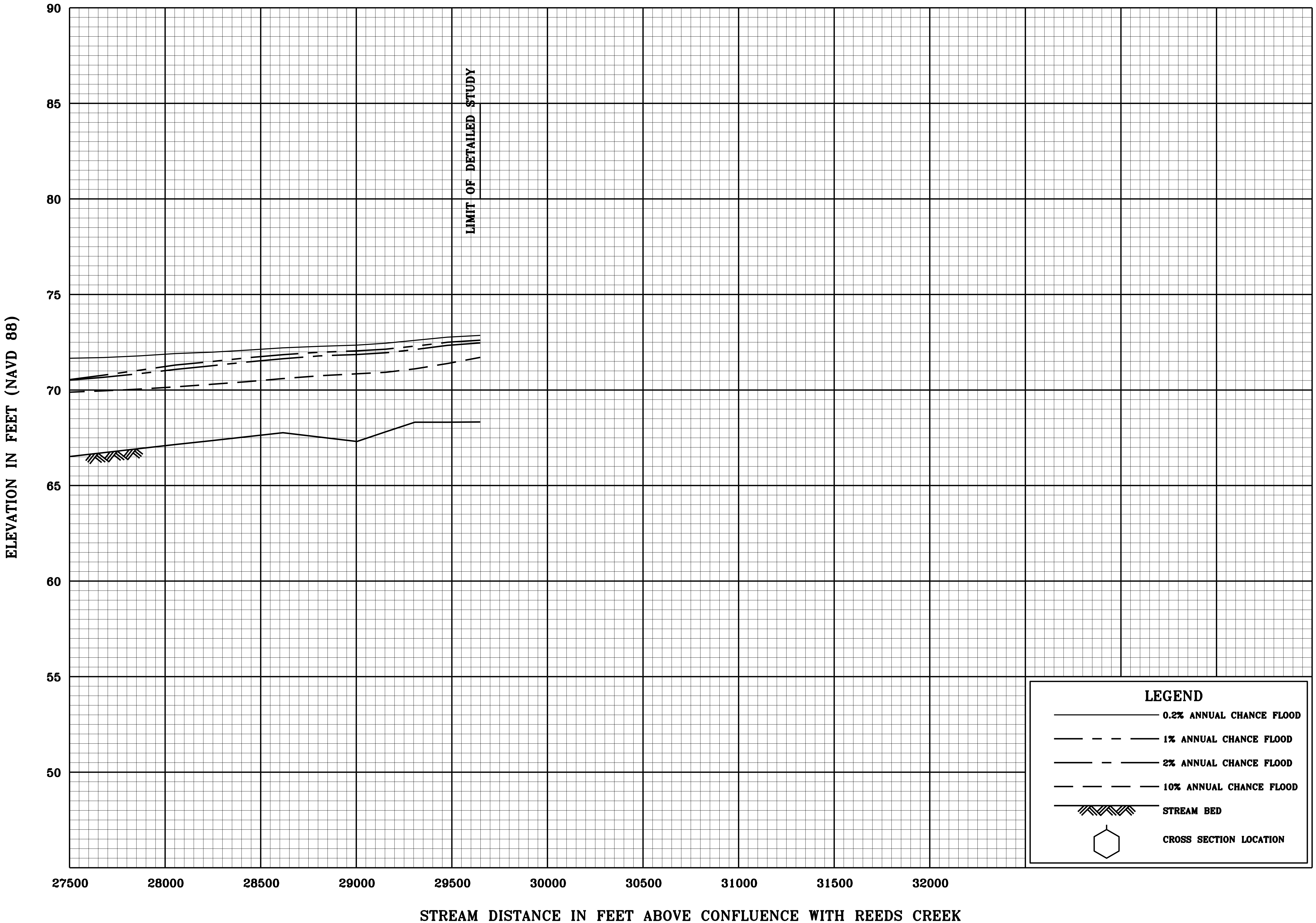


FLOOD PROFILES

UPPER LINDA DRAIN

FEDERAL EMERGENCY MANAGEMENT AGENCY

YUBA COUNTY, CA AND INCORPORATED AREAS

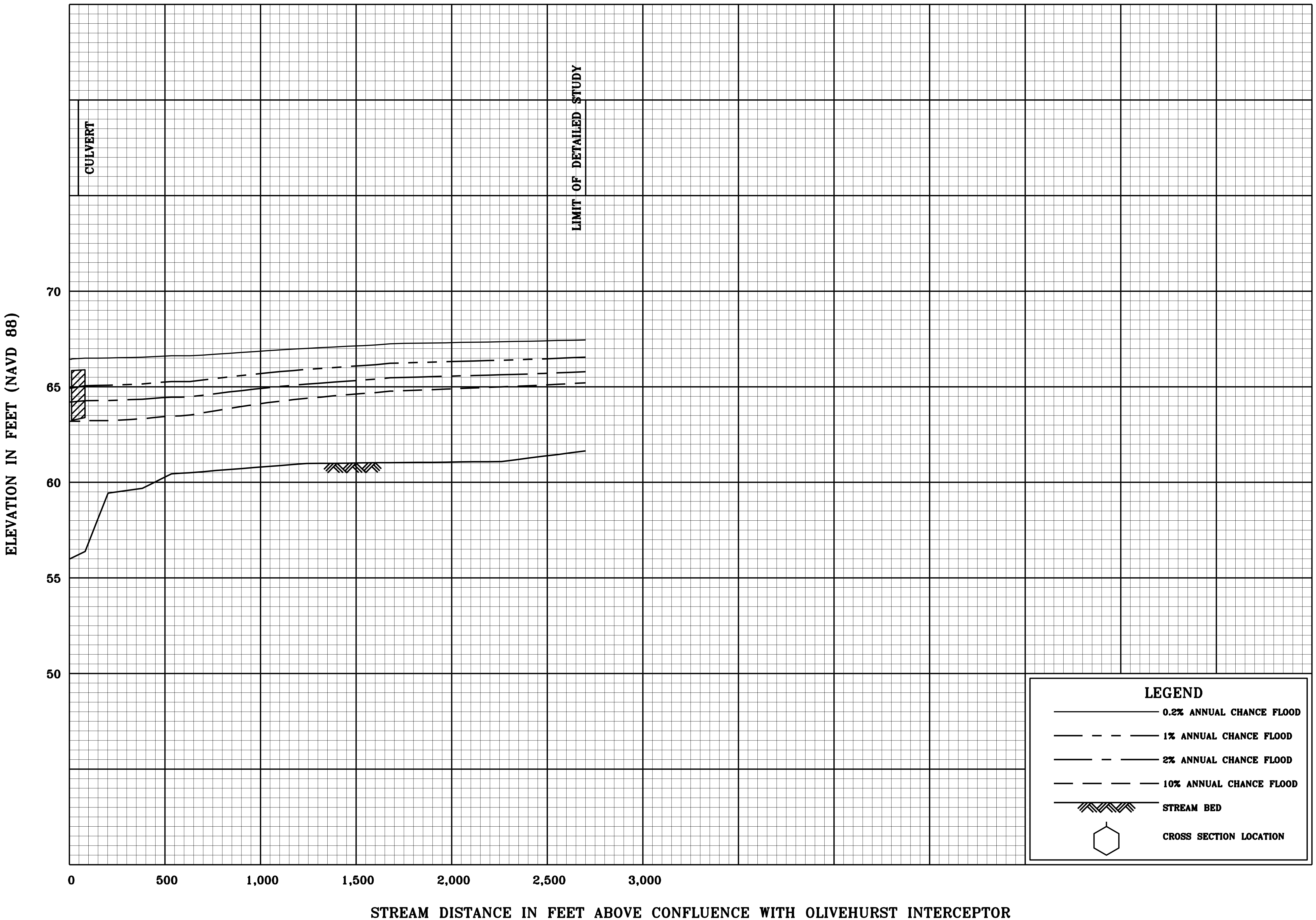


FLOOD PROFILES

UPPER LINDA DRAIN

FEDERAL EMERGENCY MANAGEMENT AGENCY

YUBA COUNTY, CA
AND INCORPORATED AREAS

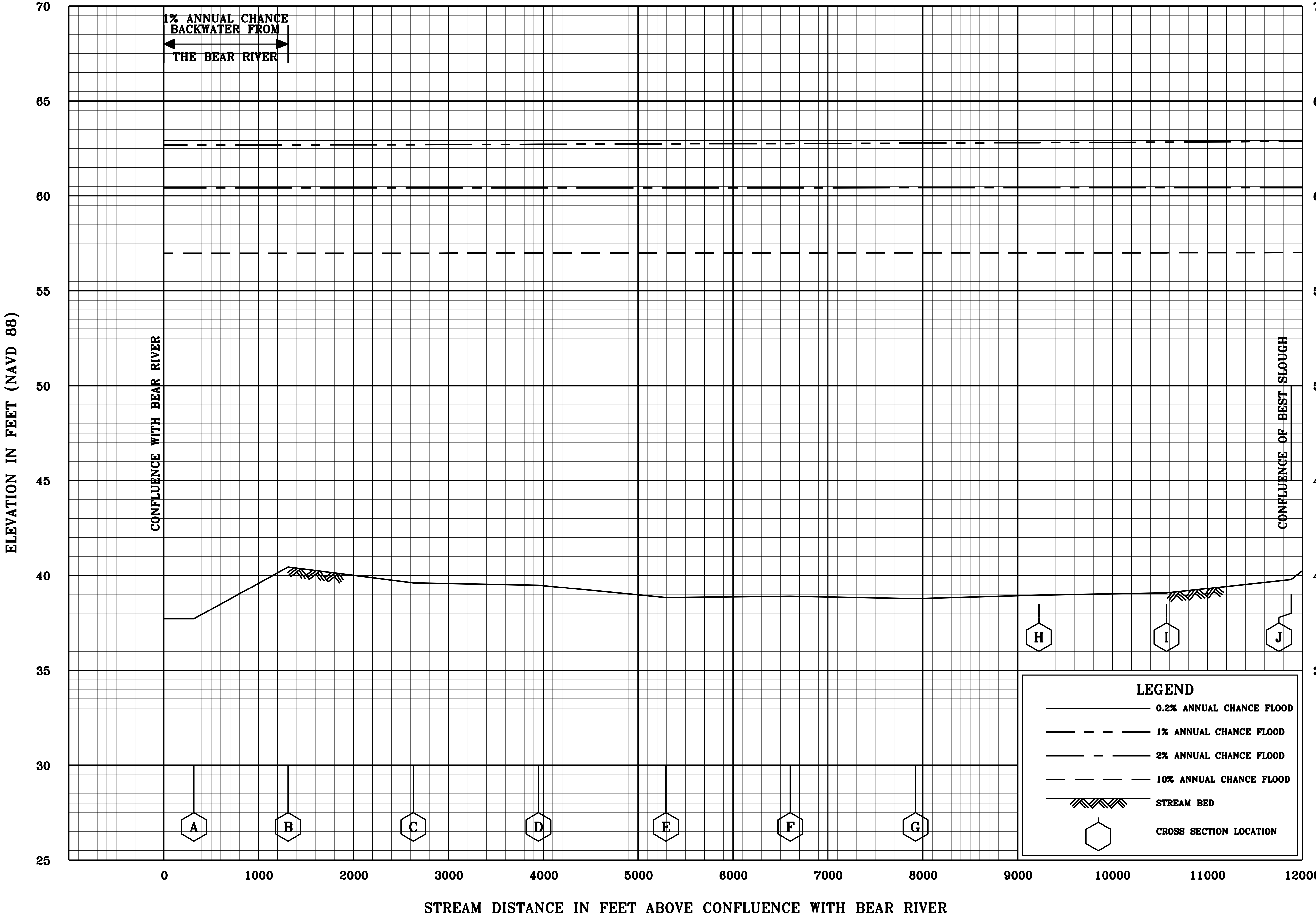


FLOOD PROFILES

UPPER OLIVEHURST DRAIN

FEDERAL EMERGENCY MANAGEMENT AGENCY

YUBA COUNTY, CA AND INCORPORATED AREAS



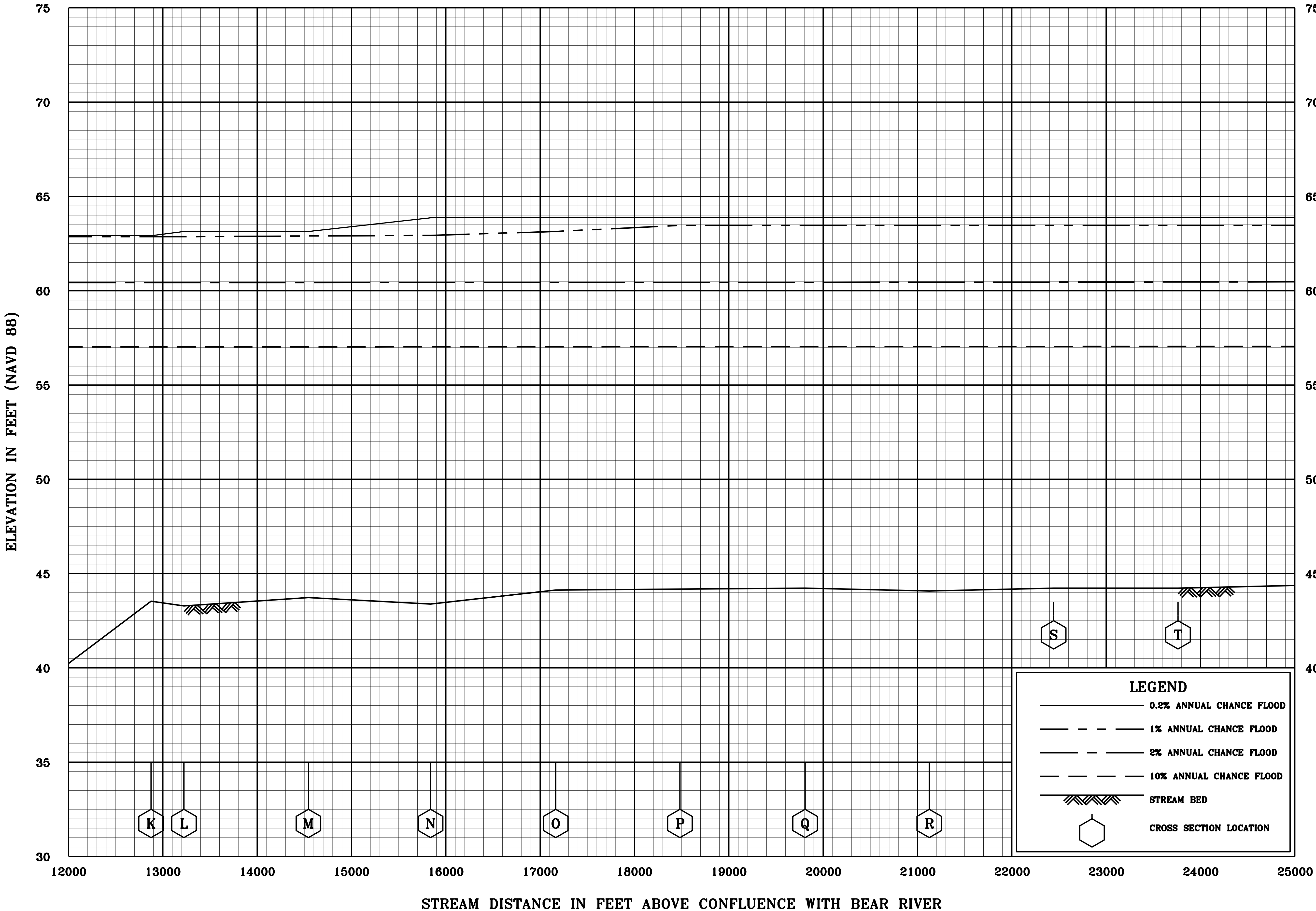
FLOOD PROFILES

WESTERN PACIFIC INTERCEPTOR CANAL

FEDERAL EMERGENCY MANAGEMENT AGENCY

YUBA COUNTY, CA AND INCORPORATED AREAS

31P

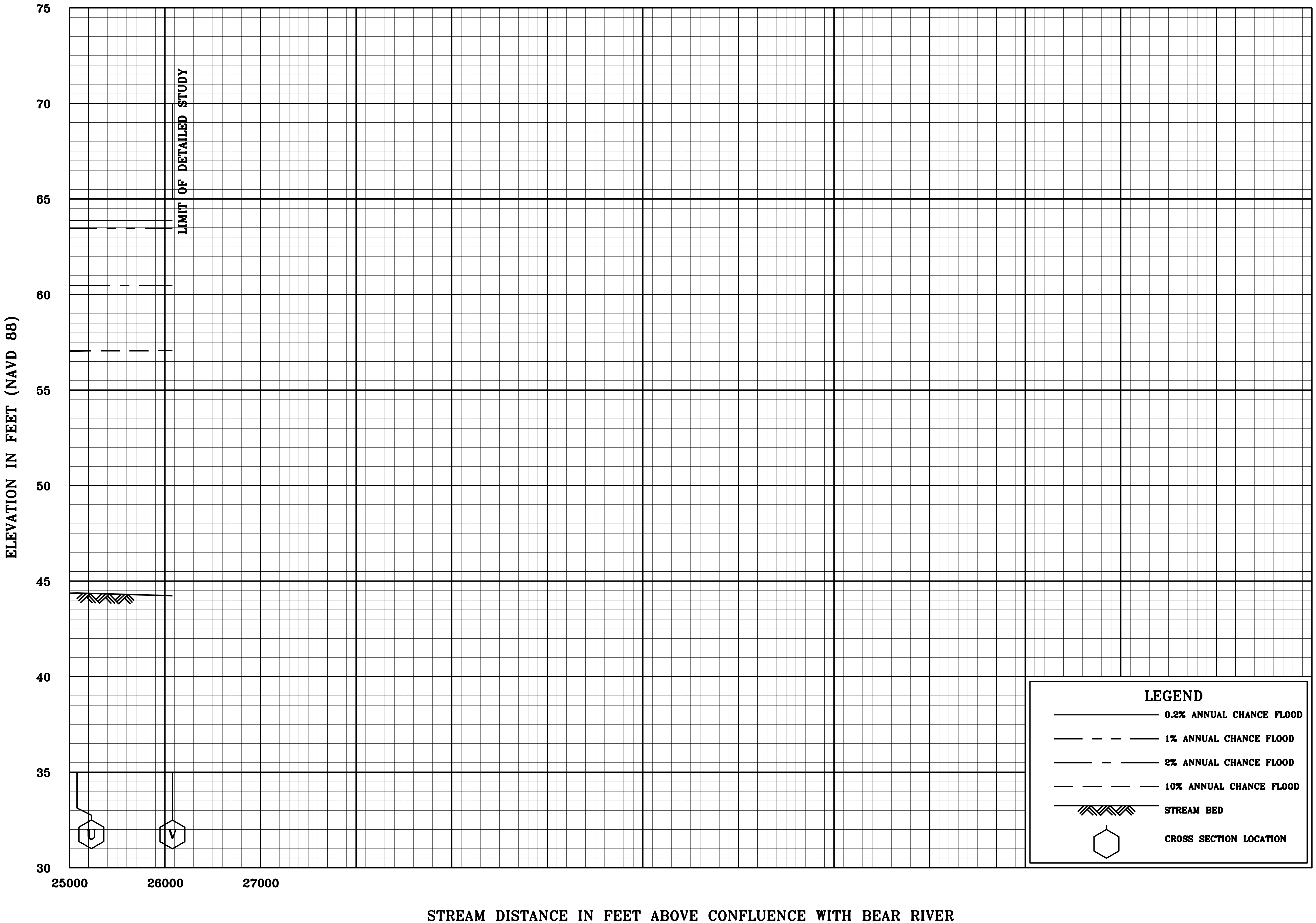


FLOOD PROFILES

WESTERN PACIFIC INTERCEPTOR CANAL

FEDERAL EMERGENCY MANAGEMENT AGENCY

YUBA COUNTY, CA AND INCORPORATED AREAS

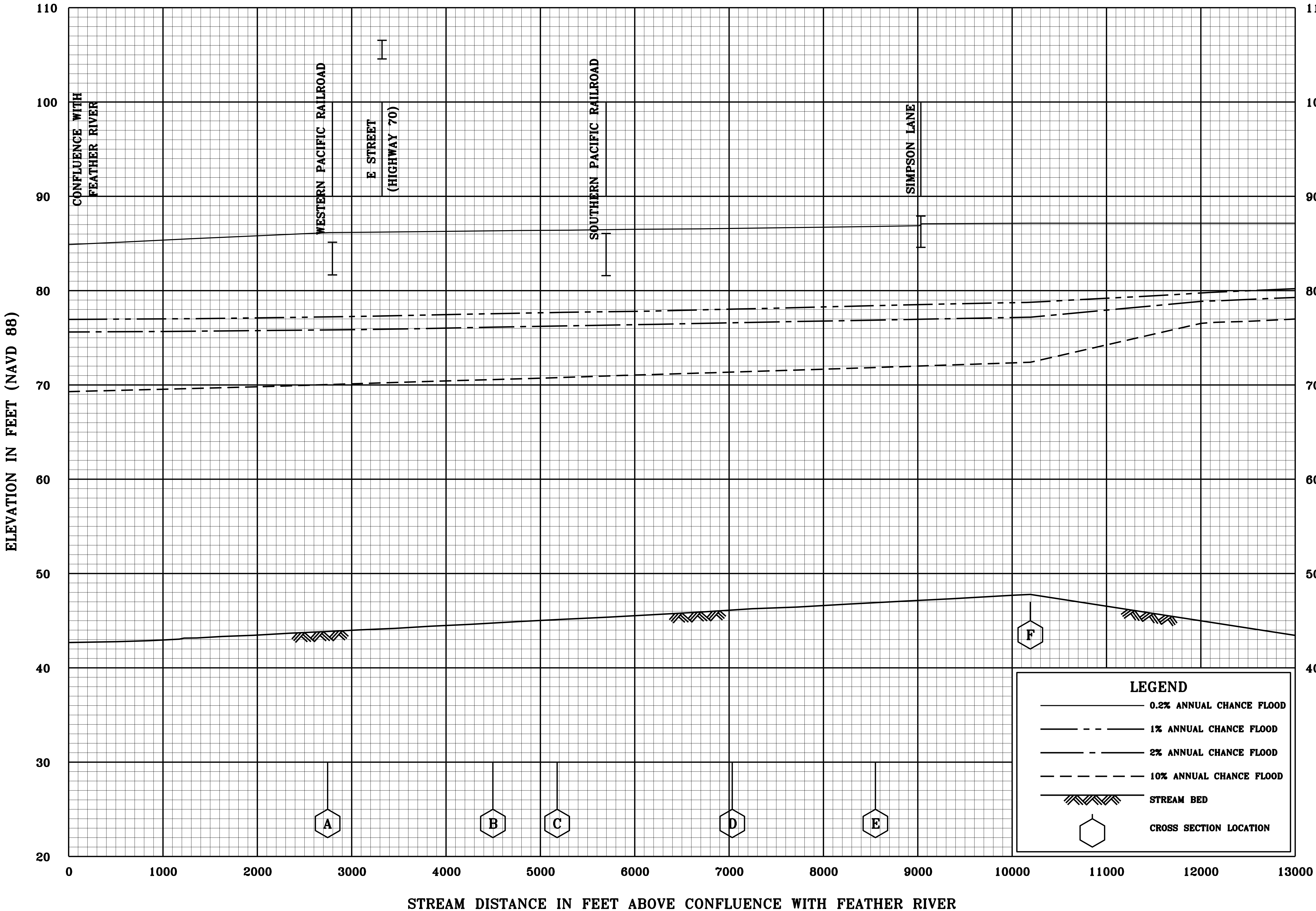


FLOOD PROFILES

WESTERN PACIFIC INTERCEPTOR CANAL

FEDERAL EMERGENCY MANAGEMENT AGENCY

YUBA COUNTY, CA AND INCORPORATED AREAS

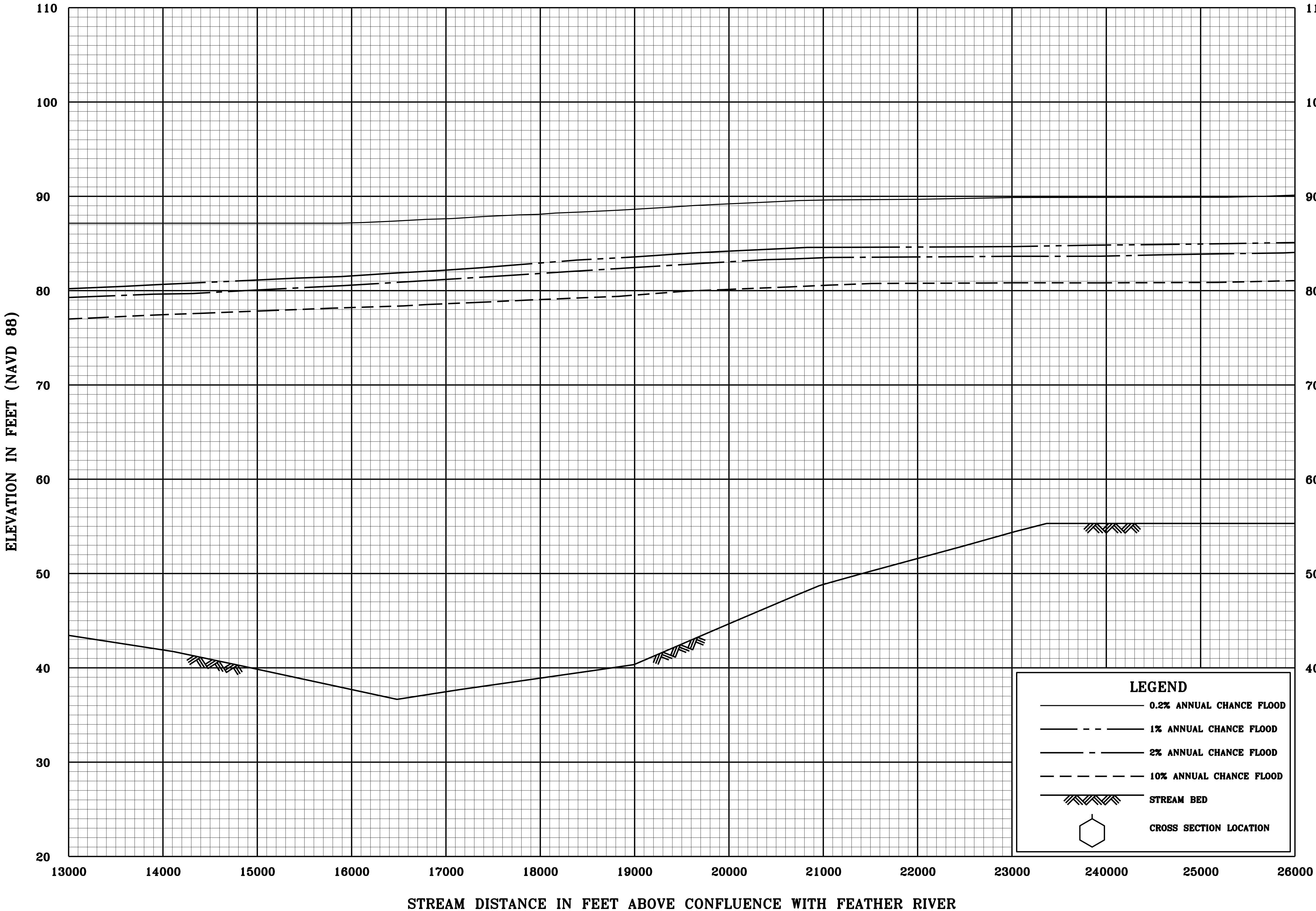


FLOOD PROFILES

YUBA RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

YUBA COUNTY, CA
AND INCORPORATED AREAS



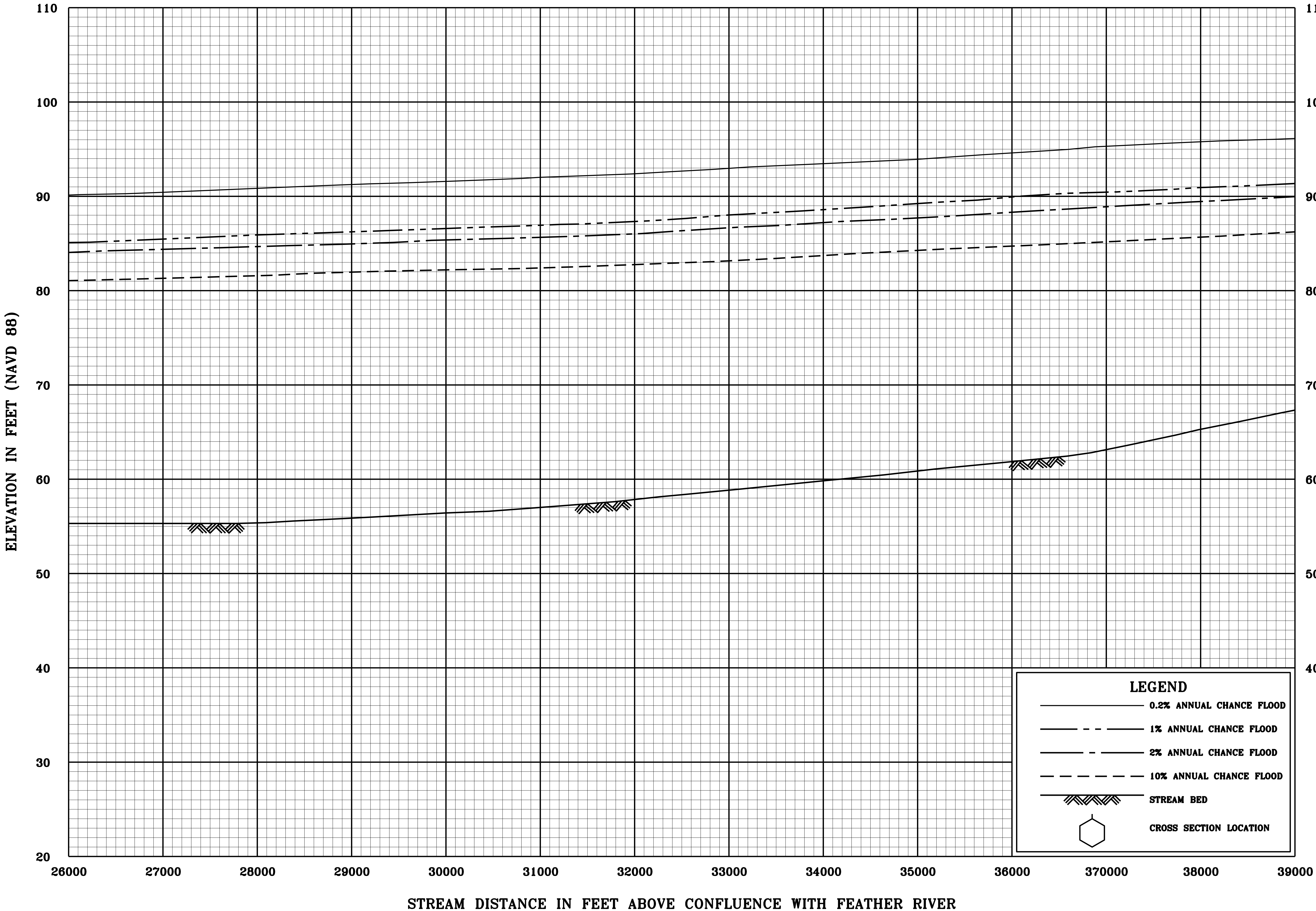
FLOOD PROFILES

YUBA RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

YUBA COUNTY, CA
AND INCORPORATED AREAS

35P

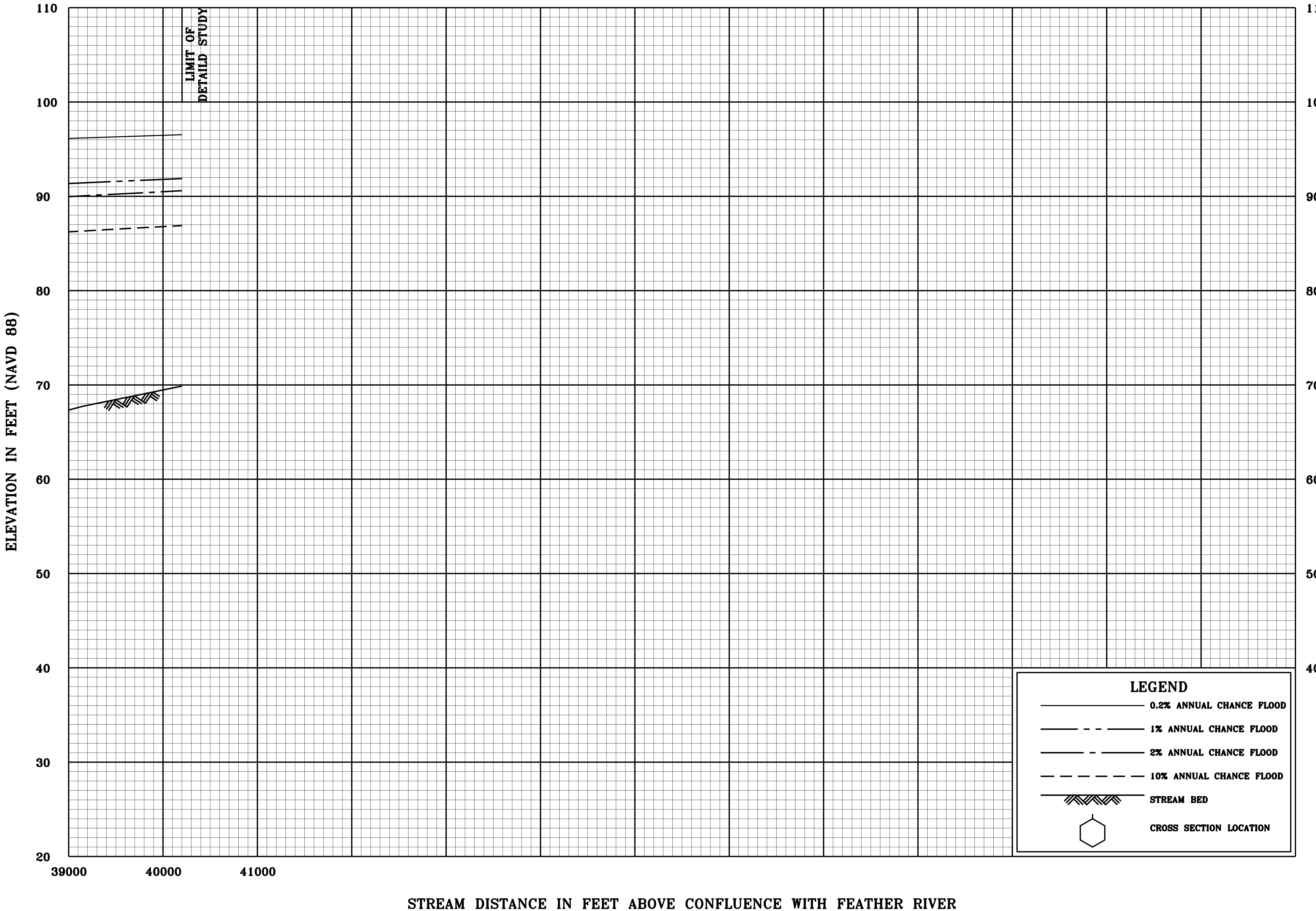


FLOOD PROFILES

YUBA RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

YUBA COUNTY, CA
AND INCORPORATED AREAS



FLOOD PROFILES

YUBA RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

YUBA COUNTY, CA AND INCORPORATED AREAS