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Hydrology Design Report

West Gallatin River
Gallatin County, MT

Montana DNRC Cooperating Technical Partners Mapping Activity Statement (MAS): No. 2014-02: Gallatin County, MT

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TABLE OF CONTENTS

1.0 Introduction 1-1
1.1 Watershed Description 1-1
2.0 Hydrologic Analysis 2-1
2.1 Flood History 2-1
2.2 Historic Data 2-2
2.2.1 Effective Flood Insurance Study 2-2
2.2.2 Natural Resources Conservation Service 2-3
2.2.3 United States Geologic Survey Flood-Frequency 2-4
2.3 Hydrologic Analysis Procedure 2-1
2.4 Stream Gage Analysis 2-2
2.5 Two-Gage Interpolation Method 2-6
3.0 Results of Hydrologic Analysis 3-1
3.1 Discussion and Selected Discharge 3-4
4.0 References 4-1

LIST OF TABLES

Table 2-1. Active and Historic USGS Gaging Stations Near Project Area 2-1
Table 2-2. Five Largest Peak Flow Events Recorded at USGS Gage 2-2
Table 2-3. Effective FIS Peak Flow Values 2-3
Table 2-4. Basin-Characteristics, Channel-Width, and Flood-Frequency Data for West Gallatin River and Gallatin River Stream Gages from USGS WRIR 03-4308 (Reference 8). 2-1
Table 2-5. Flood-Frequency Results for USGS Gages 06043500 Gallatin River near Gallatin Gateway and 06052500 Gallatin River at Logan MT 2-5
Table 3-1. Two-Gage Analyses at Previously Identified Flow Change Locations 3-3
Table 3-2. Recommended Flow Values for Flood Study 3-4

LIST OF FIGURES

Figure 1. West Gallatin River Watershed and Project Area..... i
Figure 2. Project Vicinity.....ii
Figure 3a. West Gallatin River FEMA Panel 30031C0340D iiii
Figure 3b. West Gallatin River FEMA Panel 30031C0345D. iiii
Figure 3c. West Gallatin River FEMA Panels 30031C0555D, 0560D, 0558D, and 0559D. iv
Figure 3d. West Gallatin River FEMA Panels 30031C0566D, 0567D, 0586D, 569D, and 0588D. iv

Figure 2e. West Gallatin River FEMA Panel 30031C0780D. v
Figure 2f. West Gallatin River FEMA Panel 30031C0790D. v
Figure 2g. West Gallatin River FEMA Panel 30031C0905D. vii

APPENDICES

Appendix A – USGS Stream Gage Data

Appendix B – Hydrologic Calculations

Appendix C – Photographs and Press Information

1.0 Introduction

As part of the Mapping Activity Statement (MAS) contract for the West Gallatin River in Gallatin County, Montana (Reference 1), Morrison-Maierle, Inc. is completing a detailed floodplain study for approximately 30 miles of the West Gallatin River within Gallatin County, Montana. The West Gallatin River study limits extend from the confluence with the East Gallatin River at the downstream limit to approximately 30 miles upstream to just above Gallatin Gateway, Montana at the upstream limit. The project area is presented in Figure 1.

A Flood Insurance Study (FIS) has been completed for Gallatin County, the most recent effective September 2, 2011 (Reference 2). Flood hazards currently mapped are approximate Zone A from the confluence of the West Gallatin River with the East Gallatin River upstream to the Interstate 90 bridge and detailed Zone AE from the Interstate 90 bridge upstream to approximately ½ mile downstream of the upstream limit. The uppermost ½ mile of the currently mapped area is approximate Zone A. The effective flooding hazards for the West Gallatin River are shown in Figure 2.

This report summarizes the hydrologic analyses and results for the study area. The flood study will include hydrologic analyses performed to estimate the 10%, 4%, 2%, 1%, 1%+ and 0.2% annual chance flood events for the West Gallatin River.

1.1 Watershed Description

The West Gallatin River originates at Gallatin Lake inside Yellowstone National Park, Wyoming. The West Gallatin River flows north from its headwaters in and adjacent to Yellowstone National Park. The West Gallatin River and its tributaries drain the Gallatin and Madison Ranges, eventually flowing near the towns of Belgrade and Manhattan, Montana, joining the Missouri River near Three Forks, Montana. At the confluence with the East Gallatin River, the river drains approximately 1,100 square miles.

Located in the Gallatin River watershed (HUC 8 10020008), the topography of the West Gallatin River varies from steep rugged mountains with peaks extending above 10,000 ft in the upper reaches to a broad valley floodplain with multi-thread active and relic channel features. Over geologic time scales, West Gallatin River migrated over its current floodplain which was formed on glacial and alluvial deposits. The watershed above the upper study limit is mostly forested with narrow riparian corridors along the channel margins at the bottom of the steep valley slopes. The valley opens up to a broader floodplain once the West Gallatin River exits the Gallatin Canyon, just upstream of Gallatin Gateway, Montana and the beginning of the study area. Through the study area, the West Gallatin River flows through a broader valley characterized by a mature cottonwood forest and brush understory.

Land use along the West Gallatin River corridor and floodplain is primarily agriculture of hay and pasture with pockets of developing areas. Development along the lower West Gallatin River corridor is generally characterized more as medium-sized lots on the order

of several to tens of acres with very little high density sub-divisions. These larger lot sizes retain the rural character of the valley, with pastures, hay fields, and cottonwood forests still the general land-use in the floodplain. While there are numerous small irrigation features (diversions, headgates, turnouts) along the West Gallatin River corridor, there are no major impoundments or diversion features that would have large-scale or broader influences on watershed hydrology for purposes of a flood insurance study. Other major infrastructure within the watershed include roads, highways, and railroads, with associated bridges and culverts. While these features are somewhat prevalent within and upstream of the study area, they do not significantly alter the watershed hydrology.

2.0 Hydrologic Analysis

This update to the flood study covers approximately 30 miles of the West Gallatin River, beginning at the confluence with the East Gallatin River and extending upstream to just upstream of the community of Gallatin Gateway, Montana (Figure 1). 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. Figure 1 identifies the gage locations. Summary data for the gages are listed in Table 2-1.

Table 2-1.
Active and Historic USGS Gaging Stations Near Project Area

Gaging Station Number	Gaging Station Name	Period of Record	Number of Peaks in Record	Drainage Area (mi^2)	Maximum Peak Discharge (cfs) / Year	Minimum Peak Discharge (cfs) / Year
06043500	Gallatin River near Gallatin Gateway	1890 – 2013 (123 years)	85	825(1)	9,160 / 1997	1,740 / 1934
06052500	Gallatin River at Logan, MT	1895 – 2013 (118 years)	94	1,795	9,840 / 1899	1,990 / 1941
06044000	Gallatin River near Salesville MT	1895 – 1923 (28 years)	15	833	10,000 / 1899	2,700 / 1905

(1) As currently published by USGS.

2.1 Flood History

The five highest annual peak discharges recorded by each gage are listed in Table 2-2. With the exception of two events at the Gallatin Gateway gage since the effective FIS (1997 and 2011) and one event on the Logan gage (2011), the majority of the previous high flow events were included in the effective Flood Insurance Study (FIS) hydrologic analyses. As described above, the Salesville gage is located in relatively close proximity to the Gallatin Gateway gage and based on this proximity and the lack of tributary inputs between the gages, the Salesville gage data were utilized to augment the flow record for the Gallatin Gateway gage. Thus, the peak discharge from the Salesville gage in 1899 (10,000 cfs) represents the highest flood in the Gallatin Gateway / Salesville gage flow

record. The 1899 peak on the Logan gage (9,840 cfs) is consistent with this high flow event and also represents the highest flood event in the Logan gage flow record.

Table 2-2.
Five Largest Peak Flow Events Recorded at USGS Gage

Ranking	06043500 Gallatin River near Gallatin Gateway		06052500 Gallatin River at Logan, MT	
	Date	Peak Discharge (cfs)	Date	Peak Discharge (cfs)
1	June 20, 1899	10,000(1)	June 21, 1899	9,840
2	June 2, 1997	9,160	June 8, 1997	9,400
3	June 17, 1974	9,100	June 10, 1970	9,390
4	June 18, 1896	8,700(1)	June 18, 1974	9,170
5	June 30, 2011	8,410	June 28, 1971	8,480

(1) Note: Peak flow from 06044000 Gallatin River near Salesville, MT

Previous Flood Insurance Studies note a number of years of significant flood events, which include floods which happened in years 1952, 1959, 1963, 1970, 1971, 1974, and 1975. Since the 1984 FIS, two significant peak flow events occurred, one in 1997 (9,160 cfs), the other in 2011 (8,410 cfs). Photographs and press coverage of notable flood events are included in Appendix C. Flooding extents from aerial photography of the 1997 flood event will be used to validate hydraulic evaluations.

2.2 Historic Data

2.2.1 Effective Flood Insurance Study

Previous flood-frequency analyses have been performed for the study area. The effective Flood Insurance Study (FIS) was recently revised and became the effective FIS on September 2, 2011. The 2011 revision updates the 1984 FIS for Gallatin County (Reference 2 - FEMA 2011). However, these revisions are primarily a result of two studies prepared by Anderson Engineers, Inc., one for the East Gallatin River (Reference 3 - Anderson, 2002) and the other for the East Gallatin River and Bridger Creek (Reference 4 - Anderson, 2007), and new data associated with the City of Three Forks. Thus, the information in the 2011 Effective FIS for the West Gallatin River is carried over from the 1984 FIS (Reference 2 - FEMA 2011).

A Special Flood Hazard Information Report on Gallatin River was prepared by the US Army Corps of Engineers in 1973. In 1975, the Montana DNRC published a flood area map and profile for the West Gallatin River, which revised the flood profiles and boundaries based on aerial photographs taken during the June 1974 flood event. The Soil Conservation Service (now NRCS) published a Flood Insurance Study that included the West Gallatin River in 1979, providing water surface elevations. This information was later incorporated into a 1984 FIS. The 1984 FIS further revised the peak discharge values, water surface elevations, and flood boundaries from previous studies and reports. The 1984 FIS revisions were based on additional information derived through flood-

frequency analyses, more coverage in the Baker Creek channels and greater detail paid to delineating areas which lie above the base flood elevations.

The hydrologic analysis performed in the 1984 FIS was based on a flood-frequency analysis of the Gallatin Gateway gage (USGS gage 06043500 Gallatin River near Gallatin Gateway). The effective FIS (2011) reports that the hydrologic analyses performed in the 1984 study utilized 52 years of peak discharge data and appear to utilize peak flow data at the Gallatin Gateway gage (without data augmentation from the Salesville gage) from 1890 to 1977. The revised analyses performed for this study, as described in Section 2.4, has a peak flow record that nearly doubles (100 years of peak flow data) the peak flow record utilized in the 1984 analyses. The 1984 analysis further notes that it included the high flow years of the 1970's. As part of the study, regression analyses were performed on 19 gages in the area to develop regression equations. Additionally, the 1984 analysis utilized gage transfer equations (based on the Gallatin Gateway gage and ungaged drainage areas) to estimate peak flow events at the flow change locations within the study area.

Table 2-3 lists the flow change locations and values published in the 1984 FIS (and published in the current effective FIS).

Table 2-3.
Effective FIS Peak Flow Values

Flooding Source and Location	Peak Discharges (cubic feet per second)				
	Drainage Area (Square Miles)	10-Percent Annual Chance	2-Percent Annual Chance	1-Percent Annual Chance	0.2-Percent Annual Chance
At Interstate Highway 90	970 (1)	8,850 (1)	11,400 (1)	12,350 (1)	14,800 (1)
At State Highway 289 (Sheds Bridge) (2)	946.0	8,700	11,200	12,150	14,570
At upstream limit of study	853.0	8,100	10,400	11,330	12,550

(1) Reflects combination of West Gallatin River, Baker Creek Area, Camp Creek, and Baker Creek West Overflow.
(2) Sheds Bridge previously labeled State Highway 289 in the effective FIS, and is revised to reflect its current Montana Department of Transportation (MDT) designation as State Highway 84.

2.2.2 Natural Resources Conservation Service

The Natural Resources Conservation Service (NRCS) performed a flood study on the Lower Gallatin and Lower East Gallatin Rivers (Reference 5). This study was performed in 2000 and, in addition to the East Gallatin River, covered the portion of the West Gallatin River from the Interstate 90 bridge to the confluence with the East Gallatin River, and down to the confluence with the Missouri River near Three Forks, Montana. The NRCS study utilized flood-frequency data published by the USGS at the USGS gage 06052500 Gallatin River at Logan through water 1998. The study identified the 1% annual chance flood published by the USGS at the Logan gage was 10,800. However, it noted that the effective FIS reported a 1% annual chance flood peak on the West Gallatin River at the

Interstate 90 bridge as 12,350 cfs. The study did not resolve the discrepancy and simply noted that the value from the FIS at the Interstate 90 bridge would be utilized within its study area for consistency. The 2000 NRCS flood study on the Lower Gallatin and Lower East Gallatin Rivers was incorporated into the 2011 DFIRM update as an Existing Data Study (XDS). However, since the 2000 NRCS flood study on the Lower Gallatin did not satisfy FEMA detailed study standards, it was incorporated as an Approximate-level study.

2.2.3 United States Geologic Survey Flood-Frequency

2.2.3.1 West Gallatin River

The USGS operates a gaging station on the West Gallatin River approximately six miles above the study area (06043500 Gallatin River near Gallatin Gateway). This gage has a flow record from 1890 through 2013, although there are periods in the record with no data. Peak discharge values are available for 85 years of this record. The USGS has published a flood-frequency analysis at this gaging station through water year 1998 (Reference 8). The published 1998 USGS flood-frequency analysis for this site combined the flow through data augmentation with another gaging station which was operated in the late 1890's and early 1900's (USGS gage 06044000 Gallatin River near Salesville, MT). This gaging station was located approximately 3.7 miles downstream of the Gallatin River near the Gallatin Gateway gaging station. There are no significant tributaries located between the two gaging stations and the USGS determined that the data from the Salesville station is representative of flows at the Gallatin Gateway gaging station. There are 15 years of peak flow data (1896 through 1923) for the Salesville site which, when combined with the 85 years of peak flow data at the Gallatin Gateway gaging data through data augmentation, provide 100 years of peak flow data dating back to 1890. None of the years of peak flow data overlap between the Gallatin Gateway and Salesville gaging stations.

The 1998 USGS flood-frequency results for the Gallatin Gateway gage (with data augmentation from the Salesville gage) are provided in Table 2-4. As described in Section 2.4 Stream Gage Analysis, the 1998 USGS flood-frequency analyses use peak flow data for water years 1970 and 1971 that are higher than the currently published peak flow data for those years on the Gallatin Gateway gage. Thus, the reported peak discharges for the indicated recurrence interval years is greater than if the 1998 analyses was performed using currently published flow values for the 1970 and 1971 water years. The 1998 USGS flood-frequency analysis was a log-Pearson Type III frequency analysis with data augmentation from the Salesville gage. The 1998 flood-frequency analysis was based on 85 years of record, and the 1% annual chance flood event was determined to be 10,700 cfs.

2.2.3.2 Gallatin River

The USGS operates a gaging station on the Gallatin River below the confluence with the East Gallatin River (downstream limit of study area) approximately 5.6 miles below the study area (06052500 Gallatin River at Logan, MT). This gage has a flow record from 1895 through 2013, although there are periods in the record with no data. Peak discharge

values are available for 94 years of this record. The peak flow record for the Logan site is nearly continuous with the peak flow record from the Gallatin Gateway and Salesville gaging stations. The East Gallatin River, Camp Creek, and South Cottonwood Creek are the only significant tributaries between the Logan gaging station and the Gallatin Gateway gaging station.

The 1998 USGS flood-frequency results for the Logan gage are provided in Table 2-4. This flood-frequency analysis was a log-Pearson Type III frequency analysis on a peak flood record of 79 years. The 1% annual chance flood event at the Logan gage was determined to be 10,800 cfs.

Table 2-4. Basin-Characteristics, Channel-Width, and Flood-Frequency Data for West Gallatin River and Gallatin River Stream Gages from USGS WRIR 03-4308 (Reference 8).

Station Number		06043500	06052500
Station Name		Gallatin River near Gallatin Gateway	Gallatin River at Logan
Type of Flood Data and Frequency Analysis[(1)]		C,LP	LP
Years of Record		85	79
Drainage Area (mi^2)		825	1,795
Mean Basin Elevation (ft)		7,960	6,820
Percent Basin Above 6,000 Feet Elevation (%)		95	64
Percent Basin Covered by Forest (%)		83.3	60.3
Mean Annual Precipitation (in)		37	27
Active-Channel Width (ft)		102	150
Bankfull Width (ft)		120	170
Annual Peak Discharge, in Cubic Feet per Second, for Indicated Recurrence Interval, in Years	***2***	5,340	5,050
	5	6,960	6,780
	10	7,930	7,830
	25	9,080	9,090
	50	9,880	9,970
	100	10,700	10,800
	200	11,400	11,600
	500	12,300	12,700
Largest Known Annual Peak Discharge (cfs)		9,270	9,840
Latitude of Gage (Decimal Degrees)		45.498	45.885
Longitude of Gage (Decimal Degrees)		111.270	111.438

[(1)] C indicates that the record for this station was combined with record for station 06044000; LP indicates a log-Pearson Type III frequency analysis

2.3 Hydrologic Analysis Procedure

The procedures selected to complete the hydrologic analysis for the study reach are the stream gage analyses following Bulletin 17B guidelines and the USGS linear interpolation between logarithms of flood-frequency characteristics between two gaged sites. This method, from USGS WRIR 03-4308, is an alternate method for estimating flood frequency on gaged streams, and uses logarithms of drainage area and logarithms of gaged flow data as the basis for interpolation. Specifically, Equation 1 (USGS WRIR 03-4308, Equation 21) is presented below:

Equation 1:

$$\log Q_{T,U} = \log Q_{T,G1} + [(\log Q_{T,G2} - \log Q_{T,G1})/(\log DA_{G2} - \log DA_{G1})] (\log DA_U - \log DA_{G1}),$$

where:

log is the base 10 logarithm,

$Q_{T,U}$ is the *T*-year flood at the ungaged site, in cubic feet per second,

$Q_{T,G1}$ is the *T*-year flood at the upstream gaged site, in cubic feet per second,

$Q_{T,G2}$ is the *T*-year flood at the downstream gaged site, in cubic feet per second,

DA_{G2} is the drainage area at the downstream gaged site, in square miles,

DA_{G1} is the drainage area at the upstream gaged site, in square miles, and

DA_U is the drainage area, at the ungaged site, in square miles.

Guidelines under FEMA's Hydrologic Analysis Procedures specify that as long as existing watershed conditions are consistent with the watershed conditions under which the peak flow record is developed and the gaging station has a sufficient peak flow record, the logarithmic interpolation stream gage analysis should be selected to estimate peak flood discharges. Further, USGS WRIR 03-4308 guidance indicates that there should be sufficient overlap between the flow records of the two gages to demonstrate a trend in the data. The Logan gage and Gallatin Gateway-Salesville have 91 years of overlapping data in the flow record which is adequate to satisfy this requirement.

2.4 Stream Gage Analysis

Because 48 years of peak flow data are available since the flood-frequency analysis was performed for the Effective Flood Insurance Study, a new log-Pearson Type III (LP3) distribution analysis was performed for this study. Additionally, because the two-gage method was selected for the analyses, a LP3 distribution analysis was performed for gaging stations on the Gallatin River near Gallatin Gateway (06043500 Gallatin River near Gallatin Gateway) and the Gallatin River at Logan (06052500 Gallatin River at Logan, MT). The flood-frequency analyses were performed following the procedures in Bulletin 17B (Reference 6). The analyses were performed using the USGS software program PeakFQ v 7.1 (Reference 7). The annual peak flow record was downloaded from the USGS website for the stream gages in the WATSTORE text format for PeakFQ input and annual peak flow frequency analysis.

Prior to performing the new analysis, a baseline analysis was run for each gage in an effort to reproduce the flood-frequency analyses reported in USGS Water-Resources Investigation Report 03-4308 (Reference 8). The baseline analysis was performed as a quality assurance check to identify any data inconsistencies and to verify the input parameters for the previous analysis and the ability of the PeakFQ software package to produce the same results as published analyses. In the course of developing the

validation runs, it was determined that data for water years 1970 and 1971 at the Gallatin Gateway gage had been revised by the USGS from 9,240 cfs and 9,270 cfs (values used in the 1998 analyses) to 7,600 cfs and 7,610 cfs (currently published on WATSTORE), respectively. The USGS was contacted (P. McCarthy, personal communication) about the change in data and responded that the site was not operated in 1970 and 1971 due to funding constraints. However, a Stevens A35 recorder was operated during the time and recorded gage heights during the 1970 and 1971 peak events. The rating curve used to estimate the peak flow values for 1970 and 1971 was a straight line extension using the highest measured value, which at the time was near 4,000 cfs. After the 1974 peak, when a much higher discharge measurement was made, the rating curve for the gage was updated. The 1970 and 1971 peaks were not reviewed under the revised rating curve until 2001 when the hydrologic technician in charge of the Helena Field Office determined that based on the rating curves, the peaks should be revised. Thus, the peak flows for water years 1970 and 1971 are now published with values approximately 1,600 cfs lower than those used in the flood-frequency analyses performed on the Gallatin Gateway gage through water year 1998. The USGS Data Section was consulted about the discrepancy and determined that the revised values currently published for water years 1970 and 1971 will remain the published values. The peak flow record for the Gallatin River at Logan site appears consistent and unchanged.

The results were successfully duplicated using default PeakFQ program settings with the exception that the input value for Generalized Skew Standard Error was 0.64 rather than the default setting of 0.55 for both gaging stations, and the higher peak flow values for water years 1970 and 1971 were used for the Gallatin Gateway gage. The revised peak flow values for water years 1970 and 1971 as verified by USGS and published are used for all subsequent hydrologic analyses. The adjustment to Generalized Skew Standard Error was made after consultation with USGS personnel responsible for USFS flood-frequency data in Montana (P. McCarthy, personal communication) who indicated that Generalized Skew Standard Error of 0.64 is the appropriate input parameter for these gages on the Gallatin River. The results of the validation LP3 analysis for the two gages with data through 1998 are provided in Appendix B.

The new LP3 flood-frequency analyses incorporated the 100 year (1890 – 2013) period of record on USGS gage 06043500 Gallatin River near Gallatin Gateway and the 94 year (1895 – 2013) period of record on USGS gage 06052500 Gallatin River at Logan MT using the same options and parameters as the validation analyses (using revised peak flow data for water years 1970 and 1971 on the Gallatin Gateway gage). These input parameters include a Generalized Skew Standard Error value of 0.64, the weighted skew method, and no defined outliers.

Several small dams and impoundments are found within the West Gallatin River drainage. These impoundments are relatively small impoundments and do not significantly alter the hydrology associated with peak annual flows for the less frequent, higher peak flow events (e.g. 1% annual chance). For example, the two largest impoundments in the watershed are on tributaries to the West Gallatin River, and are the Green Hollow Creek Dam and (on Green Hollow Creek) and the Big Sky Dam (on Middle Fork West Fork

Gallatin River), with storage of 300 acre-ft and 225 acre-ft, respectively. These impoundments have a designated purpose of recreation, and although they may contribute to other uses, their volume of storage is not significant enough to alter the timing or magnitude of flood peaks in the study reach. Several irrigation diversions exist on the West Gallatin River between the Gallatin Gateway gage and the confluence with the East Gallatin River. The larger of these diversions can deliver as much as approximately 1,500 cfs and the effective FIS reports that these diversions have produced flows that high during past floods. Irrigation demands are typically very low during flood events. Additionally, these diversions may not be operable during large floods. Therefore, this study assumes that these diversions would not be operating during significant flood events.

Consistent with FEMA guidelines (Reference 9), no expected probability adjustments were made to the Bulletin 17B frequency curve. Results of the flood-frequency analyses are presented in Table 2-5, and the PeakFQ output is provided in Appendix B.

Table 2-5.
Flood-Frequency Results for USGS Gages 06043500 Gallatin River near Gallatin Gateway and 06052500 Gallatin River at Logan MT

Gage	Description	Period of Record	Percent Annual Chance Peak Discharge (cfs)					
			10%	4%	2%	1%	1%+	0.2%
06043500 Gallatin River near Gallatin Gateway	Baseline Analysis / Duplicate model run	1890 – 1998 (85 years)	7,932	9,080	9,882	10,650	N/A	12,320
	Updated / New Analysis(1)	1890 – 2013 (100 years)	7,662	8,719	9,456	10,160	10,780	11,680
06052500 Gallatin River at Logan MT	Baseline Analysis / Duplicate model run	1895 – 1998 (79 years)	7,832	9,082	9,959	10,800	N/A	12,630
	Updated / New Analysis	1895 – 2013 (94 years)	7,668	8,845	9,667	10,450	11,200	12,160

(1) Updated analysis includes revised (lower) peak flows for water years 1970 and 1971 as published by USGS

These results reflect notable differences in the Annual Chance Exceedance Probabilities at both gaging stations. As noted above and footnoted in the table, since the analysis was performed on the Gallatin Gateway gage through water year 1998 and published in the USGS Water-Resources Investigation Report 03-4308 (Reference 8), USGS personnel lowered the peak flood values for water years 1970 and 1971 by about 1,600 cfs each. The peak flow revisions largely explain the nearly 500 cfs reduction in the 1% Annual Exceedance Probability (AEP) flows at the Gallatin Gateway gage when analyzed through the 2013 water year. However, another contributing factor that is indicated on the Logan gage results are the longer flow record only adds one peak in the top 20 peak flows of record.

Another notable result from the flood-frequency analyses of the two gages is how little change there is in the annual chance peak discharge values between the two gages. Even though the contributing drainage area nearly doubles between the Gallatin Gateway gage and Logan gage, the 1% annual chance peak discharge only increases by 290 cfs between the gages. A discussion with USGS and Montana Department of Natural Resources and Conservation (DNRC) personnel, as well as a general review of local topographic information and previous flood studies indicate that the relative small change in peak discharge values between the two gaging stations can be attributed to attenuation of the flood peak between the Gallatin Gateway gage and the Logan gage through storage and overbank flows in the broad, extensive, and multi-thread floodplain which is a characteristic between the two gaging stations. Thus, while overall annual volume of runoff may increase between the two gaging stations, the relative timing and magnitude of the peak flows are very similar between the Gallatin Gateway and Logan gages.

2.5 Two-Gage Interpolation Method

As described in Section 2.0, the study area is located between two gaged sites on the Gallatin River (06043500 Gallatin River near Gallatin Gateway and 06052500 Gallatin River at Logan MT). The approximately 30 mile long study reach begins about 3.6 miles below the Gallatin Gateway gage, and ends at the confluence with the East Gallatin River, about 5.6 miles above the Logan gage. A review of the annual peak flow data indicates that on average, the peak flow dates for these two gages are within 2 days of each other (June 6 for the Gallatin Gateway gage and June 8 for the Logan gage), and have similar magnitudes of peak flows. Additionally, each gage has relatively long record of annual peak flows (100 years for the Gallatin Gage (with data augmentation from Salesville gage) and 94 years for the Logan gage) and have significant overlap of flow records (91 years).

Because of the similarity between the two gages, the close proximity to the study reach, length of flow records, and overlapping flow records, it was determined that the two-gage interpolation method described in USGS Water-Resources Investigation Report 03-4308 (Reference 8) is the appropriate method for evaluating the hydrology in the study reach.

The two-gage interpolation method described in USGS Water-Resources Investigation Report 03-4308 (Reference 8) provides a means for estimating the flood frequency characteristics at an ungaged site located between the two gages. The method performs a linear interpolation between the logarithms of the desired percent annual chance peak discharge based on the drainage area at ungaged sites relative to the drainage areas of the gaged sites (Section 2.3).

The East Gallatin River joins the West Gallatin River immediately below the lower extent of the study area and the contribution of the East Gallatin River flows are reflected in the Logan gage flow record. A review of the peak flow events for the East Gallatin River at two locations (6048000 East Gallatin River at Bozeman, MT and 6048700 East Gallatin River below Bridger Creek near Bozeman, MT) indicate that on average, peak flow events on the East Gallatin River occur nearly a month earlier than the Gallatin River (May 10). However, years with coincident peaks are reflected in the Logan gage peak flow record and as part of the two-gage analyses contributes to a more conservative analysis.

The effective FIS identifies three flow change locations: 1) at the upstream limit of study area, 2) at Shed's Bridge (State Highway 84 bridge crossing the Gallatin River) near Four Corners, MT, and 3) the Interstate 90 bridge crossing the Gallatin River (downstream limits of the study area). The downstream limit of the effective FIS is at the Interstate 90 bridge crossing the Gallatin River. The study update presented in this report extends the effective FIS study beyond the Interstate 90 bridge to the confluence of the East Gallatin River, approximately 6.6 miles downstream from the Interstate 90 bridge. Thus, four potential flow change locations at ungaged sites between the two gaging stations are evaluated using the USGS two-gage method. The calculation worksheets are presented in Appendix B and the results are summarized in Section 3.

3.0 Results of Hydrologic Analysis

This hydrologic analysis evaluates the study reach at potential flow change locations. The potential flow change locations include the flow change locations identified in the effective FIS, the contribution of potentially significant tributaries in the study area, and other potential influences that may affect the hydrology. Thus, four potential flow change locations have been identified and evaluated: 1) upstream study limit; 2) Shed's Bridge; 3) Interstate 90 bridge; and 4) downstream study limit. The results of the hydrologic analyses are presented in Table 3-1, and provide a comparison of the revised analysis with results of the effective FIS.

As indicated in Table 3-1, the revised hydrologic analysis results in a reduction in all percent annual chance peak discharges at each flow change location (excluding the 4% annual chance and 1%+ annual chance discharges which were not evaluated in the effective FIS). The reduction in the percent annual chance peak discharges is primarily due to the change in analysis methods for determining flood frequency characteristics between this study and the effective FIS. This analysis utilizes a two-gage interpolation method, whereas the effective FIS utilizes a drainage-area ratio adjustment based on a single gage and regression coefficients derived from ordinary least squares regressions. The two-gage interpolation method is deemed the appropriate analysis for this study as discussed in Section 2.5. Another factor resulting in a reduction in the percent annual chance peak discharges in this study from the effective FIS is the reduction in peak flow events at the Gallatin Gateway for water years 1970 and 1971 (see Section 2.4). Another potential factor which may have resulted in a reduction in the percent annual chance peak discharges in this study from the effective FIS is the extension of the peak flow record to included peak flow data through water year 2013.

Another significant difference between the USGS analysis and the effective FIS analysis is the relative difference between flow change locations. For instance, the effective FIS reports a 1,020 cfs difference in 1% annual chance peak discharge between the upstream limit of study and the Interstate Highway 90 bridge. In contrast, the USGS analysis results in only a 92 cfs difference between the upstream limit of study and the Interstate Highway 90 bridge. The relative difference between peak discharge at flow change locations from the effective FIS and the USGS analysis is similar for other percent annual chance peak discharges. The explanation for the reduction in difference in percent annual chance peak discharge at flow change locations between the effective FIS and USGS analysis is due to the change in analysis methodology from the drainage-area ratio adjustment based on a single gage and regression coefficients derived from ordinary least squares regressions (effective FIS) to a two-gage interpolation method (USGS analysis).

Confidence in the new flood-frequency analysis is high due to the 123 year and 118 year gage records for the Gallatin Gateway and Logan gages, respectively. Additionally, in accordance with FEMA Guidelines and Specifications (Reference 9) statistical gage analysis should be the method used to estimate flood discharge – frequency relations.

The stream gage flood-frequency analysis method utilizing two gages was selected based on method confidence and reliability based on the extensive gage data record for the two gages and the strength of the agreement between the two gages. Based on the strength of the gaged data and the relatively large prediction intervals for regression analyses, regression analyses were not performed at this site.

As described in Section 2.4, a review of peak runoff data was performed for the East Gallatin River gaging stations, the West Gallatin River gage, and the Gallatin River gage at Logan. After reviewing these data, it does not appear that a coincident peak assumption is appropriate for the flood study, as the arrival times of flood peaks are not similar for the two combining watersheds.

Table 3-1.
Two-Gage Analyses at Previously Identified Flow Change Locations

Location	Drainage Area	USGS Analysis						Effective Flood Insurance Study					
		Percent Annual Chance Peak Discharge (cfs)						Percent Annual Chance Peak Discharge (cfs)					
	(Square Miles)	10%	4%	2%	1%	1%+	0.2%	10%	4%	2%	1%	1%+	0.2%
At Confluence with East Gallatin River	1099.8	7,664	8,766	9,535	10,269	10,937	11,859	N/A	N/A	N/A	N/A	N/A	N/A
At Interstate Highway 90	1092.1	7,664	8,765	9,533	10,266	10,933	11,855	8,850	N/A	11,400	12,350	N/A	14,800
At State Highway 84(1) (Shed's Bridge)	945.7	7,663	8,742	9,495	10,213	10,856	11,767	8,700	N/A	11,200	12,150	N/A	14,570
At Upstream Limit of Study	849.7	7,662	8,725	9,466	10,174	10,800	11,702	8,100	N/A	10,400	11,330	N/A	12,550

(1) Sheds Bridge previously labeled State Highway 289 in the effective FIS, and is revised to reflect its current Montana Department of Transportation (MDT) designation as State Highway 84.

3.1 Discussion and Selected Discharge

As indicated by the results in Table 3-1, the evaluation of potential flow change locations that were utilized in the effective FIS suggests there is little difference in each of the annual chance peak discharge intervals as the drainage area increases through the study reach at previously identified flow change locations. For example, the 1% annual chance peak discharge is predicted to be 10,174 cfs at the upstream limit of the study area and 10,269 cfs at the downstream limit of the study area, an increase of only 95 cfs through the entire study area. Similar results are indicated for the other annual chance peak discharge values. Based on the relatively small increases in peak discharge values between the upstream and downstream study limits, it is appropriate to simply utilize a single flow value for each of the annual chance peak discharge intervals as shown in Table 3-2.

Table 3-2.
Recommended Flow Values for Flood Study

Location	Drainage Area	USGS Analysis					
		Percent Annual Chance Peak Discharge (cfs)					
	(Square Miles)	10%	4%	2%	1%	1%+	0.2%
At Confluence with East Gallatin River	1,099.8	7,664	8,766	9,535	10,269	10,937	11,859

Utilizing the peak discharge values at the confluence with the East Gallatin River will provide appropriate representation of the discharge values for the study area. Another significant result produced by the updated analyses are the changes to the peak discharge values from the effective FIS. For example, the 1% annual chance peak discharge at the Interstate 90 bridge under the updated analysis is 10,266 cfs, which is about 2,000 cfs lower than the 1% annual chance peak discharge reported at the Interstate 90 bridge in the effective FIS. The reasons for the reduction in peak discharge values between the effective FIS and this study are a result of the revised flood-frequency analyses of the Gallatin River gages from the analyses performed for the effective FIS with nearly 40 years of additional flow data coupled with a change in the analysis method from a simple gage transfer equation based on drainage area (utilized in the effective FIS) to a method that performs a linear interpretation of ungaged sites between two gaging stations. The discussion of the updated flood-frequency analysis is provided in Section 2.3 and the updated gage analysis is provided above. This study represents the first major update to the hydrologic analysis of the West Gallatin River in the study area and the analyses suggest that the peak discharge values of the various annual chance peak discharge intervals should be revised downward. An evaluation will be made during the hydraulic analyses of the study area to determine the relative magnitude the changes in hydrology will have on the predicted water surface elevations in the study area.

4.0 References

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2. Federal Emergency Management Agency (FEMA). 2011. Flood Insurance Study, Gallatin County, Montana, and Incorporated Areas, 164 pp. September 2.
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8. Parrett, C. and D.R. Johnson. 2004. Methods for estimating flood frequency in Montana based on data through water year 1998: U.S. Geological Survey Water-Resources Investigations Report 03-4308, Helena, MT., 101 p.
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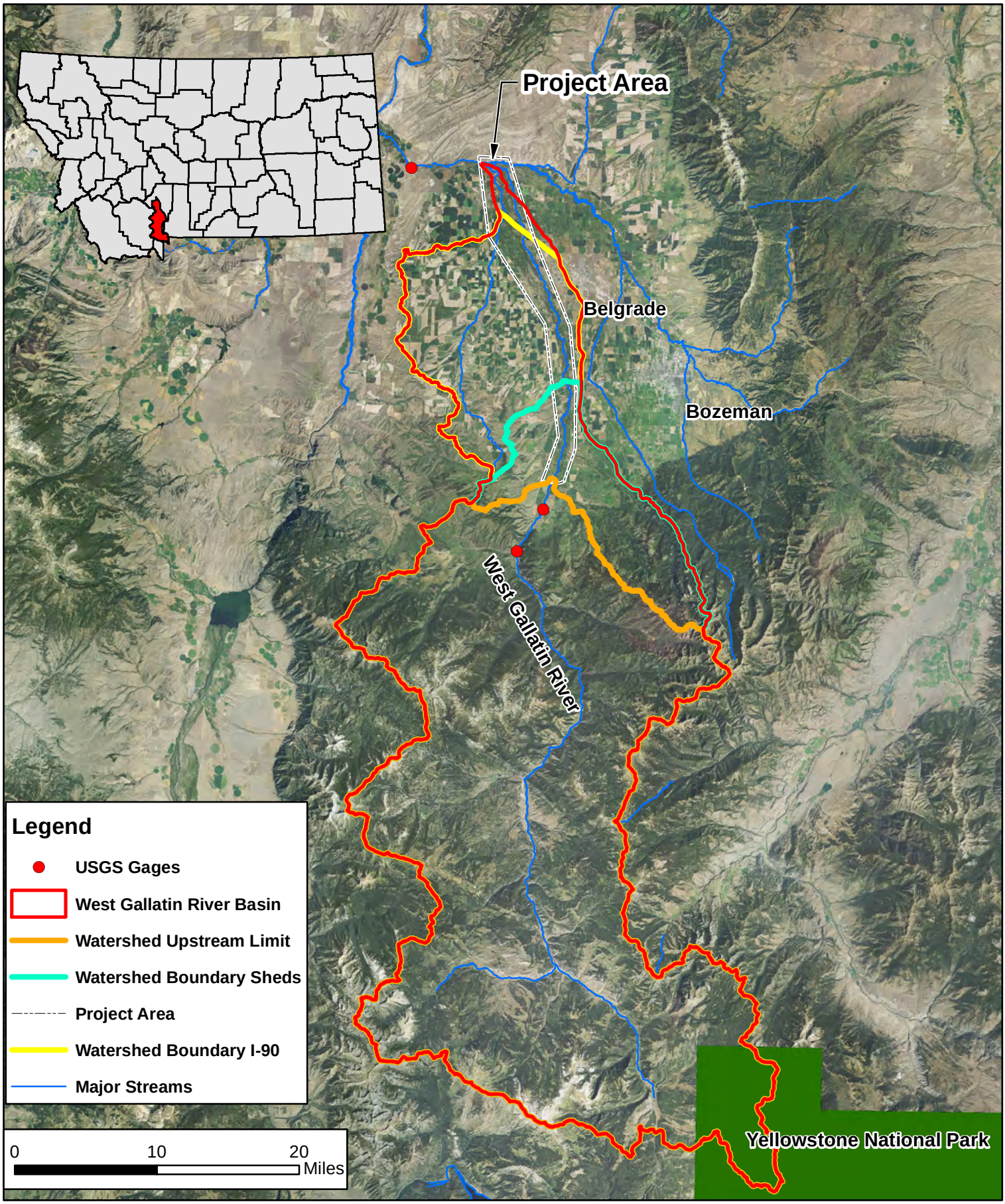

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West Gallatin Watershed and Project Area

Watershed Basin

PROJECT NO. 1447.037

FIGURE NUMBER
FIGURE 1

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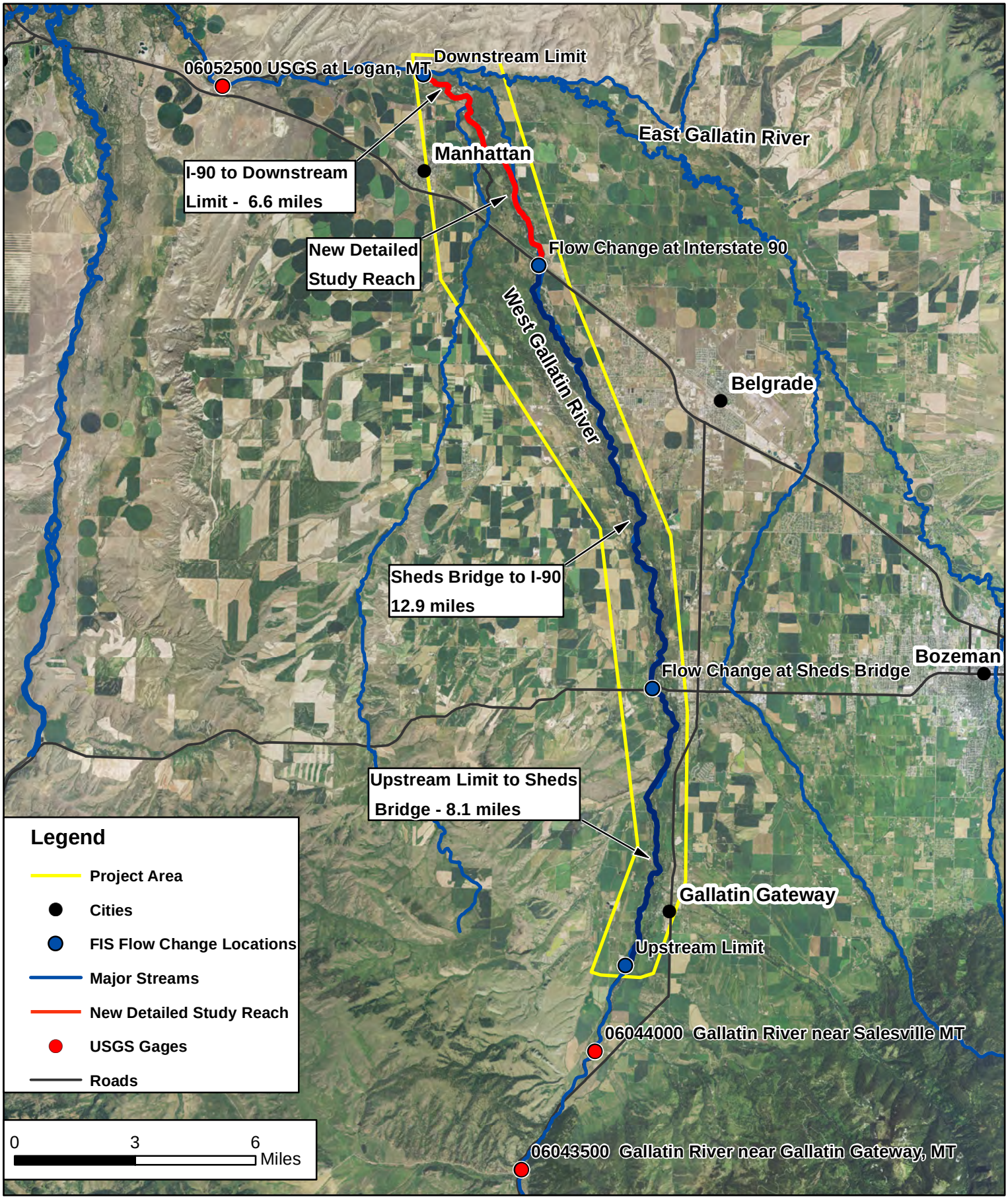

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Project Vicinity

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FIGURE NUMBER
FIGURE 2

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Figure 3a. West Gallatin River FEMA Panel 30031C0340D

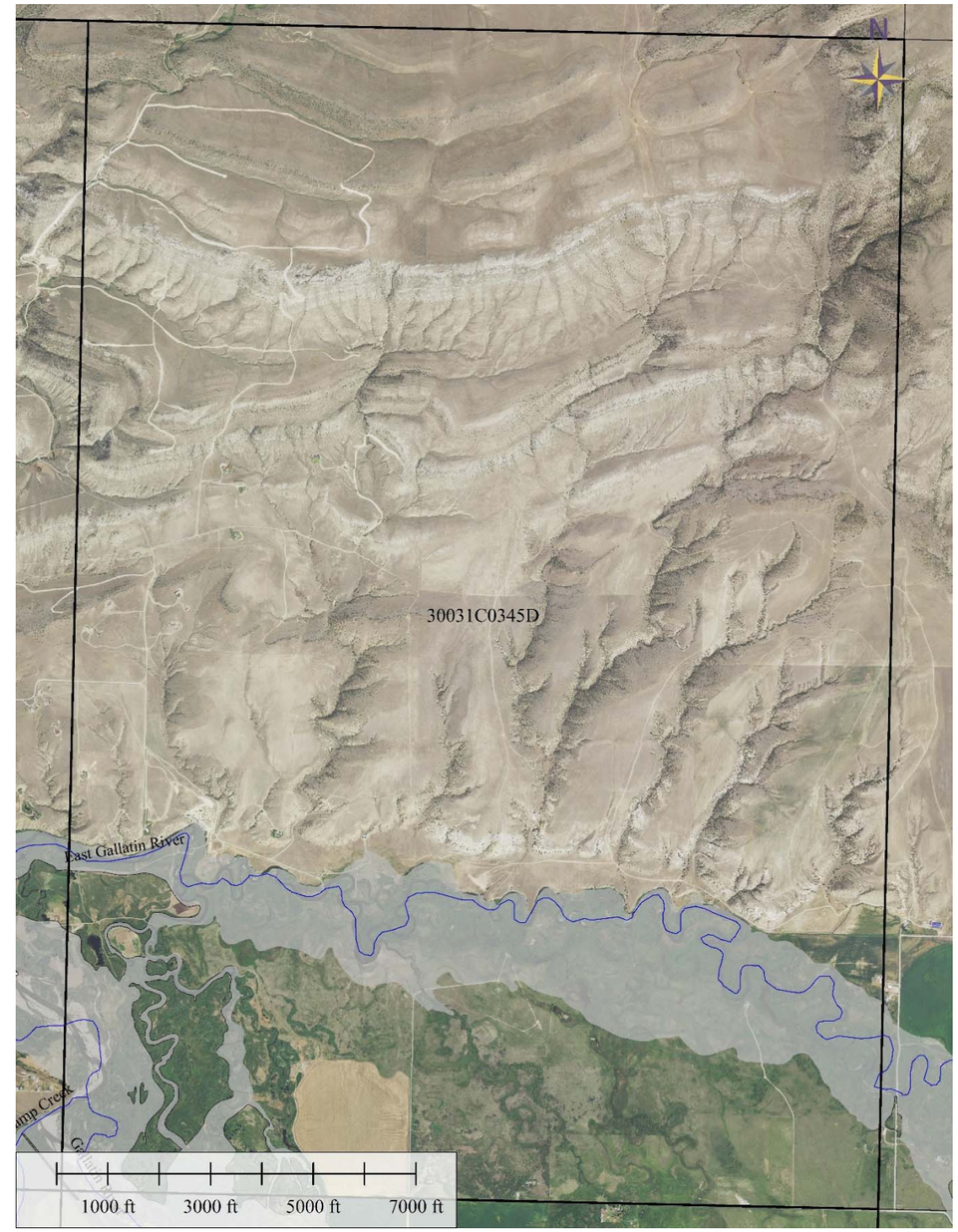

Figure 3b. West Gallatin River FEMA Panel 30031C0345D.

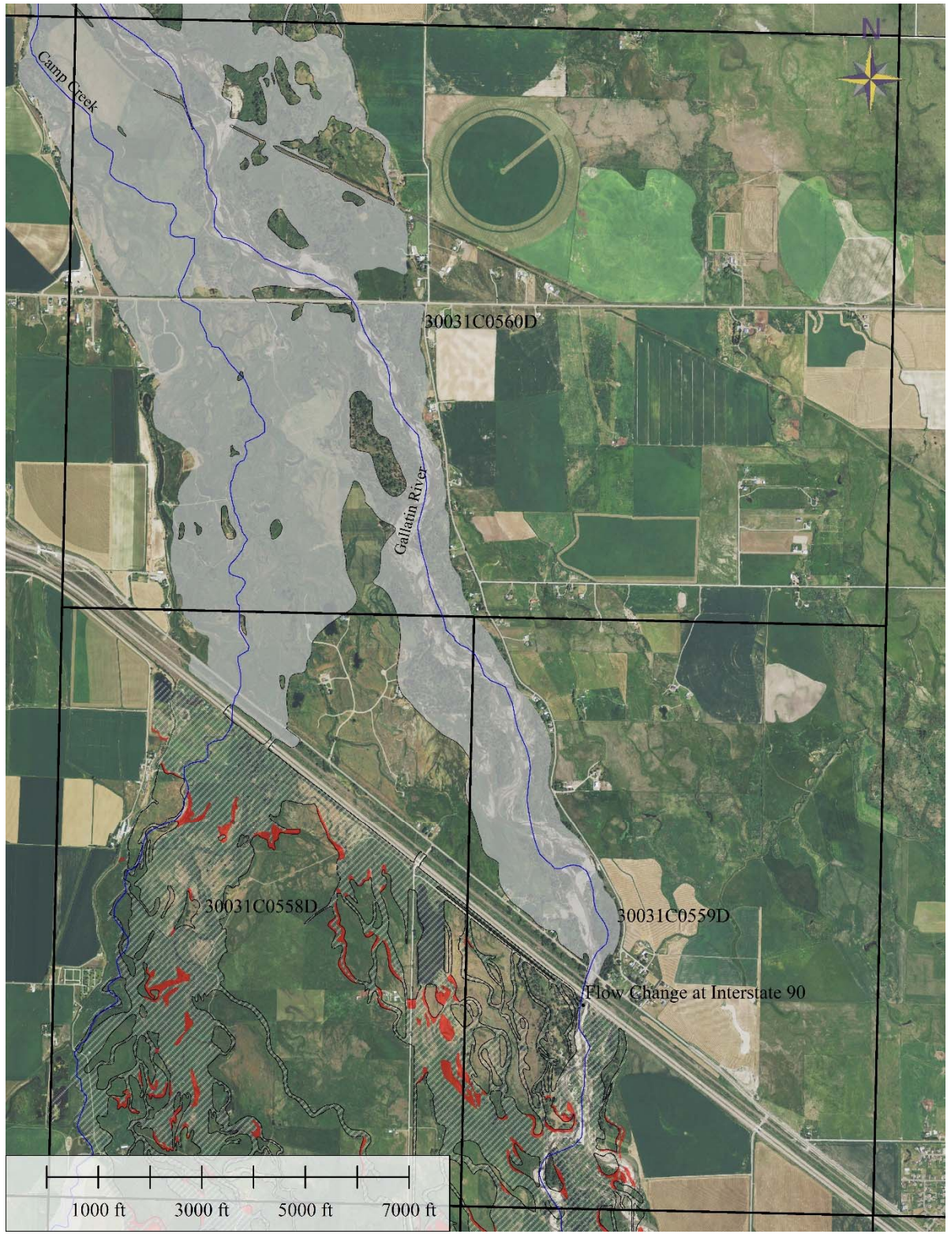

Figure 3c. West Gallatin River FEMA Panels 30031C0555D, 0560D, 0558D, and 0559D.

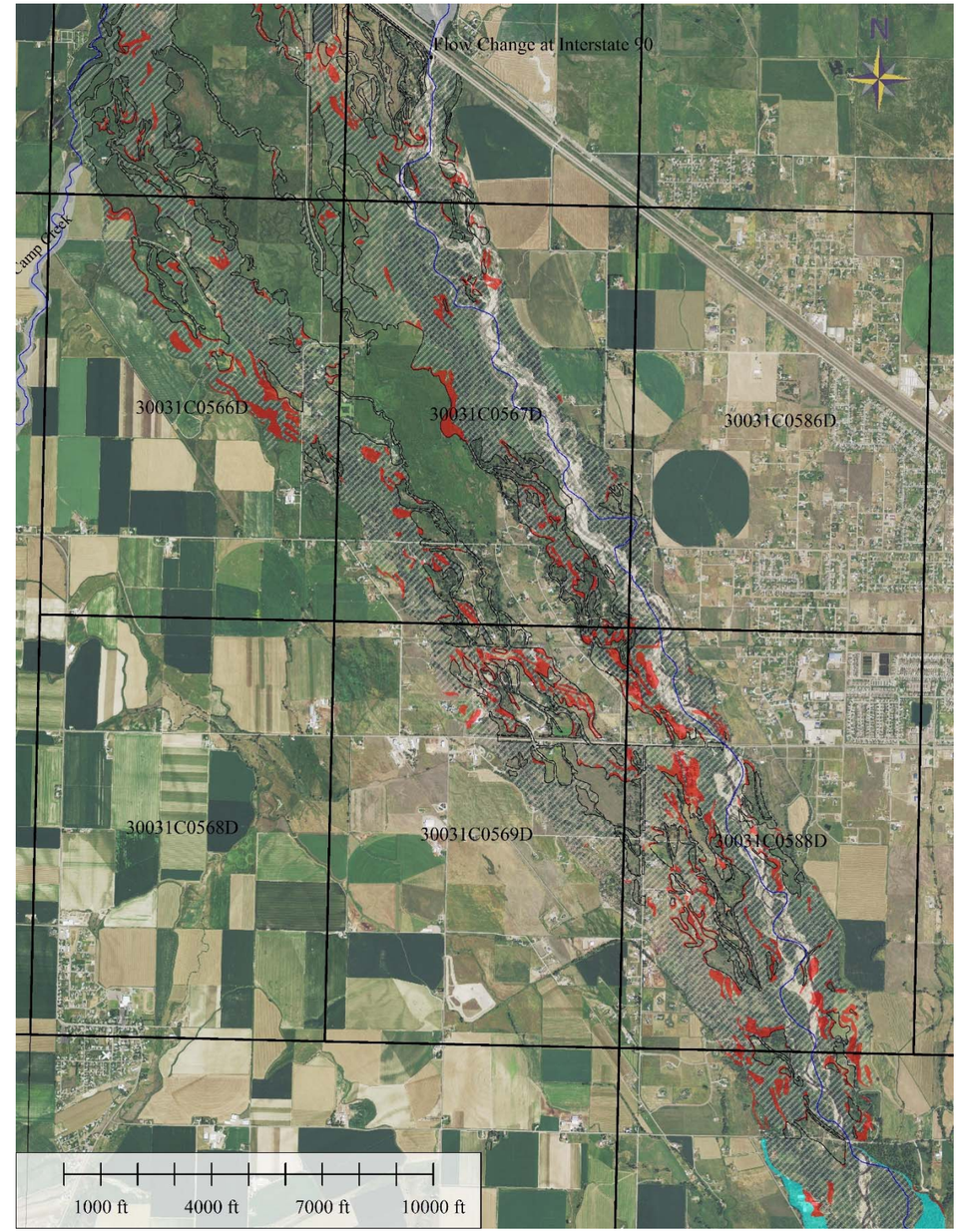

Figure 3d. West Gallatin River FEMA Panels 30031C0566D, 0567D, 0586D, 569D, and 0588D.

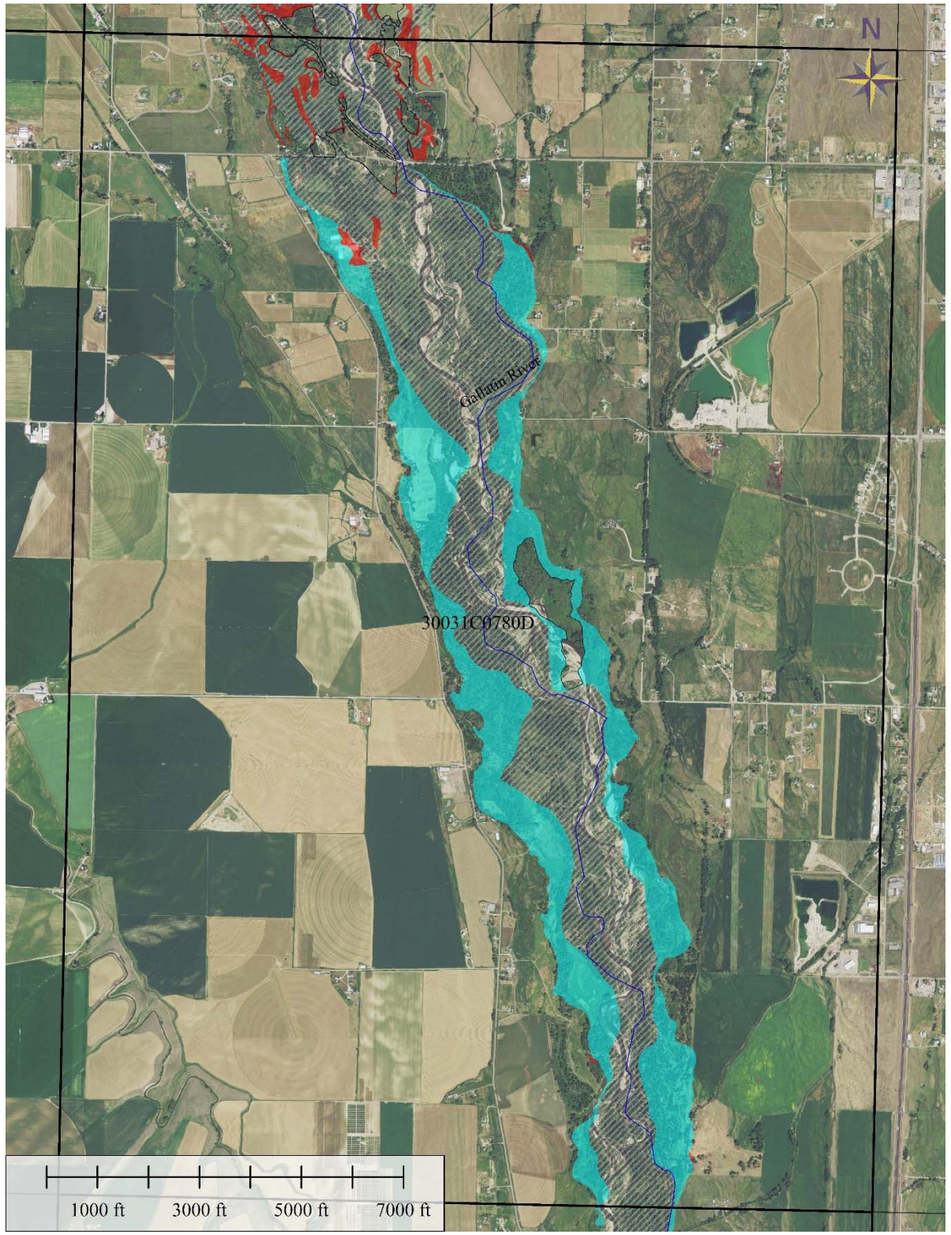

Figure 3e. West Gallatin River FEMA Panel 30031C0780D.

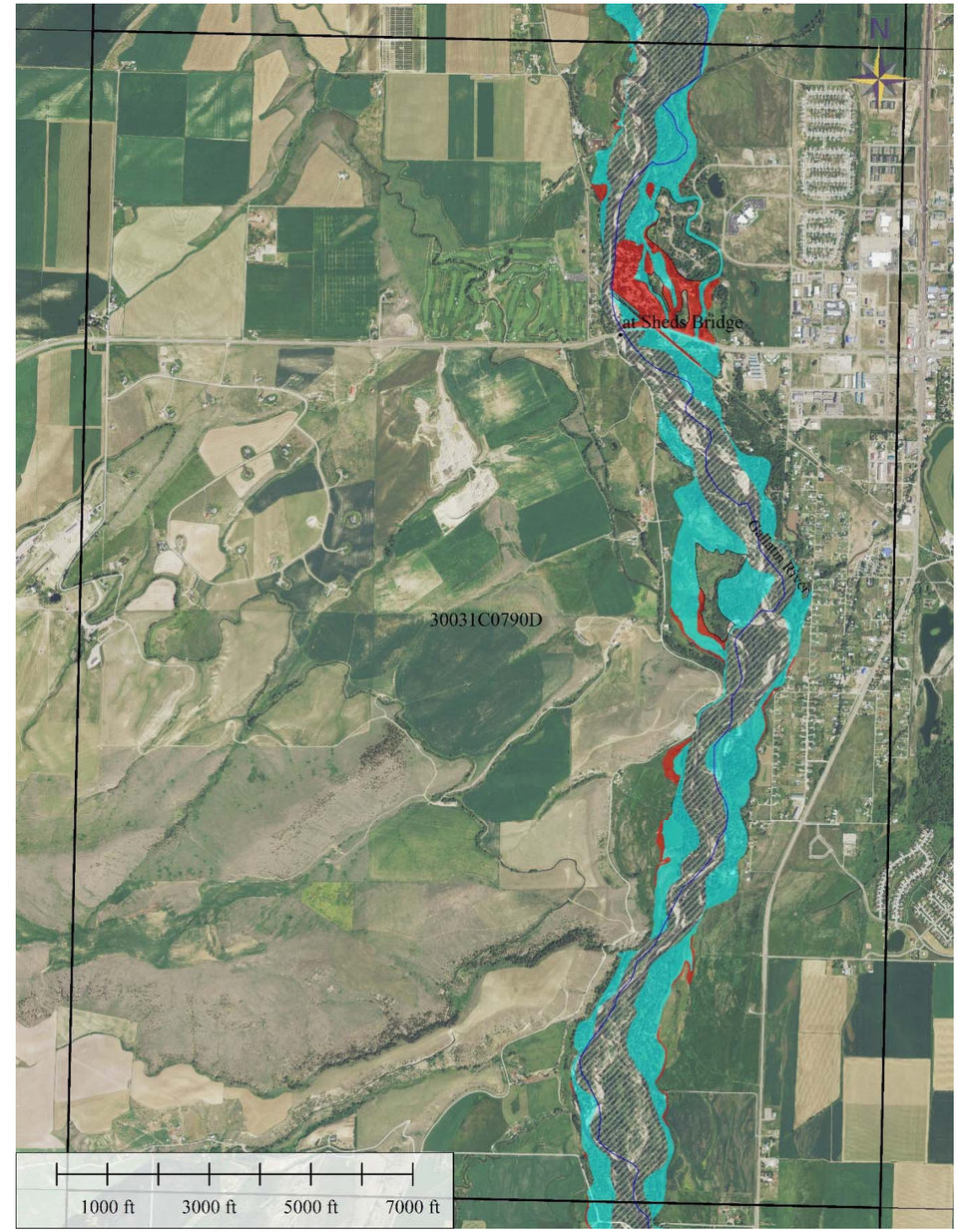

Figure 3f. West Gallatin River FEMA Panel 30031C0790D.

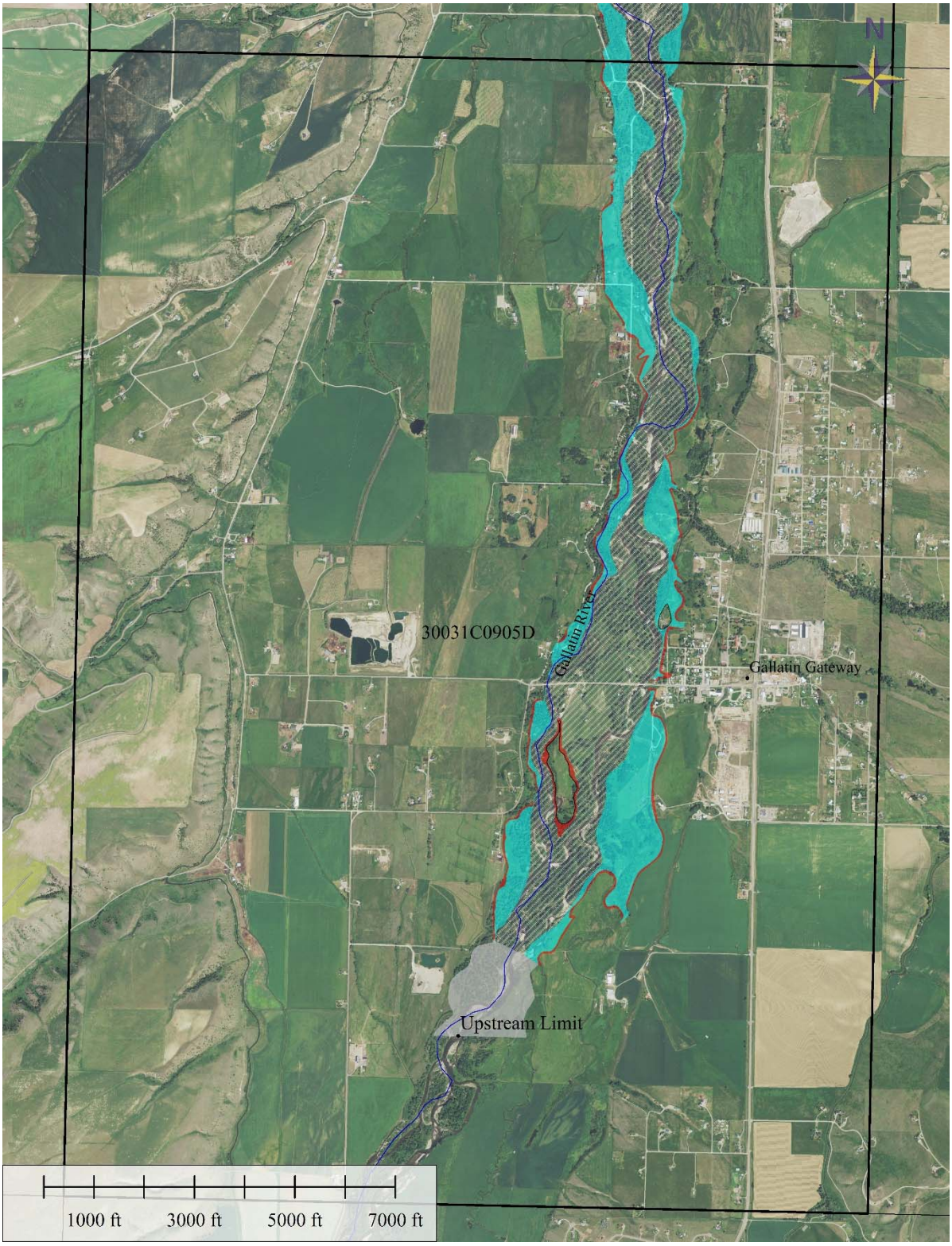

Figure 3g. West Gallatin River FEMA Panel 30031C0905D.

Appendix A – USGS Stream Gage Data

- USGS Gage 06043500 Gallatin River near Gallatin Gateway, MT
    - Systematic Peak Streamflow – Table
    - Systematic Peak Stream Flow – Graph
    - Log Pearson Type III through Water Year 1998
- USGS Gage 06044000 Gallatin River near Salesville MT
    - Systematic Peak Streamflow – Table
    - Systematic Peak Stream Flow – Graph
- USGS Gage 06052500 Gallatin River at Logan, MT
    - Systematic Peak Streamflow – Table
    - Systematic Peak Stream Flow – Graph
    - Log Pearson Type III through Water Year 1998

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USGS 06043500 Gallatin River near Gallatin Gateway MT

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Gallatin County, Montana
Hydrologic Unit Code 10020008
Latitude 45°29'50.28", Longitude 111°16'14.55" NAD83
Drainage area 825 square miles
Gage datum 5,167.67 feet above NGVD29

Output formats

- Table
- Graph
- Tab-separated file
- peakfq (watstore) format
- Reselect output format

Water Year	Date	Gage Height (feet)	Stream-flow (cfs)
1890	Jun. 10, 1890		3,800
1891	Jun. 07, 1891		2,980
1892	Jun. 20, 1892		8,060
1893	Jun. 12, 1893		6,800
1894	Jun. 02, 1894		8,060
1931	Jun. 02, 1931		2,940
1932	Jun. 16, 1932		5,780
1933	Jun. 13, 1933	5.03	4,270
1934	May 08, 1934	3.03	1,740
1935	Jun. 13, 1935	5.09	4,340

1936	May 15, 1936	4.58	3,660
1937	Jun. 17, 1937	4.22	3,120
1938	Jun. 06, 1938	5.00	4,550
1939	May 30, 1939	4.04	3,170
1940	Jun. 13, 1940	4.39	3,660
1941	May 27, 1941	3.74	2,820
1942	Jun. 09, 1942	5.32	6,050
1943	Jun. 19, 1943	5.61	6,480
1944	Jun. 09, 1944	4.07	3,600
1945	Jun. 24, 1945	4.55	4,450
1946	Jun. 06, 1946	4.38	4,360
1947	Jun. 20, 1947	4.96	5,250
1948	Jun. 04, 1948	5.77	6,740
1949	May 17, 1949	4.32	4,110
1950	Jun. 22, 1950	4.89	5,030
1951	May 24, 1951	4.69	3,940
1952	Jun. 06, 1952	5.71	6,910
1953	Jun. 13, 1953	5.28	6,010
1954	Jun. 27, 1954	4.21	3,790
1955	Jun. 16, 1955	4.42	4,480
1956	May 28, 1956	5.57	7,030
1957	Jun. 07, 1957	5.59	5,970
1958	May 24, 1958	5.08	5,010
1959	Jun. 15, 1959	6.23	7,230
1960	Jun. 04, 1960	4.92	4,940
1961	Jun. 04, 1961	4.32	3,670
1962	Jun. 14, 1962	4.89	4,780
1963	Jun. 15, 1963	4.91	4,800
1964	Jun. 08, 1964	5.70	6,450
1965	Jun. 13, 1965	6.02	7,010
1966	May 31, 1966	4.69[1]	4,530[2]
1967	Jun. 22, 1967	5.44	5,960
1968	Jun. 20, 1968	5.56	6,570
1969	May 27, 1969	5.12	5,350
1970	Jun. 09, 1970	6.48	7,600
1971	Jun. 27, 1971	6.49	7,610
1972	Jun. 08, 1972	5.33	6,030
1973	Jun. 10, 1973	5.41	6,500
1974	Jun. 17, 1974	7.38	9,100
1975	Jul. 04, 1975	6.27	7,950
1976	Jun. 22, 1976	5.27	5,870

1977	Jun. 10, 1977	4.08	3,370
1978	Jun. 10, 1978	5.12	5,230
1979	May 28, 1979	4.87	4,730
1980	May 23, 1980	4.76	4,150
1981	Jun. 09, 1981	5.56	5,920
1985	May 26, 1985	4.31	3,650
1986	Jun. 06, 1986	6.00	6,830
1987	May 17, 1987	3.43	2,390
1988	Jun. 05, 1988	4.70	4,340
1989	Jun. 16, 1989	4.55	4,280
1990	Jun. 11, 1990	4.97	5,140
1991	Jun. 06, 1991	6.50	7,640
1992	Jun. 17, 1992	4.32	3,660
1993	May 22, 1993	5.31	5,740
1994	May 13, 1994	4.46	4,110
1995	Jun. 06, 1995	6.31	7,330
1996	Jun. 11, 1996	6.11	7,010
1997	Jun. 02, 1997	6.71	9,160
1998	Jun. 26, 1998	5.18	5,400
1999	May 29, 1999	4.98	4,990
2000	May 29, 2000	4.44	4,070
2001	May 15, 2001	4.26	3,740
2002	Jun. 02, 2002	5.03	5,260
2003	May 30, 2003	5.71	6,710
2004	Jun. 10, 2004	4.30	3,810
2005	Jun. 23, 2005	4.52	4,220
2006	May 21, 2006	5.17	5,550
2007	May 14, 2007	4.04	3,350
2008	Jun. 23, 2008	5.54	6,010
2009	Jun. 01, 2009	5.28	5,500
2010	Jun. 05, 2010	5.20	5,360
2011	Jun. 30, 2011	6.51	8,410
2012	Jun. 05, 2012	5.17	5,220
2013	Jun. 11, 2013	4.48	3,950

Peak Gage-Height Qualification Codes.

- 1 -- Gage height affected by backwater

Peak Streamflow Qualification Codes.

- 2 -- Discharge is an Estimate

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Hydrologic Unit Code 10020008
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Output formats

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- Graph
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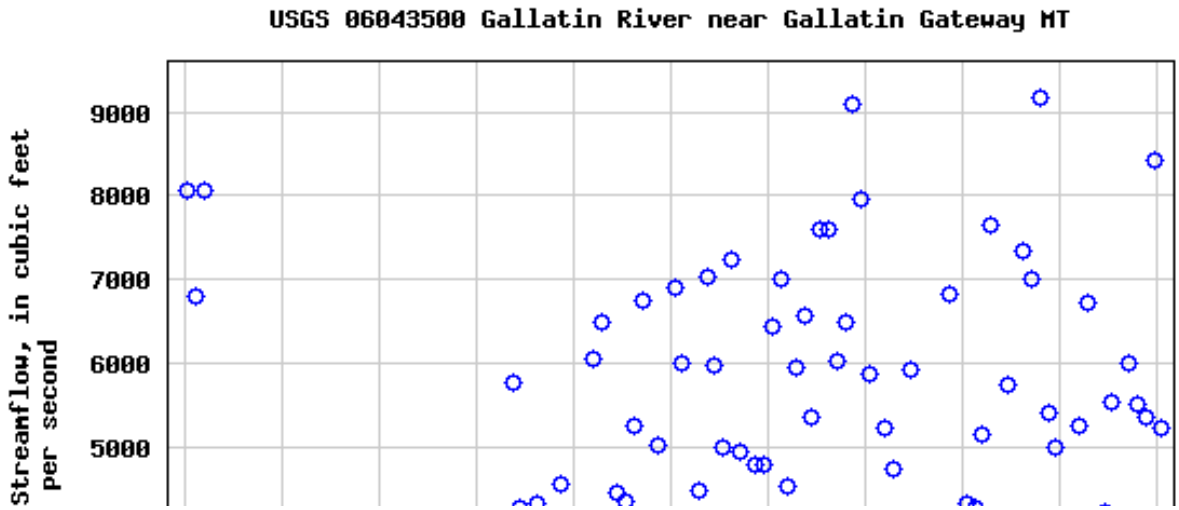

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USGS

Montana Flood-Frequency and Basin-Characteristic Data

Flood-frequency data are based on recorded annual peak discharges through 1998. Peak discharges for specified frequencies (exceedance probabilities) were determined by fitting a log-Pearson Type 3 probability distribution to base 10 logarithms of recorded annual peak discharges as described by the Interagency Advisory Committee on Water Data (1982, Guidelines for Determining Flood Flow Frequency--Bulletin 17-B of the Hydrology Subcommittee: U.S. Geological Survey, Office of Water Data Coordination). **Note: Data are provisional and user is responsible for assessment and interpretation of flood-frequency data.**

Most of the basin characteristic data were measured in the 1970s from the best-scale topographic maps available at the time. Some data, such as mean annual precipitation, soil index data, and mean January minimum temperatures, were compiled from maps prepared by other agencies. Channel widths were measured in the field by USGS personnel.

The flood-frequency and basin characteristics data were used in a new flood-frequency report just published by the USGS, entitled "Methods for estimating Flood Frequency in Montana Based on Data through Water Year 1998" (Water-Resources Investigations Report 03-4308). Information about the equations described in that report can be found at the following link.

For more detailed information contact Wayne Berkas:
Phone: 406-457-5903 or by e-mail.

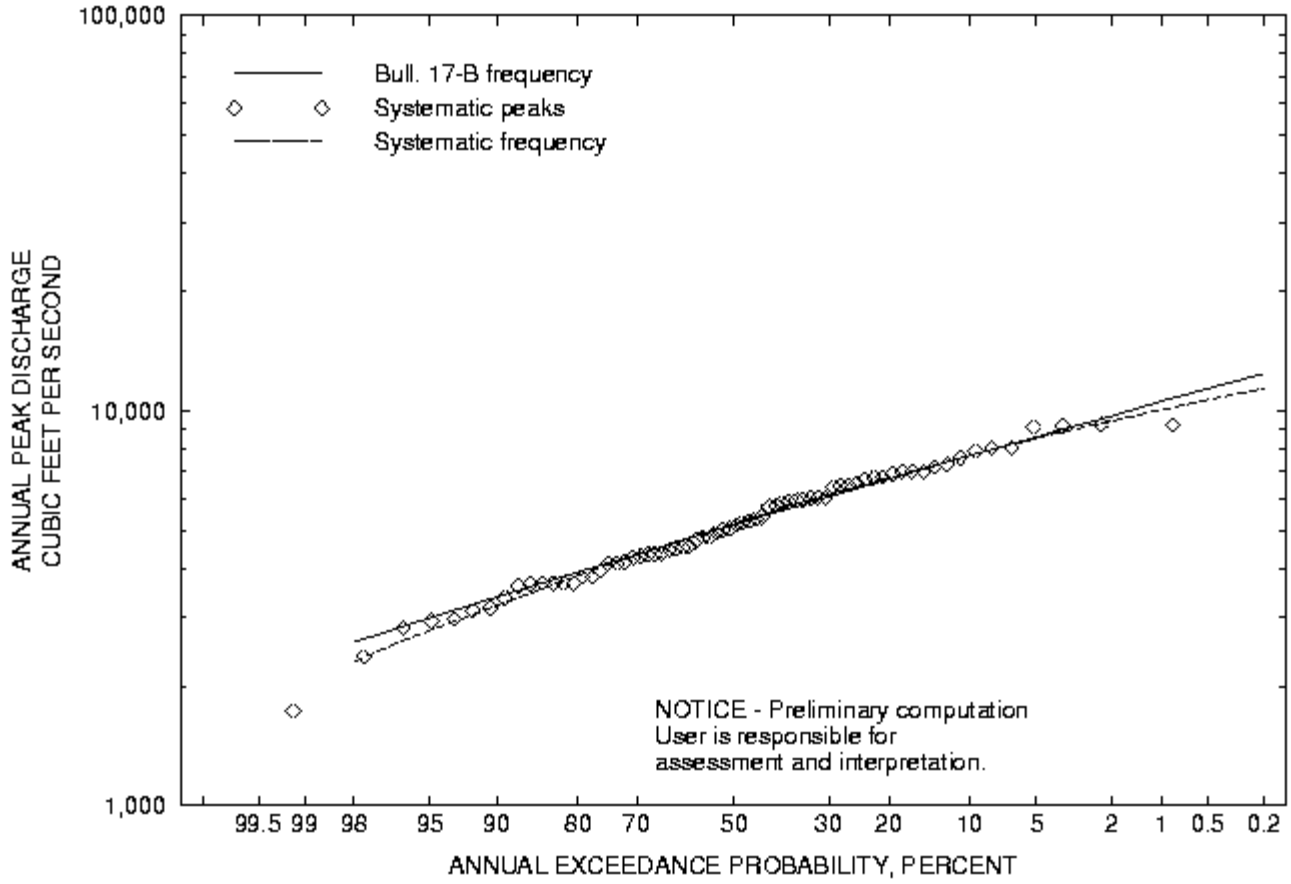
06043500 Gallatin River near Gallatin Gateway, MT

Annual peak discharge at this site combined with annual peak discharge at:

06044000 Gallatin River near Salesville MT

Annual peak discharge, in cubic feet per second (top line), for indicated exceedance probability, in percent (bottom line):

--	--	3040	3470	4040	5340	6960	7930	9080	9880	10700	11400	12300
99.5	99	95	90	80	50	20	10	4	2	1	0.5	0.2



NOTE: Systematic peaks are those that are recorded within the period of gaged record. The computed systematic flood-frequency curve is based only on the systematic peaks. The computed Bulletin 17-B flood-frequency curve often is different from the systematic flood-frequency curve because of differences between station skew and regional skew, low- or high-outlier adjustments, or the presence of one or more historical peaks outside the systematic record. Historical peaks also result in historical adjusted plotting positions (exceedance probabilities) for all peaks.

Recorded Annual Peak Discharge:

06043500 Gallatin River near Gallatin Gateway, MT

```
Location.-- Lat 45 29'51", Long 111 16'11", Hydrologic Unit 10020008.
Drainage area.--  825.00 square miles.
Datum of gage.--    5167.67 ft above sea level.
```

Table of annual peak discharge data [--, no data]

Water year	Date	Gage height (ft)	Discharge ft3/s	Date of Max. gage height	Maximum gage height (ft)
1890	June 10, 1890	--	3800	--	--
1891	June 7, 1891	--	2975	--	--
1892	June 20, 1892	--	8060	--	--
1893	June 12, 1893	--	6800	--	--
1894	June 2, 1894	--	8060	--	--
1931	June 2, 1931	--	2940	--	--
1932	June 16, 1932	--	5780	--	--
1933	June 13, 1933	5.03	4270	--	--
1934	May 8, 1934	3.03	1740	--	--
1935	June 13, 1935	5.09	4340	--	--

1936	May 15, 1936	4.58	3660		--	--
1937	June 17, 1937	4.22	3120		--	--
1938	June 6, 1938	5.00	4550		--	--
1939	May 30, 1939	4.04	3170		--	--
1940	June 13, 1940	4.39	3660		--	--
1941	May 27, 1941	3.74	2820		--	--
1942	June 9, 1942	5.32	6050		--	--
1943	June 19, 1943	5.61	6480		--	--
1944	June 9, 1944	4.07	3600		--	--
1945	June 24, 1945	4.55	4450		--	--
1946	June 6, 1946	4.38	4360		--	--
1947	June 20, 1947	4.96	5250		--	--
1948	June 4, 1948	5.77	6740		--	--
1949	May 17, 1949	4.32	4110		--	--
1950	June 22, 1950	4.89	5030		--	--
1951	May 24, 1951	4.69	3940		--	--
1952	June 6, 1952	5.71	6910		--	--
1953	June 13, 1953	5.28	6010		--	--
1954	June 27, 1954	4.21	3790		--	--
1955	June 16, 1955	4.42	4480		--	--
1956	May 28, 1956	5.57	7030		--	--
1957	June 7, 1957	5.59	5970		--	--
1958	May 24, 1958	5.08	5010		--	--
1959	June 15, 1959	6.23	7230		--	--
1960	June 4, 1960	4.92	4940		--	--
1961	June 4, 1961	4.32	3670		--	--
1962	June 14, 1962	4.89	4780		--	--
1963	June 15, 1963	4.91	4800		--	--
1964	June 8, 1964	5.70	6450		--	--
1965	June 13, 1965	6.02	7010		--	--
1966	May 31, 1966	4.69 _/1	4530	_/2	--	--
1967	June 22, 1967	5.44	5960		--	--
1968	June 20, 1968	5.56	6570		--	--
1969	May 27, 1969	5.12	5350		--	--
1970	June 9, 1970	6.48	9240		--	--
1971	June 27, 1971	6.49	9270		--	--
1972	June 8, 1972	5.33	6030		--	--
1973	June 10, 1973	5.41	6500		--	--
1974	June 17, 1974	7.38	9100		--	--
1975	July 4, 1975	6.27	7950		--	--
1976	June 22, 1976	5.27	5870		--	--
1977	June 10, 1977	4.08	3370		--	--
1978	June 10, 1978	5.12	5230		--	--
1979	May 28, 1979	4.87	4730		--	--
1980	May 23, 1980	4.76	4150		--	--
1981	June 9, 1981	5.56	5920		--	--
1985	May 26, 1985	4.31	3650		--	--
1986	June 6, 1986	6.00	6830		--	--
1987	May 17, 1987	3.43	2390		--	--
1988	June 5, 1988	4.70	4340		--	--
1989	June 16, 1989	4.55	4280		--	--
1990	June 11, 1990	4.97	5140		--	--
1991	June 6, 1991	6.50	7640		--	--
1992	June 17, 1992	4.32	3660		--	--
1993	May 22, 1993	5.31	5740		--	--
1994	May 13, 1994	4.46	4110		--	--
1995	June 6, 1995	6.31	7330		--	--
1996	June 11, 1996	6.11	7010		--	--
1997	June 2, 1997	6.71	9160		--	--
1998	June 26, 1998	5.18	5400		--	--

```
_/ Explanation of the footnotes used for Gage height data:
      1  Gage height affected by backwater.

_/ Explanation of the footnotes used for Discharge data:
      2  Discharge is an estimate.
```

Basin Characteristics:

Value	Abbrev	Explanation
16.8	SLOPE	Main channel slope, in ft per mile
59.5	LENGTH	Total stream length, miles
7960.0	ELEV	Mean basin elevation, ft above msl

95.0	EL6000	Percent of basin above 6,000 ft, msl
0.03	STORAGE	Percent of basin in lakes, ponds, and swamps
83.3	FOREST	Percent of basin in forest
4.9	SOIL_INF	Soil index, in inches
45.4975	LAT_GAGE	Latitude of gage, in decimal degrees
111.26972222	LNG_GAGE	Longitude of gage, in decimal degrees
37.0	PRECIP	Mean annual precipitation, in inches
1.6	I24_2	Precipitation intensity for a 24-hour storm having a 2-year recurrence interval, in inches per hour
12.0	JANMIN	Mean minimum January temperature, in degrees F
102.0	WAC	Width of active channel, in feet
2.5	W2	Mean depth for active channel, in feet
120.0	WBF	Width of bankfull channel, in feet
5.5	W4	Mean depth of bankfull channel, in feet

Montana Flood-Frequency and Basin-Characteristic Data

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Peak Streamflow for Montana
USGS 06052500 Gallatin River at Logan MT

Available data for this site peak GO

Gallatin County, Montana
Hydrologic Unit Code 10020008
Latitude 45°53'07.28", Longitude 111°26'17.83" NAD83
Drainage area 1,795 square miles
Gage datum 4,086.42 feet above NGVD29

Output formats

- Table
- Graph
- Tab-separated file
- peakfq (watstore) format
- Reselect output format

Water Year	Date	Gage Height (feet)	Stream-flow (cfs)
1895	Jun. 24, 1895		4,060
1896	Jun. 18, 1896		6,550
1897	May 26, 1897		6,460
1898	Jun. 19, 1898		7,300
1899	Jun. 21, 1899		9,840
1900	May 28, 1900		4,850
1902	Jun. 11, 1902		4,430
1903	Jun. 14, 1903		4,500
1904	May 24, 1904		5,400

1905	Jun. 09, 1905		3,090
1929	Jun. 17, 1929	6.60	4,970
1930	May 31, 1930	5.36	2,820
1931	Jun. 03, 1931	5.46	2,970
1932	Jun. 16, 1932	6.42	4,570
1933	Jun. 13, 1933	5.94	3,700
1935	Jun. 14, 1935	6.10	3,990
1936	May 15, 1936	6.30	4,370
1937	Jun. 17, 1937	5.95	3,650
1938	May 30, 1938	6.90	5,590
1939	May 06, 1939	5.40	2,790
1940	Jun. 14, 1940	5.92	3,500
1941	Jun. 06, 1941	4.80	1,990
1942	Jun. 09, 1942	7.10[2]	5,940
1943	Jun. 20, 1943	7.50[2]	6,160
1944	Jun. 27, 1944	6.68	4,820
1945	Jun. 24, 1945	5.83[2]	3,500
1946	Jun. 06, 1946	6.04	3,730
1947	Jun. 21, 1947	7.46	6,160
1948	Jun. 05, 1948	8.40	7,870
1949	May 18, 1949	6.26[2]	3,900
1950	Jun. 22, 1950	6.29[2]	3,940
1951	May 25, 1951	6.41[2]	4,140
1952	Jun. 07, 1952	7.78[2]	6,640
1953	Jun. 14, 1953	7.34	5,930
1954	Jun. 28, 1954	5.74[2]	3,380
1955	Jun. 16, 1955	6.18[2]	4,050
1956	May 29, 1956	7.97[2]	7,190
1957	Jun. 09, 1957	6.79[2]	4,990
1958	May 26, 1958	5.90	3,620
1959	Jun. 15, 1959	7.65	6,120
1960	May 13, 1960	6.34[2]	4,320
1961	May 30, 1961	4.88	2,160
1962	Jun. 15, 1962	6.64[2]	4,830
1963	Jun. 15, 1963	6.56[2]	4,750
1964	Jun. 08, 1964		6,290
1965	Jun. 26, 1965		6,100
1966	May 31, 1966		3,460
1967	Jun. 23, 1967		6,950

1968	Jun. 14, 1968	7.97[2]	7,280
1969	Jun. 11, 1969	7.18[2]	5,200
1970	Jun. 10, 1970	9.03	9,390
1971	Jun. 28, 1971	8.74[2]	8,480
1972	Jun. 08, 1972	7.13	5,130
1973	Jun. 10, 1973	7.41[2]	5,550
1974	Jun. 18, 1974	9.02[2]	9,170
1975	Jul. 04, 1975	8.44[2]	7,770
1976	Jun. 23, 1976	7.93	6,660
1977	Jun. 11, 1977	5.57	2,620
1978	Jun. 10, 1978	7.05[2]	4,970
1979	May 29, 1979		4,300[2]
1980	May 25, 1980	6.87[2]	4,550
1981	May 23, 1981	8.47	7,380
1982	Jun. 29, 1982	8.16[2]	7,160
1983	Jun. 12, 1983	7.89	6,390
1984	May 16, 1984	8.12[2]	7,050
1985	May 04, 1985	6.61[2]	3,710
1986	Jun. 02, 1986		6,700[1]
1987	May 29, 1987	5.59	2,100
1988	May 17, 1988	6.96	3,980
1989	Jun. 17, 1989	6.69	3,740
1990	Jun. 11, 1990	7.30	4,370
1991	Jun. 06, 1991	9.06	8,120
1992	Jun. 18, 1992	7.33	4,310
1993	May 22, 1993	8.30[2]	6,410
1994	May 13, 1994	6.64[2]	3,410
1995	Jun. 06, 1995	8.67	7,220
1996	Jun. 10, 1996	8.71[2]	7,310
1997	Jun. 08, 1997	9.80[2]	9,400
1998	Jun. 26, 1998	8.30	6,270
1999	May 30, 1999	8.11	5,600
2000	May 29, 2000	7.10	3,930
2001	May 15, 2001	6.26[2]	2,610
2002	Jun. 03, 2002	8.11	5,580
2003	May 30, 2003	8.24	5,830
2004	Jun. 11, 2004	7.02[2]	3,700
2005	Jun. 18, 2005	7.14[2]	4,050

2006	Jun. 10, 2006	7.68[2]	5,010
2007	Jun. 07, 2007	3.49[2]	3,720
2008	Jun. 23, 2008	8.59	6,270
2009	Jun. 01, 2009	8.09	5,580
2010	Jun. 05, 2010	8.52	6,110
2011	Jun. 30, 2011	9.35[2]	7,980
2012	Jun. 05, 2012	8.05	4,990
2013	Jun. 14, 2013	7.46[2]	4,010

Peak Gage-Height Qualification Codes.

- 2 -- Gage height not the maximum for the year

Peak Streamflow Qualification Codes.

- 1 -- Discharge is a Maximum Daily Average
- 2 -- Discharge is an Estimate

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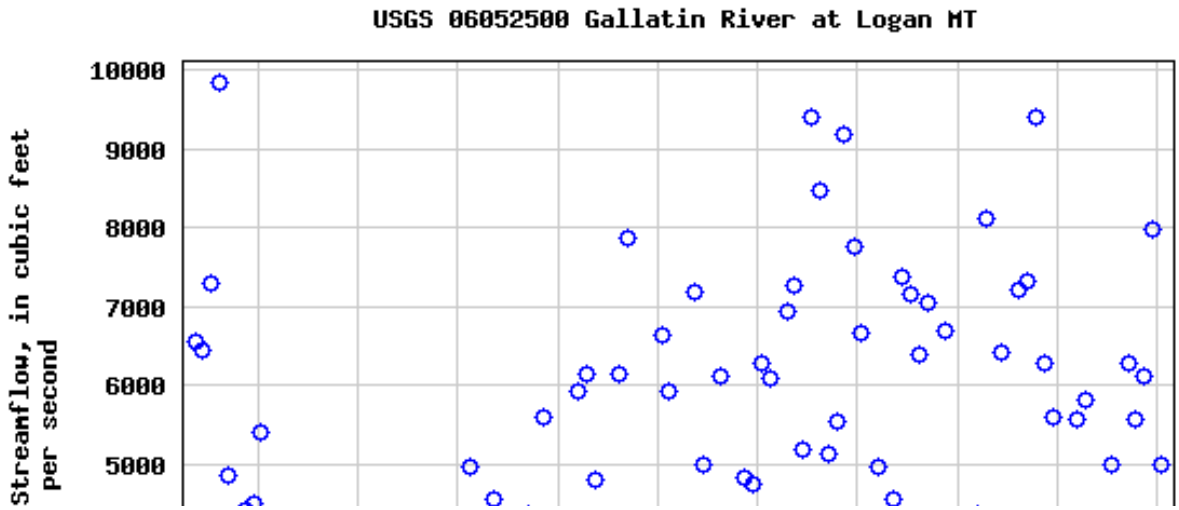
Peak Streamflow for Montana
USGS 06052500 Gallatin River at Logan MT

Available data for this site: peak GO

Gallatin County, Montana
Hydrologic Unit Code 10020008
Latitude 45°53'07.28", Longitude 111°26'17.83" NAD83
Drainage area 1,795 square miles
Gage datum 4,086.42 feet above NGVD29

Output formats

- Table
- Graph
- Tab-separated file
- peakfq (watstore) format
- Reselect output format



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USGS

Montana Flood-Frequency and Basin-Characteristic Data

Flood-frequency data are based on recorded annual peak discharges through 1998. Peak discharges for specified frequencies (exceedance probabilities) were determined by fitting a log-Pearson Type 3 probability distribution to base 10 logarithms of recorded annual peak discharges as described by the Interagency Advisory Committee on Water Data (1982, Guidelines for Determining Flood Flow Frequency--Bulletin 17-B of the Hydrology Subcommittee: U.S. Geological Survey, Office of Water Data Coordination). **Note: Data are provisional and user is responsible for assessment and interpretation of flood-frequency data.**

Most of the basin characteristic data were measured in the 1970s from the best-scale topographic maps available at the time. Some data, such as mean annual precipitation, soil index data, and mean January minimum temperatures, were compiled from maps prepared by other agencies. Channel widths were measured in the field by USGS personnel.

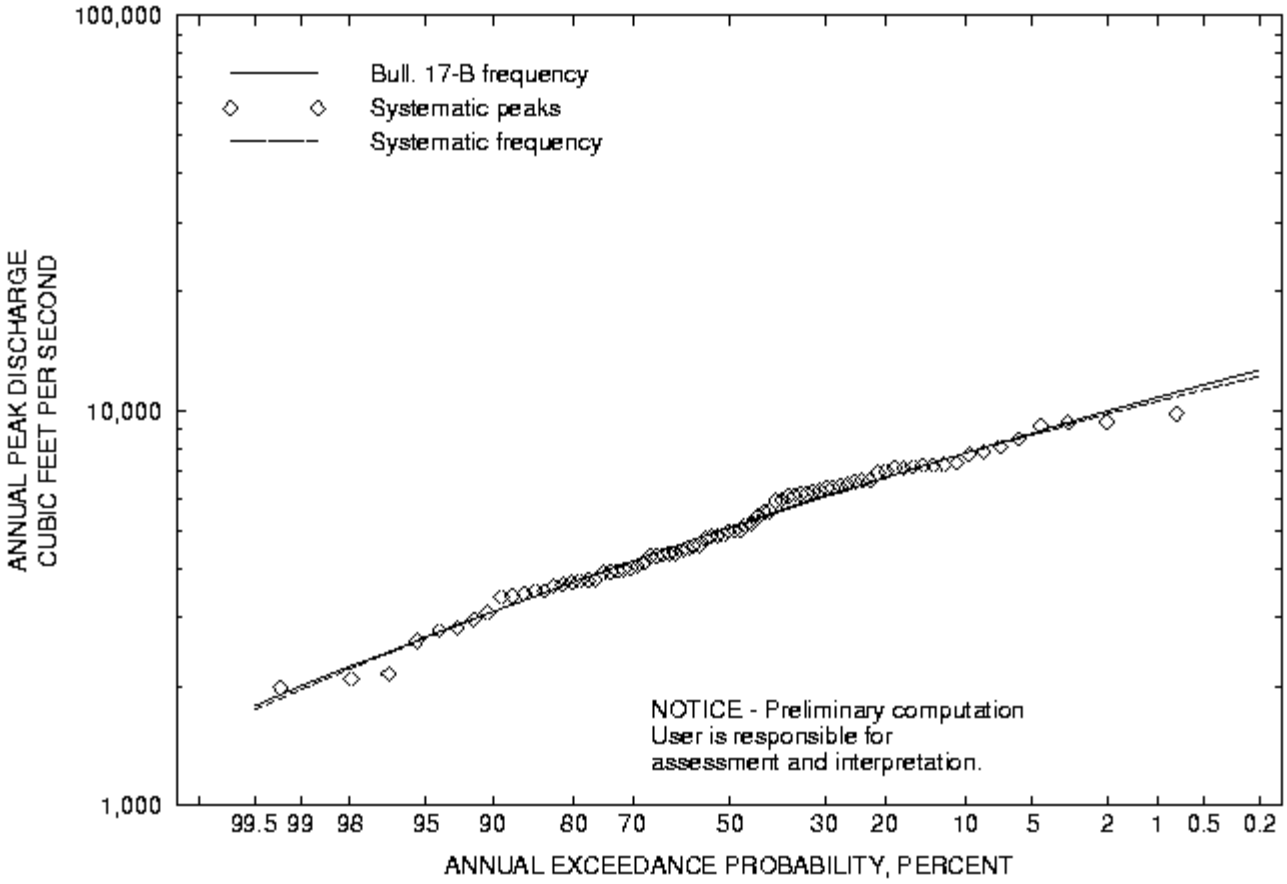
The flood-frequency and basin characteristics data were used in a new flood-frequency report just published by the USGS, entitled "Methods for estimating Flood Frequency in Montana Based on Data through Water Year 1998" (Water-Resources Investigations Report 03-4308). Information about the equations described in that report can be found at the following link.

For more detailed information contact Wayne Berkas:
Phone: 406-457-5903 or by e-mail.

06052500 Gallatin River at Logan, MT

Annual peak discharge, in cubic feet per second (top line), for indicated exceedance probability, in percent (bottom line):

1790	2000	2670	3100	3690	5050	6780	7830	9090	9970	10800	11600	12700
99.5	99	95	90	80	50	20	10	4	2	1	0.5	0.2



NOTE: Systematic peaks are those that are recorded within the period of gaged record. The computed systematic flood-frequency curve is based only on the systematic peaks. The computed Bulletin 17-B flood-frequency curve often is different from the systematic flood-frequency curve because of differences between station skew and regional skew, low- or high-outlier adjustments, or the presence of one or more historical peaks outside the systematic record. Historical peaks also result in historical adjusted plotting positions (exceedance probabilities) for all peaks.

Recorded Annual Peak Discharge:

06052500 Gallatin River at Logan, MT

```
Location.-- Lat 45 53'07", Long 111 26'15", Hydrologic Unit 10020008.
Drainage area.-- 1795.00 square miles.
Datum of gage.--     4086.4 ft above sea level.
```

Table of annual peak discharge data [--, no data]

Water year	Date	Gage height (ft)	Discharge ft3/s	Date of Max. gage height	Maximum gage height (ft)
1895	June 24, 1895	--	3904	--	--
1896	June 18, 1896	--	6550	--	--
1897	May 26, 1897	--	6460	--	--
1898	June 19, 1898	--	7300	--	--
1899	June 21, 1899	--	9840	--	--
1900	May 28, 1900	--	4850	--	--
1902	June 11, 1902	--	4430	--	--
1903	June 14, 1903	--	4500	--	--
1904	May 24, 1904	--	5400	--	--
1905	June 9, 1905	--	3090	--	--

1929	June 17, 1929	6.60	4970		--	--	
1930	May 31, 1930	5.36	2820		--	--	
1931	June 3, 1931	5.46	2970		--	--	
1932	June 16, 1932	6.42	4570		--	--	
1933	June 13, 1933	5.94	3700		--	--	
1935	June 14, 1935	6.10	3990		--	--	
1936	May 15, 1936	6.30	4370		--	--	
1937	June 17, 1937	5.95	3650		--	--	
1938	May 30, 1938	6.90	5590		--	--	
1939	May 6, 1939	5.40	2790		--	--	
1940	June 14, 1940	5.92	3500		--	--	
1941	June 6, 1941	4.80	1990		--	--	
1942	June 9, 1942	7.10 _/2	5940		Jan. 3, 1942	7.23 _/1	
1943	June 20, 1943	7.50 _/2	6160		Feb. 10, 1943	8.94 _/1	
1944	June 27, 1944	6.68	4820		--	--	
1945	June 24, 1945	5.83 _/2	3500		Dec. 27, 1944	7.30 _/1	
1946	June 6, 1946	6.04	3730		--	--	
1947	June 21, 1947	7.46	6160		--	--	
1948	June 5, 1948	8.40	7870		--	--	
1949	May 18, 1949	6.26 _/2	3900		Dec. 25, 1948	7.23 _/1	
1950	June 22, 1950	6.29 _/2	3940		--	--	
1951	May 25, 1951	6.41 _/2	4140		--	--	
1952	June 7, 1952	7.78 _/2	6640		Jan. 24, 1952	7.94 _/1	
1953	June 14, 1953	7.34	5930		--	--	
1954	June 28, 1954	5.74 _/2	3380		Jan. 23, 1954	7.18 _/1	
1955	June 16, 1955	6.18 _/2	4050		Jan. 7, 1955	7.48 _/1	
1956	May 29, 1956	7.97 _/2	7190		Dec. 19, 1955	8.83 _/1	
1957	June 9, 1957	6.79 _/2	4990		Feb. 5, 1957	7.29 _/1	
1958	May 26, 1958	5.90	3620		--	--	
1959	June 15, 1959	7.65	6120		--	--	
1960	May 13, 1960	6.34 _/2	4320		Jan. 17, 1960	8.83 _/1	
1961	May 30, 1961	4.88	2160		--	--	
1962	June 15, 1962	6.64 _/2	4830		Dec. 11, 1961	8.50 _/1	
1963	June 15, 1963	6.56 _/2	4750		Feb. 5, 1963	11.88 _/1	
1964	June 8, 1964	--	6290		--	--	
1965	June 26, 1965	--	6100		--	--	
1966	May 31, 1966	--	3460		--	--	
1967	June 23, 1967	--	6950		--	--	
1968	June 14, 1968	7.97 _/2	7280		Feb. 1, 1968	9.80 _/1	
1969	June 11, 1969	7.18 _/2	5200		Feb. 17, 1969	11.85 _/1	
1970	June 10, 1970	9.03	9390		--	--	
1971	June 28, 1971	8.74 _/2	8480		Jan. 7, 1971	9.30 _/1	
1972	June 8, 1972	7.13	5130		Dec. 28, 1971	9.03 _/1	
1973	June 10, 1973	7.41 _/2	5550		Feb. 10, 1973	8.55 _/1	
1974	June 18, 1974	9.02 _/2	9170		Jan. 16, 1974	9.90 _/1	
1975	July 4, 1975	8.44 _/2	7770		Jan. 29, 1975	10.63 _/1	
1976	June 23, 1976	7.93	6660		--	--	
1977	June 11, 1977	5.57	2620		--	--	
1978	June 10, 1978	7.05 _/2	4970		Jan. 3, 1978	7.15 _/1	
1979	May 29, 1979	--	4300	_/2	Jan. 3, 1979	9.38 _/1	
1980	May 25, 1980	6.87 _/2	4550		1980	10.32 _/1	
1981	May 23, 1981	8.47	7380		--	--	
1982	June 29, 1982	8.16 _/2	7160		Jan. 23, 1982	9.54 _/1	
1983	June 12, 1983	7.89	6390		--	--	
1984	May 16, 1984	8.12 _/2	7050		Dec. 21, 1983	9.87 _/1	
1985	May 4, 1985	6.61 _/2	3710		Feb. 4, 1985	9.16 _/1	
1986	June 2, 1986	--	6700	_/1	Nov. 26, 1985	8.06 _/1	
1987	May 29, 1987	5.59	2100		--	--	
1988	May 17, 1988	6.96	3980		--	--	
1989	June 17, 1989	6.69	3740		--	--	
1990	June 11, 1990	7.30	4370		--	--	
1991	June 6, 1991	9.06	8120		--	--	
1992	June 18, 1992	7.33	4310		--	--	
1993	May 22, 1993	8.30 _/2	6410		Jan. 1, 1993	8.67 _/1	
1994	May 13, 1994	6.64 _/2	3410		Nov. 26, 1993	10.18 _/1	
1995	June 6, 1995	8.67	7220		--	--	
1996	June 10, 1996	8.71 _/2	7310		Feb. 9, 1996	10.18 _/1	
1997	June 8, 1997	9.80 _/2	9400		Dec. 27, 1996	9.87 _/1	
1998	June 26, 1998	8.30	6270		--	--	

_/ Explanation of the footnotes used for Gage height data:
2 Gage height not the maximum for the year.

_/ Explanation of the footnotes used for Discharge data:
1 Discharge is maximum daily average.
2 Discharge is an estimate.

_/ Explanation of the footnotes used for Maximum gage height data:
1 Gage height due to backwater.

Basin Characteristics:

Value	Abbrev	Explanation
37.8	SLOPE	Main channel slope, in ft per mile
98.7	LENGTH	Total stream length, miles
6820.0	ELEV	Mean basin elevation, ft above msl
64.0	EL6000	Percent of basin above 6,000 ft, msl
0.08	STORAGE	Percent of basin in lakes, ponds, and swamps
60.3	FOREST	Percent of basin in forest
--	SOIL_INF	Soil index, in inches
45.88527778	LAT_GAGE	Latitude of gage, in decimal degrees
111.4375	LNG_GAGE	Longitude of gage, in decimal degrees
27.0	PRECIP	Mean annual precipitation, in inches
1.5	I24_2	Precipitation intensity for a 24-hour storm having a 2-year recurrence interval, in inches per hour
9.0	JANMIN	Mean minimum January temperature, in degrees F
150.0	WAC	Width of active channel, in feet
3.0	W2	Mean depth for active channel, in feet
170.0	WBF	Width of bankfull channel, in feet
6.0	W4	Mean depth of bankfull channel, in feet

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Peak Streamflow for Montana
USGS 06044000 Gallatin River near Salesville MT

Available data for this site peak GO

Gallatin County, Montana
Hydrologic Unit Code 10020008
Latitude 45°32'25.90", Longitude 111°14'03.00" NAD83
Drainage area 833 square miles
Gage datum 5,050 feet above NGVD29

Output formats

- Table
- Graph
- Tab-separated file
- peakfq (watstore) format
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Water Year	Date	Gage Height (feet)	Stream-flow (cfs)
1896	Jun. 18, 1896	7.90	8,700
1897	May 21, 1897	6.85	5,780
1898	Jun. 16, 1898	7.45	7,230
1899	Jun. 20, 1899	8.55	10,000
1900	May 28, 1900	6.90	5,410
1901	May 18, 1901	7.55	7,810
1902	May 31, 1902	6.65	5,570
1903	Jun. 14, 1903	6.85	5,330
1904	May 24, 1904	7.20	5,780

1905	Jun. 13, 1905	5.30	2,700
1912	Jun. 12, 1912	7.20	5,860
1913	May 28, 1913	7.80	6,940
1921	Jun. 11, 1921	8.32	6,390
1922	May 25, 1922	8.50	7,460
1923	Jun. 09, 1923	7.20	5,120

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Latitude 45°32'25.90", Longitude 111°14'03.00" NAD83
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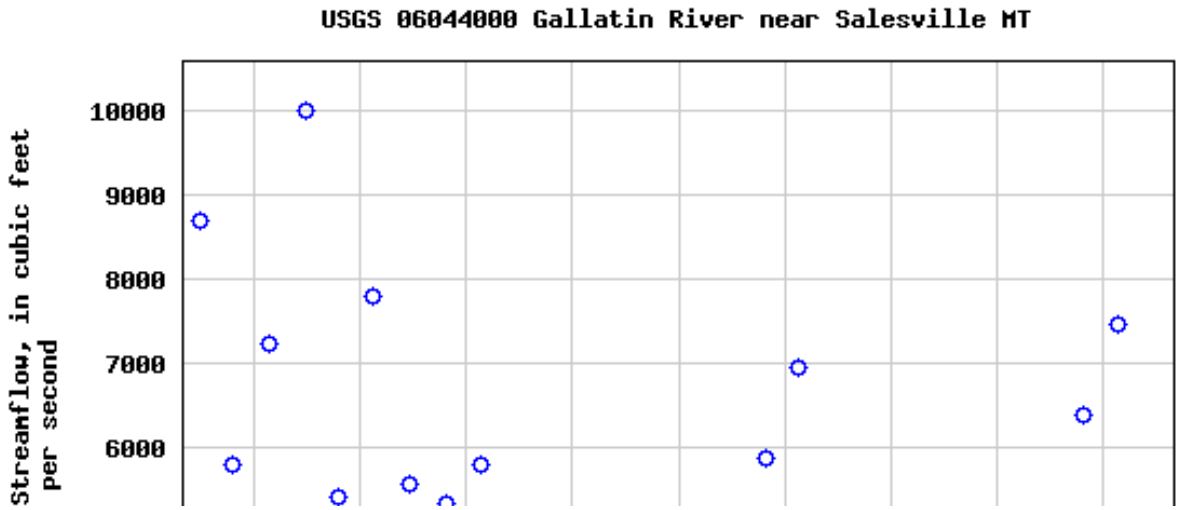

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Appendix B – Hydrologic Calculations

- Stream Gage Analysis – USGS Gage No. 06043500 Gallatin River near Gallatin Gateway, MT
    - Input – PeakFQ WATSTORE data format
    - Output – Baseline Run (through Water Year 1998)
    - Output – Updated Run (through Water Year 2013)
- Stream Gage Analysis – USGS Gage No. 06052500 Gallatin River at Logan, MT
    - Input – PeakFQ WATSTORE data format
    - Output – Baseline Run (through Water Year 1998)
    - Output – Updated Run (through Water Year 2013)

- Ungaged Analysis – Two-gage Method Calculations
    - Excel Worksheet Results

```
Z06043500                    USGS
H06043500       45295011116140030300 31SW10020008825            5167.67
N06043500       Gallatin River near Gallatin Gateway MT
Y06043500
306043500       18900610   3800
306043500       18910607   2980
306043500       18920620   8060
306043500       18930612   6800
306043500       18940602   8060
306043500       18960618   8700                7.90
306043500       18970521   5780                6.85
306043500       18980616   7230                7.45
306043500       18990620  10000                8.55
306043500       19000528   5410                6.90
306043500       19010518   7810                7.55
306043500       19020531   5570                6.65
306043500       19030614   5330                6.85
306043500       19040524   5780                7.20
306043500       19050613   2700                5.30
306043500       19120612   5860                7.20
306043500       19130528   6940                7.80
306043500       19210611   6390                8.32
306043500       19220525   7460                8.50
306043500       19230609   5120                7.20
306043500       19310602   2940
306043500       19320616   5780
306043500       19330613   4270                5.03
306043500       19340508   1740                3.03
306043500       19350613   4340                5.09
306043500       19360515   3660                4.58
306043500       19370617   3120                4.22
306043500       19380606   4550                5.00
306043500       19390530   3170                4.04
306043500       19400613   3660                4.39
306043500       19410527   2820                3.74
306043500       19420609   6050                5.32
306043500       19430619   6480                5.61
306043500       19440609   3600                4.07
306043500       19450624   4450                4.55
306043500       19460606   4360                4.38
306043500       19470620   5250                4.96
306043500       19480604   6740                5.77
306043500       19490517   4110                4.32
306043500       19500622   5030                4.89
306043500       19510524   3940                4.69
306043500       19520606   6910                5.71
306043500       19530613   6010                5.28
306043500       19540627   3790                4.21
306043500       19550616   4480                4.42
306043500       19560528   7030                5.57
306043500       19570607   5970                5.59
306043500       19580524   5010                5.08
306043500       19590615   7230                6.23
306043500       19600604   4940                4.92
306043500       19610604   3670                4.32
306043500       19620614   4780                4.89
306043500       19630615   4800                4.91
306043500       19640608   6450                5.70
306043500       19650613   7010                6.02
306043500       19660531   4530                4.69
306043500       19670622   5960                5.44
306043500       19680620   6570                5.56
306043500       19690527   5350                5.12
```

306043500	19700609	9240	6.48
306043500	19710627	9270	6.49
306043500	19720608	6030	5.33
306043500	19730610	6500	5.41
306043500	19740617	9100	7.38
306043500	19750704	7950	6.27
306043500	19760622	5870	5.27
306043500	19770610	3370	4.08
306043500	19780610	5230	5.12
306043500	19790528	4730	4.87
306043500	19800523	4150	4.76
306043500	19810609	5920	5.56
306043500	19850526	3650	4.31
306043500	19860606	6830	6.00
306043500	19870517	2390	3.43
306043500	19880605	4340	4.70
306043500	19890616	4280	4.55
306043500	19900611	5140	4.97
306043500	19910606	7640	6.50
306043500	19920617	3660	4.32
306043500	19930522	5740	5.31
306043500	19940513	4110	4.46
306043500	19950606	7330	6.31
306043500	19960611	7010	6.11
306043500	19970602	9160	6.71
306043500	19980626	5400	5.18

```
Z06043500                          USGS
H06043500       452950111161400303003 1SW10020008825            5167.67
N06043500       Gallatin River near Gallatin Gateway MT
Y06043500
306043500       18900610   3800
306043500       18910607   2980
306043500       18920620   8060
306043500       18930612   6800
306043500       18940602   8060
306043500       18960618   8700                7.90
306043500       18970521   5780                6.85
306043500       18980616   7230                7.45
306043500       18990620  10000                8.55
306043500       19000528   5410                6.90
306043500       19010518   7810                7.55
306043500       19020531   5570                6.65
306043500       19030614   5330                6.85
306043500       19040524   5780                7.20
306043500       19050613   2700                5.30
306043500       19120612   5860                7.20
306043500       19130528   6940                7.80
306043500       19210611   6390                8.32
306043500       19220525   7460                8.50
306043500       19230609   5120                7.20
306043500       19310602   2940
306043500       19320616   5780
306043500       19330613   4270                5.03
306043500       19340508   1740                3.03
306043500       19350613   4340                5.09
306043500       19360515   3660                4.58
306043500       19370617   3120                4.22
306043500       19380606   4550                5.00
306043500       19390530   3170                4.04
306043500       19400613   3660                4.39
306043500       19410527   2820                3.74
306043500       19420609   6050                5.32
306043500       19430619   6480                5.61
306043500       19440609   3600                4.07
306043500       19450624   4450                4.55
306043500       19460606   4360                4.38
306043500       19470620   5250                4.96
306043500       19480604   6740                5.77
306043500       19490517   4110                4.32
306043500       19500622   5030                4.89
306043500       19510524   3940                4.69
306043500       19520606   6910                5.71
306043500       19530613   6010                5.28
306043500       19540627   3790                4.21
306043500       19550616   4480                4.42
306043500       19560528   7030                5.57
306043500       19570607   5970                5.59
306043500       19580524   5010                5.08
306043500       19590615   7230                6.23
306043500       19600604   4940                4.92
306043500       19610604   3670                4.32
306043500       19620614   4780                4.89
306043500       19630615   4800                4.91
306043500       19640608   6450                5.70
306043500       19650613   7010                6.02
306043500       19660531   4530                4.69
306043500       19670622   5960                5.44
306043500       19680620   6570                5.56
306043500       19690527   5350                5.12
```

306043500	19700609	7600	6.48
306043500	19710627	7610	6.49
306043500	19720608	6030	5.33
306043500	19730610	6500	5.41
306043500	19740617	9100	7.38
306043500	19750704	7950	6.27
306043500	19760622	5870	5.27
306043500	19770610	3370	4.08
306043500	19780610	5230	5.12
306043500	19790528	4730	4.87
306043500	19800523	4150	4.76
306043500	19810609	5920	5.56
306043500	19850526	3650	4.31
306043500	19860606	6830	6.00
306043500	19870517	2390	3.43
306043500	19880605	4340	4.70
306043500	19890616	4280	4.55
306043500	19900611	5140	4.97
306043500	19910606	7640	6.50
306043500	19920617	3660	4.32
306043500	19930522	5740	5.31
306043500	19940513	4110	4.46
306043500	19950606	7330	6.31
306043500	19960611	7010	6.11
306043500	19970602	9160	6.71
306043500	19980626	5400	5.18
306043500	19990529	4990	4.98
306043500	20000529	4070	4.44
306043500	20010515	3740	4.26
306043500	20020602	5260	5.03
306043500	20030530	6710	5.71
306043500	20040610	3810	4.30
306043500	20050623	4220	4.52
306043500	20060521	5550	5.17
306043500	20070514	3350	4.04
306043500	20080623	6010	5.54
306043500	20090601	5500	5.28
306043500	20100605	5360	5.20
306043500	20110630	8410	6.51
306043500	20120605	5220	5.17
306043500	20130611	3950	4.48

```
1
  Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.002.000
  Version 7.1         Annual peak flow frequency analysis      Run Date / Time
  3/14/2014                                                    12/24/2014 10:59

                        --- PROCESSING OPTIONS ---

                     Plot option         = None
                     Basin char output   = None
                     Print option        = Yes
                     Debug print         = No
                     Input peaks listing = Long
                     Input peaks format  = WATSTORE peak file

                     Input files used:
                        peaks (ascii)  -
C:\rja\PeakFQ\data\6043500GALLATINRIVERGALLATINGATEWAY1998HIGHFLOWS.TXT
                        specifications - C:\rja\PeakFQ\data\PKFQWPSF.TMP

                     Output file(s):
                        main -
C:\rja\PeakFQ\data\6043500GALLATINRIVERGALLATINGATEWAY1998HIGHFLOWS.PRT

1


  Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.001.001
  Version 7.1         Annual peak flow frequency analysis      Run Date / Time
  3/14/2014                                                    12/24/2014 10:59

          Station - 06043500  Gallatin River near Gallatin Gateway MT


                    I N P U T   D A T A   S U M M A R Y

               Number of peaks in record           =       85
               Peaks not used in analysis          =        0
               Systematic peaks in analysis        =       85
               Historic peaks in analysis          =        0
               Beginning Year                      =     1890
               Ending Year                         =     1998
               Historical Period Length            =        0
               Generalized skew                    =    0.023
                    Standard error                 =    0.640
                    Mean Square error              =    0.410
               Skew option                         =   WEIGHTED
               Gage base discharge                 =      0.0
               User supplied high outlier threshold =   --
               User supplied PILF (LO) criterion   =   --
               Plotting position parameter         =     0.00
               Type of analysis                      BULL.17B
               PILF (LO) Test Method                     GBT
               Perception Thresholds            =   Not Applicable
               Interval Data                    =   Not Applicable


  *********  NOTICE  --  Preliminary machine computations.        *********
  *********  User responsible for assessment and interpretation.  *********

    WCF134I-NO SYSTEMATIC PEAKS WERE BELOW GAGE BASE.                   0.0
    WCF198I-LOW OUTLIERS BELOW FLOOD BASE WERE DROPPED.       1      1902.9
    WCF163I-NO HIGH OUTLIERS OR HISTORIC PEAKS EXCEEDED HHBASE.     13752.3
```

6043500GALLATINRIVERGALLATINGATEWAY1998HIGHFLOWS.PRT

Kendall's Tau Parameters

	TAU	P-VALUE	MEDIAN SLOPE	No. of PEAKS
SYSTEMATIC RECORD	0.019	0.802	2.439	85

1

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.001.002
Version 7.1 Annual peak flow frequency analysis Run Date / Time
3/14/2014 12/24/2014 10:59

Station - 06043500 Gallatin River near Gallatin Gateway MT

ANNUAL FREQUENCY CURVE PARAMETERS -- LOG-PEARSON TYPE III

	FLOOD BASE		LOGARITHMIC		
	DISCHARGE	EXCEEDANCE PROBABILITY	MEAN	STANDARD DEVIATION	SKEW
SYSTEMATIC RECORD	0.0	1.0000	3.7193	0.1486	-0.517
BULL.17B ESTIMATE	1902.9	0.9882	3.7228	0.1406	-0.217

BULL.17B ESTIMATE OF MSE OF AT-SITE SKEW 0.0760

ANNUAL FREQUENCY CURVE -- DISCHARGES AT SELECTED EXCEEDANCE PROBABILITIES

ANNUAL EXCEEDANCE PROBABILITY	BULL.17B ESTIMATE	SYSTEMATIC RECORD	<-- FOR BULLETIN 17B ESTIMATES --> VARIANCE OF EST.	95% CONFIDENCE INTERVALS LOWER	UPPER
0.9950		1842.	--	--	--
0.9900		2082.	--	--	--
0.9500	3043.	2852.	----	2750.0	3306.0
0.9000	3465.	3331.	----	3178.0	3727.0
0.8000	4039.	3976.	----	3757.0	4303.0
0.6667	4640.	4640.	----	4358.0	4919.0
0.5000	5344.	5396.	----	5043.0	5666.0
0.4292	5659.	5726.	----	5341.0	6009.0
0.2000	6956.	7024.	----	6527.0	7480.0
0.1000	7932.	7936.	----	7383.0	8635.0
0.0400	9080.	8937.	----	8364.0	10030.0
0.0200	9882.	9592.	----	9038.0	11030.0
0.0100	10650.	10180.	----	9671.0	11990.0
0.0050	11380.	10720.	----	10270.0	12930.0
0.0020	12320.	11360.	----	11040.0	14140.0

1

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.001.003
Version 7.1 Annual peak flow frequency analysis Run Date / Time
3/14/2014 12/24/2014 10:59

Station - 06043500 Gallatin River near Gallatin Gateway MT

I N P U T D A T A L I S T I N G

WATER YEAR	PEAK VALUE	PEAKFQ CODES	REMARKS
1890	3800.0		
1891	2980.0		
1892	8060.0		
1893	6800.0		
1894	8060.0		
1896	8700.0		
1897	5780.0		
1898	7230.0		
1899	10000.0		
1900	5410.0		
1901	7810.0		
1902	5570.0		
1903	5330.0		
1904	5780.0		
1905	2700.0		
1912	5860.0		
1913	6940.0		
1921	6390.0		
1922	7460.0		
1923	5120.0		
1931	2940.0		
1932	5780.0		
1933	4270.0		
1934	1740.0		
1935	4340.0		
1936	3660.0		
1937	3120.0		
1938	4550.0		
1939	3170.0		
1940	3660.0		
1941	2820.0		
1942	6050.0		
1943	6480.0		
1944	3600.0		
1945	4450.0		
1946	4360.0		
1947	5250.0		
1948	6740.0		
1949	4110.0		
1950	5030.0		
1951	3940.0		
1952	6910.0		
1953	6010.0		
1954	3790.0		
1955	4480.0		
1956	7030.0		
1957	5970.0		
1958	5010.0		
1959	7230.0		
1960	4940.0		
1961	3670.0		
1962	4780.0		
1963	4800.0		
1964	6450.0		
1965	7010.0		
1966	4530.0		

1967	5960.0
1968	6570.0
1969	5350.0
1970	9240.0
1971	9270.0
1972	6030.0
1973	6500.0
1974	9100.0
1975	7950.0
1976	5870.0
1977	3370.0
1978	5230.0
1979	4730.0
1980	4150.0
1981	5920.0
1985	3650.0
1986	6830.0
1987	2390.0
1988	4340.0
1989	4280.0
1990	5140.0
1991	7640.0
1992	3660.0
1993	5740.0
1994	4110.0
1995	7330.0
1996	7010.0
1997	9160.0
1998	5400.0

Explanation of peak discharge qualification codes

PeakFQ CODE	NWIS CODE	DEFINITION
D	3	Dam failure, non-recurrent flow anomaly
G	8	Discharge greater than stated value
X	3+8	Both of the above
L	4	Discharge less than stated value
K	6 OR C	Known effect of regulation or urbanization
H	7	Historic peak

- Minus-flagged discharge -- Not used in computation
  -8888.0 -- No discharge value given
- Minus-flagged water year -- Historic peak used in computation

1

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.001.004
Version 7.1 Annual peak flow frequency analysis Run Date / Time
3/14/2014 12/24/2014 10:59

Station - 06043500 Gallatin River near Gallatin Gateway MT

EMPIRICAL FREQUENCY CURVES -- WEIBULL PLOTTING POSITIONS

WATER YEAR	RANKED DISCHARGE	SYSTEMATIC RECORD	B17B ESTIMATE

1899	10000.0	0.0116	0.0116
1971	9270.0	0.0233	0.0233
1970	9240.0	0.0349	0.0349
1997	9160.0	0.0465	0.0465
1974	9100.0	0.0581	0.0581
1896	8700.0	0.0698	0.0698
1892	8060.0	0.0814	0.0814
1894	8060.0	0.0930	0.0930
1975	7950.0	0.1047	0.1047
1901	7810.0	0.1163	0.1163
1991	7640.0	0.1279	0.1279
1922	7460.0	0.1395	0.1395
1995	7330.0	0.1512	0.1512
1898	7230.0	0.1628	0.1628
1959	7230.0	0.1744	0.1744
1956	7030.0	0.1860	0.1860
1965	7010.0	0.1977	0.1977
1996	7010.0	0.2093	0.2093
1913	6940.0	0.2209	0.2209
1952	6910.0	0.2326	0.2326
1986	6830.0	0.2442	0.2442
1893	6800.0	0.2558	0.2558
1948	6740.0	0.2674	0.2674
1968	6570.0	0.2791	0.2791
1973	6500.0	0.2907	0.2907
1943	6480.0	0.3023	0.3023
1964	6450.0	0.3140	0.3140
1921	6390.0	0.3256	0.3256
1942	6050.0	0.3372	0.3372
1972	6030.0	0.3488	0.3488
1953	6010.0	0.3605	0.3605
1957	5970.0	0.3721	0.3721
1967	5960.0	0.3837	0.3837
1981	5920.0	0.3953	0.3953
1976	5870.0	0.4070	0.4070
1912	5860.0	0.4186	0.4186
1897	5780.0	0.4302	0.4302
1904	5780.0	0.4419	0.4419
1932	5780.0	0.4535	0.4535
1993	5740.0	0.4651	0.4651
1902	5570.0	0.4767	0.4767
1900	5410.0	0.4884	0.4884
1998	5400.0	0.5000	0.5000
1969	5350.0	0.5116	0.5116
1903	5330.0	0.5233	0.5233
1947	5250.0	0.5349	0.5349
1978	5230.0	0.5465	0.5465
1990	5140.0	0.5581	0.5581
1923	5120.0	0.5698	0.5698
1950	5030.0	0.5814	0.5814
1958	5010.0	0.5930	0.5930
1960	4940.0	0.6047	0.6047
1963	4800.0	0.6163	0.6163
1962	4780.0	0.6279	0.6279
1979	4730.0	0.6395	0.6395
1938	4550.0	0.6512	0.6512
1966	4530.0	0.6628	0.6628
1955	4480.0	0.6744	0.6744
1945	4450.0	0.6860	0.6860
1946	4360.0	0.6977	0.6977
1935	4340.0	0.7093	0.7093
1988	4340.0	0.7209	0.7209
1989	4280.0	0.7326	0.7326

```
    1933     4270.0     0.7442      0.7442
    1980     4150.0     0.7558      0.7558
    1949     4110.0     0.7674      0.7674
    1994     4110.0     0.7791      0.7791
    1951     3940.0     0.7907      0.7907
    1890     3800.0     0.8023      0.8023
    1954     3790.0     0.8140      0.8140
    1961     3670.0     0.8256      0.8256
    1936     3660.0     0.8372      0.8372
    1940     3660.0     0.8488      0.8488
    1992     3660.0     0.8605      0.8605
    1985     3650.0     0.8721      0.8721
    1944     3600.0     0.8837      0.8837
    1977     3370.0     0.8953      0.8953
    1939     3170.0     0.9070      0.9070
    1937     3120.0     0.9186      0.9186
    1891     2980.0     0.9302      0.9302
    1931     2940.0     0.9419      0.9419
    1941     2820.0     0.9535      0.9535
    1905     2700.0     0.9651      0.9651
    1987     2390.0     0.9767      0.9767
    1934     1740.0     0.9884      0.9884
1


 End PeakFQ analysis.
   Stations processed :       1
   Number of errors   :       0
   Stations skipped   :       0
   Station years      :      85


Data records may have been ignored for the stations listed below.
(Card type must be Y, Z, N, H, I, 2, 3, 4,  or *.)
(2, 4, and * records are ignored.)

 For the station below, the following records were ignored:

 FINISHED PROCESSING STATION:  06043500       USGS Gallatin River near Gallatin


 For the station below, the following records were ignored:

 FINISHED PROCESSING STATION:
```

```
1
  Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.002.000
  Version 7.1         Annual peak flow frequency analysis      Run Date / Time
  3/14/2014                                                    02/13/2015 13:38

                        --- PROCESSING OPTIONS ---

                      Plot option         = None
                      Basin char output   = None
                      Print option        = Yes
                      Debug print         = No
                      Input peaks listing = Long
                      Input peaks format  = WATSTORE peak file

                      Input files used:
                         peaks (ascii)  -
C:\rja\PeakFQ\data\6043500GALLATINRIVERGALLATINGATEWAY2013.TXT
                         specifications - C:\rja\PeakFQ\data\PKFQWPSF.TMP

                      Output file(s):
                         main -
C:\rja\PeakFQ\data\6043500GALLATINRIVERGALLATINGATEWAY2013.PRT

1


  Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.001.001
  Version 7.1         Annual peak flow frequency analysis      Run Date / Time
  3/14/2014                                                    02/13/2015 13:38

         Station - 06043500  Gallatin River near Gallatin Gateway MT


                    I N P U T   D A T A   S U M M A R Y

               Number of peaks in record            =      100
               Peaks not used in analysis           =        0
               Systematic peaks in analysis         =      100
               Historic peaks in analysis           =        0
               Beginning Year                       =     1890
               Ending Year                          =     2013
               Historical Period Length             =        0
               Generalized skew                     =    0.023
                    Standard error                  =    0.640
                    Mean Square error               =    0.410
               Skew option                          =   WEIGHTED
               Gage base discharge                  =      0.0
               User supplied high outlier threshold =   --
               User supplied PILF (LO) criterion    =   --
               Plotting position parameter          =     0.00
               Type of analysis                       BULL.17B
               PILF (LO) Test Method                      GBT
               Perception Thresholds            =   Not Applicable
               Interval Data                    =   Not Applicable


  *********  NOTICE  --  Preliminary machine computations.        *********
  *********  User responsible for assessment and interpretation.  *********

    WCF134I-NO SYSTEMATIC PEAKS WERE BELOW GAGE BASE.                   0.0
    WCF198I-LOW OUTLIERS BELOW FLOOD BASE WERE DROPPED.       1      1948.7
    WCF163I-NO HIGH OUTLIERS OR HISTORIC PEAKS EXCEEDED HHBASE.     13141.1
```

6043500GALLATINRIVERGALLATINGATEWAY2013_84pctConfInterval.PRT

Kendall's Tau Parameters

	TAU	P-VALUE	MEDIAN SLOPE	No. of PEAKS
SYSTEMATIC RECORD	-0.024	0.723	-2.275	100

1

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.001.002
Version 7.1 Annual peak flow frequency analysis Run Date / Time
3/14/2014 02/13/2015 13:38

Station - 06043500 Gallatin River near Gallatin Gateway MT

ANNUAL FREQUENCY CURVE PARAMETERS -- LOG-PEARSON TYPE III

	FLOOD BASE		LOGARITHMIC		
	DISCHARGE	EXCEEDANCE PROBABILITY	MEAN	STANDARD DEVIATION	SKEW
SYSTEMATIC RECORD	0.0	1.0000	3.7136	0.1405	-0.499
BULL.17B ESTIMATE	1948.7	0.9900	3.7166	0.1333	-0.204

BULL.17B ESTIMATE OF MSE OF AT-SITE SKEW 0.0648

ANNUAL FREQUENCY CURVE -- DISCHARGES AT SELECTED EXCEEDANCE PROBABILITIES

ANNUAL EXCEEDANCE PROBABILITY	BULL.17B ESTIMATE	SYSTEMATIC RECORD	<-- FOR BULLETIN 17B ESTIMATES --> VARIANCE OF EST.	84% CONFIDENCE INTERVALS LOWER	UPPER
0.9950		1934.	--	--	--
0.9900		2169.	--	--	--
0.9500	3090.	2913.	----	2937.0	3233.0
0.9000	3493.	3371.	----	3343.0	3634.0
0.8000	4036.	3982.	----	3890.0	4177.0
0.6667	4603.	4606.	----	4456.0	4749.0
0.5000	5262.	5312.	----	5104.0	5426.0
0.4292	5556.	5619.	----	5388.0	5733.0
0.2000	6760.	6823.	----	6531.0	7016.0
0.1000	7662.	7665.	----	7368.0	7999.0
0.0400	8719.	8587.	----	8334.0	9169.0
0.0200	9456.	9191.	----	9001.0	9993.0
0.0100	10160.	9734.	----	9631.0	10780.0
0.0050	10830.	10230.	----	10230.0	11540.0
0.0020	11680.	10830.	----	10990.0	12520.0

1

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.001.003
Version 7.1 Annual peak flow frequency analysis Run Date / Time
3/14/2014 02/13/2015 13:38

Station - 06043500 Gallatin River near Gallatin Gateway MT

I N P U T D A T A L I S T I N G

WATER YEAR	PEAK VALUE	PEAKFQ CODES	REMARKS
1890	3800.0		
1891	2980.0		
1892	8060.0		
1893	6800.0		
1894	8060.0		
1896	8700.0		
1897	5780.0		
1898	7230.0		
1899	10000.0		
1900	5410.0		
1901	7810.0		
1902	5570.0		
1903	5330.0		
1904	5780.0		
1905	2700.0		
1912	5860.0		
1913	6940.0		
1921	6390.0		
1922	7460.0		
1923	5120.0		
1931	2940.0		
1932	5780.0		
1933	4270.0		
1934	1740.0		
1935	4340.0		
1936	3660.0		
1937	3120.0		
1938	4550.0		
1939	3170.0		
1940	3660.0		
1941	2820.0		
1942	6050.0		
1943	6480.0		
1944	3600.0		
1945	4450.0		
1946	4360.0		
1947	5250.0		
1948	6740.0		
1949	4110.0		
1950	5030.0		
1951	3940.0		
1952	6910.0		
1953	6010.0		
1954	3790.0		
1955	4480.0		
1956	7030.0		
1957	5970.0		
1958	5010.0		
1959	7230.0		
1960	4940.0		
1961	3670.0		
1962	4780.0		
1963	4800.0		
1964	6450.0		
1965	7010.0		
1966	4530.0		

1967	5960.0
1968	6570.0
1969	5350.0
1970	7600.0
1971	7610.0
1972	6030.0
1973	6500.0
1974	9100.0
1975	7950.0
1976	5870.0
1977	3370.0
1978	5230.0
1979	4730.0
1980	4150.0
1981	5920.0
1985	3650.0
1986	6830.0
1987	2390.0
1988	4340.0
1989	4280.0
1990	5140.0
1991	7640.0
1992	3660.0
1993	5740.0
1994	4110.0
1995	7330.0
1996	7010.0
1997	9160.0
1998	5400.0
1999	4990.0
2000	4070.0
2001	3740.0
2002	5260.0
2003	6710.0
2004	3810.0
2005	4220.0
2006	5550.0
2007	3350.0
2008	6010.0
2009	5500.0
2010	5360.0
2011	8410.0
2012	5220.0
2013	3950.0

Explanation of peak discharge qualification codes

PeakFQ CODE	NWIS CODE	DEFINITION
D	3	Dam failure, non-recurrent flow anomaly
G	8	Discharge greater than stated value
X	3+8	Both of the above
L	4	Discharge less than stated value
K	6 OR C	Known effect of regulation or urbanization
H	7	Historic peak

- Minus-flagged discharge -- Not used in computation
  -8888.0 -- No discharge value given
- Minus-flagged water year -- Historic peak used in computation

1

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.001.004
Version 7.1 Annual peak flow frequency analysis Run Date / Time
3/14/2014 02/13/2015 13:38

Station - 06043500 Gallatin River near Gallatin Gateway MT

EMPIRICAL FREQUENCY CURVES -- WEIBULL PLOTTING POSITIONS

WATER YEAR	RANKED DISCHARGE	SYSTEMATIC RECORD	B17B ESTIMATE
1899	10000.0	0.0099	0.0099
1997	9160.0	0.0198	0.0198
1974	9100.0	0.0297	0.0297
1896	8700.0	0.0396	0.0396
2011	8410.0	0.0495	0.0495
1892	8060.0	0.0594	0.0594
1894	8060.0	0.0693	0.0693
1975	7950.0	0.0792	0.0792
1901	7810.0	0.0891	0.0891
1991	7640.0	0.0990	0.0990
1971	7610.0	0.1089	0.1089
1970	7600.0	0.1188	0.1188
1922	7460.0	0.1287	0.1287
1995	7330.0	0.1386	0.1386
1898	7230.0	0.1485	0.1485
1959	7230.0	0.1584	0.1584
1956	7030.0	0.1683	0.1683
1965	7010.0	0.1782	0.1782
1996	7010.0	0.1881	0.1881
1913	6940.0	0.1980	0.1980
1952	6910.0	0.2079	0.2079
1986	6830.0	0.2178	0.2178
1893	6800.0	0.2277	0.2277
1948	6740.0	0.2376	0.2376
2003	6710.0	0.2475	0.2475
1968	6570.0	0.2574	0.2574
1973	6500.0	0.2673	0.2673
1943	6480.0	0.2772	0.2772
1964	6450.0	0.2871	0.2871
1921	6390.0	0.2970	0.2970
1942	6050.0	0.3069	0.3069
1972	6030.0	0.3168	0.3168
1953	6010.0	0.3267	0.3267
2008	6010.0	0.3366	0.3366
1957	5970.0	0.3465	0.3465
1967	5960.0	0.3564	0.3564
1981	5920.0	0.3663	0.3663
1976	5870.0	0.3762	0.3762
1912	5860.0	0.3861	0.3861
1897	5780.0	0.3960	0.3960
1904	5780.0	0.4059	0.4059
1932	5780.0	0.4158	0.4158
1993	5740.0	0.4257	0.4257
1902	5570.0	0.4356	0.4356
2006	5550.0	0.4455	0.4455
2009	5500.0	0.4554	0.4554
1900	5410.0	0.4653	0.4653
1998	5400.0	0.4752	0.4752

2010	5360.0	0.4851	0.4851
1969	5350.0	0.4950	0.4950
1903	5330.0	0.5050	0.5050
2002	5260.0	0.5149	0.5149
1947	5250.0	0.5248	0.5248
1978	5230.0	0.5347	0.5347
2012	5220.0	0.5446	0.5446
1990	5140.0	0.5545	0.5545
1923	5120.0	0.5644	0.5644
1950	5030.0	0.5743	0.5743
1958	5010.0	0.5842	0.5842
1999	4990.0	0.5941	0.5941
1960	4940.0	0.6040	0.6040
1963	4800.0	0.6139	0.6139
1962	4780.0	0.6238	0.6238
1979	4730.0	0.6337	0.6337
1938	4550.0	0.6436	0.6436
1966	4530.0	0.6535	0.6535
1955	4480.0	0.6634	0.6634
1945	4450.0	0.6733	0.6733
1946	4360.0	0.6832	0.6832
1935	4340.0	0.6931	0.6931
1988	4340.0	0.7030	0.7030
1989	4280.0	0.7129	0.7129
1933	4270.0	0.7228	0.7228
2005	4220.0	0.7327	0.7327
1980	4150.0	0.7426	0.7426
1949	4110.0	0.7525	0.7525
1994	4110.0	0.7624	0.7624
2000	4070.0	0.7723	0.7723
2013	3950.0	0.7822	0.7822
1951	3940.0	0.7921	0.7921
2004	3810.0	0.8020	0.8020
1890	3800.0	0.8119	0.8119
1954	3790.0	0.8218	0.8218
2001	3740.0	0.8317	0.8317
1961	3670.0	0.8416	0.8416
1936	3660.0	0.8515	0.8515
1940	3660.0	0.8614	0.8614
1992	3660.0	0.8713	0.8713
1985	3650.0	0.8812	0.8812
1944	3600.0	0.8911	0.8911
1977	3370.0	0.9010	0.9010
2007	3350.0	0.9109	0.9109
1939	3170.0	0.9208	0.9208
1937	3120.0	0.9307	0.9307
1891	2980.0	0.9406	0.9406
1931	2940.0	0.9505	0.9505
1941	2820.0	0.9604	0.9604
1905	2700.0	0.9703	0.9703
1987	2390.0	0.9802	0.9802
1934	1740.0	0.9901	0.9901

1

```
 End PeakFQ analysis.
   Stations processed :       1
   Number of errors   :       0
   Stations skipped   :       0
   Station years      :     100
```

```
Data records may have been ignored for the stations listed below.
(Card type must be Y, Z, N, H, I, 2, 3, 4,  or *.)
(2, 4, and * records are ignored.)

 For the station below, the following records were ignored:

 FINISHED PROCESSING STATION:  06043500       USGS Gallatin River near Gallatin


 For the station below, the following records were ignored:

 FINISHED PROCESSING STATION:
```

```
Z06052500                       USGS
H06052500       455307111261700303003 1SW100200081795           4086.42
N06052500       Gallatin River at Logan MT
Y06052500
306052500       18950624   4060
306052500       18960618   6550
306052500       18970526   6460
306052500       18980619   7300
306052500       18990621   9840
306052500       19000528   4850
306052500       19020611   4430
306052500       19030614   4500
306052500       19040524   5400
306052500       19050609   3090
306052500       19290617   4970                6.60
306052500       19300531   2820                5.36
306052500       19310603   2970                5.46
306052500       19320616   4570                6.42
306052500       19330613   3700                5.94
306052500       19350614   3990                6.10
306052500       19360515   4370                6.30
306052500       19370617   3650                5.95
306052500       19380530   5590                6.90
306052500       19390506   2790                5.40
306052500       19400614   3500                5.92
306052500       19410606   1990                4.80
306052500       19420609   5940                7.10
306052500       19430620   6160                7.50
306052500       19440627   4820                6.68
306052500       19450624   3500                5.83
306052500       19460606   3730                6.04
306052500       19470621   6160                7.46
306052500       19480605   7870                8.40
306052500       19490518   3900                6.26
306052500       19500622   3940                6.29
306052500       19510525   4140                6.41
306052500       19520607   6640                7.78
306052500       19530614   5930                7.34
306052500       19540628   3380                5.74
306052500       19550616   4050                6.18
306052500       19560529   7190                7.97
306052500       19570609   4990                6.79
306052500       19580526   3620                5.90
306052500       19590615   6120                7.65
306052500       19600513   4320                6.34
306052500       19610530   2160                4.88
306052500       19620615   4830                6.64
306052500       19630615   4750                6.56
306052500       19640608   6290
306052500       19650626   6100
306052500       19660531   3460
306052500       19670623   6950
306052500       19680614   7280                7.97
306052500       19690611   5200                7.18
306052500       19700610   9390                9.03
306052500       19710628   8480                8.74
306052500       19720608   5130                7.13
306052500       19730610   5550                7.41
306052500       19740618   9170                9.02
306052500       19750704   7770                8.44
306052500       19760623   6660                7.93
306052500       19770611   2620                5.57
306052500       19780610   4970                7.05
```

306052500	19790529	4300	
306052500	19800525	4550	6.87
306052500	19810523	7380	8.47
306052500	19820629	7160	8.16
306052500	19830612	6390	7.89
306052500	19840516	7050	8.12
306052500	19850504	3710	6.61
306052500	19860602	6700	
306052500	19870529	2100	5.59
306052500	19880517	3980	6.96
306052500	19890617	3740	6.69
306052500	19900611	4370	7.30
306052500	19910606	8120	9.06
306052500	19920618	4310	7.33
306052500	19930522	6410	8.30
306052500	19940513	3410	6.64
306052500	19950606	7220	8.67
306052500	19960610	7310	8.71
306052500	19970608	9400	9.80
306052500	19980626	6270	8.30

```
Z06052500                       USGS
H06052500       455307111261700303003 1SW100200081795           4086.42
N06052500       Gallatin River at Logan MT
Y06052500
306052500       18950624   4060
306052500       18960618   6550
306052500       18970526   6460
306052500       18980619   7300
306052500       18990621   9840
306052500       19000528   4850
306052500       19020611   4430
306052500       19030614   4500
306052500       19040524   5400
306052500       19050609   3090
306052500       19290617   4970                6.60
306052500       19300531   2820                5.36
306052500       19310603   2970                5.46
306052500       19320616   4570                6.42
306052500       19330613   3700                5.94
306052500       19350614   3990                6.10
306052500       19360515   4370                6.30
306052500       19370617   3650                5.95
306052500       19380530   5590                6.90
306052500       19390506   2790                5.40
306052500       19400614   3500                5.92
306052500       19410606   1990                4.80
306052500       19420609   5940                7.10
306052500       19430620   6160                7.50
306052500       19440627   4820                6.68
306052500       19450624   3500                5.83
306052500       19460606   3730                6.04
306052500       19470621   6160                7.46
306052500       19480605   7870                8.40
306052500       19490518   3900                6.26
306052500       19500622   3940                6.29
306052500       19510525   4140                6.41
306052500       19520607   6640                7.78
306052500       19530614   5930                7.34
306052500       19540628   3380                5.74
306052500       19550616   4050                6.18
306052500       19560529   7190                7.97
306052500       19570609   4990                6.79
306052500       19580526   3620                5.90
306052500       19590615   6120                7.65
306052500       19600513   4320                6.34
306052500       19610530   2160                4.88
306052500       19620615   4830                6.64
306052500       19630615   4750                6.56
306052500       19640608   6290
306052500       19650626   6100
306052500       19660531   3460
306052500       19670623   6950
306052500       19680614   7280                7.97
306052500       19690611   5200                7.18
306052500       19700610   9390                9.03
306052500       19710628   8480                8.74
306052500       19720608   5130                7.13
306052500       19730610   5550                7.41
306052500       19740618   9170                9.02
306052500       19750704   7770                8.44
306052500       19760623   6660                7.93
306052500       19770611   2620                5.57
306052500       19780610   4970                7.05
```

306052500	19790529	4300	
306052500	19800525	4550	6.87
306052500	19810523	7380	8.47
306052500	19820629	7160	8.16
306052500	19830612	6390	7.89
306052500	19840516	7050	8.12
306052500	19850504	3710	6.61
306052500	19860602	6700	
306052500	19870529	2100	5.59
306052500	19880517	3980	6.96
306052500	19890617	3740	6.69
306052500	19900611	4370	7.30
306052500	19910606	8120	9.06
306052500	19920618	4310	7.33
306052500	19930522	6410	8.30
306052500	19940513	3410	6.64
306052500	19950606	7220	8.67
306052500	19960610	7310	8.71
306052500	19970608	9400	9.80
306052500	19980626	6270	8.30
306052500	19990530	5600	8.11
306052500	20000529	3930	7.10
306052500	20010515	2610	6.26
306052500	20020603	5580	8.11
306052500	20030530	5830	8.24
306052500	20040611	3700	7.02
306052500	20050618	4050	7.14
306052500	20060610	5010	7.68
306052500	20070607	3720	3.49
306052500	20080623	6270	8.59
306052500	20090601	5580	8.09
306052500	20100605	6110	8.52
306052500	20110630	7980	9.35
306052500	20120605	4990	8.05
306052500	20130614	4010	7.46

06052500GALLATINRIVERATLOGAN1998.PRT

1

```
  Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.002.000
  Version 7.1         Annual peak flow frequency analysis      Run Date / Time
  3/14/2014                                                    12/24/2014 10:31

                        --- PROCESSING OPTIONS ---

                     Plot option         = None
                     Basin char output   = None
                     Print option        = Yes
                     Debug print         = No
                     Input peaks listing = Long
                     Input peaks format  = WATSTORE peak file

                     Input files used:
                        peaks (ascii)  -
C:\rja\PeakFQ\data\06052500GALLATINRIVERATLOGAN1998.TXT
                        specifications - C:\rja\PeakFQ\data\PKFQWPSF.TMP

                     Output file(s):
                        main -
C:\rja\PeakFQ\data\06052500GALLATINRIVERATLOGAN1998.PRT
```

1

```
  Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.001.001
  Version 7.1         Annual peak flow frequency analysis      Run Date / Time
  3/14/2014                                                    12/24/2014 10:31

                Station - 06052500  Gallatin River at Logan MT


                    I N P U T   D A T A   S U M M A R Y

               Number of peaks in record            =       79
               Peaks not used in analysis           =        0
               Systematic peaks in analysis         =       79
               Historic peaks in analysis           =        0
               Beginning Year                       =     1895
               Ending Year                          =     1998
               Historical Period Length             =        0
               Generalized skew                     =    0.098
                    Standard error                  =    0.640
                    Mean Square error               =    0.410
               Skew option                          =   WEIGHTED
               Gage base discharge                  =      0.0
               User supplied high outlier threshold =   --
               User supplied PILF (LO) criterion    =   --
               Plotting position parameter          =     0.00
               Type of analysis                       BULL.17B
               PILF (LO) Test Method                      GBT
               Perception Thresholds            =   Not Applicable
               Interval Data                    =   Not Applicable


  *********  NOTICE  --  Preliminary machine computations.        *********
  *********  User responsible for assessment and interpretation.  *********

    WCF134I-NO SYSTEMATIC PEAKS WERE BELOW GAGE BASE.                   0.0
    WCF195I-NO LOW OUTLIERS WERE DETECTED BELOW CRITERION.           1718.5
    WCF163I-NO HIGH OUTLIERS OR HISTORIC PEAKS EXCEEDED HHBASE.     14417.9
```

06052500GALLATINRIVERATLOGAN1998.PRT

Kendall's Tau Parameters

	TAU	P-VALUE	MEDIAN SLOPE	No. of PEAKS
SYSTEMATIC RECORD	0.163	0.034	20.385	79

1

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.001.002
Version 7.1 Annual peak flow frequency analysis Run Date / Time
3/14/2014 12/24/2014 10:31

Station - 06052500 Gallatin River at Logan MT

ANNUAL FREQUENCY CURVE PARAMETERS -- LOG-PEARSON TYPE III

	FLOOD BASE		LOGARITHMIC		
	DISCHARGE	EXCEEDANCE PROBABILITY	MEAN	STANDARD DEVIATION	SKEW
SYSTEMATIC RECORD	0.0	1.0000	3.6970	0.1574	-0.330
BULL.17B ESTIMATE	0.0	1.0000	3.6970	0.1574	-0.256

BULL.17B ESTIMATE OF MSE OF AT-SITE SKEW 0.0850

ANNUAL FREQUENCY CURVE -- DISCHARGES AT SELECTED EXCEEDANCE PROBABILITIES

ANNUAL EXCEEDANCE PROBABILITY	BULL.17B ESTIMATE	SYSTEMATIC RECORD	<-- FOR BULLETIN 17B ESTIMATES --> VARIANCE OF EST.	95% CONFIDENCE INTERVALS LOWER	UPPER
0.9950	1794.	1750.	----	1513.0	2053.0
0.9900	2003.	1965.	----	1714.0	2266.0
0.9500	2674.	2656.	----	2376.0	2945.0
0.9000	3101.	3095.	----	2803.0	3374.0
0.8000	3689.	3696.	----	3392.0	3970.0
0.6667	4314.	4331.	----	4011.0	4617.0
0.5000	5055.	5078.	----	4726.0	5411.0
0.4292	5389.	5412.	----	5039.0	5779.0
0.2000	6777.	6782.	----	6295.0	7377.0
0.1000	7832.	7804.	----	7209.0	8647.0
0.0400	9082.	8992.	----	8262.0	10200.0
0.0200	9959.	9812.	----	8986.0	11310.0
0.0100	10800.	10580.	----	9669.0	12390.0
0.0050	11600.	11320.	----	10320.0	13440.0
0.0020	12630.	12230.	----	11140.0	14800.0

1

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.001.003
Version 7.1 Annual peak flow frequency analysis Run Date / Time
3/14/2014 12/24/2014 10:31

Station - 06052500 Gallatin River at Logan MT

I N P U T D A T A L I S T I N G

WATER YEAR	PEAK VALUE	PEAKFQ CODES	REMARKS
1895	4060.0		
1896	6550.0		
1897	6460.0		
1898	7300.0		
1899	9840.0		
1900	4850.0		
1902	4430.0		
1903	4500.0		
1904	5400.0		
1905	3090.0		
1929	4970.0		
1930	2820.0		
1931	2970.0		
1932	4570.0		
1933	3700.0		
1935	3990.0		
1936	4370.0		
1937	3650.0		
1938	5590.0		
1939	2790.0		
1940	3500.0		
1941	1990.0		
1942	5940.0		
1943	6160.0		
1944	4820.0		
1945	3500.0		
1946	3730.0		
1947	6160.0		
1948	7870.0		
1949	3900.0		
1950	3940.0		
1951	4140.0		
1952	6640.0		
1953	5930.0		
1954	3380.0		
1955	4050.0		
1956	7190.0		
1957	4990.0		
1958	3620.0		
1959	6120.0		
1960	4320.0		
1961	2160.0		
1962	4830.0		
1963	4750.0		
1964	6290.0		
1965	6100.0		
1966	3460.0		
1967	6950.0		
1968	7280.0		
1969	5200.0		
1970	9390.0		
1971	8480.0		
1972	5130.0		
1973	5550.0		
1974	9170.0		
1975	7770.0		

1976	6660.0
1977	2620.0
1978	4970.0
1979	4300.0
1980	4550.0
1981	7380.0
1982	7160.0
1983	6390.0
1984	7050.0
1985	3710.0
1986	6700.0
1987	2100.0
1988	3980.0
1989	3740.0
1990	4370.0
1991	8120.0
1992	4310.0
1993	6410.0
1994	3410.0
1995	7220.0
1996	7310.0
1997	9400.0
1998	6270.0

Explanation of peak discharge qualification codes

PeakFQ CODE	NWIS CODE	DEFINITION
D	3	Dam failure, non-recurrent flow anomaly
G	8	Discharge greater than stated value
X	3+8	Both of the above
L	4	Discharge less than stated value
K	6 OR C	Known effect of regulation or urbanization
H	7	Historic peak

- Minus-flagged discharge -- Not used in computation
  -8888.0 -- No discharge value given
- Minus-flagged water year -- Historic peak used in computation

1

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.001.004
Version 7.1 Annual peak flow frequency analysis Run Date / Time
3/14/2014 12/24/2014 10:31

Station - 06052500 Gallatin River at Logan MT

EMPIRICAL FREQUENCY CURVES -- WEIBULL PLOTTING POSITIONS

WATER YEAR	RANKED DISCHARGE	SYSTEMATIC RECORD	B17B ESTIMATE
1899	9840.0	0.0125	0.0125
1997	9400.0	0.0250	0.0250
1970	9390.0	0.0375	0.0375
1974	9170.0	0.0500	0.0500
1971	8480.0	0.0625	0.0625
1991	8120.0	0.0750	0.0750

1948	7870.0	0.0875	0.0875
1975	7770.0	0.1000	0.1000
1981	7380.0	0.1125	0.1125
1996	7310.0	0.1250	0.1250
1898	7300.0	0.1375	0.1375
1968	7280.0	0.1500	0.1500
1995	7220.0	0.1625	0.1625
1956	7190.0	0.1750	0.1750
1982	7160.0	0.1875	0.1875
1984	7050.0	0.2000	0.2000
1967	6950.0	0.2125	0.2125
1986	6700.0	0.2250	0.2250
1976	6660.0	0.2375	0.2375
1952	6640.0	0.2500	0.2500
1896	6550.0	0.2625	0.2625
1897	6460.0	0.2750	0.2750
1993	6410.0	0.2875	0.2875
1983	6390.0	0.3000	0.3000
1964	6290.0	0.3125	0.3125
1998	6270.0	0.3250	0.3250
1943	6160.0	0.3375	0.3375
1947	6160.0	0.3500	0.3500
1959	6120.0	0.3625	0.3625
1965	6100.0	0.3750	0.3750
1942	5940.0	0.3875	0.3875
1953	5930.0	0.4000	0.4000
1938	5590.0	0.4125	0.4125
1973	5550.0	0.4250	0.4250
1904	5400.0	0.4375	0.4375
1969	5200.0	0.4500	0.4500
1972	5130.0	0.4625	0.4625
1957	4990.0	0.4750	0.4750
1929	4970.0	0.4875	0.4875
1978	4970.0	0.5000	0.5000
1900	4850.0	0.5125	0.5125
1962	4830.0	0.5250	0.5250
1944	4820.0	0.5375	0.5375
1963	4750.0	0.5500	0.5500
1932	4570.0	0.5625	0.5625
1980	4550.0	0.5750	0.5750
1903	4500.0	0.5875	0.5875
1902	4430.0	0.6000	0.6000
1936	4370.0	0.6125	0.6125
1990	4370.0	0.6250	0.6250
1960	4320.0	0.6375	0.6375
1992	4310.0	0.6500	0.6500
1979	4300.0	0.6625	0.6625
1951	4140.0	0.6750	0.6750
1895	4060.0	0.6875	0.6875
1955	4050.0	0.7000	0.7000
1935	3990.0	0.7125	0.7125
1988	3980.0	0.7250	0.7250
1950	3940.0	0.7375	0.7375
1949	3900.0	0.7500	0.7500
1989	3740.0	0.7625	0.7625
1946	3730.0	0.7750	0.7750
1985	3710.0	0.7875	0.7875
1933	3700.0	0.8000	0.8000
1937	3650.0	0.8125	0.8125
1958	3620.0	0.8250	0.8250
1940	3500.0	0.8375	0.8375
1945	3500.0	0.8500	0.8500
1966	3460.0	0.8625	0.8625

```
    1994     3410.0     0.8750      0.8750
    1954     3380.0     0.8875      0.8875
    1905     3090.0     0.9000      0.9000
    1931     2970.0     0.9125      0.9125
    1930     2820.0     0.9250      0.9250
    1939     2790.0     0.9375      0.9375
    1977     2620.0     0.9500      0.9500
    1961     2160.0     0.9625      0.9625
    1987     2100.0     0.9750      0.9750
    1941     1990.0     0.9875      0.9875
1


 End PeakFQ analysis.
   Stations processed :       1
   Number of errors   :       0
   Stations skipped   :       0
   Station years      :      79


Data records may have been ignored for the stations listed below.
(Card type must be Y, Z, N, H, I, 2, 3, 4,  or *.)
(2, 4, and * records are ignored.)

 For the station below, the following records were ignored:

 FINISHED PROCESSING STATION:  06052500       USGS Gallatin River at Logan MT


 For the station below, the following records were ignored:

 FINISHED PROCESSING STATION:
```

```
1
  Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.002.000
  Version 7.1         Annual peak flow frequency analysis      Run Date / Time
  3/14/2014                                                    02/13/2015 13:41

                         --- PROCESSING OPTIONS ---

                      Plot option         = None
                      Basin char output   = None
                      Print option        = Yes
                      Debug print         = No
                      Input peaks listing = Long
                      Input peaks format  = WATSTORE peak file

                      Input files used:
                         peaks (ascii)  -
C:\rja\PeakFQ\data\06052500GALLATINRIVERATLOGAN2013.TXT
                         specifications - C:\rja\PeakFQ\data\PKFQWPSF.TMP

                      Output file(s):
                         main -
C:\rja\PeakFQ\data\06052500GALLATINRIVERATLOGAN2013.PRT

1


  Program PeakFq           U. S. GEOLOGICAL SURVEY             Seq.001.001
  Version 7.1         Annual peak flow frequency analysis      Run Date / Time
  3/14/2014                                                    02/13/2015 13:41

                 Station - 06052500  Gallatin River at Logan MT


                     I N P U T   D A T A   S U M M A R Y

               Number of peaks in record            =       94
               Peaks not used in analysis           =        0
               Systematic peaks in analysis         =       94
               Historic peaks in analysis           =        0
               Beginning Year                       =     1895
               Ending Year                          =     2013
               Historical Period Length             =        0
               Generalized skew                     =    0.098
                    Standard error                  =    0.640
                    Mean Square error               =    0.410
               Skew option                          =   WEIGHTED
               Gage base discharge                  =      0.0
               User supplied high outlier threshold =   --
               User supplied PILF (LO) criterion    =   --
               Plotting position parameter          =     0.00
               Type of analysis                       BULL.17B
               PILF (LO) Test Method                      GBT
               Perception Thresholds            =   Not Applicable
               Interval Data                    =   Not Applicable


  *********  NOTICE  --  Preliminary machine computations.        *********
  *********  User responsible for assessment and interpretation.  *********

    WCF134I-NO SYSTEMATIC PEAKS WERE BELOW GAGE BASE.                   0.0
    WCF195I-NO LOW OUTLIERS WERE DETECTED BELOW CRITERION.           1738.4
    WCF163I-NO HIGH OUTLIERS OR HISTORIC PEAKS EXCEEDED HHBASE.     14110.4
```

06052500GALLATINRIVERATLOGAN2013_84pctConfInt.PRT

Kendall's Tau Parameters

	TAU	P-VALUE	MEDIAN SLOPE	No. of PEAKS
SYSTEMATIC RECORD	0.099	0.157	9.714	94

1

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.001.002
Version 7.1 Annual peak flow frequency analysis Run Date / Time
3/14/2014 02/13/2015 13:41

Station - 06052500 Gallatin River at Logan MT

ANNUAL FREQUENCY CURVE PARAMETERS -- LOG-PEARSON TYPE III

	FLOOD BASE		LOGARITHMIC		
	DISCHARGE	EXCEEDANCE PROBABILITY	MEAN	STANDARD DEVIATION	SKEW
SYSTEMATIC RECORD	0.0	1.0000	3.6948	0.1518	-0.319
BULL.17B ESTIMATE	0.0	1.0000	3.6948	0.1518	-0.256

BULL.17B ESTIMATE OF MSE OF AT-SITE SKEW 0.0727

ANNUAL FREQUENCY CURVE -- DISCHARGES AT SELECTED EXCEEDANCE PROBABILITIES

ANNUAL EXCEEDANCE PROBABILITY	BULL.17B ESTIMATE	SYSTEMATIC RECORD	<-- FOR BULLETIN 17B ESTIMATES --> VARIANCE OF EST.	84% CONFIDENCE INTERVALS LOWER	UPPER
0.9950	1852.	1814.	----	1699.0	1996.0
0.9900	2058.	2026.	----	1903.0	2205.0
0.9500	2721.	2705.	----	2562.0	2870.0
0.9000	3138.	3133.	----	2981.0	3288.0
0.8000	3710.	3716.	----	3553.0	3862.0
0.6667	4315.	4329.	----	4154.0	4476.0
0.5000	5027.	5046.	----	4850.0	5212.0
0.4292	5347.	5365.	----	5158.0	5547.0
0.2000	6670.	6674.	----	6405.0	6967.0
0.1000	7668.	7646.	----	7325.0	8066.0
0.0400	8845.	8773.	----	8392.0	9380.0
0.0200	9667.	9550.	----	9130.0	10310.0
0.0100	10450.	10280.	----	9826.0	11200.0
0.0050	11200.	10970.	----	10490.0	12060.0
0.0020	12160.	11840.	----	11330.0	13170.0

1

Program PeakFq U. S. GEOLOGICAL SURVEY Seq.001.003
Version 7.1 Annual peak flow frequency analysis Run Date / Time
3/14/2014 02/13/2015 13:41

Station - 06052500 Gallatin River at Logan MT

I N P U T D A T A L I S T I N G

WATER YEAR	PEAK VALUE	PEAKFQ CODES	REMARKS
1895	4060.0		
1896	6550.0		
1897	6460.0		
1898	7300.0		
1899	9840.0		
1900	4850.0		
1902	4430.0		
1903	4500.0		
1904	5400.0		
1905	3090.0		
1929	4970.0		
1930	2820.0		
1931	2970.0		
1932	4570.0		
1933	3700.0		
1935	3990.0		
1936	4370.0		
1937	3650.0		
1938	5590.0		
1939	2790.0		
1940	3500.0		
1941	1990.0		
1942	5940.0		
1943	6160.0		
1944	4820.0		
1945	3500.0		
1946	3730.0		
1947	6160.0		
1948	7870.0		
1949	3900.0		
1950	3940.0		
1951	4140.0		
1952	6640.0		
1953	5930.0		
1954	3380.0		
1955	4050.0		
1956	7190.0		
1957	4990.0		
1958	3620.0		
1959	6120.0		
1960	4320.0		
1961	2160.0		
1962	4830.0		
1963	4750.0		
1964	6290.0		
1965	6100.0		
1966	3460.0		
1967	6950.0		
1968	7280.0		
1969	5200.0		
1970	9390.0		
1971	8480.0		
1972	5130.0		
1973	5550.0		
1974	9170.0		
1975	7770.0		

1976	6660.0
1977	2620.0
1978	4970.0
1979	4300.0
1980	4550.0
1981	7380.0
1982	7160.0
1983	6390.0
1984	7050.0
1985	3710.0
1986	6700.0
1987	2100.0
1988	3980.0
1989	3740.0
1990	4370.0
1991	8120.0
1992	4310.0
1993	6410.0
1994	3410.0
1995	7220.0
1996	7310.0
1997	9400.0
1998	6270.0
1999	5600.0
2000	3930.0
2001	2610.0
2002	5580.0
2003	5830.0
2004	3700.0
2005	4050.0
2006	5010.0
2007	3720.0
2008	6270.0
2009	5580.0
2010	6110.0
2011	7980.0
2012	4990.0
2013	4010.0

Explanation of peak discharge qualification codes

PeakFQ CODE	NWIS CODE	DEFINITION
D	3	Dam failure, non-recurrent flow anomaly
G	8	Discharge greater than stated value
X	3+8	Both of the above
L	4	Discharge less than stated value
K	6 OR C	Known effect of regulation or urbanization
H	7	Historic peak

- Minus-flagged discharge -- Not used in computation
  -8888.0 -- No discharge value given
- Minus-flagged water year -- Historic peak used in computation

1

Station - 06052500 Gallatin River at Logan MT

EMPIRICAL FREQUENCY CURVES -- WEIBULL PLOTTING POSITIONS

WATER YEAR	RANKED DISCHARGE	SYSTEMATIC RECORD	B17B ESTIMATE
1899	9840.0	0.0105	0.0105
1997	9400.0	0.0211	0.0211
1970	9390.0	0.0316	0.0316
1974	9170.0	0.0421	0.0421
1971	8480.0	0.0526	0.0526
1991	8120.0	0.0632	0.0632
2011	7980.0	0.0737	0.0737
1948	7870.0	0.0842	0.0842
1975	7770.0	0.0947	0.0947
1981	7380.0	0.1053	0.1053
1996	7310.0	0.1158	0.1158
1898	7300.0	0.1263	0.1263
1968	7280.0	0.1368	0.1368
1995	7220.0	0.1474	0.1474
1956	7190.0	0.1579	0.1579
1982	7160.0	0.1684	0.1684
1984	7050.0	0.1789	0.1789
1967	6950.0	0.1895	0.1895
1986	6700.0	0.2000	0.2000
1976	6660.0	0.2105	0.2105
1952	6640.0	0.2211	0.2211
1896	6550.0	0.2316	0.2316
1897	6460.0	0.2421	0.2421
1993	6410.0	0.2526	0.2526
1983	6390.0	0.2632	0.2632
1964	6290.0	0.2737	0.2737
1998	6270.0	0.2842	0.2842
2008	6270.0	0.2947	0.2947
1943	6160.0	0.3053	0.3053
1947	6160.0	0.3158	0.3158
1959	6120.0	0.3263	0.3263
2010	6110.0	0.3368	0.3368
1965	6100.0	0.3474	0.3474
1942	5940.0	0.3579	0.3579
1953	5930.0	0.3684	0.3684
2003	5830.0	0.3789	0.3789
1999	5600.0	0.3895	0.3895
1938	5590.0	0.4000	0.4000
2002	5580.0	0.4105	0.4105
2009	5580.0	0.4211	0.4211
1973	5550.0	0.4316	0.4316
1904	5400.0	0.4421	0.4421
1969	5200.0	0.4526	0.4526
1972	5130.0	0.4632	0.4632
2006	5010.0	0.4737	0.4737
1957	4990.0	0.4842	0.4842
2012	4990.0	0.4947	0.4947
1929	4970.0	0.5053	0.5053
1978	4970.0	0.5158	0.5158
1900	4850.0	0.5263	0.5263
1962	4830.0	0.5368	0.5368
1944	4820.0	0.5474	0.5474
1963	4750.0	0.5579	0.5579
1932	4570.0	0.5684	0.5684

1980	4550.0	0.5789	0.5789
1903	4500.0	0.5895	0.5895
1902	4430.0	0.6000	0.6000
1936	4370.0	0.6105	0.6105
1990	4370.0	0.6211	0.6211
1960	4320.0	0.6316	0.6316
1992	4310.0	0.6421	0.6421
1979	4300.0	0.6526	0.6526
1951	4140.0	0.6632	0.6632
1895	4060.0	0.6737	0.6737
1955	4050.0	0.6842	0.6842
2005	4050.0	0.6947	0.6947
2013	4010.0	0.7053	0.7053
1935	3990.0	0.7158	0.7158
1988	3980.0	0.7263	0.7263
1950	3940.0	0.7368	0.7368
2000	3930.0	0.7474	0.7474
1949	3900.0	0.7579	0.7579
1989	3740.0	0.7684	0.7684
1946	3730.0	0.7789	0.7789
2007	3720.0	0.7895	0.7895
1985	3710.0	0.8000	0.8000
1933	3700.0	0.8105	0.8105
2004	3700.0	0.8211	0.8211
1937	3650.0	0.8316	0.8316
1958	3620.0	0.8421	0.8421
1940	3500.0	0.8526	0.8526
1945	3500.0	0.8632	0.8632
1966	3460.0	0.8737	0.8737
1994	3410.0	0.8842	0.8842
1954	3380.0	0.8947	0.8947
1905	3090.0	0.9053	0.9053
1931	2970.0	0.9158	0.9158
1930	2820.0	0.9263	0.9263
1939	2790.0	0.9368	0.9368
1977	2620.0	0.9474	0.9474
2001	2610.0	0.9579	0.9579
1961	2160.0	0.9684	0.9684
1987	2100.0	0.9789	0.9789
1941	1990.0	0.9895	0.9895

1

```
 End PeakFQ analysis.
   Stations processed :       1
   Number of errors   :       0
   Stations skipped   :       0
   Station years      :      94

Data records may have been ignored for the stations listed below.
(Card type must be Y, Z, N, H, I, 2, 3, 4,  or *.)
(2, 4, and * records are ignored.)

 For the station below, the following records were ignored:

 FINISHED PROCESSING STATION:  06052500       USGS Gallatin River at Logan MT


 For the station below, the following records were ignored:

 FINISHED PROCESSING STATION:
```

USGS Two Gage Interpolation

$$\log Q_{T,U} = \log Q_{T,G1} + [(\log Q_{T,G2} - \log Q_{T,G1})/(\log DA_{G2} - \log DA_{G1})] (\log DA_U - \log DA_{G1})$$

where:

log = base 10 logarithm

$Q_{T,U}$ = T-year flood at a the ungaged site.

$Q_{T,G1}$ = T-year flood at the upstream gaged site.

$Q_{T,G2}$ = T-year flood at the downstream gaged site.

DA_{G1} = Drainage area at the upstream gaged site.

DA_{G2} = Drainage area at the downstream gaged site.

DA_U = Drainage area at the ungaged site.

Upstream Gage

USGS Gage:	06043500
Gage Location:	Gallatin River near Gallatin Gateway, MT

Downstream Gage

USGS Gage:	06052500
Gage Location:	Gallatin River at Logan

DA_{G1} =	818.70	square miles (mi^2)
DA_{G2} =	1789.09	square miles (mi^2)
DA_U =	849.67	square miles (mi^2)

At Upper Project Limit

Stream Gage Flow Rates

Upstream			*Downstream*			*Ungaged Flow Rates*	
$Q_{2,G1}$ =	5,262	cfs	$Q_{2,G2}$ =	5,027	cfs	Q_2 =	5,251 cfs
$Q_{5,G1}$ =	6,760	cfs	$Q_{5,G2}$ =	6,670	cfs	Q_5 =	6,756 cfs
$Q_{10,G1}$ =	7,662	cfs	$Q_{10,G2}$ =	7,668	cfs	Q_{10} =	7,662 cfs
$Q_{25,G1}$ =	8,719	cfs	$Q_{25,G2}$ =	8,845	cfs	Q_{25} =	8,725 cfs
$Q_{50,G1}$ =	9,456	cfs	$Q_{50,G2}$ =	9,667	cfs	Q_{50} =	9,466 cfs
$Q_{100,G1}$ =	10,160	cfs	$Q_{100,G2}$ =	10,450	cfs	Q_{100} =	10,174 cfs
$Q_{100+,G1}$ =	10,780	cfs	$Q_{100+,G2}$ =	11,200	cfs	Q_{100+} =	10,800 cfs
$Q_{200,G1}$ =	10,830	cfs	$Q_{200,G2}$ =	11,200	cfs	Q_{200} =	10,847 cfs
$Q_{500,G1}$ =	11,680	cfs	$Q_{500,G2}$ =	12,160	cfs	Q_{500} =	11,702 cfs

USGS Two Gage Interpolation

$$\log Q_{T,U} = \log Q_{T,G1} + [(\log Q_{T,G2} - \log Q_{T,G1})/(\log DA_{G2} - \log DA_{G1})] (\log DA_U - \log DA_{G1})$$

where:

- log = base 10 logarithm
- $Q_{T,U}$ = T-year flood at a the ungaged site.
- $Q_{T,G1}$ = T-year flood at the upstream gaged site.
- $Q_{T,G2}$ = T-year flood at the downstream gaged site.
- DA_{G1} = Drainage area at the upstream gaged site.
- DA_{G2} = Drainage area at the downstream gaged site.
- DA_U = Drainage area at the ungaged site.

Upstream Gage
USGS Gage: 06043500
Gage Location: Gallatin River near Gallatin Gateway, MT

Downstream Gage
USGS Gage: 06052500
Gage Location: Gallatin River at Logan

DA_{G1} =	818.70	square miles (mi^2)	
DA_{G2} =	1789.09	square miles (mi^2)	
DA_U =	945.70	square miles (mi^2)	*At Sheds Bridge*

Stream Gage Flow Rates

Upstream			*Downstream*			*Ungaged Flow Rates*	
$Q_{2,G1}$ =	5,262	cfs	$Q_{2,G2}$ =	5,027	cfs	Q_2 =	5,218 cfs
$Q_{5,G1}$ =	6,760	cfs	$Q_{5,G2}$ =	6,670	cfs	Q_5 =	6,743 cfs
$Q_{10,G1}$ =	7,662	cfs	$Q_{10,G2}$ =	7,668	cfs	Q_{10} =	7,663 cfs
$Q_{25,G1}$ =	8,719	cfs	$Q_{25,G2}$ =	8,845	cfs	Q_{25} =	8,742 cfs
$Q_{50,G1}$ =	9,456	cfs	$Q_{50,G2}$ =	9,667	cfs	Q_{50} =	9,495 cfs
$Q_{100,G1}$ =	10,160	cfs	$Q_{100,G2}$ =	10,450	cfs	Q_{100} =	10,213 cfs
$Q_{100+,G1}$ =	10,780	cfs	$Q_{100+,G2}$ =	11,200	cfs	Q_{100+} =	10,856 cfs
$Q_{200,G1}$ =	10,830	cfs	$Q_{200,G2}$ =	11,200	cfs	Q_{200} =	10,897 cfs
$Q_{500,G1}$ =	11,680	cfs	$Q_{500,G2}$ =	12,160	cfs	Q_{500} =	11,767 cfs

USGS Two Gage Interpolation

$$\log Q_{T,U} = \log Q_{T,G1} + [(\log Q_{T,G2} - \log Q_{T,G1})/(\log DA_{G2} - \log DA_{G1})] (\log DA_U - \log DA_{G1})$$

where:

- log = base 10 logarithm
- $Q_{T,U}$ = T-year flood at a the ungaged site.
- $Q_{T,G1}$ = T-year flood at the upstream gaged site.
- $Q_{T,G2}$ = T-year flood at the downstream gaged site.
- DA_{G1} = Drainage area at the upstream gaged site.
- DA_{G2} = Drainage area at the downstream gaged site.
- DA_U = Drainage area at the ungaged site.

Upstream Gage
USGS Gage: 06043500
Gage Location: Gallatin River near Gallatin Gateway, MT

Downstream Gage
USGS Gage: 06052500
Gage Location: Gallatin River at Logan

DA_{G1} =	818.70	square miles (mi^2)
DA_{G2} =	1789.09	square miles (mi^2)
DA_U =	1092.10	square miles (mi^2)

At Interstate 90

Stream Gage Flow Rates

Upstream			*Downstream*			*Ungaged Flow Rates*	
$Q_{2,G1}$ =	5,262	cfs	$Q_{2,G2}$ =	5,027	cfs	Q_2 =	5,174 cfs
$Q_{5,G1}$ =	6,760	cfs	$Q_{5,G2}$ =	6,670	cfs	Q_5 =	6,727 cfs
$Q_{10,G1}$ =	7,662	cfs	$Q_{10,G2}$ =	7,668	cfs	Q_{10} =	7,664 cfs
$Q_{25,G1}$ =	8,719	cfs	$Q_{25,G2}$ =	8,845	cfs	Q_{25} =	8,765 cfs
$Q_{50,G1}$ =	9,456	cfs	$Q_{50,G2}$ =	9,667	cfs	Q_{50} =	9,533 cfs
$Q_{100,G1}$ =	10,160	cfs	$Q_{100,G2}$ =	10,450	cfs	Q_{100} =	10,266 cfs
$Q_{100+,G1}$ =	10,780	cfs	$Q_{100+,G2}$ =	11,200	cfs	Q_{100+} =	10,933 cfs
$Q_{200,G1}$ =	10,830	cfs	$Q_{200,G2}$ =	11,200	cfs	Q_{200} =	10,965 cfs
$Q_{500,G1}$ =	11,680	cfs	$Q_{500,G2}$ =	12,160	cfs	Q_{500} =	11,855 cfs

USGS Two Gage Interpolation

$$\log Q_{T,U} = \log Q_{T,G1} + [(\log Q_{T,G2} - \log Q_{T,G1})/(\log DA_{G2} - \log DA_{G1})] (\log DA_U - \log DA_{G1})$$

where:

- log = base 10 logarithm
- $Q_{T,U}$ = T-year flood at a the ungaged site.
- $Q_{T,G1}$ = T-year flood at the upstream gaged site.
- $Q_{T,G2}$ = T-year flood at the downstream gaged site.
- DA_{G1} = Drainage area at the upstream gaged site.
- DA_{G2} = Drainage area at the downstream gaged site.
- DA_U = Drainage area at the ungaged site.

Upstream Gage
USGS Gage: 06043500
Gage Location: Gallatin River near Gallatin Gateway, MT

Downstream Gage
USGS Gage: 06052500
Gage Location: Gallatin River at Logan

DA_{G1} =	818.70	square miles (mi^2)
DA_{G2} =	1789.09	square miles (mi^2)
DA_U =	1099.80	square miles (mi^2)

Confluence with East Gallatin River

Stream Gage Flow Rates

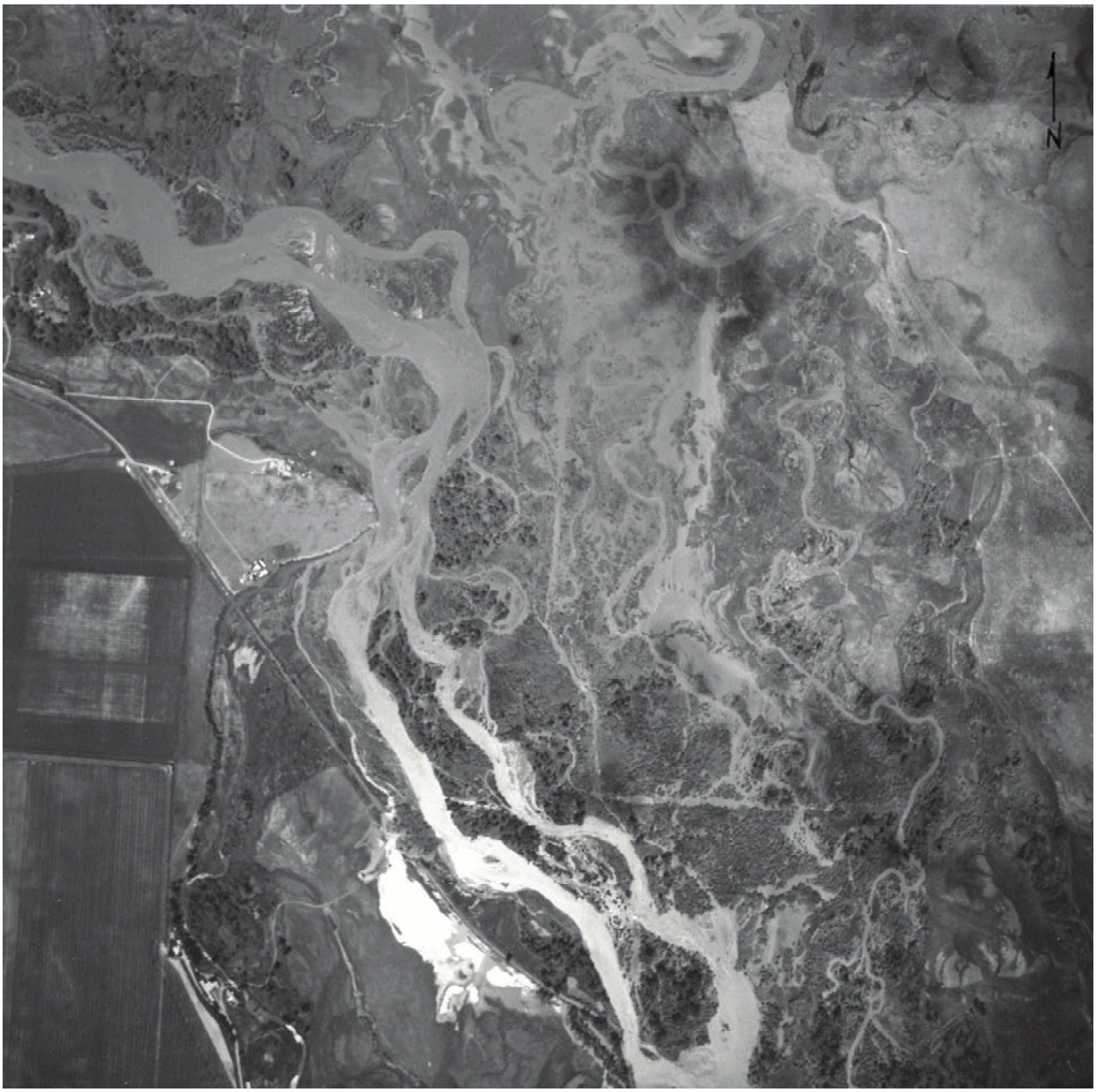
Upstream			*Downstream*			*Ungaged Flow Rates*	
$Q_{2,G1}$ =	5,262	cfs	$Q_{2,G2}$ =	5,027	cfs	Q_2 =	5,172 cfs
$Q_{5,G1}$ =	6,760	cfs	$Q_{5,G2}$ =	6,670	cfs	Q_5 =	6,726 cfs
$Q_{10,G1}$ =	7,662	cfs	$Q_{10,G2}$ =	7,668	cfs	Q_{10} =	7,664 cfs
$Q_{25,G1}$ =	8,719	cfs	$Q_{25,G2}$ =	8,845	cfs	Q_{25} =	8,766 cfs
$Q_{50,G1}$ =	9,456	cfs	$Q_{50,G2}$ =	9,667	cfs	Q_{50} =	9,535 cfs
$Q_{100,G1}$ =	10,160	cfs	$Q_{100,G2}$ =	10,450	cfs	Q_{100} =	10,269 cfs
$Q_{100+,G1}$ =	10,780	cfs	$Q_{100+,G2}$ =	11,200	cfs	Q_{100+} =	10,937 cfs
$Q_{200,G1}$ =	10,830	cfs	$Q_{200,G2}$ =	11,200	cfs	Q_{200} =	10,968 cfs
$Q_{500,G1}$ =	11,680	cfs	$Q_{500,G2}$ =	12,160	cfs	Q_{500} =	11,859 cfs

Appendix C – Photographs and Press Information

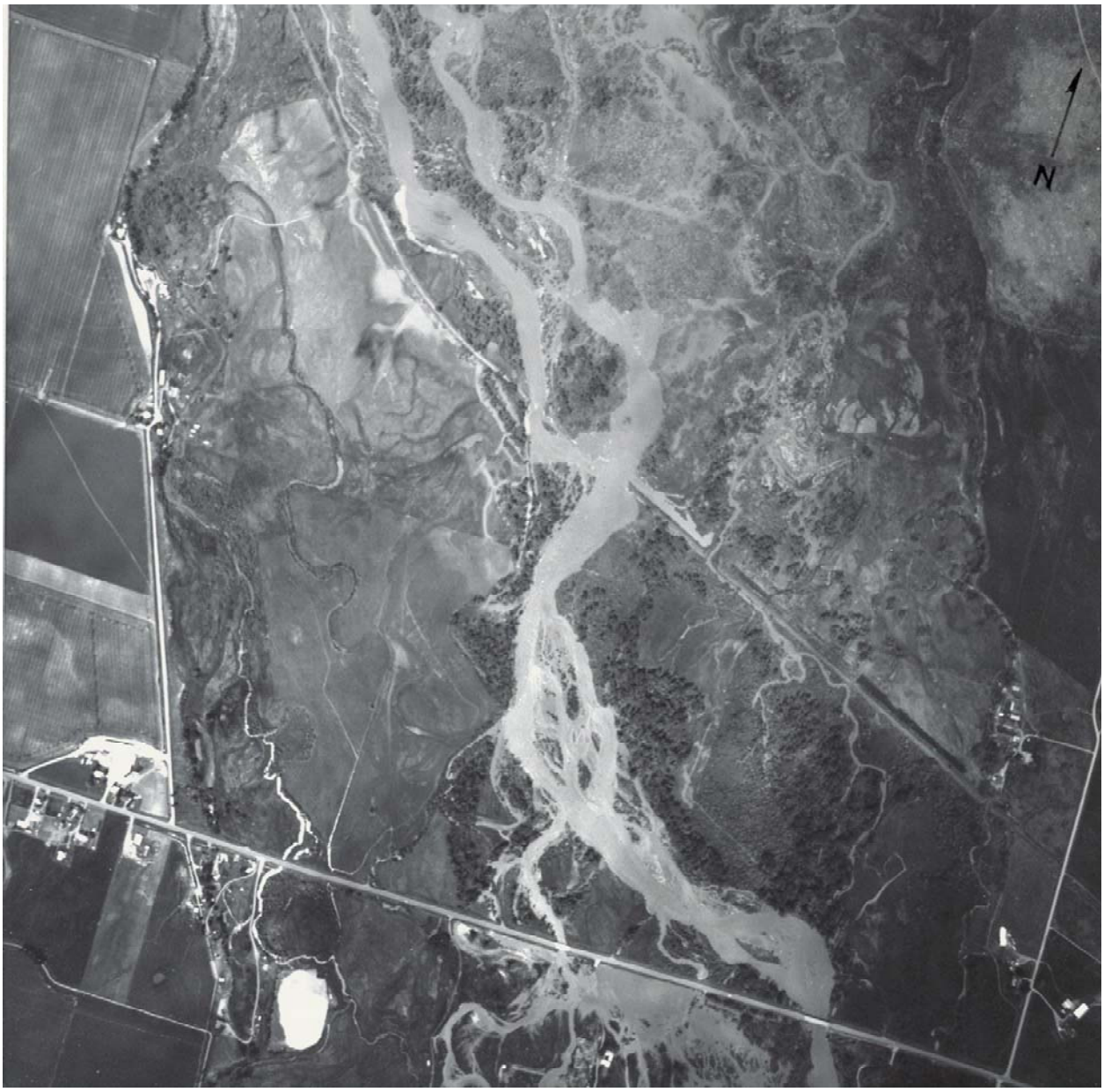
1997 Flood Event (aerial photos of West Gallatin River from confluence with East Gallatin River to south of Gallatin Gateway, Piedmont Air Services, June 5, 1997. Discharge on Gallatin Gateway gage approximately 8,500 cfs)

1 – Confluence of East Gallatin and West Gallatin Rivers

2 – At and immediately upstream of the confluence of East Gallatin and West Gallatin Rivers



3 – Upstream of confluence of East Gallatin and West Gallatin Rivers, downstream of Dry Creek Road



4 – Downstream of Dry Creek Road

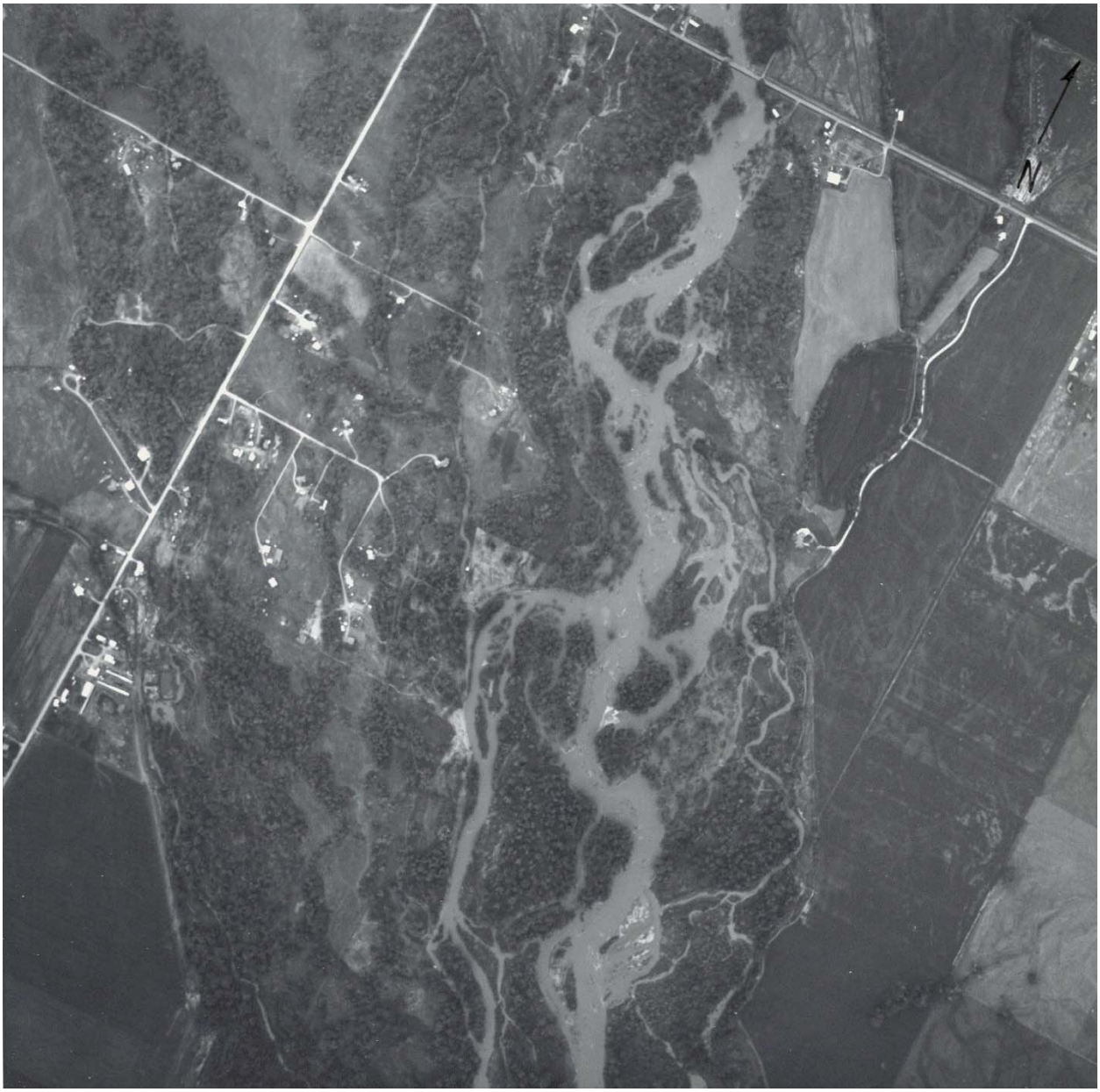
5 – Upstream of Dry Creek Road, downstream of Interstate 90

6 – Immediately downstream of Interstate 90

7 – Immediately upstream of Interstate 90

8 – Upstream of Interstate 90 near Belgrade

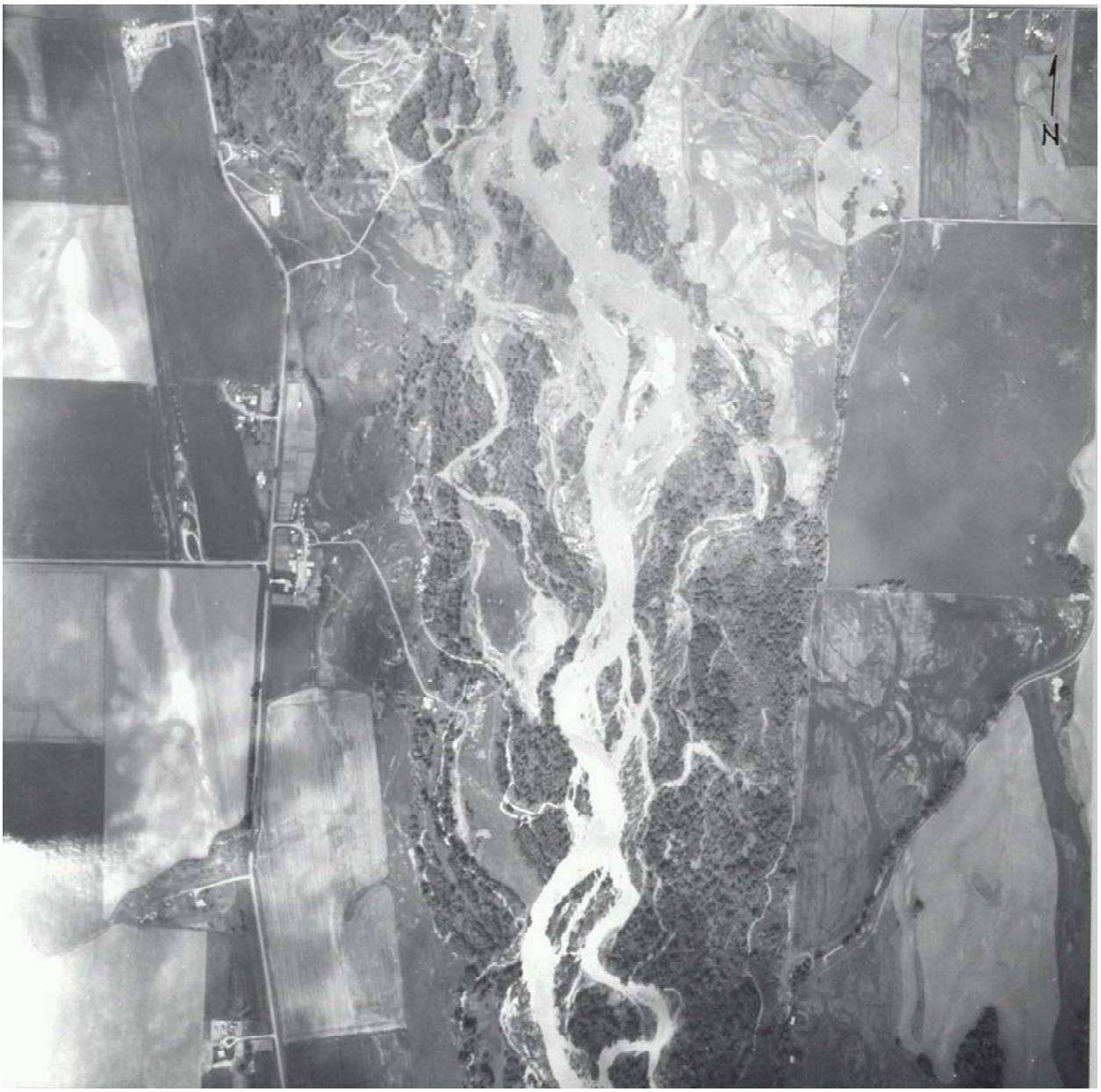
9 – Downstream of Amsterdam Road bridge, near Belgrade



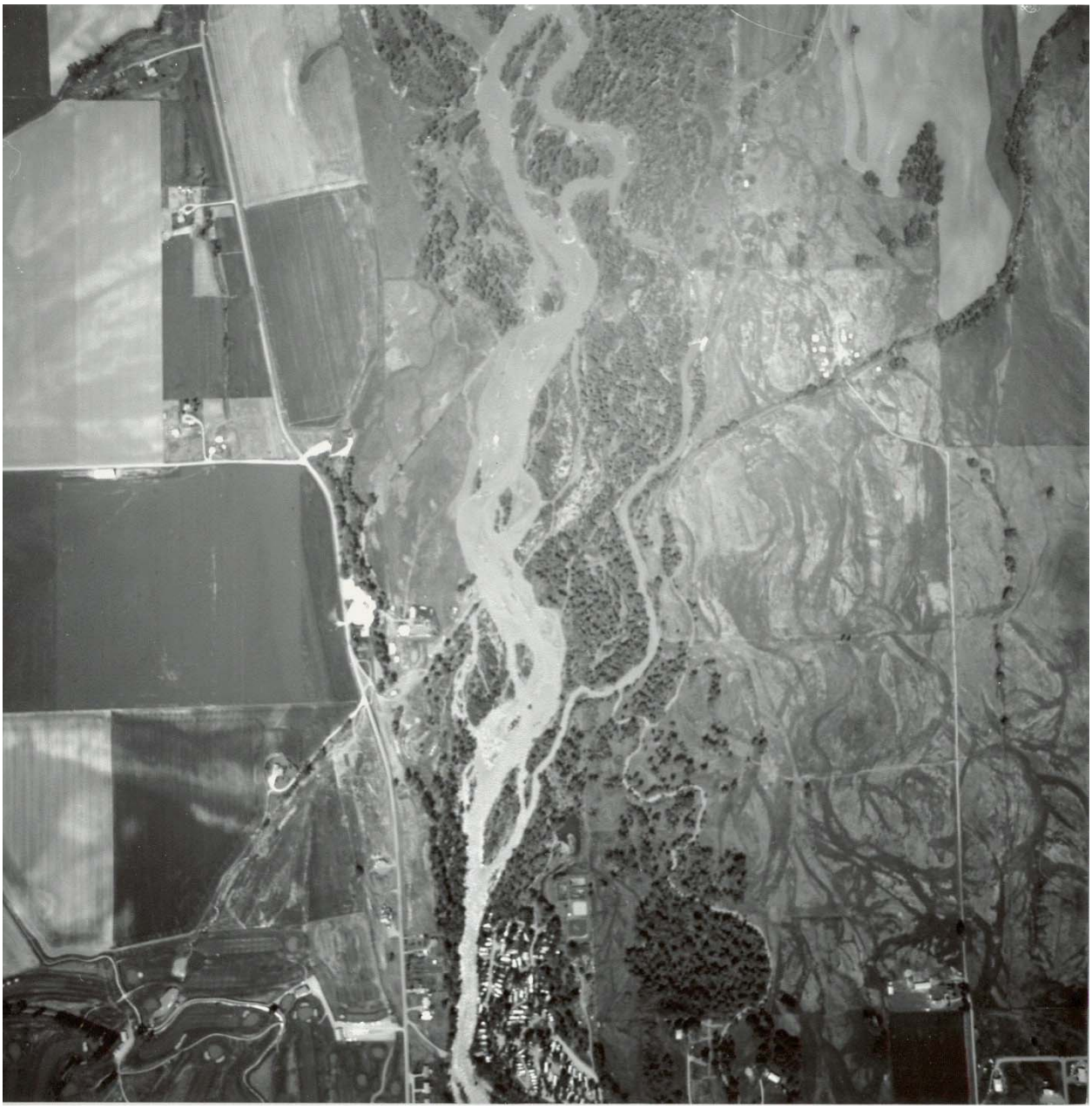
10 – Upstream of X bridge, near Belgrade

11 – At Cameron Bridge

12 – Upstream of Cameron Bridge



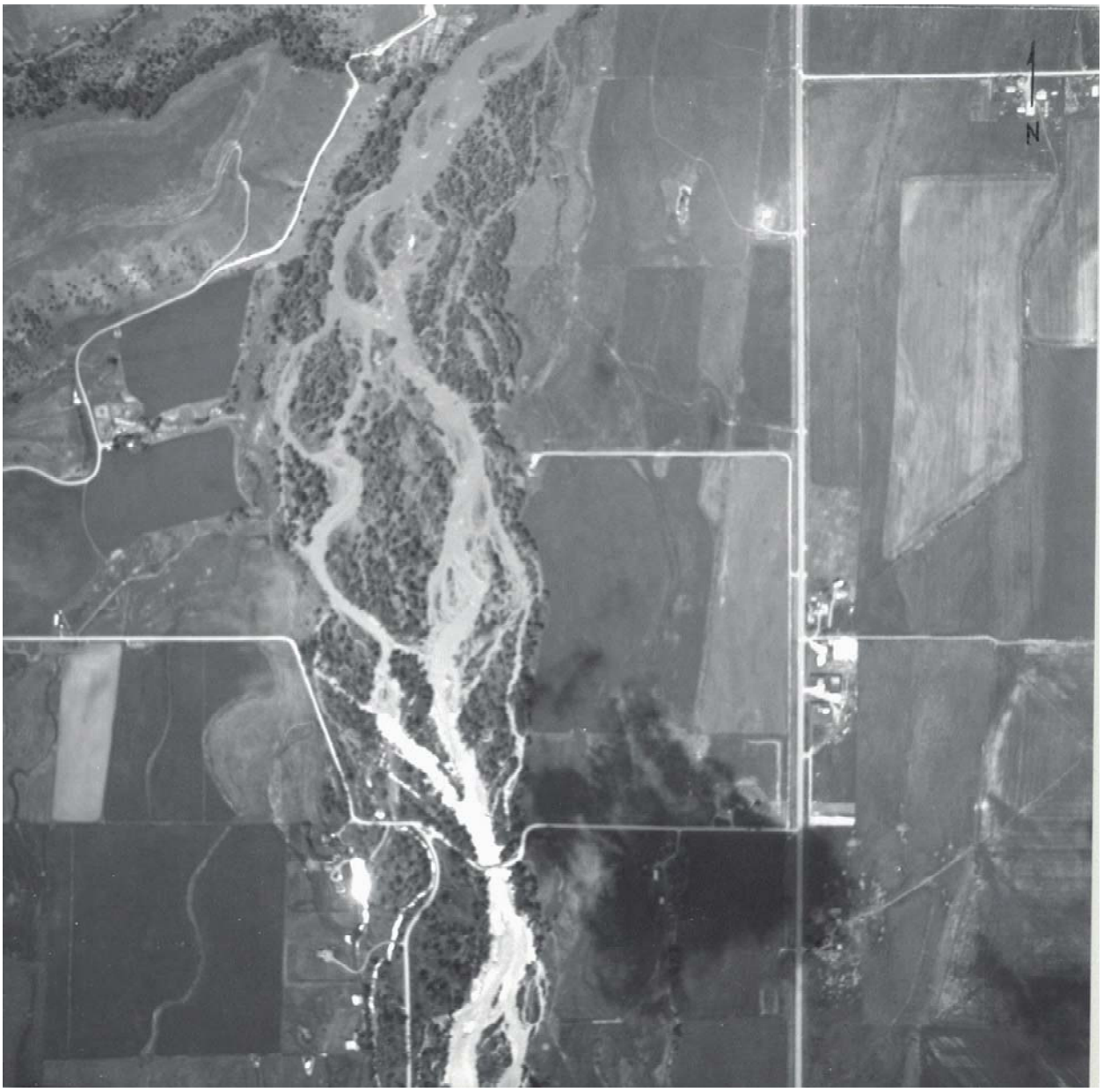
13 – Upstream of Sheds Bridge



14 – Upstream of Sheds Bridge

15 – At Sheds Bridge near Four Corners

16 – Upstream of Four Corners



17 – At Axtell Anceney Road Bridge, upstream of Four Corners

18 – Upstream of Four Corners

19 – Near Gallatin Gateway

20 – Bridge at Cottontail Road near Gallatin Gateway

21 – Above Gallatin Gateway

22 – Above Gallatin Gateway

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FLOOD WATCH: High water expected this week

Jefferson, Gallatin to overflow this week

Andy Malby

The Gallatin River, having receded in the past week, was above flood stage again Tuesday morning, June 7, flooding lowland areas near Logan. The river is expected to crest nearly two feet above flood stage by mid-week, according to the National Weather Service. For a chronicle of this site, see photos named Spring Runoff 8, 21, 22, 23, 24, 53, 54.

Posted: Tuesday, June 7, 2011 7:00 am |
Updated: 1:36 pm, Tue Jun 7, 2011.

By Andy Malby, editor | 0 comments

The Jefferson River is expected to crest more than a foot above flood stage near Three Forks Thursday, causing "major" flooding in the area, the National Weather Service said Monday. Flooding also is expected in places along the Gallatin River between Gallatin Gateway and Logan this week.

The forecast calls for the Jefferson River to reach 9.4 feet by 6 p.m. Thursday. Flood stage is 8 feet and "major flood stage" is 9 feet, according to the Weather Service. The record flood stage, reached in 1997, was 9.9 feet.

The forecast for the Jefferson was substantially revised from Sunday's predictions, which called for the river to crest at 10.5 feet. Weather Service hydrologist Gina Loss said forecasts are frequently revised based on rainfall and snow melt patterns.

At 8.5 feet, the river will begin washing over some county roads and bridges in the area, and may affect "several homes," according to the National Weather Service.

[[KEEP AN EYE ON CURRENT JEFFERSON RIVER LEVELS HERE]]

At Logan, the Gallatin River is expected to crest more than two feet above flood stage late Wednesday or early Thursday, causing moderate flooding. Major flood stage at Logan is 11 feet, and the river is expected to crest at 10 feet, 3 inches.

[[KEEP AN EYE ON CURRENT GALLATIN RIVER LEVELS HERE]]

Storms this week are expected to add some water to area rivers and reservoirs, and southwest Montana could receive up to 2 inches of rain over the next few days, she said. But cooler temperatures are expected to slow snow melt at the same time.

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Nevertheless, nearly all of southwest Montana remained under a flood watch Monday, Loss said.

Snowpack is slowly melting and rivers and streams are “just now coming up,” she said. “Response has been slower than we expected.”

Loss said most of Montana remains flood prone, though.

“We still have a lot of water and we definitely aren’t done with our spring flood event yet,” she said. “We do have virtually the entire state under some type of flood watch or warning at this point in time. A lot (is) going on with the water.”

Also, she said, a “long stream of really warm days” is forecast to start later this week, and with snow water content at 200 percent of average in nearly every river basin in Montana, the threat of flooding will continue over the next several weeks.

“We haven’t lost as much snow as we should have for this time of year,” she said. “Some mountains are starting to lose some snow, but we have a long way to go.”

The SNO-TEL site at Darkhorse Lake near Wisdom, for example, is showing some 47 inches of snow water, where 25 inches is normal for this time of year, Loss said.

The Jefferson at Three Forks, which should start its climb toward flood stage Tuesday, is “one of the sites we’re watching fairly closely,” Loss said.

Three Forks Mayor Gene Townsend said in May that the city has pinpointed several sites where flooding from the Jefferson could enter town, and is prepared to sandbag as necessary.

“We will react if we have to,” he said.

View our Spring Flooding Gallery frequently, as new photos are added throughout the runoff season.

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Posted in News on *Tuesday, June 7, 2011 7:00 am. Updated: 1:36 pm.*

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June 24, 2011 flooding in the Gallatin Gateway area.

A truck and trailer move south over a flooded Heeb Road Monday morning, June 13, 2011 east of Manhattan. Baker Ditch, which flows from the Gallatin River about a mile to the east, was flooding along Interstate 90 in the area.

Ice jams cause Gallatin River to jump its banks

Posted: Thursday, December 31, 2009 12:00 am

By Andy Malby, editor | 0 comments

Ice jams sent the Gallatin River over its banks Wednesday near Amsterdam Road west of Belgrade, flooding pastures and threatening a handful of homes.

The National Weather Service late Tuesday issued a flood warning for the Logan area, where the Gallatin River rose to 8.38 feet by Wednesday afternoon (flood stage is 8 feet).

The ice jams occurred all along the Gallatin, "most notably in the Big Sky area," county emergency manager Patrick Lonergan said.

"It is expected that these ice jams will remain for the near future," he said.

In the Amsterdam Road area Wednesday afternoon, sheriff deputies were busy warning residents about the rising water, and some home owners tried to stem the flow with straw bales. Property owners are advised to keep a close eye on conditions and prepare their homes for flooding, Lonergan said.

Ice dams on the river caused waters to back up in many areas along the stretch from Big Sky to Trident, and some areas had begun to see flooding, including low-lying areas near

For updates on this story throughout the weekend, please keep an eye on our Web site at belgrade-news.com.

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Ice dam flooding on West Gallatin River, winter 2009/2010 (Michael Tucker)