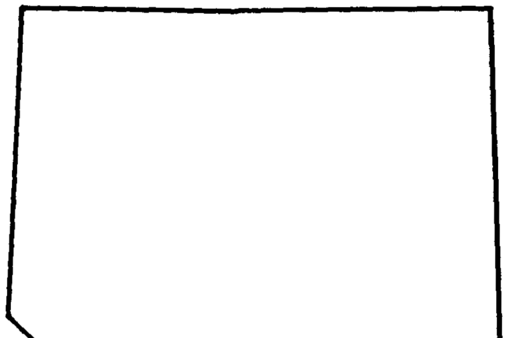
FLOOD INSURANCE STUDY

CLARK COUNTY, NEVADA AND INCORPORATED AREAS



COMMUNITY NAME	COMMUNITY NUMBER
BOULDER CITY, CITY OF	320004
CLARK COUNTY UNINCORPORATED AREAS	320003
HENDERSON, CITY OF	320005
LAS VEGAS, CITY OF	325276
MESQUITE, CITY OF	320035
NORTH LAS VEGAS, CITY OF	320007

AUGUST 16, 1995

Federal Emergency Management Agency

NOTICE TO
FLOOD INSURANCE STUDY USERS

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

This publication incorporates revisions to the original Flood Insurance Study. These revisions are presented in Section 10.0.

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PUBLISHED SEPARATELY:

FLOOD INSURANCE STUDY
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1.0 INTRODUCTION

1.1 Purpose of Study

The Flood Insurance Study revises and updates information on the existence and severity of flood hazards in the geographic area of Clark County, including the Cities of Boulder City, Henderson, Las Vegas, Mesquite, and North Las Vegas, and the unincorporated areas of Clark County (referred to collectively herein as Clark County) and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates and assist the community in its efforts to promote sound floodplain management. Minimum floodplain management requirements for participation in the National Flood Insurance Program (NFIP) are set forth in the Code of Federal Regulations at 44 CFR, 60.3. This information will be used to update existing floodplain regulations as part of the Regular Phase of the NFIP. The information will also be used by local and regional planners to further promote sound land use and floodplain development.

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

1.2 Authority and Acknowledgments

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

The hydrologic and hydraulic analyses for the Flood Insurance Studies for the communities listed in Section 1.1 were performed under contract to the Federal Emergency Management Agency (FEMA). Additional information on the study contractors for each study is provided in Table 1.

1.3 Coordination

The following were contacted for information pertinent to the individual Flood Insurance Studies: U.S. Soil Conservation Service (SCS); Clark County Department of Comprehensive Planning; U.S. Army Corps of Engineers (COE); State of Nevada Division of Emergency Management; U.S. Geological Survey (USGS); the U.S. Bureau of Reclamation (USBR); and The Boulder City News.

Table 1. Flood Insurance Study Contractors

Community Name	Study Contractor	Contract or Interagency Agreement No.	Completion Date
Boulder City, City of	Soil Conservation Service	IAA-H-8-77 Project Order No. 1	November 1978
Clark County (Unincorporated Areas)	James M. Montgomery	EMW-83-C-1197	August 1986
	PRC Engineering	EMW-83-C-1193	March 1986
Henderson, City of	Soil Conservation Service	IAA-H-8-77 Project Order No. 1 Amendment 9	November 1978
Las Vegas, City of	Soil Conservation Service	IAA-H-8-77	November 1978
Mesquite, City of	James M. Montgomery	EMW-83-C-1197	May 1986
North Las Vegas, City of	Soil Conservation Service	IAA-H-8-77 Project Order No. 1	November 1978
	James M. Montgomery	--[1]	November 1982

[1]Performed for the City of North Las Vegas

During the preparations of the initial Flood Insurance Studies for the individual communities, FEMA representatives held coordination meetings with community officials, representatives of the study contractor for each study, and other interested agencies and citizens. The meetings, referred to as the initial, intermediate, and final community coordination meetings, were held at specified intervals during the preparation of the studies. The comments and issues raised at those meetings were addressed in the Flood Insurance Study for each community. The dates that the meetings were held for each community are provided in Table 2.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the geographic area of Clark County, Nevada, including the incorporated areas of the Cities of Las Vegas, North Las Vegas, Henderson, Boulder City, and Mesquite.

For the purposes of this study, the unincorporated areas of Clark County were divided into three separate study areas: the Moapa Valley, the Laughlin Area, and the Las Vegas Valley.

The Moapa Valley includes the floodplains of the Muddy River and the major washes draining to it from the west. Streams studied by detailed methods are: the Muddy River, from the Fish and Game diversion structure to the Wells Siding diversion structure, and from a point approximately 19,200 feet upstream of the Wells Siding diversion structure to a point approximately 15,500 feet upstream of Interstate Highway 15; Overton Wash, from a point approximately 3,900 feet above its mouth for a reach of approximately 12,600 feet; and the West Branch Muddy River, from its convergence to its divergence from the main branch of the Muddy River, a reach of about 7,000 feet. A portion of the Muddy River between River Mile 8.1 and 11.7 was analyzed using approximate methods.

The Laughlin Area includes detailed riverine analyses along the Colorado River and detailed alluvial fan analyses along Bridge Canyon Wash, Dripping Springs Wash, Hiko Springs Wash, and the Southwest Unnamed Wash.

The Las Vegas Valley area incorporates approximate alluvial fan analyses along Blue Diamond Wash, Flamingo Wash, and Red Rock Wash.

In addition, approximate alluvial fan analysis was performed along Peak Springs Canyon Wash in the Pahrump Valley area of Clark County.

The streams, or portions of streams, studied by detailed methods in the incorporated communities include the following: Hemenway Wash

Table 2. Community Coordination Officer (CCO) Meetings

Community Name	Initial CCO Meeting or Coordination Meetings	Intermediate CCO Meeting	Final CCO Meeting
Boulder City, City of	June 1975	July 20, 1978	October 7, 1980
Clark County (Unincorporated Areas)	April 14, 1983	--	--
Henderson, City of	June 1975	January 8, 1976	October 7, 1980
Las Vegas, City of	January 1976 July 1977 April 1978	July 19, 1978	June 13, 1979
Mesquite, City of	April 14, 1983	--	July 17, 1986
North Las Vegas, City of	January 1976 July 1977 December 1977 April 1978	July 19, 1978	June 12, 1979

studied from the mouth upstream to Lakeview Drive extended; Georgia Avenue Wash studied from the corporate limits to the north end of Sierra Vista Place; approximately 1 mile of the upstream end of Wash C, which flows from near the intersection of Utah Street and Adams Boulevard to the corporate limits of Boulder City; Wash D, which crosses U.S. Highway 93 1.3 miles west of the junction with Nevada Highway studied from U.S. Highway 93 downstream 0.4 mile; Wash B, which parallels U.S. Highway 93 (Business); Las Vegas Wash from Nellis Boulevard extending northward to Owens Avenue and from approximately 200 feet downstream of Lake Mead Boulevard to approximately 2,720 feet north of Craig Road; Unnamed Tributary of Las Vegas Wash northwesterly from its confluence with Las Vegas Wash to approximately 1,000 feet south of Lone Mountain Road; Union Pacific Overflow from its confluence with Unnamed Tributary of Las Vegas Wash to its confluence with Las Vegas Wash; Las Vegas Creek from its confluence with Las Vegas Wash to Las Vegas Boulevard North, a distance of 3.4 miles; Pulsipher Wash from the edge of the Virgin River floodplain and ending just above Interstate 15; and alluvial fan flooding within the City of Henderson.

The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development or proposed construction through August 1991.

The streams, or portions of streams studied by approximate methods include the following: Abbott Wash; Town Wash; Wash C; and Wash D.

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 Clark County.

2.2 Community Description

Clark County is located in southern Nevada and is bordered to the west by Nye County, Nevada, to the north by Lincoln County, Nevada, to the east by the Colorado River and Mohave County, Arizona, and to the south by San Bernardino County and Inyo County, California. The Cities of Las Vegas, North Las Vegas, Boulder City, Mesquite, and Henderson are the major incorporated population centers.

Boulder City is located in southern Clark County. It is 5 miles from Lake Mead and 23 miles southeast of Las Vegas. Situated on the drainage divide between the Colorado River and the Eldorado Valley, the elevations within the corporate limits range from 2,000 feet in the Hemenway Wash and Eldorado Valley areas to more than 3,600 feet in the River Mountains, located in the northwest portion of the city. The city encompasses approximately 32 square miles.

The largest wash in Boulder City is Hemenway Wash, located in the northern portion of the city. At the corporate limits, this wash has a drainage area of approximately 4.1 square miles. The Georgia Avenue Wash in the southern portion of the city has a drainage area of approximately 1.9 square miles at the corporate limits. There are a number of washes with drainage areas of approximately 1.0 square mile or less, and alluvial fan areas with distributary drainage patterns.

Boulder City was founded in 1931, during the construction of the Hoover Dam. It served as a residence for those involved in the construction on the dam. The community was designed to house as many as 2,500 workers. Boulder City became incorporated in 1960 when the USBR deeded the area to self-government.

The City of Henderson is located in central Clark County. It is near the center of a broad desert valley surrounded by mountains ranging from 2,000 to 10,000 feet above the valley. Las Vegas is approximately 10 miles north of Henderson. The total land area within the city is approximately 64 square miles. Henderson is situated in the Las Vegas Valley drainage basin at the northern end of the McCullough Mountain range.

The City of Las Vegas is located in central Clark County, and occupies the central part of a broad, open desert basin. Las Vegas is bounded by the City of North Las Vegas on the north and Clark County on the east, west, and south.

The corporate limits encompass an area of approximately 33 square miles, of which approximately 95 percent is developed. The development consists of single-family residences, some multiple-family residence complexes, small business, and large casino-hotel facilities in the downtown area.

Las Vegas Wash originates in the mountains, approximately 28 miles north of the City of Las Vegas, and continues southeastward for approximately 42 miles, where it terminates at Lake Mead. The drainage basin is bounded by the Spring Mountains on the west; by parts of the Desert, Sheep, and Las Vegas Ranges on the north; by the Frenchman and River Mountains and a low range of hills on the east; and, by the Spring Mountains and the Bird Spring and McCullough Ranges on the south.

The drainage area of Las Vegas Creek is bounded on the west by La Madre Mountain, which has an elevation of approximately 7,000 feet. Three miles east of this boundary, the drainage area consists of a well-defined alluvial fan that continues eastward to Interstate 15 in downtown Las Vegas. Flows on this fan are often the result of intense, short-duration thunderstorms. The flow pattern on the fans is complex, and areas of concentrated flows can shift often. Urban development of this fan is changing the runoff potential and the flow paths.

Las Vegas Creek flows from west to east between the traffic lanes of Washington Avenue. At the confluence with Las Vegas Wash, the combined drainage area is over 800 square miles.

The City of Mesquite incorporated in March 1984 is located in the northeastern corner of Clark County. It lies immediately north of the Virgin River approximately 80 miles northeast of the City of Las Vegas. Mesquite has an area of approximately 11.3 square miles.

Mesquite is situated at an elevation of approximately 1,600 feet. There are three distinct topographic regions within the city. The northernmost region is composed of steep, barren, foothills from which many dry washes originate and flow southerly into the city. The central region is a broad, flat plain between the foothills and the Virgin River. This is part of the historical Virgin River floodplain, and has gently sloping topography to the south and west. This central region supports essentially all of the existing Virgin River channel and floodplain, and must be kept free of development.

The City of North Las Vegas is located in central Clark County, and occupies the central part of a broad, open desert basin. North Las Vegas is bounded by the City of Las Vegas on the south and west and Clark County on the east and north. Henderson and Boulder City, are approximately 15 miles and 25 miles, respectively, southeast from North Las Vegas. Interstate 15 passes through the city. Boulder Dam is approximately 32 miles southeast of North Las Vegas. The corporate limits encompass an area of approximately 22.75 square miles.

Las Vegas Wash originates in the Desert and Sheep Mountain ranges located north of the City of North Las Vegas. An alluvial apron formed by numerous coalesced alluvial fans skirt the mountains and are located within the northern portion of the city. The southern portion of the city is dissected by many small channels, which do not have the capacity to contain the larger, more infrequent storms that occur.

Las Vegas Wash runs through the eastern portion of North Las Vegas and continues southeastward until it terminates at Lake Mead on the Colorado River. Unnamed Tributary to Las Vegas Wash joins it from the west at Las Vegas Boulevard. Here Las Vegas Wash has a drainage area of 880 square miles and a channel length of 38 miles from its headwaters.

Population growth has been rapid in Clark County over the past 60 years, increasing from less than 5,000 in 1920 to over 598,300 in 1986. Half of the total county population is located within the unincorporated areas of the county. The population of Clark County is concentrated in the Las Vegas Valley; 96 percent of the total county population, or 574,335, are located in the valley. Of those, over 288,500 are within the unincorporated portion of the valley (Reference 1).

In addition to the permanent population, a significant visitor population is present in the Las Vegas Valley throughout the year. The visitor population is generated principally by the entertainment, gaming, and recreational opportunities of the area. Legalized gambling has been the prime element in the economic development. Mining and agriculture have become secondary industries.

Typical soils types of the Las Vegas Valley include the Delnorte-Nickel family, the Bodlard-Bracken-McCarran association, and the Nickel-Arizo-Delnorte family. The Bodlard-Bracken-McCarran association consists of a gravely fine sandy loam and fine sandy loam, with slopes of 0 to 8 percent. The two other soil types are gravelly loams to very gravelly sandy loams formed on alluvial fans from mixed rock sources, with slopes of 2 to 15 percent.

The weather in the county is arid, characterized by sparse rainfall, low humidity, and wide extremes in daily temperatures. The average annual precipitation is approximately 3.95 inches. The average annual temperature is about 66°F with average daily maximums in the high 70s and average daily minimums in the mid-50s. Daily maximum temperatures in summer usually exceed 100°F (Reference 2).

Winter storms in the area are regional in nature. These storms are associated with broad low-pressure systems that develop over the Pacific Ocean and move easterly. Precipitation from these storms is generally widespread and is intense only on rare occasions. Summer storms, however, occur as localized thunderstorms and can be intense. These local convective storms are associated with moisture from the Gulf of California and the southern Pacific Ocean that moves northeasterly. Floods occurring in the area in and around Clark County are generally associated with precipitation from the summer convective thunderstorms originating in the mountains, occurring mainly during the hotter months (July through September) (References 3 and 4).

Due to the arid nature of the desert in which Clark County is located, the area is dry except during and shortly after a storm. When a major storm does move into the area, water collects rapidly as surface runoff and concentrates in a short period of time. Consequently, resultant floodflows are of the flash flood type, having sharp peaks and short durations.

Natural vegetation in the area around Clark County is typical of the Mojave Basin desert region and includes creosote brush, a variety of yuccas, mesquite, and sagebrush. Soils are coarse and rocky in the foothill areas, producing rapid runoff. Soils on the plain are more porous, particularly where modified by agricultural activity.

The topography of Clark County is characterized by north-south-trending mountain ranges eroding laterally to vast desert valleys. The ranges rise to elevations as high as 11,918 feet (Mt. Charleston, Spring Mountain Range). Other range crests are between 9,000 and 6,000 feet. Wide alluvial fans or aprons extend from the base of the mountains. The alluvial fans gently level out of the basin lowlands, where sediments from the gullies and washes draining the aprons are deposited. The basin lowlands have been continually filling with sediment since the mountains were formed. Sediment deposition is attributed to the reduced runoff velocities and associated low scouring in the valley bottom areas. Storm drainage channels in the lowlands are poorly defined, and most storm runoff occurs as sheetflow, which is concentrated ultimately in major wash areas with very high speed and intensity.

The Moapa Valley is 50 miles northeast of Las Vegas. Meadow Valley Wash is a major tributary of the Muddy River entering from north. The Muddy River flows southeasterly into Lake Mead, southeast of the Town of Overton.

In the Lower Moapa Valley, the irrigated land is intensively farmed, and the prime crops are vegetables, other cash crops, and forage crops, which are fed to dairy cattle and horses. More recent irrigation development has occurred in the Upper Moapa Valley. The Moapa Indian Reservation covers a large portion of the irrigated land in this area. In the Meadow Valley Wash area, there is minimal agricultural development, but residential development has begun west of Glendale.

The nonirrigated areas have either phreatophytic tree and shrub cover or grass and desert brush. The vegetation of the surrounding watershed is very sparse desert brush.

Alluvium is the dominant valley-fill material in the Moapa Valley and Mesquite-Bunkerville area. It is generally very thick and consists of gravel, sand, silt, and clay of sedimentary origin. The soils in the area are generally fine to moderately coarse textured in the valley bottom, and moderately coarse or coarse textured and gravelly on the upper terraces. Colors are usually pale or light brown. There is little organic matter or nitrogen in the native soil. Deposits of gypsum and other salts originating from the Muddy Creek Formation are found in parts of the valley.

The Laughlin Area is located 70 miles south and slightly east of the City of Las Vegas. The development consists of a coal-fired power plant and a small casino-resort complex located on the west bank of the Colorado River.

Soils in the Laughlin area consist of: Carrizo-Gunsight, a sloping sandy loam surface; rock outcrop Gachado, a very cobbly fine sandy loam surface; Gunsight-Carrizo-Ajo, a sandy gravelly loam; and Gilman-McClellan-Coachella, loam and loamy fine sand.

2.3 Principal Flood Problems

The typical flood-producing storm causing flooding problems in Clark County are associated with summer thunderstorms of short duration and high intensity which result in significant runoff rates. These storms result from tropical depressions which approach Clark County from the south or southeast. Summer or winter general storms of longer duration and lower intensity have not contributed to significant discharges in the past.

Severe storms have occurred in the Clark County area in the past decade. There are only three first-order rain gages in Southern Nevada (at Las Vegas Airport, Boulder City, and Searchlight). Thus, much of the information regarding historical storms comes from other scattered gages and eyewitness accounts.

Newspaper accounts of flood damage in and around Boulder City date back to July 11, 1932, when a large storm extending from Indian Springs on the west to Boulder City on the east caused damage to the Boulder Dam Highway. Other flood damage in Boulder City occurred on September 24, 1935; March 3, 1938; June 29, 1938; September 7, 1939; July 27, 1952; and, October 27, 1974. The heaviest rainfall recorded at Boulder City since a weather station was established there in 1931 occurred on September 11, 1976. The rainfall recorded for the day was 2.62 inches, which reportedly occurred within a 3-hour time span. The amount of precipitation which occurred from this storm exceeded that which would be expected once in 100 years.

There have been a number of major floods in Henderson. In September 1952, a storm blackened Henderson; power poles were downed and rains were torrential. In June 1954, homes on the northside of Henderson were ravaged by high waters. Several homeowners were forced to knock out walls to allow mud and water to pass through. In July 1974, severe flooding forced Henderson Police to close Sunset Road due to flooding (Reference 7). Conclusions drawn from limited data are that these three floods were smaller than the 10-year recurrence interval flood. The July 1974 flood was the most recent as well as the most severe flood of record.

A flood occurred in Henderson on July 24, 1955, resulting from an intense storm centered over Henderson. The greatest amount of rainfall observed was 1.75 inches approximately 8 miles southeast of the city along U.S. Highway 95. Rainfall measurements in other parts of Henderson ranged from 0.6 to 1.5 inches. Floodwater swept down on Henderson, swamping hundreds of homes and stopping traffic. The recurrence interval for this flood is estimated to be 25 years.

The largest recorded flow on Las Vegas Creek in the City of Las Vegas occurred on July 3-4, 1975, when a flow of 1,000 cubic feet per second (cfs) was measured at a point above F Street (Reference 8). The return period for this event is 28 years. This flood resulted from an average of 1.75 inches of rain. The next largest floods occurred in 1955; when on June 13, 700 cfs, and on July 24, 600 cfs, were measured at a point located 300 feet downstream of the intersection of the Tonopah Highway (U.S. Highway 95) and Las Vegas Creek (References 9 and 10). These flows have return periods of 12 and 8 years, respectively. An additional 6,000 cfs were measured on the west side of the Union Pacific Railroad, approximately 200 feet north of San Francisco Street, on

June 13, 1955. The Charleston Boulevard and Bonanza Road underpasses at the Union Pacific Railroad have been inundated many times in the past in the City of Las Vegas.

The largest recorded flood that occurred on Las Vegas Wash happened on July 3, 1976, when 12,000 cfs was measured at the USGS gaging station located upstream of Las Vegas Boulevard north of Las Vegas. The next measured events occurred on May 31, 1973, and September 25, 1967, when flows measured 1,640 cfs and 1,170 cfs, respectively. These three floods have return period of 111, 5, and 4 years, respectively (References 11 and 12).

Principal flood problems in the City of Mesquite are associated with a series of washes that originate in the mountains to the north of the city and flow southerly to the Virgin River. The three washes of major concern are Pulsipher, Abbott, and Town. Flows from these washes concentrate at the mouths, then spread out across the broad area between the foothills and the Virgin River. The channels for the washes have a limited capacity, and are only capable of containing approximately a 10-year floodflow. In addition, the channels are unlined, and are susceptible to erosion and sediment deposition problems, particularly at bridge and unimproved road crossings.

Recent major flood events have occurred in August 1981 and July 1984. The 1984 flood reportedly caused flow to overtop Mesquite Boulevard on Abbott Wash by approximately 0.5 foot, and led to extensive erosion and sediment deposition throughout all of the channels. Local residents claimed that the worst flood event on Town Wash in the past 40 years caused water to overtop Mesquite Boulevard by approximately 1.0 foot. There are no available estimates of flow rates or frequencies for any past floods on any of the three dry washes.

The Virgin River causes frequent flooding problems in the Mesquite area. The largest peak flow of record at the gage at Bunkerville bridge (downstream of the confluence of Abbott Wash) was 35,200 cfs on December 6, 1966 (Reference 12). This flow has an estimated return period of approximately 98 years. Damage from flooding of this nature generally consists of erosion, sedimentation, inundation of crop land, and road and bridge washouts. Vegetation in the floodplain (natural and agricultural) becomes uprooted and obstructs downstream bridges.

Most severe flood events on Las Vegas Wash result from intense, short-duration thunderstorms. One of largest recorded floods on Las Vegas Wash in North Las Vegas was 12,010 cfs on July 3, 1975. The next largest measured events occurred on May 31, 1973, and September 25, 1967, when 1,640 cfs and 1,170 cfs, respectively, were measured. These three floods have return periods of approximately 150, 4, and 3 years, respectively.

Recent major flood events have occurred in August 1981, August 1983, and July 1984. The 1981 event was the result of a severe thunderstorm which occurred on August 10, 1981, moving from north to south across southeastern Nevada. Heaviest rainfall was reported over the Moapa Valley (Reference 5), with at least one inch of rain falling over approximately 10,000 square miles. In the area of greatest intensity, 6.5 inches of rain was estimated to fall in less than one hour.

On August 10, 1983, an intense flash-flood thunderstorm occurred over the upper portion of Flamingo Wash (Reference 13), moving from south to north and causing flooding in the Las Vegas Valley area of Clark County. The storm produced at least one inch of rain over 100 to 150 square miles. The maximum total storm depth was estimated to be 4 inches occurring over a 3-hour period.

A series of thunderstorms swept through southern Nevada in July and August 1984 and caused flooding in the Las Vegas Valley, the Moapa Valley, and the City of Boulder City. The total storm depth at the City of Boulder City was 3.25 inches in a 2.5-hour period (Reference 3).

Most of the stream channels located on debris cones or alluvial fans are inadequate to pass even minor floods, and flows rarely spread out evenly over the surface of an alluvial fan. Typically, flow is concentrated in a temporary channel or confined to a portion of the fan surface. The flow paths are prone to lateral migration and sudden relocation to other areas of the fan during a single flood event. This erratic, unpredictable behavior subjects all portions of the fan to potential flood hazard.

Channel migration is considerably less on larger well-defined washes, especially where channel stability measures have been constructed (i.e., reinforced concrete lining or rock riprap). On washes where protective measures have not been constructed, rapid alteration may occur in the channel banks due to the highly erosive materials that produce an alluvial fan. In undeveloped areas, floodflows on alluvial fans are essentially unmodified, and processes such as fanhead trenching, braiding of distributary channels, and channel abandonment occur.

Urban development on alluvial fans is subjected to major flood-related hazards such as high velocities, rapid bank erosion, and sediment deposition.

Flooding within the Moapa Valley is of two types: (1) Major storms on the upstream watershed of the Muddy River and its tributary, Meadow Valley Wash; and (2) intense convective storms on the watershed of local side washes. Flooding of both types has always been a problem in the developed and irrigated areas.

On August 17, 1922, a large flood damaged much of the Moapa Valley. The flood came through Arrow Canyon into the upper end of the valley and was augmented by flow from side washes emptying into the valley. Roads and bridges were washed out, and the drugstore and many houses were flooded in Overton. The estimated discharge for the lower Moapa area was 8,110 cfs and had a recurrence interval of approximately 20 years.

A large flood hit Meadow Valley Wash and Lower Moapa Valley on March 3, 1983. The estimated discharge was 10,000 cfs, and the recurrence interval was 30 years.

On August 11, 1941, the largest flood recorded in the Lower Moapa Valley occurred. An intense short-duration storm over the Lower Moapa Valley and California Wash produced estimated discharges of 10,000 cfs at California Wash and 12,000 cfs at Glendale. The latter is estimated to be a 36-year flood. The discharge on California Wash is estimated to be a 100-year flood.

The most recent large flood in the Moapa Valley occurred in November 1960. The estimated discharge near Glendale was 7400 cfs, with a return period of 16 years.

Vegetation in channels of the Muddy River and Meadow Valley Wash obstruct floodflows. In many areas, trees and shrubs grow on the channel banks and bottom and thereby increase roughness and decrease the effective flow area of the channel. There are several culverts and bridge crossings along the Muddy River. The culverts are often overtopped by floodwaters, and erosion and washing occurs. In past floods, bridges have been washed out and carried downstream, thus aggravating flood problems.

The Laughlin area is subject to flash floods coming from west of the area. There are few well-defined channels to concentrate the floodflows. Most of the damage consists of roads being covered with silt, boulders, and other debris, making travel impossible at times.

The Colorado River has been a major flooding source in the Laughlin area of Nevada and the entire Mohave Valley. This valley is of alluvial origin and prior to the construction of levees for channelization, the river twisted and meandered through the area. Prior to the construction of Hoover Dam and other dams on the Colorado River, major snowmelt floods caused damage to the lower Colorado River basin each spring. Peak floodflows of 300,000 cfs occurred in 1884, and 220,000 cfs occurred in 1921 (Reference 4). These flows are far in excess of the present 500-year frequency flood used in this study.

During the spring and early summer of 1984, higher than normal snowmelt in the Colorado River Basin filled the storage capacity of the Colorado River dam system. Releases in excess of 40,000 cfs from Davis Dam were required for a period of time during the late summer and fall of 1984. Several residential structures adjacent to the Colorado River experienced flood damage as a result of these releases.

2.4 Flood Protection Measures

Development occurred in Clark County without any significant flood control structures until the Civilian Conservation Corps (CCC) was sent to Nevada in 1933. After the CCC left in 1935, no major flood control improvements were made in the county for over 20 years.

The North Las Vegas Detention Basin is a 2,600 acre-foot facility located in the northern Las Vegas Valley, on Las Vegas Wash. The amount originally funded for the project was $2.8 million and was budgeted by the 1981 Clark County Flood Control Bond Issue. An additional $500,000 was requested and received from Clark County when this amount proved to be insufficient to complete construction. Construction of the project began in September 1983, and work was completed by April 1984. The basin is located 3.5 miles north of Craig Road on Losee Road. It is the largest detention basin in the State of Nevada. Flows from the north on Las Vegas Wash are routed through the basin, which diverts up to 9,000 cfs from the wash and reduces the flow to a 4,500 cfs outflow. When full, the basin is designed to contain a 100-year floodflow on Las Vegas Wash. Flows from storms of a frequency higher than the 100-year event will cause some overtopping of the diversion berm in the wash.

The Angel Park Detention Basin is located upstream of the Las Vegas Expressway and currently has a storage capacity of approximately 950 acre-feet. The project was funded in phases through the 1981 Clark County Flood Control Bond Issue and a cooperative agreement between the City of Las Vegas and Clark County for appropriation of bond issue funds for design and construction of the basin. This agreement was dated July 1982. The final phase (Phase IIB) of the project was completed in late 1985.

The Red Rock Detention Basin is located in the southwestern Las Vegas Valley, on the alluvial fan portion of Red Rock Wash, downstream of the Charleston Boulevard crossing. The facility has a storage volume of 1,673 acre-feet at the spillway crest. It reduces the 100-year peakflow on Red Rock Wash to 1,390 cfs through a pair of 60-inch RCP outlet works.

Several flood control structures have been built on the Muddy River and Meadow Valley Wash in the Moapa Valley.

In 1935 and 1936, Wells Siding Diversion Dam and Bowman Reservoir were constructed by the CCC. These structures are located near the upper end of the Lower Moapa Valley. The Wells Siding Diversion Dam diverts Muddy River flows into the Lower Moapa Valley Canal System and into Bowman Reservoir. The feeder canal to Bowman Reservoir has a capacity of approximately 1,000 cfs. Bowman Reservoir is approximately 1 mile east of Wells Siding Dam and is approximately 30 feet high and 780 feet long. The reservoir is used to store excess winter flows to supplement the normal Muddy River discharge during the heavy irrigation season. Runoff from a small side wash is collected in Bowman Reservoir, but this has a minor effect on reducing peak flows on the Muddy River.

The Muddy River channel was enlarged for 2 miles in the vicinity of Logandale by the CCC.

Arrow Canyon Dam was built by the CCC on the Muddy River. This dam is approximately 30 feet high and is constructed of rubble masonry. At the time of compiling this study, the storage area of the dam was filled with sediment and no longer controlled floodflows.

A channelization project completed in the early 1960s, between the Union Pacific Railroad and the upstream boundary of the Moapa Indian Reservation, affords some flood protection to the lands within this portion of the Muddy River.

Two COE dams, Pine Canyon and Mathews Canyon Dams, are located in the drainage area of Meadow Valley Wash above the Town of Caliente, Lincoln County, Nevada. The SCS has constructed a watershed protection and flood prevention project in the headwaters of Meadow Valley Wash. Because of the distance from the study area, their effect on major floodflows in the study area is minimal.

In the Laughlin area, flows in the Colorado River are regulated by Hoover Dam and Davis Dam, north of the area. These structures offer flood protection from events larger than the 100-year flood on the Colorado River.

Additionally, the USBR has constructed a levee for flood protection along the Colorado River through the area. The levee, designed to contain the 100-year discharge, is armored with rock riprap to protect it from erosion.

Current county ordinances require that any new construction be elevated 18 inches above the 100-year water-surface elevation, as determined by the developer.

3.0 ENGINEERING METHODS

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

3.1 Hydrologic Analyses

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

Peak discharges for the desired return periods were computed for flooding sources in Clark County primarily through the use of the TR-20 Project Formulation-Hydrology computer program (Reference 15) or by using log-Pearson Type III procedures. The TR-20 program was developed by the SCS to implement the SCS unit hydrograph procedures.

Aspects for the hydrologic analysis which are common to all of the study areas are discussed in the following paragraphs, after which specific procedures applied to each individual area are described.

An investigation of flood-producing storms typical of Southern Nevada was conducted. It was determined, based on a review of published historical storm events, that thunderstorms in the study area are generally of approximately 3-hour duration, and cover at most 150 to 200 square miles. Qualitative descriptions of historical events were used to develop a synthetic cumulative time distribution for a 3-hour thunderstorm in Southern Nevada. This distribution was adopted rather than any of the SCS standard dimensionless storm patterns. This approach was coordinated with local meteorologists.

Point precipitation values for the 10-year, 50-year, and 100-year 3-hour storms were obtained from the National Oceanic and Atmospheric Administration (NOAA) Precipitation-Frequency Atlas for the State of Nevada (Reference 16). Depth-area reduction factors from a recent publication of NOAA called HYDRO-40 (Reference 17) were used to estimate average rainfall over each of the study watersheds. Although HYDRO-40 was developed using actual storm data from Arizona and western New Mexico, common storm-producing mechanisms would appear to justify application of the results to southern Nevada as well. Peak 500-year floodflows for the study streams analyzed with TR-20 were estimated by extrapolating graphically from the computed 10-, 50-, and 100-year discharges.

All peak flows adopted for use in this study are considered to be clear water flows. That is, no sediment or debris bulking factors have been applied to the results of the TR-20 or log-Pearson Type III analyses. Bulking has not been used in this study based on discussions with Clark County Public Works engineers, who indicated that channels and storage facilities in the study reaches do not seem to exhibit large widespread amounts of sedimentation or erosion.

The primary flooding source in the Moapa Valley is the Muddy River. This is a major watercourse with a USGS stream gage located in "The Narrows" between the Upper and Lower Moapa Valley. The gage has a 33-year period of systematic record, as well as historical peak estimates, which was considered adequate for use in a statistical analysis. The log-Pearson Type III method recommended by Water Resources Council Bulletin 17B (Reference 18), was used to determine 10-, 50-, 100-, and 500-year peak flows at the gage site. This analysis made use of the full systematic record up to the 1983 water year, and incorporated the 15 historical peaks as per Bulletin 17B.

Subsequent to the initial statistical analysis and preliminary hydraulic calculations, a large flood occurred on the Muddy River in August 1984, which generated the highest peak flow in the systematic record. As a result, frequency statistics were recomputed, including the new flow. However, it was determined that the previously estimated discharges fell within the 50-percent confidence interval of the more recent estimates and thus, in accordance with Flood Insurance Study Guidelines, the original discharges were adopted.

Peak discharges at the Muddy River gage were translated downstream by two compensating methods: (1) flows were increased by the ratio of the increased drainage area; and (2) flows were routed through the Moapa Valley floodplain using the normal depth routing method, assuming a hydrograph shape similar to that developed by the COE in the Flood Plain Information Report for the Muddy River (Reference 19). In addition, peak flows for all recurrence intervals were reduced by 1,000 cfs downstream of Wells Siding to account for water supply diversions to Bowman Reservoir. This is the maximum capacity of the diversion facility.

Peak flows for the Muddy River upstream of Meadow Valley Wash were determined by a discharge-drainage area relationship developed using log-Pearson analyses of records from two gages: the Muddy River near Glendale and Meadow Valley Wash near Caliente.

Peak floodflows for Overton Wash were originally scheduled to be determined using a regional regression approach. However, the best available regional methods had questionable reliability, so a recent TR-20 analysis by the SCS was used for Overton Wash hydrology.

Peak 100-year floodflows at the apexes of the four major alluvial fans in the Laughlin area (Hiko Springs Wash, Bridge Canyon Wash, Dripping Springs Wash, and Southwest Unnamed Wash) were computed using a TR-20 model developed by the Clark County Department of Comprehensive Planning. The flood magnitude-frequency relationships for these washes were assumed to be normal distributions of the base 10 logarithms of the peak discharges. The distributions were assumed to have a standard deviation of 0.8.

This area had originally been scheduled for analysis with regional regression methods. However, during the course of the study, the Department of Comprehensive Planning conducted a floodplain study for the Laughlin Area which included a TR-20 model for each of the fan tributary areas. After review and some minor revisions, this model was adopted for the Flood Insurance Study hydrology as the best available information. There is no historical rainfall-runoff data available from the Laughlin flooding sources with which to calibrate the hydrologic model. Critical storms were assumed to occur independently over each of the four fan watersheds, which have areas ranging from 4 to 18 squares miles.

Peak discharge-frequency relationships for the Colorado River were based on operating procedures for the Hoover Dam (Reference 20) and USBR information (Reference 14). These discharges were adopted for the Bullhead City study area. The 100-year peak discharge is equivalent to the "levee design flood" used by the USBR. The 10-, 50-, and 500-year peak discharge relationships were based on operating procedures for Hoover Dam and additional information provided by the USBR (Reference 14 and 20).

Estimates of flood discharges for the alluvial fan analysis in the City of Henderson were based on published USGS data (Reference 21).

The Las Vegas Wash watershed in North Las Vegas was divided into 78 subbasins to model the rainfall-runoff process. Subbasin areas varied from 1.1 to 432.7 square miles, while times of concentration ranged from 0.37 to 6.52 hours. Soil type and land-use impacts on runoff were modeled using the SCS, Curve Number; subbasin curve numbers varied from 77 to 93.

The TR-20 model for Las Vegas Wash was roughly calibrated using historical rainfall and runoff data gathered during the July 3, 1975, flood, which is the largest recorded flood event in the study area.

Peak discharges corresponding to the selected frequencies were computed at key locations in the watershed, including Las Vegas Wash at the Union Pacific Railroad and the Unnamed Tributary to Las Vegas Wash at the Union Pacific Railroad. Flows at these two points were routed downstream to their confluence above Las Vegas Boulevard. Below the confluence, peak discharges were determined by adding peak flows in Las Vegas Wash to concurrent flows in the Unnamed Tributary to Las Vegas Wash.

Channel overflows occurring at bridges, culverts, and other locations or reduced channel capacity were computed based on hydraulic rating curves developed using the <u>HEC-2 Water-Surface Profiles</u> computer program (Reference 22).

Peak discharge-drainage area relationships for all of the flooding sources studied by detailed methods are shown in Table 3.

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.

Cross sections for the backwater analyses of the detailed riverine study streams in the unincorporated areas of Clark County and the City of Mesquite were obtained from an aerial survey conducted in May 1984. This information was augmented by relative channel sections obtained by field measurement. All bridges and culverts were field surveyed to obtain hydraulic data and structural geometry.

Cross sections for the backwater analyses of the Colorado River were obtained from the USBR (Reference 14). The below-water sections were obtained by field measurement. Ground topography was joined with the river cross section information at appropriate locations. Ground topography was obtained from three sources:

1. From aerial photogrammetry, flown in 1984 and compiled at a map scale of 1:4,800 with a 4-foot contour interval (Reference 23).

2. From aerial photogrammetry, flown in 1977 and compiled at a map scale of 1:1,200 with a 2-foot contour interval (Reference 24).

3. From USGS quadrangle maps at a scale of 1:24,000 with a 5-foot contour interval (Reference 25).

The cross section data for Hemenway Wash, Georgia Avenue Wash, Wash B, Wash C, and Wash D in the City of Boulder consisted of 11 cross sections digitized from aerial photogrammetry, 4 cross sections surveyed, and 15 cross sections for which data were derived from 2-foot contour interval maps (Reference 26).

Cross sections for the backwater analysis of Las Vegas Wash and Las Vegas Creek in the City of Las Vegas were obtained from field surveys, construction drawings of Washington Avenue, and topographic maps compiled in 1976 and 1977 from photographs dated February 1974 (Reference 27). Additional bridge and culvert data were obtained by field measurement.

Cross sections for the backwater analysis of Las Vegas Wash and the Unnamed Tributary to Las Vegas Wash in the City of North Las Vegas were obtained from aerial photographs flown on September 26, 1981, which were compiled to produce topographic mapping at a scale of 1:2,400 with a contour interval of 2 feet (Reference 28), and from field reconnaissance of the study area. Additional topographic data in the overflow area parallel to the Union Pacific Railroad

Table 3. Summary of Discharges

Flooding Source and Location	Drainage Area (square miles)	Peak Discharges (cfs) 10-Year	50-Year	100-Year	500-Year
Alluvial Fan					
In Eastern Henderson	5.54	370	2,200	3,600	--[1]
Alluvial Fan					
In Western Henderson	76	1,490	13,300	23,370	--[1]
Abbott Wash					
At Interstate 15	7.1	1,050	1,940	2,340	3,690
Blue Diamond Fan					
At Apex	69.5	2,010	8,800	14,820	42,550
Bridge Canyon Wash					
At Apex	7.3	650	2,680	4,430	12,240
Colorado River					
At Laughlin	169,300	--[1]	--[1]	40,000[2]	--[1]
Dripping Springs Wash					
At Apex	4.5	460	1,910	3,150	8,710
Duck Creek					
At Robindale Road	136.5	--[1]	--[1]	11,500	--[1]
At Confluence with Duck Creek Tributary	119.5	--[1]	--[1]	11,000	--[1]
Above Interstate 15	71.5	--[1]	--[1]	9,700	--[1]
Duck Creek Tributary					
At Confluence with Duck Creek	46.2	--[1]	--[1]	6,300	--[1]
Above Interstate 15	44.2	--[1]	--[1]	5,700	--[1]

[1]Discharge not available
[2]Established by the Colorado River Floodway Protection Act, Public Law 99-450

Table 3. Summary of Discharges (Cont'd)

Flooding Source and Location	Drainage Area (square miles)	Peak Discharges (cfs) 10-Year	50-Year	100-Year	500-Year
Georgia Avenue Wash					
At Buchanan Boulevard	1.98	263	781	1,285	4,300
At Mendota Drive	0.95	177	459	727	2,000
At Cross Section E	0.45	68	189	310	1,000
Hemenway Wash					
At Cross Section C	2.86	290	635	815	1,380
At Cross Section E	1.06	80	195	260	420
Hiko Springs Wash					
At Apex	17.9	1,220	5,070	8,370	23,130
Las Vegas Creek					
At Las Vegas Boulevard	13	640	1,280	1,570	2,420
At Confluence with Las Vegas Wash	14	660	1,300	1,600	2,450
Las Vegas Wash					
At Carey Avenue[1]	836	3,050	8,750	11,800	21,400
At Charleston Boulevard	858	3,180	9,000	12,100	21,800
At Losee Road	568	3,960	7,300	8,820	17,000
Below Union Pacific Railroad	--[2]	2,100	2,330	2,440	2,700
Below Interstate 15	--[2]	2,100	2,330	2,370	3,150
Below Confluence with Middle Overflow Area	--[2]	2,720	3,040	3,120	4,500
Below East Cheyenne Avenue	--[2]	2,300	2,560	2,610	3,500
Below Confluence with Unnamed Tributary	--[2]	3,940	7,580	9,220	17,200
Below Las Vegas Boulevard	--[2]	3,940	6,400	6,660	9,300
Below Cutoff Channel	--[2]	3,940	6,530	6,860	10,700
Below Carey Avenue	--[2]	3,940	6,530	6,860	9,700
Below Lake Mead Boulevard	--[2]	3,940	5,500	5,710	7,250
Middle Branch Blue Diamond Wash					
At Union Pacific Railroad	71.6	20	1,230	2,800	12,500
At Interstate 15	72.6	20	1,230	2,800	12,500

[1] Located outside corporate limits

[2] Flow affected by upstream overflows, diversions, or obstructions; drainage area does not apply

Table 3. Summary of Discharges (Cont'd)

Flooding Source and Location	Drainage Area (square miles)	Peak Discharges (cfs) 10-Year	50-Year	100-Year	500-Year
Muddy River					
At Cooper Avenue	4,035	5,250	14,750	21,300	45,900
Downstream of Wells Siding	3,950	5,270	14,800	21,400	45,500
Upstream of Confluence with Meadow Valley Wash	1,360	3,620	10,900	16,000	34,400
North Branch Blue Diamond Wash					
At Union Pacific Railroad	71.6	30	1,280	2,900	12,700
At Interstate 15	72.6	30	1,280	2,900	12,700
Overton Wash					
At Upstream Limit of Detailed Study	21.7	2,170	4,510	5,680	8,200
Pulsipher Wash					
At Interstate 15	4.9	930	1,730	2,070	3,230
Southwest Unnamed Wash					
At Apex	3.9	260	1,070	1,770	4,890
Town Wash					
At Interstate 15	20.7	2,810	5,260	6,350	9,890
Tropicana Wash - Central Branch					
At Flamingo Wash	20.1	--[1]	--[1]	5,300	--[1]
Upstream of Airport Wash	12.1	--[1]	--[1]	3,320	--[1]
Downstream of Koval Road	11.0	--[1]	--[1]	3,320	--[1]
Interstate 15 to 600 feet downstream of Union Pacific Railroad	8.9	--[1]	--[1]	800	--[1]
Just downstream of Union Pacific Railroad	8.1	--[1]	--[1]	710	--[1]

[1]Discharge Not Available

Table 3. Summary of Discharges (Cont'd)

Flooding Source and Location	Drainage Area (square miles)	Peak Discharges (cfs) 10-Year	50-Year	100-Year	500-Year
Tropicana Wash - Central Branch (Cont'd)					
Downstream of Tropicana Wash - North Branch	8.1	--[1]	--[1]	4,100	--[1]
Upstream of Union Pacific Railroad	8.1	--[1]	--[1]	4,100	--[1]
Breakout upstream of Union Pacific Railroad	8.1	--[1]	--[1]	3,295	--[1]
Downstream of Tropicana Wash - South Branch	5.5	--[1]	--[1]	3,300	--[1]
Above confluence with Tropicana Wash - South Branch	1.7	--[1]	--[1]	1,000	--[1]
At confluence with Tributary No. 1	1.1	--[1]	--[1]	640	--[1]
At Jones Boulevard	0.9	--[1]	--[1]	530	--[1]
Tropicana Wash - North Branch					
At confluence with Tropicana Wash - Central Branch	2.6	--[1]	--[1]	1,450	--[1]
At confluence with Tributary No. 1	1.8	--[1]	--[1]	1,250	--[1]
At Jones Boulevard	1.6	--[1]	--[1]	1,200	--[1]
At confluence with Tributary No. 2	1.1	--[1]	--[1]	850	--[1]
Tropicana Wash - South Branch					
At confluence with Tropicana Wash - Central Branch	2.9	--[1]	--[1]	1,800	--[1]
Above Jones Boulevard	2.4	--[1]	--[1]	1,500	--[1]

[1]Discharge Not Available

Table 3. Summary of Discharges (Cont'd)

Flooding Source and Location	Drainage Area (square miles)	Peak Discharges (cfs) 10-Year	50-Year	100-Year	500-Year
Union Pacific Railroad Overflow					
At Las Vegas Wash	--[1]	1,860	4,970	6,380	11,100
At Middle Tributary to Las Vegas Wash	--[1]	1,240	4,260	5,300	8,600
Unnamed Fan (Just West of Blue Diamond Fan)					
At Apex	1.3	140	660	1,140	3,460
Unnamed Tributary to Las Vegas Wash					
At Lone Mountain Road	126	2,120	4,060	4,890	7,850
At Craig Road	--[2]	1,560	3,500	4,330	6,550
Below Interstate 15	177	3,000	5,720	6,870	9,100
Below Civic Center Drive	--[2]	3,000	5,720	5,970	7,100
Wash B					
At Cross Section A	0.41	140	255	315	460
Wash C					
At Cross Section A	1.04	120	265	335	490
At Cross Section C	0.81	90	195	250	390
At Cross Section D	0.60	70	150	195	300
Wash D					
At Cross Section D	1.38	205	400	490	740
West Branch Muddy River					
Downstream of Cooper Avenue	--[3]	100	2,450	9,000	20,900

[1]Discharge Not Available
[2]Flow affected by upstream overflows, diversions, or obstructions; drainage area does not apply
[3]Flow due to overflows from Muddy River

were obtained from 1:480 topographic maps provided by the City of North Las Vegas, based on aerial photography from February and March 1980 (Reference 29). Topographic information required to extend cross sections beyond the corporate limits for the shallow flooding analysis between Lake Mead Boulevard and Las Vegas Boulevard was obtained from the most current USGS topographic mapping for the study area (Reference 30).

Water-surface elevations of floods of the selected recurrence intervals for the Cities of Boulder City and Las Vegas were computed through use of the SCS WSP-2 step-backwater computer program (Reference 31).

Water-surface elevations of floods of the selected recurrence intervals for the unincorporated areas of Clark County, the City of Mesquite, and the City of North Las Vegas were computed through the use of the COE HEC-2 step-backwater computer program (Reference 22).

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

Roughness coefficients (Manning's "n") used in the hydraulic analysis were selected based on field observation and engineering judgment. These values are shown in Table 4.

Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals. The starting water-surface elevations for the Muddy River, Overton Wash, and the West Branch Muddy River were calculated using the slope-area method. This starting method assumes that floods on the tributary stream are independent of floods on the main stream. The large difference in watershed areas between these tributaries and their main streams makes it very unlikely that concurrent floods would occur on both sources.

Starting water-surface elevations for the original study for the Colorado River were determined by constructing stage/discharge curves from information supplied by the USBR and USGS.

In evaluating the floodplains for the Muddy River and Overton Wash, it was determined that channel overflows occurred, particularly for the more infrequent flood events. These overflows leave the channel and do not return to it. Overflow magnitudes were determined by modeling the full flow over the entire floodplain (including the overflow area), and using either the flow distribution routine of HEC-2 or hand calculations to estimate the percentage of flow occurring in the overbanks. For determination of natural profiles, the overflow was subtracted from the full flow and the cross sections were modified to show effective flow area only in the main floodplain (excluding the overflow areas). Thus, flows in the HEC-2 model may decrease in a downstream direction as

Table 4. Summary of Manning's "n" Values

Stream	Manning's "n" Values Channel	Manning's "n" Values Overbanks
Blue Diamond Wash, Middle Branch	0.025 - 0.040	0.020 - 0.040
Blue Diamond Wash, North Branch	0.030 - 0.044	0.030 - 0.060
Duck Creek	0.025 - 0.040	0.025 - 0.040
Duck Creek Tributary	0.038	0.040
Georgia Avenue Wash	0.020 - 0.035	0.035 - 0.045
Hemenway Wash	0.028	0.045
Las Vegas Creek	0.013 -0.035	0.015 - 0.055
Las Vegas Wash	0.025 - 0.040	0.035 - 0.080
Muddy River	0.050 - 0.070	0.040 - 0.065
Muddy River, West Branch	0.050 - 0.060	0.040 - 0.050
Overton Wash	0.040 - 0.050	0.040 - 0.070
Pulsipher Wash	0.030 - 0.050	0.030 - 0.047
Tropicana Wash - Central Branch	0.015 - 0.095	0.002 - 0.125
Tropicana Wash - North Branch	0.027 - 0.053	0.025 - 0.085
Tropicana Wash - South Branch	0.032 - 0.038	0.043 - 0.060
Unnamed Tributary of Las Vegas Wash	0.025 - 0.040	0.035 - 0.080
Wash B	0.035	0.045
Wash C	0.035	0.045
Wash D	0.040	0.045

overflows are progressively subtracted from the main flow area at subsequent cross sections.

Normal depth calculations were made at cross sections taken from USGS maps (Reference 32) for the reach of the Muddy River analyzed using approximate methods.

The starting water-surface elevations for Pulsipher Wash were calculated using the slope-area method. This starting method assumed that floods on Pulsipher Wash are independent of floods on the Virgin River. The large difference in watershed areas between the wash and the river makes it very unlikely that concurrent floods would occur on both sources.

In evaluating the floodplain for Pulsipher Wash, it was found that channel overflows occurred at or downstream of Mesquite Boulevard for the more infrequent flood events. These overflows leave the channel and do not return to it, due in part to the slope of the floodplain away from the channel, and to the presence of levees on the channel banks. At the locations on the wash, the main floodplain is separated from the overflow areas only by a slight topographic ridge. Overflow magnitudes were determined by modeling the full flow over the entire floodplain (including the overflow area), and using the flow distribution routine of HEC-2 to estimate the percentage of flow occurring in the overbanks. For determination of natural profiles, the overflow was subtracted from the full flow, and the cross sections were modified to show effective flow areas only in the main floodplain (excluding the overflow areas). Flows in the HEC-2 model decrease in a downstream direction as overflows are progressively subtracted from the main flow area at subsequent cross sections.

Average 100-year flow depths in overflow areas for Pulsipher Wash were determined using normal-depth calculations. In all cases average depths were less than 1.0 foot. Boundaries of the shallow flooding overflow areas could be determined only by approximate methods due to the general lack of topography on the broad Virgin River historical floodplain.

Starting water-surface elevations for Las Vegas Wash, the Unnamed Tributary to Las Vegas Wash, Las Vegas Creek, and the Union Pacific Railroad overflow were calculated using the slope-area method.

Shallow flooding occurs in the floodplain of Las Vegas Wash and the Unnamed Tributary to Las Vegas Wash. Shallow flooding is a result of overflows caused by reduced channel capacities frequently related to undersized bridge or culvert openings. Average depths and flow paths in these areas were estimated using normal depth calculations and accounts of historical flooding.

Shallow flooding is often characterized by highly unpredictable flow directions caused by low relief or shifting channels and high debris loads. Where such conditions exist, the entire area susceptible to this unpredictable flow was delineated as a zone of equal risk. Small scale topographic variations were averaged across inundated areas to determine flood depths.

The FEMA alluvial fan methodology was used to determine the flood depths and velocities on the alluvial fans in the Laughlin area (Reference 33). For two of the four fans in the area (Bridge Canyon Wash and Southwest Unnamed Wash), it was determined that the flood events consist of multiple channels. Therefore, the methodology for multiple flood channels was used to analyze the multiple channel regions of those alluvial fans.

In alluvial fan areas subject to flooding from more than one flooding source, flood depths and velocities were computed by assuming that the event of inundation by a flood from any canyon is independent of the event of inundation by a flood from any other canyon. In accordance with FEMA guidelines, the union of such events, which has a probability of 0.01, was used to define depths and velocities in areas where multiple alluvial fans intersect.

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

All elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD). Elevation reference marks and the descriptions of the marks used in this study are shown on the maps.

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound floodplain management programs. Therefore, each Flood Insurance Study provides 100-year flood elevations and delineations of the 100- and 500-year floodplain boundaries and 100-year floodway to assist communities in developing floodplain management measures.

4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1-percent annual chance (100-year) flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent annual chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For each stream studied by detailed methods, the 100- and 500-year floodplain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries for the unincorporated areas of Clark County and the City of Mesquite were interpolated using rectified photo-topographic maps at a scale of 1:4,800, with a contour interval of 4 feet (Reference 34).

For the Colorado River for the original study, floodplain boundaries were interpolated using topographic maps at scale of 1:4,800 with a contour interval of 4 feet (Reference 23).

Between cross sections in the City of Boulder City, the boundaries were interpolated using topographic maps at a scale of 1:2,400, with a contour interval of 2 feet (Reference 26).

Between cross sections in the City of Las Vegas, the boundaries were interpolated using topographic maps at a scale of 1:2,400, with a contour interval of 5 feet. Shallow flooding areas were delineated using topographic maps (Reference 27).

Between cross sections in the City of North Las Vegas, the boundaries were interpolated using topographic maps at a scale of 1:2,400, with a contour interval of 2 feet (Reference 28).

Alluvial fan boundaries in the City of Henderson were delineated using topographic maps at a scale of 1:24,000 with a contour interval of 20 feet (Reference 36).

Approximate flood boundaries in the City of Boulder City were determined with the use of the following information and data:

1. Shallow flood depth as determined

2. Flood Hazard Boundary Map for Boulder City

3. USGS Flood-Prone Area Map (Reference 37)

4. Historical flood data

Approximate flood boundaries in the City of Henderson were delineated using topographic maps at a scale of 1:24,000 with a contour interval of 20 feet and at a scale of 1:2,400 with a contour interval of 5 feet (References 36 and 27). Approximate flood boundaries in some portions of the study area were taken from the Flood Hazard Boundary Map (Reference 38).

Approximate 100-year flood boundaries in the City of Las Vegas were delineated using the previously cited topographic maps (Reference 27) and topographic maps at a scale of 1:24,000, with a contour interval of 20 feet (Reference 39).

For the streams studied by approximate methods in the City of North Las Vegas, the boundary of the 100-year flood was developed from normal depth calculations and topographic maps at a scale of 1:2,400, with a contour interval of 2 feet (Reference 28), and topographic maps at a scale of 1:24,000, with a contour interval of 20 feet (Reference 30). Shallow flooding areas were delineated using normal depth calculations and topographic maps at a scale of 1:2,400, with a contour interval of 2 feet (Reference 28).

Approximate 100-year floodplain boundaries in some portions of the study area were taken directly from the Flood Hazard Boundary Map for the City of Mesquite (Reference 40).

Approximate floodplain boundaries on the Muddy River were delineated on USGS 7.5-Minute Series Topographic Maps (Reference 32).

The alluvial fan boundaries were also delineated using rectified photo-topographic maps at a scale of 1:4,800, with a contour interval of 4 feet (Reference 34).

The 100- and 500-year floodplain boundaries are shown on the Flood Insurance Rate Map. On this map, the 100-year floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A, AE, and AO); and the 500-year floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 100- and 500-year floodplain boundaries are close together, only the 100-year floodplain boundary has been shown. Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

For the streams studied by approximate methods, only the 100-year floodplain boundary is shown on the Flood Insurance Rate Map.

Approximate 100-year floodplain boundaries in some portions of the study area were taken directly from the Flood Hazard Boundary Map for Clark County (Reference 35).

4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment. 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 100-year 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 100-year 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 study are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

The floodways presented in this study 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 at selected cross sections (Table 5). In cases where the floodway and 100-year floodplain boundaries are either close together or collinear, only the floodway boundary has been shown.

The area between the floodway and 100-year 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 100-year flood 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.

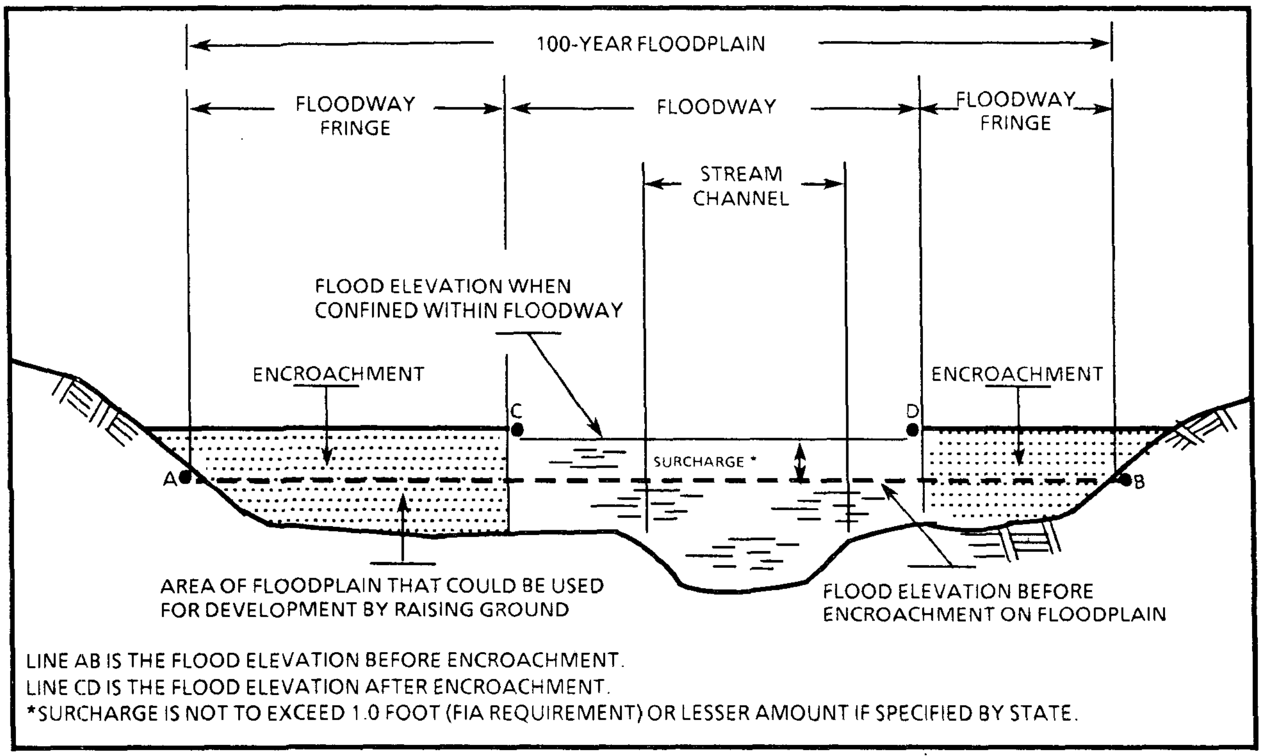

Figure 1. Floodway Schematic

In the areas studied in detail where no floodway is shown, the concept of a floodway does not apply because of shifting channels (upstream portions of Hemenway Wash, Georgia Avenue Wash and Wash D), and no overbank flooding (Wash B and Wash C).

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET NGVD)
Blue Diamond Wash - Middle Branch								
A	50	39	538	5.6	2,177.7	2,177.7	2,177.7	0.0
B	400	26	184	15.2	2,183.8	2,183.8	2,183.8	0.0
C	770	119	558	5.0	2,186.1	2,186.1	2,186.8	0.7
D	1,320	352	450	6.2	2,195.3	2,195.3	2,195.3	0.0
E	1,920	80	312	9.0	2,200.6	2,200.6	2,200.7	0.1
F	2,060	381	608	4.6	2,202.6	2,202.6	2,203.0	0.4
G	2,810	255	437	6.4	2,211.0	2,211.0	2,211.0	0.0
H	3,030	100	388	7.2	2,212.5	2,212.5	2,212.7	0.2
I	3,530	300	602	4.7	2,215.7	2,215.7	2,216.5	0.5
J	4,200	209	352	7.9	2,224.2	2,224.2	2,224.1	0.0
K	4,330	135	441	6.3	2,225.7	2,225.7	2,225.8	0.1
L	4,880	312	451	6.2	2,231.1	2,231.1	2,231.1	0.0
M	5,480	255	1,178	2.4	2,232.8	2,232.8	2,232.8	0.0
N	5,630	255	2,606	1.1	2,238.4	2,238.4	2,238.4	0.0
O	7,280	44	219	12.8	2,249.5	2,249.5	2,249.5	0.0
P	7,980	89	347	8.1	2,257.2	2,257.2	2,258.0	0.8

[1]Feet Above Bermuda Road

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS

FLOODWAY DATA

BLUE DIAMOND WASH - MIDDLE BRANCH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET NGVD)
Blue Diamond Wash - North Branch								
A	4,635	230	794	3.7	2,135.0	2,135.0	2,135.6	0.6
B	4,800	265	404	7.2	2,138.2	2,138.2	2,138.2	0.0
C	6,200	176	370	7.8	2,157.9	2,157.9	2,157.9	0.0
D	6,280	220	382	7.6	2,160.7	2,160.7	2,160.7	0.0
E	6,875	260	510	5.7	2,167.3	2,167.3	2,167.5	0.2
F	7,675	35	215	13.5	2,175.6	2,175.6	2,175.8	0.2
G	7,755	215	602	4.8	2,178.3	2,178.3	2,179.3	1.0
H	9,050	130	322	9.0	2,191.7	2,191.7	2,191.7	0.0
I	9,160	95	350	8.3	2,192.6	2,192.6	2,192.6	0.0
J	9,830	111	350	8.3	2,197.3	2,197.3	2,197.8	0.5
K	9,950	260	405	7.2	2,205.1	2,205.1	2,205.3	0.2
L	11,015	160	487	6.0	2,212.9	2,212.9	2,213.0	0.1
M	12,095	155	339	8.5	2,224.9	2,224.9	2,224.9	0.0
N	12,215	268	2,077	1.4	2,230.0	2,230.0	2,230.0	0.0
O	12,415	418	937	3.1	2,233.1	2,233.1	2,233.1	0.0
P	13,225	202	370	7.8	2,241.0	2,241.0	2,241.0	0.0
Q	14,045	209	477	6.1	2,249.5	2,249.5	2,249.5	0.0
R	14,995	113	304	9.5	2,264.4	2,264.4	2,264.4	0.0

[1]Feet Above Confluence With Duck Creek

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV
AND INCORPORATED AREAS

FLOODWAY DATA

BLUE DIAMOND WASH - NORTH BRANCH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Colorado River								
A	257.7	540	--2	--2	482.9	482.9	482.9	0.0
B	258.1	540	--2	--2	483.3	483.3	483.3	0.0
C	259.1	520	--2	--2	484.2	484.2	484.2	0.0
D	259.6	500	--2	--2	484.7	484.7	484.7	0.0
E	260.1	500	--2	--2	485.1	485.1	485.1	0.0
F	261.2	530	--2	--2	486.2	486.2	486.2	0.0
G	262.2	480	--2	--2	487.2	487.2	487.2	0.0
H	262.9	500	--2	--2	488.0	488.0	488.0	0.0
I	263.3	420	--2	--2	488.5	488.5	488.5	0.0
J	264.3	500	--2	--2	491.3	491.3	491.3	0.0
K	265.3	600	--2	--2	494.2	494.2	494.2	0.0
L	266.5	680	--2	--2	496.5	496.5	496.5	0.0
M	267.2	860	--2	--2	497.9	497.9	497.9	0.0
N	268.0	640	--2	--2	499.5	499.5	499.5	0.0
O	269.0	830	--2	--2	501.0	501.0	501.0	0.0
P	269.5	880	--2	--2	501.7	501.7	501.7	0.0
Q	270.5	500	--2	--2	504.3	504.3	504.3	0.0
R	271.2	490	--2	--2	505.9	505.9	505.9	0.0
S	271.9	700	--2	--2	506.6	506.6	506.6	0.0
T	273.0	710	--2	--2	507.5	507.5	507.5	0.0
U	274.1	950	--2	--2	509.2	509.2	509.2	0.0
V	275.3	500	--2	--2	510.4	510.4	510.4	0.0
W	275.6	450	--2	--2	510.9	510.9	510.9	0.0
X	275.7	650	--2	--2	511.0	511.0	511.0	0.0

[1]Stream Distance in Miles Above Mexican Boundary
[2]Data Not Available

Note: Floodway Established by Colorado River Floodway Protection Act (Public Law 99-450) and Prepared by U.S. Department of Interior, Bureau of Reclamation

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS

FLOODWAY DATA

COLORADO RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET NGVD)
Duck Creek								
A	200[1]	92	699	15.7	2,164.5	2,164.5	2,164.5	0.0
B	650[1]	132	791	13.9	2,169.8	2,169.8	2,169.8	0.0
C	850[1]	405	1,138	9.7	2,174.2	2,174.2	2,174.2	0.0
D	1,450[1]	465	1,930	5.7	2,178.5	2,178.5	2,178.5	0.0
E	2,600[1]	439	1,168	9.4	2,185.7	2,185.7	2,185.7	0.0
F	3,750[1]	566	1,994	4.8	2,193.5	2,193.5	2,194.3	0.8
G	4,800[1]	322	954	10.0	2,201.1	2,201.1	2,201.1	0.0
H	5,590[1]	235	1,087	8.7	2,209.9	2,209.9	2,209.9	0.0
I	6,470[1]	221	1,284	7.4	2,214.9	2,214.9	2,215.1	0.2
J	6,890[1]	212	837	11.4	2,217.2	2,217.2	2,217.5	0.3
K	8,570[1]	253	982	11.2	2,230.0	2,230.0	2,230.4	0.4
L	9,635[1]	702	2,312	4.8	2,237.6	2,237.6	2,238.5	0.9
M	10,435[1]	290	1,019	10.8	2,244.1	2,244.1	2,244.1	0.0
N	11,435[1]	2,127	7,380	1.3	2,253.0	2,253.0	2,253.8	0.8
O	12,455[1]	423	1,068	9.1	2,261.1	2,261.1	2,261.6	0.5
P	13,110[1]	569	1,309	7.4	2,273.7	2,273.7	2,274.2	0.5
Q	14,493[1]	255	896	10.8	2,286.0	2,286.0	2,286.3	0.3
Duck Creek - South Channel								
A	720[2]	130	594	2.5	2,196.6	2,196.6	2,197.0	0.4
B	1,320[2]	150	219	6.9	2,198.3	2,198.3	2,198.5	0.2
C	2,120[2]	60	222	6.8	2,206.4	2,206.4	2,207.2	0.8
D	2,720[2]	85	264	5.7	2,210.1	2,210.1	2,210.9	0.8
E	3,570[2]	195	283	5.3	2,217.6	2,217.6	2,217.7	0.1

[1]Feet Above Pebble Road
[2]Feet Above Confluence With Duck Creek

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS

FLOODWAY DATA

DUCK CREEK – DUCK CREEK - SOUTH CHANNEL

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET NGVD)
Duck Creek Tributary								
A	1,870[1]	1,084	2,400	2.4	2,256.8	2,256.8	2,256.9	0.1
B	2,735[1]	259	727	7.8	2,263.0	2,263.0	2,263.6	0.6
C	3,650[1]	361	870	6.5	2,271.2	2,271.2	2,272.0	0.8
D	4,650[1]	159	549	10.4	2,281.7	2,281.7	2,281.7	0.0
Hemenway Wash								
A	4,420[2]	150	325	3.25	2,000.2	2,000.2	2,001.2	1.0
B-E[3]								

[1]Feet Above Confluence With Duck Creek
[2]Feet Above Mouth
[3]100-Year Flood Contained in Channel

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS

FLOODWAY DATA

DUCK CREEK TRIBUTARY - HEMENWAY WASH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET NGVD)
Las Vegas Wash								
A	38,670[1]	140	1,493	8.2	1,738.7	1,738.7	1,739.7	1.0
B	41,070[1]	110	1,100	11.0	1,740.2	1,740.2	1,741.2	1.0
C	42,665[1]	160	1,042	11.6	1,751.0	1,751.0	1,752.0	1.0
D	44,120[1]	157	1,320	9.2	1,757.6	1,757.6	1,758.6	1.0
E	45,500[1]	550	2,773	4.4	1,764.8	1,764.8	1,765.8	1.0
F	47,245[1]	500	2,861	4.2	1,773.6	1,773.6	1,774.6	1.0
G	49,340[1]	150	2,755	4.4	1,782.9	1,782.9	1,783.9	1.0
H	51,265[1]	145	1,235	9.8	1,791.1	1,791.1	1,792.1	1.0
I	53,365[1]	200	1,200	10.1	1,800.4	1,800.4	1,801.4	1.0
J-T[2]								
U	7,490[3]	71	338	8.4	1,853.9	1,853.9	1,854.1	0.2
V	8,110[3]	55	238	11.9	1,858.0	1,858.0	1,858.4	0.4
W	8,660[3]	73	377	7.5	1,862.8	1,862.8	1,863.3	0.5
X	9,125[3]	80	482	5.9	1,864.8	1,864.8	1,865.2	0.4
Y	9,745[3]	79	405	7.0	1,866.4	1,866.4	1,866.5	0.1
Z	10,105[3]	56	286	9.9	1,867.6	1,867.6	1,867.6	0.0
AA	10,475[3]	95	439	6.5	1,870.4	1,870.4	1,870.4	0.0
AB	10,875[3]	76	429	6.6	1,871.5	1,871.5	1,871.5	0.0
AC	11,335[3]	50	299	7.2	1,872.7	1,872.7	1,872.7	0.0
AD	11,715[3]	76	283	7.6	1,874.2	1,874.2	1,874.2	0.0
AE	12,005[3]	180	448	4.8	1,875.2	1,875.2	1,875.2	0.0
AF	12,245[3]	160	519	4.2	1,875.4	1,875.4	1,875.5	0.1
AG	12,725[3]	320	1,032	2.1	1,875.4	1,875.4	1,876.1	0.7
AH	13,365[3]	117[4]	255	8.5	1,875.9	1,875.9	1,876.7	0.8
AI	13,895[3]	160[4]	369	5.8	1,880.8	1,880.8	1,881.4	0.6
AJ	14,335[3]	93	275	7.9	1,884.5	1,884.5	1,884.5	0.0
AK	14,805[3]	73	220	9.8	1,888.9	1,888.9	1,888.9	0.0
AL	15,285[3]	133[4]	371	5.8	1,893.1	1,893.1	1,893.2	0.1

[1]Feet Above Mouth
[2]Floodway Not Computed
[3]Feet Upstream of Lake Mead Boulevard
[4]Width Includes Islands

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS

FLOODWAY DATA

LAS VEGAS WASH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET NGVD)
Las Vegas Wash (Cont'd)								
AM	15,795[1]	57	202	10.7	1,897.5	1,897.5	1,897.5	0.0
AN	16,510[1]	65	271	8.0	1,904.7	1,904.7	1,904.7	0.0
AO	16,820[1]	117	416	5.2	1,906.3	1,906.3	1,906.3	0.0
AP	17,690[1]	129	883	2.4	1,913.8	1,913.8	1,913.8	0.0
AQ	18,080[1]	185	530	9.6	1,915.0	1,915.0	1,915.1	0.1
AR	18,300[1]	192	989	5.1	1,916.1	1,916.1	1,917.0	0.9
AS	18,640[1]	295	616	8.2	1,919.1	1,919.1	1,919.1	0.0
AT	18,830[1]	299[2]	657	7.7	1,920.5	1,920.5	1,920.6	0.1
AU	19,200[1]	235	1,109	4.6	1,921.6	1,921.6	1,922.3	0.7
AV	19,610[1]	394[2]	593	8.6	1,922.9	1,922.9	1,923.1	0.2
AW	20,030[1]	320[2]	635	8.0	1,927.6	1,927.6	1,928.1	0.5
AX	20,480[1]	180	590	8.6	1,931.9	1,931.9	1,932.2	0.3
AY	21,010[1]	132	468	10.8	1,937.0	1,937.0	1,937.1	0.1
AZ	21,380[1]	90	422	12.0	1,940.2	1,940.2	1,941.2	1.0
Las Vegas Creek								
A	1,789[3]	33	242	6.6	1,779.9	1,779.9	1,780.9	1.0
B	2,039[3]	20	166	9.6	1,783.4	1,783.4	1,784.4	1.0
C	4,598[3]	19	123	13.0	1,793.8	1,793.8	1,794.8	1.0
D	7,035[3]	26	159	10.1	1,802.7	1,802.7	1,803.7	1.0
E	7,740[3]	30	155	10.3	1,806.8	1,806.8	1,807.8	1.0
F	15,157[3]	36	152	10.5	1,870.6	1,870.6	1,871.6	1.0

[1]Feet Upstream of Lake Mead Boulevard
[2]Width Includes Islands
[3]Feet Above Confluence With Las Vegas Wash

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS

FLOODWAY DATA

LAS VEGAS WASH - LAS VEGAS CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE
Overton Wash								
G	8,217[1]	457	905	6.3	1,311.0	1,311.0	1,311.1	0.1
H	9,147[1]	629	1104	5.1	1,320.9	1,320.9	1,320.9	0.0
I	10,387[1]	321	684	8.3	1,341.3	1,341.3	1,341.3	0.0
J	10,927[1]	840	945	6.0	1,352.8	1,352.8	1,252.8	0.0
K	11,817[1]	317	824	6.9	1,365.0	1,365.0	1,365.0	0.0
L	13,297[1]	750	897	6.3	1,390.2	1,390.2	1,390.2	0.0
M	15,097[1]	555	993	5.7	1,417.9	1,417.9	1,417.9	0.0
N	16,477[1]	371	716	7.9	1,437.4	1,437.4	1,437.4	0.0
Pulsipher Wash								
A	490[2]	800	557	3.7	1,538.8	1,538.8	1,538.8	0.0
B	880[2]	222	311	6.7	1,546.3	1,546.3	1,547.0	0.7
C	1,210[2]	165	398	5.2	1,550.9	1,550.9	1,551.6	0.7
D	2,400[2]	336	819	2.5	1,573.9	1,573.9	1,574.9	1.0
E	3,350[2]	52	194	10.7	1,580.0	1,580.0	1,580.1	0.1
F	4,020[2]	65	210	9.9	1,588.2	1,588.2	1,589.0	0.8
G	4,870[2]	200	1,213	1.7	1,603.4	1,603.4	1,603.5	0.1

[1]Feet Above Confluence with Muddy River
[2]Feet Upstream of Confluence with Virgin River

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS

FLOODWAY DATA

OVERTON WASH - PULSIPHER WASH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET NGVD)
Tropicana Wash Central Branch								
A	0.000	112	786	6.1	2,001.1	2,001.1	2,002.1	1.0
B	0.080	87	392	12.2	2,011.6	2,011.6	2,011.6	0.0
C	0.135	81	486	9.9	2,022.1	2,022.1	2,022.1	0.0
D	0.170	79	446	11.9	2,024.6	2,024.6	2,024.6	0.0
E	0.219	120	497	10.7	2,027.1	2,027.1	2,027.3	0.2
F	0.276	142	877	6.0	2,029.0	2,029.0	2,029.9	0.9
G	0.301	172	1,321	4.0	2,031.5	2,031.5	2,031.7	0.2
H	0.345	99	579	9.2	2,031.5	2,031.5	2,031.5	0.0
I	0.397	77	406	13.0	2,033.2	2,033.2	2,033.2	0.0
J	0.446	109	828	6.4	2,037.1	2,037.1	2,037.2	0.1
K	0.491	106	450	11.8	2,037.9	2,037.9	2,037.9	0.0
L	0.587	191	353	5.3	2,043.8	2,043.8	2,044.5	0.7
M	0.667	356	605	3.1	2,044.8	2,044.8	2,045.8	1.0
N	0.705	290	683	7.8	2,048.9	2,048.9	2,048.9	0.0
O	0.800	197	619	8.6	2,050.8	2,050.8	2,051.8	1.0
P	0.866	106	449	11.8	2,055.8	2,055.8	2,055.8	0.0
Q	0.887	92	431	12.3	2,057.0	2,057.0	2,057.0	0.0
R	0.903	104	771	4.3	2,059.8	2,059.8	2,059.8	0.0
S	0.912	120	802	4.1	2,060.2	2,060.2	2,060.2	0.0
T	0.936	123	744	4.5	2,060.2	2,060.2	2,060.2	0.0
U	0.992	107	553	6.0	2,060.2	6,020.2	2,060.2	0.0
V	1.036	95	444	7.5	2,160.4	2,060.4	2,060.4	0.0
W	1.073	85	364	9.1	2,060.7	2,060.7	2,060.7	0.0
X	1.080	58	356	9.3	2,061.1	2,061.1	2,061.1	0.0
Y	1.095	67	283	11.8	2,063.8	2,063.8	2,063.8	0.0
Z	1.118	109	686	4.8	2,066.2	2,066.2	2,066.2	0.0

[1] Miles Above Confluence With Flamingo Wash

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS

FLOODWAY DATA

TROPICANA WASH-CENTRAL BRANCH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET NGVD)
Tropicana Wash-Central Branch								
AA	1.142	152	1,047	3.2	2,068.4	2,068.4	2,068.4	0.0
AB	1.166	83	399	8.3	2,068.9	2,068.9	2,069.8	0.9
AC	1.237	109	332	10.0	2,074.2	2,074.2	2,074.2	0.0
AD	1.340	73	318	10.5	2,081.9	2,081.9	2,081.9	0.0
AE	1.391	88	561	5.9	2,084.5	2,084.5	2,084.6	0.1
AF	2.566	613	6,370	0.4	2,154.7	2,154.7	2,155.7	1.0
AG	2.668	48	194	11.6	2,155.8	2,155.8	2,156.8	1.0
AH	2.763	68	240	3.3	2,161.9	2,161.9	2,162.8	0.9
AI	2.859	36	89	9.0	2,169.4	2,169.4	2,169.4	0.0
AJ	2.906	30	84	9.6	2,174.1	2,174.1	2,174.1	0.0
AK	2.936	39	138	5.8	2,176.1	2,176.1	2,176.1	0.0
AL	2.967	35	98	8.2	2,176.5	2,176.5	2,176.5	0.0
AM	3.060	31	98	8.2	2,181.6	2,181.6	2,181.6	0.0
AN	3.157	52	129	6.2	2,187.9	2,187.9	2,187.9	0.0
AO	3.260	59	98	7.2	2,198.8	2,198.8	2,199.8	1.0
AP	3.353	86	257	2.8	2,202.6	2,202.6	2,203.3	0.7
AQ	3.411	125	770	5.3	2,213.6	2,213.6	2,214.6	1.0
AR	3.585	160	466	8.8	2,220.4	2,220.4	2,221.4	1.0
AS	3.682	145	1,118	3.7	2,230.9	2,230.9	2,231.9	1.0
AT	3.800	150	432	9.5	2,233.9	2,233.9	2,233.9	0.0
AU	3.866	82	252	9.5	2,236.2	2,236.2	2,237.1	0.9
AV	3.884	80	456	5.3	2,240.9	2,240.9	2,240.9	0.0
AW	3.907	58	382	6.3	2,240.9	2,240.9	2,240.9	0.0
AX	3.945	57	357	6.7	2,240.9	2,240.9	2,241.1	0.2
AY	3.979	73	425	5.6	2,243.1	2,243.1	2,243.1	0.0
AZ	4.084	79	242	9.9	2,245.5	2,245.5	2,245.5	0.0

[1]Miles Above Confluence With Flamingo Wash

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS

FLOODWAY DATA

TROPICANA WASH-CENTRAL BRANCH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET NGVD)
Tropicana Wash-Central Branch (Cont'd)								
BA	4.113[1]	97	412	5.8	2,247.0	2,247.0	2,247.6	0.6
BB	4.137[1]	118	295	8.1	2,250.4	2,250.4	2,250.6	0.2
BC	4.179[1]	73	253	8.1	2,251.7	2,251.7	2,252.7	0.9
BD	4.366[1]	61	318	10.4	2,259.4	2,259.4	2,260.2	0.9
BE	4.461[1]	62	324	10.2	2,266.0	2,266.0	2,266.0	0.0
BF	4.560[1]	81	330	10.0	2,273.6	2,273.6	2,273.8	0.3
Tropicana Wash-North Branch								
A	0.093[2]	104	188	7.7	2,237.9	2,237.9	2,237.9	0.0
B	0.188[2]	110	211	6.9	2,243.1	2,243.1	2,243.1	0.0
C	0.203[2]	150	328	4.4	2,243.8	2,243.8	2,243.9	0.1
D	0.215[2]	179	499	2.9	2,246.6	2,246.6	2,246.6	0.0
E	0.284[2]	180	225	6.5	2,248.3	2,248.3	2,248.7	0.4
F	0.381[2]	174	332	4.4	2,253.7	2,253.7	2,254.4	0.7
G	0.476[2]	187	293	5.0	2,258.7	2,258.7	2,259.6	0.9
H	0.570[2]	124	273	5.3	2,263.4	2,263.4	2,264.2	0.8
I	0.667[2]	70	181	8.0	2,268.6	2,268.6	2,268.6	0.0
J	0.760[2]	68	237	6.1	2,271.4	2,271.4	2,272.0	0.6
K	0.840[2]	49	175	8.3	2,274.0	2,274.0	2,274.0	0.0
L	0.863[2]	50	369	3.9	2,279.1	2,279.1	2,279.1	0.0
M	0.886[2]	51	286	5.1	2,279.2	2,279.2	2,279.2	0.0
N	0.953[2]	49	171	8.5	2,279.4	2,279.4	2,279.6	0.2
O	1.045[2]	82	221	6.6	2,283.2	2,283.2	2,284.1	0.9

[1]Miles Above Confluence With Flamingo Wash
[2]Miles Above Confluence With Tropicana Wash-Central Branch

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS

FLOODWAY DATA

TROPICANA WASH-CENTRAL BRANCH - TROPICANA WASH-NORTH BRANCH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET NGVD)
Tropicana Wash-North Branch (Cont'd)								
P	1.134	92	205	7.1	2,289.0	2,289.0	2,289.3	0.3
Q	1.235	81	186	6.7	2,295.2	2,295.2	2,295.8	0.6
R	1.337	76	214	5.8	2,300.3	2,300.3	2,301.0	0.7
S	1.434	57	140	8.9	2,306.2	2,306.2	2,306.2	0.0
T	1.530	63	153	7.9	2,312.1	2,312.1	2,312.4	0.3
U	1.630	52	131	9.1	2,318.0	2,318.0	2,318.5	0.5
V	1.733	38	191	6.3	2,326.9	2,326.9	2,326.9	0.0
W	1.831	44	241	5.0	2,327.8	2,327.8	2,328.0	0.2
X	1.926	53	132	9.1	2,330.3	2,330.3	2,330.3	0.0
Y	2.026	32	112	10.7	2,339.5	2,339.5	2,339.9	0.4
Z	2.137	28	93	9.2	2,348.6	2,348.6	2,348.7	0.1
AA	2.240	28	102	8.3	2,354.0	2,354.0	2,354.6	0.6
AB	2.348	48	101	8.4	2,362.2	2,362.2	2,362.2	0.0
AC	2.446	35	95	8.9	2,370.5	2,370.5	2,370.5	0.0
AD	2.545	30	87	9.8	2,380.7	2,380.7	2,380.7	0.0

[1]Miles Above Confluence With Tropicana Wash Central Branch

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS

FLOODWAY DATA

TROPICANA WASH-NORTH BRANCH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET NGVD)
Tropicana Wash-South Branch								
A	0.093	95	688	2.6	2,275.4	2,275.4	2,275.6	0.2
B	0.191	68	189	9.5	2,277.8	2,277.8	2,278.8	1.0
C	0.292	59	187	9.6	2,285.5	2,285.5	2,286.4	0.9
D	0.393	52	173	10.4	2,293.6	2,293.6	2,293.6	0.0
E	0.486	84	226	8.0	2,299.3	2,299.3	2,299.7	0.4
F	0.584	76	203	8.9	2,310.9	2,310.9	2,310.9	0.0
G	0.676	89	230	7.8	2,316.8	2,316.8	2,317.8	1.0
H	0.779	85	203	8.9	2,324.4	2,324.4	2,324.4	0.0
I	0.872	83	217	8.3	2,330.1	2,330.1	2,330.3	0.2
J	0.967	65	194	9.3	2,336.8	2,336.8	2,337.7	0.9
K	1.079	86	213	8.5	2,344.6	2,344.6	2,345.5	0.9
L	1.173	56	203	8.9	2,350.8	2,350.8	2,351.5	0.7
M	1.272	60	211	8.5	2,356.1	2,356.1	2,356.2	0.1
N	1.368	69	189	9.5	2,361.4	2,361.4	2,361.4	0.0
O	1.465	73	171	8.8	2,370.5	2,370.5	2,370.5	0.0
P	1.565	50	166	9.0	2,376.1	2,376.1	2,376.6	0.5
Q	1.664	66	166	9.1	2,383.6	2,383.6	2,384.0	0.4
R	1.761	66	166	9.0	2,391.0	2,391.0	2,391.5	0.5
S	1.860	92	203	7.4	2,398.0	2,398.0	2,398.3	0.3
T	1.963	60	161	9.3	2,405.7	2,405.7	2,405.7	0.0

[1]Miles Above Confluence With Tropicana Wash Central Branch

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS

FLOODWAY DATA

TROPICANA WASH-SOUTH BRANCH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET NGVD)
Union Pacific Railroad Overflow								
A	510	70	413	5.4	1,900.8	1,900.8	1,900.9	0.1
B	1,030	78	299	7.5	1,901.4	1,901.4	1,901.7	0.3
C	1,270	130	435	5.2	1,903.2	1,903.2	1,903.5	0.3
D	1,640	170	580	3.9	1,905.2	1,905.2	1,906.1	0.9
E	1,970	160	566	4.0	1,906.4	1,906.4	1,907.2	0.8
F	2,420	464	2,206	1.3	1,907.0	1,907.0	1,907.6	0.6
G	2,640	327	980	3.0	1,906.9	1,906.9	1,907.5	0.6
H	2,875	108	321	9.1	1,906.9	1,906.9	1,907.2	0.3
I	3,505	79	318	9.1	1,910.7	1,910.7	1,911.1	0.4
J	4,030	199	426	6.8	1,914.1	1,914.1	1,914.2	0.1
K	4,325	119	585	5.0	1,915.1	1,915.1	1,915.6	0.5
L	4,665	102	590	4.9	1,915.4	1,915.4	1,915.9	0.5

[1]Feet Upstream of Unnamed Tributary to Las Vegas Wash

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS

FLOODWAY DATA

UNION PACIFIC RAILROAD OVERFLOW

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Unnamed Tributary to Las Vegas Wash								
B	810	104	597	11.5	1,855.7	1,855.7	1,856.3	0.6
C	1,490	87	830	8.3	1,859.8	1,859.8	1,860.5	0.7
D	2,915	78	483	14.2	1,870.5	1,870.5	1,871.0	0.5
E	3,500	200	837	8.2	1,877.0	1,877.0	1,877.7	0.7
F	3,950	85	518	13.3	1,879.4	1,879.4	1,879.9	0.5
G	4,550	150	1,050	6.5	1,884.4	1,884.4	1,885.2	0.8
H	4,720	106	643	10.7	1,884.7	1,884.7	1,885.4	0.7
I	5,395	100	575	12.0	1,889.6	1,889.6	1,890.1	0.5
J	6,345	99	472	12.5	1,897.5	1,897.5	1,897.6	0.1
K	7,025	110	614	8.0	1,901.3	1,901.3	1,901.8	0.5
L	7,995	99	455	10.8	1,904.0	1,904.0	1,904.0	0.0

[1]Feet Upstream of Confluence With Las Vegas Wash

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS

FLOODWAY DATA

UNNAMED TRIBUTARY TO LAS VEGAS WASH

5.0 INSURANCE APPLICATION

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

Zone A

Zone A is the flood insurance rate zone that corresponds to the 100-year floodplains determined in the Flood Insurance Study by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no base flood elevations (BFEs) or depths are shown within this zone.

Zone AE

Zone AE is the flood insurance rate zone that corresponds to the 100-year floodplains determined in the Flood Insurance Study by detailed methods. Whole-foot BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone AO

Zone AO is the flood insurance rate zone that corresponds to the areas of 100-year 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. Alluvial fan flood hazard areas are shown on the FIRM as Zone AO, and average depths and velocities of flow are shown. In these areas, the 100-year flood depths may exceed 3 feet. Development on alluvial fans is subject to a more severe flood hazard than would normally be encountered in Zone AO because the velocities of flows in the alluvial fan are high and the locations of the flow paths on the alluvial fan are unpredictable.

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, areas of 100-year flooding where average depths are less than 1 foot, areas of 100-year flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 100-year flood by levees. No BFEs or depths are shown within this zone.

Zone D

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

6.0 FLOOD INSURANCE RATE MAP

The Flood Insurance Rate Map is designed for flood insurance and floodplain management applications.

For flood insurance applications, the map designates flood insurance rate zones as described in Section 5.0 and, in the 100-year floodplains that were studied by detailed methods, shows selected whole-foot base flood elevations (BFEs) or average depths. Insurance agents use the zones and BFEs in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

For floodplain management applications, the map shows by tints, screens, and symbols, the 100- and 500-year floodplains, floodways, and locations of selected cross sections used in the hydraulic analyses and floodway computations.

The current Flood Insurance Rate Map represents flooding information for the entire geographic areas of Clark County. Previously separate Flood Insurance Rate Maps were prepared for each identified flood prone incorporated community and the unincorporated areas of the country. Historical data relating to the maps prepared for each community are presented in Table 6.

7.0 OTHER STUDIES

A Flood Plain Information report for Lower Las Vegas Wash was prepared by the COE in 1967 (Reference 41). The limits of the report extended to the southern corporate limits of the City of Las Vegas but did not extend to the City of North Las Vegas. Peak discharge values were calculated for Las Vegas Wash that did not correspond to values used by the COE for their Flood Plain Information report. However, these differences were resolved during earlier coordination meetings.

Boulder City completed a floodplain study (Reference 42) in 1975. Another study completed in Boulder City was the Hemenway Wash Inventory and Evaluation (Reference 43). Flood Boundaries were not drawn for that study; only peak discharges were computed.

Detailed Flood Insurance Studies have previously been performed for the incorporated Cities of Las Vegas, North Las Vegas, Henderson, Boulder City, and Mesquite (References 44, 45, 46, 47, 48, respectively).

Detailed analyses of flooding along Colorado River matches exactly with the detailed analyses of flooding shown in the Flood Insurance Study for the City of Bullhead City, Arizona (Reference 49). Flood Insurance Studies for Nye County, Nevada; Lincoln County, Nevada; Mohave County, Arizona; San Bernardino County, California; and Inyo County, California have been performed (References 50, 51, 52, 53 and 54, respectively). The information in those studies generally agrees with the information given in this study for Clark County.

Table 6. Community Map History

Community Name	Initial Identification	Flood Hazard Boundary Map Revision Date(s)	FIRM Effective Date	FIRM Revision Date(s)
Boulder City, City of	June 28, 1974	December 26, 1975	September 16, 1981	--
Clark County (Unincorporated Areas)	August 30, 1974	June 27, 1978	September 29, 1989	--
Henderson, City of	June 28, 1974	January 28, 1977	June 15, 1982	--
Las Vegas, City of	December 3, 1976	--	September 30, 1980	October 18, 1983
Mesquite, City of	November 1, 1985	--	September 28, 1990	--
North Las Vegas, City of	February 15, 1974	February 4, 1977	January 16, 1981	December 15, 1983

8.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting the Natural and Technological Hazards Division, FEMA, Presidio of San Francisco, Building 105, San Francisco, California 94129.

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10.0 REVISION DESCRIPTIONS

This section has been added to provide information regarding significant revisions made since the original Flood Insurance Study was printed. Future revisions may be made that do not result in the republishing of the Flood Insurance Study report. To ensure that any user is aware of all revisions, it is advisable to contact the community repositories.

10.1 First Revision

Countywide Update

This revision has combined the Flood Insurance Rate Maps and Flood Insurance Study Reports of the County and incorporated cities into the countywide format.

Under the countywide format, Flood Insurance Rate Map panels have been produced using a single layout format for the entire area within the county instead of separate layout formats for each community. The single layout format facilitates the matching of adjacent panels and depicts the flood hazard area within the entire panel border, even in areas beyond a community corporate boundary line. In addition, under the countywide format, this single Flood Insurance Study report provides all Flood Insurance Study information and data for the entire county area.

The mapping for the countywide conversion has been prepared using digital data. Previously published Flood Insurance Rate Map data produced manually have been converted to vector digital data by a digitizing process. These vector data were fit to raster digital images of the USGS quadrangle maps of the county area to provide horizontal positioning.

Road and highway names and centerline data have been obtained from the Clark County Geographical Information System (GIS) Management Office. The Clark County GIS data were positioned using the USGS quadrangle maps with the relative centerline configuration and names maintained for the City of Las Vegas. For county areas outside of Las Vegas the centerlines were modified to the positional accuracy of the USGS quadrangle maps and the roads, highways and street names were taken from the Flood Insurance Rate Map panels. The adjusted centerline data were then computer plotted with the digitized floodplain data to produce the countywide Flood Insurance Rate Map.

This study was revised on August 16, 1995, to include the restudy of hydrologic and hydraulic conditions on Tropicana Wash and Tributaries; Blue Diamond Alluvial Fan and an unnamed alluvial fan just west of Blue Diamond Alluvial Fan; North Branch Blue Diamond Wash and Middle Branch Blue Diamond Wash; Duck Creek; Duck Creek South Channel; and Duck Creek Tributary.

Duck Creek, North Branch Blue Diamond Wash, Middle Branch Blue Diamond Wash, Blue Diamond Alluvial Fan, and an Unnamed Alluvial Fan just West of Blue Diamond Alluvial Fan

Authority and Acknowledgments:

The hydrologic analyses for Duck Creek were performed by James M. Montgomery Consulting Engineers, Inc. (JMM) and were included in the report entitled "Las Vegas Valley Flood Insurance Study Hydrology Report," September 1991 (Reference 55). Flood-frequency curves were developed by MBJ at the apexes of Blue Diamond Alluvial Fan and the unnamed alluvial fan and for North Branch Blue Diamond Wash and Middle Branch Blue Diamond Wash at the Union Pacific Railroad (UPRR). The hydraulic analyses for all flooding sources were performed by Michael Baker Jr. (MBJ).

Coordination:

An initial meeting was held on February 25, 1992, to review the scope of work and the streams to be studied. Representatives from Clark County Public Works (CCPW), Clark County Regional Flood Control District (CCRFCD), MBJ and FEMA attended the meeting.

A second meeting was held on December 2, 1992, to review the results of the study. Representatives from CCPW, CCRFCD, MBJ and FEMA attended the meeting. All comments from the community have been incorporated into this study.

Scope:

This study covers Duck Creek from Robindale Road to Interstate 15, Duck Creek South Channel, Duck Creek Tributary from its confluence with Duck Creek to Interstate 15, North Branch Blue Diamond Wash from its confluence with Duck Creek to the UPRR, Middle Branch Blue Diamond Wash from its confluence with Duck Creek to the UPRR, Blue Diamond Alluvial Fan from its apex to the UPRR, and the unnamed alluvial fan from its apex to Flamingo Wash.

The areas studied by detailed methods were selected with priority given to all known flood hazards and areas of projected development or proposed construction through May 1993.

Hydrologic Analysis:

For Duck Creek and Duck Creek Tributary, peak discharge values for the 100-year flood were obtained from the report entitled "Las Vegas Valley Flood Insurance Study Hydrology Report," dated September 1991 (Reference 55). Peak discharges were determined in this study by use of the COE HEC-1 hydrologic model (Reference 56).

The flood frequency curves developed at the apexes of the alluvial fans are log-normal. Standard deviations for the curves were found using 100-year discharge values listed in the Technical Appendix to JMM's report entitled "Las Vegas Valley Flood Insurance Study

Hydrology Report," dated September 1991 (Reference 55). Two-year discharge values were determined using COE regional relationships presented in its report entitled "Hydrologic Documentation for Feasibility Study, Las Vegas Wash and Tributaries, Clark County, Nevada," dated April 1988 (Reference 57).

The flood frequency curves for North Branch Blue Diamond Wash and Middle Branch Blue Diamond Wash at the UPRR were defined by the identification of two points for each wash through which flow would pass to enter the respective culverts. The frequency at which a given discharge is exceeded between those points is a function of the frequency at which it is exceeded at the apex of the Blue Diamond alluvial fan, the width of the opening between the two points, and the width of the area subject to alluvial flooding at the elevation of the two points. Flow values with recurrence intervals of 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 200, and 500 years were computed. The flood frequency curves at the UPRR were defined by fitting a log-Pearson Type III distribution to those pairs of flow values and recurrence intervals.

Hydraulic Analysis:

Cross-sectional information for Duck Creek and Duck Creek Tributary, North Branch Blue Diamond Wash and Middle Branch Blue Diamond Wash were obtained from the HEC-2 computer analyses prepared by JMM in 1986 for the draft Flood Insurance Study for the unincorporated areas of Clark County, Nevada, dated August 1986 (Reference 63). Additional information used to update and/or revise these data was obtained from Conditional Letter of Map Revision (CLOMR) and Letter of Map Revision (LOMR) data listed below, from recent aerial photographic maps entitled "Las Vegas," dated April 1991 (Reference 58), from plans and mapping obtained from the CCPW, from recent topographic maps entitled "Duck Creek Wash," dated October 15, 1992 (Reference 59), and from field investigations conducted in February 1992.

List of CLOMRs and LOMRs

Stream	Property	Request Type	Date Issued
Duck Creek	Symphony Encore	LOMR	10/04/91
Duck Creek	Paradise Estates	CLOMR	Dropped
Duck Creek	Robindale Terrace	LOMR	06/05/91
Duck Creek	Crystal Springs-Unit 5-6	LOMR	10/26/89
Duck Creek	Crystal Springs-Unit 6-7	LOMR	07/17/89
Duck Creek	Crystal Springs-Unit 8-9	LOMR	10/16/90

Duck Creek	Crystal Springs-Unit 11-12	LOMR	06/23/92
Duck Creek	Windmill Village	CLOMR	11/24/92
Middle Branch Blue Diamond Wash	Buckingham Estates-Unit 1	LOMR	08/01/90
Middle Branch Blue Diamond Wash	Carousel Park	LOMR	04/01/91
North Branch Blue Diamond Wash	Buckingham Estates-Unit 2	CLOMR	03/12/91

The COE HEC-2 hydraulic model (Reference 22) was used to determine the 100-year flood elevations for Duck Creek, Duck Creek Tributary, North Branch Blue Diamond Wash, and Middle Branch Blue Diamond Wash.

The starting water-surface elevations for Duck Creek and North Branch Blue Diamond Wash were based on the slope-area method. The starting water-surface for Middle Branch Blue Diamond Wash was based on critical depth at the downstream end of the culvert under Bermuda Road.

Channel roughness factors (Manning's "n") used in the hydraulic computations were chosen by engineering judgment and based on field observations of the streams and floodplain areas. The channel roughness varies from 0.025 to 0.044 and the overbank roughness varies from 0.025 to 0.060. These values are included in Table 4.

The hydraulic analyses included divided flow analyses on the reach of Duck Creek between Pebble Road and its confluence with Duck Creek Tributary. These analyses involved balancing the quantity of flow in Duck Creek and the divided flow reach (Duck Creek-South Channel) so that water-surface elevations and energy grades were balanced at the upstream cross sections of the reach.

The hydraulic analysis for North Branch Blue Diamond Wash included a HEC-2 computer model for the 100-year flood and floodway from Amigo Street upstream to Interstate 15. For areas downstream from Amigo Street, HEC-2 computations were utilized to determine channel capacities. For flows exiting the channel, shallow flooding methods and available topographic mapping were utilized to determine areas subject to shallow flooding. Computations in this area were based on development plans for Buckingham Estates, Units Nos. 1 and 2. The channel area from Amigo Street to Duck Creek was designated Zone A because final channel banks and linings have not been completed.

The hydraulic analysis for Middle Branch Blue Diamond Wash included a HEC-2 computer model that used the split flow option to calculate the amount of flow that leaves the main channel at Gilespie Street. The ground to the north of the wash is lower than the water-surface elevation, resulting in a flow split toward the north. At Gilespie Street, approximately 80 cfs overflows the main channel to the north. The 80 cfs that escape at Gilespie Street continues to flow south of and parallel to Windmill Lane. The resulting flooding is less than 1 foot in average depth. The flow combines with the flow in the main channel east of Bermuda Road and flows into Windmill Lane and Windmill Channel to the confluence with Duck Creek.

Floodways for the split flow areas on Duck Creek and Duck Creek Tributary at Las Vegas Boulevard and Interstate 15, and the area downstream of the split flow at Gilespie Street, were analyzed assuming that the flow splits would be confined in the main wash for the floodway run. The encroached 100-year flood elevations (with no flow splits allowed) were compared to the unencroached 100-year flood elevations (with the flow splits allowed) to make certain that the 1-foot surcharge was not exceeded.

The areas subject to alluvial fan flooding were delineated based on the information shown on topographic maps, (Reference 62) site investigation, and recent aerial photographs. The recent aerial photographs are shown on maps entitled "Las Vegas," dated April 1991 (Reference 58). FEMA's FAN program (Reference 60) was used to compute the contour widths corresponding to flood insurance zone boundaries. For Blue Diamond Alluvial Fan, two boundaries were determined for the northern side of the fan between elevations 2,352 and 2,644 feet NGVD. It was determined that flood flow not exceeding 1.5 feet in energy would be confined to south of the southern most of these boundaries. In the multiple channel region of the fan the flow corresponding to 1.5 feet in energy is 6,954 cfs. Therefore, for flows less than 6,954 cfs, contour widths were measured using the southernmost of the two northern boundaries; for flows greater than 6,954 cfs, contour widths were measured using the northernmost boundary.

For North Branch Blue Diamond Wash, between the UPRR and Interstate 15, the analysis showed that at a point approximately 1,400 feet downstream of the UPRR, the capacity of the wash is approximately 2,000 cfs. At Decatur Boulevard it was found that approximately 50 percent of the flow in the wash at the road crossing (1,000 cfs) would continue east, not following the wash. The remaining 50 percent of the flood flow (1,000 cfs) was modeled as if it followed the wash down to a point approximately 4,000 feet downstream of Decatur Boulevard. Those percentages were estimated from the cross-sectional areas to the left and right of the crossing of Decatur Boulevard when it is flowing full.

The alluvial fan flooding for North Branch Blue Diamond Wash was modeled the following way. Below elevation 2,384 feet, only that part of the flow exceeding 2,000 cfs was modeled as alluvial fan flooding originating at the breakout point on the right bank. Flows of less than 2,000 cfs were modeled as though they proceeded downstream to Decatur Boulevard. Below Decatur Boulevard, only 50 percent of the flow was modeled as alluvial fan flooding. The remaining 50 percent (of flows less than 2,000 cfs) was modeled as though it proceeded downstream to a point approximately 4,000 feet downstream of Decatur Boulevard. At that point the wash vanishes. The remaining flow was modeled as alluvial fan flooding.

For Middle Branch Blue Diamond Wash, between the UPRR and Interstate 15, all flows were modeled as alluvial fan flooding.

Areas subject to alluvial fan flooding where the 100-year flood depth is, on average, less than 1.0 foot are labeled Zone X (Shaded). When realized, the hazards associated with alluvial fan flooding are just as severe in areas designated Zone X (Shaded) as those designated Zone AO. The distinction between the zones should be regarded as a distinction between flooding potentials and not a distinction between the severity of damages to be expected in the event of a flood.

The flood-frequency relationships defined at the North and Middle Branch Blue Diamond Wash culverts under UPRR depend, in part, on the likelihood that a flood passing through the apex of the Blue Diamond Alluvial Fan follows a path to the culvert. Thus, although a flood passing through one of the culverts will be approximately the same magnitude at both the apex and the culvert, the frequency at which that magnitude flood is expected at the culvert is much less than that at the apex. Therefore, for floodplain management purposes, it should be noted that any flow realized at the apex of the Blue Diamond Alluvial Fan may follow a path to and, thus, be realized at one of the UPRR culverts.

Colorado River Floodway

This update also includes the addition of flood hazard data produced as a result of the "Colorado Floodway Protection Act" passed by Congress in 1986. The act was passed to establish a floodway along the Colorado River from Davis Dam to the U.S.-Mexican border. The hydrologic and hydraulic analyses were prepared by the USBR.

The hydrologic analysis was performed to determine the 100-year peak discharges at all points along the Colorado River for the study reach. Runoff from above Hoover Dam is typically the dominant contributing factor of flood flows, although combinations of releases from Davis and Parker Dams with flash floods originating from the watersheds contributing flows into the Colorado River, are significant in determining the peak 100-year discharges. A peak discharge of 40,000 cfs was determined to flow along the Colorado River from Davis Dam to the Clark County line. Further details regarding the methods used to produce the peak discharges along the Colorado River are outlined in the report entitled "Flood Frequency Determinations for the Lower Colorado River," Volume I, Supporting Hydrologic Documents of the Colorado River Floodway Protection Act of 1986, dated March 1989, prepared by the USBR.

The base (100-year) flood elevations along the Colorado River were determined by using the HEC-2 hydraulic computer model. The hydraulic analysis was based only on effective flow areas. A floodway was determined by setting the floodway boundaries at the limits of the effective flow model. The base flood elevations shown on the Flood Insurance Rate Map are both the 100-year natural and floodway elevations. The floodway fringe area (100-year floodplain) was determined using the computed water-surface elevations and topographic mapping. Base flood elevating for the Colorado River are provided on the Flood Insurance Rate Map.

Tropicana Wash and Tributaries

The reach of Tropicana Wash located in the unincorporated areas of Clark County, Nevada, from its confluence with Flamingo Wash extending westward to near the base of Spring Mountains was revised based on data submitted by CCRFCD.

The flooding sources studied by detailed methods were selected by the CCRFCD and CCPW with priority given to known flood hazard areas and developed areas or areas of proposed construction. The detailed study areas encompass the following:

- The Central Branch of Tropicana Wash from its confluence with Flamingo Wash to approximately 2,000 feet west of the UPRR. The North and Central Branches of the wash combine at this point. (Approximate Rivermile 0.0 to 3.7).

- The North Branch of Tropicana Wash from approximately 2,000 feet west of the UPRR to the Rainbow Boulevard crossing. (Approximate Rivermile 0.0 to 2.6 on the North Branch).

- The Central Branch of Tropicana Wash from approximately 2,000 feet west of the UPRR to the Rainbow Boulevard crossing. (Approximate Rivermile 3.7 to 7.0).

- The South Branch of Tropicana Wash from its confluence with the Central Branch near Decatur Boulevard to the west Sunset Road crossing. (Approximate Rivermile 0.0 to 1.9 on the South Branch).

The approximate study reaches were outlined by the CFRFCD in consultation with CCPW. In general, the reaches extend upstream from the limits of the detailed study reaches to a point where the contributing flow is less than 300 cfs. For the purposes of this study, future street and local drainage systems are assumed to convey flows less than 300 cfs.

Tributaries of the Tropicana Wash not studied include the unnamed wash and the Airport Channel.

The topographic mapping and hydraulic analyses for this study were performed by CH2M Hill for the Clark County Regional Flood Control District (CCRFCD). Ground control and check surveys were performed by Wesco Surveys, Inc. The work was completed in November 1992.

On June 10, 1992, representatives of the CCRFCD, CCPW, and CH2M Hill met for the initial coordination meeting to discuss scheduling, study methods, assumptions, and the format of the deliverable items. Throughout the project, coordination meetings were held to discuss progress and preliminary study results.

In general, hydrologic data for the study reaches examined by detailed methods were derived from the "Las Vegas Valley Flood Insurance Study Hydrology Report, 1991" (FIS Hydrology Report) (Reference 55). This report provides 100-year recurrence interval flow rate estimates for floodplain delineation studies in Clark County, Nevada. The report has previously been adopted by the CCRFCD. The data is based on HEC-1 computer models prepared for the various watersheds including Tropicana Wash.

Where additional hydrologic data at intermediate concentration points were required in the detailed methods study, the adopted HEC-1 model was modified according to procedures in the CCRFCD's "Hydrologic Criteria and Drainage Design Manual" (Reference 64). The associated flow rates are given in Table 3.

For areas studied by detailed methods, water-surface elevations for the 100-year flood were computed using the COE HEC-2 Water Surface Profile computer program (Reference 22). Where otherwise unknown, the starting water-surface elevations were developed using the slope-area method in the program. The Federal Highway Administration's computer program HY8 (Reference 65) was used to model water-surface elevations and capacities at some of the culvert crossings. Undersized crossings included weir flow calculations over the roadways.

The cross-section data for each of the streams were derived from aerial mapping. The mapping was prepared specifically for this project and based on aerial photography dated June 1992 (Reference 66). The cross-section data were digitized directly from the stereographic aerial models.

Ground control surveys, check profiles, and establishment of elevation reference marks were completed by Wesco Surveys. Vertical control is based on the National Geodetic Vertical Datum (NGVD 1929) and horizontal control is tied into the Nevada State Plane Coordinate System (NAD 1983). Clark County survey monuments were used for control whenever possible. The topographic mapping used for most of the areas studied by approximate methods were prepared by an earlier study (Reference 67).

Dimensions of hydraulic structures were obtained by field surveys.

Roughness coefficients (Manning's "n") used in the hydraulic analyses were selected based on field inspection of the entire stream reaches and engineering judgment. For Tropicana Wash Central Branch, roughness values range from 0.015 to 0.095 for the channel and from 0.002 to 0.125 for the overbank areas. For Tropicana Wash North Branch, roughness values range from 0.027 to 0.053 for the channel and from 0.025 to 0.085 for the overbank areas. For Tropicana Wash South Branch, roughness values range from 0.032 to 0.038 for the channel and for 0.043 to 0.060 for the overbank areas. These values are summarized in Table 4.

Headwater conditions at the Intersection 15/MGM culvert were previously modeled for the 100-year discharge (Reference 68). Since the original study, the potential headwater elevation has been raised by the addition of Jersey barriers. New headwater conditions were estimated with the Federal Highway Administration computer model HY8. The model was initially calibrated to the previous study and then the allowable headwater conditions were raised as appropriate. The resulting headwater elevation was used as the starting water-surface elevation for the backwater model. The new culvert flows were subtracted from the flowrate at the head of the culvert to obtain the breakout flows at Interstate 15.

The 9.75 foot diameter CMP culvert and a 2-barrel, 36-inch CMP structure at the UPRR crossing, the RCBC culvert at Paradise Road, and the 3- 10 x 6 box culverts at Arville Street were also modeled with HY8 and the results inserted into the HEC-2 model using the X5 record option.

The hydraulic analysis for the approximate methods were performed by normal depth calculations. The cross sections were constructed from topographic maps (Reference 67) and field reconnaissance.

The breakout flow characteristics at Cameron Street, the UPRR, and the Interstate 15/MGM culvert were modeled by approximate methods.

Results of the modeling indicate that flow breaks out of the main Tropicana channel in two general areas; namely, at the UPRR culvert and the Interstate 15/MGM culvert. In addition, a flow split occurs at the Arville Street and Cameron Street culverts.

At Cameron Street, the wash branches into two channels with one turning approximately 600 feet to the north and the other flowing east to the UPRR grade. The 66-inch RCP culvert under Cameron Street begins upstream of the flow split and outlets into the northern branch. Flow through the culvert was estimated from the hydraulic grade line given in the construction drawings. Flow in excess of the culvert capacity bypassed the culvert, broke over Cameron Street, and split into the two branches previously described. The flow in each branch was estimated by balancing the water-surface elevations in the channels downstream of the flow split. The break over flows were assumed to rejoin at the UPRR culvert crossing.

At the Arville Street crossing of the central branch of Tropicana Wash, a new 3-cell 10' by 6' RCBC culvert structure was designed and constructed by the CCPW. The culvert as designed does not contain the 100-year discharge. A portion of the flow that exceeds the capacity will flow northerly within Arville right-of-way and then northeasterly as shallow sheetflow to the UPRR railroad bed.

The HEC-2 special culvert routine was used in conjunction with a split flow analysis. The floodplain area from the flow which is conveyed in Arville Street was estimated by approximate methods based on topographic information and field evaluations.

The culverts at the UPRR were also modeled using HY8 to determine breakout flows at the railroad. The culvert capacity was subtracted from the runoff estimates upstream of the railroad to estimate the breakout discharge to the north. These flows follow north along the railroad grade for several hundred feet and then outlet into Tropicana Avenue. The runoff then flows generally within the Tropicana Avenue right-of-way to Industrial Road. At Industrial Road, the flow splits into two patterns; one flowing north and the other continuing south. Flows to the North follow Industrial Road, eventually crossing the Interstate 15 right-of-way between the Tropicana Avenue and Flamingo Road overpasses. The south branch rejoins Tropicana Wash flows just upstream of the Interstate 15/MGM culvert.

Breakout flow at the Interstate 15/MGM culvert generally travels north into the depressed median of Interstate 15. Approximately 100 cfs crosses Interstate 15 and enters ditches in the surrounding areas and is conveyed in the local storm drain system. The balance of the flow travels north in the Interstate 15 right-of-way and joins the breakout flows from Industrial Road. Some runoff continues north in the median eventually entering the Flamingo Wash; however, the bulk of the flows cross Interstate 15, and sheet flow through the city streets and adjacent parking lots in a northeasterly direction and eventually drain into the Flamingo Wash.

Floodplain boundaries for the detailed studies were delineated on topographic maps with a scale of 1" = 400" and a contour interval of four feet (Reference 66). Supplemental 2-foot contours were plotted in areas requiring greater definition. The boundaries of the 100-year flood were delineated using the elevations computed at each cross section by the HEC-2 models. The delineations were interpolated between cross sections using engineering judgment in conjunction with the topographic map features and known field conditions. The year flood elevations were not determined by this study.

The 100-year floodplain boundaries for approximately studies on areas west of Rainbow Boulevard and south of Sunset Road were delineated on topographic maps (Reference 67) prepared for the 1984 Flood Insurance Study. Approximate study boundaries east of Rainbow Boulevard and north of Sunset Road are shown on the 1992 mapping prepared for this study.

Existing stream sections effected substantially by backwater conditions include the channel just upstream of the Interstate 15/MGM culvert and the channel just upstream of the UPRR. At both of these locations, limited capacities of the structures cause breakout flows and flooding.

For this study, floodways were initially computed using the Method 4 encroachment option in the HEC-2 computer program. This option equally reduces the conveyance on each side of the cross section, thus raising the water-surface elevations, but maintaining it within the specified target value. These initial encroachments were then refined by plotting the floodplains on the mapping, using engineering judgment to adjust the floodplains as appropriate, and verifying the resulting floodplains with the Method 1 encroachment option in HEC-2. With this method, the encroachment stations are input into the model and the results reviewed, to ensure the floodplain water-surface elevation has not been raised more than the specified target value. The resulting floodways are shown on the Flood Insurance Rate Map.

Floodways were not determined on Tropicana Wash where it flows through the Interstate 15/MGM culvert (Interstate 15 to Koval Lane) and through the box culvert between Paradise Road and Swenson Street. Floodways were delineated for these reaches representing the approximate interior conveyance areas of the culvert structures. In addition, at the request of the CCRFCD, a floodway was not computed for the reach of Tropicana Wash Central Branch from upstream of the confluence with Tropicana Wash South Branch.

Best Available Data Letter

The following information, contained in a Best Available Data Letter dated January 30, 1989, for the City of North Las Vegas, is included in this update.

The Las Vegas Wash Detention Basin is a major flow reduction facility. It is located several miles north of the UPRR on the main branch of the Las Vegas Wash. It has a capacity of 2,430 acre-feet and controls an 880-square-mile watershed. It reduces flows at the UPRR by approximately 50 percent. A TR-20 computer model was prepared by JMM to show the effects of Las Vegas Wash Detention Basin.

The reduced flows for Las Vegas Wash and the Union Pacific Overflow were used in the revised HEC-2 hydraulic computer models between Lake Mead Boulevard and Lone Mountain Road, and for the UPRR overflow, prepared by JMM.

For both streams, the 100- and 500-year floodplain boundaries 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 1:2,400 with a contour interval of 2 feet (Reference 61).

The floodways for Las Vegas Wash and Union Pacific Overflow have been revised to reflect the new hydrologic and hydraulic analyses. The revised floodway boundary delineations are reflected on the Flood Insurance Rate Map for Las Vegas Wash from Las Vegas Boulevard to Lone Mountain Road, and for the overflow reach along the railroad. Table 5, "Floodway Data Table," also incorporates the revised data.

Letters of Map Change (LOMCs)

This revision also incorporates the determinations of LOMCs (LOMRs and Letters of Map Amendment) issued by FEMA for the projects listed by community in Table 7, "Letters of Map Change." These changes are reflected in the Summary of Discharges and Floodway Data Tables and on the Flood Profiles.

An Appeal Resolution Letter was issued on February 3, 1995, for the unincorporated areas of Clark County. The resolution of the appeal revised the zone designations of two unnamed tributaries to North Branch Tropicana Wash (NBTW) from Zone A to Zone X (shaded), to reflect areas of 100-year flooding with average depths of less than 1 foot. These modifications are shown on Flood Insurance Rate Map Panels 2535, 2545, and 2553. In addition, the BFEs, floodway boundaries, and floodplain boundaries were revised along NBTW to reflect a new culvert and channelization of the stream through Castle Vista Estates. The modifications are shown on Flood Insurance Rate Map Panel 2553 and Flood Profile Panel 41P and in the Floodway Data Table.

TABLE 7 - LETTERS OF MAP CHANGE

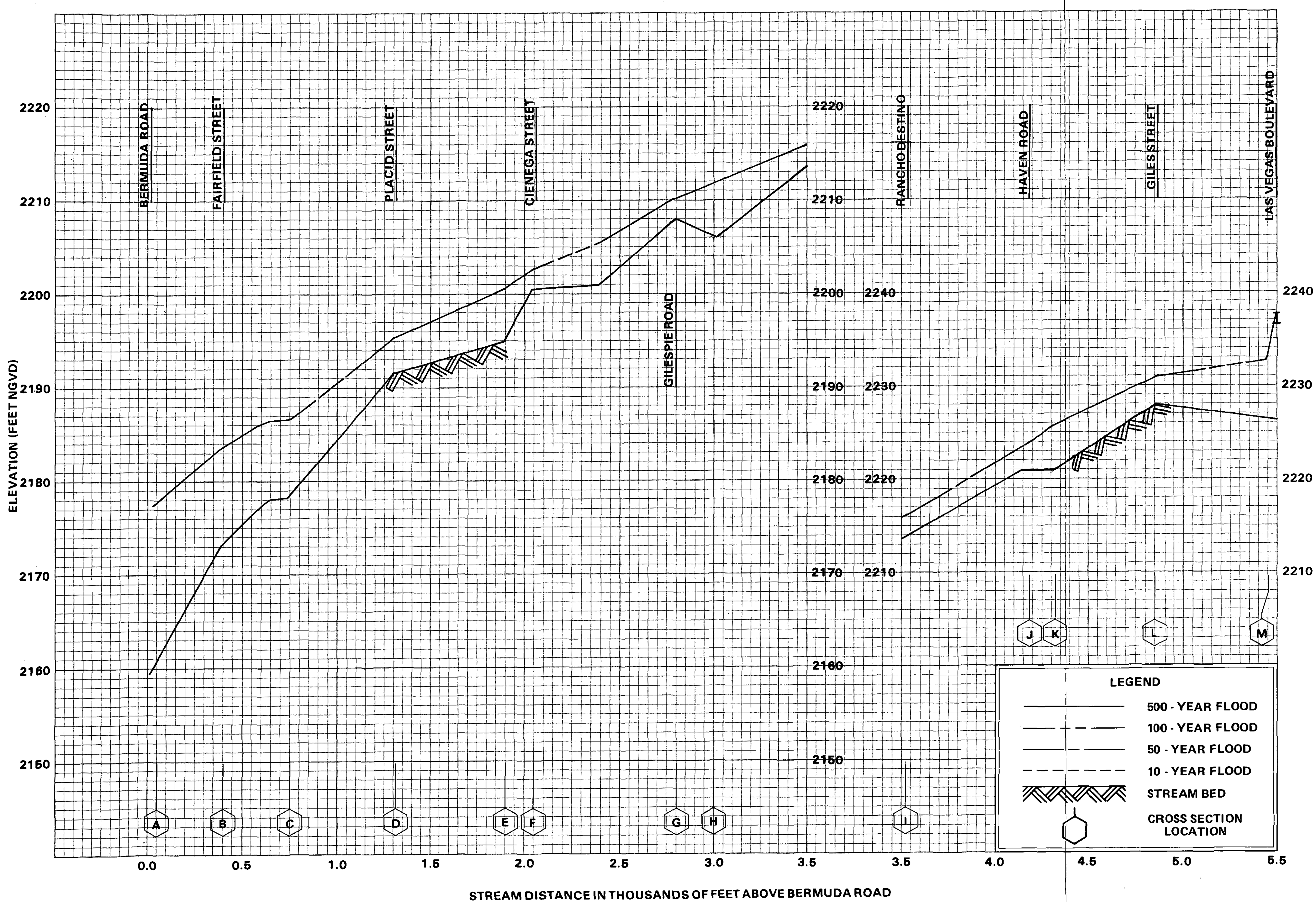
PROJECT	STREAM	DATE
CITY OF BOULDER CITY		
Hemenway Wash Channelization	Hemenway Wash	April 19, 1994
Georgia Avenue Wash	Georgia Avenue Wash	April 20, 1992
CITY OF HENDERSON		
Westwood Village	Pittman Wash	October 19, 1994
Wash A Channelization Project	Wash A	July 14, 1994
Lakeside Highlands	Zone A	June 24, 1994
Parcel K, Golf Village South	Unnamed Tributary to Pittman Wash	May 3, 1994
Pebble Creek Subdivision	Unnamed Tributaries to Pittman Wash	April 28, 1994
Lakeside Highlands Unit 1	Zone A	April 14, 1994
Country Brook Subdivision	C-1 Channel	March 29, 1994
Foothills Subdivision	Two Unnamed Tributaries	February 15, 1994
Union Pacific Railroad Channel	Pittman Wash Tributary and Union Pacific Railroad Channel	January 12, 1994
Hillsboro Heights	Zone A	January 11, 1994
Vintage at Grand Legacy	Zone A	January 6, 1994
Ocotillo Pointe I and II	Zone A	December 2, 1993
Union Pacific Railroad Channel	Pittman Wash Tributaries and Union Pacific Railroad Channel	September 28, 1993
Calico Terrace Subdivision	Unnamed Tributary to Las Vegas Wash	May 27, 1993
Ventana at Green Valley	Unnamed Zone A	September 8, 1992
Trailside Point Subdivision	Zone A	January 7, 1992
The Masters	Unnamed Zone A	December 16, 1991
Legacy Condominiums	Unnamed Zone A	November 14, 1991
Sandwedge Estates	Unnamed Tributary to Pittman Wash	September 30, 1991
Rolling Hills Ranch	Unnamed Zone A	February 1, 1991
Morningside II	Unnamed Tributary to Pittman Wash	December 21, 1990
Woodland Ridge Unit 2	Zone A	September 25, 1990
DKS Development	Unnamed Zone A	August 28, 1990
La Mancha Townhomes	Unnamed Zone A	January 4, 1990
Candle Creek Units 3 & 4	Whitney Ranch Channel	October 23, 1989
Warm Springs Reserve Unit 10	Zone A	October 4, 1989
Creekside Unit 1	Zone A	February 10, 1989
Warm Springs Reserve Unit 2	Zone A	November 1, 1988
Fox Ridge Terrace Unit 2	Zone A	October 18, 1988
Warm Springs Reserve Unit 5	Zone A	September 7, 1988
Pardee Green Valley South	Wash B	July 19, 1988

TABLE 7 - LETTERS OF MAP CHANGE (Cont'd)

PROJECT	STREAM	DATE
CITY OF HENDERSON (Cont'd)		
Warm Springs Reserve Unit 5	Zone A	June 28, 1988
Warm Springs Reserve Unit 4	Zone A	October 23, 1987
Pueblo Verde II Apartments	Unnamed Zone A	August 18, 1987
Wilton Commons	Zone A	December 13, 1985
Summerfield Units 1, 2, & 4	Zone A	July 28, 1982
Highland Hills Units 13-18	Zone A	June 23, 1982
Green Valley Village Units B & F	Zone A	February 11, 1982
CITY OF LAS VEGAS		
Northshore Lot D	Ponding	October 27, 1994
Unnamed Zone A	Unnamed Zone A	September 7, 1994
Country Lane Series II	Unnamed Zone A	July 19, 1994
Summerlin Parkway	Unnamed Zone A	September 13, 1993
Rancho Alta Mira Development	Unnamed Zone A	February 8, 1993
Northwind Subdivision	Unnamed Zone A	November 28, 1983
Proposed Lake Mead Villa	Unnamed Zone A	August 14, 1981
CITY OF NORTH LAS VEGAS		
Monterey Villas	Unnamed Tributary to Las Vegas Wash	January 25, 1995
Cheyenne Ridge Unit 1A	Unnamed Tributary to Las Vegas Wash	February 4, 1993
Upper Mendenhall and So. NV. Industrial Center Channels	Unnamed Tributary to Las Vegas Wash	August 20, 1990
UNINCORPORATED AREAS		
Fernwood Subdivision	Unnamed Basin	February 1, 1995
Woodside Village Apartments	Las Vegas Wash and Sloan Channel	November 11, 1994
Unnamed Zone A	Unnamed Zone A	September 7, 1994
Champion Estates	Zone A	June 17, 1994
Sloan Channel	Unnamed Tributary to Sloan Channel	June 8, 1994
Parcel 250-560-004	Unnamed Zone A	March 8, 1994
Sloan Channel	Las Vegas Wash and Sloan Channel	January 14, 1994
Mizrachi Property	Zone A	November 29, 1993
Summerlin Village I	Zone A	May 18, 1993
Sunrise Valley Homes	Sloan Channel	May 13, 1993
Rancho Nevada No. 2	Duck Creek	March 15, 1993
Summerlin Village 2	Zone A	December 18, 1992
Alta View West	Zone A	July 13, 1992
Realty Executive Plaza	Zone A	July 8, 1992
Flamingo Wash	Flamingo Wash	March 23, 1992

TABLE 7 - LETTERS OF MAP CHANGE (Cont'd)

PROJECT	STREAM	DATE
UNINCORPORATED AREAS (Cont'd)		
Pebble Canyon	Pebble Canyon	February 21, 1992
Custom Estates East	Duck Creek	December 12, 1991
Rancho Las Brisas	Buffalo Channel	October 3, 1991
Hillcrest Manor	Zone A	August 16, 1991
Sheaker Heights	Zone A	July 19, 1991
Richard Rundle Elementary School	Zone A	May 13, 1991
Winterwood Units 1, 2, & 3	Zone A	October 15, 1990
Arville Commerce Center	Flamingo Wash	August 17, 1990
Macchiaverna Villas	Flamingo Wash	March 30, 1990
Winterwood Sunrise	Zone A	March 23, 1990
Estates at Spanish Trail No. 1	Red Rock Wash and Flamingo Wash	November 2, 1989
Spanish Trail	Red Rock Wash and Flamingo Wash	October 11, 1989



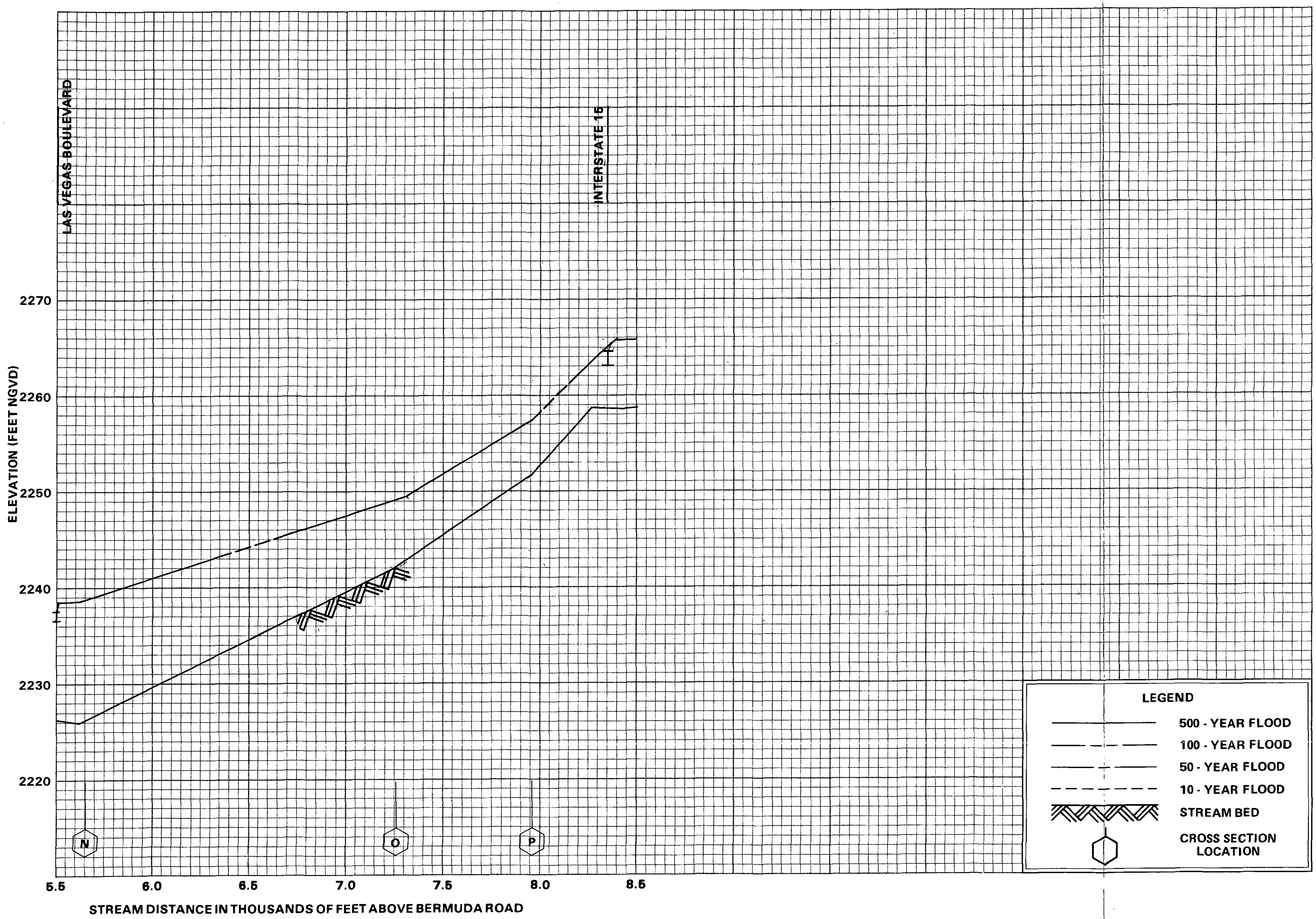
FLOOD PROFILES

BLUE DIAMOND WASH MIDDLE BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS

01P

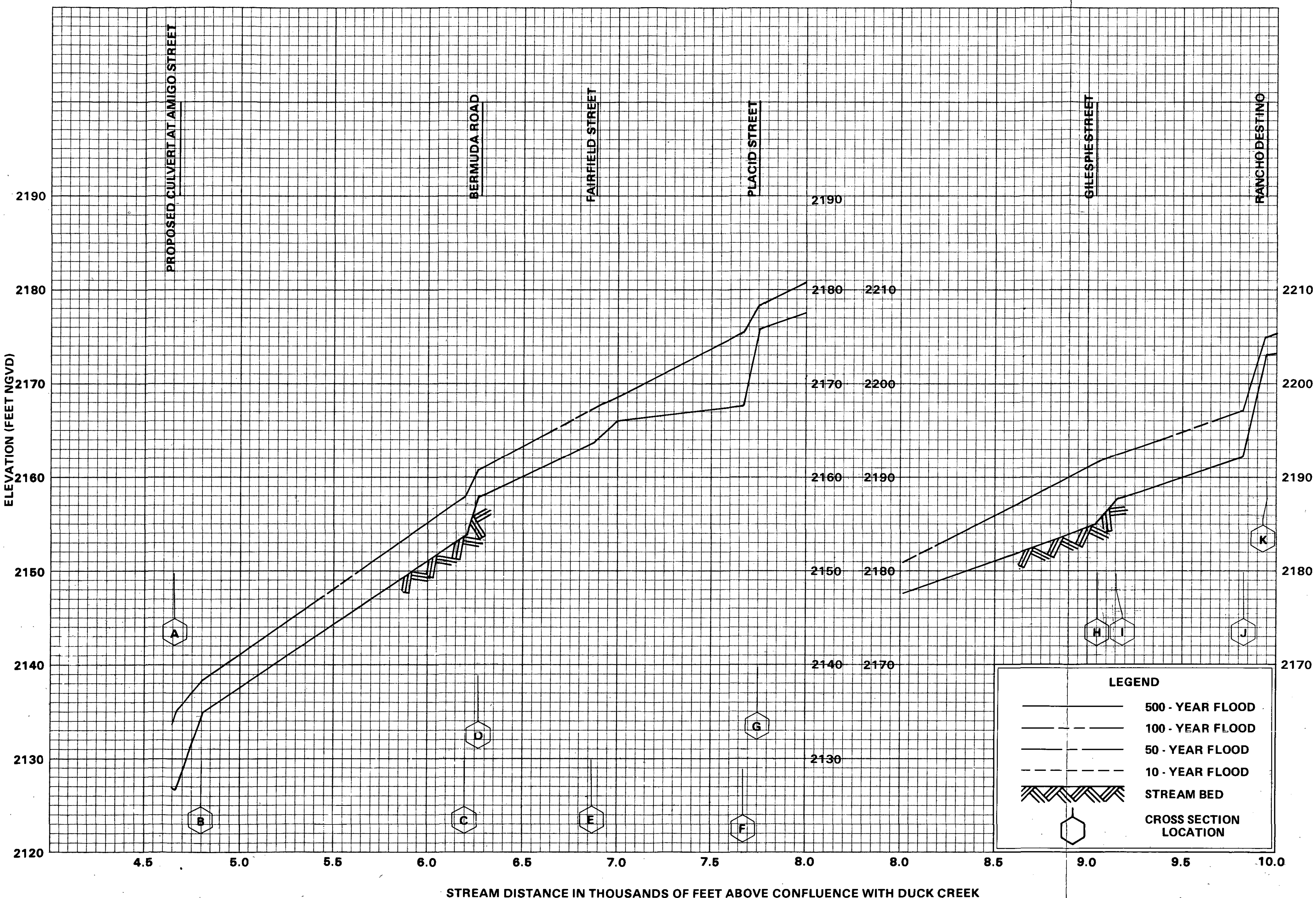


FLOOD PROFILES

BLUE DIAMOND WASH MIDDLE BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV
AND INCORPORATED AREAS



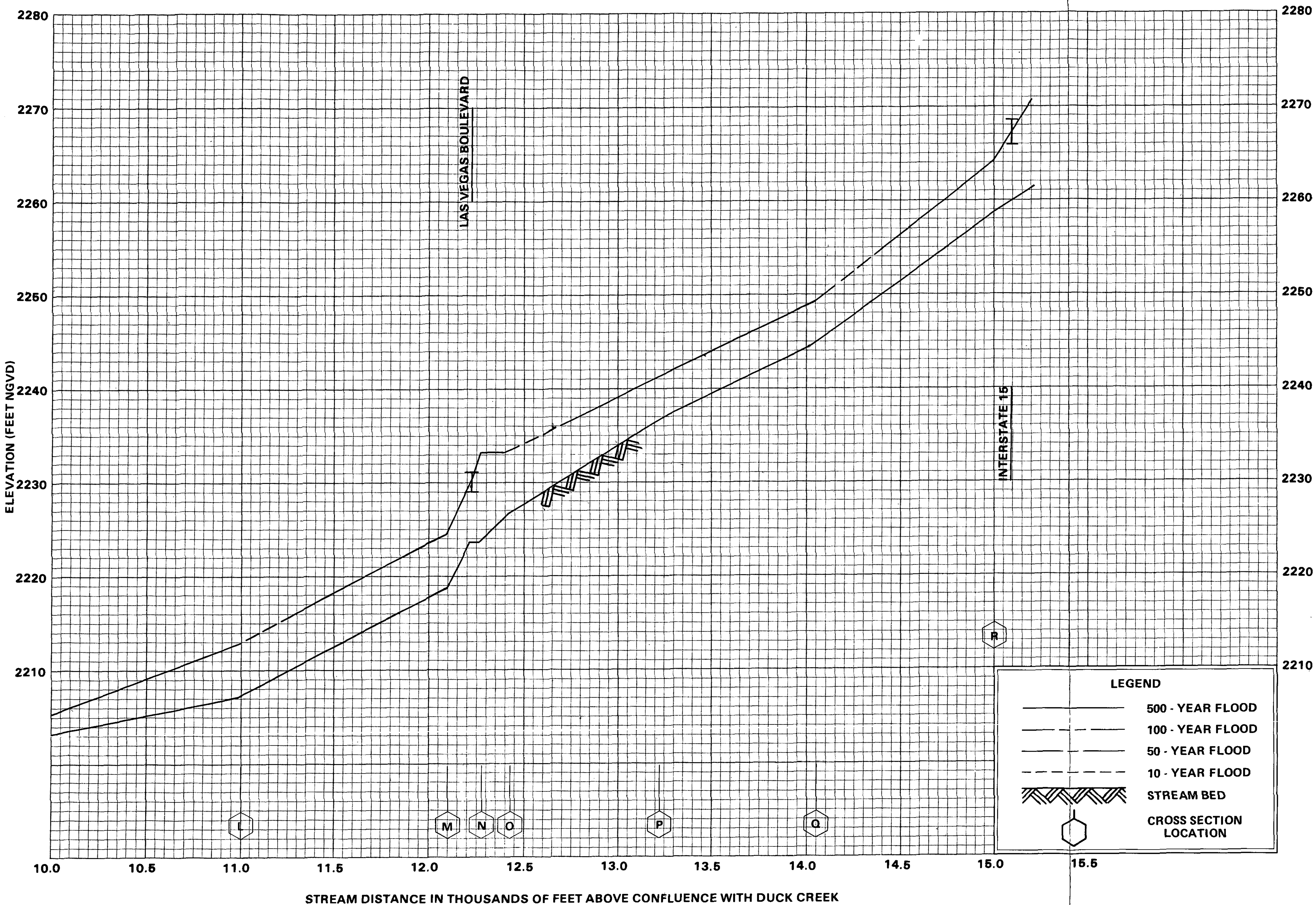
FLOOD PROFILES

BLUE DIAMOND WASH NORTH BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS

03P



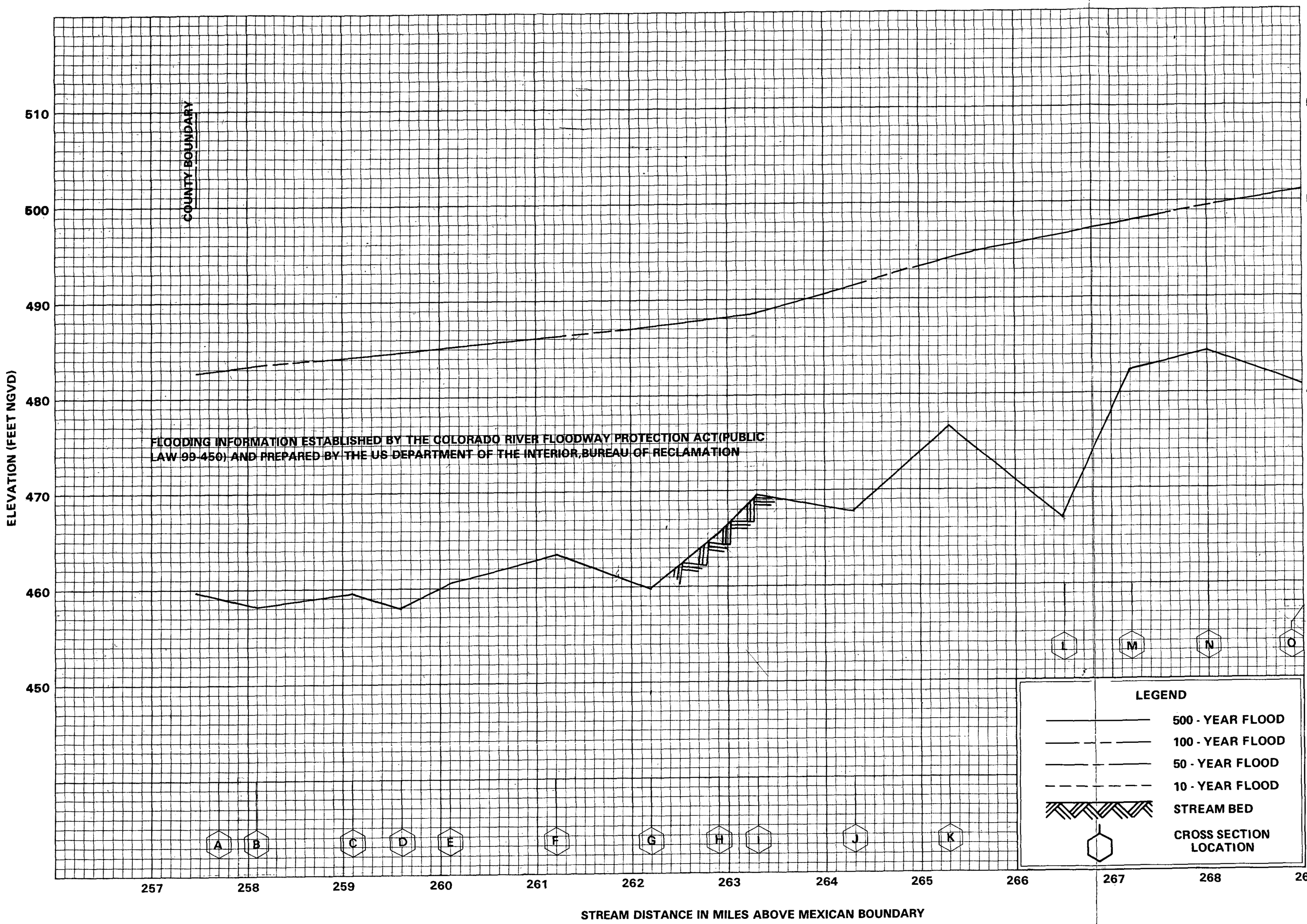
FLOOD PROFILES

BLUE DIAMOND WASH NORTH BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV
AND INCORPORATED AREAS

04P



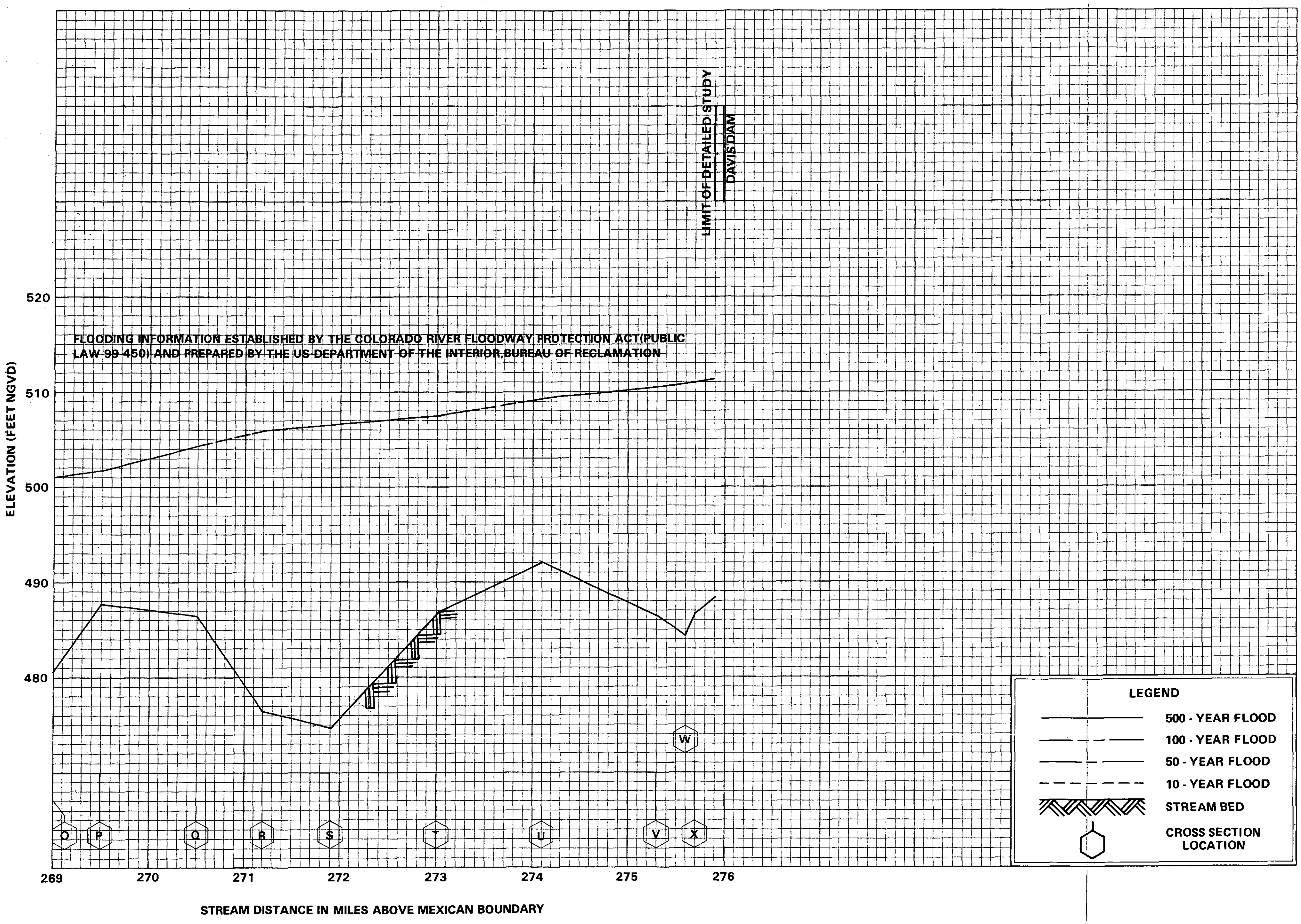
FLOOD PROFILES

COLORADO RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS

05P



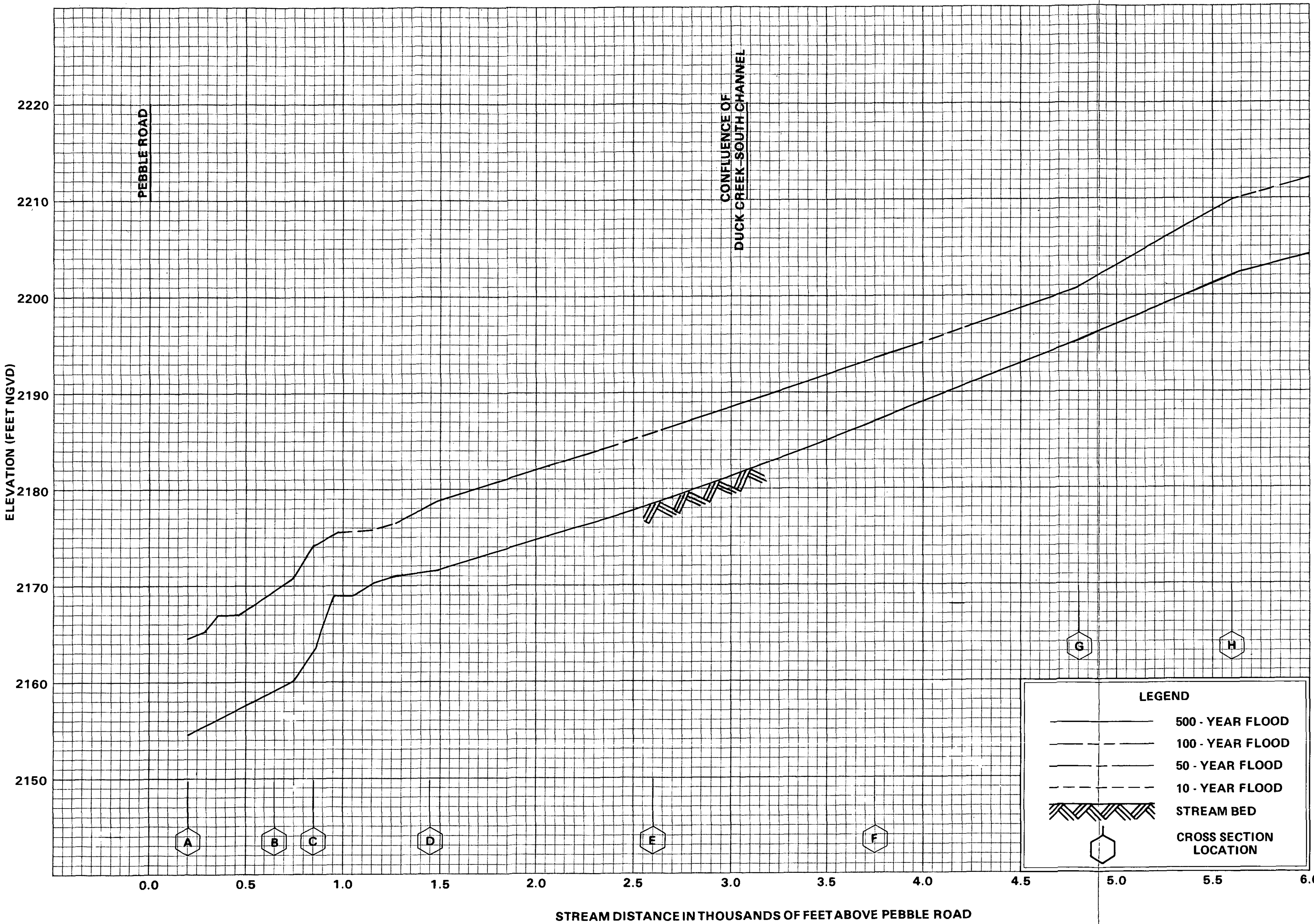
FLOOD PROFILES

COLORADO RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS

06P



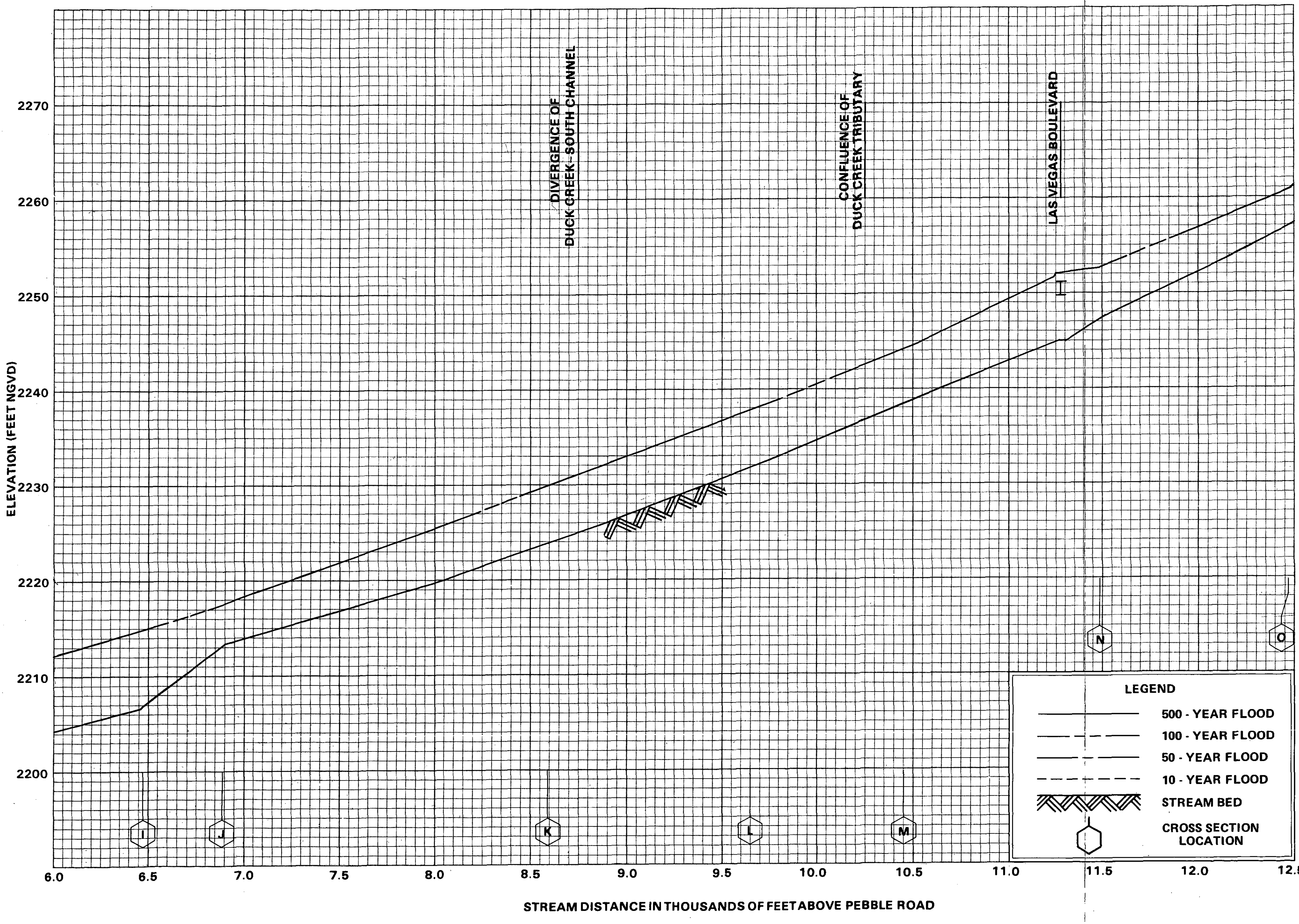
FLOOD PROFILES

DUCK CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV
AND INCORPORATED AREAS

07P



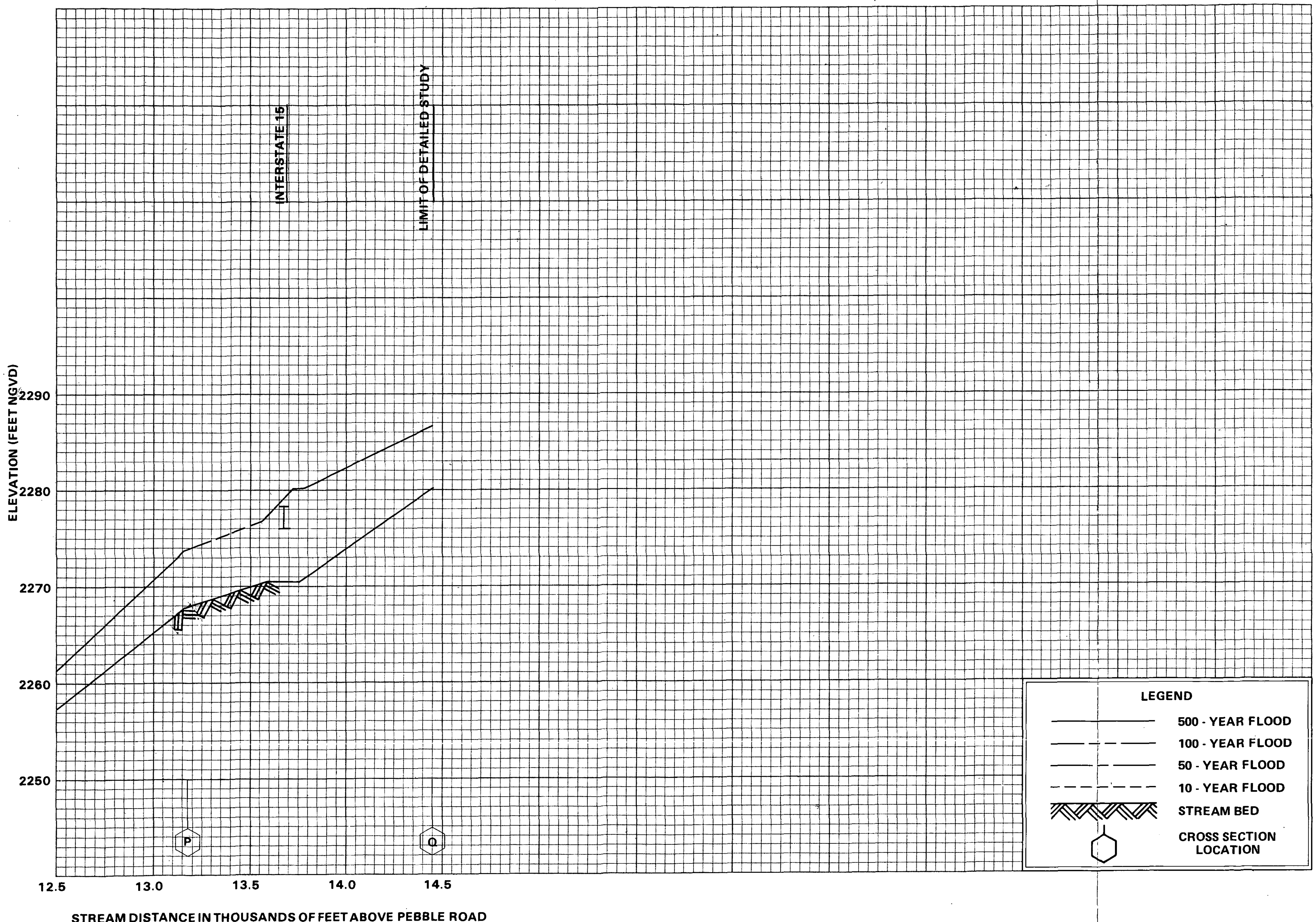
FLOOD PROFILES

DUCK CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV
AND INCORPORATED AREAS

08P

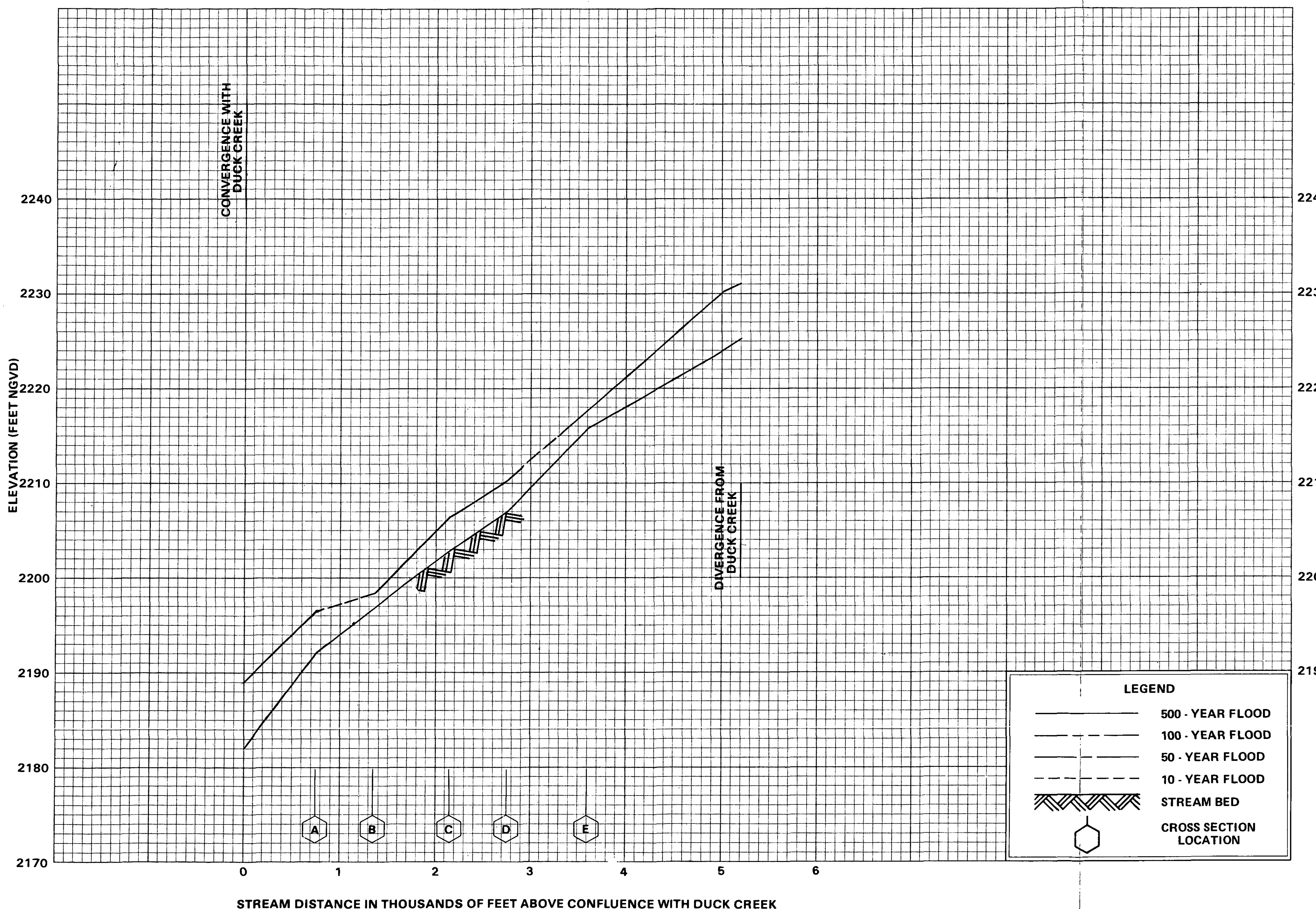


FLOOD PROFILES

DUCK CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS



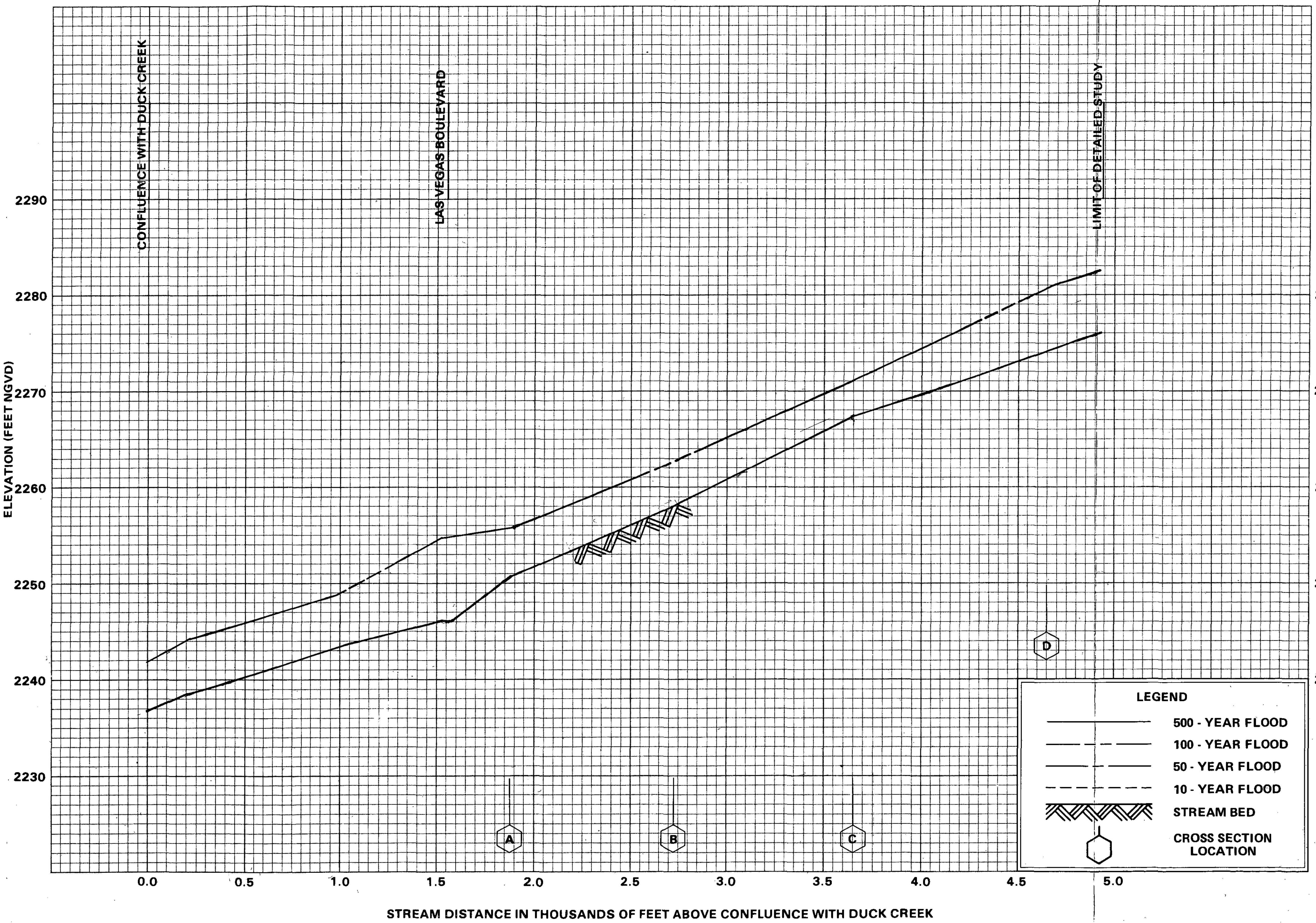
FLOOD PROFILES

DUCK CREEK SOUTH CHANNEL

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV
AND INCORPORATED AREAS

10P



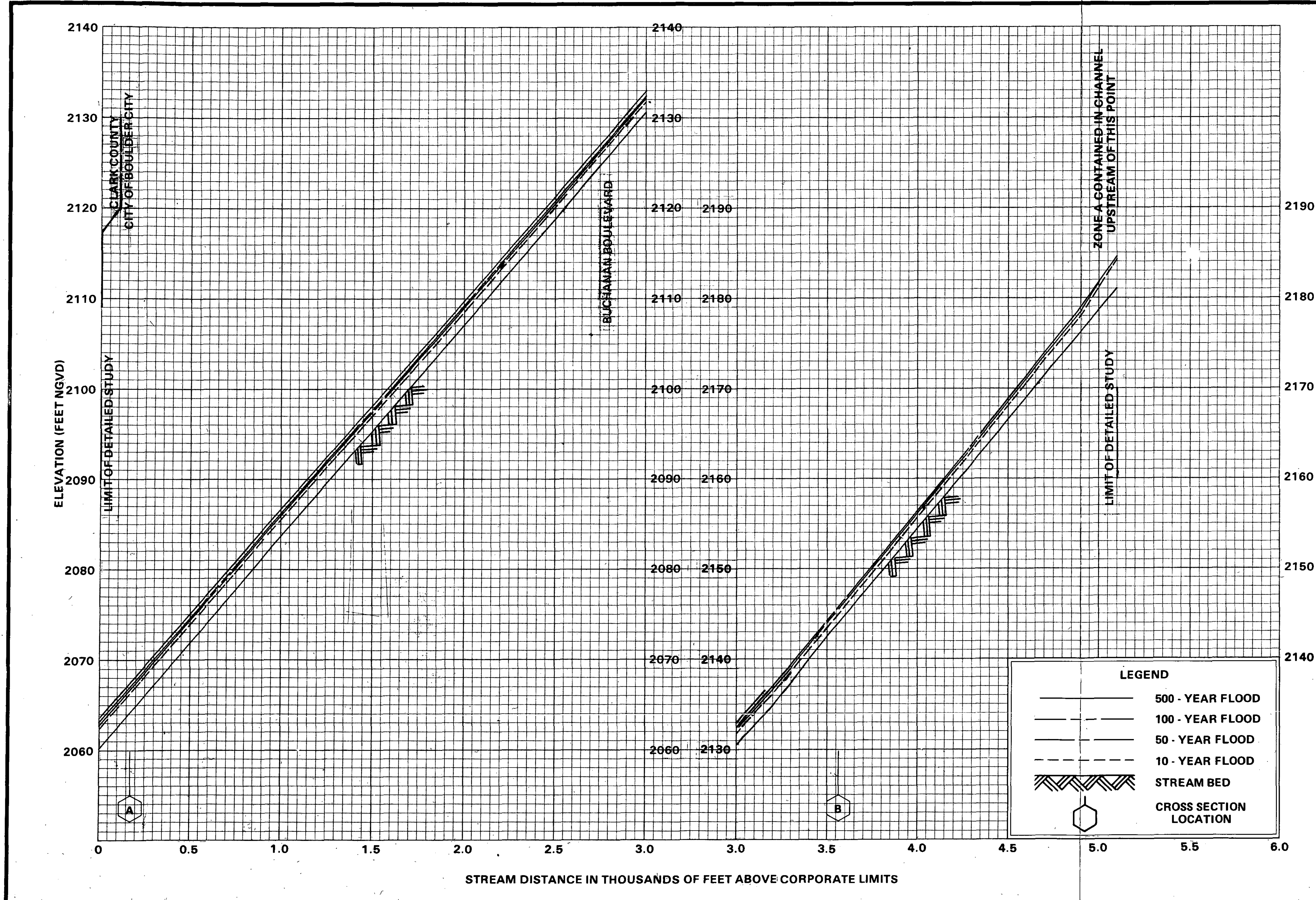
FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV
AND INCORPORATED AREAS

FLOOD PROFILES

DUCK CREEK TRIBUTARY

11P



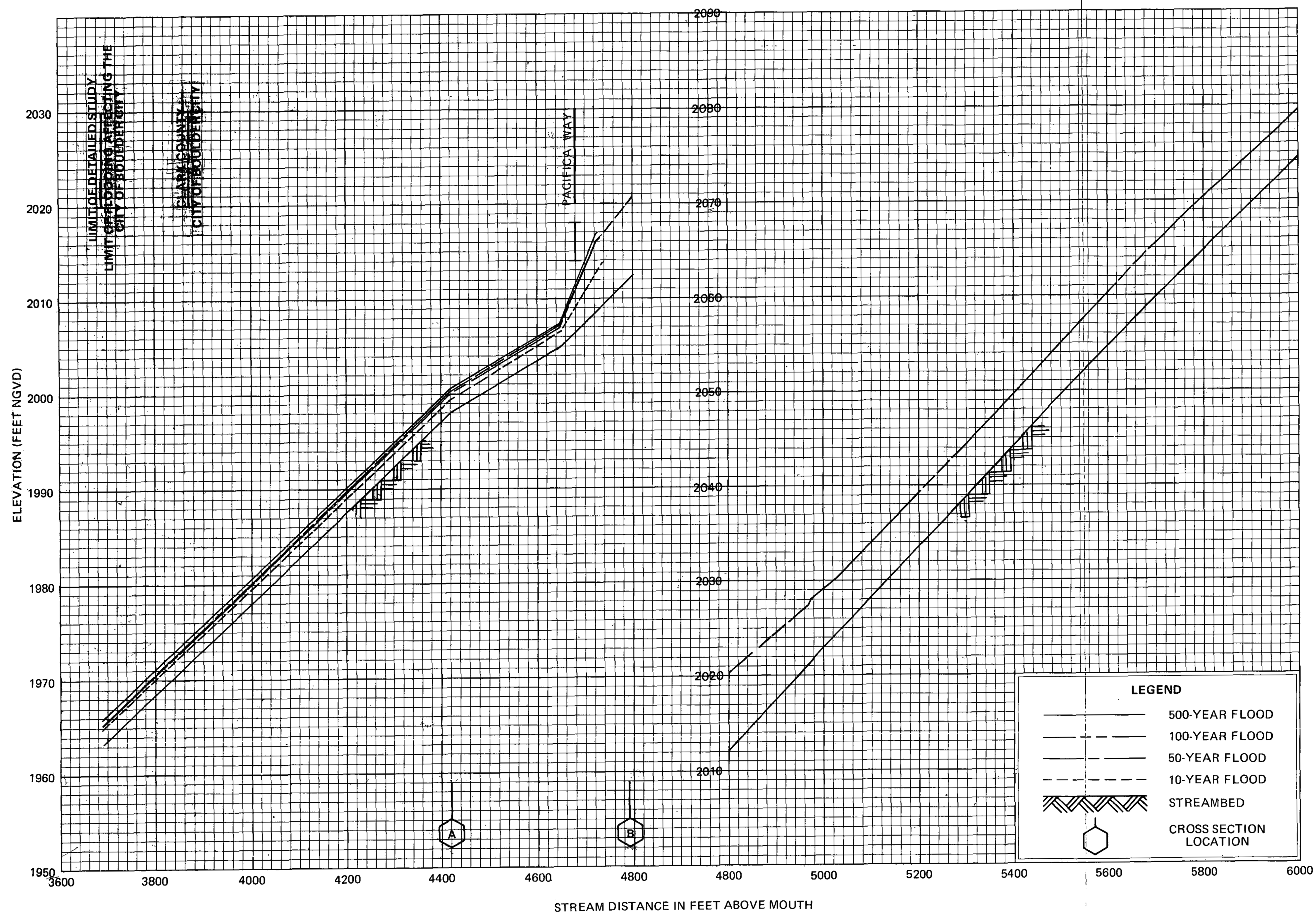
FLOOD PROFILES

GEORGIA AVENUE WASH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS

12P



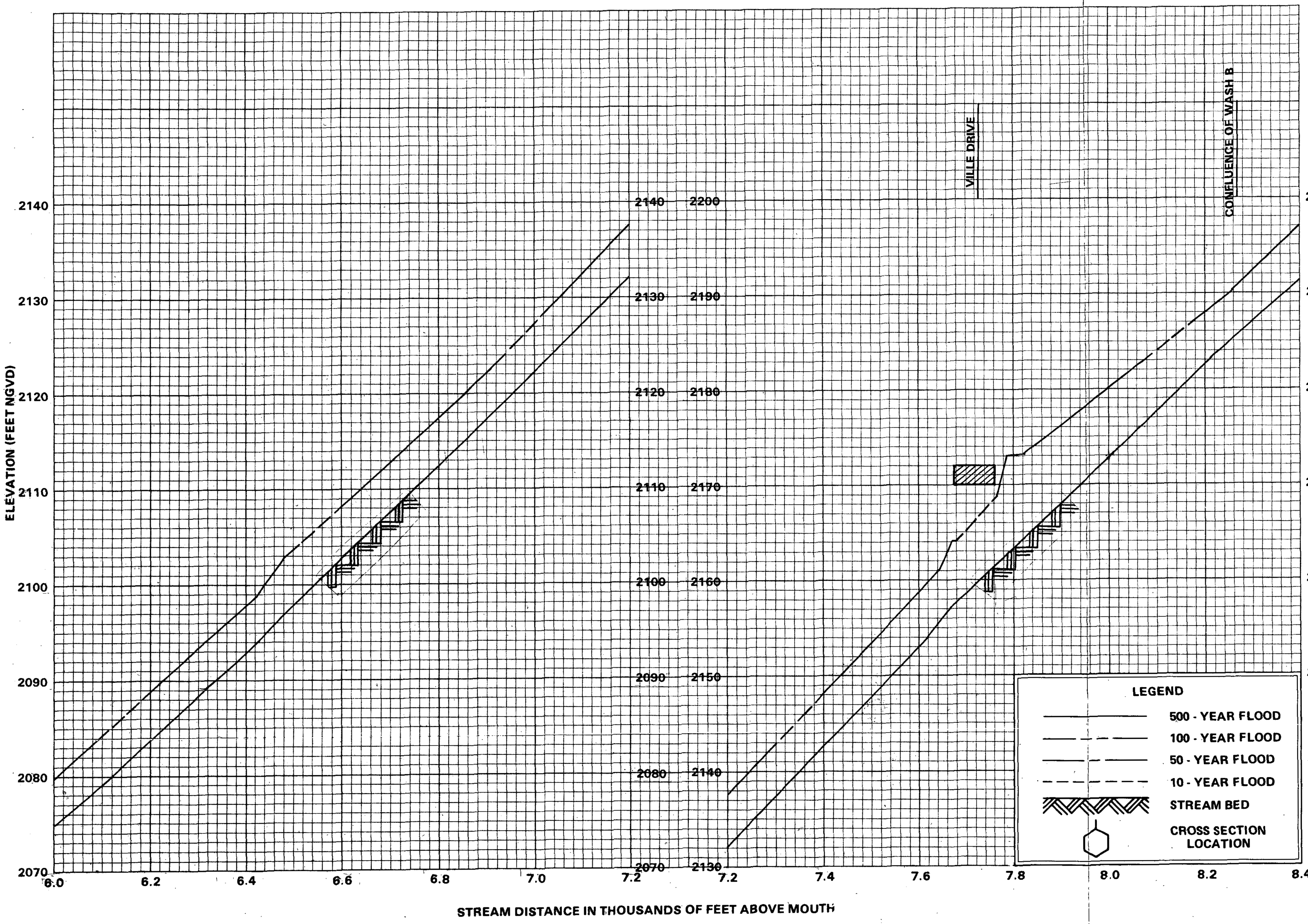
FLOOD PROFILES

HEMENWAY WASH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS

13P

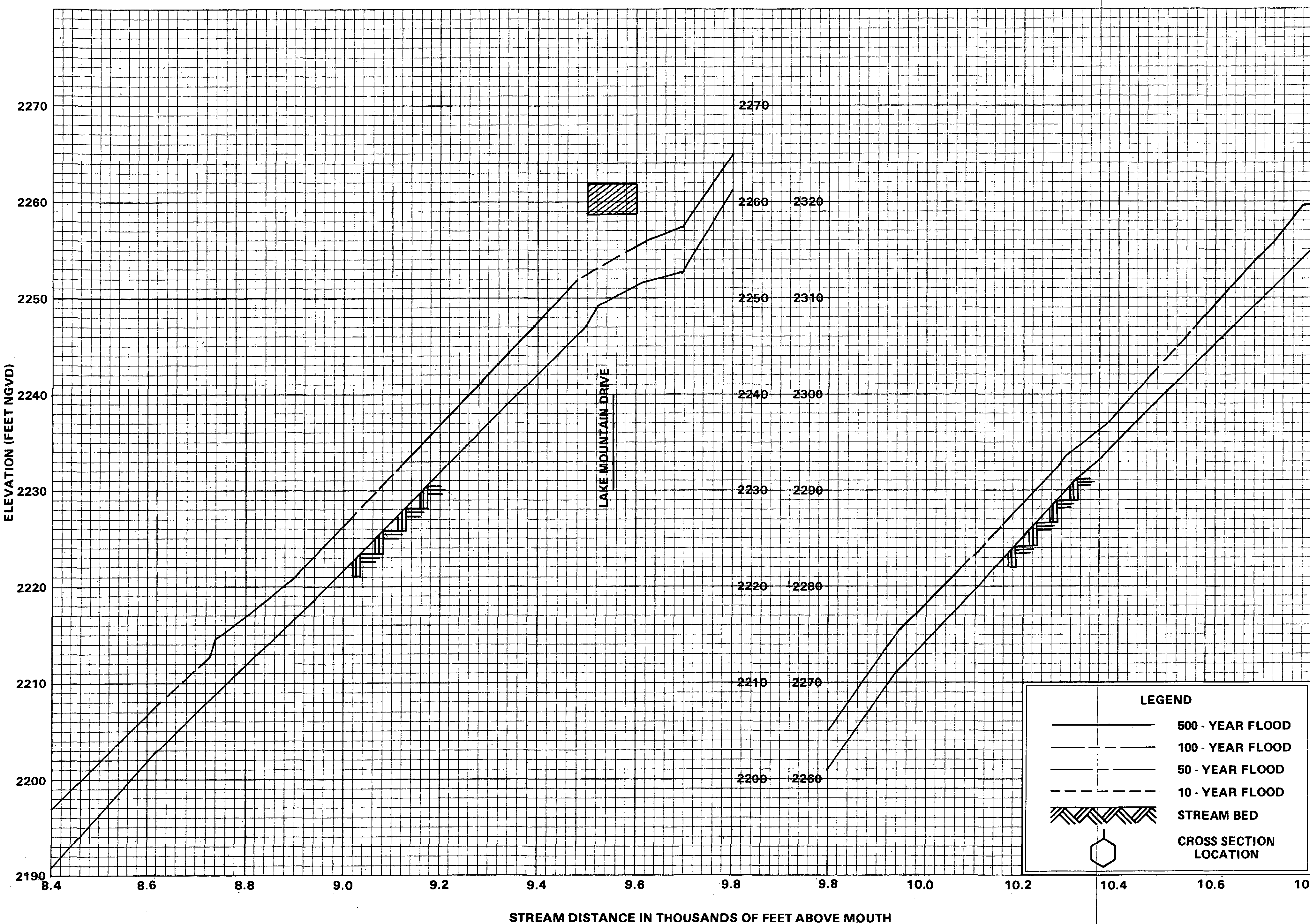


FLOOD PROFILES

HEMENWAY WASH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV
AND INCORPORATED AREAS



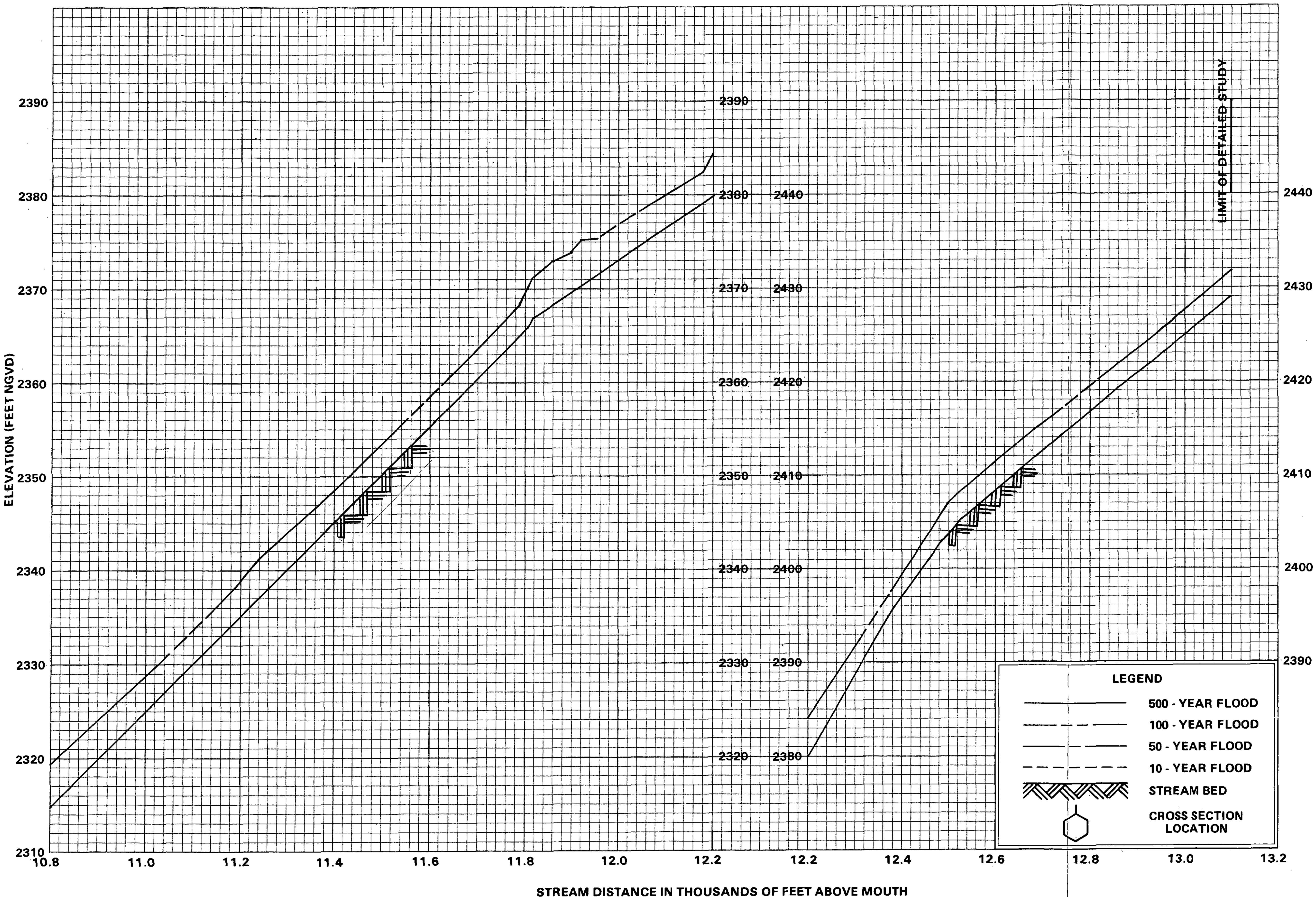
FLOOD PROFILES

HEMENWAY WASH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS

15P



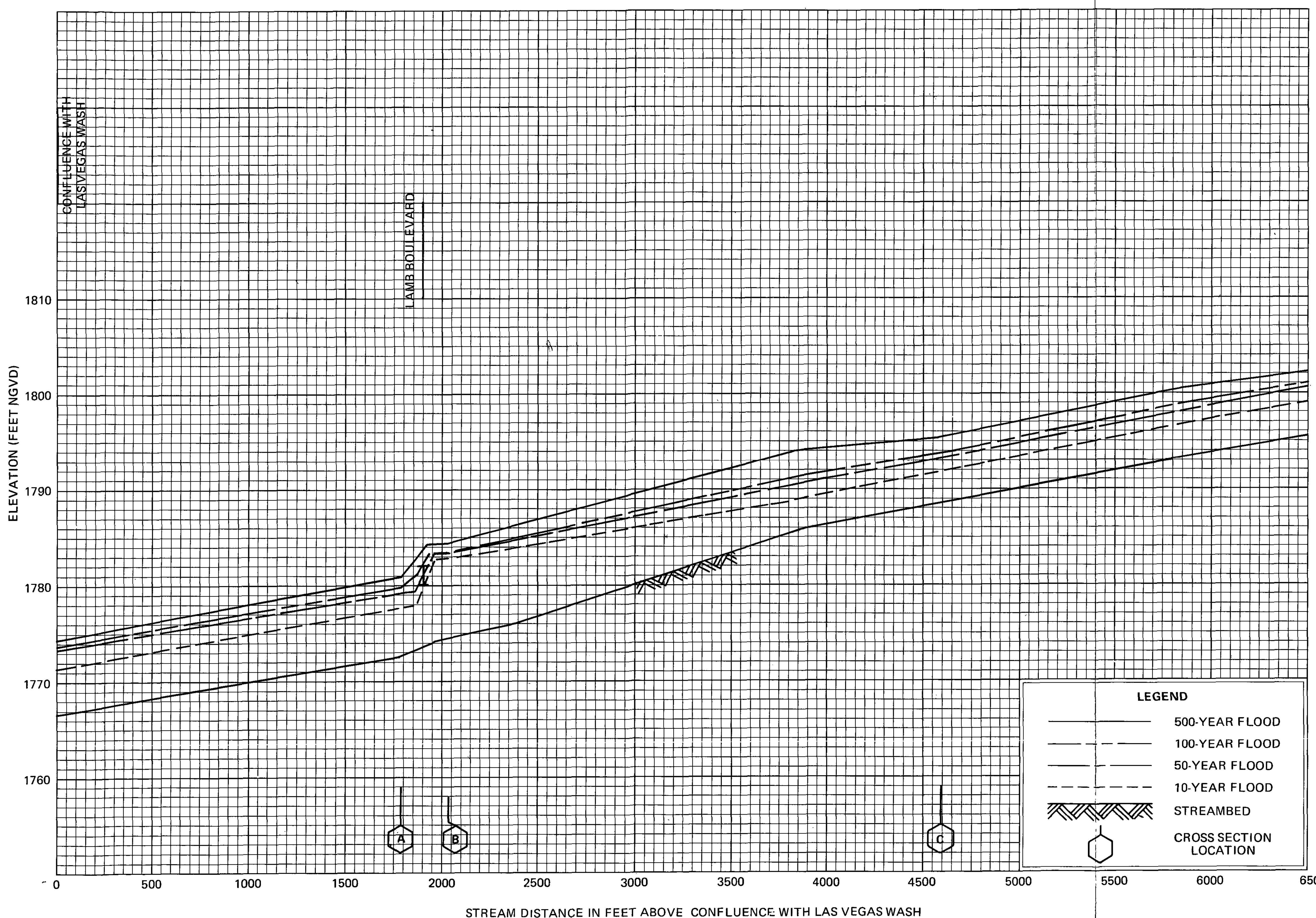
FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS

FLOOD PROFILES

HEMENWAY WASH

16P

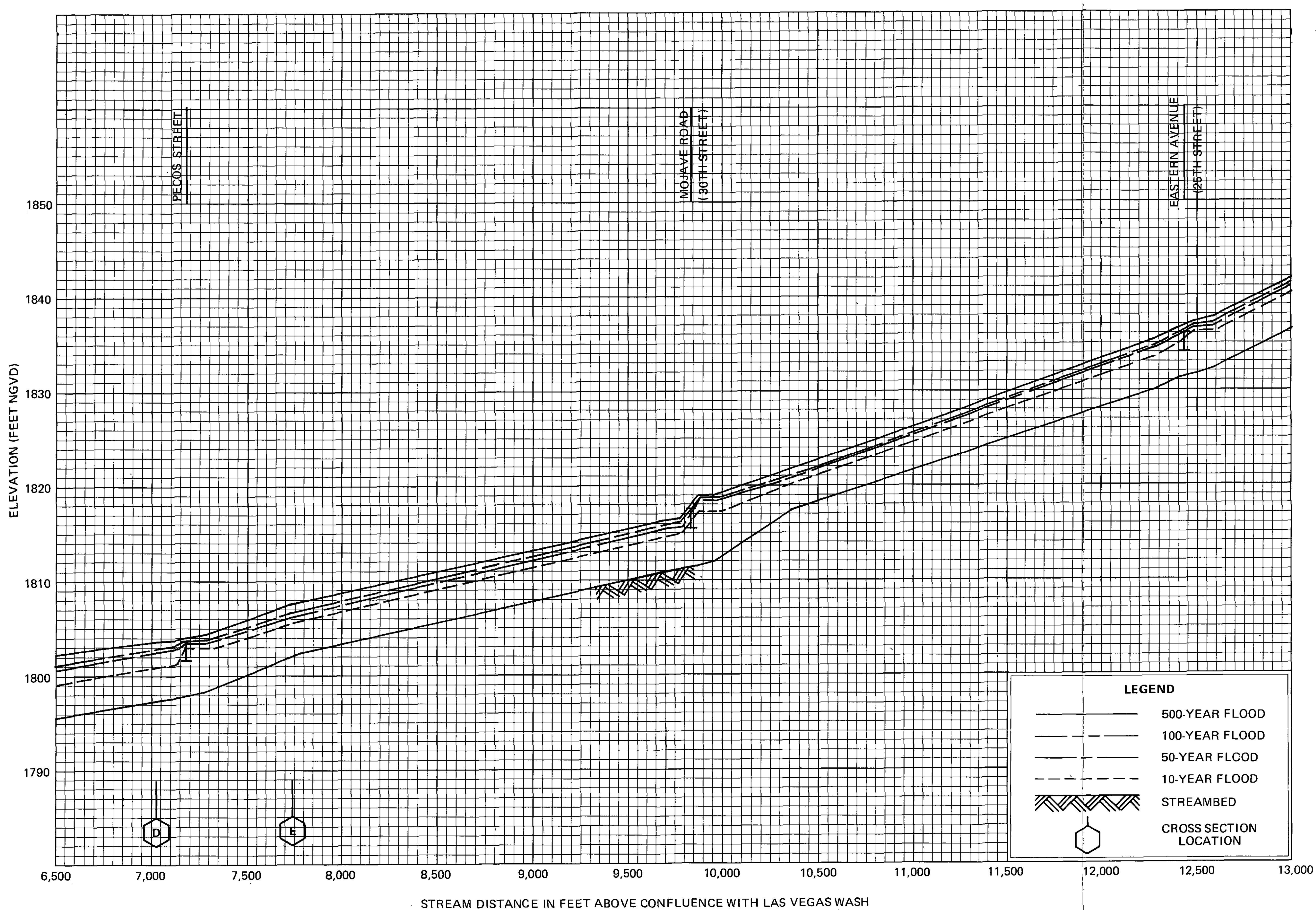


FLOOD PROFILES

LAS VEGAS CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV
AND INCORPORATED AREAS



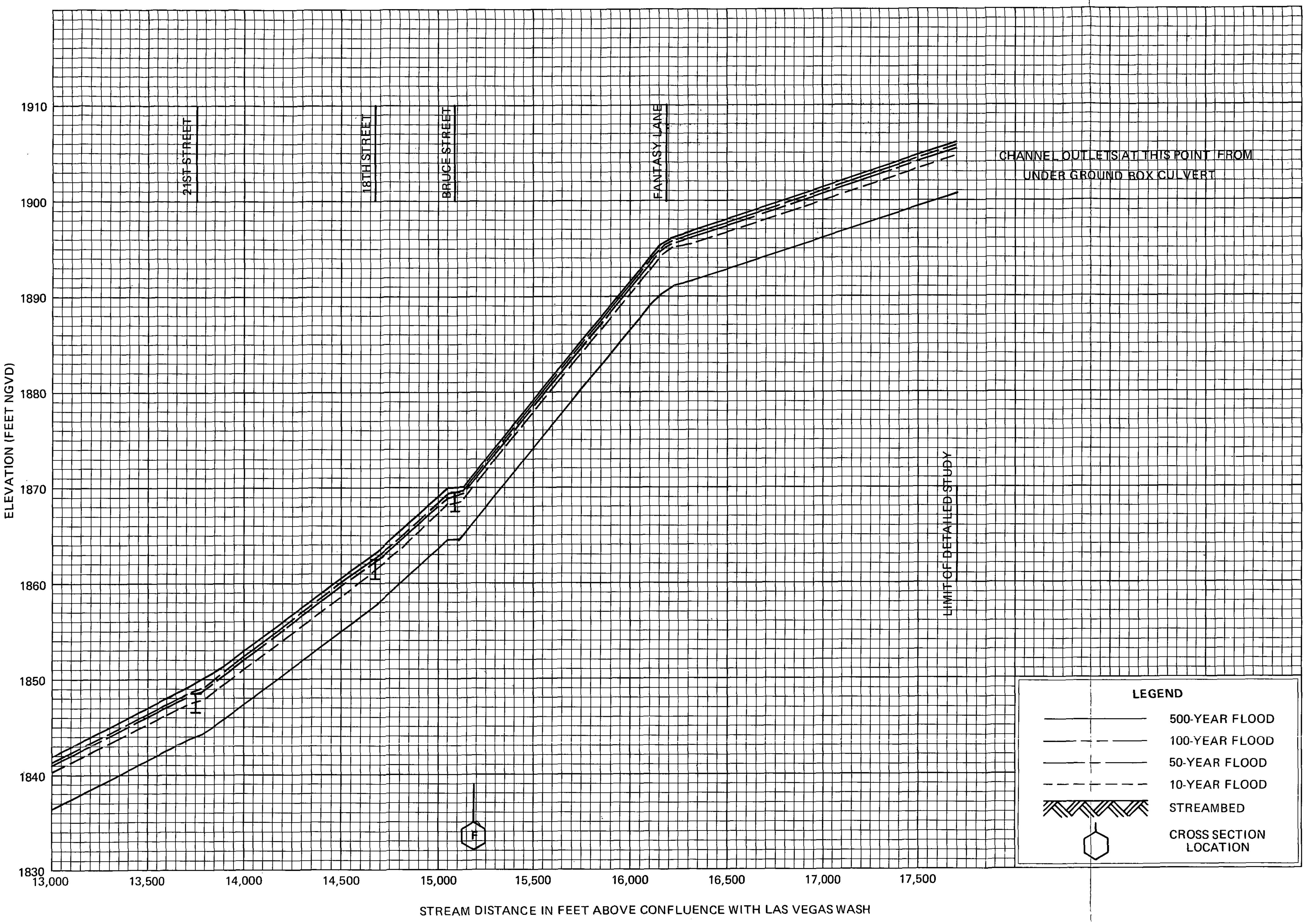
FLOOD PROFILES

LAS VEGAS CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS

18P



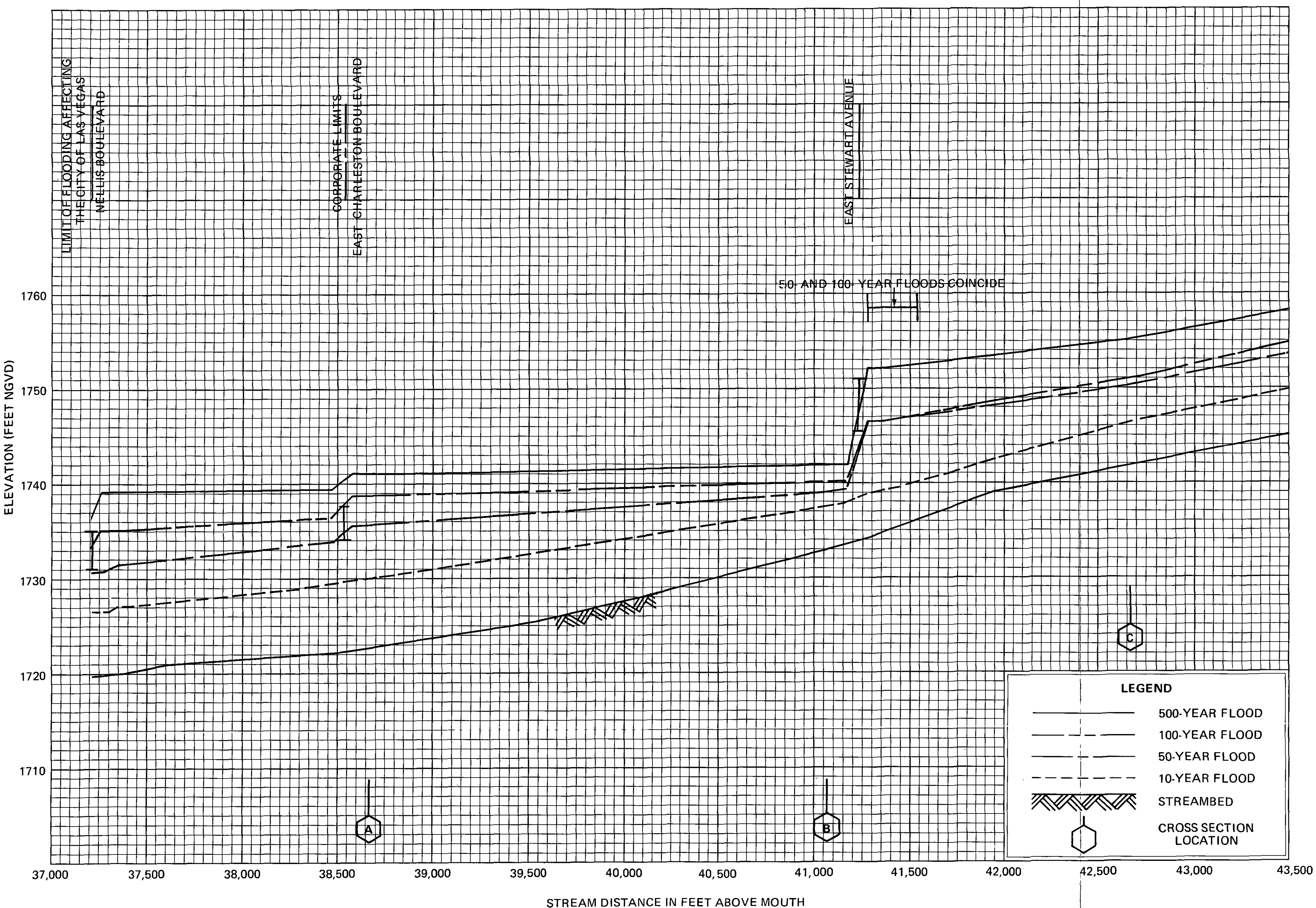
FLOOD PROFILES

LAS VEGAS CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS

19P

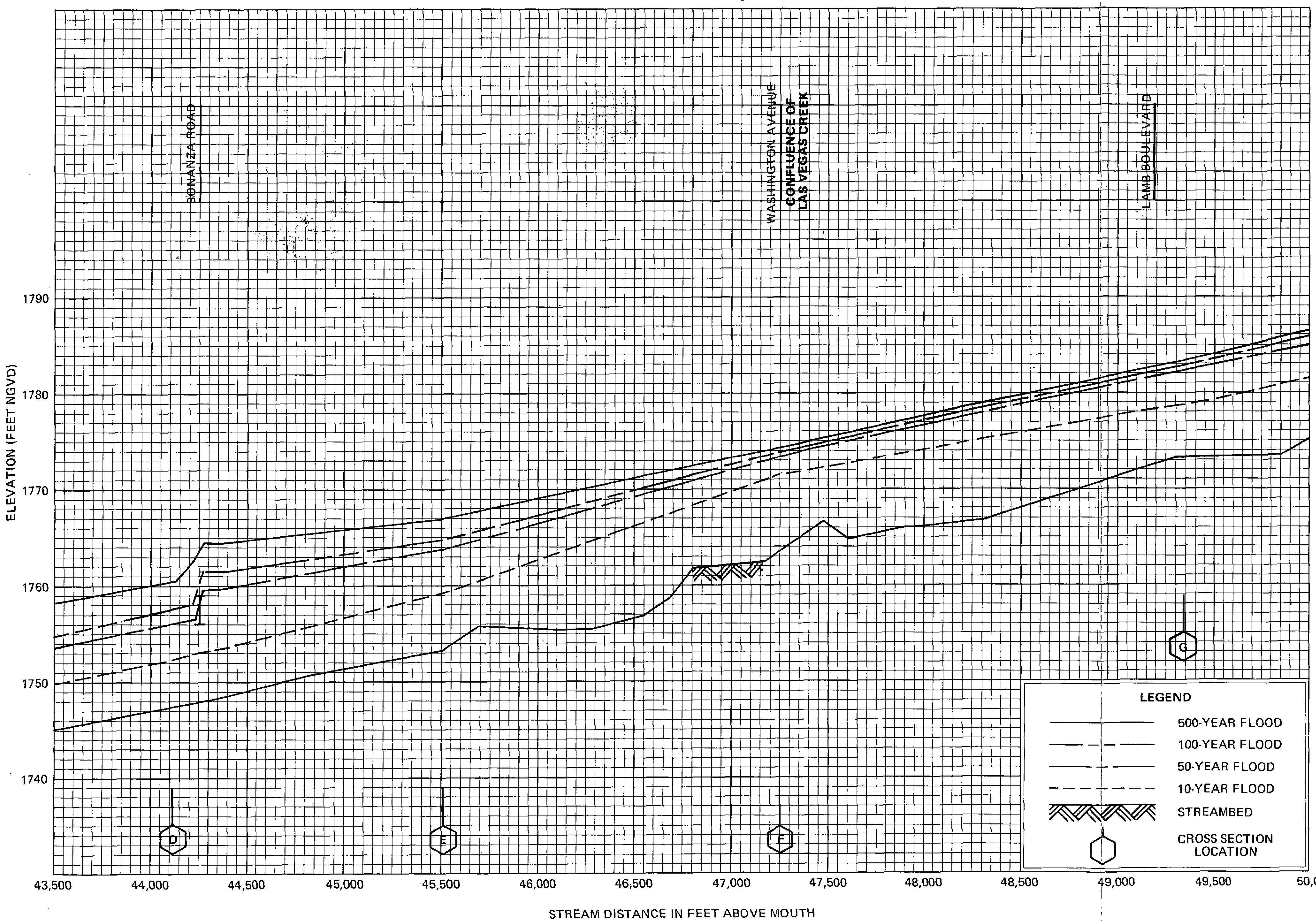


FLOOD PROFILES

LAS VEGAS WASH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS

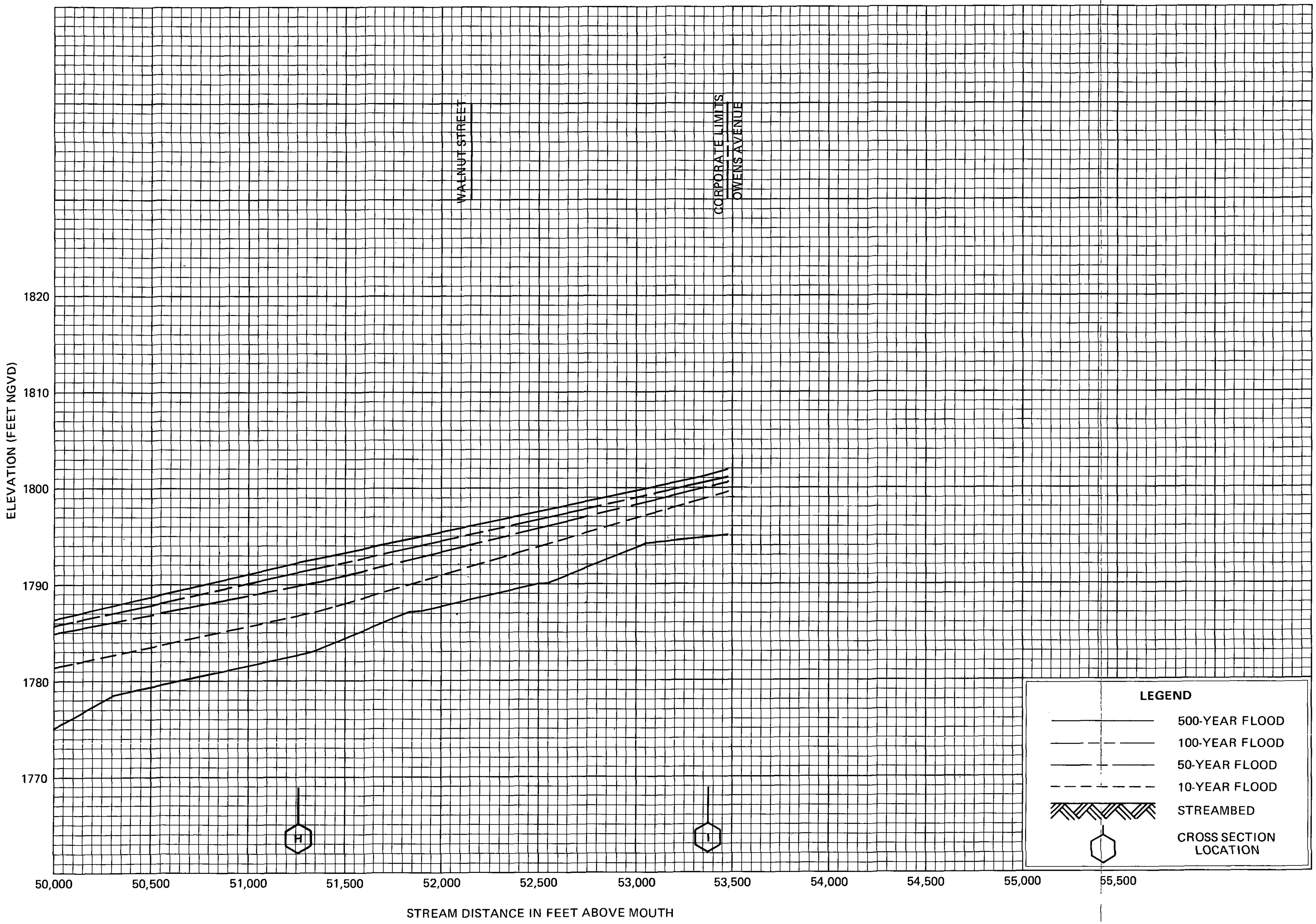


FLOOD PROFILES

LAS VEGAS WASH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS

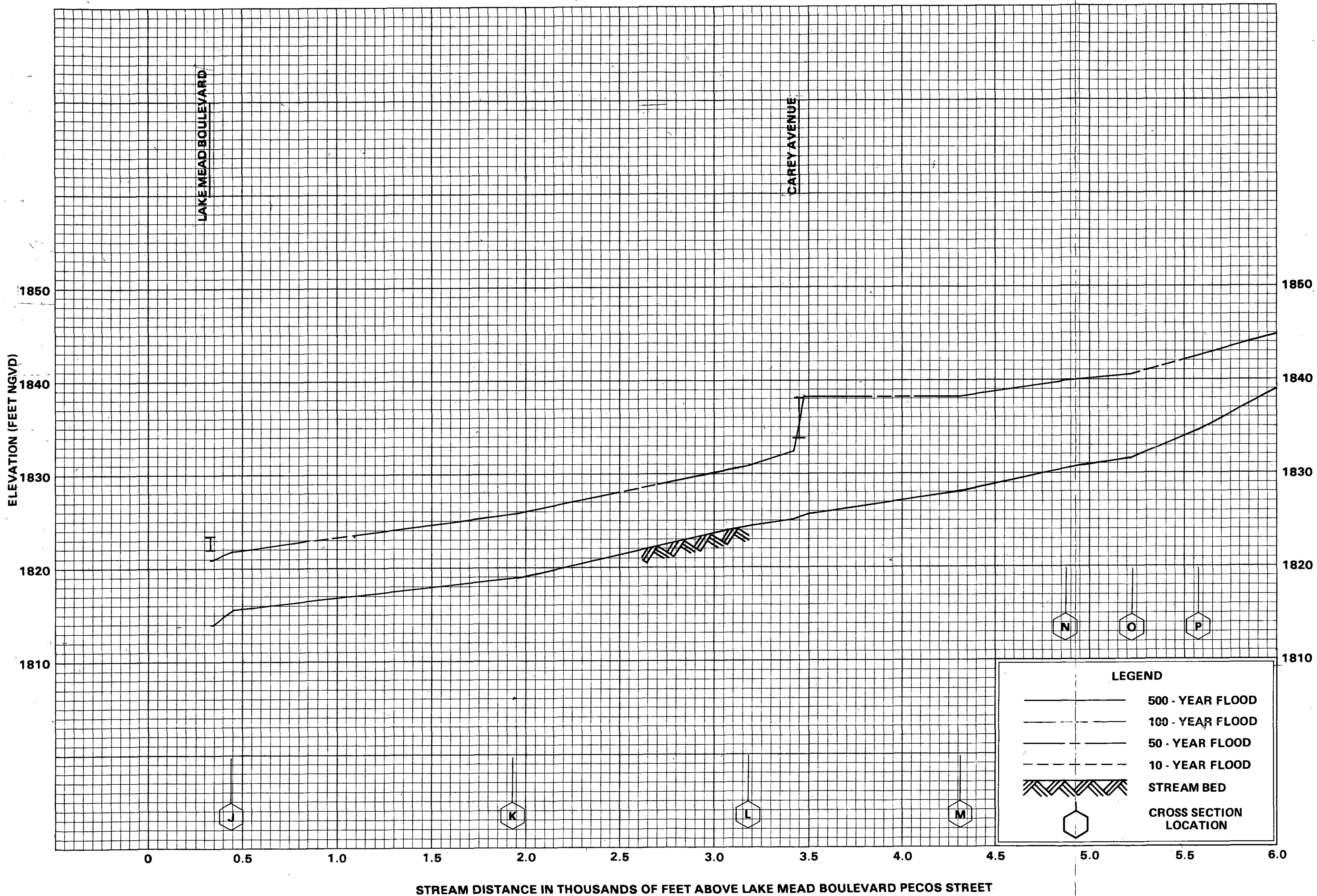


FLOOD PROFILES

LAS VEGAS WASH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS

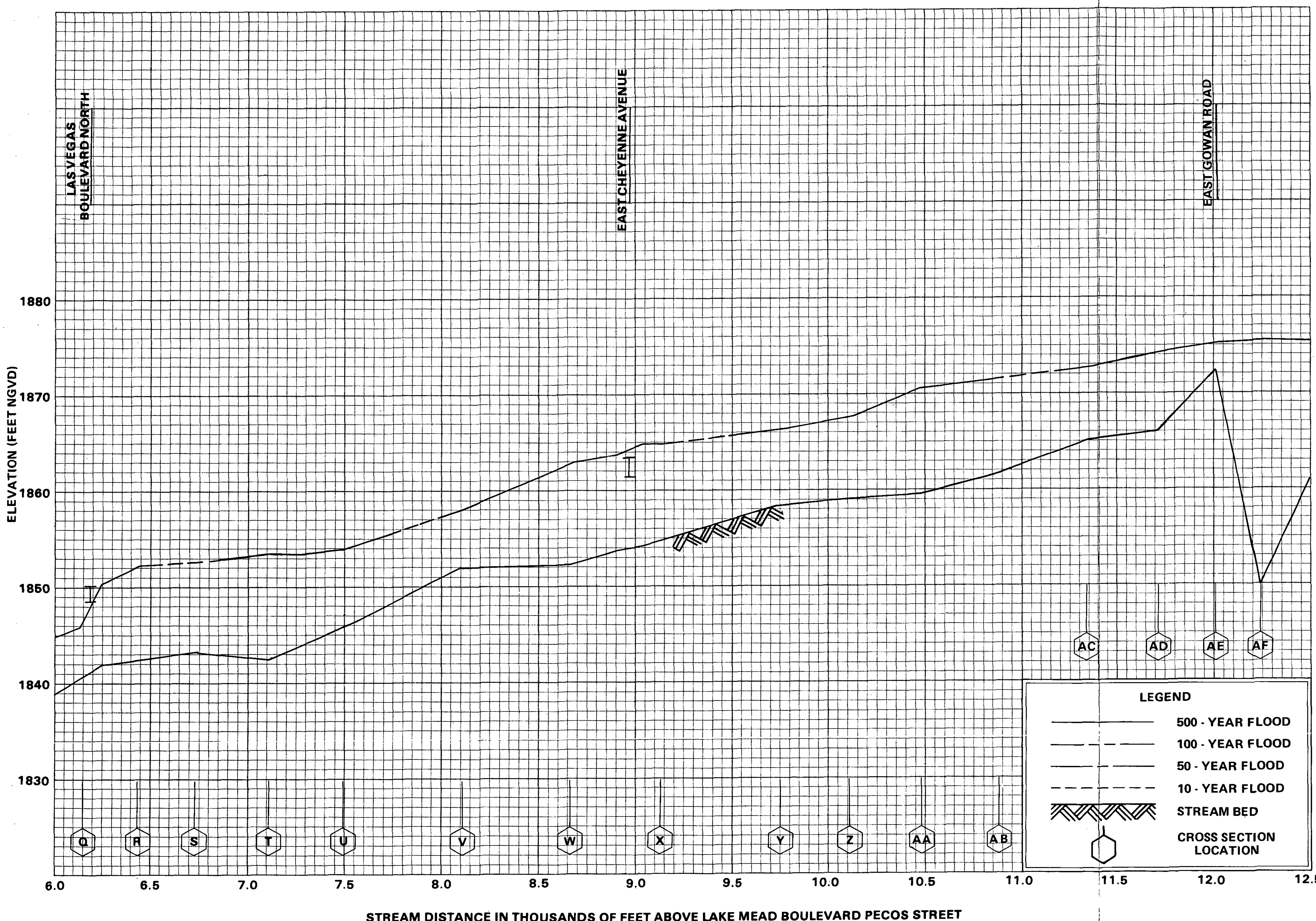


FLOOD PROFILES

LAS VEGAS WASH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS



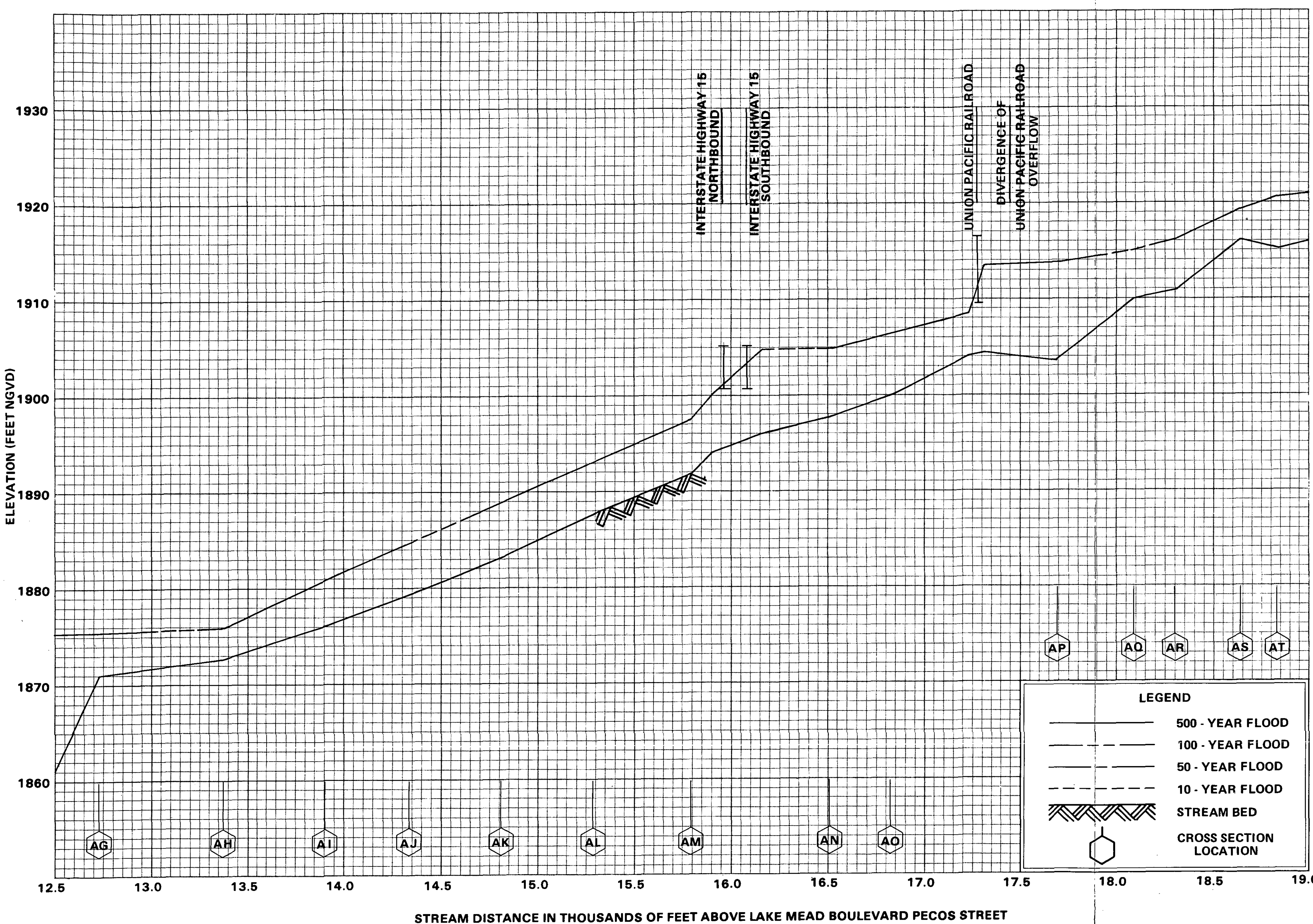
FLOOD PROFILES

LAS VEGAS WASH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV
AND INCORPORATED AREAS

24P



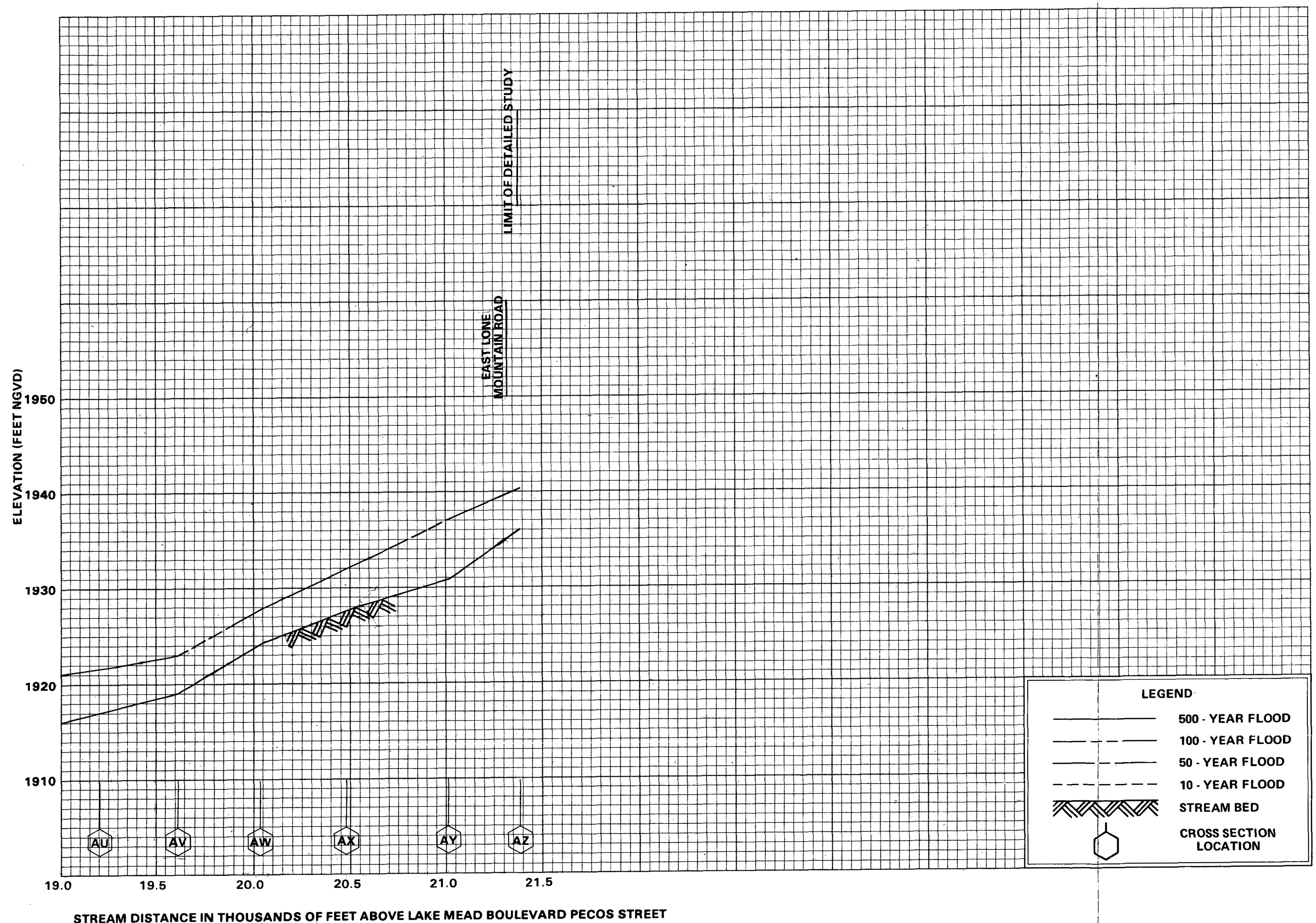
FLOOD PROFILES

LAS VEGAS WASH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS

25P

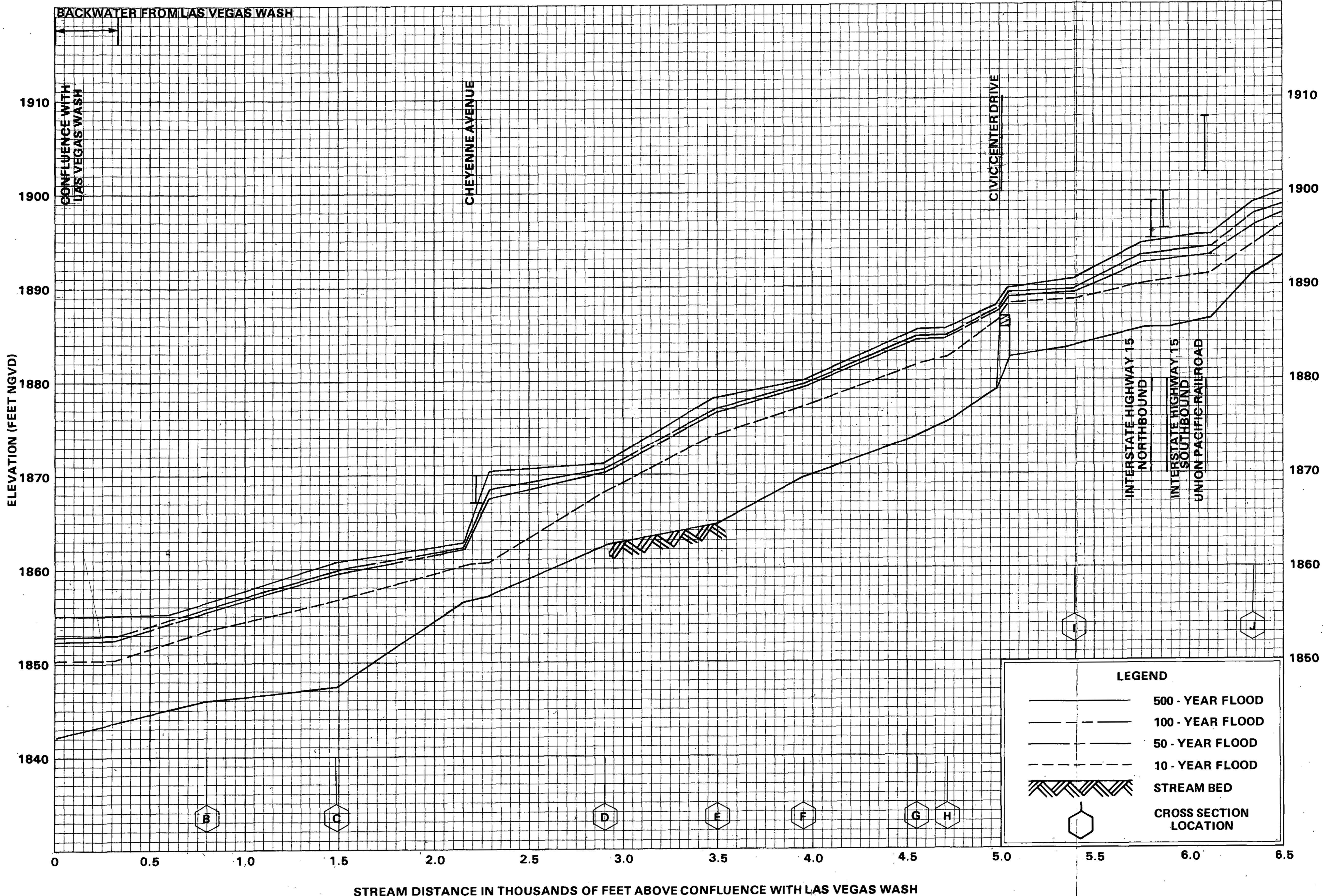


FLOOD PROFILES

LAS VEGAS WASH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS

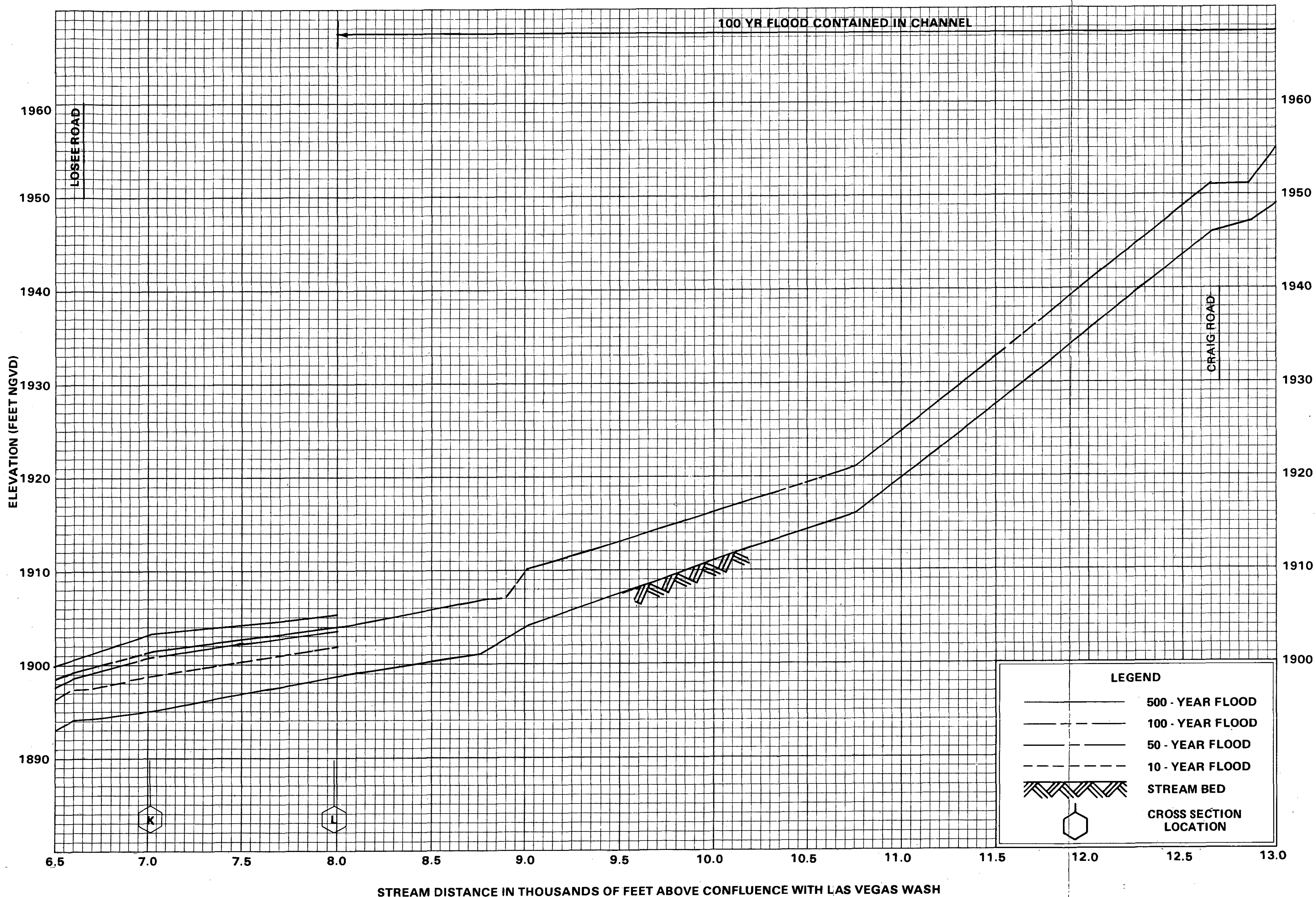


FLOOD PROFILES

UNNAMED TRIBUTARY TO LAS VEGAS WASH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS



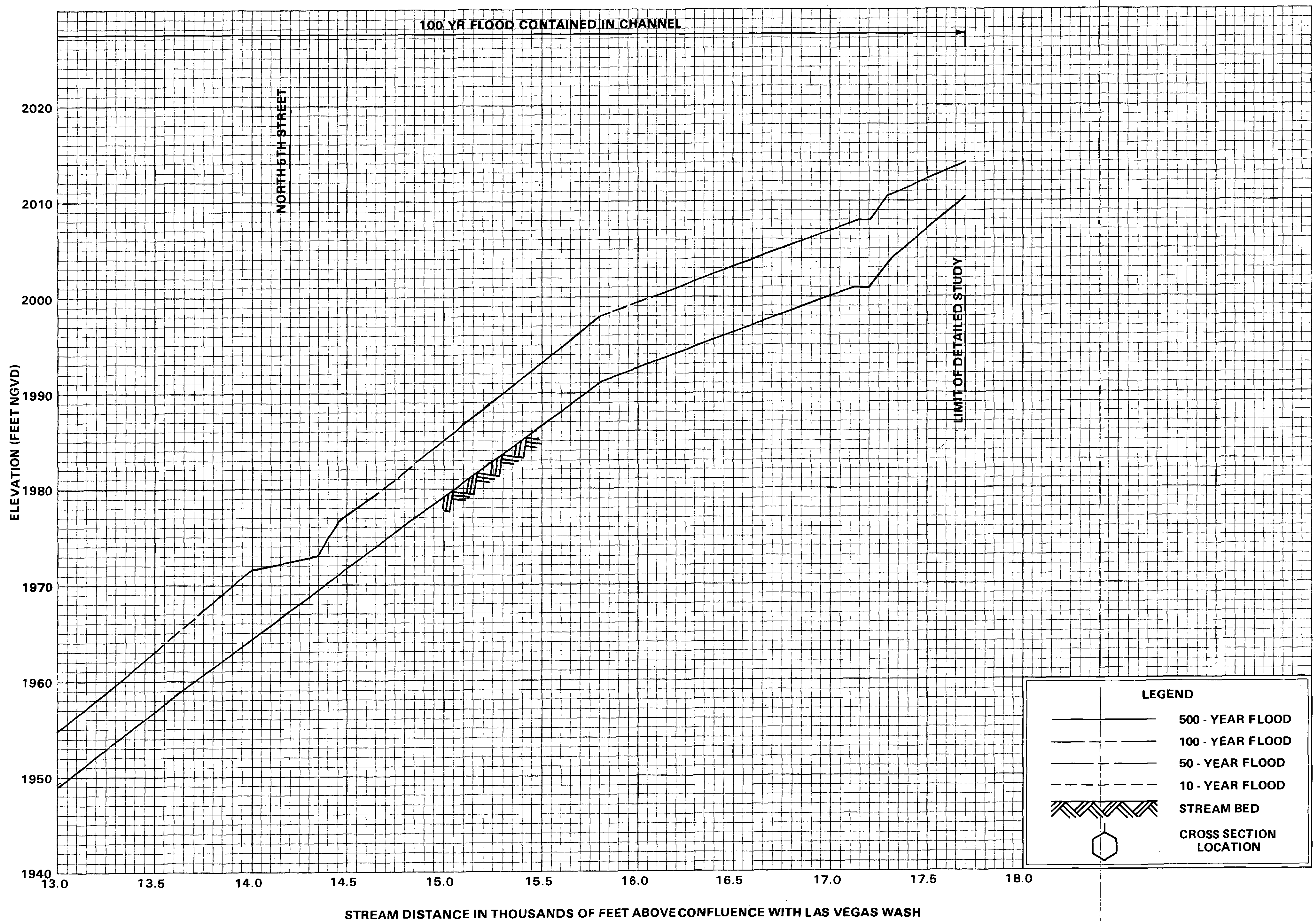
FLOOD PROFILES

UNNAMED TRIBUTARY TO LAS VEGAS WASH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV
AND INCORPORATED AREAS

28P



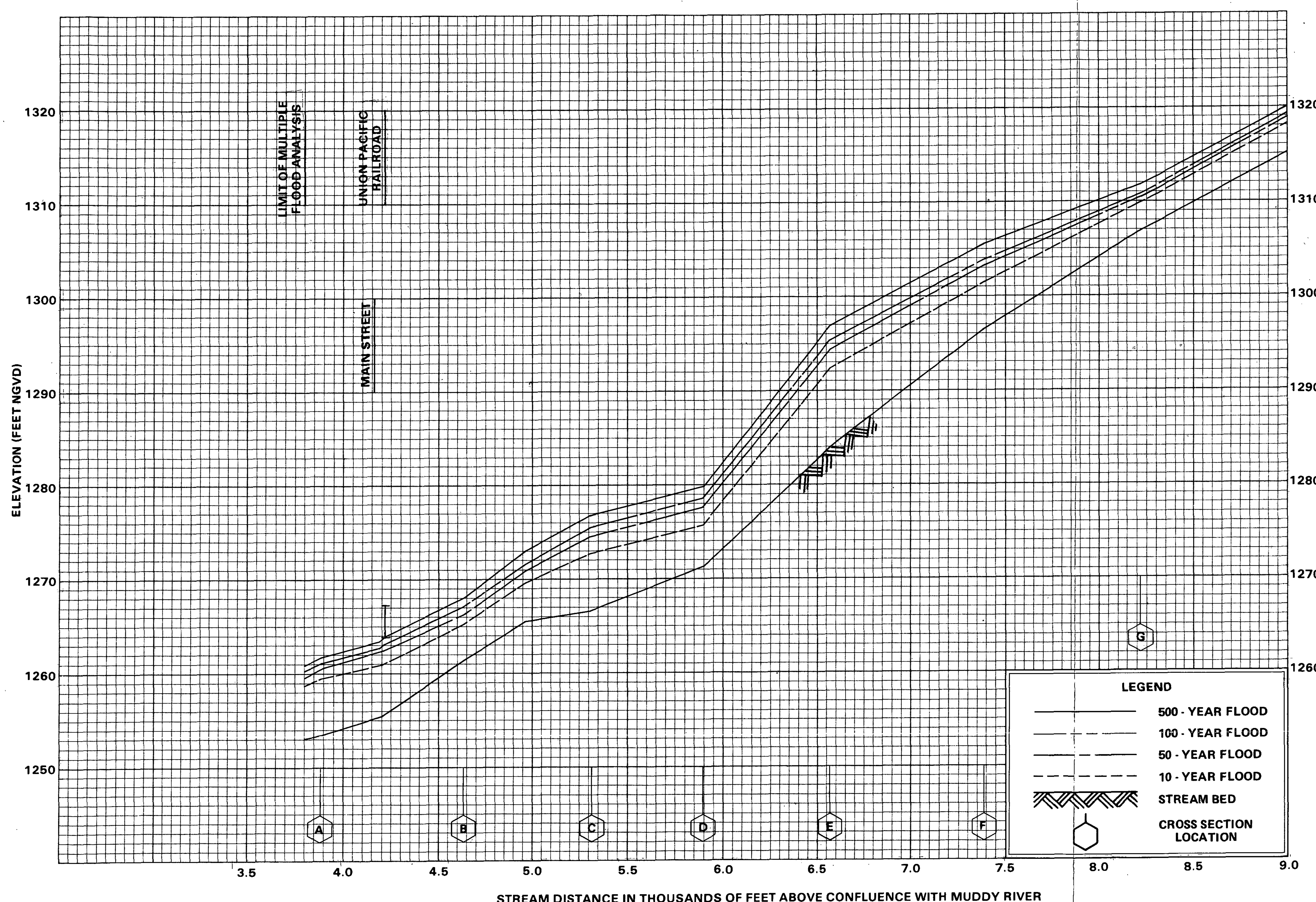
FLOOD PROFILES

UNNAMED TRIBUTARY TO LAS VEGAS WASH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV
AND INCORPORATED AREAS

29P



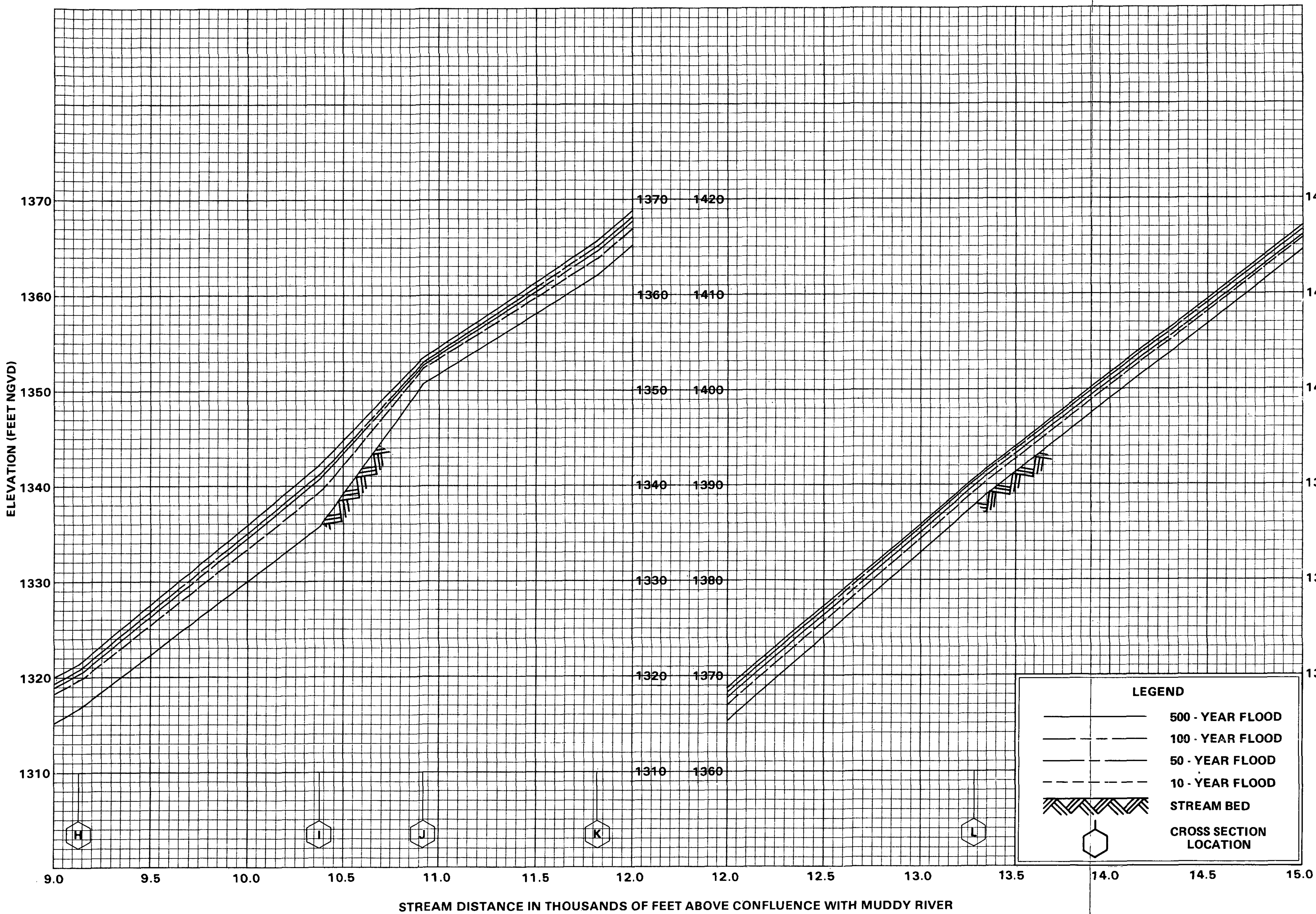
FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS

FLOOD PROFILES

OVERTON WASH

30P

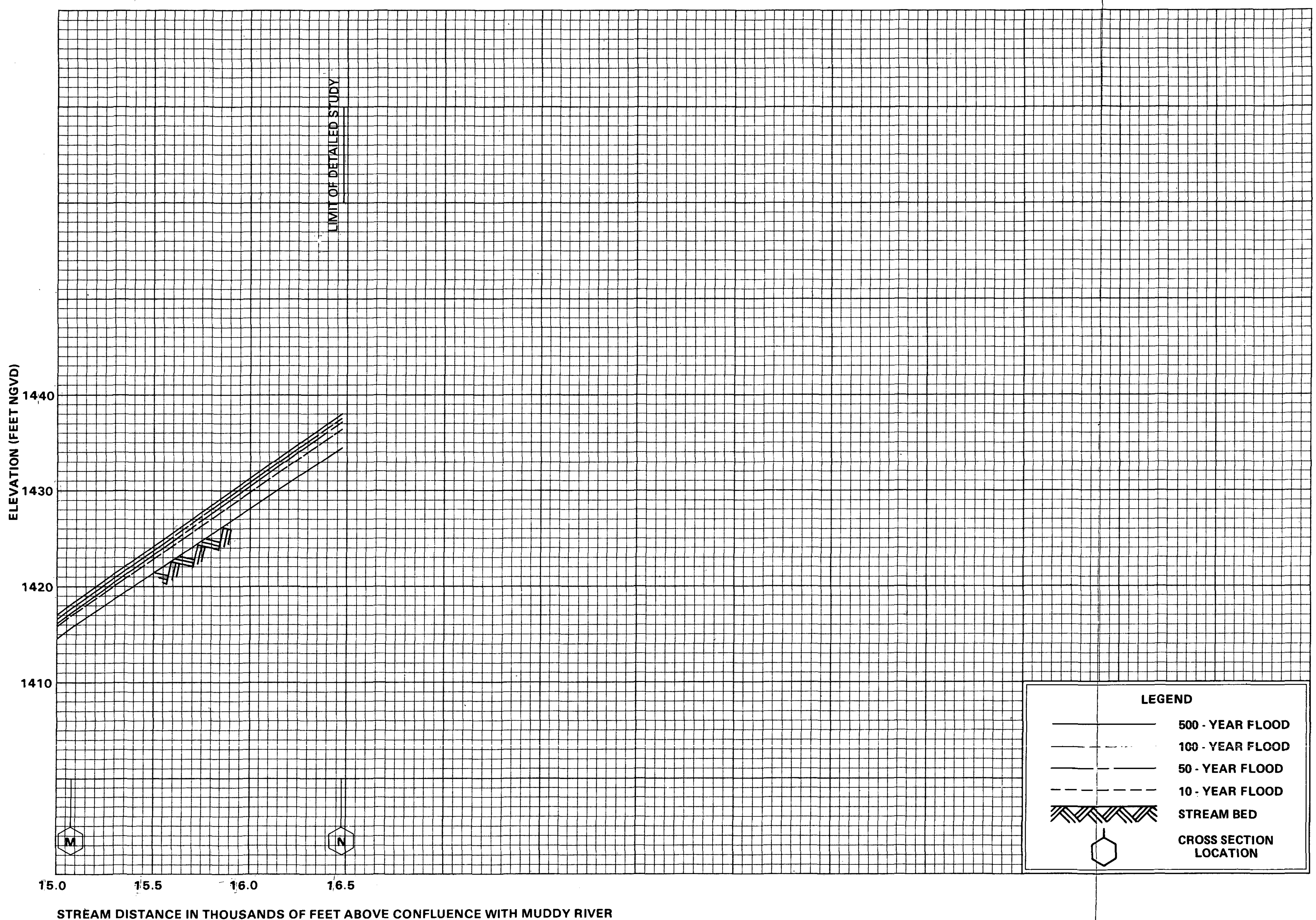


FLOOD PROFILES

OVERTON WASH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS

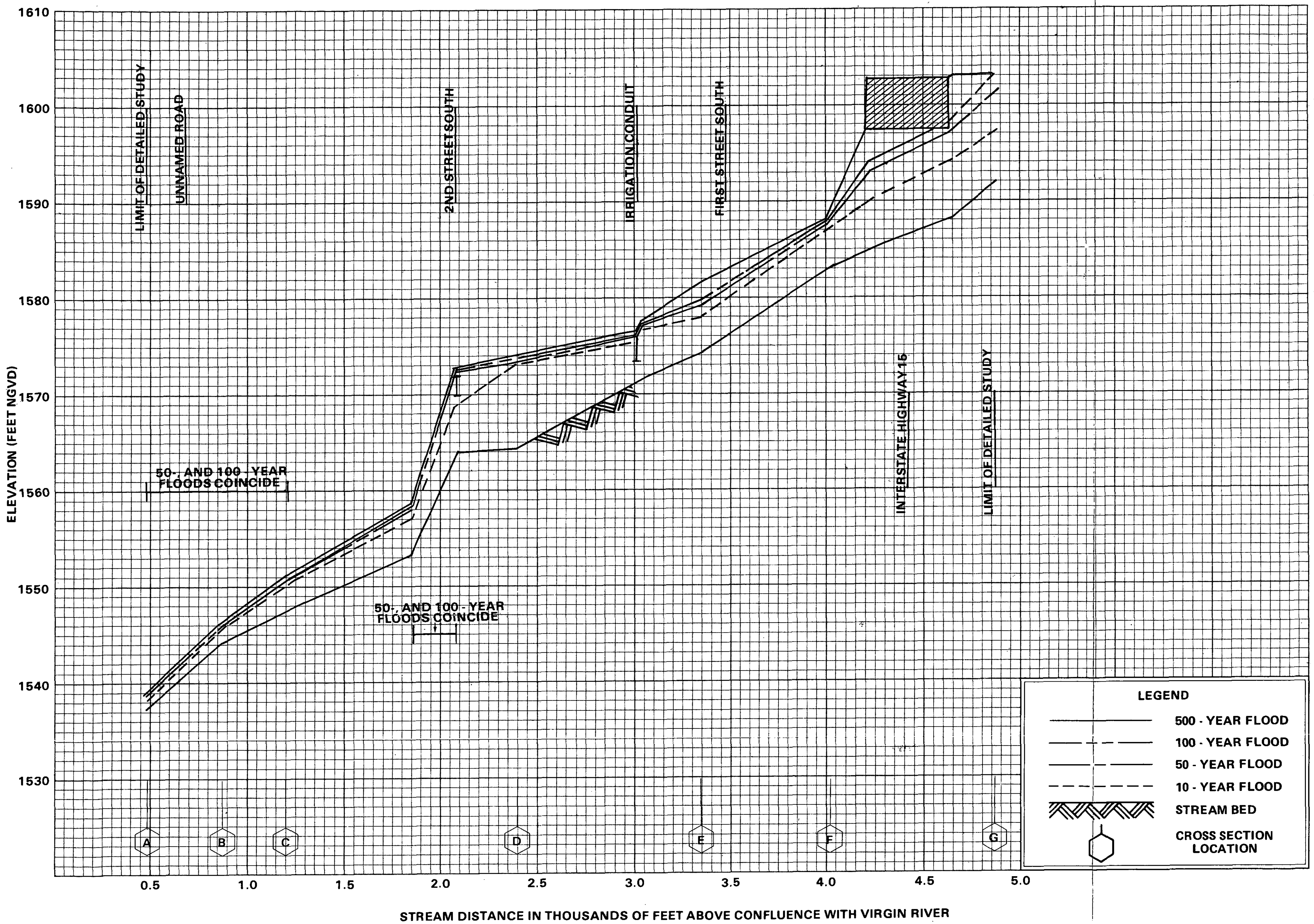


FLOOD PROFILES

OVERTON WASH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS



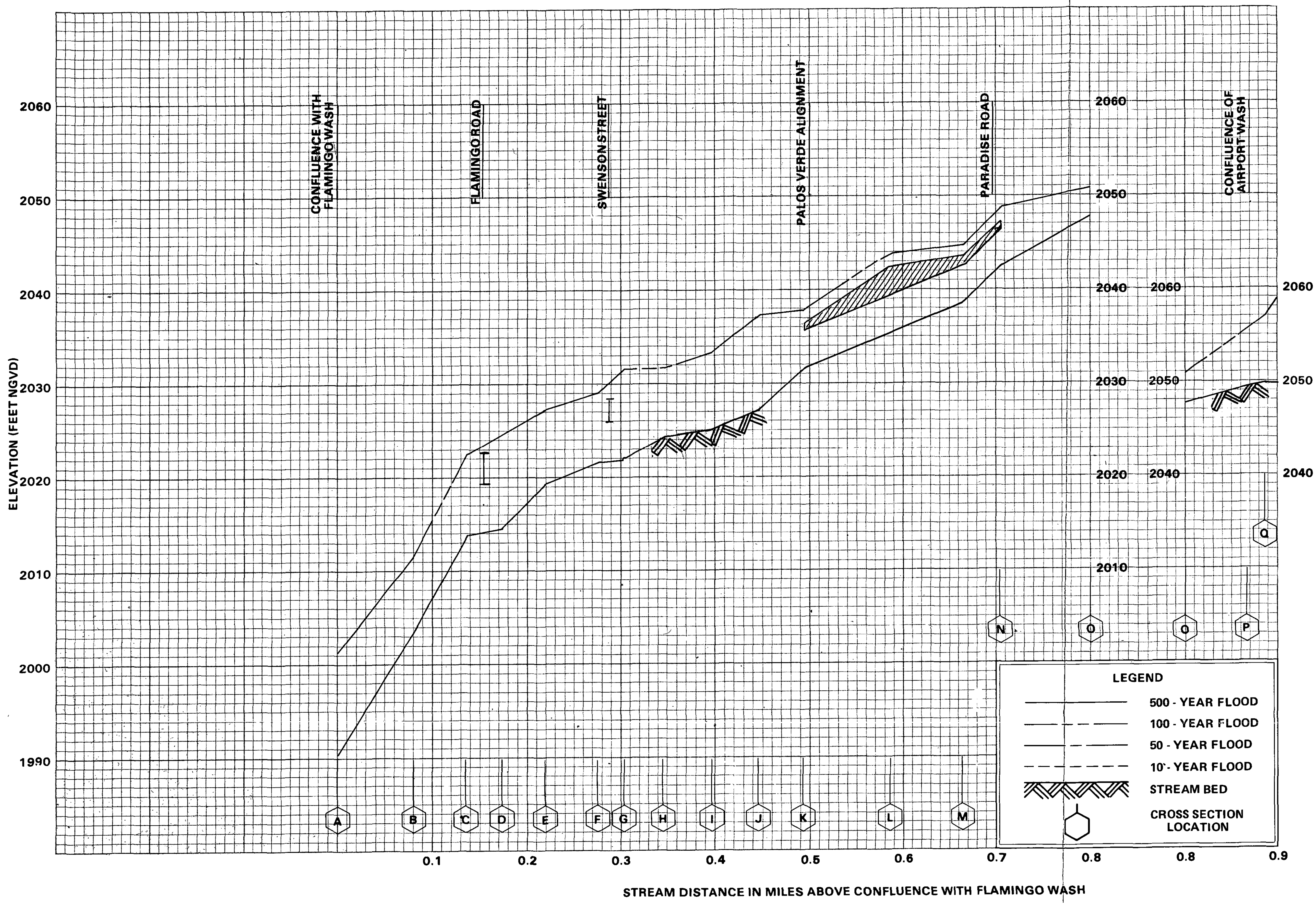
FLOOD PROFILES

PULSIPHER WASH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS

33P



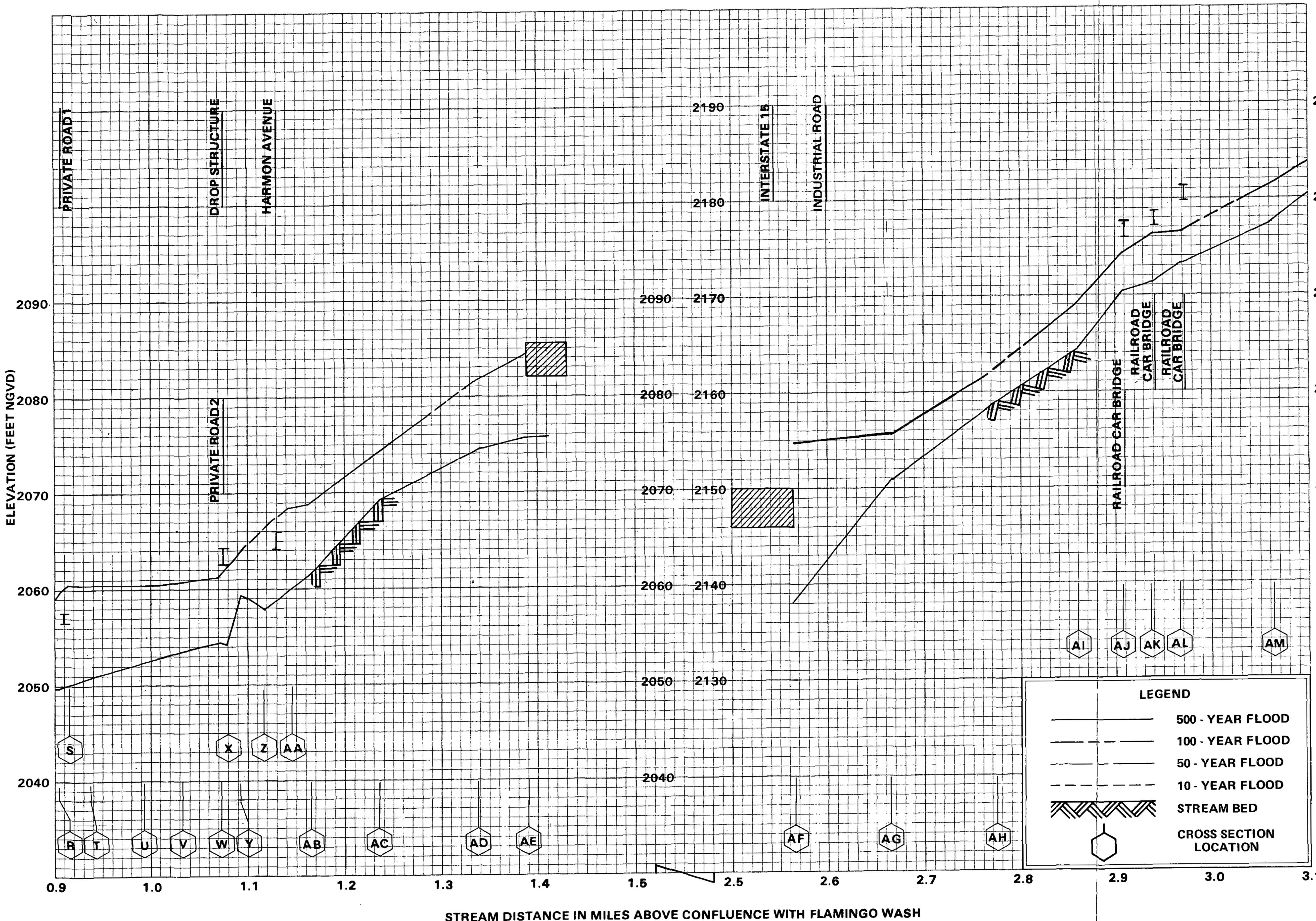
FLOOD PROFILES

TROPICANA WASH-CENTRAL BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS

34P

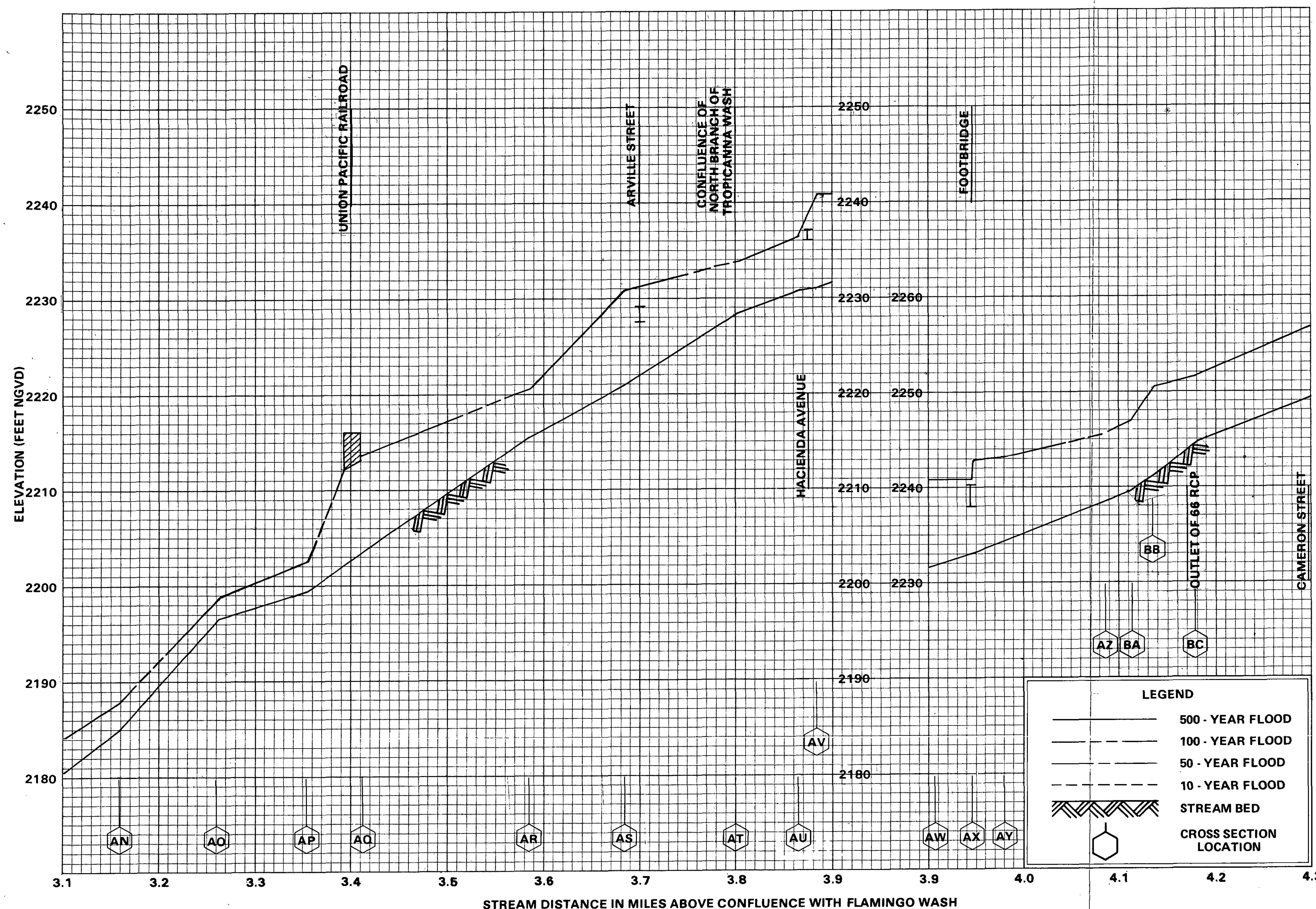


FLOOD PROFILES

TROPICANA WASH–CENTRAL BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS

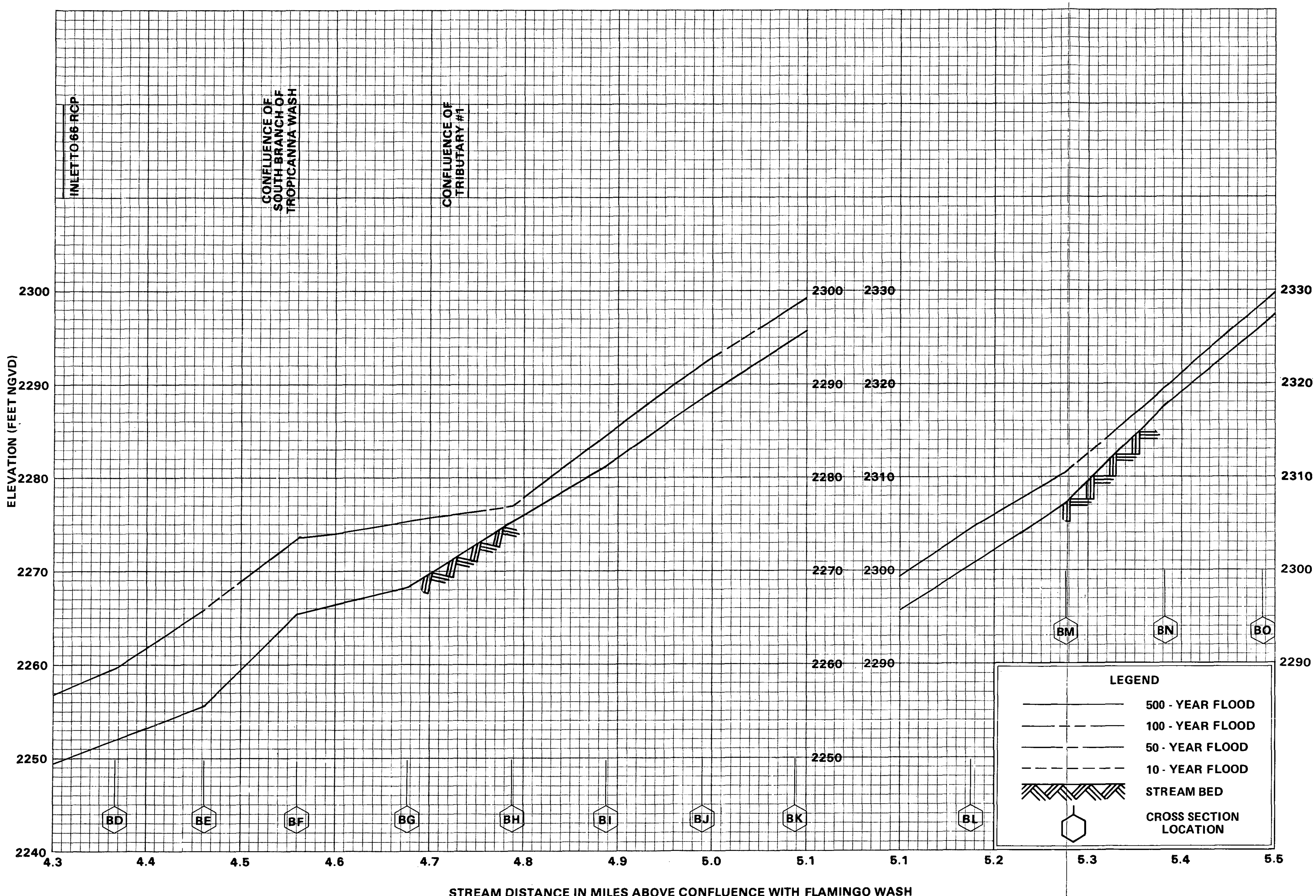


FLOOD PROFILES

TROPICANA WASH-CENTRAL BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS



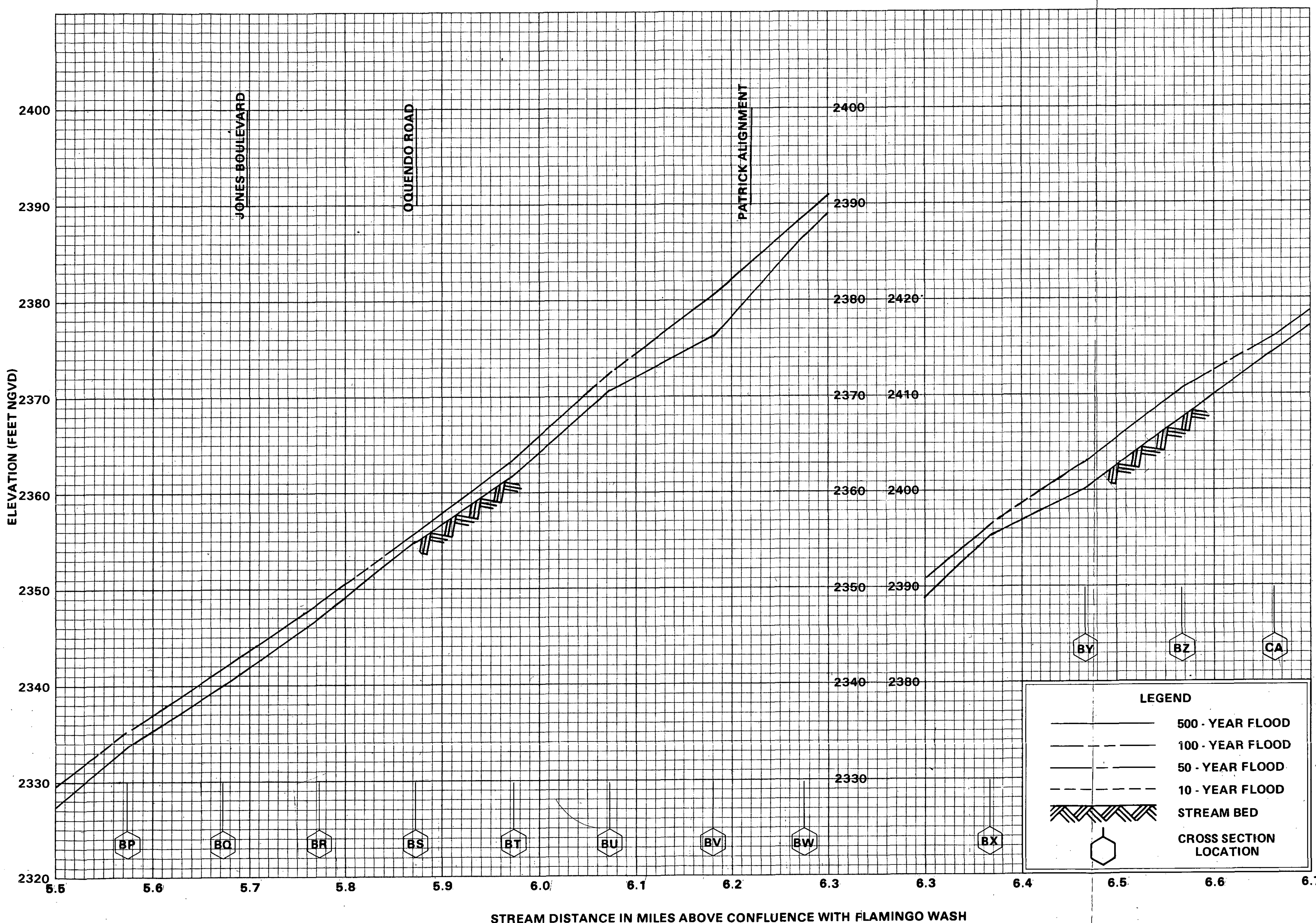
FLOOD PROFILES

TROPICANA WASH-CENTRAL BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS

37P

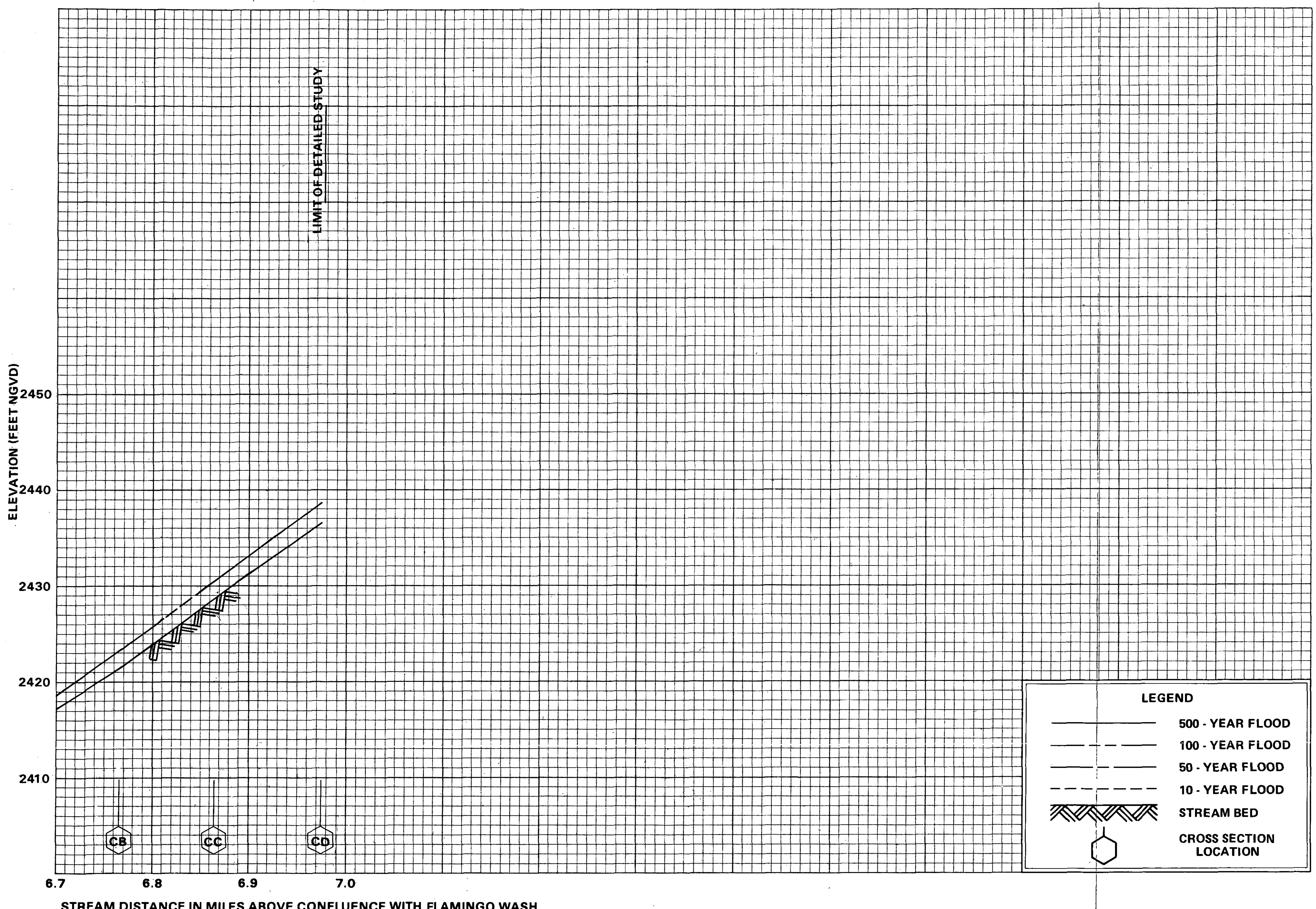


FLOOD PROFILES

TROPICANA WASH-CENTRAL BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS

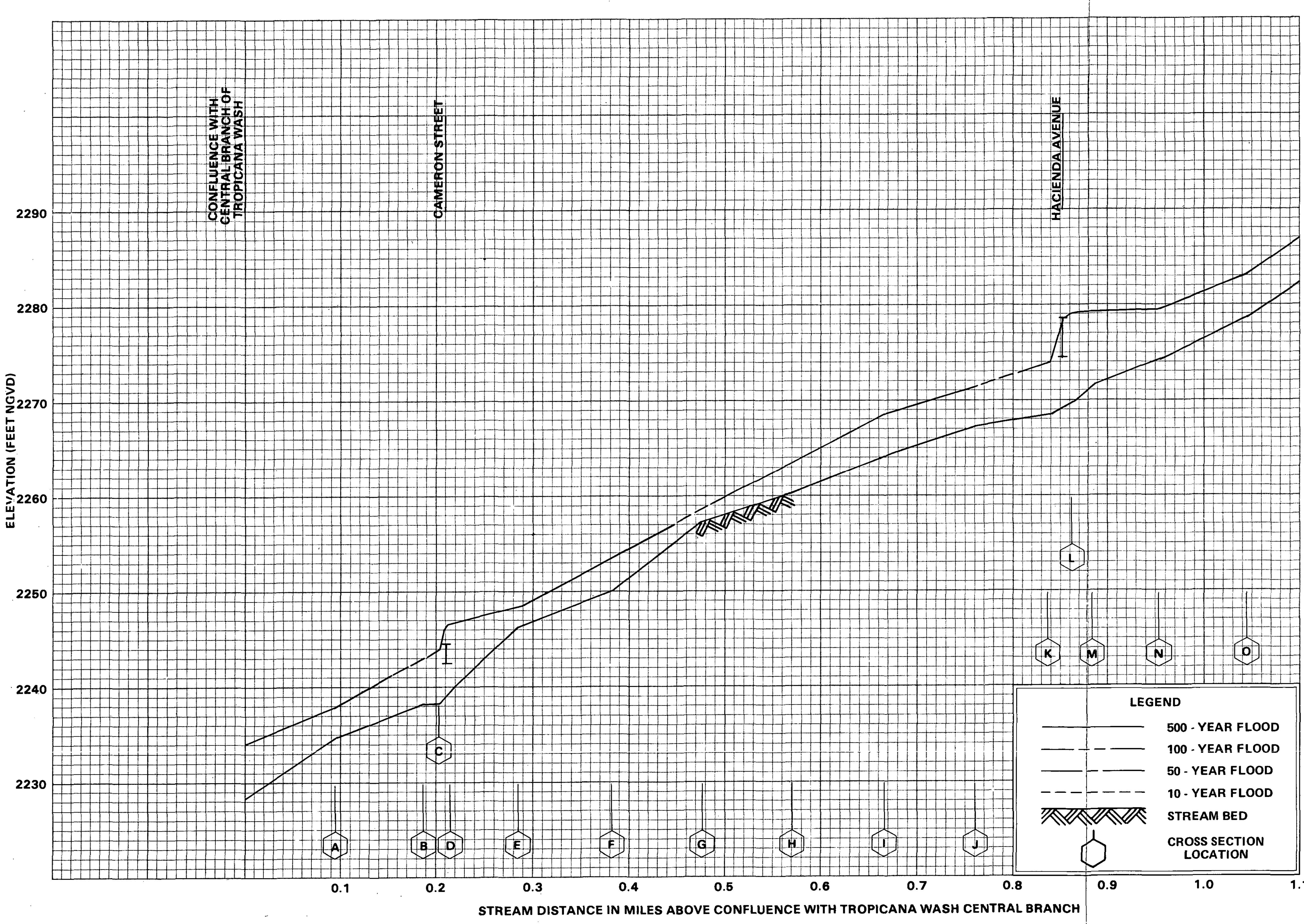


FLOOD PROFILES

TROPICANA WASH-CENTRAL BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV
AND INCORPORATED AREAS



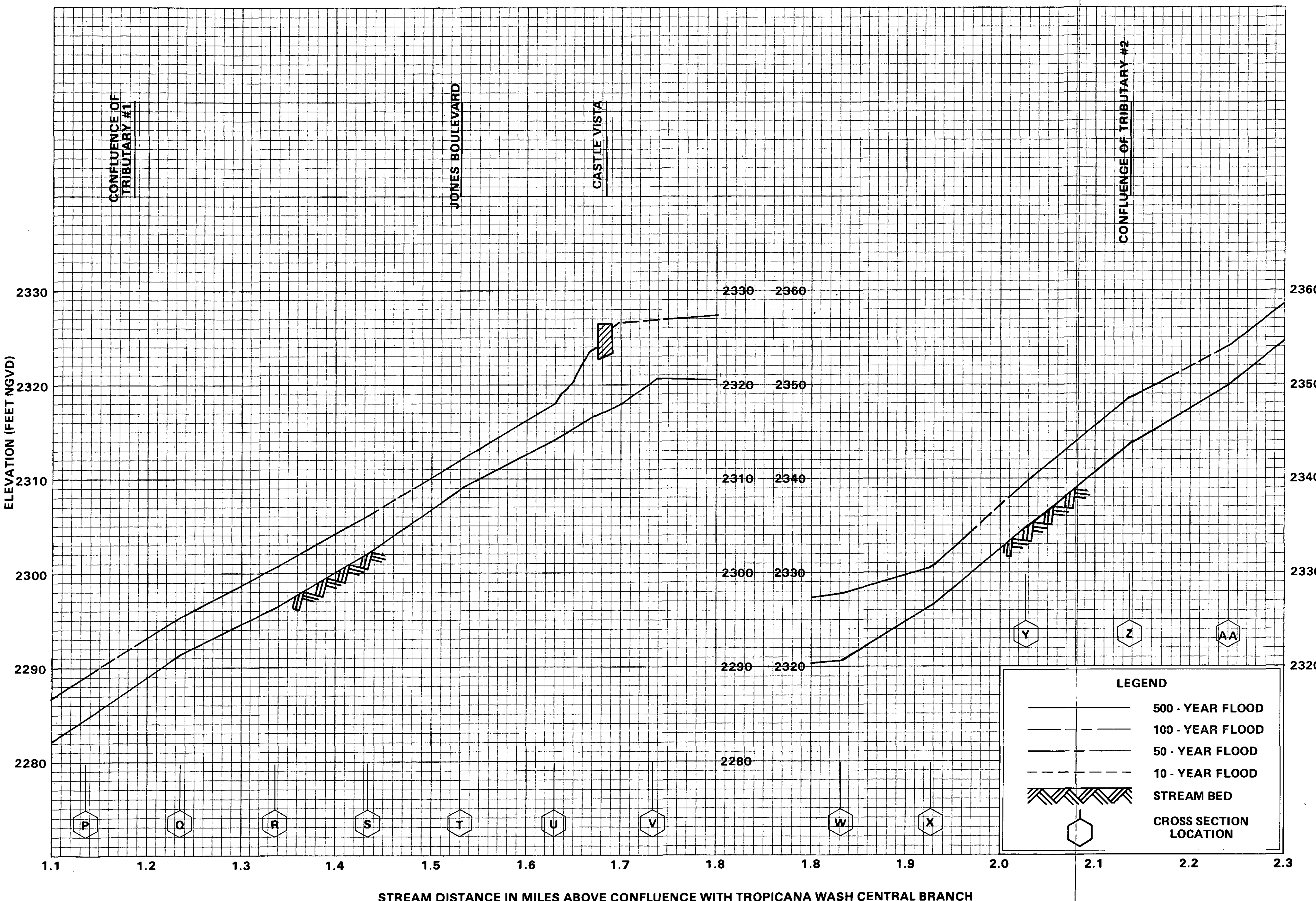
FLOOD PROFILES

TROPICANA WASH-NORTH BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS

40P

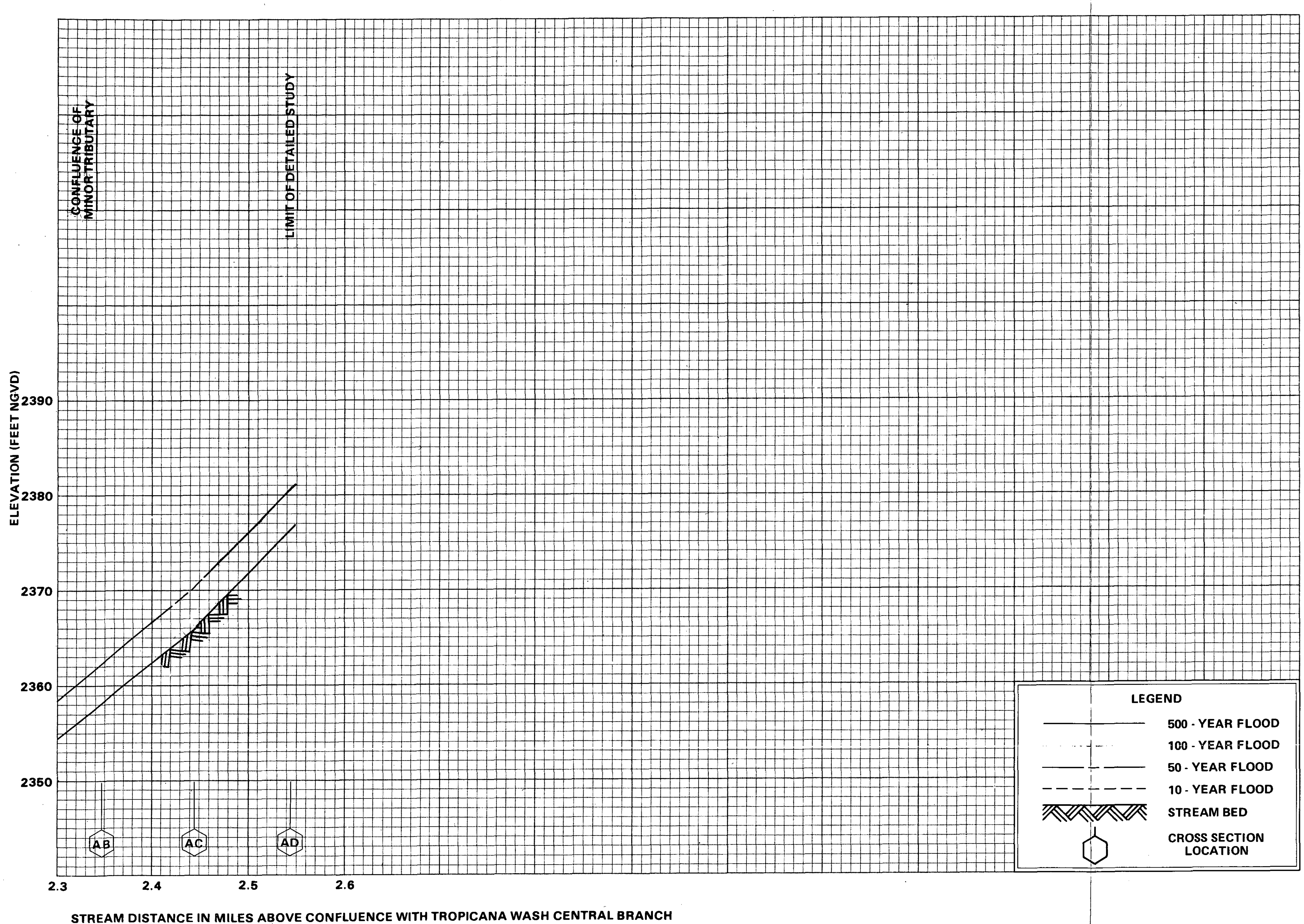


FLOOD PROFILES

TROPICANA WASH–NORTH BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV
AND INCORPORATED AREAS



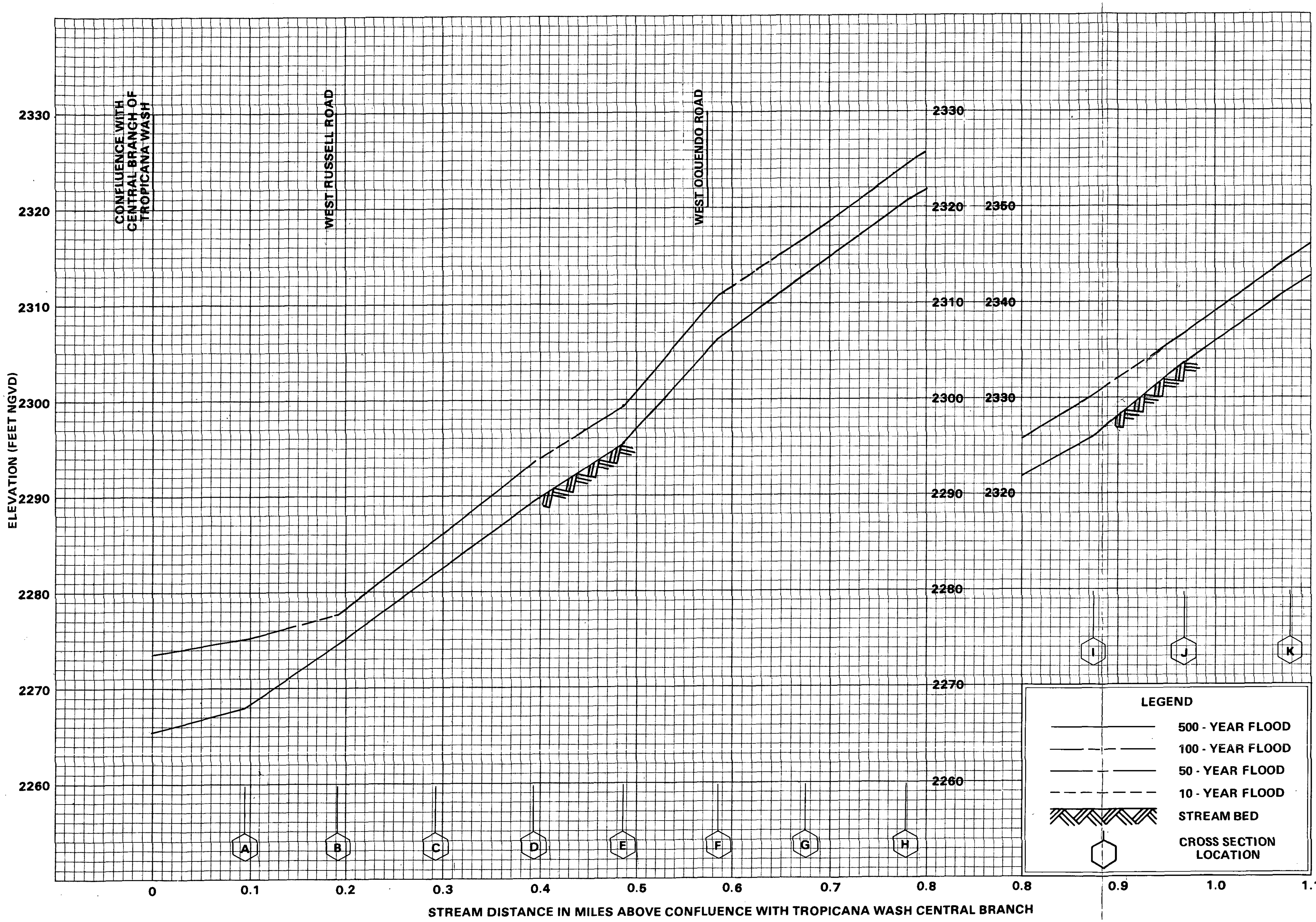
FLOOD PROFILES

TROPICANA WASH–NORTH BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS

42P

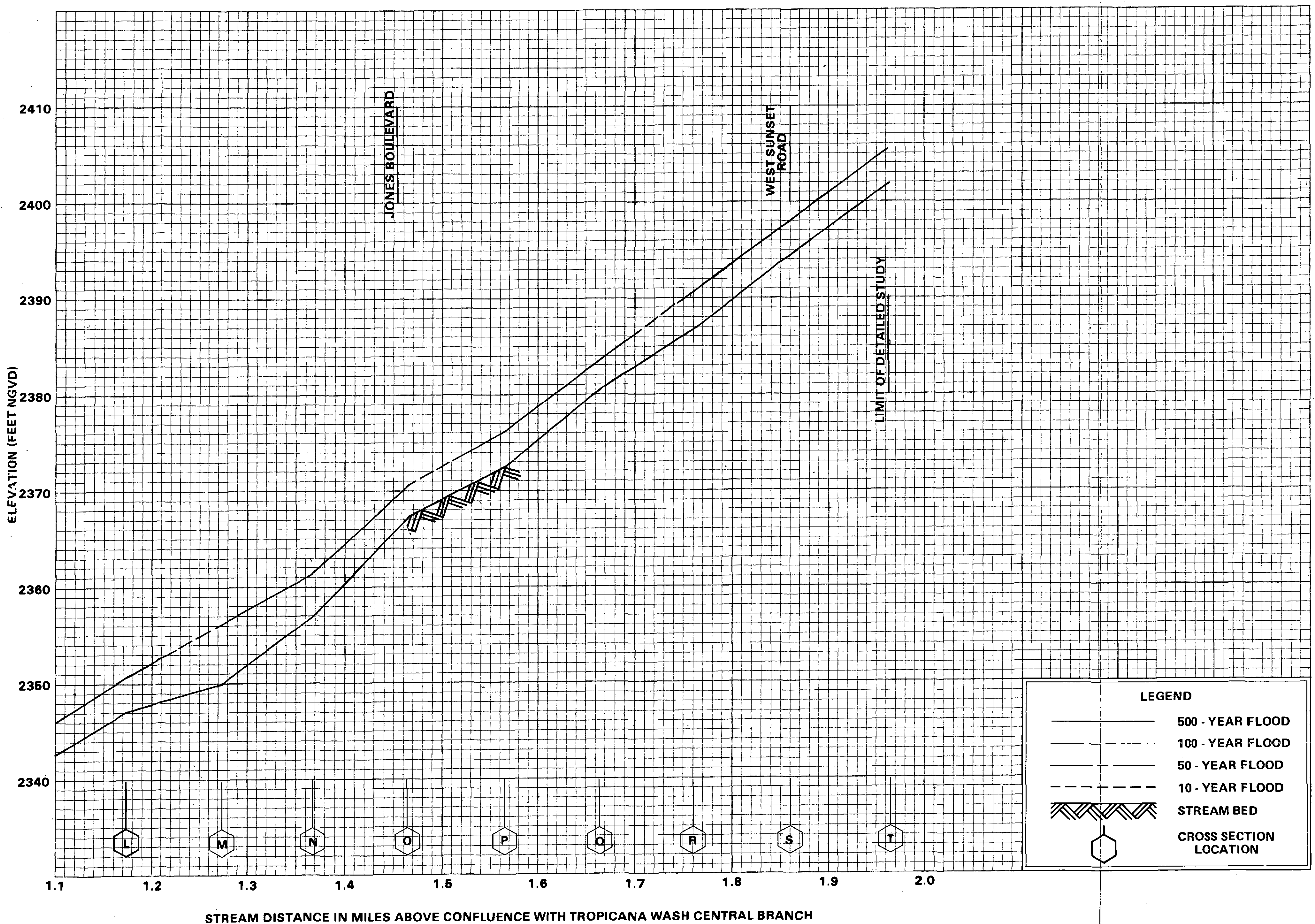


FLOOD PROFILES

TROPICANA WASH—SOUTH BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS



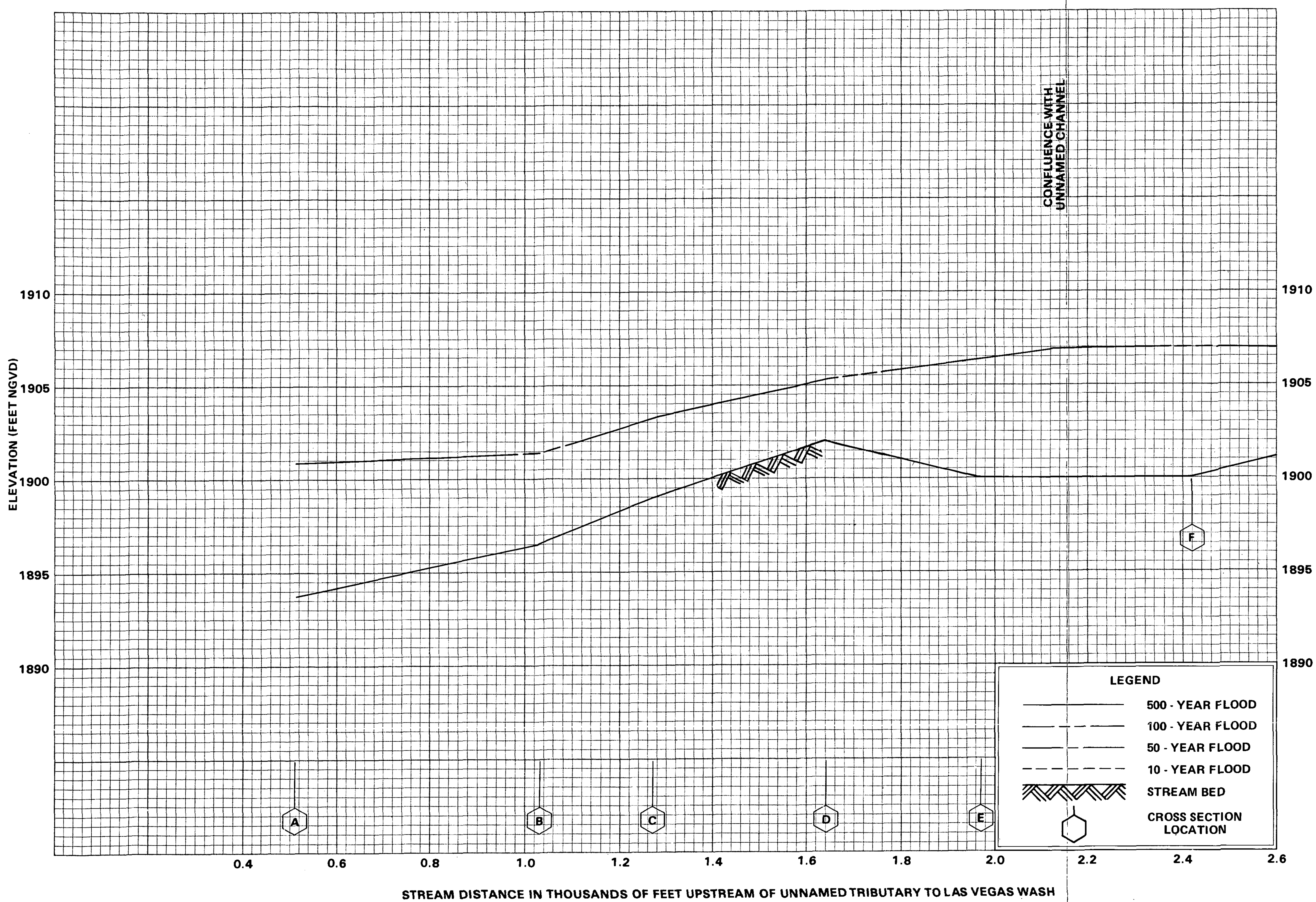
FLOOD PROFILES

TROPICANA WASH - SOUTH BRANCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV
AND INCORPORATED AREAS

44P

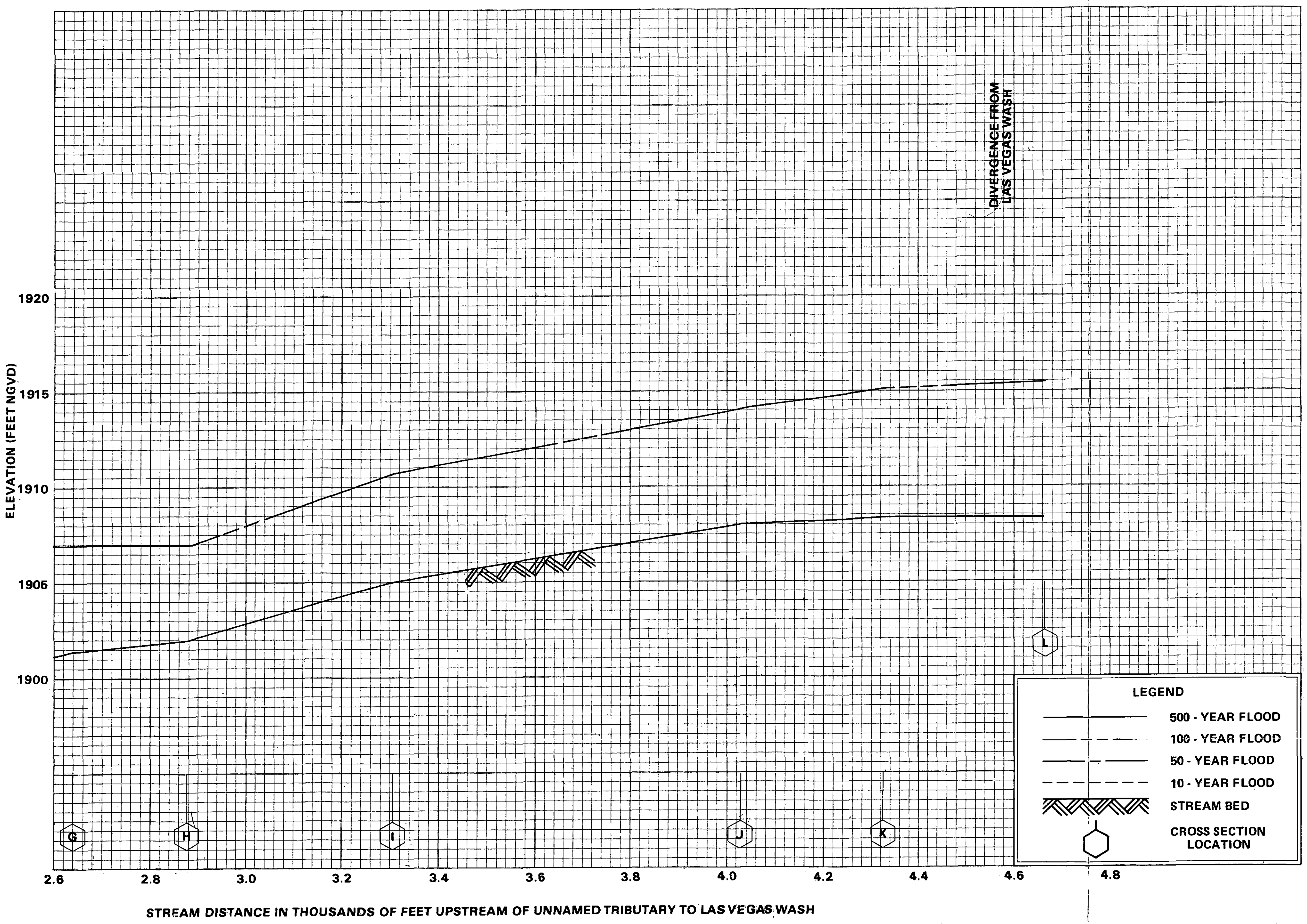


FLOOD PROFILES

UNION PACIFIC RAILROAD OVERFLOW

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS

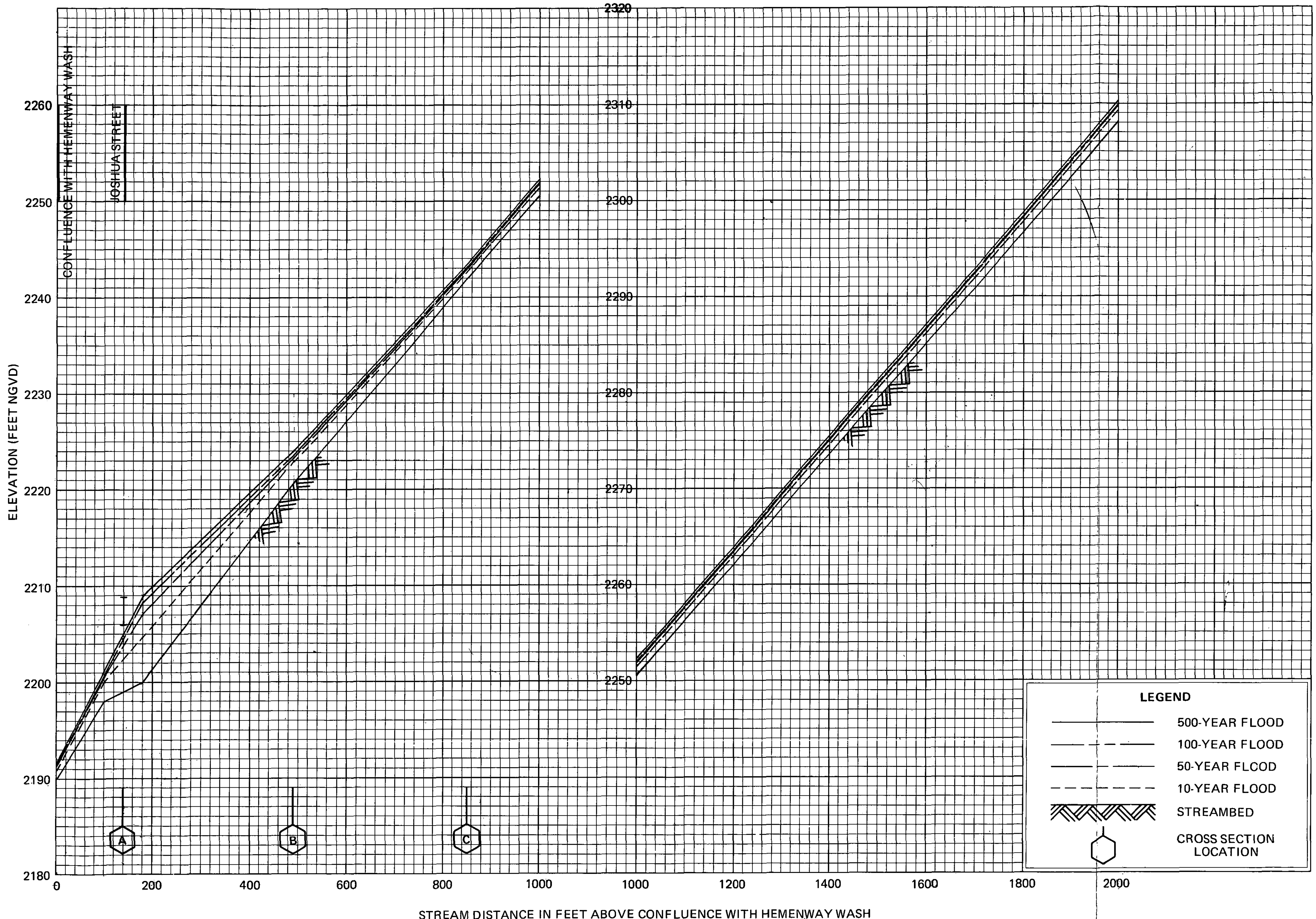


FLOOD PROFILES

UNION PACIFIC RAILROAD OVERFLOW

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS

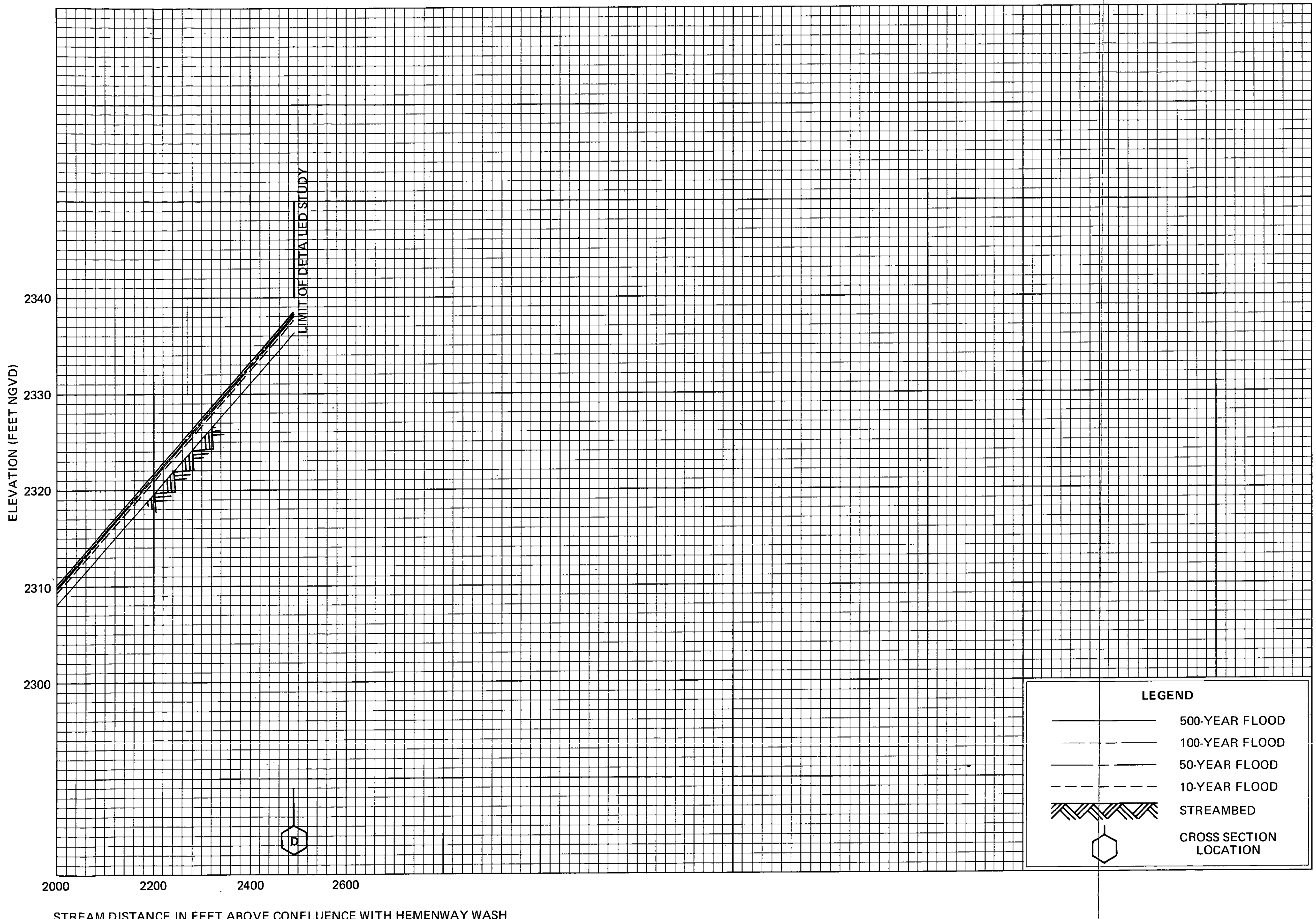


FLOOD PROFILES

WASH B

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS

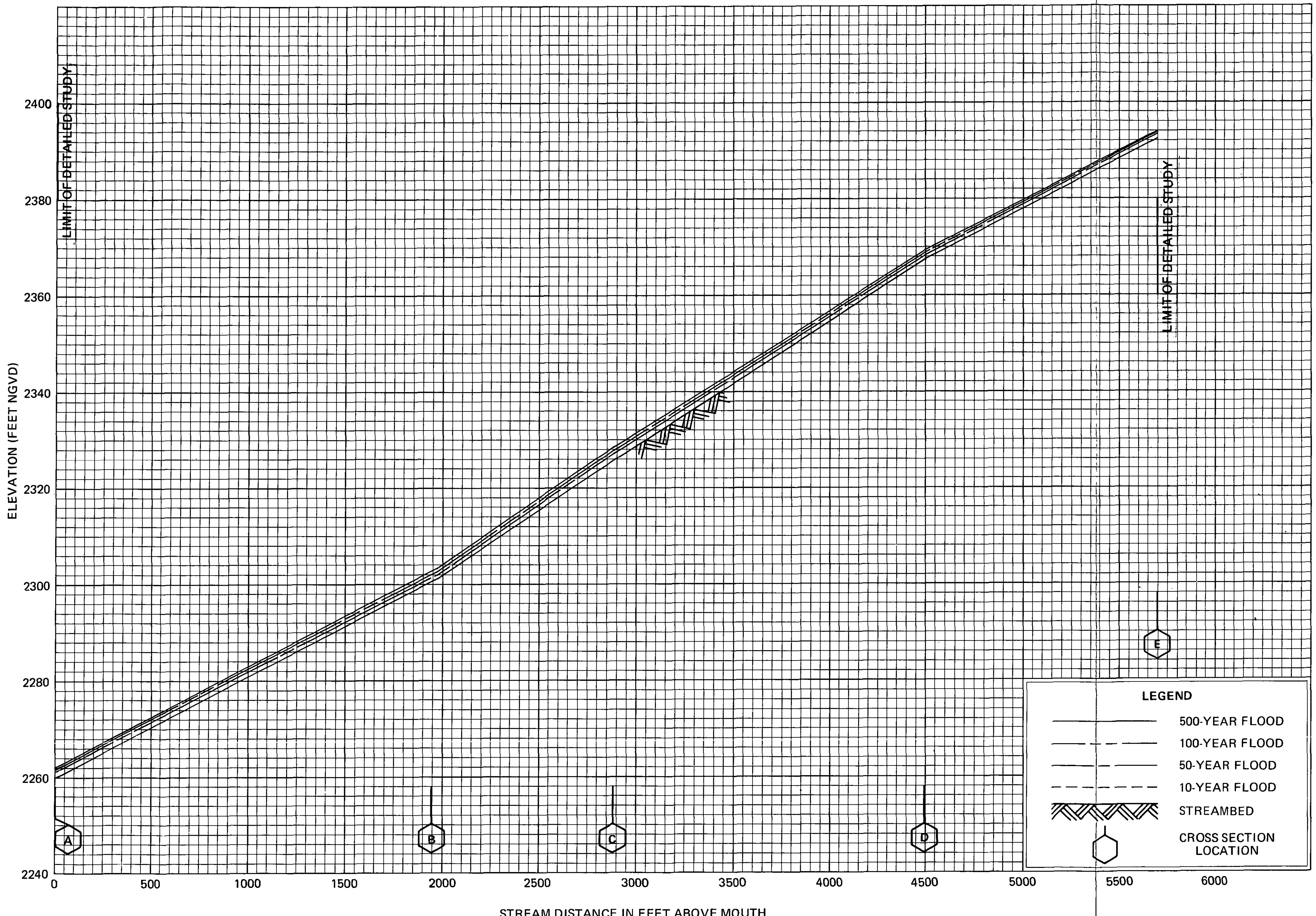


FLOOD PROFILES

WASH B

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS

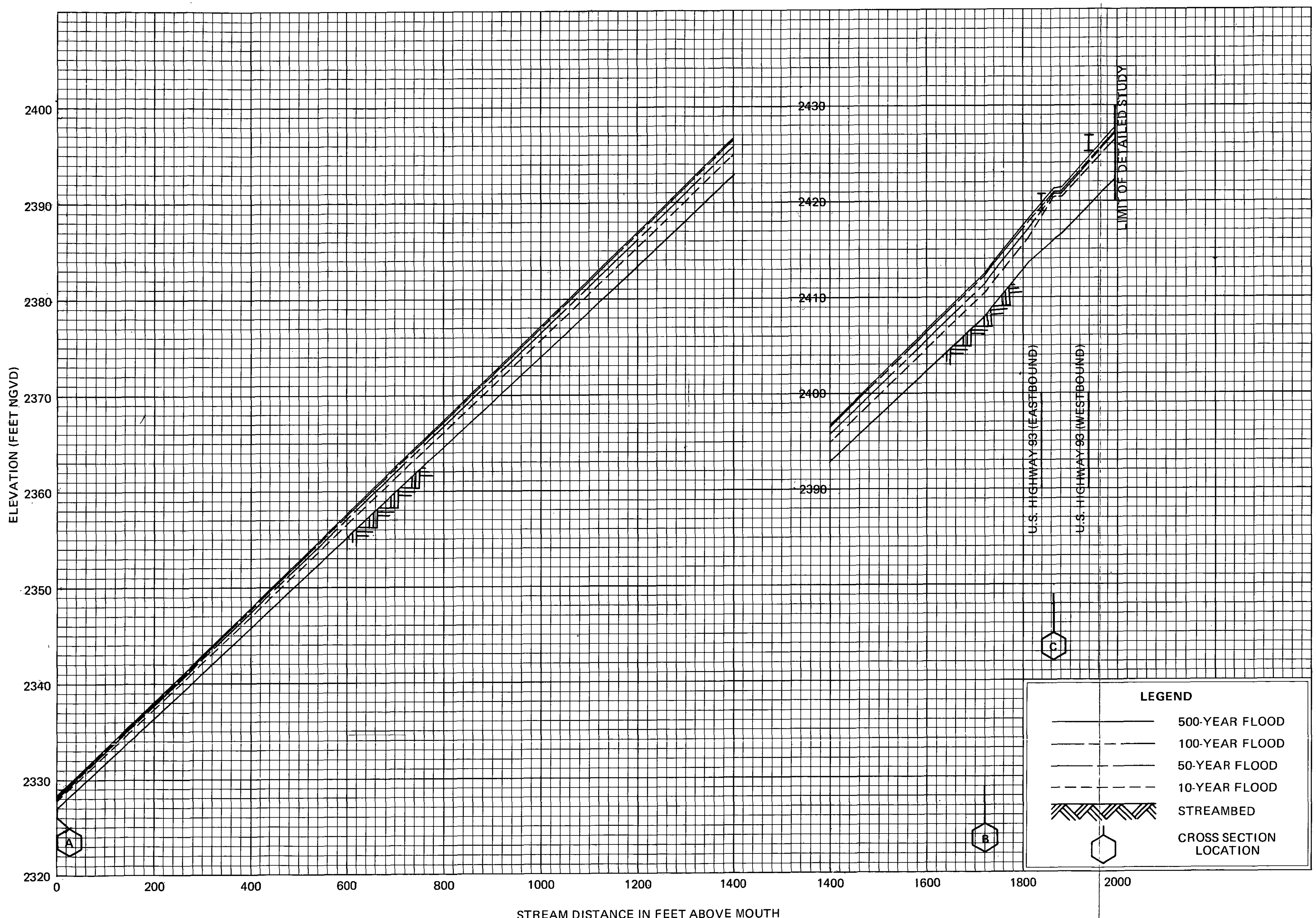


FLOOD PROFILES

WASH C

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS



FLOOD PROFILES

WASH D

FEDERAL EMERGENCY MANAGEMENT AGENCY

CLARK COUNTY, NV AND INCORPORATED AREAS

50P