FLOOD INSURANCE STUDY

CITY OF CONCORD, CALIFORNIA
CONTRA COSTA COUNTY

REVISED: SEPTEMBER 7, 2001

Federal Emergency Management Agency

COMMUNITY NUMBER - 065022V000

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 9.0.

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FLOOD INSURANCE STUDY

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the City of Concord, Contra Costa County, California, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates and assist the community in its efforts to promote sound flood plain management. Minimum flood plain management requirements for participation in the National Flood Insurance Program are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some states or communities, flood plain 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 this study were performed by Tudor Engineering Company, for the Federal Emergency Management Agency (FEMA), under Contract No. H-4033. This study was completed in April 1981. Hydraulic analyses for Mt. Diablo Creek downstream of Ayers Road was performed by Dames & Moore under Contract No. C-0542.

1.3 Coordination

Streams requiring detailed study were identified at the initial community meeting held on February 22, 1977. It was attended by representatives of FEMA, the study contractor, and the City of Concord.

Contact was made with the Contra Costa County Flood Control and Water Conservation District, the City of Concord, and with the U.S. Army Corps of Engineers for additional information on flooding problems and past studies.

An intermediate-final community meeting was held on February 5, 1981, to present preliminary results of the study. The meeting was attended by representatives of FEMA, the City of Concord, the Contra Costa County Flood Control District, and the study contractor.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated areas of the City of Concord, Contra Costa County, California. The area of study is shown on the Vicinity Map (Figure 1).

Unincorporated areas of Contra Costa County located within Concord have been excluded from the study. A U.S. Naval Reservation has also been excluded from the study, with the exception of the flood plains studied along Mt. Diablo Creek and Clayton Valley Drain.

Flooding caused by the overflow of Walnut Creek, Galindo Creek, Pine Creek, Ditch No. 2, Farm Bureau Road Drain, Clayton Valley Drain, and Mt. Diablo Creek was studied by detailed methods.

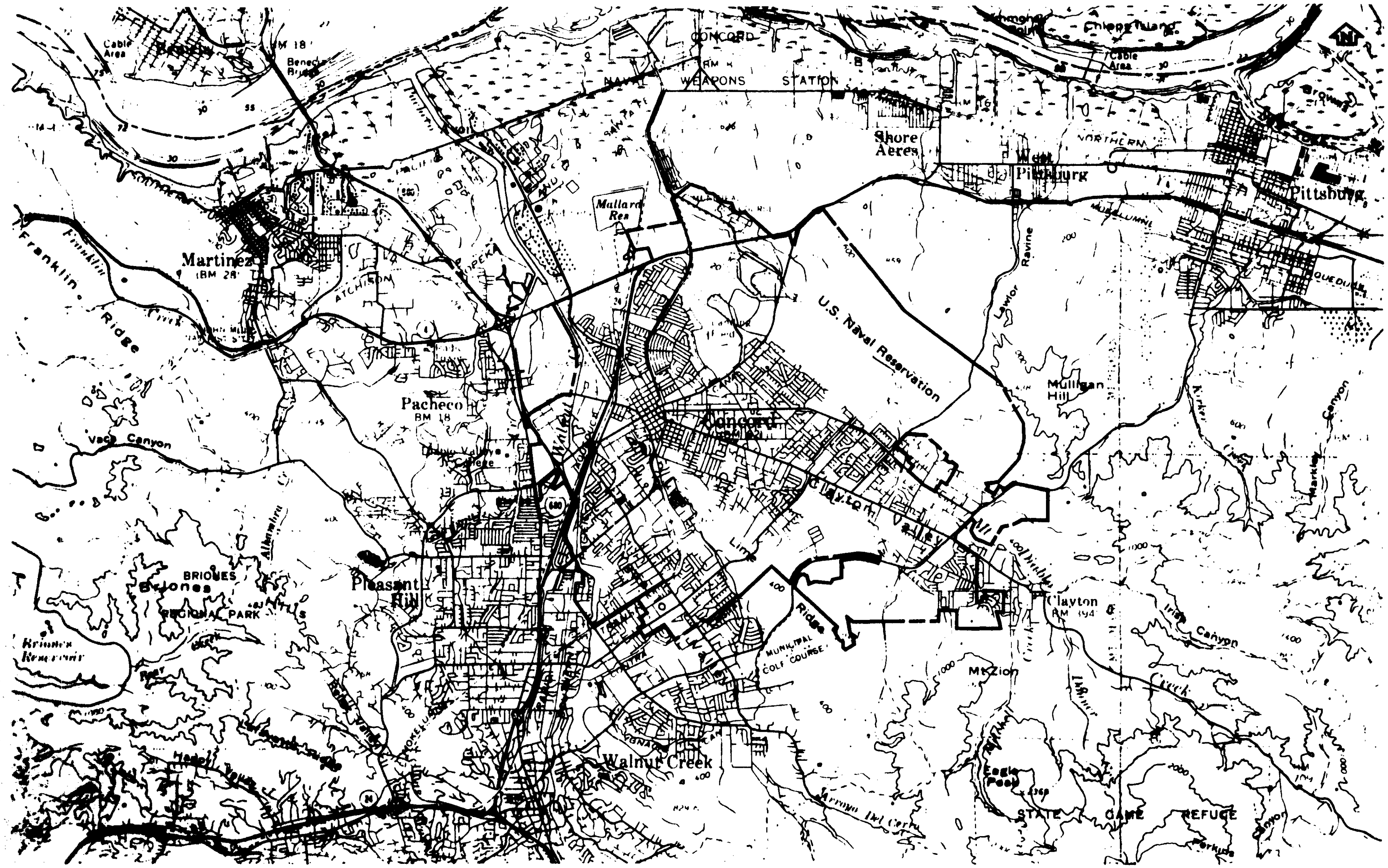
The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development or proposed construction through 1984.

Galindo Creek was originally studied as a detailed analysis from the confluence with Pine Creek upstream to Pine Hollow Road. However, flows along the downstream portion of Galindo Creek were not increased to include overflow of 100-year shallow flooding from Mt. Diablo Creek. Therefore, at the request of FEMA, the study contractor's analysis of Galindo Creek downstream of Dam No. 1 has been presented as an approximate study.

2.2 Community Description

The City of Concord is located in central Contra Costa County, in west-central California, approximately 20 miles east of San Francisco. Concord is bordered by the City of Walnut Creek to the south, the City of Pleasant Hill to the west, the City of Clayton to the east, and unincorporated areas of Contra Costa County.

Concord is in the Walnut Creek and Mt. Diablo Creek drainage basins, both of which discharge north into Suisun Bay north of Concord. Most of Concord lies in the nearly level to sloping valleys along the lower reaches of the streams. The Ygnacio and Clayton Valleys have been substantially developed, covering the old flood plains and gently rolling fans, while some of the adjacent hills remain undeveloped, with trees and shrubs along the stream channels and annual grasses covering the hillsides. Clayton Valley Drain



APPROXIMATE SCALE

2 0 2 4 6

FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CONCORD, CA
(CONTRA COSTA CO.)

VICINITY MAP

receives runoff from a highly developed urban area whose main storm sewers are designed for a 1- in 50-year storm. Elevations in Concord range from approximately 6 feet at Walnut Creek and State Highway 4 to approximately 1,040 feet on Mulligan Hill at the east edge of the city.

The upland areas in Concord along Lime Ridge and the hills along the east side of the city are dominated by moderately deep to deep, strongly sloping to very steep, well-drained clays and silty clay loams that formed in material weathered from soft, fine-grained sandstone and shale on uplands. The lower valley areas are dominated by very deep, nearly level to gently sloping, well-drained clay loams and silty clay loams on valley fill, alluvial fans, and low terraces (Reference 1).

Concord has a mild two-season climate with cool, wet winters and hot, dry summers. Annual rainfall is influenced somewhat by elevation and proximity to the Bay, with most rain falling between the months of October and April. The average annual precipitation is approximately 20 inches, and the average annual temperature ranges from 58°F in January to 70°F in September (Reference 2).

The City of Concord was incorporated on February 2, 1905, with a population of approximately 700. In the 1950s the population began to increase rapidly as Concord became a major suburban residential center. Between 1970 and 1975, the population increased 11.2 percent from 85,164 to 94,673 (Reference 3). The 1980 population is approximately 103,000.

2.3 Principal Flood Problems

The flooding in the Concord area is the result of general rainstorm runoff and independent flows which have overtopped the channel banks or levees and departed from the channel. The recent major flood-producing storms occurred in December 1952, December 1955, April 1958, October 1962, and February 1963. The estimated average recurrence interval of the floods is 10 years for the December 1955 flood, 30 years for the April 1958 flood, and 8 years for the October 1962 flood.

During the December 1955 flood, the Meadow Homes area in Concord was flooded severely with several hundred homes affected. Police and firemen used boats to evacuate some of the residents.

On April 3, 1958, the Contra Costa Gazette reported that a bridge on Sunshine Drive in Concord had buckled from floodwater. The Walnut Kernel on the same date reported the overflow of Pine Creek and the evacuation of approximately 400 families from the Meadow Homes area. On October 14, 1962, the Walnut Kernel reported the evacuation of 30 families from the Meadow Homes area when Pine

Creek went over its banks. On November 11, 1962, the Contra Costa Times reported that a total of 83 homes were flooded on October 12 and 13, 1962.

Areas of the city which were damaged by past floods include the area near the confluence of Pine Creek and Galindo Creek from Monument Boulevard to the confluence with Walnut Creek; the area between Mt. Diablo Creek near Ayers Road and Galindo Creek; and local flooding along Pine Creek, Galindo Creek, Ditch No. 2, Farm Bureau Road Drain, and Mt. Diablo Creek.

2.4 Flood Protection Measures

Existing flood protection measures include sections of improved channel along parts of all of the study streams.

All of Walnut Creek within the City of Concord has been improved by the U.S. Army Corps of Engineers to contain the 100-year flood. Walnut Creek is lined with leveed banks which are maintained by the U.S. Army Corps of Engineers. The levees are elevated more than 3 feet above the 100-year flood level for most of the reach within the city. Overbank areas along most of the leveed banks are elevated higher than the levees. However, levees along the left overbank north of Willow Pass Road are elevated less than 3 feet above the 100-year flood.

The U.S. Army Corps of Engineers has completed part of a channel improvement project designed to contain the 100-year flood along the lower reaches of Pine and Galindo Creeks. The completed improvements include a concrete-lined channel along Pine Creek downstream of the bay area rapid transit tracks. A drainage channel has been constructed along Galindo Creek from San Miguel Road to the confluence with Pine Creek. This is a significant improvement as it will eliminate a large overflow from Monument Boulevard.

Most of the remaining streams have sections of channels which have been improved by local agencies, but in most cases the improvements are still not able to handle the 100-year flood. Stream channels that have been improved include most of Clayton Valley Drain, a section of Farm Bureau Road Drain between Walnut Avenue and Farm Bureau Road, a section of Mt. Diablo Creek near Concord Avenue, sections of Galindo Creek between Ygnacio Valley Road and Academy Road and downstream of Treat Boulevard, most of Pine Creek within the city, and most of Ditch No. 2.

Levees have been constructed along Clayton Valley Drain near the confluence with Walnut Creek. Below Solano Way there is greater than 3 feet of freeboard between the top of levees and the 100-year flood along Clayton Valley Drain. Upstream of Solano Way there is less than 3 feet of freeboard. Along the right overbank, the levee-protected area is flooded by 100-year overflows originating further upstream from Clayton Valley Drain. Approximate 100-year boundaries have been determined for the levee-protected area along the left overbank.

3.0 ENGINEERING METHODS

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

3.1 Hydrologic Analyses

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

Walnut Creek flood estimates are based on an analysis of 16 years of records (Reference 4) from the Walnut Creek U.S. Geological Survey Gage (No. 11183500), which is located 2 miles upstream of the Concord corporate limits. The study contractor performed a regional flood peak regression analysis for Walnut Creek. The results of these analyses were very similar to discharges previously adopted by the U.S. Army Corps of Engineers for the Walnut Creek Project (Reference 5) and to the results of regional flood peak regression equations independently developed by the U.S. Geological Survey (Reference 6).

U.S. Geological Survey stream gages were operated on Galindo Creek (No. 11184000) for 4 years on Pine Creek (No. 11184500) for 8 years; the record, however, was too short for direct use in determining the flood frequency. The flood peak estimates for Pine and Galindo Creeks, Ditch No. 2, Clayton Valley Drain, and Farm Bureau Road Drain were based primarily on the U.S. Geological Survey's Central Coast regional regression equations published in Magnitude and Frequency of Floods in California, Water Resources Investigation 77-21 (Reference 6).

The results for the 100-year flood are on average 10 percent lower than those determined for an unpublished Flood Insurance Study prepared for the Federal Insurance Administration by the U.S. Army Corps of Engineers in September 1971 (Reference 7). They are considerably lower than discharges determined by the U.S. Army Corps of Engineers for the ultimate development of the area projected in the year 2020 (Reference 8).

Flood peak estimates for Mt. Diablo Creek were based on regional regression equations developed by the study contractor for the Central-Delta region of Contra Costa County in accordance with the U.S. Water Resources Council procedures (Reference 9). A 100-year overflow occurs along the left overbank of Mt. Diablo Creek at Ayers Road and flows as Zone B shallow flooding to Galindo Creek and Farm Bureau Road Drain. Peak 100-year discharges downstream of Ayers Road along Mt. Diablo Creek reflect the overflow loss of 1,071 cfs.

Peak discharge-drainage area relationships for streams studied by detailed methods are shown in Table 1.

3.2 Hydraulic Analyses

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

For streams studied by detailed methods, water-surface elevations and capacities of natural channels were computed using the U.S. Army Corps of Engineers HEC-2 step-backwater computer program (Reference 10), supplemented by hand calculations and special computer programs where required (Reference 11).

Water-surface elevations for the 100-year flood on Mt. Diablo Creek downstream of Ayers Road account for 100-year overflow losses at Ayers Road. Flood elevations were not determined for the 50-year flood. The 100-year flood elevations were computed using the U.S. Army Corps of Engineers HEC-2 computer program.

Table 1. Summary of Discharges

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (Cubic Feet per Second)			
		10-Year	50-Year	100-Year	500-Year
Walnut Creek					
At corporate limits at State Highway 4 (Arnold Industrial Highway)	117.30	9,520	18,000	22,300	31,000
At Walnut Creek Stream Gage (upstream of Concord)	77.20	9,520	17,700	22,000	30,600
Galindo Creek					
At San Miguel Road	8.00	1,580	2,330	2,570	3,100
At Contra Costa Canal	7.73	1,580	2,330	2,570	3,100
At Cowell Road	6.33	1,400	2,050	2,270	2,740
At Treat Boulevard	5.52	1,290	1,930	2,140	2,590
Approximately 2,500 feet downstream of Newhall Parkway	4.73	1,200	1,790	1,990	2,400
At Newhall Parkway	3.56	900	1,360	1,510	1,830
Pine Creek					
At confluence with Walnut Creek	29.10	3,200	6,000	7,300	10,000
At Monument Boulevard	19.40	1,700	3,400	4,300	6,400
At confluence with Contra Costa Canal	13.80	980	2,200	2,800	4,400
Ditch No. 2					
At confluence with Pine Creek	3.30	1,100	1,500	1,700	2,000
At Bart Culvert	2.10	900	1,300	1,450	1,650
Farm Bureau Road Drain					
At confluence with Contra Costa Canal	1.40	290	510	610	800
Clayton Valley Drain					
At confluence with Walnut Creek	4.40	1,200	1,800	2,100	2,400
1,135 feet upstream of Salvio Street	2.10	480	790	930	1,200

Table 1. Summary of Discharges (Cont'd)

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (Cubic Feet per Second) 10-Year	50-Year	100-Year	500-Year
Mount Diablo Creek					
Downstream of Bailey Road	22.06	3,670	5,670	6,350	7,760
Approximately 700 feet downstream of Kirker Pass Road	19.75	3,660	5,610	6,270	7,640
At Kirker Pass Road	17.00	3,450	5,240	5,860	7,130
Downstream of confluence of Mitchell Creek	15.85	3,450	5,240	5,860	7,130
Downstream of Irish Canyon	11.29	2,610	3,950	4,400	5,350
Upstream of Irish Canyon	7.90	1,900	2,840	3,170	3,840
Downstream of confluence of Donner Creek	7.01	1,890	2,810	3,130	3,780
Upstream of confluence of Donner Creek	4.07	1,050	1,570	1,750	2,110
At Regency Drive	3.35	960	1,430	1,590	1,930
Downstream of confluence of Russellmann Creek	2.20	880	1,280	1,420	1,700

Most culverts were analyzed using a separate computer program developed by the study contractor that gave a headwater elevation to be used in continuing the backwater analysis upstream (Reference 11).

Flooding along Walnut Creek was determined to be contained within the levees and channel. Flows along Pine Creek downstream of the Bart tracks were determined to be contained within the channel. Flooding on Clayton Valley Drain downstream of Solano Way was determined to be contained within the levees.

Cross sections for the hydraulic analyses were digitized from aerial photographs flown in March 1978 at a scale of 1:12,000 (Reference 12). These data were supplemented by field measurements.

The cross sections were located short distances upstream and downstream of bridges and other hydraulically significant features in order to establish the backwater effect of such features.

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 Boundary and Floodway Map (Exhibit 2).

Flood profiles were not presented for those stream segments where flooding is contained within channels or levees.

Channel roughness factors (Manning's "n") used in the hydraulic computations were assigned on the basis of field inspection of flood plain areas. The values used for the channels varied between 0.012 and 0.070; values for the overbank varied between 0.050 and 0.100.

Starting water-surface elevations for Ditch No. 2, Clayton Valley Drain, Mt. Diablo Creek, Pine Creek, and Galindo Creek were calculated using the slope-area method. The starting water-surface elevation for the Farm Bureau Road Drain was determined using culvert and weir analyses at the outlet to the Contra Costa Canal.

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 and operate properly.

Where overbank flooding is shallow and hydraulically independent of the adjacent stream channel, channel flood profiles are not applicable. The extent of such overbank flooding was determined by normal depth calculations.

From Ditch No. 2, 500-year flooding flows northward along Sierra Road and enters Pine Creek upstream of Monument Boulevard.

North of Willow Pass Road, 100-year flood boundaries were determined for the levee-protected area west of Walnut Creek where there is less than 3 feet of freeboard between the top of the levee and the 100-year flood along Walnut Creek. This flooding was determined using a normal-depth analysis.

Approximate 100-year flood boundaries presented along Galindo Creek downstream of Dam No. 1 were determined using the U.S. Army Corps of Engineers HEC-2 computer analysis (Reference 10).

Approximate 100-year flood boundaries were determined in the levee-protected overbank area along Clayton Valley Drain.

All elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD). Elevation Reference Marks (ERMs) used in this study are shown on the maps. ERMs shown on the FIRM represent those used during the preparation of this and previous Flood Insurance Studies. The elevations associated with each ERM were obtained and/or developed during FIS production to establish vertical control for determination of flood elevations and floodplain boundaries shown on the FIRM. Users should be aware that these ERM elevations may have changed since the publication of this FIS. To obtain up-to-date elevation information on National Geodetic Survey (NGS) ERMs shown on this map, please contact the Information Services Branch of the NGS at (301) 713-3242, or visit their website at www.ngs.noaa.gov. Map users should seek verification of non-NGS ERM monument elevations when using these elevations for construction or floodplain management purposes.

4.0 FLOOD PLAIN MANAGEMENT

The NFIP encourages State and local governments to adopt sound floodplain management programs. To assist in this endeavor, each FIS provides 100-year floodplain data, which may include a combination of the following: 10-, 50-,100-, and 500-year flood elevations; delineations of the 100-year and 500-year floodplains; and 100-year floodway. This information is presented on the FIRM and in many components of the FIS, including Flood Profiles, Floodway Data tables and Summary of Stillwater Elevation tables. Users should reference the data presented in the FIS as well as additional information that may be available at the local community map repository before making flood elevation and/or floodplain boundary determinations.

4.1 Flood 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 flood plain management purposes. The 0.2 percent annual chance (500-year flood is employed to indicate areas of flood risk in the community. For each stream studied in detail, the 100- and 500-year flood plain 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 1:3,600, with a contour interval of 2 feet (Reference 13).

Shallow flood boundaries were delineated using the topographic maps referenced above (Reference 13) and the appropriate depths determined by methods discussed in Section 3.2.

Approximate 100-year flood boundaries were delineated using topographic maps as referenced above (Reference 13).

Approximate flood boundaries in some portions of the study area were taken from the Flood Hazard Boundary Map (Reference 14).

The 100- and 500-year flood boundaries are shown on the Flood Boundary and Floodway Map (Exhibit 2). In cases where the 100- and 500-year flood plain boundaries are close together, only the 100-year flood plain boundary has been shown. Small areas within the flood plain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

4.2 Floodways

Encroachment on flood plains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of flood plain management involves balancing the economic gain from flood plain development against the resulting increase in flood hazard. For purposes of the National Flood Insurance Program, a floodway is used as a tool to assist local communities in this aspect of flood plain management. Under this concept, the area of the 100-year flood plain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent flood plain area, 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.

Floodways were not determined for Pine Creek downstream of Treat Boulevard, Ditch No. 2, and Clayton Valley Drain due to shallow overflows leaving the streams.

The floodways presented in this study were computed on the basis of equal-conveyance reduction from each side of the flood plain. The results of these computations are tabulated at selected cross sections for each stream segment for which a floodway is computed (Table 2).

As shown on the Flood Boundary and Floodway Map (Exhibit 2), the floodway boundaries were computed at cross sections. Between cross sections, the boundaries were interpolated. In cases where the floodway and 100-year flood plain boundaries are either close together or collinear, only the floodway boundary has been shown.

The area between the floodway and 100-year flood plain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the flood plain that could be completely obstructed without increasing the water-suface elevation of the 100-year

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
Galindo Creek								
ZH	16,620	105	382	5.9	149.2	149.2	150.2	1.0
ZI	17,220	95	338	6.7	152.6	152.6	153.0	0.4
ZJ	17,770	54	246	9.2	156.3	156.3	156.4	0.1
ZK	18,270	52	234	9.4	161.2	161.2	161.4	0.2
ZL	18,590	45	170	12.9	163.5	163.5	163.6	0.1
ZM	19,010	56	232	9.5	168.7	168.7	168.8	0.1
ZN	19,330	46	272	8.1	170.3	170.3	171.3	1.0
ZO	19,630	50	180	12.2	172.5	172.5	172.5	0.0
ZP	19,880	61	348	6.2	175.5	175.5	175.5	0.0
ZQ	20,280	84	594	3.6	178.8	178.8	178.8	0.0
ZR	20,680	50	347	6.2	178.9	178.9	178.9	0.0
ZS	20,910	119	299	7.2	183.7	183.7	183.7	0.0
ZT	21,440	55	227	9.4	188.4	188.4	188.5	0.1
ZU	21,890	45	203	10.5	193.2	193.2	193.2	0.0
ZV	22,540	55	257	8.3	199.2	199.2	199.5	0.3
ZW	23,040	46	226	8.8	203.2	203.2	204.0	0.8
ZX	23,540	59	288	6.9	207.4	207.4	208.1	0.7
ZY	24,040	42	209	9.5	211.2	211.2	211.7	0.5
ZZ	24,570	45	234	8.5	217.0	217.0	217.6	0.6

[1]Feet above mouth

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CONCORD, CA
(CONTRA COSTA CO.)

FLOODWAY DATA

GALINDO CREEK

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
Galindo Creek (Cont'd)								
A	25,318[1]	207	219	5.9	223.8	223.8	223.8	0.0
B	25,841[1]	109	325	4.0	225.3	225.3	225.7	0.4
C	26,296[1]	41	134	9.7	230.9	230.9	231.3	0.4
D	26,393[1]	444	247	5.3	237.3	237.3	237.5	0.2
E	27,536[1]	138	918	1.4	248.8	248.8	248.8	0.0
F	29,000[1]	32	141	9.2	257.8	257.8	258.8	1.0
G	30,177[1]	128	205	6.4	271.1	271.1	271.3	0.2
H	32,008[1]	70	942	1.4	294.2	294.2	294.2	0.0
I	32,591[1]	39	150	4.7	300.5	300.5	300.5	0.0
J	33,179[1]	22	70	10.2	314.7	314.7	314.7	0.0
K	33,996[1]	45	128	5.5	330.6	330.6	331.4	0.8
Pine Creek								
M	14,195[2]	59	262	12.2	93.5	93.5	93.5	0.0
N	15,837[2]	31	205	13.6	100.7	100.7	100.7	0.0

[1]Feet above mouth [2]Feet above confluence with Galindo Creek

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CONCORD, CA
(CONTRA COSTA CO.)

FLOODWAY DATA

GALINDO CREEK – PINE CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NGVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Mount Diablo Creek								
A	27,901	57	499	12.9	195.9	195.9	196.9	1.0
B	29,095	162	578	11.0	203.7	203.7	203.7	0.0
C	31,550	372/40[2]	1,446	4.4	223.1	223.1	224.0	0.9
D	33,625	58	442	14.2	235.1	235.1	235.4	0.3
E	34,575	52	396	15.8	243.0	243.0	243.3	0.3
F	35,600	127	699	9.0	249.8	249.8	250.5	0.7
G	37,450	147	840	7.5	265.5	265.5	265.8	0.3
H	38,450	130	642	9.8	273.1	273.1	273.3	0.2
I	39,450	141	554	11.3	282.5	282.5	282.5	0.0
J	40,650	285	752	7.8	297.8	297.8	297.8	0.0
K	43,056	163/50[2]	671	8.7	318.4	318.4	319.3	0.9

[1]Feet above mouth [2]Total width/width within corporate limits

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CONCORD, CA
(CONTRA COSTA CO.)

FLOODWAY DATA

MOUNT DIABLO CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE
Farm Bureau Road Drain								
A	404	41	78	7.8	109.1	109.1	109.1	0.0
B	745	127	182	3.3	111.2	111.2	111.2	0.0
C	1,806	30	98	6.7	119.4	119.4	119.4	0.0
D	2,106	114	176	3.5	123.7	123.7	123.7	0.0
E	2,593	41	77	7.9	125.1	125.1	125.1	0.0

[1]Feet Above Culvent Entrance to Contra Costa Canel

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FLOODWAY DATA

FARM BUREAU ROAD DRAIN

TABLE 2

flood by more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to flood plain development are shown in Figure 2.

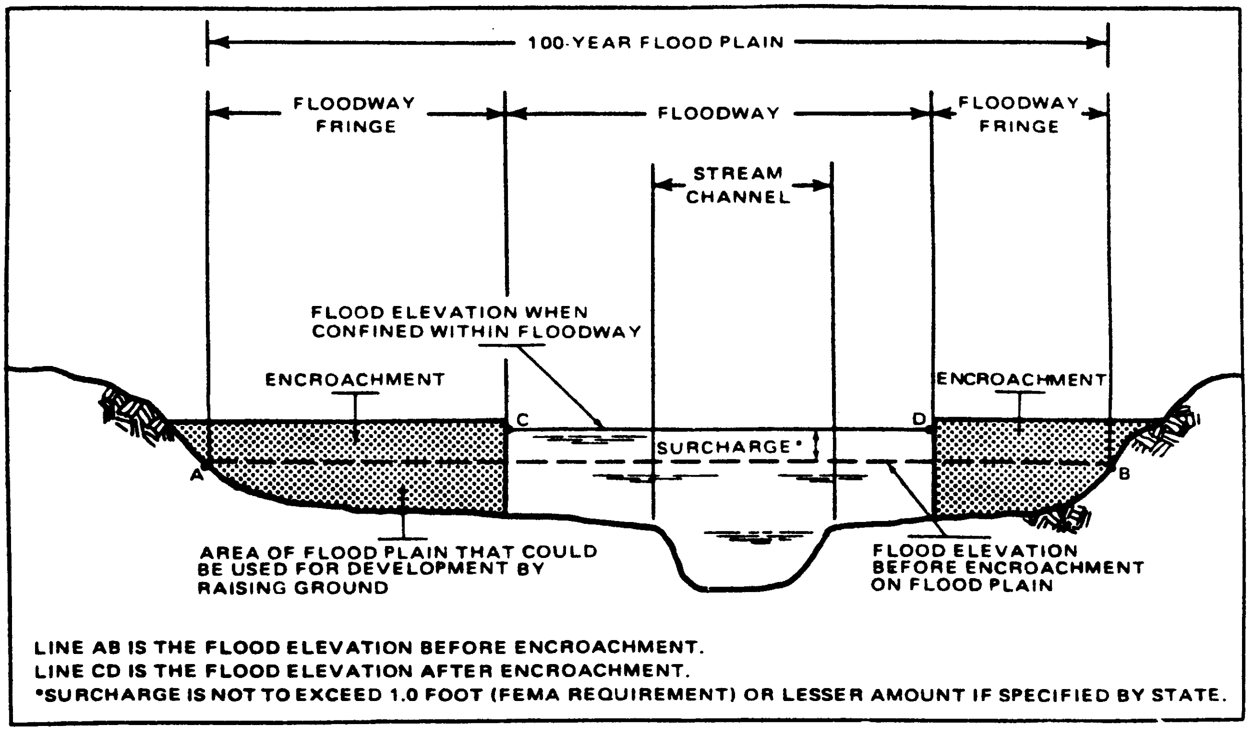

Figure 2. Floodway Schematic

5.0 INSURANCE APPLICATION

To establish actuarial insurance rates, data from the engineering study must be transformed into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors, and flood insurance zone designations for each flooding source studied in detail affecting the City of Concord.

5.1 Reach Determinations

Reaches are defined as sections of flood plain that have relatively the same flood hazard, based on the average weighted difference in water-surface elevations between the 10- and 100-year floods. This difference may not have a variation greater than that indicated in the following table for more than 20 percent of the reach:

Average Difference Between 10- and 100-Year Floods	Variation
Less than 2 feet	0.5 foot
2 to 7 feet	1.0 foot
7.1 to 12 feet	2.0 feet
More than 12 feet	3.0 feet

The locations of the reaches determined for the flooding sources of the City of Concord are shown on the Flood Profiles (Exhibit 1) and summarized in Table 3.

5.2 Flood Hazard Factors

The Flood Hazard Factor (FHF) is used to establish relationships between depth and frequency of flooding in any reach. This relationship is then used with depth-damage relationships for various classes of structures to establish actuarial insurance rate tables.

The FHF for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations rounded to the nearest one-half foot, multiplied by 10, and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year flood water-surface elevations is greater than 10.0 feet, it is rounded to the nearest whole foot.

5.3 Flood Insurance Zones

Flood insurance zones and zone numbers are assigned based on the type of flood hazard and the FHF, respectively. A unique zone number is associated with each possible FHF, and varies from 1 f- a FHF of 005 to a maximum of 30 for a FHF of 200 or greater.

Zone A:	Special Flood Hazard Areas inundated by the 100-year flood, determined by approximate methods; no base flood elevation shown or FHFs determined.
Zone A0:	Special Flood Hazard Areas inundated by types of 100-year shallow flooding where depths are between 1.0 and 3.0 feet; depths are shown, but no FHFs are determined.
Zone AH:	Special Flood Hazard Areas inundated by types of 100-year shallow flooding where depths are between 1.0 and 3.0 feet; base flood elevations are shown, but no FHFs are determined.
Zones A1-A5, and A7:	Special Flood Hazard Areas inundated by the 100-year flood; with base flood elevations shown, and zones subdivided according to FHFs.

FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1% (100-YEAR) FLOOD AND			FLOOD HAZARD FACTOR	ZONE	BASE FLOOD ELEVATION[3] (FEET NGVD)
		10% (10-YEAR)	2% (50-YEAR)	0.2% (500-YEAR)			
Galindo Creek							
Reach 1	0006,0007 0010	-1.4	-0.4	0.7	015	A3	Varies - See Map
Shallow Flooding	0007	N/A	N/A	N/A	N/A	AH	247
Pine Creek							
Reach 1	0008,0009	-2.0	-0.4	1.2	020	A4	Varies - See Map
Shallow Flooding	0008,0009	N/A	N/A	N/A	N/A	AH	64
Ditch No. 2							
Reach 1	0008	-0.6	-0.1	0.2	005	A1	Varies - See Map
Shallow Flooding	0008	N/A	N/A	N/A	N/A	AH	53

[1]Flood Insurance Rate Map Panel [2]Weighted Average [3]Rounded to Nearest Foot

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FLOOD INSURANCE ZONE DATA

GALINDO CREEK-PINE CREEK-DITCH NO. 2

TABLE 3

FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1% (100-YEAR) FLOOD AND			FLOOD HAZARD FACTOR	ZONE	BASE FLOOD ELEVATION (FEET NGVD)[3]
		10% (10-YEAR)	2% (50-YEAR)	0.2% (500-YEAR)			
Farm Bureau Road Drain							
Reach 1	0003,0006	-0.8	-0.3	0.2	010	A2	Varies - See Map
Shallow Flooding	0006	N/A	N/A	N/A	N/A	AH	142
Clayton Valley Drain							
Reach 1	0002,0003	-1.0	-0.3	0.3	010	A2	Varies - See Map
Shallow Flooding	0002	N/A	N/A	N/A	N/A	AH	18
Shallow Flooding	0002	N/A	N/A	N/A	N/A	AH	20
Shallow Flooding	0002,0003	N/A	N/A	N/A	N/A	A0	Depth 1, 2
Mt. Diablo Creek							
Reach 1	0007	-2.0	N/A	2.6	020	A4	Varies - See Map
Reach 2	0007,0010	-2.6	N/A	1.4	025	A5	Varies - See Map

[1] Flood Insurance Rate Map Panel [2] Weighted Average [3] Rounded to Nearest Foot

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CONCORD, CA
(CONTRA COSTA CO.)

FLOOD INSURANCE ZONE DATA

FARM BUREAU ROAD DRAIN-CLAYTON VALLEY DRAIN-MT. DIABLO CREEK

TABLE 3

Zone B: Areas between the Special Flood Hazard Areas and the limits of the 500-year flood; areas that are protected from the 100- or 500-year floods by dike, levee, or other local water-control structure; areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided.

Zone C: Areas of minimal flood hazard; not subdivided.

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for the City of Concord is, for insurance purposes, the principal product of the Flood Insurance Study. This map contains the official delineation of flood insurance zones and base flood elevations. Base flood elevation lines show the locations of the expected whole-foot water-surface elevation of the base (100-year) flood. The base flood elevations and zone numbers are used by insurance agents, in conjunction with structure elevations and characteristics, to assign actuarial insurance rates to structures and contents insured under the National Flood Insurance Program.

6.0 OTHER STUDIES

Flood Insurance Studies have been prepared for the City of Walnut Creek, which borders Concord to the south (Reference 15); for the City of Pleasant Hill, which borders Concord to the west (Reference 16); and the City of Clayton, which borders Concord to the east (Reference 17).

A Flood Insurance Study has also been prepared for the unincorporated areas of Contra Costa County (Reference 18). The adjacent studies are in agreement with this study.

A Flood Hazard Boundary Map has been prepared for the City of Concord (Reference 14). Flood boundaries in some portions of the city have been added from the Flood Hazard Boundary Map. In all other areas, this Flood Insurance Study represents a more detailed analysis and therefore supersedes the previous study.

The U.S. Army Corps of Engineers prepared a hydrologic analysis of streams within the City of Concord for an unpublished Flood Insurance Study (Reference 7). The U.S. Army Corps of Engineers prepared an April 1971 Internal Memorandum of flood frequencies (Reference 8) for use in developing the unpublished Flood Insurance Study for Concord (Reference 7). Results of peak discharges determined on Pine Creek, Galindo Creek, Ditch No. 2, and Clayton Valley Drain for this study are lower than the flows developed by the U.S. Army Corps of Engineers due to different methodologies.

The U.S. Army Corps of Engineers prepared a hydrologic analysis as part of the Walnut Creek Project of channel improvements (Reference 5). The 100-year peak discharges determined for Walnut Creek were similar to those determined for this study.

7.0 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, Building 105, Presidio of San Francisco, San Francisco, California 94129.

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9.0 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 assure that any user is aware of all revisions, it is advisable to contact the community repository of flood hazard data located at the City of Concord Public Library, 900 Salvio Street, Concord, CA 94519.

9.1 First Revision

This study was revised on September 7, 2001, to incorporate detailed flood hazard information along Galindo Creek from approximately 3,025 feet (0.57 mile) downstream of Contra Costa Canal to Dam #1, which is approximately 2,840 feet upstream of Wharton Way and along Mount Diablo Creek from a point approximately 2,675 feet downstream of Bailey Road to a point approximately 35 feet downstream of Russelmann Park Road, located in the Unincorporated Areas of Contra Costa County.

The hydraulic analyses for this restudy were performed for the Federal Emergency Management Agency (FEMA) by Questa Engineering Corporation, under Contract No. EMW-93-C-4186 and the work was completed in October 1997. The hydrologic data utilized in this restudy were obtained from the Contra Costa County Flood Control and Water Conservation District (CCCFCWCD). The information prepared by Questa Engineering Corporation was subsequently modified by Michael Baker Jr., Inc. to conform to current FEMA standards. The modifications were completed in August 1999.

An initial Consultation Coordination Officer (CCO) meeting was held on January 8, 1993, and attended by representatives of the CCCFCWCD, the Cities of Antioch, Clayton, Concord, Lafayette, Martinez, Pittsburg, Pleasant Hill, San Pablo and Walnut Creek, FEMA and the study contractor.

The results of this revision were reviewed at a final CCO meeting held on September 26, 2000, and attended by representatives of FEMA, Questa Engineering, and the City of Concord. All problems raised at that meeting have been addressed in this study.

CCCFCWCD, Mackay & Somps, the City of Concord and the City of Clayton Public Works Department were contacted for hydrologic and hydraulic data.

The population of the City of Concord in July 1998, was approximately 117,708 according to the U.S. Bureau of the Census (Reference 19).

The flooding that occurs on Galindo Creek is caused by lack of channel capacity and undersized or poorly maintained culverts and bridge crossings. The Galindo Creek watershed has undergone some urbanization in the last decade but few channel modifications have been completed. In numerous instances even routine desiltation at culverts has been ignored. Residential encroachments and lack of adequate County right-of-way prohibit channel improvements at this time.

The sources of flooding along Mount Diablo Creek are primarily attributed to inadequate bridge crossings. In the lower portion of Mount Diablo Creek overbank flooding occurs between Bailey Road and Concord Boulevard due to inadequate channel capacity. At the Concord Boulevard bridge crossing flow is lost to left overbank flooding down Concord Boulevard due to inadequate capacity at this crossing. At Ayers Road water spills out of the channel onto the left floodplain and flows to Heather Road which eventually discharges to Galindo Creek. Upstream of Kirker Pass Road, the development of a large supermarket and channel widening has altered the floodplain. Mount Diablo Creek does not have the capacity to accommodate the 100-year flows from Kirker Pass Road to approximately 1,400 feet upstream of Lydia Lane.

The peak discharges used for this study were obtained from CCCFCWCD who developed the discharge values using their HYDRO-II hydrologic computer program (Reference 20).

CCCFCWCD collects precipitation data and has developed mean seasonal precipitation isohyetal maps and precipitation depth-duration-frequency curves for Contra Costa County. A total of 76 rain gages, which are maintained by the National Weather Service, the East Bay Municipal Utility District and CCCFCWCD, have been used to develop this information. CCCFCWCD has adopted a unit hydrograph approach to determine peak runoff conditions which incorporates U.S. Army Corps of Engineers (USACE) procedures for developing the unit hydrograph which are very similar to the USACE program HEC-1 (Reference 21). CCCFCWCD has developed their HYDRO-II program to compute and plot hydrographs. This program uses the relationship between lag time and time rate-of-change of runoff to construct synthetic unit hydrographs. The time rate of change of runoff "S" curves, as well as infiltration and base flow assumptions, were adopted by CCCFCWCD utilizing procedures and previous studies conducted by USACE within the County. HYDRO-II also has routing capabilities. Watershed routing is based on Tatum routing procedures that were adopted by USACE. On- and off-site detention basins may be routed using the program.

Water-surface elevations were computed using the USACE HEC-2 step-backwater computer program (Reference 22). The depth of sheet flow areas were calculated using Manning's equation. Roughness factors (Manning's "n" values) for the hydraulic computations were assigned on the basis of field inspection of the floodplain and channel. Cross sections were photographed and compared with information published by the U.S. Geological Survey (USGS) concerning roughness factors (Reference 23). Along Galindo Creek roughness values used for the channel ranged from 0.015 to 0.035 and the values used for overbanks ranged from 0.030 to 0.100 and along Mount Diablo Creek channel values ranged from 0.025 to 0.075 and overbank values ranged from 0.035 to 0.100.

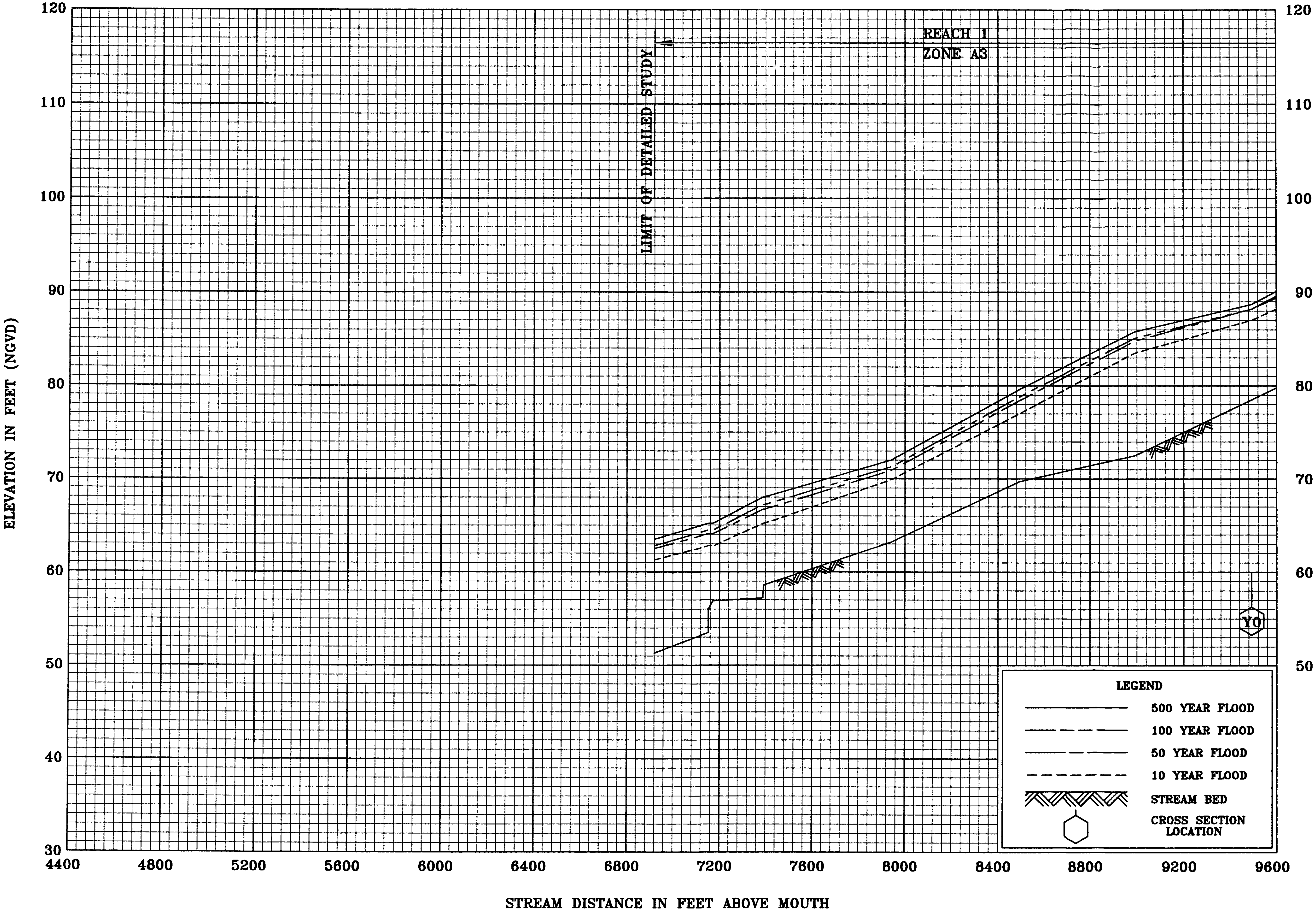
Cross sections along Galindo and Mount Diablo Creeks were field surveyed by Allied Engineering Company. Photogrammetry was used in the overbank areas where a clear line of sight existed. Plans and drawings obtained from the Cities of Clayton and Concord and from Contra Costa County were used as general reference for the hydraulic analysis of Galindo and Mount Diablo Creeks (References 24 through 72). Starting water-surface elevations for Galindo and Mount Diablo Creeks were determined based on normal depth calculations using the slope-area method.

The 100- and 500-year flood boundaries shown on the Flood Insurance Rate Map have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using aerial topographic mapping at a scale of 1"=400' with a contour of 4 feet, that was prepared for this restudy (Reference 73).

The floodways presented for Galindo Creek and Mount Diablo Creek were computed on the basis of equal conveyance reduction from each side of the floodplain.

Table 1, "Summary of Discharges," and Table 2, "Floodway Data," have been revised to reflect the results of the restudy.

The Flood Insurance Studies for the unincorporated areas of Contra Costa County, California (Reference 74) and the City of Clayton (Reference 75) were updated concurrently with this restudy and these studies are in complete agreement.



FLOOD PROFILES

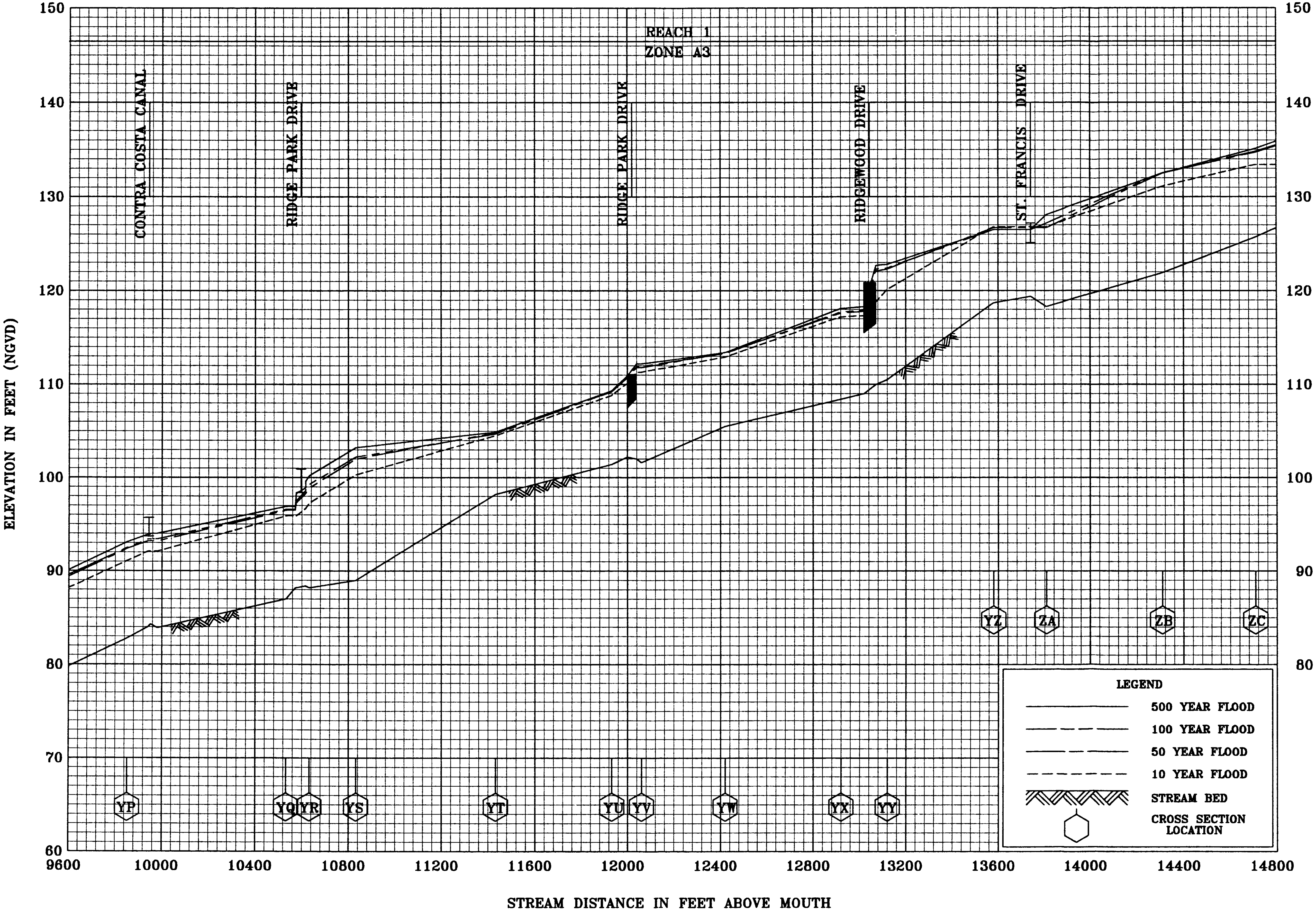
GALINDO CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CONCORD, CA

(CONTRA COSTA CO.)

01P



FLOOD PROFILES

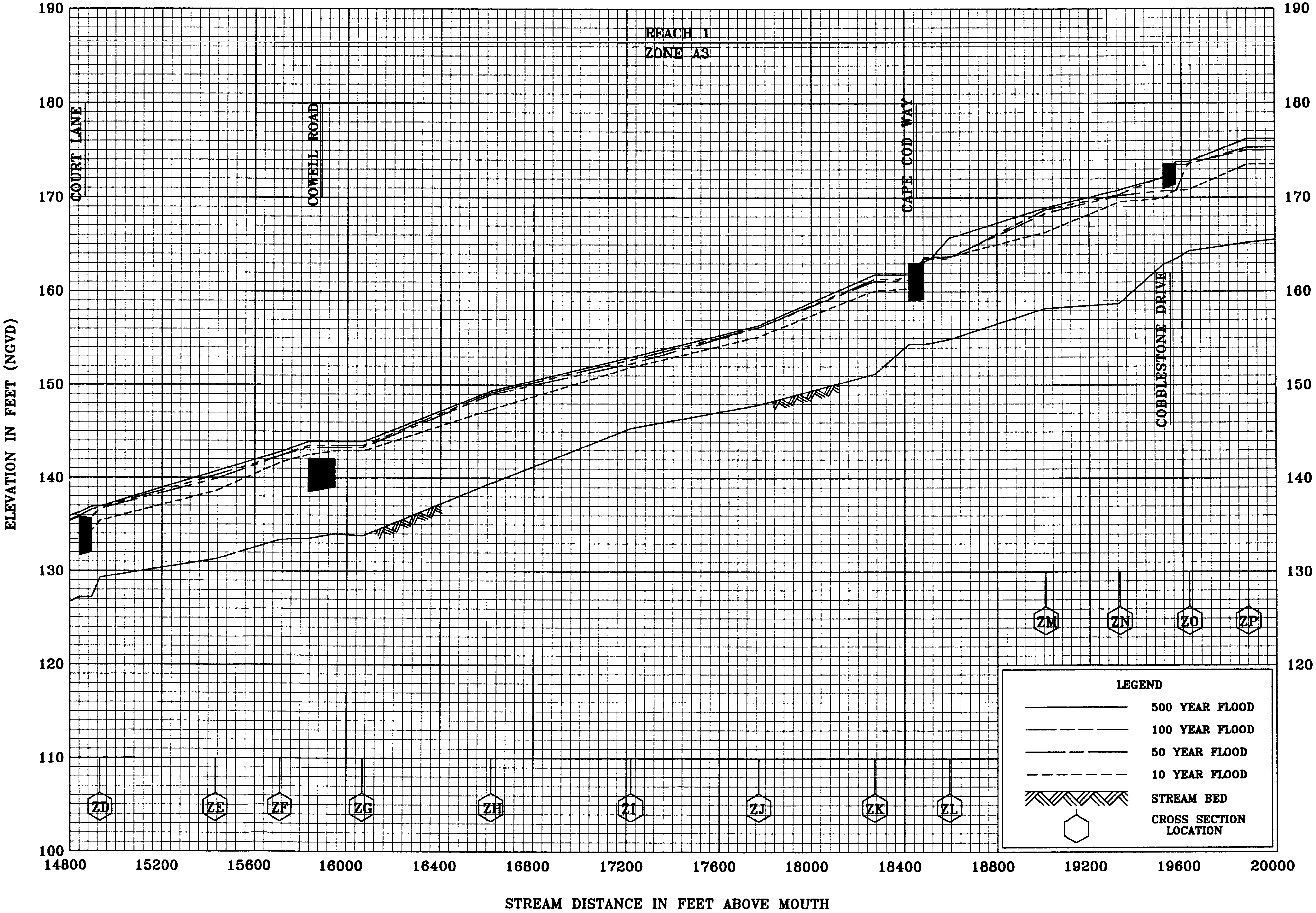
GALINDO CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CONCORD, CA

(CONTRA COSTA CO.)

01P(a)



FLOOD PROFILES

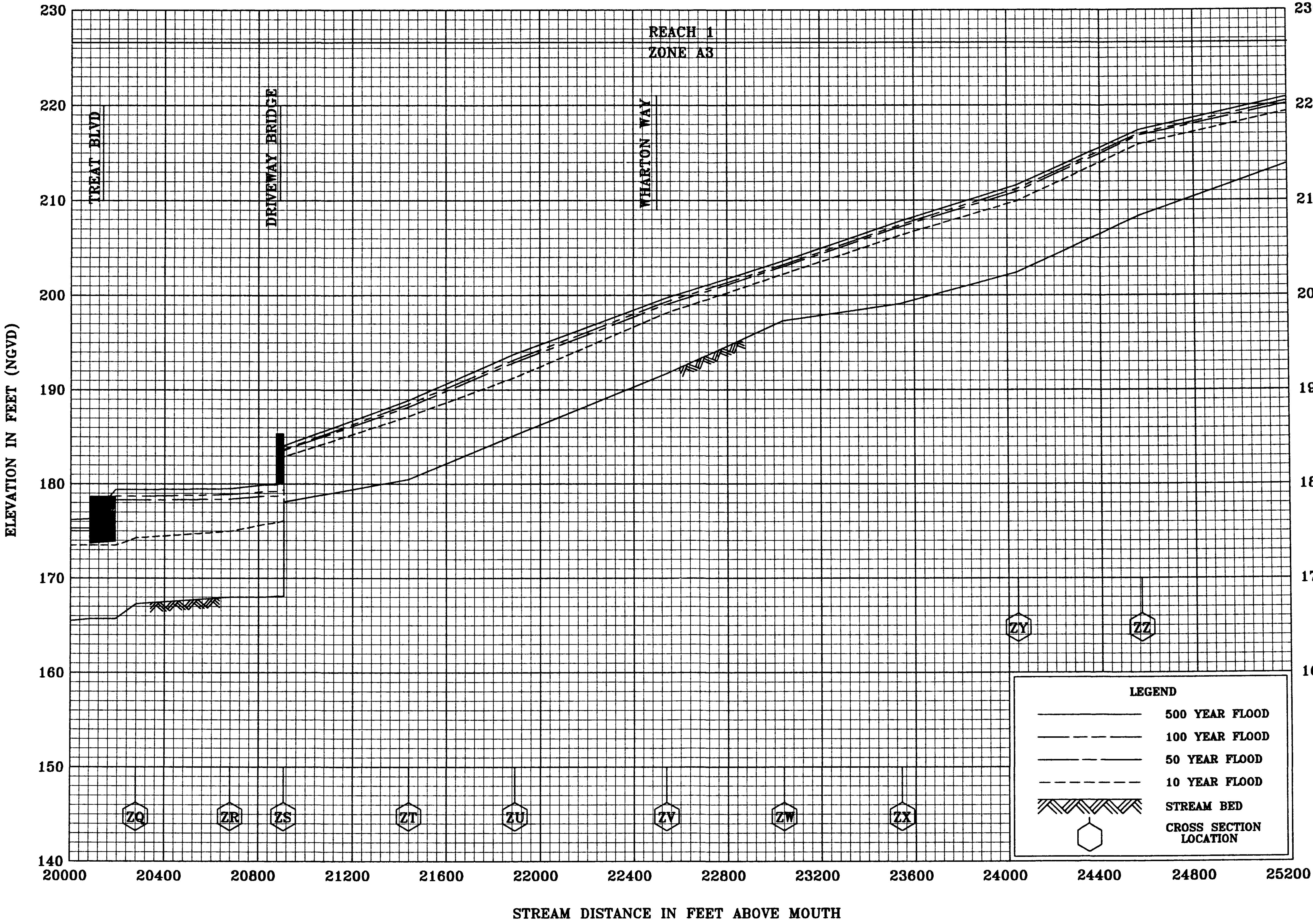
GALINDO CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CONCORD, CA

(CONTRA COSTA CO.)

01P(b)



FLOOD PROFILES

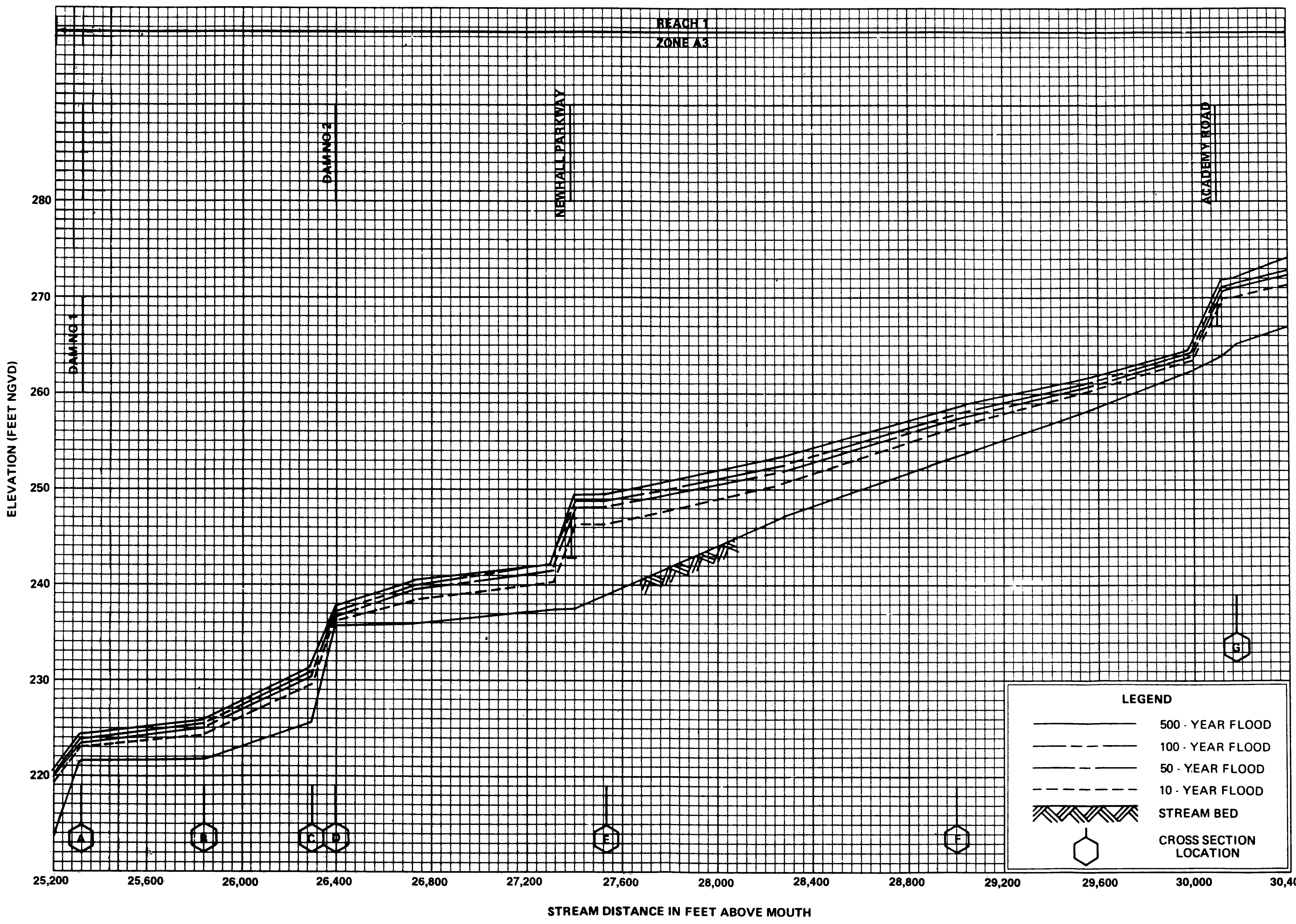
GALINDO CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CONCORD, CA

(CONTRA COSTA CO.)

01P(c)



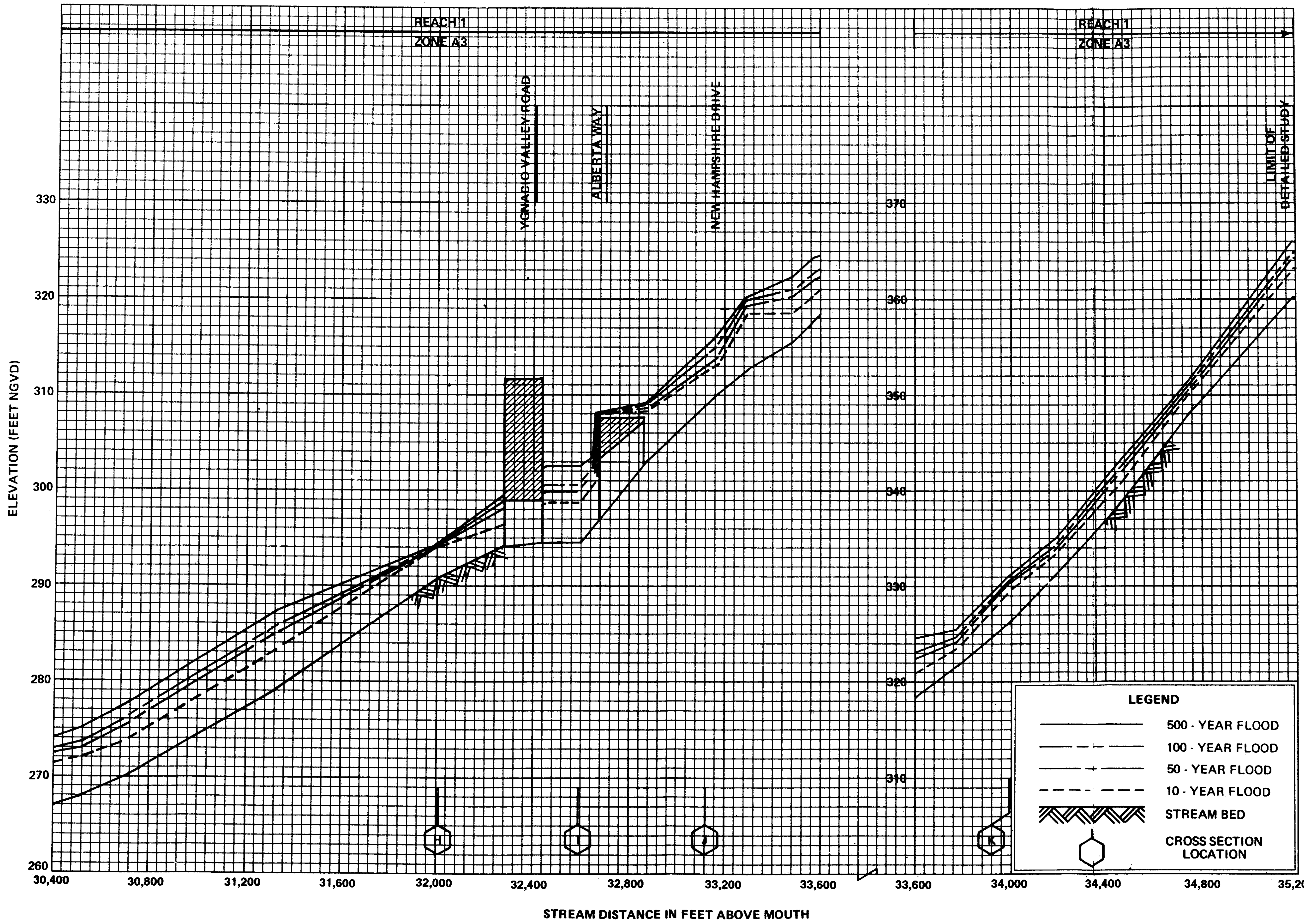
FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CONCORD, CA
(CONTRA COSTA CO.)

FLOOD PROFILES

GALINDO CREEK

01P(d)



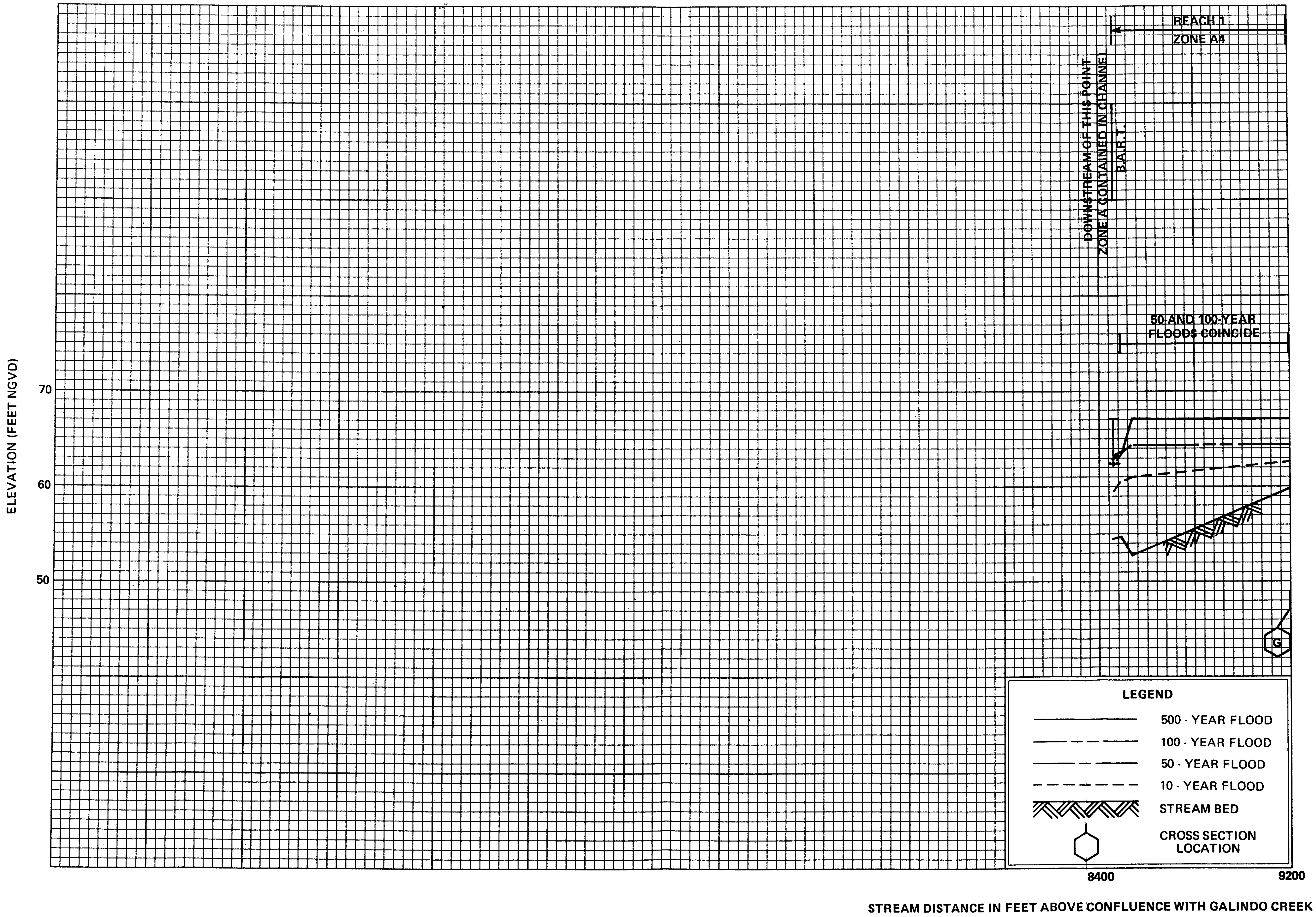
FLOOD PROFILES

GALINDO CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CONCORD, CA
(CONTRA COSTA CO.)

02P



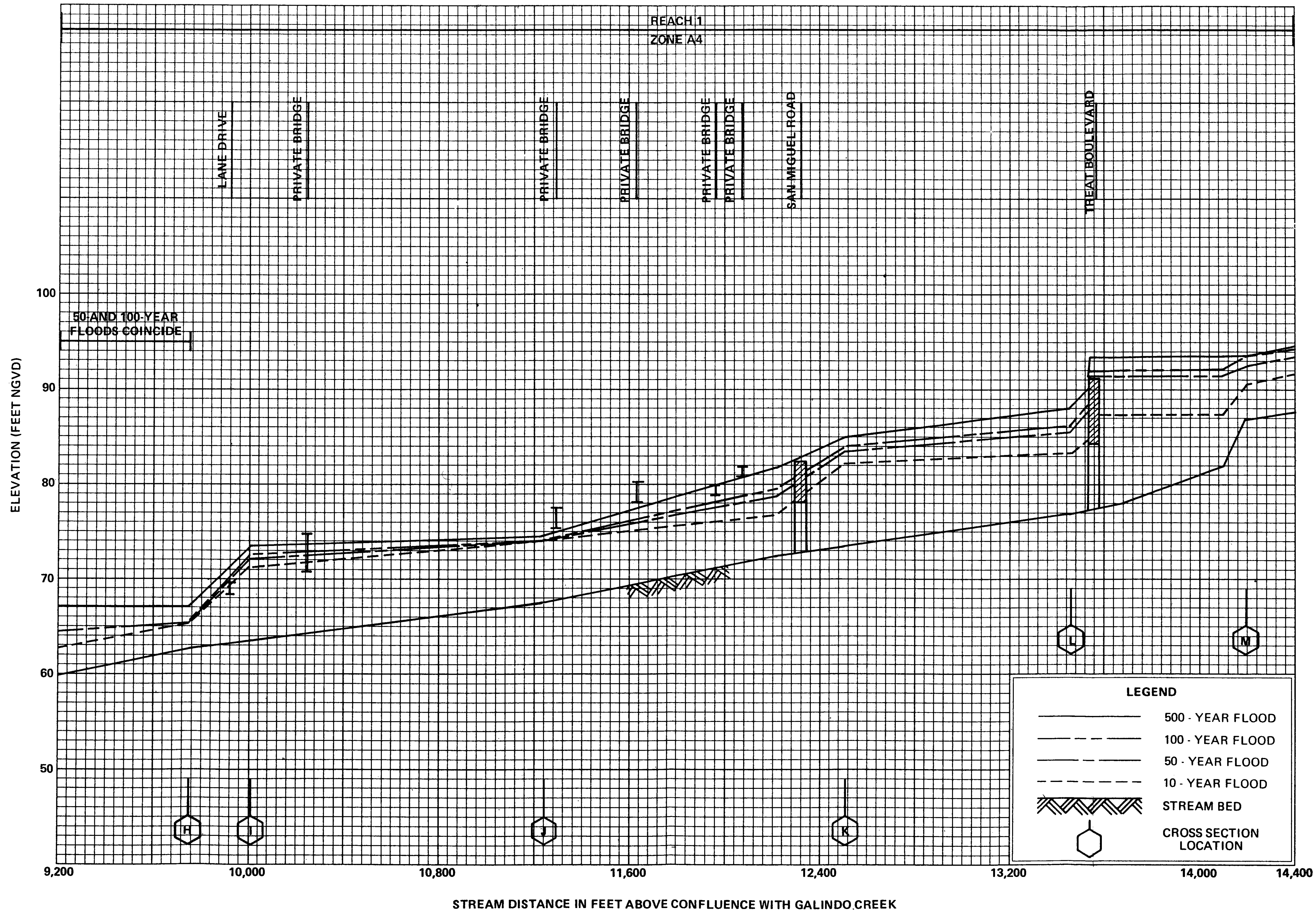
FLOOD PROFILES

PINE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CONCORD, CA
(CONTRA COSTA CO.)

03P

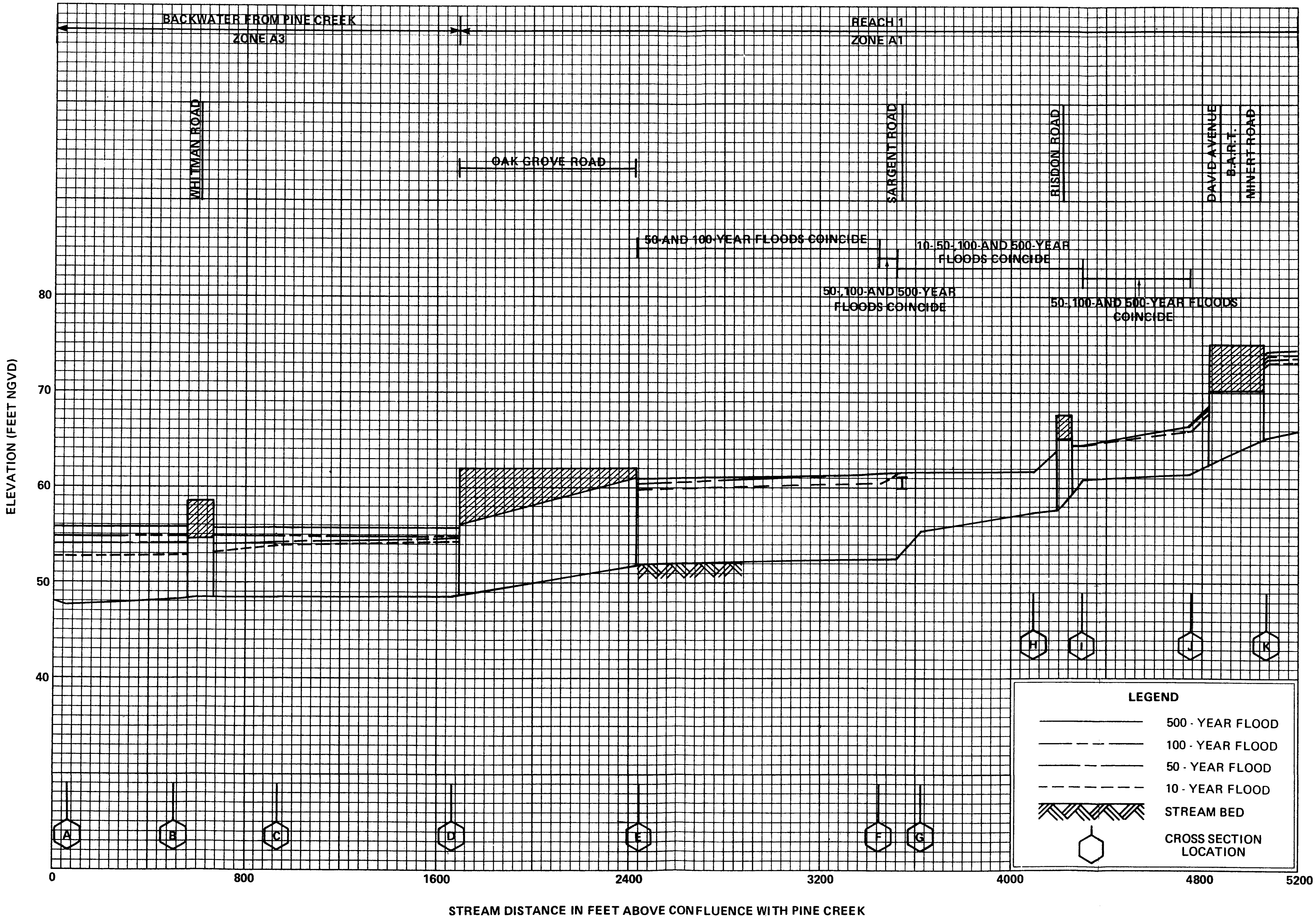


FLOOD PROFILES

PINE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CONCORD, CA
(CONTRA COSTA CO.)



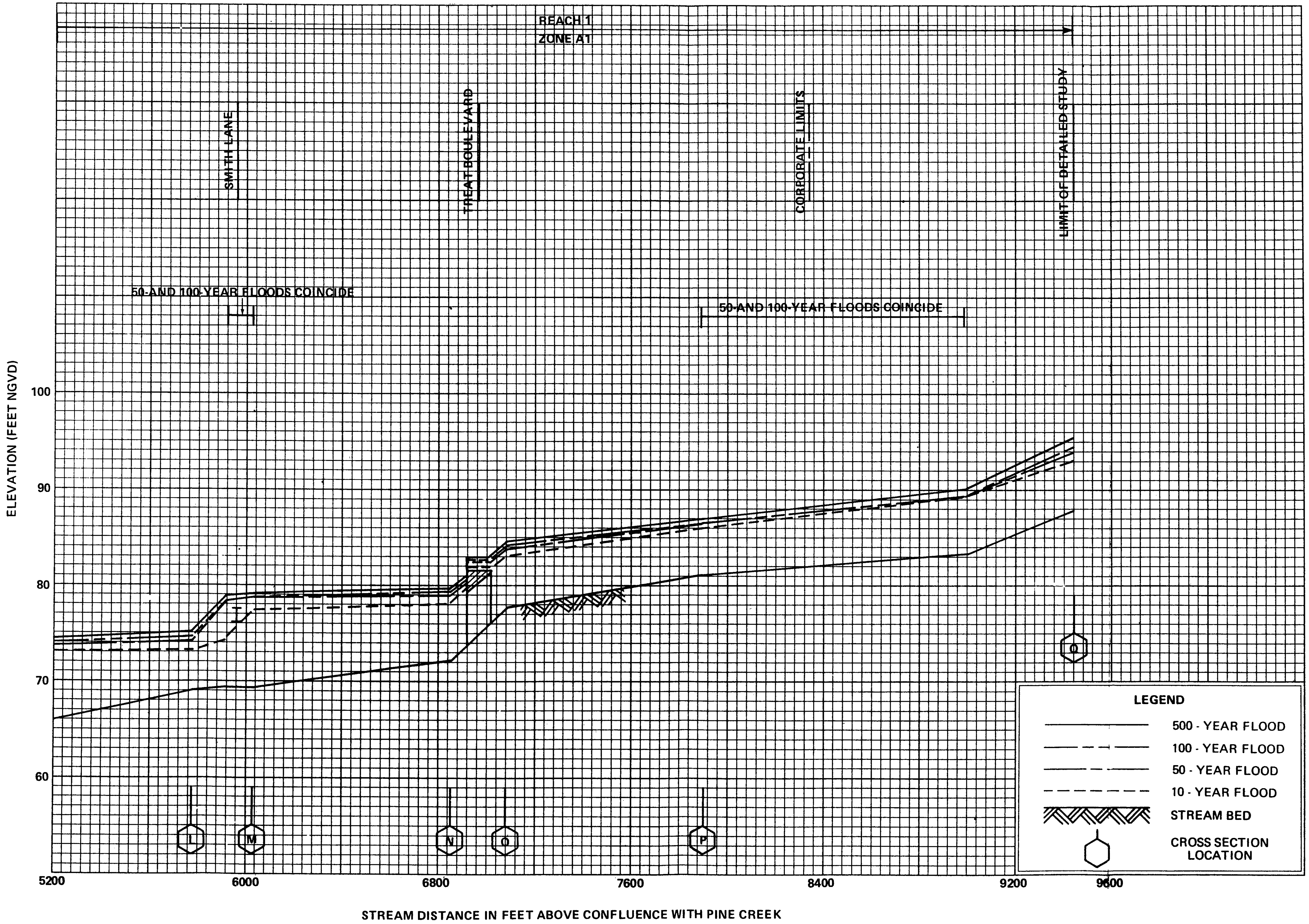
FLOOD PROFILES

DITCH NO 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CONCORD, CA
(CONTRA COSTA CO.)

06P

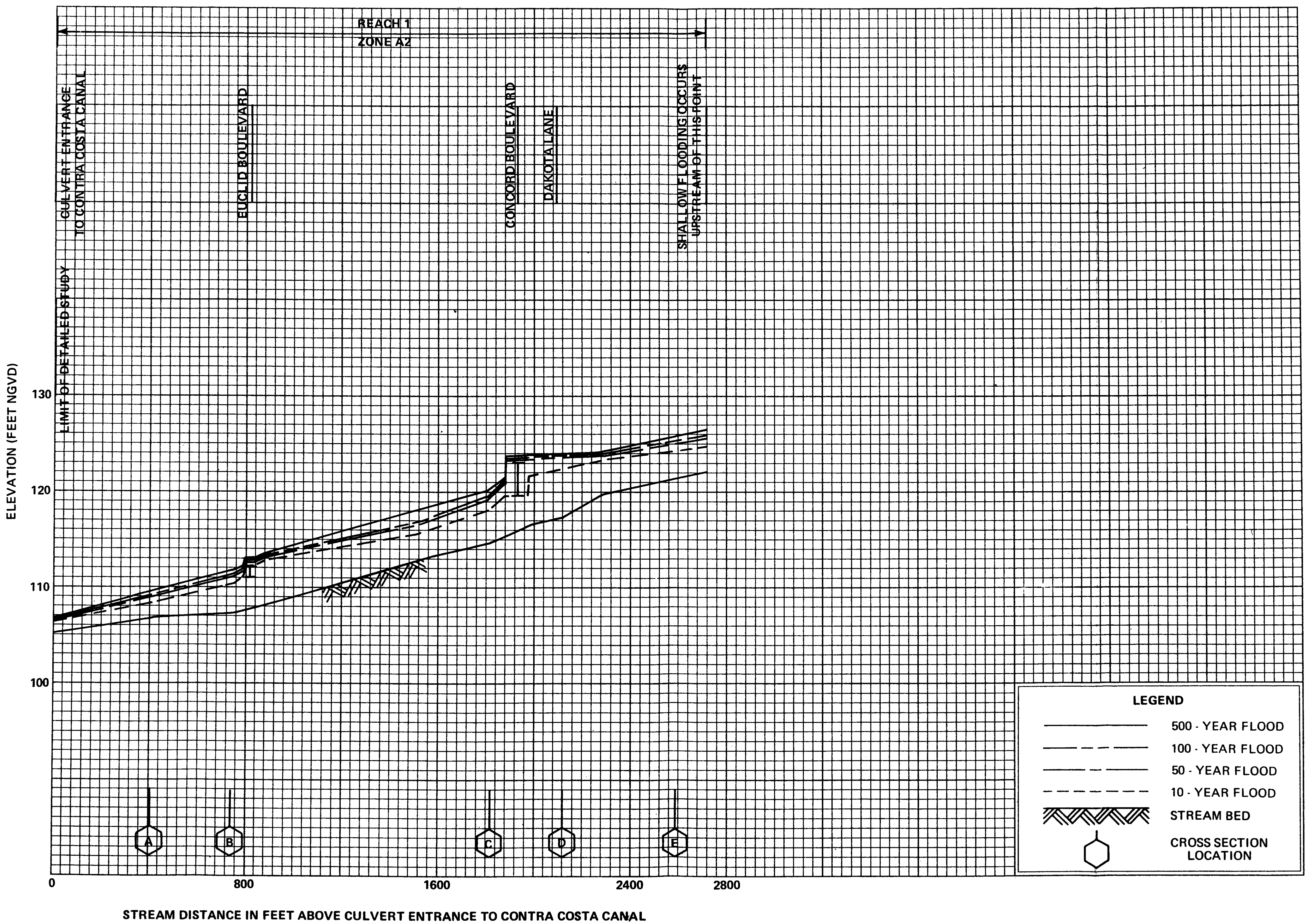


FLOOD PROFILES

DITCH NO 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CONCORD, CA
(CONTRA COSTA CO.)

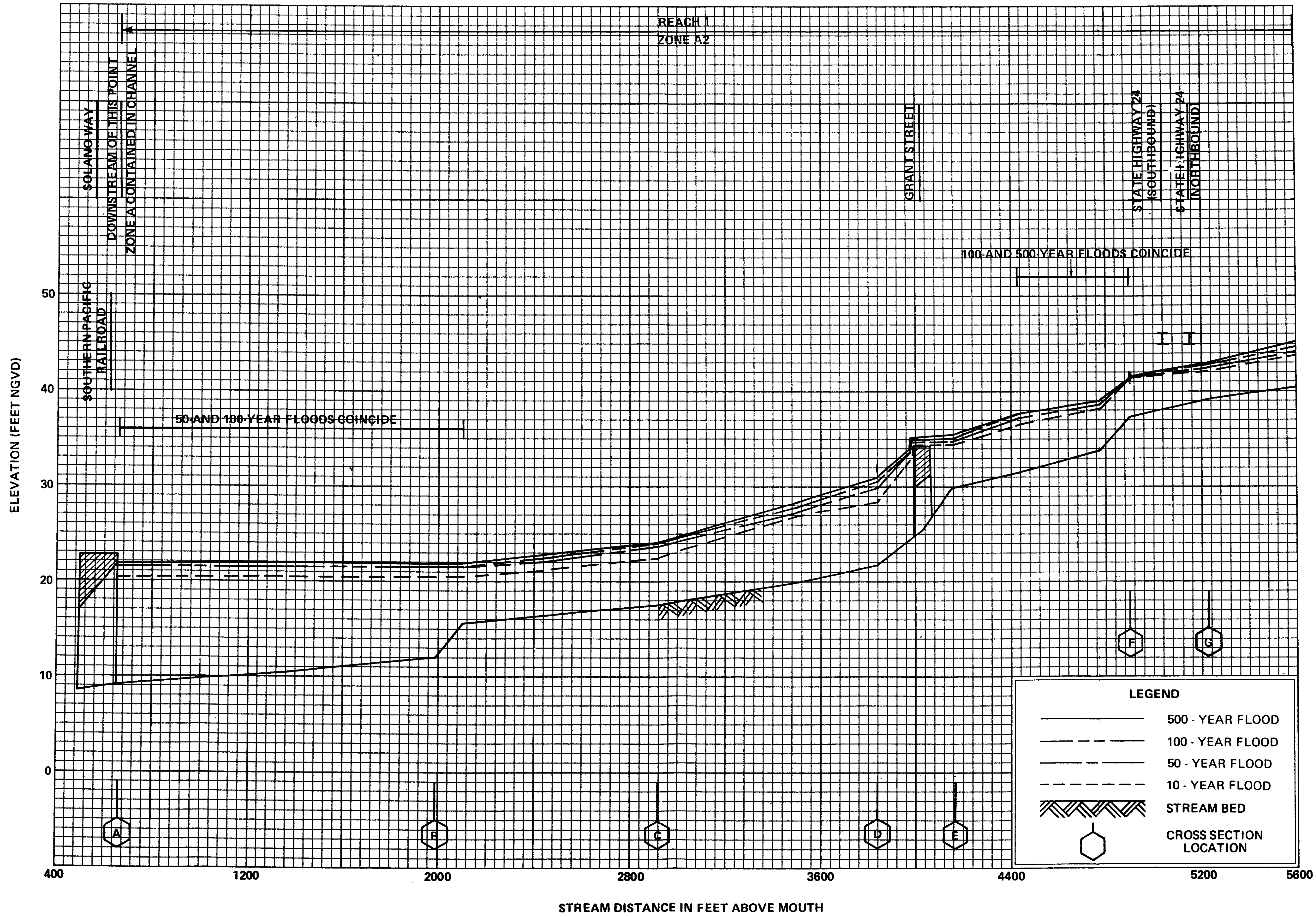


FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CONCORD, CA
(CONTRA COSTA CO.)

FLOOD PROFILES

FARM BUREAU ROAD DRAIN



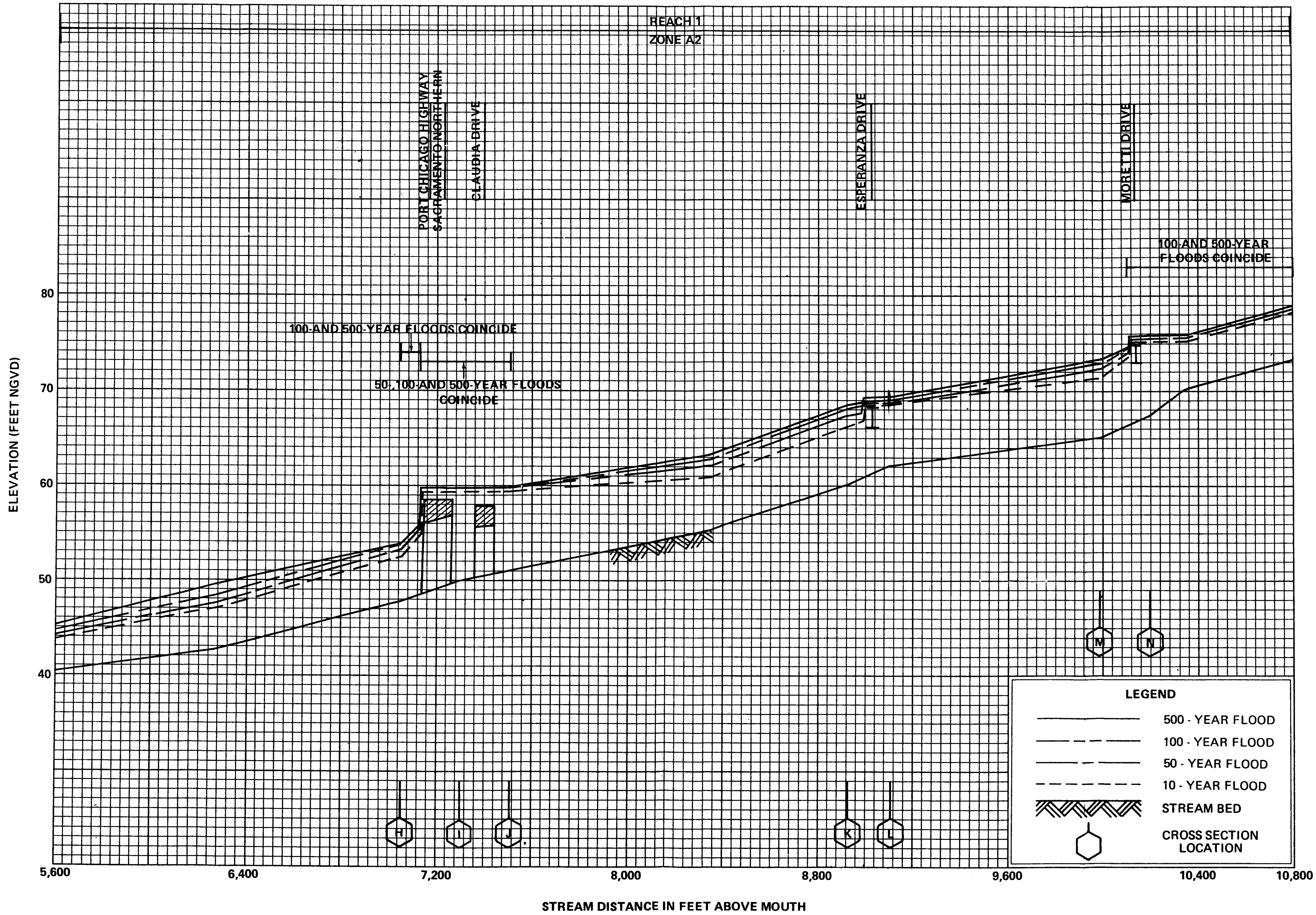
FLOOD PROFILES

CLAYTON VALLEY DRAIN

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CONCORD, CA
(CONTRA COSTA CO.)

09P



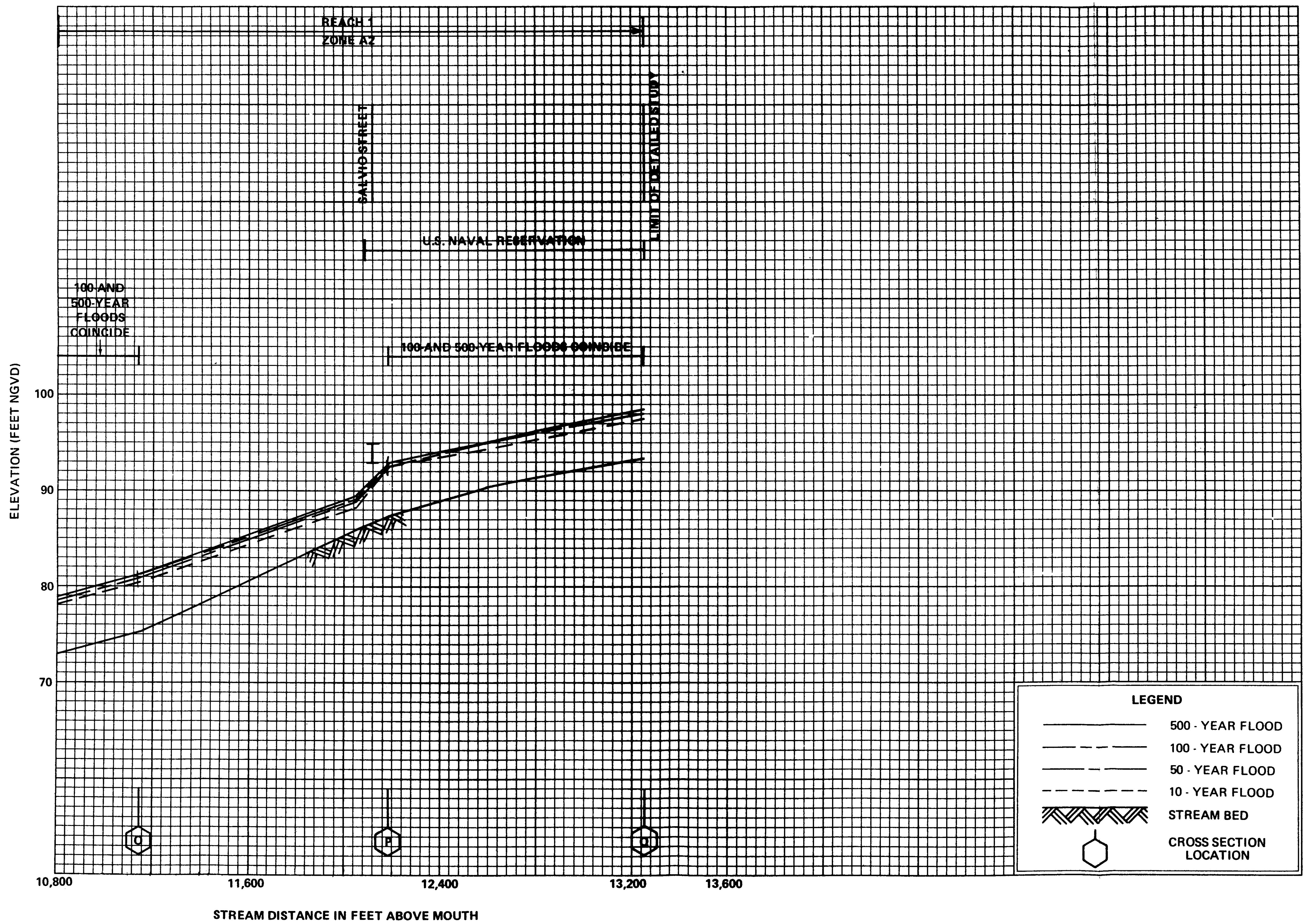
FLOOD PROFILES

CLAYTON VALLEY DRAIN

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CONCORD, CA
(CONTRA COSTA CO.)

10P

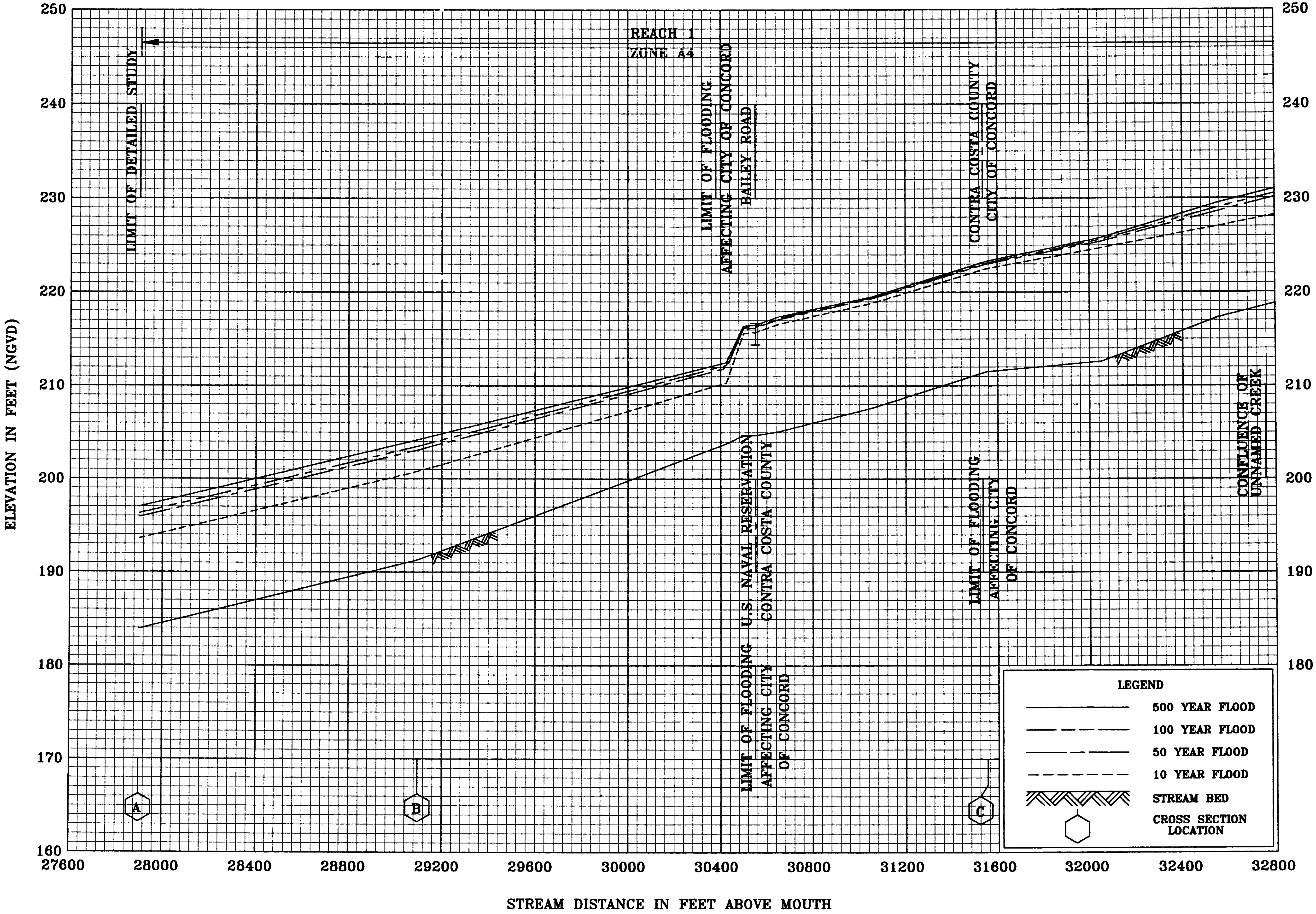


FLOOD PROFILES

CLAYTON VALLEY DRAIN

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CONCORD, CA
(CONTRA COSTA CO.)



FLOOD PROFILES

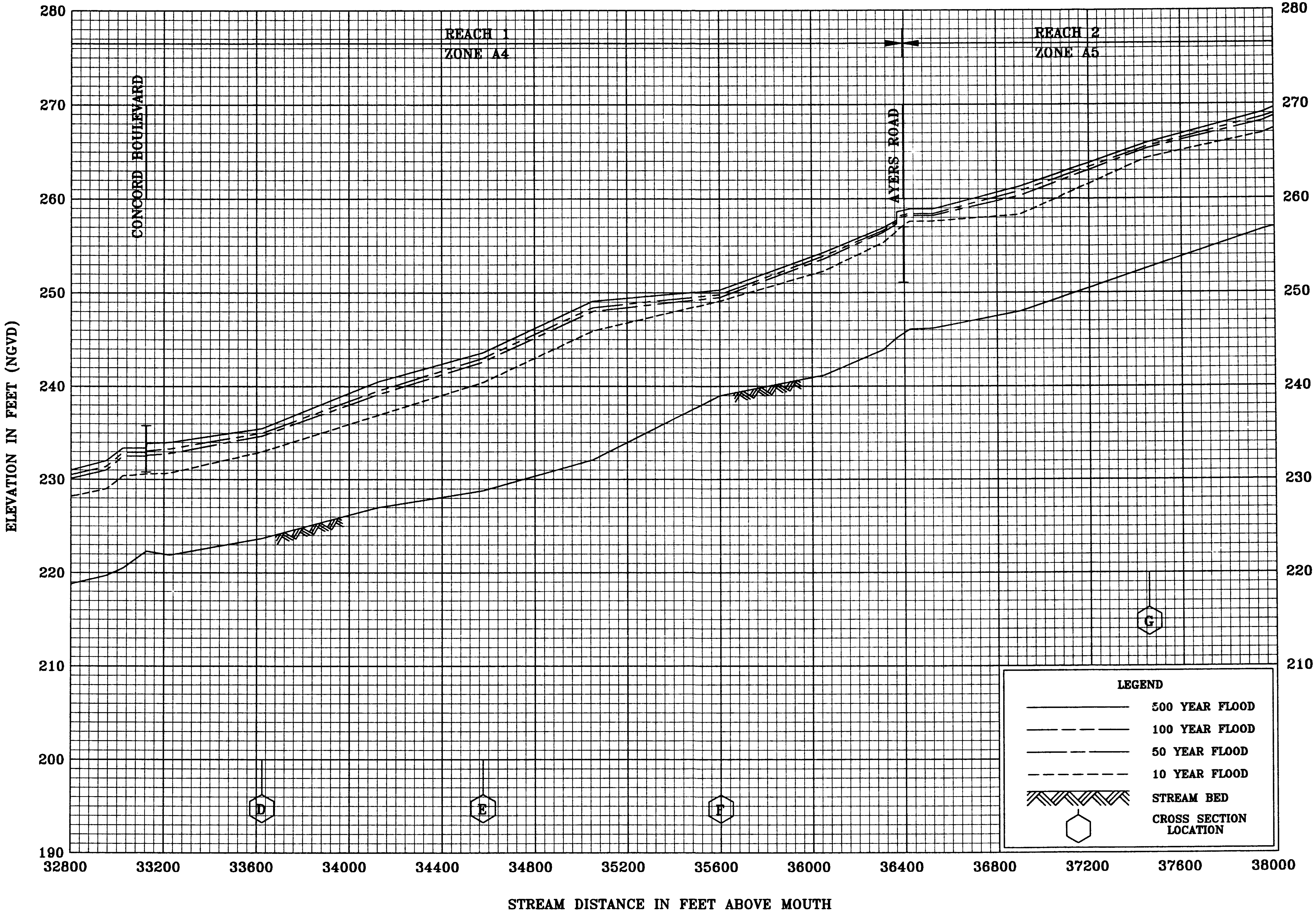
MT. DIABLO CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CONCORD, CA

(CONTRA COSTA CO.)

12P



FLOOD PROFILES

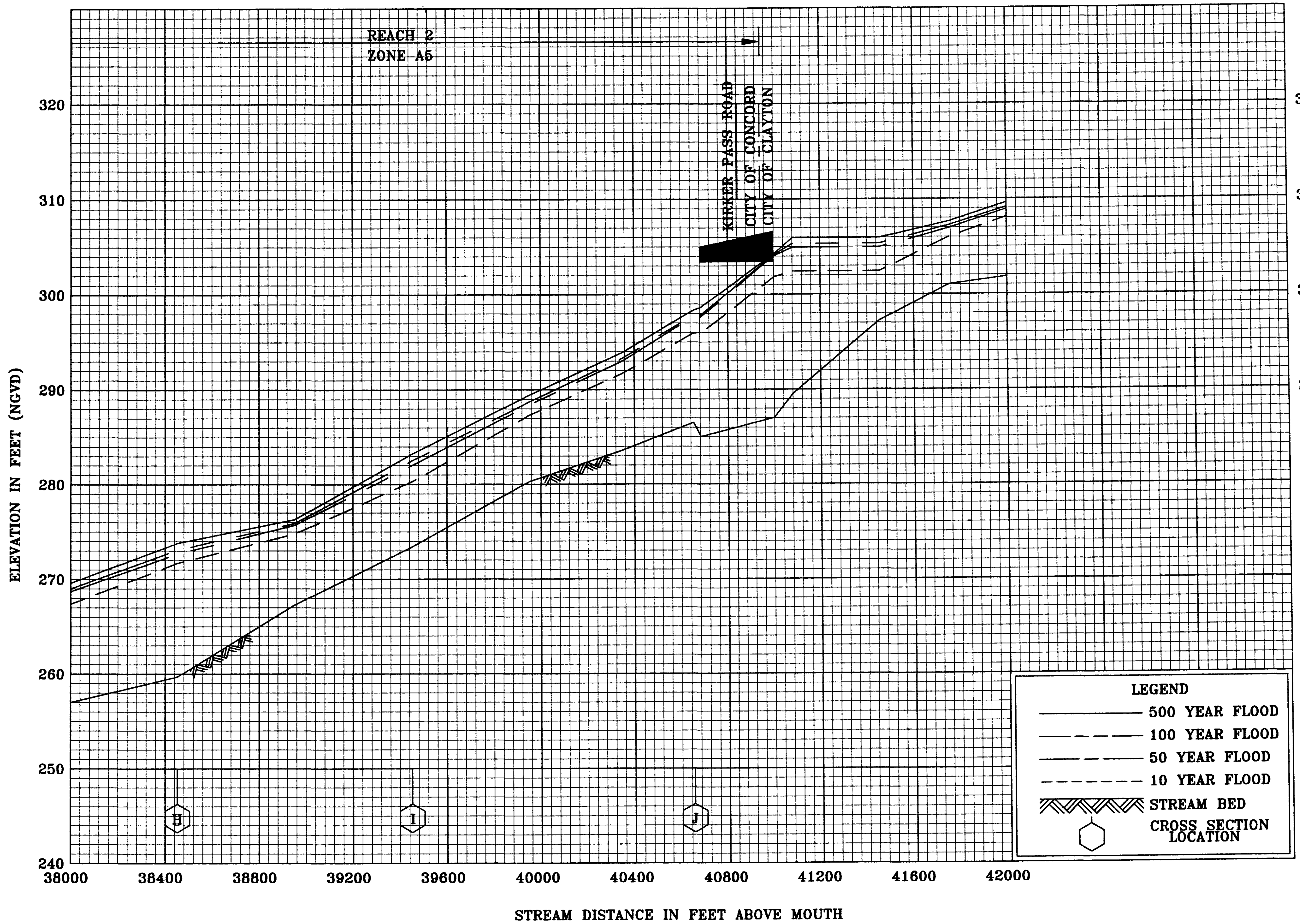
MT. DIABLO CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CONCORD, CA

(CONTRA COSTA CO.)

13P



FLOOD PROFILES

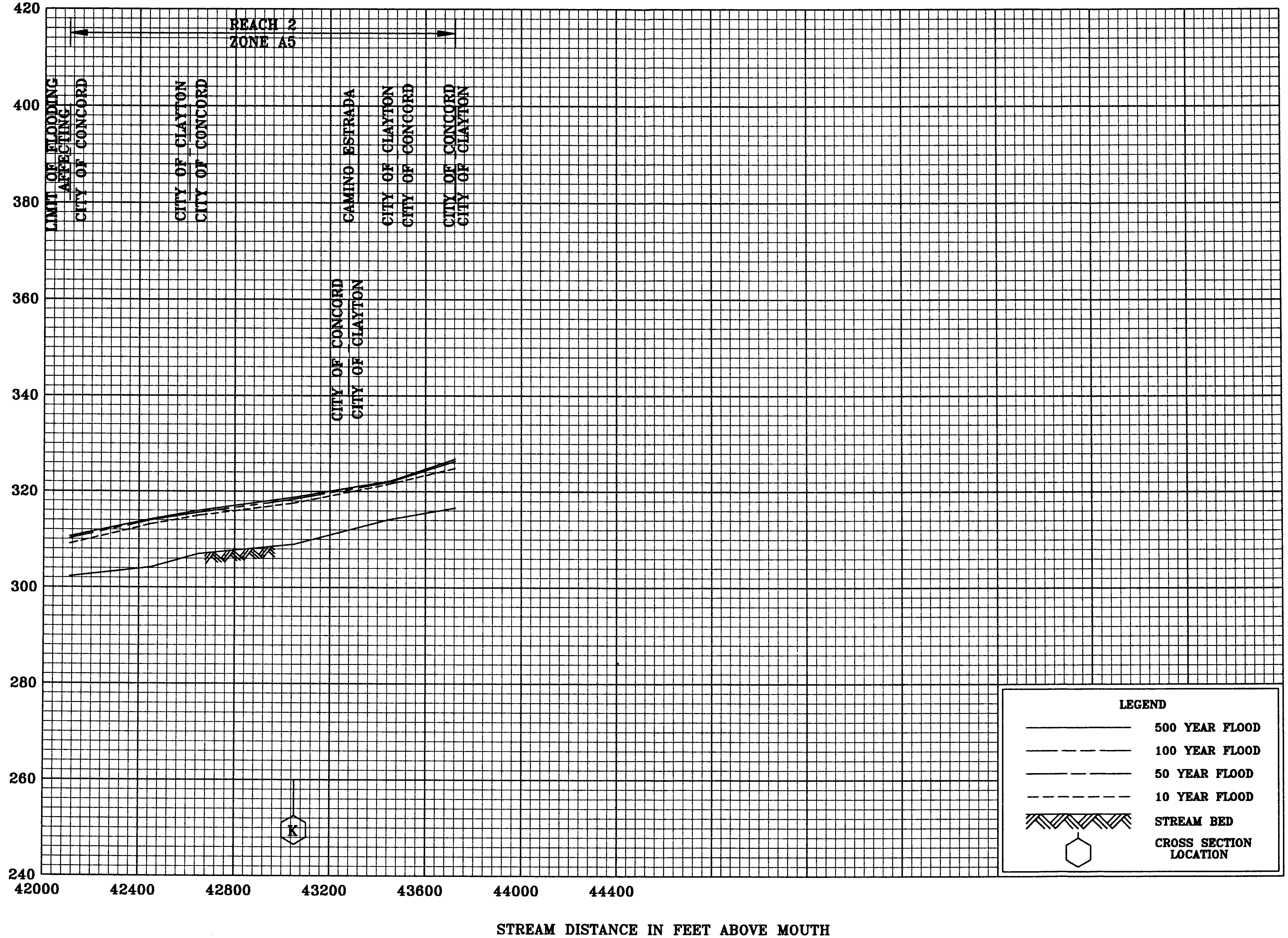
MT. DIABLO CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CONCORD, CA

(CONTRA COSTA CO.)

14P



FLOOD PROFILES

MT. DIABLO CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CONCORD, CA

(CONTRA COSTA CO.)