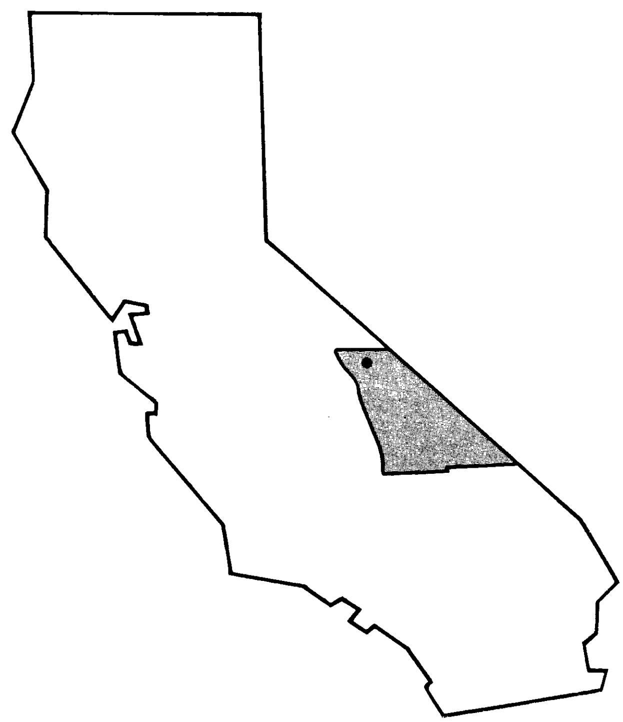
FLOOD INSURANCE STUDY



CITY OF BISHOP, CALIFORNIA
INYO COUNTY

DECEMBER 19, 1984

Federal Emergency Management Agency

COMMUNITY NUMBER - 060074

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont'd)

Page

FIGURES

TABLES

EXHIBITS

PUBLISHED SEPARATELY:

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 Bishop, Inyo 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 (NFIP) 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 James M. Montgomery, Consulting Engineers, Inc., for the Federal Emergency Management Agency (FEMA), under Contract No. EMW-C-0700. This study was completed in May 1984.

1.3 Coordination

On August 22, 1979, areas requiring detailed study were identified at a meeting attended by representatives of FEMA, the study contractor, and the City of Bishop. Results of the hydrologic analyses for Bishop were coordinated with the U.S. Army Corps of Engineers, Los Angeles District; the California Department of Water Resources; the Los Angeles Department of Water and Power; the Southern California Edison Company; Inyo County; and the City of Bishop.

Results of the study were presented to the community at a meeting held on March 27, 1984. The study was acceptable to the community.

2.0 AREA STUDIED

2.1 Scope of Study

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

The limits of study were determined by FEMA with community and study contractor consultation at the meeting on August 22, 1979. Floods caused by North Fork Bishop Creek and South Fork Bishop Creek within and near the corporate limits were studied by detailed methods. Preliminary hydraulic calculations for Bishop Creek Canal indicated that 100-year flooding in Bishop would not be readily associated with the Bishop Creek Canal. Overflows from this source would be at an average depth of less than 3 feet. Therefore, the flooding by the overflow of Bishop Creek Canal was studied by the methods prescribed for conditions of shallow flooding.

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 1989.

2.2 Community Description

The City of Bishop is located in the northern portion of the Owens Valley in eastern California. The Owens Valley is a narrow depression, 12 miles wide at Bishop, surrounded by the Sierra Nevada Mountains on the west, the White Mountains on the east, a small range of mountains on the north, and the Mojave Desert on the south. Bishop is approximately 100 miles northeast of Fresno, California, and approximately 200 miles south of Reno, Nevada. The total land area of the city is approximately 1.1 square miles. According to U.S. Census Bureau figures, the 1980 population of Bishop was 3,333, which is approximately 19 percent of the total Inyo County population (Reference 1).

Development in Bishop consists primarily of residences and commercial establishments. In addition to utilities, mining, and governmental agencies, a large portion of the community is employed in tourism-oriented businesses. The main transportation arteries serving Bishop are U.S. Highways 395 and 6. Bishop is connected by air commuter service with metropolitan areas in California and Nevada. The Owens River, which flows north and east of the Bishop corporate limits is one of the major watercourses in Inyo County. All principal sources of flooding in Bishop, which include North Fork Bishop Creek, South Fork Bishop Creek, and Bishop Creek Canal, ultimately drain into the Owens River.

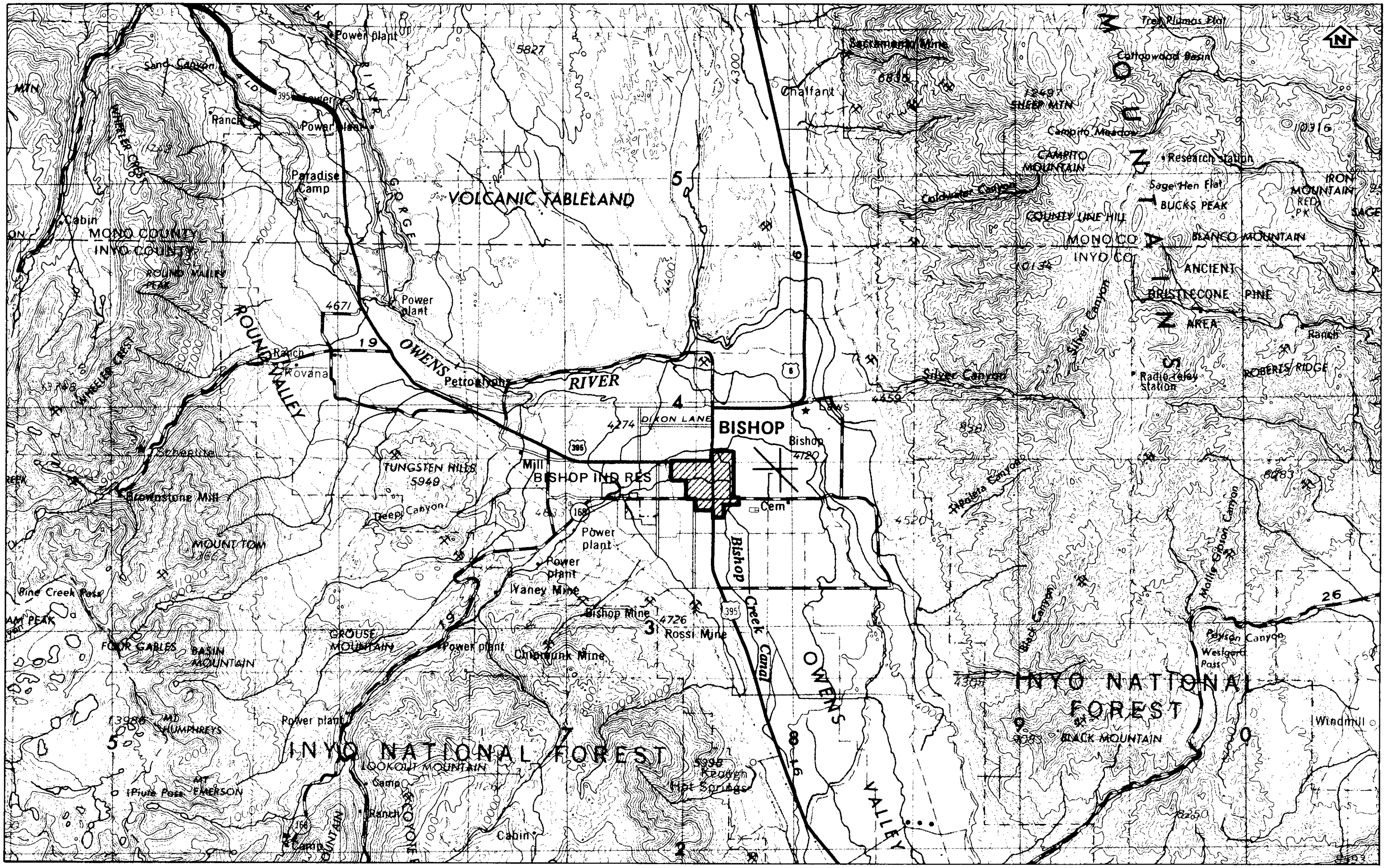


FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BISHOP, CA
(INYO CO.)

APPROXIMATE SCALE

4 0 4 8 12 MILES

VICINITY MAP

Bishop Creek drains a 104 square mile portion of the steep eastern slopes of the Sierra Nevada Mountains. Runoff from this watershed is significantly affected by a system of dams and reservoirs operated by the Southern California Edison Company for purposes of water storage and/or electrical power generation. The most important of these impoundment facilities include South Lake on South Fork Bishop Creek, Lake Sabrina on Middle Fork Bishop Creek, North Lake on North Fork Bishop Creek, and Bishop Creek Dam on Bishop Creek below the confluence of the three upper forks. Although these reservoirs are not designed or normally operated for flood control, they nevertheless affect the timing and magnitude of flood runoff from the Bishop Creek watershed.

At the base of the Sierra Nevada Mountains, Bishop Creek is divided by a control structure into North Fork Bishop Creek and South Fork Bishop Creek. These forks supply a complex network of irrigation canals in the vicinity of Bishop. North Fork Bishop Creek passes to the north of Bishop while South Fork Bishop Creek passes directly through the city. Bishop Creek Canal flows south along the eastern corporate limits.

The soil complexes and natural vegetation of the Bishop Creek watershed and flood plain can be roughly classified based on their location. On the valley floor itself, soils are generally characterized as fine to coarse sandy loam with gravelly subsoils. They have gentle slopes, are moderately to well drained, and may be locally high in either alkai or organics. Natural vegetation has largely been replaced by agricultural and pastoral development. In the foothills, soils consist of coarse sand, gravel, and frequent rock outcrops. Alluvial deposits of loose, porous material are prevalent.

The topsoil layer is very thin, and much of the area is barren or supports only sparse desert vegetation. The mountainous portions of the watershed consist largely of exposed granite or very rocky soil, and vegetation is typical of high mountainous areas. There are many small natural lakes and several small glaciers in the upper portions of the basin (Reference 2).

The climate throughout the study area varies considerably with elevation. While the climate of Bishop is classified as semiarid, much of the Bishop Creek watershed has an alpine climate. The mean annual precipitation at the Bishop Municipal Airport rain gage is 5.7 inches, whereas the higher elevations in the basin experience an average of approximately 40 inches of precipitation annually. Temperatures on the valley floor range from an average summer high of 95°F to an average winter low of 20°F; temperatures at the higher elevations tend to be lower, particularly the winter lows. Most of the Bishop Creek watershed precipitation falls as snow between November and April. Summer thunderstorms, which may be of locally high intensity, typically occur between May and September (References 3 and 4).

2.3 Principal Flood Problems

The largest flood of record in the Bishop Creek watershed, with a recurrence interval of 79 years, occurred on September 26, 1982, as a result of tropical storm Olivia, which resulted in over 7 inches of rainfall in three days. Direct storm runoff and the failure of North Lake Dam generated a peak discharge at the Bishop Creek gage site of approximately 1,750 cubic feet per second (cfs). The return period of this flood, based on updated frequency analyses, is approximately 150 years. Despite this large discharge, very little flooding actually occurred within Bishop. The C-Drain and bypass were opened to divert water out of the main channel and carry it to the north of the city. The capacities of North Fork Bishop Creek, South Fork Bishop Creek, and Bishop Creek Canal were not exceeded within the city. However, significant flooding did occur north of the city and at locations further upstream in the watershed. Figures 2 and 3 depict damage caused by this flood.

The second largest flood of record on Bishop Creek was the result of tropical storm Norman. Norman, a large general storm which came from the southwest, dropped warm and heavy showers along the eastern side of the Sierra Nevada Mountains between September 3 and September 5, 1978. At Lake Sabrina, a 40-year frequency, 10-hour duration rainfall of 1.02 inches was recorded on September 5, 1978. This produced a peak flow of 940 cfs at Power Plant No. 6 on Bishop Creek. This was estimated to be a 50-year frequency flooding event. To prevent or mitigate flood damage to Bishop and surrounding areas, the Los Angeles Department of Water and Power, in conjunction with Inyo County, activated the Owens River Canal Bypass. No major damage occurred to structures in Bishop.

In the winter of 1969, an abnormal amount of snow fell in the upper elevations of the Sierra Nevada. Snow courses run by the Southern California Edison Company estimated that the snowpack was 210 percent of normal in the Bishop Creek watershed. A warmer than normal May caused flows to reach 700 cfs for Bishop Creek at Power Plant No. 6 on June 1, 1969. Predictions were made that the flows could have reached 1,350 cfs (a potential 100-year event), but a change in the weather, including temperatures below freezing, actually reduced the snowmelt runoff in June. When the summer thaw continued, peak runoff reached 600 cfs on July 23, 1969.

Prior to the construction of the reservoir system in the Bishop Creek watershed, peak flows on Bishop Creek were generally of a greater magnitude. In the brief natural record (7 years) of the U.S. Geological Survey stream gage on Bishop Creek near Bishop, California (#1027200), there were two events in excess of the 1969 event. The peak flows of these floods were 822 cfs on July 6, 1906, and 713 cfs on June 26, 1909.

Figure 2. Diversion Structure Dividing South Fork Bishop Creek, North Fork Bishop Creek, and Owens River By-Pass, Two Days After the September 1982 Flood. Note Debris Obstruction Which Prevented Normal Operation of the Structure, and Resulted in Overflows Which Caused Flooding North of Bishop.

Figure 3. Dixon Lane at the C-Drain Northwest of Bishop, Two Days After the September 1982 Flood. Damaged Was Caused by Overflows From the Diversion Structure Shown in Figure 2.

2.4 Flood Protection Measures

Due to the heavy buildup of snow in the Sierra Nevada during the winter of 1969, and the anticipated damaging runoff that would result, a statewide, multiagency mobilization program called Operation Foresight was initiated (Reference 5). The Los Angeles District of the Corps of Engineers, Inyo County, the City of Los Angeles Department of Water and Power, and the California Division of Highways combined their efforts to clear and dredge existing channels, and to make provisions for using drainage ditches and irrigation canals as diversions. In addition, a new diversion canal was created which incorporated portions of the Owens River Canal. The bypass diversion as constructed in 1969 had a capacity of 200 cfs. Recently there have been improvements to the diversion canal, including a new larger headgate structure.

Flood protection is also provided to the Bishop area by the dams operated by the Southern California Edison Company in the Bishop Creek watershed. The principal dams are Sabrina Dam (Lake Sabrina), Hillside Dam (South Lake), and Bishop Creek Dam with storage capacities of 7,350, 13,191, and 115 acre-feet, respectively. These dams are operated principally for power generation and water storage, but do provide incidental flood protection.

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.

The method for modeling the hydrology of the Bishop Creek watershed was determined after a detailed review of available data and coordination with public agencies interested in the Bishop Creek watershed. It was assumed that a summer rainfall event occurring with the reservoir system already at capacity would be the critical event. This assumption was supported by the fact that the largest floods of record, September 1978 and September 1982, were of a similar nature.

Peak flows for the Bishop Creek watershed were estimated using the U.S. Army Corps of Engineers HEC-1 computer program (Reference 6). This method was chosen primarily to account for the upstream regulation of runoff caused by the complex reservoir system. Standard streamflow-frequency analyses were not applicable, because the regulated annual peaks do not fit a log-Pearson Type III distribution, or any other appropriate distribution. Regional methods were of limited reliability, since the unregulated gages in hydrologically similar areas monitor runoff from watersheds having smaller areas, fewer lakes and reservoirs, and varying snowmelt and accumulation characteristics (i.e., varying percentage of watershed above winter snow line) compared to the Bishop Creek watershed.

The sources of data used in the rainfall analyses included the National Oceanic and Atmospheric Administration Precipitation-Frequency Atlas of the Western United States, Volume XI - California, (Reference 7) and precipitation records obtained at the Southern California Edison Company recording station at Lake Sabrina (Reference 8).

To obtain depth and duration data for summer storms in the study basin, the original recording charts for the Southern California Edison Company recording station at Lake Sabrina from 1952 to 1982 were accessed. Assuming that the design storm was centered on Lake Sabrina, the rainfall distributions for each subbasin were adjusted for areal reductions in intensities. This was accomplished using the Depth-Area curves in the National Oceanic and Atmospheric Administration Atlas (Reference 7). HEC-1 (Reference 6) was used to model the rainfall-runoff process for the 10-, 50-, and 100-year flood events.

The 500-year flow was estimated by plotting the 50- and 100-year summer rainfall peak flows on log-probability paper and extrapolating to the 500-year value. A rainfall-runoff model was not run for the 500-year event because the National Oceanic Atmospheric Administration Atlas does not have data at that frequency and the historical rainfall records are too limited to allow reliable estimates for an event of that severity.

The rating curves for North Fork Bishop Creek and South Fork Bishop Creek at their originating diversion structure were determined using the U.S. Army Corps of Engineers HEC-2 computer program (Reference 9). The flow diverted to the bypass canal was assumed to be at capacity (300 cfs) during the 50-, 100-, and 500-year events. During the 10-year event, the bypass flow was assumed to be 50 cfs. Both water-surface elevations and energy gradeline elevations were rated with the individual channel flows. In this analysis, the structure was assumed to be completely open with no flashboards in place. The divided flow analysis was carried out under two separate assumptions due to the presence of critical depth conditions at the diversion structure. In one case, the water-surface elevations of both channels were assumed to be equal at the upstream side of the diversion; in the other case, the energy gradeline elevations were assumed to be equal. The variations in the results of the two assumptions were less than 6 percent of the total flow. As a result, the average values of the two methods were used.

In developing the downstream flows for North Fork Bishop Creek and South Fork Bishop Creek, the significant diversion structures and canals were assumed to be operating at their maximum capacities. The most prominent diversion from South Fork Bishop Creek is the B-1 Drain, which conveys flows (capacity of 50 cfs) to North Fork Bishop Creek just upstream of the study area.

All discharges in the Bishop Creek diversion network were assumed coincident, due to their common source. No flow was assumed diverted to North Fork Bishop Creek from the Owens River by either the Owens River Canal or the Bishop Creek Canal.

Peak discharge-drainage area relationships for North Fork Bishop Creek and South Fork Bishop Creek are shown in Table 1.

The 50-, 100-, and 500-year peak discharges for North Fork Bishop Creek exceeded the channel capacity between the U.S. Highway 6 crossing and the Bishop Creek diversion. The 50-year, 50 cfs; 100-year, 250 cfs; 500-year, 570 cfs overflows leaving the channel in a northeasterly direction were calculated using a divided flow analysis. At three other locations, 500-year floodflows leave the channel. A 400 cfs overflow just downstream of the confluence with Bishop Creek Canal leaves the channel and flows northeasterly; a 470 cfs overflow near cross section E flows southeasterly; and a 130 cfs overflow just upstream of the U.S. Highway 6 crossing flows northerly parallel to the highway.

A divided flow analysis was performed for the Bishop Creek Canal diversion structure to determine the discharges leaving North Fork Bishop Creek for the floods of selected recurrence intervals. The discharges entering Bishop Creek Canal were calculated to be 70 cfs, 150 cfs, 220 cfs, and 250 cfs, respectively for the 10-, 50-, 100-, and 500-year floods.

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
North Fork Bishop Creek At B-1 Drain Confluence	--[1]	230	510	890	2,300
South Fork Bishop Creek At Western Corporate Limits	--[1]	25	70	160	580

[1]Not Applicable Due to Upstream Flow Diversions and Regulation

The sources of the 100-year peak discharges used in the analysis of Bishop Creek Canal were the computed flow from the 220 cfs diversion at North Fork Bishop Creek and the 160 cfs inflow from South Fork Bishop Creek.

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.

Water-surface elevations for floods of the selected recurrence intervals on South Fork Bishop Creek and North Fork Bishop Creek were computed using the U.S. Army Corps of Engineers HEC-2 computer program (Reference 9).

Cross sections for streams studied in detail were digitized from aerial photographs flown on December 1, 1981, at a scale of 1:9,600 (Reference 10) and from field reconnaissance. All bridges, diversion structures, and culverts were field checked to obtain elevation data and structural geometry.

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).

Hydraulic roughness factors (Manning's "n") used in the hydraulic computations were chosen by engineering judgment and were based on aerial photographs and field observations of the streams and flood plain areas. Roughness values for South Fork Bishop Creek ranged from 0.028 to 0.050 for the channel and from 0.035 to 0.065 for the overbanks. Roughness values for North Fork Bishop Creek ranged from 0.030 to 0.035 for the channel and from 0.050 to 0.060 for the overbanks. The acceptability of assumed hydraulic factors, cross sections, and bridge structure dimensions was checked by comparing calculated water-surface elevations with historical information.

Starting water-surface elevations for South Fork Bishop Creek and North Fork Bishop Creek were calculated using the slope-area method.

Areas of shallow flooding were determined using the HEC-2 computer program (Reference 9).

Bishop Creek Canal generally parallels the topographic contours, with a grade sloping away from the channel to the east. Flow in excess of the channel capacity leaves the canal along the east bank. It was assumed that any point on the east bank of the canal would be susceptible to breakouts. Breakout flows were estimated to be the total flow in the canal at each point investigated. Potential overflow areas would be subject to shallow flooding less than 1.0 foot deep (Zone B).

Shallow flooding is often characterized by an unpredictable pattern of flow, 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 (Zone B). Small-scale topographic variations were averaged across inundated areas to determine flood depths.

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 used in this study are shown on the maps.

4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound flood plain management programs. Therefore, each Flood Insurance Study produces maps designed to assist communities in developing flood plain management measures.

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 additional 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 1:4,800, with a contour interval of 4 feet (Reference 11).

For stream channels designated Zone A, the 100-year flood boundaries are based on existing channel alignment and right-of-way.

The 100- and 500-year flood plain 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 NFIP, 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 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 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).

At the Bishop Creek Canal diversion on North Fork Bishop Creek, the total flow cannot be conveyed downstream within the natural 100-year flood plain. Therefore, the floodway on North Fork Bishop Creek was terminated at cross section C.

Floodways are not applicable to areas of shallow flooding; therefore, floodways were not computed for Bishop Creek Canal and the overflow areas.

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-surface elevation of the 100-year 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 4.

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
North Fork Bishop Creek								
A	0	--[2]	--[2]	--[2]	4,131.2	--[2]	--[2]	--[2]
B	390	--[2]	--[2]	--[2]	4,133.2	--[2]	--[2]	--[2]
C	720	105	276	3.2	4,140.6	4,140.6	4,141.6	1.0
D	1,400	31	120	7.4	4,142.3	4,142.3	4,142.6	0.3
E	2,030	73	164	5.4	4,145.5	4,145.5	4,145.6	0.1
F	2,560	46	140	6.4	4,147.5	4,147.5	4,147.9	0.4
G	3,390	41	137	6.5	4,151.2	4,151.2	4,151.2	0.0
H	3,830	40	117	7.6	4,152.9	4,152.9	4,153.0	0.1
I	4,000	30	97	9.1	4,153.9	4,153.9	4,153.9	0.0
J	4,160	51	177	5.0	4,155.7	4,155.7	4,155.7	0.0

[1] Feet Above Cross Section A (530 Feet Downstream of Bishop Creek Canal Division)   [2] Data Not Applicable

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BISHOP, CA
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FLOODWAY DATA

NORTH FORK BISHOP CREEK

TABLE 2

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
South Fork Bishop Creek								
A	164	29	93	1.7	4,130.9	4,130.9	4,131.9	1.0
B	524	23	50	3.2	4,131.1	4,131.1	4,132.0	0.9
C	1,036	23	43	3.7	4,133.4	4,133.4	4,133.4	0.0
D	1,473	38	33	4.8	4,134.6	4,134.6	4,134.6	0.0
E	1,973	22	53	3.0	4,137.5	4,137.5	4,137.5	0.0
F	2,489	28	62	2.6	4,140.6	4,140.6	4,140.8	0.2
G	2,916	23	51	3.1	4,141.9	4,141.9	4,142.0	0.1
H	3,236	34	72	2.2	4,142.3	4,142.3	4,142.4	0.1
I	3,742	16	37	4.3	4,146.9	4,146.9	4,147.1	0.4
J	4,118	23	48	3.3	4,147.7	4,147.7	4,148.1	0.4
K	4,578	29	61	2.6	4,148.7	4,148.7	4,149.0	0.3
L	4,993	24	26	6.1	4,150.6	4,150.6	4,150.6	0.0
M	5,784	22	26	6.2	4,156.9	4,156.9	4,156.9	0.0
N	6,146	24	31	5.1	4,160.5	4,160.5	4,160.6	0.1

[1]Feet Above Confluence With Bishop Creek Canal

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BISHOP, CA
(INYO CO.)

FLOODWAY DATA

SOUTH FORK BISHOP CREEK

TABLE 2

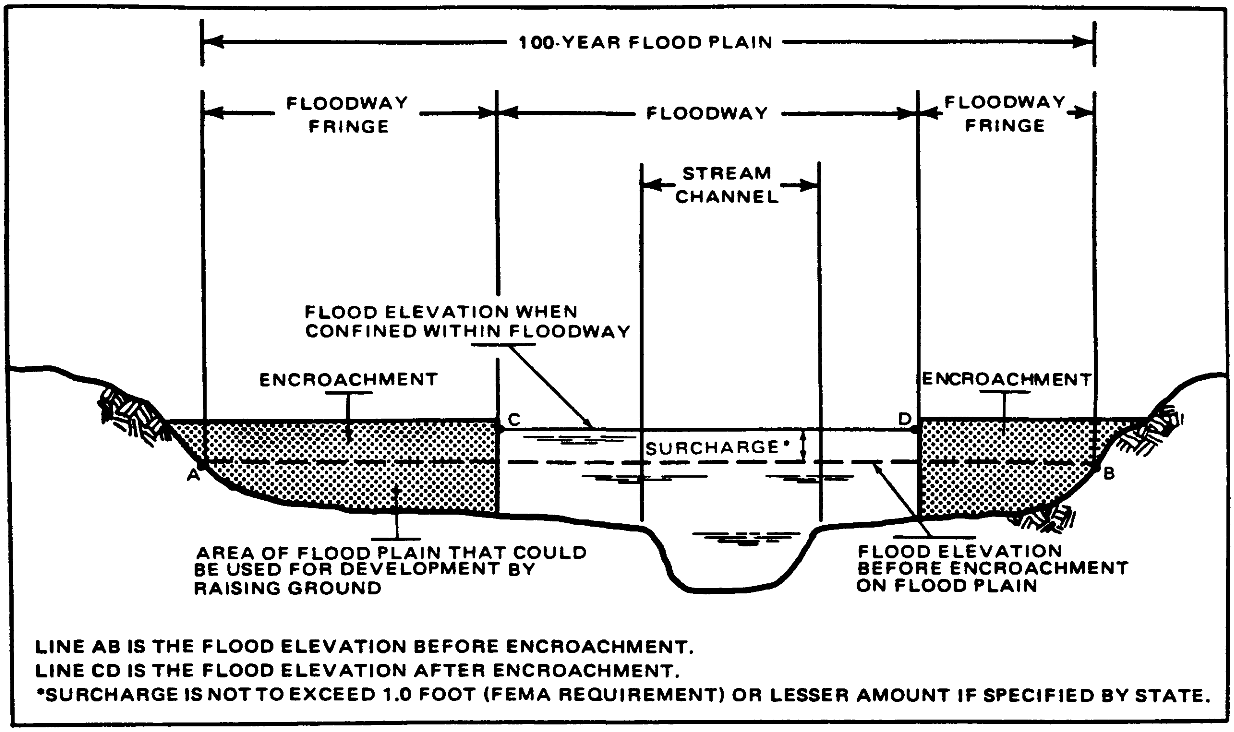

Figure 4. Floodway Schematic

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 Bishop.

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 Bishop 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 for 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 elevations shown or FHFs determined.

Zones A3 and A4: Special Flood Hazard Areas inundated by the 100-year flood; with base flood elevations shown, and zones subdivided according to FHFs.

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.

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)			
South Fork Bishop Creek Reach 1	0001	-1.48	-0.79	2.11	015	A3	Varies - See Map
North Fork Bishop Creek Reach 1	0001	-2.00	-0.83	0.92	020	A4	Varies - See Map

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

FEDERAL EMERGENCY MANAGEMENT AGENCY

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(INYO CO.)

FLOOD INSURANCE ZONE DATA

SOUTH FORK BISHOP CREEK-NORTH FORK BISHOP CREEK

TABLE 3

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

The flood elevation differences, FHFs, flood insurance zones, and base flood elevations for each flooding source studied in detail in the community are summarized in Table 3.

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for Bishop 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 NFIP.

6.0 OTHER STUDIES

The U.S. Army Corps of Engineers prepared a flood hazard study for the Paiute-Shoshone Indian Reservation west of Bishop in 1973 (Reference 12).

The hydrologic methodology was based on the assumption that the peak discharges are due to snowmelt. A regional analysis was performed which accounted for the percentage of watershed area above the winter snow line, assumed to be 8,000 feet. Although the hydrologic results agree with the flows for the 50- and 100-year events, presented in this Flood Insurance Study, the U.S. Army Corps of Engineers predicted larger flows for more frequent events. This is due to the fact that the method used by the U.S. Army Corps of Engineers did not take into account the routing effects of the lake and reservoir system in the Bishop Creek watershed. The hydraulic results of the U.S. Army Corps of Engineers study indicated 100-year flood depths less than 1.0 foot throughout the study area, except in the channels. This is consistent with the results presented in this Flood Insurance Study.

This Flood Insurance Study supersedes the 1974 Flood Hazard Boundary Map for Bishop (Reference 13) and the 1978 Flood Hazard Boundary Map for Inyo County (Reference 14).

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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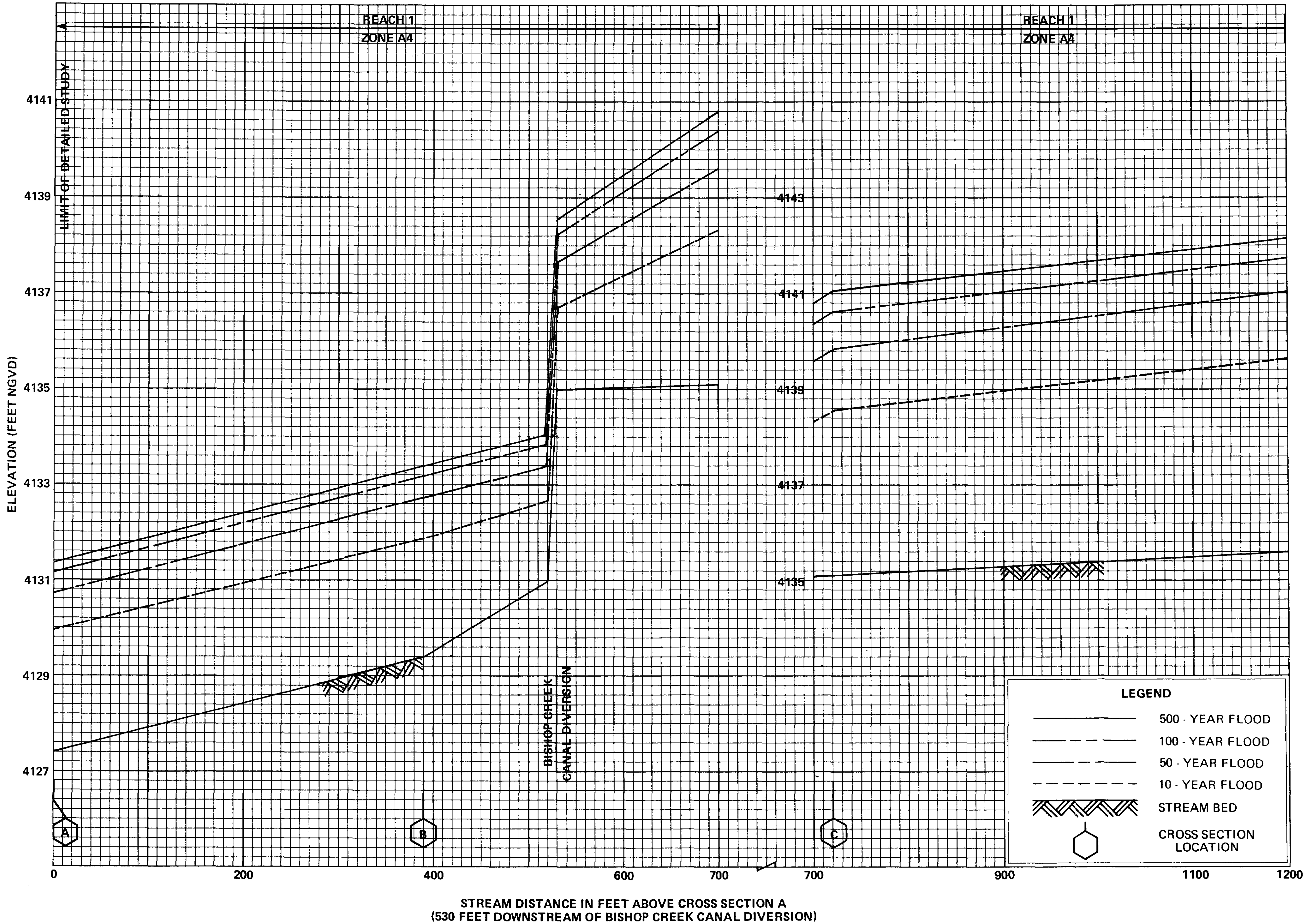


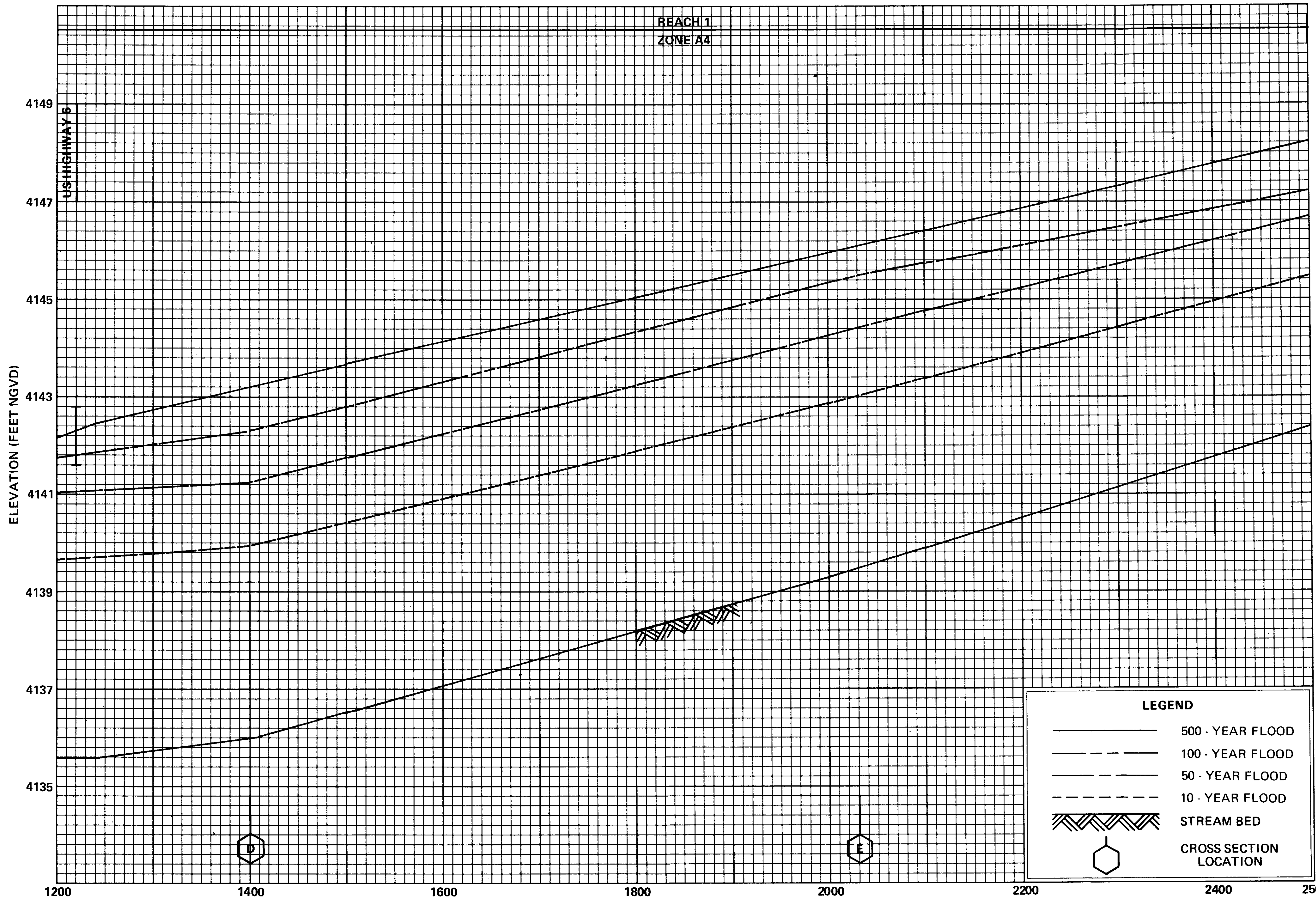
FLOOD PROFILES

NORTH FORK BISHOP CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BISHOP, CA
(INYO CO.)

01P



STREAM DISTANCE IN FEET ABOVE CROSS SECTION A
(530 FEET DOWNSTREAM OF BISHOP CREEK CANAL DIVERSION)

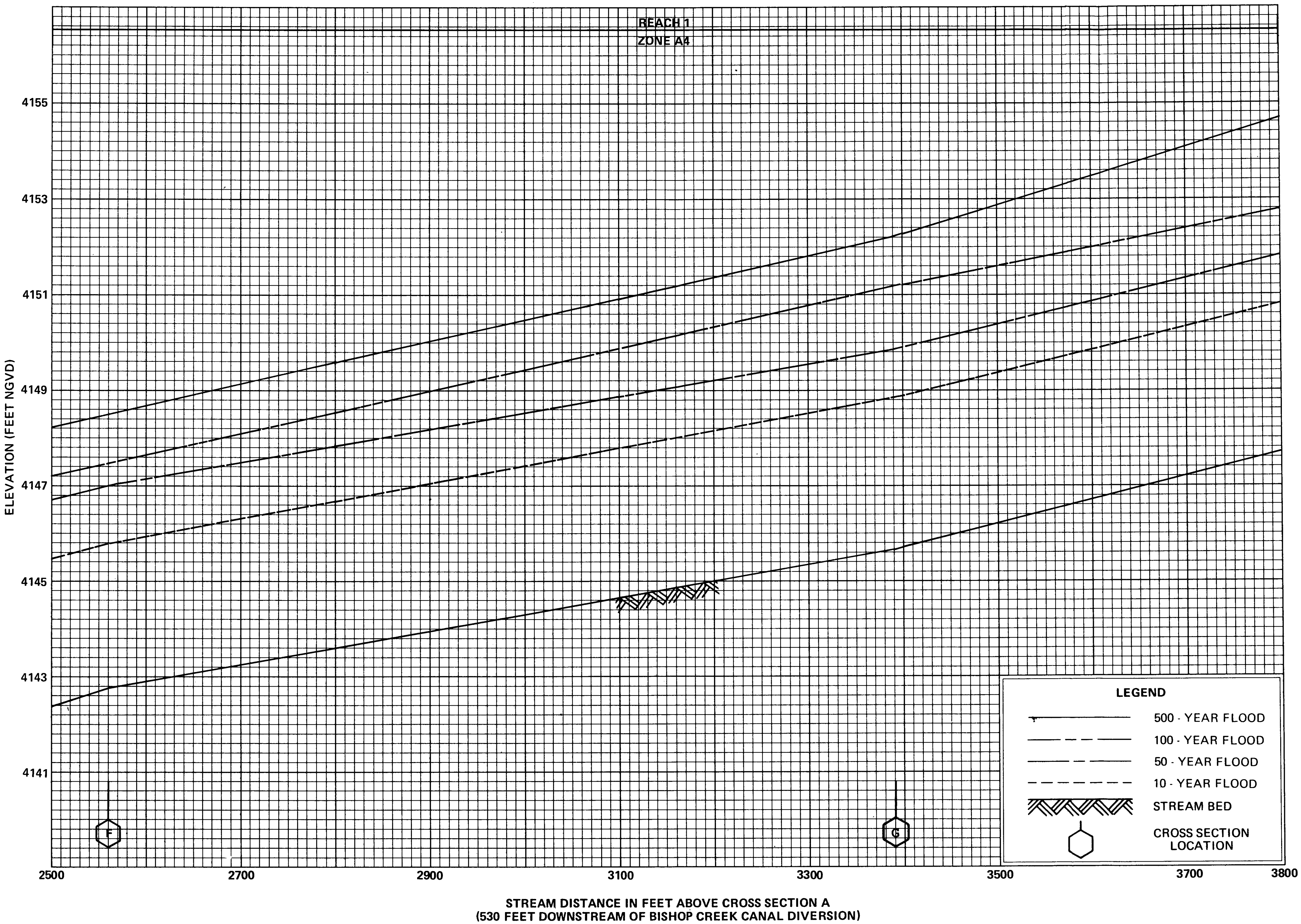
FLOOD PROFILES

NORTH FORK BISHOP CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BISHOP, CA
(INYO CO.)

02P



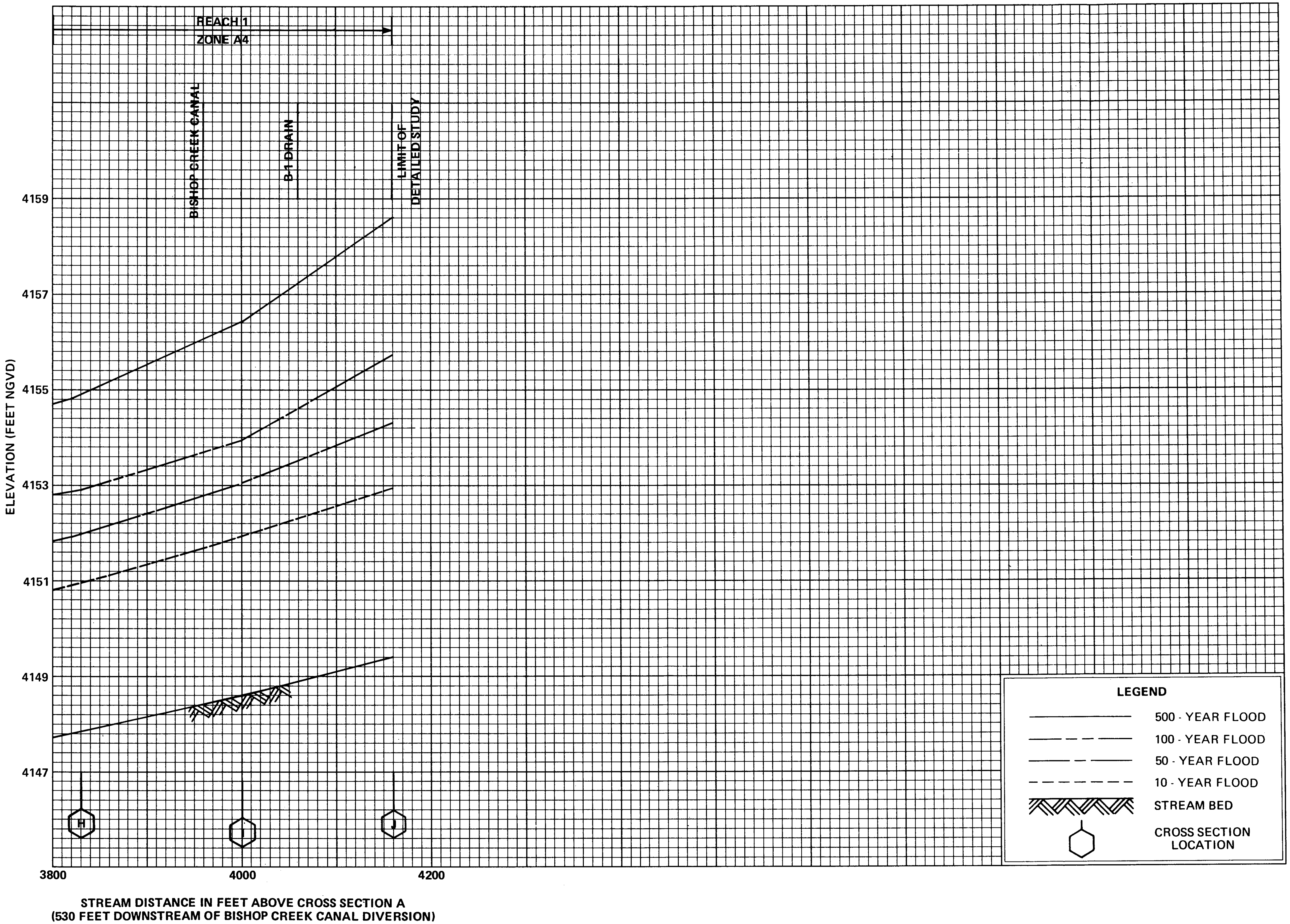
FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BISHOP, CA
(INYO CO.)

FLOOD PROFILES

NORTH FORK BISHOP CREEK

03P



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CITY OF BISHOP, CA
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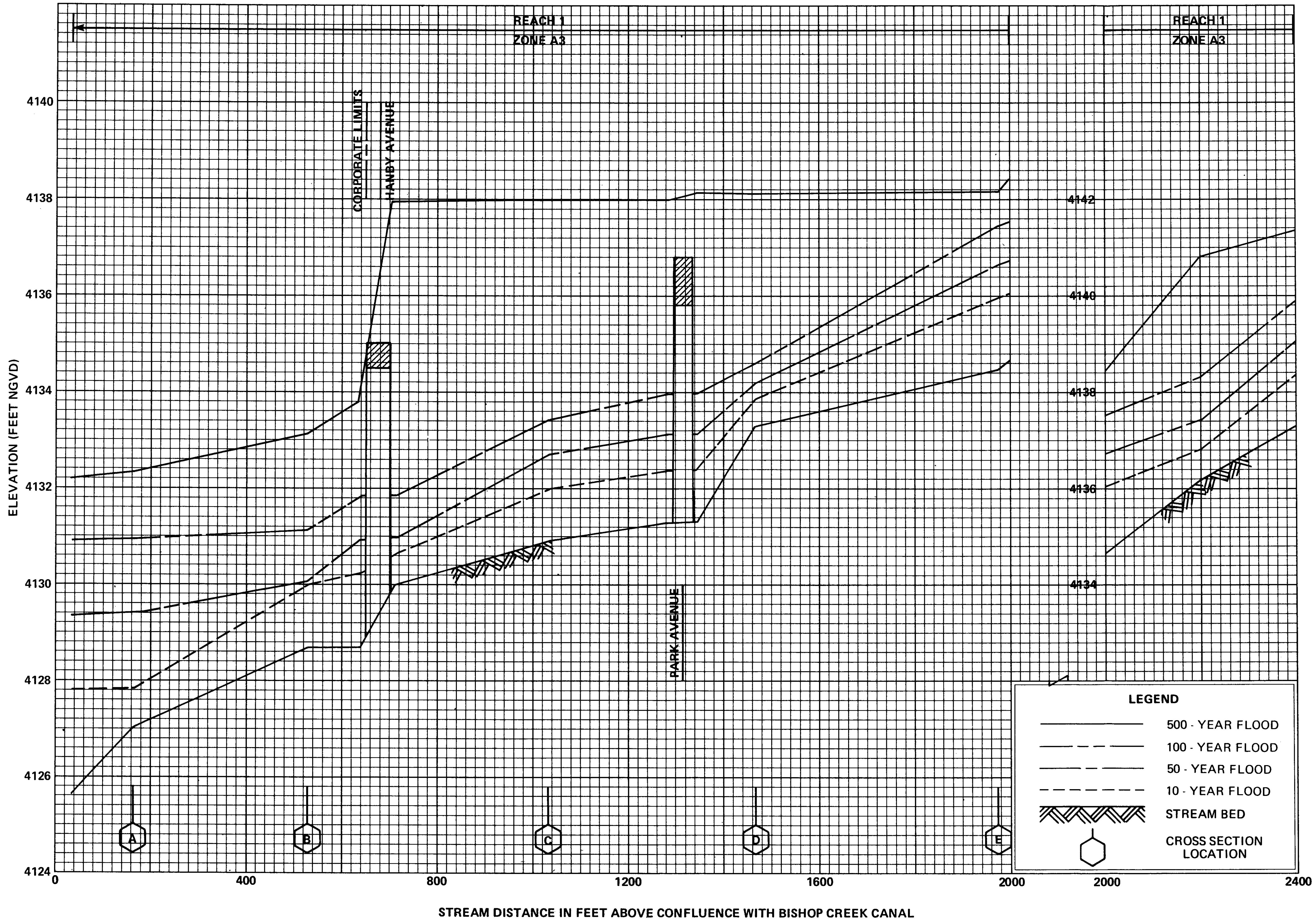
FLOOD PROFILES

NORTH FORK BISHOP CREEK

04P



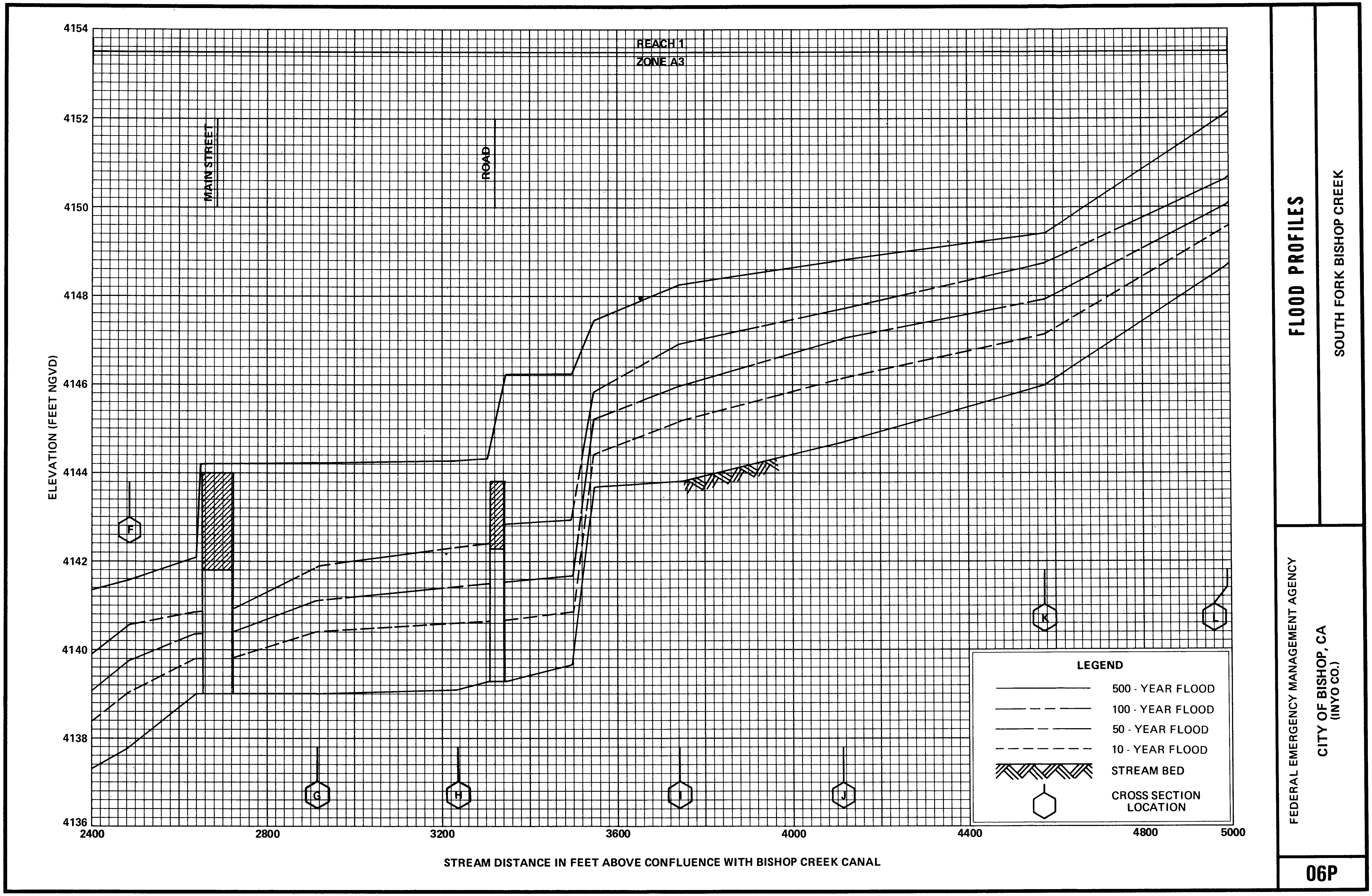
FLOOD PROFILES

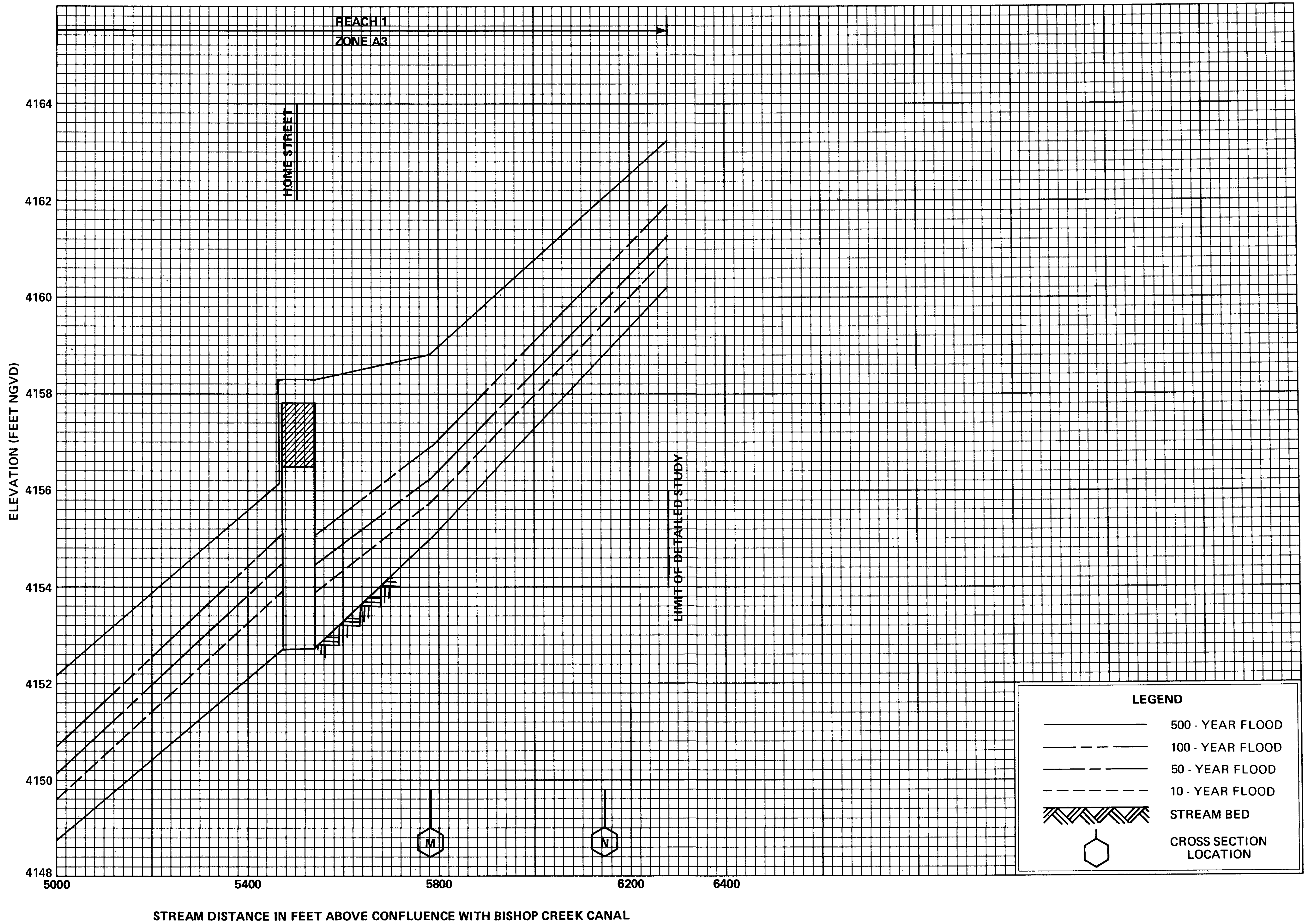
SOUTH FORK BISHOP CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BISHOP, CA
(INYO CO.)

05P


REACH 1
ZONE A3
MAIN STREET
ROAD
4154
4152
4150
4148
4146
4144
4142
4140
4138
4136
ELEVATION (FEET NGVD)
F
G
H
I
J
K
L
2400
2800
3200
3600
4000
4400
4800
5000
STREAM DISTANCE IN FEET ABOVE CONFLUENCE WITH BISHOP CREEK CANAL
LEGEND
500 - YEAR FLOOD
100 - YEAR FLOOD
50 - YEAR FLOOD
10 - YEAR FLOOD
STREAM BED
CROSS SECTION LOCATION
FLOOD PROFILES
SOUTH FORK BISHOP CREEK
FEDERAL EMERGENCY MANAGEMENT AGENCY
CITY OF BISHOP, CA
(INYO CO.)
06P



FLOOD PROFILES

SOUTH FORK BISHOP CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BISHOP, CA
(INYO CO.)

07P