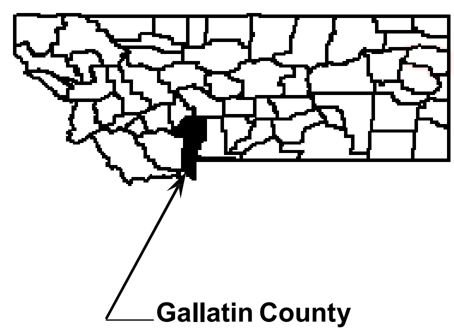
FLOOD INSURANCE STUDY

GALLATIN COUNTY, MONTANA

AND INCORPORATED AREAS
VOLUME 1 OF 4

Community Name	Community Number
* BELGRADE, CITY OF	300105
BOZEMAN, CITY OF	300028
GALLATIN COUNTY	
UNINCORPORATED AREAS	300027
* MANHATTAN, TOWN OF	300034
THREE FORKS, CITY OF	300029
* WEST YELLOWSTONE, TOWN OF	300135



* NON-FLOOD PRONE COMMUNITY

REVISED
APRIL 21, 2021

Reprinted with corrections on November 5, 2021

Federal Emergency Management Agency
Flood Insurance Study Number
30031CV001B

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
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.

Initial Countywide FIS effective date: September 2, 2011

Revised FIS Dates: April 21, 2021

This FIS report was reissued on November 5, 2021 to make a correction; this version replaces any previous versions. See the Notice-to-User Letter that accompanied this correction for details.

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(continued)

FLOOD INSURANCE STUDY
GALLATIN COUNTY, MONTANA AND INCORPORATED AREAS

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 Gallatin County, Montana, including the Cities of Belgrade, Bozeman and Three Forks; the Towns of Manhattan, and West Yellowstone; as well as the remaining unincorporated area (referred to collectively herein as Gallatin County), 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.

Please note that the City of Belgrade, and the Towns of Manhattan, and West Yellowstone are non-flood prone.

In some states or communities, floodplain management criteria or regulations may exist that are more restrictive or comprehensive than 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 2011 countywide FIS (Reference 1) was prepared by first utilizing data from the effective FIS reports for the City of Three Forks, the City of Bozeman, and the unincorporated areas of Gallatin County (Reference 2, 3 and 4). More recent data has also been incorporated from several sources: 1) two studies by Anderson Engineers, Inc. (Anderson), the study of the East Gallatin River (Reference 5), and the East Gallatin River and Bridger Creek Flood Insurance Re-Study (Reference 6); 2) data concerning the City of Three Forks area provided by David Smith and Associates (DSA) (Reference 7) and Van Mullen Engineers (VME)(Reference 8). Information on the authority and acknowledgements for each jurisdiction included in this countywide FIS, as compiled from their previously submitted FISs or the new studies listed above are presented in Figure 1, "Study and Stream Identification Map" and are described below:

City of Three Forks The hydrologic and hydraulic analyses for the original study were performed by the NRCS, for the Federal Insurance Administration, (FIA) under Inter-Agency Agreement No. IAA-H-9-76, Project Order No. 16. This work was completed in February 1979.

A re-study hydrologic and hydraulic analysis along with an ice jam analysis was performed by VME for FEM in May 2003 and revised in May 2004.

A LOMR, case # 15-08-1248P, was completed to convert areas on Zone D to Zone X (unshaded). This LOMR went effective on October 30, 2015.

A LOMR, case # 18-08-1069P, was completed to update Hydraulic analysis, and incorporate new topographic data. This LOMR went effective on March 14, 2019.

A LOMR, case # 18-08-1070P, was completed to update Hydraulic analysis, and incorporate new topographic data. This LOMR went effective on March 18, 2019.

A LOMR, case # 19-08-0500P, was completed to update Hydraulic analysis, and incorporate new topographic data. This LOMR went effective on March 2, 2020.

A LOMR, case # 19-08-0850P, was completed to update Hydraulic analysis, and incorporate new topographic data. This LOMR went effective on June 22, 2020.

A LOMR, case # 15-08-0124P, was completed to update Hydraulic analysis, and was superseded in the April 21, 2021 study. This LOMR went effective on October 23, 2015.

A LOMR, case # 18-08-1068P, was completed to update Hydraulic analysis, and superseded by the April 21, 2021 study. This LOMR went effective on March 18, 2019.

Gallatin County (Unincorporated Areas)

The hydrologic and hydraulic analyses for the original study were performed by the NRCS, for FEMA, under Inter-Agency Agreement No. IAA- H-9-76, Project Order No. 16. This work was completed in September 1979.

The City of Belgrade did not previously have an FIS or FIRMs published.

This Flood Insurance Study report revises and updates information on the existence and severity of flood hazards in the geographical area of the unincorporated area of Gallatin County along the West Gallatin River and tributaries. For the Bozeman River and its tributaries, multiple contractors were involved in the delivery of the many components that comprise the project. Allied Engineering Services, Inc. (Allied) completed the field surveying tasks for all flooding sources in the project area (Reference 9). The Allied tasks included the collection of cross-section survey data and hydraulic structure data. The topographic data collection was provided by a joint venture between Photo Science, Inc. and Gaston Engineering & Surveying (Reference 10). Respec Consulting & Services (Respec) completed the hydrologic analyses for the 6 main basins in the Bozeman Creek watershed (HUC 12 100200080905) (References 11 to 16) the work was completed April 2014.

1.3 Coordination

For this revision, the initial CCO meeting was held on January 24, 2017, and attended by representatives of FEMA, Study Contractor COMPASS, community officials, and the State NFIP Coordinator.

The final CCO meeting was held on January 24, 2017 to review and accept the results of this FIS. Those who attended this meeting included representatives of FEMA, the Study Contractor, FEMA, and the communities. All problems raised at that meeting have been addressed in this study.

The initial Consultation Coordination Officer (CCO) meetings were held with representatives from the communities, the State of Montana, the study contractors, the NRCS, and FEMA, to explain the nature and purpose of FISs, and to identify the streams to be studied by detailed methods. All affected communities were requested to provide any data pertinent to the study. The final CCO meetings were held with representatives from the communities, the study contractors, the state of Montana, and FEMA to review the results of the studies. The dates for all these meetings are listed on Table 1, "Initial and Final CCO Meeting Dates".

Table 1. Initial and Final CCO Meeting Dates

Community	Initial CCO Meeting Date	Final CCO Meeting Date
Bozeman, City of	November 5-6, 1975	February 2, 1981
	April 13, 1984	July 16, 1987
	*	*
Three Forks, City of	November 6,1975	September 11, 1979
Gallatin County	November 6, 1975	January 28, 1982
(Unincorporated Areas)	May 28, 1991	NA
	March 1995	NA
	May 30, 2001	November 7, 2002

* Dates not available for the 2007 Anderson study.

The 2002 and 2007 Anderson studies were coordinated through the Gallatin County Planning Department and the MDNRC.

For the 2011 countywide FIS the final CCO meeting was held on January 13, 2010 to review the results of the countywide FIS.

2.0 **AREA STUDIED**

2.1 Scope of Study

This FIS report covers the geographic area of Gallatin County, Montana, including the incorporated communities listed in Section 1.1. The areas studied by detailed methods were selected with priority given to all known flood hazards and areas of projected development or proposed construction through 2003 for the unincorporated areas of Gallatin County and the City of Three Forks, and through 1990 for City of Bozeman.

All, or portions of, the flooding sources listed in Table 2, "Detailed Studied Streams", were studied by detailed methods. Limits of detailed study are indicated on the Flood Profiles (Exhibit 1) and on the Flood Insurance Rate Maps (FIRMs).

Table 2. Detailed Studied Streams

3rd Avenue – Kagy Boulevard Split	I-90 Split
Baker Creek	Ice Pond Split
Baker Creek (Area) Overflow	Jefferson River
Baker Creek West Overflow	Kagy Rouse Split
Black Avenue Split	Linney Road Split
Bozeman Creek	Lower Black Avenue Split
Bridger Creek	Madison River
Buster Gulch	Main Street Split
Camp Creek	Mathew-Bird Creek
Cedar Street Split	Mill Ditch Diversion
Church Avenue Split	Museum Split
East Gallatin River	Moreland Ditch
East Gallatin River Golf Course Reach	Nash Road Split
East Gallatin River Overflow Reach	Nash-Spring Creek
East Gallatin River Spillway Reach	Rain Roper Split
East Gallatin River Springhill Reach	Rouse Avenue Downtown
Figgins Creek	Rouse Avenue Split
Flat Creek	Shed's Split
Flat Creek – East Kagy Boulevard Split	Sourdough Trail Split
Gallagator Split	Tracy Avenue Split
Garfield Street Split	Wallace Avenue Split
Golf Course Split	West Gallatin River
I-90 Diversion	West Gallatin East Overflow
I-90 Lateral	

For this countywide FIS, limits of detailed study for the newly studied or revised streams are shown in Table 3, "Limits of Detailed Study"

Table 3. Limit of Detailed Study

Stream Name	Limits of Detailed Study
3rd Avenue – Kagy Boulevard Split	From the confluence with Figgins Creek to the diversion of Figgins Creek
Baker Creek	From the approximately 0.8 mile from the confluence with West Gallatin River to the diversion from West Gallatin River
Baker Creek (Area) Overflow	From the confluence with the West Gallatin River upstream to approximately 11 miles upstream.

Stream Name	Limits of Detailed Study
Baker Creek West Overflow	From the confluence with Camp Creek upstream to the divergence from the West Gallatin River.
Black Avenue Split	From the confluence with Garfield Street Split to the diversion of Flat Creek
Bozeman Creek	From the confluence with the East Gallatin River upstream to approximately 0.18 mils upstream of Nash Road
Bridger Creek	From the confluence with the East Gallatin River to approximately 0.18 mile upstream of Fish Hatchery Road. The 2007 Anderson re-study only included the reach from the confluence with the East Gallatin River to approximately 1.0 river mile upstream of Story Mill Road.
Buster Gulch	From approximately 0.9 mile upstream of Airport Road to approximately 0.5 upstream of Sunny Access Drive.
Camp Creek	From the confluence with Baker Creek Area to its confluence with Baker Creek West Overflow
Cedar Street Split	From the confluence with Mill Ditch Diversion to the Diversion from Mill Ditch Diversion
Church Avenue Split	From the confluence with Bozeman Creek to the Diversion from Bozeman Creek
East Gallatin River	From the confluence with the Gallatin River to approximately 1.1 miles upstream of Kelly Canyon Road. The 2007 Anderson re-study was from Bozeman waste water treatment plant west of Springhill Road to approximately 8.6 miles upstream.
East Gallatin River Golf Course Reach	From the confluence with the East Gallatin River Springhill Reach to approximately 0.4 mile upstream (entire length).
East Gallatin River Overflow Reach	From the confluence with the East Gallatin River to approximately 2.8 miles upstream (entire length).
East Gallatin River Spillway Reach	From the confluence with the East Gallatin River Overflow Reach to approximately 0.5 mile upstream (entire length).
East Gallatin River Springhill Reach	From the confluence with East Gallatin River Overflow

Stream Name	Limits of Detailed Study
	Reach to approximately 0.4 mile upstream (entire length).
Figgins Creek	From the confluence with Mathew-Bird Creek to approximately 0.3 mil upstream of Alder Creek Road
Flat Creek	From the confluence with Rouse Avenue Split to approximately 500 feet downstream of Mathew Bird Circle
Flat Creek – East Kagy Boulevard Split	From the confluence with Mathew-Bird Creek to the Diversion from Flat Creek
Gallagator Split	From the confluence with Mill Ditch Diversion to the Diversion from Bozeman Creek
Garfield Street Split	From the confluence with Rouse Avenue Split to the Diversion from Mathew-Bird Creek
Golf Course Split	From the confluence with Flat Creek to the Diversion from Nash-Spring Creek
I-90 Diversion	From the confluence with Baker Creek to the Diversion from Mill Ditch
I-90 Lateral	From the confluence with I-90 Diversion to the Diversion from West Gallatin River
I-90 Split	From the confluence with East Gallatin River to the Diversion from Mill Ditch Diversion
Ice Pond Split	From the confluence of Bozeman Creek to the diversion of Bozeman Creek
Jefferson River	From approximately 3.5 miles upstream of the Madison River to approximately 120 feet upstream of Frontage Road
Kagy Rouse Split	From the confluence with Bozeman Creek to the Diversion from Nash-Spring Creek
Linney Road Split	From the confluence with Baker Creek Overflow to the Diversion from Baker Creek
Lower Black Avenue Split	From the confluence with Rouse Avenue Split to the Diversion from Golf Course Split
Madison River	From approximately 2.5 miles upstream of the confluence with the Jefferson River to approximately 1.2 miles upstream of Interstate Highway 90
Main Street Split	From the confluence with Church Avenue Split to the diversion from Rouse Avenue Downtown.

Stream Name	Limits of Detailed Study
Mathew-Bird Creek	From the confluence with Bozeman Creek to approximately 0.6 miles upstream of Goldenstein Lane
Mill Ditch Diversion	From the confluence with the East Gallatin River to the confluence with Bozeman Creek.
Moreland Ditch	From the confluence with Bozeman Creek to the Diversion from Bozeman Creek
Museum Split	From the confluence with Figgins Creek to the Diversion from Flat Creek
Nash Road Split	From the confluence with Bozeman Creek to the Diversion from Bozeman Creek
Nash-Spring Creek	From the confluence with Bozeman Creek to approximately 0.6 mile upstream of Goldenstein Lane.
Rain Roper Split	From the confluence with Mathew-Bird Creek to Diversion from Mathew-Bird Creek
Rouse Avenue Downtown	From the confluence with Bozeman Creek to the diversion from Bozeman Creek
Rouse Avenue Split	From the confluence with Bozeman Creek the Diversion from Flat Creek
Shed’s Split	From the confluence with West Gallatin River to the Diversion from West Gallatin River
Sourdough Trail Split	From the confluence with Nash Spring Creek to the Diversion from Bozeman Creek
Tracy Avenue Split	From the confluence with Mathew-Bird Creek to Diversion from Figgins Creek
Wallace Avenue Split	From the confluence with Bozeman Creek to the confluence of Church Avenue Split
West Gallatin River	From the confluence with East Gallatin River to approximately 4.0 mile upstream of Mill Street
West Gallatin East Overflow	From the confluence with West Gallatin River to the Overflow point from West Gallatin River

The limits of detailed study are indicated on the Flood Profiles (Exhibit 1) and on the FIRM (Exhibit 2).

Each FIS report provides floodplain data, which may include a combination of the following: 10-, 4-, 2-, 1-, and 0.2-percent-annual-chance flood elevations (the 1- percent-annual-chance flood elevation is also referred to as the Base Flood

Elevation (BFE)); delineations of the 1-percent-annual-chance floodway. This information is presented on the FIRM and/or in many components of the FIS report, including Flood Profiles and Floodway Data tables.

Figure 1 presents important considerations for using the information contained in this FIS report and the FIRM and is provided in response to changes in format and content.

Table 4 includes jurisdictions that are included in this project area, along with the Community Identification Number (CID) for each community and the 8-digit Hydrologic Unit Codes (HUC-8) sub-basins affecting each, are shown in Table 5. The Flood Insurance Rate Map (FIRM) panel numbers that affect each community are listed. If the flood hazard data for the community is not included in this FIS Report, the location of that data is identified.

The location of flood hazard data for participating communities in multiple jurisdictions is also indicated in the table.

Jurisdictions that have no identified SFHAs as of the effective date of this study are indicated in the table. Changed conditions in these communities (such as urbanization or annexation) or the availability of new scientific or technical data about flood hazards could make it necessary to determine SFHAs in these jurisdictions in the future.

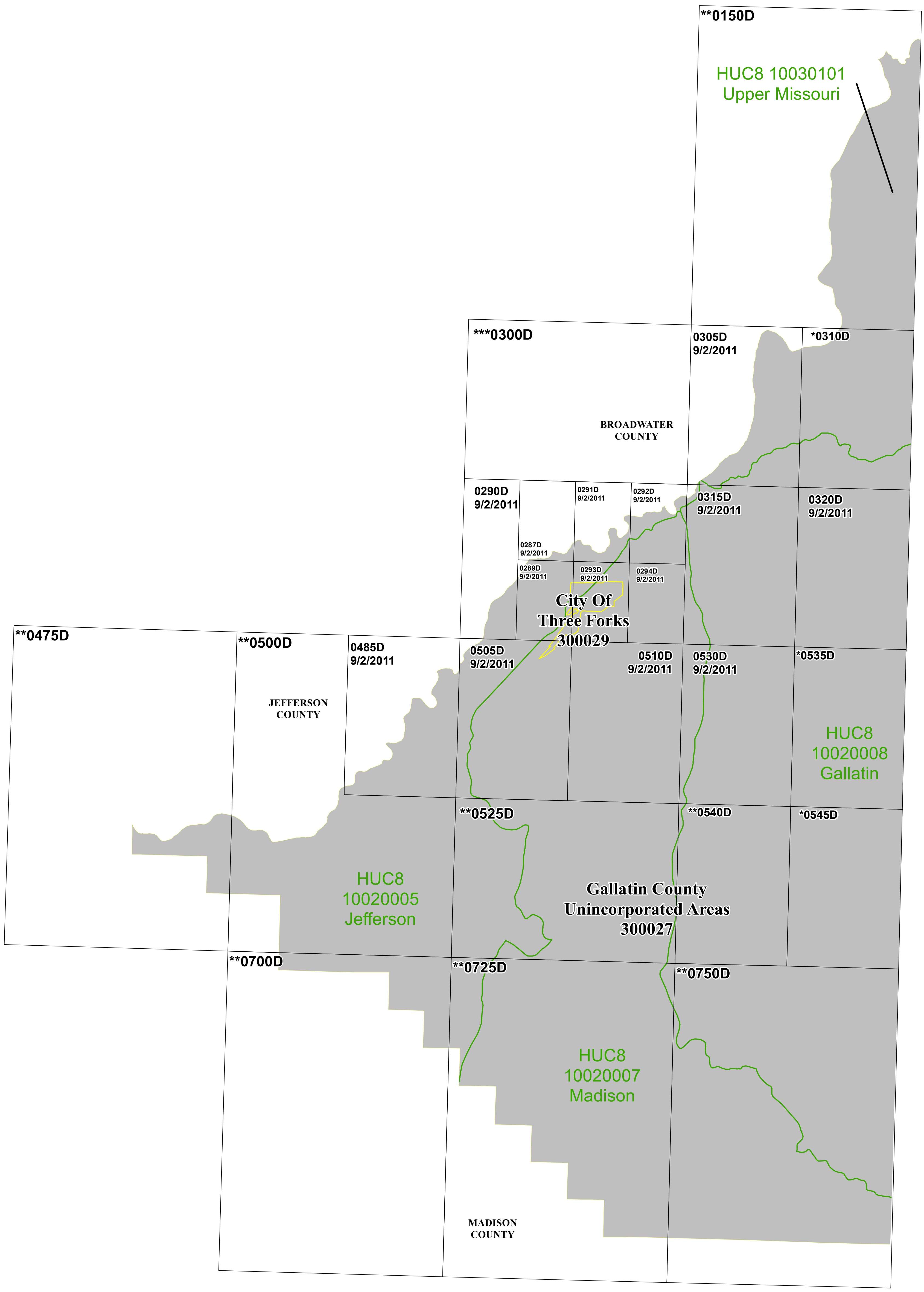
Table 4: Listing of NFIP Jurisdictions

Community	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s)	If Not Included, Location of Flood Hazard Data
City of Belgrade	300105	10020008	30031C0590D[1], 30031C0595D	
City of Bozeman	300028	10020008	30031C0802D, 30031C0803D[1], 30031C0804D[1], 30031C0806D, 30031C0807D[1], 30031C0808E, 30031C0809E, 30031C0811D[1], 30031C0812D[1], 30031C0814D[1], 30031C0816E, 30031C0817E, 30031C0818E, 30031C0819E, 30031C0828D, 30031C0836D	
Gallatin County, Unincorporated Areas	300027	10020005 10020007 10020008 10030101 10070002 10070003 17040202	30031C0025D[1], 30031C0050D[1], 30031C0075D[1], 30031C0100D[1], 30031C0125D[1], 30031C0150D[1], 30031C0175D[1], 30031C0200D[1], 30031C0225D[1], 30031C0250D[1], 30031C0275D[1], 30031C0287D, 30031C0289D, 30031C0290D, 30031C0291D, 30031C0292D, 30031C0293D, 30031C0294D, 30031C0305D, 30031C0310D[1], 30031C0315D, 30031C0320D, 30031C0340E, 30031C0345E, 30031C0350D[1], 30031C0365D, 30031C0375D[1], 30031C0400D[1], 30031C0425D[1], 30031C0450D[1], 30031C0475D[1], 30031C0485D, 30031C0500D[1], 30031C0505D, 30031C0510D, 30031C0525D[1], 30031C0530D, 30031C0535D[1], 30031C0540D[1], 30031C0545D[1], 30031C0555E, 30031C0558E, 30031C0559E, 30031C0560E, 30031C0565D, 30031C0566E, 30031C0567E, 30031C0568D[1], 30031C0569E, 30031C0580D, 30031C0585D, 30031C0586E, 30031C0588E, 30031C0590D[1], 30031C0595D, 30031C0605D[1], 30031C0610D[1], 30031C0615D, 30031C0620D[1], 30031C0640D[1], 30031C0645D[1], 30031C0650D[1], 30031C0675D[1], 30031C0700D[1], 30031C0725D[1], 30031C0750D[1], 30031C0760D[1], 30031C0770D[1],30031C0775D[1], 30031C0780E, 30031C0785D[1], 30031C0790E, 30031C0792D[1], 30031C0794D[1],30031C0795D[1], 30031C0801D, 30031C0802D,30031C0803D[1], 30031C0804D[1], 30031C0806D, 30031C0807D[1], 30031C0808E, 30031C0809E, 30031C0811D[1], 30031C0812D[1], 30031C0813D[1], 30031C0814D[1], 30031C0816E, 30031C0817E, 30031C0818E, 30031C0819E, 30031C0828D, 30031C0829D, 30031C0830D[1], 30031C0835D, 30031C0836D, 30031C0837D, 30031C0838D[1], 30031C0839D, 30031C0845D, 30031C0875D[1], 30031C0885D[1], 30031C0900D[1], 30031C0905E,	

Community	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s)	If Not Included, Location of Flood Hazard Data
Gallatin County, Unincorporated Areas	300027	10020005 10020007 10020008 10030101 10070002 10070003 17040202	30031C0910D[1], 30031C0925E, 30031C0926D[1], 30031C0927D[1], 30031C0931E, 30031C0932E, 30031C0935D, 30031C0950D[1], 30031C0955D[1], 30031C0960D, 30031C0975D[1], 30031C1000D[1], 30031C1025D[1], 30031C1050D[1], 30031C1075D, 30031C1100D[1], 30031C1114D, 30031C1118D, 30031C1119D, 30031C1125D[1], 30031C1130D[1], 30031C1131D, 30031C1133D, 30031C1135D[1], 30031C1136D, 30031C1137D, 30031C1138D, 30031C1139D[1], 30031C1145D[1], 30031C1175D[1], 30031C1200D[1], 30031C1207D, 30031C1225D[1], 30031C1226D, 30031C1228D, 30031C1236D, 30031C1250D[1], 30031C1275D[1], 30031C1300D[1], 30031C1325D[1], 30031C1350D[1], 30031C1375D[1], 30031C1400D[1], 30031C1425D[1], 30031C1450D[1], 30031C1475D[1], 30031C1500D[1], 30031C1525D[1], 30031C1550D[1], 30031C1575D[1], 30031C1600D1, 30031C1625D[1], 30031C1650D[1], 30031C1675D[1], 30031C1700D[1], 30031C1725D[1]	
Town of Manhattan	300034	10020008	30031C0555E	
City of Three Forks	300029	10020008	30031C0289D, 30031C0293D, 30031C0505D	
Town of West Yellowstone	300135	10020007	30031C1625D[1]	

Table 4: Listing of NFIP Jurisdictions (continued)

[1]Panel not Printed



ATTENTION: The corporate limits shown on this FIRM Index are based on the best information available at the time of publication. As such, they may be more current than those shown on FIRM panels issued before April 21, 2021.

N

1 inch = 3 miles

0 1.5 3 6 Miles

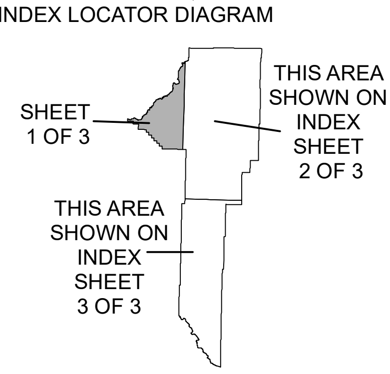
Map Projection:
StatePlane Montana FIPS 2500 Feet
North American Datum 1983

THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT

HTTPS://MSC.FEMA.GOV

SEE FLOOD INSURANCE STUDY FOR ADDITIONAL INFORMATION
*PANEL NOT PRINTED - NO SPECIAL FLOOD HAZARD AREAS
**PANEL NOT PRINTED - AREA IN ZONE D
***PANEL NOT PRINTED - AREA OUTSIDE COUNTY BOUNDARY

GALLATIN COUNTY, MT
INDEX LOCATOR DIAGRAM



NATIONAL FLOOD INSURANCE PROGRAM

FLOOD INSURANCE RATE MAP INDEX

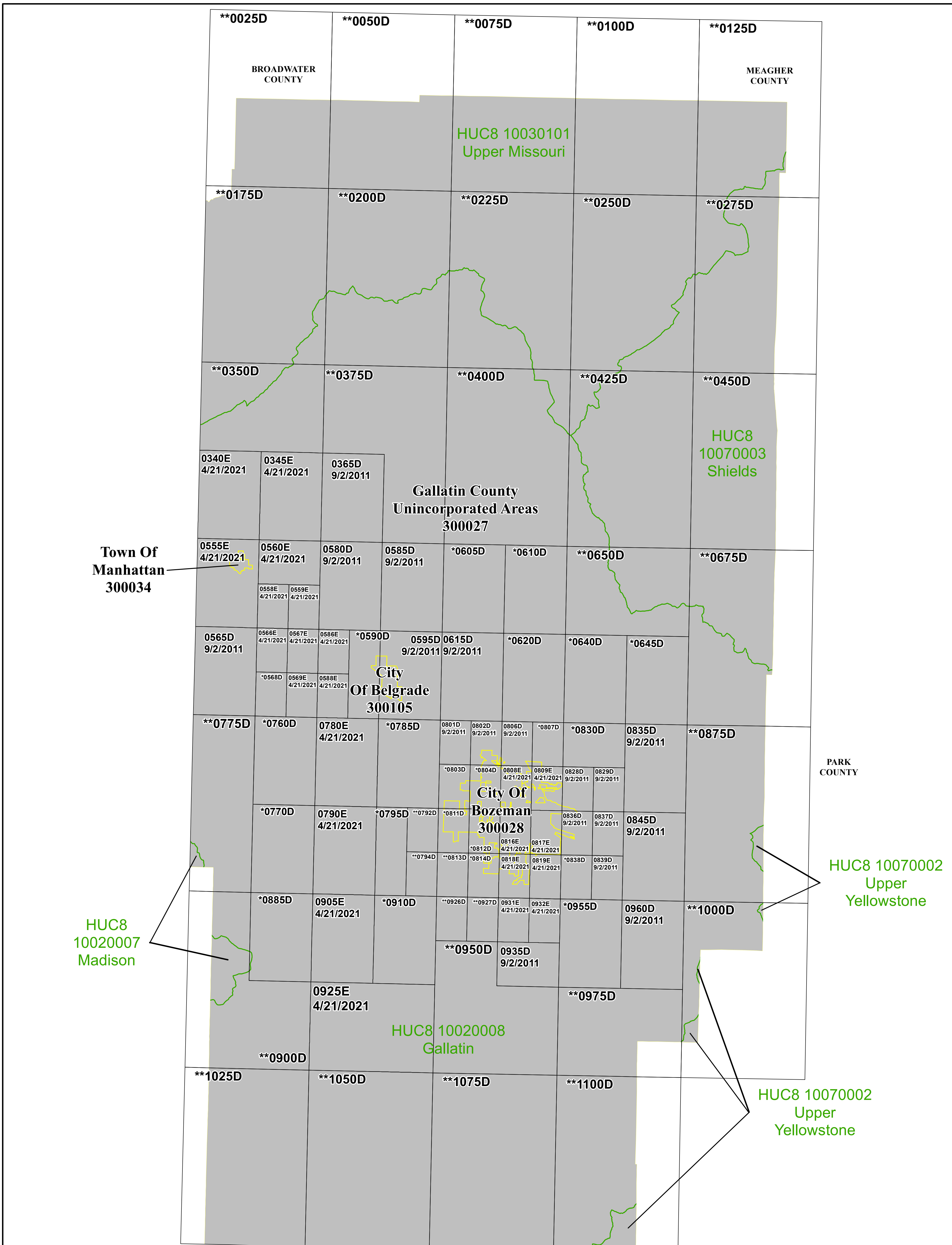
GALLATIN COUNTY, MONTANA And Incorporated Areas
SHEET 1 OF 3

PANELS PRINTED:
0287, 0289, 0290, 0291, 0292, 0293, 0294, 0305, 0315, 0320, 0485, 0525, 0510, 0530

FEMA

MAP NUMBER
30031CIND1B

MAP REVISED
April 21, 2021



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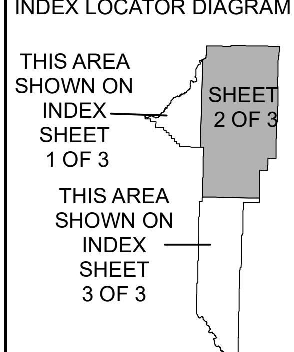
GALLATIN COUNTY, MT
INDEX LOCATOR DIAGRAM



NATIONAL FLOOD INSURANCE PROGRAM

FLOOD INSURANCE RATE MAP INDEX

GALLATIN COUNTY, MONTANA And Incorporated Areas

SHEET 2 OF 3

PANELS PRINTED:

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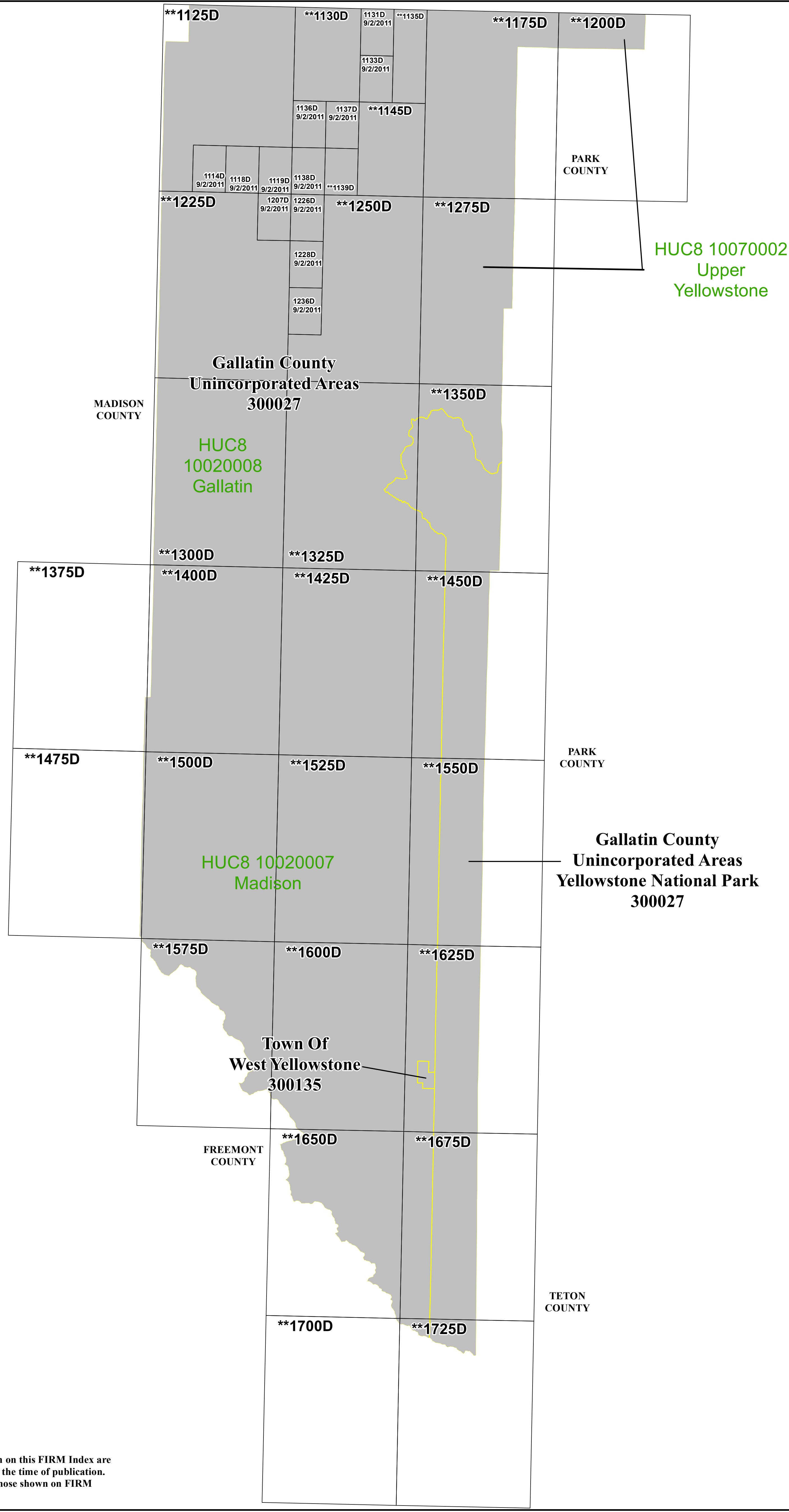
FEMA

MAP NUMBER
30031CIND2B

MAP REVISED
April 21, 2021



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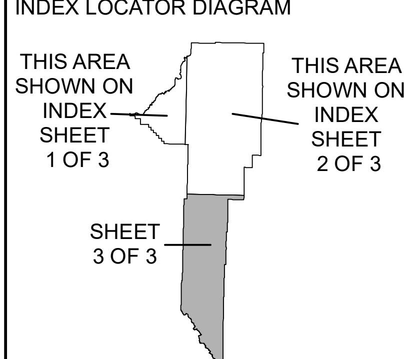
GALLATIN COUNTY, MT
INDEX LOCATOR DIAGRAM



NATIONAL FLOOD INSURANCE PROGRAM

FLOOD INSURANCE RATE MAP INDEX

GALLATIN COUNTY, MONTANA And Incorporated Areas
SHEET 3 OF 3

PANELS PRINTED:
1114, 1118, 1119, 1131, 1133, 1136, 1137, 1138, 1207, 1226, 1228, 1236

FEMA

MAP NUMBER
30031CIND3B

MAP REVISED
April 21, 2021

Figure 2 : FIRM Notes to Users

NOTES TO USERS

For information and questions about this map, available products associated with this FIRM including historic versions of this FIRM, how to order products, or the National Flood Insurance Program in general, please call the FEMA Mapping and Insurance eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Flood Map Service Center website at msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the website. Users may determine the current map date for each FIRM panel by visiting the FEMA Flood Map Service Center website or by calling the FEMA Mapping and Insurance eXchange.

Communities annexing land on adjacent FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM Index. These may be ordered directly from the Flood Map Service Center at the number listed above.

For community and countywide map dates, refer to Table 8 in this FIS Report.

To determine if flood insurance is available in the community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

PRELIMINARY FIS REPORT: FEMA maintains information about map features, such as street locations and names, in or near designated flood hazard areas. Requests to revise information in or near designated flood hazard areas may be provided to FEMA during the community review period, at the final Consultation Coordination Officer's meeting, or during the statutory 90-day appeal period. Approved requests for changes will be shown on the final printed FIRM.

The map is for use in administering the NFIP. It may not identify all areas subject to flooding, particularly from local drainage sources of small size. Consult the community map repository to find updated or additional flood hazard information.

BASE FLOOD ELEVATIONS: For more detailed information in areas where Base Flood Elevations (BFEs) and/or floodways have been determined, consult the Flood Profiles and Floodway Data and/or Summary of Non-Coastal Stillwater Elevations tables within this FIS Report. Use the flood elevation data within the FIS Report in conjunction with the FIRM for construction and/or floodplain management.

FLOODWAY INFORMATION: Boundaries of the floodways were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the FIS Report for this jurisdiction.

FLOOD CONTROL STRUCTURE INFORMATION: Certain areas not in Special Flood Hazard Areas may be protected by flood control structures. Refer to Section 4.3 "Non-Levee Flood Protection Measures" of this FIS Report for information on flood control structures for this jurisdiction.

PROJECTION INFORMATION: The projection used in the preparation of the map was State Plane Montana FIPS 2500. The horizontal datum was the North American Datum of 1983 NAD83, GRS1980 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of the FIRM.

ELEVATION DATUM: Flood elevations on the FIRM are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at www.ngs.noaa.gov.

BASE MAP INFORMATION: Base map information shown on the FIRM was provided by Gallatin County GIS Department in 2015 at a scale of 1:5,000.

The map reflects more detailed and up-to-date stream channel configurations than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables may reflect stream channel distances that differ from what is shown on the map.

Corporate limits shown on the map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after the map was published, map users should contact appropriate community officials to verify current corporate limit locations.

NOTES FOR FIRM INDEX

REVISIONS TO INDEX: As new studies are performed and FIRM panels are updated within Gallatin County, MT, corresponding revisions to the FIRM Index will be incorporated within the FIS Report to reflect the effective dates of those panels. Please refer to Table 8 of this FIS Report to determine the most recent FIRM revision date for each community. The most recent FIRM panel effective date will correspond to the most recent index date.

Figure 3: Map Legend for FIRM

SPECIAL FLOOD HAZARD AREAS: *The 1% annual chance flood, also known as the base flood or 100-year flood, has a 1% chance of happening or being exceeded each year. Special Flood Hazard Areas are subject to flooding by the 1% annual chance flood. The Base Flood Elevation is the water surface elevation of the 1% annual chance flood. The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights. See note for specific types. If the floodway is too narrow to be shown, a note is shown.*

	Special Flood Hazard Areas subject to inundation by the 1% annual chance flood (Zones A, AE, AH, AO, AR, A99, V and VE)
Zone A	The flood insurance rate zone that corresponds to the 1% annual chance floodplains. No base (1% annual chance) flood elevations (BFEs) or depths are shown within this zone.
Zone AE	The flood insurance rate zone that corresponds to the 1% annual chance floodplains. Base flood elevations derived from the hydraulic analyses are shown within this zone.
Zone AH	The flood insurance rate zone that corresponds to the areas of 1% annual chance shallow flooding (usually areas of ponding) where average depths are between 1 and 3 feet. Whole-foot BFEs derived from the hydraulic analyses are shown at selected intervals within this zone.
Zone AO	The flood insurance rate zone that corresponds to the areas of 1% annual chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. Average whole-foot depths derived from the hydraulic analyses are shown within this zone.
Zone AR	The flood insurance rate zone that corresponds to areas that were formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
Zone A99	The flood insurance rate zone that corresponds to areas of the 1% annual chance floodplain that will be protected by a Federal flood protection system where construction has reached specified statutory milestones. No base flood elevations or flood depths are shown within this zone.
Zone V	The flood insurance rate zone that corresponds to the 1% annual chance coastal floodplains that have additional hazards associated with storm waves. Base flood elevations are not shown within this zone.
Zone VE	Zone VE is the flood insurance rate zone that corresponds to the 1% annual chance coastal floodplains that have additional hazards associated with storm waves. Base flood elevations derived from the coastal analyses are shown within this zone as static whole-foot elevations that apply throughout the zone.
	Regulatory Floodway determined in Zone AE.

OTHER AREAS OF FLOOD HAZARD	
	Shaded Zone X: Areas of 0.2% annual chance flood hazards and areas of 1% annual chance flood hazards with average depths of less than 1 foot or with drainage areas less than 1 square mile.
	Future Conditions 1% Annual Chance Flood Hazard – Zone X: The flood insurance rate zone that corresponds to the 1% annual chance floodplains that are determined based on future-conditions hydrology. No base flood elevations or flood depths are shown within this zone.
	Area with Reduced Flood Risk due to Levee: Areas where an accredited levee, dike, or other flood control structure has reduced the flood risk from the 1% annual chance flood. See Notes to Users for important information.
OTHER AREAS	
	Zone D (Areas of Undetermined Flood Hazard): The flood insurance rate zone that corresponds to unstudied areas where flood hazards are undetermined, but possible.
NO SCREEN	Unshaded Zone X: Areas of minimal flood hazard.
FLOOD HAZARD AND OTHER BOUNDARY LINES	
(ortho) (vector)	Flood Zone Boundary (white line on ortho-photography-based mapping; gray line on vector-based mapping)
	Limit of Study
	Jurisdiction Boundary
	Limit of Moderate Wave Action (LiMWA): Indicates the inland limit of the area affected by waves greater than 1.5 feet
GENERAL STRUCTURES	
Aqueduct *Channel* *Culvert* *Storm Sewer*	Channel, Culvert, Aqueduct, or Storm Sewer
Dam *Jetty* *Weir*	Dam, Jetty, Weir

	Levee, Dike, or Floodwall
Bridge	Bridge
COASTAL BARRIER RESOURCES SYSTEM (CBRS) AND OTHERWISE PROTECTED AREAS (OPA): *CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas. See Notes to Users for important information.*	
CBRS AREA **09/30/2009**	Coastal Barrier Resources System Area: Labels are shown to clarify where this area shares a boundary with an incorporated area or overlaps with the floodway.
OTHERWISE **PROTECTED AREA** **09/30/2009**	Otherwise Protected Area
REFERENCE MARKERS	
22.0	River mile Markers
CROSS SECTION & TRANSECT INFORMATION	
B 20.2	Lettered Cross Section with Regulatory Water Surface Elevation (BFE)
5280 21.1	Numbered Cross Section with Regulatory Water Surface Elevation (BFE)
17.5	Unlettered Cross Section with Regulatory Water Surface Elevation (BFE)
8	Coastal Transect
	Profile Baseline: Indicates the modeled flow path of a stream and is shown on FIRM panels for all valid studies with profiles or otherwise established base flood elevation.
	Coastal Transect Baseline: Used in the coastal flood hazard model to represent the 0.0-foot elevation contour and the starting point for the transect and the measuring point for the coastal mapping.
513	Base Flood Elevation Line
ZONE AE **(EL 16)**	Static Base Flood Elevation value (shown under zone label)
ZONE AO **(DEPTH 2)**	Zone designation with Depth

ZONE AO (DEPTH 2) (VEL 15 FPS)	Zone designation with Depth and Velocity
BASE MAP FEATURES	
Missouri Creek	River, Stream or Other Hydrographic Feature
234	Interstate Highway
234	U.S. Highway
234	State Highway
234	County Highway
MAPLE LANE	Street, Road, Avenue Name, or Private Drive if shown on Flood Profile
RAILROAD	Railroad
	Horizontal Reference Grid Line
	Horizontal Reference Grid Ticks
+	Secondary Grid Crosshairs
Land Grant	Name of Land Grant
7	Section Number
R. 43 W. T. 22 N.	Range, Township Number
$^{42}76^{000m}E$	Horizontal Reference Grid Coordinates (UTM)
365000 FT	Horizontal Reference Grid Coordinates (State Plane)
80° 16’ 52.5”	Corner Coordinates (Latitude, Longitude)

2.2 Community Description

Gallatin County is located in southwestern Montana. It is bordered by Broadwater and Meagher Counties to the north; Park County and Yellowstone National Park to the east; Fremont County and the State of Idaho to the south; and Madison and Jefferson Counties to the west.

The headwaters of numerous streams are located in Gallatin County that forms in part, the Gallatin and Madison Rivers. The Gallatin River joins the Madison and Jefferson Rivers to form the Missouri River in the northwestern part of the county, near the City of Three Forks. Gallatin County has experienced a continuous growth in population. The US Census Bureau estimates the population of Gallatin County in 2014 as 97,308 (Reference 17).

The City of Bozeman, the county seat, is located in central Gallatin County, in southwestern Montana along Bozeman Creek, which, along with the tributaries of Rocky, Bear, and Bridger Creeks, forms the East Gallatin River. The city is entirely surrounded by unincorporated areas of Gallatin County. The US Census Bureau estimates the population of the City of Bozeman in 2014 as 41,660 (Reference 17).

The City of Three Forks is located in western Gallatin County, in southwestern Montana. The city is bounded on the east by the Madison River and on the west and north by the Jefferson River. The city is bounded at the northwest corner by Broadwater County. The remaining limits are bordered by unincorporated area of Gallatin County. The US Census Bureau estimates the population of City of Three Forks in 2009 as 1,970 (Reference 17).

The climate in Gallatin County is characterized by warm summers and cold winters. The mean annual temperature varies from 43 degrees Fahrenheit (°F) in the City of Bozeman to 46°F in the City of Three Forks. The average maximum temperature for Bozeman is 80°F and for Three Forks is 87°F. The average minimum temperatures are 11°F and 10°F, respectively. Extremes range from high temperatures above 100°F in July and August to lows below -40°F during winter. Average annual precipitation varies from approximately 12 inches at Three Forks approximately 18 inches at Bozeman (Reference 18). Average annual precipitation at the top of the mountain ranges at the head of various drainages varies from 40 inches in the Jefferson River basin to 60 inches in the Gallatin and Madison River basins (Reference 19).

2.3 Principal Flood Problems

Flood flows on the streams studied in detail are caused primarily by snowmelt or snowmelt and rain during the months of April, May, and June. The county is subject to warm, westerly Chinook winds that are usually responsible for the rapid snowmelt. Flooding can also be caused by ice jams forming in the winter. This problem is especially prevalent on the Madison River.

<u>Bozeman Creek, Bridger Creek, East Gallatin River</u>

Most severe flooding events in the Bozeman Creek watershed (HUC 12 100200080905) have been produced either from high snowmelt, or rain on snow events. Notable flooding within this watershed has occurred numerous times, most recently in May 2011. In the May 25, 2011, edition of the Bozeman Daily Chronicle (Reference 20), multiple pictures show the extensive flooding that occurred along Bozeman Creek. During that flooding event, water spilled out of the banks of Bozeman Creek, finding alternative flowpaths in some locations. Many culverts and bridges, particularly in the downtown area, were overtopped and water flowed freely down roads and caused damage to numerous structures. Per information in a May 26, 2011, Bozeman Daily Chronicle article (Reference 21), Bozeman Creek overtopped Mendenhall Street and Kagy Boulevard causing multiple road and sidewalk closures. The floodwaters threatened numerous commercial buildings in the downtown areas as well.

Notable flooding occurred along Bozeman Creek in April 1893, with the most recent occurring in April 1977. In 1948, heavy snowfall for 2 weeks throughout the East Gallatin River valley was followed by a period of warm weather. Maximum temperatures reached 68°F, resulting in rapid snowmelt and heavy surface runoff. The crest of the flood occurred on April 15, 1948. Runoff from farm land south of Bozeman entered the city and flowed northerly, causing considerable flood damage. This was the maximum flood of record. There are no known high-water marks existing for any of these flooding events.

Bridger Creek flooding is generally restricted to areas along the main channel because it is fairly well entrenched; however, overtopping can occur along the low bank just south of the bridge on State Highway 86, causing minor flooding along Bridger Drive in Bozeman.

Flooding along East Gallatin River north of Bozeman spreads out over a wide flood plain area. At numerous places, the bottom of the river channel is higher in elevation than flood plain land away from the channel. When flooding occurs, overland flows often travel considerable distances downstream before they can return to the main channel.

<u>West Gallatin River</u>

The studied portion of West Gallatin River has numerous areas where the river flows through a number of braided, unstable channels. In some cases, the riverbed is higher than nearby flood plain land. Debris jams, or ice jams, can cause the river to flood at

unpredictable places. The United States Army Corps of Engineers (USACE) reported that ice jams have caused higher flood stages downstream at Logan, Montana and downstream of Interstate Highway 90. The maximum flood of record occurred on June 1997 as a result of rapid snowmelt. A peak discharge of 9,160 cubic feet per second (cfs) was recorded on June 2, 1997 at U.S. Geological Survey (USGS) gage 06043500 near Gallatin Gateway. Erosion damage to roads, bridges, and irrigation structures has been most severe from prolonged high snowmelt runoff (Reference 22).

Notable flooding has occurred since 1952, with the most recent occurring in 1975. The maximum flood of record occurred in June 1974 as a result of rapid snowmelt. A peak discharge of 9,690 cubic feet per second (cfs) was recorded on June 17, 1974, at the U.S. Geological Survey (USGS) gage near Gallatin Gateway (No. 6-0435). This flood had an estimated recurrence interval of 35 years. A discharge of 12,350 cfs will cause more overflow in Baker Creek and Camp Creek than occurred during the 1974 flood.

<u>City of Three Forks Area</u>

The two principal sources of flooding in the Three Forks area are the Jefferson River, northwest of Three Forks, and the Madison River, east of Three Forks. Flooding from the Jefferson River has usually occurred during the high spring runoff period in May and June.

Flooding from the Madison River has primarily been due to ice jams and overtopping or failure of protective levees.

Jefferson River

The most recent major flood on the Jefferson River occurred in 1948 (estimated to have been equal to a 4-percent-annual-chance flood) with a flow of 19,900 cfs recorded at the USGS gage near Sappington (No. 6-0345) just upstream of Three Forks. Floodwater overtopped U.S. Highway 10 west of the overpass at the Chicago, Milwaukee, St. Paul and Pacific Railroad southwest of Three Forks. Floodwater entered the western part of Three Forks and flowed northerly.

A base (1-percent-annual-chance) flood elevations (BFEs) of the Jefferson River is expected to produce a flood flow that would exceed the capacity of Jefferson River above

U.S. Highway 10. Water would flow easterly to the intersection of the U.S. Highway 10 overpass and the Chicago, Milwaukee, St. Paul and Pacific Railroad west of Three Forks. Here, the water will overtop both highway and railroad, allowing floodwater to enter Three Forks on both sides of the railroad tracks.

A potential for increased flooding at Three Forks from the Jefferson River exists from the restriction of the flood plain caused by Interstate Highway 90. This would force water over the Chicago, Milwaukee, St. Paul and Pacific Railroad tracks north of Three Forks, where it would then flow back into the city (Reference 23).

Madison River

Prior to construction of the Madison River dike in 1920, flooding occurred nearly every year, inundating parts of the valley floor (Reference 24). There is no record of major flooding in Three Forks from the Madison River.

The 1-percent-annual-chance ice jam flood is expected to force the Madison River over the west levee or break out of the channel upstream of the levee. Water would move northwesterly and be impounded by the highway system, causing it to back up into Three Forks.

2.4 Flood Protection Measures

Nonstructural measures of flood protection are being utilized to aid in the prevention of future flood damage. These are in the form of land-use regulations adopted from the code of Federal and State regulations that control building within areas that have a high risk of flooding. Gallatin County does have flood plain zoning in effect. Construction is restricted within the confines of the 1- percent-annual-chance flood plain. Construction is allowed if buildings are flood proofed or built with a first-floor elevation equal to or greater than 2 feet above the 1-percent-annual-chance flood elevation. Areas within this study that have a defined 1-percent-annual-chance flood plain are Bozeman Creek, Bridger Creek, East Gallatin River, and West Gallatin River.

There are no major flood-control structures on Bozeman Creek, Bridger Creek, or East Gallatin River. There is a minor flood control structure adjacent to East Gallatin River at the Riverside Country Club, 2 miles northwest of Bozeman. However, this structure does not provide flood protection against the 1-percent- annual-chance flood event.

West Gallatin River can be considered a wild and Natural River until it breaks out of the canyon onto the valley floor. From the mouth of the canyon downstream to Interstate Highway 90, there are several irrigation diversions that can significantly reduce channel flow; the major diversions alone can account for approximately 1,500 cfs. Also, there are several minor earthen berms which have been built along portions of the main channel of West Gallatin River to prevent overflow to the west into Baker Creek.

The Jefferson River has several dams on its tributaries, but these have little modifying effect on peak discharges. The Chicago, Milwaukee, St. Paul and Pacific Railroad bed acts as a levee like structure when flows from the Jefferson River overtop U.S. Highway 10, as in 1948. These provide some protection for the City of Three Forks, on the east side of the railroad, from Jefferson River flooding of a 4-percent-annual-chance or less recurrence interval.

The USACE completed a study and plan for a protective dike to be constructed on the west side of City of Three Forks. This dike would protect Three Forks from Jefferson River floods (Reference 23). The current status of this project is unknown.

The Madison River is controlled to some degree by the operations of Hebgen Dam, Quake Lake, and Ennis Lake that are all located upstream of the study area. Hebgen Lake especially can have some modifying effect on peak discharges, depending on how it is managed.

Levees have been built on both sides of Madison River in the area east of Three Forks. The first levee was constructed in 1919-1920 to protect low-lying land east of Three Forks (Reference 23). Following the ice jam flood of 1949, levees were rebuilt and raised. The levees now direct river flows through several railroad and highway bridges that have a large capacity, except during winter periods when the channel freezes up and becomes blocked with ice. The east levee is higher than the west levee, preventing water from flowing easterly as in the 1949 flood. The east levee and Interstate Highway 90 put additional pressure on the west levee south of the highway. During winter ice jams, failure or overtopping of the west levee can occur, allowing water to back into Three Forks. The potential for damaging floods in Three Forks has been increased due to the rebuilding of the east levee and interstate highway construction in the mid-1960s. This is evidenced by the recent ice jam floods of 1972, 1975, and 1978 that backed water in near city development.

The levees along Madison River should not be considered adequate for full flood protection. Additional rebuilding and protective riprap are needed for this levee system. The upper portion of the west levee is particularly vulnerable where the Madison River flows adjacent to the levees.

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 each community.

September 2, 2011 Countywide Study

The hydrologic analysis was divided into three general areas: (1) the area around the City of Bozeman involving East Gallatin River, Bridger Creek, and Bozeman Creek; (2) the area along West Gallatin River; and (3) the area around the City of Three Forks involving the Jefferson and Madison Rivers.

Bozeman Area

Peak discharges for the selected recurrence intervals for each gage site used in the original analysis discussed below were computed using log-Pearson Type III analysis (Reference 25).

To estimate peak discharge-frequency relationships for the detailed studied streams, regression equations using peak discharge for a selected frequency and drainage area were developed for 10 gages on streams in or near the study area. While these estimates of peak discharge for a selected frequency do not agree exactly with the analysis of the data for any one gage on streams in the study area, the results do correlate well.

Because all gages on streams within the study area had records of 25 years or less, the regional equations are considered more reliable. Therefore, these equations were used to develop peak discharge- frequency relationships for all detailed studied streams in this area.

USGS gage records in this area are Rocky Creek near Bozeman (No. 6-0465, 20 years of record); East Gallatin River at Bozeman (No. 6-0480, 22 years of record); Bear Canyon Creek near Bozeman (No. 6-0470,18 years of record); and Bridger Creek near Bozeman (No. 6-0485, 25 years of record) (Reference 26, 27, and 28).

Discharges for Buster Gulch near Bozeman were determined by split flow analysis of the junction where floodwater spills from the East Gallatin River floodplain into the Buster Gulch channel.

The hydrologic analysis that was developed in 1996 for the adjacent reach of the East Gallatin River was reviewed and adopted for the 2002 Anderson Study.

The stream gage for the East Gallatin River near Bozeman (USGS 0604800) was analyzed following the methods described in Guidelines for Determining Flood Flow Frequency, Bulletin 17B (Reference 29). There were 23 years of record, with continuous record from 1940 through 1961 and with 1981 as an historic event. The flood of 1981 was the largest during the period from 1940 through 1995. The flood of 1997 was probably the second largest since 1940; however, the peak discharge was not recorded in 1997.

To extend the record and improve the flood frequency analysis for the East Gallatin River, a two-station comparison was made between gauge (0604800) and the Gallatin River gauge at Logan (06052500). The gauge at Logan had 73 years of record. A good correlation was obtained between the two records. The analysis resulted in increased discharges for the East Gallatin River.

The study reach is located downstream several miles from the USGS stream gage (06052500). The drainage area at the stream gage is 148 square miles and in the study reach is 262 square miles. A regional analysis was made to determine the flood frequency discharge in the study reach. Data from 13 stream gages in the region was used for the regional analysis. Most of these streams, like the East Gallatin, have their headwaters in the Bridger or Gallatin Mountain Ranges and have similar watershed and climate characteristics.

The best equation related the 1-percent-annual-chance peak discharge (Q100) to drainage area (A), watershed elevation (E), and percent above 6,000 feet elevation (HE). The 1-percent-annual-chance discharge for various locations on the East Gallatin was then determined by the ratio of the regional equation to the East Gallatin gauge values as follows:

$$Q_{100} = 2305\ (A/148)^{.601}(E/6.21)^{5.456}(HE/51)^{-1.398}$$

The value of 2,305 cfs is the 1-percent-annual-chance peak discharge at the Bozeman stream gage. The peak discharges at other frequencies were assumed to be proportional to the values of those frequencies at the Bozeman stream gage.

Peak discharges for the 10, 2, 1 and 0.2-percent-annual-chance storms were arrived at by analyzing three existing flood studies of this stretch of the East Gallatin River and Bridger Creek. After carefully analyzing these values they were found to be accurate up until the confluence of the East Gallatin River with Bridger Creek. Beginning at the confluence, the referenced peak discharge values from the 2003 Old River Farm/Manley Meadows Hydrology and Hydraulic Analyses were used. In that report the values at the confluence were updated by NRCS to reflect small out-of-bank losses to the west. These values were recommended for use in modeling the East Gallatin River upstream of Manley Road by the NRCS, and were in turn used in the 2007 Anderson re-study from the confluence to the downstream end of the study.

Peak discharge values for Bridger Creek beginning at the Story Mill Road bridge were referenced from the 2002 hydraulic report for the MDOT BR 86-1(23)3 CN 4230 project. In that report peak discharge values were calculated for the purposes of the design and construction of a new bridge over Bridger Creek.

West Gallatin River Area

Records from the USGS gage, West Gallatin River near Gallatin Gateway (No. 6-0435), were used to estimate peak discharge-frequency relationships in this area (Reference 29, 30, and 31). The study area includes several secondary channels into which floodwater flows as West Gallatin River water-surface elevations rise. The peak discharges developed for this area were routed among these various channels based on the capacity of each.

Peak discharges developed from the West Gallatin River gage near Gallatin Gateway were consistently higher than the regional equation developed from data on 19 gages in the area. These estimated peak discharges are valid because this gage record is 52 years in length, includes the recent high flow years of the 1970s, and has drainage with higher precipitation.

Peak discharges for the entire reach were developed using a ratio of the drainage area at the gage to the drainage area at a particular point raised to the exponent developed in the regional regression analysis.

There are several irrigation diversions on West Gallatin River between the USGS gage near Gallatin Gateway and Interstate Highway 90. The larger of these historically has accounted for a reduction in flow of approximately 1,500 cfs: however, for the purpose of

this study, the diversions were not assumed to be operating. There is no assurance that they would be operating or operable during a major flood event.

Peak discharges for the local watershed which drains into the Baker Creek Area and the Camp Creek Watershed were developed using a regression equation similar to the one cited earlier. These local peak discharges would not contribute to the West Gallatin River peak because of the great difference in times of concentration. This can be attributed to the fact that the individual watersheds of these tributaries are much smaller in comparison to the West Gallatin River.

Three Forks Area

The peak discharge-frequency relationship for Madison River at the City of Three Forks was based on regional regression equations developed using peak discharges for selected frequencies and drainage area data from 19 selected USGS stream gages in the surrounding area.

Two gages on Madison River were included in this analysis. One is USGS gage No. 6-0410, Madison River below Ennis Lake near McAllister, which has 34 years of record; and the other is USGS gage No. 6-0425, Madison River near Three Forks, which has 16 years of record (Reference 26, 27, and 28). Estimates of peak discharges from direct analyses of these gages, using log- Pearson Type III analysis (Reference 25) equations, compared very closely with estimates from the regression equations. Because neither of these records on Madison River was long enough to be completely reliable, the regression equations were considered to give more reliable estimates of the discharge frequency relationship on Madison River at the City of Three Forks. The 17 other gages used in the development of the regression equations were located in the Gallatin and Jefferson River drainage basins.

A problem which is especially prevalent on Madison River is flooding caused by ice jams during the winter. To develop flood flow-frequency information for this period, records for the USGS gage near Three Forks (No. 6-0425) were used. Maximum monthly flows for December, January, and February were analyzed. The discharge-frequency curve for January gave the highest estimates of flow for this period. These values were projected to Three Forks using a ratio of drainage areas to the 0.65 power. It was assumed for the purposes of this analysis that 50 percent of the Madison River flows during ice jam conditions would remain within the levees, and the remaining 50 percent would spillover the west levee and backup into Three Forks. This assumption was supported by comparison with historic flood elevations.

The peak discharge-frequency relationship for Jefferson River near the City of Three Forks was also based on the regression equations used for Madison River. Three gages on the main stem of Jefferson River were included in the analysis. They were USGS gage No. 6-0265, Jefferson River near Twin Bridges, which has 17 years of record; USGS gage No.6-0272, Jefferson River near Silverstar, which has 26 years of record; and USGS gage No. 6-0345, Jefferson River near Sappington, which has 40 years of record (Reference 26, 27, and 28). The gage near Sappington is closest to Three Forks. The regression equation gives estimates of peaks for selected frequencies that were higher than those computed directly from the data for the Sappington gage and the Twin Bridges gage using log-Pearson Type III analysis (Reference 25). However, the peaks computed from the data at the Silverstar gage were higher than those from the regression equations. To balance out this inconsistency, as well as take full advantage of as much data as possible, the regression equation was considered to yield a more reliable estimate of peak discharges for Jefferson River near Three Forks. The regression equation was, therefore, used to estimate the l-percent-annual-chance peak discharge. The slope of the discharge- frequency line developed for the gage near Sappington was used to estimate discharges for other frequencies at the City of Three Forks. Peak discharges for all local drainages were developed using the regional regression equation directly.

<u>This Revision to the Countywide:</u>

Revised hydrologic analyses for the primary flooding sources in the Bozeman Creek watershed were completed by Respec from January 2014 to April 2014 in order to establish discharges for the 10-, 4-, 2-, 1, and 0.2-percent-annual-chance flood events for use in the hydraulic analysis (Reference 20, 21, and 32 to 35). Each analysis included of several different regression equations, a rainfall runoff model, and the effective discharge rates, as well as a recommendation for the discharges that should be used in the hydraulic model.

This study also updates approximately 30 miles of the West Gallatin River, beginning at the confluence with the East Gallatin River and extending upstream approximately four river miles above of the community of Gallatin Gateway, Montana. Two active United States Geological Survey (USGS) gaging stations are located in the vicinity of the study area. The USGS gage 06043500 Gallatin River near Gallatin Gateway is on the West Gallatin River approximately six miles above the study area and has been in operation since 1890. USGS gage 06052500 Gallatin River at Logan, MT is approximately 5.6 miles below the confluence of the West and East Gallatin Rivers (downstream limit of study area) and has been in operation since 1895. A third USGS gaging station (USGS gage 06044000 Gallatin River near Salesville, MT) is no longer in service, but was operational from 1895 to 1923. This gage was located approximately 3.7 miles downstream of the Gallatin Gateway gage.

The hydrologic analyses included flood frequency analysis following Bulletin 17B Guidelines at two stream gages (USGS 1982), along with drainage-area ratio adjustments for estimating peaks at ungagged sites per USGS WRIR 03-4308 (Parrett & Johnson 2004). The USGS PeakFQ software program (Flynn, Kirby and Hummel 2006) was used to perform the log-Pearson III flood frequency analysis. The analysis was summarized in the hydrologic report title ‘Hydrology Design Report, West Gallatin River, Gallatin County, MT (MMI 2015) which was reviewed and approved by FEMA’s National Service Provider (NSP) and the MT DNRC as documented in their letters dated April 6, 2015 and April 7, 2015, respectively.

A summary of drainage area-peak discharge relationships for each stream studied in detail is shown in Table 5, “Summary of Discharges.”

Table 5. Summary of Discharges

Flooding Source and Location	Drainage Area (Square Miles)	Hydraulic Cross Section	Peak Discharges (cubic Feet per second) 10-Percent-Annual Chance	4-Percent-Annual Chance	2-Percent-Annual Chance	1-Percent-Annual Chance	0.2-Percent Annual Chance
3rd Avenue – Kagy Split							
At divergence from Figgins Creek	*	1,324	40	89	122	144	196
Baker Creek							
Confluence with West Gallatin River Lateral Weir	*	4,991	1,073	1,324	1,517	1,717	2,375
Confluence with West Gallatin River Lateral Weir	*	8,777	1,007	1,199	1,347	1,505	2,070
Confluence with West Gallatin River Lateral Weir	*	15,615	920	1,062	1,170	1,287	1,778[2]
Confluence with Baker Creek Overvlow	*	42,252	809	928	1,012	1,096	1,297
Flow Split to Linney Road Reach	*	62,594	202	216	221	229	248
Flow from West Gallatin River Lateral Weir	*	63,500	405	432	443	458	495
Upstream Limit	*	65,547	303	322	328	339	367
Baker Creek Overflow							
Confluence with Linney Road Reach	*	16,295	793	910	993	1,076	1,276
Confluence with Moreland Ditch	*	27,543	776	892	973	1,056	1,254

Table 5. Summary of Discharges

Flooding Source and Location	Drainage Area (Square Miles)	Hydraulic Cross Section	Peak Discharges (cubic Feet per second)				
			10-Percent-Annual Chance	4-Percent-Annual Chance	2-Percent-Annual Chance	1-Percent-Annual Chance	0.2-Percent Annual Chance
Confluence with West Gallatin River Lateral Weir	*	31,012	158	221	270	319	428
Confluence with West Gallatin River Lateral Weir	*	32,965	159	221	269	317	421
Upstream Limit	*	33,456	24	49	70	92	142
Black Avenue Split							
At divergence from Flat Creek	*	2,972	14	17	19	26	35
Bozeman Creek							
At I-90	*	3,817	484	614	729	874	1,252
Downstream of confluence with Wallace Avenue Split	*	4,795	467	585	689	816	1,152
At Aspen Street	*	5,858	460	574	675	796	1,132
Downstream of confluence with Church Avenue Split	*	6,765	476	616	761	924	1,378
At Lamme Street	*	8,566	458	570	707	863	1,302
At Mendenhall Street	*	8,948	399[1]	442[1]	486[1]	540[1]	676[1]
At Olive Street	*	10,202	512	*	837	1007	1,411
Approximately 150 feet upstream of Story Street	50	11,561	512	685	837	1,007	1,475
At Mill Ditch Diversion Structure	*	11,829	512	685	837	1,007	1,411

Table 5. Summary of Discharges

Flooding Source and Location	Drainage Area (Square Miles)	Hydraulic Cross Section	Peak Discharges (cubic Feet per second) 10-Percent-Annual Chance	4-Percent-Annual Chance	2-Percent-Annual Chance	1-Percent-Annual Chance	0.2-Percent Annual Chance
Approximately 100 feet upstream of Mill Ditch Diversion Structure	*	11,927	531	724	877	1,039	1,447
Just downstream of Gallagator Split	*	12,135	531	726	884	1,052	1,485
Just downstream of confluence with Rouse Avenue Split	*	13,969	439[1]	550	652[1]	768[1]	1,088[1]
Just downstream of confluence with Kagy/Rouse Split	*	18,559	387	497	592	682	969
Just downstream of confluence with Nash Spring Creek	*	20,724	387	489	567	636	818
Just upstream of confluence with Nash Spring Creek	*	20,786	343	427	490	543	688
Downstream of divergence of Sourdough Trail Split	*	27,296	338	420	475	532	668
Approximately 3,400 feet downstream of Goldenstein Lane	*	27,305	338	422	478	538	678
Approximately 3,000 feet downstream of Goldenstein Lane	*	28,687	453	630	751	879	1,172

Table 5. Summary of Discharges

Flooding Source and Location	Drainage Area (Square Miles)	Hydraulic Cross Section	Peak Discharges (cubic Feet per second) 10-Percent-Annual Chance	4-Percent-Annual Chance	2-Percent-Annual Chance	1-Percent-Annual Chance	0.2-Percent Annual Chance
At Goldenstein Lane	*	31,772	388	538	644	743	972
Approximately 500 feet upstream of Goldenstein Lane	*	32,217	377	523	625	720	953
At confluence with Nash Road Split	*	45,459	377	525	647	777	1,120
At Nash Road	30	47,091	374	468	517	553	605
Approximately 300 feet upstream of Nash Road	*	47,519	375	517	628	737	995
Upstream limit of detailed study – approximately 900 feet upstream of Nash Road	*	47,979	377	525	647	777	1,120
Bridger Creek							
At confluence with East Gallatin River	70	*	790	*	1,170	1,350	1,810
At upstream limit of study	64	*	725	*	1,090	1,260	1,700
Buster Gulch							
Entire Reach	*	*	407	*	582	673	898
Cedar Street Split							
At divergence from Mill Ditch Diversion	*	1,312	19	52	69	88	137
Church Avenue Split							
At Fridley Street	*	865	17	47	54	61	76
At Davis Street	*	1,306	23	57	65	73	89
At Lamme Street	*	1,689	2[1]	15[1]	29[1]	45[1]	94[1]
At Mendenhall Street	*	2,069	36	82	92	103	125
At Main Street	*	2,436	48	106	119	133	161

Table 5. Summary of Discharges

Flooding Source and Location	Drainage Area (Square Miles)	Hydraulic Cross Section	Peak Discharges (cubic Feet per second)				
			10-Percent-Annual Chance	4-Percent-Annual Chance	2-Percent-Annual Chance	1-Percent-Annual Chance	0.2-Percent Annual Chance
At divergence from Bozeman Creek	*	3,601	73	135	185	239	387
East Gallatin River							
At Airport Road	262	*	1,810	*	2,880	3,420	4,900
Near Commercial Drive	162	*	1,510	*	2,130	2,390	3,030
At confluence with Bozeman Creek	148	*	1,410	*	1,990	2,250	2,880
At Griffin Drive	96	*	1,100	*	1,590	1,810	2,360
At confluence with Mill Ditch Diversion	95	*	1,100	*	1,560	1,770	2,290
Approximately 1.3 miles upstream from CMSP&P Railroad	95	*	1,000	*	1,460	1,670	2,190
Figgins Creek							
Approximately 450 feet downstream of Kagy Boulevard	*	280	39	58	66	93	142
Approximately 400 feet downstream of Kagy Boulevard	*	322	49	76	92	124	187
Approximately 300 feet downstream of Kagy Boulevard	*	414	51	84	108	149	235
Downstream of Kagy Boulevard	*	514	91	149	198	240	360
Approximately 400 feet downstream of 3rd Avenue	*	1,431	51	60	76	96	164
At 3rd Avenue	*	1,862	46	53	67	85	150

Table 5. Summary of Discharges

Flooding Source and Location	Drainage Area (Square Miles)	Hydraulic Cross Section	Peak Discharges (cubic Feet per second) 10-Percent-Annual Chance	4-Percent-Annual Chance	2-Percent-Annual Chance	1-Percent-Annual Chance	0.2-Percent Annual Chance
Downstream of confluence with Museum Split	*	2,198	86	142	189	229	346
Approximately 300 feet downstream of Overbrook Drive	*	2,711	81	123	154	179	249
Approximately 600 feet upstream of Overbrook Drive	*	3,970	48	70	85	98	129
Downstream of divergence of Museum Split	*	4,026	35	49	59	65	77
Approximately 800 feet downstream of Brookdale Drive	*	5,882	40	68	94	115	174
At Brookdale Drive	*	6,766	23	42	58	72	110
Approximately 200 feet upstream of Alder Creek Drive	*	7,747	15	27	38	48	75
Upstream limit of study – approximately 1,500 feet upstream of Alder Creek Road	*	9,071	10	19	27	34	52
Flat Creek							
Downstream of Black Avenue	*	1,191	29	29	31	31	33
Approximately 120 feet downstream of Kagy Boulevard	*	1,319	57	63	68	82	97
Approximately 100 feet downstream of Kagy Blvd	*	1,344	60	66	72	90	106
Just upstream of Kagy Blvd	*	1,592	67	74	82	112	133

Table 5. Summary of Discharges

Flooding Source and Location	Drainage Area (Square Miles)	Hydraulic Cross Section	Peak Discharges (cubic Feet per second) 10-Percent-Annual Chance	4-Percent-Annual Chance	2-Percent-Annual Chance	1-Percent-Annual Chance	0.2-Percent Annual Chance
Approximately 300 feet upstream of Kagy Boulevard	*	1,702	90	168	232	308	420
Downstream of confluence with Golf Course Split	*	1,808	91	176	248	336	515
Upstream limit of study – approximately 500 feet downstream of Mathew Bird Circle	*	5,566	11	17	22	26	38
Flat/Kagy Split							
At divergence from Flat Creek	*	697	23	102	167	224	362
Gallagator Split							
At divergence from Bozeman Creek	*	279	10	31	51	78	145
Garfield Street Split							
Just downstream of Black Avenue	*	1,212	10	96	163	218	438
Just upstream of Black Avenue	*	1,371	14	113	190	257	518
At divergence from Mathew Bird Creek	*	1,459	15	121	205	277	565
Golf Course Split							
	*	356	91	176	248	336	514
	*	482	91	184	273	380	610
	*	755	91	184	273	381	669
	*	1,084	91	179	263	357	598
	*	1,266	37	95	163	230	409
	*	1,419	37	95	162	224	369
Garfield Street Split							
	*	356	91	176	248	336	514
	*	482	91	184	273	380	610

Table 5. Summary of Discharges

Flooding Source and Location	Drainage Area (Square Miles)	Hydraulic Cross Section	Peak Discharges (cubic Feet per second) 10-Percent-Annual Chance	4-Percent-Annual Chance	2-Percent-Annual Chance	1-Percent-Annual Chance	0.2-Percent Annual Chance
	*	755	91	184	273	381	669
	*	1,084	91	179	263	357	598
	*	1,266	37	95	163	230	409
	*	1,419	37	95	162	224	369
At divergence from Nash Spring Creek							
I-90 Diversion							
Confluence with Heeb Road West	*	3,667	221	256	293	341	647
Upstream Limit	*	7,829	219	250	281	319	588
I-90 Lateral							
Upstream Limit	*	7,615	2	6	12	23	60
I-90 Lateral							
At divergence for Mill Ditch Diversion	*	3,806	0	33	71	113	220
I-90 Split							
At confluence with East Gallatin River	*	*	21	87	155	222	388
Jefferson River							
At Three Forks	9,600	*	18,300	*	25,000	27,600	34,000
Kagy/Rouse Split							
Approximately 500 feet downstream of Kagy Boulevard	*	556	*	8	25	45	151
At divergence from Golf Course Split	*	1,066	0	8	25	45	155
Lower Black Split							
	*	541	3	8	11	11	30
	*	622	3	7	8	13	23
	*	709	4	17	25	39	44
	*	867	4	17	25	39	44
	*	1,266	4	17	28	39	81

Table 5. Summary of Discharges

Flooding Source and Location	Drainage Area (Square Miles)	Hydraulic Cross Section	Peak Discharges (cubic Feet per second) 10-Percent-Annual Chance	4-Percent-Annual Chance	2-Percent-Annual Chance	1-Percent-Annual Chance	0.2-Percent Annual Chance
At divergence from Garfield Street Split							
Linney Rd. Split							
Upstream Limit	*	4,181	202	216	221	229	248
Madison River							
At Three Forks (Spring runoff)	2,535	*	8,000	*	10,800	12,000	14,900
At Three Forks (Winter runoff)	2,535	*	2,600	*	3,295	3,550	4,135
Main Street Split							
At confluence with Church Avenue Split	*	*	11	33	53	71	94
Matthew Bird Creek							
	*	1,754	169	208	234	257	302
Approximately 500 feet downstream of Garfield Street	*	1,843	169	199	218	229	251
At Garfield Street	*	2,262	151	169	179	187	219
Just upstream of Hoffman Drive	*	5,117	165	282	369	444	737
Approximately 100 feet downstream of Graf Street	*	10,510	77	158	234	303	490
Approximately 450 feet upstream of Graf Street	*	11,096	71	150	224	290	473
At confluence with Rain Roper Split	*	14,073	62	133	200	260	428

Table 5. Summary of Discharges

Flooding Source and Location	Drainage Area (Square Miles)	Hydraulic Cross Section	Peak Discharges (cubic Feet per second) 10-Percent-Annual Chance	4-Percent-Annual Chance	2-Percent-Annual Chance	1-Percent-Annual Chance	0.2-Percent Annual Chance
Approximately 450 feet upstream of Graf Street	*	11,096	71	150	224	290	473
At confluence with Rain Roper Split	*	14,073	62	133	200	260	428
Approximately 1,400 feet downstream of Peace Pipe Lane	*	14,294	61	100	114	126	144
	*	14,706	55	89	100	108	120
	*	14,801	55	89	100	108	120
	*	15,247	56	99	116	130	150
Approximately 300 feet downstream of Peace Pipe Lane	*	15,481	56	111	145	171	214
Just upstream of Peace Pipe Lane	*	15,773	56	122	186	242	338
Just upstream of Goldenstein Lane	*	17,343	56	122	186	242	404
Upstream limit of study – approximately 3,500 feet upstream of Goldenstein Lane	*	20,778	19	34	47	58	88
Mill Ditch Diversion							
Just downstream of I-90	*	79	92	130	138	143	157
Just upstream of I-90	*	266	87	121	126	128	135
Just downstream of confluence with Cedar Street Split	*	282	87	154	197	241	355

Table 5. Summary of Discharges

Flooding Source and Location	Drainage Area (Square Miles)	Hydraulic Cross Section	Peak Discharges (cubic Feet per second) 10-Percent-Annual Chance	4-Percent-Annual Chance	2-Percent-Annual Chance	1-Percent-Annual Chance	0.2-Percent Annual Chance
Just upstream of Cedar Street	*	1,404	68	102	128	153	218
Just downstream of confluence with Mill/ Railroad Split	*	1,611	87	154	197	241	355
Approximately 650 feet downstream of Railroad Crossing	*	2,322	87	154	197	239	291
Just upstream of Railroad Crossing	*	3,018	77	136	171	207	242
	*	3,534	57	97	132	161	176
	*	3,576	57	97	132	161	184
Approximately 1,400 feet downstream of Main Street	*	4,536	57	97	132	163	240
Just upstream of Main Street	*	5,973	35	72	98	123	158
	*	8,745	29	72	98	123	155
At confluence with Gallagator Split	*	8,938	29	72	98	123	219
At divergence from Bozeman Creek	*	9,226	19	41	45	45	74
Mill Railroad Split							
At divergence from Mill Ditch Diversion	*	815	0	0	0	2	64
Moreland Ditch							
Upstream Limit	*	1,870	566	593	603	612	631
Museum Split							
At divergence from Flat Creek	*	1,561	5	19	36	51	97

Table 5. Summary of Discharges

Flooding Source and Location	Drainage Area (Square Miles)	Hydraulic Cross Section	Peak Discharges (cubic Feet per second) 10-Percent-Annual Chance	4-Percent-Annual Chance	2-Percent-Annual Chance	1-Percent-Annual Chance	0.2-Percent Annual Chance
Nash Road Split							
At divergence from Bozeman Creek	*	2,373	3	57	130	224	515
Nash Spring Creek							
	*	458	68	90	102	116	131
	*	515	69	94	110	132	176
	*	669	69	95	113	140	203
	*	752	97	135	159	196	282
	*	896	122	179	212	267	392
	*	994	122	179	213	271	420
	*	1,064	122	179	213	273	431
	*	1,157	125	188	229	300	483
	*	1,283	125	193	240	323	534
At divergence of Golf Course Split	*	1,436	156	254	335	441	710
Approximately 300 feet downstream of confluence with Sourdough Trail Split	*	4,176	159	274	375	497	800
Downstream of confluence with Sourdough Trail Split	*	4,609	157	271	373	493	795
Approximately 150 feet downstream of Goldenstein Lane	*	10,392	73	122	167	225	457
At Goldenstein Lane	*	10,574	62	104	153	207	420
Upstream limit of study – approximately 3,500 feet upstream of Goldenstein Lane	*	14,160	62	104	153	207	420

Table 5. Summary of Discharges

Flooding Source and Location	Drainage Area (Square Miles)	Hydraulic Cross Section	Peak Discharges (cubic Feet per second) 10-Percent-Annual Chance	4-Percent-Annual Chance	2-Percent-Annual Chance	1-Percent-Annual Chance	0.2-Percent Annual Chance
Peace Pipe Split							
At divergence from Mathew Bird Creek	*	2,877	0	0	0	0	66
Rain Roper Split							
	*	379	1	33	86	134	219
	*	525	1	33	86	134	218
	*	792	1	33	86	133	216
	*	1,023	0	21	63	103	173
At divergence from Mathew Bird Creek	*	1,180	0	12	42	72	125
Rouse Avenue Downtown							
At confluence with Bozeman Creek	*	*	47[1]	94[1]	137[1]	189[1]	356[1]
Downstream of Main Street Split divergence	*	*	47[1]	107[1]	155[1]	211[1]	376[1]
At divergence from Bozeman Creek	*	*	56	158	253	355	603
Rouse Avenue Split							
Below confluence with Garfield Street Split	*	751	53	104	174	229	467
Below confluence with Flat Creek	*	3,380	53	58	63	86	107
	*	4,727	25	28	32	55	74
At divergence from Flat Creek	*	4,769	14	17	19	26	39
Sourdough Trail Split							
At Divergence from Bozeman Creek	*	1,765	115	210	277	346	504

Table 5. Summary of Discharges

Flooding Source and Location	Drainage Area (Square Miles)	Hydraulic Cross Section	Peak Discharges (cubic Feet per second)				
			10-Percent-Annual Chance	4-Percent-Annual Chance	2-Percent-Annual Chance	1-Percent-Annual Chance	0.2-Percent Annual Chance
Tracy Avenue Split							
At divergence from Figgins Creek	*	840	54	95	137	153	225
Wallace Avenue Split							
At confluence with Bozeman Creek	*	2,786	7[1]	16[1]	23[1]	31[1]	49[1]
At Tamarack Street	*	*	14[1]	25[1]	33[1]	41[1]	60[1]
At Davis Street	*	3,238	30	68	95	122	188
At Mendenhall Street	*	3,982	11[1]	24[1]	34[1]	45[1]	74[1]
At divergence from Church Avenue Split	*	4,826	29	59	85	113	184
West Gallatin River							
Headwaters of Gallatin River	1,100	-121	7,668	8,845	9,667	10,450	12,160
East Overflow Flow Split	1,098	20,324	7,653	8,739	9,491	10,205	11,735
Confluence with Baker Creek	1,097	21,688	7,664	8,766	9,535	10,269	11,859
Flow Split to Baker Creek North I-90	1,097	24,752	7,081	7,942	8,516	9,037	9,961
Flow Split to Baker Creek North I-90	1,096	26,546	7,181	8,105	8,724	9,293	10,321
Flow Split to Baker Creek at I-90	1,079	38,860	7,296	8,276	8,938	9,548	10,655
Flow Split to Baker Creek South I-90	1,075	42,105	7,418	8,424	9,114	9,760	11,124
Flow Split to Baker Creek at North Diversion	1,023	68,398	7,419	8,430	9,126	9,783	11,183
Flow Split to Baker Creek at Moreland Ditch	1,010	75,810	7,454	8,468	9,165	9,824	11,228

Table 5. Summary of Discharges

Flooding Source and Location	Drainage Area (Square Miles)	Hydraulic Cross Section	Peak Discharges (cubic Feet per second) 10-Percent-Annual Chance	4-Percent-Annual Chance	2-Percent-Annual Chance	1-Percent-Annual Chance	0.2-Percent Annual Chance
Flow Split to Baker Creek Overflow South Cameron Bridge	1,010	76,476	7,506	8,545	9,265	9,951	11,431
Flow Split to Baker Creek Overflow South Cameron Bridge	1,004	78,758	7,506	8,545	9,266	9,953	11,438
Flow Split to Baker Creek Overflow South Cameron Bridge	1,003	79,310	7,640	8,717	9,465	10,177	11,717
Confluence with Shed's Split	888.7	105,350	7,664	8,766	9,535	10,269	11,859
Flow Split from Shed's Split	888.7	105,986	7,451	8,525	9,254	9,924	11,265
Flow Split to Shed's Split	888.7	106,900	7,451	8,526	9,260	9,938	11,305
Flow Split to Shed's Split	888.7	107,039	7,451	8,526	9,260	9,938	11,315
Flow Split to Shed's Split	888.7	107,608	7,451	8,526	9,261	9,948	11,366
Flow Split to Shed's Split	888.7	108,014	7,451	8,531	9,279	9,986	11,498
Upstream Study Limits	888.7	163,181	7,664	8,755	9,535	10,269	11,859
Shed's Split							
Confluence with West Gallatin River	*	0	213	242	281	345	594
Flow Split from West Gallatin River	*	1,003	213	240	275	331	554
Flow Split from West Gallatin River	*	1,071	213	240	274	321	493
Upstream Limit	*	1,804	213	232	246	257	282
West Gallatin East Overflow Upstream Study Limits	*	3,667	221	256	293	341	592

* Data not Available

[1] Discharge decrease downstream due to flow loss to split

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.

<u>September 2, 2011 Countywide Study</u>

Hydraulic analysis of all the streams studied was complicated by the fact that once flow exceeded the capacity of the main channel, it usually dropped into one (or more) secondary channels or was lost to an entirely different channel or overflow area. This required the development of several independent water- surface profile computations to be made on each channel or overflow area. Discharge curves for over bank flow also had to be developed or estimated to determine the amount of flow that would transfer from one channel or flow area to another.

Composite discharge curves were developed combining channel discharge curves with over bank discharge curves or other channel curves. These composite discharge curves were used to determine flow losses or flow splits at points where channels separated or at points where water overtopped roads, railroads, levees, or natural banks.

Cross Sections

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway is computed (Section 4.2), selected cross section locations are also shown on the FIRM. Distances between cross sections are channel distances including meander lengths.

Bozeman Area

Cross sections presented in the original study were developed for East Gallatin River and Buster Gulch from topographic data (Reference 30). Underwater cross sections for East Gallatin River and Buster Gulch were obtained by field- surveying methods for every fifth cross section. Bridge and culvert data were gathered in the field by the NRCS in 1971. Supplemental field surveys were made in 1978 at critical locations to ensure accuracy.

Cross sections for the hydraulic analysis presented in the 2002 and 2007 Anderson re-studies for East Gallatin River were developed from the digital terrain model developed by photogrammetric methods from aerial photographs taken in September of 2001. This data was supplemented with field surveys at bridge locations.

West Gallatin River Area

Due to the braided nature of the stream channels on West Gallatin River, Baker Creek Area, Baker Creek West Overflow, Camp Creek, and Jefferson River, the distances between cross sections do not necessarily follow a defined stream channel. Thus, the distances between cross sections for these streams, as measured on the FIRM, will not necessarily match the distances shown in the Floodway Data Table (FDT) referenced as Table 7 later in this report. This is due to the fact that the distances in the hydraulic model represent the flow path taken during the 1-percent-annual-chance flood event.

For the West Gallatin River, the area upstream of Cameron Bridge, cross sections were located by field surveys conducted by the NRCS in 1976 and 1977. These sections include bridge and culvert data. From Cameron Bridge to Interstate Highway 90, cross section data were developed from topographic data (Reference 31). Underwater sections were obtained by field-surveying methods for approximately every fifth cross section. In 1978, the NRCS gathered all bridge and culvert crossing data from field observations. Some supplemental field survey data were also gathered at critical overflow areas.

Three Forks Area

Cross sections for the Jefferson River were located by field surveys conducted by the NRCS in the spring of 1978. These sections include bridge, culvert, and approximately every third underwater channel section. The remaining cross sections were developed from topographic data (Reference 32). The basis of the topographic data was photographs taken in June 1977 (Reference 33). Field checks indicated that map accuracy was approximately 0.5 foot.

Cross sections for the Madison River were developed from the same topographic data used for Jefferson River. The NRCS conducted field surveys in the spring of 1978 to collect bridge, culvert, and underwater data for approximately every third cross section.

To route water on the west side of Madison River, a separate set of cross sections was developed and water-surface elevations were computed for the Old Town and Interstate Highway 90 interchange area northeast of Three Forks.

No profiles were developed for, Madison River and Jefferson River Overflow Area, Jefferson River Middle Channel, Jefferson River Easternmost Channel, and Overflow Area.

Cross section surveys of the underwater channel sections and bridges were obtained during the November 2002 to February 2003 period by Allied Engineering Services Inc (AES). The overbank portions of the cross sections were developed from topographic data prepared by David C. Smith and Associates (DSA). The basis of the topographic data was aerial photography taken November 15, 2002. Horizontal and vertical control was provided by AES by Global Positioning Survey (GPS) methods. Two-foot contour interval maps were prepared at a scale of 1:1200.

<u>Water Surface Elevations</u>

Water-surface elevations were determined using the HEC-RAS (Reference 38) and WSP-2 NRCS computer programs (Reference 39), which performs subcritical flow backwater computations by a modified step method. The program computes head losses at restrictive sections, including roadways, with either a bridge opening or culverts using the U.S. Bureau of Public Roads method (Reference 40).

Bozeman Area

For the extensions of Mathew-Bird, Figgins, and Nash-Spring Creeks, and the restudy of a portion of Mathew-Bird Creek, water-surface profile determinations were computed using the USACE HEC-2 water-surface profiles computer program.

Water-surface elevations computed for Bridger Creek, East Gallatin River, and Buster Gulch were checked against historical elevations and found to be consistent with the historical observations.

There were no elevations of record for the 1981 flood. The finished maps show this area to be in the 1-percent-annual-chance floodplain.

There was an elevation from the flood of 1997 that was estimated from a photograph in the Outlaw Subdivision along the East Gallatin River. This elevation was determined to be 0.15 feet higher than the predicted 10- percent- annual-chance flood event at this location. The recurrence interval for the 1997 event has been estimated at between 10- and 4-percent-annual-chance events.

In the 2002 Anderson re-study, the 1-percent-annual-chance elevations are about 2 feet lower than the original study. Much of this can be attributed to channel scour which lowered the channel bottom 2 to 2.5 feet though most of the reach. Bridge losses were computed by energy methods or by pressure and weir flow methods for submerged conditions.

West Gallatin River Area

Water-surface elevations computed for the main channel of West Gallatin River were checked against aerial photographs taken during high water. One set of photographs was taken by the MDNRC on June 18, 1974 (Reference 41).

Another set of photographs was taken by the USGS on June 11, 1970, during a peak flow of approximately one-half the 1974 flow (Reference 42). These aerial photographs were valuable in calibrating the water-surface computations and increasing the accuracy of the flood routing. Flood routing data correlated very closely with the historical data.

Up to four channels, or flood areas, were computed and used in combination to flood route the downstream portion of the study area for the West Gallatin River due to the complicated and divergent flow pattern that exists there. This flow pattern was developed by computing the amount of floodwater that overtops the west bank of the main channel of West Gallatin River at various points and routing it through a complex maze of channels on the west of the valley, including Baker Creek and Camp Creek. Once water leaves the main channel, it does not return within the study area. Instead, it flows north and west down Baker Creek and other channels, transferring back and forth across small ridges as these channels vary in size and capacity and as they intersect roads and other obstructions.

Three Forks Area

Water surface profiles were computed using the USACE computer program HEC- RAS. Steady State sub critical flow backwater computations were performed using the average conveyance method.

Water-surface elevations and flood boundaries for the Jefferson River were checked against documented information including aerial photographs taken during high water (Reference 37, 38, 39).

Starting Water Surface Elevations

Bozeman Area

Starting water-surface elevations for Bozeman Creek were determined assuming flooding to be occurring on East Gallatin River at the same time as flooding on Bozeman Creek. The slope-area method was used for determining starting water-surface elevations on East Gallatin River. Starting water-surface elevations on Bridger Creek were determined assuming flooding to be occurring on East Gallatin River at the same time as flooding on Bridger Creek. Starting water-surface elevations on Mill Ditch Diversion, Mathew-Bird Creek, and Nash-Spring Creek were taken from the completed profile on Bozeman Creek. Starting water-surface elevations for Figgins Creek were taken from the completed profile on Mathew-Bird Creek. Flat Creek starting water-surface elevations were computed using the completed profile of Mathew-Bird Creek with consideration of head loss through its downstream section.

Each of the three streams (Mathew-Bird Creek, Figgins Creek, and Nash-Spring Creek) studied in the revised portion of the FIS were extended to show detailed flooding to the extraterritorial jurisdiction limits of the City of Bozeman. These streams are located in areas which are or were once used for farmland or pasture. Reaches of these streams were channelized and/or realigned years ago to accommodate farming practices. The result in some cases is stream channels which may not follow the natural flow line of the topography. These streams and others not disturbed, have in some reaches limited capacity which results in large areas of shallow overbank flooding. This flooding was not a large problem when used for agricultural purposes and was part of the flood irrigation practice. However, now that these areas are being developed, the flooding characteristics have the potential to cause serious problems and damages.

The culverts on the restudy reach of Mathew-Bird Creek at Kagy Boulevard, Hoffman Drive, and Mason Street demonstrate the problems which can be created. The original stream channel in this reach had a substantial capacity. The existing culverts have approximately a 10-percent-annual-chance flood capacity. Flood events such as an l-percent-annual-chance event are forced out of the channel at these road crossings and cause substantial shallow sheet flooding in the overbank areas. These overbank areas are fully developed.

The new study reach of Mathew-Bird Creek parallel to Sundance Drive has four small dams which increase the flood widths and depths in their immediate vicinity when compared to the undeveloped condition. These dams, however, do not have a significant effect on the 10-, 2-, 1-, and 0.2-percent-annual-chance flood events. Therefore, no indication of their existence is recorded anywhere else in the Flood Insurance Study.

The reach above the end of Sundance Drive and Goldenstein Lane includes a section of channel which was most likely relocated in the past. This reach is perched and floods greater than a 0.2-percent-annual-chance event will overtop the east bank and cause substantial sheet flooding in the east overbank area. There is one small dam on Nash-Spring Creek between the start of the study and Goldenstein Lane. This dam causes
a small backwater effect and interrupts the natural flow profile. However, like the four small dams on Mathew-Bird Creek, this dam has little significance and is not mentioned anywhere else in the effective FIS.

The Figgins Creek channel downstream of Kagy Boulevard has been relocated and joins Mathew-Bird Creek just above Hoffman Street. The culvert under Kagy Boulevard has a capacity less than a 10-percent-annual-chance event. This situation causes a large transfer of flow out of the channel and a substantial sheet flooding area. The channel and three private driveway crossings downstream of Kagy Boulevard have a capacity slightly less than the culvert at Kagy and cause additional transfer of flood flows to Hoffman Drive.

In the 2002 and 2007 Anderson studies, the USACE HEC-RAS computer model was used for the hydraulic computations. Starting elevations were determined by the slope- area method at cross sections downstream of the study area with slopes taken from the downstream studies.

West Gallatin River Area

The slope-area method was used for determining starting water surface elevations on the West Gallatin River, Baker Creek, and Camp Creek. Calculations were started downstream of U.S. Highway 10 so that the slope would normalize before reaching the study area. Starting water-surface elevations on Baker Creek West Overflow were determined assuming that flooding occurred on Camp Creek at the same time as flooding on Baker Creek West Overflow.

Three Forks Area

The slope-area method was used to determine starting water-surface elevations for the Jefferson River. Jefferson River is a braided river within the study area, so cross sections were broken into as many as four separate major channel segments to represent the different flow areas. Independent water-surface profile computations were made for each of these channel segments. The water-surface elevations, therefore, vary as one proceeds across any cross section from the main channel on the west across the secondary channels toward Three Forks.

Starting water-surface elevations for spring-runoff floods on the Madison River were determined using the slope-area method. Analysis showed that the spring flood flows did not produce elevations as high as ice jam floods in the study area. Therefore, flood elevations on Madison River were determined by assuming that winter ice jams would cause water to reach the top of the lower west side bank or levee. This can and has happened frequently.

Roughness Factors

Roughness coefficients (Manning's "n" values) for computations in the hydraulic analyses were calculated using known slopes and discharges from USGS gage measurements and by field observations of the stream and floodplain areas unless noted otherwise. These values were modified as channel vegetation or flow conditions changed.

Channel values ranged from 0.028 to 0.070 and overbank values ranged from 0.045 to 0.300. These more recent values are presented on Table 6, Manning's "n" Values."

Table 6. Manning's 'n' Values

Stream Name	Channel "n"	Overbanks
Bozeman Creek	0.035 to 0.065	0.045 to 0.15
Bridger Creek	0.050 to 0.07	0.100 to 0.30
East Gallatin River	0.045 to 0.05	0.055 to 0.09
Jefferson River	0.028 to 0.04	0.050 to 0.30
Madison River	0.035 to 0.04	0.050 to 0.15
Shed's Split Flow	0.045	0.10
The Buster Gulch	0.045	0.065 to 0.15
West Gallatin River	0.038 to 0.04	0.055 to 0.10

Shallow 1-percent-annual-chance flooding of the Madison River, less than 1 foot in depth, is prevalent in overland flow areas and along some roads near Three Forks. Overland and street flows were routed using Manning's equation to determine capacity of flow sections. Wherever possible, photographic documentation of street and yard flooding was used. This flooding is designated as the 1-percent-annual-chance shallow flooding on the FIRMs. For the Madison River, miscellaneous measurements were available at the old Highway 10 Bridge.

The degree of precision used to compute the flow separation depended on the data available and how critical it was to determine the actual extent of the flood plain. The hydraulic analysis for this study was based on unobstructed flow except on Madison River. The flood elevations shown on the profiles are valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

Levees

Located along the lower reach of the East Gallatin River are two uncertified levee systems. In accordance with Appendix H of the FEMA Guidelines and Specifications for Flood Hazard Mapping Partners, two hydraulic models of the river were created. The first scenario was modeled as if the levees are in place and containing the flood flows. The second being modeled as if the levees failed.

In both levee locations, losses occurring from modeling the river without the levees created a situation where the water leaving the main channel and floodplain didn't return until downstream, outside the scope of this study. In these situations, losses were modeled using a lateral weir system and two new reaches were created, East Gallatin Overflow and East Gallatin Golf Course.

The first uncertified levee is located between sections BH and BJ, upstream of Manley Road. This levee is a primitive structure that appears to be created by pushing soil up into a berm shape. The losses from this area leave the right riverbank and head northwest through agricultural grazing areas. This area was modeled by the East Gallatin Overflow reach.

The second uncertified levee is located between sections AP and AS, just upstream of Springhill Road and directly adjacent to the Riverside Country Club. This levee was created in the 1970's to protect the Country Club from flooding. The losses from this area leave the right riverbank and head north/northwest following the Springhill Road roadside ditches. This area was modeled by the East Gallatin Golf Course reach.

Madison River

The effects of ice jams dominate the Madison River flood profiles. The HEC- RAS model was used to determine the flood water levels from the winter ice jamming condition. These levels ranged from one to four feet higher than the open flow floods for the 1-percent-annual-chance event. These levels have been documented by past winter ice jam flood events. Additional discussion of the ice-jam analysis follows.

The left or west levee which extends through most of the study reach would be overtopped during the 1-percent-annual-chance ice jam event. The levee also has inadequate freeboard in several places during the 1-percent-annual-chance open flow event. The base flood elevations shown east (channel side) of this levee are assuming the levee does not fail. The 1-percent-annual-chance flood elevations shown west or outside of the levee assumes that the levee is not effective in containing the flow and has failed. The right levee is assumed to not fail since this condition creates a higher water surface in Three Forks than the failed condition. The floodway for the Madison River is based on the ice jam condition with the levees in place. The floodway was taken as the area between the levees except where the levees failed or were nonexistent.

Insufficient data was available involving ice-jam stages to determine ice-jam frequency directly from historical stage data. The indirect approach as described in the FEMA Guidelines (2002) under section F.4.2 was therefore used. The existing limited historical documentation for the reach and stream gage records upstream of the area supports the results of the indirect analysis.

Peak discharge-frequency data for the ice-jam season (January-March) was obtained from stream gage records using Bulletin 17B methods (see hydrology report). The ice- jam season is distinctly different and separate from the normal flood season which occurs in May and June.

The HEC-RAS ice-jam analysis was done on the entire study reach for both the with- levee and without-levee condition. The HEC-RAS geometry file was modified for the ice-jam condition by eliminating the small bridges on the multiple opening road sections. There was a difficulty getting convergence to a solution at these sections and it was determined that these minor bridges were not conveying a significant amount of discharge.

Ice jamming in the model was limited to the channel only. For much of the reach the channel section consists of several braided channels and the areas in between them. The overbank areas were modeled with an ice cover, but no jamming. Manning's "n" for the ice was initially allowed to vary within the model. However, this resulted in crossing of the multiple profiles and the values were then fixed based on the average results in the initial runs.

Although it is believed that grounding may occur for ice jams in the Madison River, that analysis was not used. The stages obtained with the floating-type jams agreed well enough with the historical data without the need to further obstruct the channel.

Ice jam stages for the 1-percent-annual-chance return period are three to four feet higher than free flow stages. Ice thickness ranged from five to ten feet. The observed water surface shown on the plots is the effective BFE inside the levee. It was taken as the top of the levee at the time of the study and was not necessarily a water surface.

Photographs of the 1978 flood show ice levels at the top of the levee to two feet below the top. The flood of 1972 had similar stages through the reach. An analysis of the ice stages at the stream gage upstream (06042500) for nine years of record showed the ice stage for a ten-year event, 4.5 feet above the stage of open flow for that frequency (see hydrology documentation). The Ice stage for the 1-percent-annual-chance level runs between one-half and one foot above the 10-percent-annual-chance stage. All of this supports the modeling, which shows the three to four feet difference between ice and open flow stages.

Based on the record at the Madison stream gage, ice-jam floods occurred four years out of nine or 44 percent of the time. This agrees with other stream gages in the area that show high ice stages from 40 to 50 percent of the years. Equation (3) as shown in the Guidelines was used to combine the stage probability curves for the ice-jam and open flow seasons. Because of the large difference between the ice stage and open flow stage the probability of exceeding a given ice-jam stage with free-flow conditions, either in the ice-jam season (p(so»), or during the free-flow season (p(sq)) are both nearly zero. Therefore equation (3) becomes P(s) = P(sw) * P(si = ice jam event), where P(sw) is the probability of the ice-jam stage and P(si = ice jam event) is the probability of having an ice-jam in any particular year (for our case .44).

Jefferson River

The flow splits on the Jefferson River just upstream of old Highway 10. At discharge exceeding about 15,500 cfs (10-percent-annual-chance flood) flow overtops the normal banks and part of it flows to the east. From there it can enter Three Forks in the southwest comer of the city. During the 1-percent-annual- chance flood the amount flowing east was determined to be about 1,900 cfs or about 8 percent of the total storm flow. The split flow is added back to the main flow at the appropriate locations and was not routed separately through the city area because the highway and railroad embankment was not considered as an effective barrier. The area south of old US 10 is outside of the study area and was not mapped.

The Milwaukee Railroad embankment was not considered as an effective barrier to flow for this study. The embankment was ignored for the hydraulic modeling through Three

Forks.

However, for that area north of Three Forks, and upstream of Interstate 90, the area to the right (east) of the railroad embankment was considered as ineffective flow due to the blockage and ponding caused by the highway. Ice was determined not to be a controlling factor for the Jefferson River flood stage. Ice jams at the stream gage show a lower stage than open flow floods of a like frequency. Historical records also support this, since no significant damage has resulted from ice jam flooding on the Jefferson River.

This Revision to the Countywide:

Bozeman Creek Watershed

Hydraulic modeling was performed using HEC-RAS version 4.1.0 (Reference 32). Cross Sections were cut and terrain data was transferred from GIS using HEC-GeoRAS version 10 (Reference 33). All culverts, bridges, and inline structures were modeled in accordance with the HEC-RAS User's Manual, Version 4.1 (Reference 34). In addition, standards listed in FEMA's Knowledge Sharing Site (KSS) (Reference 35) were followed to ensure the study meets industry standards.

Four model plans were set up for various purposes. The plan titled "Bozeman Flow Calculations" uses discharges from the hydrologic analyses for the primary flooding sources, and optimized lateral weirs to determine the magnitude of each split flow and was used to develop the workmaps.

Field survey and topographic information was collected using the methods and procedures outlined in Appendix A (Aerial Mapping and Surveying) of FEMA's Guidelines and Specifications (Reference 44).

Terrain data was collected on April 18, 2013, for the entire study footprint area in the form of Light Detection and Ranging (LiDAR) points by Photo Science, Inc. (Reference 10). The data was calibrated and checked by Gaston Engineering. The LiDAR deliverables included digital elevation models (DEM) (1-meter resolution), 1-foot contours, and a report documentation among other items.

The data exists in the following projection and datum:

Projection: Montana State Plane	Units
Datum: Horizontal – MT 2500 St Pl NAD83 (2011)	Feet
Vertical – NAVD88, Geoid 12A	Feet

The LiDAR DEM (1-meter resolution) was the primary topographic source for the project and was used to develop the HEC-RAS cross-sections.

Bathymetric data collection was necessary to supplement the LiDAR data since the streams are detailed study reaches which require a higher level of data inputs to achieve better modeling results. Also, detailed hydraulic analyses also require that all structures be included in the modeling unless it can be shown that the structure is not hydraulically significant to the model results. Therefore, field survey was collected.

Ground survey was collected for select riverine cross sections and all hydraulic structures between October 2012 and January 2013 by Allied (Reference 11). Channel cross- sections were taken at approximate maximum 1,000-foot intervals. In total, 500 cross sections and 219 structures were surveyed.

Due to the limited capacity of the primary flooding sources, there are numerous split flows that leave main channels and become flooding sources unto themselves. Some splits only leave during extreme flood events, but others can be expected with some regularity. Each flow where a significant amount of flow (more than 10 cfs) would leave the main channel was modeled. (Flow may split in other locations, but will likely be either low discharge or less than 0.5 feet deep). The table below lists each of these flow splits and gives information on how each is expected to form.

Bozeman Creek Watershed, List of Flow Splits Descriptions			
Split Flow Name	**Splits from**	**Description**	**Stream Length (miles)**
3rd/Kagy Split	Figgins Creek	Splits from Figgins Creek upstream of the 3rd Avenue Culvert. Heads north along 3rd Avenue, bends east on Kagy Boulevard, and rejoins Figgins Creek	0.2
Black Avenue Split	Flat Creek	Some flow along Flat Creek overtopping the road at Black Avenue splits and continues along Black Avenue. Flow heads northeast and north before joining Garfield Street Split	0.6
Cedar Street Split	Mill Ditch Diversion	Splits from Mill Ditch Diversion upstream of Cedar Street. Flows to the northwest adjacent to Cedar Street, before crossing at a low point along Cedar Street and returning to Mill Ditch Diversion	0.2
Church Avenue Split	Bozeman Creek	Exists Bozeman Creek at Olive Street heading west. Bends north on Church Avenue and continues on Church Avenue before returning to Bozeman Creek	0.6
Flat/Kagy Split	Flat Creek	Splits from Flat Creek upstream of Kagy Boulevard and heads northwest parallel to Kagy before joining Mathew-Bird Creek	0.1
Gallagator Split	Bozeman Creek	Splits from Bozeman Creek upstream of Gallagator Trail and heads northeast parallel to the Gallagator Trail before joining Mill Ditch Diversion	0.1
Garfield Street Split	Mathew-Bird Creek	Some flow along Mathew-Bird Creek overtopping the road at Garfield Street splits and continues along Garfield Street to the east. Bends north at Bozeman Avenue, then east on Cleveland Street before joining Rouse Avenue Split	0.3

Bozeman Creek Watershed, List of Flow Splits Descriptions			
Split Flow Name	**Splits from**	**Description**	**Stream Length (miles)**
Golf Course Split	Nash Spring Creek	Flow gradually departs Nash Spring Creek through and goes through the golf course before joining Flat Creek upstream of Kagy Boulevard	0.3
I-90 Split	Mill Ditch Diversion	Flow splits from Mill Ditch Diversion upstream of I-90 and heads northwest parallel to I-90. Crosses under I-90 at L street and spreads out heading north before joining East Gallatin River	0.7
Kagy/Rouse Split	Golf Course Split	Some flow along Golf Course Split overtops Kagy Boulevard and heads north. Some flow joins Rouse Avenue Split to the northwest and some rejoins Bozeman Creek to the northeast	0.1
Lower Black Split	Garfield Street Split	Some flow on Garfield Street Split bends north onto Black Avenue. Some of this flow returns to Mathew Bird Split and some continues to join Rouse Avenue Split	0.2
Main Street Split	Church Avenue Split	Flow splits from Church Avenue Split and flows to the east on Main Street and returns to Bozeman Creek	0.1
Mill/Railroad Split	Mill Ditch Diversion	Flow on the left overbank of Mill Ditch Diversion splits and crosses railroad tracks before rejoining Mill Ditch Diversion downstream. This split is not significant for flows with a 1-percent-annual chance recurrence interval or less.	0.2
Museum Split	Figgins Creek	Flow splits from Figgins Creek upstream of the trail embankment, heading north alongside the embankment before crossing it at a low point and returning to Figgins Creek	0.3
Nash Road Split	Bozeman Creek	Flow on the left overbank of Bozeman Creek splits across farmland before crossing Nash Road at a low point and continuing north before rejoining Bozeman Creek	0.4
Peace Pipe Split	Mathew Bird Creek	Flow splits from Mathew Bird Creek to the right along Peace Pipe Drive. It continues along Peace Pipe Drive for approximately 600 feet before finding a low point and moving north through a residential area, before returning to Mathew Bird Creek. This split is not significant for flows with a 1-percent-annual chance recurrence interval or less.	0.5
Rain Roper Split	Mathew Bird Creek	Flow on the right overbank leaves Mathew Bird Creek downstream of Peace Pipe Drive	0.2

Bozeman Creek Watershed, List of Flow Splits Descriptions			
Split Flow Name	**Splits from**	**Description**	**Stream Length (miles)**
		and continues north, parallel to Rain Roper before rejoining Mathew-Bird Creek	
Rouse Avenue Downtown	Bozeman Creek	Exits Bozeman Creek just south of East Babcock Street and heads northeast before bending north on South Rouse Avenue. Flows along Rouse Avenue before bending northwest to return to Bozeman Creek	0.2
Rouse Avenue Split	Flat Creek	Some flow along Flat Creek overtopping the road at Black Avenue splits and continues along Rouse Avenue Flow heads north before joining Bozeman Creek	0.8
Sourdough Trail Split	Bozeman Creek	Flow in the left overbank of the Bozeman Creek splits to the left upstream of a private driveway and heads north before joining Nash Spring Creek	0.3
Tracy Avenue Split	Figgins Creek	Flow in the left overbank of Figgins Creek splits to the north upstream of Hoffman Drive and continues along Tracy Avenue northward before joining Matthew-Bird Creek	0.2
Wallace Avenue Split	Church Avenue Split	Some flow on Church Avenue Split splits to the east on Main Street and bends to the north on Wallace Avenue, heads north and returns to Bozeman Creek	0.9

Black Avenue Split and Rouse Avenue Split – Due to the unique physical circumstances at this flow split location, lateral weirs were not used. Flow along Flat Creek that does not fit in the culvert at Black Avenue overtops the road at a high point. Half the overtopping flow can be expected to head in each direction. Therefore, the flow overtopping the road was evenly divided between these two flooding sources. This is a more reasonable representation of how the flow would split than the use of a lateral weir would be at this location.

Bozeman Creek – Flow that leaves Bozeman Creek at Goldenstein Lane and the Sourdough Trail Split goes through the large network of splits in the vicinity of Kagy Boulevard before gradually returning, split by split, to Bozeman Creek. In general, conservative assumptions were made as to when the flow returns to Bozeman Creek in this area. For example, when flow enters Bozeman Creek from Rouse Avenue Split at Cross Section 13969, all flow that left Bozeman Creek at Goldenstein Lane or via Sourdough Trail Split is assumed to have returned. Also, a significant portion of flow along Mathew Bird Creek will enter Bozeman Creek at this location. Therefore, the flow at this location is equal to the flow from the hydrology report "Bozeman Creek at Olive Street", even though Olive Street is some distance downstream of this point.

Church Avenue Split – As flow goes north along Church Avenue, it gradually splits to both the east (towards Wallace Avenue split) and the west (towards Bozeman Creek) along the crossing east-west roads. These flow transfers were modeled and calculated simultaneously using lateral weirs on both sides of Church Avenue Split.

Flat Creek at confluence with Golf Course Split – Flow that joins Flat Creek from Golf Course Split greatly overwhelms any flow coming from the upper reaches of Flat Creek. Golf Course Split will have its greatest peak discharges during Bozeman Creek flooding events, which are unlikely to occur simultaneously with Flat Creek flooding events. Therefore, flow that originates in the Flat Creek watershed is assumed to be zero when the Golf Course Split is at its peak.

Flat Creek at Hoffman Drive – The effective map shows Flat Creek ending at Hoffman Drive as a result of an inlet to the City's storm sewer system. However, a review of the sewer system revealed that the inlet and pipe is not adequately sized to be able to handle all the flows along Flat Creek. (The storm sewer system has a 21" diameter pipe; insufficient to handle the flows given the great increase of discharge on Flat Creek caused by flows delivered from Bozeman Creek via Sourdough Trail Split, Nash Spring Split, and Golf Course Split). However, downstream of Hoffman Drive, the 1-percent annual chance flood event is less than 1 foot in average depth, so is mapped as X-shaded.

Garfield Street Split – Peak flows on Garfield Street Split occur during flooding originating in the Mathew Bird Creek watershed. Because the flood peaks at a different time, flow on Black Avenue Split will be minimal during flooding on Garfield Street Split. Therefore, flow from Black Avenue Split is not added on to the peak flows on Garfield Street Split.

Lower Black Split – Peak flows on Lower Black Split occur during flooding originating in the Mathew Bird Creek watershed.

Mathew-Bird Creek at Kagy Boulevard – Mathew Bird Creek accepts flow that originates from splits ultimately fed by Bozeman Creek in the Flat/Kagy Split. However, peak flows on Bozeman Creek are unlikely to be significant at the same time as peak flows are occurring on flow that originates in the Mathew-Bird Creek watershed. Peak flows that originate in the Mathew Bird watershed dominate at all cross sections.

Mathew Bird Creek at Figgins Creek and Tracy Avenue Split – Flow from Figgins Creek will enter Mathew Bird Creek both at the confluence with Figgins Creek and at the confluence with Tracy Avenue Split. Given the uncertainty in the flow split, Mathew Bird Creek is modeled conservatively to assume that all flow from Figgins Creek enters Mathew Bird Creek at the confluence with Figgins Creek.

Mill Ditch Diversion at diversion structure – Lateral structure calculations reveal that approximately 45 cfs will split from Bozeman Creek in the vicinity of the Mill Ditch Diversion structure during the 1-percent-annual chance flooding event. This is significantly lower than the 340 cfs on Mill Ditch Diversion presented in the effective study. It appears that the effective study is in error. The right overbank of Bozeman Creek in this area is relatively high, which doesn't allow much flow to overtop into Mill Ditch Diversion. The structure itself has a relatively small opening (3' x 2.5'), which can only pass a limited amount of flow. Additionally, given the relatively flat slope of Mill Ditch Diversion in this area, backwater limits the amount of flow that splits. All of this taken into account, 45 cfs in Mill Ditch Diversion at this location is reasonable.

Mill Ditch Diversion at diversion structure – The 2-percent-annual-chance and 1- percent-annual chance are the same at this location. It is reasonable that these discharges would be similar given the size of the diversion structure and the fact that it is largely limited by backwater.

Mill Ditch Diversion at South Church Avenue – During the 0.2 percent-annual-chance event, flow at this location splits back across the Gallagator Trail to Bozeman Creek. This is caused by an undersized culvert at South Church Avenue. This demonstrates that even if the Mill Ditch Diversion structure size was increased, flow along Mill Ditch Diversion would still be limited by this structure.

Mill Ditch Diversion – In the Mill Ditch Diversion hydrologic analysis report, it clearly states that the greater of two discharges should be used – flow that originates in the Mill Diversion Ditch watershed, or flow that splits from Bozeman Creek. For the reach identified in the hydrologic report as “at Main Street”, the discharges originating from the Mill Ditch Diversion dominate for the 10- and 0.2-percent-annual-chance event, while the flows splitting from Bozeman Creek dominate for the 4-, 2-, 1-percent-annual- chance event. For the reach identified in the hydrologic report as “upstream of Northern Pacific Railroad” (and downstream), the flow that originates in the Mill Ditch Diversion watershed dominates for all recurrence intervals.

Mill/Railroad Split – According to the lateral weir calculations, discharges to Mill/Railroad Split will be less than 2 cfs during the 1-percent-annual chance flood event. This is not a significant amount of flow. Therefore, Mill/Railroad Split is considered to be a split during the 0.2-percent-annual chance event only, and is mapped as Zone X shaded.

Nash Spring Creek at Goldenstein Lane – Some flow splits from Bozeman Creek toward Nash Spring Creek at Goldenstein Lane. However, flow peaks on Bozeman Creek and Nash Spring Creek do not occur at the same time. Peak flows on Nash Spring Creek between Goldenstein Lane and the confluence with Sourdough Trail Split are caused by floods originating in the Nash Spring Creek watershed.

Nash Spring Creek downstream of Sourdough Trail Split - Peak discharges are influenced by the combined flow that originates in the Nash Spring Creek watershed, and the flow from Sourdough Trail Split (which originates from Bozeman Creek). The maximum peak discharges on Nash Spring Creek downstream of Sourdough Trail Split are attained during the maximum flow on Bozeman Creek. According to data interpolated from the hydrologic analysis, while Bozeman Creek is peaking, flows originating on Nash Spring Creek are at between 58% (for the 10- percent) and 27% (for the 0.2- percent event) of their maximums. The peak Sourdough Trail Split flow and this percentage of the Nash Spring Creek flow are added together to calculate total peak flows in this area.

Rouse Avenue Split – The upper reaches of Rouse Avenue Split are fed by flows from Flat Creek (flows that originate in the Bozeman Creek watershed). However, peak flows downstream of the confluence with Garfield Street Split are dominated by flows from

Garfield Street Split, which originates in the Mathew Bird Creek watershed.

The reach boundary conditions were set using normal depth water surface elevations for all the primary flooding sources in this study. The slope was calculated based on the slope of the channel in the vicinity of the most downstream cross section. For the split flow flooding sources, boundary condition was set either using a junction or known water surface elevation (if the timing of the peak is the same for the split as for the receiving flooding source), or using normal depth (if the timing of the peak of the split is not the same as the receiving flooding source.

Manning's roughness coefficients (Manning's 'n' values) were determined based on aerial imagery and photographs provided by the Allied Engineering Surveyors.
For channel areas, Manning's 'n' values were set to 0.045 for most cross sections. This is indicative of a clean, winding channel with some weeds and stones. At other cross sections, Manning's 'n' values were higher, indicative of timber or brush in the channel. For flooding sources that run along roadways, Manning's 'n' values were set to 0.016, indicative of rough asphalt.

Manning's 'n' values for overbank areas were more variable, to account for different land uses and vegetation growth. At some cross sections, overbank Manning's 'n' values were as low as 0.040, indicative of grassy yard or pasture areas, or cultivated areas with field crops. At other cross sections, Manning's 'n' values were set higher, indicative of brush, trees, and undergrowth. At some cross sections, Manning's 'n' values were elevated somewhat higher than the vegetation would indicate to account for other obstructions in the floodplain, such as buildings, garages, or sheds. Table below provides a summary of the range of Manning's 'n' values used for this watershed.

Land Use and Description	**Range of Manning's 'n' Values**
Channel – Winding with some weeds and stones	0.045
Channel – Winding with more weeds, brush, or trees	0.050 – 0.080
Channel – Street flow on asphalt	0.016
Overbanks – grassy areas	0.040 – 0.060
Overbanks – farmed/cultivated areas	0.040 – 0.060
Overbanks – brush, trees, other obstructions	0.060 – 0.080
Overbanks – low density development	0.045 – 0.080

Cross sectional geometries were established based on the geometry of both the 2013 LiDAR and the 2012-2013 field survey. Cross sectional geometries were first taken from the LiDAR using HEC-GeoRAS, version 10 (Reference 33). At locations, where cross section survey was collected, the survey data was superimposed on the cross section at the appropriate location using manual methods.

At cross section locations along the primary flooding sources where survey data not collected, bathymetric cross section geometry was interpolated between adjacent surveyed cross sections.

For cross sections on the secondary or split flow flooding sources, cross sectional geometries were determined using the LiDAR terrain data only. Given that these flooding sources did not contain water when the LiDAR was collected, bathymetric or survey data would not improve the modeling geometries. Therefore, survey was not collected or used in the model for these flooding sources.

Cross section locations were set using established engineering practice and guidance provided in the HEC-RAS Hydraulic Reference Manual. Several cross sections were modified using the skew adjustment in HEC-RAS. All total, there are 1,047 cross sections in the hydraulic model, across approximately 28 miles of detailed study. This averages out to approximately one cross section every 140 feet.

Contraction and expansion coefficients were set as recommended in the HEC-RAS Hydraulic Reference Manual – 0.3 and 0.5 in cross sections adjacent to hydraulic structures, and 0.1 and 0.3 in cross sections that are not adjacent to hydraulic structures. There are a handful of other cross sections that are not adjacent to hydraulic structures where higher expansion and contraction coefficients are used. These are indicative of rapid contraction or expansion caused by natural land features or man-made embankments.

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Structure geometries were taken from the collected survey data. The photographs, sketches, and spatial data in GIS were all used to most reasonably and accurately model the geometry of each individual hydraulic structure.

Low flow and high flow structure modeling approaches were all determined in accordance with guidance provided in the HEC-RAS Hydraulic Reference Manual. Due to practical spacing limitations, not all hydraulic structures have the standard 4-cross section contraction and expansion placements recommended in the Hydraulic Reference Manual. However, for many structures, cross section 1 and 4 of the recommended approach are not necessary. For example, in the instance of small footbridges that overtop easily, distinct contraction and expansion reaches do not exist in the traditional way. In these areas, the cross section associated with the next upstream or downstream structure is sufficient as a stand-in for the traditional cross section 1 or 4.

Ineffective areas and blocked obstructions were used in the model to restrict flows to areas of cross sections capable of actively conveying flow. Ineffective flow areas were used to model several different hydraulic scenarios:

In the vicinity of hydraulic structures, ineffective areas are used in areas that would not actively convey flow due to being blocked by the abutments or the approach to the structure itself. These ineffective areas were placed in accordance with structure modeling guidance provided in the HEC-RAS Hydraulic Reference Manual.

For hydraulically disconnected regions, ineffective areas were added to the model to account for the fact that flow would not be actively conveyed in these areas.
In overbank areas where flow during flooding events would be minor or insignificant, ineffective areas were used to ensure that accurate hydraulic calculations were taking place in the active, more significant flowpaths. This type of area tended to be a location where flow would not significantly penetrate, such as locations where flow to the lower overbank areas would be mostly blocked by high ground or an embankment near to the bank station.

Areas of backwater were modeled as ineffective flow. Areas where the flow would be predominately lateral to the primary direction of flow were modeled as ineffective flow areas. One example of this would be at a cross section where a lateral incoming ditch was picked up along the cross section from the terrain data. These areas of lateral flow would not convey flow effectively in the primary flow direction during a flooding event.

Areas near buildings (or in the hydraulic "shadow" of buildings) were occasionally modeled as ineffective areas. This is done to account for areas of flow that would not be active to do the blockage caused by nearby buildings.

West Gallatin River

This study also update approximately 30 miles of the West Gallatin River, beginning at the confluence with the East Gallatin River and extending approximately four river miles above the community of Gallatin Gateway, Montana (Reference 1) . Appendix C of FEMA Guidelines and Specifications (FEMA 2009) was used as a guide for the West Gallatin hydraulic model development. The water surface elevations (WSEL's) were calculated with HEC-RAS, Version 4.1.0 hydraulic modeling software (USACE 2010). Cross sections were placed with ArcMap 10.1 (ESRI 2012) at locations where bathymetric surveys were completed and at structure locations along the floodplain. HEC-RAS for steady flow analysis, performs the standard step energy balance calculation between cross sections, starting at the most downstream cross section and moving upstream for a fully subcritical analysis.

Through the development of the hydraulic model, it was confirmed that floodwaters are directed throughout the floodplain through irrigation ditches and secondary channels away from the parent channel. In the event that the separated flow would not reconnect to the original stream channel within a distance of one mile, a new profile baseline was established. Junctions and lateral weirs were defined to model the flow split and a secondary flow path that would be created. Utilizing the flow optimization routine within HEC-RAS, the discharge split across the junction and lateral weirs was calculated ensuring that conservation of mass was balanced across the system while also balancing the energy equation. Lateral weirs were specified as a broad crested weir and utilize a weir coefficient of 0.5. In general, lateral weir coefficients should be lower than typical values used for inline weirs. The lower weir coefficients value is due to the energy/momentum loss associated with the turning flow lines from their downstream orientation to a lateral direction out of the river/reach (RAS Solution 2013). The discharge determined over each weir was calculated using the optimization routine within HEC-RAS.

Topographic survey data was completed in 2013 under Phase I of the project by Photo Science, Inc. in conjunction with Gaston Engineering & Surveying, PC. Phase I included discovery, along with acquisition and processing for 50.7 square miles of LiDAR data along with project corridor as well as bathymetric survey of the stream channel (Photo Science 2013 and Gaston 2013).

The field survey completed by MMI in the fall of 2014 (MMI 2015) included structure surveys for approximately 172 hydraulic structures (bridges, culverts, diversions, etc.) and site visit assessments of 50 additional structures.

State plane coordinates used for this survey are referenced to the Montana Coordinate System, North American Datum of 1983 (NAD83-2011). Elevations are referenced to the North American Vertical Datum of 1988 (NAVD88). Units are reported in International feet. GNSS-derived orthometric heights (elevations) were computed using Geoid 12A. These datum and units are identical to those used for the LiDAR calibration control points previously established in the Phase 1 portion of this project.

The roughness data were evaluated at each cross-section in HEC-RAS and adjustments to the horizontal limits were made to fit with the terrain data represented by the cross section. Adjustments to the roughness values were also made as needed during hydraulic model development. The adjustments to the HEC-RAS roughness values remained within the range of acceptable values determined for each land class. Roughness coefficients are provided in the Table below.

Flooding Source	Channel "n"	Overbank "n"
West Gallatin River	0.038-0.040	0.055-0.10
Baker Creek Split	0.040	0.055-0.080
Baker Creek Overflow Split Flow	0.040	0.055-0.080
East Overflow Split Flow	0.040	0.055-0.080
I-90 Diversion Split Flow	0.055-0.080	0.055-0.080
I-90 Lateral Split Flow	0.053-0.055	0.055-0.080
Linney Road Split Flow	0.040	0.055-0.080
Moreland Ditch Split Flow	0.040	0.055-0.080

Split Flow Analysis

There are four flow scenarios occurring throughout the West Gallatin River floodplain. With the development of the hydraulic model and review of the initial results, locations were identified in which discharge overflowed the one or both banks of the channel or via a diversion structure so the resultant overflow would be directed away from the parent West Gallatin River channel. In the event that the separated flow would not reconnect to the original stream channel within a distance of one mile, a new profile baseline for the overflow channel was established. Junctions and lateral weirs were defined to model the flow split and the secondary flow path that would be created. Utilizing the flow optimization option within HEC-RAS, the discharge split across the junction and lateral weirs was calculated ensuring that conservation of mass was balanced across the system while also balancing the energy equation. Lateral weirs were also specified as a broad crested weir and utilized a weir coefficient of 0.5. In general, lateral weir coefficients should be lower than typical values used for inline weirs. The lower weir coefficients value is due to the energy/momentum loss associated with the turning flow lines from their downstream orientation to a lateral direction out of the river/reach (RAS Solution 2013). The discharge determined over each weir was calculated using the flow optimization option within HEC-RAS.

Given the complex nature of the West Gallatin River watercourse, a systematic approach was developed to the optimization process in order to properly calculate the split discharges across the lateral weirs and junctions. There are points of divergence within split flow system which are dependent upon the separation of discharges located further upstream. This flow divergence from the West Gallatin River commences approximately one-half river mile upstream of the Cameron Bridge Road crossing and was modeled with lateral weirs conveying flow from the west bank to the Baker Creek Overflow Channel. The next downstream divergence is located at the Moreland Ditch diversion structure upstream and adjacent to the Cameron Bridge Road. This flow diversion was modeled with the inline structure feature to calculate the hydraulics of the vertical lift slide gates associated with this structure. The following sections describes the four flow scenarios that were developed to the optimization process in order to properly calculate the split flow discharges.

For this revision, a split flow analysis was performed in the vicinity of the Highway 84 Bridge known as Shed's Bridge. The original model was based on the use of the multiple opening option within HEC-RAS 4.1 to account for the conveyance through twin reinforced box culvert (RBC) under the highway on the Spain Ferris Ditch. The analysis presented in this revision is based on the use of the split flow option, including the main stem of the West Gallatin River channel and the Shed's Split channel. The calculation of flows conveyed to Shed's Split was modeled using the one-dimensional HEC-RAS v4.1 lateral weir module. Four lateral weir sections were set along the West Gallatin River to measure the flood flows that would be conveyed over the historic railroad embankment also known as St. Paul Boulevard and bridge crossing to Shed's Split.

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 National Geodetic Vertical Datum of 1929 (NGVD29). With the completion of the North American Vertical Datum of 1988 (NAVD88), many FIS reports and FIRMs are now prepared using NAVD88 as the referenced vertical datum.

Flood elevations shown in this FIS report and on the FIRM have been converted to NAVD88. Elevations were established by GPS methods. Additional elevation reference marks were set at convenient locations in the study area. Table 7 shows individual datum conversion factors for each stream studied in this community.

Table 7– Vertical Datum Conversion

Stream Name	Conversion from NGVD29 to NAVD88 (feet)
Baker Creek Area	+3.59
Baker Creek West Overflow	+3.61
Bozeman Creek	+4.06
Bridger Creek	+3.94
Buster Gulch	+3.79
Camp Creek	+3.51
East Gallatin River	+3.88
Figgins Creek	+4.03
Flat Creek	+4.03
Jefferson River	+3.39
Gallatin River West Fork -Big Sky	+4.69
Madison River	+3.39
Mathew-Bird Creek	+4.05
Mill Ditch Diversion	+3.96
Nash-Spring Creek	+4.08
West Gallatin River	+3.80

These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. For information regarding conversion between the NGVD29 and NAVD88, or to obtain current elevation, description, and/or location information for benchmarks shown on this map, visit the National Geodetic Survey website at www.ngs.noaa.gov, or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242
(301) 713-4172 (fax)

There was an elevation from the flood of 1997 that was estimated from a photograph in the Outlaw Subdivision along the East Gallatin River. This elevation was determined to be 0.15 feet higher than the predicted 10-percent- annual-chance flood event at this location. The recurrence interval for the 97 event has been estimated at between 10- and 25-years, so this elevation verifies the study at this location.

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 and Floodway Data 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. Between cross sections, the boundaries were interpolated using topographic maps at a scale of 1:4,800, with a contour interval of 2 feet (Reference 30, 31, and 36) and developed photogrammetrically, using aerial photographs at a scale of 1:4,800 (Reference 37).

On the FIRM, the 1-percent-annual-chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A and AE), 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.

Flood boundaries of the 1- and 0.2-percent-annual-chance floods along the East Gallatin River and Buster Gulch have been delineated using aerial photographs taken in September 2001 and digitized topographic maps developed at 1:6000 with contour intervals of two feet.

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 unless otherwise noted. 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 and are presented on Table 7, "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.

In Montana, the designated floodway is developed using a 0.5-foot surcharge instead of the Federal maximum of 1.0 foot (Reference 43). These criteria take precedence over the minimum Federal criteria for purposes of regulating development in the flood plain, as set forth in the Code of Federal Regulations, 24 CFR, 1910 (d). The floodways computed for this study are based on a maximum increase of 0.5 foot.

Determination of whether separate regulatory floodways were to be completed for the split flow reaches was verified in accordance with Appendix C (FEMA 2009). This protocol includes calculating the water-surface elevations for the total flow in the main channel and comparing the water-surface elevations with the reduced flow rate due to divergence to the split flow reaches. If the difference in water-surface elevations is greater than the 0.5 foot maximum regulatory surcharge, than a separate regulatory floodway is to be delineated for the split flow channels of the mainstream. This was completed on the West Gallatin River and the differences in WSE's was on the order of 0.1 to 0.2 feet. Therefore, the floodways for the split flow reaches of Baker Creek, Baker Creek Overflow, East Overflow, I-90 Diversion, I-90 Lateral, Linney Road Split, and Moreland Ditch were not determined and only the identified 1% and 0.2% annual chance floodplain delineations are included on the floodplain work maps.

The floodways for, Baker Creek, Baker Creek West Overflow, and Camp Creek were made equal to the identified 1-percent-annual-chance flood plain. This was due to the complicated and divergent flow pattern that exists in this area. Anything that might be built or altered within this complex flow system could drastically affect the amount and depth of flow at points downstream. This means that any floodway that might be computed which would allow encroachment into any presently identified flow area could cause more than just an increase in the floodwater elevation at that point. It could also cause a change in the flow pattern and the flood hazard downstream. Therefore, to avoid this possibility, it was determined that the floodway and the identified 1-percent-annual-chance year flood plain should be equal.

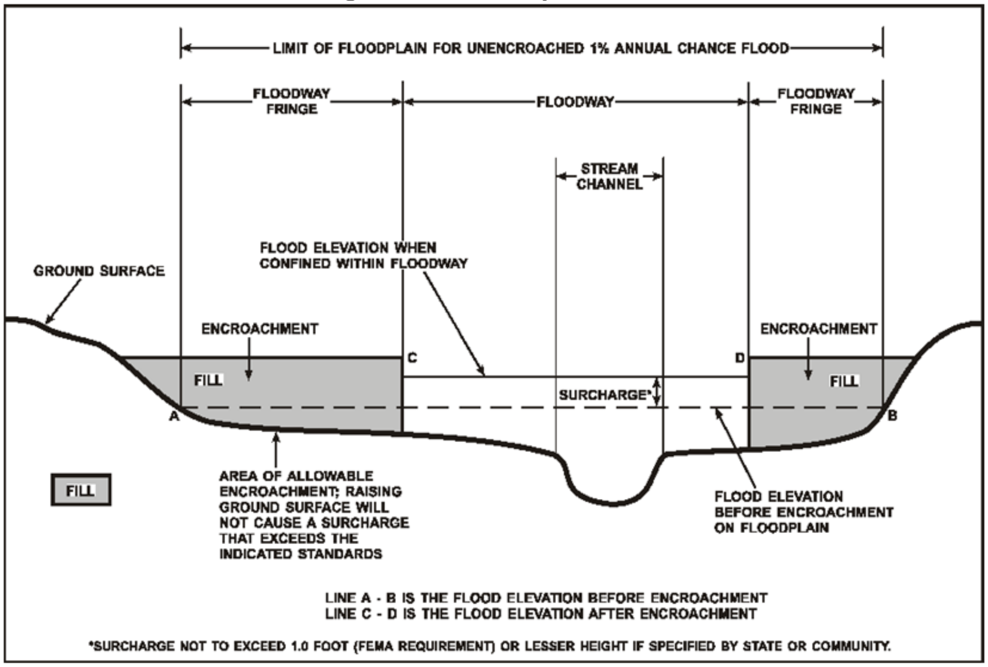
Floodway widths for the Jefferson River (computed to include various high ground "islands" within the floodway) and for the West Gallatin River, Baker Creek Area, Baker Creek West Overflow, and Camp Creek were computed at locations which do not necessarily match cross section locations as shown on the FIRM (Exhibit 1); for this reason, floodway widths, as shown on the Floodway Data Table (Table 7) will not necessarily agree with map floodway widths.

No floodway data for West Gallatin River Overflow Area, Madison River and Jefferson River Overflow Area, Jefferson River Middle Channel, and Jefferson River Easternmost Channel and Overflow Area are presented because only main channel areas have computed floodway data.

The Madison River floodway was determined to stay within the present levees. The floodway for Jefferson River, including its various secondary channels between U.S. Highway 10 and Interstate Highway 90, was computed by reducing the conveyance on the right-hand flood plain area of Jefferson River west of the City of Three Forks. The conveyance on this side of the flood plain was reduced until an average elevation rise of 0.5 foot in the water surface was achieved or the bank of the first secondary channel was reached, whichever occurred first. Downstream of Interstate Highway 90, the floodway was computed using equal- conveyance reduction.

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 0.5 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 1.

Figure 4. Floodway Schematic



FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET)			
CROSS SECTION	DISTANCE [1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD88)	WITHOUT FLOODWAY (NAVD88)	WITH FLOODWAY (NAVD88)	INCREASE FEET)
A	1,079	142	44	3.3	4,911.0	4,911.0	4,911.0	0.0
B	1,324	39	42	3.4	4,913.3	4,913.3	4,913.3	0.0

[1]Feet above confluence with Figgins Creek

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

GALLATIN COUNTY, MT

AND INCORPORATED AREAS

FLOODWAY DATA

3RD AVENUE - KAGY BOULEVARD SPLIT

FLOODING SOURCE		FLOODWAY			1-PERCENT ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	**DISTANCE [1]**	**WIDTH (FEET)**	**SECTION AREA (SQUARE FEET)**	**MEAN VELOCITY (FEET PER SECOND)**	**REGULATORY (NAVD88)**	**WITHOUT FLOODWAY (NAVD88)**	**WITH FLOODWAY (NAVD88)**	**INCREASE (FEET)**
Baker Creek West Overflow								
A	330	128	217	2.1	4,304.7	4,304.7	4,304.7	0.0
B	1,580	365	310	1.5	4,306.9	4,306.9	4,306.9	0.0
C	3,280	815	460	1.0	4,311.6	4,311.6	4,311.6	0.0
D	3,780	662	487	0.9	4,312.3	4,312.3	4,312.3	0.0
E	5,140	1,825	407	1.1	4,317.9	4,317.9	4,317.9	0.0
F	6,080	1,495	420	1.1	4,321.0	4,321.0	4,321.0	0.0
G	7,220	957	272	1.7	4,326.2	4,326.2	4,326.2	0.0
H	7,860	927	266	1.7	4,327.9	4,327.9	4,327.9	0.0
I	9,380	810	430	1.1	4,334.1	4,334.1	4,334.1	0.0
J	10,220	520	412	1.1	4,338.3	4,338.3	4,338.3	0.0
K	11,420	996	399	1.1	4,342.0	4,342.0	4,342.0	0.0
L	12,220	1,440	2,834	0.1	4,348.5	4,348.5	4,348.5	0.0
M	12,920	1,216	281	1.1	4,351.3	4,351.3	4,351.3	0.0
N	13,820	560	249	1.2	4,358.1	4,358.1	4,358.1	0.0
0	14,670	415	236	1.5	4,363.1	4,363.1	4,363.1	0.0
P	16,030	1,447	782	1.2	4,368.4	4,368.4	4,368.4	0.0
Q	16,590	715	686	2.2	4,372.0	4,372.0	4,372.0	0.0
R	17,350	920	987	1.5	4,376.7	4,376.7	4,376.7	0.0
S	18,390	698	776	1.9	4,382.5	4,382.5	4,382.5	0.0
T	20,170	967	915	1.6	4,389.9	4,389.9	4,389.9	0.0
U	21,010	1,214	558	3.2	4,395.2	4,395.2	4,395.2	0.0
V	21,450	1,523	893	2.0	4,398.3	4,398.3	4,398.3	0.0
W	22,290	1,545	570	2.7	4,403.2	4,403.2	4,403.2	0.0
X	23,450	1,995	972	1.6	4,409.0	4,409.0	4,409.0	0.0
Y	24,770	1,653	1,016	1.4	4,413.1	4,413.1	4,413.1	0.0
Z	24,930	1,432	1,929	0.7	4,416.5	4,416.5	4,416.5	0.0

[1] Feet above confluence with Camp Creek

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

GALLATIN COUNTY, MT

AND INCORPORATED AREAS

FLOODWAY DATA

BAKER CREEK WEST OVERFLOW

FLOODING SOURCE		FLOODWAY			1-PERCENT ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD88)	WITHOUT FLOODWAY (NAVD88)	WITH FLOODWAY (NAVD88)	INCREASE (FEET)
Baker Creek West Overflow (Continued)								
AA	25,370	800	553	2.5	4,418.9	4,418.9	4,418.9	0.0
AB	26,550	1,537	863	1.6	4,424.6	4,424.6	4,424.6	0.0
AC	27,630	1,660	1,364	1.0	4,429.7	4,429.7	4,429.7	0.0
AD	28,250	1,514	969	1.4	4,432.7	4,432.7	4,432.7	0.0
AE	29,570	1,392	1,201	1.2	4,438.7	4,438.7	4,438.7	0.0
AF	30,050	1,155	1,050	1.3	4,440.9	4,440.9	4,440.9	0.0
AG	31,270	470	494	1.7	4,448.7	4,448.7	4,448.7	0.0
AH	31,870	799	1,111	0.8	4,450.5	4,450.5	4,450.5	0.0
AI	32,200	610	664	2.9	4,455.0	4,455.0	4,455.0	0.0
AJ	32,880	1,767	1,176	1.6	4,459.0	4,459.0	4,459.0	0.0
AK	34,040	1,667	1,503	1.3	4,466.2	4,466.2	4,466.2	0.0
AL	34,500	1,001	1,225	1.6	4,468.0	4,468.0	4,468.0	0.0
AM	35,180	1,244	1,227	1.6	4,472.4	4,472.4	4,472.4	0.0
AN	35,860	1,390	1,518	1.3	4,475.7	4,475.7	4,475.7	0.0
AO	36,860	1,071	1,006	1.9	4,479.9	4,479.9	4,479.9	0.0
AP	38,140	590	835	1.9	4,484.1	4,484.1	4,484.1	0.0
AQ	40,540	1,191	1,041	1.4	4,496.0	4,496.0	4,496.0	0.0
AR	41,580	1,091	1,146	1.3	4,499.2	4,499.2	4,499.2	0.0
AS	42,340	1,100	1,073	1.4	4,502.3	4,502.3	4,502.3	0.0
AT	42,940	730	1,545	1.0	4,503.5	4,503.5	4,503.5	0.0
AU	43,216	1,560	2,529	0.6	4,506.7	4,506.7	4,506.7	0.0

[1] Feet above confluence with Camp Creek

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY
GALLATIN COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

BAKER CREEK WEST OVERFLOW

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD88)	WITHOUT FLOODWAY (NAVD88)	WITH FLOODWAY (NAVD88)	INCREASE (FEET)
A	2,695	51	11	2.4	4,901.5	4,901.5	4,901.5	0.0
B	2,932	60	10.5	2.5	4,903.7	4,903.5	4,903.5	0.0

[1]Feet above confluence with Garfield Street Split

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

GALLATIN COUNTY, MT

AND INCORPORATED AREAS

FLOODWAY DATA

BLACK AVENUE SPLIT

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	321	129	317	3	4,717.9	4,717.9	4,718.0	0.1
B	961	39	119	7.9	4,723.4	4,723.4	4,723.6	0.2
C	1,022	69	209	4.5	4,724.6	4,724.6	4,724.8	0.2
D	1,253	50	126	7.5	4,726.2	4,726.2	4,726.2	0.0
E	1,410	63	244	3.9	4,728.8	4,728.8	4,728.8	0.0
F	2,032	54	141	6.6	4,733.6	4,733.6	4,733.8	0.2
G	2,707	89	203	4.6	4,739.3	4,739.3	4,739.3	0.0
H	3,357	124	214	4.4	4,744.8	4,744.8	4,744.9	0.1
I	3,503	48	195	4.8	4,746.3	4,746.3	4,746.3	0.0
J	3,817	44	263	3.4	4,752.1	4,752.1	4,752.5	0.4
K	4,253	44	154	5.5	4,752.6	4,752.6	4,752.9	0.3
L	4,766	35	147	5.7	4,758.6	4,758.6	4,758.7	0.1
M	5,170	39	156	5.2	4,761.3	4,761.3	4,761.3	0.0
N	5,626	45	153	5.3	4,765.8	4,765.8	4,765.8	0.0
O	6,297	32	134	6	4,774.3	4,774.3	4,774.3	0.0
P	6,765	96	235	3.4	4,782.5	4,782.5	4,782.6	0.1
Q	7,189	33	88	9	4,784.1	4,784.1	4,784.1	0.0
R	7,530	79	177	4.5	4,789.4	4,789.4	4,789.9	0.5
S	7,863	26	98	8.1	4,792.0	4,792.0	4,792.1	0.1
T	8,225	57	142	5.6	4,796.5	4,796.5	4,796.5	0.0
U	8,627	228	309	2.5	4,800.8	4,800.8	4,800.8	0.0
V	9,009	108	174	3.1	4,804.7	4,804.7	4,804.8	0.1

[1] Feet above confluence with East Gallatin River

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

GALLATIN COUNTY, MT

AND INCORPORATED AREAS

FLOODWAY DATA

BOZEMAN CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
W	9,573	19	124	4.4	4,813.3	4,813.3	4,813.3	0.0
X	9,905	48	162	2.6	4,816.8	4,816.8	4,816.8	0.0
Y	10,582	46	135	7.4	4,821.7	4,821.7	4,821.7	0.0
Z	10,981	33	109	9.2	4,825.9	4,825.9	4,826.2	0.3
AA	11,367	27	135	7.5	4,832.6	4,832.6	4,832.6	0.0
AB	11,781	50	214	4.7	4,837.3	4,837.3	4,837.3	0.0
AC	12,267	153	202	5.6	4,842.1	4,842.1	4,842.1	0.0
AD	12,350	80	257	4.4	4,843.2	4,843.2	4,843.2	0.0
AE	12,960	245	269	4.2	4,848.0	4,848.0	4,848.0	0.0
AF	13,506	350	398	2.8	4,851.0	4,851.0	4,851.3	0.3
AG	13,932	149	356	9.0	4,855.2	4,855.2	4,855.4	0.2
AH	14,471	41	137	5.0	4,858.3	4,858.3	4,858.8	0.5
AI	15,162	96	170	4.0	4,862.9	4,862.9	4,863.2	0.3
AJ	15,545	31	119	5.7	4,865.0	4,865.0	4,865.5	0.5
AK	15,842	34	109	6.2	4,868.0	4,868.0	4,868.3	0.3
AL	16,299	69	116	5.9	4,870.7	4,870.7	4,871.0	0.3
AM	16,704	48	172	4.0	4,875.6	4,875.6	4,875.7	0.1
AN	17,312	34	110	6.2	4,882.0	4,882.0	4,882.0	0.0
AO	17,686	52	156	4.4	4,885.8	4,885.8	4,885.8	0.0
AP	18,140	28	74	9.2	4,889.7	4,889.7	4,889.7	0.0

[1] Feet above confluence with East Gallatin River

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

GALLATIN COUNTY, MT

AND INCORPORATED AREAS

FLOODWAY DATA

BOZEMAN CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD88)	WITHOUT FLOODWAY (NAVD88)	WITH FLOODWAY (NAVD88)	INCREASE (FEET)
AQ	18,559	99	219	3.1	4,893.7	4,893.7	4,894.0	0.3
AR	19,042	24	101	6.3	4,898.1	4,898.1	4,898.6	0.5
AS	19,387	81	182	3.5	4,900.8	4,900.8	4,900.8	0.0
AT	19,933	160	204	3.1	4,904.3	4,904.3	4,904.6	0.3
AU	20,476	28	92	6.9	4,909.0	4,909.0	4,909.0	0.0
AV	20,786	63	139	3.9	4,911.2	4,911.2	4,911.2	0.0
AW	21,307	30	86	6.2	4,914.2	4,914.2	4,914.5	0.3
AX	21,766	34	104	5.1	4,919.0	4,919.0	4,919.2	0.2
AY	22,348	64	109	4.9	4,923.5	4,923.5	4,923.9	0.4
AZ	22,755	78	150	3.6	4,928.8	4,928.8	4,928.8	0.0
BA	22,960	28	108	4.9	4,931.9	4,931.9	4,931.9	0.0
BB	23,292	32	96	5.5	4,935.0	4,935.0	4,935.0	0.0
BC	23,560	23	79	6.7	4,937.7	4,937.7	4,937.7	0.0
BD	23,953	38	103	5.2	4,941.7	4,941.7	4,941.8	0.1
BE	24,567	30	91	5.9	4,947.8	4,947.8	4,947.9	0.1
BF	24,977	159	159	3.4	4,952.3	4,952.3	4,952.6	0.3
BG	25,342	70	123	4.3	4,954.5	4,954.5	4,954.8	0.3
BH	25,699	107	210	2.5	4,957.1	4,957.1	4,957.6	0.5
BI	26,012	93	160	3.3	4,959.5	4,959.5	4,959.6	0.1
BJ	26,624	106	166	3.2	4,963.9	4,963.9	4,964.4	0.5
BK	27,296	48	118	4.5	4,972.0	4,972.0	4,972.0	0.0

[1] Feet above confluence with East Gallatin River

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

GALLATIN COUNTY, MT

AND INCORPORATED AREAS

FLOODWAY DATA

BOZEMAN CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD88)	WITHOUT FLOODWAY (NAVD88)	WITH FLOODWAY (NAVD88)	INCREASE (FEET)
BL	27,684	108	214	4.1	4,974.0	4,974.0	4,974.1	0.1
BM	28,041	54	186	4.7	4,978.5	4,978.5	4,978.9	0.4
BN	28,687	45	147	6.0	4,983.8	4,983.8	4,983.9	0.1
BO	29,316	32	112	6.6	4,989.3	4,989.3	4,989.4	0.1
BP	29,721	30	98	7.6	4,993.3	4,993.3	4,993.3	0.0
BQ	30,507	29	82	9.1	5,001.0	5,001.0	5,001.0	0.0
BR	31,302	45	114	6.5	5,009.9	5,009.9	5,010.2	0.3
BS	31,772	36	115	6.4	5,016.9	5,016.9	5,016.9	0.0
BT	32,217	37	128	5.6	5,020.2	5,020.2	5,020.2	0.0
BU	32,491	77	170	4.6	5,022.7	5,022.7	5,022.7	0.0
BV	32,709	95	212	3.7	5,024.6	5,024.6	5,024.8	0.2
BW	33,782	97	191	4.1	5,032.1	5,032.1	5,032.3	0.2
BX	34,449	34	128	6.1	5,037.5	5,037.5	5,037.5	0.0
BY	35,745	70	154	5.1	5,047.7	5,047.7	5,048.2	0.5
BZ	36,929	102[2]	194	4.0	5,057.6	5,057.6	5,058.0	0.4
CA	37,744	64	119	6.5	5,065.9	5,065.9	5,066.3	0.4
CB	38,737	36	125	6.2	5,077.0	5,077.0	5,077.0	0.0
CC	39,830	51	155	5.0	5,088.5	5,088.5	5,088.9	0.4
CD	40,502	78	171	4.5	5,095.3	5,095.3	5,095.8	0.5
CE	41,142	36	109	7.1	5,102.4	5,102.4	5,102.7	0.3
CF	41,643	44	96	8.1	5,109.0	5,109.0	5,109.1	0.1

[1] Feet above confluence with East Gallatin River

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

GALLATIN COUNTY, MT

AND INCORPORATED AREAS

FLOODWAY DATA

BOZEMAN CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET)			
CROSS SECTION	DISTANCE [1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD88)	WITHOUT FLOODWAY (NAVD88)	WITH FLOODWAY (NAVD88)	INCREASE (FEET)
CG	42,337	51	138	5.6	5,116.0	5,116.0	5,116.2	0.2
CH	43,067	48	134	5.8	5,124.5	5,124.5	5,124.5	0.0
CI	43,944	100	212	3.7	5,134.1	5,134.1	5,134.5	0.4
CJ	44,994	71	160	4.8	5,143.6	5,143.6	5,144.0	0.4
CK	45,788	41	83	6.7	5,154.1	5,154.1	5,154.5	0.4
CL	46,610	21	85	6.5	5,164.0	5,164.0	5,164.0	0.0
CM	47,519	81[3]	76	9.7	5,176.0	5,176.0	5,176.0	0.0
CN	47,979	96[3]	164	4.7	5,181.8	5,181.8	5,181.8	0.0

[1] Feet above confluence with East Gallatin River

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

GALLATIN COUNTY, MT

AND INCORPORATED AREAS

FLOODWAY DATA

BOZEMAN CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE [1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD88)	WITHOUT FLOODWAY (NAVD88)	WITH FLOODWAY (NAVD88)	INCREASE (FEET)
Bridger Creek								
A	360	130	259	4.5	4,690.7	4,690.7	4,691.2	0.5
B	1,410	275	334	3.4	4,697.3	4,697.3	4,697.8	0.5
C	2,370	52	148	7.8	4,705.5	4,705.5	4,705.8	0.3
D	2,970	46	169	6.8	4,712.0	4,712.0	4,712.3	0.4
E	3,410	60	200	5.7	4,716.3	4,716.3	4,716.4	0.1
F	4,440	41	147	7.8	4,724.5	4,724.5	4,724.5	0.0
G	5,150	46	179	6.4	4,731.8	4,731.8	4,731.8	0.0
H	5,262	126	433	2.5	4,732.1	4,732.1	4,732.6	0.5
I	7,310	42	206	5.2	4,750.9	4,750.9	4,751.4	0.5
J	9,800	25	148	7.2	4,777.2	4,777.2	4,777.7	0.5
K	12,100	60	251	4.0	4,795.9	4,795.9	4,796.4	0.5[2]
L	12,250	87	315	3.5	4,797.8	4,797.8	4,798.3	0.5[2]
M	12,430	92	369	3.5	4,801.4	4,801.4	4,801.9	0.5[2]
N	13,440	41	214	6.1	4,810.3	4,810.3	4,810.8	0.5
O	14,480	398	894	1.5	4,813.3	4,813.3	4,813.8	0.5
P	15,568	94	359	3.6	4,820.5	4,820.5	4,821.0	0.5
Q	15,960	342	674	1.9	4,825.4	4,825.4	4,825.9	0.5
R	18,272	79	306	4.3	4,846.6	4,846.6	4,847.1	0.5[2]
S	18,468	71	365	3.6	4,848.8	4,848.8	4,849.3	0.5[2]
T	19,568	313	670	1.9	4,858.9	4,858.9	4,859.4	0.5
U	20,183	50	208	6.1	4,868.8	4,868.8	4,869.3	0.5[2]
V	20,305	39	168	7.5	4,872.0	4,872.0	4,872.5	0.5[2]
W	20,464	221	1,118	1.1	4,873.1	4,873.1	4,873.6	0.5
X	21,334	35	181	7.0	4,884.2	4,884.2	4,884.7	0.5[2]

[1] Feet above confluence with East Gallatin River

[2] Floodway confined within channel banks. Floodway water surface elevation may be less than 0.5 foot higher than floodway condition.

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

GALLATIN COUNTY, MT

AND INCORPORATED AREAS

FLOODWAY DATA

BRIDGER CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE [1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD88)	WITHOUT FLOODWAY (NAVD88)	WITH FLOODWAY (NAVD88)	INCREASE (FEET)
Buster Gulch								
A	5,076	100	534	1.0	4,480.7	4,480.7	4,480.8	0.1
B	5,144	324	577	1.2	4,480.7	4,480.7	4,480.7	0.0
C	5,736	186	291	2.3	4,482.3	4,482.3	4,482.8	0.4
D	6,269	133	191	3.5	4,484.9	4,484.9	4,485.2	0.4
E	7,279	299	425	1.6	4,488.8	4,488.8	4,489.2	0.4
F	7,911	243	244	2.8	4,491.9	4,491.9	4,492.2	0.3
G	8,494	259	370	1.8	4,495.3	4,495.3	4,495.7	0.4
H	9,028	204	287	2.4	4,497.7	4,497.7	4,498.0	0.3
I	9,800	349	356	1.9	4,501.2	4,501.2	4,501.5	0.2
J	10,032	329	495	1.4	4,502.6	4,502.6	4,502.8	0.1
K	10,156	186	199	3.4	4,504.5	4,504.5	4,504.6	0.1
L	10,639	166	259	2.6	4,507.2	4,507.2	4,507.4	0.2
M	11,139	195	290	2.3	4,508.8	4,508.8	4,509.1	0.3
N	11,561	117	142	4.7	4,513.0	4,513.0	4,513.0	0.1
O	11,721	220	712	1.0	4,517.1	4,517.1	4,517.3	0.2
P	12,777	255	306	2.2	4,520.1	4,520.1	4,520.5	0.3
Q	13,286	235	264	2.6	4,523.6	4,523.6	4,523.6	0.1
R	14,079	141	223	3.0	4,527.5	4,527.5	4,527.6	0.1
S	14,703	143	214	3.2	4,530.8	4,530.8	4,531.2	0.5
T	15,313	71	174	3.9	4,534.4	4,534.4	4,534.7	0.3
U	16,534	102	207	3.3	4,539.3	4,539.3	4,539.7	0.4
V	17,136	178	228	3.0	4,541.6	4,541.6	4,542.1	0.5
W	17,735	129	255	2.9	4,545.1	4,545.1	4,545.3	0.2
X	17,907	150	423	1.6	4,548.2	4,548.2	4,548.6	0.4
Y	18,739	67	161	4.2	4,549.5	4,549.5	4,549.9	0.4
Z	19,411	189	239	2.8	4,553.0	4,553.0	4,553.5	0.5

[1] Stream distance in feet above Airport Road

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

GALLATIN COUNTY, MT

AND INCORPORATED AREAS

FLOODWAY DATA

BUSTER GULCH

FLOODING SOURCE		FLOODWAY			1-PERCENT ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE [1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD88)	WITHOUT FLOODWAY (NAVD88)	WITH FLOODWAY (NAVD88)	INCREASE (FEET)
Buster Gulch (continued)								
AA	19,860	105	427	1.6	4,555.7	4,555.7	4,556.0	0.3
AB	21,085	248	781	7.4	4,557.6	4,557.6	4,557.7	0.1
AC	21,788	211	435	2.3	4,562.4	4,562.4	4,562.8	0.4

[1] Stream distance in feet above Airport Road

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY
GALLATIN COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

BUSTER GULCH

FLOODING SOURCE		FLOODWAY			1-PERCENT ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	**DISTANCE [1]**	**WIDTH (FEET)**	**SECTION AREA (SQUARE FEET)**	**MEAN VELOCITY (FEET PER SECOND)**	**REGULATORY (NAVD88)**	**WITHOUT FLOODWAY (NAVD88)**	**WITH FLOODWAY (NAVD88)**	**INCREASE (FEET)**
Camp Creek								
A	250	2,056	11,239	0.1	4,266.9	4,266.9	4,266.9	0.0
B	1,050	1,770	6,961	0.3	4,267.8	4,267.8	4,267.8	0.0
C	2,540	1,509	1,214	1.0	4,268.4	4,268.4	4,268.4	0.0
D	3,560	1,106	1,102	1.1	4,271.9	4,271.9	4,271.9	0.0
E	5,480	1,230	568	1.0	4,278.3	4,278.3	4,278.3	0.0
F	6,870	850	396	1.4	4,282.2	4,282.2	4,282.2	0.0
G	7,470	850	497	1.1	4,284.4	4,284.4	4,284.4	0.0
H	8,510	730	416	1.3	4,287.1	4,287.1	4,287.1	0.0
I	10,050	1,350	609	0.9	4,290.0	4,290.0	4,290.0	0.0
J	10,960	188	336	2.9	4,297.7	4,297.7	4,297.7	0.0
K	12,850	270	334	3.0	4,304.5	4,304.5	4,304.5	0.0

[1] Feet above confluence with Baker Creek Area

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY
GALLATIN COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

CAMP CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD88)	WITHOUT FLOODWAY (NAVD88)	WITH FLOODWAY (NAVD88)	INCREASE (FEET)
A	590	97	91	1.0	4,756.5	4,756.5	4,756.5	0.0
B	932	32	49	1.8	4,756.6	4,756.6	4,756.7	0.1
C	1,312	61	27	3.3	4,757.0	4,757.0	4,757.0	0.0

[1] Feet above confluence will Mill Ditch Diversion

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

GALLATIN COUNTY, MT

AND INCORPORATED AREAS

FLOODWAY DATA

CEDAR STREET SPLIT

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	2,919	277	117	2.0	4,815.7	4,815.7	4,815.7	0.0
B	3,449	74	52	4.6	4,818.0	4,818.0	4,818.0	0.0
C	3,601	89	78	3.1	4,819.0	4,819.0	4,819.0	0.0

[1]Feet above confluence with Bozeman Creek

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

GALLATIN COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

CHURCH AVENUE SPLIT

FLOODING SOURCE		FLOODWAY			1-PERCENT ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE [1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD88)	WITHOUT FLOODWAY (NAVD88)	WITH FLOODWAY (NAVD88)	INCREASE (FEET)
East Gallatin River								
A	534	191	838	3.3	4,465.9	4,465.9	4,466.2	0.3
B	1,233	135	460	6.4	4,468.5	4,468.5	4,468.6	0.1
C	1,767	212	718	3.8	4,471.6	4,471.6	4,471.7	0.1
D	2,274	262	637	4.3	4,473.8	4,473.8	4,474.0	0.2
E	2,997	385	878	3.1	4,477.5	4,477.5	4,478.0	0.5
F	3,798	245	636	4.3	4,482.1	4,482.1	4,482.4	0.3
G	4,256	179	525	5.1	4,485.0	4,485.0	4,485.0	0.0
H	5,017	110	412	6.7	4,489.3	4,489.3	4,489.7	0.4
I	5,566	226	652	4.2	4,492.8	4,492.8	4,493.2	0.4
J	6,091	365	885	3.1	4,495.3	4,495.3	4,495.5	0.2
K	6,585	321	784	3.5	4,497.7	4,497.7	4,497.7	0.1
L	7,214	208	444	6.2	4,501.4	4,501.4	4,501.4	0.0
M	7,841	291	660	4.2	4,505.6	4,505.6	4,505.7	0.1
N	8,770	461	1,020	2.7	4,509.6	4,509.6	4,510.1	0.5
O	9,633	377	877	3.1	4,512.8	4,512.8	4,513.2	0.4
P	10,146	324	473	5.8	4,516.3	4,516.3	4,516.5	0.2
Q	10,687	203	607	4.5	4,520.1	4,520.1	4,520.2	0.1
R	11,213	122	481	5.7	4,523.0	4,523.0	4,523.1	0.1
S	12,586	287	774	3.6	4,529.5	4,529.5	4,530.0	0.5
T	13,655	410	855	3.2	4,534.3	4,534.3	4,534.8	0.5
U	15,101	635	1,264	2.2	4,537.9	4,537.9	4,538.4	0.5
V	15,983	268	447	6.2	4,541.3	4,541.3	4,541.4	0.1
W	16,766	485	1,184	2.3	4,545.7	4,545.7	4,546.2	0.5
X	17,788	194	545	5.0	4,549.8	4,549.8	4,550.2	0.3
Y	18,603	547	1,198	2.3	4,553.1	4,553.1	4,553.5	0.4
Z	19,967	716	1,439	1.9	4,556.2	4,556.2	4,556.3	0.1

[1] Distance in feet above Airport Road

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY
GALLATIN COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

EAST GALLATIN RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE [1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD88)	WITHOUT FLOODWAY (NAVD88)	WITH FLOODWAY (NAVD88)	INCREASE (FEET)
East Gallatin River (continued)								
AA	20,576	158	419	6.6	4,558.5	4,558.5	4,558.6	0.1
AB	21,081	186	853	3.2	4,562.8	4,562.8	4,562.9	0.1
AC	22,433	402	685	4.0	4,566.5	4,566.5	4,566.9	0.4
AD	23,450	931	1,511	1.8	4,569.6	4,569.6	4,570.0	0.4
AE	25,206	565	696	1.8	4,572.6	4,572.6	4,573.0	0.4
AF	25,733	472	1,006	1.3	4,574.0	4,574.0	4,574.0	0.0
AG	26,573	274	312	4.0	4,576.7	4,576.7	4,576.7	0.0
AH	28,420	385	538	2.3	4,585.9	4,585.9	4,586.2	0.3
AI	30,876	922	2,230	0.6	4,585.9	4,585.9	4,586.2	0.3
AJ	31,458	496	399	3.2	4,589.1	4,589.1	4,589.5	0.4
AK	31,876	1,363	1,616	2.1	4,594.1	4,594.1	4,594.3	0.3
AL	33,723	576	1,250	2.0	4,599.0	4,599.0	4,599.5	0.5
AM	35,148	139	448	5.6	4,602.8	4,602.8	4,602.9	0.1
AN	37,938	551	847	2.9	4,611.5	4,611.5	4,611.9	0.4
AO	40,903	190	510	4.9	4,618.8	4,618.8	4,619.1	0.3
AP	40,952	89	359	6.9	4,618.8	4,618.8	4,619.3	0.5
AQ	41,102	89	496	5.0	4,621.5	4,621.5	4,621.5	0.0
AR	41,316	277	1,353	1.8	4,622.2	4,622.2	4,622.2	0.0
AS	41,739	382	643	4.4	4,622.6	4,622.6	4,622.7	0.1
AT	42,478	458	980	2.6	4,623.2	4,623.2	4,623.6	0.4
AU	43,177	130	374	6.7	4,627.4	4,627.4	4,627.6	0.2
AV	44,473	473	742	3.4	4,633.7	4,633.7	4,634.2	0.5
AW	45,420	60	374	6.7	4,636.9	4,636.9	4,637.1	0.2
AX	47,551	717	658	3.8	4,647.8	4,647.8	4,648.3	0.5
AY	49,074	278	512	4.9	4,654.4	4,654.4	4,654.9	0.5
AZ	52,461	460	1,176	3.1	4,662.8	4,662.8	4,663.2	0.4

[1] Distance in feet above Airport Road

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY
GALLATIN COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

EAST GALLATIN RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
BA	53,307	119	324	7.7	4,665.7	4,665.7	4,665.8	0.1
BB	53,878	661	1,544	1.6	4,667.8	4,667.8	4,668.3	0.5
BC	54,923	91	311	8.0	4,670.1	4,670.1	4,670.2	0.1
BD	55,015	64	289	8.6	4,670.9	4,670.9	4,671.1	0.2
BE	55,064	64	352	7.1	4,671.9	4,671.9	4,671.9	0.0
BF	55,154	92	596	4.2	4,672.8	4,672.8	4,672.8	0.0
BG	55,507	90	411	6.1	4,673.5	4,673.5	4,673.5	0.0
BH	56,543	62	379	3.0	4,676.3	4,676.3	4,676.4	0.1
BI	57,105	89	326	4.9	4,677.1	4,677.1	4,677.2	0.1
BJ	57,832	114	469	3.4	4678.8	4,678.8	4,679.0	0.2
BK	58,715	118	315	6.4	4680.9	4,680.9	4,681.4	0.5
BL	59,282	355	919	2.8	4683	4,683.0	4,683.5	0.5
BM	61,028	487	827	3.6	4686.7	4,686.7	4,687.1	0.4
BN	61,564	644	985	2.3	4688.3	4,688.3	4,688.8	0.5
BO	62,535	261	468	4.8	4690.3	4,690.3	4,690.8	0.5
BP	63,644	121	326	6.9	4696.8	4,696.8	4,697.3	0.5
BQ	64,861	690	1059	2.1	4701.5	4,701.5	4,701.9	0.4
BR	65,665	269	386	5.8	4704.7	4,704.7	4,704.8	0.1
BS	66,031	227	806	2.8	4706.1	4,706.1	4,706.5	0.4
BT	66,500	457	441	5.1	4709.7	4,709.7	4,710.1	0.4
BU	66,721	428	410	5.5	4710.9	4,710.9	4,711.4	0.5
BV	66,814	53	1,631	11.0	4712.1	4,712.1	4,712.1	0.0
BW	66,924	575	1,859	1.2	4715.1	4715.1	4,715.3	0.2
BX	67,033	442	1,645	1.4	4715.2	4715.2	4,715.4	0.2

[1]Distance in feet above Airport Road

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

GALLATIN COUNTY, MT

AND INCORPORATED AREAS

FLOODWAY DATA

EAST GALLATIN RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
BY	67,633	73	344	6.5	4,716.3	4,716.3	4,716.6	0.3
BZ	68,335	169	542	3.3	4,719.5	4,719.5	4,719.8	0.3
CA	68,552	247	491	3.6	4,720.3	4,720.3	4,720.5	0.2
CB	68,617	196	725	4.0	4,721.0	4,721.0	4,721.5	0.5
CC	68,754	82	364	4.9	4,722.0	4,722.0	4,722.2	0.2
CD	68,917	89	354	5.0	4,722.5	4,722.5	4,722.7	0.2
CE	69,729	57	227	7.8	4,726.1	4,726.1	4,726.2	0.1
CF	69,799	79	349	5.1	4,727.8	4,727.8	4,727.8	0.0
CG	70,045	137	624	2.8	4,729.2	4,729.2	4,729.2	0.0
CH	70,480	44	187	9.5	4,731.5	4,731.5	4,731.5	0.1
CI	70,735	71	274	7.5	4,735.0	4,735.0	4,735.0	0.1
CJ	70,850	531	1,832	1.3	4,737.4	4,737.4	4,737.4	0.0
CK	70,928	391	630	3.1	4,737.2	4,737.2	4,737.2	0.1
CL	71,699	154	484	3.7	4,739.4	4,739.4	4,739.4	0.2
CM	72,743	78	225	7.9	4,743.6	4,743.6	4,743.6	0.5
CN	73,730	42	226	7.4	4,753.5	4,753.5	4,753.5	0.1
CO	74,745	94	188	8.9	4,762.9	4,762.9	4,762.9	0.0
CP	74,831	162	285	5.9	4,764.8	4,764.8	4,764.8	0.0
CQ	74,866	265	409	4.1	4,765.5	4,765.5	4,765.5	0.3
CR	75,040	45	243	6.9	4,765.9	4,765.9	4,765.9	0.4
CS	75,256	51	243	6.9	4,767.0	4,767.0	4,767.0	0.5
CT	75,769	111	321	5.2	4,770.2	4,770.2	4,770.2	0.4
CU	76,240	38	148	11.3	4,775.3	4,775.3	4,775.3	0.0
CV	76,319	41	230	7.3	4,777.3	4,777.3	4,777.3	0.0

[1]Distance in feet above Airport Road

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

GALLATIN COUNTY, MT

AND INCORPORATED AREAS

FLOODWAY DATA

EAST GALLATIN RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
CW	76,405	52	303	5.5	4,778.0	4,778.0	4,778.1	0.1
CX	76,605	43	221	7.6	4,778.6	4,778.6	4,778.7	0.1
CY	76,907	70	275	6.1	4,780.7	4,780.7	4,780.9	0.2
CZ	78,147	161	406	4.1	4,787.0	4,787.0	4,787.5	0.5
DA	78,969	55	276	6.0	4797.1	4797.1	4797.6	0.5
DB	79,727	59	326	5.1	4798.6	4798.6	4799.1	0.5
DC	80,982	64	261	5.7	4806.5	4806.5	4807.0	0.5
DD	81,090	216	632	2.6	4808.0	4808.0	4808.5	0.5
DE	82,166	195	482	3.3	4813.5	4813.5	4814.0	0.5
DF	82,955	96	289	5.5	4820.0	4820.0	4820.5	0.5
DG	85,542	196	529	3.1	4836.9	4836.9	4837.4	0.5
DH	89,928	121	452	3.3	4853.6	4853.6	4854.1	0.5
DI	90,020	255	1,096	1.4	4854.7	4854.7	4855.2	0.5
DJ	92,915	197	422	3.6	4869.3	4869.3	4869.8	0.5
DK	93,036	400	1,342	1.1	4871.9	4871.9	4872.4	0.5
DL	95,720	235	562	2.7	4880.4	4880.4	4880.9	0.5
DM	95,814	234	853	1.8	4882.4	4882.4	4882.9	0.5
DN	99,680	150	492	3.1	4906.6	4906.6	4907.1	0.5
DO	101,665	103	342	4.2	4921.5	4921.5	4922.0	0.5
DP	101,770	70	244	5.9	4922.6	4922.6	4923.1	0.5

[1]Distance in feet above Airport Road

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

GALLATIN COUNTY, MT

AND INCORPORATED AREAS

FLOODWAY DATA

EAST GALLATIN RIVER

FLOODING SOURCE		FLOODWAY			1-PERCENT ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	**DISTANCE [1]**	**WIDTH (FEET)**	**SECTION AREA (SQUARE FEET)**	**MEAN VELOCITY (FEET PER SECOND)**	**REGULATORY (NAVD88)**	**WITHOUT FLOODWAY (NAVD88)**	**WITH FLOODWAY (NAVD88)**	**INCREASE (FEET)**
East Gallatin River Golf Course Reach								
A	87	72	184	5.8	4,604.5	4,604.5	4,605.0	0.5
B	333	73	138	7.7	4,606.9	4,606.9	4,607.0	0.2
C	980	424	394	2.7	4,609.1	4,609.1	4,609.5	0.5
D	1,345	558	311	3.4	4,611.4	4,611.4	4,611.4	0.1
E	1,966	154	219	4.9	4,613.9	4,613.9	4,614.3	0.4
F	2,369	392	370	2.9	4,616.7	4,616.7	4,616.8	0.1

[1] Feet above confluence with East Gallatin River Springhill Reach

TABLE 8

FEDERAL EMERGENCY MANAGEMENTAGENCY
GALLATIN COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

EAST GALLATIN RIVER GOLF COURSE REACH

FLOODING SOURCE		FLOODWAY			1-PERCENT ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE [1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD88)	WITHOUT FLOODWAY (NAVD88)	WITH FLOODWAY (NAVD88)	INCREASE (FEET)
East Gallatin River Overflow Reach								
A	300	220	559	3.6	4,589.4	4,589.4	4,589.9	0.5
B	928	114	263	4.0	4,591.6	4,591.6	4,592.1	0.5
C	1,263	32	121	8.6	4,594.6	4,594.6	4,594.6	0.0
D	1,336	32	190	5.3	4,595.9	4,595.9	4,596.1	0.2
E	1,925	115	501	1.9	4,596.2	4,596.2	4,596.7	0.5
F	2,760	111	360	6.2	4,596.8	4,596.8	4,597.1	0.3
G	3,358	201	326	2.3	4,600.1	4,600.1	4,600.6	0.5
H	4,682	155	184	4.1	4,605.2	4,605.2	4,605.3	0.1
I	5,326	333	323	2.3	4,608.0	4,608.0	4,608.4	0.4
J	6,386	139	160	3.8	4,612.1	4,612.1	4,612.6	0.5
K	6,927	176	240	2.8	4,615.2	4,615.2	4,615.5	0.3
L	7,511	149	126	4.8	4,619.0	4,619.0	4,619.1	0.1
M	8,139	302	639	1.4	4,623.1	4,623.1	4,623.6	0.5
N	9,120	86	116	5.2	4,629.2	4,629.2	4,629.7	0.5
O	9,842	242	303	2.0	4,634.5	4,634.5	4,634.9	0.4
P	10,413	290	318	4.1	4,640.4	4,640.4	4,640.5	0.1
Q	10,983	206	196	2.8	4,645.4	4,645.4	4,645.8	0.4
R	11,424	211	146	3.8	4,648.5	4,648.5	4,649.0	0.5
S	11,994	81	130	4.2	4,653.4	4,653.4	4,653.9	0.5
T	12,077	290	139	3.9	4,656.0	4,656.0	4,656.0	0.0
U	12,642	216	194	2.2	4,659.6	4,659.6	4,660.0	0.4
V	13,227	93	86	4.9	4,662.0	4,662.0	4,662.2	0.2
W	13,452	270	414	1.0	4,662.5	4,662.5	4,662.9	0.4
X	13,846	69	72	5.9	4,664.5	4,664.5	4,664.6	0.1
Y	14,576	209	170	2.5	4,671.2	4,671.2	4,671.4	0.2
Z	14,776	48	65	6.6	4,673.5	4,673.5	4,673.5	0.0

[1] Feet above confluence with East Gallatin River

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

GALLATIN COUNTY, MT

AND INCORPORATED AREAS

FLOODWAY DATA

EAST GALLATIN RIVER OVERFLOW REACH

FLOODING SOURCE		FLOODWAY			1-PERCENT ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE [1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD88)	WITHOUT FLOODWAY (NAVD88)	WITH FLOODWAY (NAVD88)	INCREASE (FEET)
East Gallatin River Spillway Reach								
A	250	51	169	5.8	4,591.8	4,591.8	4,592.3	0.5
B	860	203	442	0.8	4,592.9	4,592.9	4,593.4	0.5
C	1,418	78	65	5.4	4,595.7	4,595.7	4,595.8	0.0
D	1,837	172	79	4.4	4,600.2	4,600.2	4,600.6	0.4
E	2,027	114	168	2.1	4,601.3	4,601.3	4,601.7	0.5
F	2,447	40	53	6.6	4,603.1	4,603.1	4,603.4	0.3

[1] Feet above confluence with East Gallatin River Overflow Reach

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY
GALLATIN COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

EAST GALLATIN RIVER SPILLWAY REACH

FLOODING SOURCE		FLOODWAY			1-PERCENT ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE [1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD88)	WITHOUT FLOODWAY (NAVD88)	WITH FLOODWAY (NAVD88)	INCREASE (FEET)
East Gallatin River Springhill Reach								
A	240	98	88	1.0	4,596.0	4,596.0	4,596.5	0.5
B	660	46	52	4.3	4,597.2	4,597.2	4,597.5	0.3
C	995	105	181	3.9	4,598.9	4,598.9	4,599.2	0.3
D	1,435	73	152	4.7	4,600.6	4,600.6	4,601.1	0.5
E	1,635	68	129	5.5	4,601.8	4,601.8	4,602.2	0.4
F	1,950	88	192	3.7	4,603.5	4,603.5	4,603.6	0.2

[1] Feet above confluence with East Gallatin River Overflow Reach

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY
GALLATIN COUNTY, MT
AND INCORPORATED AREAS

FLOODWAY DATA

EAST GALLATIN RIVER SPRINGHILL REACH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	15	14	20	4.6	4,896.4	4,895.0[2]	4,895.0[2]	0.0
B	280	36	53	1.8	4,898.0	4,898.0	4,898.0	0.0
C	596	27	45	3.0	4,900.8	4,900.8	4,900.8	0.0
D	886	110	148	0.7	4,904.2	4,904.2	4,904.2	0.0
E	1,431	12	19	5.2	4,905.3	4,905.3	4,905.3	0.0
F	1,962	128	489	0.5	4,914.4	4,914.4	4,914.4	0.0
G	2,689	65	47	3.8	4,920.9	4,920.9	4,921.1	0.2
H	2,817	25	32	5.6	4,922.2	4,922.2	4,922.5	0.3
I	3,047	31	59	1.7	4,926.5	4,926.5	4,926.5	0.0
J	3,367	51	39	2.7	4,929.8	4,929.8	4,929.8	0.0
K	3,576	20	61	1.1	4,934.9	4,934.9	4,935.3	0.4
L	4,026	47	188	2.5	4,940.7	4,940.7	4,940.7	0.0
M	5,005	26	30	3.8	4,952.2	4,952.2	4,952.3	0.1
N	5,864	54	37	3.1	4,965.5	4,965.5	4,965.8	0.3
O	6,643	25	31	2.3	4,976.6	4,976.6	4,976.6	0.0
P	7,484	24	43	1.1	4,990.6	4,990.6	4,990.6	0.0
Q	7,727	20	12	4.1	4,994.7	4,994.7	4,994.7	0.0
R	8,618	8	13	2.6	5,008.7	5,008.7	5,008.7	0.0
S	9,071	11	15	2.3	5,014.3	5,014.3	5,014.3	0.0

[1]Feet above confluence with Mathew Bird Creek

[2]Elevation shown without consideration of Mathew Bird Creek

TABLE 24

FEDERAL EMERGENCY MANAGEMENT AGENCY

GALLATIN COUNTY, MT

AND INCORPORATED AREAS

FLOODWAY DATA

FIGGINS CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD88)	WITHOUT FLOODWAY (NAVD88)	WITH FLOODWAY (NAVD88)	INCREASE (FEET)
A	1,191	10	10	4.2	4,902.7	4,902.7	4,902.7	0.0
B	1,299	125[2]	45	3.1	4,905.1	4,905.1	4,905.1	0.0
C	1,890	13	35	0.7	4,912.2	4,912.2	4,912.2	0.0
D	2,076	5	5	5.4	4,912.3	4,912.3	4,912.3	0.0
E	2,464	7	7	3.7	4,915.6	4,915.6	4,915.6	0.0
F	2,832	8	10	2.5	4,918.4	4,918.4	4,918.4	0.0
G	3,268	8	13	2.0	4,923.2	4,923.2	4,923.3	0.1
H	3,948	11	21	2.5	4,930.9	4,930.9	4,931.1	0.2
I	4,282	11	24	1.1	4,935.2	4,935.2	4,935.3	0.1
J	4,830	13	21	1.2	4,940.1	4,940.1	4,940.3	0.2
K	5,031	9	22	1.2	4,942.0	4,942.0	4,942.3	0.3
L	5,384	37	35	0.7	4,946.7	4,946.7	4,946.7	0.0
M	5,566	40	21	1.3	4,947.9	4,947.9	4,948.1	0.2

[1]Feet above Rouse Avenue Split

[2]Floodway topwidth includes width of high ground area

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

GALLATIN COUNTY, MT

AND INCORPORATED AREAS

FLOODWAY DATA

FLAT CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD88)	WITHOUT FLOODWAY (NAVD88)	WITH FLOODWAY (NAVD88)	INCREASE (FEET)
A	318	133[2]	62	3.6	4,906.8	4,906.8	4,906.8	0.0
B	697	54[2]	44	5.1	4,909.2	4,909.2	4,909.2	0.0

[1] Feet above confluence with Mathew Bird Creek

[2] Floodway top-width influenced by flow from Flat Creek

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

GALLATIN COUNTY, MT

AND INCORPORATED AREAS

FLOODWAY DATA

FLAT/KAGY SPLIT