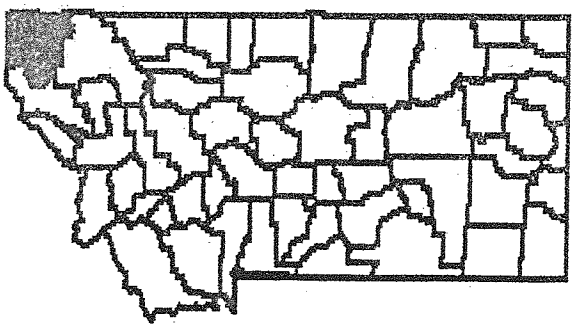
FLOOD INSURANCE STUDY

LINCOLN COUNTY, MONTANA
UNINCORPORATED AREAS



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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.

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

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Flood Boundary and Floodway Map

FLOOD INSURANCE STUDY
LINCOLN COUNTY, MONTANA (UNINCORPORATED AREAS)

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study (FIS) revises and updates a previous FIS report and Flood Insurance Rate Map (FIRM) for the unincorporated areas of Lincoln County, Montana. This information will be used by Lincoln County to update existing floodplain regulations as part of the Regular Phase of the National Flood Insurance Program (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 FIS report are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for the original study were performed by HKM Associates, for the Federal Insurance Administration (FIA), under Contract No. H-4026. This work, which was completed in November 1977, covered all significant flooding sources affecting the unincorporated areas of Lincoln County, Montana.

The hydrologic and hydraulic analyses for this restudy were performed by the U.S. Army Corps of Engineers (USACE), Seattle District, (the Study Contractor (SC)) for the Federal Emergency Management Agency (FEMA), under Inter-Agency Agreement EMW-97-IA-0154, Project Order Number 6, EMW-98-IA-0206, Project Order Number 7, and EMW-99-IA-0235, Project Order Number 4. This work was completed in November 2001.

1.3 Coordination

For the original February 1980 report, the identification of streams requiring approximate and detailed study was done in a pre-study community meeting held in Libby, Montana, on April 14, 1976. The meeting was attended by personnel of the FIA, Montana Department of Natural Resources Floodway Management Bureau, Kootenai National Forest Service, the SC, and local county and city officials.

Telephone conversations and personal contacts were made by the SC throughout the term of the study in an effort to coordinate activities and accumulate pertinent information. Agencies and offices contacted in addition to those mentioned above were: U.S. Geological Survey (USGS); the local newspapers; Lincoln County Library; Montana Department of Highways; St. Regis Paper Company; USACE, Seattle District; and the U.S. Soil Conservation Service (SCS).

Hydrologic analyses and flood profiles for the 1980 study streams were coordinated by the SC with those developed by the USGS, the USACE, and the SCS. The SCS work is published in the form of Flood-Prone Area Maps, and the USACE and USGS have performed statistical analyses on the gaged records. Reasonable concurrence was obtained between the above mentioned work and the results of the SC.

The results of this study were reviewed at a final community coordination meeting held on February 26, 1979. Attending the meeting were representatives of the FIA, the SC, and the county. The 1980 study incorporates all appropriate comments, and all problems have been resolved.

On January 7, 1999, at a scoping meeting held in Libby, Montana, Lincoln County and the City of Libby identified the need for detailed studies on Libby, Big Cherry, Flower, and Parmenter Creeks. Due to funding limitations, FEMA decided these studies would be done in phases under FEMA's Limited Map Maintenance Program.

The results of the study were reviewed at the final Consultation Coordination Officer meeting held on September 21, 2005, and attended by representatives of Lincoln County and FEMA. All problems raised at that meeting have been addressed in this study.

2.0 AREA STUDIED

2.1 Scope of Study

This FIS report covers the unincorporated areas of Lincoln County, Montana, and summarizes the investigations and findings to revise the hydrology and hydraulics for selected streams in the northwest region of the State of Montana, and shown in the February 1980 Lincoln County FIS report.

The November 1977 study performed by HKM Associates provided detailed studies for Bobtail Creek and Callahan Creek, and portions of Big Cherry Creek. Flower Creek, Kootenai River, Libby Creek, Parmenter Creek, Quartz Creek, and Tobacco River were studied by detailed methods. Deep Creek, Grave Creek, Lake Creek, North Fork Yaak River, Sinclair Creek, Therriault Creek, and Yaak River were studied by approximate methods.

The November 2001 restudy covers Big Cherry Creek from the mouth to River Mile (RM) 3.5 just below the confluence with Granite Creek including all overbank areas, Libby Creek from the mouth to RM 13.85, just upstream of the U.S. Highway 2 (US 2) bridge including all overbank areas in Libby and unincorporated Lincoln County, Flower Creek from the mouth to RM 1.8 about 0.5 mile above the alluvial fan apex, and Parmenter Creek from the mouth to its alluvial fan apex at RM 1.7 including all overbank areas in Libby and the unincorporated areas of Lincoln County. All of these streams except Big Cherry Creek flow into the Kootenai River. The Kootenai River has been regulated by Libby Dam, about 17 miles upstream of Libby, since 1973 and is operated by the USACE.

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 Lincoln County. Table 1 details those streams studied by detailed methods and those that were studied by approximate methods.

2.2 Community Description

Lincoln County is located in the extreme northwestern corner of the State of Montana and is bounded on the north by the Canadian Province of British Columbia, on the west by the State of Idaho, and to the east and south by the Counties of Flathead and Sanders, respectively. The total land area is 3,728 square miles, of which only 13 represent water-surface area. The water-surface area consists almost entirely of the Kootenai River and several small lakes in the southwest corner of the county. Surface water characteristics are typical of those found in mountainous terrain. The major drainage feature is a network of rivers and streams, the main one being the Kootenai River. The Yaak, Tobacco, and Fisher Rivers also provide drainage. The county has many smaller streams that provide a year-round source of water for many uses.

The topography of Lincoln County is characterized by high, rugged mountain ridges separated by narrow valleys; elevations vary from 3,000 feet to over 7,000 feet. The wide variations in elevations across the county add to the complex surface drainage system. Mountain ranges predominant in the county are the Cabinet Range, which is located in the southwest; the Purcell Mountains in the north and west; the Flathead Mountains in the east; and the Whitefish Range in the extreme northeast.

The large stands of timber are by far the most important natural resource possessed by Lincoln County. In fact, 95 to 97 percent of the county is covered by forest, and 4 acres of timber out of each 5 is classified as commercial timber. The plains of the Tobacco River near Eureka comprise the major timber-free area.

Lincoln County has been influenced by alpine glaciation. Some areas are covered with material that was picked up, mixed, and redeposited either by the ice or by water from the ice as it melted. The variations in soils seen today result from alterations of geologic material by climate and living organisms, especially vegetation. The length of time these factors have been active and the topography on which the action has occurred also contribute to these variations.

The climate of Lincoln County is very similar to that of the Pacific Coast regions. Within the county itself are wide variations in climate due to the extremes of topography. In general, however, the winters are not as severe and the precipitation averages are much higher than those of counties in Montana east of the Continental Divide.

Only the area around Fortine and Eureka in northwestern Lincoln County shows continental climate characteristics. In this area, approximately one-half of the yearly precipitation occurs during the warmest months of each year (April-September) and the yearly averages are somewhat lower than those of the remainder of the county. The yearly average for Eureka, for example, is between 12 and 14 inches. For Fortine, the yearly average precipitation is between 17 and 18 inches.

Table 1. Study Areas and Methods

Study Stream	Scope of Study	Miles of Study
Big Cherry Creek	A	0.40
	D	3.25
Bobtail Creek	D	0.25
Callahan Creek	D	1.00
Deep Creek	A	3.00
Flower Creek	A	1.00
	D	0.70
Grave Creek	A	4.00
Kootenai River	D	1.10
	A	41.51
Lake Creek	A	13.00
Libby Creek	A	4.00
	D	9.50
North Fork Yaak River	A	3.50
Parmenter Creek	A	1.50
	D	1.50
Quartz Creek	A	0.80
	D	0.20
Sinclair Creek	A	4.90
Therriault Creek	A	4.00
Tobacco River	A	6.75
	D	2.45
Yaak River	A	40.50

NOTE: A = Approximate Study and D = Detailed Study

The remainder of the county reflects Pacific coastal precipitation characteristics in that the wettest months of the year are November, December, and January. A typical community with this classification is Libby, where approximately 37 percent of the annual precipitation falls during the April to September growing season. The fall and winter rains and snows most often are the steady, gentle, soaking type and are accompanied by periods of cloudy skies with small diurnal temperature changes. The annual snowfall (approximately 55 inches) comes in the December-February period. The overall average annual precipitation for Libby is typically around 20 inches. Snowfall amounts quite commonly reach several hundred inches along the mountains, with heaviest snows falling on the prevailing windward (west to southwest) slopes in most years. The mountain snowfall is a significant contribution to the pronounced spring-early summer runoff maximums observed on all streams in the county that arise in mountain country.

With most valleys sheltered by rugged mountains, destructive winds are infrequent. This corner of Montana has a much lower thunderstorm frequency than counties to the east, and when thunderstorms do occur, they are less forceful, on the average, than elsewhere in the State. In fact, if one recognizes that heavy mountain snowfall is a normal winter part of the county climate complex, it may be concluded that severe storms are rare in most of Lincoln County.

The U.S. Bureau of the Census has classified Lincoln County as a semirural area containing at least one incorporated community of 2,500 or more persons. Lincoln County has shown an upward trend in growth since 1930, with a faster rate experienced between 1950 and 1970. During this period, Lincoln County continued to grow even faster than the State of Montana. Records indicate that the primary reason for the overall growth in the county since 1950 can be attributed to the increasing activity in wood and timber processing. However, the July 1, 1973, population estimate showed 17,674 people versus the 18,063 for the 1970 census. This recent downward trend is primarily due to the moving of construction workers and their families upon the completion of the Libby Dam. The population growth in Lincoln County, present and future, seems to indicate that the rural non-farm areas will continue to serve as an attractive location for residential development. It is anticipated that the county will continue to grow because of plans for construction of new industries and expansion of the present ones.

Big Cherry Creek originates in the Cabinet Mountains of Kootenai National Forest and flows northeasterly and northerly for approximately 18 miles before joining Libby Creek. Big Cherry Creek is a mountain-type stream and characteristically has a steep channel slope throughout its length. The channel slope gradually flattens as it passes through the detailed study area near South Libby Flats. Average annual precipitation values throughout the watershed range from approximately 120 inches along the mountain ridges to approximately 30 inches in the lower elevations, or an overall weighted value of 61 inches.

Big Cherry Creek watershed is generally characterized by alluvial soils along the stream and brown podzolic soils in the mountain regions. The alluvial soils usually occur in small areas along the stream bottom and in areas that may be flooded periodically. The material below the surface is essentially the same as it was at the time of deposition. The brown podzolic soils are typically found in the higher elevations where the moisture accumulations are quite high and where there is a dense cover of timber and miscellaneous vegetation.

Bobtail Creek originates in the Purcell Mountains of the Kootenai Forest and flows southerly until its confluence with the Kootenai River. Bobtail Creek has a total channel length of approximately 10.5 miles and a total vertical drop of approximately 2,750 feet. Bobtail Creek can be described as a typical mountain-type stream with relatively steep channel slopes. The Bobtail Creek watershed has a weighted average annual precipitation of 37 inches.

Specifics concerning watershed soils and vegetation are similar to those described above for Big Cherry Creek.

Callahan Creek originates in the Cabinet Mountains of the Kootenai National Forest and flows easterly for approximately 18 miles before joining the Kootenai River near Troy. Elevations range from approximately 6,600 feet in the upper watershed to 1,900 feet in the detailed study reach. The overall weighted average annual precipitation for the watershed is 64 inches.

Reference should be made to the discussion on soils and vegetative growth provided for Big Cherry Creek, as the two watersheds are quite similar in those respects.

Flower Creek originates in the Cabinet Mountains of the Kootenai National Forest and flows easterly for approximately 8 miles before turning north and traveling approximately 4 miles to its confluence with the Kootenai River. Flower Creek maintains relatively steep channel slopes in the mountainous and foothill environments, and gradually flattens as it passes through the developed areas in and near Libby. The average annual precipitation for the watershed upstream of the gaging station near Libby is approximately 79 inches, and 63 inches for the entire shed upstream of the mouth.

As with the other streams and their watersheds in this part of the county, the Flower Creek watershed is generally characterized by alluvial soils along the stream and brown podzolic soils in the mountains regions. The alluvial soils usually occur in small areas along the stream and in areas that may be flooded periodically. The material below the surface is essentially the same as it was at the time of deposition. Dense stands of timber are located in the higher elevations where the soils are typically classified as brown podzolic and moisture accumulations are quite high.

The Kootenai River is the major drainage feature of Lincoln County. The Kootenai River, which carries a larger volume of water than the Missouri River, flows through the central part of Lincoln County for a distance of approximately 100 miles. It enters the county in the north from Canada, at Gateway, and flows southwest to Libby, then flows northwest past Troy and into Idaho. The Kootenai River is an important tributary of the Upper Columbia River.

Along some areas of the Kootenai River there is evidence of alluvial soils, but these soils are limited in extent due to narrow river valleys. Consequently, there is very little farming done along the Kootenai River. More typically, the watershed of the Kootenai River is characterized by the gray wooded and brown podzolic soils, with abundant vegetation and dense timber stands.

Libby Creek is another mountain-type stream with elevations ranging from approximately 6,800 feet in the upper limits of the watershed to 2,050 feet at the mouth. Libby Creek travels northwesterly and northerly along its 27-mile

course, which begins in the Cabinet Mountains of the Kootenai National Forest and terminates at the Kootenai River near Libby. Annual average precipitation values vary from over 100 inches along the mountain ridges to 19.5 inches in Libby, or a weighted average of 56 inches.

The other watershed characteristics for Libby Creek are similar to those described earlier for Big Cherry Creek.

Parmenter Creek is a mountain-type stream and is tributary to the Kootenai River. The Creek arises in the Cabinet Mountains of the Kootenai National Forest and flows northeasterly for approximately 9 miles before joining the Kootenai River. Parmenter Creek has an upstream watershed of 17.7 square miles above the detailed study reach. Elevations in the watershed range from approximately 7,600 feet in the upper reaches to 2,045 feet at the mouth. Thus, it too has relatively steep channel slopes throughout its length. Average annual precipitation values for the watershed range from a high of 120 inches in the mountains to 30 inches in the foothills near Libby, or an overall weighted average of 67 inches.

Refer to the vegetation and soils description provided for Flower Creek for further amplification on watershed characteristics.

Quartz Creek originates in the Purcell Mountains and flows southerly for approximately 12 miles before joining the Kootenai River. Watershed elevations range from approximately 6,200 feet in the upper reaches to 2,020 feet at the mouth. Quartz Creek has a drainage area of 35.4 square miles upstream of the detailed study reach. The average annual precipitation for the watershed is approximately 46 inches with extremes of over 70 inches in the higher elevations and slightly under 30 inches along the Kootenai River bottom.

Soil and vegetation are similar to those described earlier for Big Cherry Creek and Flower Creek.

The Tobacco River originates in the Salish Mountains of the Kootenai National Forest and flows northwesterly and westerly until emptying into Lake Koocanusa. The total stream course length from the mountain ridges to the lake is approximately 50 miles with an elevation difference of approximately 3,200 feet. The river maintains relatively steep channel slopes in the mountainous and foothill environments, and gradually flattens in the valley areas near Eureka and further west to the lake. The Tobacco River has an upstream watershed of approximately 400 square miles above the detailed study reach near Eureka, and 440 square miles above the stream gage site. A weighted average annual precipitation for the watershed is approximately 33 inches.

Most of the Tobacco River watershed is characterized by gray wooded soils (Alfisols) in the mountain regions and alluvial soils along the stream. In the mountain regions, vegetation consists mainly of coniferous forests. A dark surface layer of less than 4 inches may be present just under the forest litter, and in its absence, a light gray to white zone 4 to 12 inches thick lies just beneath the litter. The subsoil, a mixture of surface soil and substratum, may extend to depths of 3 to 4 feet. The clay accumulation lies below this zone of mixing and may extend to depths of 6 feet in extreme samples.

A more elaborate discussion of the Tobacco River and its associated study communities (Eureka and Lincoln County) is provided in the Eureka FIS report.

2.3 Principal Flood Problems

Typically, the most severe flooding in Lincoln County occurs in the mid-winter or spring months as a result of snowmelt combined with runoff from heavy rains. Occasionally, ice jams (winter and spring) cause some overbank flooding. In addition to flooding along streams, shallow flooding periodically occurs in other isolated but developing areas of Lincoln County because of a relatively high groundwater table, rapid snowmelt, and/or rainfall. Areas in the county usually experiencing this are either located at the foothills or in low-lying areas of the Kootenai Valley where there is minimal topographic relief.

Four severe flood events have occurred in Lincoln County within the record period (early 1900s to the present). The largest flow ever recorded on the Kootenai River near Libby occurred in 1916 and was measured to be 121,000 cubic feet per second (cfs). The estimated frequency for this flood is roughly equivalent to the 50-year event. However, there appears to be minimal detailed documentation of flooding severity and extent of damages.

Another severe flood event for Lincoln County occurred in December 1933. Streams that experienced flooding at that time were Bobtail Creek, Callahan Creek, Granite Creek (or Big Cherry Creek), Fisher River, Kootenai River, Lake Creek, Libby Creek, Swamp Creek, and others. The following are excerpts from the December 28, 1933, issue of *The Western News*: "One of the most disastrous floods ever to visit the western part of Lincoln County followed a rain that continued most of last week, on top of a heavy snowfall that preceded the rain. On account of the unprecedented amount of precipitation, all creeks in the district went on wild rampages. Fortunately the clouds cleared away last Saturday, the temperature dropped and the worst of the flood was over.... In the immediate vicinity of Libby, damage consists of the flood's carrying out half of the Granite Creek (Big Cherry Creek) bridge just south of the city and also part of the bridge over Libby Creek, leading to the Herbst ranch. The highway between Libby and the main Granite Creek bridge is also badly cut up, with deep holes in many places.... one of the worst pieces of destruction is said to be along Fisher River where the stream parallels the highway for some distance. It is said the entire roadbed has been washed out for a distance of about two miles and earthen slides from the hillsides came down over what was left, so that now it's said one would never know a highway had been there.... County Commissioner Brink states that a jam formed at the Bobtail Creek bridge and diverted the stream down the roadbed, with the result that the entire roadway was cut out to a depth of eight to 10 feet for a considerable distance....."

Another article in the same issue specifically discussed flooding near Troy: "A marked drop in temperature Saturday night checked the flow of water which wrought much havoc last week in this community. Callahan Creek went on a rampage Thursday night. First tearing out the upper bridge, newly built this spring, and carrying it about 300 yards downstream. Next in its path of destruction, was the bridge on the main highway, from which it tore the approach on the north bank, leaving, in its fight for a new channel, a gap of about 200 feet between the bridge and the present bank.... This is not the first time Callahan has gone on the tear. Old timers say it was even worse in 1897.... Lake Creek, too, was unusually high, flooding meadows and filling the dam to within about seven feet of the top....."

In May 1948, the Kootenai Valley experienced another severe flood. There were limited streamflow records in Lincoln County at that time--even miscellaneous peak flow measurements were a rarity. In fact, the only records available on many of the streams are newspaper accounts. The following are excerpts from the May 27, 1948, issue of The Western News: "One of the highest floods in the history of the Kootenai Valley is pouring down the river and spreading from its banks in low places. Warm weather coming suddenly is melting the heavy snows in the mountains all along the stream's course from Kootenai National Park in British Columbia on south through Montana and northwest back through Idaho into Canada....."

The Bull Dam near Wardner went out last Saturday releasing dammed up waters which added to the high waters coming down into Montana and Idaho.... The river, itself yesterday afternoon had not broken from its banks in Libby, to damage any residence buildings, but flood waters coming in from Libby Creek, Flower and Parmenter Creeks were being backed up by higher waters in the Kootenai making it impossible for the stream to handle them. The waters from Libby Creek spread over much of the northeast part of the city and are running a swift stream on the south side of the Great Northern Depot.... Many residence basements are filling from the underflow which is threatening several foundations.... Much damage is being done to low farm lands and buildings on low banks up and down the river.... Bob Baker, who has lived five miles above Libby on the south bank of the river for over 40 years, was in Libby yesterday noon, and stated there is more water going down the stream than he has ever seen in the past, though it was not so high at his home as he has seen it when the waters were confined more to the channel below his place...."

The Kootenai River basin and the lower Clark Fork basin experienced heavy flooding following the heavy rains of January 13, 1974. Rain began in most of the area on January 13, and continued for 4 days at the rate of approximately 1 inch per day. Precipitation in the Yaak area, 18 miles north of Troy, totaled 6.12 inches for the period of January 13 through January 17, with a maximum day of 2.75 inches on January 15. Preceding the flood, varying amounts of snow covered most of northwestern Montana. In the relatively low-altitude areas where snow cover was deepest, flooding was most severe. Mild temperatures in the area during the flood period, accompanied by the unseasonal rainfall, reduced the low-level snowpack in the valley and foothill areas. Melting of the snow caused streams to remain at flood levels for 3 days. Subsequent to the peak flows, snow cover remained in nearly all areas. Most of the flood damage in the Kootenai River basin centered around the Towns of Libby and Troy. The flooding in the area near Libby was caused by Big Cherry, Flower, Libby, and Parmenter Creeks and, although the incorporated area of Libby did not suffer extensive flooding, water covered much of the surrounding area to the west and south where many homes and businesses are located. The American Red Cross reported that 1,500 people in the Libby area were evacuated and 200 homes were flood damaged. In Libby, it was also reported that two houses and six mobile homes were swept away by floodwaters. In Troy, an Amtrak train with 92 passengers aboard was stranded for the nights of January 15 through January 17 because of floodwaters and mud slides. Roads and bridges suffered most of the damage. US 2, a major eastwest road, was closed to traffic for 5 days by mudslides and bridge washouts. Segments of U.S. Forest Service roads were completely destroyed when floodwaters covered the entire valley floor of several of the smaller streams. Much of northwestern Montana was subsequently given national disaster area status. Some of the streams in the region experienced flows that are considered to be far more severe than the 0.2-percent-annual-chance event.

After reviewing some of the most severe flood events in Lincoln County, it becomes obvious that the Kootenai River has a history of periodic flooding in some of the developed areas along the valley, including the communities of Libby and Troy. Kootenai River flood damages were not limited to that resulting from overtopping banks. The high water levels of the Kootenai River during regional flood events would affect the free flowing characteristics of its tributaries. Of particular importance are Bobtail, Callahan, Flower, Libby, Parmenter, Quartz, and Lake Creeks. That is, the high stage of the Kootenai River would create backwater effects on the tributaries such that they would leave their banks and cause flooding throughout the valley before joining the main stem.

2.4 Flood Protection Measures

Big Cherry Creek has minimal flood protection within the detailed study reach. There is an earthen and rock riprap dike located along the left bank upstream of the US 2 bridge. This dike was constructed subsequent to the January 1974 flood event.

Bobtail Creek has no significant flood protection measures. However, some channel and bank reshaping occurred subsequent to the January 1974 flood. In some areas along Bobtail Creek, the channel rehabilitation work resulted in bank berms that previously did not exist and that will accommodate higher flow stages before overtopping.

Callahan Creek also experienced channel reshaping after the 1974 event. An earthen and rock riprap dike has been constructed just upstream of the US 2 bridge along the left bank looking downstream. It too appears to be capable of containing and withstanding the 1-percent-annual-chance and 0.2-percent-annual-chance flood events.

There is minimal to no flood protection along Flower Creek within the detailed study reach. Of some significance is the manmade rechannelization that was performed subsequent to the January 1974 flooding. There is particular evidence of this type of work near the footbridge upstream of US 2 and along a reach approximately 700 feet downstream of the US 2 crossing.

The Kootenai River is regulated by Libby Dam, which is located 17 miles upstream from Libby and 48 miles downstream from the International Boundary. The USACE started construction of the dam in the spring of 1966 and essentially completed the project in March 1973. Since its completion, the flows have been regulated such that minimal flood hazards exist in the immediate downstream area of the dam. The Libby Dam is a concrete structure that rises 420 feet above bedrock, and the reservoir behind the dam (Lake Koocanusa) is 90 miles in length and has a maximum storage capacity of 5.9 million acre-feet. Additional dam statistics are as follows: 1) the spillway has two separate bays with tainter gates having the dimensions 48 x 59 feet each; and 2) the dam has the capability at full-pool level to discharge 60,000 cfs through the outlet works and 145,000 cfs through the spillway, or a spillway design flood of 205,000 cfs. There is no particular frequency attached to the spillway design flood other than it is some proportion of the probable maximum flood.

Libby Creek has only one flood protection measure of any significance, an earthen and rock riprap dike located along the left bank upstream of the bridge crossing for State Route 482. This dike appears to have been built or rebuilt following the January 1974 flood and should be capable of containing the 1-percent-annual-chance and 0.2-percent-annual-chance flood events.

There are essentially no flood protection measurements along Parmenter Creek within the detailed study reach. A minimal amount of rechannelization was performed along Parmenter Creek after the January 1974 flooding.

An earthen and rock riprap, dike was constructed or replaced within the detailed study area of Quartz Creek following the 1974 flood. The dike is quite short and is located immediately upstream of the county bridge along the right bank looking downstream. This particular area appears to be quite dependent upon the dike, otherwise a substantial amount of land would have to be added to the proposed floodplain. However, with the dike, it appears that the 1-percent-annual-chance and 0.2-percent-annual-chance events will be contained within the banks through this reach.

There is minimal to no flood protection work along the Tobacco River. Natural topographic features contain the flows on the north side, and both natural topographic features and a railroad embankment control flooding on the south side (Reference 1).

A FEMA-funded flood control and channel migration control project was completed on Parmenter Creek in 2000. The project includes a levee, two bridges, and several thousand feet of stream relocation and wetland construction. Several dikes and levees are constructed along Flower and Parmenter Creeks. None meet flood control criteria (Reference 2).

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 is 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 1-percent-annual-chance flood 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

In the February 1980 study, hydrologic analyses were carried out to establish peak discharge-frequency relationships for each flooding source studied by detailed methods affecting the community.

The hydrology of some of the streams studied required consideration by more than one analytical method. The SC felt that a particular method would be more or less accurate than others due to the different variables considered for each method.

The methods used were weighted by engineering judgment based on physical characteristics of the area in question and their relation to the specific method employed.

Because the length of record was too short to exclusively use the Log-Pearson Type III statistical analysis, several other flood frequency determination methods were implemented. Regional regression relationships developed by Doge and the USGS (References 3 and 4, respectively) were used, as well as the SCS precipitation/runoff technique (Reference 5). The three different approaches were weighted according to level of reliability and significance to obtain values for the 10-percent-annual-chance, the 2-percent-annual-chance, the 1-percent-annual-chance, and the 0.2-percent-annual-chance peak discharges. A regional skew value of -0.15 was implemented as suggested by the USGS.

The 2001 study was needed to include 25 years of new streamflow record and the January 1974 flood of record, which was only qualitatively addressed in the previous FEMA study. A more detailed method of localized regional flood frequency analysis was applied in this study that replaces the used of limited analytical frequency analysis, USGS regional equations, and other approximate methods of flood frequency determination used in the previous studies (Reference 1).

Adjustments to the streamflow data were made where they could be confirmed by various collaborating sources of information as gage records, written documentation, letters, etc. Unsubstantiated streamflow records were either eliminated if obviously erroneous, or treated as high outliers (there were no new outliers) if the flood was real but the flow was unusually large.

The occurrence of distinct flood seasons necessitated development of separate winter rainfall and spring snowmelt Log-Pearson Type III flood frequency curves for gages analyzed in accordance with this guidance. The winter and spring curves were combined by probabilistic methods to form a single maximum annual flood frequency curve. Flood frequency estimates at ungaged locations were made using several methods that utilized the analytical results obtained at the gage stations.

Winter and spring Log-Pearson Type III peak flood frequency curves were derived using the computer program HEC-FFA (Reference 6). Statistical parameters used to compute the frequency curves were slightly "smoothed" between the flow durations to prevent potential convergence of crossing of the frequency curves.

For ungaged points on a stream, three methods were used to estimate peak flood frequency discharges. These include localized winter and spring flood statistic plots to compute analytical Log-Pearson Type III flood frequency curves, localized unit-flow versus drainage area plots, and streamflow transfer equations. The USGS regional equations from Magnitude and Frequency of Floods (Reference 7) for the West Region were not used since they tended to considerable under estimate flood discharges for the gages. USGS equations for the northwest region, which included effects of both winter and spring flood conditions were tested but these equations tended to overestimate the discharges and were not used either. Depending on the flood of concern, several estimates of the ungaged flow were generally made and the one considered most reasonable adopted.

The "coincident" frequency of flow for a given flood event were determined to be very similar and tended to have similar ranking based on evaluation of major events at gages investigated. The "coincident" timing of flood peaks at their confluence points is more difficult to determine and can vary considerably depending on the flood type and magnitude. For hydraulic model setup and calibration purposes, the coincident timing of observed floods was estimated directly from the available streamflow data.

The computed flood flow in this study were found to be significantly higher than those published in the previous FEMA study at nearly all frequency levels. In most cases, the previous FEMA flows were below the 95 percent (lowest) confidence limit of the new frequency curves at the 2-percent-annual-chance through the 0.2-percent-annual-chance recurrence points indicating a significant change based on FEMA criteria in *Contractor Guidelines* (Reference 8). Since the preponderance of stations showed a significant change in flood frequency flows, all flows were revised even if they did not explicitly exceed the FEMA criteria.

Peak discharge-drainage area relationships for Big Cherry Creek, Bobtail Creek, Callahan Creek, Flower Creek, Kootenai River, Libby Creek, Parmenter Creek, Quartz Creek, and Tobacco River are shown in Table 2.

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 the original February 1980 study, stream cross sections were located using available topographic mapping (References 9 and 10) and October 1976 aerial photographs (Reference 11). Below-water cross-section data was obtained by field observations and measurements. For Big Cherry, Flower, Libby, and Parmenter Creeks, the overbank area data were obtained using photogrammetric techniques. The overbank data for all other study streams were obtained by field measurements. However, additional cross sections were occasionally required which necessitated in-office development using field control information and topographic mapping. The last method was implemented, in lieu of using HEC-2 (Reference 12), cross section interpolation capability, because it appeared that the HEC-2 technique was not adequately sensitive to the rapidly changing channel morphology and flow conditions.

Table 2. Summary of Discharges

Flooding Source and Location	Drainage Area (Square Feet)	Peak Discharges (Cubic Feet per Second) 10-Percent-Annual-Chance	2-Percent-Annual Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
Callahan Creek					
At mouth	85.5	2,800	3,680	3,980	4,610
Fisher River	838	5,600	8,600	10,900	18,600
Granite Creek	30.5	1,320	2,120	2,660	5,070
Big Cherry Creek					
At Highway 2 bridge	84.7	2,580	4,500	6,160	12,100
At end of study	61.4	2,580	4,500	6,160	12,100
Bobtail Creek					
At Mouth	22.0	480	660	745	875
Libby Creek					
At Mouth	238	3,600	6,440	8,500	16,000
Below confluence with Big Cherry Creek	236.5	3,600	6,440	8,500	16,000
Above confluence with Big Cherry Creek	151.6	3,140	5,660	7,700	14,700
At Farm to Market Road	137	3,080	5,350	7,230	13,800
Below Swamp Creek	95.2	2,665	4,665	6.380	13,330
Above Swamp Creek	67.2	2,350	3,900	5,105	10,415
Flower Creek					
At USGS Gage (#3031) near Libby	11.1	390	610	840	1,730
At alluvial fan apex	17.9	675	1,080	1,490	2,960
Kootenai River					
At Libby[1]	10,240	50,100	59,300	60,500	84,900
At Libby[2]	10,240	92,300	115,300	124,400	146,000
At Libby Dam[1,3]	8,985	44,000	50,000	50,000	70,000
At Libby Dam[2,3]	8,985	88,000	108,000	115,000	130,000

Table 2. Summary of Discharges (Cont'd)

Flooding Source and Location	Drainage Area (Square Feet)	Peak Discharges (Cubic Feet per Second) 10-Percent-Annual-Chance	2-Percent-Annual Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
Parmenter Creek					
At alluvial fan apex	17.7	580	1,020	1,410	2,810
Lake Creek					
Near Troy	210	3,500	6,300	8,500	16,000
Quartz Creek					
At mouth	37.4	1,060	1,430	1,610	1,940
Tobacco River					
At USGS Gage No. 12301300	440.0	2,700	3,830	4,360	5,460
At Eureka	410.0	2,590	3,670	4,180	5,230

[1]Regulated by Libby Dam, 17 Miles Upstream from Corporate Limits
[2]Unregulated by Libby Dam
[3]Obtained from the U.S. Army Corps of Engineers, Seattle District

Hydraulic structures were field measured unless data summaries and/or plans were available to define elevations and geometry.

Roughness coefficients (Manning's "n") were estimated by field inspection and aerial photograph review. Roughness value selection was made using any one of a combination of the following approaches depending on the reach in question: 1) a detailed development and weighting technique that considers all factors affecting the value of "n"; 2) consultation of tables with typical "n" values for channels of various types; 3) comparison and familiarity with certain channel hydraulics and associated roughness coefficients; and 4) comparison to work previously completed by the USGS on indirect flow measurement exercises. Ranges for Manning's "n" used in the 1980 FIS are as follows:

	Manning's "n" Values	
Stream	Channel	Overbank
Big Cherry Creek	0.037 - 0.038	0.032 - 0.090
Bobtail Creek	0.040 - 0.045	0.035 - 0.090
Callahan Creek	0.032 - 0.040	0.030 - 0.150
Flower Creek	0.036 - 0.047	0.032 - 0.095
Kootenai River	0.032 - 0.041	0.031 - 0.090
Libby Creek	0.037 - 0.041	0.031 - 0.090
Parmenter Creek	0.040 - 0.048	0.030 - 0.090
Quartz Creek	0.040 - 0.042	0.030 - 0.085
Tobacco River	0.036 - 0.045	0.030 - 0.090

Water-surface profiles were developed using the HEC-2 computer step-backwater model (Reference 12).

In the 2001 study, for the Libby Creek cross sections, a digital terrain model (DTM) was developed for the project that meshed all the various data sources which enabled cutting cross sections between surveyed sections to augment the hydraulic models. The U.S. Forest Service regional office in Libby supplied the cross sections for Reach 6, from the Kootenai River to the confluence with Big Cherry (Granite) Creek. Cross sections were taken at approximately the same locations as the 1979 and 1980 FIS, tied to established bench marks. The USGS supplied horizontal and vertical control up to the end or Reach 3. The Lincoln Area Conservation District (LACD) supplied the channel cross sections for Reach 2 and 3. Reach 5 was surveyed by Montana Fish and Wildlife Parks and extends beyond the upstream limit of the 1980 FIS.

For Big Cherry (Granite) Creeks, the LACD provided the ground cross sections for Big Cherry/Granite Creek at the approximate locations of the 1980 FIS cross sections. The USGS provided horizontal and vertical control for the survey. A DTM was developed for the project that meshed all the various data sources which enabled cutting cross sections between surveyed sections to augment the hydraulic models.

For both Flower and Parmenter Creeks, the USACE obtained typical channel dimensions in the field to perform the FLO-2D analysis (Reference 13). No control was required for channel cross sections. The USGS provided control for the floodplain topography. The topography was converted to a DTM and overlain with evenly spaced 100 feet x 100 feet grid elements. An elevation was taken from the center point of each grid element to represent the surrounding terrain. This formed the basis of the FLO-2D grid used to determine the alluvial fan floodplain limits.

All structures were measured in the field by USACE and USGS. Bridge plans were obtained for some bridges.

Due to the highly variable flow conditions along most of Libby and Big Cherry (Granite) Creeks, composite Manning's "n" roughness values were assigned to represent the active migration zone where boundary and form losses occur. These channels are wide and braided, and generally have a high bed load, and a limited transport capacity in places. Channel roughness estimates were initially made for low-flow conditions using published guidelines. These baseline values were revised upwards across the migration zone to reflect the highly variable hydraulic conditions at flood stage. These revised estimates were validated by Limerinos' and Jarret's equations (References 13 and 14). Results of the analysis agreed well with similar analyses on steep alluvial channels.

Although several profile points were surveyed in the floodplain during this study, none were tied to an established benchmark. Calibration of roughness coefficients was limited to a debris line at a staff gage at the Stimson Timber Mill Bridge on Libby Creek.

For Flower and Parmenter Creeks, roughness coefficients were estimated by field inspection and review of recent aerial photographs. Channel and overbank roughness value selection was made by using any one or a combination of the following approaches: 1) a detailed development and weighting technique that considers all factors affecting the value of "n"; 2) consultation of tables and photographs with typical "n" values for channels of various types; 3) comparison and familiarity with certain channel hydraulics and associated roughness coefficients, and 4) comparison with values used in the 1980 FIS. Manning's "n" values for the 2001 study are as follows:

	Manning's "n" Values	
Stream	Channel	Overbank
Libby Creek	0.050 - 0.065	0.040 - 0.120
Big Cherry/Granite	0.040 - 0.054	0.050 - 0.090
Flower/Parmenter	0.040 - 0.054	0.050 - 0.090

Water-surface elevations (WSELs) were calculated for all streams studied by detail methods. The Seattle District of the Corps of Engineers developed HEC-RAS steady flow backwater models for Libby Creek and Big Cherry (Granite) Creek (References 15 and 16). FLO-2D was used to analyze the unsteady alluvial fan flooding on Parmenter and Flower Creeks. Libby Creek is modeled as four separate reaches for computational efficiency (Reach 6, 2, 3, 5). Big Cherry Creek is modeled as one reach (Reach 1). Flower and Parmenter Creeks are modeled together as a reach (Reach 4).

The Kootenai River is the ultimate downstream boundary for all flood sources studied, however its impact on flood elevations is limited because the likelihood that major floods would occur coincidentally is very small. It is, however, logical that the Kootenai River would experience high flows during a major regional flood and this could impact the studied streams. In the 1980 FIS, backwater from the Kootenai was used to start the Libby Creek model. The revised FIS intended to use the same starting elevations. This was unnecessary because the bed elevation of Libby Creek has increased such that the Kootenai backwater has very little impact on Libby Creek hydraulics. Thus, the model

was started at critical depth to model the flows dispersing abruptly on the delta after leaving the confined Libby Creek channel. The last cross section of a reach was set as the starting cross section for the reach upstream. Thus, the ending hydraulic conditions were used to start the next model.

The ending surface elevation for a downstream reach was input as the starting WSEL for the upstream reach for Libby. This was not the case for Big Cherry Creek because the hydrographs of Libby and Big Cherry Creeks are not coincident. Thus, the ending WSEL for Libby Reach 6 was not input as the starting WSEL for Big Creek. Big Cherry was started with a normal depth, "slope-area" assumption downstream of the confluence and routed up to the beginning of the study to begin the model.

Flooding on Parmenter and Flower Creeks was analyzed with FLO-2D, an unsteady, two-dimensional hydraulic model. The hypothetical "balanced" 1-percent-annual-chance hydrograph were used as input for hydraulic modeling on Flower Creek and Parmenter Creek.

The debris option at bridge piers was activated in HEC-RAS 3.01 to represent observed debris loads on Libby Creek Reach 6 only. FLO-2D was used to model out of bank flows on Flower and Parmenter Creeks, which are adjacent alluvial fans. Bridges on these creeks are subject to debris and ice jams which completely obstruct flow. The bridges were modeled both obstructed and unobstructed to create a worst-case floodplain.

3.3 Vertical Datum

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

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

NGS Information Services, NOAA, N/NGS12
National Geodetic Survey SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

Fax: (301) 713-4172, or
Telephone: (301) 713-3242

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

To obtain current elevation, description, and/or location information for benchmarks shown on this map, please contact the NGS.

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound floodplain management programs. To assist in this endeavor, each FIS report provides 1-percent-annual-chance floodplain data, which may include a combination of the following: 10-, 2-, 1-, and 0.2-percent-annual-chance flood elevations; delineations of the 1- and 0.2-percent-annual-chance floodplains; and a 1-percent-annual-chance floodway. This information is presented on the FIRM and in many components of the FIS report, including Flood Profiles, Floodway Data tables, and Summary of Stillwater Elevation tables. Users should reference the data presented in the FIS report as well as additional information that may be available at the local community map repository before making flood elevation and/or floodplain boundary determinations.

4.1 Floodplain Boundaries

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

The USGS and the Seattle District coordinated to develop topography and planimetrics of the floodplain and channel. Reaches 1, 2, 3, 4, and 6 were digitally mapped from aerial photos to 4 foot contour accuracy (Reference 17). Reach 5 of Libby Creek is only partially mapped due to unanticipated extension of the study scope beyond the limit of the photogrametry. An aerial photo and a USGS 7.5-minute quadrangle map were used to supplement the available survey data. Flooding occurs beyond the topographic limits of Reach 5. The aerial photos were used to define the approximate limit of the floodplain.

The 1-percent-annual-chance and the 0.2-percent-annual-chance floodplain and floodway boundaries were computed at the cross sections. Between cross sections, the floodplain and floodway boundaries were interpolated using the computed water surface profiles and the topographic maps. The floodplain and floodway boundaries are shown on the work maps. HEC-GeoRas 3.0, and Arc View extension, were used extensively on Libby Creek Reaches 6, 3, and 5 to generate cross-sectional information and to map floodplain inundation following hydraulic analysis with RAS. FLO-2D explicitly computes the floodplain boundary.

The 1- and 0.2-percent-annual-chance floodplain boundaries are shown on the FIRM. On this map, the 1-percent-annual-chance floodplain boundary corresponds to the boundary of the areas of special flood hazard Zones A, AE, AO, and the 0.2-percent-annual-chance floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 1- and 0.2-percent-annual-chance floodplain boundaries are close together, only the 1-percent-annual-chance floodplain boundary has been shown. Small areas within the 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 1-percent-annual-chance floodplain boundary is shown on the FIRM.

4.2 Floodways

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

In Montana, encroachment in the floodplain is limited to that which will cause an increase in flood heights of 0.5 foot. Thus, on the recommendation of the Montana Floodway Bureau, a floodway having no more than a 0.5-foot surcharge has been delineated for this study.

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 for selected cross sections (see Table 3, Floodway Data). In cases where the floodway and 1-percent-annual-chance floodplain boundaries are either close together or collinear, only the floodway boundary is shown.

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					FEET (NGVD)			
BIG CHERRY CREEK								
A	930	1,200	2,508	3.4	2,161.0	2,161.0	2,161.0	0.1
B	2,250	390	928	6.6	2,178.3	2,178.3	2,178.3	0.0
C	3,430	200	805	7.7	2,193.2	2,193.2	2,193.2	0.0
D	3,730	134	692	8.9	2,197.3	2,197.3	2,197.3	0.0
E	4,160	280	859	7.2	2,202.1	2,202.1	2,202.1	0.0
F	5,410	250	1,052	5.9	2,212.9	2,212.9	2,212.9	0.0
G	6,340	348	835	7.4	2,224.3	2,224.3	2,224.3	0.0
H	8,450	405	1,013	6.1	2,249.8	2,249.8	2,249.8	0.0
I	10,750	775	1,284	4.8	2,273.0	2,273.0	2,273.0	0.0
J	12,105	1,100	841	8.0	2,288.3	2,288.3	2,288.3	0.0
K	13,385	935	1,511	4.1	2,301.2	2,301.2	2,301.6	0.5
L	14,630	905	1,714	3.6	2,316.4	2,316.4	2,316.4	0.0
M	14,811	885	1,431	4.3	2,317.9	2,317.9	2,317.9	0.0
N	16,311	874	1,444	4.3	2,333.6	2,333.6	2,333.6	0.0
O	18,621	1,030	1,542	4.0	2,359.0	2,359.0	2,359.0	0.0

[1] Stream distance in feet above confluence with Libby Creek

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINCOLN COUNTY, MT

(UNINCORPORATED AREAS)

FLOODWAY DATA

BIG CHERRY 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	WITH FLOODWAY	INCREASE
					FEET (NGVD)			
Bobtail Creek								
A	160	70	421	1.8	2,036.5	2,030.9[2]	2,030.9[2]	0.0
B	960	155	124	6.1	2,048.2	2,048.2	2,048.2	0.0
C	1,290	160	74	10.2	2,059.4	2,059.4	2,059.4	0.0
D	1,450	160	77	9.8	2,064.5	2,064.5	2,064.5	0.0
E	1,500	160	91	8.3	2,065.8	2,065.8	2,065.8	0.0
F	1,582	225	105	7.2	2,067.4	2,067.4	2,067.4	0.0
G	2,032	100	84	9.0	2,073.8	2,073.8	2,073.8	0.0
H	2,182	85	95	7.9	2,076.7	2,076.7	2,076.7	0.0
Callahan Creek								
A	210	2,200	16,310	0.0	1,883.0	1,876.4[2]	1,876.4[2]	0.0
B	756	150	347	11.5	1,883.0	1,882.8[2]	1,882.8[2]	0.0
C	776	180	559	7.1	1,885.2	1,885.2	1,885.2	0.0
D	992	340/200[3]	663	6.0	1,887.3	1,887.3	1,887.3	0.0
E	1,422	550/340[3]	785	5.1	1,890.0	1,890.0	1,890.0	0.0
F	1,922	220/100[3]	470	8.5	1,901.5	1,901.5	1,901.5	0.0
G	2,582	140/80[3]	541	7.4	1,914.3	1,914.3	1,914.3	0.0
H	2,942	270	498	8.0	1,917.1	1,917.1	1,917.1	0.0
I	3,452	310	408	9.8	1,924.6	1,924.6	1,924.6	0.0
J	3,862	415	562	7.1	1,930.9	1,930.9	1,930.9	0.0
K	4,862	240	535	7.4	1,946.4	1,946.4	1,946.4	0.0

[1] Feet above mouth

[2] Elevations computed without consideration given to backwater effects of Kootenai River

[3] Width/Width within county limits

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINCOLN COUNTY, MT

(UNINCORPORATED AREAS)

FLOODWAY DATA

BOBTAIL CREEK-CALLAHAN 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	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Flower Creek								
A-O[2]								
P	10,975	44	104	8.8	2,223.0	2,223.0	2,223.0	0.0
Q	13,125	33	94	9.7	2,283.2	2,283.2	2,283.2	0.0

[1] Feet above confluence with Kootenai River

[2] Sections not used

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINCOLN COUNTY, MT

(UNINCORPORATED AREAS)

FLOODWAY DATA

FLOWER 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	WITH FLOODWAY	INCREASE
					FEET (NGVD)			
LIBBY CREEK								
A	138	108	689	12.3	2,061.6	2,061.6	2,062.1	0.5
B	453	415	1,718	5.0	2,065.1	2,065.1	2,065.2	0.0
C	1,011	1050	3,507	2.4	2,067.1	2,067.1	2,067.4	0.3
D	1,357	1200	3,393	2.5	2,067.8	2,067.8	2,068.2	0.4
E	1,466	1150	3,325	2.6	2,068.1	2,068.1	2,068.4	0.4
F	2,318	300	1,237	6.9	2,076.2	2,076.2	2,076.2	0.2
G	4,953	150	972	8.8	2,094.5	2,094.5	2,095.0	0.5
H	6,650	450	1,708	5.0	2,104.4	2,104.4	2,104.7	0.3
I	8,564	306	1,431	5.9	2,119.7	2,119.7	2,120.1	0.4
J	11,983	510	1,201	7.1	2,151.3	2,151.3	2,151.6	0.3
K	13,163	1200	2,508	3.4	2,160.9	2,160.9	2,161.0	0.1
L	14,632	680	2,212	3.5	2,171.6	2,171.6	2,171.8	0.2
M	18,402	352	1,529	5.0	2,202.8	2,202.8	2,202.8	0.0
N	21,782	412	1,570	4.8	2,231.0	2,231.0	2,231.0	0.0
O	24,362	385	1,472	5.1	2,252.7	2,252.7	2,252.8	0.1
P	28,007	278	1,379	5.4	2,282.8	2,282.8	2,282.8	0.0
Q	30,307	380	1,234	6.0	2,305.3	2,305.3	2,305.6	0.3
R	31,467	481	1,524	4.8	2,316.0	2,316.0	2,316.0	0.0
S	32,117	680	1,454	5.0	2,321.8	2,321.8	2,321.8	0.0
T	34,167	400	1,419	5.1	2,339.5	2,339.5	2,339.5	0.0
U	35,132	140	948	7.6	2,352.2	2,352.2	2,352.2	0.0
V	35,379	520	1,634	4.4	2,354.3	2,354.3	2,354.3	0.0
W	36,029	305	1,214	6.0	2,358.8	2,358.8	2,358.8	0.0
X	41,079	385	1,364	5.3	2,402.4	2,402.4	2,402.9	0.5
Y	44,099	500	1,450	5.0	2,429.7	2,429.7	2,430.1	0.4
Z	47,709	600	1,441	5.0	2,465.3	2,465.3	2,465.5	0.2

[1] Stream distance in feet above confluence with Kootenai River

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINCOLN COUNTY, MT

(UNINCORPORATED AREAS)

FLOODWAY DATA

LIBBY 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	WITH FLOODWAY	INCREASE
						FEET (NGVD)		
LIBBY CREEK								
AA	49,529	525	1,542	4.7	2,481.5	2,481.5	2,482.0	0.5
AB	51,099	950	2,453	2.9	2,496.8	2,496.8	2,497.0	0.3
AC	52,865	840	1,340	5.2	2,514.4	2,514.4	2,514.4	0.0
AD	55,005	335	1,179	5.9	2,532.7	2,532.7	2,532.7	0.0
AE	56,965	270	1,314	5.2	2,549.8	2,549.8	2,549.9	0.1
AF	58,874	810	1,418	5.4	2,568.2	2,568.2	2,568.2	0.0
AG	60,870	570	1,384	4.8	2,581.1	2,581.1	2,581.1	0.0
AH	63,686	233	1,267	5.3	2,611.5	2,611.5	2,611.5	0.1
AI	65,379	387	1,281	5.0	2,627.3	2,627.3	2,627.7	0.4
AJ	66,600	645	1,870	3.4	2,635.3	2,639.2	2,639.8	0.5
AK	67,705	275	1,066	6.0	2,645.7	2,645.7	2,646.1	0.5
AL	69,391	370	1,248	5.1	2,658.7	2,662.6	2,662.9	0.3
AM	71,153	705	1,843	3.5	2,672.4	2,672.4	2,672.8	0.4
AN	72,167	350	1,222	5.2	2,680.6	2,680.6	2,680.6	0.1
AO	73,559	370	1,309	4.9	2,690.2	2,690.2	2,690.7	0.5
AP	75,176	275	1,255	5.1	2,701.1	2,704.9	2,705.4	0.5
AQ	75,552	409	1,622	3.9	2,703.5	2,703.5	2,704.0	0.5
AR	76,460	312	1,241	5.1	2,711.8	2,711.8	2,712.3	0.5
AS	77,729	317	1,297	4.9	2,725.0	2,725.0	2,725.5	0.5
AT	78,204	398	1,413	3.6	2,728.4	2,728.4	2,728.9	0.5
AU	78,837	410	1,103	4.6	2,734.6	2,734.6	2,734.6	0.0
AV	79,807	408	966	5.3	2,740.5	2,740.5	2,741.0	0.5
AW	80,509	415	1,067	4.8	2,749.1	2,749.1	2,749.5	0.5
AX	80,880	450	1,102	4.6	2,752.4	2,752.4	2,752.8	0.5
AY	81,799	180	790	6.5	2,760.8	2,760.8	2,761.2	0.5
AZ	82,676	138	784	6.5	2,773.3	2,773.3	2,773.7	0.4

[1] Stream distance in feet above confluence with Kootenai River

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINCOLN COUNTY, MT
(UNINCORPORATED AREAS)

FLOODWAY DATA

LIBBY 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	WITH FLOODWAY	INCREASE
					FEET (NGVD)			
QUARTZ CREEK								
A	210	277	538	3.0	2,028.9	2026.0[2]	2026.0[2]	0.0
B	560	140	135	11.9	2,033.8	2,033.8	2,033.8	0.0
C	580	140	153	10.5	2,034.4	2,034.4	2,034.4	0.0
D	680	115	177	9.1	2,036.8	2,036.8	2,036.8	0.0
E	780	85	196	8.2	2,039.4	2,039.4	2,039.4	0.0

[1] Feet above mouth

[2] Elevation Computed without consideration given to backwater effects of Kootenai River

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINCOLN COUNTY, MT

(UNINCORPORATED AREAS)

FLOODWAY DATA

QUARTZ 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	WITH FLOODWAY	INCREASE
					FEET (NGVD)			
Tobacco River								
A	10,638	258	1,381	3.0	2,551.6	2,551.6	2,552.1	0.5
B	12,288	81	350	11.9	2,555.3	2,555.3	2,555.3	0.0
C	15,705	270/105[2]	610	6.4	2,566.4	2,566.4	2,566.4	0.0
D	16,935	460	747	5.2	2,572.3	2,572.3	2,572.6	0.3
E	17,190	365	633	6.1	2,573.9	2,573.9	2,574.1	0.2
F	17,828	87	498	8.4	2,576.8	2,576.8	2,577.0	0.2
G	18,578	175	774	5.4	2,579.8	2,579.8	2,580.3	0.5
H	22,106	245	729	5.7	2,594.6	2,594.6	2,595.1	0.5
I	23,216	146	554	7.5	2,601.8	2,601.8	2,601.8	0.0
J	23,581	121	692	6.0	2,603.4	2,603.4	2,603.9	0.5
K	23,734	179	698	6.0	2,604.2	2,604.2	2,604.4	0.2
L	24,754	119	517	8.1	2,608.8	2,608.8	2,609.0	0.2
M	26,554	90	402	10.4	2,620.7	2,620.7	2,621.2	0.5

[1] Stream distance in feet above Gaging Station 2519.

[2] Width/Width within county limits

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINCOLN COUNTY, MT

(UNINCORPORATED AREAS)

FLOODWAY DATA

TOBACCO RIVER

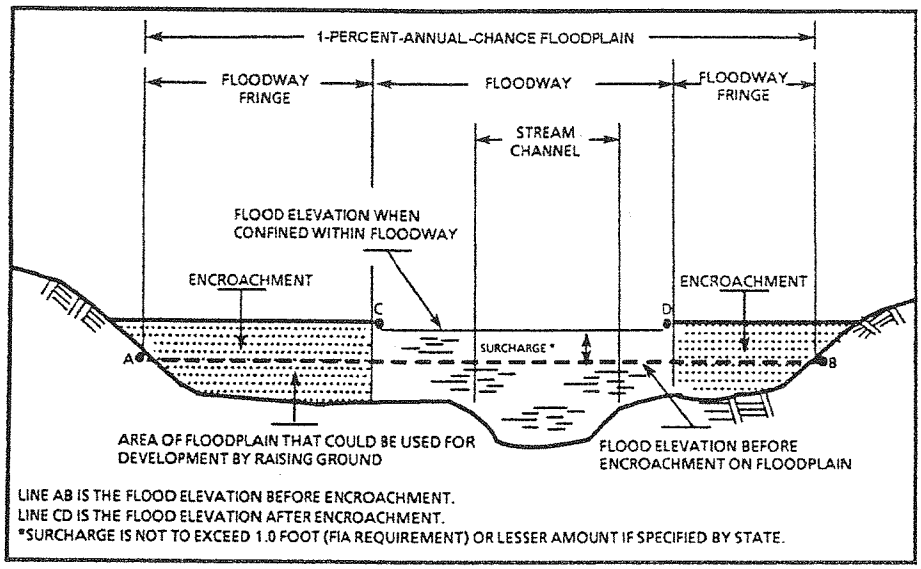

Figure 1. Floodway Schematic

No floodway was computed for Parmenter or the lower portion of Flower Creek because the alluvial fan flooding is not confined enough to designate a floodway.

5.0 INSURANCE APPLICATION

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

Zone A

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

Zone AE

Zone AE is the flood insurance rate zone that corresponds to the 1-percent-annual-chance floodplains that are determined in the FIS report 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 areas of 1-percent-annual-chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 foot and 3 feet. Average whole-foot depths derived from the detailed hydraulic analyses are shown within this zone.

Zone X

Zone X is the flood insurance rate zone that corresponds to areas outside the 0.2-percent-annual-chance floodplain, areas within the 0.2-percent-annual-chance floodplain, areas of 1-percent-annual-chance flooding where average depths are less than 1 foot, areas of 1-percent-annual-chance flooding where the contributing drainage area is less than 1 square mile, and areas protected from the base flood by levees. No BFEs or depths are shown within this zone.

6.0 FLOOD INSURANCE RATE MAP

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

For flood insurance applications, the map designates flood insurance rate zones as described in Section 5.0 and, in the 1-percent-annual-chance floodplains that were studied by detailed methods, shows selected whole-foot BFEs or average depths. Insurance agents use zones and BFEs in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

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

7.0 OTHER STUDIES

An FIS report was published for Lincoln County in February 1980 (Reference 1).

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

8.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting Federal Insurance and Mitigation Division, FEMA Region VIII, Denver Federal Center, Building 710, Box 25267, Denver, Colorado 80225-0267.

9.0 BIBLIOGRAPHY AND REFERENCES

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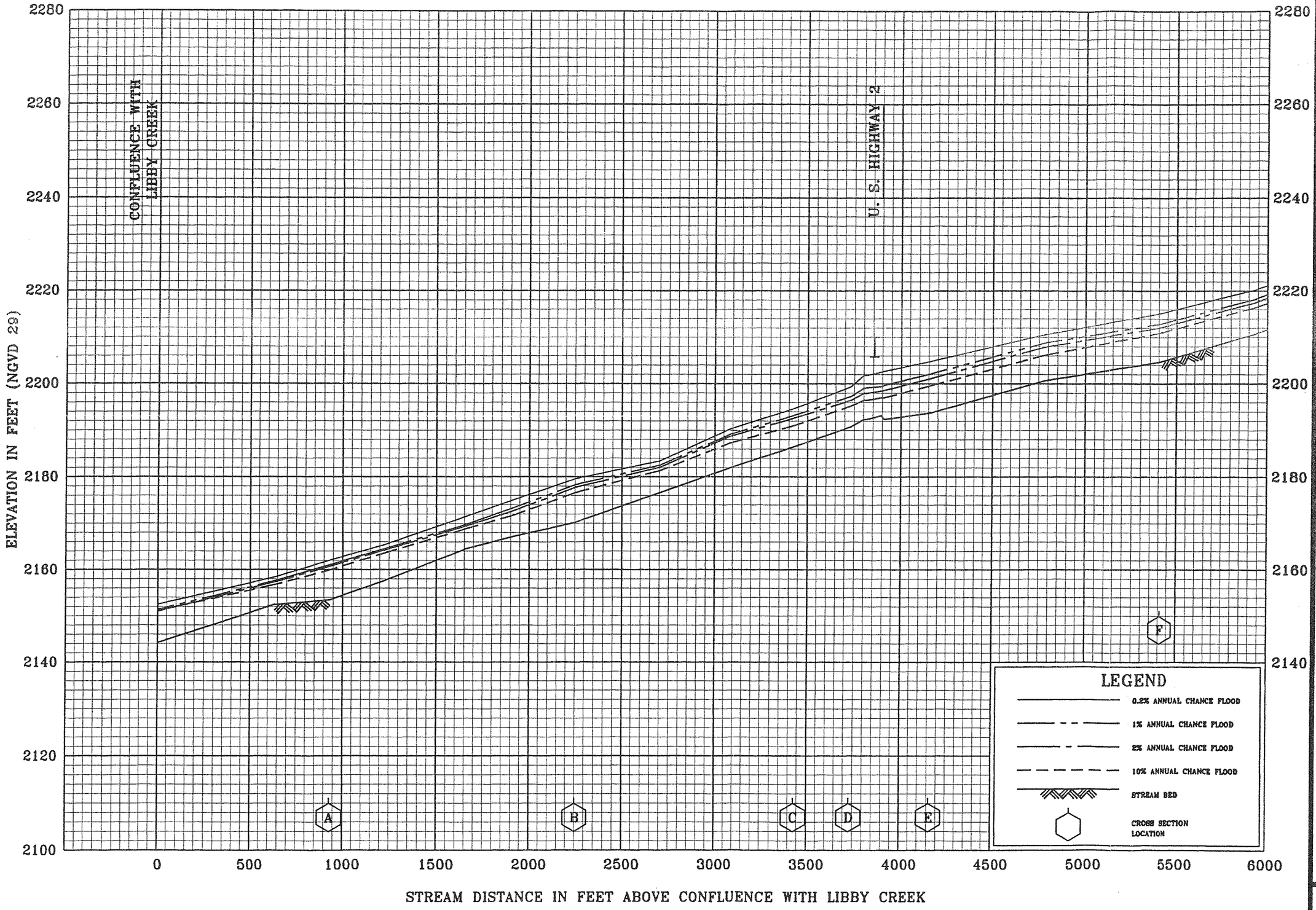


FLOOD PROFILES

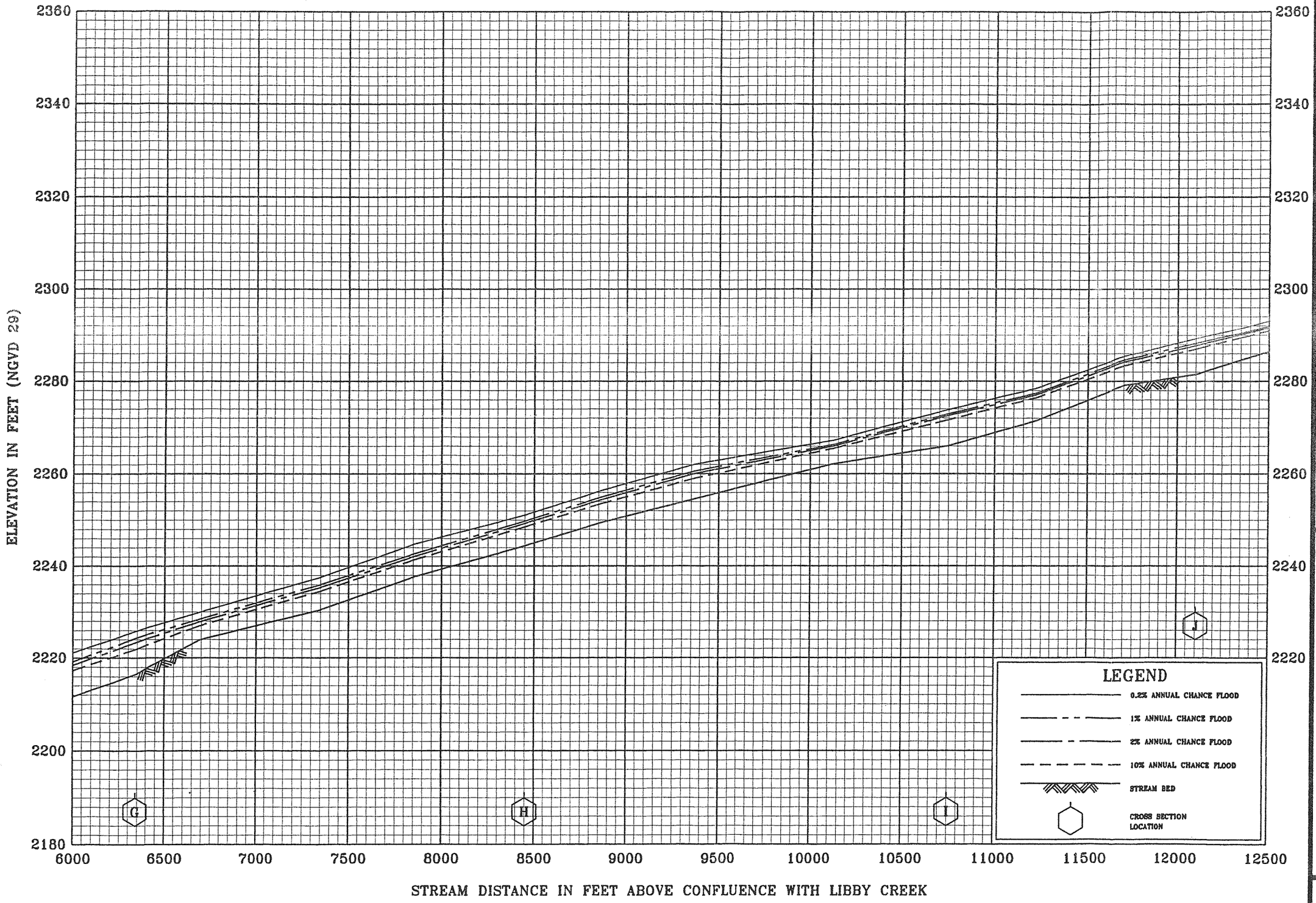
BIG CHERRY CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINCOLN COUNTY, MT

(UNINCORPORATED AREAS)

01P



FLOOD PROFILES

BIG CHERRY CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINCOLN COUNTY, MT

(UNINCORPORATED AREAS)

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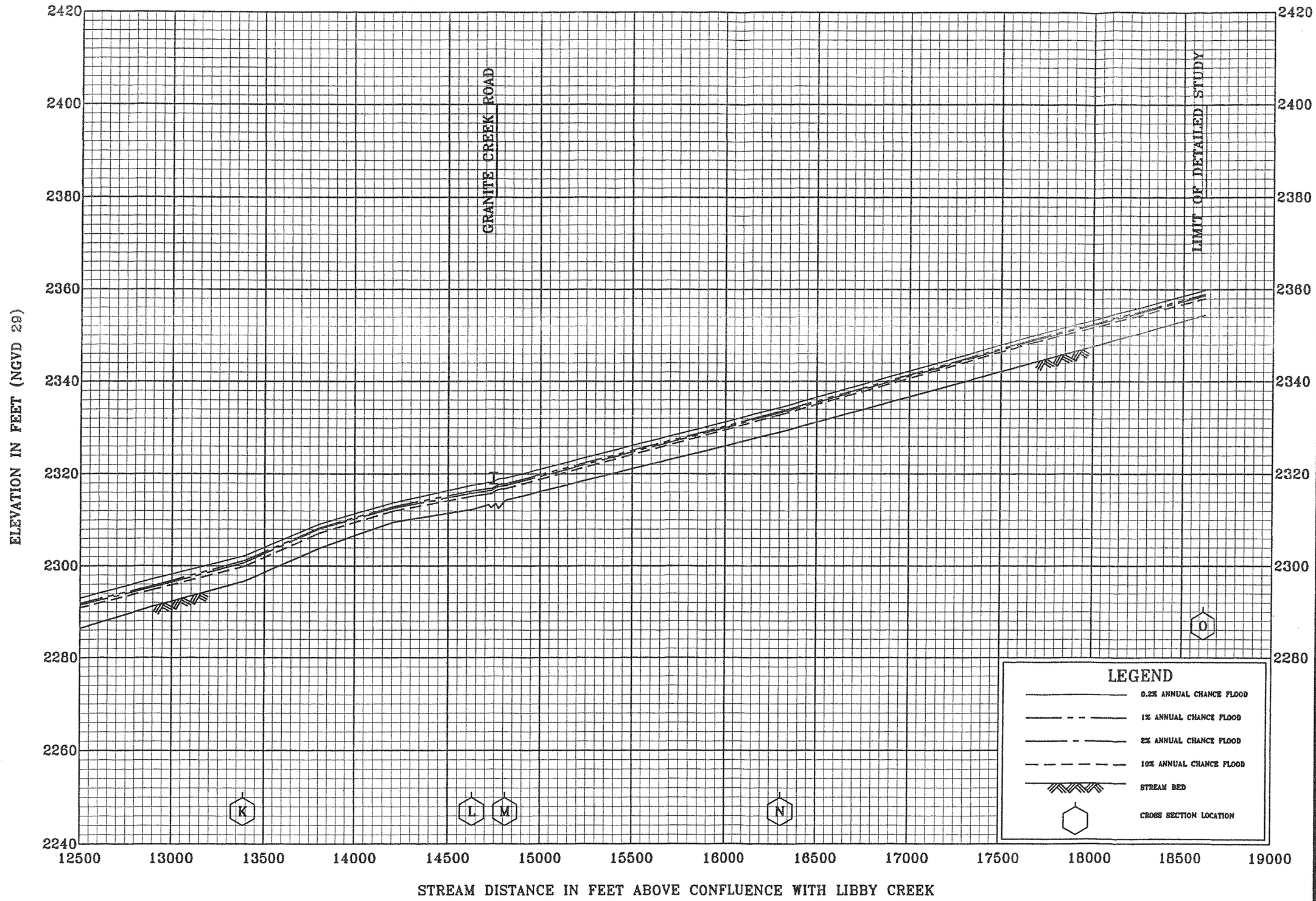

FLOOD PROFILES

BIG CHERRY CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINCOLN COUNTY, MT

(UNINCORPORATED AREAS)

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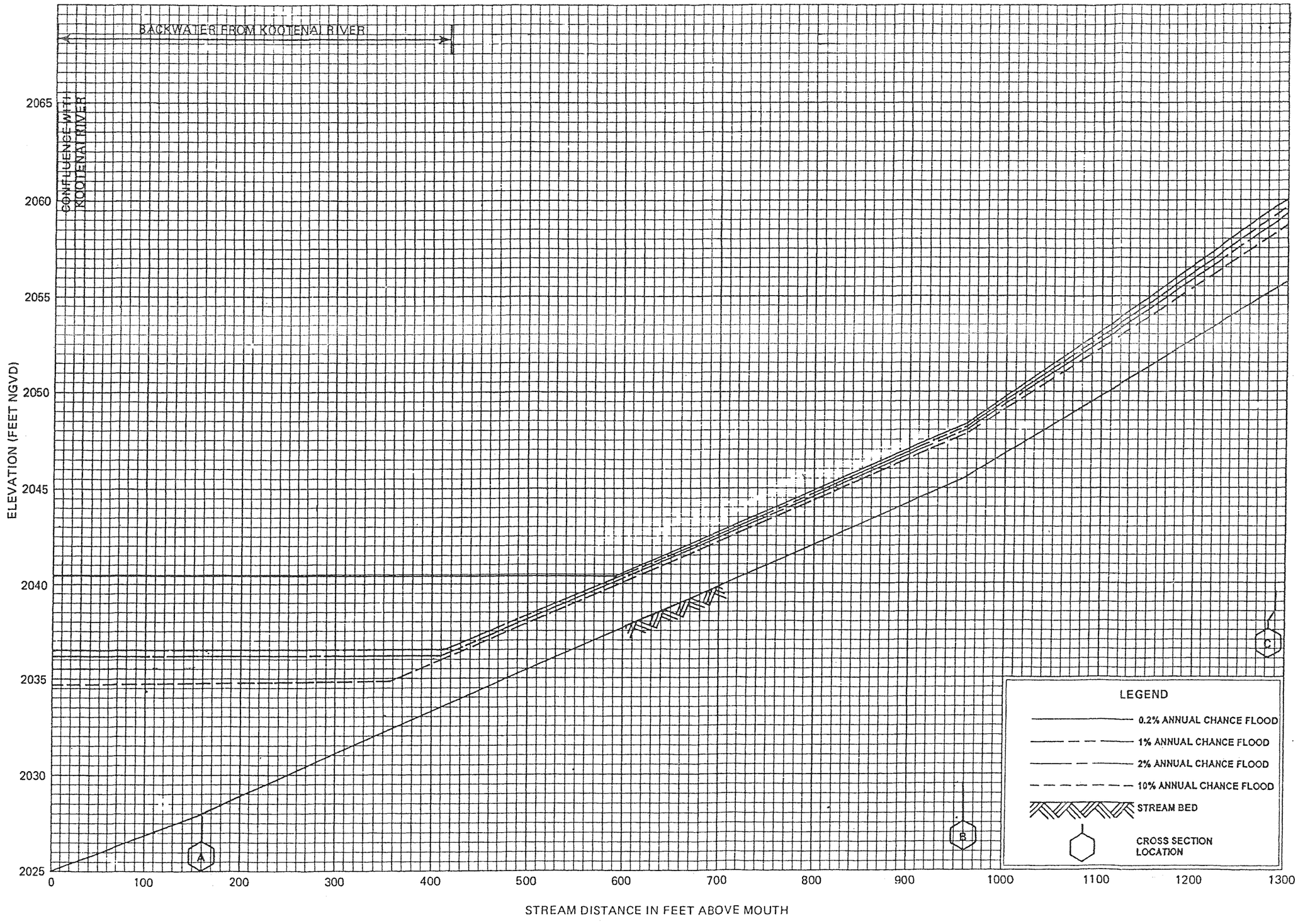


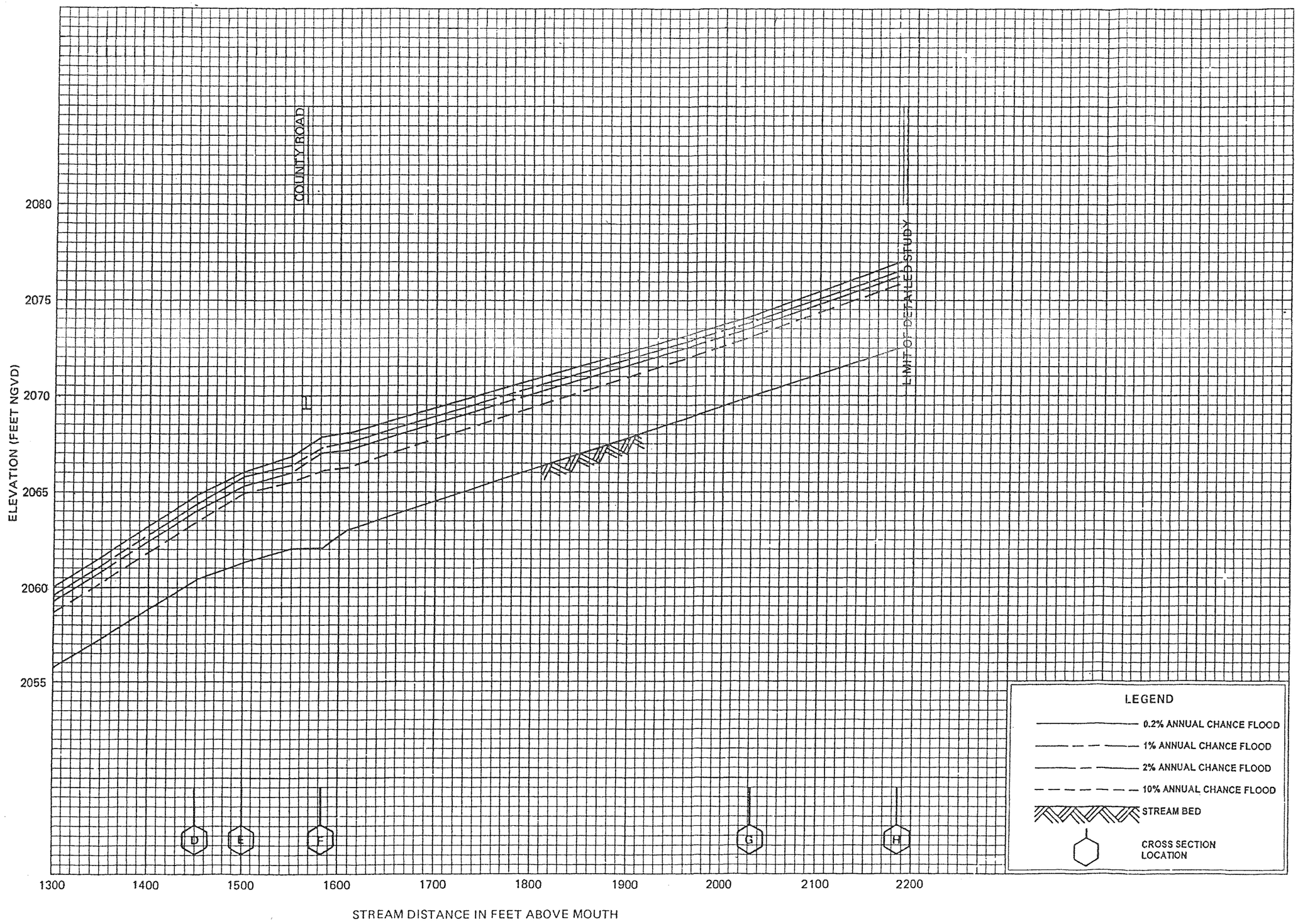
FLOOD PROFILES

BOBTAIL CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINCOLN COUNTY, MT
(UNINCORPORATED AREAS)

04P



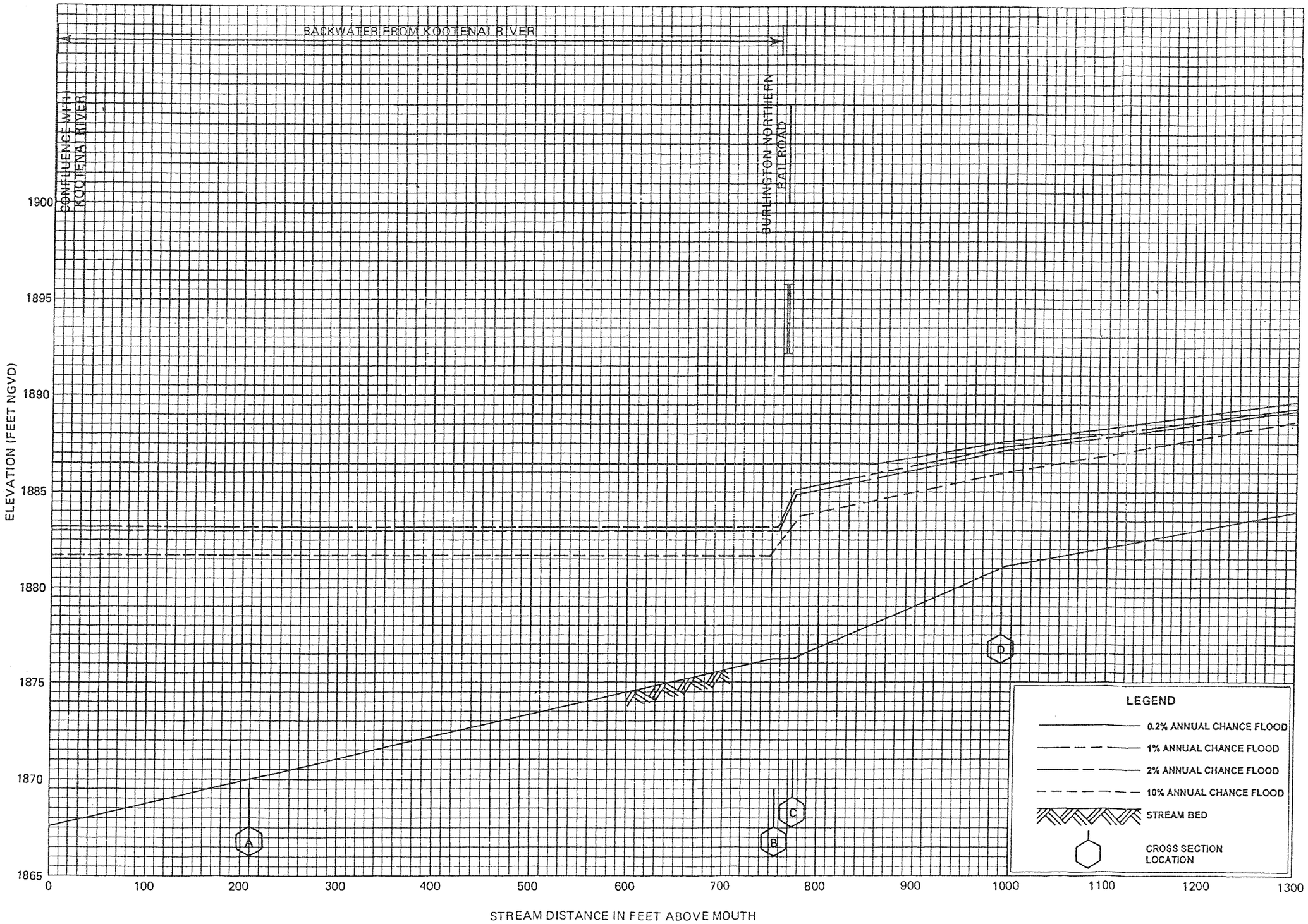
FLOOD PROFILES

BOBTAIL CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINCOLN COUNTY, MT
(UNINCORPORATED AREAS)

05P



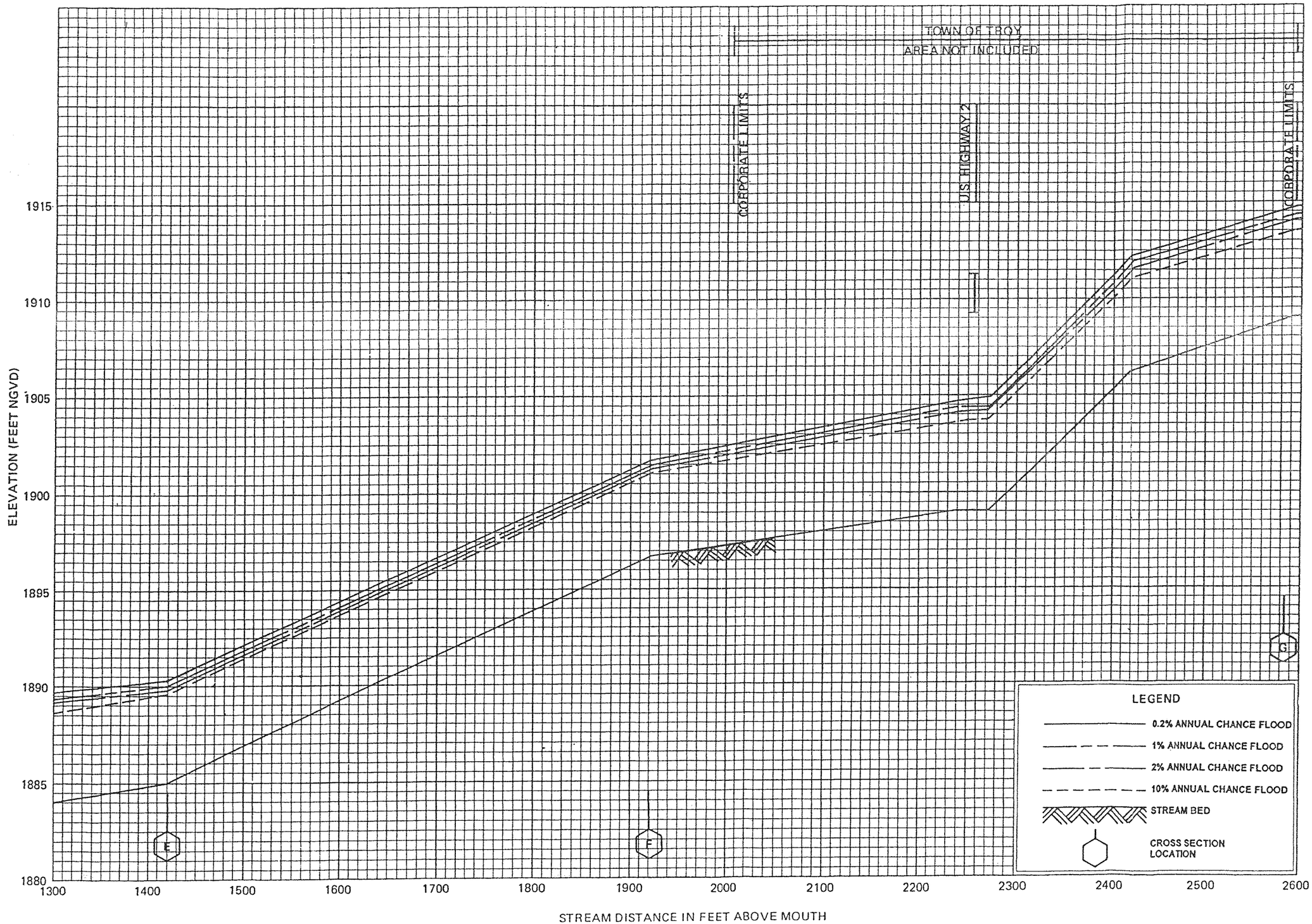
FLOOD PROFILES

CALLAHAN CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINCOLN COUNTY, MT
(UNINCORPORATED AREAS)

06P



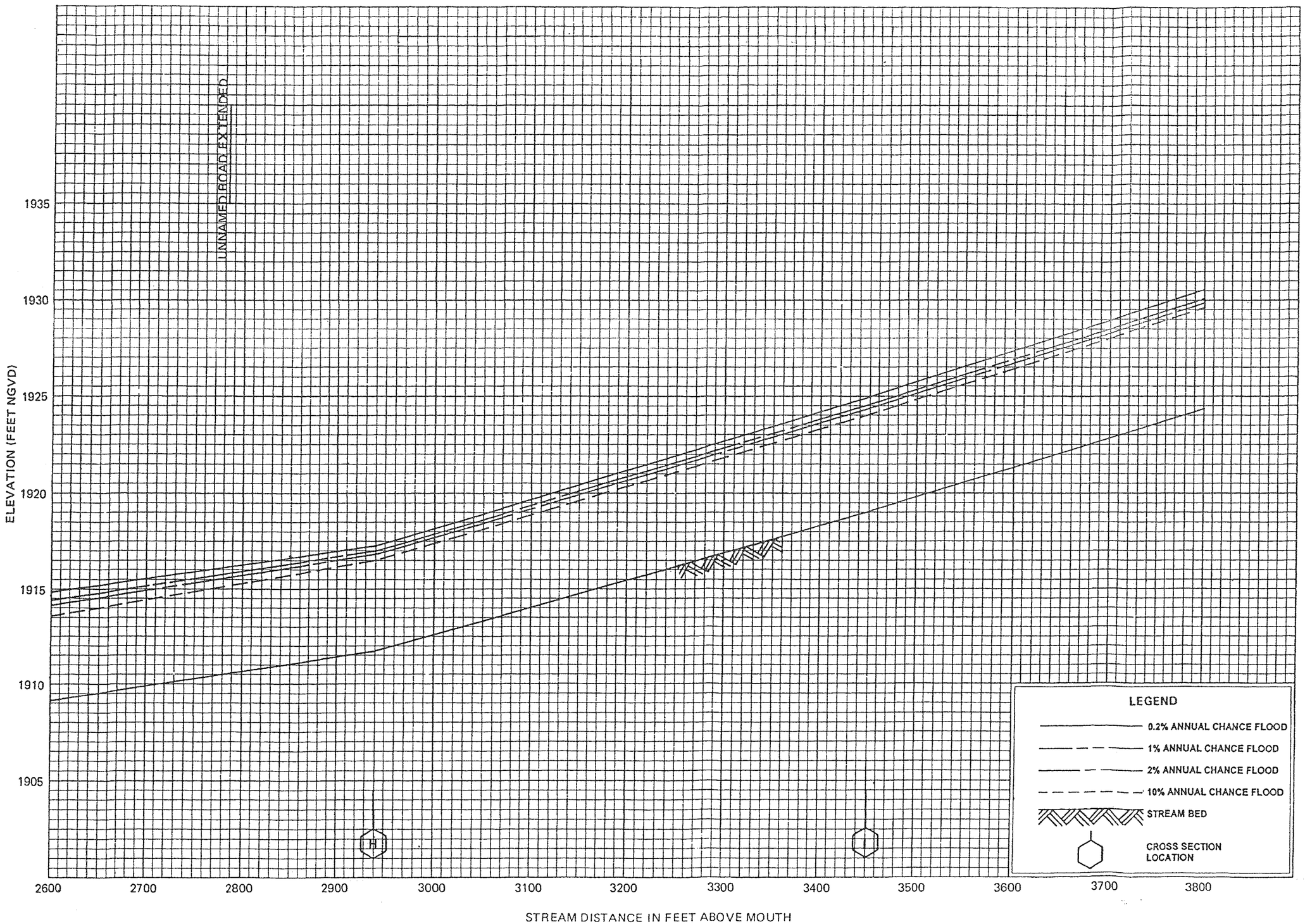
FLOOD PROFILES

CALLAHAN CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINCOLN COUNTY, MT
(UNINCORPORATED AREAS)

07P



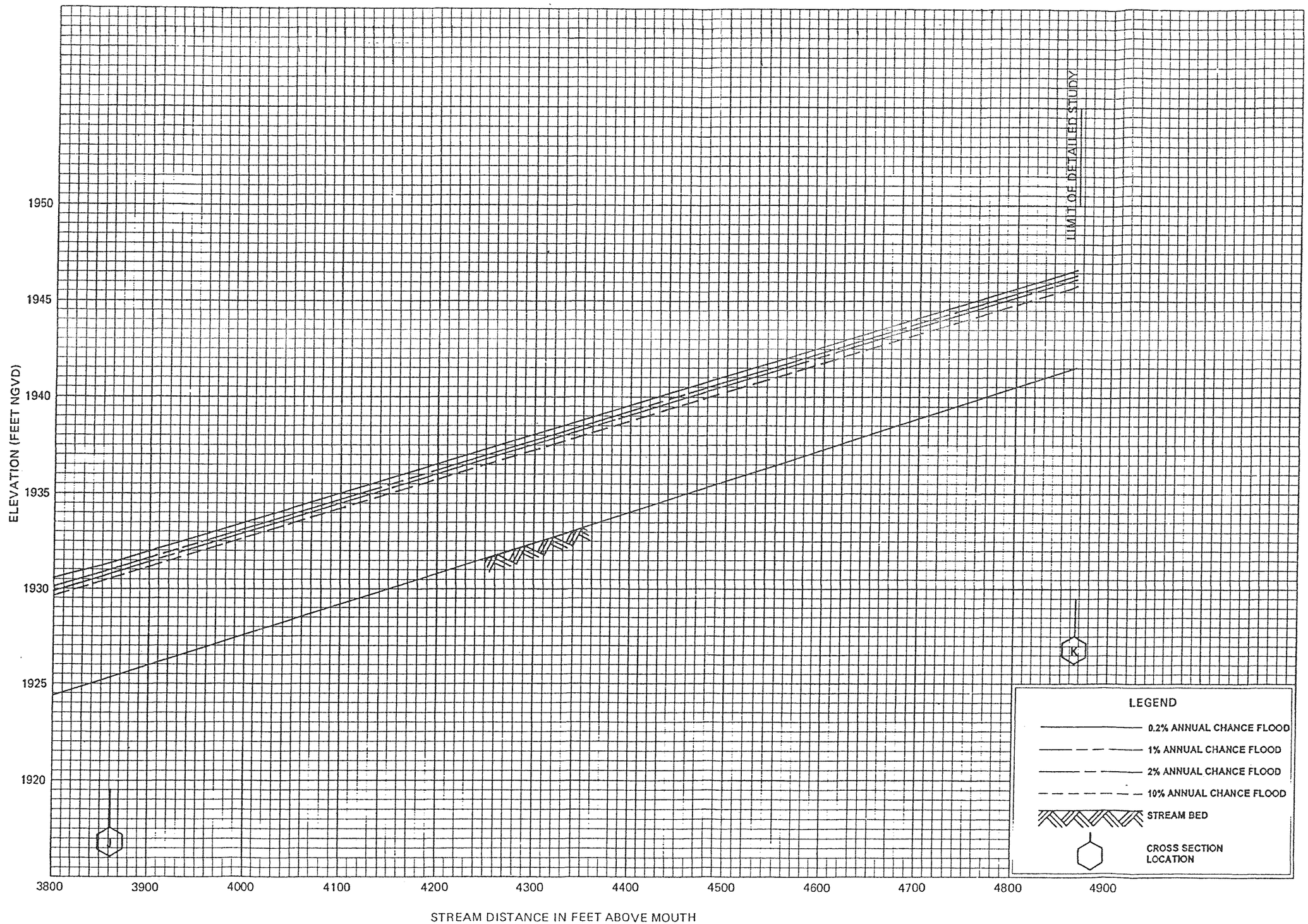
FLOOD PROFILES

CALLAHAN CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINCOLN COUNTY, MT
(UNINCORPORATED AREAS)

08P



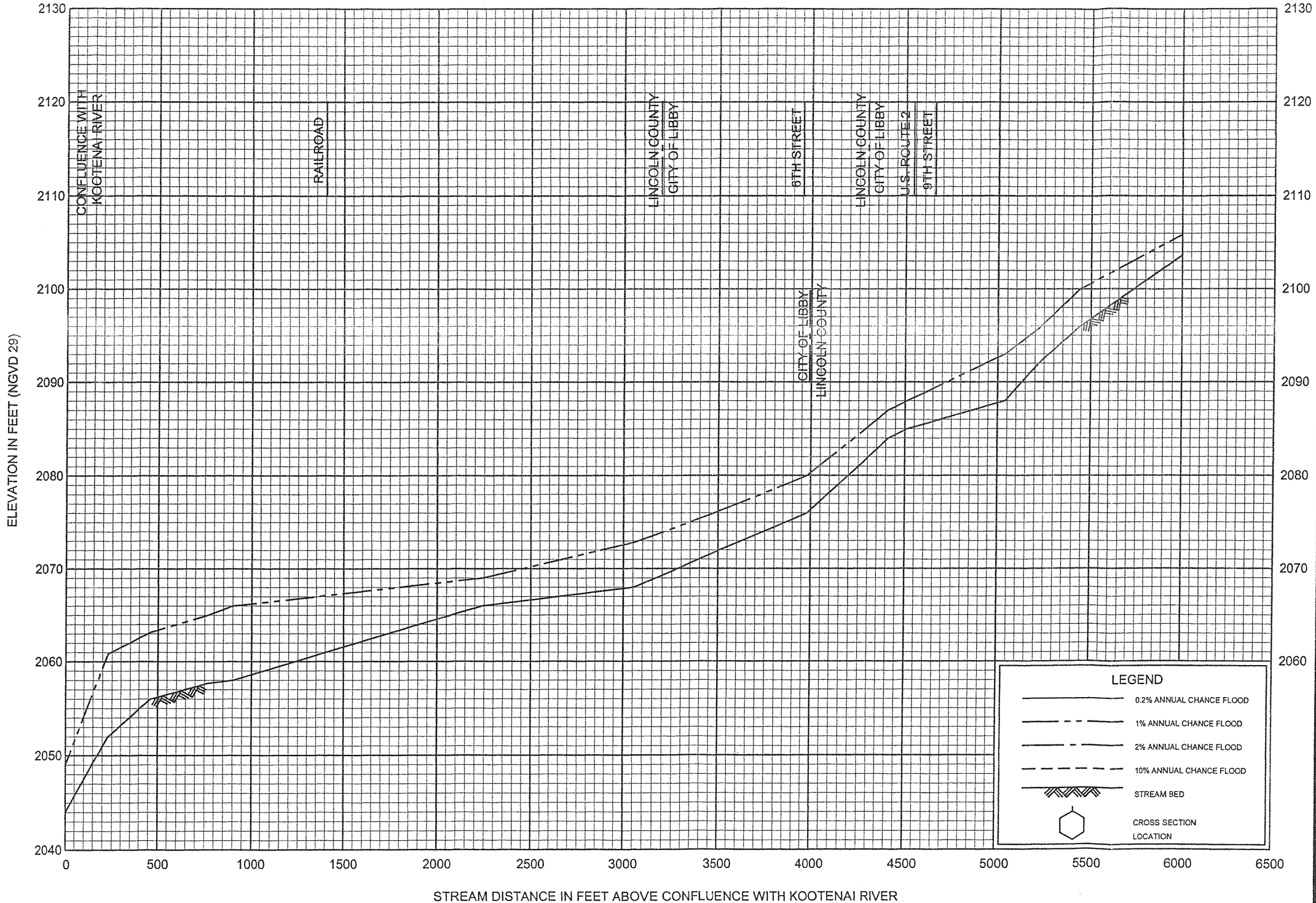
FLOOD PROFILES

CALLAHAN CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINCOLN COUNTY, MT
(UNINCORPORATED AREAS)

09P



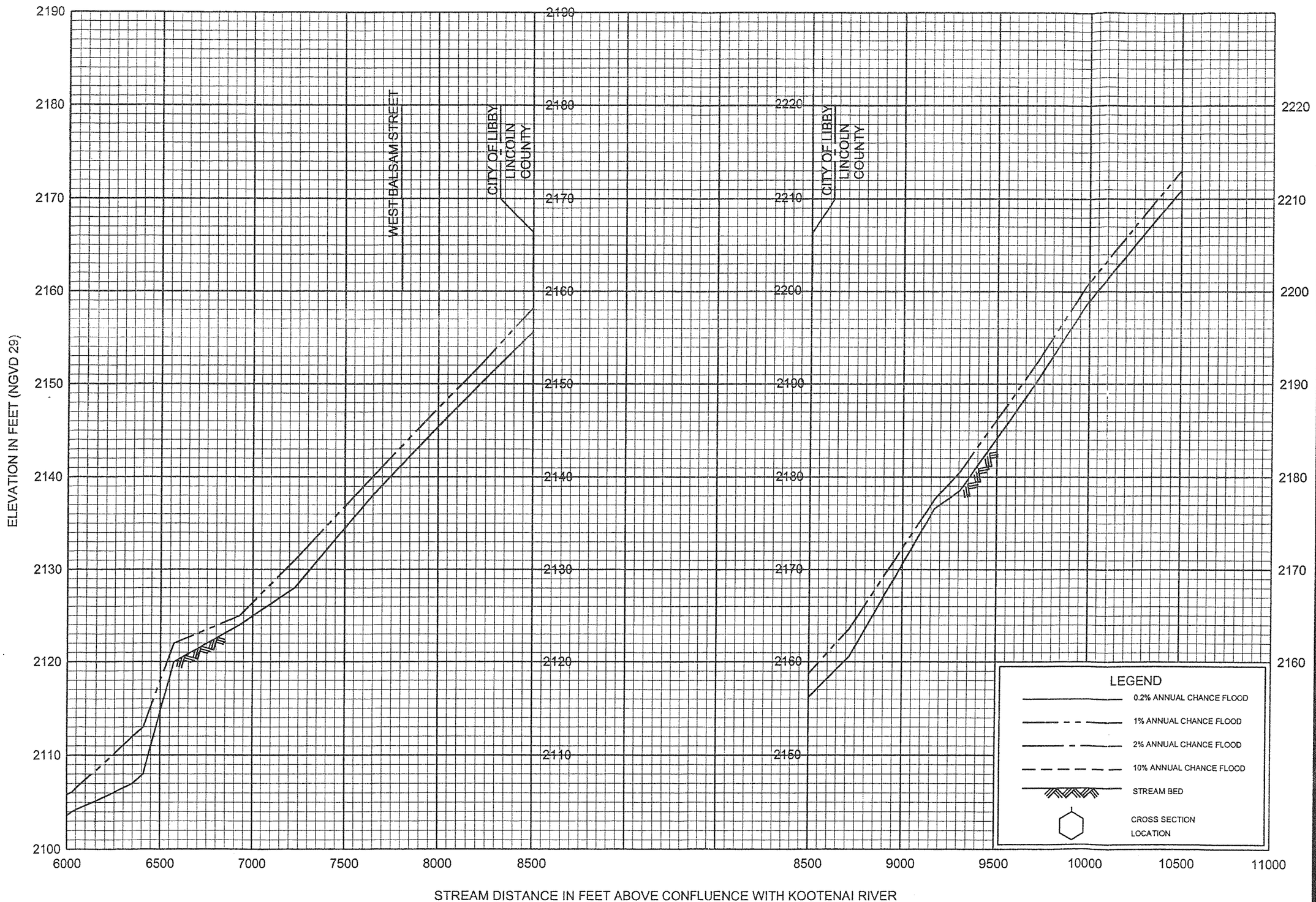
FLOOD PROFILES

FLOWER CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINCOLN COUNTY, MT

(UNINCORPORATED AREAS)



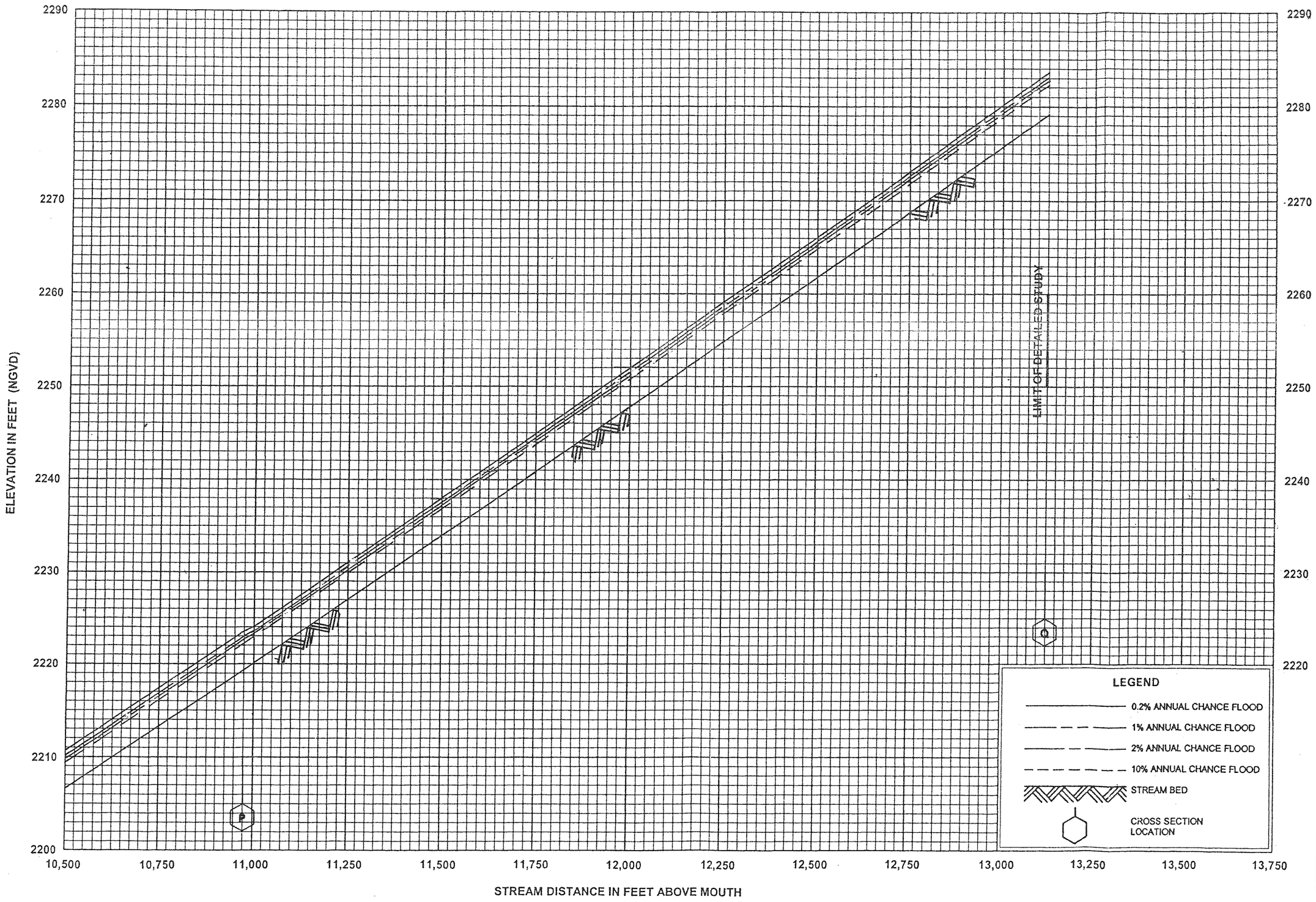
FLOOD PROFILES

FLOWER CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINCOLN COUNTY, MT

(UNINCORPORATED AREAS)

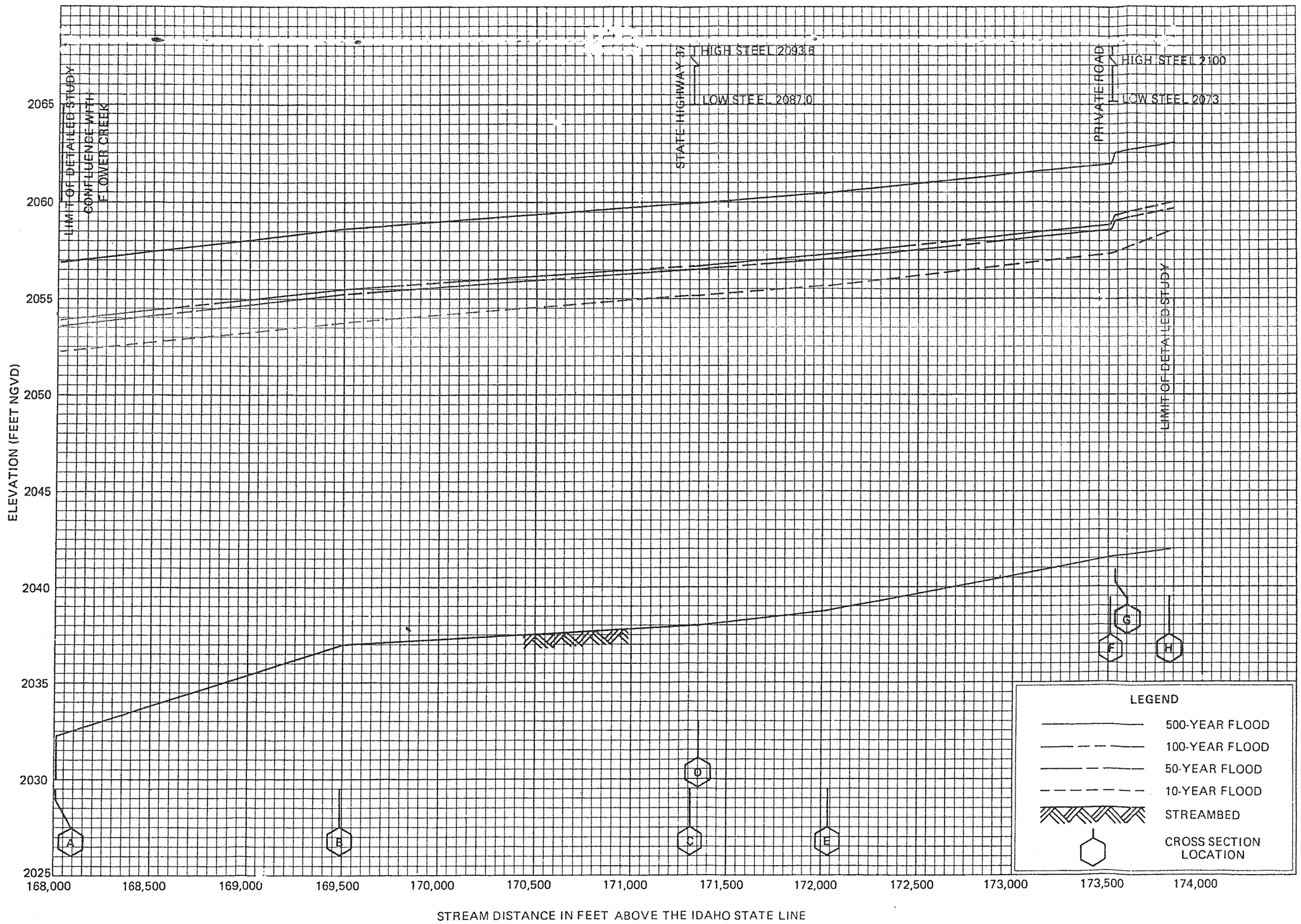


FLOOD PROFILES

FLOWER CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINCOLN COUNTY, MT
(UNINCORPORATED AREAS)

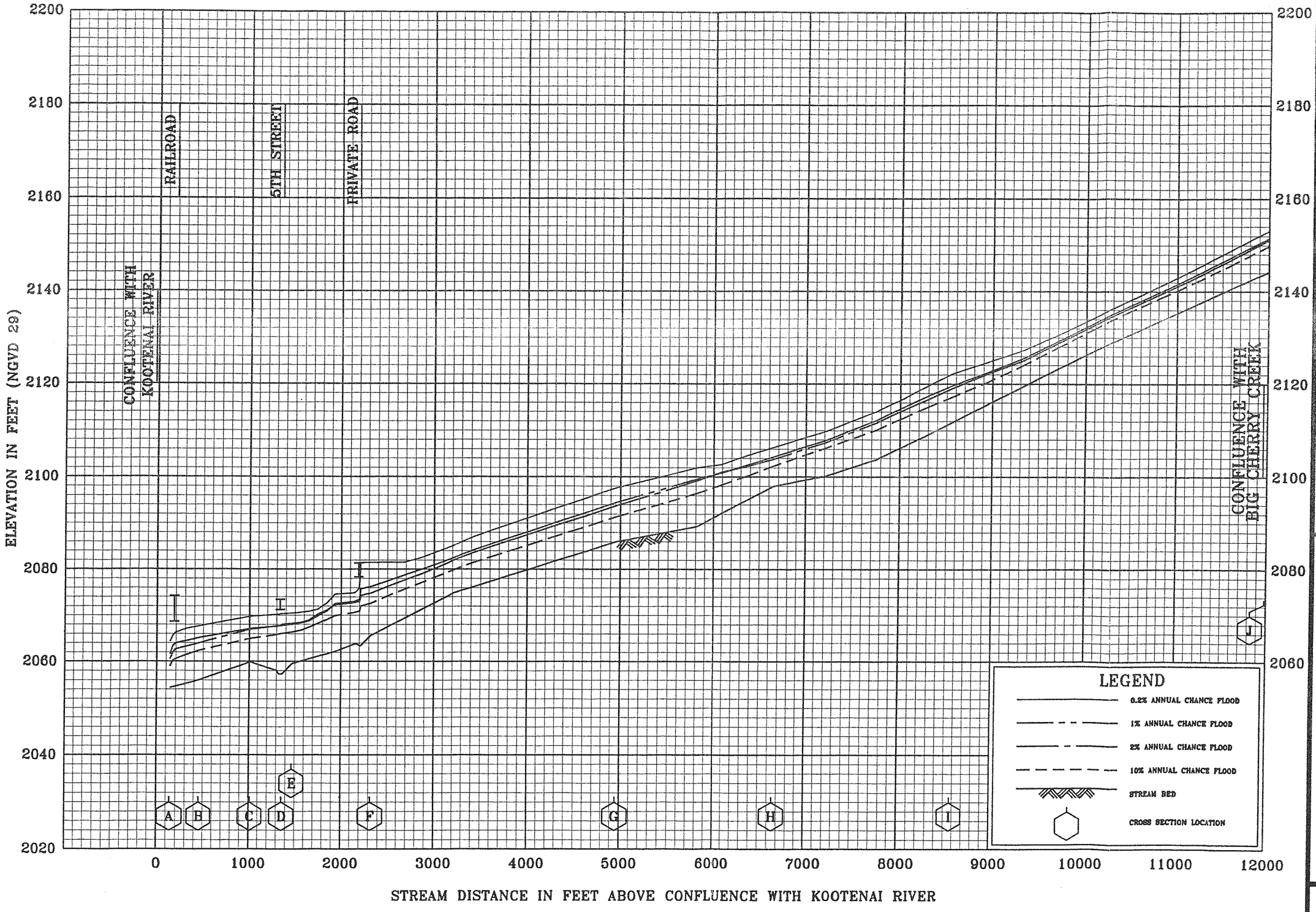


FLOOD PROFILES

KOOTENAI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINCOLN COUNTY, MT
(UNINCORPORATED AREAS)



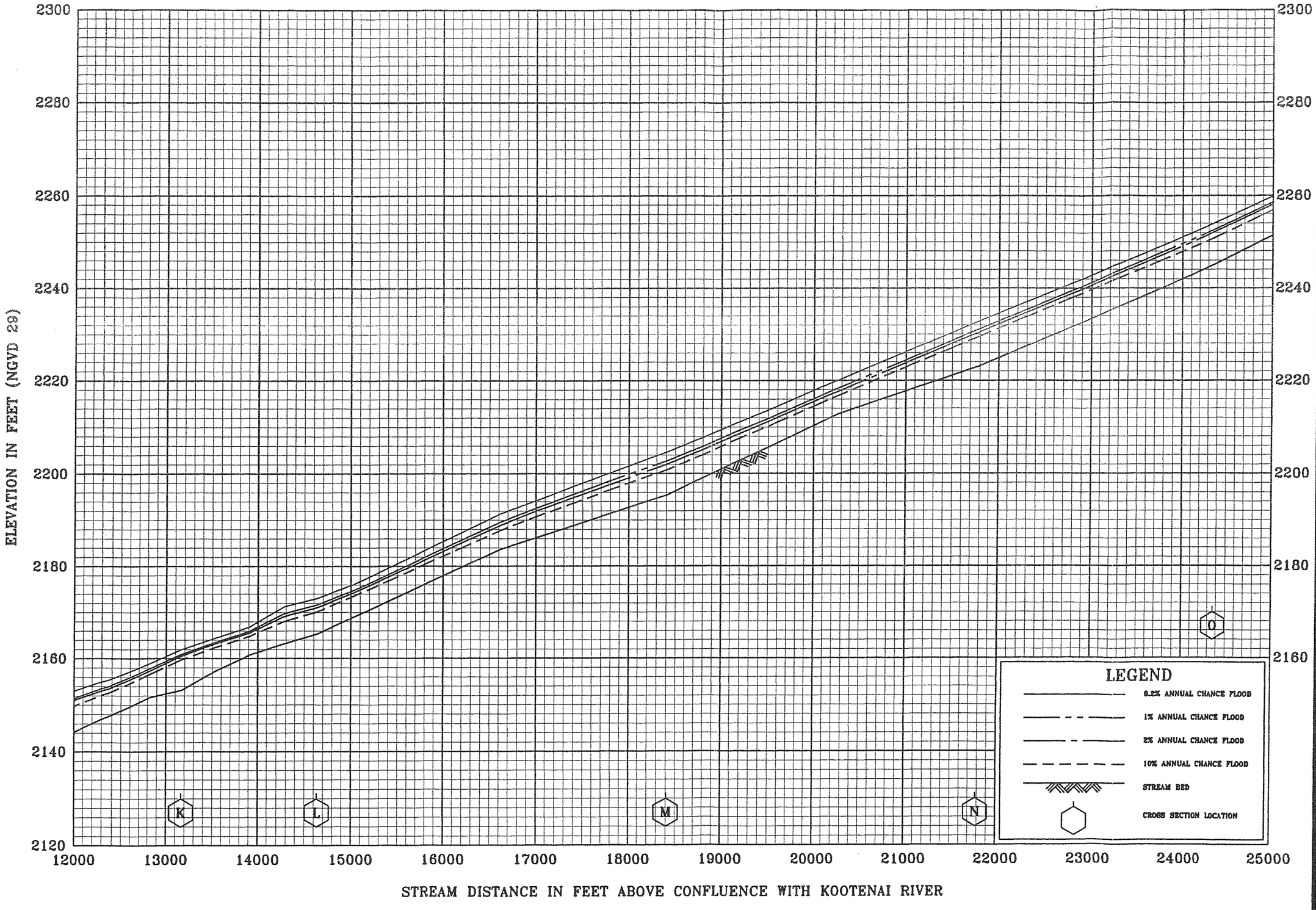
FLOOD PROFILES

LIBBY CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINCOLN COUNTY, MT

(UNINCORPORATED AREAS)



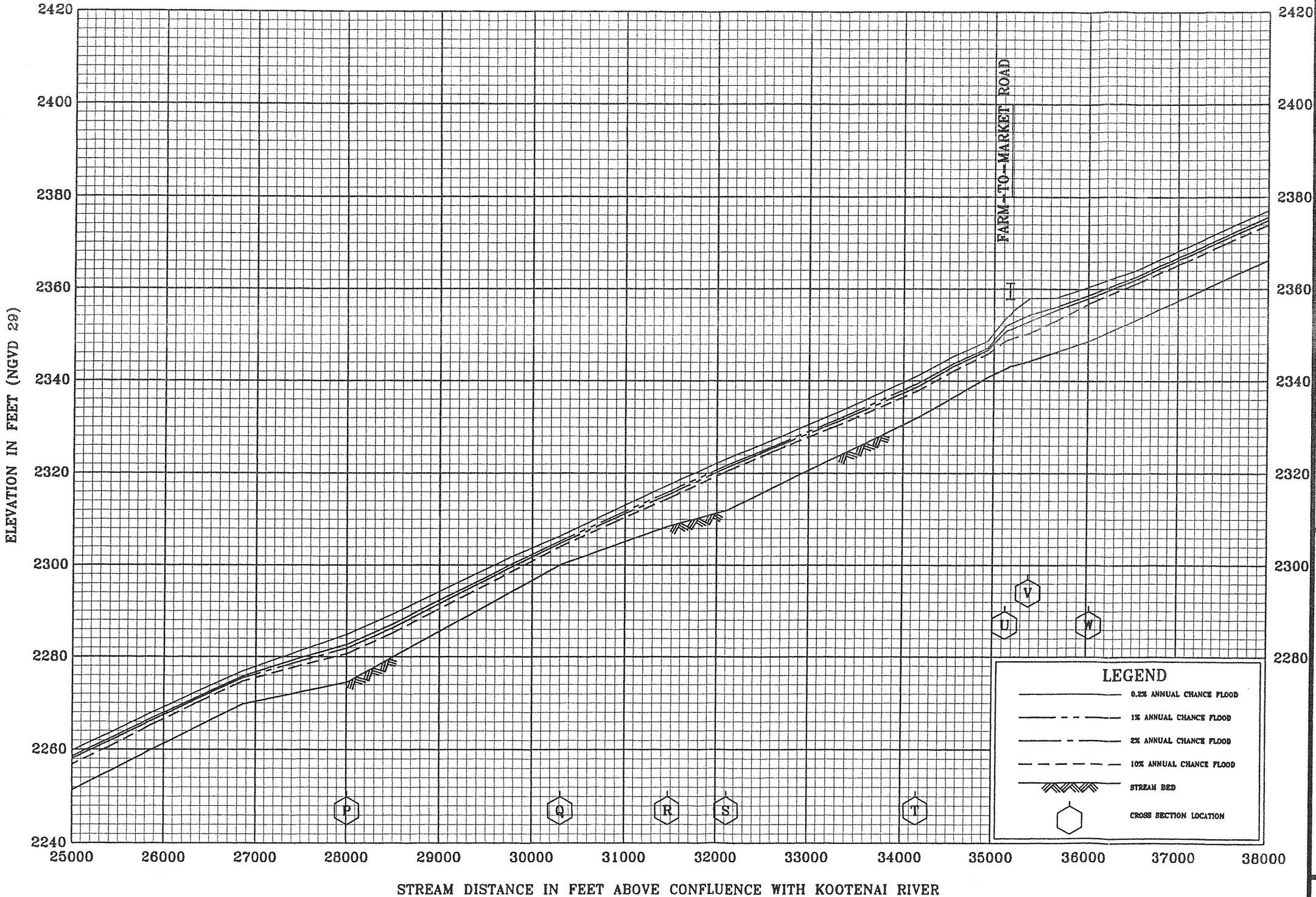
FLOOD PROFILES

LIBBY CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINCOLN COUNTY, MT

(UNINCORPORATED AREAS)



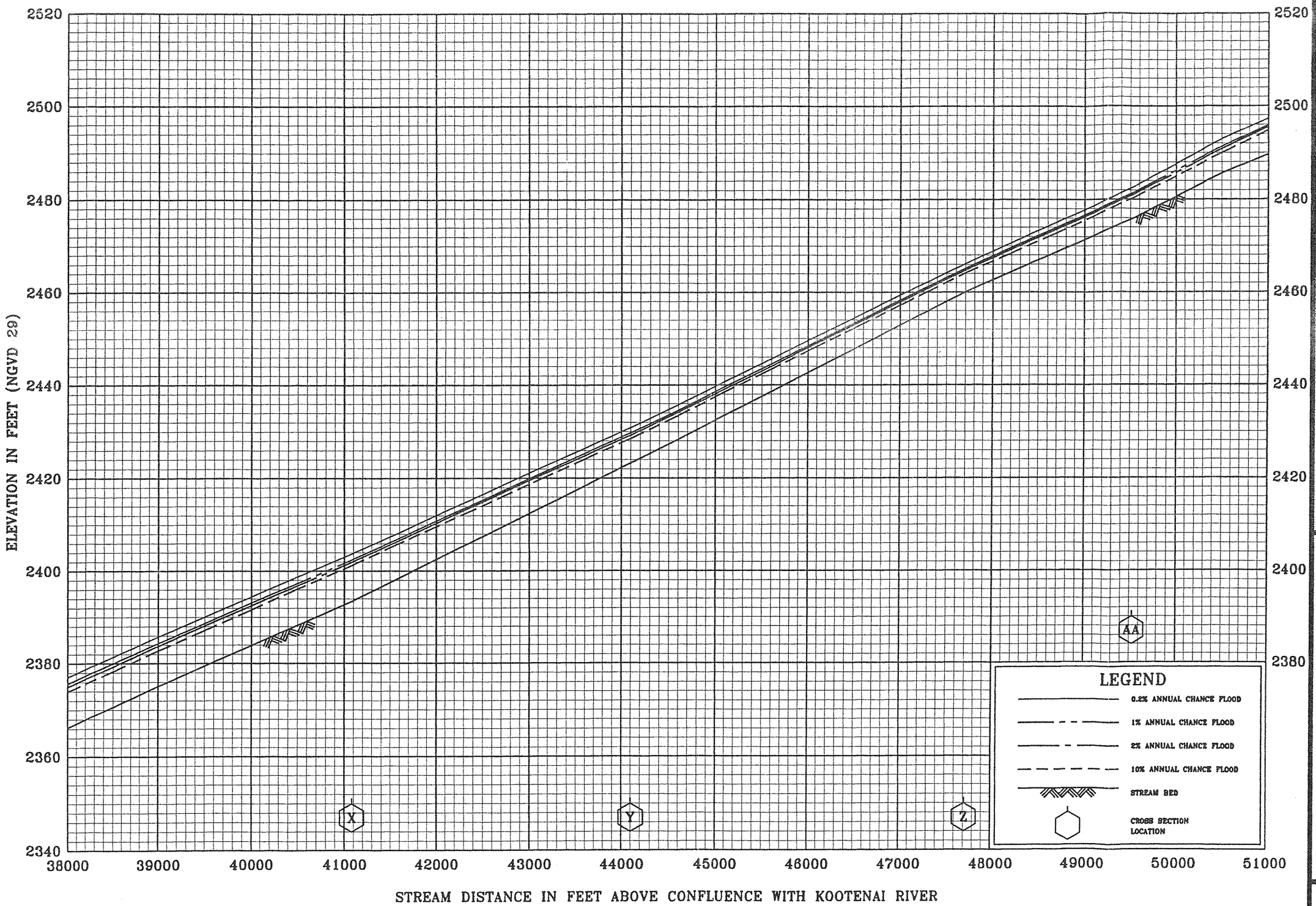
FLOOD PROFILES

LIBBY CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINCOLN COUNTY, MT

(UNINCORPORATED AREAS)



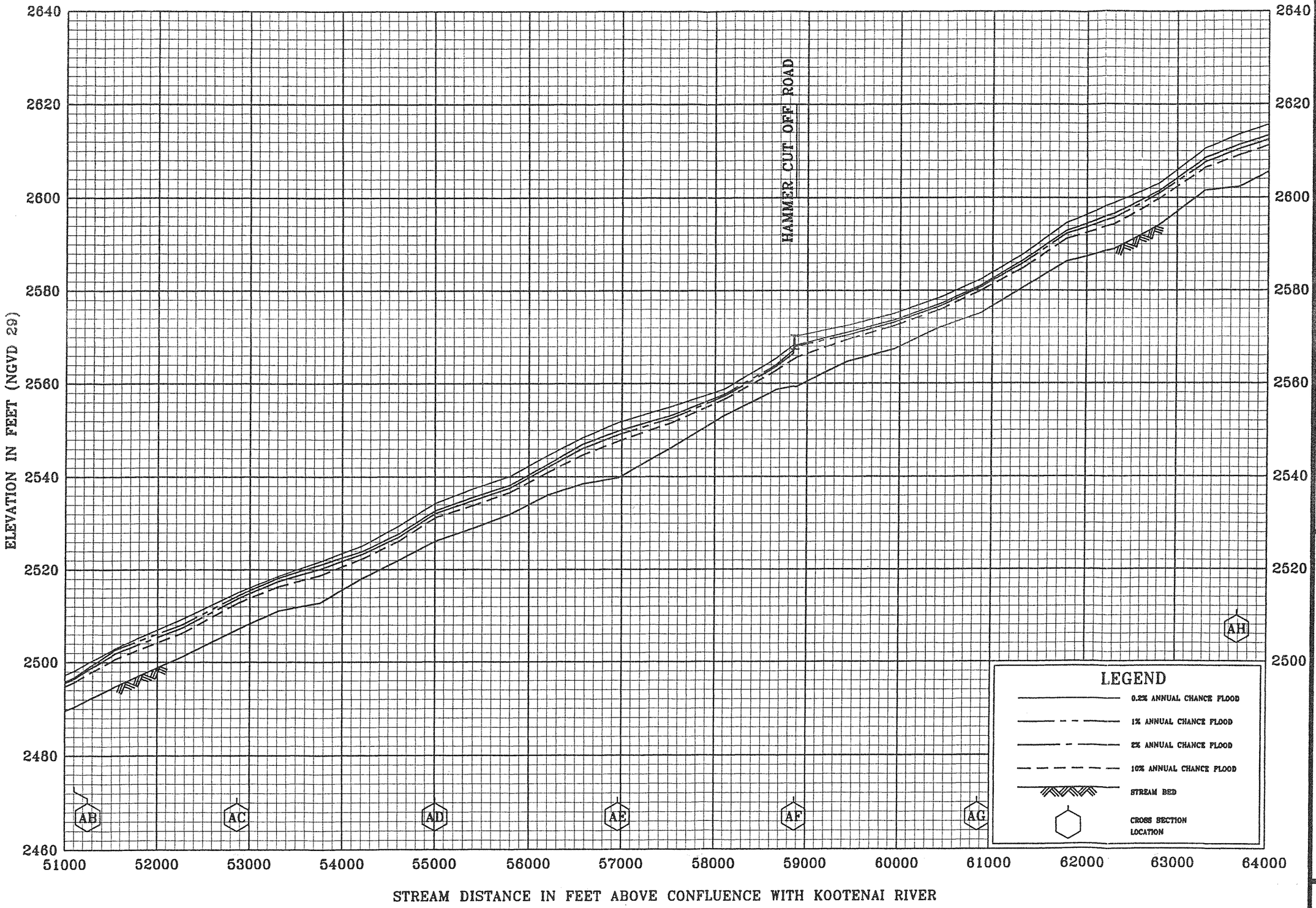
FLOOD PROFILES

LIBBY CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINCOLN COUNTY, MT

(UNINCORPORATED AREAS)



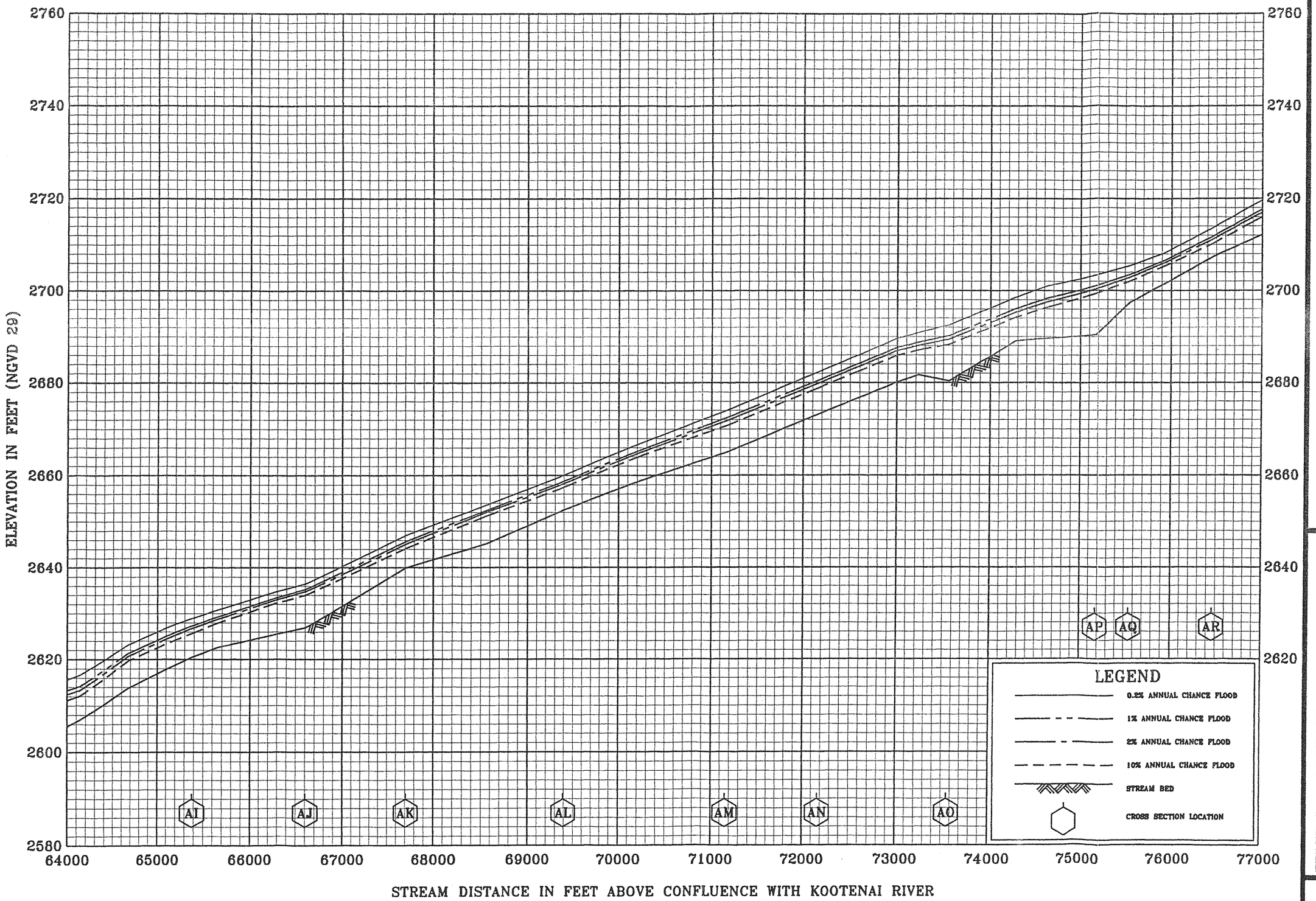
FLOOD PROFILES

LIBBY CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINCOLN COUNTY, MT

(UNINCORPORATED AREAS)



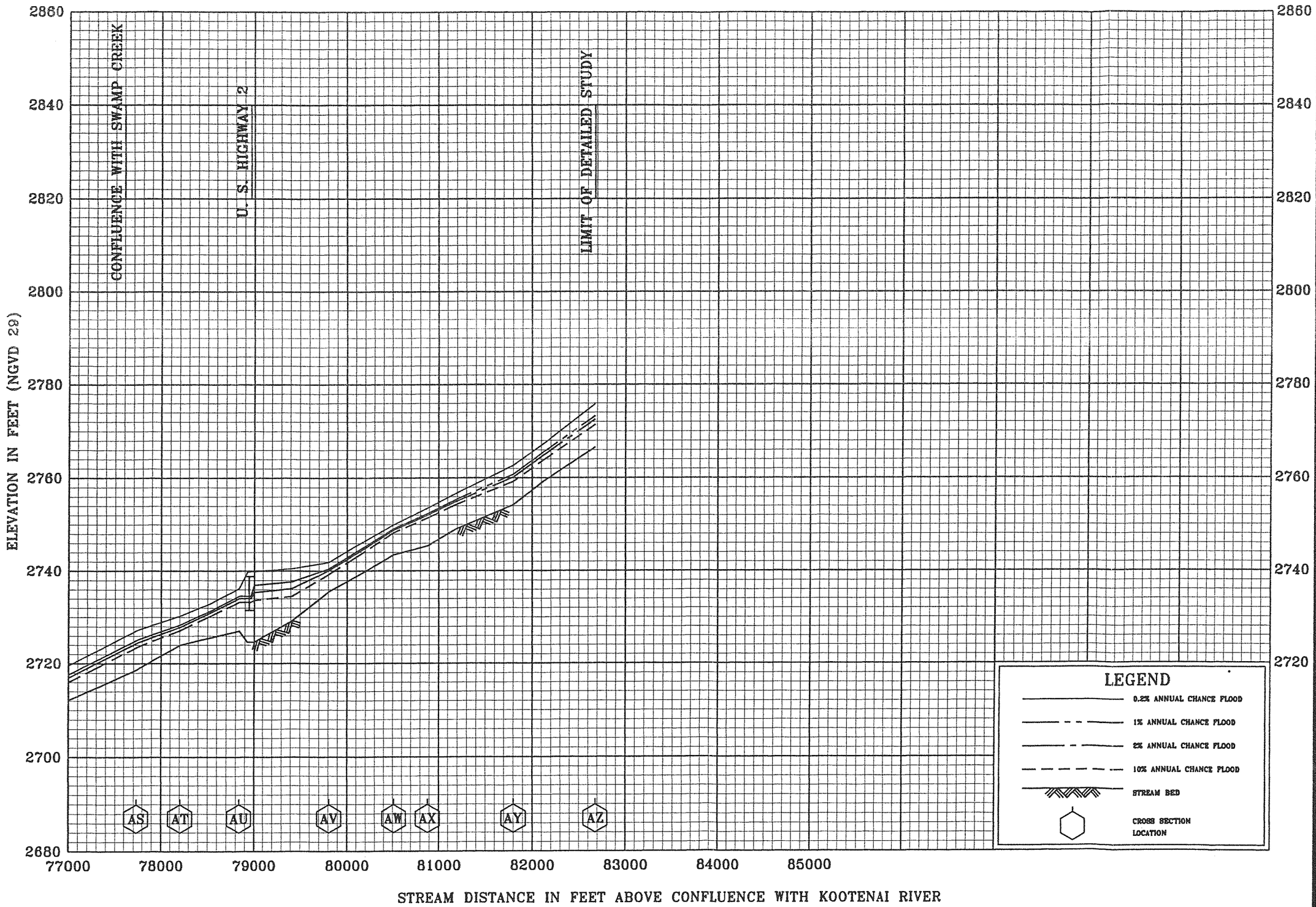
FLOOD PROFILES

LIBBY CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINCOLN COUNTY, MT

(UNINCORPORATED AREAS)



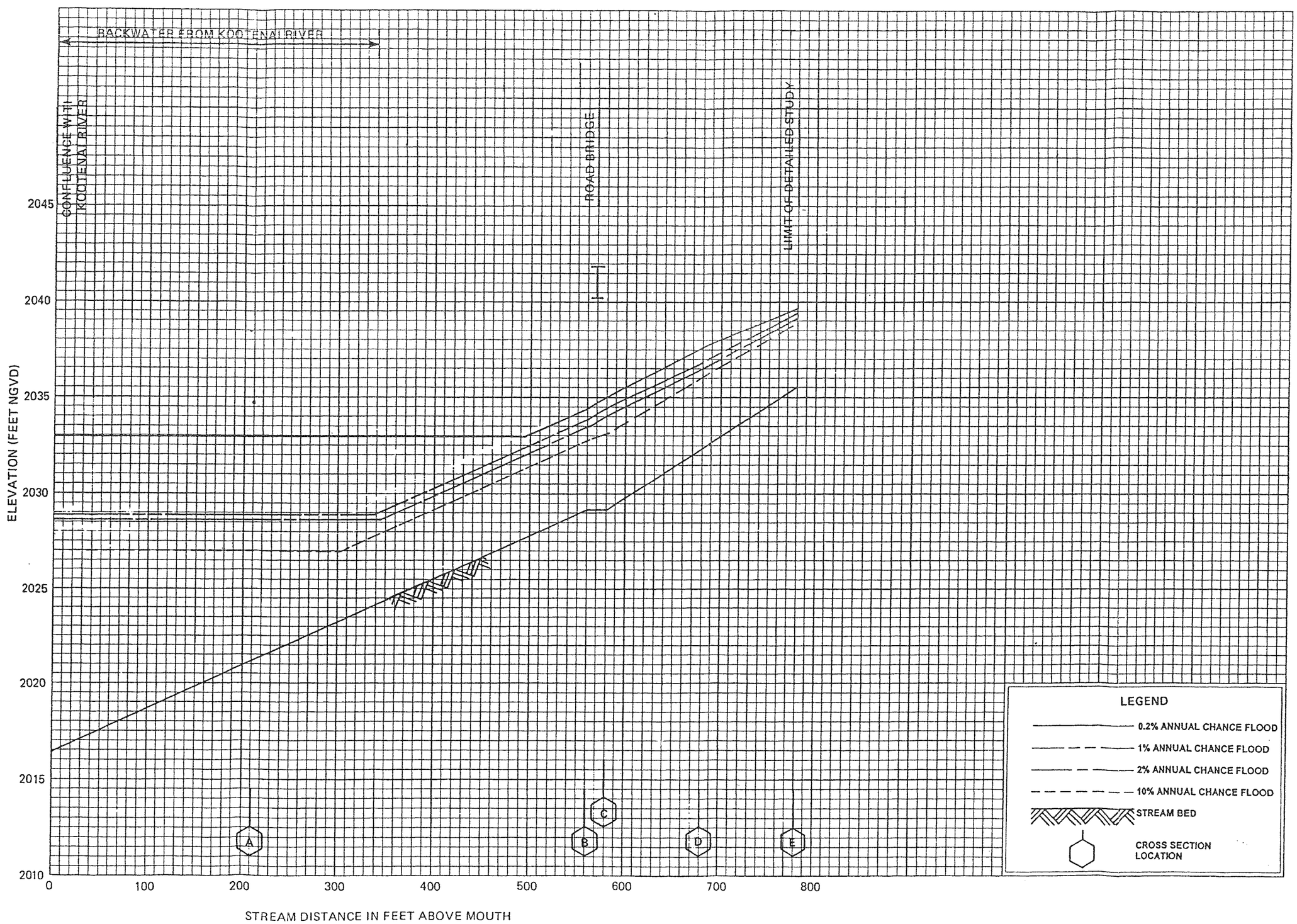
FLOOD PROFILES

LIBBY CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINCOLN COUNTY, MT

(UNINCORPORATED AREAS)

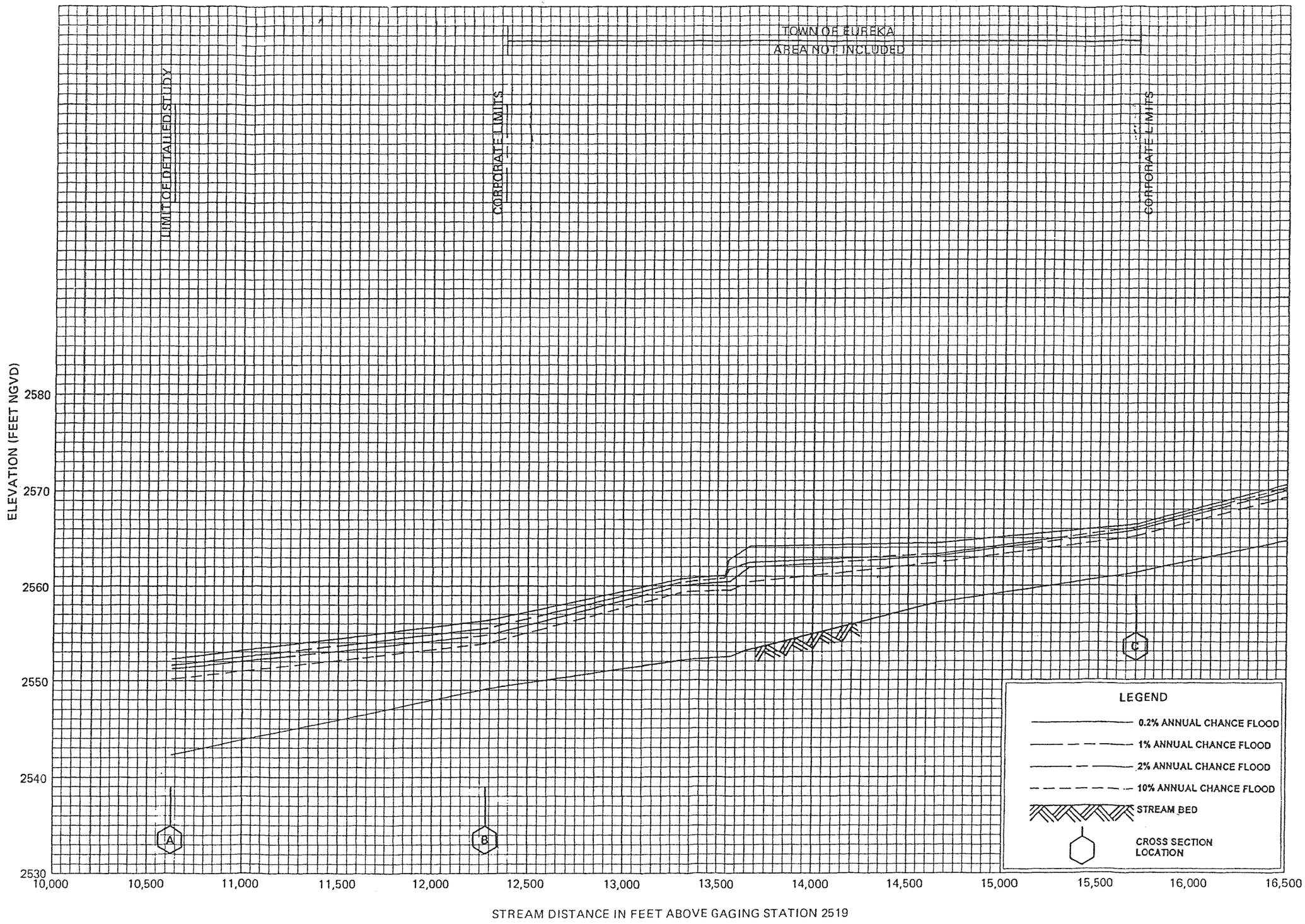


FLOOD PROFILES

QUARTZ CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINCOLN COUNTY, MT
(UNINCORPORATED AREAS)

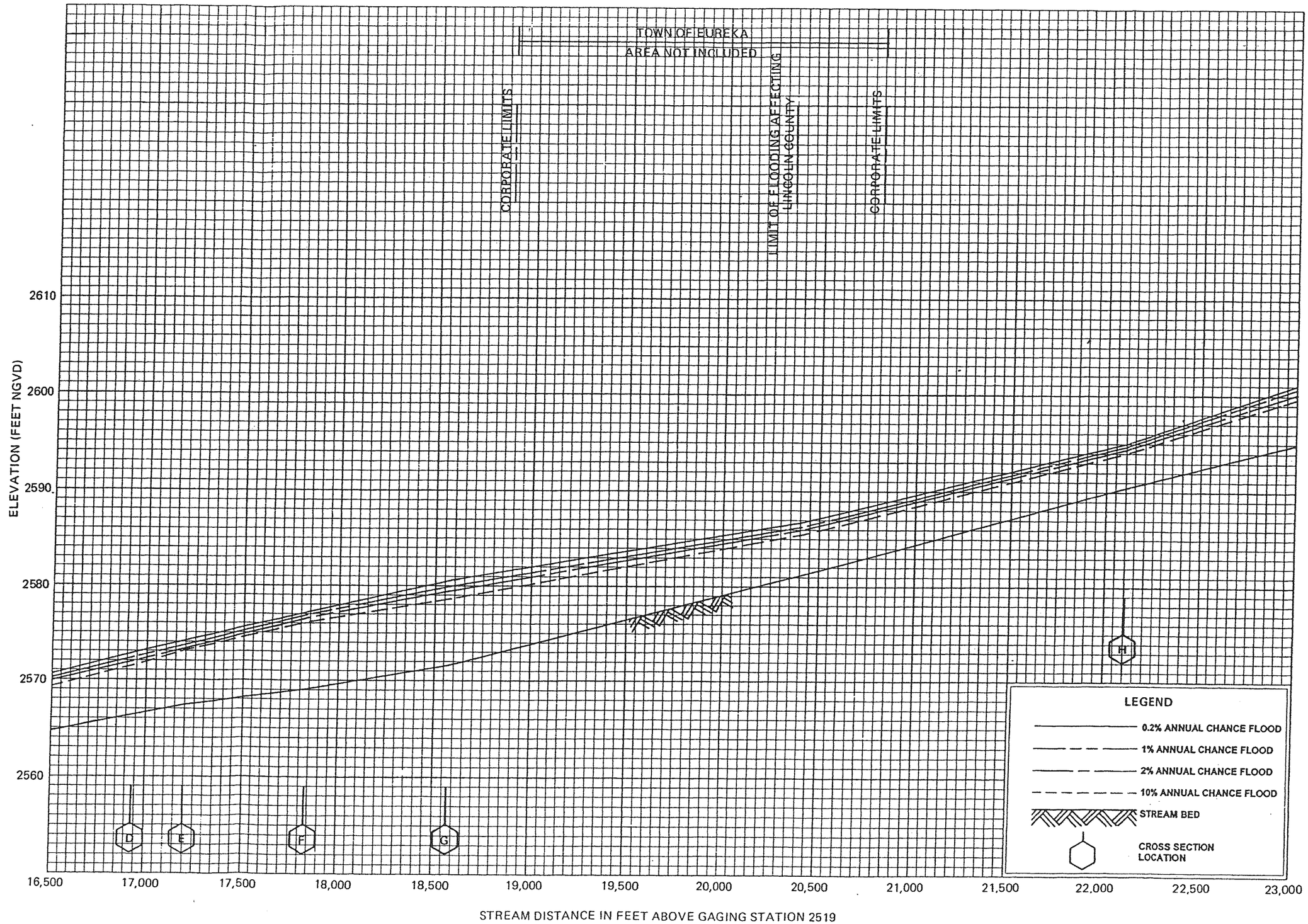


FLOOD PROFILES

TOBACCO RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINCOLN COUNTY, MT
(UNINCORPORATED AREAS)

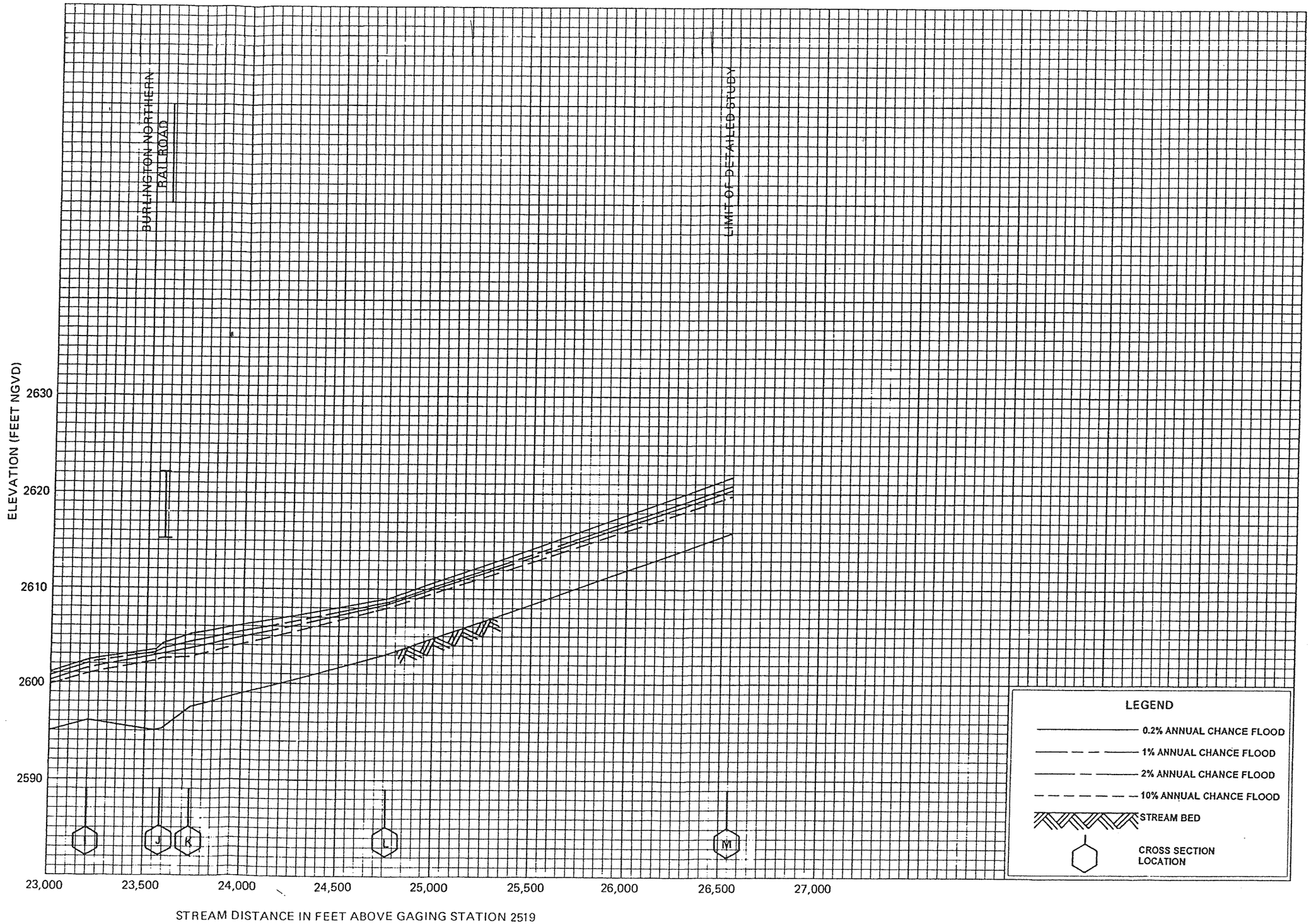


FLOOD PROFILES

TOBACCO RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINCOLN COUNTY, MT
(UNINCORPORATED AREAS)

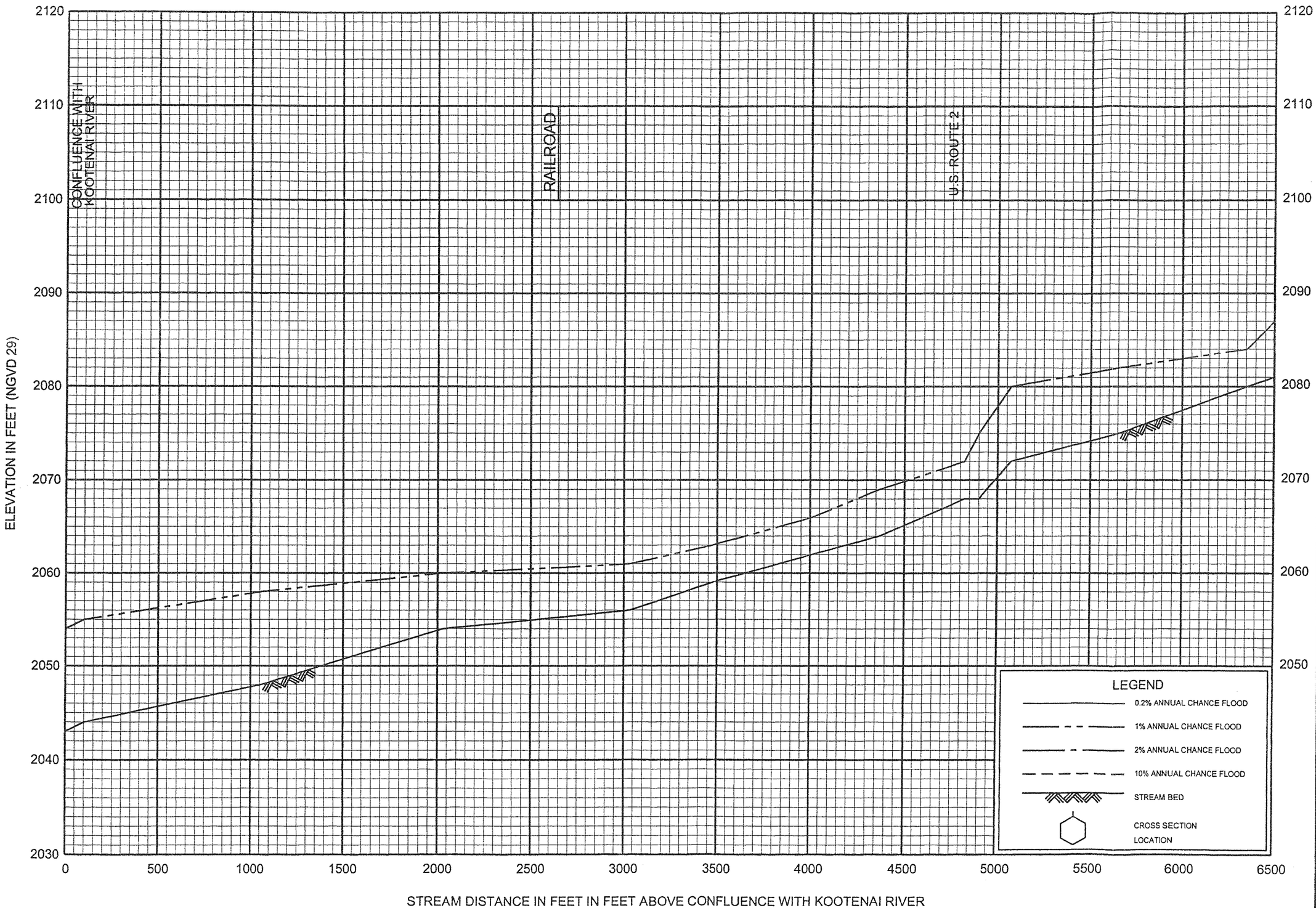


FLOOD PROFILES

TOBACCO RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINCOLN COUNTY, MT
(UNINCORPORATED AREAS)



FLOOD PROFILES

PARMENTER CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

LINCOLN COUNTY, MT

(UNINCORPORATED AREAS)