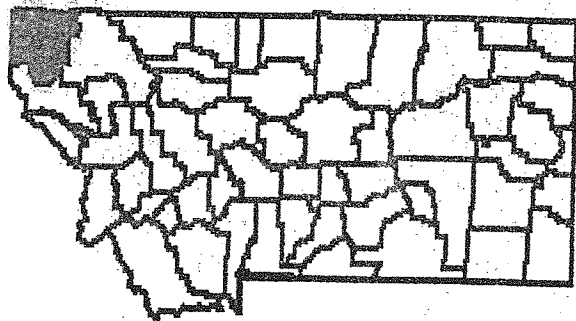


FLOOD INSURANCE STUDY



**CITY OF LIBBY,
MONTANA
LINCOLN COUNTY**



REVISED:
SEPTEMBER 29, 2006



Federal Emergency Management Agency
FLOOD INSURANCE STUDY NUMBER
300042V000A

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.

Selected Flood Insurance Rate Map panels for the community contain information that was previously shown separately on the corresponding Flood Boundary and Floodway Map panels (e.g., floodways, cross sections). In addition, former flood hazard zone designations have been changed as follows:

| <u>Old Zone</u> | <u>New Zone</u> |
|-----------------|-----------------|
| A1 through A30 | AE |
| V1 through V30 | VE |
| B | X |
| C | X |

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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Published Separately:

Flood Insurance Rate Map Index
Flood Insurance Rate Map

**FLOOD INSURANCE STUDY
CITY OF LIBBY, LINCOLN COUNTY, MONTANA**

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 City of Libby, Lincoln County, Montana. This information will be used by the City of Libby 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 analysis for the January 1979 study was performed by HKM Associates for the Federal Insurance Administration under Contract No. H-4026 and was completed in October 1977 (Reference 1)

The hydrologic and hydraulic analyses for this study 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 Interagency Agreement EMW-97-IA-0154, Project Order No. 6, EMW98-IA0206, Project Order No. 7, and EMW-99-IA-0235, Project Order No. 4 (Reference 2). This work was completed in October 2001.

1.3 Coordination

For the original study of the City of Libby, streams requiring approximate and detailed study were identified in a pre-study community meeting held in Libby, Montana, on April 14, 1976. The meeting was attended by local county and city officials and personnel of the Federal Insurance Administration; Montana Department of Natural Resources, Floodway Management Bureau; National Forest Service; and the SC (Reference 2).

Phone conversations and personal contacts were made by the SC throughout the course of the study in an effort to coordinate activities and accumulate pertinent information. The agencies and offices contacted, in addition to those cited, were the U.S. Geological Survey (USGS); the local newspaper; the Lincoln County Library; the Montana Department of Highways; the St. Regis Paper Company; and the USACE, Seattle District.

Hydrologic analyses and flood profiles for Flower Creek and the Kootenai River in the City of Libby were coordinated by the SC with those developed by the USGS, the USACE, and the U.S. Soil Conservation Service (SCS). The SCS work is published in the form of Flood-Prone Area Maps, and the USACE and the USGS have done some statistical analyses on the gaged records. Reasonable concurrence was obtained between the work of these agencies and the SC's results.

A final community coordination meeting was held on June 15, 1978, attended by representatives of the Federal Insurance Administration, the USACE, and Lincoln County Planning Board. All corrections resulting from the meeting have been incorporated into the study.

On January 7, 1999, at a scoping meeting held in Libby, 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 (Reference 2).

The results of the study were reviewed at the final Consultation Coordination Officer (CCO) meeting held on September 21, 2005, and attended by representatives of the City of Libby 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 covers the incorporated areas of the City of Libby, Lincoln County, Montana. The hydrology report supports hydraulic studies of Flower Creek from the mouth to River Mile (RM) 1.8 about 0.5 mile above its alluvial fan apex, Parmenter Creek from the mouth to its alluvial fan apex at RM 1.7, and Libby Creek from the mouth to RM 13.85 just upstream of the U.S. Highway 2 (US 2) bridge. These streams flow into the Kootenai River. The Kootenai River has been regulated by the Libby Dam located about 17 miles upstream since about 1973 and operated by the USACE (Reference 2).

2.2 Community Description

The City of Libby is located in the south-central portion of Lincoln County, in northwestern Montana. It is situated on the Kootenai River in the Kootenai National Forest. Libby is significant in this region in that it serves as the county seat, has the largest population of any community in the county, and has one of the largest and most complete lumber mills in the State of Montana. In general, the Greater Libby Area (City of Libby plus the surrounding area) contains by far the majority of Lincoln County residents and has made the greatest contribution to the growth and development of the county over the years.

As of July 2002, the City of Libby had an estimated population of 2,582, a decrease of approximately 700 from the 1970 census. Part of the decrease in population was due to the departure of construction workers and their families after the completion of the Libby Dam. It is projected that the Libby area will continue to attract the majority of growth in Lincoln County.

It appears that the major growth will be in the western part of Libby and in the fringe areas to the west of the city. There are very few remaining areas within the city that are available for development; however, some of these areas are located in potential flood hazard areas along Flower Creek. Areas outside the corporate limits experiencing significant growth are the South Libby Flats area. The view area is across the Kootenai River. The view area is located on relatively high ground that is safe from the Kootenai River.

The City of Libby is located on the banks of the Kootenai River, in an area characterized by densely forested hills and mountains in all directions. The climate of Libby has many features characteristic of a valley bottom surrounded by mountains. Elevations on nearby peaks and ridges range up to approximately 800 feet; most nearby ridges are from 2,000 to 4,000 feet higher than the city. The effects of the local terrain on the climate are significant, particularly during the summer months.

According to a city website ([http://www.city-data.com/city/Libby Montana.html](http://www.city-data.com/city/Libby_Montana.html)), days during the summer are usually quite warm; the July average is approximately 67 degrees Fahrenheit (°F), with approximately one-half of the days in July and August reaching maximum temperatures of 90°F or more. The days cool quickly after sunset; the nighttime low is approximately 45°F. The mean January temperature is approximately 26°F; the mean annual temperature is approximately 47°F.

It is difficult to classify the climate of Libby. Much of the time, the weather has characteristics similar to that of Pacific Maritime areas westward to the Washington coast; there are a few occasions each winter when cold air from the Canadian interior will produce continental winter conditions for a few days. It is probably best to describe the climate as modified Pacific Maritime, inferring less severe winters than

in continental areas farther east in Montana but also inferring a different precipitation pattern than continental areas, where the summer is the wet season. In contrast to most of the State of Montana east of the Continental Divide, where from two-thirds to three-fourths of the annual precipitation normally falls during the April-to-September growing season, only approximately 37 percent of the annual precipitation falls during that season at Libby. The late fall and early winter months are the wettest, and it is this feature of Libby's climate that corresponds most closely to the Pacific Maritime type. The fall and winter rains and snows most often are the steady, gentle, soaking type, accompanied by periods of cloudy skies with small diurnal temperature changes. The mean annual snowfall is approximately 55 inches, most of which falls during December, January, and February. In contrast to the majority of cities in Montana, July and August are the dry months in Libby. The overall average annual precipitation for Libby is approximately 19 inches.

Severe storms seldom occur in the Libby area; damaging winds occur infrequently, but have been known to blow down nearby timber of considerable value at intervals of several years. Hail and severe thunderstorms are a rare occurrence. Some local streams occasionally produce enough spring runoff to cause flooding in the Libby area. Most of the water involved originates from the spring melting of mountain snow packs which prevail in the Kootenai River watersheds. Warm temperatures occurring late in the spring season, combined with rainfall, are the main factors responsible for local flooding.

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 melting ice. The variations in soils are the result of alterations of geological material by climate and living organisms, especially vegetation. The length of time that these forces have been active and the topography of the area also contribute to these variations.

Flower Creek originates in the Cabinet Mountains of the Kootenai National Forest and flows east 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 areas, and gradually flattens as it passes through the developed areas in and near Libby.

The watershed of Flower Creek is generally characterized by alluvial soils along the stream and brown podzolic soils in the mountainous regions. The alluvial soils usually occur in small areas along the stream and in areas that may be periodically flooded. 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 moisture accumulations are quite high and there is a dense cover of timber and miscellaneous vegetation.

There are some areas along the Kootenai River where 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 Kootenai River is characterized by the gray wooded and brown podzolic soils, with abundant vegetation and good timber stands.

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 from the north from Canada, at Gateway, and flows southwest to Libby, then northwest past Troy and into Idaho. The Kootenai River is an important tributary of the Upper Columbia River.

The Kootenai River is regulated by the Libby Dam, which is located 17 miles upstream from Libby and 48 miles downstream from the International Boundary. The USACE started construction on the dam in the spring of 1966 and essentially completed the project in March 1973. The dam is a concrete structure that rises 420 feet above the bedrock. The reservoir behind Libby Dam, Lake Koocanusa, is 90 miles long and has a maximum storage capacity of 5.9 million acre-feet (Reference 2).

2.3 Principal Flood Problems

The most severe flooding in Libby occurs in either the mid-winter or spring months as a result of snowmelt and heavy rains. Occasionally, ice jams, occurring in either winter or spring, cause some over bank flooding. In addition to flooding along streams, shallow flooding periodically occurs in other isolated areas of Libby due to a relatively high ground water table, rapid snowmelt, and/or rainfall. Areas in Libby experiencing this condition are either located in the foothills or in low-lying areas of the valley where topographic relief is minimal.

Libby is subject to periodic flooding caused by the overflow of Flower Creek. All types of structures, both residential and commercial, have encroached on the floodplain and are occasionally flooded as Flower Creek passes through the developed area. The backwater effects caused by the Kootenai River and the type and grouping of hydraulic structures on Flower Creek near the confluence are of particular interest to the flooding of Flower Creek. Upstream from the mouth, there are some corrugated steel culverts, which are followed by three bridges with minimal spacing between them.

The City of Libby is also susceptible to Alluvial Fan Flooding due to the periodic overflow of Parmenter and Flower Creeks.

Bridges with piers in the channel collect debris and sediment and increase backwater, erosion, and overbank flooding. This is most pronounced on the lower reaches of Parmenter, Flower, and Libby Creeks. Debris was modeled in the Libby Creek backwater analysis. The Stimson Timber bridge over Libby Creek, Reach 6, is likely to fail during a significant flood due to debris loading and shallow foundations. The left center pier footing is presently undermined and debris blocks about 10 percent of the channel. The effects of a failed pier on flooding were not analyzed.

Other bridges in the study area span the low flow channel but constrict overbank flows. The resulting backwater appears to encourage the formation of large gravel and cobble bars just upstream and overbank split flows. This phenomena is especially pronounced at Farm-to-Market, Hammer Cutoff Road, and US 2 (Reference 2).

Bridges on Parmenter and Flower Creeks are subject to plugging from ice and debris. This is due to a combination of seasonal conditions, high sediment and debris loads, poorly sized and aligned bridges (lack of clearance at railroad, shopping center, etc.) and channel encroachments. These creeks have experienced significant overbank flooding, and channel/bank erosion and migration throughout the study area. All of the bridges were modeled as being plugged, with the exception of the Dome Mountain Road bridge which was recently constructed.

Throughout the study area, high sediment loads from active landslides, tributaries, steeper upstream reaches, and historic activities and events contribute to widespread erosion, sedimentation, channel migration, and overbank flooding (Reference 1). This can be ascertained by reviewing aerial flood photos. It is likely that many of the unstable portions of creeks in the study area occur where sediment transport capacity is diminished by previous natural and man-made sediment inputs or channel controls. No formal sediment analysis was undertaken in this study. Given the frequent erosion witnessed and documented during moderate and large floods in the study area it is likely that all but the largest channel and bank material is transportable during these flood events. The frequency and duration of these events are probably insufficient to move coarse sediments through the entire study area in one flood event. Thus mobilized sediments are likely to persist for some time in the active channel before making it out of the study area or becoming stabilized. There is evidence of reach scale deposition increasing flood elevations at the confluence of Libby Creek with the Kootenai River. Here, comparisons of channel thalweg elevations (after a datum adjustment) showed that the 1999 thalweg elevation had increased by more than 6 feet since the last survey (1974-80). This delta induces sedimentation and higher flood elevations for several thousand feet upstream.

All streams in the study area are braided and appear to be laterally unstable where not confined by man-made structures. The source of this instability has been attributed to historic events and activities that have caused a condition where vegetation that would ordinarily limit sediment supply is absent, allowing for lateral migration during even moderate flood events. The resulting erosion and sedimentation has further destabilized the channel. The assumption of steady-state, one-dimensional flow conditions may be more adequate to describe flood elevations than the extent of the floodplain and floodway. Significant changes in geometry should require restudy to verify the flood profiles and determine the new floodplain and floodway limit. A two-dimensional channel and floodplain hydraulic model would be well suited to any future restudy

2.4 Flood Protection Measures

There is minimal flood protection along Flower Creek within the corporate limits. The manmade rechannelization of a reach through the central part of town in the neighborhood of the footbridge may be of minor significance. This rechannelization was performed subsequent to the January 1974 flood and consists of straighter channel alignment and gravel and cobble berms along both banks.

Uncertified levees composed of native materials dredged from Libby Creek line both banks from the Kootenai River past the Stimson Timber Mill site. The left bank levee is adequate to contain the 0.2-percent-annual-chance flood with freeboard for much of its length, and portions meet the 3-foot freeboard requirement. The levee is armored at the toe, but woody vegetation is taking root on the stream ward face. The right bank levee is poorly maintained, overgrown, and serves little function. It is overtopped during moderate events. During a major flood event, the levees will, as designed, confine more water to the channel and limit floodplain storage. Low and weakened portions of the levee will suffer greater damages because of the increased flood volumes and depths caused by the levee impoundment. A private road runs 1 mile along the left bank of Libby Creek from the Farm-to-Market Road bridge, downstream to the location of a long washed out bridge. This road is armored with riprap and exceeds the 3-foot freeboard requirement for the entire length downstream of the bridge. It is included in the model as a levee. Upstream of the Farm-to-Market Road bridge, backwater overtops the private road/levee at a location where the road was washed out during past floods. Continued erosion and overtopping are expected, unless the bridge is replaced with a wider span to reduce backwater.

The Big Cherry/Granite Creek levee is located upstream of the US 2 bridge, left bank. This levee is certified to provide protection from the 1-percent-annual-chance flood event and freeboard. It is free of vegetation and well-armored. It is modeled to pass the 0.2-percent-annual-chance flood with freeboard.

A FEMA funded flood control and channel migration control project was completed on Parmenter Creek in 2000. The project included 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

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

The hydrology revision 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 in January 1979. Also, the previous FEMA flood flow frequency estimates were believed to have been too low based on preliminary analysis of recorded flood flows and anecdotal data. A more detailed method of localized regional flood frequency analysis was applied in this study that replaces the use of limited analytical frequency analysis, USGS regional equations, and other approximate methods of flood frequency determination used in previous FEMA studies (Reference 2).

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 low outliers) if the flood was real but the flow was unusually large. Gage record adjustments or notable flood information found in this study are presented in the following discussions.

Flood frequency analyses were performed in this study based on guidance found in the USGS *Bulletin 17B* and USACE engineering and hydrology manuals. 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. An explanation of this procedure is also provided in the USGS *Magnitudes and Frequency of Floods in Montana* (Reference 3). Frequency curves for the longer duration flows (peak, 1-, 3-, and 7-day) were computed for use in developing hypothetical hydrographs for unsteady flow hydraulic modeling on Parmenter Creek and Flower Creek Flood frequency estimates and 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 4). Statistical parameters (mean flow, standard deviation, and skew) used to compute the frequency curves were slightly "smoothed" between the flow durations (peak, 1-, 3-, and 7-day) to prevent potential convergence or crossing of the frequency curves. Generalized skew coefficients were set equal to the computed station skew. Winter and spring curves were probabilistically combined using the equation of union to produce a single flood frequency curve for each gage.

Stream gages where combined peak (and longer duration) flood frequency curves were developed from observed streamflow record and those for Fisher River near Libby, Granite Creek near the mouth, Flower Creek near Libby, and Lake Creek near Troy. These frequency curves were also used to develop flood flow frequency relationships for ungaged locations. The Libby Creek streamflow records for the KNFS gage at Farm-to-Market Road bridge were too short to compute an analytical frequency curve. Therefore, the flood flow frequency curve was estimated by methods for ungaged sites. However, streamflow records from the Libby Creek gage were used to verify the flood frequency results by cross comparison with other gages.

For ungaged points on a stream, three methods were used to estimate peak flood frequency discharges. These included localized winter and spring flood statistics, 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 Magnitudes and Frequency of Floods (Reference 5) for the West Region were not used since they tended to considerably underestimate flood discharges for the gages. USGS equations for the northwest region, which included the effects of both winter and spring flood conditions similar to the Libby area, 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 was adopted. The flows below the alluvial fan apex points on Flower Creek and Parmenter Creek will be estimated hydraulically from unsteady flow modeling.

Unit-flow plots were derived from the computed peak frequency curves of the combined winter and spring floods. USGS estimates of the 1974 flood discharges were used to assist in shaping the curves. Locations where flood frequencies were estimated from the unit-flow graph are Libby Creek at the mouth, and Libby Creek above and below Swamp Creek.

The coincident and timing of floods on Flower Creek and Parmenter Creek were assumed to be perfectly coincident due to their hydrologic similarity and lack of comparative streamflow data.

Coincidence and timing of floods on the Kootenai River were adopted from the prior FEMA report for the City of Libby. The relationships presented in the reports were verified based on a review of current streamflow records and regulation practices for Libby Dam from conversations with the USACE and a recent status report on a proposed regulation alternative for the VARQ Flood Control Operation (Reference 6) provided by the USACE.

The computed flood flows in this study were found to be significantly higher than those publications 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 50-year through 0.2-percent-annual-chance recurrence points indicating a significant change based on FEMA criteria in *Contractor Guidelines* (Reference 7). Two exceptions were the Flower Creek gage and Parmenter Creek near the mouth where the FEMA flows fell below the 95 percent confidence limits only at the 0.2-percent-annual-chance level and were on or within the 25-75 percent limits for the 50-year and 1-percent-annual-chance floods. The FEMA flows on Flower Creek near the mouth, however, fell below the 95 percent confidence limit at all points. 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 the Kootenai River and Flower Creek are shown in Table 1, Summary of Discharges.

Table 1. Summary of Discharges

| Floodng 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 |
| Kootenai River | | | | | |
| At Libby | 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 |
| Flower Creek | (Square Miles) | | | | |
| At USGS Gage No. 3031 near Libby | 11.1 | 390 | 610 | 840 | 1,730 |
| At alluvial fan apex | 17.9 | 675 | 1,080 | 1,490 | 2,960 |

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

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.

Libby Creek

The USGS regional office in Libby supplied the cross sections from the Kootenai River to the confluence with Big Cherry (Granite) Creek. The USGS took channel cross sections 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 of reach 3. The Lincoln Area Conservation District supplied the channel cross sections for Reach 2 and 3 (Reference 8). Reach 5 was surveyed by Montana Fish Wildlife and Parks and extends beyond the upstream limit of the 1980 FIS. This survey was tied to State plane coordinates using a Global Positioning System unit. The USACE obtained an additional topographic survey of the upper portion of Reach 5 from the USGS, performed for Montana Fish Wildlife and Parks in 1999. This survey did not span the entire floodplain. 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.

Flower/Parmenter Creeks

The USACE obtained typical channel dimensions in the field to perform the FLO-2D analysis. 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 U.S. Forest Service. Bridge plans were obtained for some bridges.

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 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 report (References 9 and 10).

FLO-2D (FLO-2D Inc. 2001) was used to analyze the unsteady alluvial fan flooding on Parmenter and Flower Creeks (Reference 11) and are modeled together as a reach.

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 event and this could impact the studied streams.

Flooding on Parmenter and Flower Creeks was analyzed with FLO-2D, an unsteady, two-dimensional hydraulic model. The hypothetical “balanced” 100-year hydrographs described in the Hydrologic Analyses section 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 only (Reference 11). FLO-2D was used to model out of bank flows on Flower and Parmenter creeks, which are adjacent alluvial fans (References 12 and 13). 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.

All elevations are referenced to the National Geodetic Vertical Datum of 1929. Elevation Reference Marks used in this study are shown on the maps.

4.0 **FLOODPLAIN MANAGEMENT APPLICATIONS**

The NFIP encourages State and local governments to adopt sound floodplain management programs. 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 (100-year) flood has been adopted by FEMA as the

base flood for floodplain management purposes. The 0.2-percent-annual-chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For each stream studied in detail, the 100- and 500-year floodplain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the flood boundaries were interpolated using the USGS 7.5-minute quadrangle maps.

The 1-percent-annual-chance and 0.2-percent-annual-chance floodplain boundaries are shown on the FIRM. On these maps, the 1-percent-annual-chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A, AE, AH, AO, X) and the 0.2-percent-annual-chance floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 1-percent-annual-chance 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.

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.

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

In Montana, however, encroachment in the floodplain is limited to that which will cause an increase in flood heights of 0.5 foot.

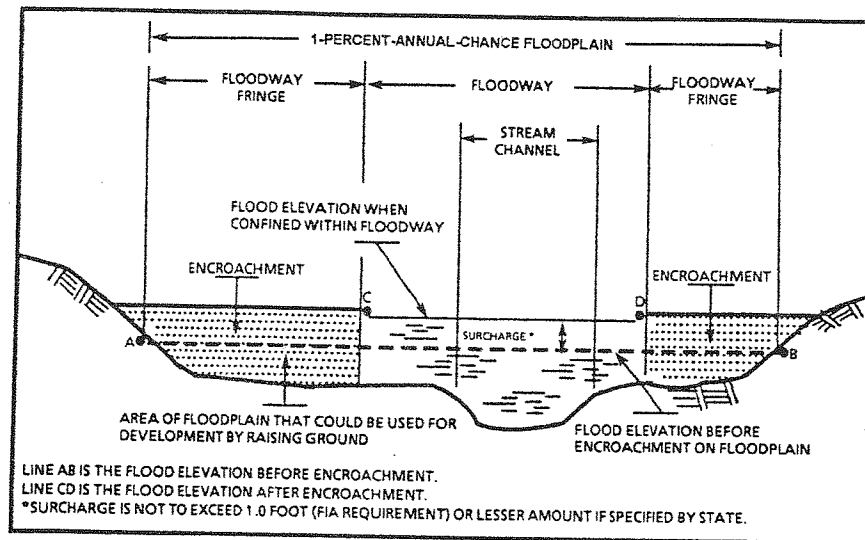


Figure 1. Floodway Schematic

No floodways were computed for 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

As part of a flood hazard reduction project on Flower Creek, the City of Libby retained West Water consultants to design habitat mitigation features including natural bank revetments, grade control structures, and a major channel realignment. This work was completed in 2000. During review by the USACE it was discovered that the consultants peak hydrology estimates were considerably under those being developed for this FIS. The USACE was using a more complete hydrologic data record and accounting for seasonal variations, where the consultant was not. The consultant agreed with the explanation of differences and stated that the peak flow events would not have appreciable effects on the project due to the availability of floodplain area for storage and conveyance of large flood events.

In October 1996, Inter-Fluve, Inc., of Bozeman, Montana, documented the Libby area flood history and ongoing problems and recommended the Libby area FIS restudy in the Long Range Flood Hazard Reduction Plan (Reference 8)

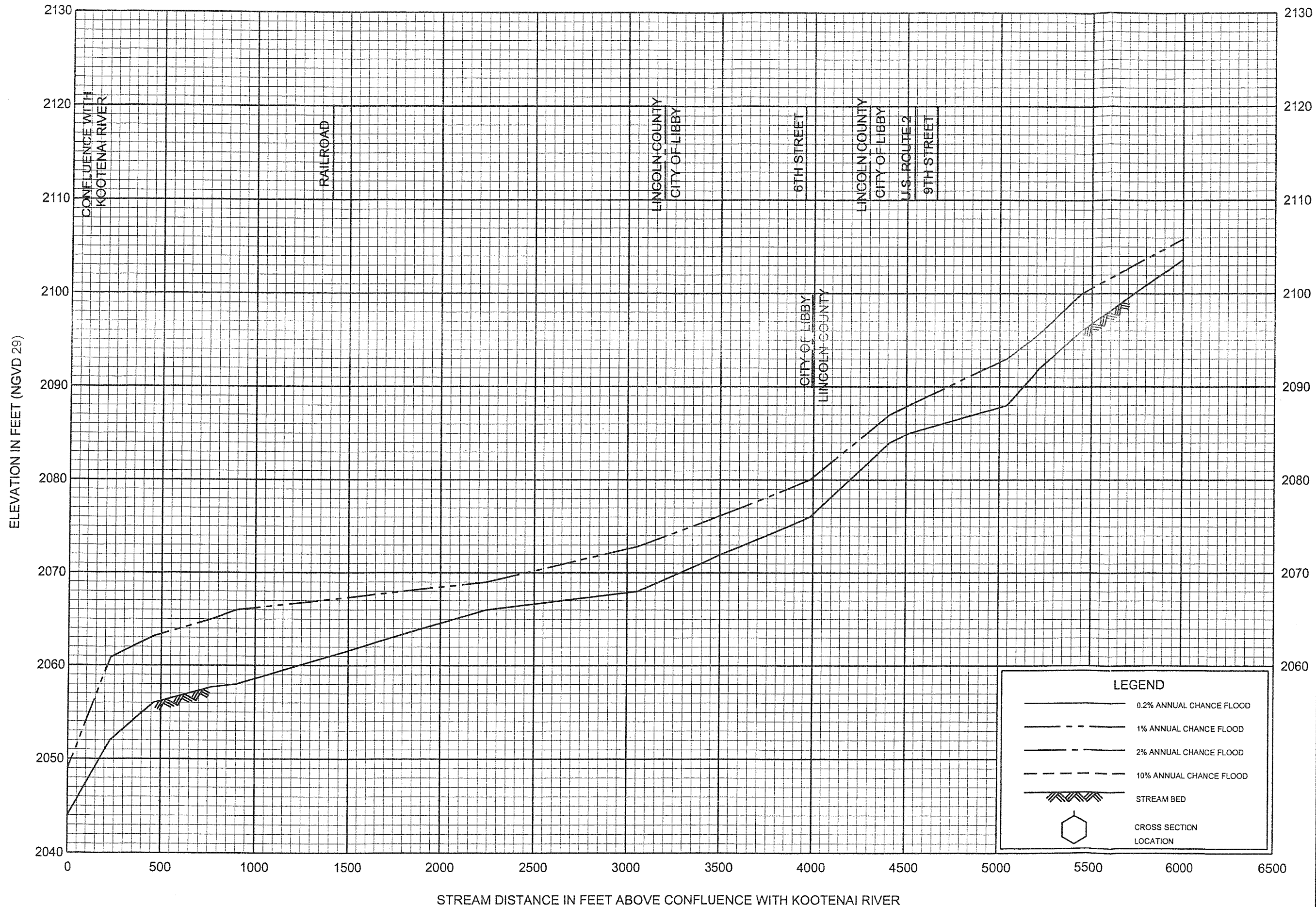
This FIS report either supersedes or is compatible with all previous studies published on streams studied in this report and should be considered authoritative for the purposes of the NFIP.

8.0 LOCATION OF DATA

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

9.0 BIBLIOGRAPHY AND REFERENCES

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13. Montana Fish, Wildlife & Parks, Libby Field Station, Surveyed Channel Cross Section, Libby Montana, 1998.



FLOOD PROFILES

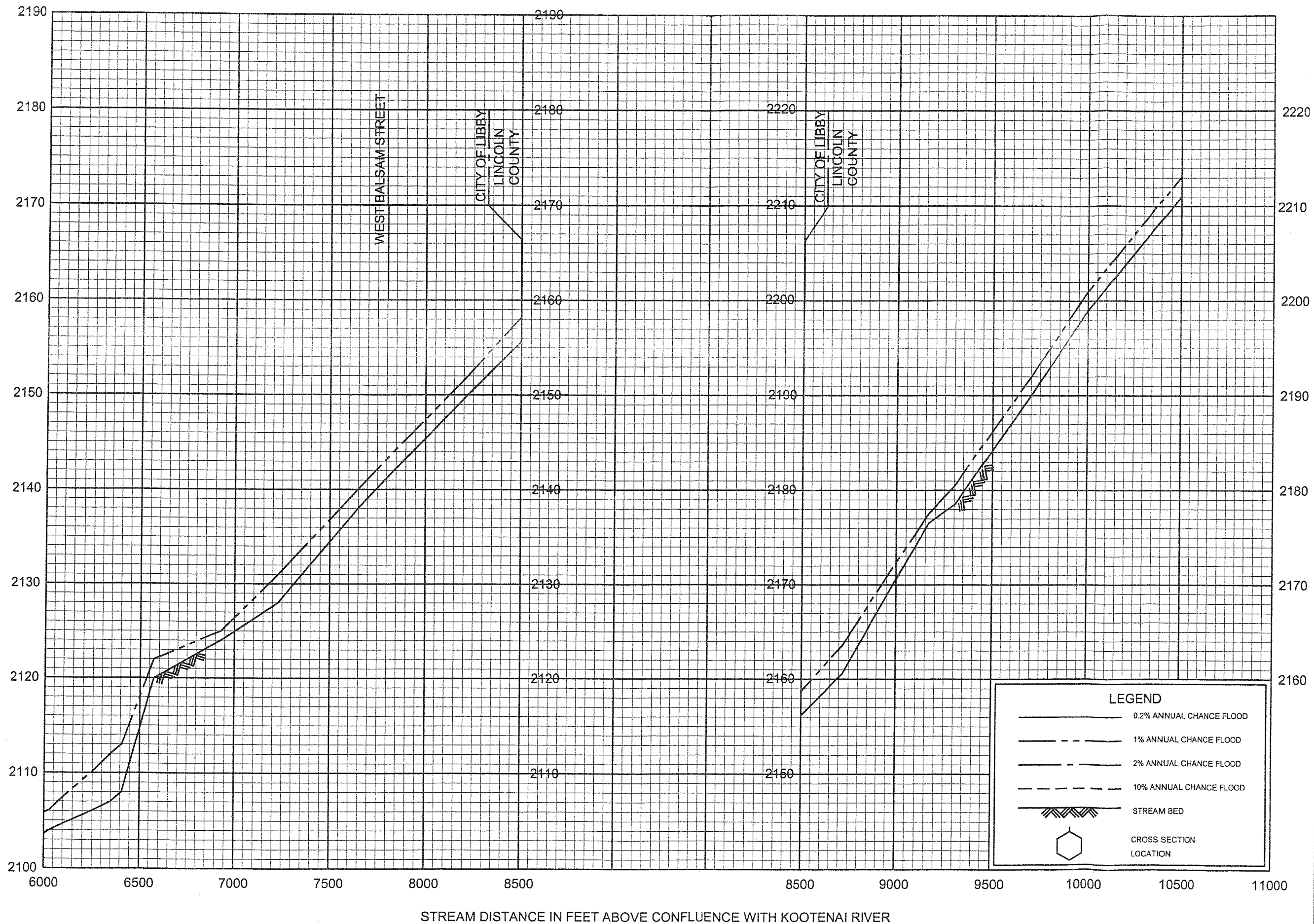
FLOWER CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LIBBY, MT

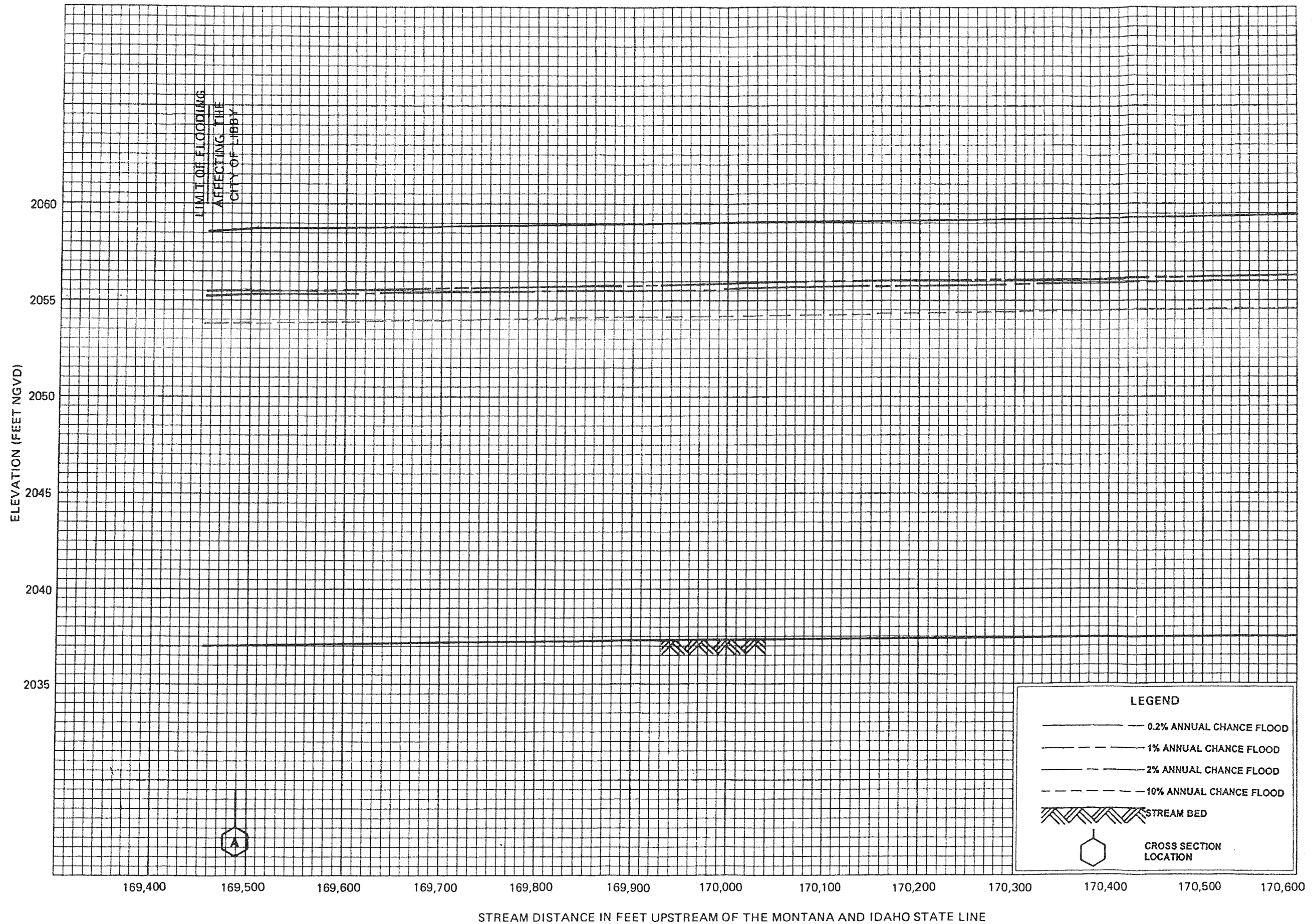
(LINCOLN CO.)

ELEVATION IN FEET (NGVD 29)



FLOOD PROFILES
FLOWER CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY
CITY OF LIBBY, MT
(LINCOLN CO.)

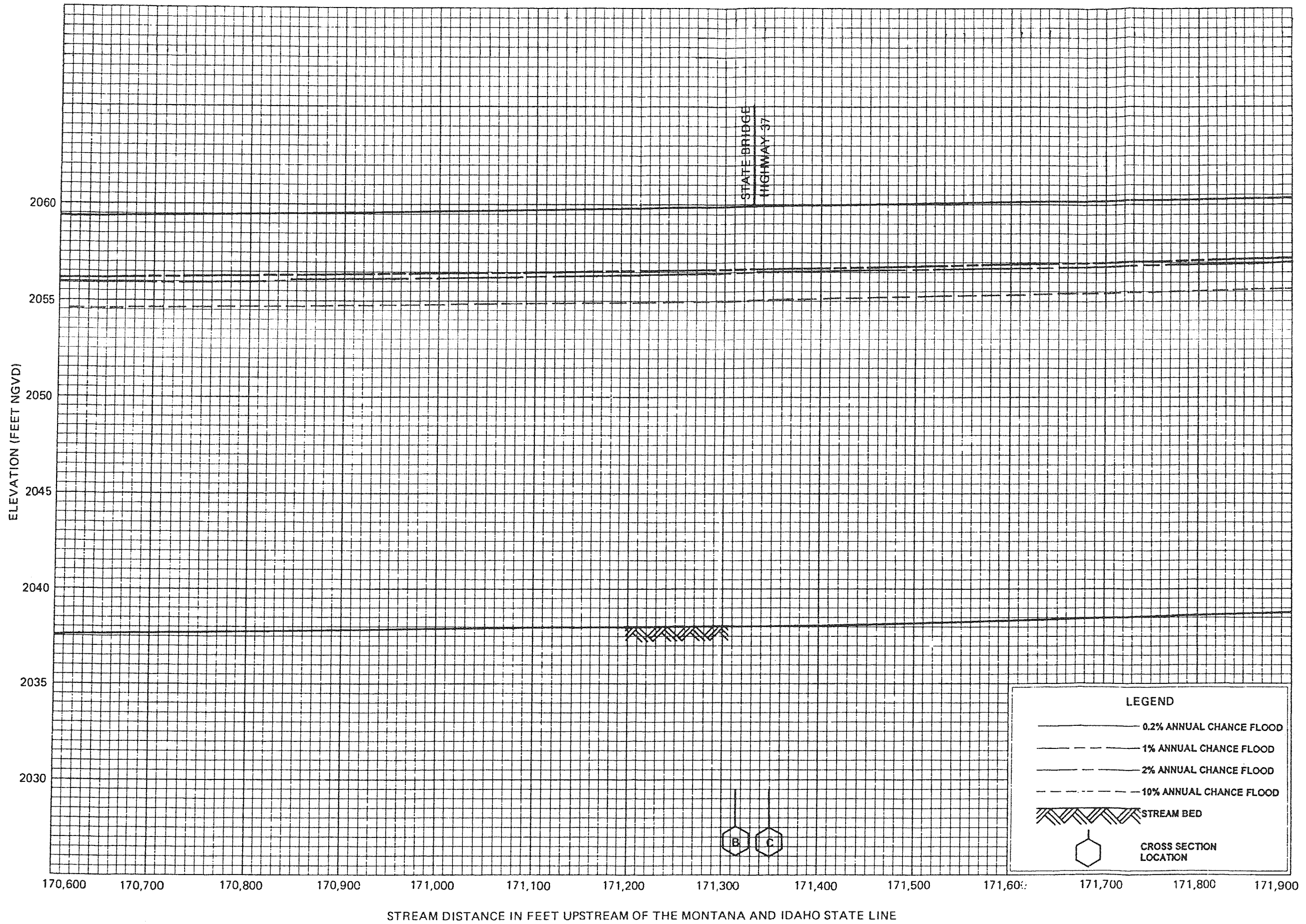


FLOOD PROFILES

KOOTENAI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LIBBY, MT
(LINCOLN CO.)



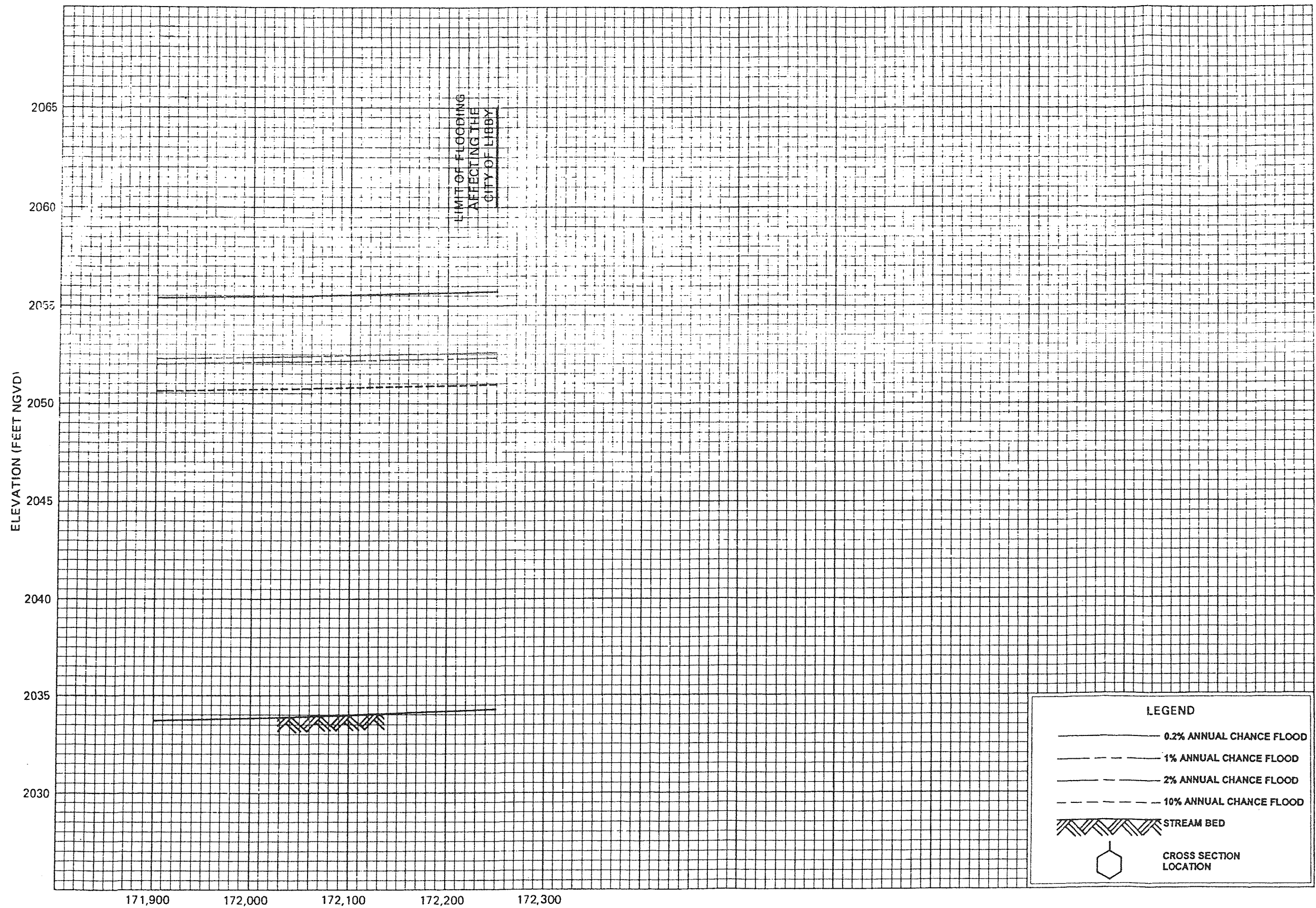
FLOOD PROFILES

KOOTENAI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LIBBY, MT
(LINCOLN CO.)

04P



STREAM DISTANCE IN FEET UPSTREAM OF THE MONTANA AND IDAHO STATE LINE

FEDERAL EMERGENCY MANAGEMENT AGENCY

FLOOD PROFILES

KOOTENAI RIVER

CITY OF LIBBY, MT
(LINCOLN CO.)

05P