FLOOD INSURANCE STUDY

TOWN OF ENNIS, MONTANA,
MADISON COUNTY
VOLUME 1 OF 1

EFFECTIVE: JUNE 16, 2011

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
300044V000A

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:

Old Zone	New Zone
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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FLOOD INSURANCE STUDY
TOWN OF ENNIS, MADISON COUNTY, MONTANA

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study (FIS) revises and updates information on the existence and severity of flood hazards in the geographic area of the Town of Ennis in Madison County, Montana, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood-risk data for various areas of the community that will be used to establish actuarial flood insurance rates and to assist the community in its efforts to promote sound floodplain management. Minimum floodplain management requirements for participation in the National Flood Insurance Program (NFIP) are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

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.

There was not an original hydrologic and hydraulic analyses completed for Town of Ennis. Thus the flooding for Moores Creek that runs through the Town of Ennis was delineated as Zone A. The hydrologic and hydraulic analyses for Moores Creek were updated by the Great West Engineering (GWE), under the Hazard Mitigation Grant Program (HMGP). This work was completed in 2005.

1.3 Coordination

On July 27, 1976, streams requiring detailed study were identified in meetings attended by representatives of Miles City, the Floodplain Management Bureau of the Montana Department of Natural Resources (MTDNR), the Federal insurance Administration (FIA), and Morrison-Maierle, Inc. During the course of this study coordination was maintained through the City Planners, the City Engineer and the United States Army Corps of Engineers (USACE).

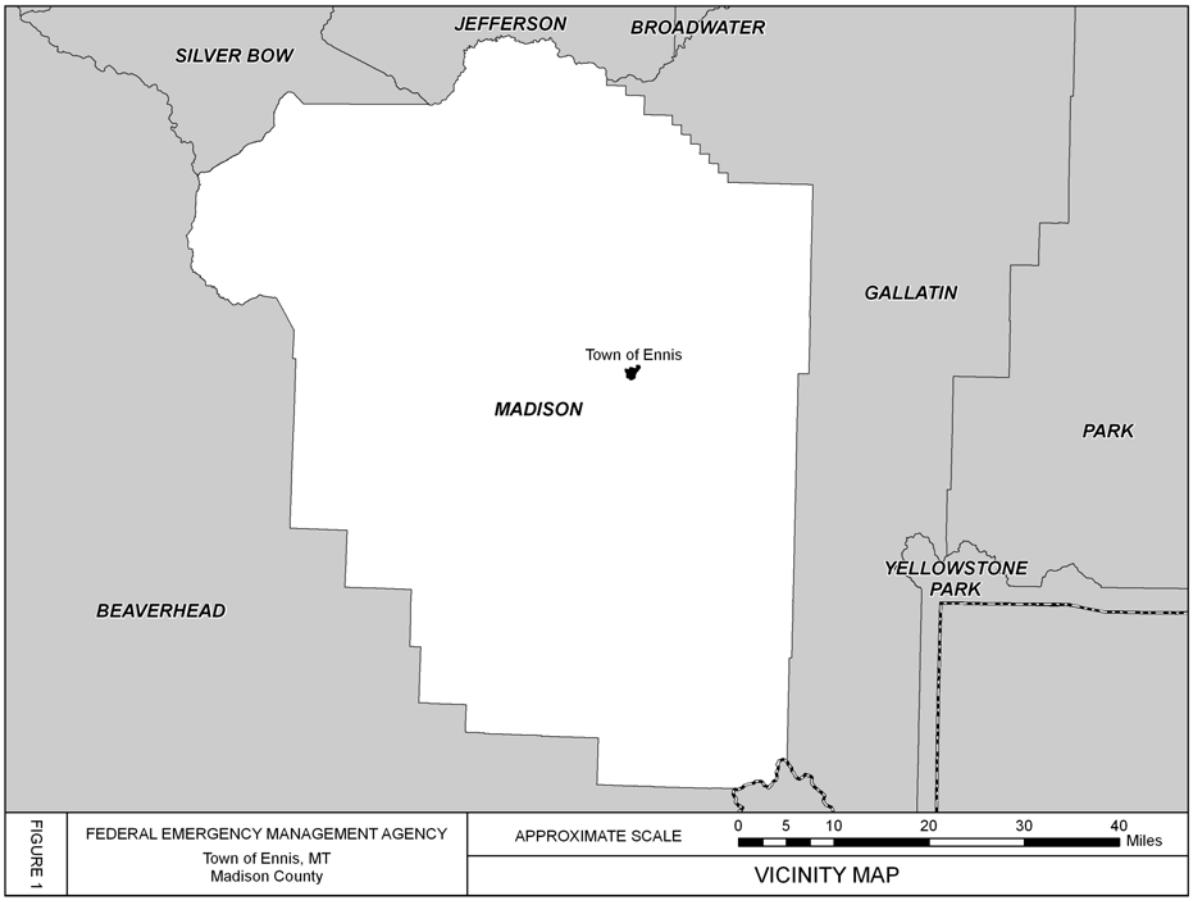
A final Consultation Coordination Officer (CCO) meeting was held on December 7, 2004, to present the results of the Great West Engineering study. Attending the meeting were representatives of the FIA, the study contractor, and the Floodplain Management Bureau of the MTDNR, and the interested public. No problems were raised at the meeting.

The results of this countywide study, including the 2005 Great Western Engineering study along Moores Creek, were reviewed at the final CCO meeting held on August 17, 2009, and attended by representatives of the Town of Ennis. 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 geographic area of The Town of Ennis in Madison County, Montana, listed in Section 1.1, as shown in Figure 1.



The areas studied by approximate methods were originally selected and studied with priority given to all known flood hazards and areas of projected development or proposed construction through 1986. Moores Creek was updated by the 2005 GWE study.

All other flood hazards within the Town were studied by approximate analyses for the November 19, 1986, Town of Ennis Flood Insurance Rate Map (FIRM). Approximate analyses were used to study those areas originally determined to have a low development potential or minimal flood hazards within the town limits.

2.2 Community Description

Town of Ennis

Ennis is a town located near the southwestern part of the state of Montana in the Beaverhead National Forest. It is commonly stated that Lewis and Clark found their way through the Madison County area and possibly Ennis in 1805. Ennis began in 1863 when gold was discovered in Adler Gulch. Two months later, William Ennis homesteaded the site along the Madison River that soon became the town of Ennis (Reference 1). Today, Ennis and the Madison Valley are mainly used for cattle-raising with many ranches and farms (Reference 1). The population of Miles City in the 2000 census was 840 (Reference 2).

Ennis is the largest town in Madison County (Reference 3). It is approximately 34 miles to the northeast of Virginia City, the county seat, and approximately 85 miles south of Helena, the state capital of Montana (Reference 4). The town is surrounded by the unincorporated areas of Madison County on all sides. Ennis is surrounded by a relatively flat region with some gently sloping hills to the west and mountains with higher elevations to the east. Agricultural areas have sprung up at a close vicinity to the city. The areas within the Ennis corporate limits contain mostly clay loams or gravelly and sandy loams that drain water well. Near Madison River within the town limits, the soils consist of very cobbly or very gravely sandy loams.

The largest flooding source, Madison River, is mostly not adjacent to residential areas within the town limits. Moores Creek runs throughout the Ennis town limits for approximately 3.05 miles and crosses multiple roads including State Highway 287 in the northwest corner of the town. Residences surround these roads which raises the concern for flooding without a detailed delineation for Moores Creek.

Ennis is served by State Highway 287 to the north, south and west, and is at the junction of this State Highway. Private air traffic is served by the local Ennis Big Sky Airport.

The climate in Ennis is in a semi-arid band in the United States that stretches from the lower tip of Texas into southern Canada. Madison Valley is mostly open prairie and grasslands. Flooding sources are lined with cottonwoods. Average high temperatures range from 82 degrees in the summer to 32 degrees during the winter months (Reference 5). Average rainfall in July is approximately 1.31 inches and average snowfall in January is 0.35 inches (Reference 5). There are no gage data records for Moores Creek.

2.3 Principal Flood Problems

Town of Ennis

The history of flooding is not very well documented for the Town of Ennis. Seasonal flooding does occur most noticeably during the late winter, and early spring and summer months (Reference 6). However, because of more encroachment of buildings along Moores Creek, flooding has become more of a concern for the town. The last flooding occurred in the winter of 1995 when debris was caught in a culvert that caused icing and raised flood levels and caused water to overflow the banks.

2.4 Flood Protection Measures

Town of Ennis

No flood protection measures have been constructed for Moores Creek within the Town of Ennis. The USACE conducted a study in March of 1981 which determined that parts of Moores Creek were

impacted during base (1-percent-annual-chance) flood flow conditions (Reference 6). However, this USACE study was not used for the most currently effective FIS because it does not reflect current conditions in Ennis (Reference 6).

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

A hydrologic analysis was carried out to establish peak discharge-frequency relationships for each flooding source studied by detailed methods affecting the community.

For this community-based FIS, the hydrology information for the Town of Ennis was taken from a hydrology report prepared by GWE in April 2005 (Reference 6). This report developed the peak flows from a United States Geological Society (USGS) report entitled, "Methods for Estimating Flood Frequency in Montana Based on Data through Water Year 1998" (USGS WRIR 03-4308) (Reference 7). The USGS report creates regression equations based on basin characteristics, active channel width, and bankfull widths within eight different geographical regions. GWE used all of these methods and created average peak flows with a combined weighted factor.

The Moores Creek drainage basin is a mountain stream that starts in the Tobacco Root Mountains east of Ennis and is approximately 35 square miles with 62 percent of the drainage basin lying above 6000 feet in elevation (Reference 6). Because the drainage basin begins in a mountainous area and then flows through a valley area in Ennis, the upper characteristics of the basin include mainly forested regions and the lower area contains mostly agricultural and residential type terrain.

Moores Creek

The regression equation peak flow estimates for the Moores Creek were calculated for the 10-, 2-, 1-, and 0.2-percent-annual-chance floods. As mentioned previously, the regression equation calculations for Moores Creek were calculated using three methods. These include basin characteristics, active channel width and bankfull widths. These values were then weighted to determine a single value for each recurrence interval. The Moores Creek project is located in the Southwest Region of Montana according to Plate 1 in USGS report.

For the Basin-Characteristics Method, basin area and amount of basin above 6000 feet is used to

determine the flows. It was determined using topographical maps in AutoCAD that the drainage area for Moores Creek was 34.6 square miles and that 62.2 percent of that area was above 6000 feet (Reference 6). The other two methods, the Active Channel Width Method and the Bankfull-Width Method, use channel characteristics to determine the flows. A topographical survey from 2003 was used to determine the stream characteristics along Moores Creek (Reference 6). The active channel width was determined by surveying the width of the channel where short term geomorphic changes are located relative to normal flow through the channel (Reference 6). The bankfull width was measured from the top of the main channel banks with the actual bankfull locations with bankfull indicators. These indicators included changes in the banks such as the channel going from a vertical bank to a horizontal floodplain area, erosion along the banks and the vegetation limit along the channel (Reference 6). The average active channel width and bankfull widths were determined to be 12 feet and 17 feet respectively, from field surveys and topographic maps (Reference 6).

After the flows for each method were calculated a Weighted Average Method was used from the USGS Report to determine the final peak flows. Based on equations in the USGS Report, a weighting factor was calculated and applied to each flow in each method. These flows are then weighted inversely proportional to their error variance and then averaged. These weighted flows are listed in Table 1 below.

Table 1. Summary of Discharges

		Peak Discharges (Cubic Feet Per Second)			
Flooding Source and Location	Drainage Area (Square Miles)	10-percent-annual chance event	2-percent-annual chance event	1-percent-annual chance event	0.2-percent-annual chance event
Moores Creek					
At Center of Town	34.6	260	449	547	802

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 Table 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.

There was not a previous FIS completed for the Town of Ennis. The hydraulics for this FIS for the Town of Ennis was taken from flood studies which GWE conducted to delineate a more current floodplain because of more development in the town (Reference 8). This study included only Moores Creek which runs through the town.

For the hydraulics in this FIS, water-surface elevations of floods of the selected recurrence intervals were computed using the USACE HEC-RAS step-backwater computer program. Version 3.1.3 of the HEC-RAS program was used for developing the water surface profiles for steady, gradually varied

flows in all flooding sources studies in this report (Reference 9).

Topographic data was attained from field surveys and aerial photogrammetric mapping (Reference 8). Additional field surveys were conducted to record culvert elevation data and stream channel morphology (Reference 8). These cross sections were used to develop the flood profiles and floodplain for Moores Creek. All topographic data is referenced to the North American Vertical datum of 1988 (NAVD88).

Roughness coefficients (Manning's "n") for the flooding sources were estimated by field inspection, photos, and aerial photography at each cross section. The channel and overbank roughness value ranges for each stream are given in the following list. These values were estimated by field inspection at each cross section (Reference 8).

Table 2. Manning's "n" Values

Stream	Channel	Overbanks
Moores Creek	0.030-.00350	0.030-0.20

Starting water surface elevations for Moores Creek were based on normal depth calculations at the downstream end of the detailed study which was approximately 3 miles upstream of the Ennis town limits. The upstream and downstream channel slope data was obtained from the topographic mapping (Reference 8).

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 referenced to the NAVD. 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 website at www.ngs.noaa.gov, or contact the National Geodetic Survey at the following address:

Vertical Network Branch, N/CG13
National Geodetic Survey, NOAA
Silver Spring Metro Center 3
1315 East-West Highway
Silver Spring, Maryland 20910
(301) 713-3191

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 Information Services Branch of the NGS at (301) 713-3242, or visit their website at www.ngs.noaa.gov.

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.

The 1-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 hazards (Zones A, AE, AH, AO, and VE), 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 each stream studied in detail, the 1-percent-annual-chance floodplain boundary has been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps at a scale of 1:1,200, with contour intervals of 2 feet (Reference 10).

For this study the approximate flood boundaries were taken from the FIRM for the flooding for Madison River.

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

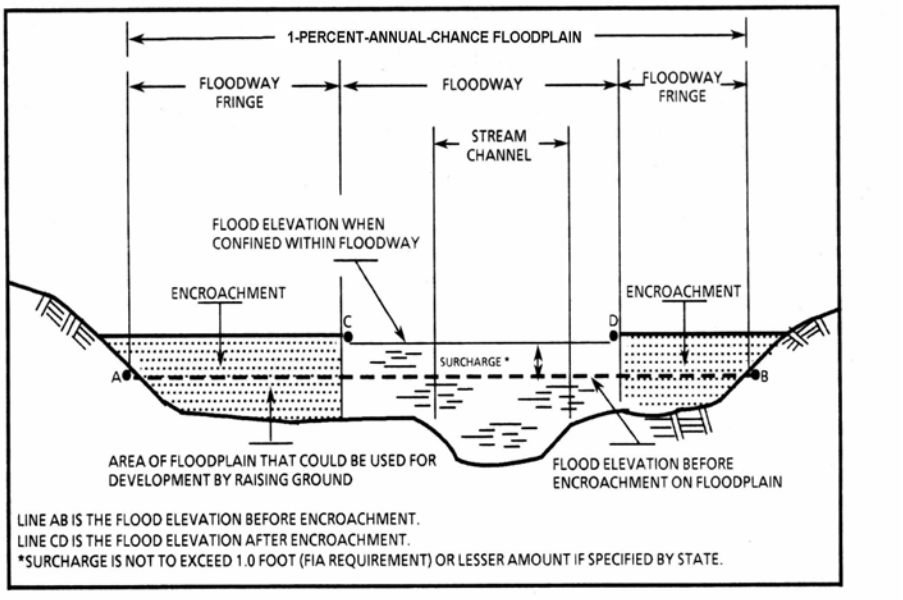
the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the base flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1 foot, provided that hazardous velocities are not produced. The 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.

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 Table3, 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.

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 (WSEL) 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 2.

FEMA suggests that communities adopt a floodway that limits rise to 1.0 feet. However the State of Montana has adopted a more stringent floodway that prohibits any rise of more than 0.5 feet. Therefore, hydraulic models were computed using the 0.5 foot requirement for the floodways for Moores Creek.

Figure 2. Floodway Schematic



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 (NAVD)			
Moores Creek								
A	972	117	160	3.5	4,919.9	4,919.9	4,920.0	0.1
B	1,928	157	250	2.2	4,924.2	4,924.2	4,924.5	0.3
C	2,744	106	221	2.5	4,926.8	4,926.8	4,927.0	0.2
D	3,676	60	141	4.0	4,931.3	4,931.3	4,931.7	0.4
E	4,163	77	166	3.4	4,933.9	4,933.9	4,934.3	0.4
F	4,919	67	161	3.5	4,938.5	4,938.5	4,938.9	0.4
G	6,259	45	145	3.8	4,951.4	4,951.4	4,951.5	0.1
H	6,974	51	168	3.3	4,957.2	4,957.2	4,957.5	0.3
I	8,124	57	95	5.9	4,964.3	4,964.3	4,964.4	0.1
J	10,053	54	117	4.8	4,986.0	4,986.0	4,986.4	0.4
K	11,675	99	124	4.5	4,995.7	4,995.7	4,996.1	0.4
L	12,774	105	105	5.3	5,006.5	5,006.5	5,006.7	0.2
M	13,634	108	155	3.6	5,013.2	5,013.2	5,013.4	0.2
N	15,024	97	99	5.7	5,029.6	5,029.6	5,029.9	0.3

1 Stream Distance in Feet above Limit of Detailed Study

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF ENNIS, MT

MADISON COUNTY

FLOODWAY DATA

MOORES CREEK

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 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 (sq. mi.), 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.

The community based FIRM presents flooding information for the entire geographic area of the Town of Ennis in Madison County. Previously, FIRMs were prepared for the community for areas that were identified as flood-prone. This community-based FIRM also includes flood-hazard information that was presented separately on Flood Boundary and Floodway Maps (FBFMs), where applicable.

7.0 OTHER STUDIES

There were no other studies completed for the Town of Ennis.

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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6. Great West Engineering, Moores Creek Floodplain Study Project Mapping Activity Statement (MAS) Activity 2 & Activity 4 Supplemental Information, April 13, 2005.

7. United States Geological Society, Methods for Estimating Flood Frequency in Montana Based on Data through Water Year 1998, February 2004.

8. Great West Engineering, Moores Creek Floodplain Study Project Mapping Activity Statement (MAS) Activity 6 Interim Hydraulic Analyses, April 13, 2005.

9. Computer Program HEC-RAS 3.1.3, River Analysis System. Davis County, California, May 1995.

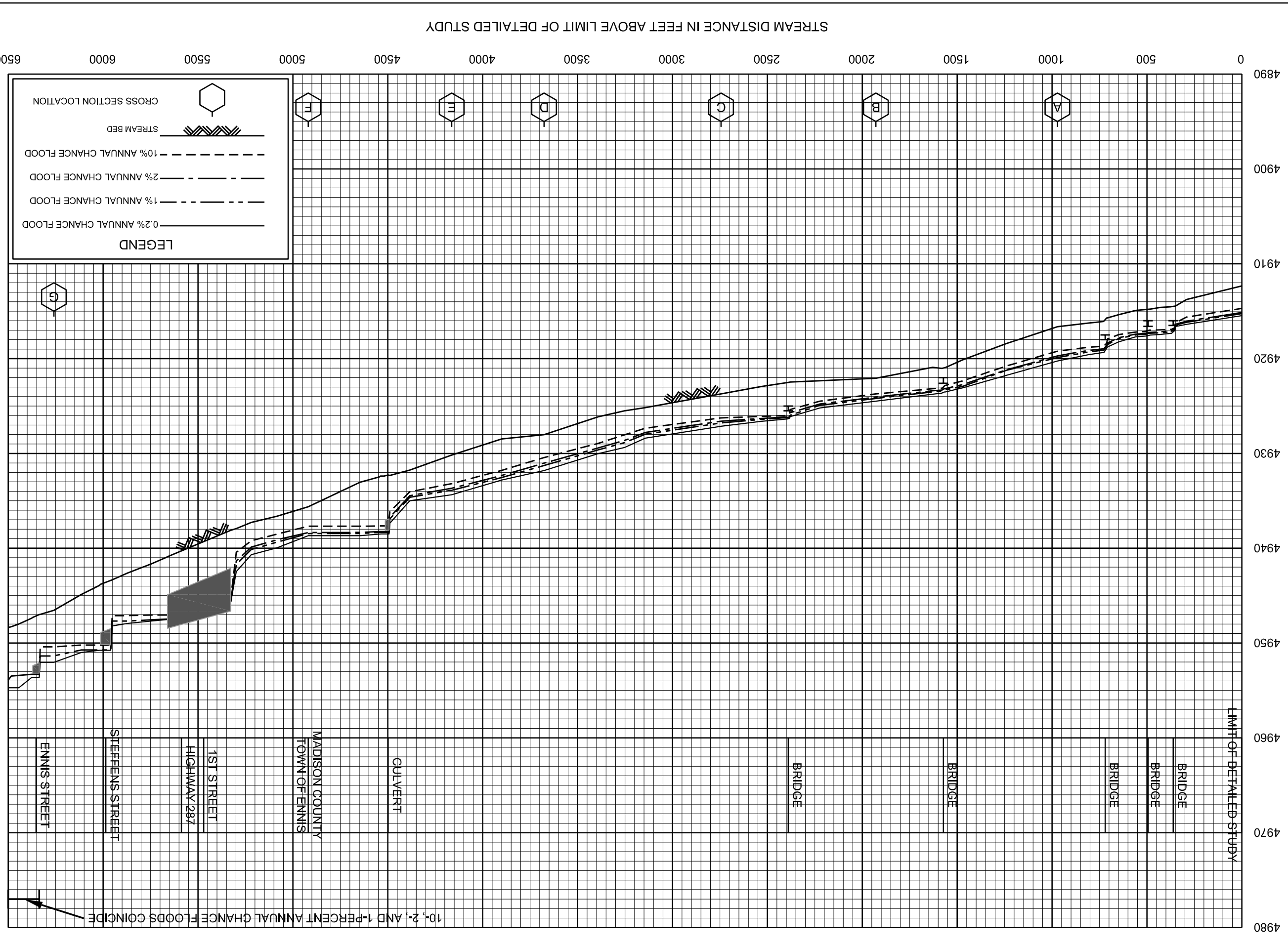
10. Entranco. Topographic Maps, Town of Ennis, Montana. Scale 1:1,200, Contour Interval 2 feet, (Aerial Photography Flown November 14, 2003).

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF ENNIS, MT
MADISON COUNTY

MOORES CREEK

FLOOD PROFILES



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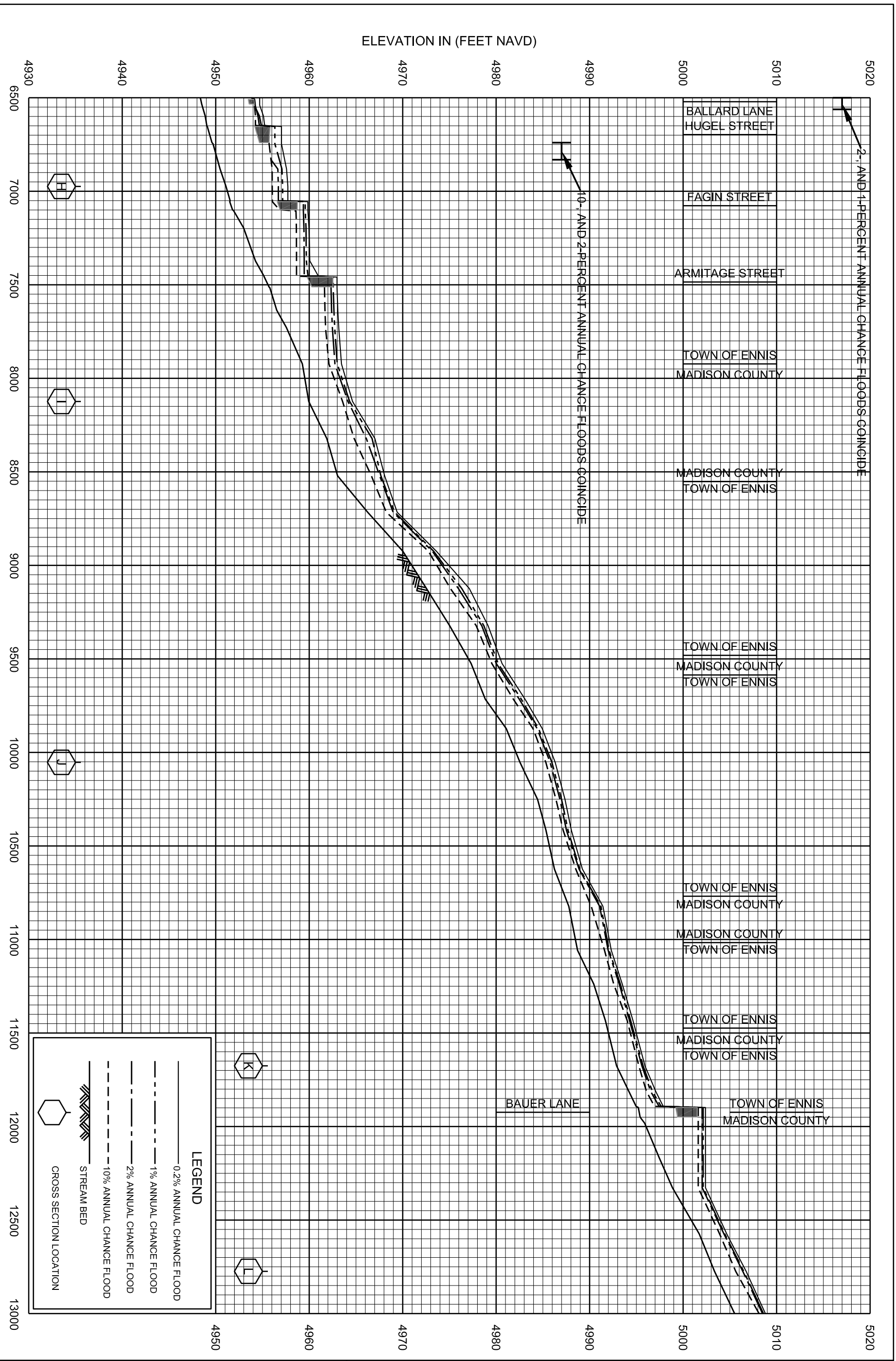

02P

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF ENNIS, MT
MADISON COUNTY

FLOOD PROFILES

MOORES CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF ENNIS, MT
MADISON COUNTY

03P

FLOOD PROFILES

MOORES CREEK

STREAM DISTANCE IN FEET ABOVE LIMIT OF DETAILED STUDY

13000 13500 14000 14500 15000 15500 16000 16500 17000 17500 18000 18500 19000 19500

ELEVATION IN (FEET NAVD)

4980 4990 5000 5010 5020 5030 5040 5050 5060 5070

LEGEND

- 0.2% ANNUAL CHANCE FLOOD
- 1% ANNUAL CHANCE FLOOD
- 2% ANNUAL CHANCE FLOOD
- 10% ANNUAL CHANCE FLOOD
- STREAM BED
- CROSS SECTION LOCATION

M

N

MOORES CREEK ROAD