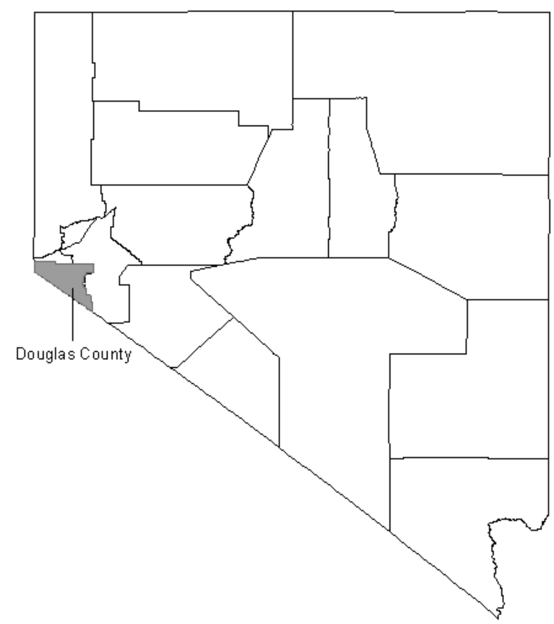
FLOOD INSURANCE STUDY

DOUGLAS COUNTY, NEVADA,
AND INCORPORATED AREAS



Community Name	**Community Number**
DOUGLAS COUNTY (UNINCORPORATED AREAS)	320008

REVISED:
June 15, 2016

Federal Emergency Management Agency
FLOOD INSURANCE STUDY NUMBER
32005CV001B

NOTICE TO
FLOOD INSURANCE STUDY USERS

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

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

Initial Countywide FIS Effective Date: September 30, 1992

Revised Countywide FIS Date: April 4, 1994
June 5, 1997
November 8, 1999
January 20, 2010
June 15, 2016

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FLOOD INSURANCE STUDY
DOUGLAS COUNTY, NEVADA AND INCORPORATED AREAS

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study (FIS) revises and supersedes the FIS reports and Flood Insurance Rate Maps (FIRMs) in the geographic area of Douglas County, Nevada 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. This information will also be used by Douglas County to update existing floodplain regulations as part of the Regular Phase of the National Flood Insurance Program (NFIP), and by local and regional planners to further promote sound land use and floodplain development. Minimum floodplain management requirements for participation in the 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 Acknowledgements

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

The hydrologic and hydraulic analyses for the original study were performed by the U.S. Soil Conservation Service (SCS), for the Federal Emergency Management Agency (FEMA), under Interagency Agreement No. IAA-I-87-5040. That study was completed in February 1979.

The September 30, 1992 revision hydrologic and hydraulic analyses were performed by the U.S Army Corps of Engineers (USACE), Sacramento District (the study contractor), for FEMA under Interagency Agreement No. EMW-86-E-2226, Project Order No. 19. This work was completed in 1988.

The April 4, 1994 revision incorporated the results of detailed study along the Carson River affecting Douglas County. The hydraulic analysis for that study was performed by the U.S. Geological Survey (USGS), for FEMA, using hydrology developed by Boyle Engineering Corporation for the City of Carson City FIS (Reference 1). That work was performed under Interagency Agreement No. EMW-89- E-2997 and completed in September 1991.

The June 5, 1997 revision incorporated the results of a detailed study along the East Fork Carson River, Cottonwood Slough, Henningson Slough, and Rocky Slough. The analysis for that study was performed by the USACE, Sacramento District.

The November 8, 1999 revision converted the FIRM for Douglas County, Nevada and Incorporated Areas to digital format. In addition, detailed flood hazard information for Clear Creek, generated for the original FIS for the City of Carson City, Nevada, was included. The hydrologic and hydraulic analyses for that revision were performed by Boyle Engineering Corporation (the study contractor), for FEMA, under Contract No. H-4609. The Clear Creek Study was prepared for the original FIS for the City of Carson City, Nevada, and was completed in December 1982.

The November 8, 1999 was revised again in February 2005 to provide detailed mapping along Airport Tributary Wash, Airport Wash, Airport Overflow Wash, Bobwhite Wash, Buckeye Creek, Calle de Asco Wash, Calle Hermosa Wash, Johnson Lane Wash and Juniper Road Wash within an unincorporated portion of Douglas County. This work was performed by Northwest Hydraulic Consultants (NHC, the study contractor) for FEMA under Contract No. EMF-2001-CO-0015, and completed in the work April 2005.

In December 2007, MAP-IX Mainland (the study contractor) conducted 6.5 miles of stream redelineation along the Carson River, Clear Creek, Pine Nut Road Wash, Rocky Slough and Smelter Creek within the unincorporated areas of Douglas County. In addition MAP-IX Mainland converted the existing FIRMs from National Geodetic Vertical Datum of 1929 (NGVD) to the North American Vertical Datum of 1988 (NAVD) and incorporated the work done by the NHC onto the FIRMs. MAP-IX Mainland completed this work for FEMA in April 2008 under Contract No. EMF-2005-CO-0046.

In December of 2013, Kimley-Horn studied Buckeye Creek, Buckbrush Wash, Johnson Lane Wash and Airport wash using two-dimensional modeling under contract with Douglas County. In June 2015, BakerAECOM incorporated the two-dimensional study results onto updated FIRMs under contract HSFEHQ-09-D-0368, task order HSFE09-13-J-0158. Results of the two-dimensional study completed by Kimley-Horn supersede the profiles for Johnson Lane Wash, Sunrise Pass Wash, Airport Wash, Airport Tributaries Wash, and Buckbrush Wash.

Base map information shown on this FIRM was derived from Department of Agriculture aerial photography, dated 2006.

The projection used in the preparation of the FIRM was Nevada State Plane West Zone (FIPS 2703). The horizontal datum was NAD83, GRS80 spheroid. Flood elevations on the FIRM are referenced to the NAVD88. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences across jurisdiction boundaries. These differences do not affect the accuracy of the FIRM.

1.3 Coordination

An initial Consultation Coordination Officer's (CCO) meeting is held with representatives from 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 with representatives from FEMA, the community, and the study contractor to review the results of the study.

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

Table 1 – Initial and Final CCO Meetings

Study	Initial CCO Date	Final CCO Date
Original Study	[1]	November 29, 1977
1st Revision	January 24, 1986	February 6, 1992
2nd Revision	[1]	November 16, 1992
3rd Revision	[1]	[1]
4th Revision	[1]	[1]
2010 Revision	October 2, 2003	January 8, 2009
June 15, 2016 revision	April 22, 2014	July 28, 2015

[1]Date not available

For this revision, an initial CCO meeting conference call was held on April 22, 2014. A final CCO meeting conference call was held on July 28, 2015, and was attended by Douglas County staff, FEMA Region IX, FEMA HQ and BakerAECOM.

2.0 AREA STUDIED

2.1 Scope of Study

This FIS covers the geographic area of Douglas County, Nevada.

Flooding Sources studied by detailed methods are shown in Tables 2 – 4. Table 2 indicates all flooding sources studied by detailed methods. Table 3 lists new stream reaches studied by two-dimensional methods. Table 4 shows redelineated study stream reaches. Limits of detailed study are indicated on the Flood Profiles (Exhibit 1) and on the FIRM (Exhibit 2).

Table 2 – Detailed Study Streams

Airport Tributary Wash	Johnson Lane Wash
Airport Wash	Juniper Road Wash
Airport Wash Overflow	Martin Slough
Bobwhite Wash	Mott Canyon Creek
Buckbrush Wash	Pine Nut Creek
Buckeye Creek	Pine Nut Creek Tributary
Calle De Asco Wash	Pine Nut Road Wash
Calle Hermosa Wash	Rocky Slough
Carson River	Schoolhouse Canyon Creek
Clear Creek	Shena Terrace Wash
Cody Wash	Sheridan Creek
Cottonwood Slough	Sierra Canyon Creek
East Fork Carson River	Smelter Creek
Fish Springs Creek	Stutler Canyon Creek
Genoa Canyon Creek	Sunrise Pass Wash

Table 3 – Two-Dimensional Study Areas

Airport Tributary Wash
Airport Wash
Buckbrush Wash
Johnson Lane Wash
Sunrise Pass Wash

Table 4 – Redelineated Stream Reaches

Stream Name	Limits of Redelineated Detailed Study
Carson River	From County Boundary to 3 miles upstream of Carson County Boundary.
Clear Creek	From 1,500 feet upstream of Vista Grande Boulevard to 3,500 feet upstream of Vista Grande Boulevard.
Pine Nut Road Wash	From East Valley Road to 3,500 feet upstream of Pine Nut Drive.
Rocky Slough	SH-88 to divergence from East Fork Carson River.
Smelter Creek	From confluence with East Fork Carson River to 1,000 feet downstream of Colt Lane.

Those areas studied by detailed methods were chosen with consideration given to all proposed construction and forecasted development.

Numerous streams were studied by approximate methods. Approximate analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to, and agreed upon by, FEMA and Douglas County. Limits of Study are shown on the FIRM.

Table 5 is a list of Letters of Map Change (LOMCs) which highlight those revisions that have been incorporated into the 2016 revision of Douglas County.

Table 5 – Letters of Map Change

Community	Case Number	New Panel(s)
Douglas County (Unincorporated Areas)	12-09-1513P	32005C0253H 32005C0254H
Douglas County (Unincorporated Areas)	13-09-2041P	32005C0253H

2.2 Community Description

Douglas County, established in 1861, is located in the west-central part of Nevada along the Nevada-California border. It is bordered on the west by four California counties: Placer, El Dorado, Alpine, and Mono from north to south, respectively; on the east and the eastern portion of the north boundary by Lyon County, Nevada; and on the western portion of the north boundary by Carson City, Nevada. The southeastern portion of Lake Tahoe, internationally known resort and gaming area, forms the westernmost border of the county. The northwestern portion of the county lies predominantly in the Carson Valley between the steep eastern slopes of the Carson Range and the western slopes of the Pine Nut Mountains. There are no incorporated cities in the county.

The community of Minden, the county seat, and its neighboring community Gardnerville were settled in the mid-1800s by German immigrants. There are the two major urban centers in the valley portion of Douglas County and form the social and commercial center of the southern part of Carson Valley. The average elevation of the two cities is about 4,730 feet. Carson City, Nevada, the State capital, is about 15 miles to the north of the Minden/Gardnerville area. The city of South Lake Tahoe, California, lies about 20 road miles to the west.

Practically all of the residential and commercial development is concentrated in the Minden/Gardnerville area. There is, however, a growing trend toward residential expansion (sporadic but increasing) along many of the eastside and westside tributaries included in this FIS.

The county population in 2006 was 45,909; in 2000 the population was 41,259 (Reference 2), and in 2010 the population was 46,977. The estimated population in 2014 is 47,536.

The study area is served by several main U.S. and State Highways (SH). U.S. Highway 395 is the principal north-south artery in the mid-valley area and connects Minden/Gardnerville to Carson City to the north and to various areas in both Nevada and California to the south. SH-88 runs south-southwesterly, linking Minden/Gardnerville to California. SH-207 runs westerly from Minden/ Gardnerville and is the connector to the Lake Tahoe region. SH-206 runs from north to south along the western edge of the valley and is the principal roadway serving the Genoa area. Additionally, there is a network of hundreds of miles of county and city roads and streets.

Ground and air public transportation services to the study area are limited. Two main bus lines provide service to the valley, but there is no direct railway service. The nearest point for rail-freight transportation is at the community of Wabuska, Nevada, about 35 miles to the northwest. Regional AMTRAK passenger connections are available at the city of Reno, approximately 40 miles to the north. Air service in the valley is limited to the General Aviation Airport at Minden (Minden-Tahoe Airport), with no commercial flights available. The closest commercial facilities are located at Reno and at South Lake Tahoe (about 25 miles to the west), where regularly scheduled commercial and charter services are available.

For many years the Carson Valley economy was based on ranching and farming activities. The area still maintains a rural, residential character and lifestyle that remains associated with agricultural pursuits. The primary agricultural activities in the valley are livestock and forage production. However, the great attraction and drawing power that has led to the tremendous inflow of permanent residents and a greatly expanded work force is the hotel/gaming/recreation industry (included in the services industry category). The services industry is now by far the leading contributor to the valley's economic base, with almost 7 out of every 10 workers included in that field (Reference 3).

The study area is characterized by the steep, forested eastern slopes of the Carson Range (source of the westside tributaries), the more gentle western slopes of the Pine Nut Mountains (source of the eastside tributaries), and the relatively flat valley floor. Elevations in the Carson Range vary from a high of over 9,000 feet to about 4,800 feet at the foothill line. In the Pine Nut Mountains, the elevations range from a high of 9,450 feet at Mount Siegel to less than 5,000 feet at canyon mouths, with most of the drainages lying below 6,000 feet. The wide, flat, elongated valley lands are enclosed on three sides (by the Carson Range on the west, the Sierra Nevadas on the south, and the Pine Nut Mountains on the east) and are open only to the north.

The headwaters of the East Fork Carson River begin at more than 10,000 feet elevation in Alpine County, California. The river flows through steep mountain canyons in a well-defined channel to the foothill line. It then emerges into Carson Valley at about 4,900 feet elevation—the foothill line, which is approximately 5 miles upstream from and southeast of Gardnerville. Below the foothill line the channel is not as distinct or incised, and its limited carrying capacity is reduced further by vegetative growth and siltation.

The channels of the East Fork and its tributaries in the study areas slope gently in a general northwesterly direction with an average drop in elevation of approximately 25 feet per mile (0.5 percent grade). The study reaches of the westside tributaries are very steep and their slopes range from 14 percent grade in the higher portions to 3 percent grade in the lower portions. The study reaches of the eastside tributaries are moderately steep; the tributaries northeast of the Minden-Tahoe Airport have slopes that range from 3 percent to 1 percent grade, while the remaining tributaries have slopes that range from 2 percent to 1 percent grade.

The valley lies in the rain shadow of the Sierra Nevadas, which effectively intercept most of the moisture from easterly traveling Pacific storms, and climatic conditions, thus affected, range from semiarid in the valley to sub-humid in the high mountains. Normal annual precipitation varies with altitude and ranges from approximately 8 inches at Minden to more than 16 inches in the uplands of the Pine Nut Mountains and 25 inches at the crest of the Carson Range to about 50 inches in the headwater regions of the East Fork Carson River. The greatest 24-hour rainfall amount at Minden was 3.03 inches and occurred in January 1963. The most rainfall in a single month, 5.22 inches, was in February 1938. Snowfall in the valley averages about 18 inches per year, while in the higher elevations of the surrounding mountains deep snowpacks accumulate, especially in the headwater regions of the East Fork. Most of the seasonal precipitation occurs during the period from November through March. Most thunderstorms occur during the summer.

Temperature also varies with altitude, and as a result of extreme ranges in elevation, wide varieties of temperature can occur within short distances. An outstanding feature of temperature in the region is the extreme range between daily maximums and minimums. For example, summer ranges of 45°F or more are not uncommon due to the hot daytime temperatures being cooled to the low 40s by down-sloping mountain breezes. Winters are moderate, as the Sierra Nevadas prevent much of the cold polar air from entering the valley. Temperature in the valley ranges from average winter lows of about 19°F to average summer highs of about 86°F. However, extremes at Minden have varied from -20°F in January to 105°F in July. The length of the growing season, based on the average number of days with minimum temperature above 32°F, is about 104 days (Reference 4).

Much of the natural vegetation in the valley has been removed by agricultural operations and urbanization. There are scattered cottonwoods and willows along the streamways and marsh-type growth within the streambanks. In foothill regions, there are dense patches of chaparral and other low brush and annual grasses. On the mountain slopes (ranging in elevation from about 5,200 to 9,000 feet), there are stands of coniferous forests with an undercover of various types of brush and annual grasses.

2.3 Principal Flood Problems

Flooding in the Carson Valley region of Douglas County is caused by any of three different and individually significant events as follows: general rainstorms, localized cloudburst storms, and snowmelt runoff. General rainstorms normally occur in the fall and winter. Cloudburst storms can be expected in the spring, summer, and fall and may occur over one or more of the smaller drainage basins. Snowmelt runoff occurs in the spring and early summer.

General rainfloods result from prolonged heavy rainfall over tributary areas 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, when the ground is frozen and infiltration is minimal, or when rain on snow in the higher elevations of the Sierra Nevadas to the southwest adds snowmelt to rainflood runoff. Cloudburst storms, sometimes lasting as long as 3 hours, are high-intensity storms that can produce floods characterized by high peak flows, short duration of floodflows, and small volume of runoff. In some areas of the county, especially where drainage basins are small, such as the eastside and westside tributaries, cloudbursts can produce peak flows substantially larger than those of general rainstorms. Cloudburst storms usually cover small areas and would not affect floodflows or flood stage on the East Fork Carson River.

Snowmelt flooding is of much larger volume and longer duration than rainflooding and cloudburst flooding; however, it does not have the high peak flows characteristic of rainfloods and cloudburst floods. Snowmelt flood runoff is sometimes augmented by spring and summer rains on the snowfields or lower elevation tributary watersheds.

The 1-percent annual chance floodflows on the East Fork Carson River are attributed to combined general rain/snowmelt runoff. The 1-percent annual chance flooding on the 5 westside and 21 eastside tributaries is due to cloudburst storms.

Most of the streams have portions with insufficient channel capacities and are not capable of containing the 1-percent annual chance floodflows. Once overbank flooding occurs, there are few major obstacles to overland flows. There is a large amount of sheetflow flooding; that is broad, shallow, overland flows generally less than 3 feet deep and characterized by unpredictable flow paths. Also, the severity of flooding in some areas is intensified by ponding conditions that can occur against obstructions such as road embankments, levees, and constrictive bridges and culverts. The ponded floodwaters usually are deeper than the contributing overland floodflows.

Additionally, flood conditions are further aggravated along some of the westside and eastside tributaries by the transition from steep, well-defined mountain channels to gently sloping valley floor streambeds with reduced carrying capacity due to vegetative growth and siltation.

Three distinct flow directions and patterns are exhibited by floodflows in the study area. The East Fork Carson River flows generally northerly to its junction with Rocky Slough and then the floodwaters are distributed in a fan-shaped pattern for several miles westerly and northwesterly to beyond SH-88. Floodwaters on the 5 westside tributaries flow mostly easterly through steep canyons, emerge onto the alluvial fans, and then spread out in a sheetflow pattern and continue toward the West Fork and main stem Carson River. Floodflows on the 21 eastside tributaries drain in a general westerly direction through canyons and well-entrenched areas and stay contained (in channel), but spread overland as channel capacity diminishes and continue toward the East Fork and main stem Carson River.

The Carson Valley region of Douglas County has a long history of flooding, but little definitive data are available for specific floods due to the following: early historical floods occurred before streamflow records were made; the rural nature of the study area, especially the basins of the westside and eastside tributaries; the short period of streamflow records for only a few of the tributaries and the absence of such records for the majority of the tributaries; sparse newspaper accounts; and the scarcity of contemporary accounts. Information on past floods is based essentially on historical accounts, various published and unpublished reports, and newspaper articles.

Flooding on the East Fork Carson River has been almost exclusively the result of general rain on saturated ground. Except for the spring snowmelt flood in 1890, all major floods on this channel have been caused by heavy rainfall on saturated or frozen ground or on snow. Table 6 shows recorded peak flows for the East Fork Carson River at the "near Gardnerville" gage (discontinuous record from 1890 to 1937) and the respective estimated frequencies of occurrence.

The largest recorded flows on the East Fork Carson River have occurred since 1937. The most damaging flood events have taken place since 1950, due to the increased development in the region. Estimates of some of the flood damages that have been caused since 1950 and the respective acres flooded are shown in Table 7. The estimates of flood damage and acres flooded were made for reaches of the Carson River, and sometimes the East and West Forks as well as the main branch were included in the same reach. Therefore, the flood damage figures listed are, of necessity, shown to be within a range from "low to high." The combined flooded acreage figures are for the East Fork from about the foothill line to the mouth, the West Fork from approximately Centerville Lane to the mouth, and about the upper 5 to 10 miles of the main stem Carson River.

The principal types of damages caused by East Fork Carson River floodwaters are to agricultural land, equipment, and improvements, and to public facilities. Very little residential and commercial damage has occurred due to overbank floodflows from the East Fork.

Documents indicate that approximately 25 flood events have taken place on the East Fork Carson River since the mid-19th century (References 5, 6, and 7). The major floods occurred in 1852 (the earliest recorded flood), 1861-62, 1867-68, 1890, 1907, 1937, 1950, 1955, 1963, 1964, 1986 and 1997.

There are no accurate records of flooding prior to 1938, but the flood of 1890 is generally regarded as one of the most severe early floods. Flooding from March 1 to June 15 of that year resulted from the terrible winter of 1889-90, referred to anecdotally as "the White Winter." Heavy snow accompanied by bitter cold weather began in November of 1889. A Chinook-like, warm, dry wind suddenly began on January 25th of 1890 and soon produced large ice jams, diverting the East Fork Carson River in some places. Blasting was required to save bridges and ranch buildings and to prevent damage in parts of Gardnerville. Following the brief January thaw, the winter resumed with heavy blizzards and cold weather. The heavy snow accumulation began melting in early March and reached its peak in late May or early June. Extensive damage occurred to roads, bridges, ranch buildings, cropland, and irrigation systems in the East Fork Carson River floodplain.

Table 6 – Approximate range of Frequency of Occurrence of Peak flows for East Fork Carson River near Gardenerville

Date	Peak Flow (cfs)	Frequency of Occurrence (years) [1]
December 11, 1937	10,300	15-20
November 21, 1950	12,100	20-25
December 3, 1950	10,700	15-20
December 23, 1955	17,600	45-50
February 1, 1963	13,400	25-30
December 23, 1964	8,230	10-15
February 19, 1986	7,380	10-15
January 3, 1997	20,300	[2]
December 31, 2005	9,730	[2]

[1]Based on data in hydrology study for Carson River Basin (Reference 7). Frequency ranges based on peak flows only.
[2]Data not available.

Table 7 – Estimates of Flood Damages and Acres Flooded

Flood Period	Flood Damages		Approximate Acres Flooded[1]
	From	Up To[1]	
November – December 1950	$120,000	$470,000	22,700
December 1955	$235,000	$700,000	21,500
February 1963	$70,000	$845,000	13,200
December 1964	$65,000	$330,000	10,100
December 1996 – January 1997	$13,100,000		[2]

[1]These are comprehensive totals for selected reaches of East and West Forks and the main stem Carson River; individual totals for the portion of the East Fork included in this study not available. These figures do show, however that even though less acres have been flooded in succeeding flood events, flood damages have increased because of greater population and development.
[2]Data not available.

Approximately 22,700 acres were flooded in Carson Valley during November and December 1950 (including reaches of the East and West Forks and the main stem Carson River) with a large portion of the flooded acreage occurring along the East Fork Carson River. The flooded areas were all devoted to agricultural pursuits, and essentially all flood damage was to agricultural lands and improvements, crops, and public facilities. Agricultural damage consisted of soil erosion and deposition of debris; damage to farm buildings and machinery; and destruction of fences and irrigation headgates and ditches. Crops in storage were damaged or destroyed. Extensive damage and destruction occurred to highways, bridges, and culverts. Only slight residential damage was caused. Practically all of the damage resulted from the peak flows that occurred from November 19 through 21.

The flood of December 1955 was caused by heavy and prolonged rainfall on the Carson Valley and surrounding mountain ranges, much of it falling on deep snowpacks. The contributing rainstorm consisted of probably the greatest sustained downpour in the history of western Nevada. The largest flow ever recorded on the East Fork Carson River near Gardnerville occurred on December 23, 1955, equaling about a 45- to 50-year flood event. Approximately 21,500 acres of agricultural land (principally pasture, hay, and grain) were inundated causing damage as follows: extensive erosion; the deposition of sand, silt, and debris; the washout of the SH-756 bridge south of Gardnerville; destruction of fences and irrigation facilities; severe damage to roads, highways, and bridges; and the interruption of traffic. Floodwaters covered much of the land from 1 to 3 feet deep for 5 to 10 days, causing the loss of hay and the use of pastureland.

Extensive rainfall occurred in late January and early February 1963 over the headwater regions of the Carson River and in the Carson Valley. The snowpack in the mountains was light, and there were large areas of frozen ground, leading to tremendous runoff. The flooding in early February was preceded by the largest 24-hour rainfall amount recorded at Minden (3.03 inches). This flood is the second largest known in the valley and is equal to approximately a 25- to 30-year event. About 13,200 acres of agricultural lands were flooded. Floodwaters 1 to 3 feet deep remained on the land from 1 to 4 days. Principal damage consisted of destruction of crops such as grains, hay, and pasture; repair and restoration of irrigation facilities, fences, and other farm improvements, removal of silt, sand, and debris; and repair of roads and bridges.

Prior to the flooding in late December 1964, the higher reaches of the East Fork Carson River drainage basin were saturated by sustained precipitation over a weeklong period--initially, snow for a few days and then rain on snow. The ensuing flood, equal to about a 10- to 15-year event, inundated approximately 10,100 acres devoted to pasture, hay, and grain. The major damage was to stream channels, levees, and agriculture properties. There was erosion and deposition of debris and silt; damage to irrigation facilities and to public facilities such as roads and bridges; and only slight residential damage.

Reportedly, much of the flooding in February 1986, as in past floods, principally affected agricultural property. However, the availability of specific flood damage information is limited. Damages were compiled on a broad-base scale and represented totals for a few general categories that included data on five affected northwestern Nevada counties. From February 16 through 20, about 5 inches of rain fell at Minden and more than twice that amount in the tributary drainage areas of the East Fork Carson River. The floodflows that resulted equaled about a 10- to 15-year event.

The flood of 1997 saw record flows throughout the Carson River system. Preliminary estimates of flood damages for Douglas County topped $13 million, including damages to over 75 homes in Minden and Gardnerville, the Carson Valley levee and irrigation systems, critical transportation infrastructure, and two deaths.

As previously noted, the westside and eastside tributary areas are decidedly rural and there are practically no records of streamflows. Because of the relative sparseness of residents in these basins and the lack of descriptive accounts of flooding, little is known about past floods and damage.

The earliest recorded flooding in the Genoa area occurred from January 20 through 26, 1886. The flood resulted from rain on snow in the drainages west of the community and resulted in damage to most of the buildings and streets. In March 1890, snowmelt caused the failure of a small dam in Genoa Canyon and several buildings were damaged. Several thunderstorms have occurred in the Genoa region and spewed mud, rocks, and debris throughout the community and even across U.S. Highway 395 to the east. However, there are few accounts of the floods that have occurred or of damage estimates.

2.4 Flood Protection Measures

There are levees along both sides of the East Fork of the Carson River from the Country Club estates area to U.S. Highway 395. These levees do not provide protection against the 1-percent annual chance flood.

3.0 ENGINEERING METHODS

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

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge frequency relationships for floods of the selected recurrence intervals for each flooding source studied in detail affecting the county.

For the original study, floodflow frequencies on the East and West Forks Carson River were established from data at nine gage locations within the Carson River basin (References 8 and 9). Each gage had a period of record greater than 10 years. Data were statistically analyzed using log-Pearson Type III procedures (Reference 10). Three gage sites, two just upstream and one just downstream of Carson Valley, were found to have continuous records in excess of 35 years, thus allowing an analysis of the mixed-population (rainfall and snowmelt) events at these locations. Comparison of the frequency values obtained by the mixed-population analysis and by the log-Pearson Type III analysis showed similar results, with the composite, mixed-population curves tending to fit the observed lower-frequency flood events more closely. The mixed- population curves were adopted for use.

Values for specific frequencies at the above three gages were plotted, and a log-log, discharge versus drainage area, straight-line curve was fitted for use at specific cross section locations within the study area.

Flood hydrographs and peak flows for the 1-percent annual chance floods for the streams included in the 2010 study were computed for 3-hour localized cloudburst storms. The cloudburst hydrographs were based on rainfall-runoff computations and statistical analysis of synthetic localized cloudburst storms. Procedures used included the unit hydrograph method of analysis, a Generalized Computer Program Flood Hydrograph Package (Reference 11), and peak-flow frequency curve development. Streamflow routings were based on storage-discharge relationships developed for reaches along each stream.

Initially, the most severe 1-percent annual chance flood conditions for the tributaries were not known. Therefore, both cloudburst storms and general rainstorms are calculated to determine which would produce the higher peak flows. A 3-hour cloudburst storm was selected as one of the alternatives based on its use in recent hydrology studies for nearby drainage basins with assumed similar statistical relationships to the stream basins in this study. A 24-hour general rainstorm was chosen as the other alternative.

There are no streamflow records for the majority of the eastside and westside tributaries, and those few records that do exist are insufficient for use. Thus, unit hydrographs for the tributaries were computed based on three individual S-curves developed during a 1980 hydrology study (Reference 12) for the nearby Truckee River basin.

Unit hydrographs for the 24-hour general rainstorm were computed using the Truckee Meadows average mountain general rain event S-curve. The following methods were used during computations of the 3-hour cloudburst unit hydrographs. The Truckee Meadows average mountain cloudburst event S-curve was used for the westside tributaries and the higher reaches of Pine Nut and Buckeye Creeks. For most of the eastside tributaries (lower reaches closer to the valley floor), the Truckee Meadows average valley S-curve was used.

Rainfall information for regional precipitation stations is inadequate since the stations are below 6,000 feet elevation and do not reflect the greater amounts of precipitation falling at the higher elevations. Therefore, precipitation amounts and areal reduction factors for computation of the 3-hour cloudburst storms and the 24-hour general rainstorms were based on data derived from the National Oceanic and Atmospheric Administration (NOAA) Atlas 2 for Nevada (Reference 13). Rainfall distribution for the 3-hour cloudburst storms is patterned after Standard Project Storm criteria used or another basin in the region. For the 24-hour general rainstorms, the rainfall distribution pattern was based on the maximum 24-hour data from the Standard Project Storm criteria for the Sacramento-San Joaquin Valley in California.

Loss rate data used in the original study for the cloudburst storms and the general rainstorms were based on data previously adopted for a 1976 USACE review of a study for a nearby region by the USGS. The loss rates were also based on the initial and constant infiltration loss concept and an analysis of soil cover.

A comparison of the peak flows on each tributary resulting from both 3-hour cloudburst storms and 24-hour general rainstorms showed that the 3-hour storm resulted in the larger 1-percent annual chance peak flows on all of the tributaries.

A revision on June 5, 1997 incorporated the results of a detailed study along the East Fork of the Carson River, Cottonwood Slough, Henningson Slough, and Rocky Slough.

Data from the Gardnerville gage from 1940-1993 was used in the hydrologic analysis for the 1997 revision. Flow-duration frequency curves were computed for the East Fork Carson River for winter rainflood and spring snowmelt using the HEC Regional Frequency Computation computer program. The shape of the hydrograph was based on a historical flood event. To account for the inflow from Indian Creek, the hydrograph was increased by 5 percent. In addition 700 cubic feet per second (cfs) was subtracted from the flows exceeding 8,900 cfs to account for the effects of the diversion to Allerman Canal.

A revision on November 8, 1999, provided detailed flood-hazard information for Clear Creek which had been generated for the original FIS for the City of Carson City.

Natural Resources Conservation Service (NRCS, formerly the SCS) Technical Release No. 20, "Computer Program for Project Formulation--Hydrology" (Reference 14), was used in the hydrologic analysis of the Carson City watershed, which included Clear Creek. The precipitation data were taken from NOAA Atlas 2, "Precipitation-Frequency Atlas of the Western United States, Volume VII-Nevada" (Reference 13). Precipitation duration and distribution used in the model were those recommended by the NRCS.

The 1999 study was revised in February 2005 to provide detailed mapping within an unincorporated portion of Douglas County.

Peak flows and hydrographs were developed for the 2010 study. Peak flows in the previous study were considerably less than the USGS regional regression estimates (Reference 15) and considered by the USGS to significantly underestimate peak discharges for streams within the study area. HEC-HMS (Reference 16) was used to develop flood hydrographs for Airport Tributary Wash, Airport Wash, Airport Overflow Wash, Bobwhite Wash, Buckeye Creek, Calle de Asco Wash, Calle Hermosa Wash, Johnson Lane Wash and Juniper Road Wash. NRCS soils maps (Reference 17), USGS Digital Elevation Models (DEMs, Reference 18), USGS quadrangle maps, aerial topography, and field reconnaissance were used to characterize the vegetation and morphologic characteristics of the study area. The HEC-HMS peak flows were fit to approximate the USGS regression equations by adjusting the soils parameters on a regional basis to values within the published range.

Flood hydrographs and peak flows for basins with drainage areas less than 20 square miles, were computed using a localized 3-hour cloudburst storm. For drainage areas greater than 20 square miles, flows were generated from 24 hour rainfall event.

The peak discharges and hydrographs in the 2010 study were developed for the 10-, 2-, 1- and 0.2-percent annual chance peak discharges. The HEC-HMS model was based on the following:

1. Subbasins areas and stream lengths were delineated from the USGS 1:24,000 scale topographic maps and USGS DEMs.
2. Soils and vegetation characteristics were defined from site investigations, USGS maps, and National Land Cover Dataset (Reference 19).
3. Loss rates were estimated using the Green-Ampt equation for infiltration.
4. Runoff transformation was performed using the SCS Unit Hydrograph method

5. Peak rainfall totals were determined from NOAA Atlas 14 data for the semi-arid southwest region (including Nevada) in a digital grid format (Reference 20). Rainfall grids for 5-minute to 24-hour durations at 100- and 500-year recurrence intervals were used to determine the average precipitation over each basin for each duration and recurrence interval.
6. The SCS unit hydrograph method was applied to generate the 10-, 2-, 1- and 0.2-percent annual chance peak discharge hydrographs at study area inflow points.
7. Muskingum routing was used to model translation and attenuation of runoff through the subbasin network.

For the 2016 revision in the Buckeye Creek watershed, a HEC-HMS model was developed to estimate the 10-, 50-, 100-, and 500-year peak flow rates. The runoff hydrographs for this watershed were developed for the entire detailed study area. The Green and Ampt watershed abstraction, the Snyder Unit Hydrograph rainfall transformation, and the Muskingum-Cunge hydrograph routing methods were paired for use in the HEC-HMS model. Runoff hydrographs from each subbasin defined in the HEC-HMS model were used as input hydrographs into the FLO-2D hydraulic model – developed over the same detailed study area. This was done because the 2-Dimensional flow calculation abilities of FLO-2D are better suited to hydraulically model the shallow flow flooding anticipated over and through the flat agricultural and urbanized lands within the detailed study area. The FLO-2D model is also used to combine and route runoff hydrographs from all flooding sources impacting this study area.

Also in the 2016 revision, peak flow hydrographs representing the 1- and 0.2-percent annual chance events for Airport Wash, Johnson Lane Wash, Buckbrush Wash and Sunrise Pass Wash watersheds (Northern Watersheds) and portions of the Buckeye Creek/Martin Slough watershed were developed using HEC-HMS for use in the FLO-2D model for those flooding sources. In order to properly route flow from one neighboring model's grid system to another, the model grids were aligned by Kimley-Horn with an overlap of one grid element at the border. Outflow node data was then used to create inflow nodes for the downstream model. Flow from cells with a peak flow of less than 0.1 cfs was determined sufficiently small and was not transferred from the Buckeye model to the Airport Wash model (Kimley-Horn, 2015).

Peak discharge-drainage area relationships for streams studied in detail within Douglas County are shown in Table 8, "Summary of Discharges."

Table 8 – Summary of Discharges

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
AIRPORT WASH					
1 mile east of East Valley Road	21.56	156	1,323	2,096	445,8
AIRPORT WASH OVERFLOW					
At mouth	1.98	147	401	548	1,070
AIRPORT WASH TRIBUTARY					
At Fremont Avenue	1.29	95	284	397	786
BOBWHITE WASH					
At mouth	0.67	2	22	59	165
BUCKBRUSH WASH					
At East Valley Road	4.64	9	117	350	1,016
BUCKEYE CREEK					
At East Valley Road	73.85	*	*	3,939	8,461
Above Confluence of Juniper Wash	67.45	261	2,842	4,525	9,714
CALLE DE ASCO WASH					
At Mouth	0.62	6	14	39	131
CALLE HERMOSA WASH					
At Mouth	1.78	13	30	77	307
Below confluence of Calle De Asco Wash	1.09	11	28	73	229
Above Confluence of Calle de Asco Wash	0.41	5	13	34	97
CARSON RIVER					
3 miles upstream of Lloyds Bridge at USGS Gage No. 10311000	876.00	*	*	36,000	*

[1]Calculated from original study; has not been revised.
* Data not calculated.

Table 8 – Summary of Discharges (continued)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs)			
		10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Approximately 1 mile upstream of US 395	16.00	*	*	2,450	*
CODY WASH					
0.5 miles upstream of Marj Lane	1.26	*	*	230	*
CODY WASH TRIBUTARY					
At Ron Lane	0.71	*	*	190	*
COTTONWOOD SLOUGH					
At SH-88	[1]	*	*	4,500	*
0.25 miles upstream of SH-88	[1]	*	*	8,000	*
At Centerville Lane	[1]	*	*	5,528	*
3.60 miles upstream of Centerville Lane	[1]	*	*	7,186	*
EAST FORK CARSON RIVER					
At SH-88	423.55	*	*	5,800	*
At Centerville Lane	405.10	*	*	10,400	*
Just downstream of Indian Creek	389.00	*	*	25,200	*
At Washoe Bridge	359.00	*	*	26,200	*
FISH SPRINGS CREEK					
1,500 ft upstream of Windmill Road	3.34	*	*	595	*
GENOA CANYON CREEK					
At Canyon Mouth	2.20	*	*	335	*
HELMAN DRIVE WASH					
Just upstream of Canal Drive	0.23	*	*	55	*
JOHNSON LANE WASH					
At Nye Drive	10.47	161	496	1,110	2,276
JUNIPER ROAD WASH					
0.3 miles East of Carlson Drive	0.55	94	214	286	521
1.8 miles East of Coyote Road	2.07	265	608	818	1,531
At Mouth	3.33	267	609	819	1,539
MARTIN SLOUGH					
At U.S. Highway 395 at Gardnerville	57.00	*	*	1,280	4,293
At U.S. Highway 395 North of Minden	58.25	*	*	3,732	3,221

[1]Calculated from original study; has not been revised.
* Data not calculated.

Table 8 – Summary of Discharges (continued)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs)			
		10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
MOTT CANYON CREEK					
At Canyon Mouth	1.99	*	*	325	*
PARK DITCH					
Just downstream of Toler Avenue	[1]	*	*	160	*
PINE NUT CREEK					
At Allerman Canal	54.0	*	*	5,510	*
At Out-R-Way	38.90	*	*	4,490	*
PINE NUT CREEK TRIBUTARY					
At Shena Terrace	4.95	*	*	685	
PINE NUT ROAD WASH					
Just Upstream of Pine Nut Drive	4.37	*	*	510	*
ROCKY SLOUGH					
At SH-756	418.40	*	*	3,000	*
At SH-88	422.30	*	*	3,000	*
SAWMILL ROAD WASH					
Just upstream of Sawmill Road	1.39	*	*	205	*
SCHOOLHOUSE CANYON CREEK					
At Canyon Mouth	0.45	*	*	85	*
SHENA TERRACE WASH					
At Mouth	1.27	*	*	265	*
SHERIDAN CREEK					
Upstream of Barber Creek	0.42	*	*	160	*
Upstream of Little Barber Creek	0.84	*	*	420	*
SIERRA CANYON CREEK					
At Canyon Mouth	3.17	*	*	505	*
SMELTER CREEK					
At Canyon Mouth	11.90	*	*	1,050	*
At Gravel Pit Road	14.70	*	*	900	*

[1]Data not available.
* Data not calculated.

Table 8 – Summary of Discharges (continued)

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
STUTLER CANYON CREEK					
At Canyon Mouth	1.90	*	*	340	*
SUNRISE PASS WASH					
At East Valley Rd	1.63	17	69	167	485
WEST FORK CARSON RIVER					
At Waterloo Ln	146.20	*	*	12,665	*
At SH-88	96.15	*	*	9,696	*
At Dresslerville Ln	86.60	*	*	9,070	*

*Data not calculated.

3.2 Hydraulic Analyses

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

For the West Fork Carson River and the East Fork Carson River system, in the original study, the SCS WSP-2 computer program was used to establish discharge-versus-elevation rating tables at each cross section within the study area (Reference 21). Water-surface elevations were then interpolated from the rating table for specific discharge values corresponding to the desired frequencies previously established. Water-surface elevations for the 1-percent annual chance flood on Martin Slough were computed using the USACE HEC-2 step-backwater computer program (Reference 22).

It was determined that flooding from most of the East and West Forks Carson River would be in the form of sheetflow and shallow overland flow with a maximum depth of 3 feet, and these areas have been zoned as shallow flooding zones in this study. However, the depth of flooding in the stream channel will be greater than the specified depths that apply to overbank areas only. There are also several areas of ponding created by natural depressions in the topography. Profiles were not produced for any of these areas.

As Pine Nut Creek approaches the valley floor, its steep, well-defined channel develops into one that is not easily identifiable. Once the flow from Pine Nut Creek reaches these lowlands, flooding from the creek can be classified as alluvial fan flooding with floodwaters generally less than 3 feet in depth. Also, several artificial canals traverse the alluvial fan, thereby adding to the uncertainty in the direction of the floodflow.

To determine the amount of flow from Pine Nut Creek that enters Martin Slough, the flow was routed starting at a point just upstream of the lower Allerman Canal. The analysis was continued for the area across the alluvial fan toward Martin Slough. The routing procedures consisted of plotting several cross sections across the alluvial fan. The depth was determined at each cross section, working downstream, using Manning's equation. Manning's equation was also utilized to estimate the amount of flow carried to the north by the major canals.

From the area downstream of Elges Avenue to the intersection of U.S. Highway 395 with Toler Avenue, the cross sections extended to U.S. Highway 395. The amount of overtopping of U.S. Highway 395 was determined using the standard weir equation. Because U.S. Highway 395 descends in elevation between Elges and Toler Avenues, weir calculations were performed in segments. At each segment, a trial-and-error method of calculation was utilized to balance the height above the road for use in the weir equation with the height above the road when determining depth at each cross section. Field survey data of the profile of U.S. Highway 395 developed by Vasey Engineering Company, Inc., between Toler Avenue and Waterloo Lane were used to determine the top-of-road elevation. South of Waterloo Lane, design plans of U.S. Highway 395 were utilized.

The publication entitled "Hydraulic Charts for the Selection of Highway Culverts," (Reference 23) and the weir equation were used to determine the amount of flow that entered Martin Slough from the East Fork Carson River via the box culvert under U.S. Highway 395 and Toler Avenue. The size of the box culvert was determined from the U.S. Highway 395 design plans.

From the routing of the flow, it was determined that the shallow flooding downstream of the lower Allerman Canal will vary in depth from less than 1 foot to 3 feet on the average. Between the lower Allerman Canal and Elges Avenue, the depth of flow is less than 1 foot. Between Elges Avenue and the intersection of Toler Avenue and U.S. Highway 395, the depth of the flow is between 1 and 3 feet. The flooding in this reach extends at least to Toler Avenue in certain areas to the north, overtops U.S. Highway 395 to the south, and enters the East Fork Carson River. As a result of this overtopping, the flow that enters Martin Slough from Pine Nut Creek was reduced.

Water-surface elevations for the 1-percent annual chance flood for the streams included in the restudy were computed through the use of the U.S. Army Corps of Engineers HEC-2 step-backwater computer program (Reference 22).

Starting water-surface elevations for the streams studied were derived by the slope-area method or were based on existing backwater conditions at stream mouths and at restrictions such as bridges and culverts.

Cross sections for backwater analyses were located at close intervals upstream and downstream from bridges, culverts, and other hydraulically significant features in order to establish the backwater effect of such structures. Additional cross sections were located at other representative locations in the study area. Cross section data were derived from topographic maps compiled from aerial photography (References 24 and 25), supplemented with field surveys. All culverts and bridges were surveyed to obtain elevation and structural data.

Channel and overbank roughness factors (Manning's "n") used in the hydraulic computations were determined by engineering judgment and were based on field observations of the streams and floodplain areas. The channel "n" values for the 31 stream reaches ranged from 0.04 to 0.15, and the overbank "n" values ranged from 0.04 to 0.15.

The depth of sheetflow flooding for the five westside tributaries and Buckbrush Wash and Johnson Lane Wash on the eastside was calculated using FEMA's "Alluvial Fan Methodology" (Reference 26).

The revision on April 4, 1994 incorporated the results of a detailed study along the Carson River. Water surface elevations for the Carson River were computed using the Federal Highway Administration / USGS WSPRO Computer Program (Reference 27). Channel and overbank roughness factors (Manning's "n") used in the hydraulic computations were selected based on field observations of the stream and floodplain area. Cross sections for backwater analyses were obtained by field surveys.

The revision on June 5, 1997 incorporated the results of a detailed study along the East Fork of the Carson River, Cottonwood Slough, Henningson Slough, and Rocky Slough. Profiles have not been drawn for some of the reaches because those areas have been designated shallow flooding.

The X-Rate model (a flow-distribution model developed by the USACE, Sacramento District) was used to determine the stream routing, including the amount of flow in each of the tributaries to the East Fork Carson River. The determination of the amount of flow leaving the main channel (represented as weir elevations, percent overflow, or actual amount of overflow) was based on field investigations and engineering judgment. The HEC-2 step-backwater model was used to determine the base flood elevations along each of the studied streams. Areas of shallow flooding were identified along the streams. The boundaries of these areas, as well as the depths of flooding, were determined using the available topography and engineering judgment.

The revision on November 8, 1999 incorporated detailed flood hazard information for Clear Creek. The 10-, 2-, 1-, and 0.2-percent annual chance water-surface elevations for Clear Creek were computed using the USACE HEC-2 computer program (Reference 28).

The base line and channel and floodplain geometry were obtained using aerial photogrammetry. Aerial reconnaissance for the Clear Creek study was performed by Cooper Aerial Survey Company on November 16, 1980 (Reference 29). Digitized cross sections, accurate to ±1 foot, were also provided by Cooper Aerial Survey Company. Topographic mapping was compiled at a scale of 1:4,800, with a contour interval of 4 feet (Reference 30).

Channel and overbank roughness factors (Manning's "n" values) used in the hydraulic computations for Clear Creek were estimated using Ven T. Chow's "Open-Channel Hydraulics" as a guide (Reference 31). The channel and overbank "n" values for Clear Creek ranged from 0.030 to 0.055 and 0.030 to 0.060, respectively.

The starting water-surface elevation for Clear Creek was calculated using the slope-area method.

For the 2010 revision, the project area consists of a series of interconnected alluvial fans located on the east side of Carson Valley approximately 12 miles south of Carson City, Nevada. These pediments are widely identified as alluvial fans on the soils (Reference 17) and geologic maps (References 32, 33, 34, 35 and 36). From north to south, the major drainages that form these alluvial fans are: Buckbrush Wash, Johnson Lane Wash, Sunrise Wash, Airport Wash, and Buckeye Creek. Flows are relatively confined to the channel in the reaches within the foothills. Along the fan surfaces downstream of the foothills the channels lose conveyance capacity resulting in shallow distibutary overland flow.

In reaches where flows are confined, The USACE computer program, HEC-RAS ver. 3.1, was applied to calculate water surface profiles for the 10-, 2-, 1-, and 0.2-percent annual chance peak flows and delineate flood hazard boundaries for the 1- and 0.2-percent annual chance peak flows. These reaches include Bobwhite Wash, Buckeye Creek, Calle de Asco Wash, Calle Hermosa Wash and Juniper Road Wash.

On the convex alluvial fans/plains where flows are distributary, flood hazards were assessed in accordance with Appendix G: Guidance for Alluvial Fan Flooding Analyses and Mapping (Reference 37). A composite method was used for determining flood hazards on the alluvial fan surface. The method incorporated numerical model results from MIKE-21, a 2-dimensional hydrodynamic flow model, along with a geomorphic assessment of the area to identify areas susceptible to the flooding under the 1- and 0.2-percent annual chance flood events. The drainages modeled with MIKE-21 include Buckbrush Wash, Johnson Lane Wash, Sunrise Pass Wash, Airport and Airport Tributary Wash and Buckeye Wash near the confluences of Calle Hermosa and Juniper Road Wash. Flood hazard zone designations on the alluvial fan surface were based on a comprehensive approach, which evaluated flow velocity, flow depth, geomorphic context, and potential for changes in flow path.

A uniform Manning's roughness value of 0.07 was selected for both the HEC-RAS and MIKE-21 model. This value was developed from a review of available literature and field inspection.

Detailed topographic mapping was collected using LIDAR technology and photogrammetrically derived breaklines at a scale that supported 2-foot contours. Additional ground surveys were performed to collect channel section and culvert information.

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

The hydraulic analyses for the 2010 revision were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

For the 2016 revision, hydraulic analyses were conducted using FLO-2D Version 2009.06, a 2-Dimensional hydraulic model for determining flood hazards. Given the mild slopes, flat agricultural lands, alluvial fan characteristics, small irrigation ditch conveyances, urbanization, and shallow sheet flow tendencies within the lower watersheds in the study area, FLO-2D is a good software package for modeling the stormwater hydraulics and floodplains for this restudy. FLO-2D is a grid-based program with both hydrologic and hydraulic modeling capabilities. Only the hydraulic aspects of the program were utilized in an unsteady analysis using hydrologic inputs (runoff hydrographs). The flow inputs for the FLO-2D model include the flood hydrographs from the hydrologic analyses.

FLO-2D simulates hydraulic and flood conveyance characteristics using gridded cells, which route the movement of runoff using the full dynamic wave momentum equation in eight possible directions (adjacent cells) using the method of finite differences. Each cell is defined by its centroid coordinates, its average elevation, and a Manning's n roughness coefficient. FLO-2D uses the coordinates to determine the spatial relationship between cells and the elevation and roughness coefficients to determine velocity and depth of flow cell to cell. In addition, the model incorporates 1-Dimensional hydraulic elements, developed and entered by the modeler, to analyze flow in open channels, streets, culverts, and other concentrated flow features.

Primary model features and components include peak flow hydrographs, grid size, Manning's n roughness coefficients (channels, floodplain, shallow flow and streets), flow obstructions (including homes, commercial buildings, barns, sheds, and fences), hydraulic structures, channels, major roadways, levees and flow splits/diversions. ArcGIS was used extensively in this process to join lookup value tables, edit spatial data, attribute the GIS layers, and perform calculations such as intersecting the soils and land use layers to derive the Green & Ampt soil infiltration parameters. Parameter development included four major elements: precipitation, land use, subbasin hydrology parameters, and hydraulic components. Peak flow hydrographs representing the 1- and 0.2-percent annual chance events for the FLO-2D model were developed using HEC-HMS. In order to properly route flow from one neighboring model's grid system (i.e. flow from Airport Wash to the Northern Watersheds FLO-2D model) to another, the model grids were aligned with an overlap of one grid element at the border. Outflow node data was then used to create inflow nodes for the downstream model. Flow from cells with a peak flow of less than 0.1 cfs was determined sufficiently shallow and was not transferred from the Buckeye model to the Airport Wash model.

The Carson Water Subconservancy District (CWSD) LiDAR data from 2012 and FEMA LIDAR data from 2004 (where 2012 LiDAR data was not available) were used as inputs. In addition, supplemental field surveying was performed and field measurements were collected for several areas and features within the watershed area. The areas and features include: Johnson Lane Wash, Buckbrush Wash and other constructed channels along Heybourne Road. The 1-Dimensional channel was developed in HEC-RAS based on the surveyed cross sections and cross sections cut from the LiDAR surface. The HEC-RAS cross sections were then imported into FLO-2D, and cross sections were interpolated for each channel grid cell. Grid size was determined using the same methodology as the Buckeye Creek FLO-2D model. Modeling cell size is the largest cell size that can be used for computational efficiency, but small enough so that it does not have an effect on model results. Based on this analysis, the modeling cell size was determined to be 30 feet by 30 feet.

In the FLO-2D model, Manning's n values are used in each cell to simulate the surface roughness and obstructions present. FLO-2D utilizes depth-varying values to model both shallow and deeper concentrated flow in channels and floodplain overbanks. For the floodplain roughness coefficients classified by land use, initial Manning's n values are assigned based on land use codes summarized below. Manning's n values were also adjusted in specific areas based on high Froude numbers in accordance with FLO-2D recommended procedures. In general, the FLO-2D model uses average cell elevations and appropriate Manning's n values to define and model minor streets. (The values are typically lower, but all n-values are initially calculated based on land use). The default FLO-2D shallow n-value of 0.2 was used because it is a reasonable value for shallow overland flow in the watershed, which is primarily undeveloped sagebrush land use.

Land Use Code	Land Use Description	Floodplain *n*-Value
AG	Agriculture	0.080
C	Commercial	0.030
FARM	Farmstead	0.050
I	Industrial	0.035
PG	Open Space - Good condition	0.085
PJF	Pinyon-juniper fair condition	0.075
PJG	Pinyon-juniper good condition	0.085
PJP	Pinyon-juniper poor condition	0.065
POND	Open Water	0.065
PP	Open Space - Poor condition	0.065
R12	2 acre Residential	0.065
R20	1 acre Residential	0.065
R25	1/2 acre Residential	0.060
R30	1/3 acre Residential	0.050
R38	1/4 acre Residential	0.050
SBF	Sagebrush with grass understory - Fair	0.075
SBG	Sagebrush with grass understory - Good	0.085
SBP	Sagebrush with grass understory - Poor	0.065
SCG	Streets - Curb & Gutter	0.020
SD	Dirt Roads	0.050
SOD	Streets - Open ditch	0.040

Possible flow obstructions include homes, commercial buildings, barns, sheds, and fences that impede flood flows. For this study, only permanent buildings were included in the model. These structures are accounted for in the FLO-2D model by using an Area Reduction Factor (ARF) and Width Reduction Factor (WRF). The ARF is the ratio of the total grid cell area to the area removed from the cell for surface flow and storage volume due to obstructions. ARF values range between 0.0 and 1.0, with a value of 0.0 reflecting no obstruction and a value of 1.0 representing complete obstruction. A completely obstructed cell receives no floodwater during the FLO-2D model run. Buildings can also restrict flow to an adjacent grid cell. WRFs are used to account for this flow restriction. The WRF is also defined by the ratio (0.0 to 1.0) representing the reduction in available flow area in any of the eight possible flow directions. Multiple WRF values can be defined for a given cell and can be combined with an ARF for the same cell. The ARF is determined as the percentage of building coverage in a cell. WRFs were used in the model as warranted with varying ratios depending on specific conditions within each applicable cell. The determination of obstructed areas and obstructed flow directions was based on the FLO-2D's Grid Developer System (GDS) ARF and WRF calculator and the buildings layer.

Hydraulic structures are modeled within FLO-2D using rating tables that are developed externally from the model. Seven culverts in the northern watersheds area were included in the FLO-2D model. The rating tables developed for this project were calculated using HEC-RAS Version 4.1.0 and Bentley's CulvertMaster. Six out of the seven hydraulic structures were modeled in HEC-RAS to account for backwater over a range of flows to create a detailed hydraulic profile of the structure. One of the minor structures was modeled in CulvertMaster, using a downstream cross-section to generate tailwater depth. The CulvertMaster rating curve was deemed appropriate for this culvert since the structure did not require the same level of hydraulic detail. On Airport Wash, hydraulic structures along Heybourne Road were removed from the FLO-2D model due to instability issues. Also, due to the relatively low slope of the channel or ditch along Heybourne Road, the actual conveyance capacity of the channel and culverts in that area are relatively low.

In the FLO-2D model, channels were modeled using 1-Dimensional hydrodynamic computations. Channel locations were defined in the model based on aerial imagery and Digital Terrain Model (DTM) surfaces built from LIDAR topography. Surveyed channel cross-sections were geolocated along the channel line. Between surveyed cross-sections, channel cross-sections were estimated based on FLO-2D's PROFILES.EXE program. In FLO-2D models, channel and floodplain flows exchange using the floodplain elevations of the grid cells and the bank elevations of the channel cross-sections.

When the overland flow elevation is higher than the channel bank station, FLO-2D simulates water flowing into the channel. When the channel capacity is exceeded, FLO-2D simulates water flowing out of the channel to an adjacent grid cell, where it is conveyed in accordance with the 2-Dimensional flow scheme. The following channels were analyzed in the FLO-2D model: Johnson Lane Wash, Buckbrush Wash, Heybourne Ditch, and Sunrise Pass.

For the 2016 revision, sediment transport was modeled within FLO-2D. FLO-2D uses the flow hydraulics' calculations to estimate sediment transport. Change in storage is estimated as the difference between the sediment supply (in) and sediment transport capacity (out). Sediment transport is modeled using typical sediment transport equations. The upstream sediment supply (e.g., upstream sediment boundary condition or upstream sediment load) is required as input into FLO-2D. FLO-2D calculates sediment loading as a function of the inflow hydrograph or $Q_{sediment} = a(Q_{water})^b$, where a and b are parameters that need to be determined.

The upstream sediment loading for Buckbrush, Airport, and Johnson Lane Wash was estimated using KINEROS2, for the 1-percent annual chance storm over a 24-hour period. KINEROS2, an open-source software (http://www.tucson.ars.ag.gov/kineros/, Version 3.4), is a distributed, physically-based, event model describing the processes of interception, dynamic infiltration, surface runoff, and erosion from watersheds characterized predominately by overland flow. The project watersheds were setup within KINEROS2 to estimate the sediment loading in the three washes.

Location	Estimated Sediment Load over 24-hour Period (ac-ft)
Airport Wash	16.8
Buckbrush Wash	1.0
Johnson Lane Wash	16.0

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

All flood elevations shown in this FIS report and on the FIRM are referenced to NAVD. Structure and ground elevations in the county must, therefore, be referenced to NAVD. It is important to note that adjacent counties may be referenced to NGVD. This may result in differences in base flood elevations (BFEs) across the county boundaries between the counties.

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

The conversion from NGVD to NAVD ranged between +3.66 and +3.93 for this community. Accordingly, due to the statistically significant range in conversion factors, an average conversion factor could not be established for the entire community. The elevations shown in the FIS report and on the FIRM were, therefore, converted to NAVD using a stream-by-stream approach. In this method, an average conversion was established for each flooding source and applied accordingly. The conversion factor for each flooding source in the community may be found in Table 9, “Vertical Datum Conversions,” as well as on the FIRM.

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

Table 9 – Vertical Datum Conversions

Table 9a – Stream by Stream

Stream	Conv. Factor (ft)
Airport Tributary Wash	+3.71
Airport Wash	+3.71
Airport Wash Overflow	+3.71
Bobwhite Wash	+3.75
Buckbrush Wash	+3.75
Buckeye Creek	+3.70
Calle de Asco	+3.75
Calle Hermosa Wash	+3.72
Carson River	+3.72
Clear Creek	+3.93
Cody Wash	+3.78
Cottonwood Slough	+3.68
Cottonwood Slough (Below SH88)	+3.69
East Fork Carson River	+3.82
East Fork Carson River (Below SH88)	+3.72
Fish Springs Creek	+3.81
Henningson Slough	+3.69
Johnson Lane Wash	+3.79
Juniper Road Wash	+3.73
Martin Slough	+3.67
Pine Nut Creek	+3.79
Pine Nut Creek Tributary	+3.79
Pine Nut Road Wash	+3.74
Rocky Slough	+3.70
Shena Terrace Wash	+3.77
Smelter Creek	+3.85
Sunrise Pass Wash	+3.71
West Fork Carson River	+3.76

Table 9b – Dynamic (Not Related to Stream) Zone by Zone

Dynamic Zone	Conv. Factor (ft)
Heybourne Ditch South of Airport	+3.66
Airport Rd	+3.66
Along US 395	+3.68
Airport Wash Segment	+3.67
Sunrise Pass Wash Segment	+3.68
Heybourne Ditch North of Airport	+3.69

Table 9c – Static Zone by Zone

Static Zone	Conv. Factor (ft)
Static AH Zone South of Muller Ln and East of SH-208	+3.79
Static AH Zone South of Genoa Ln and East of SH-208	+3.76
Static AH Zone Along Big Ditch South of SH-207	+3.82
Static AH Zone Along Big Ditch South of Centerville Ln	+3.82
Static AE Zones Along Wildhorse and Johnson Lanes	+3.68
Static AE Zones South East of Airport Runways	+3.66
Static AE Zone East of Heybourne Rd and Northwest of San Marcos Cir	+3.70
Static AE Zones End of Airport Wash Overflow	+3.71
Static AE Zones between Airport Wash & Airport Tributary	+3.71
Static AE Zones South of Airport Rd and North of Stockyard Rd	+3.66
Static AE Zones South of Stephanie Way	+3.69
Static AH Zone on Sawmill Rd Wash	+3.74

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

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey, SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(310) 713-3242

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The NFIP encourages state and local governments to adopt sound floodplain management programs. To assist in this endeavor, each FIS provides 1-percent annual chance floodplain data, which may include a combination of the following: 10-, 2-, 1-, and 0.2-percent annual chance flood elevations; delineations of the 1-percent and 0.2-percent annual chance floodplains; and 1-percent annual chance floodway. This information is presented on the FIRM and in many components of the FIS, including Flood Profiles, 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.

4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1-percent annual chance flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent annual chance flood is employed to indicate additional areas of flood risk in the county. For the streams studied in detail, the 1-percent and 0.2-percent annual chance floodplains have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps at a scale of 1:400 with contour intervals of 5 feet (References 24, and 25).

The boundaries of the 1-percent and 0.2-percent annual chance floods are shown on the FIRM (Exhibit 2). On this map, the 1-percent annual chance floodplain boundary corresponds to areas of special flood hazards (Zones A, AE, AO and AH); and the 0.2-percent annual chance boundary corresponds to areas if moderate flood hazards. In cases where the 1-percent and 0.2-percent annual chance floodplain boundaries are close together only the 1-percent annual chance floodplain boundary has been shown. Small areas within the flood boundaries may lie above the flood elevations and, therefore, not be subject to flooding; owing to limitations of the map scale, such areas are not shown.

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

Approximate 1-percent annual chance floodplain boundaries in some portions of the study area were taken directly from the Flood Insurance Rate Map (FIRM) for Douglas County, Nevada (Reference 38).

Detailed topographic mapping was collected using LiDAR technology and photogrammetrically derived breaklines at a scale that supported 2-foot contours as a part of the NHC restudy areas previously discussed. This data was used to determine floodplain boundaries.

Additional revisions to the floodplain boundaries within the unincorporated areas of Douglas County were made within the areas of digital terrain made available to MAP-IX Mainland as a part of the NHC study. Areas along the Carson River, Clear Creek, Pine Nut Road Wash, Rocky Slough and Smelter Creek were redelineated on a digital terrain model to produce updated floodplains for the 2010 study Flood Insurance Study update. The digital terrain model was found to have a contour interval of 1 foot (Reference 39).

Furthermore, along Cottonwood Slough (below State Highway 88), East Fork Carson River (in the area of the confluence with Cottonwood Slough), Henningson Slough, and along West Fork Carson River, MAP-IX Mainland attempted to revise and redelineate the floodplains utilizing the updated topographic information. Review of the redelineation floodplains versus the effective floodplains indicated development and earth moving activities that dramatically modified the floodplain delineations. In these areas, MAP-IX has determined that the effective modeling is unrepresentative of the current ground conditions and has modified the Zone AE floodplains in these areas, replacing them with Zone A special flood hazard areas.

For the 2016 revision, the 1-percent and 0.2-percent annual chance FLO-2D modeling results were used and the floodplain mapping was developed in GIS based on FEMA's guidelines. From the 1-percent and 0.2-percent annual chance FLO-2D modeling results, the maximum depths for each grid cell were used to produce a flood depth grid. Then the flood depth grid information was converted into flood hazard zones using ranges of flood depths to flood hazard zone relationships are summarized in the table below. Due to the gridded nature of the FLO-2D results, smoothing of the flood zone boundaries is required. This smoothing process was performed in ArcGIS and involves analyzing the gridded flow depths, available topographic data, and other surface information developed from aerial photographs and site investigations. Engineering judgment is also required to ensure the final flood zones produced from the smoothing process reflect reasonable progressions of water surface elevations (between grids) and realistic flood zone inundation areas and boundary conditions.

Flood Hazard Zone	Flood Frequency	Flood Depth Range (feet)
Zone A (Approximate)	1-percent Annual Chance	Greater than 0.99
Zone AO (1-foot)	1-percent Annual Chance	1.0 – 1.49
Zone AO (2-foot)	1-percent Annual Chance	1.50 - 2.49
Zone AO (3-foot)	1-percent Annual Chance	2.5 - 3.0
Zone AE	1-percent Annual Chance	Riverine Flooding and Shallow Flooding greater than 3.0
0.2 Percent Annual Chance (Shaded X Zone)	1-percent Annual Chance	Less than 1.0
0.2 Percent Annual Chance (Shaded X Zone)	0.2-percent Annual Chance	Greater than 0.1

4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces the flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the NFIP, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 1-percent annual chance floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the 1-percent annual chance flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this FIS are presented to local agencies as a minimum standard that can be adopted directly or that can be used as a basis for additional floodway studies.

The floodways presented in this FIS were computed for certain stream segments on the basis of equal conveyance reduction from each side of the floodplain. Floodway widths were computed at cross sections. Between cross sections, the floodway boundaries were interpolated. The results of the floodway computations are tabulated for selected cross sections in Table 10, "Floodway Data." The computed floodways are shown on the FIRM (Exhibit 2). In cases where the floodway and 1-percent annual chance floodplain boundaries are either close together or collinear, only the floodway boundary is shown.

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	106	16	13	4.5	5,121.9	5,121.9	5,121.9	0.0
B	304	17	19	3.2	5,125.1	5,125.1	5,125.2	0.1
C	550	19	18	3.2	5,127.7	5,127.7	5,127.7	0.0
D	881	13	11	5.3	5,130.8	5,130.8	5,130.8	0.0
E	898	17	25	2.4	5,131.4	5,131.4	5,131.4	0.0
F	1,073	23	16	3.7	5,131.4	5,131.4	5,131.4	0.0
G	1,274	32	16	3.8	5,133.4	5,133.4	5,133.5	0.1
H	1,383	35	34	1.7	5,133.7	5,133.7	5,133.8	0.1

[1]Feet above confluence with Juniper Road Wash.

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV AND INCORPORATED AREAS

FLOODWAY DATA

BOBWHITE WASH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	21,635	176	633	7.2	4,943.6	4,943.6	4,943.9	0.3
B	21,963	182	616	7.4	4,946.8	4,946.8	4,947.0	0.2
C	22,434	178	659	6.9	4,950.7	4,950.7	4,951.3	0.6
D	23,006	240	672	6.7	4,956.3	4,956.3	4,956.3	0.0
E	23,306	160	630	7.2	4,958.8	4,958.8	4,959.0	0.2
F	23,739	91	427	10.6	4,962.6	4,962.6	4,963.5	0.9
G	23,971	100	549	8.3	4,966.2	4,966.2	4,966.5	0.3
H	24,132	138	699	6.5	4,967.2	4,967.2	4,967.9	0.7
I	24,468	203	794	5.7	4,969.5	4,969.5	4,969.8	0.3
J	24,604	161	595	7.6	4,969.9	4,969.9	4,970.4	0.5
K	24,862	135	541	8.4	4,971.7	4,971.7	4,972.6	0.9
L	25,276	165	571	7.9	4,975.9	4,975.9	4,976.5	0.6
M	25,481	140	516	8.8	4,978.1	4,978.1	4,978.3	0.2
N	26,169	117	487	9.3	4,986.0	4,986.0	4,986.6	0.6
O	26,606	110	542	8.4	4,990.5	4,990.5	4,991.3	0.8
P	27,013	143	670	6.8	4,994.3	4,994.3	4,994.9	0.6
Q	27,572	141	491	9.2	5,000.3	5,000.3	5,000.3	0.0
R	28,108	118	473	9.6	5,006.7	5,006.7	5,007.6	0.9

[1]Feet above Old Virginia Canal.

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV AND INCORPORATED AREAS

FLOODWAY DATA

BUCKEYE CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	201	16	14	2.9	5,069.2	5,069.2	5,069.2	0.0
B	402	12	8	4.7	5,072.7	5,072.7	5,072.7	0.0
C	548	18	16	2.4	5,074.7	5,074.7	5,074.8	0.1
D	1,075	19	13	2.9	5,079.4	5,079.4	5,079.5	0.1
E	1,206	25	13	2.9	5,081.8	5,081.8	5,081.8	0.0
F	1,291	45	13	2.9	5,085.0	5,085.0	5,085.1	0.1
G	1,389	43	64	0.6	5,085.2	5,085.2	5,085.3	0.1
H	1,587	16	9	4.4	5,085.4	5,085.4	5,085.4	0.0
I	2,162	17	11	3.5	5,095.4	5,095.4	5,095.4	0.0
J	2,474	17	14	2.7	5,098.8	5,098.8	5,098.9	0.1
K	3,114	19	11	3.5	5,107.6	5,107.6	5,107.6	0.0
L	3,525	33	18	2.1	5,112.8	5,112.8	5,113.1	0.3

[1]Feet above confluence with Calle Hermosa Wash.

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV
AND INCORPORATED AREAS

FLOODWAY DATA

CALLE DE ASCO WASH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	3,897	19	18	4.0	4,931.0	4,931.0	4,931.0	0.0
B	4,301	19	18	4.1	4,936.7	4,936.7	4,936.7	0.0
C	4,584	15	17	4.2	4,940.0	4,940.0	4,940.0	0.0
D	4,895	21	18	4.0	4,943.6	4,943.6	4,943.6	0.0
E	5,409	20	18	4.0	4,950.2	4,950.2	4,950.2	0.0
F	6,161	22	18	4.1	4,960.1	4,960.1	4,960.2	0.1
G	6,758	23	21	3.5	4,968.2	4,968.2	4,968.2	0.0
H	7,417	20	18	4.1	4,977.6	4,977.6	4,977.6	0.0
I	7,944	20	20	3.7	4,985.1	4,985.1	4,985.1	0.0
J	8,578	21	20	3.6	4,992.4	4,992.4	4,992.4	0.0
K	9,034	20	20	3.6	4,998.5	4,998.5	4,998.6	0.1
L	9,264	18	21	3.4	5,001.3	5,001.3	5,001.4	0.1
M	9,707	18	14	5.1	5,008.3	5,008.3	5,008.3	0.0
N	10,192	16	20	3.6	5,016.0	5,016.0	5,016.1	0.1
O	10,626	21	18	4.1	5,022.0	5,022.0	5,022.0	0.0
P	11,016	13	19	3.8	5,027.6	5,027.6	5,027.7	0.1
Q	11,409	22	18	4.1	5,033.1	5,033.1	5,033.1	0.0
R	11,726	22	21	3.4	5,037.8	5,037.8	5,037.8	0.0
S	12,031	19	19	3.9	5,041.5	5,041.5	5,041.5	0.0
T	12,493	17	21	3.5	5,046.6	5,046.6	5,046.6	0.0
U	13,169	13	15	4.7	5,054.8	5,054.8	5,054.8	0.0

[1]Feet above confluence with Juniper Road Wash.

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV AND INCORPORATED AREAS

FLOODWAY DATA

CALLE HERMOSA WASH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
V	13,965	28	23	3.2	5,066.8	5,066.8	5,066.8	0.0
W	14,190	16	8	4.2	5,071.9	5,071.9	5,071.9	0.0
X	14,393	15	11	3.1	5,076.2	5,076.2	5,076.2	0.0
Y	14,550	11	8	4.1	5,078.9	5,078.9	5,078.9	0.0
Z	14,734	32	16	2.1	5,081.8	5,081.8	5,081.8	0.0
AA	15,062	16	9	3.6	5,086.3	5,086.3	5,086.3	0.0
AB	15,366	18	11	3.1	5,092.2	5,092.2	5,092.2	0.0
AC	15,523	17	9	3.8	5,095.5	5,095.5	5,095.5	0.0
AD	15,786	18	17	2.0	5,097.7	5,097.7	5,097.8	0.1
AE	15,850	16	8	4.2	5,098.4	5,098.4	5,098.4	0.0
AF	15,999	19	11	3.1	5,102.6	5,102.6	5,102.6	0.0
AG	16,276	22	16	2.1	5,105.2	5,105.2	5,105.4	0.2
AH	16,586	21	10	3.5	5,108.7	5,108.7	5,108.7	0.0
AI	16,616	27	16	2.2	5,109.3	5,109.3	5,109.3	0.0
AJ	16,635	18	9	3.8	5,109.7	5,109.7	5,109.8	0.1
AK	16,711	6	6	5.7	5,113.4	5,113.4	5,113.4	0.0
AL	16,795	40	64	0.5	5,113.9	5,113.9	5,114.0	0.1
AM	16,917	68	90	0.4	5,113.9	5,113.9	5,114.0	0.1
AN	17,302	26	13	2.7	5,117.5	5,117.5	5,117.5	0.0
AO	17,610	27	17	2.0	5,120.9	5,120.9	5,121.0	0.1

[1]Feet above confluence with Juniper Road Wash.

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV AND INCORPORATED AREAS

FLOODWAY DATA

CALLE HERMOSA WASH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	21,100	3,505[2]	40,151	0.90	4,649.4	4,649.4	4,650.4	1.0
B	23,700	4,401	40,195	0.90	4,649.5	4,649.5	4,650.5	1.0
C	25,800	5,098	35,466	1.02	4,649.6	4,649.6	4,650.6	1.0
D	28,000	2,611	19,052	1.89	4,649.9	4,649.9	4,650.9	1.0
E	31,010	2,439	15,728	2.29	4,650.7	4,650.7	4,651.7	1.0
F[3]	33,980	2,069	9,725	3.70	4,652.5	4,652.5	4,653.5	1.0
G[3]	36,480	1,667	19,025	1.89	4,655.0	4,655.0	4,655.8	0.8

[1]Feet above Mexican Dam.
[2]Floodway extends outside of Douglas County.
[3]A discrepancy between the FDT and the FIRM panel exists

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV AND INCORPORATED AREAS

FLOODWAY DATA

CARSON RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A – E[2]								
F	11,230	323	576	4.7	4,719.1	4,719.1	4,719.1	0.0
G	11,260	276	934	2.9	4,720.2	4,720.2	4,720.2	0.0
H – K[2]								
L[3]	16,065	123	338	7.9	4,773.8	4,773.8	4,774.2	0.4
M	16,845	333	493	5.4	4,782.7	4,782.7	4,782.7	0.0
N	16,935	350	2,468	1.1	4,787.4	4,787.4	4,787.5	0.1
O	17,235	277	1,465	1.8	4,787.6	4,787.6	4,787.6	0.0
P	17,845	70	248	10.8	4,790.3	4,790.3	4,790.6	0.3
Q	17,920	36	200	13.4	4,794.2	4,794.2	4,794.5	0.3
R	18,410	50	334	8.0	4,800.1	4,800.1	4,800.7	0.6
S	20,470	274	358	7.5	4,828.3	4,828.3	4,828.3	0.0

[1]Feet above confluence with Carson River.
[2]Floodway located outside Douglas County.
[3]Floodway extends outside of Douglas County.

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV AND INCORPORATED AREAS

FLOODWAY DATA

CLEAR CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A – G[2]								
H	6,940	55	71	3.2	5,189.5	5,189.5	5,189.5	0.0
I	7,440	45	87	2.6	5,199.7	5,199.7	5,200.1	0.4
J	7,840	30	74	3.1	5,205.6	5,205.6	5,205.9	0.3
K	8,330	30	74	3.1	5,212.5	5,212.5	5,213.4	0.9
L	8,930	55	83	2.8	5,219.5	5,219.5	5,219.7	0.2
M	9,230	65	100	2.3	5,224.6	5,224.6	5,224.8	0.2
N	9,740	50	103	2.2	5,229.9	5,229.9	5,230.5	0.6
O	10,120	40	76	3.0	5,235.0	5,235.0	5,235.4	0.4
P	10,400	35	76	3.0	5,240.0	5,240.0	5,240.4	0.4
Q	10,730	40	82	2.8	5,245.1	5,245.1	5,245.5	0.4

[1]Feet above confluence with Pine Nut Creek.
[2]Floodway not calculated – flow in overbanks.

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV AND INCORPORATED AREAS

FLOODWAY DATA

CODY WASH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY[3]	WITHOUT FLOODWAY[3]	WITH FLOODWAY	INCREASE[3]
N– S[2]								
T	29,780	1,115	6,301	4.1			4,859.3	
U	32,560	720	5,129	5.1			4,876.1	
V	34,745	650	4,257	6.2			4,886.6	
W	36,175	580	4,600	5.7			4,893.4	
X	38,000	920	3,610	7.3			4,902.5	
Y	39,705	445	3,658	7.2			4,912.4	
Z	41,305	186	2,059	12.7			4,921.6	

[1]Feet above State Highway 88.
[2]No Floodway determined.
[3]Data determined to be unrepresentative of current conditions, removed from study.

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV AND INCORPORATED AREAS

FLOODWAY DATA

EAST FORK CARSON RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	2,040	139	211	2.8	5198.1	5198.1	5198.1	0.0
B	2,400	83	210	2.8	5203.3	5203.3	5203.3	0.0
C	2,720	92	191	3.1	5207.5	5207.5	5207.5	0.0
D	3,020	112	214	2.8	5212.3	5212.3	5212.3	0.0
E	3,290	59	117	5.1	5218.6	5218.6	5218.7	0.1

[1]Feet above confluence with Pine Nut Creek Tributary.

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV AND INCORPORATED AREAS

FLOODWAY DATA

FISH SPRINGS CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	6,401	49	54	3.7	4,942.6	4,942.6	4,942.8	0.2
B	6,710	53	54	3.7	4,946.0	4,946.0	4,946.1	0.1
C	7,103	35	44	4.5	4,950.2	4,950.2	4,950.8	0.6
D	7,465	38	47	4.2	4,955.0	4,955.0	4,955.3	0.3
E	7,741	69	51	3.9	4,959.6	4,959.6	4,959.6	0.0
F	7,871	66	56	3.5	4,961.7	4,961.7	4,961.8	0.1
G	8,066	47	59	3.4	4,963.5	4,963.5	4,963.7	0.2
H	8,741	53	41	4.9	4,972.9	4,972.9	4,972.9	0.0
I	9,228	32	53	3.8	4,979.7	4,979.7	4,979.8	0.1
J	9,530	47	43	4.6	4,983.3	4,983.3	4,983.6	0.3
K	9,756	55	46	4.4	4,987.8	4,987.8	4,988.0	0.2
L	10,058	38	44	4.5	4,992.2	4,992.2	4,992.2	0.0
M	10,485	96	54	3.7	4,999.1	4,999.1	4,999.1	0.0
N	10,734	77	57	2.9	5,003.4	5,003.4	5,003.5	0.1
O	11,282	65	50	3.3	5,012.7	5,012.7	5,012.8	0.1
P	11,689	71	51	3.2	5,020.2	5,020.2	5,020.4	0.2
Q	12,080	55	42	3.9	5,026.6	5,026.6	5,026.7	0.1
R	12,613	24	35	4.8	5,034.0	5,034.0	5,034.1	0.1
S	12,943	43	36	4.6	5,040.0	5,040.0	5,040.2	0.2
T	13,294	20	32	5.1	5,046.5	5,046.5	5,046.8	0.3
U	13,738	36	40	4.2	5,053.3	5,053.3	5,053.3	0.0
V	14,004	47	42	3.9	5,058.2	5,058.2	5,058.5	0.3

[1]Feet above confluence with Buckeye Creek.

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV AND INCORPORATED AREAS

FLOODWAY DATA

JUNIPER ROAD WASH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
W	14,646	40	49	3.4	5,068.9	5,068.9	5,069.1	0.2
X	15,395	26	29	5.7	5,080.6	5,080.6	5,080.6	0.0
Y	16,020	18	32	5.2	5,090.5	5,090.5	5,090.6	0.1
Z	16,802	24	35	4.8	5,100.1	5,100.1	5,100.1	0.0
AA	17,263	21	30	5.5	5,107.3	5,107.3	5,107.4	0.1
AB	17,640	23	43	3.9	5,112.0	5,112.0	5,112.1	0.1
AC	18,102	16	27	6.2	5,116.4	5,116.4	5,116.8	0.4
AD	18,472	27	54	3.1	5,119.7	5,119.7	5,119.9	0.2
AE	18,599	24	29	3.2	5,120.9	5,120.9	5,120.9	0.0
AF	18,733	20	20	4.8	5,123.1	5,123.1	5,123.1	0.0
AG	18,887	28	35	2.7	5,124.9	5,124.9	5,124.9	0.0
AH	19,230	26	19	5.0	5,128.9	5,128.9	5,128.9	0.0
AI	19,501	37	40	2.4	5,132.1	5,132.1	5,132.1	0.0
AJ	19,892	49	31	3.0	5,135.1	5,135.1	5,135.1	0.0
AK	19,921	75	27	3.4	5,138.3	5,138.3	5,138.3	0.0
AL	19,954	50	143	0.7	5,138.4	5,138.4	5,138.5	0.1
AM	20,434	31	21	4.5	5,138.8	5,138.8	5,138.8	0.0
AN	20,639	70	37	2.6	5,141.3	5,141.3	5,141.3	0.0
AO	20,681	70	26	3.7	5,142.3	5,142.3	5,142.3	0.0
AP	20,702	77	30	3.2	5,144.1	5,144.1	5,144.1	0.0
AQ	20,729	104	191	0.5	5,144.3	5,144.3	5,144.3	0.0
AR	20,939	22	19	5.0	5,144.5	5,144.5	5,144.5	0.0

[1]Feet above confluence with Buckeye Creek.

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV AND INCORPORATED AREAS

FLOODWAY DATA

JUNIPER ROAD WASH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
AS	21,077	29	26	3.6	5,146.2	5,146.2	5,146.3	0.1
AT	21,322	29	32	2.9	5,148.0	5,148.0	5,148.2	0.2
AU	21,590	29	21	4.4	5,150.9	5,150.9	5,150.8	-0.1
AV	21,830	28	32	2.9	5,153.3	5,153.3	5,153.3	0.0
AW	22,090	32	26	3.7	5,155.0	5,155.0	5,155.0	0.0
AX	22,358	22	20	4.7	5,158.4	5,158.4	5,158.4	0.0
AY	22,576	62	22	2.6	5,162.1	5,162.1	5,162.1	0.0
AZ	22,696	39	17	3.5	5,164.4	5,164.4	5,164.4	0.0
BA	22,827	31	19	3.1	5,166.2	5,166.2	5,166.2	0.0
BB	22,890	15	12	5.0	5,167.5	5,167.5	5,167.5	0.0
BC	22,978	49	24	2.4	5,168.6	5,168.6	5,168.6	0.0
BD	23,089	16	12	5.0	5,170.1	5,170.1	5,170.1	0.0
BE	23,356	20	16	3.7	5,176.1	5,176.1	5,176.1	0.0
BF	23,607	26	17	3.5	5,180.5	5,180.5	5,180.4	-0.1
BG	23,834	25	15	3.9	5,185.3	5,185.3	5,185.3	0.0
BH	24,199	20	16	3.7	5,192.3	5,192.3	5,192.3	0.0

[1]Feet above confluence with Buckeye Creek.

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV
AND INCORPORATED AREAS

FLOODWAY DATA

JUNIPER ROAD WASH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	936	480	1,766	1.7	4,705.1	4,705.1	4,705.2	0.1
B	4,209	260	830	3.2	4,708.6	4,708.6	4,708.7	0.1
C	6,113	436	680	3.6	4,714.2	4,714.2	4,714.5	0.3
D	8,220	508	934	2.8	4,724.0	4,724.0	4,724.2	0.2
E	10,575	544	1,654	2.2	4,731.9	4,731.9	4,732.5	0.6
F	14,582	460	1,225	1.3	4,748.1	4,748.1	4,748.2	0.1
G	15,523	230	289	4.4	4,750.8	4,750.8	4,751.4	0.6
H	16,783	316	255	5.0	4,755.6	4,755.6	4,755.6	0.0

[1]Feet above Stockyard Road.

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV AND INCORPORATED AREAS

FLOODWAY DATA

MARTIN SLOUGH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A - B[2]								
C	1,620	55	338	6.8	5,096.0	5,096.0	5,096.9	0.9
D	1,975	75	465	4.9	5,103.8	5,103.8	5,103.9	0.1
E	2,205	70	349	6.6	5,105.5	5,105.5	5,105.7	0.2
F	2,605	55	308	6.7	5,110.8	5,110.8	5,111.2	0.4
G	3,165	60	232	6.7	5,120.0	5,120.0	5,120.0	0.0
H	3,650	35	236	5.4	5,126.8	5,126.8	5,127.0	0.2
I	3,935	65	255	5.0	5,129.3	5,129.3	5,129.6	0.3
J	4,265	60	208	6.1	5,134.3	5,134.3	5,134.3	0.0
K	4,615	75	309	4.1	5,138.2	5,138.2	5,138.2	0.0
L	4,985	67	242	5.3	5,141.5	5,141.5	5,141.5	0.0
M	5,335	71	264	4.2	5,145.2	5,145.2	5,145.2	0.0
N	5,675	67	226	4.9	5,148.4	5,148.4	5,148.4	0.0
O	5,935	45	135	7.4	5,153.0	5,153.0	5,153.0	0.0
P	6,115	93	273	3.3	5,158.6	5,158.6	5,158.6	0.0
Q	6,325	85	274	3.3	5,159.9	5,159.9	5,159.9	0.0
R	6,695	80	194	3.9	5,162.8	5,162.8	5,162.9	0.1
S	7,125	67	178	4.2	5,168.2	5,168.2	5,168.2	0.0
T	7,505	77	189	4.0	5,172.9	5,172.9	5,172.9	0.0
U	7,945	104	232	3.2	5,177.7	5,177.7	5,177.7	0.0
V	8,105	90	195	3.9	5.179.4	5.179.4	5.179.4	0.0

[1]Feet above confluence with Pine Nut Creek.
[2]Floodway not calculated – flow in channel.

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV
AND INCORPORATED AREAS

FLOODWAY DATA

PINE NUT CREEK TRIBUTARY

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
W	8,375	60	132	5.2	5,184.1	5,184.1	5,184.1	0.0
X	8,695	60	130	5.3	5,189.0	5,189.0	5,189.0	0.0
Y	8,895	39	117	5.9	5,192.8	5,192.8	5,193.6	0.8
Z	9,155	48	142	4.8	5,197.7	5,197.7	5,198.4	0.7
AA	9,385	69	151	4.5	5,201.8	5,201.8	5,202.2	0.4
AB	9,705	64	152	4.5	5,208.0	5,208.0	5,208.0	0.0
AC	10,075	62	167	4.1	5,213.1	5,213.1	5,213.1	0.0
AD	10,315	57	160	4.3	5,216.0	5,216.0	5,216.0	0.0
AE	10,515	52	153	4.5	5,218.4	5,218.4	5,218.4	0.0

[1]Feet above confluence with Pine Nut Creek.

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV AND INCORPORATED AREAS

FLOODWAY DATA

PINE NUT CREEK TRIBUTARY

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	50	75	266	1.9	4,919.6	4,919.6	4,920.2	0.6
B	210	101	189	2.7	4,920.2	4,920.2	4,920.7	0.5
C	490	70	126	4.1	4,924.8	4,924.8	4,924.8	0.0
D	760	55	249	2.1	4,932.0	4,932.0	4,932.5	0.5
E	835	60	209	2.5	4,932.1	4,932.1	4,932.6	0.5
F	985	50	123	4.2	4,933.1	4,933.1	4,933.6	0.5
G	1,385	75	140	3.7	4,940.7	4,940.7	4,940.7	0.0
H	1,525	40	88	5.8	4,943.4	4,943.4	4,943.7	0.3
I	1,795	40	121	4.3	4,949.1	4,949.1	4,949.5	0.4
J	2,005	43	107	4.8	4,952.8	4,952.8	4,952.8	0.0
K	2,285	60	321	1.6	4,961.6	4,961.6	4,961.6	0.0
L	2,445	95	198	2.6	4,961.6	4,961.6	4,961.8	0.2
M	2,725	65	129	4.0	4,964.9	4,964.9	4,964.9	0.0
N	3,035	70	151	3.4	4,969.3	4,969.3	4,969.7	0.4
O	3,425	60	131	3.9	4,976.4	4,976.4	4,976.4	0.0
P	3,825	58	165	3.1	4,982.8	4,982.8	4,983.0	0.2
Q	4,355	69	136	3.8	4,991.6	4,991.6	4,991.7	0.1
R	4,935	110	188	2.7	5,003.7	5,003.7	5,003.7	0.0
S	5,505	48	123	4.2	5,014.6	5,014.6	5,014.7	0.1
T	5,825	102	185	2.8	5,020.9	5,020.9	5,021.0	0.1

[1]Feet above East Valley Road.

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV AND INCORPORATED AREAS

FLOODWAY DATA

PINE NUT ROAD WASH

Encroachment into areas subject to inundation by floodwaters having hazardous velocities aggravates the risk of flood damage and heightens potential flood hazards by further increasing velocities. A listing of stream velocities at selected cross sections is provided in Table 10, "Floodway Data." To reduce the risk of property damage in areas where the stream velocities are high, the community may wish to restrict development in areas outside the floodway.

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

Floodways were developed originally for Airport Wash, Bobwhite Wash, Buckeye Creek, Calle Hermosa Wash, Cody Wash, Fish Springs Creek, Juniper Road Wash, Pine Nut Creek Tributary, Pine Nut Road Wash and Sunrise Pass Wash.

Prior revisions added floodways to Carson River, Clear Creek and East Fork Carson River. The floodways for the Carson River and Clear Creek extend beyond the limits of Douglas County.

During the 2010 revision, floodways were developed or revised for the confined reaches of Bobwhite Wash, Buckeye Creek, Calle Hermosa Wash, Calle de Asco Wash, and Juniper Road Wash. Due to the distributary nature of alluvial fans, floodways are not appropriate on the pediments and were not computed. For that reason the floodways along Airport Wash and Sunrise Pass Wash were removed during the restudy.

The area between the floodway and 1-percent annual chance floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation of the 1-percent annual chance flood by more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 1, "Floodway Schematic."

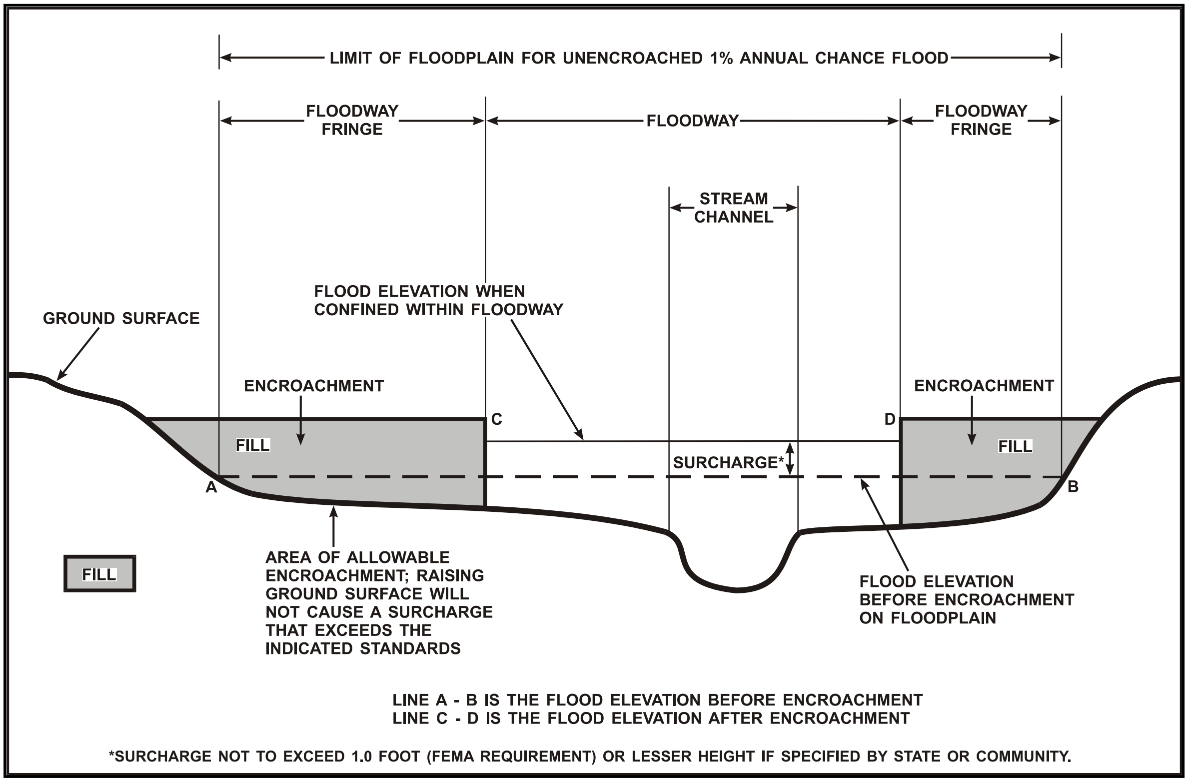

Figure 1 - Floodway Schematic

5.0 INSURANCE APPLICATIONS

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

Zone A

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

Zone AE

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

Zone AH

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

Zone AO

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

Zone X

Zone X is the flood insurance rate zone that corresponds to areas outside the 500-year floodplain, areas within the 500-year floodplain, and areas of 1-percent annual chance flooding where average depths are less than 1 foot, areas of 1-percent annual chance flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 1-percent annual chance flood by levees. No base flood elevations or depths are shown within this zone.

Zone D

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

6.0 FLOOD INSURANCE RATE MAP

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

For flood insurance applications, the map designates flood insurance rate zones as described in Section 5.0 and shows selected whole-foot BFEs or average depths in the 1-percent annual chance floodplains that were studied by detailed methods. 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 uses tints, screens, and symbols to show the 1-percent and 0.2-percent annual chance floodplains, floodways and the locations of selected cross sections used in the hydraulic analyses and floodway computations.

The current FIRM presents flooding information for the entire geographic area of Douglas County. Historical data relating to the maps prepared for each community, up to and including this countywide FIS are presented in Table 11, "Community Map History."

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISION DATE (S)	FLOOD INSURANCE RATE MAP EFFECTIVE DATE	FLOOD INSURANCE RATE MAP REVISION DATE (S)
Douglas County (Unincorporated Areas)	January 3, 1975	None	March 28, 1980	August 15, 1983 August 19, 1986 September 30, 1992 April 4, 1994 June 5, 1997 November 8, 1999 January 20, 2010 June 15, 2016

TABLE 11

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV AND INCORPORATED AREAS

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 (References 40 and 41).

8.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this FIS can be obtained by contacting:

FEMA,
Federal Insurance and Mitigation Division
1111 Broadway, Suite 1200
Oakland, California 94607-4052.

9.0 BIBLIOGRAPHY AND REFERENCES

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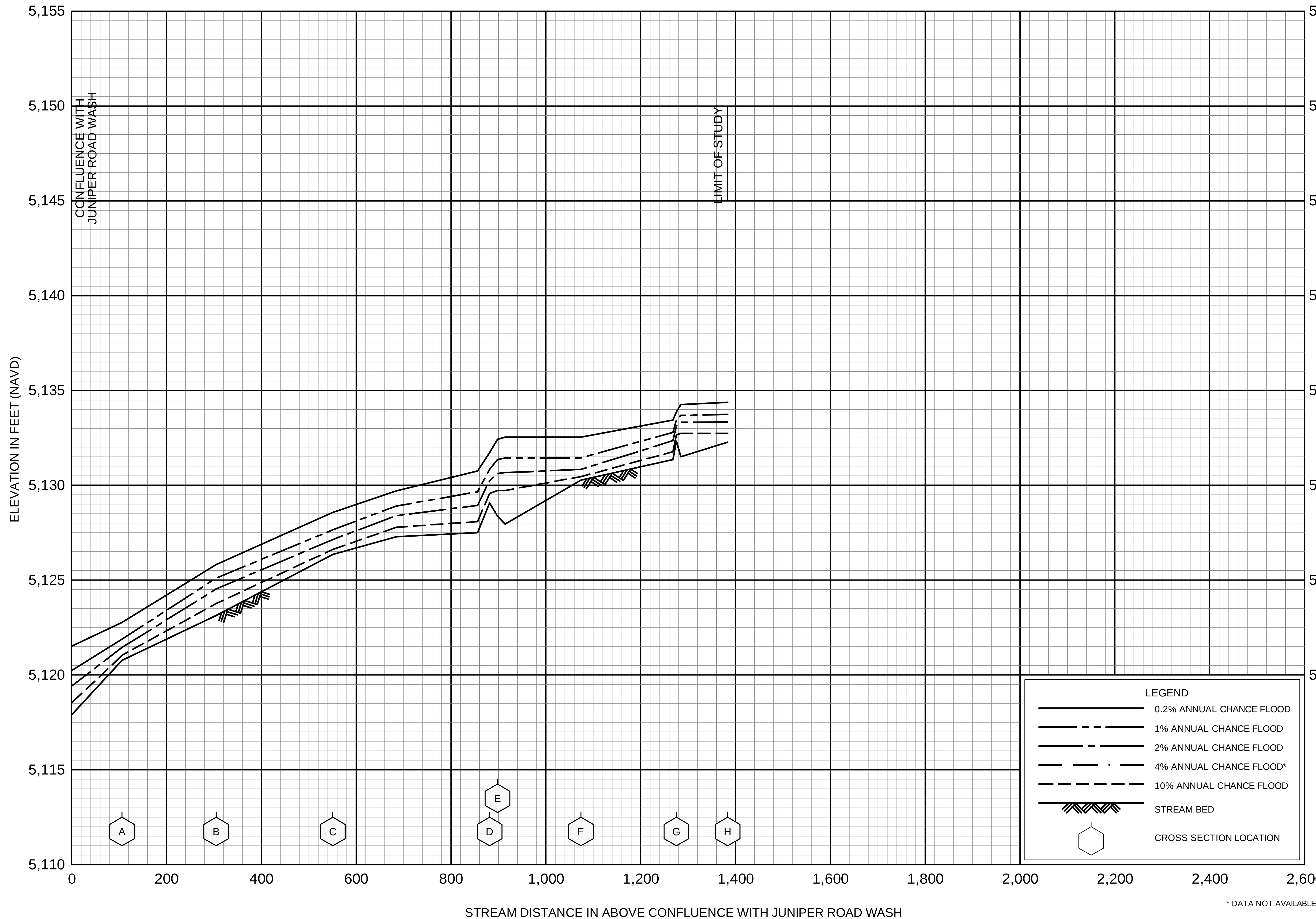


FLOOD PROFILES

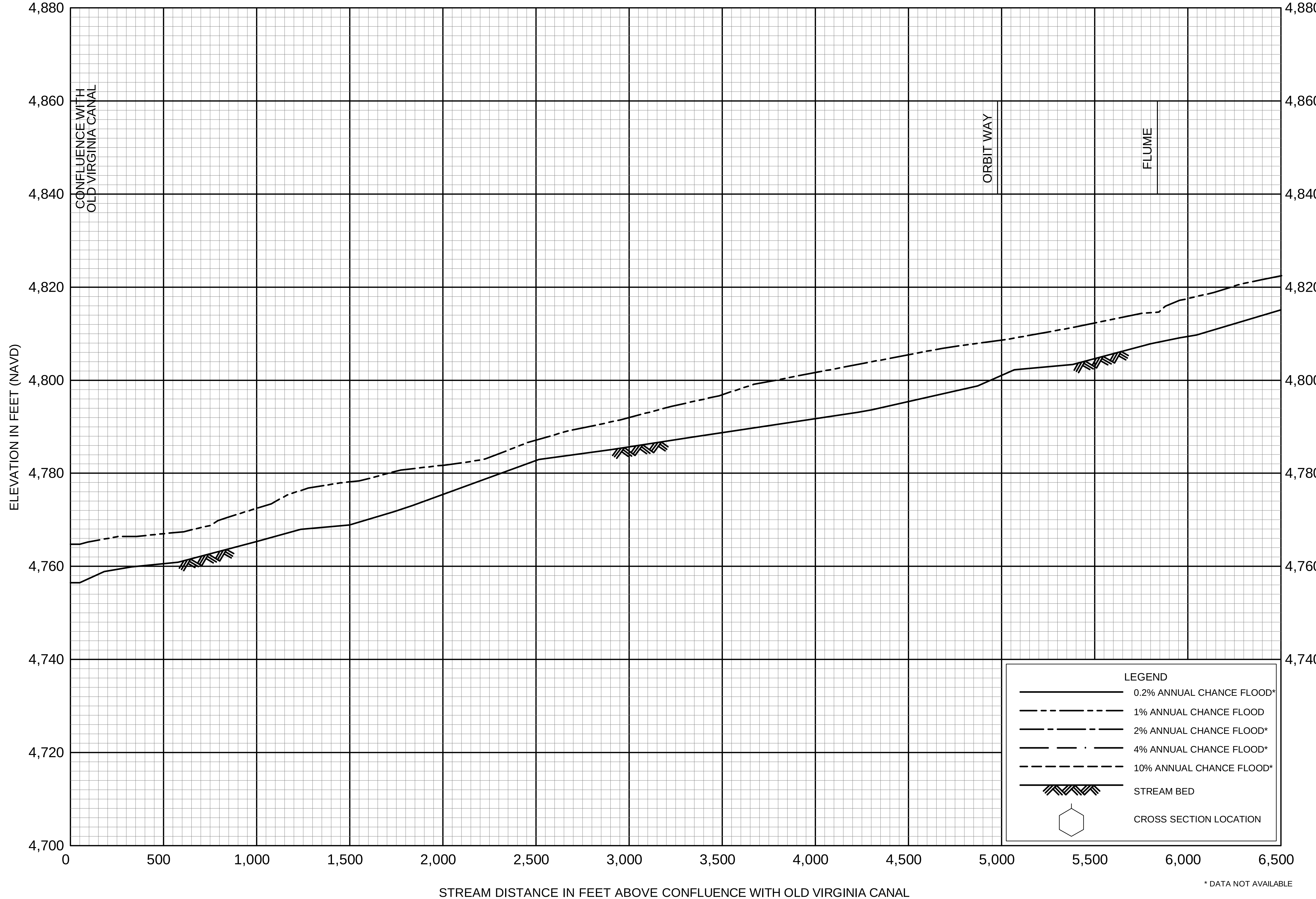
BOBWHITE WASH

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV

AND INCORPORATED AREAS

01P



FLOOD PROFILES

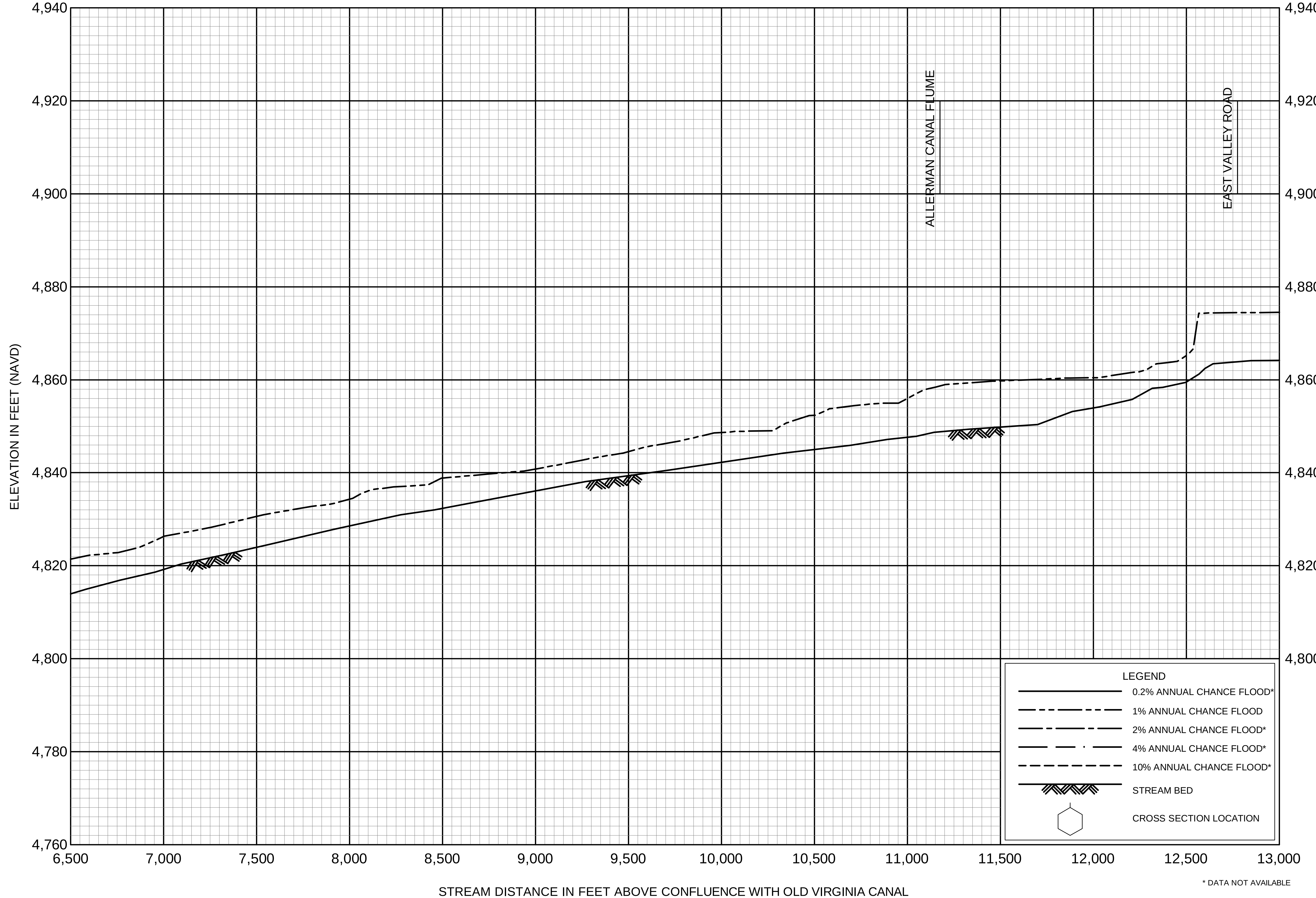
BUCKEYE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV

AND INCORPORATED AREAS

02P



FLOOD PROFILES

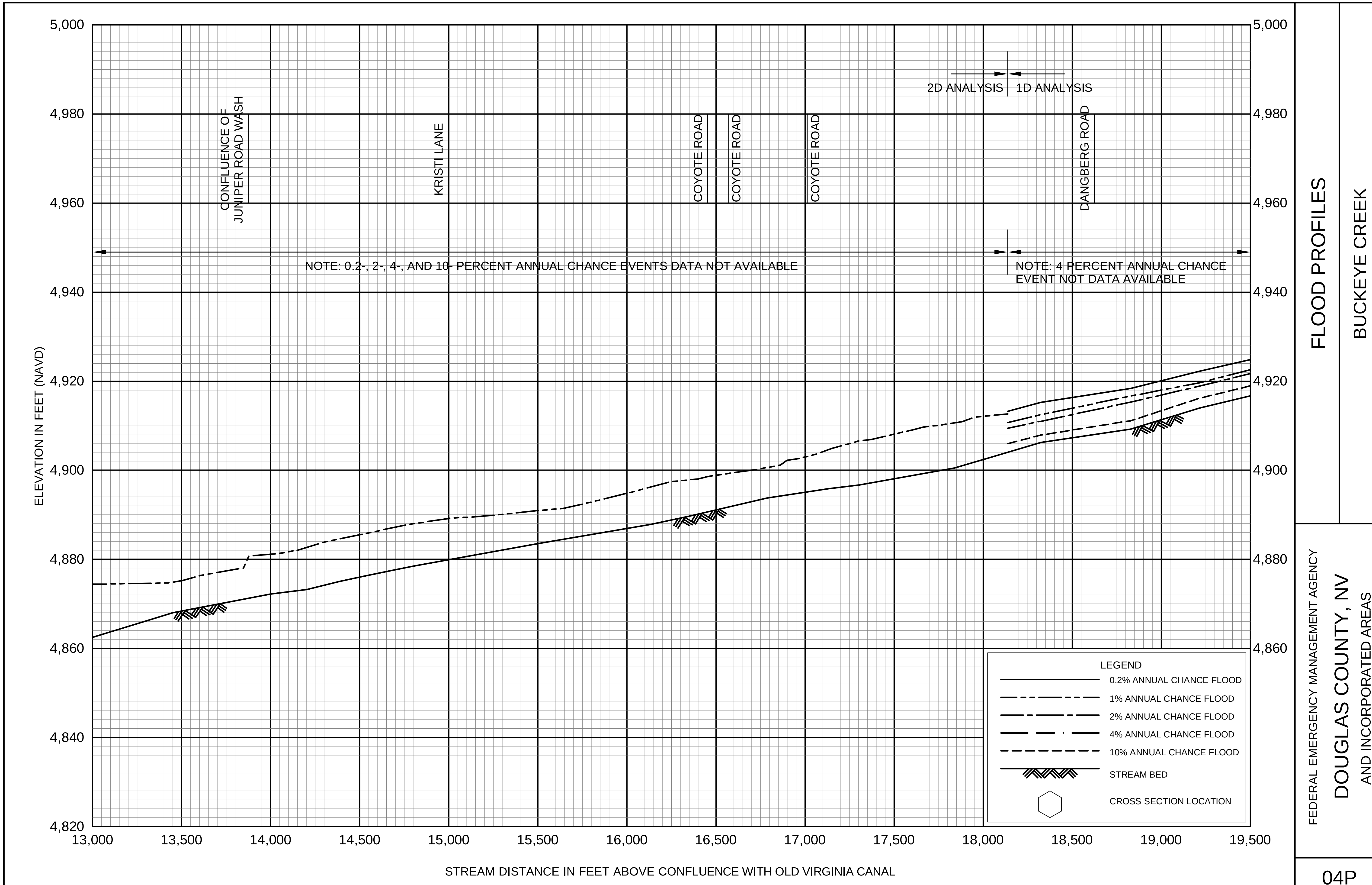
BUCKEYE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV

AND INCORPORATED AREAS

03P



FLOOD PROFILES
BUCKEYE CREEK
FEDERAL EMERGENCY MANAGEMENT AGENCY
DOUGLAS COUNTY, NV
AND INCORPORATED AREAS
04P
ELEVATION IN FEET (NAVD)
STREAM DISTANCE IN FEET ABOVE CONFLUENCE WITH OLD VIRGINIA CANAL
2D ANALYSIS
1D ANALYSIS
CONFLUENCE OF JUNIPER ROAD WASH
KRISTI LANE
COYOTE ROAD
COYOTE ROAD
COYOTE ROAD
DANGBERG ROAD
NOTE: 0.2-, 2-, 4-, AND 10- PERCENT ANNUAL CHANCE EVENTS DATA NOT AVAILABLE
NOTE: 4 PERCENT ANNUAL CHANCE EVENT NOT DATA AVAILABLE
LEGEND
0.2% ANNUAL CHANCE FLOOD
1% ANNUAL CHANCE FLOOD
2% ANNUAL CHANCE FLOOD
4% ANNUAL CHANCE FLOOD
10% ANNUAL CHANCE FLOOD
STREAM BED
CROSS SECTION LOCATION
5,000
4,980
4,960
4,940
4,920
4,900
4,880
4,860
4,840
4,820
13,000
13,500
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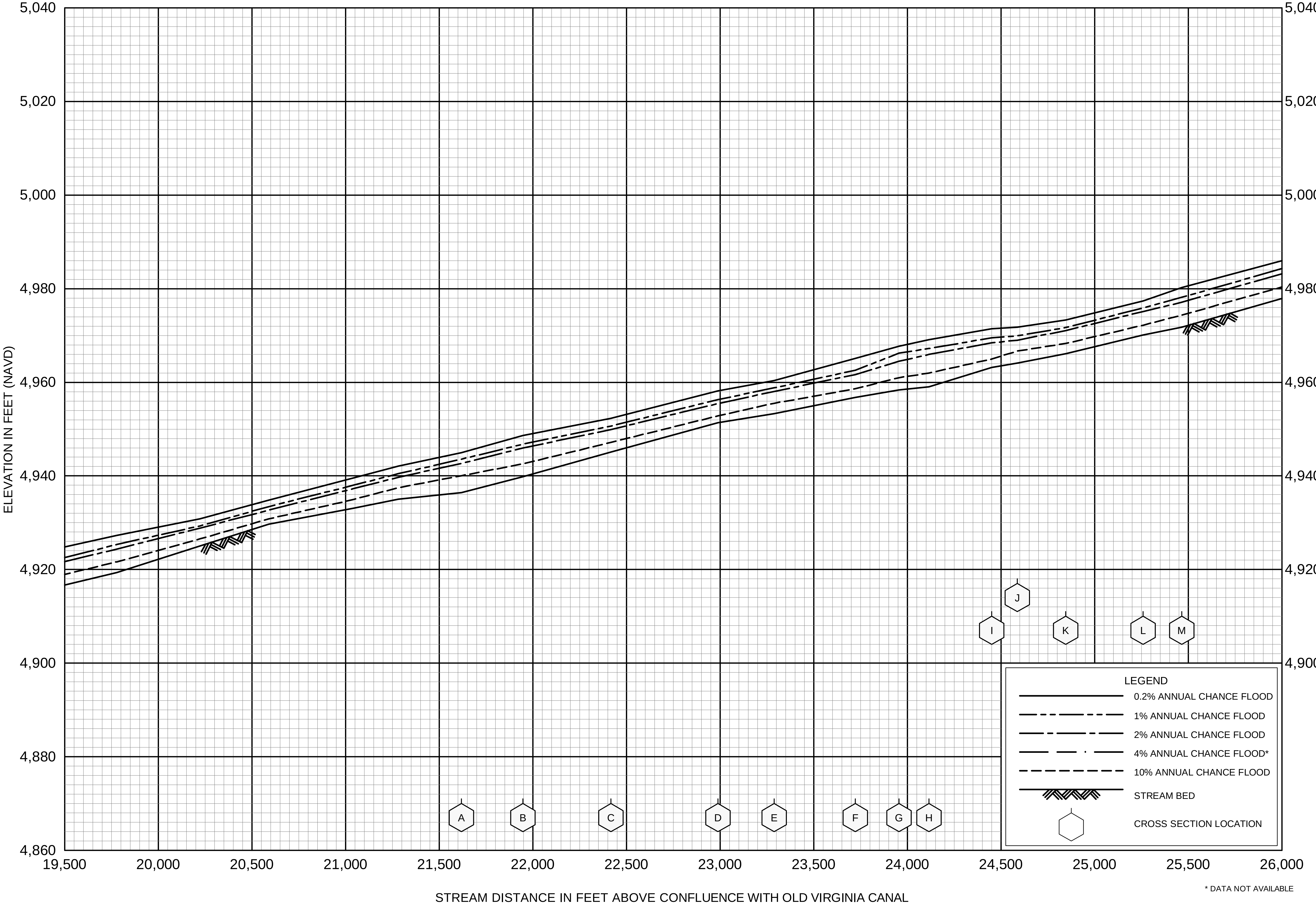


FLOOD PROFILES

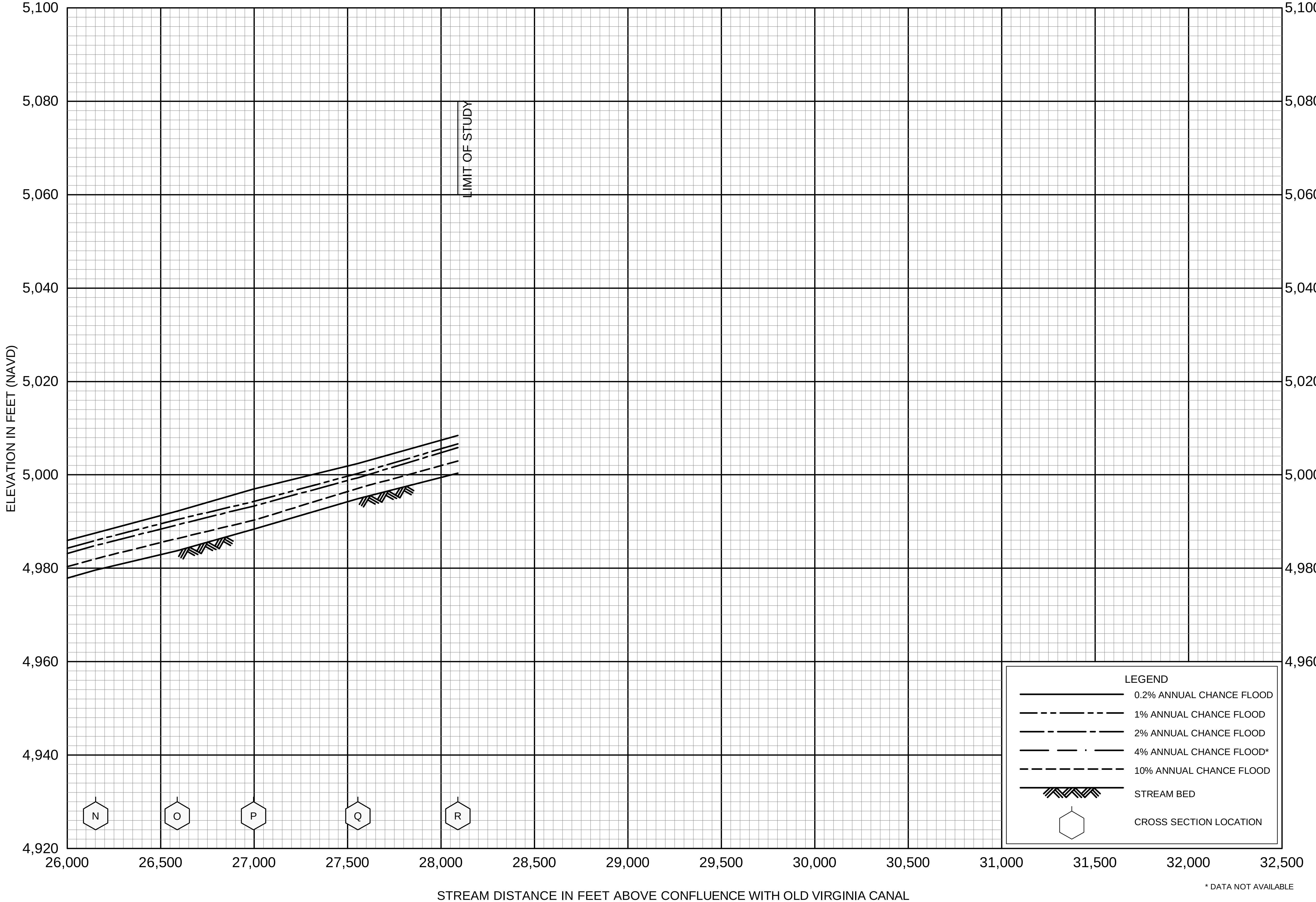
BUCKEYE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV

AND INCORPORATED AREAS

05P



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FLOOD PROFILES

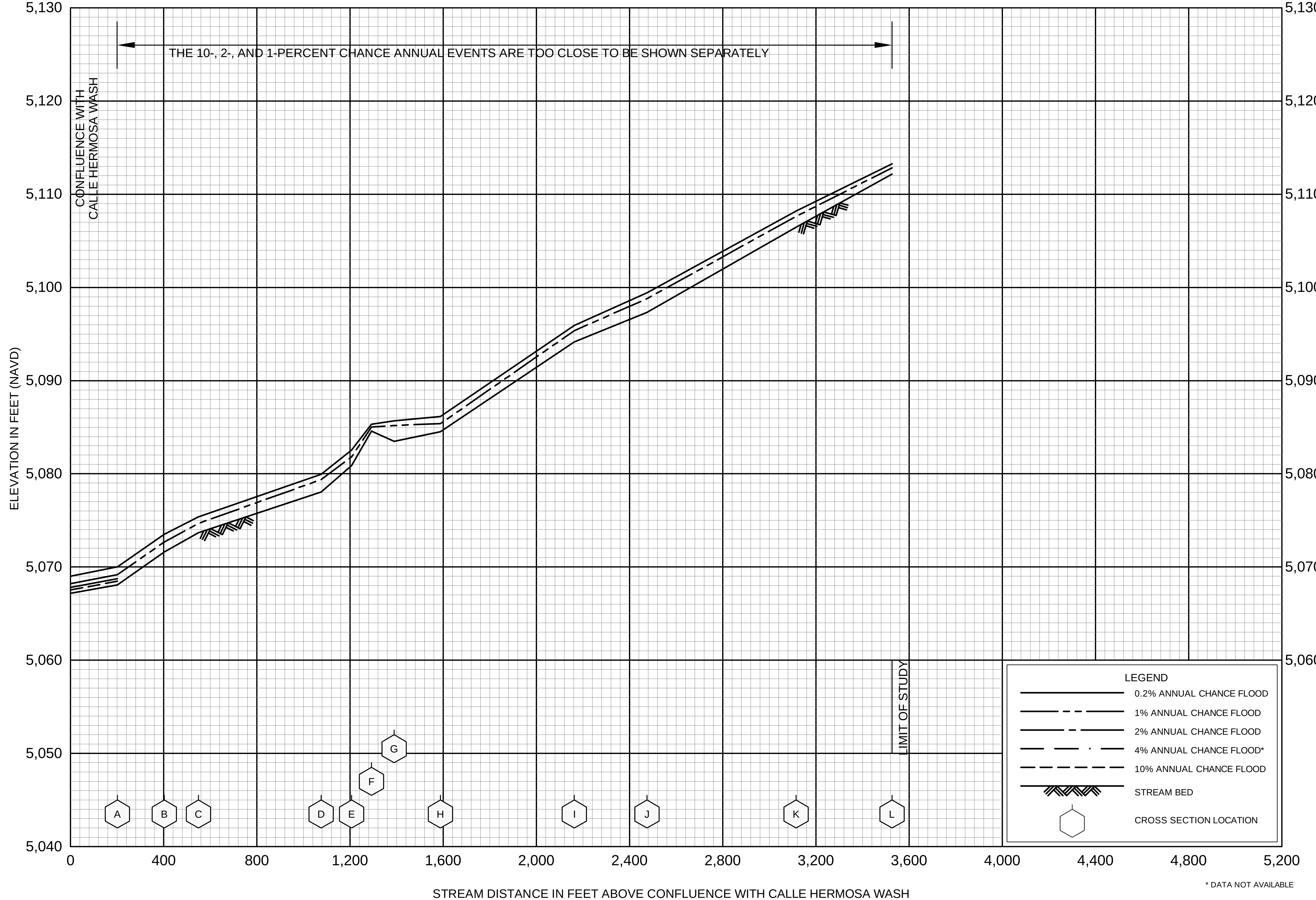
BUCKEYE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV

AND INCORPORATED AREAS

06P



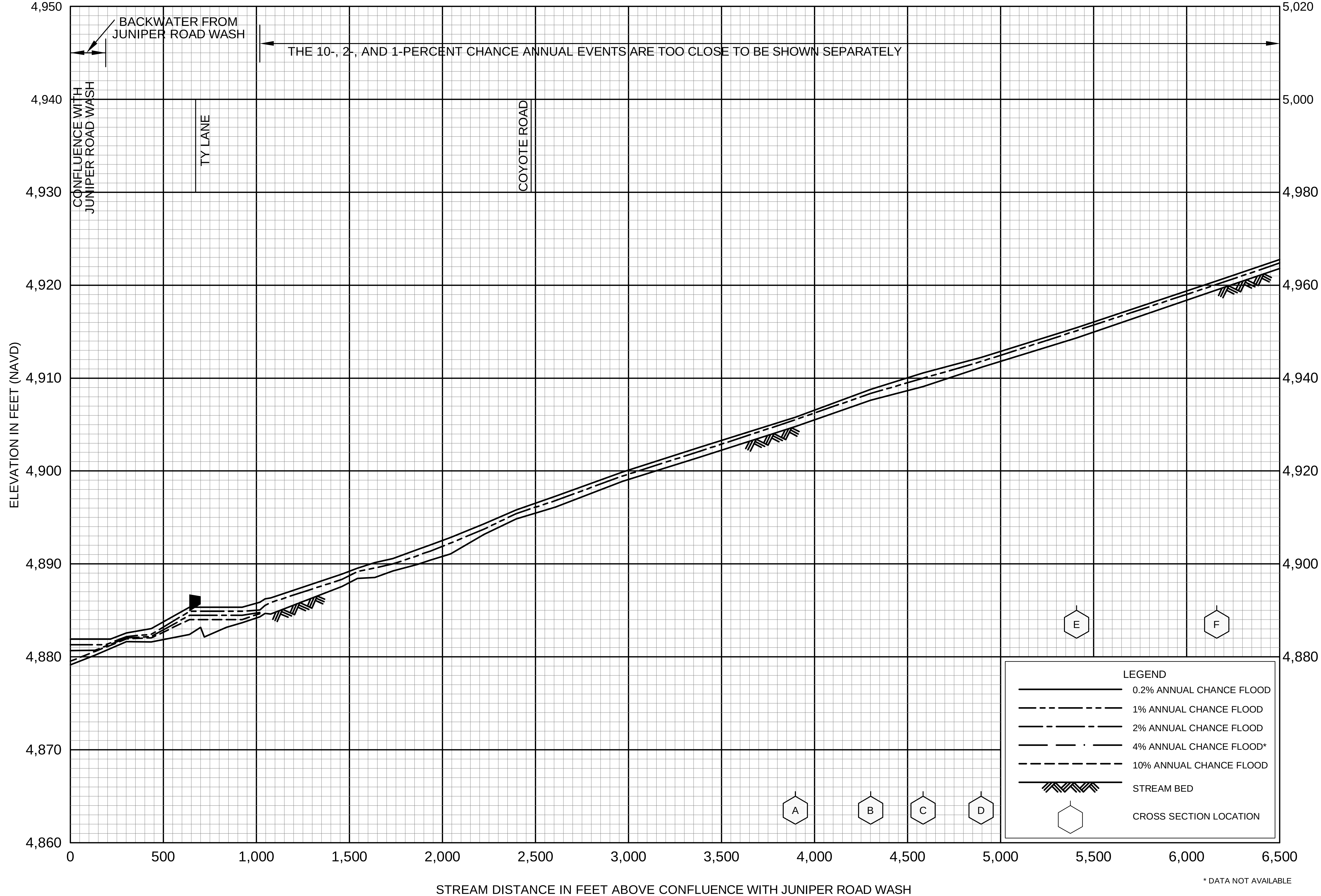
FLOOD PROFILES

CALLE DE ASCO WASH

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV

AND INCORPORATED AREAS



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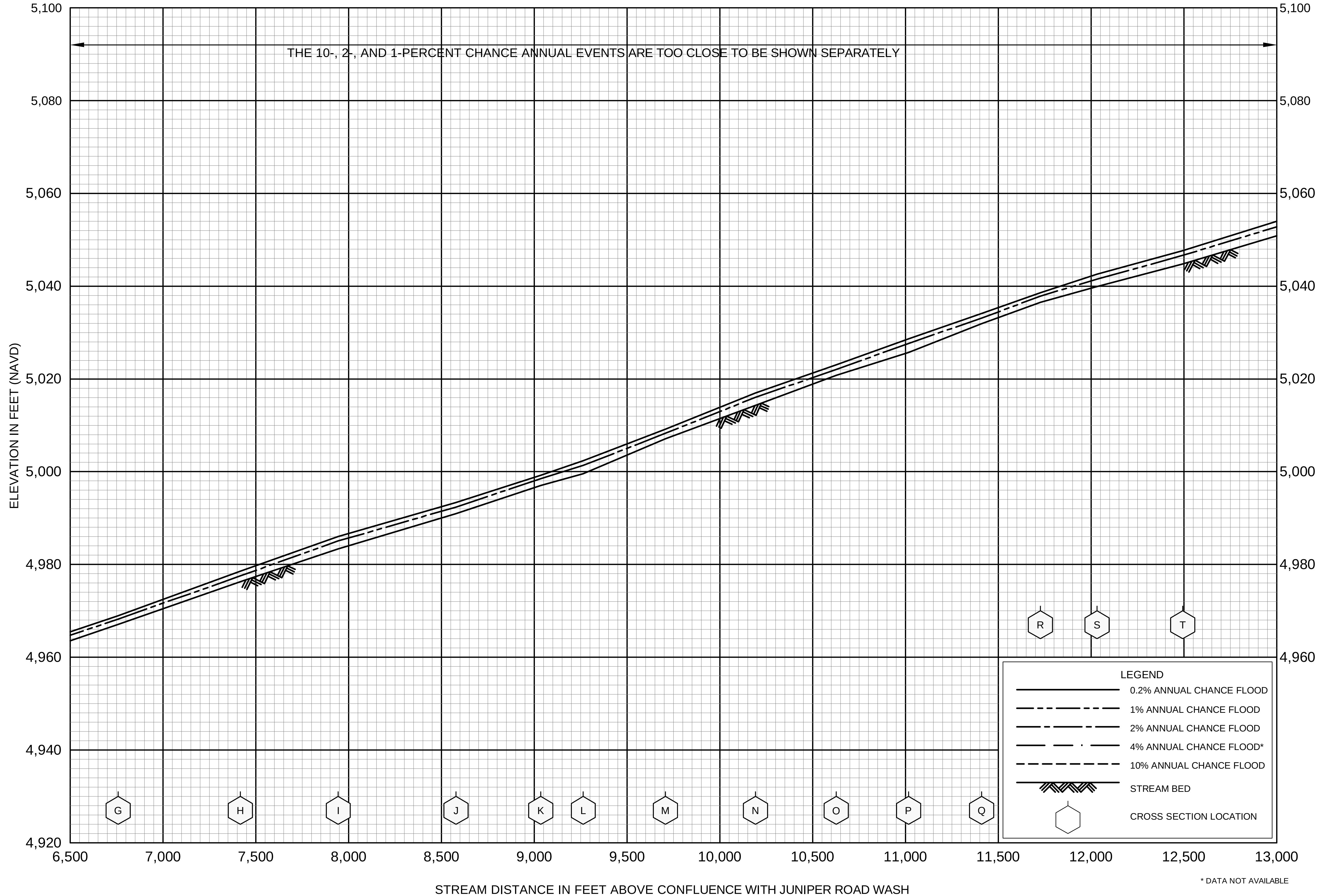
FLOOD PROFILES

CALLE HERMOSA WASH

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV
AND INCORPORATED AREAS



FLOOD PROFILES

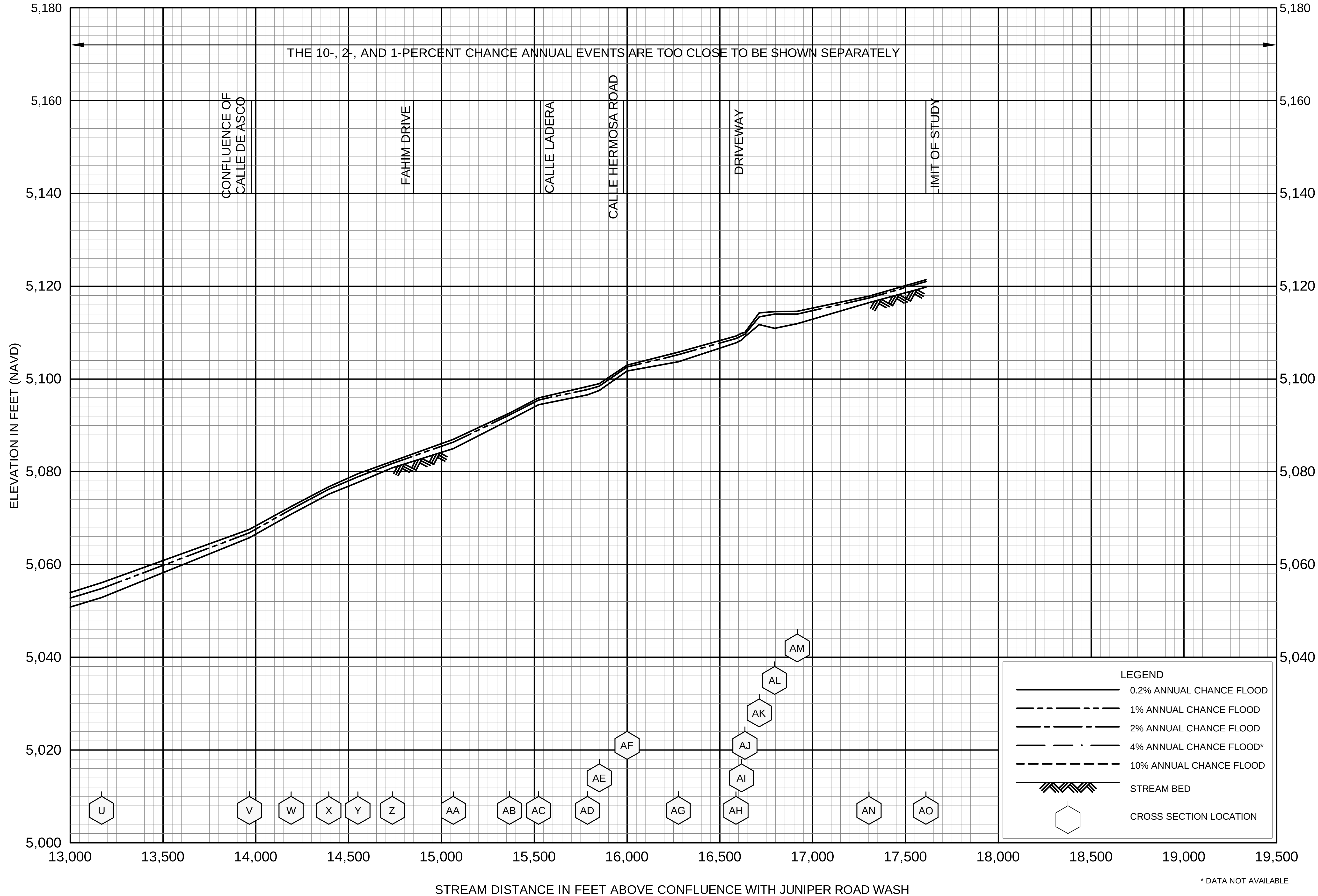
CALLE HERMOSA WASH

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV

AND INCORPORATED AREAS

09P



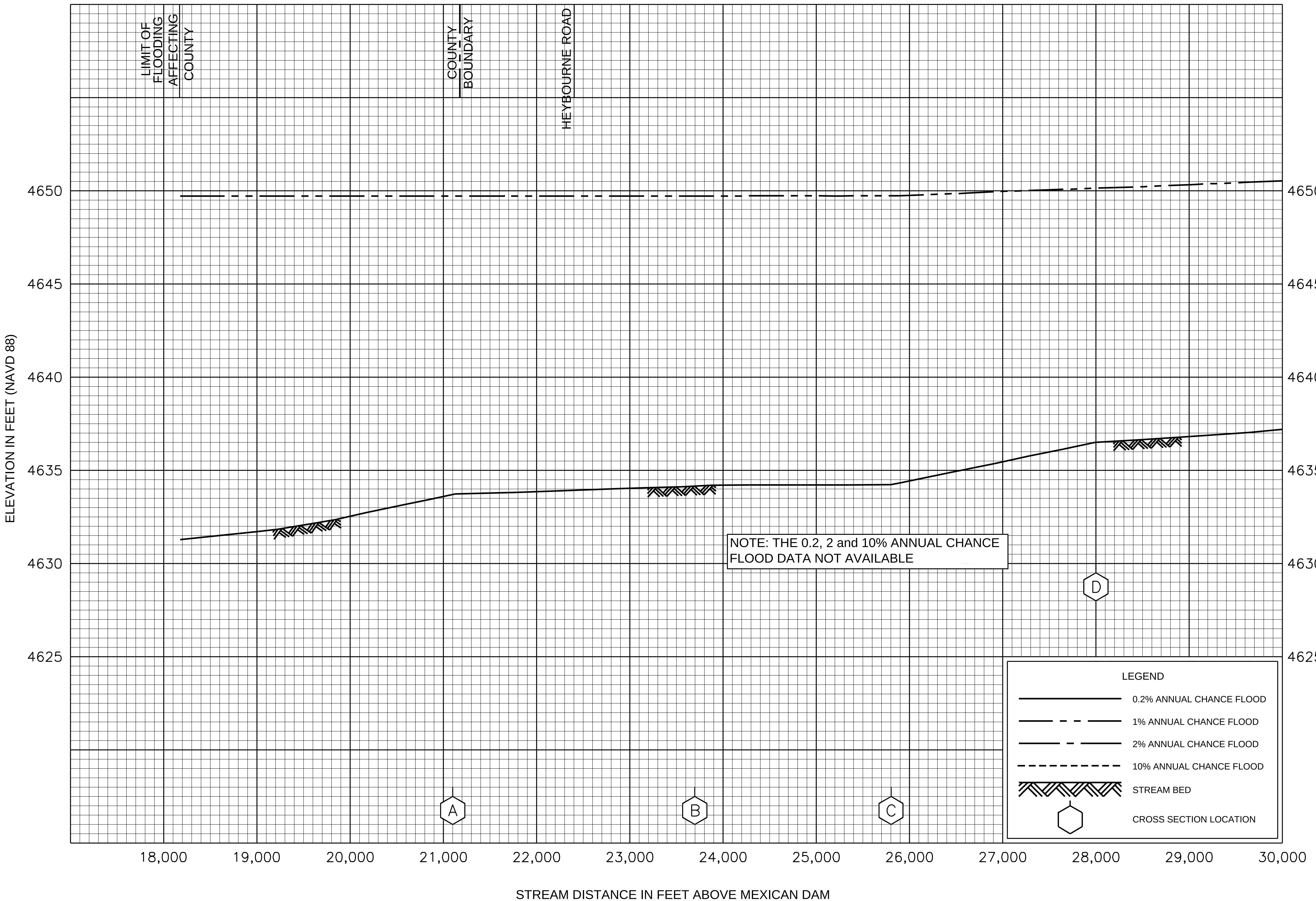
FLOOD PROFILES

CALLE HERMOSA WASH

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV

AND INCORPORATED AREAS



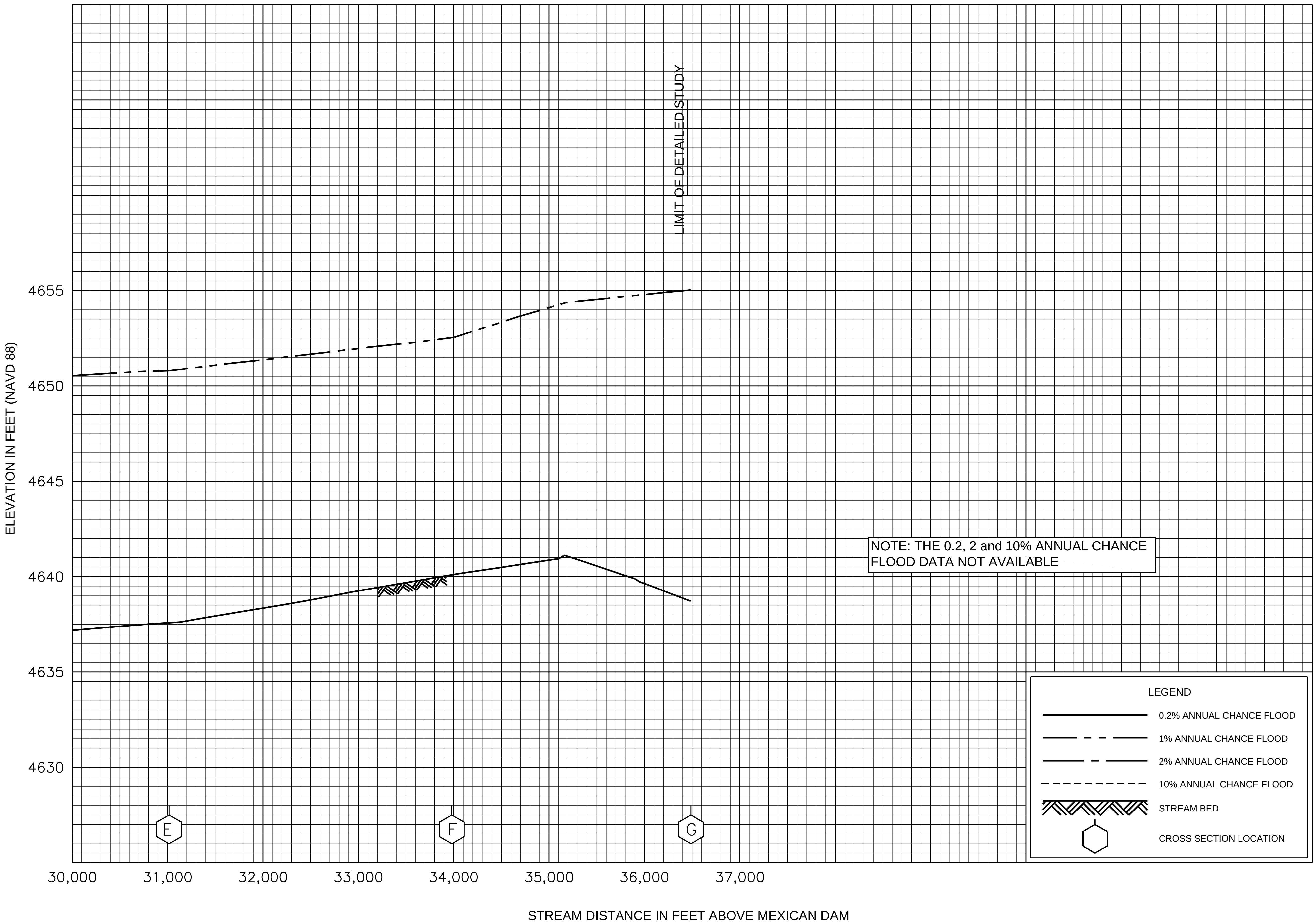
FLOOD PROFILES

CARSON RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV

AND INCORPORATED AREAS



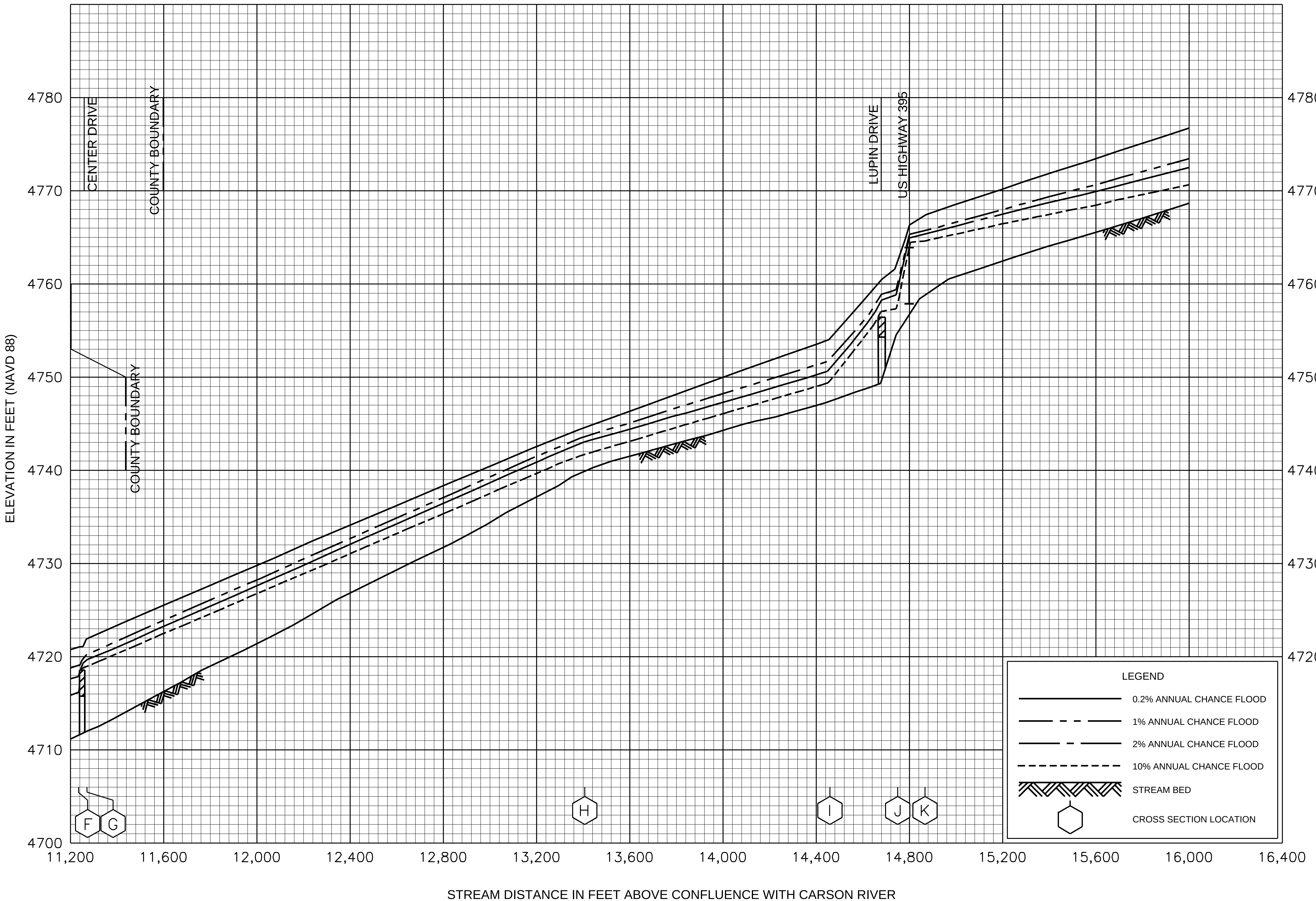
FLOOD PROFILES

CARSON RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV
AND INCORPORATED AREAS

12P

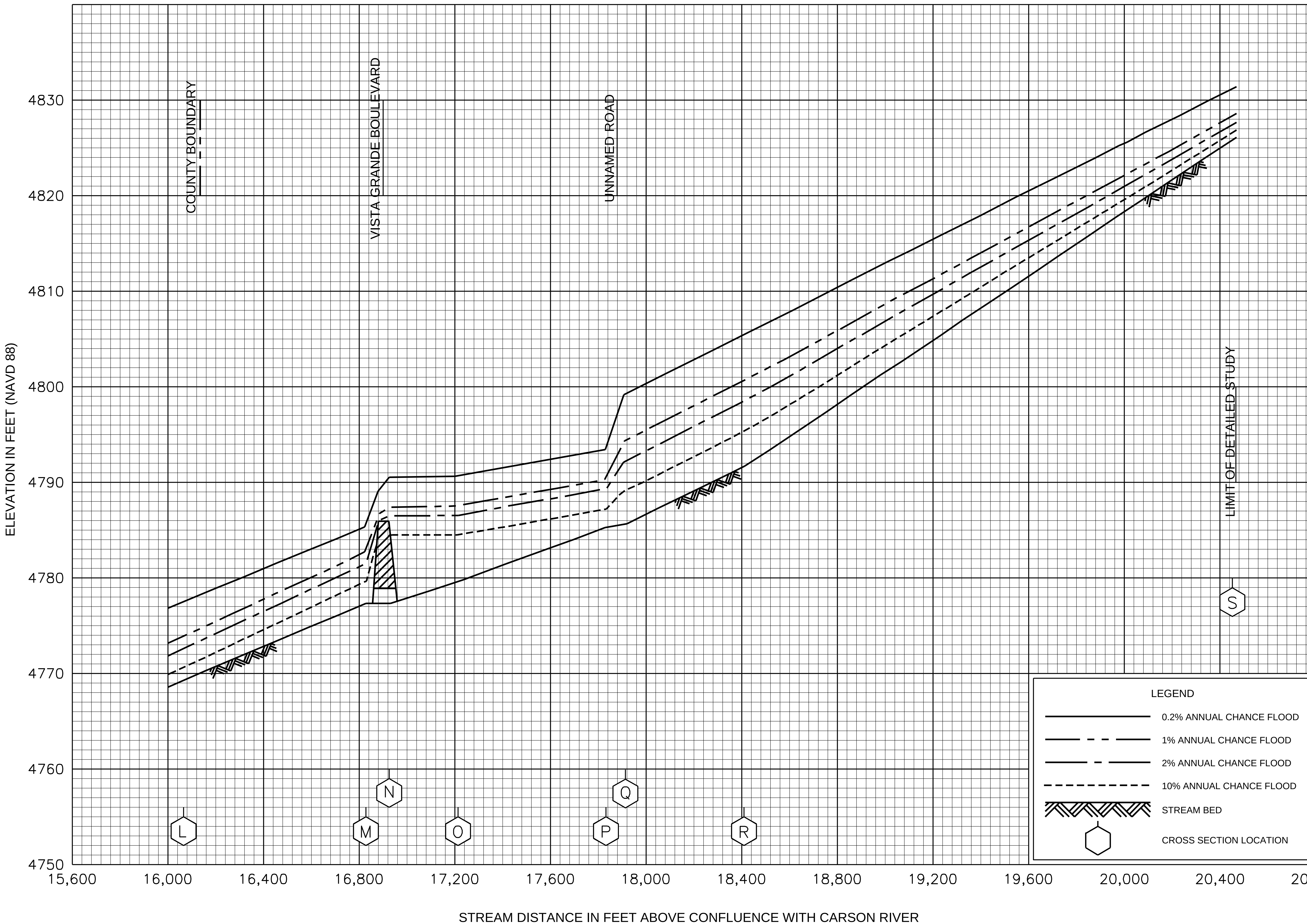


FLOOD PROFILES

CLEAR CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV
AND INCORPORATED AREAS



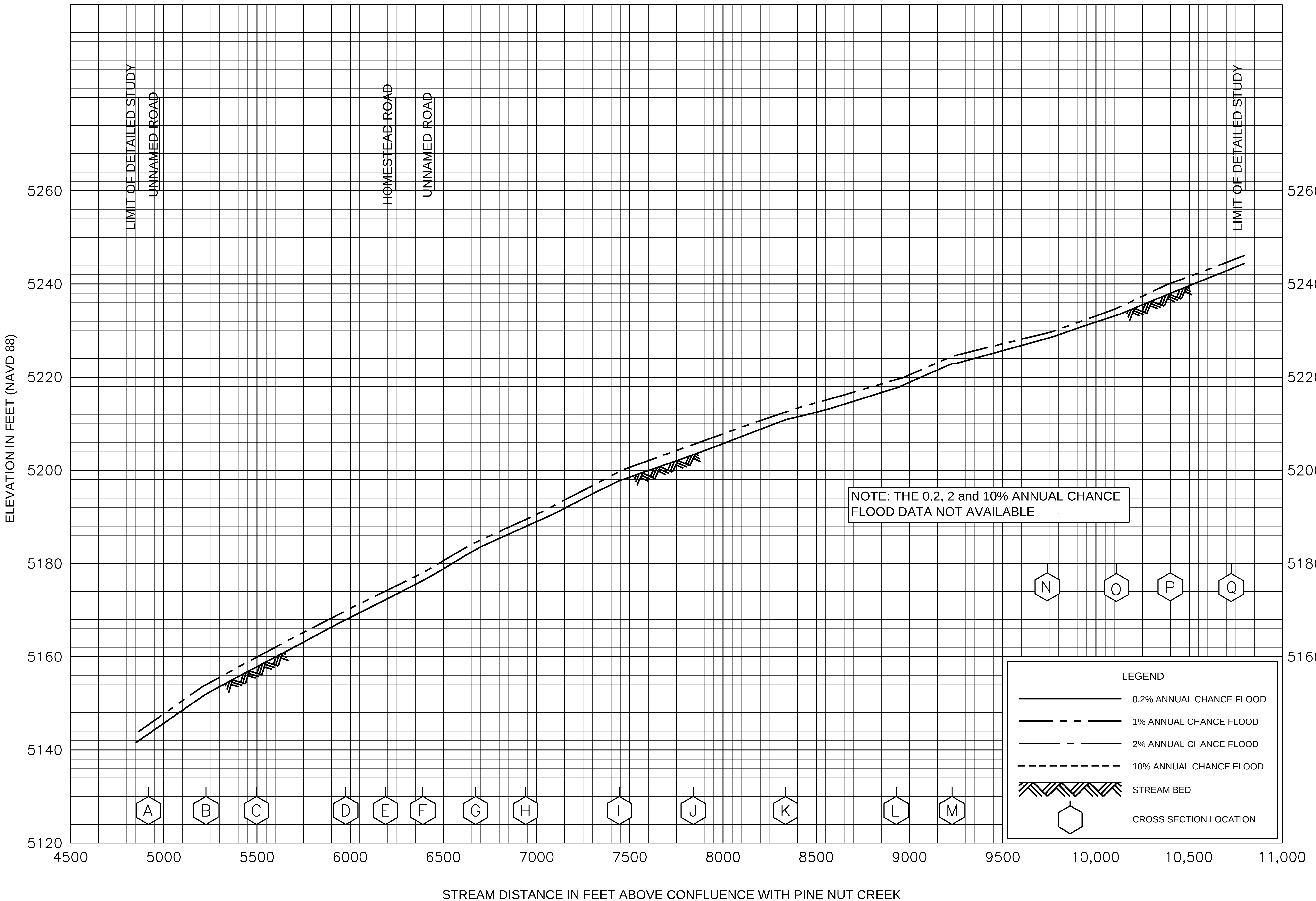
FLOOD PROFILES

CLEAR CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV

AND INCORPORATED AREAS



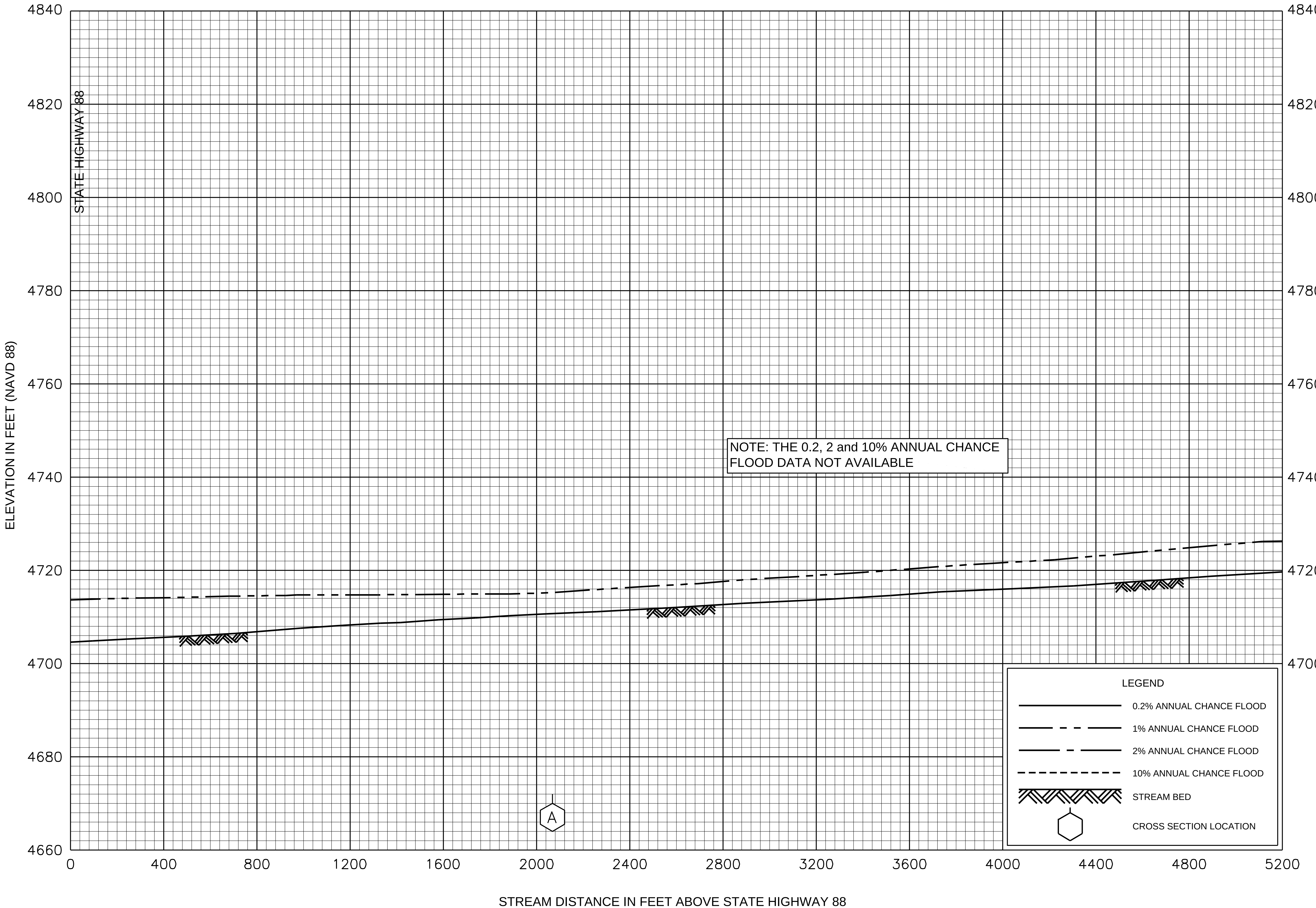
FLOOD PROFILES

CODY WASH

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV

AND INCORPORATED AREAS

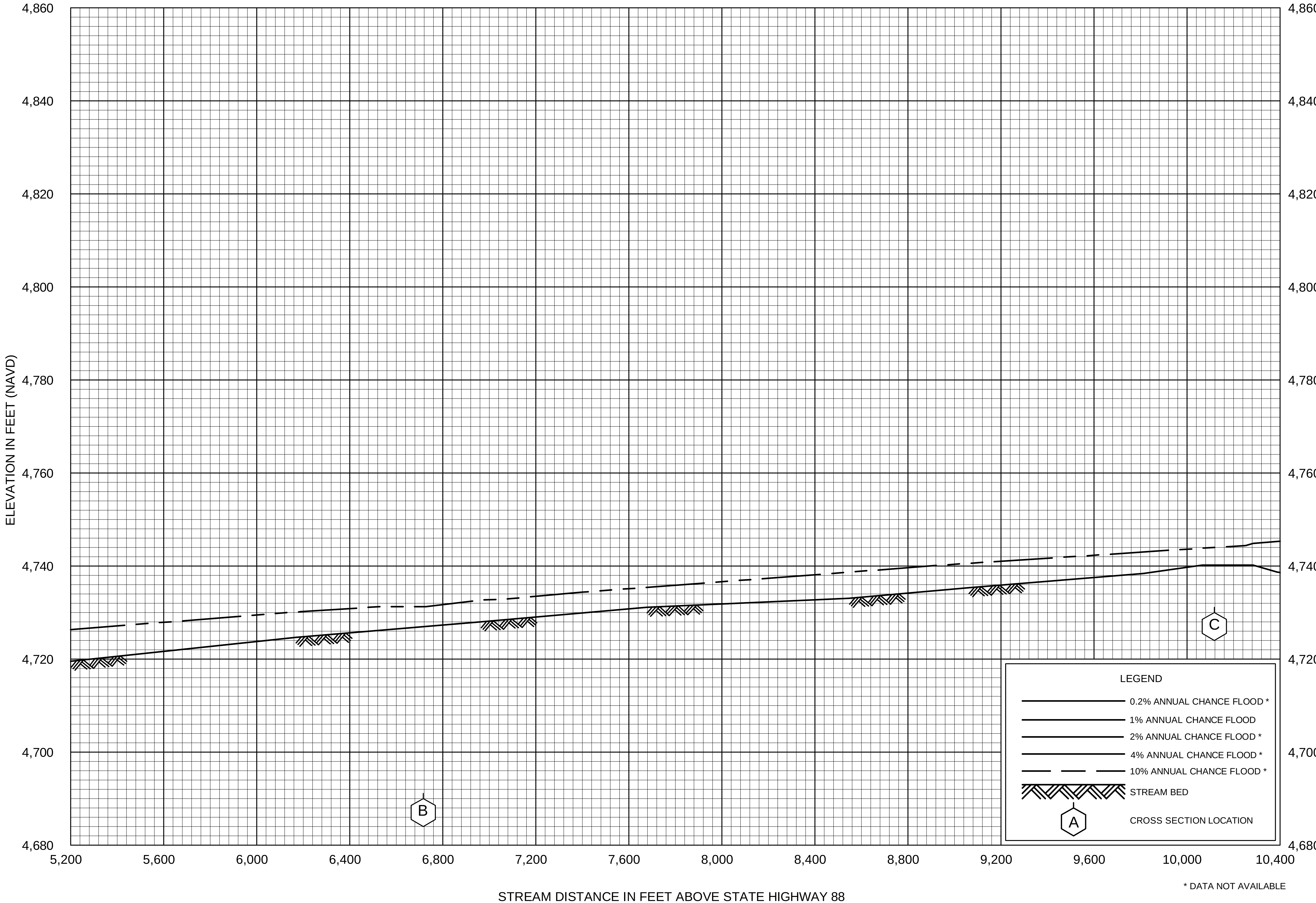


FLOOD PROFILES

COTTONWOOD SLOUGH

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV
AND INCORPORATED AREAS



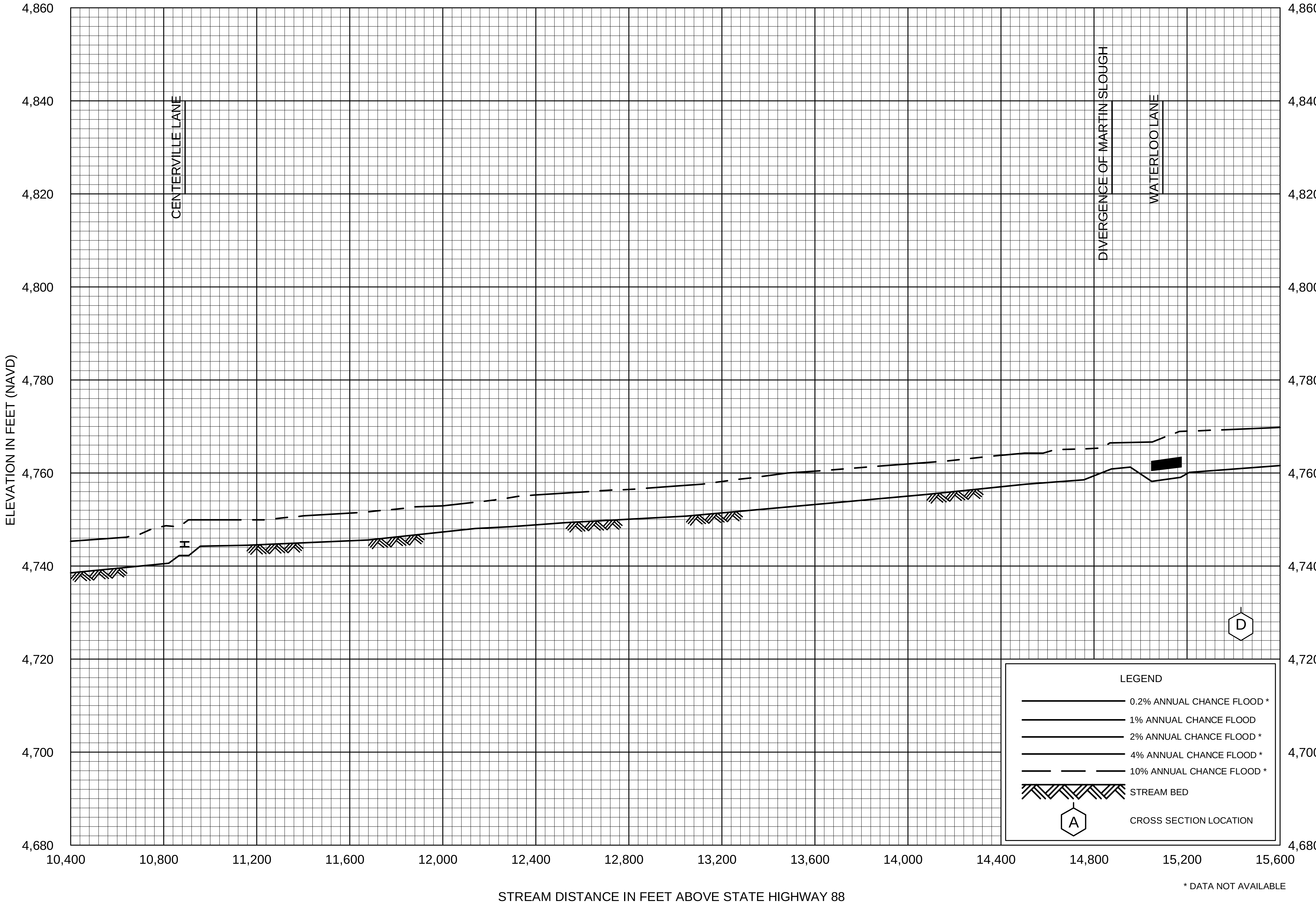
FLOOD PROFILES

COTTONWOOD SLOUGH

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV

AND INCORPORATED AREAS



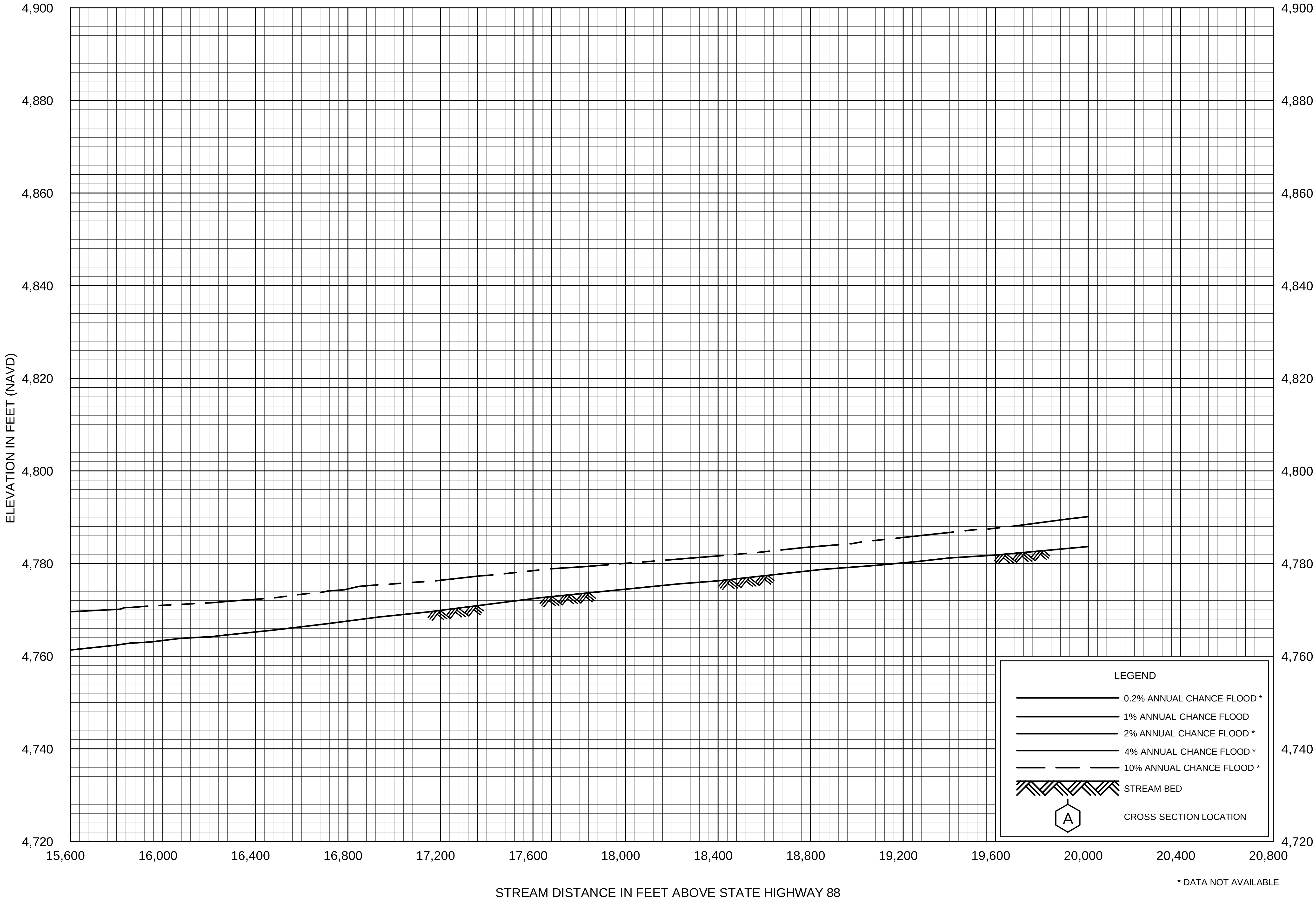
FLOOD PROFILES

COTTONWOOD SLOUGH

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV

AND INCORPORATED AREAS



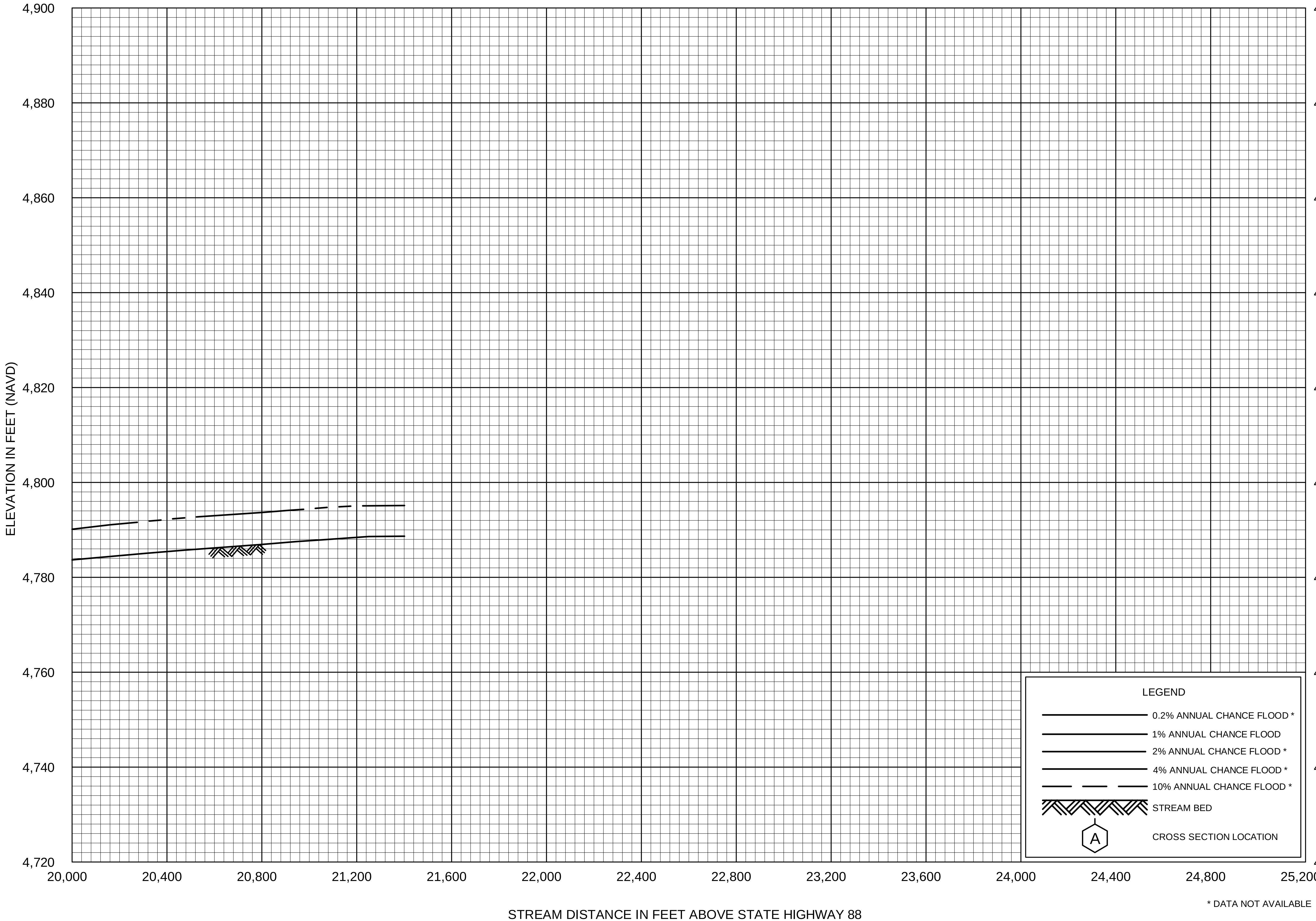
FLOOD PROFILES

COTTONWOOD SLOUGH

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV

AND INCORPORATED AREAS



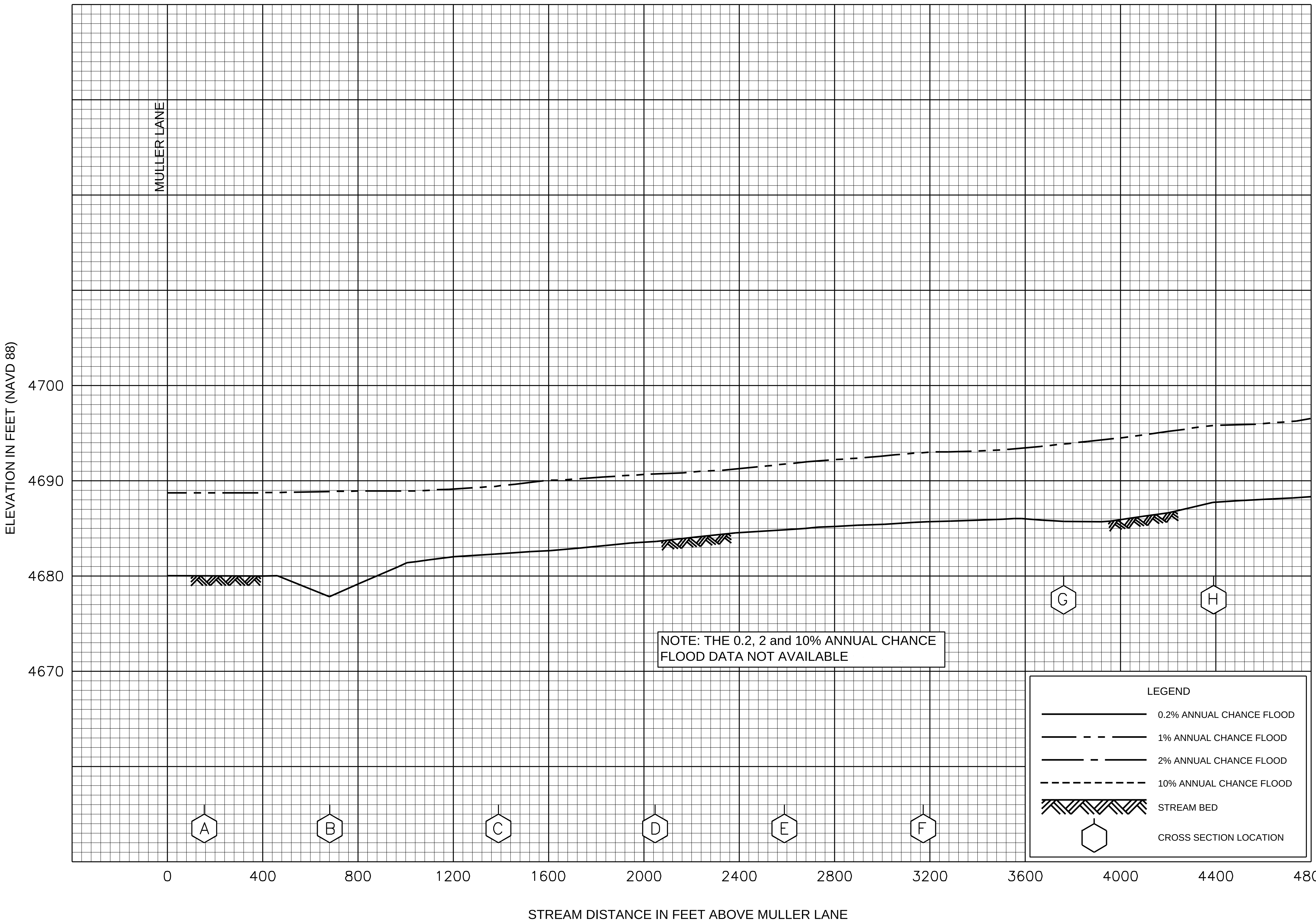
FLOOD PROFILES

COTTONWOOD SLOUGH

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV

AND INCORPORATED AREAS

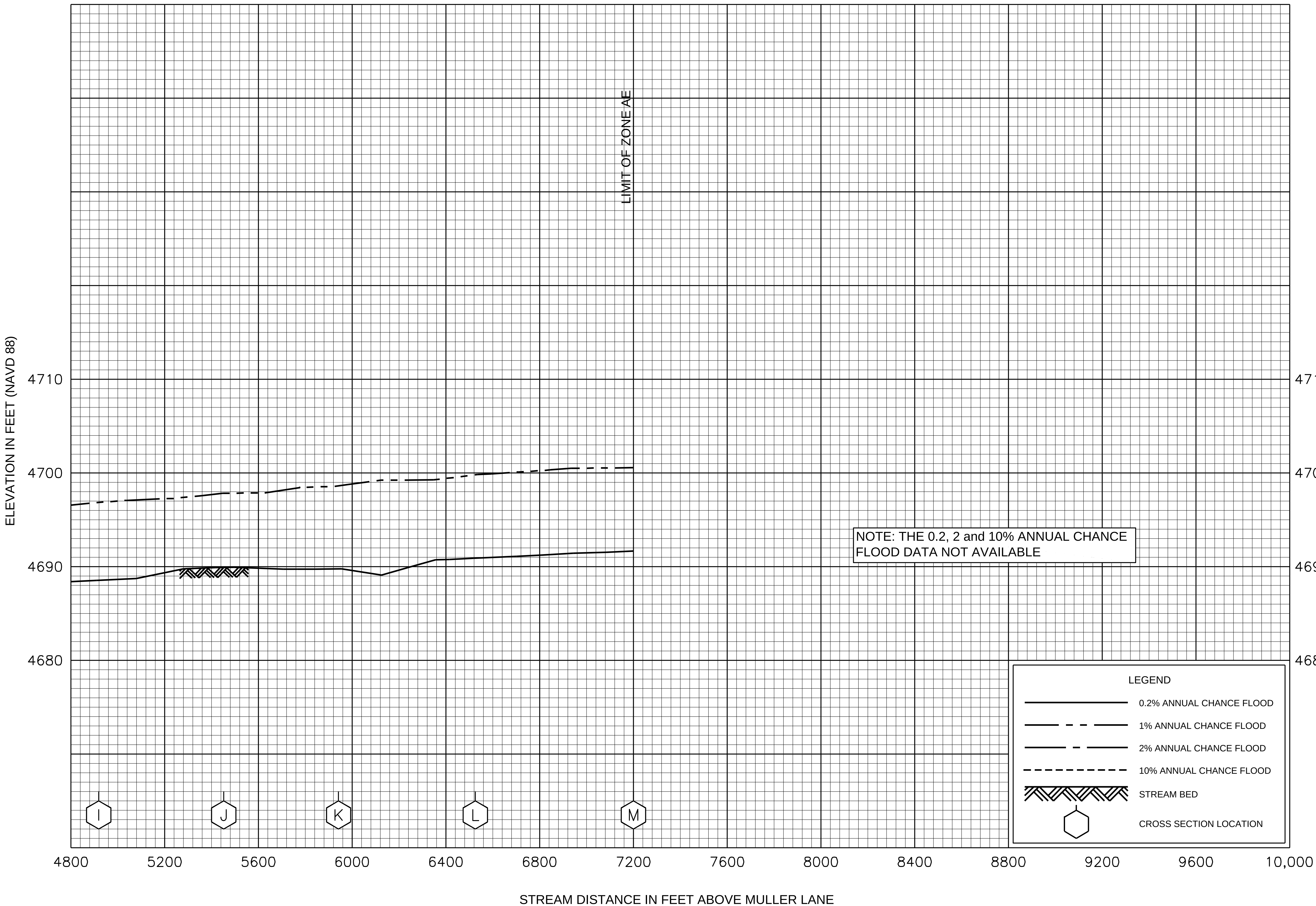


FLOOD PROFILES

EAST FORK CARSON RIVER (BELOW SH 88)

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV
AND INCORPORATED AREAS

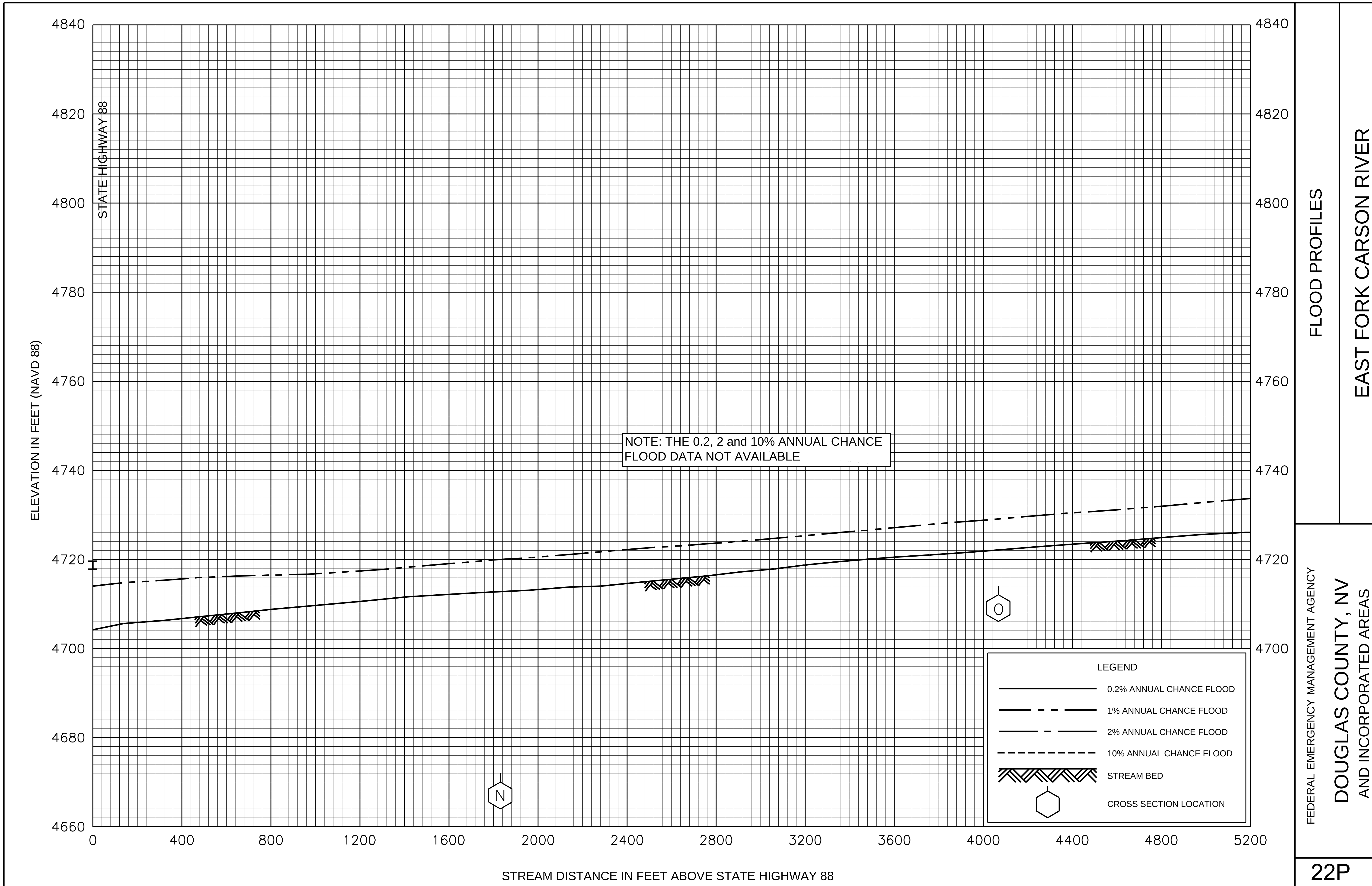


FLOOD PROFILES

EAST FORK CARSON RIVER (BELOW SH 88)

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV
AND INCORPORATED AREAS


FLOOD PROFILES
EAST FORK CARSON RIVER
FEDERAL EMERGENCY MANAGEMENT AGENCY
DOUGLAS COUNTY, NV
AND INCORPORATED AREAS
22P
STATE HIGHWAY 88
ELEVATION IN FEET (NAVD 88)
STREAM DISTANCE IN FEET ABOVE STATE HIGHWAY 88
NOTE: THE 0.2, 2 and 10% ANNUAL CHANCE FLOOD DATA NOT AVAILABLE
LEGEND
0.2% ANNUAL CHANCE FLOOD
1% ANNUAL CHANCE FLOOD
2% ANNUAL CHANCE FLOOD
10% ANNUAL CHANCE FLOOD
STREAM BED
CROSS SECTION LOCATION
N
O
4660
4680
4700
4720
4740
4760
4780
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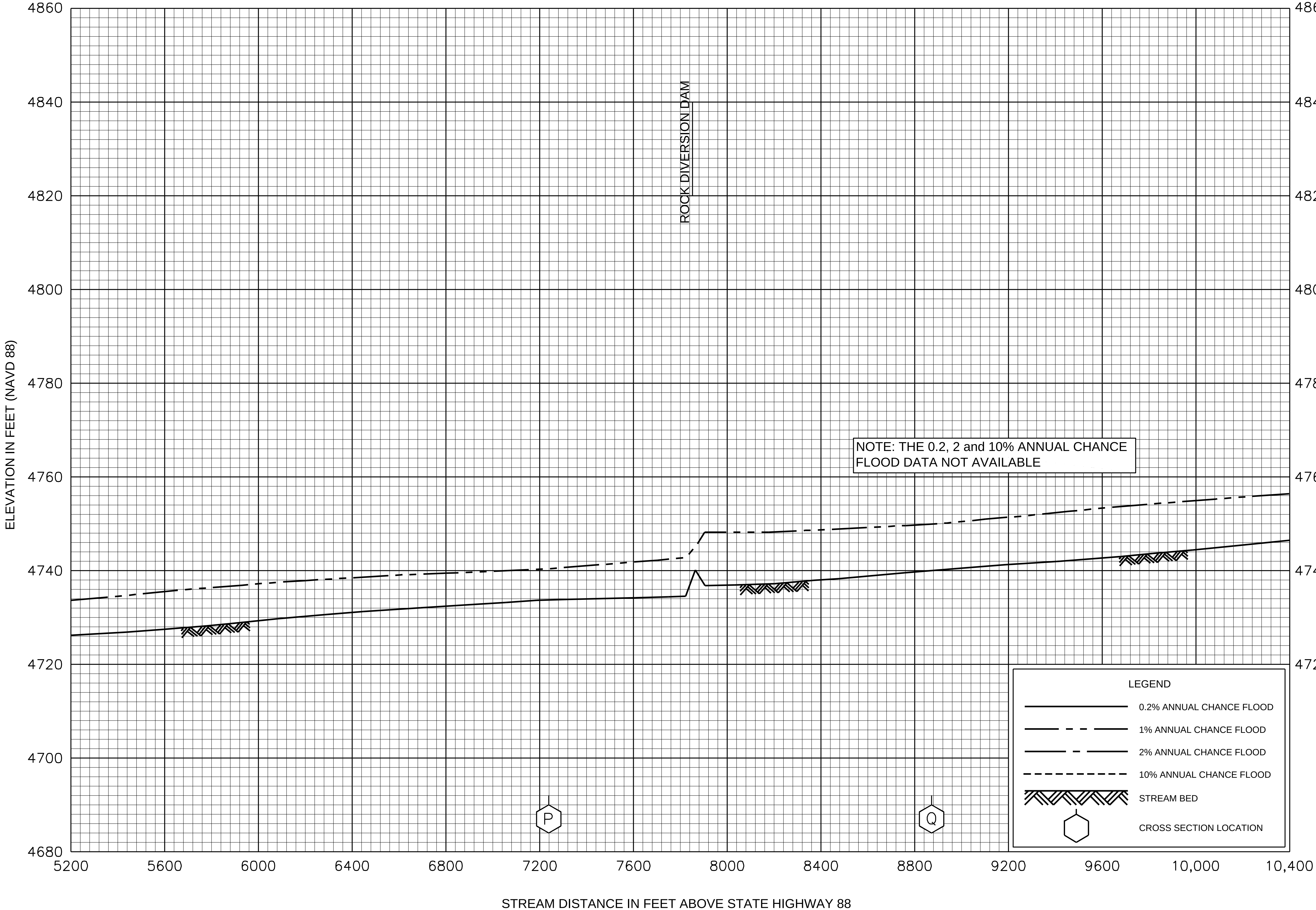
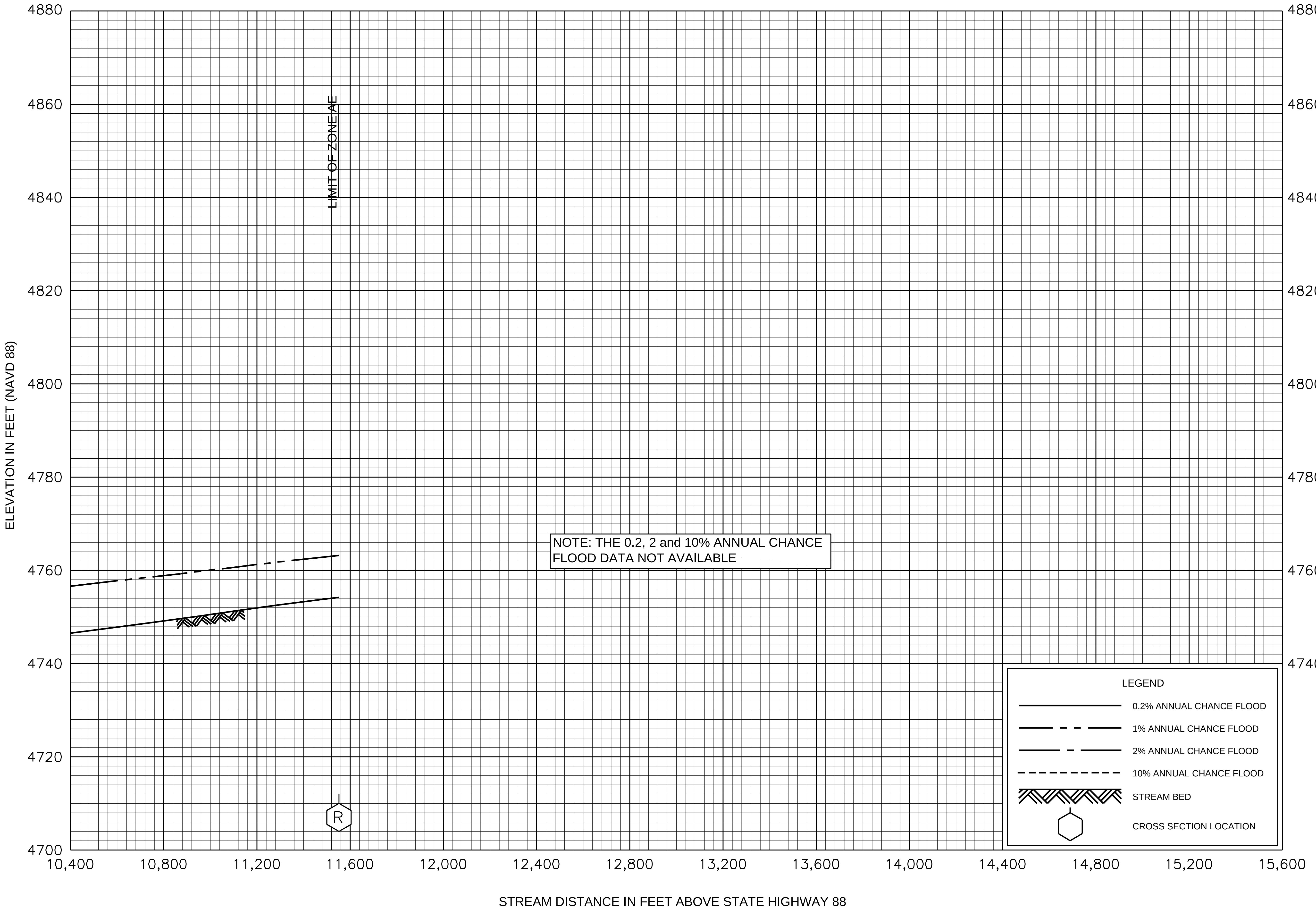


FLOOD PROFILES

EAST FORK CARSON RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV
AND INCORPORATED AREAS



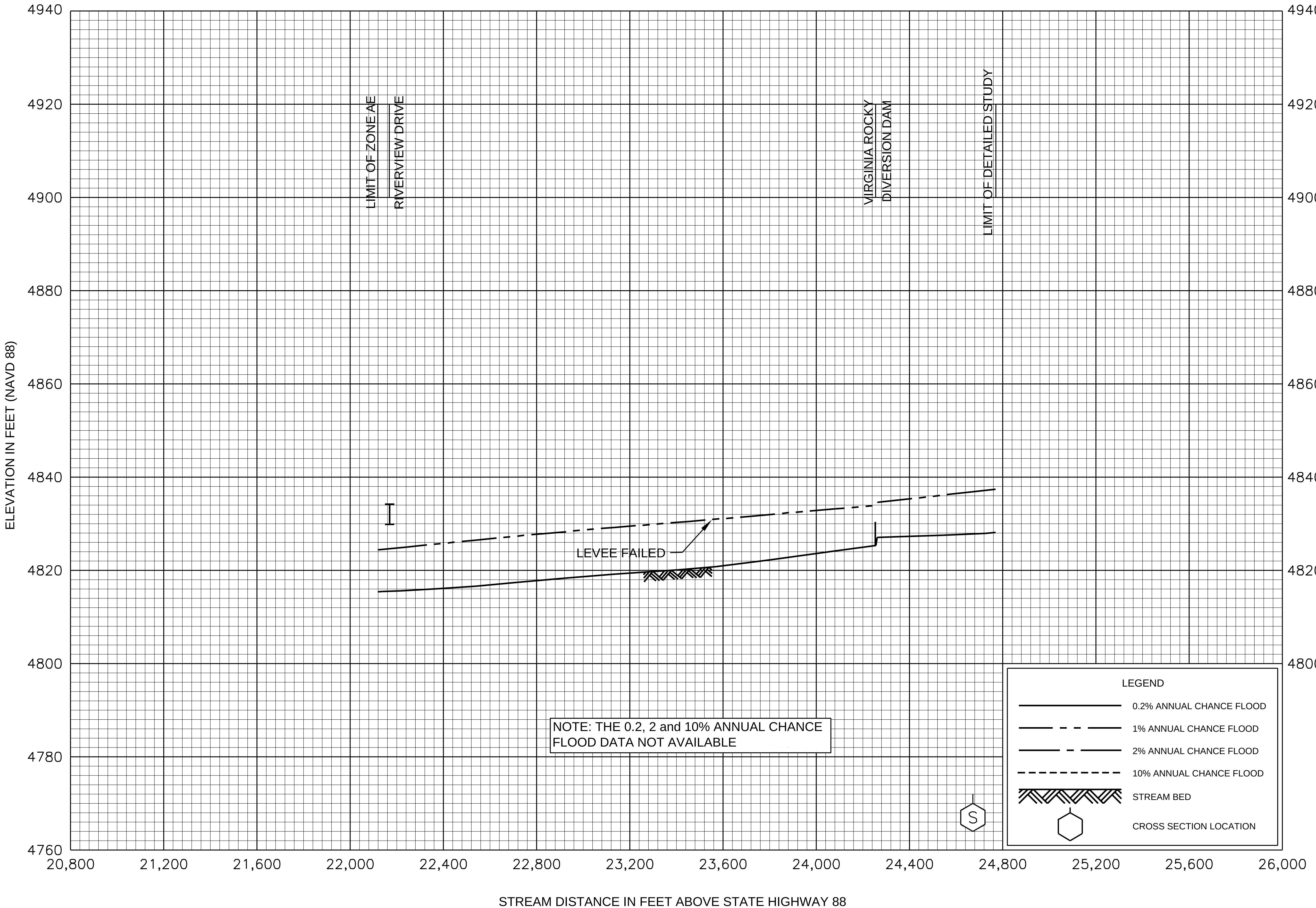
FLOOD PROFILES

EAST FORK CARSON RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV

AND INCORPORATED AREAS

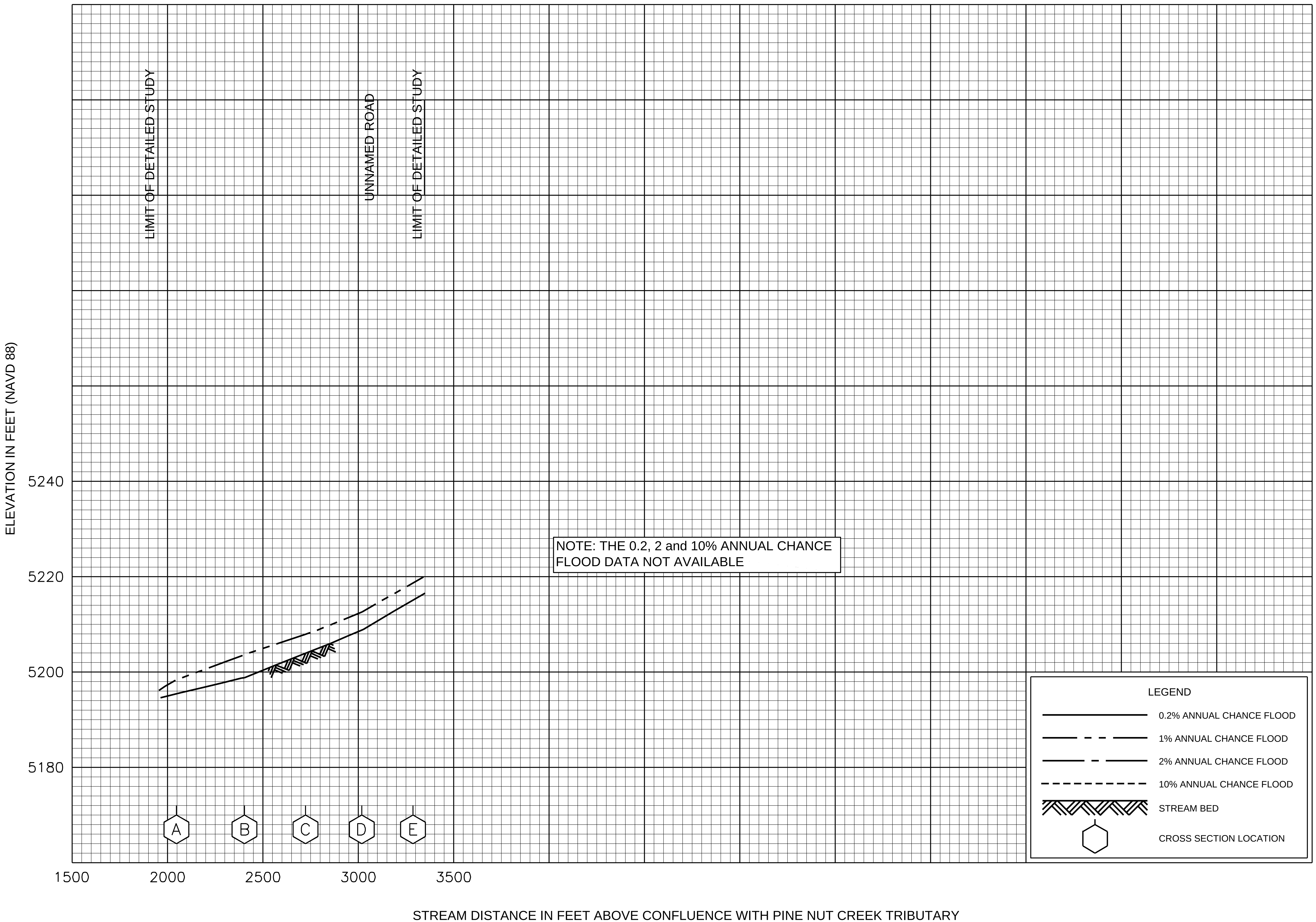


FLOOD PROFILES

EAST FORK CARSON RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV
AND INCORPORATED AREAS



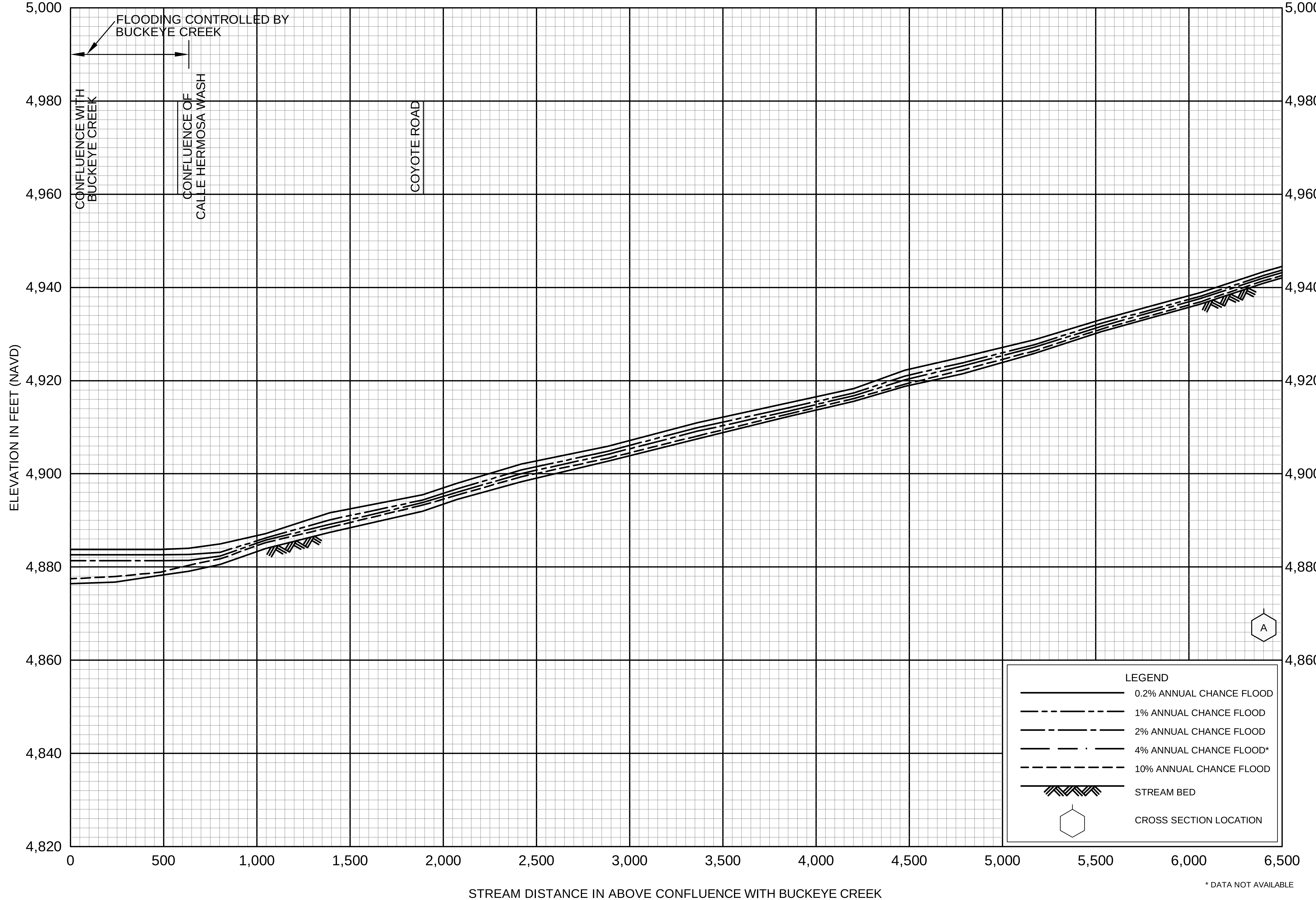
FLOOD PROFILES

FISH SPRINGS CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV

AND INCORPORATED AREAS



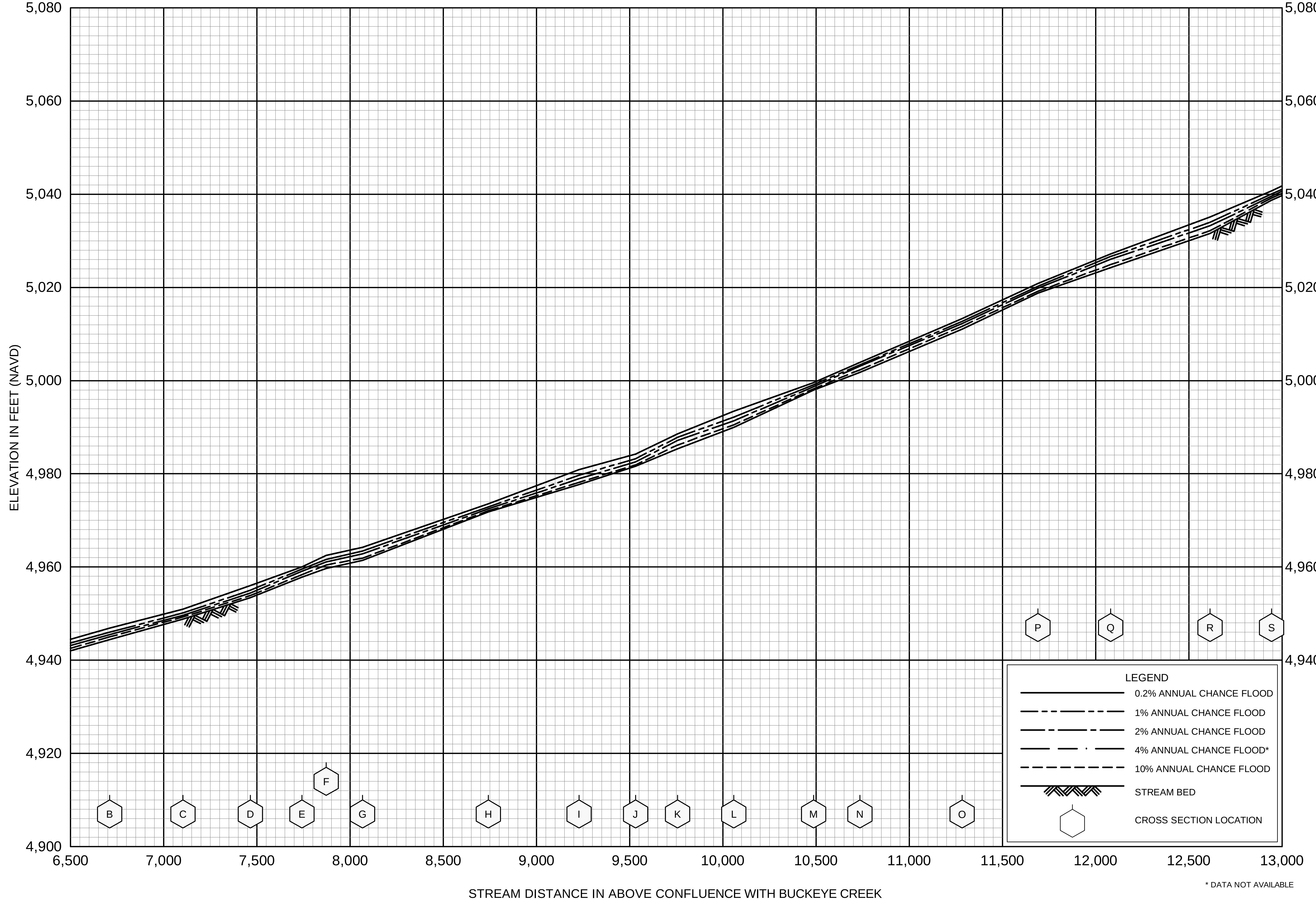
FLOOD PROFILES

JUNIPER ROAD WASH

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV

AND INCORPORATED AREAS



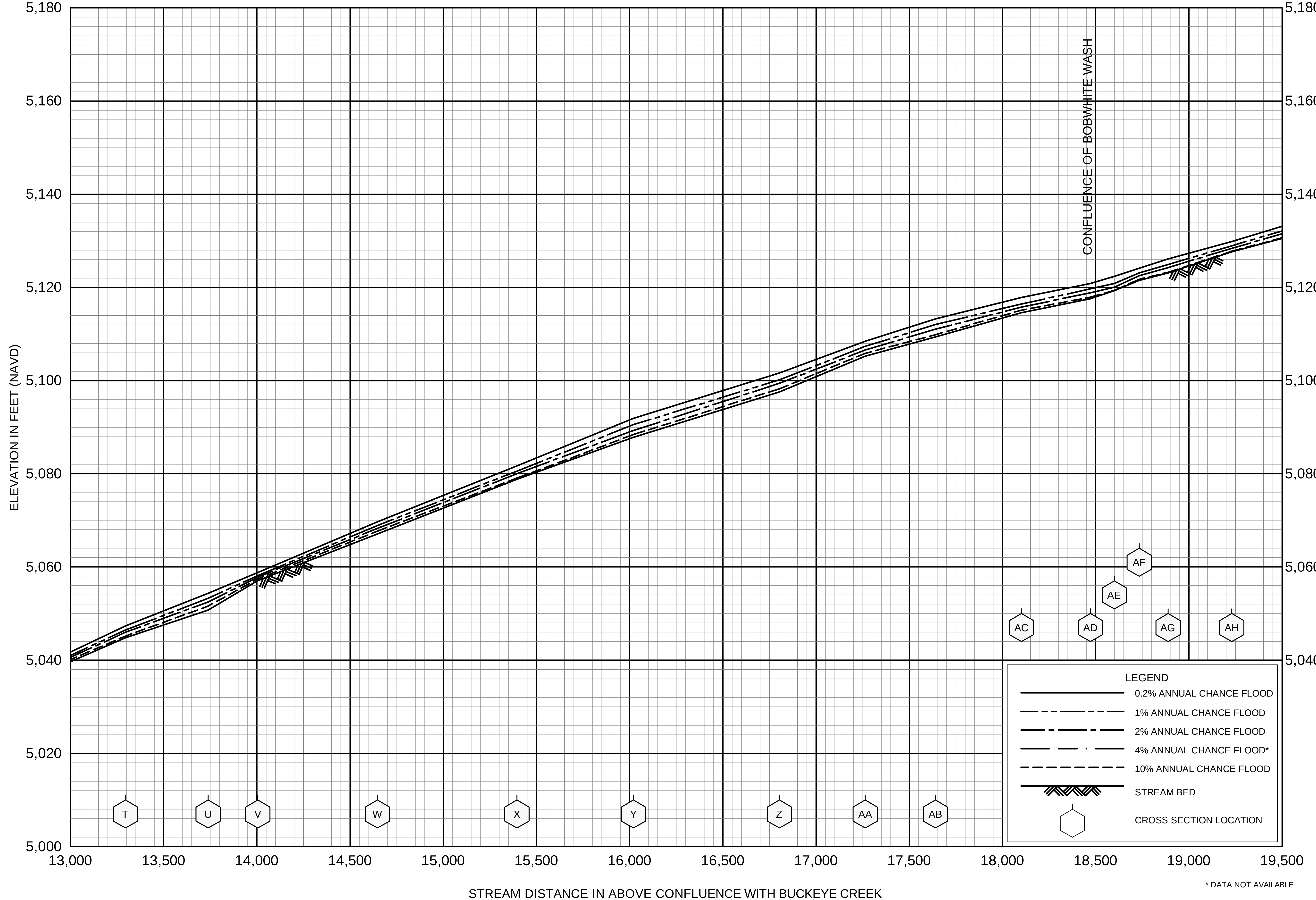
FLOOD PROFILES

JUNIPER ROAD WASH

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV

AND INCORPORATED AREAS



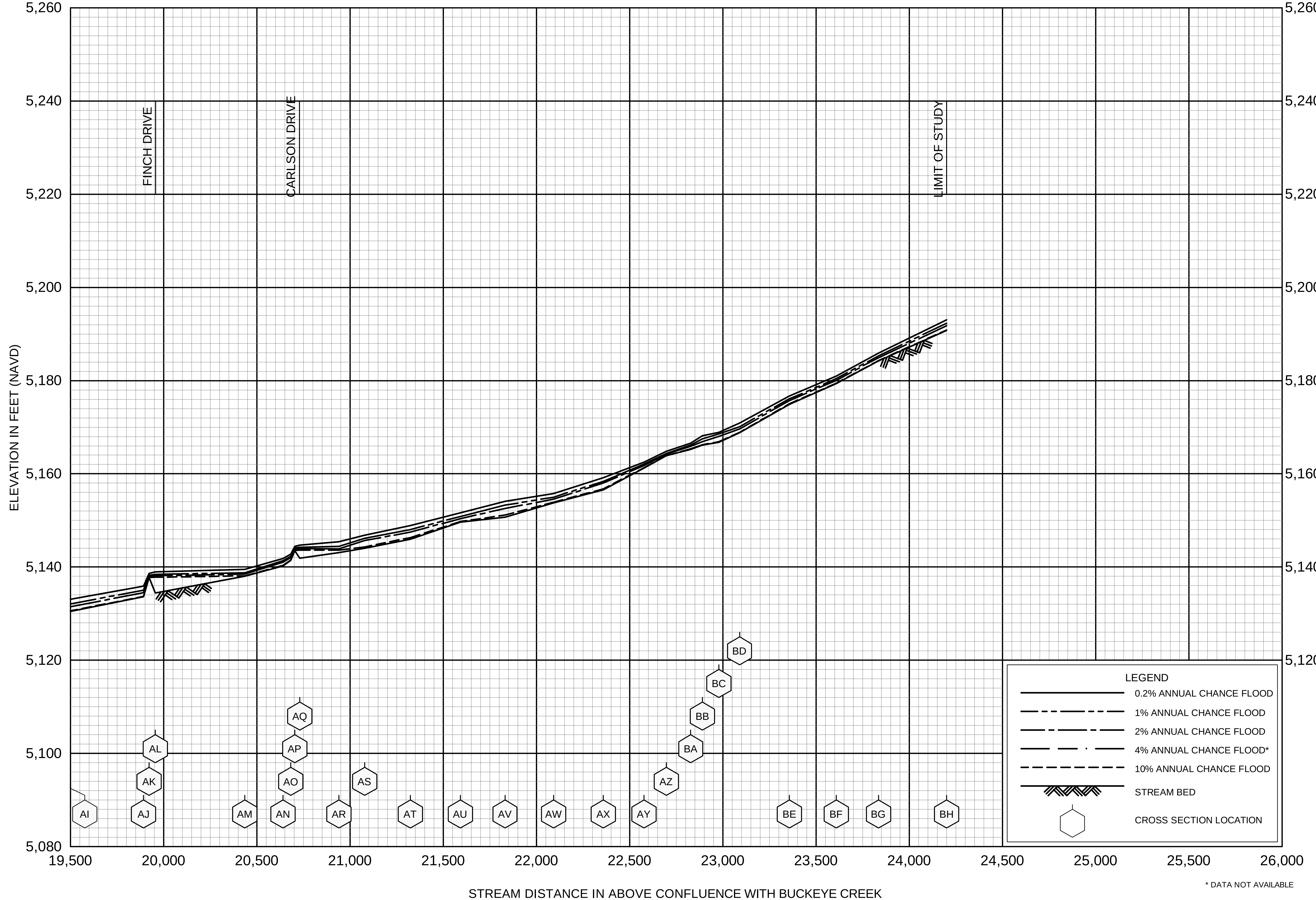
FLOOD PROFILES

JUNIPER ROAD WASH

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV

AND INCORPORATED AREAS



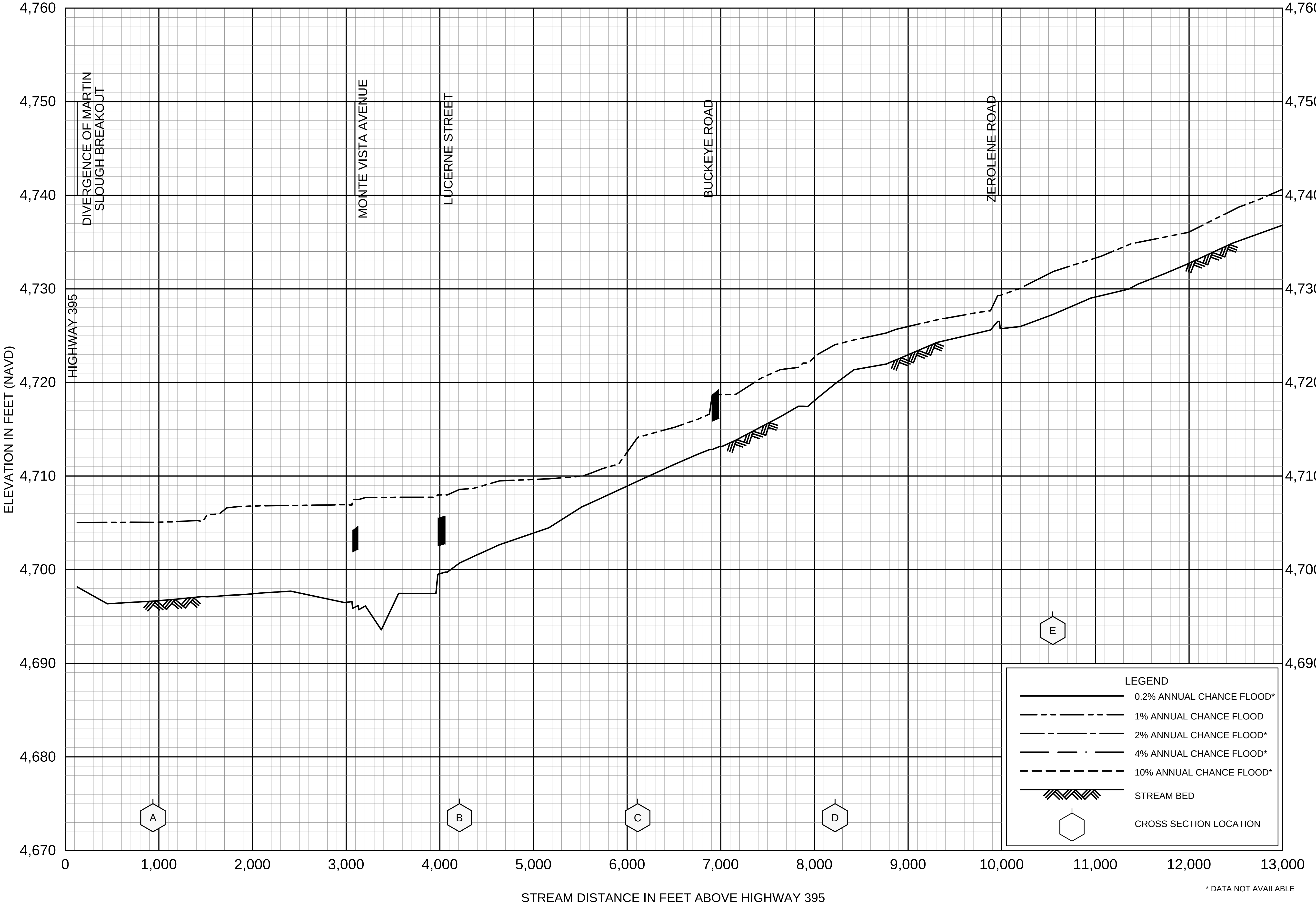
FLOOD PROFILES

JUNIPER ROAD WASH

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV

AND INCORPORATED AREAS



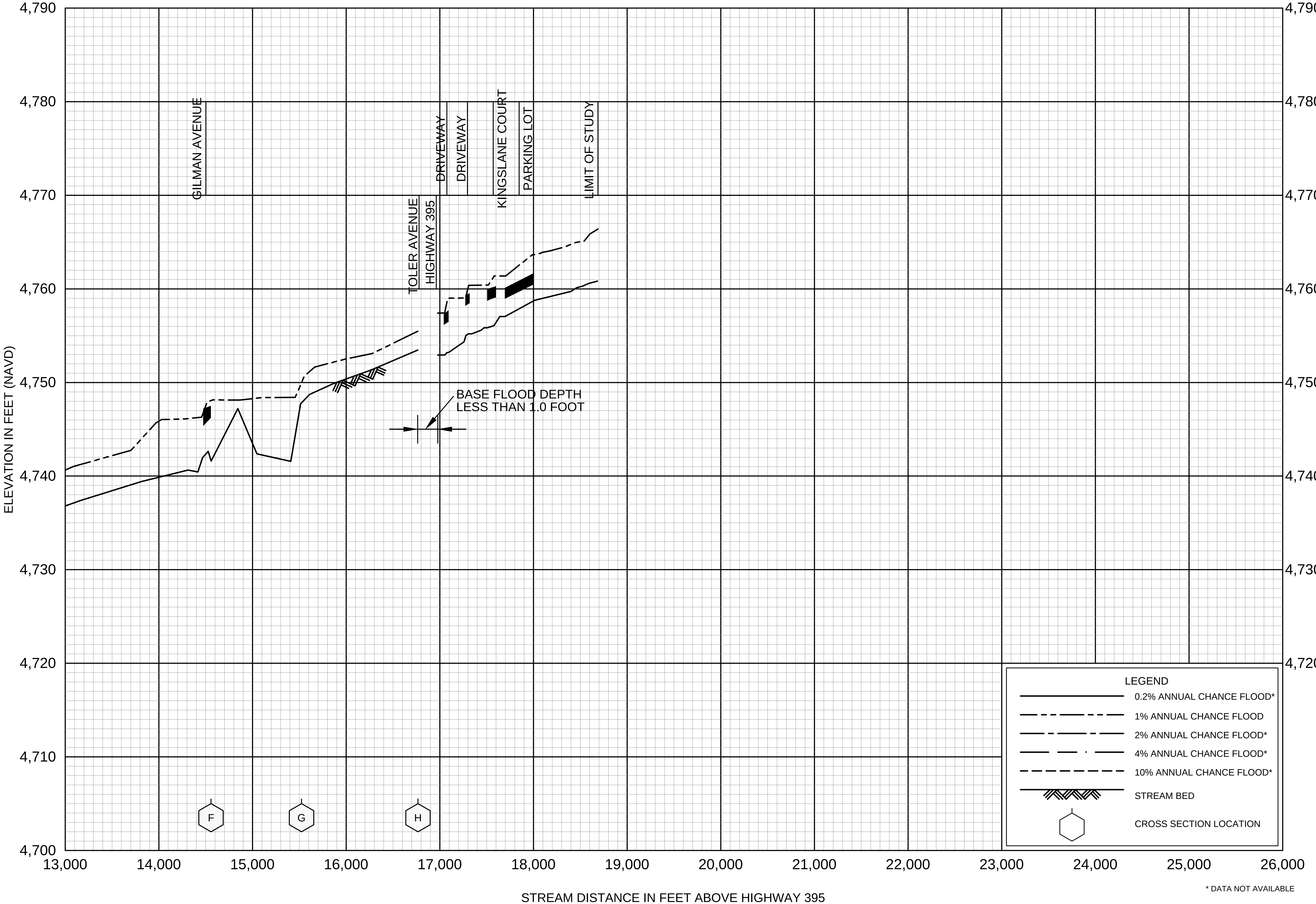
FLOOD PROFILES

MARTIN SLOUGH

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV

AND INCORPORATED AREAS



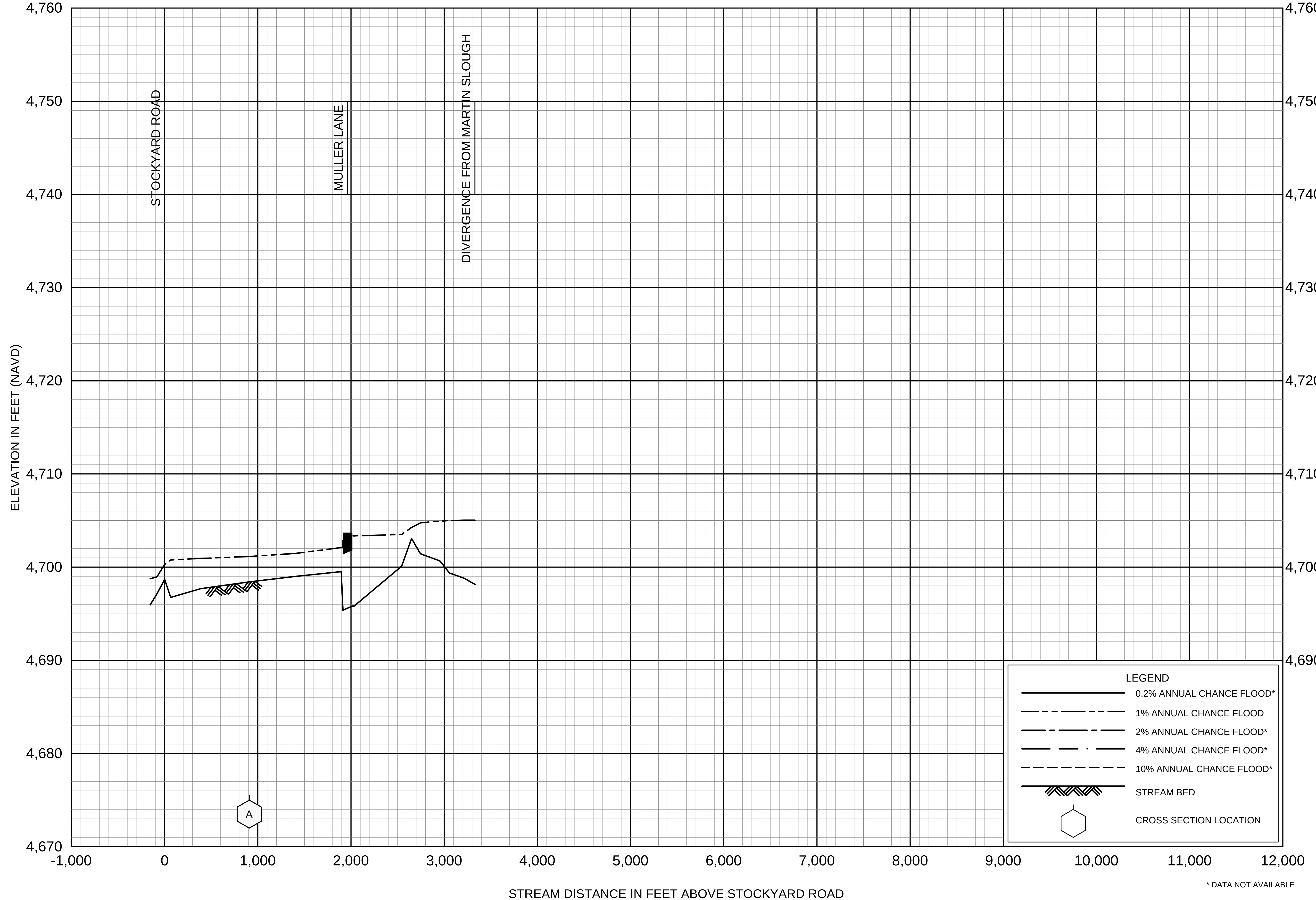
FLOOD PROFILES

MARTIN SLOUGH

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV

AND INCORPORATED AREAS



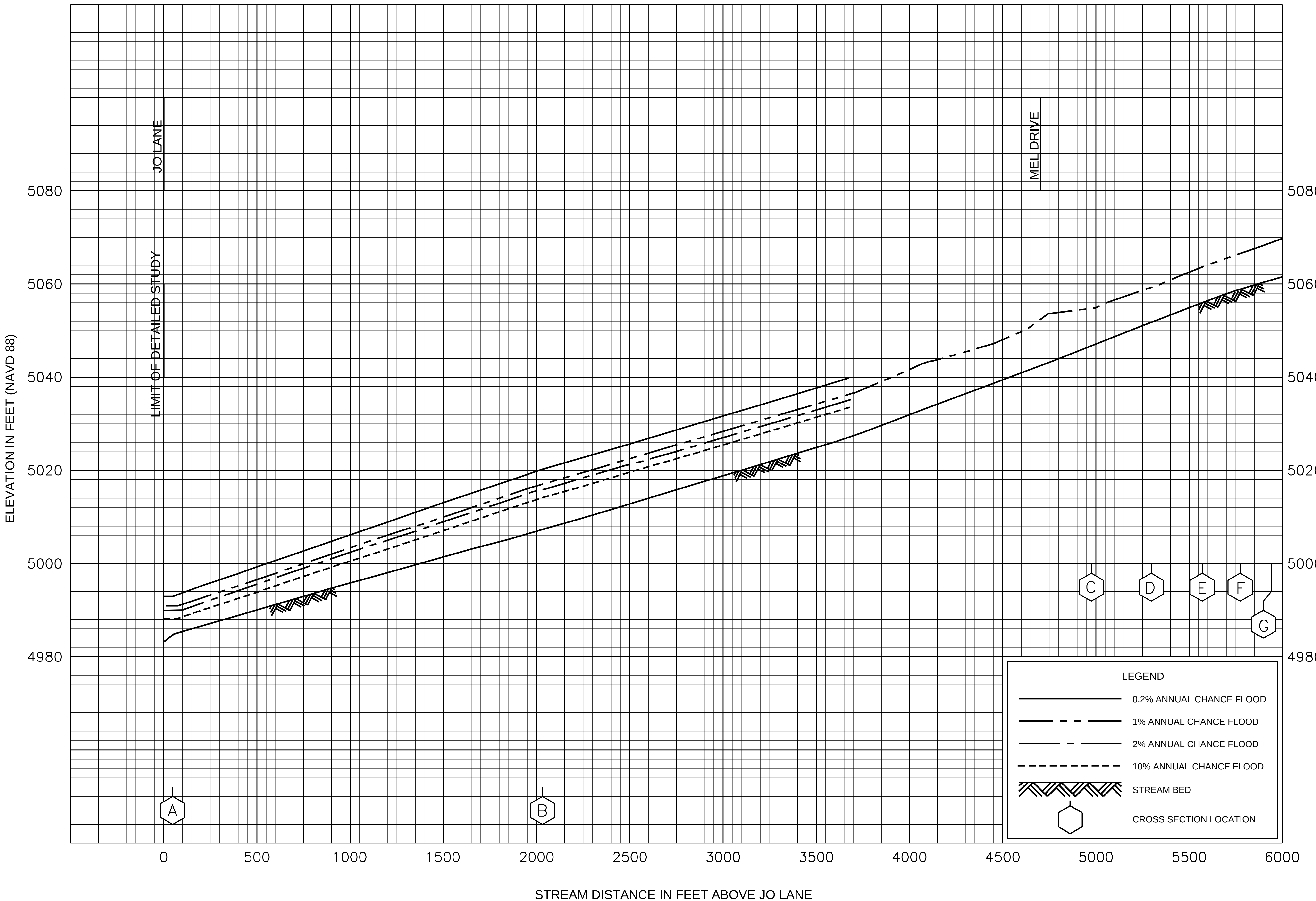
FLOOD PROFILES

MARTIN SLOUGH BREAKOUT

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV

AND INCORPORATED AREAS

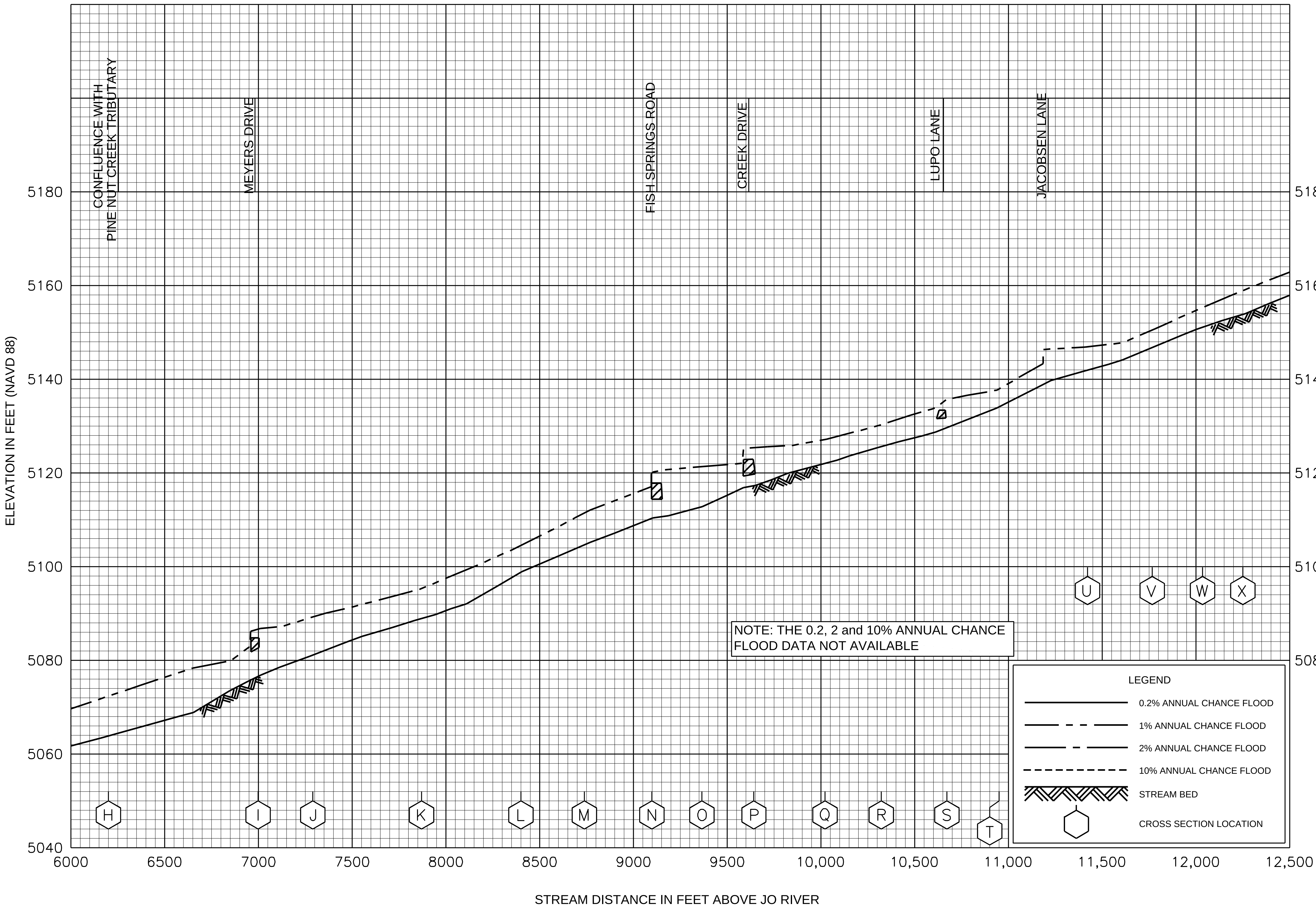


FLOOD PROFILES

PINE NUT CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV
AND INCORPORATED AREAS

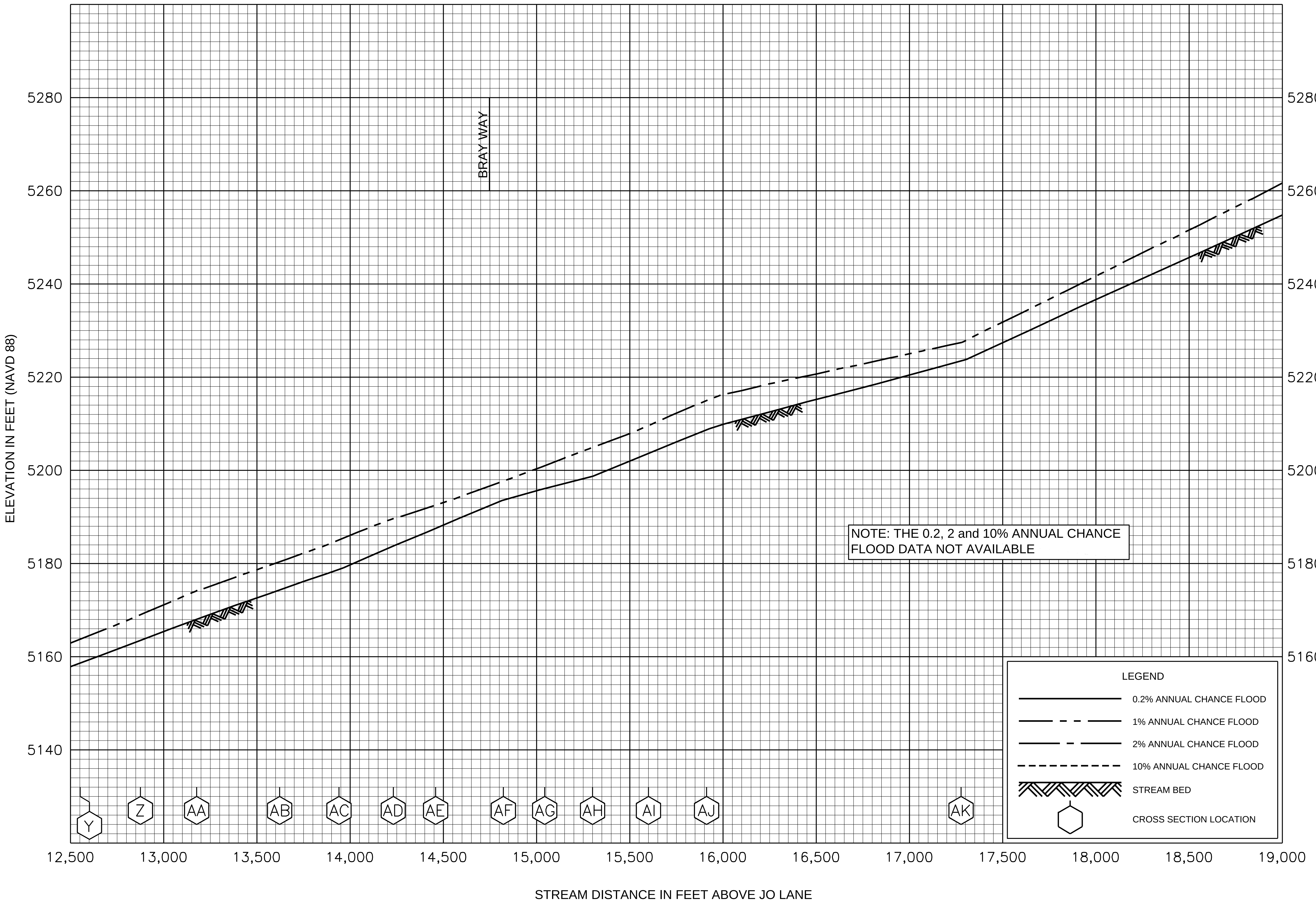


FLOOD PROFILES

PINE NUT CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV
AND INCORPORATED AREAS



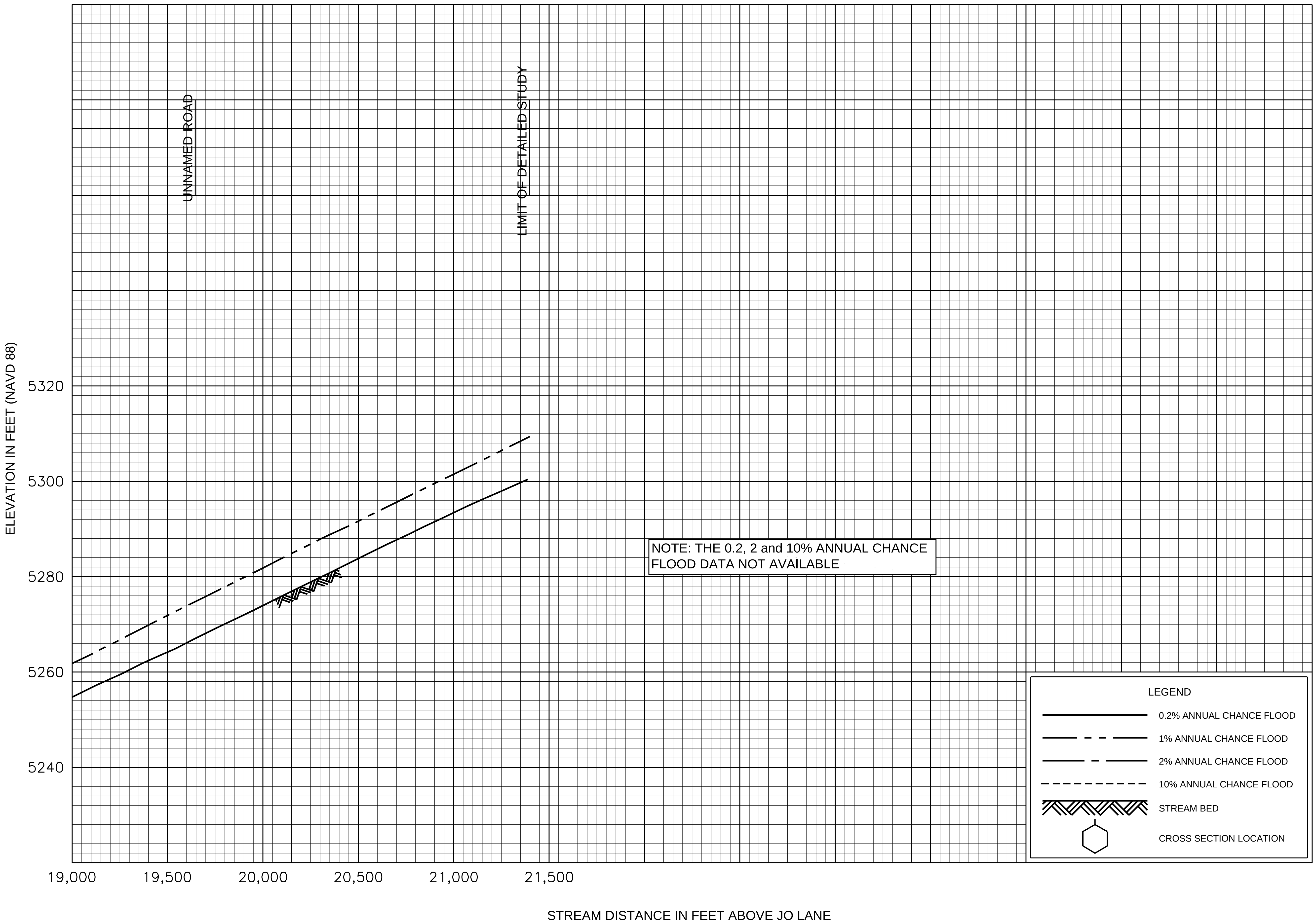
FLOOD PROFILES

PINE NUT CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV
AND INCORPORATED AREAS

37P



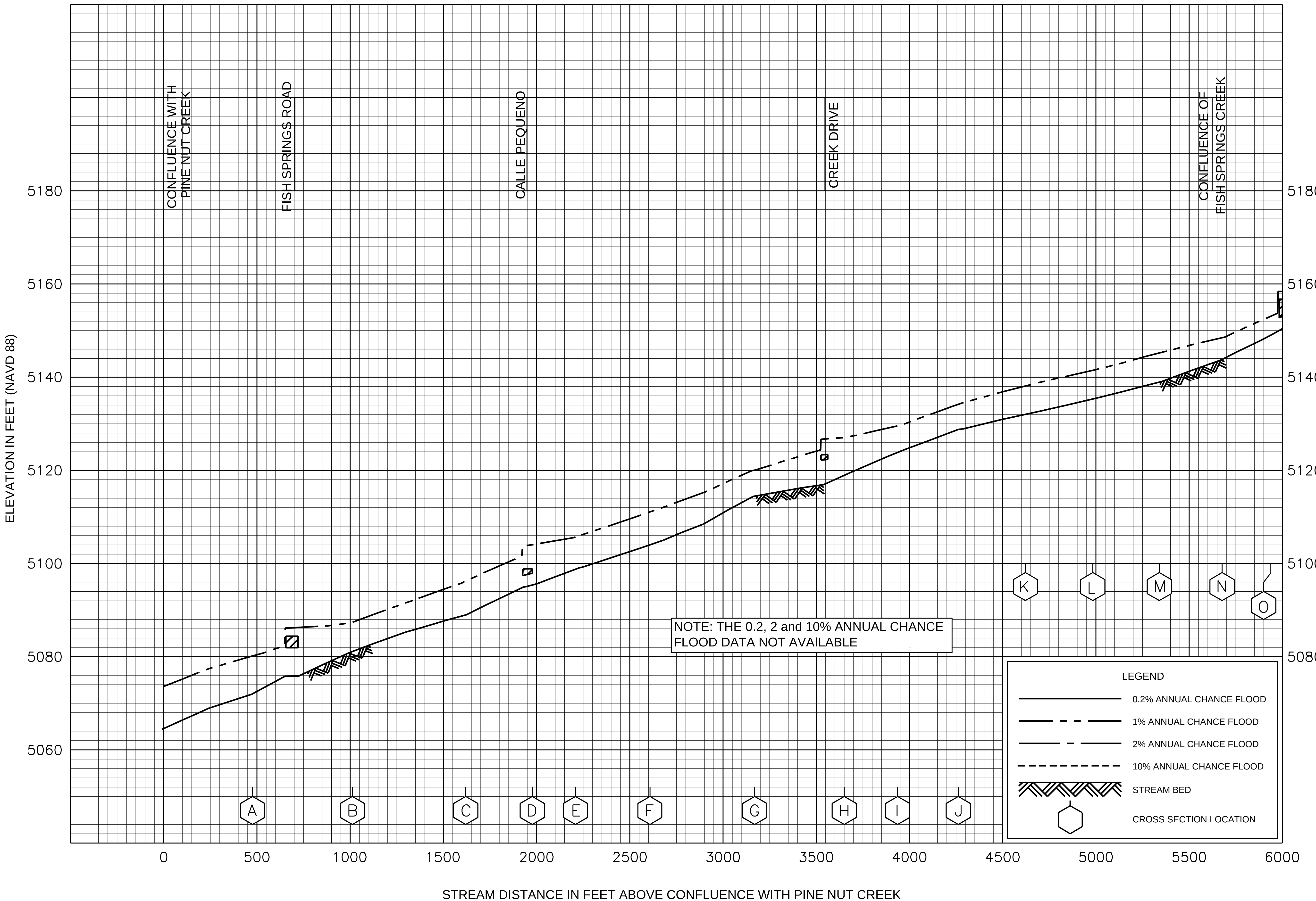
FLOOD PROFILES

PINE NUT CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV

AND INCORPORATED AREAS

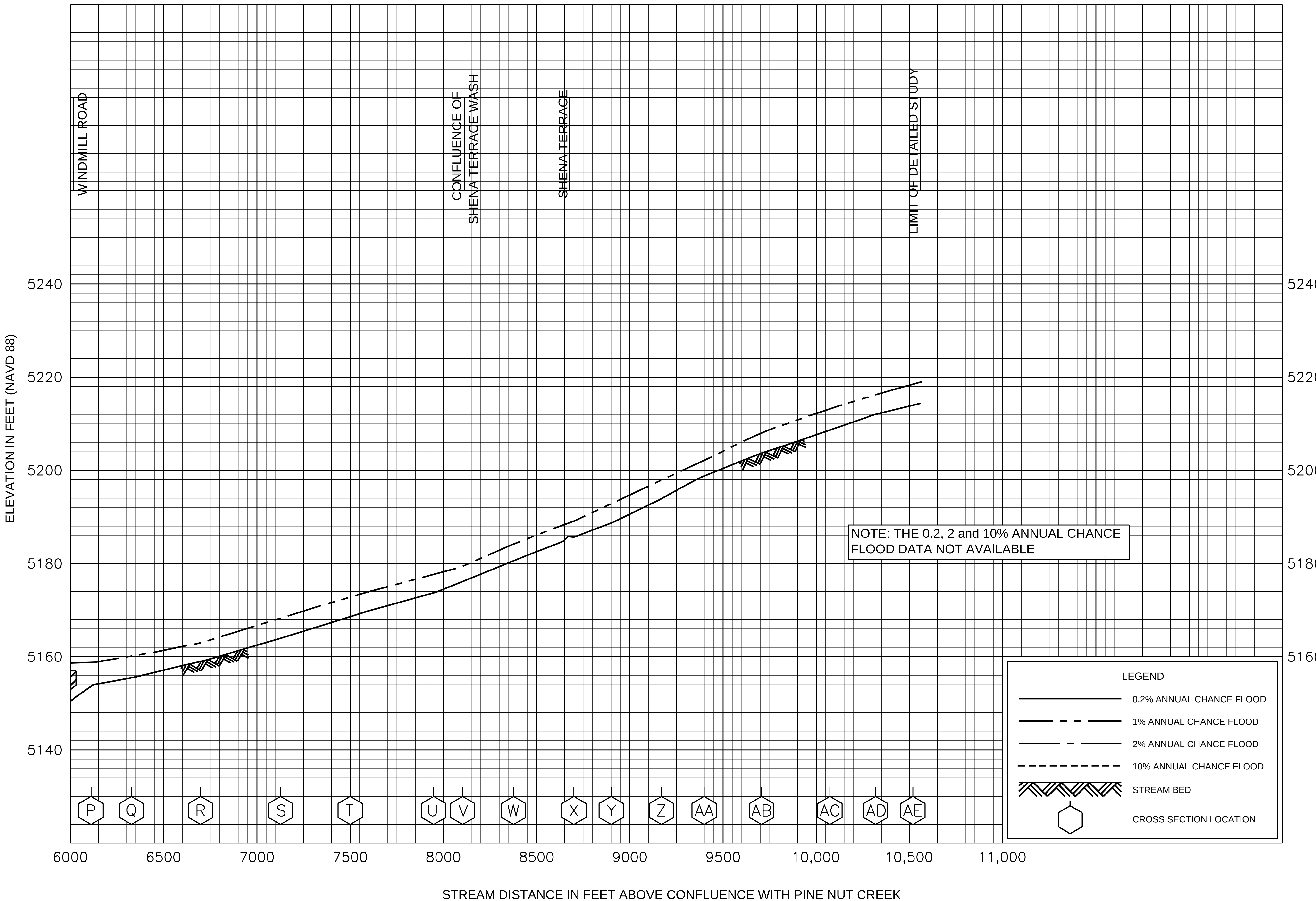


FLOOD PROFILES

PINE NUT CREEK TRIBUTARY

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV
AND INCORPORATED AREAS

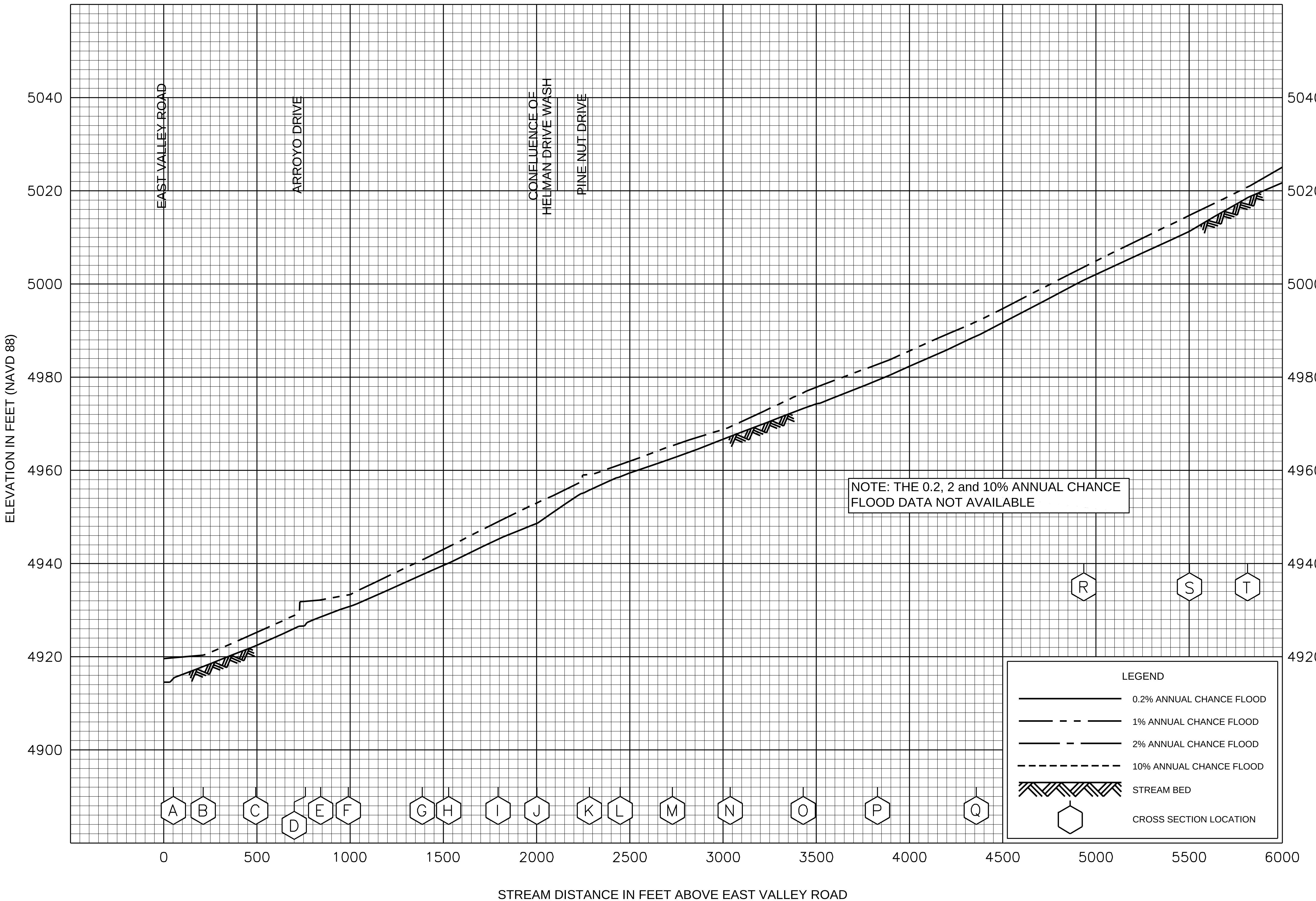


FLOOD PROFILES

PINE NUT CREEK TRIBUTARY

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV
AND INCORPORATED AREAS

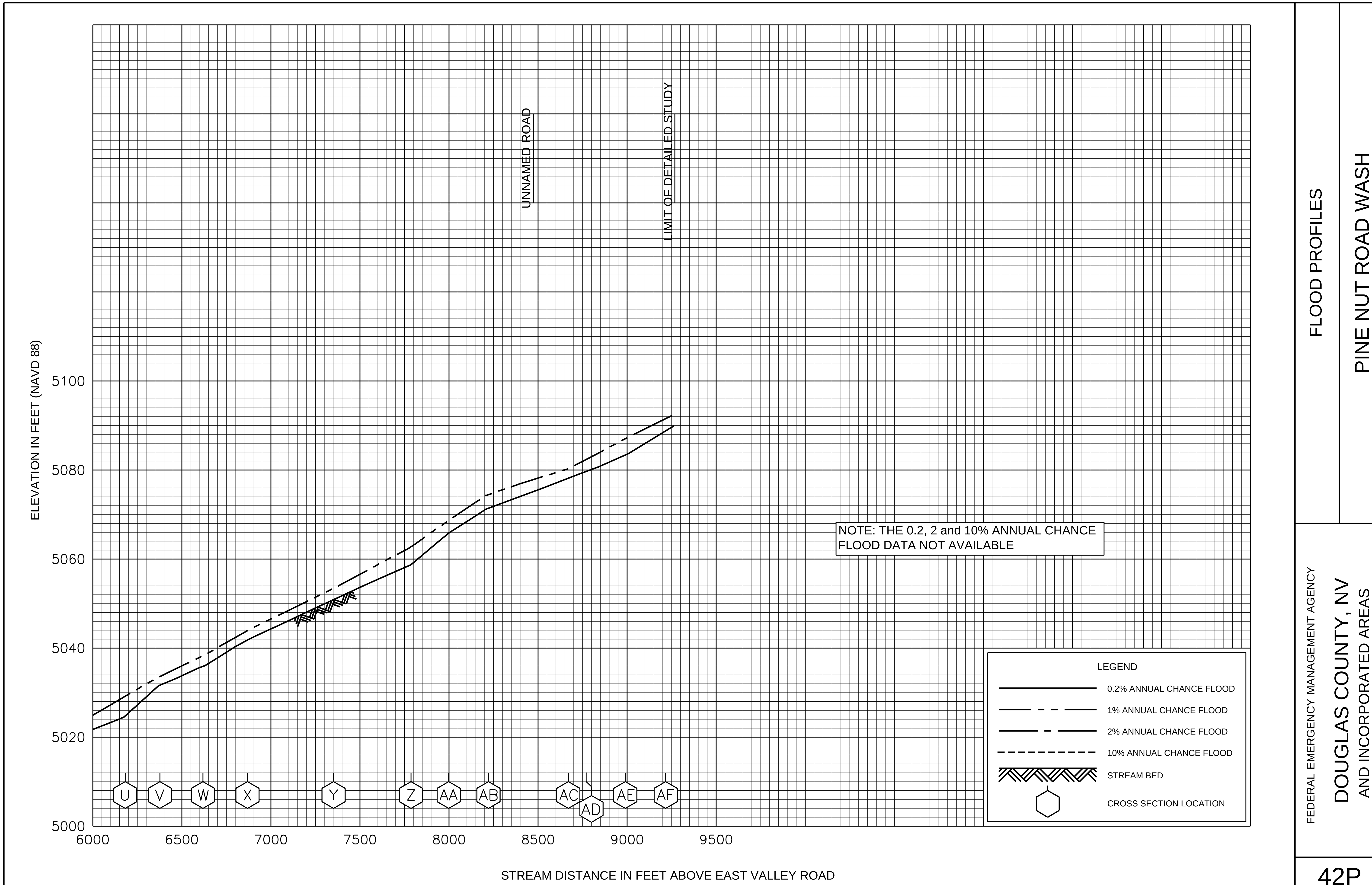


FLOOD PROFILES

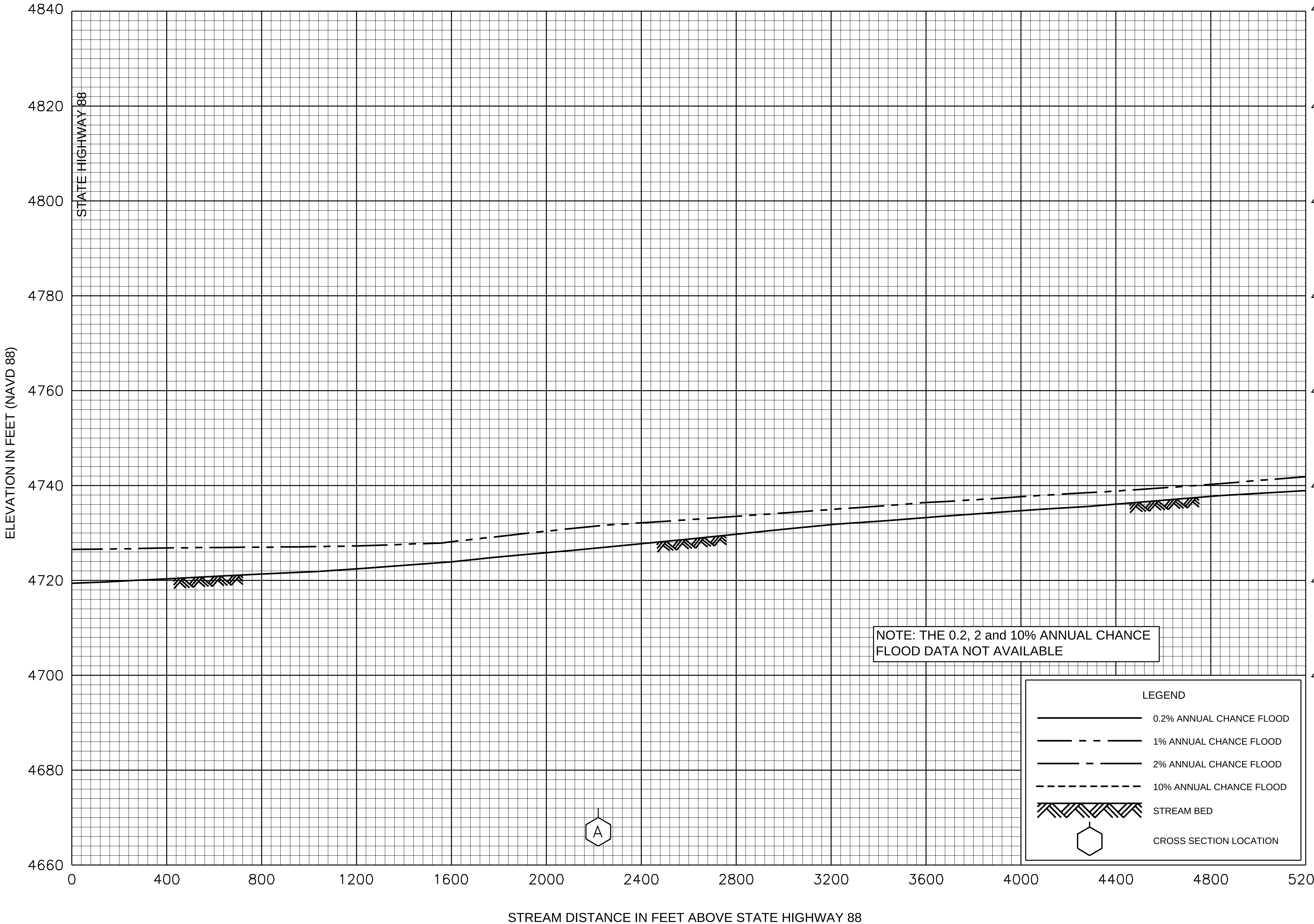
PINE NUT ROAD WASH

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV AND INCORPORATED AREAS



FLOOD PROFILES
PINE NUT ROAD WASH
FEDERAL EMERGENCY MANAGEMENT AGENCY
DOUGLAS COUNTY, NV
AND INCORPORATED AREAS
42P
ELEVATION IN FEET (NAVD 88)
STREAM DISTANCE IN FEET ABOVE EAST VALLEY ROAD
5000
5020
5040
5060
5080
5100
6000
6500
7000
7500
8000
8500
9000
9500
UNNAMED ROAD
LIMIT OF DETAILED STUDY
NOTE: THE 0.2, 2 and 10% ANNUAL CHANCE FLOOD DATA NOT AVAILABLE
LEGEND
0.2% ANNUAL CHANCE FLOOD
1% ANNUAL CHANCE FLOOD
2% ANNUAL CHANCE FLOOD
10% ANNUAL CHANCE FLOOD
STREAM BED
CROSS SECTION LOCATION
U
V
W
X
Y
Z
AA
AB
AC
AD
AE
AF

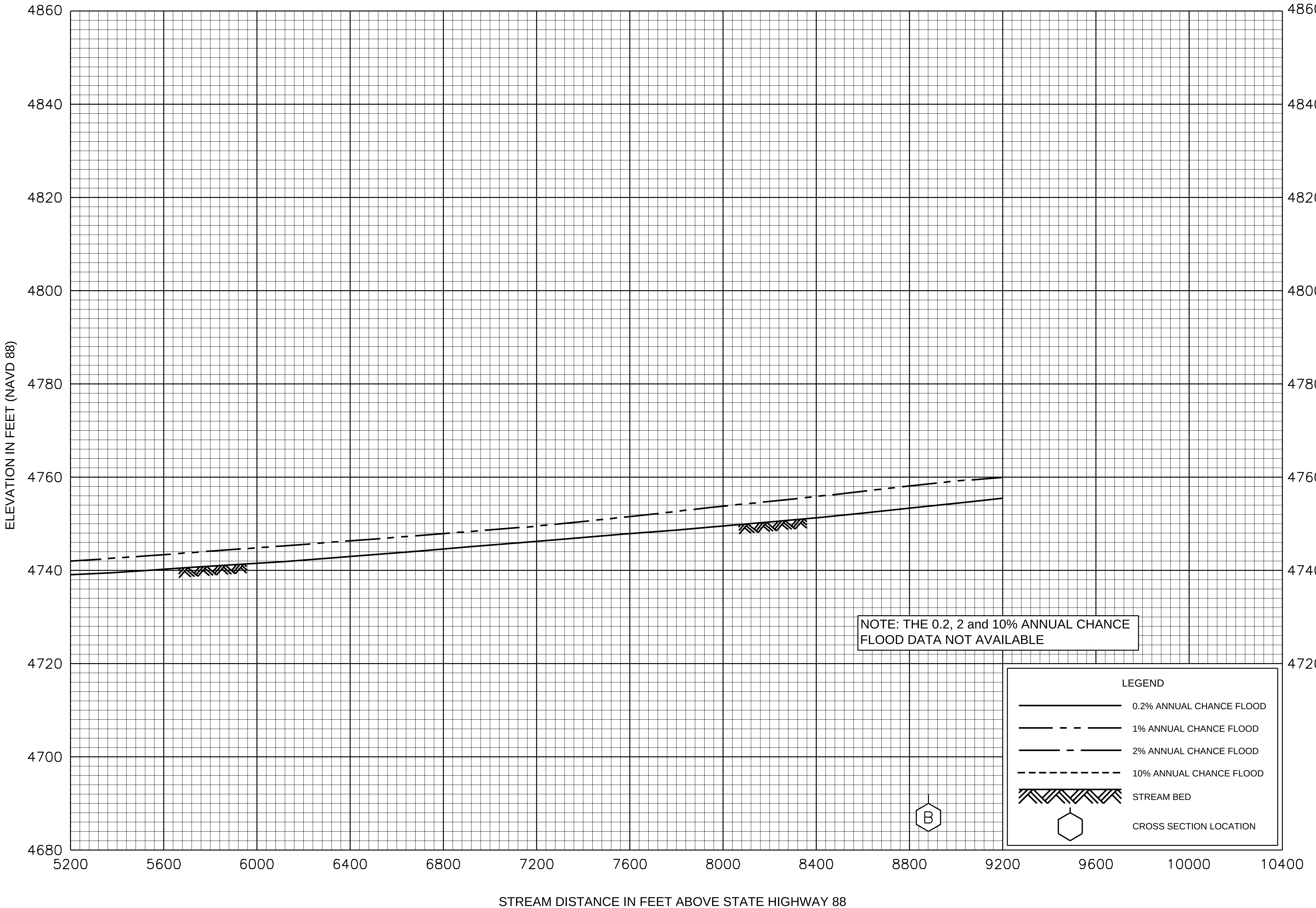


FLOOD PROFILES

ROCKY SLOUGH

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV
AND INCORPORATED AREAS

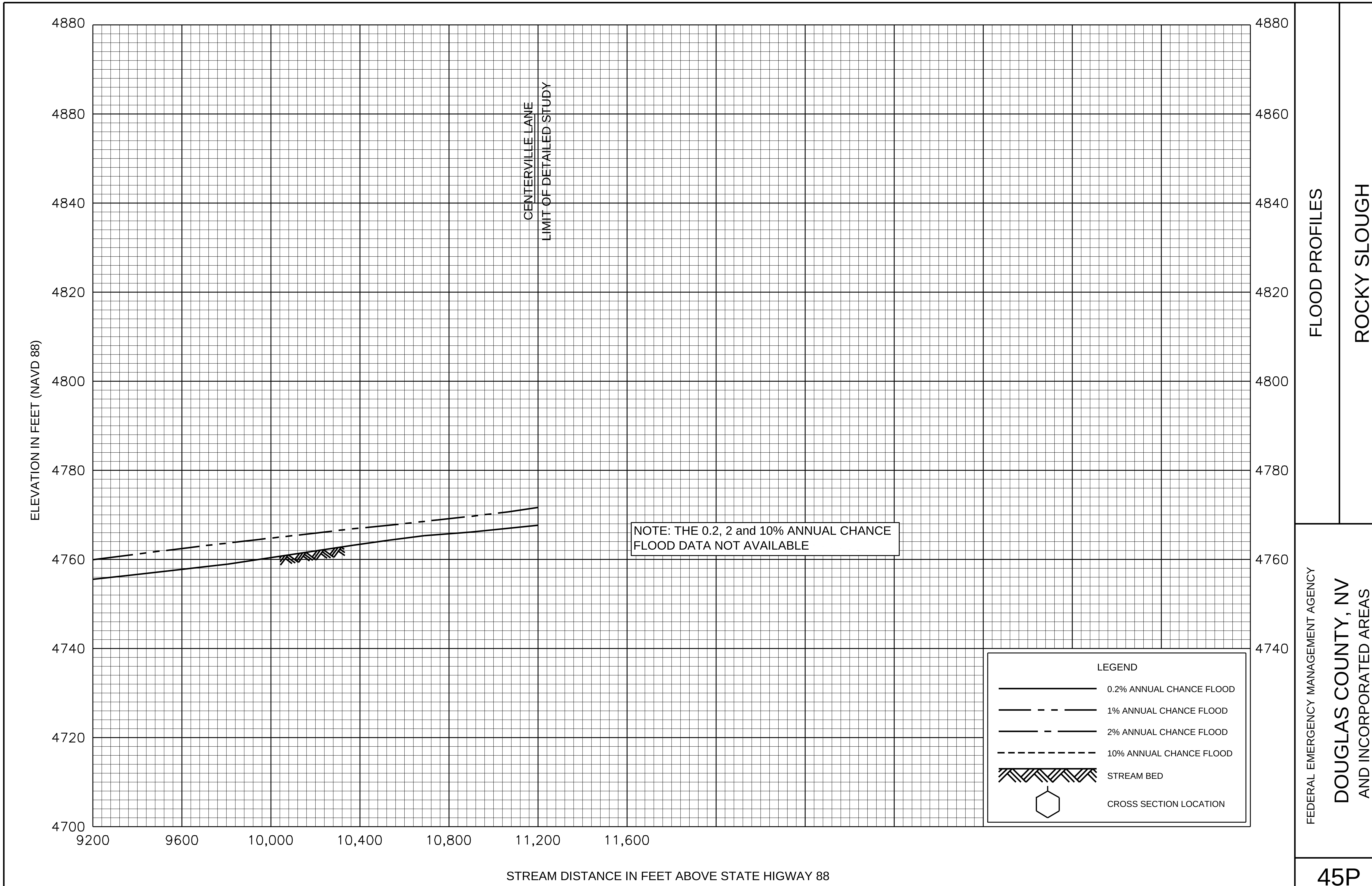


FLOOD PROFILES

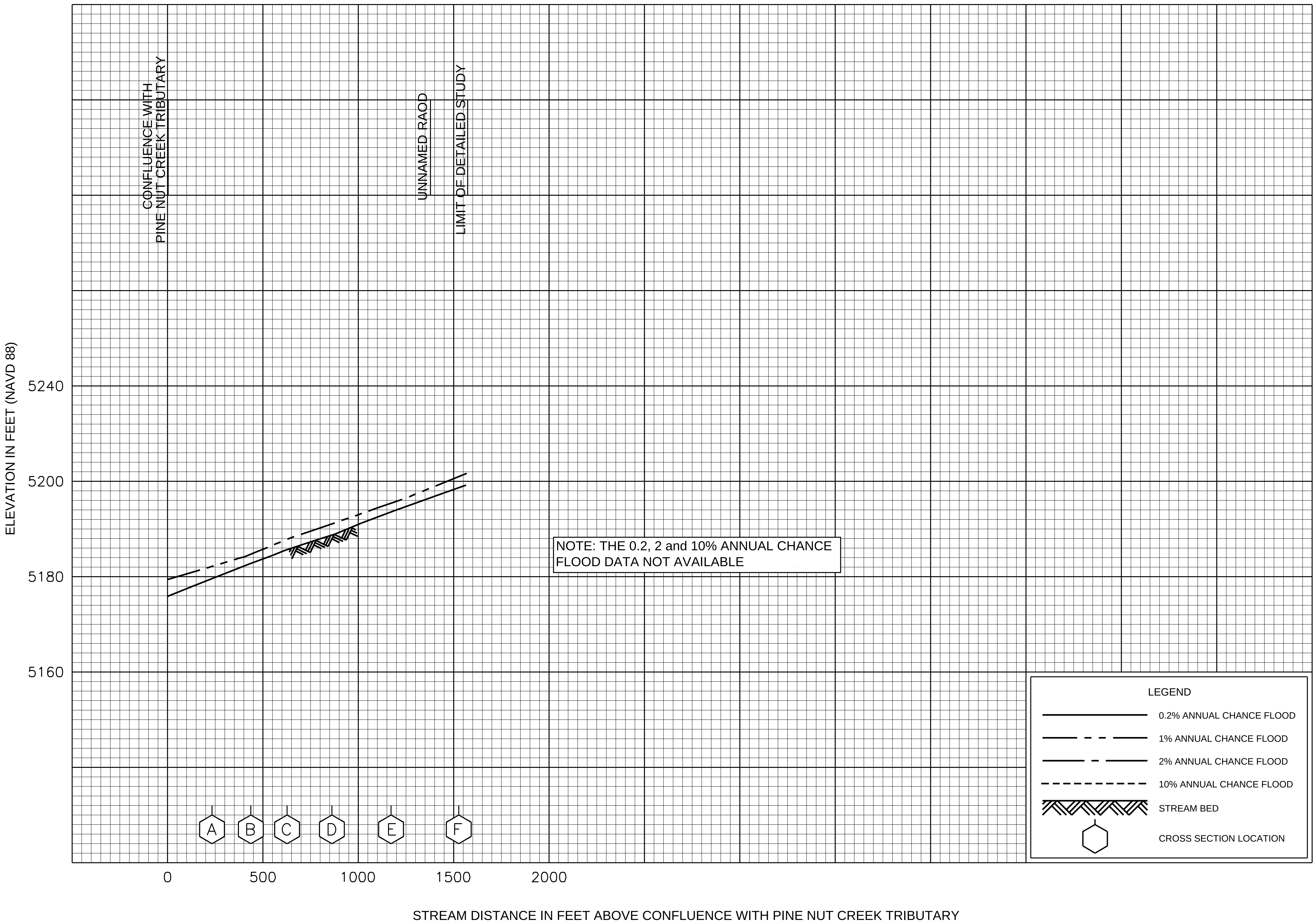
ROCKY SLOUGH

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV
AND INCORPORATED AREAS



ELEVATION IN FEET (NAVD 88)
4880
4880
4840
4820
4800
4780
4760
4740
4720
4700
4880
4860
4840
4820
4800
4780
4760
4740
9200
9600
10,000
10,400
10,800
11,200
11,600
STREAM DISTANCE IN FEET ABOVE STATE HIGWAY 88
CENTERVILLE LANE
LIMIT OF DETAILED STUDY
NOTE: THE 0.2, 2 and 10% ANNUAL CHANCE FLOOD DATA NOT AVAILABLE
LEGEND
0.2% ANNUAL CHANCE FLOOD
1% ANNUAL CHANCE FLOOD
2% ANNUAL CHANCE FLOOD
10% ANNUAL CHANCE FLOOD
STREAM BED
CROSS SECTION LOCATION
FLOOD PROFILES
ROCKY SLOUGH
FEDERAL EMERGENCY MANAGEMENT AGENCY
DOUGLAS COUNTY, NV
AND INCORPORATED AREAS

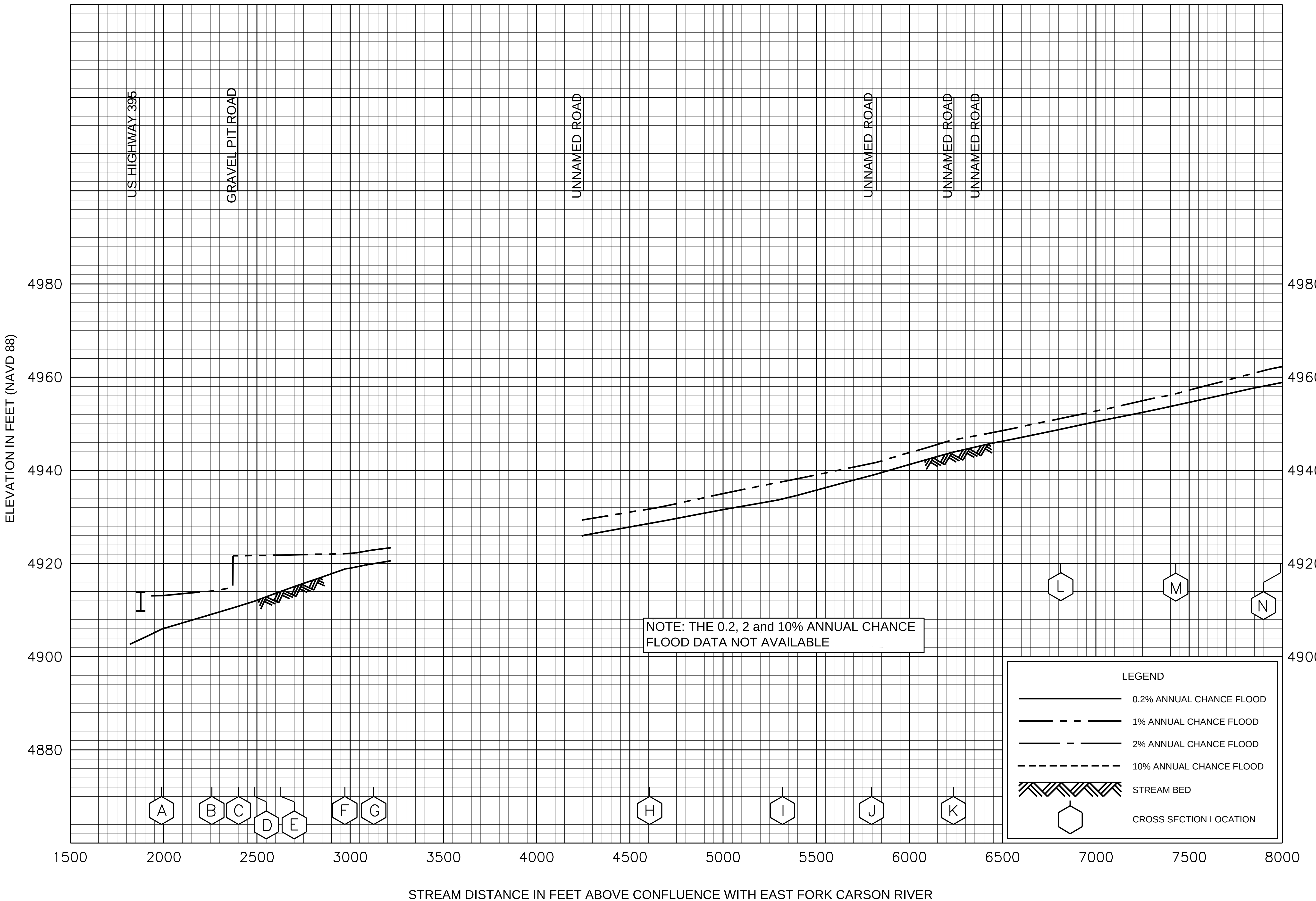


FLOOD PROFILES

SHENA TERRACE WASH

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV
AND INCORPORATED AREAS



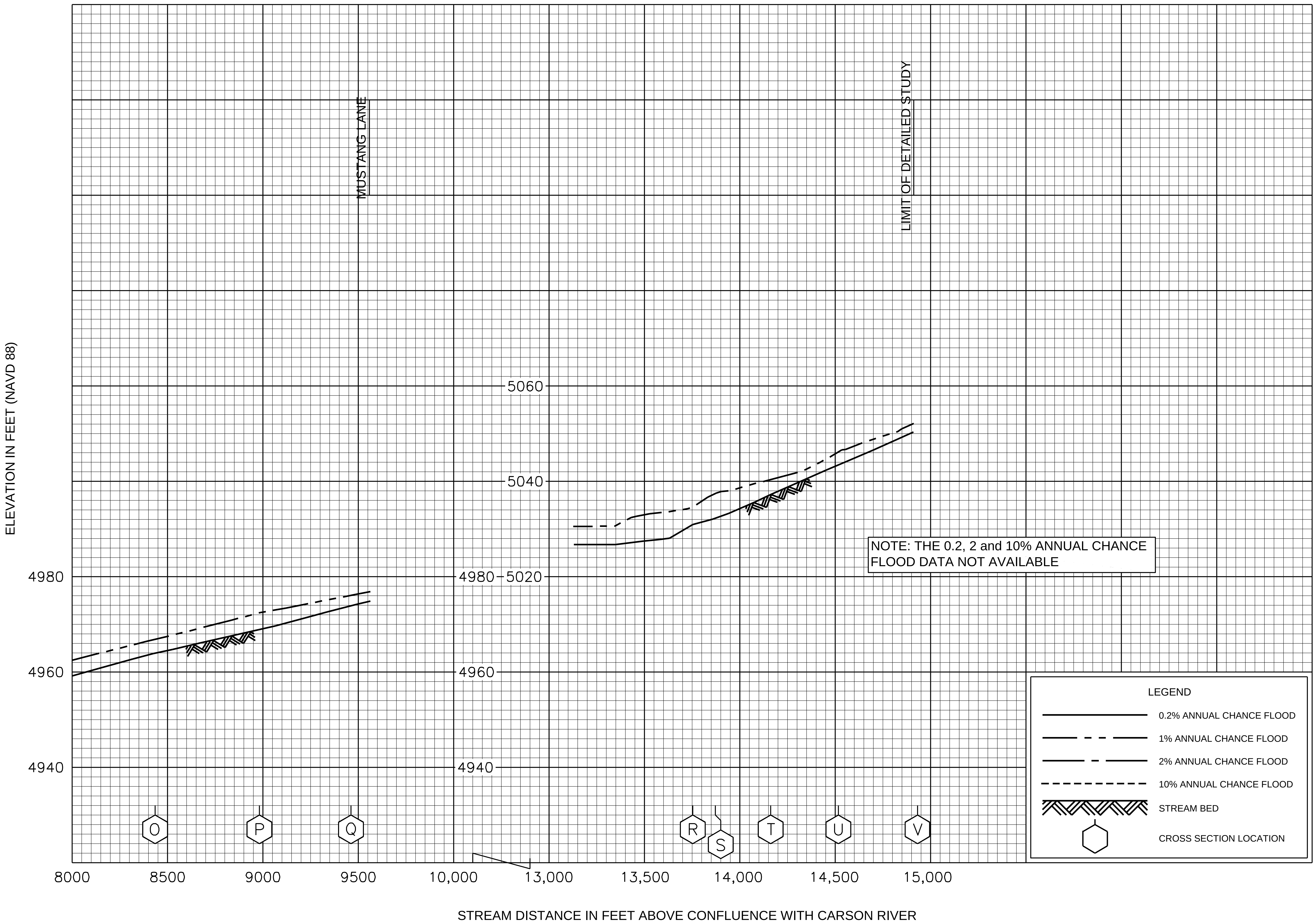
FLOOD PROFILES

SMELTER CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV

AND INCORPORATED AREAS



FLOOD PROFILES

SMELTER CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

DOUGLAS COUNTY, NV
AND INCORPORATED AREAS

48P